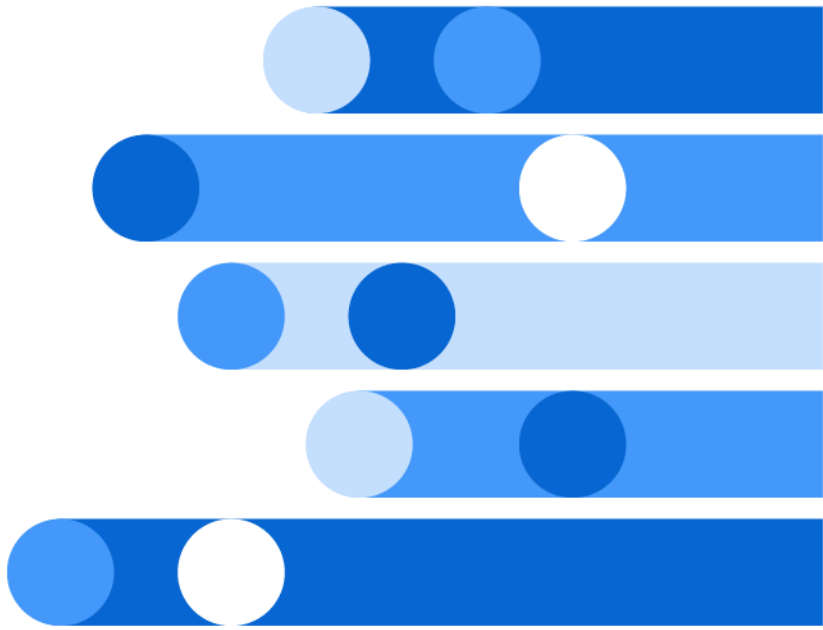
SAS/GRAPH® and Base SAS®: Mapping Reference

2024.03 - 2026.06*



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SAS/GRAPH® and Base SAS®: Mapping Reference

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About This Book

Using This Document

Prerequisites

This document describes how to produce geographical maps by using the SAS mapping procedures and their features. This document is intended for users who are experienced in using SAS. To get the most from this documentation, you should be familiar with the following tasks:

- invoking SAS at your site
- entering, editing, and submitting SAS program code
- using Base SAS procedures to create and manipulate data
- use ODS Graphics or SAS/GRAPH to visualize data
- using DATA steps to create and manipulate SAS data sets
- using the Base SAS Output Delivery System (ODS) to control program output
- assigning librefs using LIBNAME statements
- assigning filerefs using FILENAME statements

Refer to the SAS documentation for information about how to perform these tasks.

Map Data Sets

To draw maps, you need to know how to access the map data sets that are stored on your system. Map data set libraries, and access to them, are provided with Base SAS or SAS/GRAPH, if these options were chosen during installation. Depending on your SAS/GRAPH installation configuration, the map data set supplied by SAS might automatically be assigned a libref, such as MAPSGFK, MAPSSAS, or MAPS. By default, the MAPS libref is set equal to the MAPSSAS libref, sharing the same physical name (path). The configuration file at installation time sets the

MAPSGFK= option value to a physical name (path). The physical name (path) of MAPSGFK= and MAPSSAS= should not be reassigned. However, to continue using your existing programs that use other maps and in addition begin to use the MAPSGFK digital vector maps, you can use the INSERT= system option to add a path to your other maps as an additional, first value in the MAPSGFK= system option. The MAPSGFK map library contains vector-based map data sets that SAS has licensed from GfK GeoMarketing GmbH. SAS updates this map library as it receives updates from GfK, and provides the library for use with SAS/GRAPH. Typically, a SAS program specifying these librefs runs without the need to know where the map data sets reside. If necessary, ask your on-site SAS support personnel or system administrator where the map data sets are stored for your site.

If your site has SAS/GRAPH installed, you have access to the map data sets in the MAPSGFK, MAPSSAS, and MAPS libraries. Map data sets can be installed during installation or downloaded separately from https://support.sas.com/en/knowledge-base/maps-geocoding.html.

The MAPIMPORT procedure enables the import of map shapefiles from third-party sources without having SAS/GRAPH installed.

The GPROJECT procedure processes map data sets by converting spherical coordinates (longitude and latitude) into Cartesian coordinates. These coordinates can then be used by mapping procedures such as GMAP in SAS/GRAPH or SGMAP in Base SAS.

The Base SAS SGMAP procedure can plot data on maps provided with the MAPSGFK, MAPSSAS, and MAPS libraries. The procedure can also plot data on maps that you have imported with the MAPIMPORT procedure. The SGMAP procedure can also plot data on tile-based maps from OpenStreetMaps and EsriMaps with multiple plot overlays. See “Map Data Sets, Map Preparation Procedures, and Tools Provided by SAS” on page 8 for more information.

The GEOCODE procedure prepares data for geographical mapping. Geocoding is the process of estimating latitude and longitude coordinates for an address. After geocoding, the coordinates can be used to display a point on a map or to calculate distances. The GEOCODE procedure requires both input address data sets and lookup data sets. With your SAS profile, you can download lookup data sets from the SAS Maps and Geocoding website. An example is the free lookup data for the entire United States. Lookup data sets are also available for download or purchase from third-party sources. The Maps and Geocoding website also provides SAS macro code programs used to import some third-party data.

Note: For street lookup data, make sure that you download the version of %TIGER2GEOCODE that corresponds to your current version of SAS.

About Examples and Their Output

Most of the chapters in this document include examples that illustrate some of the features of a procedure or its statements. The examples in the procedures chapters provide all of the code that you need to generate the maps that are shown in the figures. You can copy and paste the example code into your code editor and generate the maps yourself. In most cases, the examples in this document use the Illuminate ODS style. Exceptions are noted in the text. When you run the examples in SAS Data and AI Studio (known as SAS Studio prior to 2026.06), the output might be different in appearance from what is shown. Refer to the SAS Data and AI Studio documentation for information about your program output.

When MAPSGFK maps are used to render a map, the graph size and resolution are reduced to fit the graphics output area. All other maps are rendered as is.

Because of size limitations, the graphs in this document are not always shown in their default size. They might be scaled down to meet the size requirements of our documentation production system. When graphs that are produced with ODS Graphics are reduced in size, several automatic processes take place to optimize the appearance of the output. Among the differences between default size graphs and smaller graphs are that the smaller graphs have scaled down font sizes. Thus, the graphs that you generate from the example programs are not always identical to the graphs that are shown in the figures. However, both graphs accurately represent the data.

Most of the examples that use the GOPTIONS statement specify these options:

RESET=ALL
: sets all graphics options to default values and cancels all global statements.

BORDER
: draws a border around the graphics output area.

When you produce your own graphical output, you can change the graph size and attributes, if needed. The GOPTIONS HSIZE= and VSIZE= settings, and the ODS GRAPHICS WIDTH= and HEIGHT= settings, are not shown in the example code and are not necessary for generating the output. However, you might want to use similar settings if your output looks significantly different from the output that is shown in the document.

Many examples process sample data contained in SAS data sets that are stored in the SASHELP library. The documentation for each example provides the data set name used. To see a brief description of any SAS data set in the SASHELP library, as well as output that displays the first five observations in each data set, refer to SASHELP Data Sets.

Some procedures documented in this book provide examples that include network requests. Note that these procedures do not authenticate any services that you specify, such as the map services and portal hosted by Esri. Check your proxy

settings by entering the map service URL with either a `curl` or a `wget` command from a command-line interface.. You can also check with your system administrator regarding the authentication setup for any Linux network proxy machine request that you might need to make.

Syntax Conventions for the SAS Language

Overview of Syntax Conventions for the SAS Language

SAS uses standard conventions in the documentation of syntax for SAS language elements. These conventions enable you to easily identify the components of SAS syntax. The conventions can be divided into these parts:

- syntax components
- style conventions
- special characters
- references to SAS libraries and external files

Syntax Components

The components of the syntax for most language elements include a keyword and arguments. For some language elements, only a keyword is necessary. For other language elements, the keyword is followed by an equal sign (=). The syntax for arguments has multiple forms in order to demonstrate the syntax of multiple arguments, with and without punctuation.

keyword
specifies the name of the SAS language element that you use when you write your program. Keyword is a literal that is usually the first word in the syntax. In a CALL routine, the first two words are keywords.

In these examples of SAS syntax, the keywords are bold:

CHAR (*string, position*)

CALL RANBIN (*seed, n, p, x*);

ALTER (*alter-password*)

BEST *w*.

REMOVE <*data-set-name*>

In this example, the first two words of the CALL routine are the keywords:

CALL RANBIN(*seed*, *n*, *p*, *x*)

The syntax of some SAS statements consists of a single keyword without arguments:

DO;
... *SAS code* ...
END;

Some system options require that one of two keyword values be specified:

DUPLEX | **NODUPLEX**

Some procedure statements have multiple keywords throughout the statement syntax:

CREATE <UNIQUE> **INDEX** *index-name* **ON** *table-name* (*column-1* <, *column-2*, ...>)

argument
specifies a numeric or character constant, variable, or expression. Arguments follow the keyword or an equal sign after the keyword. The arguments are used by SAS to process the language element. Arguments can be required or optional. In the syntax, optional arguments are enclosed in angle brackets (< >).

In this example, *string* and *position* follow the keyword CHAR. These arguments are required arguments for the CHAR function:

CHAR (*string, position*)

Each argument has a value. In this example of SAS code, the argument *string* has a value of 'summer', and the argument *position* has a value of 4:

```
x=char('summer', 4);
```

In this example, *string* and *substring* are required arguments, whereas *modifiers* and *startpos* are optional.

FIND(*string, substring* <, *modifiers*> <, *startpos*>

argument(s)
specifies that one argument is required and that multiple arguments are allowed. Separate arguments with a space. Punctuation, such as a comma (,) is not required between arguments.

The MISSING statement is an example of this form of multiple arguments:

MISSING *character(s)*;

<LITERAL_ARGUMENT> *argument-1* <<LITERAL_ARGUMENT> *argument-2* ... >
specifies that one argument is required and that a literal argument can be associated with the argument. You can specify multiple literals and argument

pairs. No punctuation is required between the literal and argument pairs. The ellipsis (...) indicates that additional literals and arguments are allowed.

The BY statement is an example of this argument:

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...>;

argument-1 <*options*> <*argument-2* <*options*> ...>
specifies that one argument is required and that one or more options can be associated with the argument. You can specify multiple arguments and associated options. No punctuation is required between the argument and the option. The ellipsis (...) indicates that additional arguments with an associated option are allowed.

The FORMAT procedure PICTURE statement is an example of this form of multiple arguments:

PICTURE name <(*format-options*)>
<*value-range-set-1* <(*picture-1-options*)>
<*value-range-set-2* <(*picture-2-options*)> ...>>;

argument-1=value-1 <*argument-2=value-2* ...>
specifies that the argument must be assigned a value and that you can specify multiple arguments. The ellipsis (...) indicates that additional arguments are allowed. No punctuation is required between arguments.

The LABEL statement is an example of this form of multiple arguments:

LABEL *variable-1=label-1* <*variable-2=label-2* ...>;

argument-1 <, *argument-2*, ...>
specifies that one argument is required and that you can specify multiple arguments that are separated by a comma or other punctuation. The ellipsis (...) indicates a continuation of the arguments, separated by a comma. Both forms are used in the SAS documentation.

Here are examples of this form of multiple arguments:

AUTHPROVIDERDOMAIN (*provider-1:domain-1* <, *provider-2:domain-2*, ...>

INTO :*macro-variable-specification-1* <, :*macro-variable-specification-2*, ...>

Note: In most cases, example code in SAS documentation is written in lowercase with a monospace font. You can use uppercase, lowercase, or mixed case in the code that you write.

Style Conventions

The style conventions that are used in documenting SAS syntax include uppercase bold, uppercase, and italic:

UPPERCASE BOLD
identifies SAS keywords such as the names of functions or statements. In this example, the keyword ERROR is written in uppercase bold:

ERROR <*message*>;

UPPERCASE
identifies arguments that are literals.

In this example of the CMPMODEL= system option, the literals include BOTH, CATALOG, and XML:

CMPMODEL=BOTH | CATALOG | XML |

italic
identifies arguments or values that you supply. Items in italic represent user-supplied values that are either one of the following:

- nonliteral arguments. In this example of the LINK statement, the argument *label* is a user-supplied value and therefore appears in italic:

  LINK *label*;

- nonliteral values that are assigned to an argument.

  In this example of the FORMAT statement, the argument DEFAULT is assigned the variable *default-format*:

  FORMAT *variable(s)* <*format* > <DEFAULT = *default-format*>;

Special Characters

The syntax of SAS language elements can contain the following special characters:

=
an equal sign identifies a value for a literal in some language elements such as system options.

In this example of the MAPS system option, the equal sign sets the value of MAPS:

MAPS=*location-of-maps*

< >
angle brackets identify optional arguments. A required argument is not enclosed in angle brackets.

In this example of the CAT function, at least one item is required:

CAT (*item-1* <, *item-2*, ...>)

|
a vertical bar indicates that you can choose one value from a group of values. Values that are separated by the vertical bar are mutually exclusive.

In this example of the CMPMODEL= system option, you can choose only one of the arguments:

CMPMODEL=BOTH | CATALOG | XML

...
an ellipsis indicates that the argument can be repeated. If an argument and the ellipsis are enclosed in angle brackets, then the argument is optional. The repeated argument must contain punctuation if it appears before or after the argument.

In this example of the CAT function, multiple *item* arguments are allowed, and they must be separated by a comma:

CAT (*item-1* <, *item-2*, ...>)

'*value*' or "*value*"
indicates that an argument that is enclosed in single or double quotation marks must have a value that is also enclosed in single or double quotation marks.

In this example of the FOOTNOTE statement, the argument *text* is enclosed in quotation marks:

FOOTNOTE <*n*> <*ods-format-options* '*text*' | "*text*">;

;
a semicolon indicates the end of a statement or CALL routine.

In this example, each statement ends with a semicolon:

```
data namegame;
   length color name $8;
   color = 'black';
   name = 'jack';
   game = trim(color) || name;
run;
```

References to SAS Libraries and External Files

Many SAS statements and other language elements refer to SAS libraries and external files. You can choose whether to make the reference through a logical name (a libref or fileref) or use the physical filename enclosed in quotation marks.

If you use a logical name, you typically have a choice of using a SAS statement (LIBNAME or FILENAME) or the operating environment's control language to make the reference. Several methods of referring to SAS libraries and external files are available, and some of these methods depend on your operating environment.

In the examples that use external files, SAS documentation uses the italicized phrase *file-specification*. In the examples that use SAS libraries, SAS documentation uses the italicized phrase *SAS-library* enclosed in quotation marks:

```
infile file-specification obs = 100;
libname libref 'SAS-library';
```

PART 1

Getting Started

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1

Get Started Mapping Using SAS/GRAPH and Base SAS

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What Is Mapping Software?

Mapping software in Base SAS and in the optional SAS/GRAPH product enables you to create maps. The maps show an area or represent variations of a variable value with respect to an area. You can summarize and analyze data spatially. You

can plot locations and highlight regional differences or extremes. The software shows trends and variations of data between geographic areas. Map data sets and response data sets are used in various mapping procedures.

Base SAS contains the %CENTROID autocall macro and all of the mapping procedures except for the GMAP procedure. The SAS/GRAPH component contains the GMAP procedure. SAS/GRAPH is separately licensed and must be installed before using the GMAP procedure.

The Base SAS mapping software enables you to do the following:

- Create a choropleth map and overlay plots using the SGMAP procedure. This procedure is based on ODS Graphics and uses the functionality of template-based Output Delivery System (ODS).
- Enhance the appearance of your map by selecting ODS Graphics text fonts, colors, patterns, and line styles, and controlling the size and position of many graphics elements.
- Import map data with the MAPIMPORT procedure. In addition, you can create your own map data sets.
- Use the GINSIDE, GPROJECT, GREDUCE, and GREMOVE procedures to prepare data as input to either the Base SAS SGMAP procedure or the SAS/GRAPH GMAP procedure.
- Invoke the %CENTROID autocall macro to retrieve the centroid positions of map data set polygons to aid in the positioning of labels on a map.

  Note: It can also be used in conjunction with the Base SAS GEODIST function that computes distances.

SAS/GRAPH is a device-based data visualization and presentation (graphics) component of SAS. As such, SAS/GRAPH does the following:

- organizes the presentation of your data. The GMAP procedure visually represents the relationship between data values as two- and three-dimensional maps. These include Block, Choropleth, Prism, and Surface maps.
- enhances the appearance of your map by selecting text fonts, colors, patterns, and line styles, and controlling the size and position of many graphics elements.
- generates a variety of graphics output that you can display on your screen or in a web browser, store in catalogs, or review. You can send the graphics output to a hard copy graphics output device such as a printer or plotter.
- provides statements to manage the output.
- includes map data sets to produce geographic maps.
- enables you to annotate maps with text or special elements

Components of Base SAS Mapping Software

Base SAS mapping software consists of procedures that enable the preparation of map data, the importing of map data, and the creation of choropleth maps with plot overlays. The %CENTROID autocall macro retrieves the centroid positions of map data set polygons to aid in the positioning of labels on a map.

Base SAS ODS Graphics SGMAP mapping procedure
: Enables you to create a choropleth map, and overlay it with text, scatter, or bubble plots.

  Enhances choropleth map rendering. The SGMAP procedure adds the SERIES plot statement and the GRADLEGEND statement. Automatic legends are now generated, and an option that disables them is provided. Continuous or discrete legends are now possible. You can also customize and group legends, as well as customize polygon borders and series plot lines.

Procedures that prepare data for mapping
: The MAPIMPORT procedure produces a map output data set, which can be used with the ODS Graphics SGMAP procedure or other mapping procedures in Base SAS. The output map data set can also be used with the SAS/GRAPH GMAP procedure.

  The GEOCODE procedure enables you to add geographic coordinates (latitude and longitude values) to an address. The procedure provides a way to convert address data into map locations.

  The GINSIDE, GPROJECT, GREDUCE, and GREMOVE procedures prepare data as input to either the Base SAS SGMAP procedure or the SAS/GRAPH GMAP procedure. To use the GMAP procedure that you must have SAS/GRAPH installed. See Chapter 11, “GEOCODE Procedure,” on page 183, Chapter 12, “GINSIDE Procedure,” on page 285, Chapter 14, “GPROJECT Procedure,” on page 525, Chapter 15, “GREDUCE Procedure,” on page 581, Chapter 16, “GREMOVE Procedure,” on page 597, and Chapter 17, “MAPIMPORT Procedure,” on page 627 for detailed procedure information.

%CENTROID autocall macro
: The %CENTROID autocall macro supports the SGMAP procedure. Running the %ANNOMAC macro before using %CENTROID is not necessary.

Map data
: The SGMAP procedure can plot coordinate data onto an OpenStreetMap or an EsriMap tile-based map. You can provide the data that contains latitude and longitude coordinates. Coordinate data can also be sourced from the GEOCODE or other mapping preparation procedures, or the %CENTROID macro. The SGMAP procedure can also create choropleth maps using the map data sets

supplied in the MAPSGFK, MAPSSAS, or MAPS library. It can also use data sets that are imported using the MAPIMPORT procedure.

The MAPIMPORT procedure imports Esri shapefiles.

Components of SAS/GRAPH Mapping Software

There are several components to SAS/GRAPH software, but the following relate to creating maps.

SAS/GRAPH mapping procedure
: enables you to create a variety of maps. The SAS/GRAPH GMAP procedure uses device drivers to generate visual output. SAS/GRAPH device drivers enable you to send output directly to your output device. Device drivers enable you to create output in a variety of formats such as PNG files and SVG. This document, *SAS/GRAPH and Base SAS: Mapping Reference*, describes both the SAS/GRAPH GMAP procedure and the Base SAS mapping procedures that include GINSIDE, GPROJECT, GREDUCE, GREMOVE, GEOCODE, and MAPIMPORT. The *SAS/GRAPH: Reference* describes how to use devices.

The Annotate Facility
: enables you to generate a special data set of graphics commands from which you can produce graphics output. This data set is referred to as an Annotate data set. You can use it to generate custom graphics or to enhance graphics output from many device-based SAS/GRAPH procedures, including the GMAP mapping procedure. "Overview: The Annotate Facility" in *SAS/GRAPH: Reference* describes this facility.

Map Data Sets
: A wide assortment of map data sets is available with a SAS/GRAPH licensed installation. You can also download map data sets from third-party vendors using the MAPIMPORT procedure. Use those data sets to create maps with SAS programs.

Maps You Can Create Using Mapping Software

Maps You Can Create Using Base SAS ODS Graphics

The ODS Graphics SGMAP procedure in Base SAS enables you to create a two-dimensional choropleth map, an OpenStreetMap, or an EsriMap that can be overlaid with bubble, scatter, series, or text plots.

See Also

Chapter 18, “SGMAP Procedure,” on page 637, for more information and procedure syntax.

Maps You Can Create Using SAS/GRAPH

The SAS/GRAPH GMAP procedure enables you to create two- and three-dimensional maps.

Block Maps
: Block maps are three-dimensional maps that represent data values as blocks of varying height rising from the middle of the map areas.

Choropleth Maps
: Choropleth maps are two-dimensional maps that display data values by filling map areas with combinations of patterns and color that represent the data values.

Prism Maps
: Prism maps are three-dimensional maps that display data by raising the map areas and filing them with combinations of patterns and colors.

Surface Maps
: Surface maps are three-dimensional maps that represent data values as spikes of varying heights.

Annotated Maps
: Annotated maps are map output from the GMAP procedure that are enhanced using the Annotate data set. Use the SAS/GRAPH Annotate Facility to generate this special data set of graphics commands.

See Also

Chapter 13, "GMAP Procedure," on page 303, for more information and procedure syntax.

What You Need to Know to Get Started

Putting It All Together

Creating maps requires map data sets, map data preparation and mapping procedures, tools, and SAS programs. Used in various combinations, and in conjunction with provided options as needed, you can control the appearance of your maps.

Map Data Sets, Map Preparation Procedures, and Tools Provided by SAS

A map data set is a data set that contains variables whose values are coordinates. These coordinates define the boundaries of map areas such as a state or country. There are several sources for map data sets. SAS provides many map data sets with SAS/GRAPH. The MAPS, MAPSSAS, and MAPSGFK map data set libraries might be provided with your IDE. You can also specify a map data set that you create, or import map data sets from a third-party source. Map data sets supplied by SAS contain all the variables expected by the map data preparation and mapping procedures.

What Is Included in Base SAS

The GEOCODE procedure
: The Chapter 11, "GEOCODE Procedure" uses U.S. Census Bureau TIGER/Line data for various U.S. localities. The nationwide U.S. lookup data available on the SAS Maps and Geocoding — Street Geocoding website is updated annually when the U.S. Census Bureau releases new TIGER/Line shapefiles. Lookup data

for previous TIGER releases are also updated when the %TIGER2GEOCODE macro program is modified. To support U.S. and Canadian street geocoding, state and direction data sets are available, as well as Canadian street type and direction data sets. An example is the SASHELP.GCTYPE data set.

The MAPIMPORT procedure
: The Chapter 17, "MAPIMPORT Procedure" imports Esri shapefiles. The imported map data set contains polygonal area coordinates that can be rendered as a map using either the SAS/GRAPH GMAP procedure or the Base SAS ODS Graphics SGMAP procedure.

Macro Tools
: SAS provides different versions of macro code programs to import some third-party data used by the GEOCODE procedure, including the %CENTROID macro. See "About the Macros" on page 175 for a description of these macros, how to access them, and how to use them.

What Is Included in SAS/GRAPH

SAS/GRAPH software includes a number of predefined map data sets. There are two types of data sets that are provided with SAS/GRAPH for mapping.

- GfK GeoMarketing digital, vector-based map data sets are available for use in addition to the traditional map data sets. The coordinate points contained in these map data sets describe geographical areas as polygons. All of the content in the traditional map data sets is represented in the GfK map data, and GfK also provides additional data. SAS licensed the map data from GfK GeoMarketing GmbH, and then converted the data into a SAS map data set format. The GfK map data sets are uniform and accurate for the whole world, and are intended to eventually replace the traditional map data sets. They reside in the MAPSGFK library.

  All except the MAPSGFK.US data set and most of the traditional map data sets that are provided with SAS/GRAPH software contain four coordinate variables (X, Y, LONG, and LAT). When all four coordinate variables are present, X and Y are always projected values. These are used by default by the SAS/GRAPH GMAP procedure and the SAS mapping procedures excepting the SGMAP procedure. The SAS SGMAP procedure and its CHOROMAP statement use latitude and longitude variables first, if they are found amongst the coordinate variables present. However, depending on the procedure you have run, you might want to use the LONG and LAT variables with the GPROJECT procedure to project the map again using a different projection type.

- The MAPSSAS and MAPS data set libraries are provided when SAS/GRAPH is installed. These contain the traditional SAS map data sets. By default, the MAPS library reference name (libref) is set equal to the MAPSSAS libref, sharing the same physical name (path).

  Note: The traditional data sets are described in "The METAMAPS Data Set" on page 324. This description excludes the MAPSGFK map library.

Note: You must have a license to install the SAS/GRAPH component, and then you have access to the map data sets found in the MAPSGFK library. Base SAS gives you access to the MAPS and MAPSSAS libraries.

Map data sets that are not available with your production release of Base SAS or SAS/GRAPH are also made available for downloading from the SAS Maps and Geocoding website. You are required to access the website with your SAS profile. You might be required to enter your site information. Your SAS/GRAPH license is required to download the MAPSGFK map data set library.

TIP After downloading and unzipping map data sets, you must take them out of transport format by running the CIMPORT procedure using your current version of SAS. For more information, see "CIMPORT Procedure" in *Base SAS Procedures Guide*.

You can also download sample SAS/GRAPH programs that use the production-level map data sets delivered with SAS/GRAPH and GIF images of maps.

The Annotate facility enables you to generate a special data set of graphics commands from which you can produce graphics output. This data set is referred to as an *Annotate data set*. You can enhance your graphics output by applying an Annotate data set to graphics that you generated using the Chapter 13, "GMAP Procedure," on page 303. Annotate data sets can be specified in the GMAP procedure to enhance any maps that are produced by PROC GMAP. You can use an annotate data set to add custom layers to a map. The data set might contain items such as labels, roads, rivers, or polygon borders.

Created Map Data Sets

It is possible to create a map data set within your SAS code with the Base SAS DATA step. See "Example 2: Creating a Map of Nevada Counties with a Bubble Plot of County Seats and Populations" on page 742, that shows how to create population response data for a state map with city bubble markers.

You can customize the area that is displayed on your map by using only part of a particular map data set. There are several ways to accomplish this. You can use WHERE processing in a DATA step to subset the map data to be used by the Base SAS SGMAP procedure or the SAS/GRAPH GMAP procedure. You can also use the GPROJECT procedure with the map data set to create a rectangular subset of a map data set. Do this by using the minimum and maximum longitude and latitude values in the map data set. See Chapter 14, "GPROJECT Procedure," on page 525 for usage details.

Third-Party Sources of Map Data Sets

Map data sets that are not provided by SAS must contain latitude and longitude boundary point coordinate variables as well as one or more map area identification

variables. The SAS/GRAPH GMAP procedure requires X and Y variables. The Base SAS SGMAP procedure processes coordinate variables in the form of LATITUDE and LONGITUDE first, then LAT and LONG or LON, and if not found, then X and Y. If the variables required by a procedure are missing, the procedure stops and displays an error message to the SAS log.

The ODS Graphics SGMAP procedure in Base SAS can use OpenStreetMaps. Specify the **OPENSTREETMAP; statement** in your SAS code.

The ODS Graphics SGMAP procedure in Base SAS can use Esri maps. Specify in your SAS code the URL for the Esri map service that contains the map that you require.

The MAPIMPORT procedure is available with Base SAS. You can import Esri shapefiles as map data sets by using the MAPIMPORT procedure. Depending on the type of coordinates that are in your shapefile, you might want to perform additional processing. For example, you might want to project the map with the GPROJECT procedure. Or you might want to use the GREDUCE procedure to create a DENSITY variable for reducing your data. The GPROJECT, GINSIDE, GREDUCE, and GREMOVE procedures are provided with Base SAS and a SAS/GRAPH license is no longer required to use them.

Note: SAS/GRAPH is required to be installed to use its GMAP procedure.

Note: Additional processing of large map data sets created with the MAPIMPORT procedure is recommended before using them in the SGMAP procedure. See "Optimizing Performance" on page 639 for detailed information.

For more information, see Chapter 17, "MAPIMPORT Procedure," on page 627, Chapter 14, "GPROJECT Procedure," on page 525, and Chapter 15, "GREDUCE Procedure," on page 581.

Geocoding lookup data sets might need to be downloaded or purchased.

Details about Map Data Sets

Before using any map data set, you should understand the variables and data that it contains. The MAPSGFK library is the most up-to-date library of map data sets that SAS provides with a SAS/GRAPH installation. Here is some key information about the MAPSGFK library contents:

- The X and Y variable values in the GfK map data sets are always projected.
- The LAT and LONG variable values in the GfK map data sets are always unprojected eastlong degrees (not radians).
- The identification variables (for example, ID and ID1) are character instead of numeric in the GfK map data sets.
- GfK map data set variable values that contain special characters are provided in UTF-8 Unicode encoding. For example, the IDNameU variable name in the

AFGHANISTAN_ATTR map data set signifies a variable that is converted to Unicode. The 'U' in the name indicates Unicode.

- GfK map data contained in the map data sets are projected using appropriate projection methods for the area of the world in which the map is located. For example, the data set MAPSGFK.MEXICO represents a relatively small map area that is near neither pole. These factors make it possible to project data without distortion using the Albers method. The **LABEL** column for the X and Y variables in each data set should identify the projection algorithm used.
- DENSITY and RESOLUTION variables are input variables that can help you manage the size of your output map. Using these variables improves performance, which shortens the time it takes to create a map, and controls the number of observation points, which avoids the cluttered look around map edges.

  The DENSITY variable can pre-exist or be added by running the GREDUCE procedure. The DENSITY variable values represent all the data map observations divided into 7 distinct sets. The GMAP and the SGMAP procedures have a DENSITY= option that enables you to subset the data from low to high values (0 to 6). LOW indicates that map points are not in as near proximity (DENSITY= 1) to each other as HIGH (DENSITY= 6), which indicates a denseness of map point proximity. See the DENSITY= option in the GMAP procedure, or the DENSITY= option in the SGMAP procedure, for details. The SGMAP procedure, by default, uses an existing RESOLUTION variable rather than the DENSITY variable from the input map data set.

  The RESOLUTION variable exists in MAPSGFK input map data sets, but not in the MAPSSAS map data sets. Its values range from 1 to 10. It specifies the screen resolution at which to display a map data point. See Table 1.1.

Table 1.1 *RESOLUTION Variable Values in Correlation to Screen Pixel Sizes*

RESOLUTION Value	X axis pixels	Y axis pixels
1	320	240
2	400	300
3	640	480
4	800	600
5	1280	1024
6	1600	1200
7	2400	1800
8	6000	4800
9	14400	11520

RESOLUTION Value	X axis pixels	Y axis pixels
10	28800	23040

The GMAP procedure automatically chooses an existing RESOLUTION variable value based on the device prerequisites for output size and maps all of the map data points. Override this behavior in the GMAP procedure by specifying the RESOLUTION= option. The SGMAP procedure chooses an existing RESOLUTION value based on the physical size of the requested map. When using the SGMAP procedure or the GMAP procedure, you can override the automatic behavior by dropping the RESOLUTION variable and subsetting the input map data set. The RESOLUTION variable values are calculated taking into account all data points for the entire map. Ensure that either procedure does not automatically use the RESOLUTION variable values by dropping this variable when you subset map data points. For example, if you subset just one county out of the U.S. county map, be sure to drop the RESOLUTION variable out of your subset input map data set. See the GMAP procedure's RESOLUTION= option for details.

Note:

Some map data sets do not contain a RESOLUTION variable. A %REDUCE macro is provided to help you produce an output map data set that is optimized for the resolution that you specify in the macro. You can download this macro from the SAS Maps and Geocoding website at https://support.sas.com/en/knowledge-base/maps-geocoding.html. You are required to access the website with your SAS profile. You might be required to enter your site information.

You can use the CONTENTS procedure to view details of any map data set. For example, to view columns in the MAPSGFK.MEXICO map data set, run the following SAS code:

```
proc contents data=mapsgfk.mexico;
run;
```

Map Data Set Storage

Map data sets store spatial information across multiple observations and the order of the observations is important. Each observation contains multiple variables with their specific data values. As such, these data sets should not be stored on a system that could possibly change the order of the observations. In your SAS code, *File-path* must be a path that is accessible to the SAS Compute Server.

Traditional map data sets can represent unprojected or projected X and Y coordinates. Check the variable description in any data set. GfK map data sets contain both projected coordinates (X, Y) and unprojected coordinates (LONG, LAT).

Using Base SAS ODS Graphics to Create Maps

Base SAS provides the SGMAP procedure that is based on the functionality of ODS Graphics. It renders maps whose data has been prepared by any number of mapping procedures such as GPROJECT. You can also use the MAPIMPORT procedure to import map data from third-party sources. After your map data sets are obtained and prepared, use the SGMAP procedure to create maps and then overlay standard ODS Graphics plots such as bubble, series, scatter, or text plots. Create a polygonal map with the CHOROMAP statement. You can also create stand-alone basemaps with either the ESRIMAP or the OPENSTREETMAP statements. A choropleth map can be overlaid on either of these basemaps. The plots are overlaid on the map based on geographic coordinate values.

The SGMAP procedure works with map data obtained and prepared by the GINSIDE, GPROJECT, GREDUCE, and GREMOVE mapping preparation procedures.

Options for controlling the appearance of maps include specifying the boundary density and controlling numeric ranges and categories. You can specify patterns, legends, and ODS styles.

The SGMAP procedure enables you to specify an input map data set that contains the coordinates for the boundary points of each map area. The coordinate variables can be LONGITUDE and LATITUDE, LONG or LON and LAT, or X and Y. The SGMAP procedure looks for the coordinates in the order listed. The SGMAP procedure uses only the X and Y coordinates for the boundary points of each map area in the input map data set. This lays the foundation of your map image. You can then specify plot data for the plot overlay on top of the created map image. The plot data contains map data for the plot overlay. In addition, you can specify a map response data set that contains the response values and the spatial information that are represented in the polygonal map areas.

Typically, the SGMAP procedure does not summarize data in map data sets. It renders this data in raw form. However, if a MAPSGFK map data set is used, the SGMAP procedure reduces the map based on graph size and resolution. If your map data set is large, consider using a WHERE clause in a DATA step. This filters out all but the geographic area that you need to create the map.

Note: You can use the SGMAP procedure even if you do not have the MAPSGFK map polygon data sets provided with a SAS/GRAPH installation. The SGMAP procedure can still render OpenStreetMaps and Esri Maps with plot overlays. You can also download the archived MAPS library of map data sets from the SAS Maps and Geocoding website. You are required to access the website with your SAS profile. You might be required to enter your site information.

The procedure and its statements are described in the Chapter 18, “SGMAP Procedure,” on page 637.

Using SAS Procedures That Aid in Map Data Preparation

SAS also provides several utility procedures for processing and handling map data sets. For example, you can convert map coordinates from spherical (longitude and latitude) to a flat plane. These procedures include GEOCODE, MAPIMPORT, GINSIDE, GPROJECT, GREDUCE, and GREMOVE. These procedures do not produce any graphics output. Instead, they produce an output map data set. This can be used as the input map data set for the GMAP procedure in SAS/GRAPH, or the ODS Graphics SGMAP procedure provided with Base SAS.

Base SAS PROC GEOCODE

The GEOCODE procedure is available with Base SAS. The procedure is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this procedure. The GEOCODE procedure can be used to add the LAT and LONG geographic coordinate values to addresses. It provides a way to convert address data into map locations. After geocoding, these coordinates can be used to display a point on a map or to calculate distances. Geocoding also enables you to add attributes values such as census blocks to the geocoded address.

PROC GEOCODE requires two types of SAS data sets; input address data sets and lookup data sets. An input address data set contains variables that relate to specific geographic locations, such as a mailing address. A lookup data set contains reference variables and geographic coordinates. For each observation in the input data set, the GEOCODE procedure attempts to match the address value to values in the various lookup data sets.

See Chapter 11, “GEOCODE Procedure,” on page 183 for details about geocoding information in preparation for creating a map.

Base SAS PROC GINSIDE

The GINSIDE procedure is available with Base SAS. The procedure is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this procedure.

The GINSIDE procedure compares a data set of X and Y coordinates to a map data set containing map polygons. The procedure determines whether the X and Y coordinates for each point fall inside or outside of the map polygons. If the point falls inside a polygon, then the ID variable is set to the ID value of that polygon. For example, if a map contains states, then the ID variable of the output data set is set to the state that contains the point. See Chapter 12, “GINSIDE Procedure,” on page 285 for usage details.

Base SAS PROC GPROJECT

The GPROJECT procedure is available with Base SAS. The procedure is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this procedure.

The GPROJECT procedure processes map data sets by converting spherical coordinates (longitude and latitude) into Cartesian coordinates. These are used by the GMAP procedure in SAS/GRAPH, or the ODS Graphics SGMAP procedure in Base SAS.

The GPROJECT procedure enables you to use one of several map projection techniques to project the latitude and longitude coordinates onto a two-dimensional plane. The output map data set that is produced by the GPROJECT procedure contains Cartesian coordinates in the X and Y variables that can be displayed using the GMAP procedure.

The GPROJECT procedure can also trim your map region by creating a rectangular subset of the input map data set. It does this by excluding all points with longitude and latitude values that fall outside of a specified range. This provides a simple way to reduce the size of the map data set if you need only a portion of a larger map.

By default, the GPROJECT procedure requires its input map data set to contain the X and Y variable values representing unprojected longitude and latitude. If instead, your map data set contains unprojected values in the LONG and LAT variables, then use GPROJECT's LATLON option. Some of the map data sets that are supplied with SAS/GRAPH have already been projected. When these map data sets contain only projected coordinate values, the previously projected X and Y coordinates cannot be projected again. An example data set is MAPS.STATES. If that map data is needed in a different projection, then the unprojected LONG and LAT values can be projected. See Chapter 14, "GPROJECT Procedure," on page 525 for usage details.

At times it is not possible to accurately overlay plot data with existing X and Y coordinate values onto a map. This happens when the map data set, although it also contains X and Y coordinates, is using a different projection method or projection parameters. In this case, the plot data points would not align with map boundaries. To avoid this situation, consider two alternative approaches. The preferable solution is to ensure that both the plot and the map data sets using the same projection method or projection parameters. You can use the GPROJECT procedure to project your maps and plot data to the same projection system or choose to plot the unprojected coordinate values. For an example of plotting unprojected coordinate values on a map with the SGMAP procedure, see "Example 2: Creating a Map of Nevada Counties with a Bubble Plot of County Seats and Populations" on page 742.

Base SAS PROC GREDUCE

The GREDUCE procedure is available with Base SAS. The procedure is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this procedure.

A reduced map data set is one that can be used to draw a map that retains the overall appearance of the original map but that contains fewer points. It requires considerably less storage space and can be drawn much more quickly. You can improve performance by plotting fewer observations for each map area. You reduce a map data set when you subset it on the variable DENSITY. You can add the variable DENSITY to a map data set by using the GREDUCE procedure. See Chapter 15, "GREDUCE Procedure," on page 581 for usage details.

Note: Some unreduced map data sets already contain a DENSITY variable like the one calculated by the GREDUCE procedure. Therefore, it is not necessary to use the GREDUCE procedure to process these data sets. Values for DENSITY range from 0 through 6 (the lower the density, the coarser the boundary line).

Base SAS PROC GREMOVE

The GREMOVE procedure is available with Base SAS. The procedure is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this procedure.

The GREMOVE procedure combines unit areas defined in a map data set into larger unit areas by removing internal borders between the original unit areas. For example, Figure 16.50 on page 598 and Figure 16.51 on page 599 show combined unit areas in a typical map data set by removing state boundaries to create regional census divisions. See Chapter 16, "GREMOVE Procedure," on page 597 for usage details.

Using SAS/GRAPH to Create Maps

SAS/GRAPH provides the GMAP procedure with its varying statements, depending on what type of map you want to create. The following table lists the map types that GMAP procedure supports.

Table 1.2 PROC GMAP SUPPORTED MAP TYPES

Map Type	Statement
Block	GMAP procedure BLOCK statement
Choropleth	GMAP procedure CHOROPLETH statement
Prism	GMAP procedure PRISM statement
Surface	GMAP procedure SURFACE statement

An example of each of these map types is in "A Quick Look at the Gallery" on page 27.

The GMAP procedure can take as input a map data set and a response data set, provided that both data sets contain the same *id-variable*. Alternatively, you can use as input a single data set to represent both the map and the response data sets. This is true if it contains either the map variables or a variable that references a map data set.

Note: You must have SAS/GRAPH installed in order to use this procedure.

Global Statements

A global statement is a statement that can be specified anywhere in your SAS program. It remains in effect until it is explicitly changed, overridden, canceled, or until the SAS session is terminated. TITLE, FOOTNOTE, and OPTIONS are examples of global statements. These and other global statements can be used with SAS/GRAPH. The global statements are described in "The Global Statements" on page 49. SAS/GRAPH provides additional global statements that affect only the graphics output that is generated by the SAS/GRAPH procedures and by the SAS/GRAPH Annotate facility.

ODS Destinations and Styles

The SAS Output Delivery System (ODS) manages output from SAS. ODS enables you to generate output in various document formats such as HTML5, PDF, Word, and PowerPoint. Each format is specified as an ODS destination, and each destination has a default style. To generate output in ODS, you must open the ODS destination for the document format that you want. You can use the default style for that destination or you can specify any one of the other available ODS styles. For more information about ODS, see *SAS Output Delivery System: User's Guide*.

Your IDE opens the ODS destination for HTML5 output by default using a style that was selected for that IDE. The IDE might allow you to select other output destinations such as PDF, Word, Excel, or PowerPoint, instead. It might also allow you to specify a different ODS style for your output. Refer to the documentation for your IDE for more information. You can also open your own ODS destination with a style of your choice by using ODS statements as described in *SAS Output Delivery System: User's Guide*. If you open your own destination, be sure to close it when you are done.

ODS Graphics Statement

You can use the ODS Graphics statement options to control features such as the size, type, and name of a map image created with PROC SGMAP. The settings that you specify remain in effect for all maps produced in the current session until you change or reset these settings with another ODS GRAPHICS statement.

In batch mode, ODS GRAPHICS is OFF by default. The basic syntax for the ODS GRAPHICS statement is as follows:

```
ODS GRAPHICS <OFF|On> </option(s)>;
```

Note: For the complete statement syntax, see "ODS GRAPHICS Statement" in *SAS ODS Graphics: Procedures Guide*.

Note: When creating a map image with the GMAP procedure, you use the GOPTIONS statement to control size and other features.

Graphics Options

SAS/GRAPH provides several graphics options that control various aspects of SAS/GRAPH output such as size, format, fonts, and so on. These options are listed in "Graphics Options and Device Parameters Dictionary" in *SAS/GRAPH: Reference*. The GOPTIONS statement sets one or more graphics options. The GOPTIONS statement is described in GOPTIONS Statement on page 67. The GOPTIONS procedure displays the current value of the graphics options. For details, see the "GOPTIONS Procedure" in *SAS/GRAPH: Reference*.

Learning By Example: Create Your First Map

About the Scenarios in This Chapter

This chapter presents two examples, each demonstrating the basic steps that are required to generate a map. The first example uses the Base SAS ODS Graphics SGMAP procedure, and the second uses the SAS/GRAPH GMAP procedure.

In the first example, you will perform the following tasks:

- Use the default output format in your IDE.
- Use the Base DATA step to create a response data set to be used as input to the mapping procedure.
- Use the global statement TITLE to add a title to your map.
- Use the Base SAS ODS Graphics SGMAP procedure to generate an OPENSTREETMAP basemap.
- Use the SGMAP procedure SERIES statement and its options to create a line plot of the hurricane's path to overlay on the map, and an associated legend.
- Use the SGMAP procedure BUBBLE statement and its options to create a bubble plot to overlay on the map and an associated legend.

In the second example, you will perform the following tasks:

- Specify the format catalog to search that has the predefined variable that is used in the map data set.
- Create a demographics response data set and populate it with variables that match the variable types and lengths in the MAPSGFK map data set.
- Specify graphics options for your map.
- Specify a title and a legend for the map, and a footnote that identifies the map data set that was used. Specify a solid color pattern with which to fill the map area.
- Use the SAS/GRAPH GMAP procedure to generate a BLOCK map.
- Identify the map data set and the response map data set.

Creating an OPENSTREETMAP Basemap Using Base SAS ODS Graphics SGMAP Procedure

This example creates an OPENSTREETMAP of the eastern United States, and overlays on the map a bubble plot of wind speeds and a series plot highlighting the path that hurricane Katrina took. Here is the SAS program.

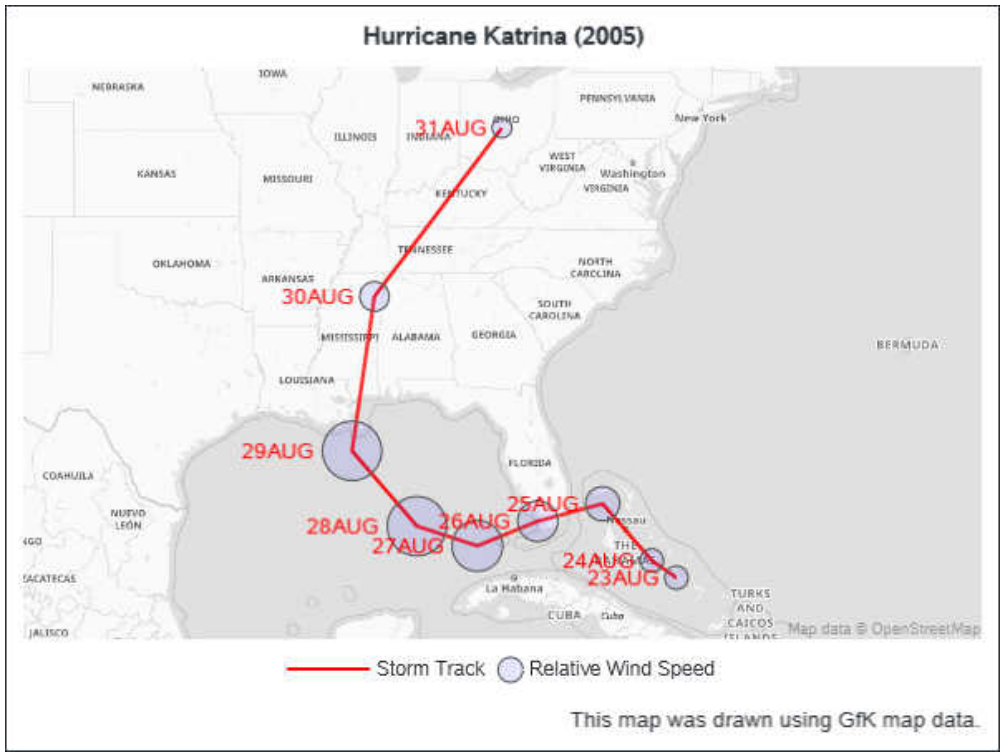
```
data katrina;    /* 1  */
format datetime datetime18.;
informat datetime datetime18.;
infile datalines dlm=',';
input datetime lat long wind;
datestring=substr(put(datepart(datetime),date9.),1,5);
datalines;
23AUG2005:18:00:00,23.1,-75.1,30
24AUG2005:06:00:00,23.8,-76.2,30
25AUG2005:06:00:00,26.1,-78.4,50
26AUG2005:06:00:00,25.4,-81.3,65
27AUG2005:06:00:00,24.4,-84,95
28AUG2005:06:00:00,25.2,-86.7,125
29AUG2005:06:00:00,28.2,-89.6,125
30AUG2005:06:00:00,34.1,-88.6,40
31AUG2005:06:00:00,40.1,-82.9,25
;
run;
title1 'Hurricane Katrina (2005)';                  /* 2 */

proc sgmap plotdata=katrina;                        /* 3 */
  openstreetmap;
  series x=long y=lat /
   lineattrs=(color=red thickness=2)
   legendlabel='Storm Track';
bubble x=long y=lat size=wind /
   fillattrs=(color=blue transparency=.9)
   datalabel=datestring datalabelpos=left
   datalabelattrs=(color=red size=10)
   legendlabel='Relative Wind Speed';
run;
quit;
```

1 Use the Base SAS DATA step to create response data for hurricane wind speed bubbles and for date and time series lines.

2 Use the Base SAS global statement TITLE to add a title to your map.

3 Use the Base SAS ODS Graphics SGMAP procedure to generate an OPENSTREETMAP basemap. The PLOTDATA= option specifies the KATRINA response map data set. The SERIES statement plots the dates and times and connects them with lines. The BUBBLE statement creates a bubble plot to overlay on the basemap, with bubble markers that vary in size according to wind speed, and marker placement is at each date and time stamp in the response data set. Name, label, and marker attributes are assigned.

Here is the program output.



Using what you have learned from this example, you can begin exploring how to create other basemaps or choropleth maps using the Base SAS ODS Graphics SGMAP procedure. The statements in this procedure give you the ability to overlay various types of plots onto the map. It also enables you to overlay a choropleth map onto an Esri map or an Open Street Map (OSM).

Creating a Block Map Using SAS/GRAPH GMAP Procedure

This example creates a block map of the population of Asia. Here is the SAS program.

```
options
fmtsearch=(sashelp.mapfmts);                                    /*
1 */
proc
sql;
/* 2 */
create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
select demo.*,
put(demo.iso,z3.) as newiso format=$3.,
put(demo.iso,ison2a.) as newid
from sashelp.demographics as demo
;
```

```
alter table demographics
modify ID char(15) label='Alpha2 Country Code';
quit;

goptions reset=all border hsize=5 in vsize= 3.8
in;                          /* 3 */

title1 "Population in
Asia";                                                    /* 4 */
legend1 label=(position=top) shape=bar(.3in,.1in);
footnote1 j=r "This map drawn with GfK map data";
pattern1 value=msolid color=tan;

proc gmap
data=demographics(where=(cont=95))                                  /*
5 */
map=mapsgfk.asia resolution=4 all;
id iso;
block pop / blocksize=1 relzero legend=legend1;
run;
quit;
title;
     /* 6 */
```

1 Use the Base SAS system option FMTSEARCH= to specify the format catalog to search that has the predefined variable that is used in the map data set.

2 Use Base SAS PROC SQL to create a demographics response data set and populate it with variables that match the variable types and lengths in the MAPSGFK map data set. The RENAME= option first renames existing variables in the data set, and then recreates the original variable names in the format that matches variables in the MAPSGFK map data set.

3 Use the GOPTIONS statement to specify the height and width of the map, and draw a border around it. Reset=ALL specifies that any previous settings are disabled.

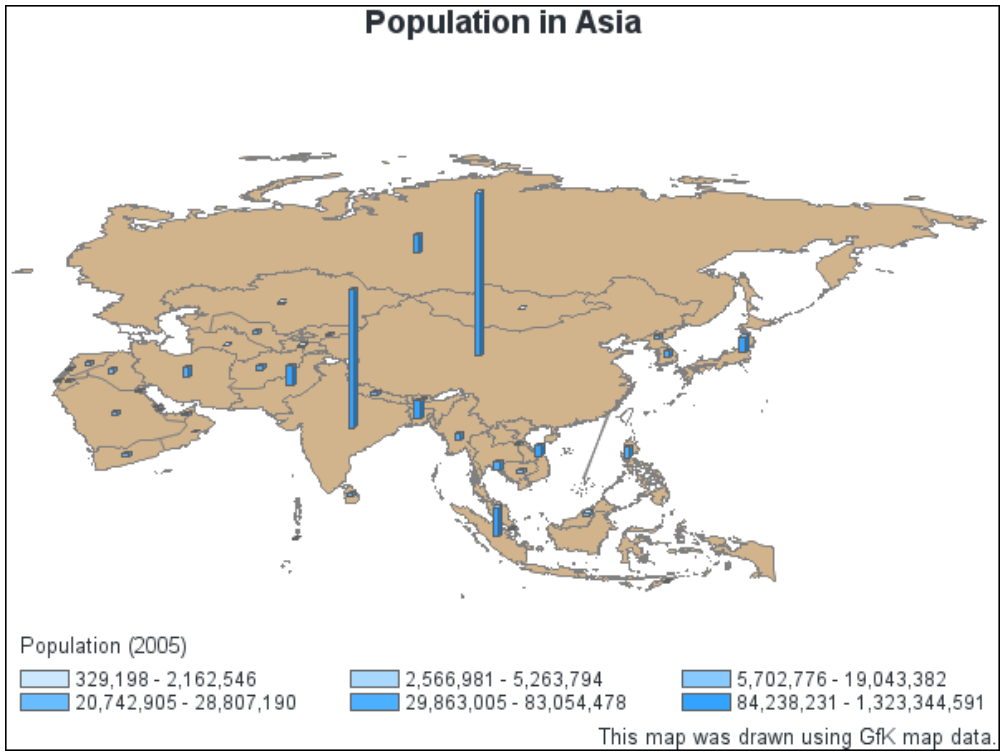
4 Use global statements TITLE, FOOTNOTE, LEGEND, and PATTERN. The first three add a title, a footnote, and a legend to the block map. PATTERN adds a tan color fill to the Asian map area.

5 Use the SAS/GRAPH GMAP procedure BLOCK statement to generate a block map. Identify the map data set and the response map data set. In this example, map data set MAPSGFK.ASIA and response data set DEMOGRAPHICS are used. The ID statement specifies the variable that is in both the map data set and the response data set and defines map areas. The ISO variable is character, and because of the preparation work from the PROC SQL step, is in common between the map data set and the response map data set. The Base SAS WHERE= statement specifies the Asian continent. The RESOLUTION= option specifies that all map observations with a RESOLUTION variable value of 4 or less be used. The 4 value corresponds to a resolution of 800 x 600 pixels. This narrows the number of polygonal lines drawn in a map area. ALL specifies that the generated map should include all the map areas from the map data set, even if there is no observation for that map area. The BLOCK statement specifies the population variable in the response data set that contains the response values

for each of the map areas. The BLOCKSIZE= option specifies the width of the blocks. The RELZERO option specifies that the block values are relative to zero.

6 The TITLE global statement clears the title.

Here is the program output.



Using what you have learned from this example, you can begin exploring how to create other maps using the SAS/GRAPH GMAP procedure. The statements in this procedure give you the ability to create choropleth, prism, and surface maps encompassing two- and three-dimensions.

Where to Go from Here

Now that you have a basic understanding of how to use Base SAS ODS Graphics and SAS/GRAPH to create maps, review the remaining topics in this book to expand on your knowledge of these products. The following table provides suggestions for your next steps.

Table 1.3 *Next Steps*

Task	Reference
If necessary, review the basic concepts of programming in the SAS language.	"Prerequisites" (p. vii)

Task	Reference
Learn more about the basic elements of a SAS/GRAPH program.	"Elements of a SAS/GRAPH Program" in *SAS/GRAPH: Reference*
See other maps that you can create using Base SAS and SAS/GRAPH.	"A Quick Look at the Gallery" (p. 27)
Learn how to perform common tasks that are associated with developing mapping programs.	"About the Base SAS and SAS/GRAPH Tasks" (p. 37)
Identify resources that you can use to help you develop your mapping programs.	Chapter 4, "Additional Resources to Help You Develop Your Mapping Programs," (p. 41)

2

Gallery of Maps

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A Quick Look at the Gallery

The GMAP procedure in SAS/GRAPH provides a variety of two- and three-dimensional map types. The Base SAS ODS Graphics SGMAP procedure produces a choropleth map type that can be overlaid on tile-based maps such as EsriMaps and Open Street Maps (OSM), or with a variety of plots. This section lists each map type and provides a sample of each. The procedure that can generate each map type is listed, as well as the procedure statements that are used to create the sample.

Note: SAS/GRAPH, a licensed product, must be installed before using its GMAP procedure.

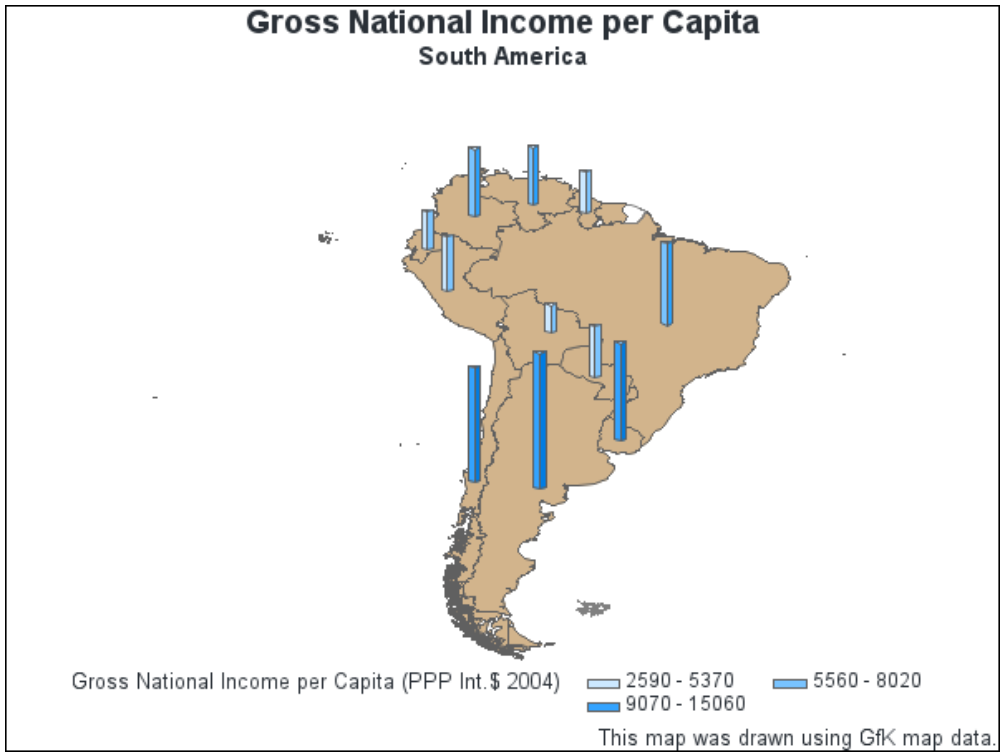
This gallery contains a sample of each of the following map types:

- Block Maps (GMAP)
- Choropleth Maps (SGMAP and GMAP)
- Prism Maps (GMAP)
- Surface Maps (GMAP)
- Annotated Maps (GMAP)

Gallery of Base SAS ODS Graphics and SAS/GRAPH Maps

Block Maps (GMAP)

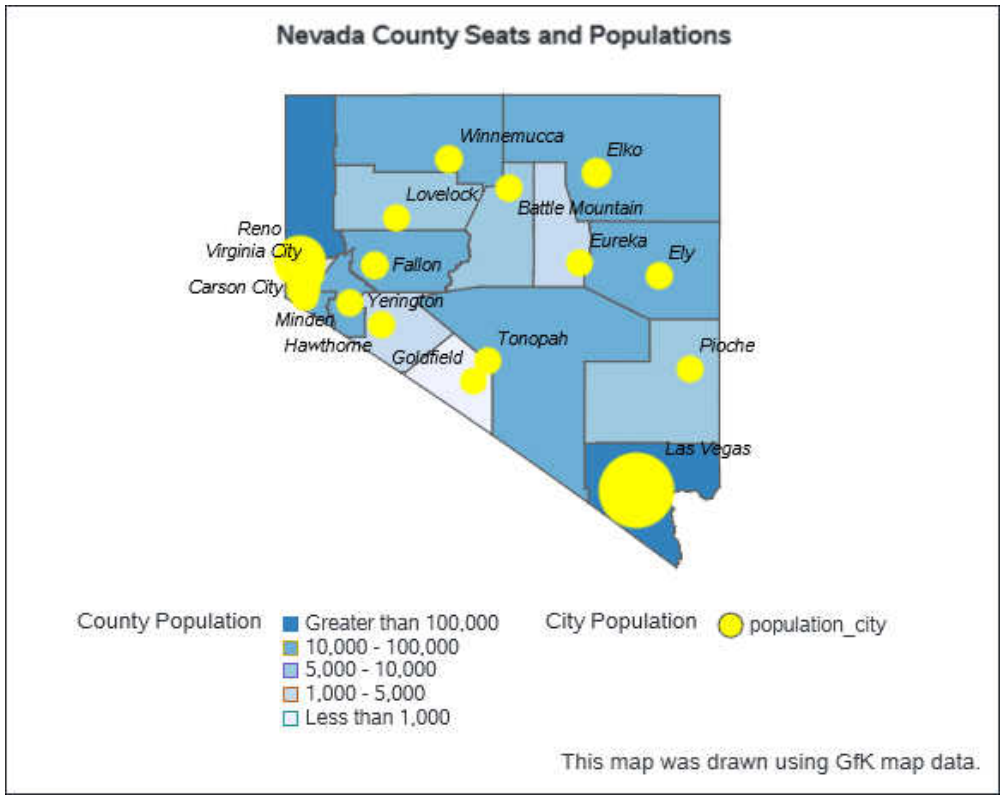
A block map is a three-dimensional map that represents data values as blocks of varying height rising from the middle of the map area. Here is a sample.



Use the GMAP procedure's MAP=, DATA=, ID, and BLOCK statements to generate a block map. The BLOCK statement is described in "BLOCK Statement" on page 345. This sample uses the GfK GeoMarketing map data set that is licensed to be used only with SAS/GRAPH. For an example of a block map, see "Example 2: Specifying Response Levels in a Block Map" on page 439.

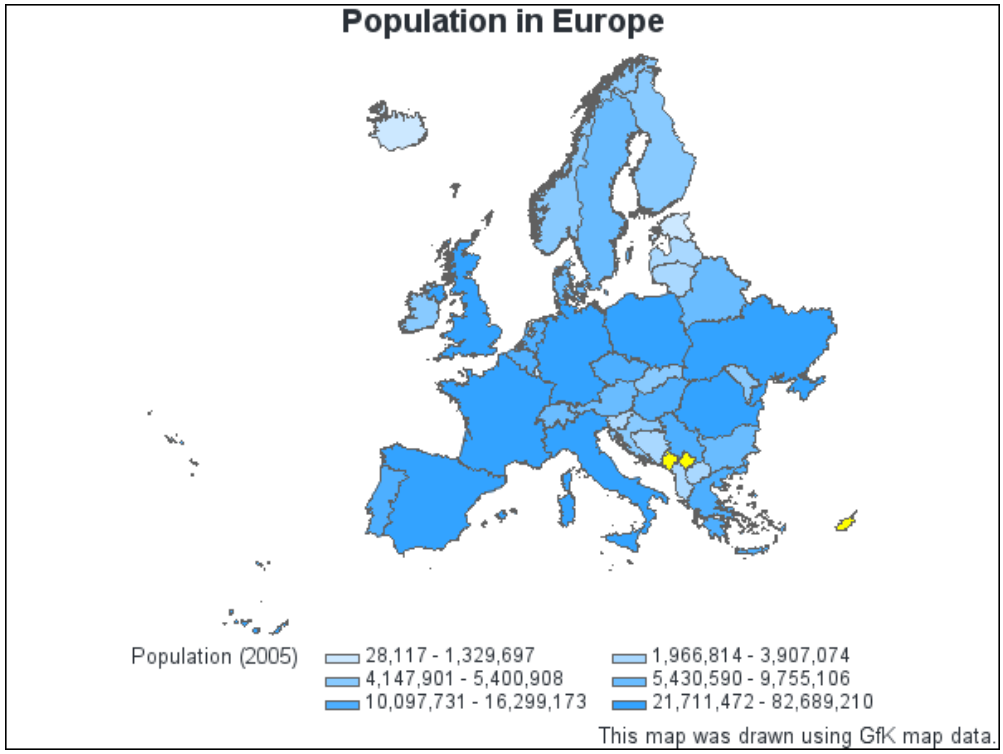
Choropleth Maps (SGMAP and GMAP)

A choropleth map is a two-dimensional map that displays data values by filling map areas with combinations of patterns and color that represent the data values. They are among the most commonly used and versatile map types. Here is a Base SAS ODS Graphics sample.



The SGMAP CHOROMAP statement is described in "CHOROMAP Statement" on page 663. This sample uses the GfK GeoMarketing map data set that is licensed to be used only with SAS/GRAPH. For an example of creating a choropleth map with the SGMAP procedure, see "Example 2: Creating a Map of Nevada Counties with a Bubble Plot of County Seats and Populations" on page 742.

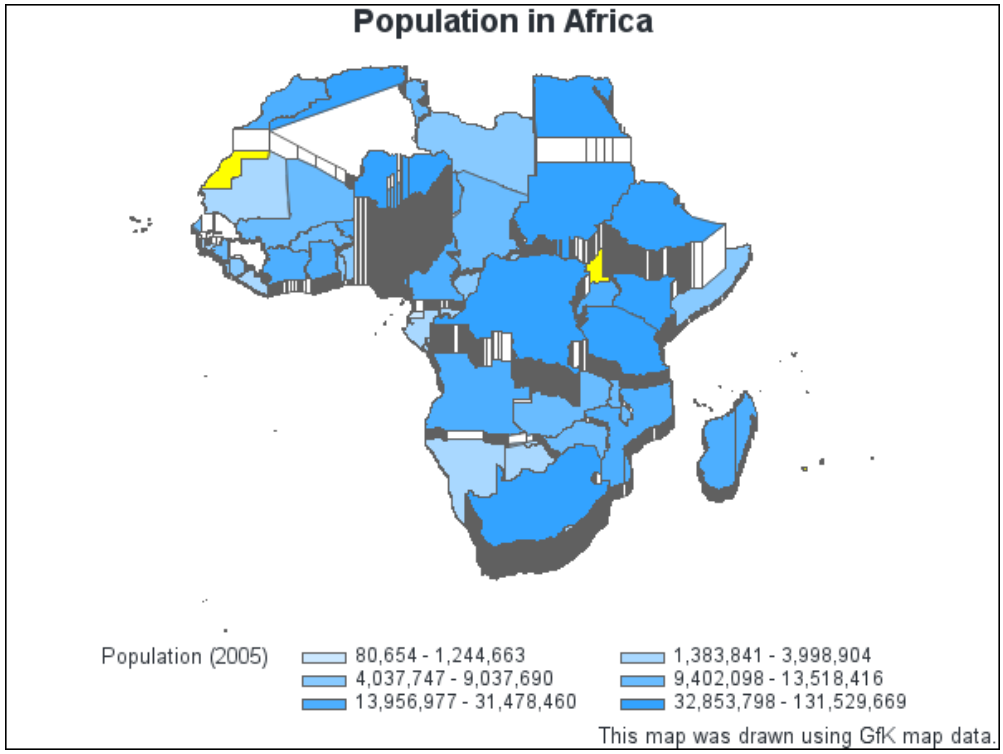
Here is a SAS/GRAPH sample.



Use the GMAP procedure's MAP=, DATA=, ID, and CHOROPLETH statements to generate a choropleth map. The GMAP CHOROPLETH statement is described in "PRISM Statement" on page 370. This sample uses the GfK GeoMarketing map data set that is licensed to be used only with SAS/GRAPH. For an example of creating a choropleth map with the GMAP procedure, see "Example 5: Producing a Simple Choropleth Map" on page 448.

Prism Maps (GMAP)

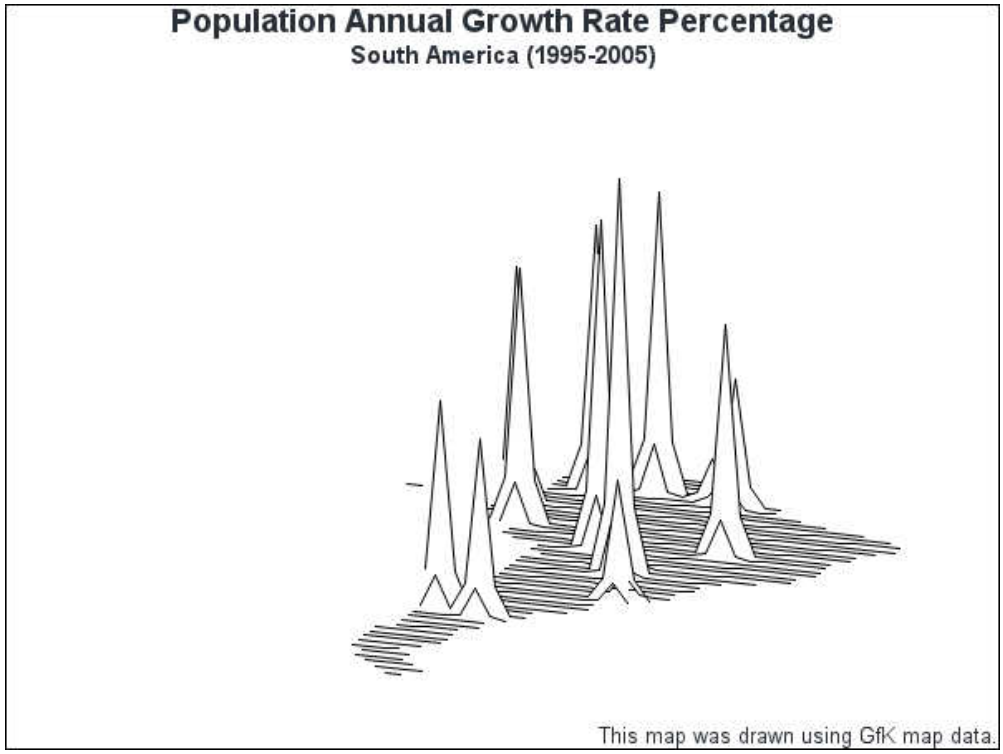
A prism map is a three-dimensional map that displays data by raising the map areas and filling them with combinations of patterns and colors. Here is a sample.



Use the GMAP procedure's MAP=, DATA=, ID, and PRISM statements to generate a prism map. The PRISM statement is described in "PRISM Statement" on page 370. This sample uses the GfK GeoMarketing map data set that is licensed to be used only with SAS/GRAPH. For an example of a prism map, see "Example 9: Producing a Simple Prism Map" on page 461.

Surface Maps (GMAP)

A surface map is a three-dimensional map that represents data values as spikes of varying heights. Here is a sample.



Use the GMAP procedure's MAP=, DATA=, ID, and SURFACE statements to generate a surface map. The SURFACE statement is described in Chapter 13, "GMAP Procedure," on page 303. This sample uses the GfK GeoMarketing map data set that is licensed to be used only with SAS/GRAPH. For an example of a surface map, see "Example 11: Producing a Simple Surface Map" on page 466.

Annotated Maps (GMAP)

An annotated map is enhanced with an overlay of graphics output. Here is a sample.

Figure 2.1 *Annotate Graphics Applied to a Map*

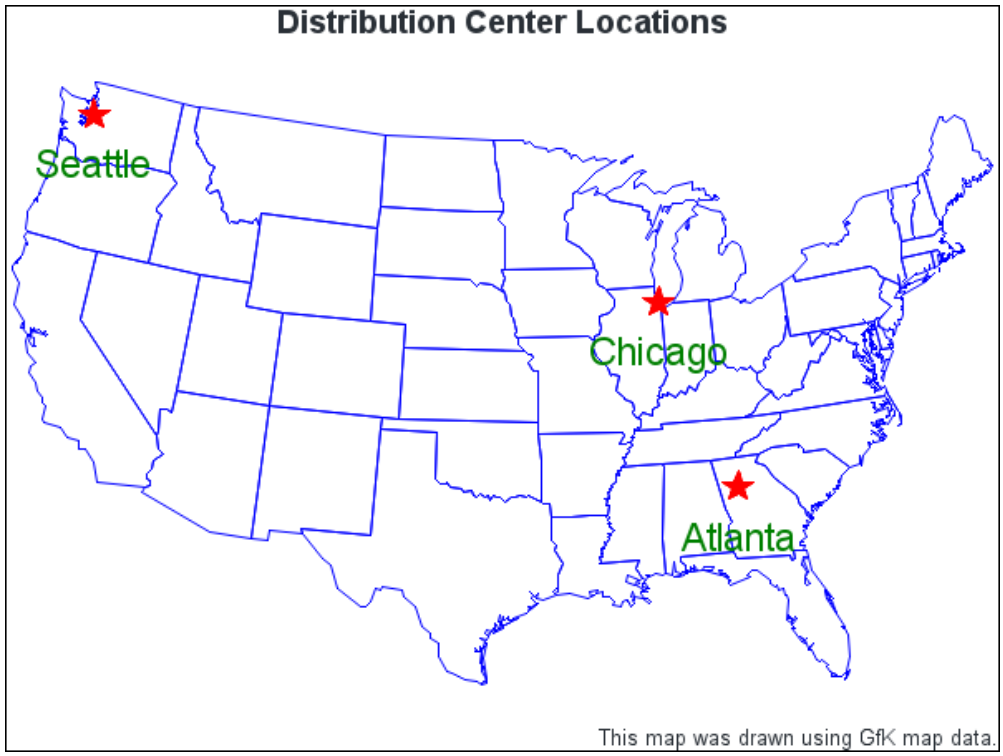


Figure 2.1 on page 33 shows GMAP procedure output annotated with stars and labels at selected cities.

The SAS/GRAPH Annotate facility enables you to programmatically create graphics by using certain variables in SAS data sets. It can be used to add text or special elements to GMAP procedure output. Text and graphics can be placed at coordinates derived from input data, as well as coordinates expressed as explicit locations on the display. See "Overview: The Annotate Facility" in *SAS/GRAPH: Reference* or "Overview: The Annotate Facility" in *SAS/GRAPH: Reference* for detailed information.

The program that creates this output is in "Example 17: Labeling Cities on a Map" on page 489.

See "Displaying Images Using Annotate" in *SAS/GRAPH: Reference* for an example of how to display an image onto a map.

The SGMAP procedure does offer the ability to overlay markers and text onto a map.See "Syntax" on page 640 for details.

Base SAS Procedures to Prepare Map Data

Procedures for Handling Map Data

Base SAS provides several utility procedures for handling data sets that contain polygonal and map area data. In the following table, Base SAS procedures listed in the left column correlate to a right column description of the procedure.

Table 2.1 *Base SAS Procedures for Handling Map Data*

Procedure	Description
GEOCODE	Adds geographic coordinates to data sets that contain information such as street addresses. The coordinates typically represent the center of a ZIP code, a city, an address, or any geographic region. After geocoding, the coordinates can be used to display a point on a map or to calculate distances. Geocoding also enables you to add attributes values such as census blocks to an address. You can also use geocoding to associate ranges of IP addresses with locations. For details see Chapter 11, "GEOCODE Procedure," on page 183.
GINSIDE	Compares a data set of X and Y coordinates to a map data set containing map polygons. The procedure determines whether the X and Y coordinates for each point fall inside or outside the map polygons. In addition, the procedure indicates the specific polygon that contains each inside point. For details see Chapter 12, "GINSIDE Procedure," on page 285.
GPROJECT	Enables you to choose how geographic maps are projected. This is particularly important for large areas. Producing a map of any large area on the Earth involves distorting some areas in the process of projecting the spherical surface of the Earth onto a flat plane. You can use the procedure to select the projection method that

Procedure	Description
	least distorts your map. In addition, you can choose not to display a particular rectangular area of the map. For details see Chapter 14, "GPROJECT Procedure," on page 525.
GREDUCE	Enables you to reduce the number of points in the data set. This is useful for large maps, where the amount of data can be prohibitively expensive in terms of computing resources or time to process. For details see Chapter 15, "GREDUCE Procedure," on page 581.
GREMOVE	Enables you to remove boundary lines within a map. For example, if your map shows sales regions, you might want to remove state borders and show only the sales regions. The results of this procedure are used as the input map data set for the Base SAS SGMAP procedure or the SAS/GRAPH GMAP procedure. For details see Chapter 16, "GREMOVE Procedure," on page 597.
MAPIMPORT	Converts Esri shapefiles into SAS map data sets. The imported map data set contains polygonal area coordinates that can be rendered as a map using either the SAS/GRAPH GMAP procedure or the Base SAS ODS Graphics SGMAP procedure. For details see Chapter 17, "MAPIMPORT Procedure," on page 627.

3

Common Tasks Associated with Developing Mapping Programs

About the Base SAS and SAS/GRAPH Tasks 37
Output Environment Tasks 38
Map Creation Tasks 39
Map Enhancement Tasks 40

About the Base SAS and SAS/GRAPH Tasks

This chapter lists common tasks that are associated with developing Base SAS and SAS/GRAPH mapping programs. For each task, one or more links are provided to information about how to complete the task. Because there are many tasks associated with Base SAS and SAS/GRAPH the tasks are categorized as follows:

- Output environment
- Map creation
- Map enhancement

The task lists in this chapter can help you quickly locate information that you need to create your maps.

Output Environment Tasks

The following table lists tasks that are related to establishing the output environment for Base SAS and SAS/GRAPH.

Task	Reference
Learn about the SAS/GRAPH output environment.	"The Graphics Output Environment" in *SAS/GRAPH: Reference* "SAS/GRAPH Output" in *SAS/GRAPH: Reference*
Learn about the SAS/GRAPH graphics devices.	"Overview: Using Graphics Devices" in *SAS/GRAPH: Reference*
Use the Output Delivery System (ODS) to set your output destination and to specify the output document format.	"ODS Destination Statement Options Affecting ODS Graphics" in *SAS ODS Graphics: Procedures Guide* "Managing Your Graphics with ODS" in *SAS/GRAPH: Reference*
Create a custom SAS/GRAPH graphics device.	"Creating Universal Printers and Shortcut Devices" in *SAS/GRAPH: Reference* "Creating a Custom Device" in *SAS/GRAPH: Reference*
Specify the graph size.	"Setting the Size of Your Graph" in *SAS/GRAPH: Reference* in SAS/GRAPH "Controlling the Size of Your Graph" in *SAS ODS Graphics: Procedures Guide* with ODS
Specify the image resolution.	"Setting the Resolution of Your Graph" in *SAS/GRAPH: Reference* in SAS/GRAPH "Controlling Image Resolution" in *SAS ODS Graphics: Procedures Guide* with ODS

Map Creation Tasks

The following table lists tasks that are related to generating maps using Base SAS and SAS/GRAPH.

Task	Reference
Determine the language elements that you need to use to create your map.	"Gallery of Base SAS ODS Graphics and SAS/GRAPH Maps" (p. 28)
Create your SAS/GRAPH program.	"Elements of a SAS/GRAPH Program" in *SAS/GRAPH: Reference*
Create a choropleth map overlaid with plots using ODS Graphics SGMAP procedure. Procedure statement options enable you to control legends, colors, fonts, and other features.	Chapter 18, "SGMAP Procedure," on page 637
Add titles, footnotes, and notes to your map.	"TITLE Statement" (p. 121) "FOOTNOTE Statement" (p. 50) "NOTE Statement" (p. 93)
Specify fonts in your SAS/GRAPH program.	"Specifying Fonts in SAS/GRAPH Programs" in *SAS/GRAPH: Reference*
Specify colors in your SAS/GRAPH program.	"Using Colors in SAS/GRAPH Programs" in *SAS/GRAPH: Reference*
Create multiple maps in a single procedure step.	"Using Run-Group Processing" in *SAS/GRAPH: Reference* "BY Statement" on page 391
Generate a map in the SVG format.	"Using SVG Graphics" in *SAS/GRAPH: Reference*

Map Enhancement Tasks

The following table lists tasks that are related to adding enhancements to your maps.

Task	Reference
Add data tips and a description to your SAS/GRAPH map.	"Enhancing Web Presentations with Chart Descriptions, Data Tips, and Drill-Down Functionality" in *SAS/GRAPH: Reference*
Add one or more images to your SAS/GRAPH map.	"Adding Images to SAS/GRAPH Output" in *SAS/GRAPH: Reference*
Annotate your SAS/GRAPH map.	"Overview: The Annotate Facility" in *SAS/GRAPH: Reference*
Add drill-down links to your SAS/GRAPH map.	"Enhancing Web Presentations with Chart Descriptions, Data Tips, and Drill-Down Functionality" in *SAS/GRAPH: Reference*
Use procedure statement options to specify attributes for lines, fills, data markers, or text.	See PROC SGMAP "Syntax" on page 640. See PROC GMAP "Syntax" on page 332.
Use ODS style elements to control map appearance.	"Overview" in *SAS ODS Graphics: Procedures Guide*
Add a legend to your map.	With the SAS/GRAPH global "LEGEND Statement" on page 69 With PROC SGMAP "GRADLEGEND Statement" on page 679 or "KEYLEGEND Statement" on page 683

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Additional Resources to Help You Develop Your Mapping Programs

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Base SAS and SAS/GRAPH Sample Programs

Most of the chapters in this document include examples that illustrate some of the features of a procedure or its statements. You can copy the example code in this document, paste it into your code editor in SAS Data and AI Studio (known as SAS Studio prior to 2026.06), and then run it.

Unless otherwise noted, the examples in this document use the Illuminate ODS style. Your IDE might be configured to use a different ODS style. In that case, your output will be different in appearance from what is shown in this document.

Examples and Resources on the Web

Examples and Resources on the Web

The SAS website contains a large number of examples that can help you visualize and code your graphs. The examples cover a range of SAS technologies including the SAS/GRAPH procedures.

- The SAS Training Post is a blog that provides tutorials, tips, and practical information about SAS. Dr. Robert Allison contributed a great deal of SAS/GRAPH and ODS Graphics data visualization examples to this blog during his tenure at SAS. His blog is no longer active, but it provides an extensive set of very useful examples. The SAS Training Post is available at the following URL:

  https://blogs.sas.com/content/sastraining/author/robertallison/

- The SAS Knowledge Base contains an abundance of searchable samples and SAS Notes. You can browse by topic, search for a particular note or a particular technology such as the name of a procedure, and conduct other searches. The SAS Knowledge Base is available at the following URL:

  https://support.sas.com/en/knowledge-base.html

  Note: The SAS Knowledge Base content is currently available only in English.

- The Graphics Samples Output Gallery in the SAS Knowledge Base is a collection of graphs organized by SAS procedure. The graphs link to the source code. The gallery is maintained by SAS Technical Support. It is available at the following URL:

  https://support.sas.com/en/knowledge-base/graph-samples-gallery.html

- The Focus Area Graphics site provides a simple interface to business and analytical graphs. The site is maintained by the SAS Data Visualization team. It is available at the following URL:

  https://support.sas.com/rnd/datavisualization/index.htm

- You can share your questions, suggestions, and experiences related to graphics on the Graphics Programming community site. It is available at the following URL:

  https://communities.sas.com/t5/Graphics-Programming/bd-p/sas_graph

In addition, SAS offers instructor-led training and self-paced e-learning courses to help you get started with platform graphics software. The SAS Training site provides information about the courses that are available. It is available at the following URL:

sas.com/training

Books

The following books provide information about creating graphs using SAS/GRAPH and ODS Graphics.

- *Producing High-Quality Figures Using SAS/GRAPH® and ODS Graphics Procedures*
- *SAS/GRAPH®: Beyond the Basics*
- *Statistical Graphics Procedures by Example: Effective Graphs Using SAS*
- *Annotate: Simply the Basics* Art Carpenter's SAS Software Series

PART 2

Statements Used by SAS/GRAPH and Base SAS for Mapping

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About the SAS/GRAPH and Base SAS Statements

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Statement Types

There are several statements that you can use with many of the SAS procedures. These statements can be categorized as follows:

- global statements
- common procedure statements
- procedure statements

About Global Statements

Global statements are statements that can be specified anywhere in a SAS program. These statements typically specify attributes of a graph, such as titles and footnotes, for the duration of a SAS session. When executed, these statements remain in effect until modified or canceled, or until the SAS session is terminated. Global statements include the following:

- AXIS

- FOOTNOTE
- GOPTIONS
- LEGEND
- ODS GRAPHICS
- PATTERN
- SYMBOL
- TITLE

For information about the common procedure statements, see "The Global Statements" on page 49.

About Common Procedure Statements

Common procedure statements are statements that can be used in the PROC step for many of the SAS procedures. These statements include the following:

- ATTRIB
- BY
- FORMAT
- LABEL
- NOTE
- WHERE

Not all of these statements are supported by every SAS procedure. The description for each procedure indicates which of these common statements is supported by that procedure. For information about the common procedure statements, see Chapter 7, "The Common Procedure Statements," on page 149.

About Procedure Statements

Procedure statements are procedure-specific statements that can be used in the PROC step for that procedure only. For a description of the procedure statements, refer to the procedure description.

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The Global Statements

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Dictionary

BY Statement

Orders the output according to the BY groups.

Type: Procedure statement

Syntax

BY <DESCENDING> *variable-1*
<-<DESCENDING> *variable-n*>
<NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, then either the observations in the data set must be sorted by all the variables that you specify, or they must be indexed appropriately. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the observations are sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The observations are grouped in another way (for example, chronological order).

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

You cannot use the NOTSORTED option in a PROC SORT step.

Note: You cannot use the GROUPFORMAT option, which is available in the BY statement in a DATA step, in a BY statement in any PROC step.

See Also

"BY Statement" on page 151 for more information about the BY statement.

FOOTNOTE Statement

Writes up to 10 lines of text at the bottom of the procedure or DATA step output.

Valid in:	Anywhere
Type:	Global statement
Restriction:	The FOOTNOTE statement does not support Unicode.
Requirement:	You must specify the FOOTNOTE option if you use a FILE statement.

Syntax

FOOTNOTE<*1-10*> <*ods-format-options*> <*text-options*><'*text-string*'>;

Without Arguments

Using FOOTNOTE without arguments cancels all existing footnotes.

```
footnote;
```

Optional Arguments

<1-10>
specifies the relative line that contains the footnote text.

Valid in Anywhere

Default If you omit a number, SAS assumes a value of 1. Therefore, you can specify FOOTNOTE or FOOTNOTE1 for the first footnote line.

Tips For footnotes, lines are pushed up from the bottom. The FOOTNOTE statement with the highest number appears on the bottom line.

You can create footnotes that contain blank lines between the lines of text. For example, if you specify text with a FOOTNOTE statement and a FOOTNOTE3 statement, there is a blank line between the two lines of text.

ods-format-options
specifies formatting options for the ODS HTML5, PDF, and RTF destinations.

BCOLOR=*color*
specifies the background color of the footnote block.

You can optionally draw a box around a text string with the BOX= option. The BCOLOR= option controls the background color of the box. By default, the background color of the box is the same as the background color for the entire graph. You can specify colors using a number of different color-naming schemes. The color of the frame of the box is determined by the color specification used in BOX=.

Valid in Base SAS, ODS Graphics, SAS/GRAPH

Alias BC=

Restriction If you omit the BOX= option, the BCOLOR= option is ignored.

Note The BCOLOR= option can be reset by the ANGLE= option or the JUSTIFY= option, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 66 for details

" BOX=1-4 " on page 59

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

BOLD
specifies that the font weight is bold for the text string.

Valid in Base SAS, ODS Graphics

Default For footnotes, the default font weight is specified by the FONTWEIGHT attribute of the GraphFootnoteText style element in the current style.

Restriction The BOLD option is for template-based procedures only.

COLOR=*color*
specifies the color for the text. You can specify colors using a number of different color-naming schemes.

The color stays in effect until another COLOR= specification is encountered. Change colors as often as you like. For example, the following code produces a footnote where the first word is red and the second word is blue:

```
footnote color=red "Total Sales" color=blue;
```

If you omit the COLOR= option, a color specification is searched for in this order:

1 the CTITLE= option in a GOPTIONS statement
2 the CTEXT= option in a GOPTIONS statement
3 the default, the first color in the color list.

Valid in Base SAS. ODS Graphics, SAS/GRAPH

Alias C=

Default For footnotes, the default font color is specified by the COLOR attribute of the GraphFootnoteText style element in the current style.

Style reference Color attribute of the GraphTitle1Text (TITLE1) and the GraphTitleText (TITLE2...n) elements

See "BCOLOR=*color*" on page 51

FONT=*system-font*
specifies the system font to use for the subsequent text string.

See "Specifying Fonts in SAS/GRAPH Programs" in *SAS/GRAPH: Reference* for details about specifying SAS/GRAPH fonts. If you omit this option, a font specification is searched for in this order:

If you omit this option, a font specification is searched for in this order:

- for a FOOTNOTE1 statement:

1 the FTITLE= option in a GOPTIONS statement
2 the FTEXT= option in a GOPTIONS statement

3 the default font, SWISS (COMPLEX in Release 6.06 and earlier)

- for all other FOOTNOTE statements:

1 the FTEXT= option in a GOPTIONS statement

2 the default hardware font, NONE

Valid in Base SAS, ODS Graphics, SAS/GRAPH

Alias F=

Default For footnotes, the default font is specified by the FONTFAMILY attribute of the GraphFootnoteText style element in the current style.

Notes SAS/GRAPH software fonts such as SWISS cannot be used with statistical graphics procedures.

Font names greater than eight characters in length must be enclosed in quotation marks.

If the FOOTNOTE is displayed using an ODS markup destination and the corresponding NOGFOOTNOTE option is specified, then the **bold** and **italic** FONT attributes are on by default. However, if you specify different attributes with the FONT= option, the **bold** and **italic** attributes are turned off.

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

HEIGHT=*numeric-value<units>*
specifies the size of the text. You can also specify the unit of measurement. Without a unit of measure, the number becomes a relative size.

If you do not specify a unit, then the size of the text is approximately 12*numeric-value* points. For example, if you specify HEIGHT=2, then the text size is approximately 24 points.

numeric-value
Height is measured from the font minimum to the capline. Ascenders can extend above the capline, depending on the font.

If your text line is too long to be displayed in the height specified in the HEIGHT= option, the height specification is reduced so that the text can be displayed. A note in the SAS log tells you what percentage of the specified size was used.

<units>
is a nonnegative number.

Measurement Units

cm	Centimeters
in	Inches
pct or %	Percentage
pt	A printer's point

Valid in: Base SAS, ODS Graphics, SAS/GRAPH

Alias: H=

Defaults: For FOOTNOTE or FOOTNOTE1 statements, HEIGHT is determined by the current ODS style. HEIGHT=1 for subsequent TITLE statements.

For the first footnote (footnote or footnote1), the default font size is specified by the FONTSIZE attribute of the GraphTitleText style element in the current style. For subsequent footnotes (FOOTNOTE2...n)), the size is the FONTSIZE attribute of the GraphLabelFont style attribute.

Style reference: Height attribute of the GraphTitle1Text (FOOTNOTE1) and the GraphTitleText (FOOTNOTE2...n) elements

Examples

"Ordering Axis Tick Marks with SAS Date Values" in *SAS/GRAPH: Reference*

"Enhancing Titles" in *SAS/GRAPH: Reference*

ITALIC
specifies that the font style is italic for the text string.

Valid in: Base SAS, ODS Graphics

Default: For footnotes, the default font style is specified by the FONTSTYLE attribute of the GraphTitleText style element in the current style.

JUSTIFY= LEFT | CENTER | RIGHT
specifies the alignment of the text string. You can specify one of the following values:

LEFT
specifies left justification.

Alias: L

CENTER
aligns the text in the center.

Alias: C

RIGHT
aligns the text to the right.

Alias: R

Valid in: Base SAS, ODS Graphics, and SAS/GRAPH

Alias: J=

Default CENTER

Notes The JUSTIFY= option affects all of the text strings that follow it in your FOOTNOTE statement. You can specify multiple alignments by using more than one JUSTIFY= option. For example, the following code creates a footnote where the first string is aligned to the left and the second string is aligned to the right:

```
footnote justify=left "Example 2" justify=right "Graph 3";
```

You can use the JUSTIFY= option to produce multiple lines of text by repeating the JUSTIFY= option with the same value before the text string for each line. Multiple lines of text with the same justification are blocked together. For example, this FOOTNOTE statement produces a three-line footnote, with each line right-justified:

```
footnote  justify=right "First Line"
     justify=right "Second Line"
     justify=right "Third Line";
```

You can get the same effect with three FOOTNOTE statements, each specifying JUSTIFY=RIGHT. You can produce a block of text by specifying the same justification for multiple text strings. You can then change the justification for an additional text string. The result is that the text is placed on the same line as the first string specified in the statement.

Using the JUSTIFY= option after one text string and before another can reset some options to their default values.

LINK='*URL*'

specifies a uniform resource locator (URL) to which a footnote links.

The *text-string* that you use to specify the URL can contain occurrences of the variables #BYVAL, #BYVAR, and #BYLINE, as described in "Using #BYLINE, #BYVAL, and #BYVAR Substitution in URL and FOOTNOTE Text Strings" in *SAS Global Statements: Reference*.

Valid in Base SAS, SAS/GRAPH

ODS destination HTML, RTF, PRINTER

Supports The LINK= option can be used in conjunction with the ALT= option.

Note The footnote can be displayed using an ODS markup destination (such as HTML). And the corresponding ODS option NOGFOOTNOTE can be specified. Then the footnote is rendered in the body of the HTML file rather than in the graphic itself. Specifying the NOGFOOTNOTE options results in increasing the amount of space allowed for the procedure output area, which can result in increasing the size of the graph. Space that would have been used for the footnote is devoted instead to the graph. You might need to be aware of

this possible difference if you are using annotate or map coordinates.

UNDERLIN=*0-3*
specifies whether the subsequent text is underlined. UNDERLIN=0 indicates no underlining. Values 1, 2, and 3 underline with an increasingly thicker line.

Underlines follow the text baseline. If you use an LANGLE= or ANGLE= option for the line of text, the underline is drawn at the same angle as the text. Underlines do not break up to follow rotated characters.

To make the text and the underline the same color, specify a COLOR= option before the UNDERLIN= option that precedes the text string. To make the text a different color, specify the COLOR= option after the UNDERLIN= option.

Valid in SAS/GRAPH

Aliases U=

UNDERLINE

See " ROTATE=*degrees*" on page 64

"Using Options That Can Reset Other Options" on page 66 for details

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

Note The defaults for how ODS renders the FOOTNOTE statement come from style elements that relate to system footnotes in the current style. The FOOTNOTE statement syntax with *ods-format-options* is a way to override the settings that are provided by the current style. The current style varies according to the ODS destination. For more information about how to determine the current style, see "Understanding Styles, Style Elements, and Style Attributes" in *SAS Output Delivery System: Procedures Guide* and "Concepts: TEMPLATE Procedure" in *SAS Output Delivery System: Procedures Guide*.

Tip You can specify these options by letter, word, or words by preceding each letter or word of the *text* by the option. For example, this code makes the footnote "Red, White, and Blue" appear in different colors.

```
footnote color=red "Red," color=white "White, and" color=blue "Blue";
```

<text-options>
specifies formatting options for the text.

Text options must precede the '*text-string*' that they modify. *Text-options* can be one or more of the following optional arguments, in any order:

ALT=*'text-string'*
The *'text-string'* that you use to describe a footnote, or the URL specified by the LINK= option, can contain occurrences of the variables #BYVAL, #BYVAR, and #BYLINE, as described in "Using #BYLINE, #BYVAL, and

#BYVAR Substitution in URL and FOOTNOTE Text Strings" in *SAS Global Statements: Reference*.

Valid in SAS/GRAPH

Restrictions The ALT= option is not for template-based procedures.

You must enclose *'text-string'* in single or double quotation marks.

Supports The ALT= option can be used in conjunction with the LINK= option.

Note The footnote can be displayed by using an ODS markup destination (such as HTML). Also, the corresponding ODS option NOGFOOTNOTE is specified. In this case, the footnote is rendered in the body of the HTML file rather than in the graphic itself. And the ALT= text is not associated with the footnote.

See "Controlling Where Titles and Footnotes Are Rendered" in *SAS/GRAPH: Reference*

"LINK='*URL*'" on page 55

Example "Example 6: Producing a Drilldown Choropleth Map" on page 451

ANGLE=*degrees*

A positive *degrees* value angles the *baseline* counterclockwise; a negative value angles it clockwise. By default, ANGLE=0 (horizontal).

Angled footnotes might require more vertical space. Consequently, there might be an increase the size of the footnote area, thereby reducing the vertical space in the procedure output area.

Using the BOX= option with angled text does not produce angled boxes; the box is sized to accommodate the angled note.

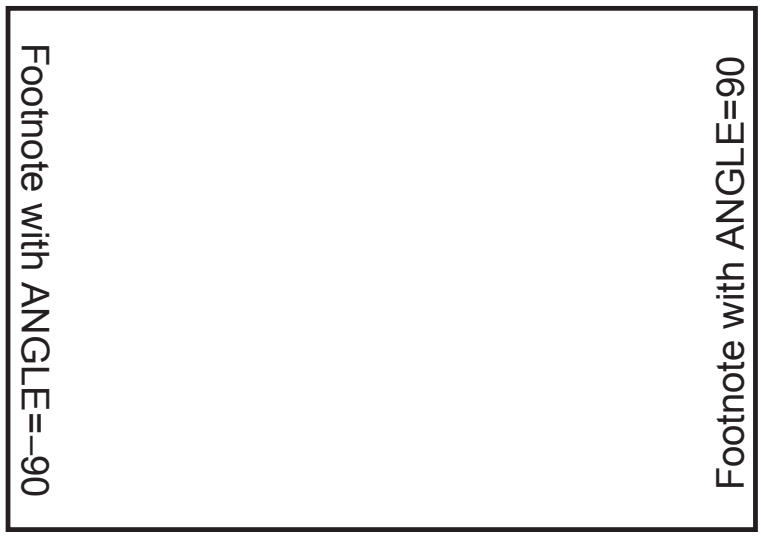
Using the ANGLE= option after one text string and before another can reset some options to their default values. See "Using Options That Can Reset Other Options" on page 66 for details.

The ANGLE= option has the same effect on the text as LANGLE=, except when you specify an angle of 90 degrees or –90 degrees. In these angle specifications, the procedure output area is shrunk from the left or right to accommodate the angled footnote.

ANGLE=90 positions the footnote at the right edge of the graphics output area, angled 90 degrees (counterclockwise) and centered vertically.

ANGLE=–90 positions the footnote at the left edge of the graphics output area, angled –90 (clockwise) and centered vertically.

Figure 6.1 *Positioning Footnotes with the ANGLE=Option*



Valid in SAS/GRAPH

Alias A=

Restriction The ANGLE= option is not for template-based procedures.

See " LANGLE=*degrees*" on page 61

" ROTATE=*degrees*" on page 64

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

BLANK=YES

It does this by blanking out the area where the box is displayed. The BLANK= option enables you to overlay graphics elements with boxed text. It is ignored if you omit the BOX= option. Because footnotes are written from the highest numbered to the lowest numbered, the BLANK= option only blanks out footnotes of a lower number.

Valid in SAS/GRAPH

Alias BL=

Restriction The BLANK= option is not for template-based procedures.

Note The BLANK= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 66 for details

" BOX=1-4 " on page 59

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

BOX=1-4

Specify a value between 1 and 4, where 1 specifies the thinnest line and 4 specifies the thickest line. Only the last BOX= option is used. Boxing angled text does not produce an angled box; the box is sized to include the angled text.

The color of the box outline is determined by the GraphBorderLines element of the current style.

The color of the box is one of the following:

- the color specified by the COLOR= option in the statement
- the default text color

The COLOR= option, preceding the BOX= option, controls the box frame color. To color the background of the box, use the BCOLOR= option. Specify the same color with both the COLOR= option and the BCOLOR= option to effect a box without a frame.

You can include more than one text string in the box as long as no text break occurs between the strings. That is, you cannot use the JUSTIFY= option to create multiple lines of text within a box.

To draw a box around multiple lines of text, you can do either of the following:

- Use the MOVE= option with relative coordinates to position an additional line of text relative to the preceding line and enclose them within the box drawn by the BOX= option. For example, this statement produces the boxed note shown in Figure 6.3 on page 59:

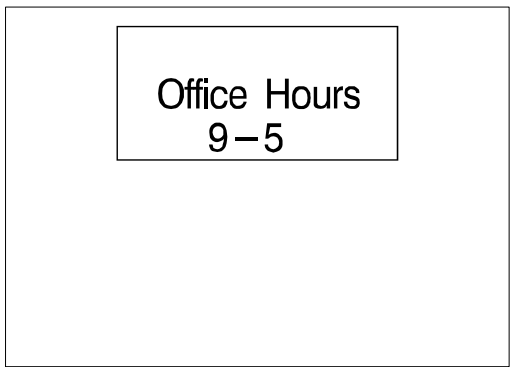
```
footnte font=swiss justify=center box=1
   "Office Hours"      move=(-7,-2)pct "9-5";
```

  The MOVE= option in this FOOTNOTE statement overrides the JUSTIFY= option that center-positioned the first line of text. The MOVE= option specifies the *x* and *y* coordinates in percentage units. The text string '9–5' is positioned relative to the first text string 'Office Hours'.

  Using the MOVE= option in a FOOTNOTE statement enables you to position a footnote on top of a graph.

- Use the DRAW= option to draw the box and do not use the BOX= option.

Figure 6.2 *Using the BOX= Option and the MOVE= Option to Box Multiple Lines of Text*



Valid in SAS/GRAPH, ODS Graphics

Alias BO=

Note The BOX= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= options with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 66 for details

"BCOLOR=*color*" on page 51

" BLANK=YES " on page 58

" BSPACE=*numeric-value<units>*" on page 60

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

BSPACE=*numeric-value<units>*

units specifies the measurement criterion. See the "Units of Measurement" in *SAS ODS Graphics: Procedures Guide* for details.

If you do not specify a unit, then the size of the space is approximately 12*numeric-value* points. For example, if you specify BSPACE=2, then the space is approximately 24 points.

The space above the text is measured from the font maximum, and the space below the text is measured from the font minimum.

The spacing is uniform around the box. Notice that BSPACE=.5IN leaves one-half inch of space between the text and the top, bottom, and sides of the box.

Valid in SAS/GRAPH, ODS Graphics

Alias BS=

Defaults 1

0

Interaction If the BOX= option is not used, the BSPACE= option is ignored

Note The BSPACE= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 66 for details

" BOX=1-4 " on page 59

DRAW=(*x,y -,x-n,y-n*)*<units>*

Lines are drawn using *x* and *y* as absolute or relative coordinates. The following table shows the specifications for absolute and relative coordinates:

Table 6.1 Coordinate Specifications

Absolute Coordinates	Relative Coordinates
x<units>	*±x<units>*
y<units>	*±y<units>*

The coordinate position (0,0) is the lower left corner of the graphics output area. Specify at least two coordinate pairs. Commas between coordinates are optional; blanks can be used instead. The DRAW= option does not affect the positioning of text.

The starting point for lines specified with relative coordinates begins at the end of the most recently drawn text or line in the current statement. If no text or line has been drawn in the current statement, a warning is issued. The relative draw is measured from where a zero-length text string would have ended, given the normal placement for the statement.

You can mix relative and absolute coordinates. For example, DRAW=(+0,+0,1IN) draws a vertical line from the end of the text to one inch from the bottom of the graphics output area.

units specifies the measurement criterion. See the "Units of Measurement" in *SAS ODS Graphics: Procedures Guide* for details.

Valid in SAS/GRAPH

Alias D=

Restriction The DRAW= option is not for template-based procedures.

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

LANGLE=*degrees*

specifies the angle of the *baseline* of the entire text string or text strings with respect to the horizontal axis. A positive value for *degrees* moves the *baseline* counterclockwise; a negative value moves it clockwise.

Angled footnotes might require more vertical space. Consequently, there might be an increase the size of the footnote area, thereby reducing the vertical space in the procedure output area.

Using the BOX= option with angled text does not produce an angled box; the box is sized to accommodate the angled text.

Unlike the ANGLE= option, the LANGLE= option does not reset any other options. Therefore, the LANGLE= option is easier to use because you do not need to repeat options after a text break.

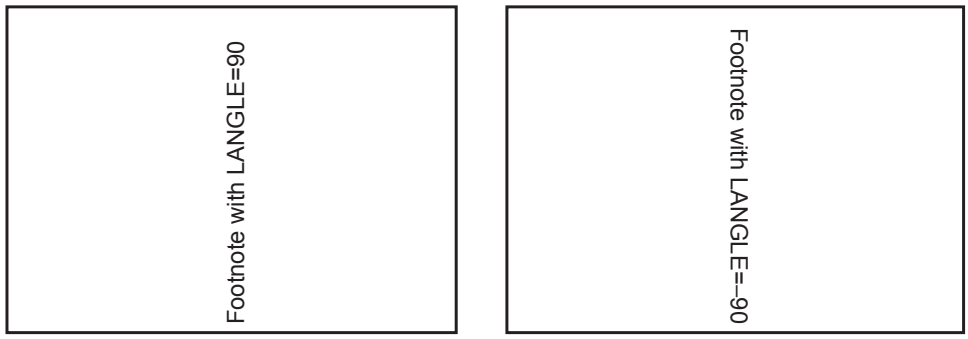
The LANGLE= option has the same effect on the text as the ANGLE= option, except when an angle of 90 degrees or –90 degrees is specified.

LANGLE=90 angles the footnote 90 degrees (counterclockwise) so that it reads from bottom to top. The footnote is

centered horizontally and positioned as the bottom of the picture.

LANGLE=–90 angles the footnote –90 degrees (clockwise) so that it reads from top to bottom. The footnote is centered horizontally and positioned at the bottom of the picture.

Figure 6.3 *Positioning Footnotes with the LANGLE= Option*



Alias LA=

Default LANGLE=0 (horizontal)

See " ANGLE=*degrees*" on page 57

LSPACE=*line-space* <*units*>

specifies the amount of spacing below lines of footnote text. For footnotes, the spacing is measured from the font minimum of the current line to the capline of the line below.

units specifies the measurement criterion. See the "Units of Measurement" in *SAS ODS Graphics: Procedures Guide* for details.

If you do not specify a unit, then the size of the text is approximately 12*numeric-value* points. For example, if you specify HEIGHT=2, then the text size is approximately 24 points.

Alias LS=

Default LSPACE=0

Interaction Interaction The LSPACE= option has no effect if you also specify the BOX= option.

Note The LSPACE= option can be reset by the ANGLE= or JUSTIFY= option, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 66 for details

MOVE=(*x*,*y*) <*units*>

positions an initial or subsequent text string, or lines of text anywhere on the graphics output area. The positioning uses *x* and *y* as absolute or relative coordinates. The following table shows the specifications for absolute and relative coordinates:

Table 6.2 Coordinate Specifications

Absolute Coordinates	Relative Coordinates
x<units>	*±x<units>*
y<units>	*±y<units>*

Commas between coordinates are optional; you can use blanks instead.

The starting point for lines specified with absolute coordinates is at the bottom left corner of the graphics output area. For example, the following program uses the FOOTNOTE statement to add a simple line of text to the lower right quadrant of the graphics output area:

```
footnote move=(85,05)pct color=purple 'My Footnote';
proc gslide;
run;
```

The starting point for lines specified with relative coordinates is at the end of the most recently drawn text or line in the current statement. If no text or line has been drawn in the current statement, a warning is issued in the SAS log. The relative move is measured from where a zero-length text string would have ended, given the normal placement for the statement.

You can mix relative and absolute coordinates.

units specifies the measurement criterion. See the "Units of Measurement" in *SAS ODS Graphics: Procedures Guide* for details.

Alias M=

Restriction The MOVE= option is not for template-based procedures.

Interactions The MOVE= option overrides a JUSTIFY= option specified for the same text string

A FOOTNOTE statement can use the MOVE= option to position the text so that the statement does not use its default position. In this case, the text of the next FOOTNOTE statement occupies the unused position and no blank lines are displayed

Notes You can specify the MOVE= option with at least one absolute coordinate. If the option follows one text string and precedes another, some options can be reset to their default values.

If you specify the GUNIT graphics option, then that unit is the default unit. If you do not specify the GUNIT= graphics option, then the default unit is CELLS.

See "Using Options That Can Reset Other Options" on page 66 for details

" BOX=1-4 " on page 59 for illustrative code that draws a box around lines of text positioned with relative coordinates

Examples

"Enhancing Titles" in *SAS/GRAPH: Reference*

ROTATE=*degrees*

specifies the angle at which each character of text is rotated with respect to the *baseline* of the text string. The angle is measured from the current text *baseline* angle, which is specified by the ANGLE= or LANGLE= options. By default, the *baseline* is horizontal. A positive value for *degrees* rotates the character counterclockwise; a negative value rotates it clockwise. By default, ROTATE=0 (parallel to the *baseline*).

Figure 6.5 on page 64 shows how characters are positioned when ROTATE=90 is used with the default (horizontal) *baseline*.

Figure 6.4 *Tilting Characters with the ROTATE= Option*

Alias R=

See " ANGLE=*degrees*" on page 57

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

WRAP

If the WRAP option is omitted, the text font-size is reduced until the text fits on one line. Wrapping occurs at the last blank before the text meets the end of the window. If there are no blanks in the text string, then there is no wrapping.

Restriction The WRAP option does not work with the BLANK, BOX, MOVE, and UNDERLINE,options.

<'text-string'>

is a text string with a maximum length of 255 bytes. You must enclose text strings in either single or double quotation marks. The text appears exactly as you enter it in the statement, including uppercase and lowercase characters and spaces. Footnotes automatically wrap to additional lines if necessary. If the length of the specified title is greater than the value of the LINESIZE option, the title is truncated to the line size.

To use single quotation marks or apostrophes within the footnote, you can do either of the following:

- use a pair of single quotation marks together:

```
footnote 'All''s Well That Ends Well';
```

- enclose the text in double quotation marks:

```
footnote "All's Well That Ends Well";
```

You can specify multiple text strings in FOOTNOTE statements. If you want each string to be separated by a blank, add a blank to the beginning of the

second and subsequent text strings rather than at the end the preceding string, as in this example:

```
footnote color=red "Sales:" color=blue " 2020";
```

With fonts that support Unicode, you can specify special characters by specifying a hexadecimal constant in quotation marks. A trailing `x` identifies a string as a hexadecimal constant. You must designate the hexadecimal constant as a Unicode specification and escape it: `(*ESC*){Unicode '`*`hexadecimal-value`*`'x}`. For example:

```
footnote "Regression with Confidence Limits ((*ESC*){unicode '03B1'x}=.05)";
```

This statement produces the footnote, "Regression with Confidence Limits (α = .05)" because '03B1'x is the hexadecimal value for the lowercase Greek letter alpha in all Unicode fonts.

> **TIP** You can instead specify lowercase Greek letters by name, and uppercase Greek letters by name_u: `(*ESC*){Unicode alpha}=.05` and `(*ESC*){Unicode alpha_u}=.05`.

For more information see "Specifying Special Characters Using Character and Hexadecimal Codes" in *SAS/GRAPH: Reference*.

You can also customize footnotes by inserting BY variable lines (#BYLINE), BY variable values (#BYVAL), or BY variable names (#BYVAR), in footnotes that are specified in procedure steps. Embed the items in the specified footnote text string at the position where you want the substitution text to appear. See "Using #BYLINE, #BYVAL, and #BYVAR Substitution in URL and FOOTNOTE Text Strings" in *SAS Global Statements: Reference*.

Restriction

Restriction #BYVAL or #BYVAR substitution in a text string is not available in the Annotate facility. The reason is that BY lines are not created in a DATA step.

Tips

For compatibility with previous releases, SAS accepts some text without quotation marks. When you write new programs or update existing programs, *always* enclose text in quotation marks.

You can use macro variables and macros to change the information in FOOTNOTE statements. If the footnote is enclosed in double quotation marks (""), the text indicated is substituted into the footnote. If the footnote is enclosed in single quotation marks ('), the text is not substituted.

See

For more information about including quotation marks as part of the footnote, see "SAS Constants in Expressions" in *SAS Programmer's Guide: Essentials*.

"Using BY-group Processing to Generate a Series of Charts" in *SAS/GRAPH: Reference*

"Combining Graphs and Reports in a Web Page" in *SAS/GRAPH: Reference*

Details

Using FOOTNOTE Statement

A FOOTNOTE statement takes effect when the step or RUN group with which it is associated executes. After you specify a footnote for a line, SAS repeats the same footnote on all pages until you cancel or redefine the footnote for that line. When a FOOTNOTE statement is specified for a given line, it cancels the previous FOOTNOTE statement for that line and for all footnote lines with higher numbers.

Operating Environment Information: The maximum footnote length that is allowed depends on the operating environment and the value of the LINESIZE= system option. For more information, see the SAS documentation for your operating environment.

Units of Measurement

Some of the options in the FOOTNOTE statement enable you to specify the unit of measurement. The following table lists the units that are supported:

Table 6.3 *Measurement Units*

Unit	Description
CM	centimeters
IN	inches
PCT or %	percentage
PT	point size, calculated at 100 dots per inch

The "HEIGHT=*numeric-value<units>*" on page 53 enables you to specify a few more units than are mentioned in the previous table.

Using Options That Can Reset Other Options

The ANGLE=, MOVE=, and JUSTIFY= options affect the position of the text and cause text breaks. (To cause a text break, the MOVE= option must have at least one absolute coordinate.) When a statement contains multiple text strings, the resulting text break can cause the following options to reset to their default values:

- BCOLOR=
- BLANK=
- BOX=
- BSPACE=
- LSPACE=
- UNDERLIN=.

Note: The LANGLE= option does not cause a text break.

In a TITLE, FOOTNOTE, or NOTE statement, before the first text string, you can use an option that can be reset (such as the UNDERLIN= option). Before the second string, if you use an option that resets it (such as the JUSTIFY= option), the first option does not affect the second string. In order for the first option to affect the second string, repeat the option and position it after the resetting option and before the text string.

For example, this statement produces a two-line title in which only the first line is underlined:

```
title underlin=2 "Line 1" justify=left "Line 2";
```

To underline Line 2, repeat the UNDERLIN= option before the second text string and after the JUSTIFY= option:

```
title underlin=2 "Line 1" justify=left
      underlin=2 "Line 2";
```

See Also

"TITLE Statement" on page 121

GOPTIONS Statement

Temporarily sets default values for many graphics attributes and device parameters used by SAS/GRAPH procedures.

Used by: all statements and procedures in a SAS session

Type: Global

Syntax

GOPTIONS <*options-list*>;

Optional Argument

options-list
can be one or more options as listed and described in the "Graphics Options and Device Parameters Dictionary" in *SAS/GRAPH: Reference*.

Details

Description: GOPTIONS Statement

The GOPTIONS statement specifies values for *graphics options*. Graphics options control characteristics of the graph, such as size, colors, type fonts, fill patterns, and symbols. If GOPTIONS are specified, they override the default style. In addition, they affect the settings of device parameters, which are defined in the device entry. Device parameters control such characteristics as the appearance of the display, the type of output produced, and the destination of the output.

The GOPTIONS statement enables you to change these settings temporarily, either for a single graph or for the duration of your SAS session. You can use the GOPTIONS statement to do the following tasks:

- override default values for graphics options that control either graphics attributes or device parameters for a single graph or for an entire SAS session
- reset individual graphics options or all graphics options to their default values
- cancel definitions for FOOTNOTE, PATTERN, and TITLE statements

To change device parameters permanently, you must use the GDEVICE procedure to modify the appropriate device entry or to create a new one. See the "GDEVICE Procedure" in *SAS/GRAPH: Reference* for details.

To review the current settings of all graphics options, use the GOPTIONS procedure. See the "GOPTIONS Procedure" in *SAS/GRAPH: Reference* for details.

Using the GOPTIONS Statement

GOPTIONS statements are global and can be located anywhere in your SAS program. However, for the graphics options to affect the output from a procedure, the GOPTIONS statement must execute before the procedure.

With the exception of the RESET= option, graphics options can be listed in any order in a GOPTIONS statement. The RESET= option should be the first option in the GOPTIONS statement.

A graphics option remains in effect until you specify the option in another GOPTIONS statement, use the RESET= option to reset the values, or end the SAS session. When a session ends, the values of the graphics options return to their default values.

Graphics options are additive. That is, the value of a graphics option remains in effect until the graphics option is explicitly changed or reset or until your SAS session ends. Graphics options remain in effect even after you submit additional GOPTIONS statements specifying different options.

To reset an individual option to its default value, submit the option without a value (a null graphics option.) You can use a comma (but it is not required) to separate a null graphics option from the next one. For example, this GOPTIONS statement sets the values for the background color, the text height, and the text font:

```
goptions cback=blue htext=6 pct ftext="Albany AMT";
```

Note: When there is a space in the font name, surround the name in quotation marks. The quotation marks also indicate use of a system font rather than a software graph font.

To reset only the background color specification to the default and keep the remaining values, use this GOPTIONS statement:

```
goptions cback=;
```

To reset all graphic options to their default values, specify RESET=GOPTIONS:

```
goptions reset=goptions;
```

Alternatively, you can use RESET=ALL, but it also cancels any global statement definitions in addition to resetting all graphics options to default values.

Graphics Option Processing

You can control many graphics attributes through statement options, graphics options, device parameters, or a combination of these. SAS/GRAPH searches these places to determine the value to use, stopping at the first place that gives it an explicit value:

1. statement options
2. the value of the corresponding graphics option
3. the value of a device parameter found in the catalog entry for your device driver

Note: Not every graphics attribute can be set in all three places. See the statement and procedure chapters for the options that can be used with each.

Some graphics options are supported for specific devices or operating environments only. See the SAS Help facility for SAS/GRAPH or the SAS companion for your operating environment for more information.

LEGEND Statement

Controls the location and appearance of legends on maps.

Used by: GMAP

Type: Global

Syntax

LEGEND*<1 - 99>* *<options>*;

Summary of Optional Arguments

Appearance options

ACROSS=*number-of-columns*
: specifies the number of columns to use for legend entries.

CBLOCK=*block-color*
: generates and colors a three-dimensional block effect behind the legend.

CBORDER=*frame-color*
: draws a colored frame around the legend.

CFRAME=*background-color*
: specifies the background color of the legend.

CSHADOW=*shadow-color*
: generates and colors a drop shadow behind the legend.

DOWN=*number-of-rows*
: specifies the number of rows to use for legend entries.

FRAME

NOFRAME
: draws a frame around the legend.

FWIDTH=*thickness-factor*
: specifies the thickness of the frame, where *thickness-factor* is a number.

REPEAT=1 | 2 | 3
: specifies how many times the plot symbol is repeated in the legend.

ROWMAJOR

COLMAJOR
: specifies the arrangement of legend entries when there are multiple rows and multiple columns.

SHAPE=BAR(*width<units>,height<units>*) *<units>*
: specifies the size and shape of the legend values displayed in each legend entry.

SPACE=*value-spacing*
: specifies the amount of space between individual legend values along a horizontal baseline.

Position options

MODE=PROTECT | RESERVE | SHARE
: specifies whether the legend is drawn in the procedure output area or whether legend elements can overlay other graphics elements.

OFFSET=(*<x><,y>*)*< units>* | (*<x< units>><,y< units>>*)
: specifies the distance to move the entire legend.

ORIGIN=(*<x><,y>*)*< units>* | (*<x< units>><,y< units>>*)
: specifies the *x* and *y* coordinates of the lower left corner of the legend box.

POSITION=(<BOTTOM | MIDDLE | TOP> <LEFT | CENTER | RIGHT> <OUTSIDE | INSIDE>)
: positions the legend on the graph.

Text options

LABEL=(*text-options* | (<*text-options*> "*text-string*") | NONE
: modifies a legend label.

ORDER=(*value-list*) | DESCENDING
: selects or orders the legend values that appear in the legend.

SPLIT="*split-char(s)*"
: specifies one or more characters that the LEGEND statement uses to break a text description string into multiple lines.

VALUE=(*text-options* | (<*text-options*> "*text-string*") | NONE
: modifies the legend value descriptions.

Optional Arguments

ACROSS=*number-of-columns*
: specifies the number of columns to use for legend entries. If there are multiple rows and columns in a legend, use the ROWMAJOR and COLMAJOR options to specify the arrangement of legend entries. Specify the ROWMAJOR option to arrange entries (from lowest to highest) starting from left to right, and then top to bottom. Specify the COLMAJOR option to arrange entries starting from top to bottom, and then left to right.

See "ROWMAJOR|COLMAJOR" on page 80

Example "Example 2: Using Global Statements When Creating a Map" on page 143

CBLOCK=*block-color*
: generates and colors a three-dimensional block effect behind the legend. The size and position of the block are controlled by the graphics option OFFSHADOW=(*x,y*)..

Restriction The CBLOCK= and CSHADOW= options are mutually exclusive. If both are present, SAS/GRAPH software uses the last one specified.

Interaction The CBLOCK= option is usually used in conjunction with the FRAME, CFRAME=, or CBORDER= options.

See "OFFSHADOW= Graphics Option" in *SAS/GRAPH: Reference*

"Creating Drop Shadows and Block Effects" on page 91

CBORDER=*frame-color*
: draws a colored frame around the legend.

Style reference Color attribute of the GraphBorderLines graph element

Restriction This option overrides the FRAME option.

Interaction CBORDER= can be used in conjunction with the CFRAME= option.

CFRAME=*background-color*
: specifies the background color of the legend. This option overrides the FRAME option.

Style reference Color attribute of the GraphLegendBackground graph element

Restriction If both the CFRAME= and FRAME= options are specified, only the solid background produced by the CFRAME= option is displayed.

Interaction The CFRAME= option can be used in conjunction with the CBORDER= option.

CSHADOW=*shadow-color*

generates and colors a drop shadow behind the legend. The size and position of the shadow is controlled by the graphics option OFFSHADOW=(*x,y*).

Restriction The CSHADOW= and CBLOCK= options are mutually exclusive. If both are present, SAS/GRAPH uses the last one specified.

Interaction The CSHADOW= option is usually specified in conjunction with the FRAME, CFRAME=, or CBORDER= options.

See "OFFSHADOW= Graphics Option" in *SAS/GRAPH: Reference*

"Creating Drop Shadows and Block Effects" on page 91

DOWN=*number-of-rows*

specifies the number of rows to use for legend entries. If there are multiple rows and columns in a legend, use the ROWMAJOR and COLMAJOR options to specify the arrangement of legend entries. Specify the ROWMAJOR option to arrange entries (from lowest to highest) starting from left to right, and then top to bottom. Specify the COLMAJOR option to arrange entries starting from top to bottom, and then left to right.

Default When there are multiple rows and columns in a legend, the ROWMAJOR option is the default

See "ROWMAJOR|COLMAJOR" on page 80

FRAME | NOFRAME

draws a frame around the legend. The color of the frame is the first color in the color list. NOFRAME suppresses the drawing of a frame, and is the default.

FWIDTH=*thickness-factor*

specifies the thickness of the frame, where *thickness-factor* is a number. The thickness of the line increases directly with *thickness-factor*. By default, FWIDTH=1.

LABEL=(*text-options* | (*<text-options>* "*text-string*") | NONE

modifies a legend label. By default, the text of the legend label is either the variable name or a previously assigned variable label (except in the case of GPLOT with OVERLAY. In that case, the default label is "PLOT"). You can use an overlay variable and suppress the legend label that would display that variable name. Specify a SAS software font to generate the unprintable hexadecimal character of '00'x, as shown in this example:

```
legend1 label=(font=swiss '00'x);
```

When specified, the *text-options* that modify an legend label must precede the *text-string* or *text-strings* for which it is intended.

Specify as many text strings and text options as you want, but enclose them all in one set of parentheses.

text-options
modifies a characteristic of the legend label, such as the font, color, or size.. *Text-options* can be one or more of these:

ANGLE=*degrees*
specifies the angle of the legend label or legend value description text with respect to the horizontal. A positive value for degrees moves the text counterclockwise; a negative value moves it clockwise. By default, ANGLE=0 (horizontal).

Note: Some settings of ANGLE= in the LEGEND statement might result in undesirable text positioning.

Alias A=

See "ROTATE=*degrees*" on page 76

COLOR=*text-color*
specifies the color of the text. If you omit the COLOR= option, a color specification is searched for in this order:

1. the CTEXT= option for the procedure
2. the CTEXT= option in a GOPTIONS statement
3. the color of the default style

Alias C=

FONT=*font* | NONE
specifies the font for the text. See "Specifying Fonts in SAS/GRAPH Programs" in *SAS/GRAPH: Reference* for information about specifying fonts. If you omit the FONT= option, a font specification is searched for in this order:

1. the FTEXT= option in a GOPTIONS statement
2. the default style font, NONE

Alias F=

HEIGHT=*text-height <units>*
specifies the height of the text characters in the number of units. By default, HEIGHT=1 CELL. If you omit the HEIGHT= option, a text height specification is searched for in this order:

1. the HTEXT= option in a GOPTIONS statement
2. the height specified by the default style

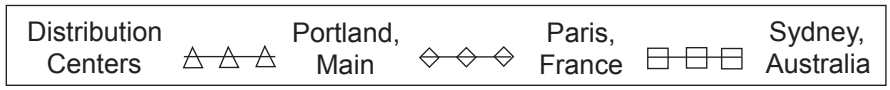
Alias H=

JUSTIFY=LEFT | CENTER | RIGHT
specifies the alignment of the text. The default for character variables is JUSTIFY=LEFT. The default for numeric variables is JUSTIFY=RIGHT. Associating a character format with a numeric variable does not change the default justification of the variable.

You can use the JUSTIFY= option to print multiple lines of text by repeating the option before the text string for each line. For example, this statement produces a legend label and value descriptions like those shown in Figure 6.6 on page 74:

```
legend label=(justify=c "Distribution"
              justify=c "Centers")
value=(tick=1 justify=c "Portland,"
              justify=c "Maine"
       tick=2 justify=c "Paris,"
              justify=c "France"
       tick=3 justify=c "Sydney,"
              justify=c "Australia");
```

Figure 6.5 *Specifying Multiple Lines of Text with the JUSTIFY= Suboption*



Place text options before the text string or text strings that they modify.

LEFT
aligns the text to the left.

Alias L

CENTER
aligns the text in the center.

Alias C

RIGHT
aligns the text to the right.

Alias R

Alias J=

See "TICK=*n*" on page 76

POSITION=(<BOTTOM | MIDDLE | TOP> <LEFT | CENTER | RIGHT>)
places the legend label in relation to the legend entries. The POSITION= option is used only with the LABEL= option. By default, POSITION=LEFT.

The parentheses are not required if only one value is supplied. If you specify two or three values and omit the parentheses, SAS/GRAPH accepts the first value and ignores the others.

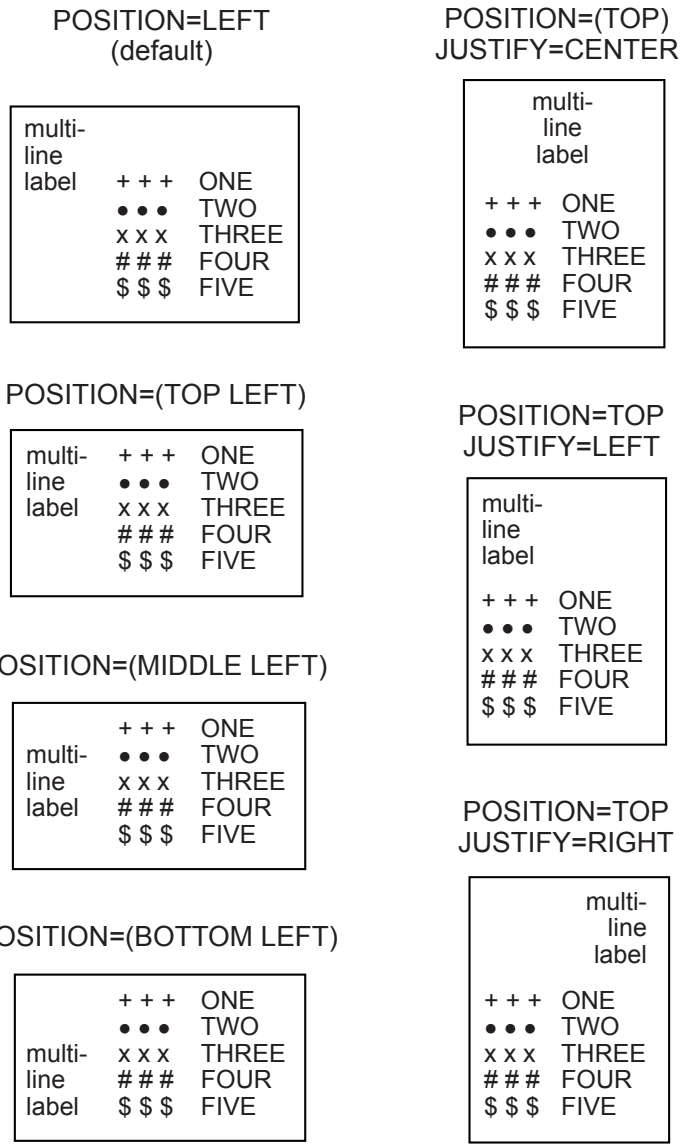
Figure 6.7 on page 75 shows some of the ways the POSITION= option affects a multiple-line legend label in which the entries are stacked in a

column (ACROSS=1). This figure uses a label specification such as the following:

```
label=("multi-"
        justify=left "line"
        justify=left "label"
        position=left)
```

In this specification, the POSITION= option specifies the default value, LEFT, which is represented by the first legend in the figure. The POSITION= value is indicated above each legend. The default justification is used unless you also use the JUSTIFY= option.

Figure 6.6 *Using the POSITION= Suboption with Multiple-line Legend Labels*



In addition, specifying POSITION=RIGHT mirrors the effect of POSITION=LEFT, and specifying POSITION=BOTTOM mirrors the effect of POSITION=TOP.

ROTATE=*degrees*
specifies the angle at which each character of text is rotated with respect to the *baseline* of the text string. A positive value for degree rotates the character counterclockwise; a negative value moves it clockwise. By default, ROTATE=0 (parallel to the *baseline*).

Note: Some settings of ROTATE= in the LEGEND statement might result in undesirable text positioning.

Alias R=

See "ANGLE=*degrees*" on page 73

TICK=*n*
specifies the nth legend entry. The TICK= option is used only with the VALUE= option to designate the legend entry whose text and appearance you want to modify. For example, to change the text of the third legend entry to `Minneapolis`, specify the following code:

```
value=(tick=3 "Minneapolis")
```

The characteristics of all other value descriptions remain unchanged.

If you use the TICK= option when you designate text for one legend entry, you must also use it when you designate text for any additional legend entries. For example, this option changes the text of both the second and third legend entries:

```
value=(tick=2 "Paris" tick=3 "Sydney")
```

If you omitted TICK=3, the text of the second legend entry would be `ParisSydney`.

Text options that precede the TICK= option affect all the value descriptions for the legend unless the same option (with a different value) follows a TICK= specification. Text options that follow the TICK= option affect only the specified legend entry. For example, suppose you specify this option for a legend with three entries:

```
value=(color=red font=swiss tick=2 color=blue)
```

The text of all three entries would use the Swiss font; the first and third entries would be red and only the second entry would be blue.

Alias T=

"text-string"
provides up to 256 characters of label text. Enclose each string in quotation marks. Separate multiple strings with blanks.

In addition, if you have a BY statement in your procedure step, you can use BY-variable substitution to include the value of one or more BY variables in *text-string*. See "Using #BYVAL and #BYVAR Substitution in Label and Value Strings" on page 92.

NONE
suppresses the value descriptions.

The legend values (bars, lines, and so on) are still displayed.

Style reference
Color attribute of the GraphLabelText graph element

Restrictions
#BYVAL or #BYVAR substitution in a text string is not available in the Annotate facility. The reason is that BY lines are not created in a DATA step.

When there is not enough room in the output to display a long label text, the variable name is displayed instead. However, when POSITION=INSIDE and the legend label is too long, the legend is suppressed. In either case, the SAS log displays a warning message.

Example
Text description options affect all the strings that follow them unless the option is changed or turned off. If the value of a option is changed, the new value affects all the text strings that follow it. Consider this example:

```
label=(font=albany amt height=4 "Weight"
       justify=right height=3 "(in tons)")
```

FONT=ALBANY AMT applies to both Weight and (in tons). HEIGHT=4 affects “Weight”, but is respecified as HEIGHT=3 for “(in tons)”. JUSTIFY=RIGHT affects only “(in tons)”.

Examples

“Example 2: Using Global Statements When Creating a Map” on page 143

MODE=PROTECT | RESERVE | SHARE

specifies whether the legend is drawn in the procedure output area or whether legend elements can overlay other graphics elements. If the space required to display the legend exceeds that of the space required to display the graph, a warning is issued and the legend is suppressed. The MODE= option can take one of these values:

PROTECT
draws the legend in the procedure output area, but a *blanking area* surrounds the legend, preventing other graphics elements from being displayed in the legend. (A blanking area is a protected area in which no other graphics elements are displayed.)

RESERVE
takes space for the legend from the procedure output area, thereby reducing the amount of space available for the graph. If MODE=RESERVE is specified in conjunction with OFFSET=, the legend can push the graph off the graphics output area. RESERVE is valid only when POSITION=OUTSIDE. If POSITION=INSIDE is specified, a warning is issued and MODE= value is changed to PROTECT.

SHARE
draws the legend in the procedure output area. If the legend is positioned over elements of the graph itself, both graphics elements and legend elements are displayed.

By default, MODE=RESERVE unless POSITION=INSIDE. In this case, the default changes to MODE=PROTECT.

If the MODE=PROTECT option is used with labels on the midpoint axis, the axis labels might overlap the legend. In that case, if a device-resident font is used as the label font, the device-resident font for each label that overlaps the legend is replaced with a SAS/GRAPH font. This includes the axis label and the tick mark labels. Because device-resident fonts do not support clipping, a SAS/GRAPH font must be substituted in that case. To correct an overlap condition, you can use the LABEL=NONE and VALUE=NONE options on your midpoint axis statement to suppress the axis labels. Another choice is to use the positioning options on your LEGEND statement to reposition the legend.

See "Positioning the Legend" on page 89

OFFSET=(<*x*><,*y*>)< *units*> | (<*x*< *units*>><,*y*< *units*>>)

specifies the distance to move the entire legend. *x* is the number of units to move the legend right (positive numbers) or left (negative numbers). *y* is the number of units to move the legend up (positive numbers) or down (negative numbers).

To set only the *x* offset, specify one value, with or without a following comma:

```
offset=(4 cm,)
```

To set both the *x* and *y* offset, specify two values, with or without a comma separating them:

```
offset=(2 pct, 4 pct)
```

To set only the *y* offset, specify one value preceded by a comma:

```
offset=(,-3 pct)
```

The OFFSET= option is usually used in conjunction with the POSITION= option to adjust the position of the legend. Moves are relative to the location specified by the POSITION= option, with OFFSET=(0,0) representing the initial position. You can also apply the OFFSET= option to the default legend position.

The OFFSET= option is unnecessary with the ORIGIN= option because the ORIGIN= option explicitly positions the legend and requires no further adjustment. However, if you specify both options, the OFFSET= values are added to the ORIGIN= values, and the LEGEND is positioned accordingly.

See "Positioning the Legend" on page 89

"POSITION=(<BOTTOM | MIDDLE | TOP> <LEFT | CENTER | RIGHT> <OUTSIDE | INSIDE>)" on page 79

ORDER=(*value-list*) | DESCENDING

selects or orders the legend values that appear in the legend. DESCENDING specifies that the legend values appear in the legend in reverse of the default order, sorted from maximum to minimum value. Alternatively, use *value-list* to select only those legend values that you want to display and by their placement in the list, order where they appear in the legend. The way you specify *value-list* depends on the type of variable that generates the legend:

- For numeric variables, *value-list* is either an explicit list of values, or a starting value and an ending value with an interval increment, or a combination of both forms:
  - *n* < *...n*>
  - *n* TO *n* <BY *increment*>
  - *n* < *...n*> TO *n* <BY *increment*> <*n* < *...n*>>

  If a numeric variable has an associated format, the specified values must be the unformatted values.
- For character variables, *value-list* is a list of unique character values enclosed in quotation marks and separated by blanks:
  - *"value-1"<" value-2" ..." value-n">*

  If a character variable has an associated format, the specified values must be the formatted values.

For a complete description of *value-list*, see the ORDER= option in the "AXIS Statement" in *SAS/GRAPH: Reference*.

Even though the ORDER= option controls whether a legend value is displayed and where it appears, the VALUE= option controls the text that the legend value displays.

Restriction Up to 256 characters in a variable value might be displayed.

ORIGIN=(<*x*><,*y*>)< *units*> | (<*x*< *units*>><,*y*< *units*>>)

specifies the *x* and *y* coordinates of the lower left corner of the legend box. The ORIGIN= option explicitly positions the legend anywhere on the graphics output area. It is possible to run a legend off the page or overlay the graph.

To set only the *x* coordinate, specify one value, with or without a following comma:

```
origin=(4 cm,)
```

To set both the *x* and *y* coordinates, specify two values, with or without a comma separating them:

```
origin=(2 pct, 4 pct)
```

To set only the *y* coordinate, specify one value preceded by a comma:

```
origin=(,3 pct)
```

The ORIGIN= option overrides the POSITION= option if both are used. Although using the OFFSET= option with the ORIGIN= option is unnecessary, if the OFFSET= option is also specified, it is applied after the ORIGIN= request has been processed.

See "Positioning the Legend" on page 89

POSITION=(<BOTTOM | MIDDLE | TOP> <LEFT | CENTER | RIGHT> <OUTSIDE | INSIDE>)

positions the legend on the graph. Values for POSITION= are as follows:

OUTSIDE
INSIDE
specifies the location of the legend in relation to the axis area.

BOTTOM
MIDDLE
TOP
specifies the vertical position.

LEFT
CENTER
RIGHT
specifies the horizontal position.

By default, POSITION=(BOTTOM CENTER OUTSIDE). You can change one or more settings. If you supply only one value, then the parentheses are not required. If you specify two or three values and omit the parentheses, SAS/GRAPH accepts the first value and ignores the others.

Once you assign the initial legend position, you can adjust it with the OFFSET= option.

The ORIGIN= option overrides the POSITION= option. The value of the MODE= option can affect the behavior of the POSITION= option.

Restriction When there is not enough room in the output to display a long label text, the variable name is displayed instead. However, when POSITION=INSIDE and the legend label is too long, the legend is suppressed. In either case, the SAS log displays a warning message.

See "OFFSET=(<*x*><,*y*>)< *units*> | (<*x*< *units*>><,*y*< *units*>>)" on page 78

"MODE=PROTECT | RESERVE | SHARE" on page 77

REPEAT=1 | 2 | 3
specifies how many times the plot symbol is repeated in the legend. Valid values are 1 to 3. The default value is 3 .

ROWMAJOR | COLMAJOR
specifies the arrangement of legend entries when there are multiple rows and multiple columns. Specify the ROWMAJOR option (the default) to arrange entries (from lowest to highest) starting from left to right, and then top to bottom. Specify the COLMAJOR option to arrange the entries starting from top to bottom, and then left to right.

See "ACROSS=*number-of-columns*" on page 71

"DOWN=*number-of-rows*" on page 72

SHAPE=BAR(*width*<*units*>,*height*<*units*>) <*units*>
specifies the size and shape of the legend values displayed in each legend entry. The SHAPE= value that you specify depends on which procedure generates the legend.

BAR(*width*,*height*)<*units*>
(*width*<*units*>,*height*<*units*>) <*units*>
is used with the GMAP procedure. Each legend value is a bar of the specified width and height.

Default *width* is 5, *height* is 0.8, and *units* are CELLS.

Note You can specify the width and height in units of character cells (CELLS), centimeters (CM), inches (IN), percentage of the graphics output area (PCT), or points (PT). There are approximately 72 points in an inch.

Tip You can specify *units* for the *width*,*height* pair or for either or both of the individual coordinates.

LINE(*length*) <*units*>
is used with the GPLOT and GCONTOUR procedures. Each legend value is a line of the length that you specify. Plotting symbols are omitted from the legend values. You can specify *units* for *length*.

Default *length* is 5 and *units* are CELLS.

Note You can specify the length in units of character cells (CELLS), centimeters (CM), inches (IN), percentage of the graphics output area (PCT), or points (PT). There are approximately 72 points in an inch.

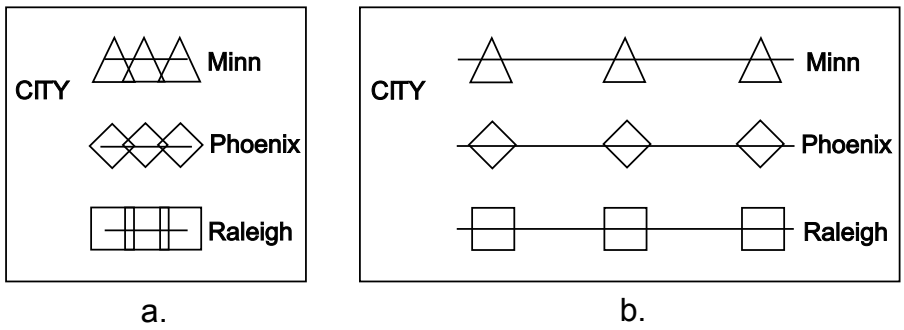
SYMBOL(*width*,*height*)<*units*>
(*width*<*units*>,*height*<*units*>) <*units*>
is used with the GPLOT procedure. Each legend value (not each symbol), is the width and height that you specify. For example, this specification produces legend values like the ones in Figure 6.8 on page 81 (a):

```
shape=symbol(.5,.5)
```

This specification produces legend values like the ones in Figure 6.8 on page 81 (b):

```
shape=symbol(2,.5)
```

Figure 6.7 *Legend Values Produced with SHAPE= SYMBOL*



Default *width* is 5, *height* is 1, and *units* are CELLS.

Note You can specify the width and height in units of character cells (CELLS), centimeters (CM), inches (IN), percentage of the graphics output area (PCT), or points (PT). There are approximately 72 points in an inch.

Tips You can specify *units* for the *width*,*height* pair or for either or both of the individual coordinates.

Use the SHAPE=SYMBOL option when using the SYMBOL statement option INTERPOL=NEEDLE to modify the width or height values of the legend entry separately from the size of the GPLOT procedure's plot needles.

SPACE=*value-spacing*

specifies the amount of space between individual legend values along a horizontal baseline. *Value-spacing* can be any nonnegative number, including decimal values. Units are only character cells. You cannot specify a unit of measure, such as inches or percent. The LEGEND statement calculates spacing based on the available display area, and the number and width of legend entries. If the spacing requested exceeds the display area, the legend values and their descriptions are rearranged to fit.

The SPACE= option is ignored if the following is true:

- SPACE=0 is specified.
- The specified spacing is requested in conjunction with vertically stacked columns.

SPLIT="*split-char(s)*"

specifies one or more characters that the LEGEND statement uses to break a text description string into multiple lines. *Split-char(s)* can be any character value that can be specified in a SAS character variable. Do not delimit when specifying multiple split characters. When the LEGEND statement encounters the split character, it automatically breaks the value at that point and continues on the next line. For example, suppose the legend text description contains the string `Berlin, Germany/Europe`, and you specify SPLIT=",/". The legend breaks the text string into top-aligned lines as follows:

```
Berlin
Germany
Europe
```

If the LEGEND statement does not encounter a specified split character, no break in the text occurs, and no warning or error is issued.

Restrictions Not supported by the GRADAR procedure

Up to 31 split characters are supported. If you specify more than 31 characters, only the first 31 are honored.

Note The split characters themselves are not displayed.

Example "Creating a Drill-Down HTML Graph" in *SAS/GRAPH: Reference*

VALUE=(*text-options* | (*<text-options>* "*text-string*") | NONE
modifies the legend value descriptions. By default, value descriptions are the values of the variable that generates the legend or an associated format value. Numeric values are right-justified and character values are left-justified.

Specify as many text strings and text options as you want, but enclose them all in one set of parentheses.

text-options
modifies a characteristic of the legend value description, such as the font, color, or size. *Text-options* can be one or more of these:

ANGLE=*degrees*
specifies the angle of the legend label or legend value description text with respect to the horizontal. A positive value for degrees moves the text counterclockwise; a negative value moves it clockwise. By default, ANGLE=0 (horizontal).

Note: Some settings of ANGLE= in the LEGEND statement might result in undesirable text positioning.

Alias A=

See "ROTATE=*degrees*" on page 86

COLOR=*text-color*
specifies the color of the text. If you omit the COLOR= option, a color specification is searched for in this order:

1. the CTEXT= option for the procedure
2. the CTEXT= option in a GOPTIONS statement
3. the color of the default style

Alias C=

FONT=*font* | NONE
specifies the font for the text. See "Specifying Fonts in SAS/GRAPH Programs" in *SAS/GRAPH: Reference* for information about specifying fonts. If you omit the FONT= option, a font specification is searched for in this order:

1. the FTEXT= option in a GOPTIONS statement
2. the default style font, NONE

Alias F=

HEIGHT=*text-height <units>*
specifies the height of the text characters in the number of units. By default, HEIGHT=1 CELL. If you omit the HEIGHT= option, a text height specification is searched for in this order:

1. the HTEXT= option in a GOPTIONS statement
2. the height specified by the default style

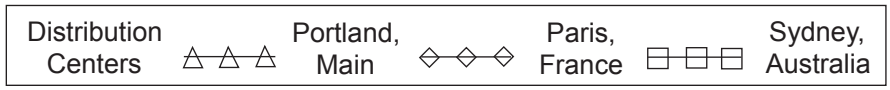
Alias H=

JUSTIFY=LEFT | CENTER | RIGHT
specifies the alignment of the text. The default for character variables is JUSTIFY=LEFT. The default for numeric variables is JUSTIFY=RIGHT. Associating a character format with a numeric variable does not change the default justification of the variable.

You can use the JUSTIFY= option to print multiple lines of text by repeating the option before the text string for each line. For example, this statement produces a legend label and value descriptions like those shown in Figure 6.9 on page 84:

```
legend label=(justify=c "Distribution"
              justify=c "Centers")
value=(tick=1 justify=c "Portland,"
              justify=c "Maine"
       tick=2 justify=c "Paris,"
              justify=c "France"
       tick=3 justify=c "Sydney,"
              justify=c "Australia");
```

Figure 6.8 *Specifying Multiple Lines of Text with the JUSTIFY= Suboption*



Place text options before the text string or text strings that they modify.

LEFT
aligns the text to the left.

Alias L

CENTER
aligns the text in the center.

Alias C

RIGHT
aligns the text to the right.

Alias R

Alias J=

See "TICK=*n*" on page 86

POSITION=(<BOTTOM | MIDDLE | TOP> <LEFT | CENTER | RIGHT>)
places the legend label in relation to the legend entries. The POSITION= option is used only with the LABEL= option. By default, POSITION=LEFT.

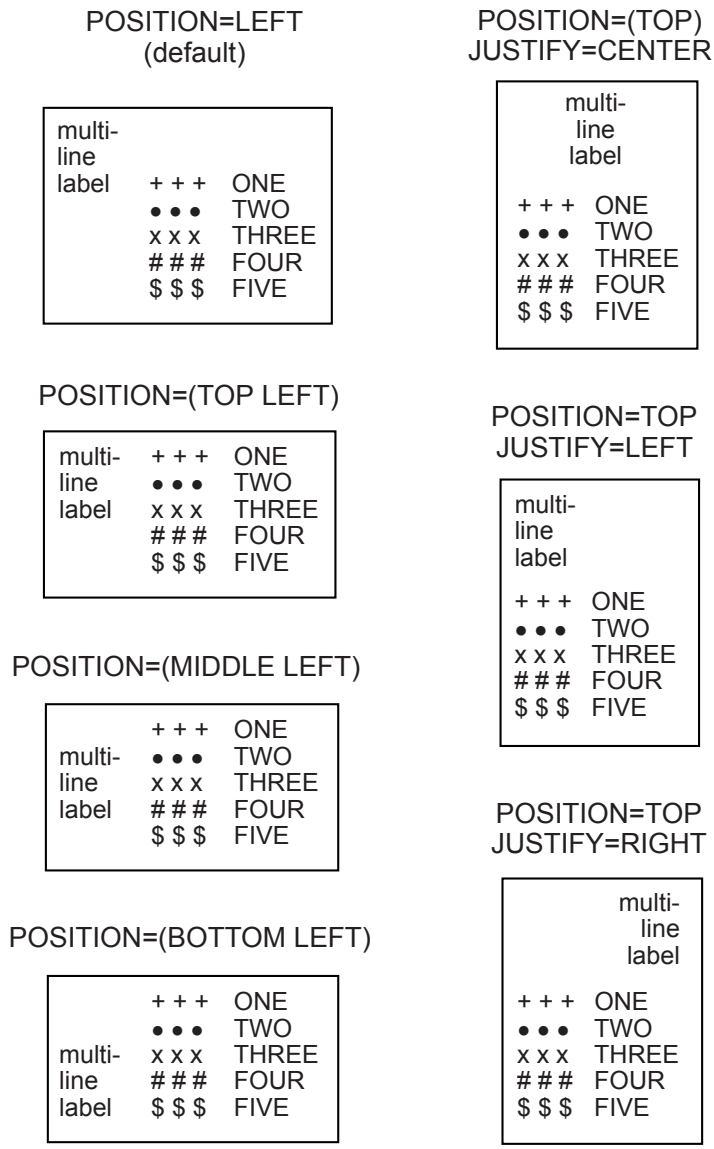
The parentheses are not required if only one value is supplied. If you specify two or three values and omit the parentheses, SAS/GRAPH accepts the first value and ignores the others.

Figure 6.10 on page 85 shows some of the ways the POSITION= option affects a multiple-line legend label in which the entries are stacked in a column (ACROSS=1). This figure uses a label specification such as the following:

```
label=("multi-"
        justify=left "line"
        justify=left "label"
        position=left)
```

In this specification, the POSITION= option specifies the default value, LEFT, which is represented by the first legend in the figure. The POSITION= value is indicated above each legend. The default justification is used unless you also use the JUSTIFY= option.

Figure 6.9 *Using the POSITION= Suboption with Multiple-line Legend Labels*



In addition, specifying POSITION=RIGHT mirrors the effect of POSITION=LEFT, and specifying POSITION=BOTTOM mirrors the effect of POSITION=TOP.

ROTATE=*degrees*
specifies the angle at which each character of text is rotated with respect to the *baseline* of the text string. A positive value for degree rotates the character counterclockwise; a negative value moves it clockwise. By default, ROTATE=0 (parallel to the *baseline*).

Note: Some settings of ROTATE= in the LEGEND statement might result in undesirable text positioning.

Alias R=

See "ANGLE=*degrees*" on page 83

TICK=*n*
specifies the nth legend entry. The TICK= option is used only with the VALUE= option to designate the legend entry whose text and appearance you want to modify. For example, to change the text of the third legend entry to `Minneapolis`, specify the following code:

```
value=(tick=3 "Minneapolis")
```

The characteristics of all other value descriptions remain unchanged.

If you use the TICK= option when you designate text for one legend entry, you must also use it when you designate text for any additional legend entries. For example, this option changes the text of both the second and third legend entries:

```
value=(tick=2 "Paris" tick=3 "Sydney")
```

If you omitted TICK=3, the text of the second legend entry would be `ParisSydney`.

Text options that precede the TICK= option affect all the value descriptions for the legend unless the same option (with a different value) follows a TICK= specification. Text options that follow the TICK= option affect only the specified legend entry. For example, suppose you specify this option for a legend with three entries:

```
value=(color=red font=swiss tick=2 color=blue)
```

The text of all three entries would use the Swiss font; the first and third entries would be red and only the second entry would be blue.

Alias T=

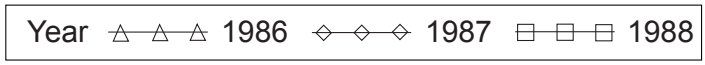
Note Place text options before the text strings that they modify. Options not followed by a text string affect the default values. To specify and describe the text for individual values or to produce multi-line text, use the TICK= text option.

"text-string"
provides up to 256 characters of text for the value description. Enclose each string in quotation marks. Separate multiple strings with blanks. Value description text that is too long to fit in a legend area can result in the entire value not being displayed.

Specified text strings are assigned to the legend values in order. If you submit only one string, only the first legend entry uses the value of that string. If you specify multiple strings, the first string is the text for the first entry; the second string is the text for the second entry; and so on. For example, this specification produces legend entries like those shown in Figure 6.11 on page 87:

```
value=("1986" "1987"
"1988")
```

Figure 6.10 *Specifying Value Descriptions with the VALUE= Option*



In addition, if you have a BY statement in your procedure step, you can use BY-variable substitution to include the value of one or more BY variables in *text-string*. See "Using #BYVAL and #BYVAR Substitution in Label and Value Strings" on page 92.

NONE
suppresses the value descriptions.

The legend values (bars, lines, and so on) are still displayed.

Restriction #BYVAL or #BYVAR substitution in a text string is not available in the Annotate facility. The reason is that BY lines are not created in a DATA step.

Tip To order or select legend entries, use the ORDER= option.

See "ORDER=(*value-list*) | DESCENDING" on page 78

Example Text description options affect all the strings that follow them unless the option is changed or turned off. If the value of a option is changed, the new value affects all the text strings that follow it. Consider this example:

```
value=(font=swiss height=4 "Weight"
       justify=right height=3 "(in tons)")
```

FONT=SWISS applies to both Weight and (in tons). HEIGHT=4 affects "Weight", but is respecified as HEIGHT=3 for "(in tons)". JUSTIFY=RIGHT affects only "(in tons)".

Details

Description: LEGEND Statement

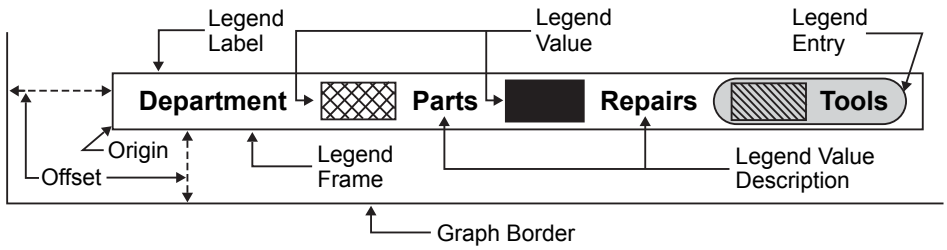
LEGEND statements specify the characteristics of a legend but do not create legends. The characteristics are as follows:

- the position and appearance of the legend box
- the text and appearance of the legend label
- the appearance of the legend entries, including the size and shape of the legend values
- the text of the labels for the legend values

LEGEND definitions are not automatically applied when a procedure generates a legend. Instead, they must be explicitly assigned with a LEGEND= option in the appropriate procedure statement.

The following figure illustrates the terms associated with the various parts of a legend.

Figure 6.11 *Parts of a Legend*



Using the LEGEND Statement

LEGEND statements can be located anywhere in your SAS program. They are global and remain in effect until canceled or until you end your SAS session. LEGEND statements are not applied automatically, and must be explicitly assigned by an option in the procedure that uses them.

You can define up to 99 different LEGEND statements. If you define two LEGEND statements of the same number, the most recently defined statement replaces the previously defined statement of the same number. A LEGEND statement without a number is treated as a LEGEND1 statement.

Cancel individual LEGEND statements by defining a LEGEND statement of the same number without options (a null statement):

```
legend4;
```

Canceling one LEGEND statement does not affect any other LEGEND definitions. To cancel all current LEGEND statements, use RESET= in a GOPTIONS statement:

```
goptions reset=legend;
```

Specifying RESET=GLOBAL or RESET=ALL cancels all current LEGEND definitions as well as other settings.

To display a list of current LEGEND definitions in the SAS LOG tab, use the GOPTIONS procedure with the LEGEND option:

```
proc goptions legend nolist;
run;
```

Positioning the Legend

How to Position a Legend

By default, the legend shares the procedure output area with the procedure output, such as a map or bar chart. See "How Graphics Elements Are Placed in the Graphics Output Area" in *SAS/GRAPH: Reference*. However, several LEGEND statement options enable you to position a legend anywhere on the graphics output area and even to overlay the procedure output. This section describes these options and their effect on each other.

Positioning the Legend on the Graphics Output Area

There are two ways that you can position the legend on the graphics output area:

- Describe the general location of the legend with the POSITION= option. If necessary, fine-tune the position with the OFFSET= option.
- Position the legend explicitly with the ORIGIN=option.

Using POSITION= and OFFSET=

The values of the POSITION= option affect the legend in two ways:

- OUTSIDE and INSIDE determine whether the legend is located outside or inside the axis area.
- BOTTOM or MIDDLE or TOP (vertical position) and LEFT or CENTER or RIGHT (horizontal position) determine where the legend is located in relation to its OUTSIDE or INSIDE position.

Figure 6.13 on page 89 shows the legend positions inside the axis area.

Figure 6.12 *Legend Positions inside the Axis Area*

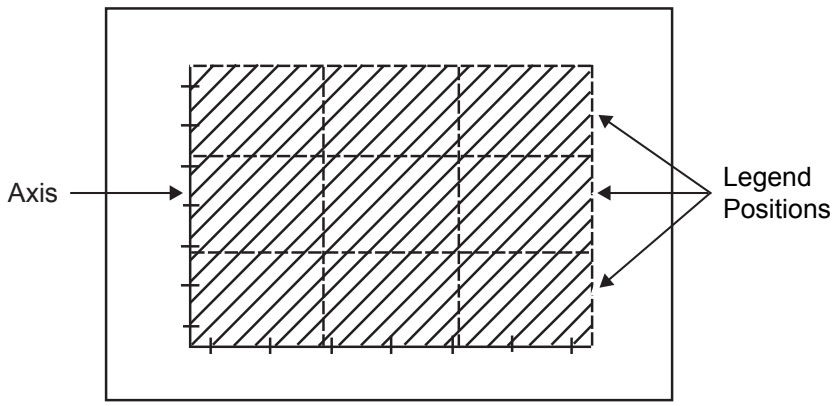
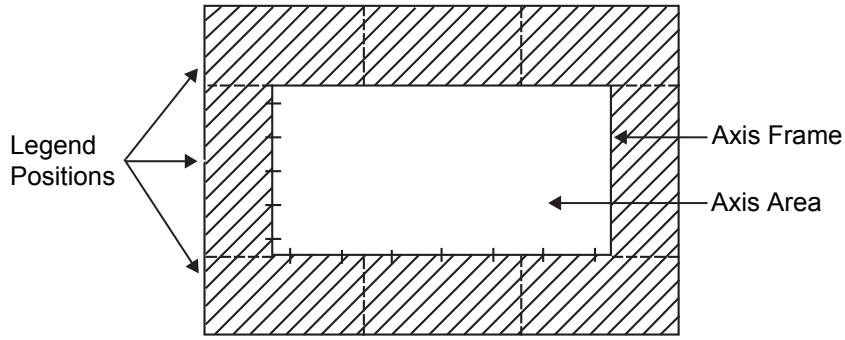


Figure 6.14 on page 90 shows legend positions outside the axis area.

Figure 6.13 *Legend Positions outside the Axis Area*



The default combination is POSITION=(BOTTOM CENTER OUTSIDE). The combination (OUTSIDE MIDDLE CENTER) is not valid.

Use OFFSET=(*x*,*y*) to adjust the position of the legend specified by the POSITION= option. The *x* value shifts the legend either left or right and the *y* value shifts the legend either up or down.

The offset values are always applied after the POSITION= request. For example, if POSITION=(TOP RIGHT OUTSIDE), the legend is located in the upper right corner of the graphics output area. If OFFSET=(0,0) is specified, the legend does not move. If OFFSET=(–5,–8)CM, the legend moves 5 centimeters to the left and 8 centimeters down.

Using ORIGIN=

Use ORIGIN=(*x*,*y*) to specify the coordinates of the exact location of the lower left corner of the legend box. Because ORIGIN=(0,0) is the lower left corner of the graphics output area, the values of *x* and *y* must be positive. If you specify negative values, a warning is issued and the default value is used.

Relating Legends to Other Graphics Elements

By default, the legend is inside the procedure output area and the space that it occupies reduces the size of the graph itself. If a choice must be made between displaying the legend or the graph, the legend is suppressed. To control how the legend relates to the other elements of the graph, use the MODE= option. These are values for the MODE= option:

- RESERVE reserves space for the legend outside the axis area and moves the graph to make room for the legend. This is the default setting and is valid only when POSITION=OUTSIDE.
- PROTECT prevents the legend from being overwritten by the procedure output. PROTECT blanks out graphics elements, allowing only legend elements to be displayed in the legend's space.
- SHARE displays both graphics elements and legend elements in the same space. This setting is usually used when the legend is positioned inside the axis area. SHARE is useful when the graph has a space that the legend can fit into.

Interactions between POSITION= and MODE=

You cannot specify both POSITION=INSIDE and MODE=RESERVE because MODE=RESERVE assumes that the legend is outside the axis area, and POSITION=INSIDE positions the legend inside the axis area. Therefore, when you specify POSITION=INSIDE, change the value of the MODE= option to SHARE or PROTECT. Otherwise, SAS/GRAPH issues a warning and automatically changes the MODE= value to PROTECT.

Creating Drop Shadows and Block Effects

You can produce a drop shadow or a three-dimensional block effect behind the legend. Use the CSHADOW= or CBLOCK= option in the LEGEND statement in conjunction with the graphics option OFFSHADOW=(*x*,*y*).

The value of *x* determines how far the shadow or block extends to the right (positive numbers) or to the left (negative numbers) of the legend. The value of *y* determines how far the shadow or block extends above (positive numbers) or below (negative numbers) the legend. If OFFSHADOW=(0,0) is specified, the shadow or block is not visible.

By default, OFFSHADOW=(0.0625, -0.0625) IN. That is, the shadow or block extends 1/16th of an inch to the right and 1/16th of an inch below the legend.

Substituting BY Line Values in a Text String

The BY statement produces a BY line that contains the variable name and its value. If you specify the variable name, options are available to substitute the variable name and its value in text strings. To use the #BYVAR and #BYVAL options, insert the option in the text string at the position that you want the substitution text to appear. Both #BYVAR and #BYVAL specifications must be followed by a delimiting character. This can be either a space or other nonalphanumeric character, such as the quotation mark that ends the text string. If not, the specification is completely ignored and its text remains intact and is displayed with the rest of the string.

To allow a #BYVAR or #BYVAL substitution to be followed immediately by other text, with no delimiter, use a trailing dot (as with macro variables). The trailing dot is not displayed in the resolved text.

If you want a period to be displayed as the last character in the resolved text, use two dots after the #BYVAR or #BYVAL substitution.

The substitution for #BYVAL or #BYVAR does not occur if the following is true:

- The BY statement does not name the variable specified by #BYVAL or #BYVAR. For example, #BYVAL2 when there is only one BY variable or #BYVAL(ABC) when ABC is not a BY variable or does not exist.
- There is no BY statement at all.

When substitution does not occur, no error or warning message is issued and the option specification is displayed with the rest of the string. The graph continues to display a BY line at the top of the page unless you suppress it by using the NOBYLINE option in an OPTION statement.

For more information, see the "BY Statement" on page 151.

Note: This feature is not available in the Annotate facility because BY lines are not created in a DATA step.

Using #BYVAL and #BYVAR Substitution in Label and Value Strings

If you use a BY statement in your procedure step, you can use one or more of the following #BYVAL and #BYVAR substitution options in *text-string* for the LABEL= and VALUE= options:

#BYVAL*n* | #BYVAL(*variable-name*)
substitutes the current value of the specified BY variable for #BYVAL in the text string and displays the value produced by the statement. Specify the variable with one of these values:

n
specifies which variable in the BY statement #BYVAL should use. The value of *n* indicates the position of the variable in the BY statement.

Example `#BYVAL2` specifies the second variable in the BY statement.

variable-name
names the BY variable.

Tip *Variable-name* is not case sensitive.

Example `#BYVAL(YEAR)` specifies the BY variable, YEAR.

#BYVAR*n* | #BYVAR(*BY-variable-name*)
substitutes the name of the BY variable or label associated with the variable (whatever the BY line would normally display) for #BYVAR in the text string and displays the name or label produced by the statement. Specify the variable with one of these:

n
specifies which variable in the BY statement #BYVAR should use. The value of *n* indicates the position of the variable in the BY statement. For example, #BYVAR2 specifies the second variable in the BY statement.

BY-variable-name
names the BY variable. For example, #BYVAR(SITES) specifies the BY variable, SITES. *Variable-name* is not case sensitive.

Note A BY variable name displayed is always in uppercase. If a label is used, it appears as specified in the LABEL statement.

Follow these rules when you use #BYVAL or #BYVAR in the FOOTNOTE, TITLE, or NOTE statement of a procedure step:

- Specify the variable that is used by #BYVAL or #BYVAR in the BY statement.
- Insert #BYVAL or #BYVAR in the specified title text string at the position where you want the substitution text to appear.

- Follow #BYVAL or #BYVAR with a delimiting character, either a space or other non-alphanumeric character (for example, a quotation mark), that ends the text string.
- To enable the #BYVAL or #BYVAR substitution to be followed immediately by other text, with no delimiter, use a trailing dot (as with macro variables).

NOTE Statement

Control the content, appearance, and placement of text.

Used by: GMAP

Type: Procedure statement.

Note: This local statement has limited use with the GMAP procedure or other procedures. The specified note appears behind the map or graph output by default. With some manipulation of coordinates, notes are useful around the perimeter or ocean area of a map.

Tip: By drawing a white box in back of a note, that boxed note can appear on top of the graph instead of behind it. Here is an example of code that outputs a note on top of a map:

```
goptions cback=white;

title font="swiss" "Note Text On a Map";
pattern1 v=s color=lightgoldenrodyellow;

proc gmap data=mapsgfk.us map=mapsgfk.us;
note move=(2,32)pct height=4pct
color=black font="swiss" "Note with 'box' behind it displays on top of map"
color=black box=2 bcolor=white blank=yes;
id state;
choro state / levels=1 stat=first nolegend;
run;
quit;
```

Syntax

NOTE*<text-options>*<*'text-string'*>;

Summary of Optional Arguments

<text-options>

Text provision option

'text-string'

is a text string or strings that can contain up to 512 characters.

Without Arguments

Using NOTE without arguments has no effect.

Optional Arguments

<text-options>
specifies formatting options for the text.

Text options must precede the '*text-string*' that they modify. *text-options* can be one or more of the following optional arguments, in any order:

ALT=*"text-string"*
specifies descriptive text for a URL to which a note links, or the note itself.

The *"text-string"* that you use to describe a note, or the URL specified by the LINK= option, can contain occurrences of the variables #BYVAL and #BYVAR. See "Substituting BY Line Values in a Text String" on page 91.

Supports The ALT= option can be used with the LINK= option.

See "LINK="URL"" in *SAS/GRAPH: Reference*

Example "Example 6: Producing a Drilldown Choropleth Map" on page 451

ANGLE=*degrees*
specifies the angle of the baseline of the entire text string with respect to the horizontal.

A positive *degrees* value angles the *baseline* counterclockwise; a negative value angles it clockwise. By default, ANGLE=0 (horizontal).

Angled notes might require more vertical space. Consequently, there might be an increase the size of the note area, thereby reducing the vertical space in the procedure output area.

Using the BOX= option with angled text does not produce angled boxes; the box is sized to accommodate the angled note.

Using the ANGLE= option after one text string and before another can reset some options to their default values. See "Using Options That Can Reset Other Options" on page 66.

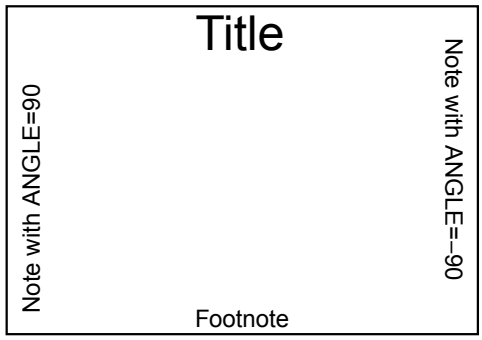
The ANGLE= option has the same effect on the text as LANGLE=, except when you specify an angle of 90 degrees or –90 degrees. In these angle specifications, the procedure output area is shrunk from the left or right to accommodate the angled note.

Figure 6.15 on page 95 shows how ANGLE= 90 degrees or -90 degrees positions and rotates note text.

ANGLE=90 positions the note at the bottom of the left edge of the graphics output area, angled 90 degrees (counterclockwise) and reading from bottom to top.

ANGLE=–90 positions the note at the top of the right edge of the graphics output area, angled –90 (clockwise) and reading from top to bottom.

Figure 6.14 *Positioning Notes with the ANGLE= Option*



Alias A=

See "LANGLE=degrees" in *SAS/GRAPH: Reference*

"ROTATE=degrees" in *SAS/GRAPH: Reference*

BCOLOR=*background-color*

specifies the background color of a box produced by the BOX= option.

By default, the background color of the box is the same as the background color for the entire graph. The color of the frame of the box is determined by the color specification used in BOX=.

Alias BC=

Restriction If you omit BOX=, BCOLOR= is ignored.

Note The BCOLOR= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 66 for details

"BOX=1 - 4" in *SAS/GRAPH: Reference*

BLANK=YES

protects the box and its contents from being overwritten by any subsequent graphics elements.

It does this by blanking out the area where the box is displayed. The BLANK= option enables you to overlay graphics elements with boxed text. It is ignored if you omit the BOX= option. Because notes are written from the highest numbered to the lowest numbered, the BLANK= option only blanks out notes of a lower number.

Alias BL=

Note The BLANK= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 66 for details

"BOX=1 - 4" in *SAS/GRAPH: Reference*

BOX=*1 - 4*

draws a box around one line of text.

A value of 1 produces the thinnest box lines; 4 produces the thickest. Boxing angled text does not produce an angled box; the box is sized to include the angled text.

The color of the box is one of the following:

- the color specified by the COLOR= option in the statement
- the default text color

The COLOR= option, preceding the BOX= option, controls the box frame color. To color the background of the box, use the BCOLOR= option. Specify the same color with both the COLOR= option and the BCOLOR= option to effect a box without a frame.

You can include more than one text string in the box as long as no text break occurs between the strings. That is, you cannot use the JUSTIFY= option to create multiple lines of text within a box.

To draw a box around multiple lines of text, you can do either of the following:

- Use the MOVE= option with relative coordinates to position an additional line of text relative to the preceding line and enclose them within the box drawn by the BOX= option. For example, this statement produces the boxed note shown in Figure 6.16 on page 97:

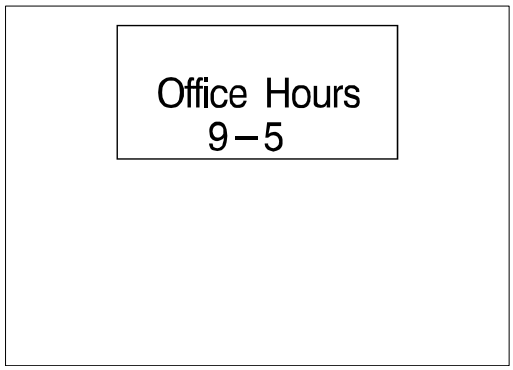
```
note font=swiss justify=center box=1 height=2
   "Office Hours" move=(-11,-4)pct "9-5";
```

  The MOVE=option in this NOTE statement overrides the JUSTIFY= option that center-positioned the first line of text. The MOVE= option specifies the *x* and *y* coordinates in percentage units. The text string '9–5' is positioned relative to the first text string 'Office Hours'.

  Using the MOVE= option in a NOTE statement enables you to position a note on top of a graph.

- Use the DRAW= option to draw the box and do not use the BOX= option.

Figure 6.15 *Using the BOX= Option and the MOVE= Option to Box Multiple Lines of Text*



Alias BO=

Note The BOX= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= options with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 66 for details

"BCOLOR=background-color" in *SAS/GRAPH: Reference*

"BLANK=YES" in *SAS/GRAPH: Reference*

"BSPACE=box-space<units>" in *SAS/GRAPH: Reference*

BSPACE=*box-space<units>*
specifies the amount of space between the boxed text and the box.

The space above the text is measured from the font maximum, and the space below the text is measured from the font minimum. By default, BSPACE=1.

The spacing is uniform around the box. Notice that BSPACE=.5IN leaves one-half inch of space between the text and the top, bottom, and sides of the box.

Alias BS=

Interaction If the BOX= option is not used, the BSPACE= option is ignored

Note The BSPACE= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 66 for details

"BOX=1 - 4" in *SAS/GRAPH: Reference*

COLOR=*color*
specifies the color for the following text, box, or line.

The COLOR= option affects all text, lines, and boxes that follow it and stays in effect until another COLOR= specification is encountered.

Change colors as often as you like. For example, this statement produces a note with red text in a box with a blue frame and a cream background:

```
proc gslide;
   note color=red height=2 "Total Sales" color=blue
      box=3 bcolor=cream;
run;
quit;
```

Although the BCOLOR= option controls the background color of the box, the frame color is controlled with the COLOR= option that precedes the BOX= option.

If you omit the COLOR= option, a color specification is searched for in this order:

1. the CTITLE= option in a GOPTIONS statement
2. the CTEXT= option in a GOPTIONS statement
3. the current ODS style
4. the first color in the color list.

Alias	C=
Style reference	GraphValueText Color attribute
See	"BCOLOR=background-color" in *SAS/GRAPH: Reference*
	"Controlling Titles and Footnotes" in *SAS/GRAPH: Reference*

DRAW=(*x,y - ,x-n,y-n*)<*units*>
draws lines anywhere on the graphics output area.

Lines are drawn using *x* and *y* as absolute or relative coordinates. The following table shows the specifications for absolute and relative coordinates:

Table 6.4 *Coordinate Specifications*

Absolute Coordinates	Relative Coordinates
x<units>	*±x<units>*
y<units>	*±y<units>*

The coordinate position (0,0) is the lower left corner of the graphics output area. Specify at least two coordinate pairs. Commas between coordinates are optional; blanks can be used instead. The DRAW= option does not affect the positioning of text.

The starting point for lines specified with relative coordinates begins at the end of the most recently drawn text or line in the current statement. If no text or line has been drawn in the current statement, a warning is issued. The relative draw is measured from where a zero-length text string would have ended, given the normal placement for the statement.

You can mix relative and absolute coordinates. For example, DRAW=(+0,+0,+0,1IN) draws a vertical line from the end of the text to one inch from the bottom of the graphics output area.

Alias D=

FONT=*font*
specifies the font for the subsequent text.

See "Specifying Fonts in SAS/GRAPH Programs" in *SAS/GRAPH: Reference* for details about specifying SAS/GRAPH fonts. If you omit this option, a font specification is searched for in this order:

1. the FTEXT= option in a GOPTIONS statement
2. the current ODS style
3. the default hardware font, NONE

Alias F=

Style reference GraphValueText Font attribute

Note Font names greater than eight characters in length must be enclosed in quotation marks.

See "Controlling Titles and Footnotes" in *SAS/GRAPH: Reference*

HEIGHT=*text-height<units>*
specifies the height of text characters in number of units.

Height is measured from the font minimum to the capline. Ascenders can extend above the capline, depending on the font.

If your text line is too long to be displayed in the height specified in the HEIGHT= option, the height specification is reduced so that the text can be displayed. A note in the SAS log tells you what percentage of the specified size was used.

If you omit the HEIGHT= option, a text height specification is searched for in this order:

1. the HTEXT= option in a GOPTIONS statement
2. the default value, 1

Alias H=

Default For NOTE or NOTE1 statements, HEIGHT is determined by the current ODS style. HEIGHT=1 for subsequent NOTE statements.

See "Controlling Titles and Footnotes" in *SAS/GRAPH: Reference*

Example "Ordering Axis Tick Marks with SAS Date Values" in *SAS/GRAPH: Reference*

JUSTIFY=LEFT | CENTER | RIGHT
specifies the alignment of the text string.

LEFT
aligns the text to the left.

Alias L

CENTER
aligns the text in the center.

Alias C

RIGHT
aligns the text to the right.

Alias R

All the text strings following JUSTIFY= are treated as a single string and are displayed as one line that is left-, right-, or center-aligned. You can change the justification within a single line of text. For example, this NOTE statement displays a date on the left side of the output and the page number on the same line on the right:

```
note "June 28, 1997" justify=right "Page 3";
```

In addition, you can use the JUSTIFY= option to produce multiple lines of text by repeating the JUSTIFY= option with the same value before the text string for each line. Multiple lines of text with the same justification are blocked together. For example, this NOTE statement produces a three-line note with each line right-justified:

```
note justify=right "First Line"
      justify=right "Second Line"
      justify=right "Third Line";
```

You can get the same effect with three NOTE statements, each specifying JUSTIFY=RIGHT. You can produce a block of text by specifying the same justification for multiple text strings. You can then change the justification for an additional text string. The result is that the text is placed on the same line as the first string specified in the statement.

Default LEFT

Note Using the JUSTIFY= option after one text string and before another can reset some options to their default values.

Tip Use the WRAP= on page 104 option with JUSTIFY= to fit long text strings.

See "Using Options That Can Reset Other Options" on page 66 for details

Example "Rotating Plot Symbols through the Color List" in *SAS/GRAPH: Reference*

LANGLE=*degrees*
specifies the angle of the *baseline* of the entire text string(s) with respect to the horizontal A positive value for *degrees* moves the *baseline*

counterclockwise; a negative value moves it clockwise. By default, LANGLE=0 (horizontal).

Using the BOX= option with angled text does not produce an angled box; the box is sized to accommodate the angled note.

Unlike the ANGLE= option, the LANGLE= option does not reset any other options. Therefore, the LANGLE= option is easier to use because you do not need to repeat options after a text break.

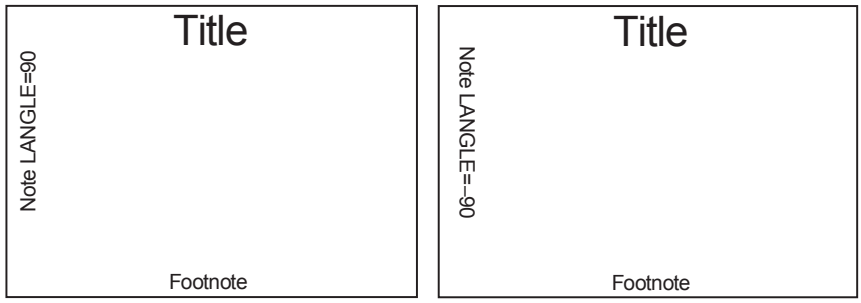
The LANGLE= option has the same effect on the text as the ANGLE= option, except when an angle of 90 degrees or –90 degrees is specified:

LANGLE=90 positions the note at the top of the left edge of the procedure output area, angled 90 degrees (counterclockwise) so that it reads from bottom to top.

LANGLE=–90 positions the note at the top of the left edge of the procedure output area, angled –90 degrees (clockwise) so that it reads from top to bottom.

Figure 6.17 on page 101 shows how LANGLE=90 degrees and LANGLE=–90 degrees positions and rotates notes.

Figure 6.16 *Positioning Notes with the LANGLE= Option*



Alias LA=

See "ANGLE=degrees" in *SAS/GRAPH: Reference*

LINK="*URL*"

specifies a uniform resource locator (URL) to which a note links.

The *text-string* that you use to specify the URL can contain occurrences of the variables #BYVAL, #BYVAR, and #BYLINE, as described in "'*text-string*'" on page 104.

Supports The LINK= option can be used in conjunction with the ALT= option.

See "Controlling Where Titles and Footnotes Are Rendered" in *SAS/GRAPH: Reference*

"ALT="text-string"" in *SAS/GRAPH: Reference*

Example "Example 6: Producing a Drilldown Choropleth Map" on page 451

LSPACE=*line-space <units>*
specifies the amount of spacing above lines of note text. The spacing is measured from the capline of the current line to the font minimum of the line above.

Alias LS=

Default LSPACE=0

Note The LSPACE= option can be reset by the ANGLE= or JUSTIFY= option, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 66 for details

MOVE=(*x*,*y*) <*units*>
positions an initial or subsequent text string, or lines of text anywhere on the graphics output area. The positioning uses *x* and *y* as absolute or relative coordinates. The following table shows the specifications for absolute and relative coordinates:

Table 6.5 *Coordinate Specifications*

Absolute Coordinates	Relative Coordinates
x<units>	*±x<units>*
y<units>	*±y<units>*

Commas between coordinates are optional; you can use blanks instead.

The starting point for lines specified with absolute coordinates is at the bottom left corner of the graphics output area. For example, the following code fragment uses the NOTE statement to add a simple line of text to the upper right quadrant of the graphics output area:

```
note move=(65,70)pct color=purple "My Note";
```

The starting point for lines specified with relative coordinates is at the end of the most recently drawn text or line in the current statement. If no text or line has been drawn in the current statement, a warning is issued in the SAS log. The relative move is measured from where a zero-length text string would have ended, given the normal placement for the statement.

You can mix relative and absolute coordinates.

Alias M=

Interactions The MOVE= option overrides a JUSTIFY= option specified for the same text string

A NOTE statement can use the MOVE= option to position the text so that the statement does not use its default position. In

this case, the text of the next NOTE statement occupies the unused position and no blank lines are displayed

Notes You can specify the MOVE= option with at least one absolute coordinate. If the option follows one text string and precedes another, some options can be reset to their default values.

If you specify the GUNIT graphics option, then that unit is the default unit. If you do not specify the GUNIT= graphics option, then the default unit is CELLS.

See "Using Options That Can Reset Other Options" on page 66 for details

"BOX=1 - 4" in *SAS/GRAPH: Reference* for illustrative code that draws a box around lines of text positioned with relative coordinates

Example "Specifying Logarithmic Axes" in *SAS/GRAPH: Reference*

ROTATE=*degrees*

specifies the angle at which each character of text is rotated with respect to the *baseline* of the text string. The angle is measured from the current text *baseline* angle, which is specified by the ANGLE= or LANGLE= options. By default, the *baseline* is horizontal. A positive value for *degrees* rotates the character counterclockwise; a negative value rotates it clockwise. By default, ROTATE=0 (parallel to the *baseline*).

Figure 6.18 on page 103 shows how characters are positioned when ROTATE=90 is used with the default (horizontal) *baseline*.

Figure 6.17 *Tilting Characters with the ROTATE= Option*

Alias R=

See "ANGLE=degrees" in *SAS/GRAPH: Reference*

UNDERLIN=*0 - 3*

underlines subsequent text.

Values of 1, 2 and 3 underline with an increasingly thicker line. UNDERLIN=0 halts underlining for subsequent text.

Underlines follow the text *baseline*. If you use an LANGLE= or ANGLE= option for the line of text, the underline is drawn at the same angle as the text. Underlines do not break up to follow rotated characters.

To make the text and the underline the same color, specify a COLOR= option before the UNDERLIN= option that precedes the text string. To make the text a different color, specify the COLOR= option after the UNDERLIN= option.

Aliases U=

UNDERLINE=

Note The UNDERLIN= option can be reset by the ANGLE= or JUSTIFY= option, or by the MOVE= option with absolute coordinates. See "Using Options That Can Reset Other Options" on page 66 for details.

See "ROTATE=degrees" in *SAS/GRAPH: Reference*

WRAP

wraps the text to a second line if the text does not fit on one line.

If the WRAP option is omitted, the text font-size is reduced until the text fits on one line. Wrapping occurs at the last blank before the text meets the end of the window. If there are no blanks in the text string, then there is no wrapping.

Restriction The WRAP option does not work with the BOX, BLANK, UNDERLINE, and MOVE options.

Tip Use the JUSTIFY= on page 99 option with WRAP= to justify the lines of text.

'text-string'

is a text string or strings that can contain up to 512 characters.

You must enclose text strings in single or double quotation marks. The text appears exactly as you enter it in the statement, including uppercase and lowercase characters and blanks.

To use single quotation marks or apostrophes within the note, you can do either of the following:

- use a pair of single quotation marks together:

```
note 'All''s Well That Ends Well';
```

- enclose the text in double quotation marks:

```
note "All's Well That Ends Well";
```

You can specify multiple text strings in NOTE statements. If you want each string to be separated by a blank, add a blank to the beginning of the second and subsequent text strings rather than at the end the preceding string, as in this example:

```
note color=red "Sales:" color=blue " 2020";
```

With fonts that support Unicode, you can specify special characters by specifying a hexadecimal constant in quotation marks. A trailing `x` identifies a string as a hexadecimal constant. You must designate the hexadecimal constant as a Unicode specification and escape it: `(*ESC*){Unicode '`*`hexadecimal-value`*`'x}`. For example:

```
note 'Regression with Confidence Limits ((*ESC*){unicode "03B1"x}=.05)';
```

This statement produces the note "Regression with Confidence Limits (α = .05)" because "03B1"x is the hexadecimal value for the lowercase Greek letter alpha in all Unicode fonts.

> **TIP** You can instead specify lowercase Greek letters by name, and uppercase Greek letters by name_u: `(*ESC*){Unicode alpha}=.05` and `(*ESC*){Unicode alpha_u}=.05`.

For more information see "Specifying Special Characters Using Character and Hexadecimal Codes" in *SAS/GRAPH: Reference*.

If you have a BY statement, you can also customize notes by inserting BY variable lines (#BYLINE), BY variable values (#BYVAL), or BY variable names (#BYVAR), in notes that are specified in procedure steps. Embed the items in the specified note text string at the position where you want the substitution text to appear.

#BYLINE
substitutes the entire BY line without leading or trailing blanks for #BYLINE in the text string. It also displays the BY line in the note produced by the statement.

#BYVAL*n*
#BYVAL(*variable-name*)
substitutes the current value of the specified BY variable for #BYVAL in the text string and displays the value produced by the statement. Specify the variable with one of these values:

n
specifies which variable in the BY statement #BYVAL should use. The value of *n* indicates the position of the variable in the BY statement.

Example **`#BYVAL2`** specifies the second variable in the BY statement.

variable-name
names the BY variable.

Tip *Variable-name* is not case sensitive.

Example **`#BYVAL(YEAR)`** specifies the BY variable, YEAR.

#BYVAR*n*
#BYVAR(*BY-variable-name*)
substitutes the name of the BY variable or label associated with the variable (whatever the BY line would normally display) for #BYVAR in the text string and displays the name or label produced by the statement. Specify the variable with one of these:

n
specifies which variable in the BY statement #BYVAR should use. The value of *n* indicates the position of the variable in the BY statement. For example, #BYVAR2 specifies the second variable in the BY statement.

BY-variable-name
names the BY variable. For example, #BYVAR(SITES) specifies the BY variable, SITES. *Variable-name* is not case sensitive.

Note A BY variable name displayed is always in uppercase. If a label is used, it appears as specified in the LABEL statement.

Follow these rules when you use #BYVAL or #BYVAR in the FOOTNOTE, TITLE, or NOTE statement of a procedure step:

- Specify the variable that is used by #BYVAL or #BYVAR in the BY statement.
- Insert #BYVAL or #BYVAR in the specified title text string at the position where you want the substitution text to appear.
- Follow #BYVAL or #BYVAR with a delimiting character, either a space or other non-alphanumeric character (for example, a quotation mark), that ends the text string.
- To enable the #BYVAL or #BYVAR substitution to be followed immediately by other text, with no delimiter, use a trailing dot (as with macro variables).

Restriction #BYVAL or #BYVAR substitution in a text string is not available in the Annotate facility. The reason is that BY lines are not created in a DATA step.

See Also

"NOTE Statement" on page 158 for more information about the NOTE statement.

PATTERN Statement

Defines the characteristics of patterns used in maps.

Used by: GMAP

Type: Global

Syntax

PATTERN*<1 - 255>*
<COLOR=*pattern-color | _style_*>
<IMAGE=*fileref | "external-file"*>
<IMAGESTYLE=TILE | FIT>
<REPEAT=*number-of-times*>
<VALUE=*block-pattern | map-pattern* >;

Optional Arguments

COLOR=*pattern-color | _style_*
specifies the color of the fill. *Pattern-color* is any SAS/GRAPH color name. The _STYLE_ value specifies the appropriate color based on the current style. See "Using Colors in SAS/GRAPH Programs" in *SAS/GRAPH: Reference*.

Using the COLOR= option with a null value cancels the color specified in a previous PATTERN statement of the same number without affecting the values of other options.

The COLOR= option overrides the CPATTERN= graphics option.

The CFILL= option in the PIE and STAR statements overrides the COLOR= option. For details, see "Controlling Pie and Donut Chart Slice Patterns and Colors" in *SAS/GRAPH: Reference*.

No color can be specified for a PATTERN statement, that is, neither the COLOR= nor the CPATTERN= option is used. In this case the PATTERN statement rotates the specified fill through each color in the color list before the next PATTERN statement is used.

Alias C=

Restriction Partially supported by the JAVAIMG device

See "Working with PATTERN Statements" on page 117

Example "Using BY-group Processing to Generate a Series of Charts" in *SAS/GRAPH: Reference*

CAUTION **Omitting the COLOR= option in a PATTERN statement can cause the PATTERN statement to generate multiple PATTERN definitions.**

IMAGE=*fileref* | "*external-file*"
specifies an image file that is used to fill one or more areas of a map. The format of the external file specification varies across operating environments. See the companion reference for your specific operating environment.

Note When you specify an image file to fill a map, the map is not outlined. Also, the COLOR= and VALUE= options are ignored.

See "IMAGESTYLE=TILE | FIT" on page 107

IMAGESTYLE=TILE | FIT
specifies how the image specified in the IMAGE= option is to be applied to fill a map. The TILE value repeats the image as needed to fill the map. The FIT value stretches a single instance of the image to fill the map.

Default TILE

REPEAT=*number-of-times*
specifies the number of times that a PATTERN definition is applied before the next PATTERN definition is used.

The behavior of the REPEAT= option depends on the color specification:

- If you use both the COLOR= and REPEAT= options in a PATTERN statement, the pattern is repeated the specified number of times in the specified color. The fill can be either the default solid or a fill specified with the VALUE= option.
- You can use the CPATTERN= option in a GOPTIONS statement to specify a single pattern color. Use the REPEAT= option either alone or with the VALUE= option in a PATTERN statement. The resulting hatch pattern is repeated the specified number of times.
- You can omit both the COLOR= and CPATTERN= options and use the REPEAT= option. If you use the REPEAT= option alone, it generates default solids. Or you can use the REPEAT= option in conjunction with the VALUE= option in a PATTERN statement. The resulting pattern is rotated through each color in the color list. The entire group generated by this cycle is then repeated the number of times specified in the REPEAT= option. Thus, the total number of patterns produced depends on the number of colors in the current color list.

Using REPEAT= with a null value cancels the repetition specified in a previous PATTERN statement of the same number without affecting the values of other options. Note that in most cases, it is preferable to use LEVELS=1 in the GMAP procedure rather than using this option in the PATTERN statement.

Alias R=

Default REPEAT=1

See "Understanding Pattern Sequences" on page 119

VALUE=*block-pattern*

Patterns are specified for the blocks in block maps produced by the BLOCK statement in the GMAP procedure. (The map area from which the block rises takes a map pattern as described in the option "VALUE= *map-pattern*" on page 109.) See also "About Block Maps and Patterns" on page 358.

Values for *block-pattern* are as follows:

EMPTY

an empty pattern.

Alias E

SOLID

a solid pattern (the only valid value for three-dimensional charts).

Alias S

style<density>

a shaded pattern. *Style* specifies the direction of the lines:

L

specifies left-slanting lines.

R

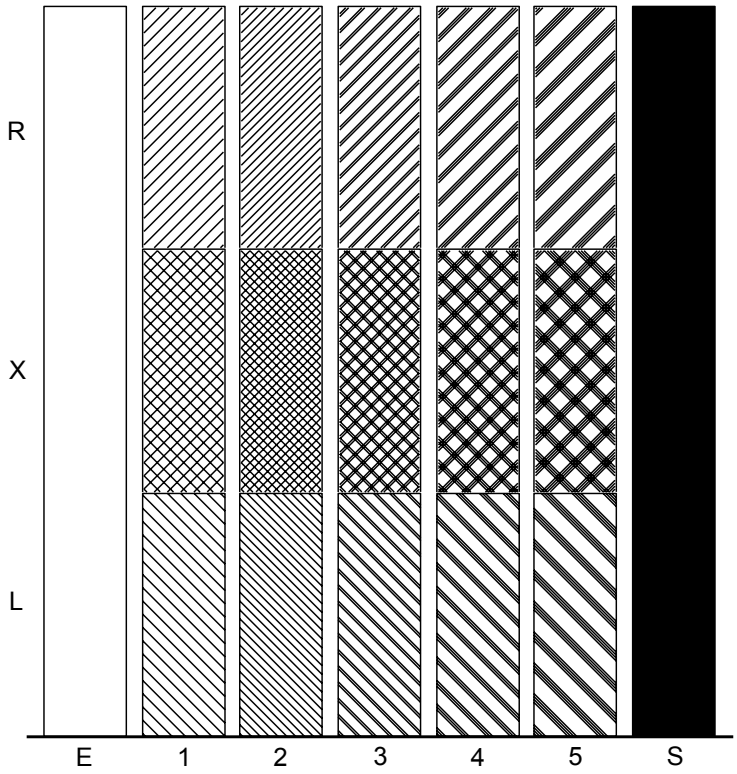
specifies right-slanting lines.

X
specifies crosshatched lines.

Density specifies the density of the pattern's shading. Specify a number from 1 to 5. The number 1 produces the lightest shading and 5 produces the heaviest shading.

Figure 6.19 on page 109 shows all of the patterns available for bars and blocks.

Figure 6.18 *Bar and Block Patterns*



If no valid patterns are available, default bar and block fill patterns are selected in this order:

1. SOLID
2. X1–X5
3. L1–L5
4. R1–R5

Each fill is used once with every color in the color list unless a pattern color is specified. The entire sequence is repeated as many times as required to provide the necessary number of patterns.

Alias V=

VALUE= ***map-pattern***
specifies patterns for the following:

The VALUE= option specifies patterns for map area surfaces in block, choropleth, and prism maps produced by the BLOCK, CHORO, AND PRISM statements in the GMAP procedure.

Values for *map-pattern* are as follows:

MEMPTY
specifies an empty pattern.

Alias ME

Restriction EMPTY or E are not valid aliases when used with the map areas in block maps created by the GMAP procedure.

MSOLID
specifies a solid pattern.

Alias MS

Restriction SOLID or S are not valid aliases when used with the map areas in block maps created by the GMAP procedure.

M*density<style<angle>>*
specifies a shaded pattern.

Density specifies the density of the pattern's shading. Specify a number from 1 to 5. The number 1 produces the lightest shading and 5 produces the heaviest shading.

Style specifies the type of the pattern lines:

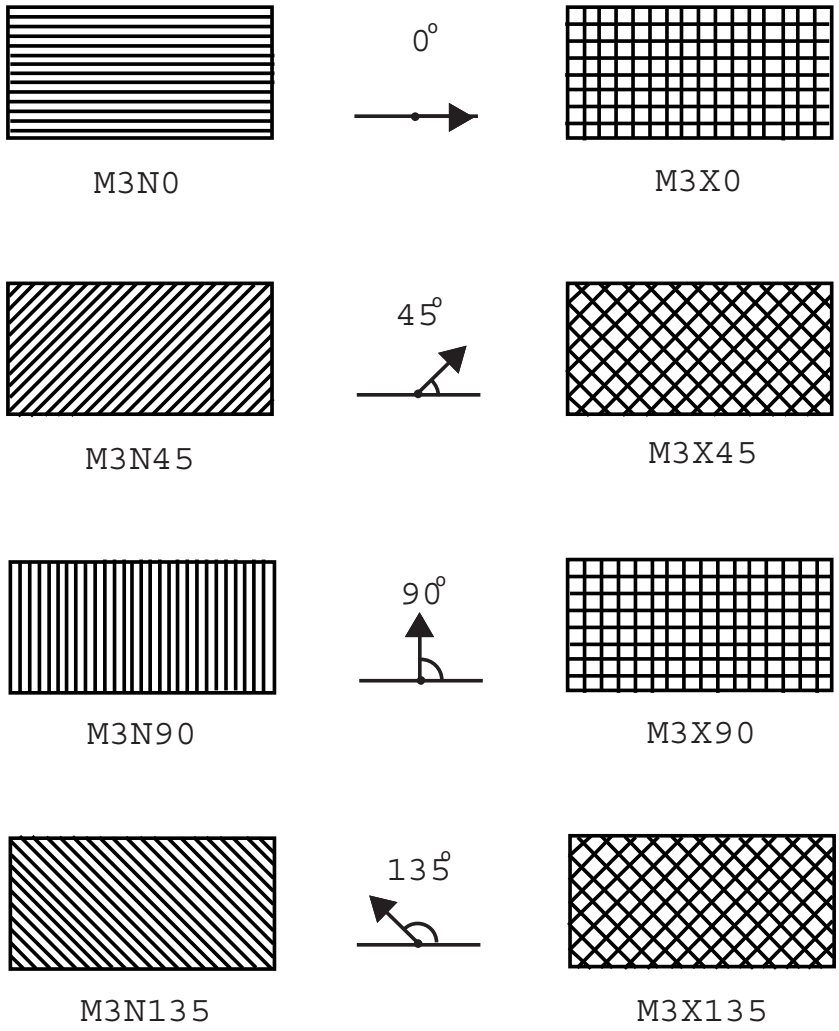
N
specifies parallel lines (the default).

X
specifies crosshatched lines.

Angle specifies the angle of the pattern lines. Specify a number from 0 to 360. The number specifies the degrees at which the parallel lines are drawn, measured from the horizontal. By default, *angle* is 0 (lines are horizontal).

Figure 6.20 on page 111 shows some typical plot patterns.Figure 6.20 on page 111 shows some typical map patterns.

Figure 6.19 *MapPatterns*



If no valid patterns are available, default plot fill patterns are selected in this order:

1 MSOLID
2 M2N0
3 M2N90
4 M2X45
5 M4N0
6 M4N90
7 M4X90

Each fill is used once with every color in the color list unless a pattern color is specified. The entire sequence is repeated as many times as required to provide the necessary number of patterns.

Alias V=

VALUE=*pie/star-pattern*

specifies patterns for pie and star charts produced by the PIE and STAR statements in the GCHART procedure. Values for *pie/star-pattern* are as follows:

PEMPTY

specifies an empty pattern. EMPTY or E are also valid aliases.

Alias PE

PSOLID

specifies a solid pattern. SOLID or S are also valid aliases.

Alias PS

P*density<style<angle>>*

specifies a shaded pattern.

Density specifies the density of the pattern's shading. Specify a number from 1 to 5. The number 1 produces the lightest shading and 5 produces the heaviest shading.

Style specifies the type of the pattern lines:

N

specifies parallel lines (the default).

X

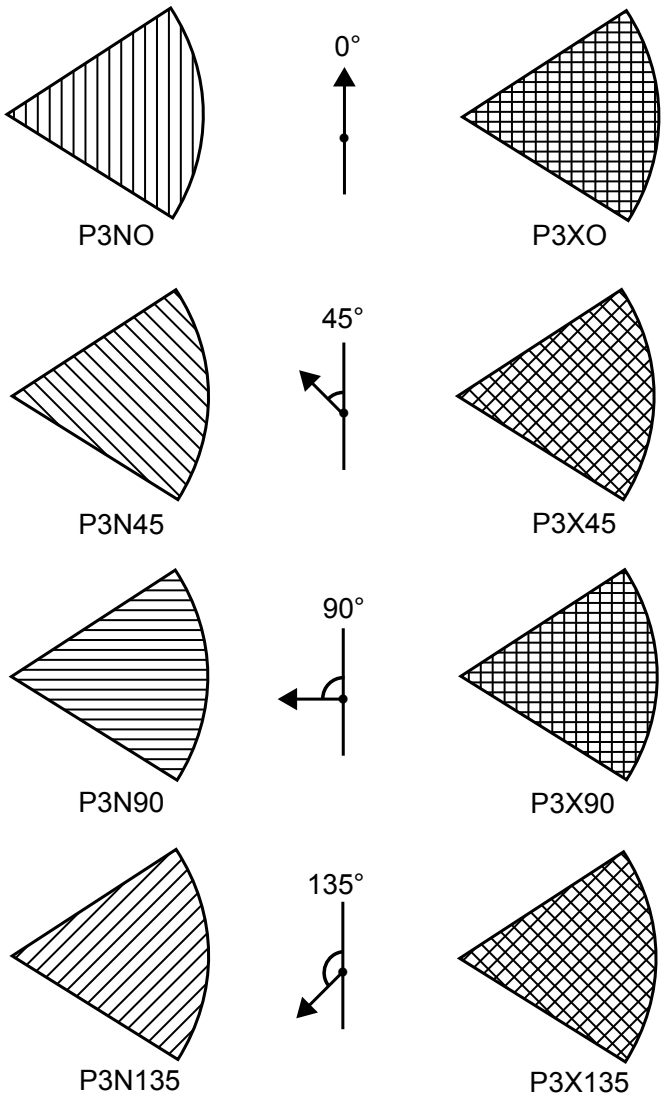
specifies crosshatched lines.

Angle specifies the angle of the pattern lines. Specify a number from 0 to 360. The number specifies the angle of the lines, measured in degrees from perpendicular to the radius of the slice. By default, *angle* is 0.

The FILL= option in the PIE and STAR statements in the GCHART procedure overrides VALUE=.

Figure 6.21 on page 113 shows some typical pie and star patterns.

Figure 6.20 *Pie and Star Patterns*



If no valid patterns are available, default pie and star fill patterns are selected in this order:

1 PSOLID
2 P2N0
3 P2N90
4 P2X45
5 P4N0
6 P4N90
7 P4X90

Each fill is used once with every color in the color list unless a pattern color is specified. The entire sequence is repeated as many times as required to provide the necessary number of patterns.

Alias V=

Note If you use hatch patterns and request a legend instead of slice labels, the patterns in the slices are oriented to be visually equivalent to the legend.

Details

Description: PATTERN Statement

PATTERN statements create PATTERN definitions that define the color and type of area fill for patterns used in maps. This is the procedure and the graphics areas that it creates that use PATTERN definitions:

GMAP
map areas in choropleth, block, and prism maps; blocks in block maps

In addition, certain Annotate facility functions and macros can use pattern specifications. and "Using Annotate Data Sets" in *SAS/GRAPH: Reference*.

You can use the PATTERN statement to control the fill and color of a pattern, and whether the pattern is repeated. There are various types of patterns:

- block patterns
- map patterns

Pattern fills can be solid or empty, or composed of parallel or crosshatched lines. In addition, you can specify device-dependent hardware patterns for polygon fills on devices that support hardware patterns.

If you do not create PATTERN definitions, SAS/GRAPH software generates them as needed and assigns them to your graphs by default. Generally, the default behavior is to rotate a solid pattern through the current color list. For details, see "About Default Patterns" on page 116.

Using the PATTERN Statement

How PATTERN Definitions Are Generated

PATTERN statements can be located anywhere in your SAS program. They are global and remain in effect until redefined, canceled, or until the end of your SAS session.

You can define up to 255 different PATTERN statements. A PATTERN statement without a number is treated as a PATTERN1 statement.

PATTERN statements generate one or more PATTERN definitions, depending on how the COLOR=, VALUE=, and IMAGE= options are used. For information about PATTERN definitions, see "Working with PATTERN Statements" on page 117, as well as the descriptions of " COLOR=*pattern-color | _style_*" on page 107, "IMAGE=*fileref* | *"external-file"*" on page 107, and "VALUE= *map-pattern*" on page 109.

PATTERN definitions are generated in the order in which the statements are numbered, regardless of gaps in the numbering or the statement's position in the

program. Although it is common practice, you do not have to start with PATTERN1, and you do not have to use sequential statement numbers.

PATTERN definitions are applied automatically to all areas of the graphics output that require patterns. When assigning PATTERN definitions, SAS/GRAPH starts with the lowest-numbered definition with an appropriate fill specification or with no fill specification. It continues to use the specified patterns until all valid PATTERN definitions have been used. Then, if more patterns are required, SAS/GRAPH returns to the default pattern rotation, but continues to outline the areas in the same color as the fill.

Altering or Canceling PATTERN Statements

PATTERN statements are additive. You can define a PATTERN statement and later submit another PATTERN statement with the same number. The new PATTERN statement redefines or cancels only the options that are included in the new statement. Options not included in the new statement are not changed and remain in effect. For example, assume you define PATTERN4 as follows:

```
pattern4 value=x3 color=red repeat=2;
```

This statement cancels only REPEAT= without affecting the rest of the definition:

```
pattern4 repeat=;
```

Add or change options in the same way. This statement changes the color of the pattern from red to blue:

```
pattern4 color=blue;
```

After all these modifications, PATTERN4 has these characteristics:

```
pattern4 value=x3 color=blue;
```

Cancel individual PATTERN statements by defining a PATTERN statement of the same number without options (a null statement):

```
pattern4;
```

Canceling one PATTERN statement does not affect any other PATTERN definitions. To cancel all current PATTERN statements, use the RESET= option in a GOPTIONS statement:

```
goptions reset=pattern;
```

Specifying RESET=GLOBAL or RESET=ALL cancels all current PATTERN definitions as well as other settings.

To display a list of current PATTERN definitions in the LOG tab, use the GOPTIONS procedure with the PATTERN option:

```
proc goptions pattern nolist;
run;
```

About Default Patterns

How SAS/GRAPH Generates and Assigns PATTERN Definitions

When a procedure produces a graph that needs one or more patterns, SAS/GRAPH does one of the following actions:

- automatically generates the appropriate default patterns and outlines to fill the areas
- uses patterns, colors, and outlines that are defined by PATTERN statements, graphics options, and procedure options.

In order to understand how SAS/GRAPH generates and assigns patterns defined with PATTERN statements, it is helpful to understand how it generates and assigns default patterns. The following sections describe the default pattern behavior for all procedures. See "Working with PATTERN Statements" on page 117 for details about defining patterns.

How Default Patterns and Outlines Are Generated

In general, the default pattern that SAS/GRAPH uses is a solid fill. SAS/GRAPH uses default patterns when no PATTERN statements are defined. The default colors are determined by the current style.

The procedure uses the style's default block fill colors, widths, patterns, and outline colors when producing output. Specifically, SAS/GRAPH uses the default values when you do not specify any of the following:

- any PATTERN statements
- the CPATTERN= graphics option
- the COLORS= graphics options (that is, you use the device's default color list and it has more than one color)
- the COUTLINE= option in the action statement

If all of these conditions are true, then SAS/GRAPH performs the following operations:

- selects the first default fill for the appropriate pattern, which is always solid. It rotates once through the list of colors available in the current style, generating one solid pattern for each color. If you use the default style colors and the first color in the list is either black or white, the procedure does not create a pattern in that color. If you specify a color list with the COLORS= graphics option, then the procedure uses all the colors in the list to generate the patterns.

  Note: The one exception to the default solid pattern is the map area pattern in a block map produced by the GMAP procedure, which uses a hatch fill by default. By default the map areas and their outlines use the first color in the color list. This happens regardless of whether the list is the default device list or one specified with COLORS= in the GOPTIONS statement.

- uses the style's outline color to outline every patterned area.

If a procedure needs additional patterns, SAS/GRAPH selects the next default pattern fill appropriate to the graph and rotates it through the color list, skipping the foreground color as before. SAS/GRAPH continues in this fashion until it has generated enough patterns for the chart.

Things That Affect Default Patterns

Changing any of these conditions can change or override the default behavior:

- If you specify a color list with the COLORS= option in a GOPTIONS statement and the list contains more than one color, SAS/GRAPH rotates the default fills, beginning with SOLID, through that list. In this case, it uses every color, even if the foreground color is black (or white). The default outline color remains the foreground color.
- If you specify either COLORS=(*one-color*) or the CPATTERN= graphics option, the default fill changes from SOLID to the appropriate list of hatch patterns. SAS/GRAPH uses the specified color to generate one pattern definition for each hatch pattern in the list.

For a description of these options, see "Graphics Options and Device Parameters Dictionary" in *SAS/GRAPH: Reference*.

Working with PATTERN Statements

What You Can Specify with PATTERN Statements

With PATTERN statements, you can specify the following:

- the type of fill (VALUE=)
- the color of the fill (COLOR=)
- the images used to fill the bars in a two-dimensional chart (IMAGE=)
- how many times to apply the statement before using the next one (REPEAT=).

You can also use procedure options to specify the pattern outline color and the CPATTERN= graphics option to specify a default color for all patterns.

Whether you use PATTERN statement options alone or with each other affects the number and type of patterns your PATTERN statements generate. Depending on which options you use, you can explicitly specify every pattern used by your graphs. Or you can let the PATTERN statement generate a series of pattern definitions using either the color list or the list of default fills.

Explicitly Specifying Patterns

To explicitly specify all the patterns in your graph, you need to do one of the following for every pattern your graph requires:

- Provide a PATTERN statement that uses the COLOR= option to specify the pattern color, for example:

  ```
  pattern1 color=red;
  ```

  By default, the fill type is SOLID.

- Provide a PATTERN statement that uses both the COLOR= option and the VALUE= option to specify the fill, for example:

```
pattern1 color=blue value=r3;
```

Including the COLOR= option in the PATTERN statement is the simplest way to ensure that you get exactly the patterns that you want. When you use the COLOR= option, the PATTERN statement generates exactly one PATTERN definition for that statement. If you also use the REPEAT= option, the PATTERN definition is repeated the specified number of times.

Generating Multiple Pattern Definitions

You can also use PATTERN statements to generate multiple PATTERN definitions. To do this use the VALUE= option to specify the type of fill you want but omit the COLOR= option. For example:

```
pattern1 value=r3;
```

In this case, the PATTERN statement rotates the R3 fill through all the colors in the color list. For more information about pattern rotation, see "Understanding Pattern Sequences" on page 119.

Selecting an Appropriate Pattern

The type of fill pattern that you specify depends on the type of graph that you are producing:

Table 6.6 *Fill Patterns for Graph Types*

Type of graph	Appropriate type of fill
block maps (PROC GMAP)	" VALUE=*block-pattern*" on page 108
map area surfaces (PROC GMAP)	"VALUE= *map-pattern*" on page 109

Note: You might specify a fill that is inappropriate for the type of graph that you are generating. For example, you might specify VALUE=L1 in a PATTERN statement for a choropleth map. In this case SAS/GRAPH ignores the PATTERN statement and continues searching for a valid pattern. If it does not find a definition with a valid fill specification, it uses default patterns instead.

Controlling Outline Colors

Whenever you use PATTERN statements, the default outline color uses the style's outline color to outline every patterned area.

You can change the outline color of any pattern, whether the pattern is default or user-defined. Use the COUTLINE= option or the CEMPTY= option, or both, in the action statement that generates the map.

The Effect of the CPATTERN= Graphics Option

Although the CPATTERN= graphics option is used most often with default patterns, it does affect the PATTERN statement. With default patterns (no PATTERN statements specified), it does the following:

- specifies the color for all patterns
- causes default patterns to use hatched fills instead of the default SOLID

In conjunction with the PATTERN statement that it does the following:

- With a PATTERN statement that specifies only a fill (VALUE=), the CPATTERN= option determines the color of that fill. For example, these statements produce two green, hatched patterns:

```
goptions cpattern=green;
pattern1 value=x3;
pattern2 value=x1;
```

- With a PATTERN statement that specifies only a color (COLOR=), the COLOR= option overrides the CPATTERN= color, but CPATTERN= causes the fill to be hatched, not the default SOLID. For example, these statements produce one red, hatched pattern:

```
goptions cpattern=green;
pattern1 color=red;
```

See also the description of "CPATTERN= Graphics Option" in *SAS/GRAPH: Reference*.

Understanding Pattern Sequences

About Pattern Sequences

Pattern sequences are sets of PATTERN definitions that SAS/GRAPH automatically generates when a PATTERN statement specifies a fill but not a color. In this case, the specified fill is used once with every color in the color list. If the REPEAT= option is also used, the resulting PATTERN definitions are repeated the specified number of times.

Generating Pattern Sequences

SAS/GRAPH generates pattern sequences when a PATTERN statement uses VALUE= to specify a fill and all of the following conditions are also true:

- The COLOR= option is not used in the PATTERN statement.
- The CPATTERN= graphics option is not used.
- The color list, either default or user-specified, contains more than one color.

In this case, the PATTERN statement rotates the fill specified by the VALUE= option through every color in the color list. One PATTERN definition is generated for every color in the list. After every color has been used once, SAS/GRAPH goes to the next PATTERN statement. For example, suppose you specified the following color list and PATTERN statements for bar or block patterns:

```
goptions colors=(blue red green) ctext=black;
```

```
pattern1 color=red   value=x3;
pattern2 value=r3;
pattern3 color=blue  value=l3;
```

Here, PATTERN1 generates the first PATTERN definition. PATTERN2 omits the COLOR= option, so the specified fill is rotated through all three colors in the color list before the PATTERN3 statement is used. This table sequentially lists the color and fill of the PATTERN definitions that would be generated if nine patterns were required:

Table 6.7 *Color and Fill PATTERN Definitions for the First Nine Patterns*

Definition Number	Source	Characteristics	
		Color	**Fill**
1	PATTERN1	Red	x3
2	PATTERN2	Blue	r3
3	PATTERN2	Red	r3
4	PATTERN2	Green	r3
5	PATTERN3	Blue	l3
6	First default	Blue	Solid
7	First default	Red	Solid
8	First default	Green	Solid
9	Second default	Blue	x1

Notice that after all the PATTERN statements are exhausted, the procedure begins using the default bar and block patterns, beginning with SOLID. Each fill from the default list is rotated through all three colors in the color list before the next default fill is used.

Repeating Pattern Sequences

If you use the REPEAT= option but not the COLOR= option, the sequence generated by cycling the definition through the color list is repeated the number of times specified by the REPEAT= option. For example, these statements illustrate the effect of the REPEAT= option on PATTERN statements both with and without explicit color specifications:

```
goptions colors=(red blue green);
pattern1 color=gold repeat=2;
pattern2 value=x1 repeat=2;
```

In the following table, PATTERN1 is used twice and PATTERN2 cycles through the list of three colors and then repeats this cycle a second time:

Table 6.8 *The Cyclical Use of PATTERN Statements*

Sequence Number	Source	Characteristics	
		Color	Fill
1	PATTERN1	Gold	Solid (first default)
2	PATTERN1	Gold	Solid (first default)
3	PATTERN2	Red	x1
4	PATTERN2	Blue	x1
5	PATTERN2	Green	x1
6	PATTERN2	Red	x1
7	PATTERN2	Blue	x1
8	PATTERN2	Green	x1

TITLE Statement

Controls the content, appearance, and placement of text in a title.

Valid in: Anywhere

Used by: GMAP, SGMAP

Type: Global statement

Restriction: The TITLE statement does not support Unicode.

Syntax

TITLE<*1-10*><*ods-format-options*> <*text-options*> <'*text-string*'>;

Without Arguments

Using TITLE without arguments cancels all existing titles.

```
title;
```

Optional Arguments

<1–10>

specifies the relative line that contains the title text.

Valid in Anywhere

Default If you omit a number, SAS assumes a value of 1. Therefore, you can specify TITLE or TITLE1 for the first title line.

Tips The TITLE statement with the highest number appears on the bottom line.

You can create titles that contain blank lines between the lines of text. For example, if you specify text with a TITLE statement and a TITLE3 statement, there is a blank line between the two lines of text.

<ods-format-options>

specifies formatting options for the ODS HTML5, PDF, and RTF destinations.

BCOLOR=*color*

specifies the background color of the title block.

You can optionally draw a box around a text string with the BOX= option. The BCOLOR= option controls the background color of the box. By default, the background color of the box is the same as the background color for the entire graph. You can specify colors using a number of different color-naming schemes. The color of the frame of the box is determined by the color specification used in BOX=.

Valid in Base SAS, ODS Graphics, SAS/GRAPH

Alias BC=

Restriction If you omit the BOX= option, the BCOLOR= option is ignored.

Note The BCOLOR= option can be reset by the ANGLE= option or the JUSTIFY= option, or by the MOVE= option with absolute coordinates.

See “Using Options That Can Reset Other Options” on page 139 for details

“ BOX=1-4 ” on page 129

Example “Enhancing Titles” in *SAS/GRAPH: Reference*

BOLD

specifies that the font weight is bold for the text string.

Valid in Base SAS, ODS Graphics

Default For titles, the default font weight is specified by the FONTWEIGHT attribute of the GraphTitleText style element in the current style.

Restriction The BOLD option is for template-based procedures only.

COLOR=*color*
specifies the color for the text, box, or line that follows it. You can specify colors using a number of different color-naming schemes.

The color stays in effect until another COLOR= specification is encountered. Change colors as often as you like. For example, the following code produces a title where the first word is red and the second word is blue:

```
title color=red "Total Sales" color=blue;
```

If you omit the COLOR= option, a color specification is searched for in this order:

1 the CTITLE= option in a GOPTIONS statement
2 the CTEXT= option in a GOPTIONS statement
3 the default, the first color in the color list.

Valid in Base SAS. ODS Graphics, SAS/GRAPH

Alias C=

Default For titles, the default text color is specified by the COLOR attribute of the GraphTitleText style element in the current style.

Style reference Color attribute of the GraphTitle1Text (TITLE1) and the GraphTitleText (TITLE2...n) elements

See "BCOLOR=*color*" on page 122

FONT='*system-font*'
specifies the system font to use for the subsequent text string.

See "Specifying Fonts in SAS/GRAPH Programs" in *SAS/GRAPH: Reference* for details about specifying SAS/GRAPH fonts. If you omit this option, a font specification is searched for in this order:

If you omit this option, a font specification is searched for in this order:

- for a TITLE1 statement:

1 the FTITLE= option in a GOPTIONS statement
2 the FTEXT= option in a GOPTIONS statement
3 the default font, SWISS (COMPLEX in Release 6.06 and earlier)

- for all other TITLE statements:

1 the FTEXT= option in a GOPTIONS statement
2 the default hardware font, NONE

Valid in Base SAS, ODS Graphics, SAS/GRAPH

Alias F=

Default — For titles, the default font is specified by the FONTFAMILY attribute of the GraphTitleText style element in the current style.

Style reference — Color attribute of the GraphTitle1Text (TITLE1) and the GraphTitleText (TITLE2...n) elements

Notes — SAS/GRAPH software fonts such as SWISS cannot be used with statistical graphics procedures.

Font names greater than eight characters in length must be enclosed in quotation marks.

If the TITLE is displayed using an ODS markup destination and the corresponding NOGTITLE option is specified, then the **bold** and **italic** FONT attributes are on by default. However, if you specify different attributes with the FONT= option, the **bold** and **italic** attributes are turned off.

Example — "Enhancing Titles" in *SAS/GRAPH: Reference*

HEIGHT=*numeric-value<units>*

specifies the size of the text. You can also specify the unit of measurement. Without a unit of measure, the number becomes a relative size.

If you do not specify a unit, then the size of the text is approximately 12*numeric-value* points. For example, if you specify HEIGHT=2, then the text size is approximately 24 points.

numeric-value

Height is measured from the font minimum to the capline. Ascenders can extend above the capline, depending on the font.

If your text line is too long to be displayed in the height specified in the HEIGHT= option, the height specification is reduced so that the text can be displayed. A note in the SAS log tells you what percentage of the specified size was used.

<units>

is a nonnegative number.

Measurement Units

cm	Centimeters
in	Inches
pct or %	Percentage
pt	A printer's point

Valid in — Base SAS, ODS Graphics, SAS/GRAPH

Alias — H=

Defaults For TITLE or TITLE1 statements, HEIGHT is determined by the current ODS style. HEIGHT=1 for subsequent TITLE statements.

For the first title (title or title1), the default font size is specified by the FONTSIZE attribute of the GraphTitleText style element in the current style. For subsequent titles (titleN), the size is the FONSIZE attribute of the GraphLabelFont style attribute.

Style reference Height attribute of the GraphTitle1Text (TITLE1) and the GraphTitleText (TITLE2...n) elements

Examples

"Enhancing Titles" in *SAS/GRAPH: Reference*

ITALIC

specifies that the font style is italic for the text string.

Valid in Base SAS, ODS Graphics

Default For titles, the default font style is specified by the FONTSTYLE attribute of the GraphTitleText style element in the current style.

JUSTIFY= LEFT | CENTER | RIGHT

specifies the alignment of the text string. You can specify one of the following values:

LEFT

aligns the text to the left.

Alias L

CENTER

aligns the text in the center.

Alias C

RIGHT

aligns the text to the right.

Alias R

Alias J=

Default CENTER

Notes The JUSTIFY= option affects all of the text strings that follow it in your TITLE statement. You can specify multiple alignments by using more than one JUSTIFY= option. For example, the following code creates a title where the first string is aligned to the left and the second string is aligned to the right:

```
title justify=left "Example 2" justify=right "Graph 3";
```

You can use the JUSTIFY= option to produce multiple lines of text by repeating the JUSTIFY= option with the same value before the text string for each line. Multiple lines of text with the same justification are blocked together. For example, this TITLE statement produces a three-line title with each line right-justified:

```
title  justify=right "First Line"
     justify=right "Second Line"
     justify=right "Third Line";
```

You can get the same effect with three TITLE statements, each specifying JUSTIFY=RIGHT. You can produce a block of text by specifying the same justification for multiple text strings. You can then change the justification for an additional text string. The result is that the text is placed on the same line as the first string specified in the statement.

Using the JUSTIFY= option after one text string and before another can reset some options to their default values.

LINK='*URL*'
specifies a uniform resource locator (URL) to which a title links.

The *text-string* that you use to specify the URL can contain occurrences of the variables #BYVAL, #BYVAR, and #BYLINE, as described in "Using #BYLINE, #BYVAL, and #BYVAR Substitution in URL and TITLE Text Strings" in *SAS Global Statements: Reference*.

Valid in Base SAS, SAS/GRAPH

Supports The LINK= option can be used in conjunction with the ALT= option.

Note The title can be displayed using an ODS markup destination (such as HTML). And the corresponding ODS option NOGTITLE can be specified. Then the title is rendered in the body of the HTML file rather than in the graphic itself. Specifying the NOGTITLE options results in increasing the amount of space allowed for the procedure output area, which can result in increasing the size of the graph. Space that would have been used for the title is devoted instead to the graph. You might need to be aware of this possible difference if you are using annotate or map coordinates.

UNDERLIN=*0-3*
specifies whether the subsequent text is underlined. UNDERLIN=0 indicates no underlining. Values 1, 2, and 3 underline with an increasingly thicker line.

Underlines follow the text baseline. If you use an LANGLE= or ANGLE= option for the line of text, the underline is drawn at the same angle as the text. Underlines do not break up to follow rotated characters.

To make the text and the underline the same color, specify a COLOR= option before the UNDERLIN= option that precedes the text string. To make the text a different color, specify the COLOR= option after the UNDERLIN= option.

Valid in SAS/GRAPH

Aliases U=

UNDERLINE

See " ROTATE=*degrees*" on page 134

"Using Options That Can Reset Other Options" on page 139 for details

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

Note The defaults for how ODS renders the TITLE statement come from style elements relating to system titles in the current style. The TITLE statement syntax with *ods-format-options* is a way to override the settings provided by the current style. The current style varies according to the ODS destination. For more information about how to determine the current style, see "Understanding Styles, Style Elements, and Style Attributes" in *SAS Output Delivery System: Procedures Guide*. Also see "TEMPLATE Procedure: Creating a Style Template" in *SAS Output Delivery System: Procedures Guide*.

Tip You can specify these options by letter, word, or words by preceding each letter or word of *text-string* by the option. For example, this code makes the title "Red, White, and Blue" appear in different colors

```
title color=red "Red," color=white "White, and" color=blue "Blue";
```

<text-options>

specifies formatting options for the text.

Text options must precede the '*'text-string*' that they modify. *text-options* can be one or more of the following optional arguments, in any order:

ALT=*'text-string'*

The *'text-string'* that you use to describe a title, or the URL specified by the LINK= option, can contain occurrences of the variables #BYVAL, #BYVAR, and #BYLINE, as described in "Using #BYLINE, #BYVAL, and #BYVAR Substitution in URL and TITLE Text Strings" in *SAS Global Statements: Reference*.

Valid in SAS/GRAPH

Restrictions The ALT= option is not for template-based procedures.

You must enclose *'text-string'* in single or double quotation marks.

Supports The ALT= option can be used in conjunction with the LINK= option.

Note The title can be displayed by using an ODS markup destination (such as HTML). Also, the corresponding ODS option NOGTITLE is specified. In this case, the title is rendered in the

body of the HTML file rather than in the graphic itself. And the ALT= text is not associated with the title.

See "Controlling Where Titles and Footnotes Are Rendered" in *SAS/GRAPH: Reference*

"LINK='*URL*' " on page 126

Example "Example 6: Producing a Drilldown Choropleth Map" on page 451

ANGLE=*degrees*

A positive *degrees* value angles the *baseline* counterclockwise; a negative value angles it clockwise. By default, ANGLE=0 (horizontal).

Angled titles might require more vertical space. Consequently, there might be an increase the size of the title area, thereby reducing the vertical space in the procedure output area.

Using the BOX= option with angled text does not produce angled boxes; the box is sized to accommodate the angled note.

Using the ANGLE= option after one text string and before another can reset some options to their default values. See "Using Options That Can Reset Other Options" on page 139 for details.

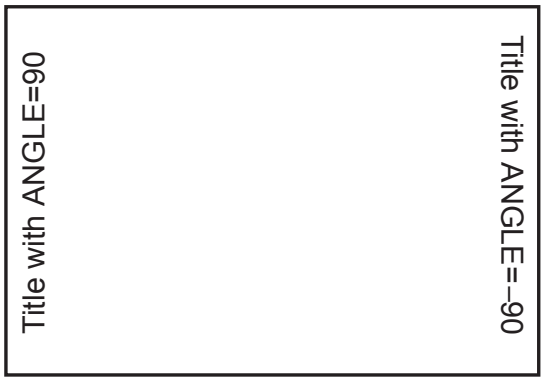
The ANGLE= option has the same effect on the text as LANGLE=, except when you specify an angle of 90 degrees or –90 degrees. In these angle specifications, the procedure output area is shrunk from the left or right to accommodate the angled title.

ANGLE=90 positions the title at the left edge of the graphics output area, angled 90 -degrees (counterclockwise) and centered vertically.

ANGLE=–90 positions the title at the right edge of the graphics output area, angled –90-degrees (clockwise) and centered vertically.

Figure 6.22 on page 128 shows how ANGLE=90 degrees and ANGLE=–90 degrees positions and rotates titles.

Figure 6.21 *Positioning Titles with the ANGLE= Option*



Valid in SAS/GRAPH

Alias A=

Restriction The ANGLE= option is not for template-based procedures.

See " LANGLE=*degrees*" on page 132

" ROTATE=*degrees*" on page 134

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

BLANK=YES

It does this by blanking out the area where the box is displayed. The BLANK= option enables you to overlay graphics elements with boxed text. It is ignored if you omit the BOX= option. Because titles are written from the highest numbered to the lowest numbered, the BLANK= option only blanks out titles of a lower number.

Valid in SAS/GRAPH

Alias BL=

Restriction The BLANK= option is not for template-based procedures.

Note The BLANK= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 139 for details

" BOX=1-4 " on page 129

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

BOX=1-4

Specify a value between 1 and 4, where 1 specifies the thinnest line and 4 specifies the thickest line. Only the last BOX= option is used. Boxing angled text does not produce an angled box; the box is sized to include the angled text.

The color of the box outline is determined by the GraphBorderLines element of the current style.

The color of the box is one of the following:

- the color specified by the COLOR= option in the statement
- the default text color

The COLOR= option, preceding the BOX= option, controls the box frame color. To color the background of the box, use the BCOLOR= option. Specify the same color with both the COLOR= option and the BCOLOR= option to effect a box without a frame.

You can include more than one text string in the box as long as no text break occurs between the strings. That is, you cannot use the JUSTIFY= option to create multiple lines of text within a box.

To draw a box around multiple lines of text, you can do either of the following:

- Use the MOVE= option with relative coordinates to position an additional line of text relative to the preceding line and enclose them within the box drawn by the BOX= option. For example, this statement produces the boxed note shown in Figure 6.23 on page 130:

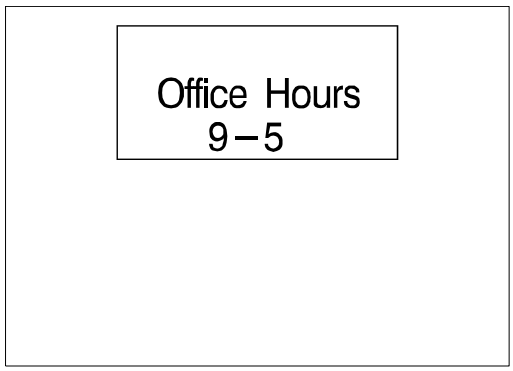
```
title font=swiss justify=center box=1
   "Office Hours"      move=(-7,-2)pct "9-5";
```

  The MOVE= option in this TITLE statement overrides the JUSTIFY= option that center-positioned the first line of text. The MOVE= option specifies the *x* and *y* coordinates in percentage units. The text string '9–5' is positioned relative to the first text string 'Office Hours'.

  Using the MOVE= option in a TITLE statement enables you to position a title on top of a graph.

- Use the DRAW= option to draw the box and do not use the BOX= option.

Figure 6.22 *Using the BOX= Option and the MOVE= Option to Box Multiple Lines of Text*



Valid in SAS/GRAPH, ODS Graphics

Alias BO=

Note The BOX= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= options with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 139 for details

"BCOLOR=*color*" on page 122

" BLANK=YES " on page 129

" BSPACE=*numeric-value<units>*" on page 130

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

BSPACE=*numeric-value<units>*

units specifies the measurement criterion. See the "Units of Measurement" in *SAS ODS Graphics: Procedures Guide* for details.

If you do not specify a unit, then the size of the space is approximately 12*numeric-value* points. For example, if you specify BSPACE=2, then the space is approximately 24 points.

The space above the text is measured from the font maximum, and the space below the text is measured from the font minimum.

The spacing is uniform around the box. Notice that BSPACE=.5IN leaves one-half inch of space between the text and the top, bottom, and sides of the box.

Valid in SAS/GRAPH, ODS Graphics

Alias BS=

Defaults 1

0

Interaction If the BOX= option is not used, the BSPACE= option is ignored

Note The BSPACE= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 139 for details

" BOX=1-4 " on page 129

DRAW=(*x,y -,x-n,y-n*)*<units>*

Lines are drawn using *x* and *y* as absolute or relative coordinates. The following table shows the specifications for absolute and relative coordinates:

Table 6.9 *Coordinate Specifications*

Absolute Coordinates	Relative Coordinates
x<units>	*±x<units>*
y<units>	*±y<units>*

The coordinate position (0,0) is the lower left corner of the graphics output area. Specify at least two coordinate pairs. Commas between coordinates are optional; blanks can be used instead. The DRAW= option does not affect the positioning of text.

The starting point for lines specified with relative coordinates begins at the end of the most recently drawn text or line in the current statement. If no text or line has been drawn in the current statement, a warning is issued. The relative draw is measured from where a zero-length text string would have ended, given the normal placement for the statement.

You can mix relative and absolute coordinates. For example, DRAW=(+0,+0,+0,1IN) draws a vertical line from the end of the text to one inch from the bottom of the graphics output area.

units specifies the measurement criterion. See the "Units of Measurement" in *SAS ODS Graphics: Procedures Guide* for details.

Valid in SAS/GRAPH

Alias D=

Restriction The DRAW= option is not for template-based procedures.

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

LANGLE=*degrees*

specifies the angle of the *baseline* of the entire text string or text strings with respect to the horizontal axis. A positive value for *degrees* moves the *baseline* counterclockwise; a negative value moves it clockwise.

Angled titles might require more vertical space. Consequently, there might be an increase the size of the title area, thereby reducing the vertical space in the procedure output area.

Using the BOX= option with angled text does not produce an angled box; the box is sized to accommodate the angled text.

Unlike the ANGLE= option, the LANGLE= option does not reset any other options. Therefore, the LANGLE= option is easier to use because you do not need to repeat options after a text break.

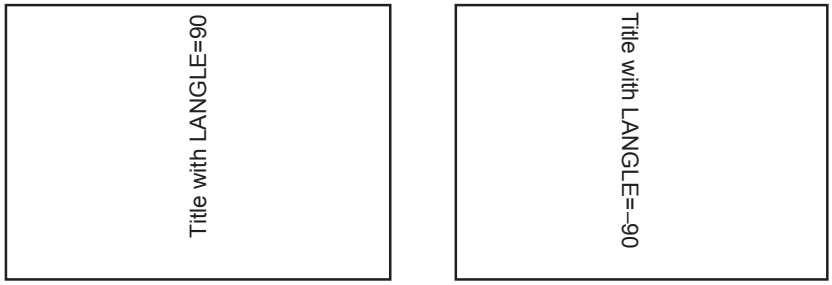
The LANGLE= option has the same effect on the text as the ANGLE= option, except when an angle of 90 degrees or –90 degrees is specified.

LANGLE=90 angles the title 90 degrees (counterclockwise) so that it reads from bottom to top. The title is centered horizontally and positioned at the top of the procedure output area.

LANGLE=-90 angles the title –90 degrees (clockwise) so that it reads from top to bottom. The title is centered horizontally and positioned at the top of the procedure output area.

Figure 6.24 on page 132 shows how LANGLE=90 degrees and LANGLE=–90 degrees positions and rotates titles.

Figure 6.23 *Positioning Titles with the LANGLE= Option*



Alias LA=

Default LANGLE=0 (horizontal)

See Figure 6.24 on page 132

LSPACE=*line-space <units>*

specifies the amount of spacing above lines of title text For titles, the spacing is measured from the capline of the current line to the font minimum of the line above.

units specifies the measurement criterion. See the "Units of Measurement" in *SAS ODS Graphics: Procedures Guide* for details.

If you do not specify a unit, then the size of the text is approximately 12*numeric-value* points. For example, if you specify HEIGHT=2, then the text size is approximately 24 points.

Alias LS=

Default LSPACE=0

Interaction Interaction The LSPACE= option has no effect if you also specify the BOX= option.

Note The LSPACE= option can be reset by the ANGLE= or JUSTIFY= option, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 139 for details

MOVE=(*x*,*y*) <*units*>

positions an initial or subsequent text string, or lines of text anywhere on the graphics output area. The positioning uses *x* and *y* as absolute or relative coordinates. The following table shows the specifications for absolute and relative coordinates:

Table 6.10 *Coordinate Specifications*

Absolute Coordinates	Relative Coordinates
x<units>	*±x<units>*
y<units>	*±y<units>*

Commas between coordinates are optional; you can use blanks instead.

The starting point for lines specified with absolute coordinates is at the bottom left corner of the graphics output area. For example, the following program uses the TITLE statement to add a simple line of text to the upper right quadrant of the graphics output area:

```
title move=(85,90)pct color=purple 'My Title';
proc gslide;
```

```
run;
```

The starting point for lines specified with relative coordinates is at the end of the most recently drawn text or line in the current statement. If no text or line has been drawn in the current statement, a warning is issued in the SAS log. The relative move is measured from where a zero-length text string would have ended, given the normal placement for the statement.

You can mix relative and absolute coordinates.

units specifies the measurement criterion. See the "Units of Measurement" in *SAS ODS Graphics: Procedures Guide* for details.

Alias M=

Restriction The MOVE= option is not for template-based procedures.

Interactions The MOVE= option overrides a JUSTIFY= option specified for the same text string

A TITLE statement can use the MOVE= option to position the text so that the statement does not use its default position. In this case, the text of the nextTITLE statement occupies the unused position and no blank lines are displayed

Notes You can specify the MOVE= option with at least one absolute coordinate. If the option follows one text string and precedes another, some options can be reset to their default values.

If you specify the GUNIT graphics option, then that unit is the default unit. If you do not specify the GUNIT= graphics option, then the default unit is CELLS.

See "Using Options That Can Reset Other Options" on page 139 for details

" BOX=1-4 " on page 129 for illustrative code that draws a box around lines of text positioned with relative coordinates

Examples

"Enhancing Titles" in *SAS/GRAPH: Reference*

ROTATE=*degrees*

specifies the angle at which each character of text is rotated with respect to the *baseline* of the text string. The angle is measured from the current text *baseline* angle, which is specified by the ANGLE= or LANGLE= options. By default, the *baseline* is horizontal. A positive value for *degrees* rotates the character counterclockwise; a negative value rotates it clockwise. By default, ROTATE=0 (parallel to the *baseline*).

Figure 6.25 on page 135 shows how characters are positioned when ROTATE=90 is used with the default (horizontal) *baseline*.

Figure 6.24 *Tilting Characters with the ROTATE= Option*

Alias R=

See " ANGLE=*degrees*" on page 128

Example "Enhancing Titles" in *SAS/GRAPH: Reference*

WRAP

If the WRAP option is omitted, the text font-size is reduced until the text fits on one line. Wrapping occurs at the last blank before the text meets the end of the window. If there are no blanks in the text string, then there is no wrapping.

Restriction The WRAP option does not work with the BLANK, BOX, MOVE, and UNDERLINE,options.

<'text-string'>

is a text string with a maximum length if 255 bytes. You must enclose text strings in either single or double quotation marks. The text appears exactly as you enter it in the statement, including uppercase and lowercase characters and spaces. Titles automatically wrap to additional lines if necessary. If the length of the specified title is greater than the value of the LINESIZE option, the title is truncated to the line size.

To use single quotation marks or apostrophes within the title, you can do either of the following:

- use a pair of single quotation marks together:

```
title 'All''s Well That Ends Well';
```

- enclose the text in double quotation marks:

```
title "All's Well That Ends Well";
```

You can specify multiple text strings in TITLE statements. If you want each string to be separated by a blank, add a blank to the beginning of the second and subsequent text strings rather than at the end the preceding string, as in this example:

```
title color=red "Sales:" color=blue " 2020";
```

With fonts that support Unicode, you can specify special characters by specifying a hexadecimal constant in quotation marks. A trailing `x` identifies a string as a hexadecimal constant. You must designate the hexadecimal constant as a Unicode specification and escape it: `(*ESC*){Unicode '`*`hexadecimal-value`*`'x}`. For example:

```
title "Regression with Confidence Limits ((*ESC*){unicode '03B1'x}=.05)";
```

This statement produces the title, "Regression with Confidence Limits (α = .05)" because '03B1'x is the hexadecimal value for the lowercase Greek letter alpha in all Unicode fonts.

> **TIP** You can instead specify lowercase Greek letters by name, and uppercase Greek letters by name_u: `(*ESC*){Unicode alpha}=.05` and `(*ESC*){Unicode alpha_u}=.05`.

For more information, see "Specifying Special Characters Using Character and Hexadecimal Codes" in *SAS/GRAPH: Reference*.

You can also customize titles by inserting BY variable lines (#BYLINE), BY variable values (#BYVAL), or BY variable names (#BYVAR), in titles that are specified in procedure steps. Embed the items in the specified title text string at the position where you want the substitution text to appear.

Restriction Restriction #BYVAL or #BYVAR substitution in a text string is not available in the Annotate facility. The reason is that BY lines are not created in a DATA step.

Note For SVG output, the value of the TITLE statement is used for the SVGTITLE option if the latter is not specified. If more than one TITLE statement is specified, the titles are concatenated, separated by a semicolon. The maximum number of characters for the SVGTITLE option is 256 characters.

Tips For compatibility with previous releases, SAS accepts some text without quotation marks. When writing new programs or updating existing programs, always enclose text in quotation marks.

You can use macro variables and macros to change the information in TITLE statements. The SAS macro facility resolves the macro variable. If the title is enclosed in double quotation marks (""), the text indicated is substituted into the title. If the title is enclosed in single quotation marks ('), the text is not substituted.

See For more information about including quotation marks as part of the title, see "SAS Constants in Expressions" in *SAS Programmer's Guide: Essentials*.

"Using BY-group Processing to Generate a Series of Charts" in *SAS/GRAPH: Reference*

"Combining Graphs and Reports in a Web Page" in *SAS/GRAPH: Reference*

Details

Using the TITLE Statement

A TITLE statement takes effect when the step or RUN group with which it is associated executes. After you specify a title for a line, it is used for all subsequent output until you cancel the title or define another title for that line. A TITLE

statement for a given line cancels the previous TITLE statement for that line and for all lines with larger numbers.

Note: If the length of the specified title is greater than the value of the LINESIZE option, the title is truncated to the line size.

Summary of Options

ods-format-options

- appearance options:
  - BOLD
  - COLOR= *color*
  - FONT= "*system-font*"
  - HEIGHT= *numeric-value* <*units*>
  - ITALIC
- placement and spacing options:
  - JUSTIFY= LEFT | CENTER | RIGHT
  - LSPACE= *numeric-value* <*units*>
- boxing and drawing options:
  - BCOLOR= *color*
  - BOX= *numeric-value*
  - BSPACE= *numeric-value* <*units*>

The following options are not supported by the SAS/GRAPH procedures:

- BOLD
- ITALIC

The following options are not supported by the ODS Graphics procedures:

- ANGLE=
- BLANK=
- DRAW=
- LANGLE=
- LINK=
- MOVE=
- ROTATE=
- UNDERLIN=
- WRAP

Measurement Units

Some of the options in the TITLE statement give you the option to specify the unit of measurement. The following table lists the units that are supported:

Table 6.11 *Measurement Units*

Unit	Description
CM	centimeters
IN	inches
PCT or %	percentage
PT	point size, calculated at 100 dots per inch

Using Multiple Options

In each statement, you can use as many text strings and options as you want, but you must place the options before the text strings that they modify. Most options affect all text strings that follow them in the same statement, unless the option is explicitly reset to another value. In general, TITLE, FOOTNOTE, and NOTE statement options stay in effect until one of these events occurs:

- The end of the statement is reached.
- A new specification is made for that option.

For example, this statement specifies that one part of the note is red and another part is blue, but the height for all of the text is 4:

```
note height=4 color=red "Red Tide"
     color=blue " Effects on Coastal Fishing";
```

Controlling Placement of Text

The following options enable the positioning of text on the graphics output area:

- “JUSTIFY= LEFT | CENTER | RIGHT” on page 125 aligns the text string
- “ MOVE=(*x*,*y*) <*units*>” on page 133 positions a line or lines of text anywhere on the graphics output area using *x* and *y* as absolute or relative coordinates.

  Figure 6.23 on page 130 illustrates using the MOVE= option with relative coordinates to position a subsequent line of text.
- “WRAP” on page 135 wraps the text to a second line

See the description of each option for usage details and restrictions.

Setting Defaults

You can set default characteristics for titles (including TITLE1 definitions), footnotes, and notes by using the following graphics options in a GOPTIONS statement:

CTITLE=*color*
sets the default color for all titles, footnotes, and notes; overridden by the COLOR= option in a TITLE, FOOTNOTE, or NOTE statement.

CTEXT=*text-color*
sets the default color for all text; overridden by the CTITLE= option for titles, footnotes, and notes.

FTITLE=*title-font*
sets the default font for TITLE1 definitions; overridden by the FONT= option in the TITLE1 statement.

FTEXT=*text-font*
sets the default font for all text, including the TITLE1 statement if the FTITLE= option is not used; overridden by the FONT= option in a TITLE, FOOTNOTE, or NOTE statement.

HTITLE=*height<units>*
sets the default height for TITLE1 definitions; overridden by the HEIGHT= option in the TITLE1 statement.

HTEXT=*n<units>*
sets the default height for all text, including the TITLE1 statement if the HTITLE= option is not used; overridden by the HEIGHT= option in a TITLE, FOOTNOTE, or NOTE statement.

See "Graphics Options and Device Parameters Dictionary" in *SAS/GRAPH: Reference* for a complete description of each option.

Using Options That Can Reset Other Options

The ANGLE=, MOVE=, and JUSTIFY= options affect the position of the text and cause text breaks. (To cause a text break, the MOVE= option must have at least one absolute coordinate.) When a statement contains multiple text strings, the resulting text break can cause the following options to reset to their default values:

- BCOLOR=
- BLANK=
- BOX=
- BSPACE=
- LSPACE=
- UNDERLIN=.

Note: The LANGLE= option does not cause a text break.

In a TITLE, FOOTNOTE, or NOTE statement, before the first text string, you can use an option that can be reset (such as the UNDERLIN= option). Before the second

string, if you use an option that resets it (such as the JUSTIFY= option), the first option does not affect the second string. In order for the first option to affect the second string, repeat the option and position it after the resetting option and before the text string.

For example, this statement produces a two-line title in which only the first line is underlined:

```
title underlin=2 "Line 1" justify=left "Line 2";
```

To underline Line 2, repeat the UNDERLIN= option before the second text string and after the JUSTIFY= option:

```
title underlin=2 "Line 1" justify=left
      underlin=2 "Line 2";
```

Examples

Example 1: Enhancing Titles

Features:

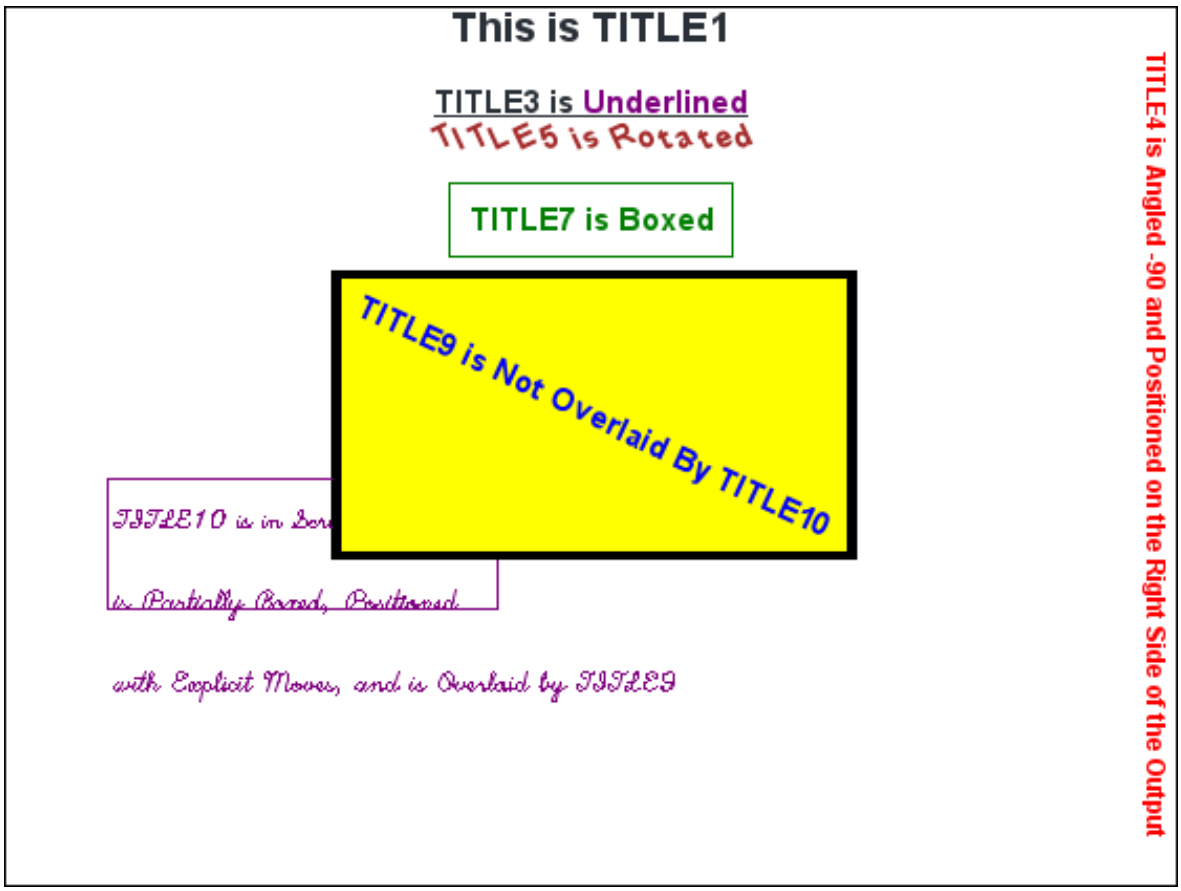
GOPTIONS statement options
- BORDER

TITLE statement options
- ANGLE=
- BCOLOR=
- BLANK=
- BOX=
- COLOR=
- DRAW=
- FONT=
- HEIGHT=
- MOVE=
- ROTATE=
- “*text-string*”
- UNDERLIN=

Details

This example illustrates some ways that you can format title text. The same options can be used to format footnotes.

Output



Program

```
goptions reset=all border;

title1 "This is TITLE1"
height=4;

title3 underlin=1
       "TITLE3 is"
       color=purple
       " Underlined";

title4 color=red
       angle=-90
       "TITLE4 is Angled -90 and Positioned on the Right Side of the
Output";

title5
       color=brown
       rotate=25
       "TITLE5 is Rotated";

title7 color=green
       box=1
       "TITLE7 is Boxed";
```

```
title9 color=black
       box=3
       blank=yes
       bcolor=yellow
       color=blue
       angle=-25
       "TITLE9 is Not Overlaid By TITLE10";

title10 color=purple
        draw=(20,35 20,27 58,27 58,35 20,35)cells
        move=(20,32)
        font=script
        "TITLE10 is in Script and "
        move=(20,27)
        height=2
        "is Partially Boxed, Positioned"
        move=(20,22)
        height=2
        "with Explicit Moves, and is Overlaid by TITLE9";

proc gslide;
run;
quit;
```

Program Description

Set the graphics environment. BORDER draws a border around the graph.

```
goptions reset=all border;
```

Define TITLE1. TITLE1 uses the default font and height defined in the default style. The HEIGHT= option sets the height of the text.

```
title1 "This is TITLE1"
height=4;
```

Define TITLE3. The UNDERLIN= option underlines both text strings.

```
title3 underlin=1
       "TITLE3 is"
       color=purple
       " Underlined";
```

Define TITLE4. The ANGLE= option tilts the line of text clockwise 90 degrees and places it at the right edge of the output, centered vertically.

```
title4 color=red
       angle=-90
       "TITLE4 is Angled -90 and Positioned on the Right Side of the
Output";
```

Define TITLE5. The ROTATE= option rotates each character in the text string at the specified angle.

```
title5
       color=brown
       rotate=25
       "TITLE5 is Rotated";
```

Define TITLE7. The BOX= option draws a green box around the text with the thinnest of the 4 available box lines.

```
title7 color=green
       box=1
       "TITLE7 is Boxed";
```

Define TITLE9. The BLANK= option prevents the boxed title from being overwritten by TITLE10. The first COLOR= option specifies the color of the box border, and the BCOLOR= option specifies the background color of the box. The second COLOR= option specifies the text color.

```
title9 color=black
       box=3
       blank=yes
       bcolor=yellow
       color=blue
       angle=-25
       "TITLE9 is Not Overlaid By TITLE10";
```

Define TITLE10. In this statement, the DRAW= option draws a box around the first two text strings. The BOX= option is turned off by the MOVE= option that uses absolute coordinates and causes a text break.

```
title10 color=purple
        draw=(20,35 20,27 58,27 58,35 20,35)cells
        move=(20,32)
        font=script
        "TITLE10 is in Script and "
        move=(20,27)
        height=2
        "is Partially Boxed, Positioned"
        move=(20,22)
        height=2
        "with Explicit Moves, and is Overlaid by TITLE9";
```

Display titles. All existing titles are automatically displayed by the procedure.

```
proc gslide;
run;
quit;
```

Example 2: Using Global Statements When Creating a Map

Features:

FOOTNOTE statement

GOPTIONS statement

LEGEND statement options

- ACROSS=
- LABEL=
- MODE=
- OFFSET=
- ORDER=

POSITION=
SHAPE=

PATTERN statement

TITLE statement

Data sets: MAPSGFK.EUROPE

SASHELP.DEMOGRAPHICS

Format: GNI (Gross National Income)

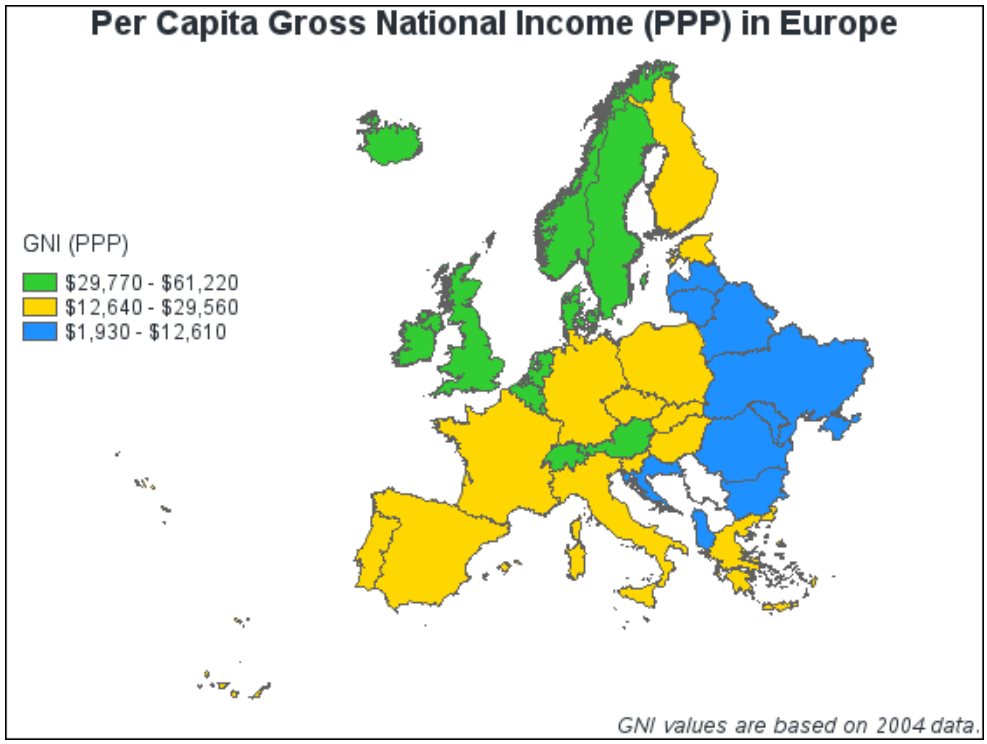
Details

This example creates a choropleth map of per capita gross national income (GNI) in Europe. The map shows GNI in three ranges, where each range is indicated by a different color. This example demonstrates how to do the following using global statements when creating a map:

- specify the map size with a GOPTIONS statement
- add a title and footnote to the map with a TITLE and FOOTNOTE statement
- assign colors to map areas with PATTERN statements
- add a legend to the map with a LEGEND statement
- format the GNI values with a FORMAT statement

Output

Output 6.1 *Map of Per Capita Gross National Income (PPP) in Europe*



Program

```
options fmtsearch=(sashelp.mapfmts);
data demographics;
   length idname $55;
   set sashelp.demographics(where=(cont = 93));
   idname = put(id,glcnsm.);
run;

goptions reset=all border xpixels=560 ypixels=420;

pattern1 color=DodgerBlue;
pattern2 color=Gold;
pattern3 color=LimeGreen;

legend across=1
        position=(bottom left)
        offset=(1.25pct,50pct)
        mode=share
        label=(position=top
               "Gross National Income per capita")
        shape=bar(.15in,.10in)
        order=descending
 ;

title "Per Capita Gross National Income (PPP) in Europe";
footnote justify=R font="Albany AMT/Italic"
```

```
   "GNI values are based on 2004 data.";

proc gmap map=mapsgfk.europe
    data=work.demographics;
    id idname;
    choro gni / name="europePop" levels=3 legend=legend1;
    format gni dollar16.;
run;
quit;

goptions reset=all;
```

Program Description

Create the demographics data for Europe from SASHELP.DEMOGRAPHICS. Add column IDNAME to match column IDNAME in the MAPSGFK.EUROPE data. Use map format format GLCNSM to generate the name from the ID column value.

```
options fmtsearch=(sashelp.mapfmts);
data demographics;
   length idname $55;
   set sashelp.demographics(where=(cont = 93));
   idname = put(id,glcnsm.);
run;
```

Specify the map size and a border around the map.

```
goptions reset=all border xpixels=560 ypixels=420;
```

Specify a color for each of the three ranges of GNI in the map.

```
pattern1 color=DodgerBlue;
pattern2 color=Gold;
pattern3 color=LimeGreen;
```

Define the legend characteristics. The ACROSS= option defines the number of columns in the legend. The POSITION= option positions the legend in the bottom left on the procedure output area. The OFFSET= option then adjusts the legend along the X and Y axes to avoid obscuring the Macaronesian islands. The MODE=SHARE option displays the legend in the procedure output area along with the map. The LABEL= option specifies a legend label and left-justifies it above the legend values. The SHAPE= option indicates a rectangular size for the legend marker bars. The ORDER= option specifies that the legend marker range values are listed in descending order, from the highest per capita range to the lowest.

```
legend across=1
        position=(bottom left)
        offset=(1.25pct,50pct)
        mode=share
        label=(position=top
               "Gross National Income per capita")
        shape=bar(.15in,.10in)
        order=descending
 ;
```

Define the title and footnote for the map.

```
title "Per Capita Gross National Income (PPP) in Europe";
footnote justify=R font="Albany AMT/Italic"
```

```
    "GNI values are based on 2004 data.";
```

Generate the choropleth map. The map of Europe is correlated with three levels of Gross National Income per capita, as derived from the SASHELP.DEMOGRAPHICS data set. The legend displays the three GNI levels in the specified colors. The colors are assigned in the order of the PATTERN statements. The FORMAT statement formats the GNI values as DOLLAR16.

```
proc gmap map=mapsgfk.europe
    data=work.demographics;
    id idname;
    choro gni / name="europePop" levels=3 legend=legend1;
    format gni dollar16.;
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

7

The Common Procedure Statements

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ATTRIB Statement

About the ATTRIB Statement

The ATTRIB statement associates attributes with one or more data set variables. It can be used in a PROC step or in a DATA step. However, the rules for usage in a PROC step differ from those in a DATA step. In a PROC step, you can use the ATTRIB statement to change attributes such as format and label for one or more variables for the duration of the PROC step. In some procedures, you can also specify the informat. For more information about using the ATTRIB statement in a PROC step, see *Base SAS Procedures Guide*. In a DATA step, the ATTRIB statement permanently changes attributes such as format, informat, label, and length for one or more variables.

You can use the ATTRIB statement to replace individual attribute statements such as FORMAT, INFORMAT, LABEL, and LENGTH.

Procedures with Which ATTRIB Can Be Used

The following table lists the mapping procedures with which you can use the ATTRIB statement.

Table 7.1 *SAS/GRAPH and Base SAS Mapping Procedures That Support the ATTRIB Statement*

Procedure	Syntax Description
GMAP	"ATTRIB Statement" (p. 390)
SGMAP	"ATTRIB Statement" (p. 723)

See Also

"ATTRIB Statement" in *SAS DATA Step Statements: Reference*

BY Statement

About the BY Statement

The BY statement divides the observations from an input data set into groups for processing. Each set of contiguous observations with the same value for a specified variable is called a *BY group*. A variable that defines BY groups is called a *BY variable* and is the variable that is specified in the BY statement. When you use a BY statement, the graphics procedure performs the following operations:

- processes each group of observations independently
- generates a separate graph or output for each BY group
- automatically adds a heading called a *BY line* to each graph identifying the BY group represented in the graph
- adds BY statement information below the **Description** field of the catalog entry

By default, the procedure expects the observations in the input data set to be sorted in ascending order of the BY variable values.

Note: The BY statement in SAS/GRAPH is essentially the same as the BY statement in Base SAS. However, the effect on the output is different when it is used with SAS/GRAPH procedures.

Note: In the GREMOVE procedure, the BY variables in the input map data set become the ID variables for the output map data set.

Procedures with Which BY Can Be Used

The following table lists the mapping procedures with which you can use the BY statement.

Table 7.2 *SAS/GRAPH and Base SAS Mapping Procedures That Support the BY Statement*

Procedure	Syntax Description
GMAP	"BY Statement" (p. 49)

Procedure	Syntax Description
SGMAP	"BY Statement" (p. 391)

Preparing Data for BY-Group Processing

Unless you specify the NOTSORTED option, observations in the input data set must be in ascending numeric or alphabetic order. To prepare the data set, you can sort it with the SORT procedure using the same BY statement that you plan to use in the target procedure. Or you can create an appropriate index on the BY variables.

If the procedure encounters an observation that is out of the proper order, it issues an error message.

If you need to group data in some other order, you can still use BY-group processing. To do so, process the data so that observations are arranged in contiguous groups that have the same BY-variable values and specify the NOTSORTED option in the BY statement.

For an example of sorting the input data set, see "Using BY-group Processing to Generate a Series of Charts" in *SAS/GRAPH: Reference*.

Controlling BY Lines

Understanding Default Behavior

By default, the BY statement prints a BY line above each graph that contains the variable name followed by an equal sign and the variable value. For example, if you specify BY SITE in the procedure, the default heading when the value of SITE is `London` would be SITE=London.

Suppressing the BY Line

To suppress the entire BY line, use the NOBYLINE option in an OPTION statement or specify HBY=0 in the GOPTIONS statement. See "Using BY-group Processing to Generate a Series of Charts" in *SAS/GRAPH: Reference*.

Suppressing the Name of the BY Variable

You can suppress the variable name and the equal sign in the heading and leave only the BY value. Use the LABEL statement to assign a null label ("00"X) to the BY variable. For example, this statement assigns a null label to the SITE variable:

```
label site="00"x;
```

You can also use the NOBYLINE option and then use the #BYVAL1 substitution in a TITLE statement:

```
options nobyline;
title #byval1;
```

Controlling the Appearance of the BY Line

To control the color, font, and height of the BY lines, use the following graphics options in a GOPTIONS statement:

CBY=*BY-line-color*
: specifies the color for BY lines.

FBY=*font*
: specifies the font for BY lines.

HBY=*n*<*units*>
: specifies the height for BY lines.

For a description of each option, see the "Graphics Options and Device Parameters Dictionary" in *SAS/GRAPH: Reference*.

Naming the Catalog Entries

The catalog entries generated with BY-group processing always use incremental naming. This means that the first entry created by the procedure uses the base name and subsequent entries increment that name. The base name is either the default entry name for the procedure (for example, GMAP) or the name specified with the NAME= option in the action statement. Incrementing the base name automatically appends a number to each subsequent entry (for example, GMAP1, GMAP2, and so on). See "Specifying the Catalog Name and Entry Name for Your GRSEGs " in *SAS/GRAPH: Reference*. For an example of incremented catalog names, see "Combining Graphs and Reports in a Web Page" in *SAS/GRAPH: Reference*.

Using the BY Statement

Overview

This section describes the following:

- the effect of BY-group processing on the GMAP procedures
- the interaction between BY-group and RUN-group processing
- the requirements for using BY-group processing with the Annotate facility
- how to include BY information in legend labels and values, and titles, notes, and footnotes
- how patterns are assigned to BY-groups
- the effect of using BY-group processing with the ODS HTML statement

For additional information about any of these topics, refer to the appropriate chapter.

Using the BY Statement with the GMAP Procedure

By default, BY-group processing affects both the map data set and the response data set. This means that you get separate, individual output for each map area common to both data sets. For example, suppose the map data set REGION contains six states and the response data set contains the same six states. If you specify BY STATE in the GMAP procedure, the resulting output is six graphs with one state on each graph.

You can use the ALL option in the PROC GMAP statement in conjunction with the BY statement. The result is one output for each map area in the response data set. However, that output displays all the map areas in the map data set. Only one map area per output contains response data information; the others are empty. For example, suppose you create a block map using the data sets REGION and SALES, specify BY STATE, and include the ALL option in the PROC GMAP statement. The resulting output is six graphs with six states on each graph. One state per graph has a block; the remaining five are empty. The UNIFORM option applies colors and heights uniformly across all BY-groups.

Using the BY Statement with the RUN Groups

You can use the BY statement with a GMAP procedure that processes data and supports RUN-group processing. In this case, each time you submit an action

statement or a RUN statement, you get a separate map for each value of the BY variable.

For an example that produces three choropleth maps for each value of the BY variables STATECODE and STATENAME within a RUN-group, see "Example 6: Producing a Drilldown Choropleth Map" on page 451.

The BY statement stays in effect for every subsequent RUN group until you submit another BY statement or exit the procedure. Variables in subsequent BY statements replace any previous BY variables.

You can also turn off BY-group processing by submitting a null BY statement (BY;) in a RUN group. Do this with care however, because the null BY statement turns off BY-group processing and the RUN group generates a graph.

For more information, see "Using Run-Group Processing" in *SAS/GRAPH: Reference*.

Using the BY Statement with the Annotate Facility

If a procedure that is using BY-group processing also specifies annotation with the ANNOTATE= option in the PROC statement, the same annotation is applied to every graph generated by the procedure.

If you specify annotation with the ANNOTATE= option in the action statements for a procedure, the BY-group processing is applied to the Annotate data set. In this way, you can customize the annotation for the output from each BY group. Include the BY variable in the Annotate data set and use each BY-variable value as a condition for the annotation to be applied to the output for that value.

Using the BY Statement with LEGEND, TITLE, FOOTNOTE, and NOTE Statements

LEGEND statements can automatically include the BY variable name or BY variable value in the text that they produce for labels, reference labels, values for major tick marks, and legend labels and values. In addition, TITLE, FOOTNOTE, and NOTE statements can automatically include the BY lines in the text that they produce. To insert BY line information into the text strings used by these statements, use the appropriate #BYVAR, #BYVAL, and #BYLINE substitution options.

Using the BY Statement with PATTERN Definitions

By default, when using a BY statement, the map for each BY group uses the same patterns in their defined order. For example, the BY variable contains four values and there are two response levels for each BY value. In this case the PATTERN1 and PATTERN2 statements are used for each map. Each BY-group starts over with PATTERN1. The UNIFORM option in the GMAP procedure changes this behavior.

See Also

"BY Statement" in *SAS DATA Step Statements: Reference*

FORMAT Statement

About the FORMAT Statement

The FORMAT statement associates formats with one or more variables in a PROC step or in a DATA step. You can specify one or more formats and associate each with one or more variables. Formats can be standard SAS formats or user-defined formats that were created using the FORMAT procedure. When used in a PROC step, the formats are applied for the duration of the PROC step. When specified in a DATA step, the formats are permanently applied to the variables.

Procedures with Which FORMAT Can Be Used

The following table lists the mapping procedures with which you can use the FORMAT statement.

Table 7.3 *SAS/GRAPH and Base SAS Mapping Procedures That Support the FORMAT Statement*

Procedure	Syntax Description
GMAP	"FORMAT Statement" (p. 392)
SGMAP	"FORMAT Statement" (p. 724)

See Also

"FORMAT Statement" in *SAS DATA Step Statements: Reference*

LABEL Statement

About the LABEL Statement

The LABEL statement applies descriptive labels to variables in a data set. You can specify one or more variable and label pairs in a LABEL statement. The LABEL statement can be used in a PROC step or in a DATA step. When used in a PROC step, the labels are applied for the duration of the PROC step. When used in a DATA step, the labels are permanently applied.

Procedures with Which LABEL Can Be Used

The following table lists the mapping procedures with which you can use the LABEL statement.

Table 7.4 *SAS/GRAPH and Base SAS Mapping Procedures That Support the LABEL Statement*

Procedure	Syntax Description
GMAP	"LABEL Statement" (p. 393)
SGMAP	"LABEL Statement" (p. 725)

See Also

"LABEL Statement" in *SAS DATA Step Statements: Reference*

NOTE Statement

About the NOTE Statement

The NOTE statement adds text to a graph. It must be used in a PROC step or in a RUN-group in a PROC step. All notes defined in the current RUN group, as well as those defined in previous RUN-groups, are displayed in the output as long as the procedure remains active.

You can use as many text strings and options as you want, but place the options before the text strings that they modify. See "Using Multiple Options" in *SAS/GRAPH: Reference*.

Procedures with Which NOTE Can Be Used

The NOTE statement can be used with the SAS/GRAPH GMAP procedure. For usage details, see NOTE Statement on page 395. The SGMAP procedure does not support the NOTE statement.

Using Multiple Options

In each NOTE statement, you can use as many text strings and options as you want, but you must place the options before the text strings that they modify. Most options affect all text strings that follow them in the same statement, unless the option is explicitly reset to another value. In general, NOTE statement options stay in effect until one of these events occurs:

- The end of the statement is reached.
- A new specification is made for that option.

For example, this statement specifies that one part of the note is red and another part is blue, but the height for all of the text is 4:

```
note height=4 color=red "Red Tide"
     color=blue " Effects on Coastal Fishing";
```

Controlling Placement of Text

The following options enable the positioning of text on the graphics output area:

- JUSTIFY= aligns the text string
- MOVE= positions a line or lines of text anywhere on the graphics output area using *x* and *y* as absolute or relative coordinates.
- WRAP= wraps the text to a second line

For usage details for these options, see NOTE Statement on page 395 for the SAS/GRAPH GMAP procedure.

Setting Defaults

You can set default characteristics for notes by using the following graphics options in a GOPTIONS statement:

CTITLE=*color*
sets the default color for all notes; overridden by the COLOR= option in a NOTE statement.

CTEXT=*text-color*
sets the default color for all text; overridden by the CTITLE= option for notes.

FTEXT=*text-font*
sets the default font for all text, overridden by the FONT= option in a NOTE statement.

HTEXT=*n<units>*
sets the default height for all text, overridden by the HEIGHT= option a NOTE statement.

See "Graphics Options and Device Parameters Dictionary" in *SAS/GRAPH: Reference* for a complete description of each option.

Using Options That Can Reset Other Options

The ANGLE=, MOVE=, and JUSTIFY= options affect the position of the text and cause text breaks. (To cause a text break, the MOVE= option must have at least one absolute coordinate.) When a statement contains multiple text strings, the resulting text break can cause the following options to reset to their default values:

- BCOLOR=
- BLANK=
- BOX=

- BSPACE=
- LSPACE=
- UNDERLIN=.

Note: The LANGLE= option does not cause a text break.

In a NOTE statement, before the first text string, you can use an option that can be reset (such as the UNDERLIN= option). Before the second string, if you use an option that resets it (such as the JUSTIFY= option), the first option does not affect the second string. In order for the first option to affect the second string, repeat the option and position it after the resetting option and before the text string.

For example, this statement produces a two-line note in which only the first line is underlined:

```
note underlin=2 "Line 1" justify=left "Line 2";
```

To underline Line 2, repeat the UNDERLIN= option before the second text string and after the JUSTIFY= option:

```
note underlin=2 "Line 1" justify=left
      underlin=2 "Line 2";
```

Substituting BY Line Values in a Text String

The BY statement produces a BY line that contains the variable name and its value. If you specify the variable name, options are available to substitute the variable name and its value in text strings. To use the #BYVAR and #BYVAL options, insert the option in the text string at the position that you want the substitution text to appear. Both #BYVAR and #BYVAL specifications must be followed by a delimiting character. This can be either a space or other nonalphanumeric character, such as the quotation mark that ends the text string. If not, the specification is completely ignored and its text remains intact and is displayed with the rest of the string.

To allow a #BYVAR or #BYVAL substitution to be followed immediately by other text, with no delimiter, use a trailing dot (as with macro variables). The trailing dot is not displayed in the resolved text.

If you want a period to be displayed as the last character in the resolved text, use two dots after the #BYVAR or #BYVAL substitution.

The substitution for #BYVAL or #BYVAR does not occur if the following is true:

- The BY statement does not name the variable specified by #BYVAL or #BYVAR. For example, #BYVAL2 when there is only one BY variable or #BYVAL(ABC) when ABC is not a BY variable or does not exist.
- There is no BY statement at all.

When substitution does not occur, no error or warning message is issued and the option specification is displayed with the rest of the string. The graph continues to

display a BY line at the top of the page unless you suppress it by using the NOBYLINE option in an OPTION statement.

For more information, see the "BY Statement" on page 151.

Note: This feature is not available in the Annotate facility because BY lines are not created in a DATA step.

WHERE Statement

About the WHERE Statement

The WHERE statement selects observations that meet a specific condition. The condition is specified as one or more arithmetic or logical expressions, which generally consist of a sequence of operands and operators. A WHERE statement can be used to improve efficiency by eliminating observations that are not relevant. It can be used in a PROC step or in a DATA step.

Procedures with Which WHERE Can Be Used

The following table lists the mapping procedures with which you can use the WHERE statement.

Table 7.5 *SAS/GRAPH and Base SAS Mapping Procedures That Support the WHERE Statement*

Procedure	Syntax Description
GMAP	"WHERE Statement" (p. 409)
SGMAP	"WHERE Statement" (p. 727)

See Also

"WHERE Statement" in *SAS DATA Step Statements: Reference*

PART 3

System Options Used by SAS/GRAPH and Base SAS Mapping

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SAS System Options Used in SAS/GRAPH and Base SAS Mapping

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Introduction to System Options

This chapter provides a detailed description of the system options used with SAS/GRAPH mapping software. The descriptions provide the syntax, defaults, and related options for each option.

The system options are listed alphabetically.

System options are instructions that affect the processing of an entire SAS program or interactive SAS session from the time the option is specified until it is changed. The three SAS system options included here specify the location of a particular SAS library that contains SAS/GRAPH map data sets.

For detailed information about using SAS System Options, see *SAS System Options: Reference*

Dictionary

MAPS= System Option

Specifies the location of the SAS library that contains SAS/GRAPH map data sets.

Valid in:	Configuration file, SAS invocation, OPTIONS statement, SASV9_OPTIONS environment variable
Category:	Graphics: Driver Settings
PROC OPTIONS GROUP=	GRAPHICS
Note:	This option can be restricted by a site administrator. For more information, see "Restricted Options" in *SAS System Options: Reference*.
Tip:	You can use the APPEND or INSERT system options to add additional *location-of-maps*.
See:	"MAPS System Option" in *SAS System Options: Reference*

Syntax

MAPS=*location-of-maps*

Syntax Description

location-of-maps
specifies either a physical path, an environment variable, or a libref to locate the SAS/GRAPH map data sets.

Default MAPSSAS

See Also

- "Using SAS/GRAPH Map Data Sets" on page 417

System Options:

- "APPEND= System Option" in *SAS System Options: Reference*
- "INSERT= System Option" in *SAS System Options: Reference*

MAPSGFK= System Option

Specifies the location of the SAS library that contains SAS/GRAPH digital vector map data sets. The libref MAPSGFK is assigned using the option value specified by the MAPSGFK= system option.

Valid in:	Configuration file, SAS invocation, SASV9_OPTIONS environment variable
Category:	Graphics: Driver Settings
PROC OPTIONS GROUP=	GRAPHICS
Restriction:	This option cannot be saved to the SAS registry by using the OPTSAVE procedure.
Note:	This option can be restricted by a site administrator. For more information, see "Restricted Options" in *SAS System Options: Reference*.
Tip:	You can use the INSERT system option to add additional *location-of-maps*.

Syntax

MAPSGFK=*location-of-maps*

Syntax Description

On the command line or in a configuration file, the syntax is specific to your operating environment. For more information, see the SAS documentation for your operating environment.

location-of-maps

specifies either a physical path, an environment variable, or the MAPSGFK libref to locate the SAS/GRAPH digital vector map data sets. The option value can consist of up to 2048 characters. Upper or lower case characters are accepted as entered. Though not required, if you specify start and end quotation marks or parentheses, these are accepted and retained as part of the option's value.

Default None

Notes The configuration file at installation time sets the MAPSGFK= option value to a physical name (path). The physical name of MAPSGFK= should not be reassigned. However, to use the MAPSGFK digital vector maps with your existing programs, issue the "INSERT= System Option" in *SAS System Options: Reference* in conjunction with the MAPSGFK= system option. Alternatively, you may specify the MAPS= system option in conjunction with either the "APPEND= System Option" in *SAS System Options: Reference* or the INSERT= system option to use MAPSGFK digital vector maps. The APPEND= system option adds a new value to the end of the current value of the MAPS= system option. The INSERT= system option adds a new value as the first value of either the MAPSGFK= system option or the MAPS= system option.

If you specify an environment variable for the option value, it is not expanded.

See Also

System Options

- "MAPS= System Option" on page 166
- "MAPSSAS= System Option" on page 168
- "APPEND= System Option" in *SAS System Options: Reference*
- "INSERT= System Option" in *SAS System Options: Reference*

MAPSSAS= System Option

Specifies the location of the SAS library that contains SAS/GRAPH map data sets.

Valid in:	Configuration file, SAS invocation, OPTIONS statement, SASV9_OPTIONS environment variable
Category:	Graphics: Driver Settings
PROC OPTIONS GROUP=	GRAPHICS
Restriction:	This option cannot be saved to the SAS registry by using the OPTSAVE procedure.
Note:	This option can be restricted by a site administrator. For more information, see "Restricted Options" in *SAS System Options: Reference*.

Syntax

MAPSSAS=*location-of-maps*

Syntax Description

On the command line or in a configuration file, the syntax is specific to your operating environment. For more information, see the SAS documentation for your operating environment.

location-of-maps

specifies either a physical path, an environment variable, or the MAPSSAS libref to locate the SAS map data sets to use with SAS/GRAPH. The option value can consist of up to 2048 characters. Upper or lower case characters are accepted as entered. Though not required, if you specify start and end quotation marks or parentheses, these are accepted and retained as part of the option's value.

Default None

Note The configuration file at installation time sets the MAPSSAS= and MAPS= option values to the same physical name (path). The MAPSSAS= option value should not be reassigned.

See Also

System Options

- “MAPS= System Option” on page 166
- “MAPSGFK= System Option” on page 167

9

ODS Graphics Statements and Options That Control Base SAS Mapping Output

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Managing Your Maps with ODS Statements and Styles

The Output Delivery System (ODS) manages all output created by the SGMAP procedure and enables you to display the output in a variety of formats, such as HTML, PDF, and RTF. The ODS GRAPHICS statement provides options that enable you to specify attributes for the lines, fills, data markers, or text that is used in the graphics mapping output. See "General Syntax for Attribute Options" in *SAS ODS Graphics: Procedures Guide* for more information. These options also enable you to control the size, type, and name of the image, as well as the use of data tips, scaling, and anti-aliasing features. The SAS ODS Graphics SGMAP procedure uses ODS Graphics for creation of its graphs. See "Introduction to Managing Your Graphics with ODS" in *SAS ODS Graphics: Procedures Guide* for more information.

Controlling the Appearance of ODS Graphics Maps

Use an ODS destination statement to change the appearance of the entire graph. The active style associated with the ODS destination affects all SAS output and remains in effect until the ODS style or destination is changed. See "Overview" in *SAS ODS Graphics: Procedures Guide* and "Specifying Styles" in *SAS ODS Graphics: Procedures Guide* for more information.

PART 4

Macros Used by SAS/GRAPH and Base SAS Mapping

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SAS Macros Used in Mapping

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About the Macros

You can use the Annotate %CENTROID macro with a SAS map data set to simplify the process of creating Annotate observations. You add these observations to a map created with the Base SAS SGMAP procedure or the SAS/GRAPH GMAP procedure. See other Annotate Facility macros, including the "%MAPLABEL Annotate Macro" in *SAS/GRAPH: Reference*, that can be used with the GMAP procedure. The remaining macros described in this section are used to augment or create input data sets that are used with the GEOCODE procedure. With a macro, you specify a function and assign variable values in one step without having to write explicit variable assignment statements. You can mix assignment statements and macro calls in the same DATA step.

This section describes macros that assist with mapping tasks. It also links to detailed information about each macro.

Using Mapping Macros

Macro-Call Syntax

The general form of an Annotate macro is as follows:

```
%macro-name(parameter1, parameter2, ...);
```

In general, the macro name represents a function and the parameters contain the values for the variables that can be used with the function.

The parameters are either numeric or character. Numeric parameters can be numeric constants or numeric variable names that have been initialized to the appropriate value. Most character parameters must be expressed as literals—that is, character strings without quotation marks.

When generating observations, an Annotate macro assigns the macro parameter values to the corresponding Annotate variables. The resulting observations are equivalent to those that you would create manually using assignment statements.

Dictionary

%ABS2GEOCODE Autocall Macro

GEOCODE auto-call macro

Details

This is a SAS macro program for importing postcode data from Australia. The Australian Bureau of Statistics (ABS) produces a generalized map of Australian postal areas. It imports those postcode boundary areas, computes the polygon centroids, and creates a lookup data set for use by the GEOCODE procedure. The macro also creates a SAS/GRAPH map data set of the postal area polygons. The ABS2Geocode.zip file on the SAS Maps and Geocoding website contains this program macro and detailed usage instructions. Click on the **Geocoding Data** radio button. You are required to access the geocoding data website with your SAS

profile. You might be required to enter your site information. Then click on the zip file URL for **Australia Postcode instructions** to obtain this geocoding download.

%CENTROID Macro Autocall Macro

Retrieves the centroid positions of map data set polygons.

Variables written out: X, Y, ID variables

Requirement: It is not necessary to run the %ANNOMAC macro before using the %CENTROID macro.

Note: The %CENTROID autocall macro is available with Base SAS. The macro is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this macro.

Tip: Use this macro as an aid in adding labels to a map. It can also be used in conjunction with the Base SAS GEODIST function when computing distances. See the "GEODIST Function" in *SAS Functions and CALL Routines: Reference* for more information.

Syntax

%CENTROID (*input-data-set*, *output-data-set*, *list-of-id-variables* <, SEGONLY=*n*>);

Parameters

input-data-set
specifies a map data set. The input map data set must be sorted by the ID variables.

output-data-set
contains the ID variables and the X and Y variables.

list-of-id-variables
specifies the variables, each of which is assigned the centroid coordinates of each observation in the input-data-set. There is one observation for each unique set of ID values. If you specify more than one ID variable, then separate each variable with a space.

SEGONLY=*n*
specifies that only the *n*th segment of each map area is used to calculate the centroid. For example, if you specify SEGONLY=1, then only the first segment of each area is used.

Note: Be sure to end the list of ID variables with a comma before specifying a SEGONLY= value.

%CODEPOINT2GEOCODE Autocall Macro

GEOCODE auto-call macro

Details

This is a macro program for importing postcode data from Great Britain. Great Britain's national mapping agency, the Ordnance Survey (OS), provides location data for 1.7 million Royal Mail postcodes in their free Code-Point Open product. The SAS macro program %CODEPOINT2GEOCODE imports the OS files. The GEOCODE procedure uses these OS files to locate British mailing addresses by postcode. The macro also converts the British National Grid coordinates to World Geodetic System 1984 (WGS 84) longitude and latitude. The CodePoint2Geocode.zip file on the SAS Maps and Geocoding website contains this program macro and detailed usage instructions. Click on the **Geocoding Data** radio button. You are required to access the geocoding data website with your SAS profile. You might be required to enter your site information. Then click on the zip file URL for **British Postcodes Instructions** to obtain this geocoding download.

%GCDMEL9 Autocall Macro

GEOCODE auto-call macro

Details

This is a macro program for importing Geo*Data files into SAS data sets. Before using this macro, you are required to purchase the GEO*Data product containing current ZIP+4 centroids from Melissa Data at this website: https://www.melissa.com/geodata-reference-data-sets. For more information, see "%GCDMEL9 Autocall Macro" on page 222.

%GEOBASE2GEOCODE Autocall Macro

GEOCODE auto-call macro

Details

This is a macro program for importing Canadian roadway and address data from the ZIPCodeDownload third-party vendor. SAS provides this macro program to create or modify the SASHELP.GCDIRECT street directional data set with specific data. Find the GCDIRECT data set in the SASHELP library. The ZIPCodeDownload2Geocode.zip file on the SAS Maps and Geocoding website contains this program macro and detailed usage instructions. Click on the **Geocoding Data** radio button. You are required to access the website with your SAS profile. You might be required to enter your site information. Then click on the zip file URL for **ZIPCodeDownload2Geocode** to obtain this geocoding download.

%MAXMIND Autocall Macro

GEOCODE auto-call macro

Details

There are two versions of this macro program, depending on whether you are converting IPv4 or IPv6 geocoding data from MaxMind, Inc. into SAS data sets. Each version of the macro and its variables are described in "%MAXMIND Autocall Macro" on page 226.

%TIGER2GEOCODE Autocall Macro

GEOCODE auto-call macro

Details

This is a macro program for importing TIGER shapefiles for specific states and counties. It imports TIGER/Line shapefiles from the U.S. Census Bureau for specific states and counties. This macro program creates the USM, USS, and USP data sets, as well as the U.S. street type and direction data sets. Download the appropriate version of these macro programs from the SAS Maps Online website to create or modify the lookup data sets needed for street method geocoding. The version that you download depends on whether you are geocoding with SAS 9.4 or later, or a release prior to SAS 9.4. The TIGER2Geocode (9.4).zip or the TIGER2Geocode (9.3).zip file on the SAS Maps and Geocoding website contains the version-specific program macro and detailed usage instructions. Click on the **Geocoding Data** radio button. You are required to access the website with your SAS profile. You might be required to enter your site information. Then click on the zip file URL for **Code To**

Import US TIGER files for 9.4 or **Code To Import US TIGER files for 9.3** to obtain either of these geocoding downloadable files.

PART 5

Dictionary of SAS/GRAPH and Base SAS Mapping Procedures

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GEOCODE Procedure

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Overview: GEOCODE Procedure

What Does the GEOCODE Procedure Do?

The GEOCODE procedure can be used without having SAS/GRAPH installed.

Geocoding is the process of adding geographic coordinates (latitude and longitude values) to an address. This process provides a way to convert address data into map locations. The geographic coordinates typically represent the center of a ZIP code, a city, an address, or any geographic region. After geocoding, the coordinates can be used to display a point on a map or to calculate distances. Geocoding also enables you to add attributes values such as census blocks to the geocoded address.

The GEOCODE procedure processes geographic information for the following entities:

- street addresses
- cities
- U.S. ZIP codes and ZIP+4 extension codes
- foreign postal codes
- custom variables in the data set, such as sales territories
- Internet Protocol (IP) addresses or other ranges

> **Note:** The process of adding coordinates for IP addresses is usually called geolocating. IP data is a form of range data and was not designed to be geographic. For more information, see “Understanding Range Geocoding ” on page 224.

To run this procedure, the various data sets and essential SAS software must be available in your installation. Storage restrictions apply to map data sets that are used with the SGMAP procedure’s CHOROMAP or SERIES statement and to geocoding lookup data sets. Because the map data sets contain sequential polygonal data, storing the mapping data on a distributed system such as aTeradata server, a SAS® LASR™ Analytic Server, or a SAS Cloud Analytic Services (CAS) server is not recommended. Data sequence cannot be guaranteed on distributed systems such as these, which can cause unexpected results. If the criterion is met, you can copy the procedure examples provided in this chapter into your program editor and run them to create the required output. Your IDE might provide additional resources for creating maps. Refer to the documentation for your IDE for more information.

About the Required Input Data

The GEOCODE procedure requires two types of SAS data sets:

input address data sets
: contain variables that relate to specific geographic locations. For example, a data set might contain mailing address variables such as ZIP codes and street addresses, or custom geographic variables such as sales regions.

lookup data sets
: contain reference variables and geographic coordinates. For example, a lookup data set for the ZIP method contains ZIP codes and the geographic coordinates that are associated with the ZIP codes. Some geocoding methods require multiple lookup data sets. This data is essential to transform address data into location information that can be viewed on a map.

  Do not use a system that cannot guarantee data order as the repository for geocoding lookup data sets. Essential polygonal data sequencing must be preserved. Lookup data set file extensions include .sas7bdat, .sasbndx, and .shp (Esri shapefiles). You can store them on a local (client) drive, a network server, or a USB plug-in drive. You can use cloud storage as long as it is a Windows or Linux system and it guarantees data order. You have the option of maximizing your storage by compressing the geocoding lookup data sets.

  Lookup data sets can also contain attribute variables containing data about the locations.

  For each observation in the input data set, the GEOCODE procedure attempts to match the address value to values in the lookup data sets. To increase the chances of a match, default lookup variable values in lookup data sets supplied by SAS are always normalized; converted to uppercase with special characters and spaces removed. These data sets are either available with the SAS release or available for download from the SAS Maps and Geocoding website. You are required to access the website with your SAS profile. You might be required to enter your site information.

  If you choose to geocode with any non-default lookup variable that is contained in a lookup data set supplied by SAS, there is a significantly decreased chance of matching data.

  The GEOCODE procedure normalizes the default lookup variable values in lookup data sets that are not supplied by SAS. The address information in your input data set is also automatically normalized by PROC GEOCODE.

  The GEOCODE procedure is not shipped with all the lookup data that you might require. In some cases, you must download or purchase the data. You can download lookup data sets from the SAS Maps and Geocoding website. For more information, see "SAS Maps and Geocoding Website" on page 186.

SAS provides macro code programs to import some third-party data. Example macros are %GEOBASE2GEOCODE, %TIGER2GEOCODE, %ABS2GEOCODE, and %CODEPOINT2GEOCODE. The macros and their accompanying documentation are available for download from the SAS Maps and Geocoding website. For street

lookup data, make sure that you download the version of %TIGER2GEOCODE that corresponds to your current version of SAS. The two versions of the %TIGER2GEOCODE macro create street lookup data sets that differ in format depending on the release of SAS with which they are associated. Street lookup data sets created with the latest SAS version of %TIGER2GEOCODE cannot be used by earlier releases of PROC GEOCODE. For more information, see "SAS Maps and Geocoding Website" on page 186.

See Also

- "%GCDMEL9 Autocall Macro" on page 222
- "%MAXMIND Autocall Macro" on page 226
- %GEOBASE2GEOCODE macro program for importing Canadian roadway and address data is described in "Obtaining Street Lookup Data Sets" on page 197
- %TIGER2GEOCODE macro program for importing TIGER shapefiles for specific states and counties is described in "Obtaining Street Lookup Data Sets" on page 197
- %ABS2GEOCODE and %CODEPOINT2GEOCODE macro programs for importing postcode data from Australia and Great Britain are described in "Non-U.S. Postcodes" on page 219
- "Deciding Which Lookup Data to Use" on page 187

SAS Maps and Geocoding Website

The SAS Maps and Geocoding website contains map-related information for areas throughout the world. You can easily locate and identify specific regions in each of the following categories: world maps, continents, and countries.

The website contains the following:

- archived maps from previous releases
- sample programs
- recent mapping and geocoding updates
- geocoding examples, techniques, and lookup data
- macro programs for importing PROC GEOCODE lookup data

Access the SAS Maps and Geocoding website at https://support.sas.com/en/knowledge-base/maps-geocoding.html. This website provides access the geocoding downloads and the SAS macro code programs that are mentioned in this chapter. For example, under Geocoding, click **Geocoding Data** to access the geocoding data. The following links appear:

- PROC Geocode

- Street Geocoding
- City Geocoding
- Postal Geocoding
- ZIP+4 Geocoding
- IP Address Geocoding

Click the link that corresponds to your area of interest to go to that section of the page. In each section, one or more links provide access to the geocoding downloads. For example, click **Street Geocoding** to go to the Street Geocoding section. In the Street Geocoding section, you can click any of the available links in the content to access data such as TIGER/Line shapefiles from the United States Census Bureau. Clicking **Street Geocoding Downloads** brings you to a sign-in page where you can provide your SAS profile credentials. Your site information might also be requested.

About the Output Data

The GEOCODE procedure adds matching geographic coordinates to the observations in the output data set. In addition, the GEOCODE procedure adds a variable named _MATCHED_ that indicates how the coordinates were found. When STREET geocoding, additional variables are also written to output to denote the matching status for each address observation. You can also choose to add variables from the lookup data set to the output data set by using the ATTRIBUTEVAR= option.

For more information, see "Understanding Output Data" on page 188.

Deciding Which Lookup Data to Use

The type of geocoding you want to do determines the type of lookup data that is required. For example, if you want to geocode street data, you can choose between U.S. or Canadian street geocoding.

Granularity of information is an important consideration in determining which geocoding process to use. For example, does the location need to be an actual house location, or is a ZIP code or even a city center sufficient? If you are viewing the addresses on a state or U.S. map, then the ZIP code or city location is probably accurate enough.

The age of the lookup data also affects your decision. How current does the data need to be? Street address data frequently changes with the addition of new roads and changes to postal codes. The older your lookup data, the more likely it is that some address matches might be incorrect or missed completely. On the other hand, city and state lookup data rarely change.

The more up-to-date, accurate, and fine-grained the data, the more it costs to purchase and maintain. Also, higher-resolution data requires more disk storage

space and takes longer to geocode. There are free sources for some types of data, but these might not be updated as frequently as the data you purchase.

It is important to remember that both purchased and free lookup data might give incorrect results. There are no guarantees with any geocoding lookup data, so the results should be carefully reviewed.

Concepts: GEOCODE Procedure

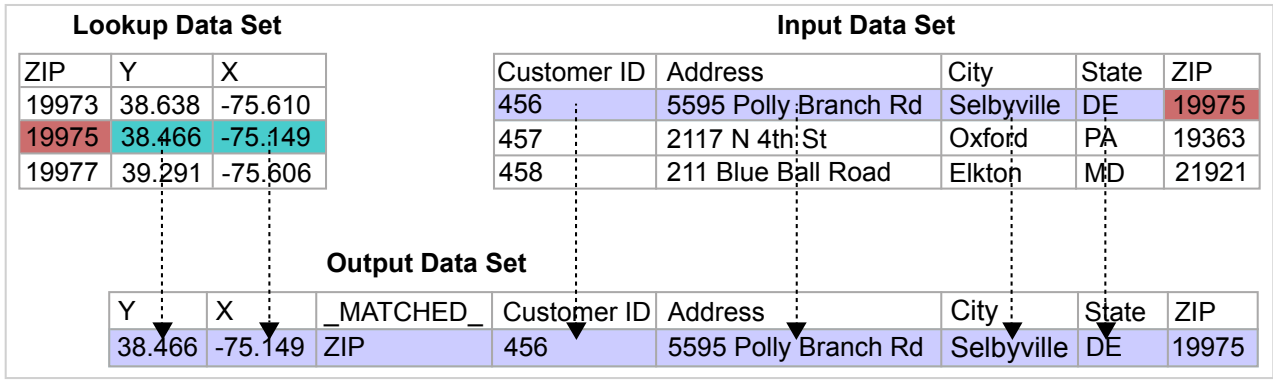
Understanding Output Data

How Geocoded Data Is Produced

When the GEOCODE procedure finds a match in the lookup data set, the procedure adds the associated coordinates to the observation in the output data set. Depending on the lookup data set, geocoded location variables can be Y and X or latitude and longitude.

The following image shows how the GEOCODE procedure obtains coordinates for the output data set by matching the ZIP code in the input data set:

Figure 11.1 *Geocoding with ZIP Codes*



The GEOCODE procedure also adds a variable named _MATCHED_ that indicates how the coordinates were found. Possible values for the _MATCHED_ variable are as follows:

State mismatch
: This value is used during international CITY geocoding. The geocoder can return multiple matches when searching for city and country. You can specify an

optional state variable to help determine which of the multiple matches is the correct one. This value indicates that the geocoder cannot resolve multiple matches in different states.

Street
A match was found for either the street address and ZIP code or the street address, city, and state.

ZIP
A match was found for the ZIP code.

ZIP+4
A match was found for the ZIP code and ZIP+4 extension.

ZIP mean
Multiple observations in the lookup data set specified with the PLUS4 geocoding method matched the five-digit ZIP code and the matching latitude and longitude coordinate values were averaged.

City
A match was found for the city and state.

City mean
Multiple observations in the SASHELP.ZIPCODE or user-supplied lookup data set matched the city and state. In either case, the matching latitude and longitude coordinate values were averaged.

variable-name
For CUSTOM and RANGE geocoding, a variable name indicates that a match was found for that variable.

None
No match was found for the address.

For each observation in the input data set, the GEOCODE procedure attempts to match the address variable value to a value in the lookup data set. For most geocoding methods, the lookup data set is expected to contain only one matching observation. For example, the SASHELP.ZIPCODE lookup data set contains only one observation for each ZIP code. If the lookup data set contains multiple matches, then results can vary. The geocoding method used determines whether the first matching observation is returned or further processing is done.

Some geocoding runs might make multiple match attempts on an address. For example, if you are using ZIP code geocoding and no match is found, then the GEOCODE procedure attempts to find a matching city and state pair. Sometimes a ZIP code is not found in the SASHELP.ZIPCODE lookup data set. In this case the GEOCODE procedure searches for a matching city and state pair in the appropriate CITY lookup data set. When the GEOCODE procedure uses either the STREET or PLUS4 geocoding method and no match is found, it then searches for a five-digit ZIP code match.

Output Data Sets

By default, the GEOCODE procedure produces an output data set that contains all of the variables from the input address data set. The data set also contains the X, Y,

or LONG, LAT, and _MATCHED_ variables. The X or LONG and Y or LAT coordinates must be in the same coordinate system as the lookup data set. The lookup data coordinate system is typically based on world latitudes and longitudes, but coordinate values in a specific map projection can also be used. If you want to use a different coordinate system for the output, you can convert the geocoded coordinates using a projection system application such as the GPROJECT procedure.

The default name for the output data set is DATA*n*, where *n* is the smallest integer that makes the name unique. For example, if the DATA1 data set already exists, then the default name for the output data set is DATA2. To override the default name, you can specify the output data set name with the option "OUT=*output-data-set*" on page 249.

The label of the output data set contains the text, "Geocoded *date*" where *date* is the date on which the output was created. This text is appended to the label from the input data set, if one exists.

For the STREET geocoding method, additional variables are included in the output data set. See "Output Variables for Street Geocoding" on page 198.

Adding Variables to the Output Data Set

You can specify that non-geocoding variables from the lookup data set be added to the output data set by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement. For example, if you are using SASHELP.ZIPCODE as the lookup data set, then you could assign the county name (COUNTYNM) to each matched observation in the output data set.

See Also

"ATTRIBUTEVAR=(*variable-1*, *variable-2*, ...)" on page 240

Understanding Street Geocoding

Overview of Street Geocoding

The street geocoding method computes geographical coordinates for specified U.S. or Canadian street addresses. This method converts a full street address that includes a house or building number, street name, city, state (or province), and ZIP (or postal) code to a map location. This method requires additional lookup data sets and additional options.

The GEOCODE procedure initially attempts to match the street name and ZIP or postal code. If no match is found, then the GEOCODE procedure attempts to match the street name, city name, and two-character postal abbreviation for state. If the second match fails, then the ZIP and the CITY geocoding methods are tried in succession. You can disable this cascading behavior by using the NOZIP and NOCITY options in the GEOCODE statement.

If a street match is found, X or LONG and Y or LAT coordinate values are interpolated along the street by using the house number.

About Street Input Data

The street input data set should minimally contain the street address and ZIP or postal code for each observation. In addition to U.S. streets, Canadian street data can be geocoded. Data that also includes the city and state or province provides a fallback way of finding a street level match if the initial attempt fails. The city, and state or province data must be presented in character format rather than a FIPS code.

For best results, use the most complete street addresses possible in your input data set. For example, “111 North Main Street” is more likely to find a match than “111 Main Street” or “111 North Main.”

About Street Lookup Data

Overview of the Required Data Sets

The format of the lookup data sets varies from that of previous releases. In support of the Canadian street geocoding, the FIPS codes in the lookup data sets are replaced with city and state or province names in character format. The geocoder for the current release cannot use lookup data sets from prior releases containing FIPS codes. Some of these lookup data sets are installed with SAS/GRAPH and others must be downloaded or created. SAS provides macro programs to import certain types of data and create these other lookup data sets. See “Obtaining Street Lookup Data Sets” on page 197 for more information.

The STREET geocoding method requires several lookup data sets:

- the ‘M’ or “street matching data set” on page 192
- the ‘S’ or “street segment data set ” on page 192
- the ‘P’ or “street coordinate data set ” on page 193
- the “street state data set” on page 194
- the “street type data set ” on page 195
- the “street directional data set” on page 197

street matching data set
contains street names, either ZIP codes or postal codes, state or province names, and references to observation numbers for the street segment data set.

The STREET geocoding method searches this street matching data set for the current street name and the ZIP or postal code, or city, or state values. The FIRST and LAST variables are then used to read the observations in the street segment data set that apply to this street.

The FIRST variable identifies the starting observation in the street segment data set. The LAST variable identifies the ending observation in the street segment data set that is associated with the street match.

Default the SASHELP.USM data set

Restriction The name of this data set can be any valid SAS name, but it must end with the letter M.

Notes The default data set is not installed with Base SAS or SAS/GRAPH. You can download the USM.csv data set from the SAS Geocode Data — Street Geocoding website.

The example SASHELP.GEOEXM data set is installed with SAS. This data set is a street matching data set for Wake County, North Carolina (NC), USA.

When creating a customized version of the data, set you must use the same variable names, data types, order, and simple indexes that are used in the default data set.

SAS provides macro programs to import additional data and write them to street matching data sets. Run these macro programs on the same system on which you intend to run the GEOCODE procedure. That ensures synchronization between the locale and indexes.

Tips If you move the location of the street lookup data set, you must also move the associated index file. If this index file is not present, a warning is issued in the SAS log by PROC GEOCODE.

Any non-default street matching data set is specified by the LOOKUPSTREET= option. When you specify this option for the M data set, the library must also contain two corresponding data sets whose names end with S (segment) and P (coordinate) respectively.

See "LOOKUPSTREET=*street-matching-data-set* " on page 245

For more information about these macros, and the default, installed, and created data sets, see "Obtaining Street Lookup Data Sets" on page 197.

street segment data set
contains variables to identify the street type suffix and prefix, and street direction prefix and suffix.

Each street segment is associated with a range of house numbers along one side of the street. The range is specified by the SIDE, FROMADD, and TOADD

variables. The START variable identifies the first observation in the street coordinate data set that is associated with the street segment. The N variable specifies the number of observations in the street coordinate data set containing the coordinates that delineate the street segment.

The street segment data sets that are provided by SAS contain attribute variables with additional information pertaining to the street segment and side. U.S. Census tracts and county names in character format are examples of such attribute variables.

You can specify that non-geocoding variables from the street segment lookup data set be added to the output data set by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement.

Default the SASHELP.USS data set

Restriction The name of this data set must be the same as the street matching data set name, except the last character must be S instead of M.

Notes The default data set is not installed with Base SAS or SAS/GRAPH. You can download the USS.csv data set from the SAS Geocode Data — Street Geocoding website.

The SASHELP.GEOEXS data set is installed with SAS. This data set is a street segment data set for Wake County, North Carolina (NC), USA.

When creating a customized version of the data set, you must use the same variable names and data types that are used in the default data set.

SAS provides macro programs to import the street type prefixes and write them to this street segment data set.

See For more information about writing out non-geocoding variables from the lookup data set, see "Adding Variables to the Output Data Set" on page 190.

"ATTRIBUTEVAR=(*variable-1*, *variable-2*, ...)" on page 240

For more information about these macros, and the default, installed, and created data sets, see "Obtaining Street Lookup Data Sets" on page 197.

street coordinate data set

contains latitude and longitude coordinates.

Default the SASHELP.USP data set

Restriction The name of this data set must be the same as the street matching data set name, except the last character must be P instead of M.

Notes The default data set is not installed with Base SAS or SAS/GRAPH. You can download the USP.csv data set from the SAS Geocode Data — Street Geocoding website.

The SASHELP.GEOEXP data set is installed with SAS. This data set is a street coordinate data set for Wake County, North Carolina (NC), USA.

SAS provides macro programs to create this street coordinate data set with specific data.

See For more information about these macros, and the installed, alternate, and created data sets, see "Obtaining Street Lookup Data Sets" on page 197.

street state data set

contains state character names rather than FIPS numeric codes. The character names can be any of the following:

- Postal service two-character code, such as 'NC'
- non-abbreviated state name, such as 'North Carolina'
- nonstandard state ID, such as 'N. Car.' or 'No. Car.'

This data set, as delivered with SAS, contains common state alias values for state IDs or Canadian provinces that are not postal service abbreviations. However, other nonstandard state IDs can be included in a customized copy of the data set, or in the input address data set.

The STREET or CITY geocoding methods can use this street state data set. In some instances a match cannot be found by using the street name and ZIP or postal code. In this case, the STREET geocoding method uses the street state data set to determine the complete state or province name. It also uses the state name or ID provided in the input address. For example, this data set enables the geocoder to equate the state postal abbreviation of TX, or the nonstandard abbreviation of Tex., with the complete state name of Texas. In another example a non-abbreviated state name might be specified in the input address data set. In this case the CITY geocoding method uses the street state data set to find a matching two-character state ID. This state ID is a necessary component of its matching algorithm.

Default SASHELP.GCSTATE. This data set contains all of the United States and its overseas territories, and all Canadian provinces.

Notes When creating a customized version of this data set you must use the same variable names, data types, and indexes that are used in the SASHELP.GCSTATE data set. It is no longer necessary to maintain the same sort order of the variables from the original data set.

The optional StateAlias variable contains nonstandard values of state or province abbreviations; those not used by the postal service. In one observation, multiple values delimited by a vertical bar '|' can be specified. For example, nonstandard designations for the state of California are ' CF | Cal. | Cali. | Calif.'.

When you create a customized version of this data set you can use duplicate values of the MapIDNameAbrv variable. These values are state or province postal service abbreviations. These values provide a key to the geocoder when it groups equivalent state or province names.

However, do not use the same abbreviation for unrelated states to avoid misleading matches. For example, do not use the abbreviation 'MI' to represent both the states of Mississippi and Michigan.

The values of the variables MAPIDNAME (state or province name), and MAPIDNAME2 (normalized state or province name) are changed. They match, respectively, the ISONAME and ISONAME2 variables found in the MAPSGFK.WORLD_CITIES data set.

Tips If you move the location of the street state lookup data set, you must also move its associated SASHELP.GCSTATE.INDEX data set. If this data set index is not present, a warning is issued in the SAS log by PROC GEOCODE.

Any non-default street state data set is specified by the STATE= option.

See "STATE=*data-set*" on page 251

For more information about these macros, and the installed and the created data sets, see "Obtaining Street Lookup Data Sets" on page 197.

street type data set

contains street type suffixes and prefixes. The STREET geocoding method uses the street type data set to convert street type suffixes and prefixes from the input address observation to standardized forms.

Default the SASHELP.GCTYPE data set

Notes The Canadian version of this data set, GCTYPE_CAN, contains standard street type prefixes most commonly used in Canadian addresses. Examples include Bannockburn Road and Boulevard Quebec. The GROUP variable equates multiple abbreviations for the same street type. For example, AVENUE can be abbreviated as 'AV' in provinces using French and as 'AVE' in provinces using English. The data set is created by the %GEOBASE2GEOCODE import program when Canadian lookup data is imported.

You might want to create a customized version of the data set. When doing so, you must use the same variable names and data types that are used in either the SASHELP.GCTYPE data set or the GCTYPE_CAN data set. An index is not provided or required for the SASHELP.GCTYPE data set. To create a data set for another nation, the data set name must be GCTYPE_*xxx*, where *xxx* is the three-character country abbreviation. A customized version of the data set must contain types consisting of more than one character. For example, to get more street matches in a location where nonstandard street type abbreviations are common, you could add them to a custom version of GCTYPE. If an addition is a variant of an existing type, that new abbreviation and the existing type must have the same GROUP value. If you add an entirely new entry that is not associated with an existing type (for example, WHARF), the new type must have a unique GROUP value. Specify a

number that is not used by any existing entry. Here is sample code that adds some of the more common nonstandard abbreviations:

```
data custom_gctype;
  length name $21. type $14. group 8.;
  input name $ type $ group;
  datalines;
  AL ALY 4
  CI CIR 64
  DM DAM 136
  HW HWY 250
  PW PKWY 358
  PZ PLZ 368
  RO ROW 422
  TE TER 490
  WA WAY 560
  WH WHARF 600
  WK WALK 556
;
run;
data work.gctype;
     set sashelp.gctype custom_gctype;
run;
proc sort data=work.gctype;  /* sort the custom data set */
   by name;
run;
proc print data=work.gctype; /* view data set with additions */
run;
```

For a full example of how to create a custom GCTYPE data set, see “Example 3: Street Geocoding” on page 262. However, adding ambiguous abbreviations to GCTYPE can create confusion when parsing addresses. For example, 'BL' is already in GCTYPE as an abbreviation for 'BOULEVARD'. Therefore, you should not add an instance of 'BL' as an abbreviation for'BLUFF'.

The SASHELP.GCTYPE data set contains standard U.S. Postal Service street type suffixes, such as Avenue and Drive. In this data set, the GROUP variable equates multiple abbreviations for the same street type. For example, AVENUE can be abbreviated as 'AVN' or 'AVE'. SASHELP.GCTYPE includes some suffixes that are not in the USPS table but are found in U.S. Census Bureau TIGER/Line data for various U.S. localities. If addresses in your geocoding input data contain unusual or nonstandard suffixes, then create a custom version of this data set that includes those suffixes. No simple index is required for the GCTYPE or GCTYPE_CAN data set. The complete list of USPS street types can be found in Appendix C of the USPS Publication 28, Postal Addressing Standards.

Tip Any non-default street type data set is specified by the TYPE= option. For example, use this option to specify the GCTYPE_CAN data set that contains the Canadian street prefixes and suffixes when geocoding Canadian street addresses.

See “TYPE=*data-set*” on page 251

For more information about these macros, and the installed, alternate, and created data sets, see "Obtaining Street Lookup Data Sets" on page 197.

street directional data set

contains various U.S. or Canadian street direction text strings used as prefixes and suffixes in street names. Examples in the U.S. data set are east, southeast, SE, and north. An example in the Canadian version of this data set is nord. Nord is the French directional string meaning north. This data set is able to be edited.

Default the SASHELP.GCDIRECT data set, which contains U.S. street direction text strings.

Notes The Canadian version of this data set, GCDIRECT_CAN, contains English and French direction names and abbreviations for Canadian streets as used by the Canada Post. An example is Nord-Ouest, the French direction name for northwest. GCDIRECT_CAN is created by the %GEOBASE2GEOCODE import program.

You might want to create a customized version of the data set. When doing so you must use the same variable names, data types, order, and simple index that are used in either the SASHELP.GCDIRECT data set or the GCDIRECT_CAN data set. To create a data set for another nation, the data set name must be SASHELP.GCDIRECT_*xxx*, where *xxx* is the three-character country abbreviation.

SAS provides the %GEOBASE2GEOCODE macro program to create or modify this street directional data set with specific data.

Tips If you move the location of the street directional lookup data sets, you must also move their associated data set index– for example, SASHELP.GCDIRECT.INDEX. If this data set index is not present, a warning is issued in the SAS log by PROC GEOCODE.

Any non-default street direction data set is specified by the DIRECT= option. For example, use this option to specify the GCDIRECT_CAN data set that contains Canadian directional strings.

See "DIRECTION=*data-set*" on page 241

For more information about these macros, and the installed, alternate, and created data sets, see "Obtaining Street Lookup Data Sets" on page 197.

Obtaining Street Lookup Data Sets

Versions of lookup data sets in SAS 9.4M0 and later are formatted differently than those in earlier releases. PROC GEOCODE in SAS 9.4M0 and later cannot read the earlier versions of the lookup data sets. Likewise, PROC GEOCODE in releases prior to SAS 9.4M0 cannot read the reformatted lookup data sets. SASHELP.GCSTATE and SASHELP.GCDIRECT are examples of the required lookup data sets used by the GEOCODE procedure's STREET matching method. To avoid a warning message

in the SAS log, ensure that you obtain the lookup data sets that correspond to the version of SAS that you are running.

Here are the most notable formatting differences:

- To enable Canadian street geocoding, the StateFp and PlaceFp variables containing FIPS codes are replaced with state and city character names.
- With the creation of lookup data sets that contain state variables with full names, variables such as MapIDName are no longer needed.
- The STREET and CITY geocoder can process state variables with alias names that are not used by the postal service.

The default street matching data sets (USM, USS, and USP) are not installed with SAS/GRAPH. These data sets contain address lookup data for the entire United States. You can download these data sets from the SAS Geocode Data website. For more information, see "SAS Maps and Geocoding Website" on page 186.

The USM, USS, and USP data sets are created from U.S. Census Bureau TIGER/Line shapefiles. After the annual release of new TIGER/Line data, updated versions of the USM, USS, and USP data sets can be downloaded from the SAS Geocode Data — Street Geocoding website.

The GEOEXM, GEOEXS, and GEOEXP data sets in the SASHELP library are installed with SAS/GRAPH by default. These data sets contain street method lookup data for Wake County, North Carolina (NC), USA.They can be used for trial geocoding tests to determine whether to download and install the nation-wide lookup data sets from the SAS Geocode Data — Street Geocoding website.

SAS offers macro programs to import lookup data. Two of these macro programs create the lookup data sets used by the GEOCODE procedure's STREET method of geocoding. The %GEOBASE2GEOCODE macro program imports Canadian roadway and address data from their GeoBase data clearinghouse. The macro program also creates the Canadian versions of the street type and direction data sets. The %TIGER2GEOCODE macro program imports TIGER/Line shapefiles from the U.S. Census Bureau for specific states and counties. This macro program creates the USM, USS, and USP data sets, as well as the U.S. street type and direction data sets. Download the appropriate version of these macro programs from the SAS Geocode Data — Street Geocoding website to create or modify the lookup data sets needed for street method geocoding. The version that you download depends on whether you are geocoding with SAS 9.4 or later, or a release prior to SAS 9.4.

The data sets created with the macro programs corresponding to SAS 9.4 or later are in a different format than those of prior SAS releases. For example, street lookup data sets in prior releases contained FIPS codes while the current data sets do not.

For more information see "SAS Maps and Geocoding Website" on page 186.

Output Variables for Street Geocoding

In addition to the default output variables, the STREET geocoding method creates the following variables in the output data set:

M_ADDR
contains the street address for a street match. The M_ADDR value is the match value from the lookup data.

MATCHED
indicates how the coordinates were found. The following values are used with the _MATCHED_ variable:

State mismatch
This value is used during international CITY geocoding. The geocoder can return multiple matches when searching for city and country. You can specify an optional state variable to help determine which of the multiple matches is the correct one. This value indicates that the geocoder cannot resolve multiple matches in different states.

Street
A match was found for either the street address and ZIP code or the street address, city, and state.

ZIP
A match was found for the ZIP code. The GEOCODE procedure uses the ZIP method when a ZIP+4 method finds no match between ZIP+4 values and when a single ZIP code match is found

ZIP+4
A match was found for the ZIP code and ZIP+4 extension. The location is the center of the street segment.

ZIP mean
Multiple observations in the lookup data set specified with the PLUS4 geocoding method matched the five-digit ZIP code and the matching latitude and longitude coordinate values were averaged. The GEOCODE procedure uses this method when no matches are located with the ZIP+4 values.

City
A match was found for the city and state. The GEOCODE procedure uses this method when either a specified ZIP or ZIP+4 method fails to return a match

City mean
Multiple observations in the SASHELP.ZIPCODE lookup data set matched the city and state and the matching latitude and longitude coordinate values were averaged.

variable-name
For CUSTOM and RANGE geocoding, a variable name indicates that a match was found for that variable.

None
No match was found for the address.

M_CITY
contains the city name for a city and state match. The M_CITY value is the match value from the lookup data.

M_STATE
contains the two-character postal abbreviation for a city and state match. The M_STATE value is the match value from the lookup data.

M_ZIP
contains the ZIP code value for a ZIP level match from the lookup data.

M_OBS
contains the row number for the matching observation from the primary lookup data set.

STATUS
indicates the type of match that was found. The following values are used with the _STATUS_ variable:

City and State Match
The street address did not match but a match was found for the city name and two-character postal abbreviation.

Found
The street address matched.

ZIP Match
The street address did not match but a match was found for the ZIP code.

(Blank)
No match was found.

NOTES
contains tokens that provide additional information about the match. For more information, see "Street Geocoding Note Values" on page 200.

SCORE
Contains a numeric value indicating the relative accuracy of the match.

Note: Abbreviated address parts that result in a match are scored lower than fully named, similar address parts. An example is LN versus LANE.

Street Geocoding Note Values

The STREET geocoding method creates a _NOTES_ variable in the output data set. This variable provides details about the quality of the address match by using token strings. For example, the value "AD ZC NM" contains three tokens that indicate that the street name, ZIP code, and house number matched.

Each token in the _NOTES_ value has an associated value, and the sum of these values makes up the value of the _SCORE_ variable. There is not a perfect score. The score depends on what components of the address are entered and which ones matched or did not match.

The following table displays the tokens for the _NOTES_ Variable and their scores:

Table 11.1 *Tokens for the _NOTES_ Variable*

Token	Score	Description
AD	20	The street name matched.

Token	Score	Description
ADSDP	5	Address Direction Suffix matched lookup data Direction Prefix.
ADPDS	5	Address Direction Prefix matched lookup data Direction Suffix.
CT	5	The city name matched.
DP	15	The street direction prefix matched.
DS	15	The street direction suffix matched.
ENDNM	2	The house number was outside the ranges of values in the lookup data set for the matching street. The geocoded coordinates for the nearest end of the street were used.
MCS	0	Multiple matches were found for the input street address and the street, city, and state in the street segment lookup data set.
MVP	0	The street geocoder detected missing values for the X or Y coordinates in the user-supplied lookup data set.
MZC	0	Multiple matches were found for the street address and ZIP code.
NM	10	The house number matched on the correct side of the street.
NMOS	5	The house number matched an address range in the lookup data set, but is on the opposite side of the street from the matched range.
NOADD	0	An invalid street address was provided.
NOCTM	0	A match was found using the input address' street and ZIP code. However, it was noted that the input city value was different from the city on the matched lookup data set observation. For example, the input data set's address contained an incorrect city, "100 Main St., Raleigh, NC 27513". However, the

Token	Score	Description
		matching lookup data set observation had the correct city value, "100 Main St., Cary, NC 27513". **Note:** The NOCTM token might act as an alert to potential data entry problems. For example, an input data set address of Green St. in Raleigh has the wrong ZIP code of 27601. It is compared to the lookup data set address of Green St. in Knightdale with the correct ZIP code of 27601. The NOCTM token in the _NOTES_ variable indicates that though a ZIP code match was found, the cities did not match.
NODPA	-10	The input address had no direction prefix but the matching street did have a direction prefix. For example, the input street name was "Main St." but the matching street was "N Main St."
NODPM	-15	The input address had a direction prefix but it either did not match the direction prefix of the matching street or the matching street had no direction prefix. For example, the input street name was "North Main St." but the matching street was "Main St."
NODSA	-10	The input address had no direction suffix but the matching street did have a direction suffix. For example, the input street name was "Johnson Ave" but the matching street was "Johnson Ave S."
NODSM	-15	The input address had a direction suffix but it either did not match the direction suffix of the matching street or the matching street had no direction prefix. For example, the input street name was "Johnson Ave South" but the matching street was "Johnson Ave."
NOLNM	0	The lookup data set contains missing values for the house numbers of the matching street. The geocoded coordinates for the center of the matching street were used.

Token	Score	Description
NONM	0	The input address has no house number. The geocoded coordinates for the center of the matching street were used.
NOSTM	0	A match was found using the input address' street and ZIP code. However, it was noted that the input state value was different from the state on the matched lookup data set observation. For example, the input data set's address contained an incorrect state, "100 Main St., Cary, ND 27513". However, the matching lookup data set observation had the correct state value, "100 Main St., Cary, NC 27513".
NOTPA	-10	The input address had no street type prefix, but the matching address did have a street type prefix. For example, the input address was "110 Quebec." but the matching address was "110 Boulevard Quebec"
NOTPM	-20	The street type prefix of the input address was either not the same as the type prefix of the matching street or the matching street had no type prefix. For example, the input street name was "Boulevard Quebec" but the matching street name was "Avenue Quebec".
NOTSA	-10	The input address had no street type suffix, but the matching address did have a street type suffix. For example, the input address was "110 Main." but the matching address was "110 Main St."
NOTSM	-20	The street type suffix of the input address was either not the same as the type suffix of the matching street or the matching street had no suffix. For example, the input street name was "Park St." but the matching street name was "Park Ave."
NS	0	The input address had no state value.
NSM	0	An initial match was found for the input city and country pair in the CITY lookup

Token	Score	Description
		data set. However, the state variable value of the matching observation was not a match.
NOZC	0	No ZIP code was provided.
NOZCM	0	A match was found using the input address' street, city, and state. However, it was noted that the input ZIP code value was different from the ZIP on the matched lookup data set observation. For example, the input data set's address contained a transposed ZIP code, "100 Main St., Cary, NC 25713". However, the matching lookup data set had the correct ZIP code value, "100 Main St., Cary, NC 27513".
ST	5	The two-character state abbreviation matched.
TP	20	The street type prefix matched.
TS	20	The street type suffix matched.
ZC	15	The five-digit ZIP code or non-U.S. postal code matched.

Missing CT and ST Tokens in the Output Data

In some cases, the _SCORE_ value that is calculated by the GEOCODE procedure might not match the sum of the scores of the tokens that are listed in the _NOTES_ variable. The scores for the individual tokens are listed in Table 11.21 on page 200. The mismatch is caused by missing CT and ST tokens in the GEOCODE procedure output data. Missing CT and ST tokens can occur when _MATCH_ is STREET and one of the following is true:

- Token NOCTM is not included in variable _NOTES_, and variable CITY is a nonmissing value.
- Token NOSTM is not included in variable _NOTES_, and variable STATE is a nonmissing value.

To correct this issue, use a DATA step to add any missing CT and ST tokens to the _NOTES_ variable value in the GEOCODE procedure output data. For more information, see Problem Note 71073 on support.sas.com. For an example, see "Example 3: Street Geocoding" on page 262.

Tips for Street Geocoding

The following table lists the suggestions and comments for the STREET geocoding method per data category.

Table 11.2 *Suggestions and Comments for the STREET Geocoding Method*

Category	Suggestions and Comments
Most recent software and lookup data	Install the most recent SAS release. The STREET method is being continuously upgraded and each release contains improved matching results. Installing the most recent SAS release also updates the existing data sets such as SASHELP.GCTYPE. They are used in STREET geocoding. The formats of the STREET lookup data sets have changed from that of releases prior to SAS 9.4. Download the lookup data sets that are not installed with SAS/GRAPH from the SAS Geocode Data — Street Geocoding website. They are differentiated by version. You can use only the lookup data sets that correspond to your SAS release.
	Obtain the most recent street lookup data sets. The nationwide U.S. lookup data available on the SAS Geocode Data — Street Geocoding website is updated annually when the U.S. Census Bureau releases new TIGER/Line shapefiles. These include the USM, USS, and USP data sets. To support U.S. and Canadian street geocoding, state and direction data sets are available, as well as Canadian street type and direction data sets. The %TIGER2GEOCODE macro program imports TIGER/Line shapefiles from the U.S. Census Bureau. This program provides more street matches for any specific SAS release. The %GEOBASE2GEOCODE macro program imports Canadian roadway and address data from the GeoBase data site. Both macro programs create the lookup data sets used by the GEOCODE procedure's STREET method. Download these macro programs from the SAS Geocode Data — Street Geocoding website. Run the macro program on the same platform and operating system on which you intend to run the GEOCODE procedure. That ensures synchronization between the locale and indexes. For more information see "SAS Maps and Geocoding Website" on page 186.

Category	Suggestions and Comments
Correct data	Examine the input address values for observations that do not get a street match. Here are some common reasons why street matches are not found: ■ The address is a P.O. box or contains apartment information. ■ The direction suffix (or prefix) is positioned such that is it not detected. For example, the input address might be 'Green Level West Road ' instead of 'Green Level Road West.' ■ The street name is not in the TIGER or GeoBase data that is being used. ■ The city or street name in the lookup data uses an alternate spelling. An example is Hillsboro versus Hillsborough. ■ Data is misspelled for street or city names. ■ Digits are incorrect or transposed for house numbers or ZIP or postal codes. The city name on the target street in the lookup data is within the city limits of one city but the mailing address uses a different city. Including the adequate amount of data can avoid this problem. ■ Hyphenated addresses do return a street match, but the results do not include the hyphenated part. An example is a two-part number, such as 1294–07, where the first number indicates a cross-street and the second number indicates a house number of 07. The results contain 1294 only. ■ Address numbers that are in character rather than numeric format. An example is Seventeen E 3rd Street, as opposed to 17 E 3rd Street. The geocode procedure attempts a ZIP code or City match when it encounters addresses such as these. ■ A street address and ZIP code are both correct, but the state code is incorrect. The geocoder treats this as a ZIP code lookup, rather than a street address lookup. Sometimes the ZIP code match is correct, as in the case where a ZIP code crosses state boundaries. But other cases involve the ZIP code being correct but it is not a match to any ZIP code in the specified state. **Note:** Do not remove house numbers.
Adequate amount of data	Include as many elements of a mailing address as possible. The street name is required. Include the house number, the ZIP code, the city, and the state values whenever possible.

Category	Suggestions and Comments
ZIP or postal codes	Always include the ZIP or postal code with the input address, if available. Street geocoding is most effective when using the ZIP or postal code. If ZIP is omitted, the city and state values must be used, and they can be misleading. If the ZIP or postal code is included, but incorrect, the street geocoder uses city and state values along with a street name. A ZIP or postal code might be incorrect for locations in the data set where the U.S. Postal Service has reassigned local ZIP codes when modifying its delivery routes. For example, when a ZIP match is not found, an input address with its direction prefix at the end of the street name, '101 Harrison Ave N', is matched to '101 N Harrison Ave' in the lookup data. Conversely, when a ZIP match is not found, an input address with its direction prefix at the beginning of the street name, '101 N Harrison Ave', is matched to '101 Harrison Ave N' in the lookup data. **Note:** When street geocoding with Canadian data that does not contain postal codes, disable the geocoder cascading to a secondary ZIP matching method by specifying the NOZIP option. The city value of a street segment from the original TIGER data is not the mailing address city. Instead, it denotes whether that segment is physically within the corporate limits of a city. A missing city value means that the street segment is not within any incorporated city. For example, a house with a Leon, Iowa mailing address is in an unincorporated portion of Decatur County, Iowa. The TIGER data for this house might have a missing city value despite the house having a valid mailing address. Also, it is common for a house to be inside one city's limits but its mail is delivered from another city's post office branch. For example, there are streets near SAS that are within Apex, North Carolina, but have a Cary, North Carolina mailing address. Specifying the ZIP code for all input addresses can prevent geocoding problems that result from this situation.
Missing lookup data set	If you change the location of the lookup data sets, always move the data set index that correlates to them. A warning is issued in the SAS log by the GEOCODE procedure if an index file is expected and not present.
	The STREET method locates an address using the street name and ZIP or postal code or by using the street name with the city and state or province. A ZIP or postal code represents less data than a city. As a result, when you use

Category	Suggestions and Comments
	these codes the geocode procedure runs faster and provides more reliable locations.

Understanding City Geocoding

Overview of City Geocoding

This section describes details about geocoding with either U.S. or international city names. The requirements for input data and lookup data vary depending on which area you choose. SAS provides a default lookup data set for each type of geocoding, but an alternate data set can be specified instead.

About City Input Data Sets

For U.S. city geocoding each observation in your input data must contain a city and a state. The recommended state value is the two-character state abbreviation but the complete state name can also be used.

For worldwide geocoding each observation in your input address data must include the city name and the country. The country value can be the complete country name or its two- or three-character country abbreviation. An example is GB or GBR for the United Kingdom. An optional state, province, or region name can also be specified.

About U.S. City Lookup Data

The default lookup data set for U.S. CITY geocoding is MAPSGFK.USCITY_ALL, if SAS/GRAPH is installed. This data set is licensed by SAS from GfK GeoMarketing GmbH, who is the single source of this data and all of its updates. The data set is covered by the GfK GeoMarketing copyright, is provided with SAS/GRAPH in the MAPSGFK library, and is updated for each SAS release.

You can download updates of the MAPSGFK.USCITY_ALL data set from the SAS Maps and Geocoding website. For more information, see “SAS Maps and Geocoding Website” on page 186.

If you do not have the MAPSGFK library at your location, an alternate U.S. CITY lookup data set can be downloaded from the SAS Maps and Geocoding website.

Another alternative is to specify your lookup data set as the SASHELP.ZIPCODE data set in your SAS code, like this:

```
LOOKUPCITY= SASHELP.ZIPCODE
```

You can specify that non-geocoding variables from the lookup data set be added to the output data set by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement.

The default lookup data set MAPSGFK.USCITY_ALL contains the following variables:

Default Name:
Label:

STATE
Numeric State code

COUNTY
Numeric County code

CITY
City name

ID
Region code

ID1
Admin1 code

ID2
Admin2 code

X
Projected longitude using the experimental Miller II projection method

Y
Projected latitude using the experimental Miller II projection method

CITY2
Normalized CITY name for geocoding

Note: Values are converted to uppercase and all spaces and characters that are not alphabetic or numeric are stripped

STATECODE
State postal code

COUNTY_NAME
County Name

LAT
Unprojected degrees latitude (WGS 84)

LONG
Unprojected degrees longitude (WGS 84)

Capital
Capital city

POP_TYPE
GfK pop2010 category

FEATURE_ID
Census Government ID

ALT_M
Altitude in meters

ALT_FT
Altitude in feet

About World City Lookup Data

The default lookup data set for world CITY geocoding is MAPSGFK.WORLD_CITIES. This data set contains more than 200,000 cities worldwide. The data set is licensed by SAS from GfK GeoMarketing GmBH, who is the single source of this data and all of its updates. The data set is covered by the GfK GeoMarketing copyright, is provided with SAS/GRAPH in the MAPSGFK library, and is updated for each SAS release.

You can download updates of the MAPSGFK.WORLD_CITIES data set from the SAS Maps and Geocoding website. An unabridged data set named MAPSGFK.WORLD_CITIES_ALL, with more than one million observations, is also available for downloading. The unabridged data set is updated annually. For more information, see "SAS Maps and Geocoding Website" on page 186.

You can specify that non-geocoding variables from the lookup data set be added to the output data set by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement.

The default lookup data set MAPSGFK.WORLD_CITIES and the unabridged data set MAPSGFK.WORLD_CITIES_ALL both contain the following variables:

Name:
Label:

X
Projected longitude using the experimental Miller II projection method.

Y
Projected latitude using the experimental Miller II projection method.

ID
Country or region Alpha code.

MapIDName2
Normalized state or province name for geocoding.

Note: Values are converted to uppercase and stripped of all spaces and characters that are not alphabetic or numeric.

CITY2
Normalized CITY name for geocoding.

Note: Values are converted to uppercase and stripped of all spaces and characters that are not alphabetic or numeric.

CONT
Numeric number for continent.

ISONAME
ISO country or region name.

CITY
City name.

CtType
POP categories for cities where applicable.

Rank
Grouping of CtType high to low.

Vintage
Recorded Year of data.

LONG
Unprojected degrees longitude (WGS 84).

LAT
Unprojected degrees latitude (WGS 84).

ISO
ISO country or region code.

ISOALPHA2
ISO Alpha2-code for country.

ISOALPHA3
ISO Alpha3-code for country or region.

MapID
ID from MAP data set.

Note: The map data set specified in the SAS/GRAPH GMAP procedure or in the Base SAS SGMAP procedure.

MapLevel
Map level.

IDNAME
Country or region name.

MapIDName1
ID1NAME from MAP data set

About Alternate U.S. City Lookup Data

The GEOCODE procedure uses the MAPSGFK.USCITY_ALL as the default lookup data set for U.S. CITY geocoding. However, you can use the LOOKUPCITY= option

to specify an alternate lookup data set. For example, if you want to exclude Puerto Rico and the U.S. Virgin Islands, use the MAPSGFK.USCITY data set. The data set is covered by the GfK GeoMarketing copyright and is provided with SAS/GRAPH in the MAPSGFK library. The data set is updated for each SAS release. Another alternate data set is SASHELP.ZIPCODE, which is made available with SAS/GRAPH in the SASHELP library. See "About the SASHELP.ZIPCODE Lookup Data Set" on page 216 for details. SASHELP.ZIPCODE was the original lookup data set used in CITY geocoding prior to SAS 9.4.

The lookup data set SASHELP.ZIPCODE contains multiple observations for cities. When using this data set, the city location is found by averaging the ZIP code data for the city and state to find the mean location.

The map data sets in the MAPSGFK library are available only with a SAS/GRAPH installation. If you do not have the MAPSGFK library at your location, an alternate U.S. CITY lookup data set can be downloaded from the SAS Maps and Geocoding website.

Alternate lookup data sets can be used automatically by the geocoder to help find equivalent state names if the specified non-abbreviated state name does not match. Such an alternate lookup data set is SASHELP.GCSTATE. It contains city and state or province names in character format. The geocoder looks in this data set if it needs additional state data in order to make a match between a non-abbreviated state name and a state code.

Any other alternate lookup data set for U.S. CITY geocoding must contain the following information. These exact variable names are not required, but the variable values must contain the following information:

CITY
Name of the city (does not have to be normalized)

Note: Values are not converted to uppercase and spaces and non-alphabetic and non-numeric characters remain intact.

STATECODE
Two-character abbreviation of the state name

Note: Instead of a two-character STATECODE, you have the option of using the complete state name. However, the state values in the alternate lookup data set must match the values that are in your input address data. The state names do not have to be normalized, meaning that values are not converted to uppercase and spaces and non-alphabetic and non-numeric characters remain intact. When using a custom lookup data set, the GEOCODE procedure converts to uppercase the state name and removes special characters and spaces.

LAT
Latitude of the city center

LONG
Longitude of the city center

About Alternate World City Lookup Data

The GEOCODE procedure uses the MAPSGFK.WORLD_CITIES as the default lookup data set for world CITY geocoding. However, you can use the LOOKUPCITY= option to specify an alternate lookup data set. An example alternate data set is MAPSGFK.WORLD_CITIES_ALL, which is made available for download from the SAS Maps and Geocoding website.

The map data sets in the MAPSGFK library are available only with a SAS/GRAPH installation. If you do not have the MAPSGFK library at your location, an alternate world CITY lookup data set can be downloaded from the SAS Maps and Geocoding website.

Any other alternate lookup data set for worldwide CITY geocoding must contain the following information. These exact variable names are not required, but the variable values must contain the following information:

CITY
: Name of the city

ISOALPHA2 or ISOALPHA3
: Two- or three-character abbreviation of the country name

> **Note:** Instead of a two- or three-character country abbreviation, you can use the complete country name. However, the country values in the alternate lookup data set must match the values that are in your input address data.

LAT
: Latitude of the city center

LONG
: Longitude of the city center

The alternate world CITY geocoding lookup data set can also include an optional state, province, or region name. This allows the GEOCODE procedure to differentiate between cities that share the same name but are located in different regions. The state, province, or region names in the lookup data do not have to be normalized, meaning converted to uppercase and stripped of spaces and non-alphabet and non-numeric characters.

Tips for City Geocoding

The following table lists the suggestions and comments for using the CITY geocoding method per data category.

Table 11.3 *Suggestions and Comments for Using the CITY Geocoding Method*

Category	Suggestions and Comments
Most recent software and lookup data	Installing the most recent SAS release updates the following data sets that can be used by the GEOCODE procedure: ■ MAPSGFK.USCITY_ALL ■ MAPSGFK.WORLD_CITIES ■ SASHELP.ZIPCODE MAPSGFK.WORLD_CITIES_ALL is an unabridged version of world cities available for download. See "SAS Maps and Geocoding Website" on page 186 for details. You can also download quarterly updates of SASHELP.ZIPCODE from the SAS Maps and Geocoding website. See "SAS Maps and Geocoding Website" on page 186 for details.
Correct data	Here are some common reasons why CITY matches are not found: ■ The city name is misspelled. ■ The city name in the lookup data uses an alternate spelling (for example, Hillsboro versus Hillsborough). ■ The two-character state ID is transposed (for example, YN instead of NY). ■ The non-U.S. city name in the lookup data uses a local spelling. MAPSGFK.WORLD_CITIES is an example of a lookup data set with local spellings. ■ There are multiple cities with that name in the country. Use the ADDRESSSTATEVAR= option to specify a state, province, or region variable to differentiate the cities. ■ The town can be very small and not included in the MAPSGFK.WORLD_CITIES data. Download the more complete MAPSGFK.WORLD_CITIES_ALL data set. See "SAS Maps and Geocoding Website" on page 186 for details. ■ The state (or province) variable is missing from the input address data set and you are geocoding within one country. The state variable is required in order for the geocoder to differentiate states or provinces sharing cities with the same name. ■ The state (or province) variable is missing from the input address data set. Or the customized state lookup data set when a state or province is specified with the ADDRESSSTATEVAR= option. When international city geocoding, use of the state variable is optional. However, when a state variable is specified, the geocoder tries to

Category	Suggestions and Comments
	match the specified state with states supplied in the input data set(s).

Understanding ZIP Code Geocoding

Overview of ZIP Code Geocoding

The terms ZIP code and postal code are used interchangeably. Both terms refer to a group of linear mail delivery routes. ZIP code is the United States Postal Service's designation while postal code is used by other national post offices. ZIP codes can also be assigned to a single building or to a post office. There are also U.S.P.S. military post office designations that associate a ZIP code with either a branch of the military or with a U.S. embassy. Whereas a ZIP code is not considered a polygonal area, a county, state, or country is considered such.

Generally, ZIP code address data specifies a center location for the ZIP code. The center approximates the geographic center of the ZIP code. The Postal Service does not create official ZIP code boundaries. Each data vendor draws its own boundaries, which causes ZIP center variations among different vendors' products.

The basic ZIP code in the United States is five digits. ZIP code data provides the general vicinity of an address, but usually not the actual street. If you want to locate the street, you can try using ZIP+4 geocoding. For more information, see "Understanding ZIP+4 Geocoding " on page 220.

About ZIP Code Input Data

Your input data must contain a valid ZIP or postal code for each observation. If a ZIP code is not found, then the GEOCODE procedure attempts to find the city center location. If you are interested in the ZIP code location only, you can turn off this cascading behavior using the NOCITY option in the GEOCODE statement.

About ZIP Code Lookup Data

ZIP code geocoding uses the SASHELP.ZIPCODE lookup data set by default. You can use the LOOKUP= option to specify alternate data sources. SASHELP.ZIPCODE can also be used as an alternate lookup data set for the CITY method. SASHELP.ZIPMIL is an alternate lookup data set that contains ZIP codes designating either a U.S. military branch or embassy. You can also import postal

codes outside the U.S. from other sources of data. To import postal codes, you can use the IMPORT procedure or a DATA step, depending on the format of the third-party data.

After you import non-U.S. postal codes with centroids into a SAS data set, you can use this data set as the lookup data set with the ZIP method. For an explanation of the sources of free Australian and British postal code locations, see "Non-U.S. Postcodes" on page 219.

When providing the geocoder with your own lookup data set of ZIP or postal codes, you must set any longitude and latitude variables containing missing values to a period (.). Do not set these missing values to zero (0), because these are valid values that indicate a location at the equator. SAS prepares the SASHELP.ZIPMIL data set in such a manner. You can use this data set for validating APO, FPO, and DPO values or you can create an alternate file by merging it with the ZIP code data set.

You can specify that non-geocoding variables from the lookup data set be added to the output data set by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement. In the case of military ZIP codes, you can assign the STATE name value using the ATTRIBUTEVAR= option to each matched observation in the output data set. This would indicate the location of the ZIP code if there are no latitude and longitude values.

About the SASHELP.ZIPCODE Lookup Data Set

The default lookup data set for ZIP code geocoding is SASHELP.ZIPCODE. This data set can also be used as an alternate lookup data set with the CITY method for U.S. locations. SASHELP.ZIPCODE is provided with Base SAS and is updated for each SAS release.

You can download quarterly updates of the SASHELP.ZIPCODE data set from the SAS Maps and Geocoding website. For more information, see "SAS Maps and Geocoding Website" on page 186.

SASHELP.ZIPCODE contains the following variables:

Name:
Label:

ZIP
The five-digit ZIP code.

Y
Latitude (decimal degrees) of the center of the ZIP code.

X
Longitude (decimal degrees) of the center of the ZIP code.

ZIP_CLASS
ZIP code Classification: P=PO Box, U=Unique zip used for large organizations or businesses or buildings, Blank=Standard or non-unique.

CITY
Name of the city or organization.

STATE
Two-digit number (FIPS code) for the state or territory.

STATECODE
Two-letter abbreviation for the state name.

STATENAME
Full name of the state or territory.

COUNTY
FIPS county code.

COUNTYNM
Name of county or parish.

MSA
Metropolitan Service Area code by common population pre-2003; no MSA for rural areas.

AREACODE
Single Area Code for the ZIP code.

AREACODES
Multiple Area Codes for the ZIP code.

TIMEZONE
Time Zone for the ZIP code.

GMTOFFSET
Difference (hours) between GMT and Time Zone for the ZIP code.

DST
ZIP code observes Eastern Time. Y is Yes and N is No.

PONAME
USPS Post Office Name: same as City.

ALIAS_CITY
USPS – Alternate names of city separated by "||".

ALIAS_CITYN
Local – alternate names of city separated by "||".

CITY2
Clean CITY name for geocoding

Note: Values are converted to uppercase and all spaces and characters that are not alphabetic or numeric are stripped.

STATENAME2
Clean STATENAME for geocoding

Note: Values are converted to uppercase and all spaces and characters that are not alphabetic or numeric are stripped.

About Alternate ZIP Code Lookup Data

The SASHELP.ZIPCODE data set is the default lookup data set for the GEOCODE procedure. SAS also supplies SASHELP.ZIPMIL as an alternate lookup data set. However, data from other sources can be used as long as it is read into a SAS data set. You can use the "LOOKUP=*lookup-data-set*" on page 241 option to specify alternate data sources.

The SASHELP.ZIPMIL alternate lookup data set contains the same variables as the SASHELP.ZIPCODE data set. However, the CITY variable contains the military acronyms AFO, FPO, and DPO, and the ALIAS_CITY variable contains those acronym descriptors. The longitude and latitude variables contain missing values, and as such cannot provide a geocoded location for a military ZIP code. However, you can programmatically identify these as military ZIP codes as you geocode. For example, use the "ATTRIBUTEVAR=(*variable-1*, *variable-2*, ...)" on page 240 option of the PROC GEOCODE statement to assign the STATE value to your military ZIP code.

- Army Post Office (APO) address information and ZIP codes associated with Army or Air Force installations.
- Fleet Post Office (FPO) address information and ZIP codes associated with Navy installations or ships.
- Diplomatic Post Office (DPO) address information and ZIP codes associated with U.S. embassies overseas.

For ZIP code geocoding, any lookup data set must contain the following values but the exact variable names are not required:

Default Name:
Description:

ZIP
Five-digit ZIP code

X
Longitude of the center coordinate

Y
Latitude of the center coordinate

CITY2
City name values must be converted to uppercase and all spaces and characters that are not alphabetic or numeric are stripped.

STATENAME2
State name values must be converted to uppercase and all spaces and characters that are not alphabetic or numeric are stripped.

Note: The character values in your input and lookup data sets do not need to be a case-sensitive match. Character value matching in the GEOCODE procedure is not case sensitive.

Note: The geocoder converts alphabetic characters to uppercase and strips all spaces and special characters from the input data set. Performing this same cleanup in your lookup data set helps the geocoder find more matches during its comparison of the lookup and input data sets.

Additional attribute variables can also be in the alternate lookup data set. You can specify that non-geocoding variables from the lookup data set be added to the output data set by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement.

Non-U.S. Postcodes

Postcode data from other countries can be used with the ZIP method if it includes either longitude and latitude or X and Y coordinates. You have to import postcode data into a SAS data set, which becomes the lookup data set for the ZIP method. If the postcodes contain alpha characters, the characters should be converted to uppercase. Remove any spaces and punctuation from the postcodes.

In addition, make sure that the geographic system of the imported data is compatible with your needs. For example, if you want geocoded locations in the World Geographic System 1984 (WGS 84) geodetic datum, your imported values should be in that datum. If they are not, then you must apply either the appropriate coordinate conversions or datum transformations or both.

Great Britain's national mapping agency, the Ordnance Survey (OS), provides location data for 1.7 million Royal Mail postcodes in their free Code-Point Open product. The SAS macro program %CODEPOINT2GEOCODE imports the OS files. The GEOCODE procedure uses these OS files to locate British mailing addresses by postcode. The macro also converts the British National Grid coordinates to World Geodetic System 1984 (WGS 84) longitude and latitude.

The Australian Bureau of Statistics (ABS) produces a generalized map of Australian postal areas. The SAS macro program %ABS2GEOCODE imports those postcode areas, computes the centroids, and creates a lookup data set for use by the GEOCODE procedure. The macro also creates a SAS/GRAPH map data set of the postal area polygons.

The %CODEPOINT2GEOCODE and %ABS2GEOCODE macro programs and their accompanying documentation are available for download from the SAS Maps and Geocoding website. For more information, see "SAS Maps and Geocoding Website" on page 186.

U.S. Military ZIP Codes

ZIP codes for U.S. military post offices are provided in the ZIPMIL data set in the SASHELP library. You can combine this data set with the ZIPCODE data set to support military ZIP codes.

Tips for ZIP Code Geocoding

The following table lists the suggestions and comments for the ZIP geocoding method per data category.

Table 11.4 *Suggestions and Comments for the ZIP Geocoding Method*

Category	Suggestions and Comments
Most recent software and lookup data	Installing the most recent SAS release updates the SASHELP.ZIPCODE data set that is used in ZIP geocoding. You can also download quarterly updates of SASHELP.ZIPCODE from the SAS Maps and Geocoding website. See "SAS Maps and Geocoding Website" on page 186 for access details.
Correct data	Remove all data entry errors from your addresses, if possible. For example, transposed digits in the input ZIP code result in no match, or worse, return a completely wrong location. **Note:** Tokens such as NOCTM act as an alert to potential data entry problems. For example, an input data set address of Green St. in Raleigh has the wrong ZIP code of 27601. It is compared to the lookup data set address of Green St. in Knightdale with the correct ZIP code of 27601. The NOCTM token in the _NOTES_ variable indicates that though a ZIP code match was found, the cities did not match.
Non-U.S. postal codes	Remove any spaces and punctuation and uppercase any characters.

Understanding ZIP+4 Geocoding

Overview of ZIP+4 Geocoding

With ZIP+4 geocoding, the GEOCODE procedure attempts to match the five-digit ZIP code and ZIP+4 extension from your address data set with the lookup data set.

If a ZIP+4 code is not found, the GEOCODE procedure attempts to match the standard five-digit ZIP code. If that is not found, the procedure attempts to find the

city. If you are interested in the ZIP code location only, you can turn off this cascading behavior using the NOCITY option in the GEOCODE statement.

About ZIP+4 Lookup Data

For ZIP+4 code geocoding, you can use data that is derived from the TIGER ZIP+4 files that are available from the SAS Maps and Geocoding website.

Note: The U.S. Census Bureau has omitted ZIP+4 values from TIGER files released after 2006, and has no plans to reinstate them. The lookup data set to be used with the PLUS4 geocode method was created using 2006 TIGER data and is available on SAS Maps Online. Use this data set with caution, as the data is vintage.For more information about the status of the ZIP+4 data, and how to download the current data, see "SAS Maps and Geocoding Website" on page 186.

You can also purchase the GEO*Data product containing current ZIP+4 centroids, available from Melissa Data at this website: https://www.melissa.com/geodata-reference-data-sets.

SAS includes an autocall macro (%GCDMEL9), which imports Geo*Data files into SAS data sets.

You can specify that non-geocoding variables from the lookup data set be added to the output data set by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement.

About Alternate ZIP+4 Lookup Data

When you use ZIP+4 geocoding, you must specify an alternative lookup data set because SASHELP.ZIPCODE does not contain any ZIP+4 values. This data set must contain the following variables:

Default Name:
Description:

ZIP
Five-digit ZIP code

PLUS4
Four-digit ZIP+4 extension

X
Longitude of the central coordinate

Y
Latitude of the central coordinate

You can specify different names for the variables by using options in the PROC GEOCODE statement. For example, the LOOKUPPLUS4 option specifies the name of the ZIP+4 extension variable in the lookup data set.

The ZIP and PLUS4 variables can contain either character data or numeric data. The lookup data type must match the type of the corresponding variable in your input data set.

Note: The character values in your input and lookup data sets do not need to be a case-sensitive match. Character value matching in the GEOCODE procedure is not case sensitive.

Additional non-geocoding attribute variables can also be in the alternate lookup data set. You can add these variables to the output data set by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement.

You can obtain a lookup data set for ZIP+4 geocoding from the SAS Geocode Data website.

An alternative source for ZIP+4 lookup data is the Geo*Data product from Melissa Data. You can use the %GCDMEL9 autocall macro to convert Geo*Data files to SAS data sets. For more information, see "%GCDMEL9 Autocall Macro" on page 222.

%GCDMEL9 Autocall Macro

Overview of the %GCDMEL9 Autocall Macro

The %GCDMEL9 autocall macro enables you to directly import Geo*Data files from Melissa Data as SAS data sets. Geo*Data files contain third-party ZIP+4 lookup data for use with PLUS4 geocoding.

Geo*Data files are available for each state. The files are provided as text files within compressed (ZIP) archives. Melissa Data also provides the PKUNZIP utility to extract the text files.

The %GCDMEL9 macro uses the following macro variables:

DATASETNAME
specifies the name of the output data set.

DATASETPATH
specifies the location where the output data set is created.

DATASETLABEL
(optional) specifies a label for the output data set.

LIBNAME
specifies the name for a new library that is assigned for the location that you specified in the DATASETPATH macro variable.

UNZIPPEDPATH
specifies the location of the extracted Geo*Data files that you want to import. The %GCDMEL9 macro attempts to read all of the text (.txt) files in this directory.

WORKPATH (Optional)
specifies the path where temporary files are written.

Usage Example for the %GCDMEL9 Autocall Macro

In this example, a Geo*Data file for the state of Delaware (DE.txt) was extracted to *file-path*. The lookup data set is created in an existing directory ***file-path*/Geocode** and assigned the libref ZIP4. The resulting data set is named ZIP4.DELAWARE.

Note: *File-path* must be a path that is accessible to the SAS Compute Server.

The following code imports the data:

```
/* Define macro variables */
  %let UNZIPPEDPATH=file-path;
  %let DATASETPATH=file-path/Geocode;
  %let DATASETNAME=Delaware;
  %let LIBNAME=ZIP4;
  %let DATASETLABEL=ZIP+4 lookup data for Delaware;
  /* Submit autocall macro */
  %GCDMEL9
```

Tips for ZIP+4 Geocoding

The following table lists the suggestions and comments for the ZIP+4 geocoding method per data category.

Table 11.5 *Suggestions and Comments for the PLUS4 Geocoding Method*

Category	Suggestions and Comments
Most recent lookup data	Check the SAS Maps and Geocoding website to see whether there is an update available for the ZIP4 lookup data set. (It is to be made available when the U.S. Census Bureau restores ZIP+4 values to their TIGER/Line shapefiles.) For access details, see "SAS Maps and Geocoding Website" on page 186. You can check with the third-party vendor, Melissa Data, to see whether its Geo*Data product contains ZIP+4 values that are more recent than 2006. The files can be imported with the %GCDMEL9 AUTOCALL macro.
Correct data	Here are some common reasons why ZIP+4 matches are not found: ■ The input ZIP+4 contains transposed digits. ■ The ZIP+4 is new and therefore is not in the lookup data set that you are using.

Understanding Range Geocoding

Overview of Range Geocoding

Range geocoding matches individual address values to a lookup data set containing a range of values. IP address data is a form of range data. IP data was not designed to be geographic like street addresses. For this reason, the process of adding coordinates to IP addresses is usually called geolocating rather than geocoding.

With IPv4 address data, this method requires specifying a second data set with the RANGEDATA= option in addition to the LOOKUP= option. The second data set contains various ranges of IPv4 addresses. The location ID is the key variable that links the two data sets. This variable in the range data set can map to more than one location in the lookup data set. When geolocating with IPv6 address data, the range coordinates are contained in the lookup data set along with their matching locations. Therefore, there is no need to use the RANGEDATA= option. The one-to-one relationship between address range and location already exists.

There are no default variable names with this method. You must specify all data sets and variable names.

Generally, IP addresses are collected from visitors to websites and indicate the connection the visitor used. IP address lookup data contains information that matches ranges of IP addresses to particular geographic locations. A range of IP addresses usually belongs to a company or an internet provider. The location found is not at the street or even ZIP code level, but might indicate the city, state, or country where the IP address is registered.

About Range Lookup Data

Range geocoding with IPv4 addresses requires a lookup data set and an additional range data set. Two data sets are required because a range of addresses can map to more than one location. Range geocoding with IPv6 addresses is possible and requires a single lookup data set that contains all geographic coordinates and the ranges of IPv6 addresses.

- The lookup data set contains geographic coordinates (latitude and longitude). Specify this data set with the LOOKUP= option.
- The range data set identifies the ranges (of IPv4 addresses or of other items). Specify this data set with the RANGEDATA= option.

A location ID key variable links the two data sets. Both data sets must contain this variable in order to identify locations for each IPv4 range. Internally, the proper range is found, and then the key value is used to access the lookup data set to find

the latitude and longitude for that key. This key variable can map a range of addresses in the range data set to more than one location in the lookup data set.

Range geocoding with IPv6 addresses requires a single lookup data set that contains all geographic coordinates and the ranges of IPv6 addresses. No key variable is necessary. If you are range geolocating both IPv4 and IPv6 addresses, specify only the IPv4 data set name with the LOOKUP= option. The %MAXMIND autocall macro automatically creates the IPv6 data set name based on the IPv4 name with the number 6 appended to it.

The lookup data set contains geographic coordinates (latitude and longitude). Specify this data set with the LOOKUP= option. When specifying the IPv6 lookup data set, make sure the number 6 is appended to the name. If you are range geolocating both IPv4 and IPv6 addresses, then provide separate data sets for each IP version.

The range data set identifies the ranges (of IPv4 addresses or of other items). Specify this data set with the RANGEDATA= option. The range data set is not required for IPv6 address data because the ranges are provided in the IPv6 lookup data set.

A KEY variable links the IPv4 lookup and range data sets. Both data sets must contain this variable in order to identify locations for each IPv4 range. Internally, the proper range is found, and then the key value is used to access the IPv4 lookup data set to find the latitude and longitude for that key. No key variable is necessary when using IPv6 addresses.

The lookup data set must contain the following variables:

- [IPv4 and IPv6] an X variable that contains the longitude value of the center coordinate. The default variable name is X.
- [IPv4 and IPv6] a Y variable that contains the latitude value of the center coordinate. The default variable name is Y.
- [IPv4 only] a key variable that corresponds to a key variable in the range data set.
- [IPv6 only] a variable that specifies the beginning value of a range of IPv6 addresses
- [IPv6 only] a variable that specifies the ending value of a range of IPv6 addresses

The IPv4 range data set must contain the following variables:

- a variable that specifies the beginning value of a range of IPv4 addresses
- a variable that specifies the ending value of a range of IPv4 addresses
- a key variable that corresponds to a key variable in the lookup data set

You can obtain lookup and range data from third-party vendors. One vendor is MaxMind, Inc. at https://www.maxmind.com/en/home. You can use the %MAXMIND autocall macro to convert their legacy IPv4 comma-separated value (CSV) files from MaxMind into SAS data sets. These CSV files must be downloaded from the MaxMind website to your local directory before running the macro. The updated version of the %MAXMIND autocall macro is available. Use it to convert IPv6 as well as IPv4 CSV files from MaxMind into SAS data sets. This macro automatically runs a new subprogram designed to convert IPv6 data. The IPv4 data

from MaxMind is provided in decimal format and in a fully qualified format with periods. MaxMind typically provides IPv6 data in collapsed hexadecimal with colons and decimal formats.

You can specify that non-geocoding variables from the lookup data set be added to the output data set by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement.

The MaxMind IPv6 GeoLite lookup data contains only country-level latitude and longitude coordinates. There are many IPv6 address ranges for each country, and the coordinates for each and every address range is to the center of the country. For example, your lookup data set contains many U.S. IPv6 addresses. Your lookup ranges list as coordinates for each of these addresses a latitude of 38 degrees and a longitude of 97 degrees. This location is the center of the United States.

If you supply your own lookup data set, change any zero representing a missing value to a SAS missing numeric: a period (.). Any 32-bit IPv4 address must consist of only integers zero (0) through nine (9) and three periods (.). Any 128-bit IPv6 address must consist of only alphanumeric characters separated by a colon (:). IPv6 addresses might be fully represented or collapsed. They cannot contain port numbers, URLs, or Fully Qualified Domain Names (FQDN).

%MAXMIND Autocall Macro

Overview of the %MAXMIND Autocall Macro

The original %MAXMIND autocall macro enables you to convert IPv4 geocoding data from MaxMind, Inc. into SAS data sets. Likewise, the updated version of the %MAXMIND autocall macro enables you to convert IPv6 data as well as IPv4 data. Either version of the %MAXMIND autocall macro supports MaxMind's IP data in its legacy, comma-separated value (CSV) format. Neither import macro supports MaxMind's next generation file format (GeoLite2).

The name of the SAS data set resulting from an IPv6 conversion is that of an IPv4 conversion with a number 6 appended to it.

The original %MAXMIND macro uses the following macro variables:

CSVPATH
: specifies the path where the MaxMind CSV files are located. You must extract the files from the ZIP archive before using the %MAXMIND autocall macro.

IPDATAPATH
: specifies the path where the output SAS data sets are created. You must have Write permission for this path.

CSVBLOCKSFILE
: specifies the file name for the CSV file that contains IPv4 address range values. The file that you specify must contain the startIpNum and endIpNum variables. The default file name is GeoLiteCity-Blocks.csv.

CSVLOCATIONFILE
specifies the file name for the CSV file that contains longitude and latitude values. The default file name is GeoLiteCity-Location.csv.

CSVCOUNTRYFILE (Optional)
specifies the name of the optional MaxMind CSV file that contains country names. The default file name is GeoIPCountryWhois.csv.

WORKPATH (Optional)
specifies the path where temporary files are written.

The %MAXMIND macro creates the CITYBLOCKS and CITYLOCATION data sets in the path that you specified for the IPDATAPATH variable. The libref IPDATA is created automatically for this path.

Compared to the macro variables required for the original %MAXMIND macro, the updated version of the macro requires an additional set of variables names. These names are identical, except for the number 6 appended to each. The following are the macro variables that cover IPv6 address data:

CSVPATH
specifies the path where the MaxMind CSV files are located. You must extract the files from the ZIP archive before using the updated %MAXMIND autocall macro.

IPDATAPATH
specifies the path where the output SAS data sets are created. You must have Write permission for this path.

CSVBLOCKSFILE6
specifies the file name for the CSV file that contains IPv6 address range values. The file that you specify must contain the startIpNum and endIpNum variables. The default file name is GeoIPv6.csv.

CSVLOCATIONFILE6
specifies the file name for the CSV file that contains longitude and latitude values. The default file name is GeoLiteCityv6.csv.

CSVCOUNTRYFILE6 (Optional)
specifies the name of the optional MaxMind CSV file that contains country names. The default file name is GeoIPASNum2v6.csv.

WORKPATH (Optional)
specifies the path where temporary files are written.

The %MAXMIND macro and its sub-programs create the CITYBLOCKSFILE6 data set in the path that you specified for the IPDATAPATH variable. This data set, among other variables, contains the starting and ending IPv6 addresses and the longitude and latitude values. The libref IPDATA is created automatically for this path.

Usage Example for the Original %MAXMIND Autocall Macro

In this example, data from MaxMind was extracted to *file-path*. The output SAS data sets are created in the directory ***file-path*/Geocode**.

Note: *File-path* must be a path that is accessible to the SAS Compute Server.

The following code imports the data:

```
%let CSVPATH=file-path;
%let IPDATAPATH=file-path/Geocode;
%let CSVBLOCKSFILE=GeoLiteCity-Blocks.csv;
%let CSVLOCATIONFILE=GeoLiteCity-Location.csv;
%let CSVCOUNTRYFILE=GeoIPCountryWhois.csv;
%MAXMIND
```

The imported data sets are IPDATA.CITYBLOCKS and IPDATA.CITYLOCATION.

Usage Example for the %MAXMIND Autocall Macro

In this example, data from MaxMind was extracted to *file-path*. The output SAS data sets are created in the directory ***file-path*/Geocode**. The %MAXMIND macro requires all IPv4 and IPv6 data files to be downloaded from MaxMind and placed in the same location. If the location is not the same, then the macro fails to execute and issues an error.

Note: *File-path* must be a path that is accessible to the SAS Compute Server.

The following code imports all the required data:

```
%global CSVPATH;
%let CSVPATH=file-path;
%let IPDATAPATH=file-path/Geocode;
%let CSVBLOCKSFILE=GeoLiteCity-Blocks.csv;
%let CSVLOCATIONFILE=GeoLiteCity-Location.csv;
%let CSVCOUNTRYFILE=GeoIPCountryWhois.csv;
%let CSVBLOCKSFILE6=GeoIPv6.csv;
%let CSVLOCATIONFILE6=GeoLiteCityv6.csv;
%let CSVCOUNTRYFILE6=GeoIPASNum2v6.csv;
%MAXMIND
```

The imported data sets are IPDATA.CITYBLOCKS, IPDATA.CITYLOCATION, and IPDATA.CITYBLOCKS6. If you chose a name other than the default, then the IPv6 data set name has a 6 appended to your specified name.

Note: Because the processing of IPv6 data is optional, the range geocoder does not issue error messages for missing IPv6 addresses. The output data set with a missing IPv6 address has a corresponding _MATCHED_ variable value of **None**.

Note: A valid IPv6 address is marked as missing when no IPv6 lookup data set is available.

Output Variables for Range Geocoding

In addition to the default output variables, the RANGE geocoding method creates the following variable in the output data set:

MATCHED
indicates how the coordinates were found. The following values are used with the _MATCHED_ variable:

Link-Local
For CUSTOM and RANGE geocoding, no match was found for the dynamically configured single-network segment IP address. In RFC 3927, the Internet Engineering Task Force has reserved the address block 169.254.1.0 through 169.254.254.255.

The link-local IPv6 address range translates to

```
FE80:0000:0000:0000:0000:0000:0000:0000 -
FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF (FE80::/10 prefix)
```

Private
For CUSTOM and RANGE geocoding, no match was found for the private IP address. The Internet Assigned Numbers Authority (IANA) has reserved the following three blocks of the IP address space for private networks:

```
10.0.0.0        -   10.255.255.255  (10/8 prefix)

172.16.0.0      -   172.31.255.255  (172.16/12 prefix)

192.168.0.0     -   192.168.255.255 (192.168/16 prefix)
```

The private IPv6 address range translates to

```
 FC00:0000:0000:0000:0000:0000:0000:0000 -
FDFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF (FC00::/7 prefix)
```

variable-name
For CUSTOM and RANGE geocoding, a variable name indicates that a match was found for that variable.

None
No match was found for the address.

Tips for Range Geocoding

The following table lists the suggestions and comments for the RANGE geocoding method per data category.

Table 11.6 *Suggestions and Comments for the RANGE Geocoding Method*

Category	Suggestions and Comments
Most recent lookup data, in its original format	Obtain the most recent lookup data, in their legacy format, from the MaxMind website. This can be IPv4 or IPv6 address data, or both. Place the unzipped files in a common directory. Do not change the file names. Import all the files with the %MAXMIND AUTOCALL macro. Open the macro and declare the macro variables for the IPv4 MaxMind files. The %MAXMIND AUTOCALL macro imports IPv4 data and the IPv6 data from MaxMind. The macro invokes the sub-macro programs to import any IPv4 and IPv6 MaxMind files that are

Category	Suggestions and Comments
	located in the designated directory. The website is located at https://www.maxmind.com/en/home. Neither import macro supports MaxMind's next generation file format (GeoLite2). If you change the file names of the MaxMind data, the %MAXMIND autocall macro and its sub-macro programs cannot recognize or import the file data.
Correct data	Here are some common reasons why IP addresses are not matched: ■ If an input IP address fails to match, the IP address might contain transposed digits. ■ IP addresses might not be in the right format. IPv4 addresses must be in either a dotted quad or a decimal format. IPv6 addresses are supported. IPv6 addresses must be hexadecimal in format with a colon (:) separator. They can be full addresses or collapsed. ■ The length of the IP address might be too long. The length of IPv4 addresses must be no longer than 15, 39 for IPv6, including Field Separators.
Missing data	An IPv6 address was detected but no IPv6 lookup data was supplied. Make sure your input lookup data includes a range of IPv6 addresses, specified with the LOOKUP= option, and appends a number 6 to the name. This data set must be separate from the IPv4 data set specified.

Understanding Custom Geocoding

Overview of Custom Geocoding

Custom geocoding is a flexible option that enables you to apply your own type of lookup data to your address data. For example, your input address data might include only telephone area codes for different customers. Other examples are internal sales territories and Metropolitan Statistical Areas (MSA).

Use the option "METHOD=geocoding-method" to specify CUSTOM when you want to geocode an unconventional, non-address type of lookup variable. You must use the option "ADDRESSVAR=variable" to identify the address variable in your address data. You must also use the option "LOOKUPVAR=variable" to identify the non-address variable in the lookup data set.

About Using Lookup Data with Custom Geocoding

Any data can be used as lookup data with the CUSTOM method of geocoding. The only requirement is that you have at least three variables. The variables must be the projected or unprojected coordinate values (X and Y or LAT and LONG), and include a key variable to look up.

You can specify that non-geocoding variables such as COUNTY, TIME ZONE, and AREA CODE from the lookup data set be added to the output data set. Do this by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement.

Optimizing Performance

Overview of Enhancing Performance

Geocoding often requires very large lookup data sets, which can affect the performance of the GEOCODE procedure. You can optimize your geocoding performance by performing the following actions:

- Index your lookup data sets by using the appropriate variables.
- Load the lookup data sets into memory by using the SASFILE statement.
- Minimize running over a network or to an external disk drive.
- Avoid using cross-environment data access (CEDA) when accessing lookup data sets.
- Exclude the location of the WORK library from either the Microsoft Security Essentials or the Microsoft Forefront antivirus program.

Indexing Your Lookup Data Sets

SAS provides indexes for the lookup data sets that it provides. If you use alternative lookup data sets, then indexing your lookup data sets can improve performance. You should create an index by using the same variables that SAS supplies and that are appropriate for your geocoding method.

Indexes that are recommended but are missing can reduce the performance of the geocoder. If your missing index is associated with a data set supplied by SAS, then re-installing that data set from the original source restores the index. You must add the index for a data set that is not supplied by SAS. Refer to Table 11.27 on page 233.

SAS provides indexing for the following data sets that are used with the GEOCODE procedure.

- The SASHELP.ZIPCODE data set and the ZIP4 data set from the SAS Geocode Data — Street Geocoding website are optimized.
- Data sets converted with either the %GCDMEL9 or the %MAXMIND autocall macros.

  Note: The necessary sorting of data set variables is done automatically when using these macros. Be sure to use the version of the %MAXMIND autocall macro that shipped with your SAS release. If you upgrade your SAS release, you should reimport the MaxMind CSV files using its version of the %MAXMIND macro.

  Note: Data sets of IPv4 addresses converted by the original or the updated %MAXMIND autocall macro are sorted and indexed. Data sets of IPv6 addresses converted by the updated %MAXMIND autocall macro are sorted only.

- The STREET geocoding lookup data sets that are provided by SAS.

If the GEOCODE procedure accesses a data set supplied by SAS or created with a SAS import program, it checks for the presence of an index if it expects one. If an expected index is not found, a warning is printed in the SAS log. Note that this check is only for the existence of an index. The procedure does not determine whether the correct variables are in the index.

If you use SAS procedures to copy or move the lookup data sets, any associated indexes are preserved. However, if you use an operating system utility and do not also copy or move the index files, you need to rebuild the indexes. Copying an indexed data set with a DATA step does not apply the index to the new data set, so any index must be regenerated.

For ZIP+4 geocoding, you should create a simple index on the ZIP variable and a compound index on the ZIP and ZIP+4 variables.

For RANGE geocoding of IPv4 addresses you can create lookup data from a source other than MaxMind. If you do this, you are required to sort and index both the range and lookup data sets. But you need only index the data sets on the location ID. For RANGE geocoding of IPv6 addresses, you can create IPv6 lookup data from a source other than MaxMind. You are required to sort this lookup data, but an index is not required. For all versions of SAS, you must sort the range data set by the beginning IP address variable. For IPv6, the lookup data set contains the ranges of IP addresses as well as the coordinates and thus has no need for an indexing key variable. In the case of an IPv4 lookup data set, you must also sort it by the key variable that links the observations between the IPv4 range and lookup data sets. In addition, add a simple index to the IPv4 lookup data set using that key variable.

Indexing for the range data set is not required.

For more information, see "Indexes" in *SAS V9 LIBNAME Engine: Reference*.

Index Names Used By Geocoding Data Sets

Here is a comprehensive list of the indexes used by geocoding data sets.

Table 11.7 *Geocoding Data Set Index Names and Variables*

Default Data Set Name and Description[1]	Index File Name	Default Index Variable(s)[2]
Primary Lookup for U.S. Streets (Default name: SASHELP.USM)	Name2_Zip Name2_Zctra Name2_MapIDNameAbrv_City2	NAME2, ZIP NAME2, ZCTA NAME2, MAPIDNAMEABRV, CITY2
Primary Lookup for Canadian Streets (Default name: Canada_m)	Name2_MapIDNameAbrv_City2 Name2_MapIDName_City2	NAME2, MAPIDNAMEABRV, CITY2 NAME2, MAPIDNAME, CITY2
SASHELP.ZIPCODE	City2_StateCode ZIP City2_StateName2	CITY2, STATECODE ZIP CITY2, STATENAME2
Australian Postal Codes	POA_CODE	POA_CODE
British Postal Codes	PC	PC
MAPSGFK.US_CITY_ALL	StateCode_City2	STATECODE, CITY2
MAPSGFK.WORLD_CITIES or WORLD_CITIES_ALL (from SAS Maps and Geocoding website)	ISOalpha2_City2 ISOalpha3_City2 ISOname2_City2 ID	ISOALPHA2, CITY2 ISOALPHA3, CITY2 ISONAME2, CITY2 ID
ZIP4 (PLUS4 method)	ZIP_PLUS4 ZIP	ZIP, PLUS4 ZIP
CITYLOCATION	CITYLOCATION	LocId
SASHELP.GCDIRECT	DIRECTION	DIRECTION

1 Some of the default lookup data set names can be replaced with the data set name of your choice. CITY, STREET, ZIP, and ZIP+4 geocoding methods allow this data set name replacement.

2 The default index variable can be replaced with an alternate variable name. CITY, STREET, ZIP, and ZIP+4 geocoding methods allow this variable name replacement.

Loading Data Sets into Memory

You can load your lookup data sets into memory by using the SASFILE statement. Loading data into memory reduces I/O processing and can improve the speed of your geocoding operation. You should test your geocoding operations with the lookup data sets loaded into memory to determine whether there is sufficient memory and whether your performance is increased.

For more information, see "SASFILE Statement" in *SAS Global Statements: Reference* in the *SAS Global Statements: Reference*.

Minimizing the Use of a Network

When geocoding large numbers of addresses, network issues can affect run times. You can obtain faster run times occur if the lookup data sets are stored locally, and if they are stored on an internal disk rather than on an external drive.

However, system administrators sometimes install the large lookup data sets in a central location that can be accessed only over the network. In that case, you can obtain faster run times by geocoding large amounts of data during times of less network traffic.

Avoiding the Use of CEDA When Accessing Lookup Data Sets

The cross-environment data access (CEDA) feature enables a SAS file that was created in a directory-based operating environment such as UNIX or Windows to be processed in an incompatible environment. It could also be processed under an incompatible session encoding. With CEDA, the processing is automatic and transparent.

Because CEDA does not support the use of indexes, it can negatively affect geocoding. This is not a concern when you geocode a small number of addresses. However, it does impede larger geocoding runs.

For best performance, the lookup data sets should be created using the same operating system that is used for geocoding. Otherwise, CEDA is used to access the lookup data sets. You can either install the lookup data sets there initially or use either CPORT or CIMPORT to move them. If you import them, make sure that the appropriate data set indexes are preserved or rebuilt.

Excluding the WORK Library from Microsoft Security Essentials and Microsoft Forefront Antivirus Programs

You might use Microsoft Security Essentials or Microsoft Forefront as your antivirus program. If you do, then you need to add the location for the WORK library to the list of excluded files and locations in Microsoft Security Essentials or Microsoft Forefront. The Microsoft 32- and 64-bit operating systems affected are Windows Vista, all editions of Windows 7, Windows XP Professional, all editions of Windows Server 2003, and Windows for 64-Bit Itanium-based systems.

To add the location for the WORK library to the excluded files and locations list in Microsoft Security Essentials, perform the following steps:

1. Click the **Settings** tab in Microsoft Security Essentials.
2. Select **Excluded files & locations**.
3. Click **Add**, and navigate to and select the directory location of the WORK library.
4. Click **OK**, and then click **Save changes**.

For information about how to exclude files and folders in Microsoft Forefront, visit this Forefront link, Excluding files, folders, and file types from scans, or contact Microsoft Technical Support directly.

Note: If you do not add the WORK library to the excluded files and locations list in Microsoft Security Essentials or Microsoft Forefront, then the following errors might occur:

```
ERROR: Rename of temporary member for WORK. failed

ERROR: User does not have appropriate authorization level for library WORK
```

See Also

"IBUFSIZE= System Option" in *SAS System Options: Reference*

Syntax: GEOCODE Procedure

PROC GEOCODE DATA=*address-data-set* <*options*>;

PROC GEOCODE Statement

Identifies the data set that contains the address data that you want to geocode and can identify a lookup data set. You can also specify an output data set, the geocoding method, alternate names for geocoding variables, and additional attribute variables to associate with the matched addresses.

Syntax

PROC GEOCODE DATA=*address-data-set* <*options*>;

Summary of Optional Arguments

ADDRESSCITYVAR=*character-variable*
: specifies the character variable in the input address data set that contains the city names.

ADDRESSCOUNTRYVAR=*character-variable*
: specifies the character variable in the input address data set that contains the country name or identifier for international CITY geocoding.

ADDRESSPLUS4VAR=*variable*
: specifies the variable in the input address data set that contains ZIP+4 extensions.

ADDRESSSTATEVAR=*character-variable*
: specifies the character variable in the input address data set that contains the two-character postal abbreviation for each state or province.

ADDRESSVAR=*variable*
: specifies the address variable for STREET, CUSTOM, or RANGE geocoding.

ADDRESSZIPVAR=*variable*
: specifies the variable in the input address data set that contains the five-digit ZIP code values or non-U.S. postcode values.

ATTRIBUTEVAR=(*variable-1, variable-2, ...*)
: lists non-geocoding variables in the lookup data set that are to be added to the output data set.

BEGINRANGEVAR=*variable*
: specifies the numeric variable in your range data set that contains the beginning IP address for each range of addresses.

DIRECTION=*data-set*
: specifies an alternate data set of street direction names.

ENDRANGEVAR=*variable*
: specifies the numeric variable in your range data set that contains the ending IP address for each range of addresses.

LOOKUP=*lookup-data-set*
: specifies a SAS data set that associates coordinates with addresses for specific geocoding methods.

LOOKUPCITY=*city-matching-data-set*
: specifies the city matching data set for associating coordinates with addresses when performing CITY geocoding.

LOOKUPCITYVAR=*character-variable*
: specifies the character variable in the lookup data set that contains the city names.

LOOKUPCOUNTRYVAR=*character-variable*
: specifies the character variable in the lookup data set that contains the country name or identifier.

LOOKUPKEYVAR=*variable*
: specifies the key variable for the lookup data set that links into the RANGE data set.

LOOKUPLATVAR=*numeric-variable*
: specifies the numeric variable in the lookup data set that contains the latitude of the geocoded location.

LOOKUPLONGVAR=*numeric-variable*
: specifies the numeric variable in the lookup data set that contains the longitude of the geocoded location.

LOOKUPPLUS4VAR=*variable*
: specifies the variable in the lookup address data set that contains ZIP+4 extensions.

LOOKUPSTATEVAR=*character-variable*
: specifies the character variable in the lookup data set that contains the two-character postal abbreviation for the states or provinces.

LOOKUPSTREET=*street-matching-data-set*
: specifies the street matching data set for associating coordinates with addresses when performing STREET geocoding.

LOOKUPVAR=*variable*
: specifies the variable in the lookup data set that contains non-address values used for geocoding with CUSTOM regions.

LOOKUPXVAR=*numeric-variable*
: specifies the numeric variable in the lookup data set that contains the longitude of the geocoded location.

LOOKUPYVAR=*numeric-variable*
: specifies the numeric variable in the lookup data set that contains the latitude of the geocoded location.

LOOKUPZIPVAR=*variable*
: specifies the variable in the lookup data set that contains the five-digit ZIP code values or the non-U.S. postcode values.

METHOD=*geocoding-method*
: specifies the primary geocoding method.

NOCITY
: disables the secondary matching attempt using the CITY geocoding method when STREET or ZIP code geocoding does not find a match.

NOSTIMER

disables the informational messages sent to the SAS log that tracks the progress of the geocoding operation.

NOZIP
: disables the secondary matching attempt using the ZIP geocoding method when PLUS4 or STREET geocoding does not find a match.

OUT=*output-data-set*
: specifies a data set for the geocoded addresses.

RANGEDATA=*data-set*
: specifies a data set that associates ranges of IPv4 addresses with locations.

RANGEDECIMAL
: specifies that the values of the ADDRESSVAR= variable are in decimal or hexadecimal format.

RANGEKEYVAR=*variable*
: specifies the key variable for the IPv4 range data set.

STATE=*data-set*
: specifies a SAS data set that is used by the STREET geocoding method to equate state or province postal abbreviations with complete names.

TYPE=*data-set*
: specifies a SAS data set that is used by the STREET geocoding method to standardize common street address elements.

Required Argument

DATA=*address-data-set*
specifies the SAS data set that contains address observations that you want to geocode.

Default If you do not specify this option, then the most recently created SAS data set is used.

Optional Arguments

ADDRESSCITYVAR=*character-variable*
specifies the character variable in the input address data set that contains the city names.

Default CITY

ADDRESSCOUNTRYVAR=*character-variable*
specifies the character variable in the input address data set that contains the country name or identifier for international CITY geocoding. The variable value can contain either a two- or three-character country name abbreviation or the complete country name.

Defaults If your input country variable has a length of two characters, then the ISOALPHA2 variable in the lookup city data set is used by default for geocoding.

If your input variable has a length of three characters, then the ISOALPHA3 variable in the lookup city data set is used by default for geocoding.

Requirement This option is required for geocoding outside of the United States.

Notes The use of this option implies that you are geocoding non-U.S. locations.

When this option is specified, the default CITY lookup data set is MAPSGFK.WORLD_CITIES. If this option is not used, the GEOCODE procedure assumes that you are geocoding U.S. locations and uses MAPSGFK.USCITY_ALL as the default lookup data set.

Tip In some cases this option can reference an input data set variable that contains complete country names rather than abbreviated ISO values. In these cases use the option "LOOKUPCOUNTRYVAR=*character-variable*" on page 243 to specify the associated variable in your lookup data set.

ADDRESSPLUS4VAR=*variable*
specifies the variable in the input address data set that contains ZIP+4 extensions. The variable can be either numeric or character, but it must be the same type as the ZIP+4 variable in the lookup data set (LOOKUPPLUS4VAR=).

Default PLUS4

Note The variables that you specify for ADDRESSPLUS4VAR= and ADDRESSZIPVAR= must be the same data type.

ADDRESSSTATEVAR=*character-variable*
specifies the character variable in the input address data set that contains the two-character postal abbreviation for each state or province.

This variable can contain the two-character state abbreviation (for example, NY). It can also contain the complete state name (for example, New York).

Default STATE

ADDRESSVAR=*variable*
specifies the address variable for STREET, CUSTOM, or RANGE geocoding. For STREET geocoding, specifies the variable in the address data set that contains the street address values (for example, "1229 North Main St.")

For CUSTOM and RANGE geocoding, the ADDRESSVAR= option specifies the variable in the address data set that contains non-address input values. The variable can be character or numeric. The variable specified can contain either an IPv4 address or an IPv6 address.

Default For STREET geocoding, the default name is ADDRESS.

Interactions For the CUSTOM method of geocoding, this option is used in conjunction with the LOOKUPVAR= option to geocode with unconventional values. Examples of unconventional variable values

include internal sales territories, Metropolitan Statistical Areas (MSA), and Internet Protocol (IP) addresses.

For the RANGE method of geolocating IP addresses, when this option is used in conjunction with the RANGEDECIMAL option, the ADDRESSVAR= variable values must be in decimal form for IPv4. For IPv6 the format is either decimal or hexadecimal. The colon separated IPv6 addresses are hexadecimal, but the up to 48 digit numbers are decimal. IPv6 is supported by range geolocating.

ADDRESSZIPVAR=*variable*
specifies the variable in the input address data set that contains the five-digit ZIP code values or non-U.S. postcode values.

The variable can be either numeric or character, but it must be the same type as the ZIP code variable in the lookup data set (specified by the LOOKUPZIPVAR= option).

Default ZIP

Restriction The values for the ZIP code variable must be five digits. You can use the `Z5.` format to prepend leading zeros to any ZIP code values that have fewer than five digits.

Note Postcodes from other countries can also be used if the appropriate lookup data is imported into a SAS data set. See "Non-U.S. Postcodes" on page 219 for more information.

ATTRIBUTEVAR=(*variable-1*, *variable-2*, ...)
lists non-geocoding variables in the lookup data set that are to be added to the output data set. The values are based on the geocoded location. Examples include county, census block, and time zone. Variable names can be separated by commas or spaces.

Notes The values for additional attribute variables are not added to observations in the output data set where the match type is "City mean" or "ZIP mean".

If an attribute variable has the same name as a variable in the address data set, then that attribute variable is not added to the output data set.

For the STREET geocoding method, only attribute variables from the street segment lookup data set can be included.

Only attribute values from the primary lookup data set that are associated with the specified geocoding method can be added to the output data set. For example, with the STREET geocoding method, you cannot specify that attribute variables be added from the ZIP or CITY lookup data sets. To add attribute variables from the ZIP lookup data set, you must run the GEOCODE procedure a second time. This second run uses the ZIP method on the addresses for which no STREET match was found.

Example ATTRIBUTEVAR=(STATENAME, COUNTYNM)

BEGINRANGEVAR=*variable*
specifies the numeric variable in your range data set that contains the beginning IP address for each range of addresses.

DIRECTION=*data-set*
specifies an alternate data set of street direction names. A data set named SASHELP.GCDIRECT that contains text strings indicating direction is installed. These can be used in U.S. street name prefixes and suffixes and text strings such as northwest or NW. If the %GEOBASE2GEOCODE macro program is used to import Canadian street data, the data set GCDIRECT_CAN is created with English and French directional text strings. Use the DIRECTION= option to reference this alternate data set when geocoding Canadian street addresses.

Aliases DIR=

DIRECT=

Default SASHELP.GCDIRECT (U.S. street geocoding only)

Restrictions The specified data set should contain two variables named DIRABRV and DIRECTION. Each variable is capable of containing text strings, but the DIRECTION variable must contain only alphabetic characters.

A text string indicating direction must exist in the DIRECTION parameter in the specified data set. This enables successful street matching of addresses using this text string. For example, a match for street address “300 N Academy St” cannot be found if the DIRECTION parameter does not include a text string of “N”. This is true even if the DIRABRV parameter in the data set contains this “N” text string.

See “%GEOBASE2GEOCODE Autocall Macro” on page 178

ENDRANGEVAR=*variable*
specifies the numeric variable in your range data set that contains the ending IP address for each range of addresses.

LOOKUP=*lookup-data-set*
specifies a SAS data set that associates coordinates with addresses for specific geocoding methods. When the geocoding method is ZIP, RANGE, or CUSTOM, the data set is searched for observations that match the address observations. The variables that are required for your lookup data set depend on your geocoding method. See “About Alternate ZIP Code Lookup Data” on page 218.

You can specify that non-geocoding variables such as COUNTY, TIME ZONE, and AREA CODE from the lookup data set be added to the output data set. Do this by using the ATTRIBUTEVAR= option in the PROC GEOCODE statement.

Default For the ZIP geocoding method, the default lookup data set SASHELP.ZIPCODE is used.

Restriction This option is not valid when using the CITY geocoding method. Use the LOOKUPCITY= option instead.

Requirements For the IPv4 or IPv6 RANGE or the CUSTOM geocoding method, you must specify the lookup data set with the LOOKUP= option. IPv6 data set names must have the number 6 appended.

You specify the CITY method lookup data set with the LOOKUPCITY= option.

See "LOOKUPCITY=*city-matching-data-set*" on page 242

LOOKUPCITY=*city-matching-data-set*

specifies the city matching data set for associating coordinates with addresses when performing CITY geocoding. Default lookup data sets are used by the GEOCODE procedure without having to specify this option. Use this option to specify an alternate lookup data set. The variables that are required in an alternate lookup data set depend on whether all of your addresses are within the United States or if there are non-U.S. addresses. See "About Alternate U.S. City Lookup Data" on page 211 or "About Alternate World City Lookup Data" on page 213 for a list of required variables.

The city lookup data set can also contain other attribute variables (such as ISONAME and COUNTY_NAME. You can add attribute values to the lookup data set using the "ATTRIBUTEVAR=(*variable-1*, *variable-2*, ...)" on page 240option.

Default For the CITY geocoding method, when the ADDRESSCOUNTRYVAR= option is not specified, the GEOCODE procedure assumes that you are geocoding only U.S. locations and uses MAPSGFK.USCITY_ALL as the default U.S. city lookup data set. When the ADDRESSCOUNTRYVVAR= option is specified, the GEOCODE procedure assumes that you are geocoding worldwide locations and uses MAPSGFK.WORLD_CITIES as the default international city lookup data set.

Restrictions This option is not valid with the RANGE or CUSTOM geocoding method.

You specify the alternate lookup data set with the LOOKUPCITY= option when using the CITY geocoding method.

LOOKUPCITYVAR=*character-variable*

specifies the character variable in the lookup data set that contains the city names. The lookup data set used by the GEOCODE procedure determines which default city name variable is used.

Defaults CITY with either a SASHELP.ZIPCODE or a user-created lookup data set. (The variable values do not have to be normalized.)

CITY2 when the lookup data set is MAPSGFK.USCITY_ALL, MAPSGFK.WORLD_CITIES, or MAPSGFK.WORLD_CITIES_ALL. (The CITY2 variable values in these data sets are normalized. This

means that they are converted to uppercase and stripped of all spaces and characters that are not alphabetic or numeric.)

Requirement This option must be specified when you include this type of variable in a lookup data set not supplied by SAS and you intend to geocode with that variable.

Note The CITY variable value in the MAPSGFK.USCITY_ALL, MAPSGFK.WORLD_CITIES, and MAPSGFK.WORLD_CITIES_ALL lookup data sets contains the mixed case version of the city name.

LOOKUPCOUNTRYVAR=*character-variable*
specifies the character variable in the lookup data set that contains the country name or identifier. Use this option for international CITY geocoding.

Default The default variables are either two- or three-character country name abbreviations in the MAPSGFK.WORLD_CITIES_ALL lookup data set. If the ADDRESSCOUNTRYVAR= option references a two-character country abbreviation (such as 'GB') in the input address data set, the default lookup country variable name is ISOALPHA2. If the ADDRESSCOUNTRYVAR= refers to a three-character country name ('GBR'), the default lookup country variable is ISOALPHA3.

Requirement This option must be specified when you include this type of variable in a lookup data set not supplied by SAS and you intend to geocode with that variable.

Note This option can also reference a lookup data set variable containing complete country names instead of abbreviations.

See "ADDRESSCOUNTRYVAR=*character-variable*" on page 238

LOOKUPKEYVAR=*variable*
specifies the key variable for the lookup data set that links into the RANGE data set. The values of the key variable correspond to values in the variable that you specify for the RANGEKEYVAR= option. The key variable provides a link from the RANGEDATA= data set to the lookup data set. This key variable is used to map more than one IPv4 address range to one location.

Restrictions The data type of the key variable must match the variable that you specify for the RANGEKEYVAR= option.

This option is used only with IPv4 address data. The geocoder uses the key variable when comparing the two lookup data sets, CITYBLOCKS and CITYLOCATION, both of which contain the key variable.

LOOKUPLATVAR=*numeric-variable*
specifies the numeric variable in the lookup data set that contains the latitude of the geocoded location. The lookup data set used by the GEOCODE procedure determines which default latitude variable is used.

Defaults The LAT variable is the default when the GEOCODE procedure uses the MAPSGFK.USCITY_ALL, MAPSGFK.WORLD_CITIES, or the MAPSGFK.WORLD_CITIES_ALL lookup data set.

The Y variable is the default when SASHELP.ZIPCODE or a user-created lookup data set is used.

Requirement This option must be specified when you include this type of variable in a lookup data set not supplied by SAS and you intend to geocode with that variable.

Notes This option supersedes the option LOOKUPYVAR=. Use this option instead of the LOOKUPYVAR= option.

The latitude variable name that you specify with this option must be contained in all of the lookup data sets that might be used during your geocoding run. For example, when you specify LOOKUPLATVAR=LATITUDE with the ZIP and CITY geocoding methods, the latitude variable in your ZIP and CITY lookup data sets must contain that exact variable name. You cannot use LAT in one lookup data set and Y in another.

LOOKUPLONGVAR=*numeric-variable*

specifies the numeric variable in the lookup data set that contains the longitude of the geocoded location. The lookup data set used by the GEOCODE procedure determines which default longitude variable is used.

Defaults The LONG variable is the default when the GEOCODE procedure uses the MAPSGFK.USCITY_ALL, MAPSGFK.WORLD_CITIES, or the MAPSGFK.WORLD_CITIES_ALL lookup data set.

The X variable is the default when SASHELP.ZIPCODE or a user-created lookup data set is used.

Requirement This option must be specified when you include this type of variable in a lookup data set not supplied by SAS and you intend to geocode with that variable.

Notes This option supersedes the option LOOKUPXVAR=. Use this option instead of the LOOKUPXVAR= option.

The longitude variable name that you specify with this option must be contained in all of the specified lookup data sets that might be used during your geocoding run. For example, when you specify LOOKUPLONGVAR=LONGITUDE with the ZIP and CITY geocoding methods, the longitude variable in your ZIP and CITY lookup data sets must contain that exact variable name. You cannot use LONG in one lookup data set and X in another.

LOOKUPPLUS4VAR=*variable*

specifies the variable in the lookup address data set that contains ZIP+4 extensions. The variable can be either numeric or character, but it must be the same type as the ZIP+4 variable in the input address data set (ADDRESSPLUS4VAR=).

Default PLUS4

Requirement This option must be specified when you include this type of variable in a lookup data set not supplied by SAS and you intend to geocode with that variable.

LOOKUPSTATEVAR=*character-variable*
specifies the character variable in the lookup data set that contains the two-character postal abbreviation for the states or provinces.

Default STATECODE

Requirement This option must be specified when you include this type of variable in a lookup data set not supplied by SAS and you intend to geocode with that variable.

LOOKUPSTREET=*street-matching-data-set*
specifies the street matching data set for associating coordinates with addresses when performing STREET geocoding. The GEOCODE procedure expects the street matching data set to have a name that ends with M. The library must also contain two associated data sets that share the same base name as the M data set. The difference is that one name ends with an S (segment) and the other name ends with a P (coordinate). For example, if you specify the street matching data set MYMAPS.GEORGIAM, then the MYMAPS library must also contain the GEORGIAS and GEORGIAP data sets.

For more information about the data sets for STREET geocoding, see "About Street Lookup Data" on page 191.

Default The SASHELP.USM data set, which is not installed with SAS. You can download the USM, USS, and USP data sets which cover the entire United States and its overseas territories from the SAS Geocode Data — Street Geocoding website.

LOOKUPVAR=*variable*
specifies the variable in the lookup data set that contains non-address values used for geocoding with CUSTOM regions. The variable can be character or numeric. For the CUSTOM method of geocoding, this option is used in conjunction with the ADDRESSVAR= option to geocode with unconventional values. Examples of unconventional variable values include internal sales territories, Metropolitan Statistical Areas (MSA), and telephone area codes.

Restriction This option is used exclusively with the CUSTOM geocoding method.

LOOKUPXVAR=*numeric-variable*
specifies the numeric variable in the lookup data set that contains the longitude of the geocoded location.

Default LONG

Requirement This option must be specified when you include this type of variable in a lookup data set not supplied by SAS and you intend to geocode with that variable.

Note This option is superseded by the option LOOKUPLONGVAR=. If you specify the LOOKUPXVAR= option, a message in the SAS log directs you to start using the LOOKUPLONGVAR = option.

LOOKUPYVAR=*numeric-variable*
specifies the numeric variable in the lookup data set that contains the latitude of the geocoded location.

Default LAT

Requirement This option must be specified when you include this type of variable in a lookup data set not supplied by SAS and you intend to geocode with that variable.

Note This option is superseded by the option LOOKUPLATVAR=. If you specify the LOOKUPYVAR= option, a message in the SAS log directs you to start using the LOOKUPLATVAR = option.

LOOKUPZIPVAR=*variable*
specifies the variable in the lookup data set that contains the five-digit ZIP code values or the non-U.S. postcode values.

The variable can be either character or numeric, but it must be the same type as the ZIP code variable in the input address data set (ADDRESSZIPVAR=).

Default ZIP

Restriction The values for a character ZIP code variable must be five digits. You can use the `Z5.` format to prepend leading zeros to any ZIP code values that have fewer than five digits.

Requirement This option must be specified when you include this type of variable in a lookup data set not supplied by SAS and you intend to geocode with that variable.

Note Postcodes from other countries can also be used if the appropriate lookup data is imported into a SAS data set. See "Non-U.S. Postcodes" on page 219 for more information.

METHOD=*geocoding-method*
specifies the primary geocoding method. This parameter is optional. Specify one of the following:

CITY
specifies the CITY geocoding method. The GEOCODE procedure attempts to match certain variables from your address data set with the lookup data set. The procedure uses city and state variables for U.S. city matching, and city and country variables for world city matching. When using a world city lookup data set, you have the option of specifying a state or province variable to help the procedure match cities. A _MATCHED_ value of **`State mismatch`** indicates that the geocoder found a city and country match but the state or province name was not matched. Separate city, country, and state variables are required in the address and lookup data sets.

Notes The city and state matching methods are case-insensitive.

When the GEOCODE procedure uses SASHELP.ZIPCODE as the CITY lookup data set and finds multiple matches for an address, the procedure averages the latitude and longitude values. These values are written to the output data set as Y and X coordinates. For lookup data sets provided by GfK GeoMarketing, the coordinates appear in the output data set as LAT and LONG. If multiple cities are matched in the GfK lookup data sets, the latitude and longitude values are set to missing and the _MATCHED_ value is the number of cities matched.

CUSTOM

specifies the CUSTOM geocoding method. The GEOCODE procedure attempts to match custom variables that you specify by using the LOOKUPVAR= and ADDRESSVAR= options. Examples of custom variables include internal sales territories and Metropolitan Statistical Areas (MSA).

Requirement You must use the ADDRESSVAR= option to identify the address variable in your address data. You must also use the LOOKUPVAR= option to identify the non-address variable in the lookup data set.

PLUS4

specifies the PLUS4 geocoding method. The GEOCODE procedure attempts to match the five-digit ZIP code and ZIP+4 extension from your address data set with the lookup data set.

If no match is found, then the GEOCODE procedure attempts to match the five-digit ZIP code only. If multiple ZIP matches are found, then the matching latitude and longitude coordinate values are averaged.

If no ZIP+4 or ZIP matches are found, then the GEOCODE procedure performs CITY geocoding. If multiple CITY matches are found in the SASHELP.ZIPCODE or user-supplied lookup data set, then the matching latitude and longitude coordinate values are averaged.

Interaction You can disable the secondary ZIP code matching by using the NOZIP option. You can disable the secondary CITY matching by using the NOCITY option.

RANGE

specifies the RANGE geocoding method. The GEOCODE procedure attempts to match an IP address from your address data set to a range of IP addresses from the range data set. If a match is found, then a key variable is used to match the IP address to a set of coordinates in the lookup data set.

STREET

specifies the STREET geocoding method. The GEOCODE procedure first attempts to match the street name and ZIP or postal code. If no match is found, then the GEOCODE procedure attempts to match the street name, city name, and two-character state abbreviation or full state name. If the second match fails, then the ZIP method and the CITY method are used instead.

If a street match is found, longitude and latitude coordinate values are interpolated along the street by using the house number from your input address.

For more information, see "Understanding Street Geocoding" on page 190.

Interactions You can disable the secondary ZIP matching by using the NOZIP option.

You can disable the secondary CITY matching by using the NOCITY option.

ZIP
specifies the ZIP code geocoding method. The GEOCODE procedure attempts to match the five-digit ZIP code or non-U.S. postal code from your address data set with the lookup data set. If no match is found, then the CITY method is used instead.

Interaction You can disable the secondary matching by using the NOCITY option.

Default ZIP

Requirement For a list of options that are required for each geocoding method, see "Required and Optional Arguments for Geocoding" on page 252.

Interaction If you specify more than one method, then the GEOCODE procedure uses the last method that you specify as the primary geocoding method.

NOCITY
disables the secondary matching attempt using the CITY geocoding method when STREET or ZIP code geocoding does not find a match.

Default If the ZIP code geocoding method does not find a match, then the GEOCODE procedure attempts to match the city and state values using the CITY geocoding method. The procedure does the same calculation if the STREET geocoding method does not find a match for the street address or ZIP code.

Restriction Cannot be used with the CITY geocoding method.

NOSTIMER
disables the informational messages sent to the SAS log that tracks the progress of the geocoding operation. If the input data set includes 1,000 or more observations, then the GEOCODE procedure writes periodic messages to the SAS log. The messages show the percentage of addresses completed and the estimated time remaining. This option disables those messages.

Note Unbuffered, real-time log output is useful in monitoring the progress of large geocoding runs. The GEOCODE procedure can write messages to the logon real time only if the LOGPARM system option was set to WRITE=IMMEDIATE when the SAS session was invoked. In addition, you must be using SAS in batch mode or line mode. Setting

LOGPARM="WRITE=IMMEDIATE" causes messages to be written immediately to the SAS log rather than buffered for later output. The Log tab output is buffered in all cases. For more information about the LOGPARM option, see "LOGPARM= System Option" in *SAS System Options: Reference*.

NOZIP

disables the secondary matching attempt using the ZIP geocoding method when PLUS4 or STREET geocoding does not find a match.

Default If PLUS4 or STREET geocoding do not find a match, then the GEOCODE procedure attempts to match the five-digit ZIP code or non-U.S. postal code.

Restriction Cannot be used with the ZIP geocoding method.

Note If your data set contains many missing ZIP+4 values, then the NOZIP option might improve performance.

Tip This option should be specified when geocoding with non-U.S. lookup data sets that do not contain postal codes.

OUT=*output-data-set*

specifies a data set for the geocoded addresses. All of the variables in the input address data set are copied to the output data set. Also added to the output data set are the following:

- Longitude and latitude variables for the geocoded location of the match
- optional variables, if specified by the ATTRIBUTEVAR option, that contain additional information about the geocoded location
- a variable named _MATCHED_ indicating how the match was made
- Additional variables written to the output data set for STREET geocoding are M_ADDR, M_CITY, M_STATE, M_ZIP, M_OBS, _STATUS_, _NOTES_, and _SCORE_. See "Output Variables for Street Geocoding" on page 198 for details.

If the output data set name that you specify already exists, then it is replaced without warning. If the output data set is the same as the input data set, then the input data set is updated by the geocoding operation.

If you omit the OUT= option, then the name of the output data set is DATA*n*, where *n* is the smallest integer that produces a unique name. For example, if a DATA1 data set exists, then the default name for the output data set is DATA2.

If the input address data set has no label, then the label of the output data set contains the text, "geocoded **`date`**". **`Date`** refers to the date on which the output was created. If the input address data set has a label, then that label is placed on the output data set and the "geocoded **`date`**" text is appended to it.

Tip You can use standard SAS data set options with the OUT= option. For example, the following code specifies which variables to keep from the input data set.

```
proc geocode data=address
   out=geocoded (keep=name city state zip);
```

For more information about data set options, see *SAS Data Set Options: Reference*.

RANGEDATA=*data-set*
specifies a data set that associates ranges of IPv4 addresses with locations. The data set should contain variables that identify the starting IPv4 address, ending IPv4 address, and location ID for each range of IPv4 addresses. Use the LOOKUP= option to specify the data set with the latitude and longitude coordinates for each location corresponding to the IPv4 addresses.

Restriction If you are providing the geocoder with an IPv6 data set and an IPv4 data set, they must reside in the same directory location.

Notes There are no default data set names. You must specify all data set names. Variable names read from the header record in the IPv4 MaxMind CSV files are used as the default names.

The RANGEDATA= option does not apply to IPv6 addresses. Use the LOOKUP= option to specify a data set with IPv6 addresses. This data set contains the beginning and ending IPv6 addresses, the location ID for each range of IPv6 addresses, and the latitude and longitude coordinates for each location.

RANGEDECIMAL
specifies that the values of the ADDRESSVAR= variable are in decimal or hexadecimal format. IPv6 addresses in hexadecimal format are supported.

Default The IPv4 addresses in the ADDRESSVAR= variable are in dotted quad notation. For example, the IP address 192.168.0.1 is represented as 3232235521 in decimal form. The IPv6 addresses in the ADDRESSVAR= variable are in eight groups of four hexadecimal digits separated by colons. An example of a full IPv6 address is FE80:0000:0000:0000:0202:B3FF:FE1E:8329. Collapsed forms of IPv6 addresses are also accepted. The collapsed format for the previous example is FE80::0202:B3FF:FE1E:8329. The full IPv6 address is also represented as the decimal number 338288524927261089654163772891438416681 in the IPv6 lookup data.

RANGEKEYVAR=*variable*
specifies the key variable for the IPv4 range data set. The values of the key variable correspond to values in the variable that you specify for the LOOKUPKEYVAR= option. They also provide a link into the LOOKUP= data set. This key variable is used to map more than one IPv4 address range to one location.

Restrictions The data type of the key variable must match the variable that you specify for the LOOKUPKEYVAR= option.

This option is used only with IPv4 address data. The geocoder uses the key variable when comparing the two lookup data sets, CITYBLOCKS and CITYLOCATION, both of which contain the key variable.

STATE=*data-set*

specifies a SAS data set that is used by the STREET geocoding method to equate state or province postal abbreviations with complete names. For example, use this option to specify a customized state data set that contains alternate state or province names.

Default SASHELP.GCSTATE

Notes The GCSTATE data set installed in SASHELP includes U.S. states and Canadian provinces. Observations for other countries can be added.

The variables MapIDName2 and ISOname2 are normalized copies of MapIDName and ISOname, respectively. Normalizing converts to uppercase the original value and removes all punctuation and spaces to provide a clean text string. This enables faster geocoding.

TYPE=*data-set*

specifies a SAS data set that is used by the STREET geocoding method to standardize common street address elements. For example, the data set of street types might standardize "parkway", "prkwy" and "pkwy" to a standard form "pkwy" to facilitate matching. Other examples include avenue (AVE) and boulevard (BLVD).

Default The SASHELP.GCTYPE data set.

Restriction All values in SASHELP.GCTYPE must be converted to uppercase and contain no punctuation or spaces.

Notes When adding street types to the data set, be sure to add at least one observation for each new type. Add two observations if the type can be abbreviated. In the first observation, the NAME value contains the full name of the type and the TYPE value contains the abbreviation. The second observation puts the abbreviation in both the NAME and TYPE values. For example, because 'AVENUE' can be abbreviated, its two observations are added as follows:

```
NAME='AVENUE' and TYPE='AVE'

NAME='AVE' and TYPE='AVE'
```

Some types are short enough that they have no abbreviation. In those cases, only one entry is needed. Both variables contain the full length name. For example:

```
 NAME='WAY' and TYPE='WAY'
```

If the %GEOBASE2GEOCODE macro program is used to import Canadian street data, it creates the GCTYPE_CAN data set. This data set contains Canadian street types and abbreviations. Use the TYPE= option to specify this alternate data set when geocoding Canadian street addresses.

See "%GEOBASE2GEOCODE Autocall Macro" on page 178

Details

Converting SAS/GIS Programs

You might have existing SAS/GIS batch geocoding programs that use the %GCBATCH autocall macro. To convert these programs to the GEOCODE procedure, using the option name from this macro is an acceptable alias in most situations. For more information, see the *SAS/GIS: Spatial Data and Procedure Guide*.

Required and Optional Arguments for Geocoding

Depending on the geocoding method that you use, additional options might also be required. The following table specifies the required and optional arguments for each method:

Table 11.8 *Required and Optional Arguments for Each Geocoding Method*

Geocoding Method	Arguments
CITY	Non-U.S. CITY geocoding requires the following options: ■ ADDRESSCOUNTRYVAR= ■ ADDRESSCITYVAR= ■ LOOKUPCITYVAR= These options are optional when geocoding cities within the United States. In addition, U.S. and non-U.S. CITY geocoding can use the following options: ■ ADDRESSSTATEVAR= ■ LOOKUPCITY= ■ LOOKUPCOUNTRYVAR= **Note:** This option is required when geocoding cities outside of the United States. ■ LOOKUPLATVAR= ■ LOOKUPLONGVAR= ■ LOOKUPSTATEVAR= If your data does not use the default variable names for any of these options, then you must specify the correct variable names with the appropriate options.
CUSTOM	CUSTOM geocoding requires the following: ■ ADDRESSVAR= ■ LOOKUPCITY= ■ LOOKUPVAR=

Geocoding Method	Arguments
	If your lookup data set does not use the default variable names for X and Y, then the following options are also required: ■ LOOKUPLATVAR= ■ LOOKUPLONGVAR=
PLUS4	PLUS4 geocoding requires the LOOKUP= argument. PLUS4 geocoding can use the following options: ■ ADDRESSPLUS4VAR= ■ ADDRESSZIPVAR= ■ LOOKUPLATVAR= ■ LOOKUPLONGVAR= ■ LOOKUPPLUS4VAR= ■ LOOKUPZIPVAR= If your data does not use the default variable names for any of these options, then you must specify the correct variable names with the appropriate options.
RANGE	RANGE geocoding requires the following: ■ ADDRESSVAR= ■ BEGINRANGEVAR= ■ ENDRANGEVAR= ■ LOOKUP= ■ LOOKUPKEYVAR= ■ RANGEDATA= ■ RANGEKEYVAR= RANGE geocoding can use the following options: ■ LOOKUPLATVAR= ■ LOOKUPLONGVAR= If your data does not use the default variable names for any of these options, then you must specify the correct variable names with the appropriate options. If your IPv4 address values are in decimal format, then you must also specify the RANGEDECIMAL option.
STREET	STREET geocoding can use the following options: ■ ADDRESSCITYVAR= ■ ADDRESSSTATEVAR= ■ ADDRESSZIPVAR= ■ ADDRESSVAR=

Geocoding Method	Arguments
	■ DIRECTION= ■ LOOKUPCITYVAR= ■ LOOKUPLATVAR= ■ LOOKUPLONGVAR= ■ LOOKUPSTATEVAR= ■ LOOKUPSTREET= ■ LOOKUPZIPVAR= ■ STATE= ■ TYPE= If your data does not use the default variable names for any of these options, then you must specify the correct variable names with the appropriate options. The following options are not required if you specify the NOCITY option: ■ ADDRESSCITYVAR= ■ ADDRESSSTATEVAR= ■ LOOKUPCITYVAR= ■ LOOKUPSTATEVAR= The following options are not required if you specify the NOZIP option: ■ ADDRESSZIPVAR= ■ LOOKUPZIPVAR=
ZIP	ZIP geocoding can use the following options: ■ ADDRESSCITYVAR= ■ ADDRESSSTATEVAR= ■ ADDRESSZIPVAR= ■ LOOKUPCITYVAR= ■ LOOKUPLATVAR= ■ LOOKUPLONGVAR= ■ LOOKUPSTATEVAR= ■ LOOKUPZIPVAR= If your data does not use the default variable names for any of these options, then you must specify the correct variable names with the appropriate options. The following options are not required if you specify the NOCITY option: ■ ADDRESSCITYVAR= ■ ADDRESSSTATEVAR=

Geocoding Method	Arguments
	■ LOOKUPCITYVAR= ■ LOOKUPSTATEVAR=

Examples: GEOCODE Procedure

About the GEOCODE Procedure Examples

Examples in This Section

This section provides basic examples of how to use the GEOCODE procedure. The following table lists the examples that are provided.

Table 11.9 *GEOCODE Procedure Examples*

Example	Description
Geocoding Using Default Values (p. 256)	Shows how to use the GEOCODE procedure in its simplest form, which specifies only the OUT= option.
Adding Additional Variables to the Output Data Set (p. 259)	Shows how to use the ATTRIBUTEVAR= option to add additional variables to the output data set and how to use the DATA= option to specify an input address data set.
Street Geocoding (p. 262)	Shows how to use the STREET geocoding method to obtain coordinates based on street addresses with house numbers.
U.S. City Geocoding (p. 267)	Shows how to use the CITY geocoding method to obtain coordinates based on a United States city and state.
World City Geocoding (p. 270)	Shows how to use the CITY geocoding method to obtain coordinates of various international cities.

Example	Description
ZIP+4 Geocoding (p. 274)	Shows how to use the PLUS4 geocoding method using US Postal Service ZIP and ZIP+4 postal codes.
British Postcode Geocoding (p. 277)	Shows how to use the ZIP geocoding method using British Royal Mail postcodes.
Australian Postcode Geocoding (p. 279)	Shows how to use the ZIP geocoding method using Australian postcodes.

Examples Available Online

You can find more examples on the Graphically Speaking blog. On the blog page, use **Search Graphically Speaking** to search for GEOCODE to find the GEOCODE procedure examples.

Example 1: Geocoding Using Default Values

Features: ZIP geocoding method

Procedure options
- OUT=

Base SAS functions
- SAS DATA step
- PRINT procedure

Data set: SASHELP.ZIPCODE (lookup data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example shows the simplest form of the GEOCODE procedure, specifying only the OUT= option. The GEOCODE procedure compares the input data set to the lookup data and displays any match that it finds based on a five-digit ZIP code. The ZIP method is the default. The result of using all of the default values is that the following is true:

- The input address data set is the most recently created SAS data set (this example assumes that you have just created WORK.CUSTOMERS).
- The ZIP geocoding method is used.
- The lookup data set is SASHELP.ZIPCODE.

- No variables are added to the output data set other than the X and Y coordinates, and a _MATCHED_ variable indicating whether and how the match was made.

Output

The following output from the PROC PRINT procedure shows the GEOCODED_CUSTOMERS output data set after running the GEOCODE procedure. Notice that three geocoding variables have been added. One is coordinate variables X and Y from the lookup data set (SASHELP.ZIPCODE). The other is a variable named _MATCHED_. This variable indicates whether the location was found by matching ZIP codes or by matching City and State (or whether no location was found because no match was made). Note that your X and Y or M_OBS values might differ depending on the version of SASHELP.ZIPCODE that is installed at your site.

Output 11.1 *The GEOCODED_CUSTOMERS Output Data Set*

Y	X	M_OBS	_MATCHED_	address	city	state	zip	cust_ID
34.0736	-118.399	12643	City	555 Junk Street	Beverly Hills	CA	99999	1
39.1500	-75.532	7549	ZIP	115 E. Water St	Dover		19901	2
39.0953	-75.570	7558	ZIP	760 Moose Lodge Road	Camden		19934	3
39.7366	-75.549	7524	ZIP	200 S. Madison Str	Wilmington	DE	19801	4
39.7317	-75.669	7531	ZIP	4701 Limestone Road	Wilmington		19808	5
39.7877	-75.961	7363	ZIP	2117 N 4th St	Oxford	PA	19363	6
.	.	.	None	1313 Mockingbird Lane	Delray	CC	.	7
38.7265	-75.081	7587	ZIP	133 Silver Lake Dr	Rehoboth Beach	DE	19971	8
38.9035	-75.432	7580	ZIP	11 SE Front Street	Milford	DE	19963	9
38.6411	-75.611	20635	City	402 Nylon Boulevard	Seaford	DE	.	10
39.2997	-75.605	19411	City	363 E Commerce St	Smyrna	DE	.	11
38.4663	-75.150	7589	ZIP	5595 Polly Branch Rd	Selbyville	DE	19975	12
38.4593	-75.053	7565	ZIP	1209 Coastal Highway	Fenwick Island	DE	19944	13
39.1509	-75.693	7572	ZIP	2899 Arthursville Rd	Hartly	DE	19953	14
.	.	.	None	41 Bramhall St			.	15
38.4564	-75.578	20301	City	9320 Old Racetrack Rd	Delmar	DE	.	16
39.2282	-75.666	7574	ZIP	281 W Commerce Str	Kenton		19955	17
39.6264	-75.850	8544	ZIP	211 Blue Ball Road	Elkton	MD	21921	18
39.0695	-75.567	7592	ZIP	3893 Turkey Point Rd	Woodside	DE	19980	19

Program

```
data CUSTOMERS (label="Customer data for geocoding");
infile datalines dlm='#';
length address $ 24 city $ 24 state $ 2;
input address    /* House number and street name */
      zip        /* Customer ZIP code (numeric)  */
```

```
      city       /* City name                    */
      state      /* State abbreviation           */
;
cust_ID = _n_;   /* Assign customer ID number    */
datalines;
555 Junk Street # 99999 # Beverly Hills # CA
115 E. Water St # 19901 # Dover #
760 Moose Lodge Road # 19934 # Camden #
200 S. Madison Str # 19801 # Wilmington # DE
4701 Limestone Road # 19808 # Wilmington #
2117 N 4th St # 19363 # Oxford # PA
1313 Mockingbird Lane # . # Delray # CC
133 Silver Lake Dr # 19971 # Rehoboth Beach # DE
11 SE Front Street # 19963 # Milford # DE
402 Nylon Boulevard # . # Seaford # DE
363 E Commerce St # . # Smyrna # DE
5595 Polly Branch Rd # 19975 # Selbyville # DE
1209 Coastal Highway # 19944 # Fenwick Island # DE
2899 Arthursville Rd # 19953 # Hartly # DE
41 Bramhall St # . #  #
9320 Old Racetrack Rd # . # Delmar # DE
281 W Commerce Str # 19955 # Kenton #
211 Blue Ball Road # 21921 # Elkton # MD
3893 Turkey Point Rd # 19980 # Woodside # DE
;
run;

proc geocode out=geocoded_customers;
run;

proc print data=geocoded_customers noobs;
run;
```

Program Description

Generate the CUSTOMERS input data set of addresses that the GEOCODE procedure uses.

```
data CUSTOMERS (label="Customer data for geocoding");
infile datalines dlm='#';
length address $ 24 city $ 24 state $ 2;
input address    /* House number and street name */
      zip        /* Customer ZIP code (numeric)  */
      city       /* City name                    */
      state      /* State abbreviation           */
;
cust_ID = _n_;   /* Assign customer ID number    */
datalines;
555 Junk Street # 99999 # Beverly Hills # CA
115 E. Water St # 19901 # Dover #
760 Moose Lodge Road # 19934 # Camden #
200 S. Madison Str # 19801 # Wilmington # DE
4701 Limestone Road # 19808 # Wilmington #
2117 N 4th St # 19363 # Oxford # PA
1313 Mockingbird Lane # . # Delray # CC
```

```
133 Silver Lake Dr # 19971 # Rehoboth Beach # DE
11 SE Front Street # 19963 # Milford # DE
402 Nylon Boulevard # . # Seaford # DE
363 E Commerce St # . # Smyrna # DE
5595 Polly Branch Rd # 19975 # Selbyville # DE
1209 Coastal Highway # 19944 # Fenwick Island # DE
2899 Arthursville Rd # 19953 # Hartly # DE
41 Bramhall St # . #  #
9320 Old Racetrack Rd # . # Delmar # DE
281 W Commerce Str # 19955 # Kenton #
211 Blue Ball Road # 21921 # Elkton # MD
3893 Turkey Point Rd # 19980 # Woodside # DE
;
run;
```

Run the GEOCODE procedure with the generated input data set. This example assumes that CUSTOMERS is the most recently generated input data set. The default lookup data set, SASHELP.ZIPCODE, is used. GEOCODE uses the default ZIP method to compare the input data set to the lookup data and match observations based on a five-digit ZIP code.

```
proc geocode out=geocoded_customers;
run;
```

Print the entire GEOCODED_CUSTOMERS output data set, suppressing the observation column.

```
proc print data=geocoded_customers noobs;
run;
```

Example 2: Adding Additional Variables to the Output Data Set

Features:

ZIP geocoding method

Procedure Options
- METHOD=
- DATA=
- OUT=
- ATTRIBUTEVAR=

Base SAS functions
- SAS DATA step
- PRINT procedure

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example illustrates using the ATTRIBUTEVAR= option to add additional variables (from the lookup data set) to the output data set. The example also illustrates using the DATA= option to specify an input address data set. The following output from PROC PRINT shows some notable items. The attribute variables STATENAME and COUNTYNM are missing where the value for

MATCHED is "None." or "City". The "City" observations were matched with multiple city-and-state observations in the lookup data set. As a result, the correct values for the attribute variables cannot be determined. Secondly, the following variables are added to the output data set after running the GEOCODE procedure:

- coordinate variables X and Y from the lookup data set (SASHELP.ZIPCODE) for the geocoded locations. Your X and Y values might differ depending on the version of SASHELP.ZIPCODE that is installed.
- a variable named _MATCHED_. This variable indicates whether the location was found by matching ZIP codes or by matching City and State (or whether no location was found because no match was made).
- an attribute variable named STATENAME from the lookup data set for each geocoded location. The lookup data set contains the full name of the state or territory .
- an attribute variable named COUNTYNM from the lookup data set for each geocoded location. The lookup data set contains the name of the county or parish.

Output

The following output from the PRINT procedure shows the GEOCODED_CUSTOMERS output data set after running the GEOCODE procedure

Output 11.2 *The GEOCODED_CUSTOMERS Output Data Set with Additional Variables*

X	Y	_MATCHED_	STATENAME	COUNTYNM	address	zip
-118.399	34.0736	City			555 Junk Street	99999
-75.532	39.1500	ZIP	Delaware	Kent	115 E. Water St	19901
-75.570	39.0953	ZIP	Delaware	Kent	760 Moose Lodge Road	19934
-75.549	39.7366	ZIP	Delaware	New Castle	200 S. Madison Str	19801
-75.669	39.7317	ZIP	Delaware	New Castle	4701 Limestone Road	19808
-75.961	39.7877	ZIP	Pennsylvania	Chester	2117 N 4th St	19363
.	.	None			1313 Mockingbird Lane	.
-75.081	38.7265	ZIP	Delaware	Sussex	133 Silver Lake Dr	19971
-75.432	38.9035	ZIP	Delaware	Sussex	11 SE Front Street	19963
-75.611	38.6411	City			402 Nylon Boulevard	.
-75.605	39.2997	City			363 E Commerce St	.
-75.150	38.4663	ZIP	Delaware	Sussex	5595 Polly Branch Rd	19975
-75.053	38.4593	ZIP	Delaware	Sussex	1209 Coastal Highway	19944
-75.693	39.1509	ZIP	Delaware	Kent	2899 Arthursville Rd	19953
.	.	None			41 Bramhall St	.
-75.578	38.4564	City			9320 Old Racetrack Rd	.
-75.666	39.2282	ZIP	Delaware	Kent	281 W Commerce Str	19955
-75.850	39.6264	ZIP	Maryland	Cecil	211 Blue Ball Road	21921
-75.567	39.0695	ZIP	Delaware	Kent	3893 Turkey Point Rd	19980

Program

```
data CUSTOMERS (label="Customer data for geocoding");
   infile datalines dlm='#';
   length address $ 24 city $ 24 state $ 2;
   input address   /* House number and street name */
      zip          /* Customer ZIP code (numeric)  */
      city         /* City name                    */
      state        /* State abbreviation           */;
   cust_ID = _n_;   /* Assign customer ID number    */
datalines;
555 Junk Street # 99999 # Beverly Hills # CA
115 E. Water St # 19901 # Dover #
760 Moose Lodge Road # 19934 # Camden #
200 S. Madison Str # 19801 # Wilmington # DE
4701 Limestone Road # 19808 # Wilmington #
2117 N 4th St # 19363 # Oxford # PA
1313 Mockingbird Lane # . # Delray # CC
133 Silver Lake Dr # 19971 # Rehoboth Beach # DE
11 SE Front Street # 19963 # Milford # DE
402 Nylon Boulevard # . # Seaford # DE
363 E Commerce St # . # Smyrna # DE
5595 Polly Branch Rd # 19975 # Selbyville # DE
1209 Coastal Highway # 19944 # Fenwick Island # DE
2899 Arthursville Rd # 19953 # Hartly # DE
41 Bramhall St # . #  #
9320 Old Racetrack Rd # . # Delmar # DE
281 W Commerce Str # 19955 # Kenton #
211 Blue Ball Road # 21921 # Elkton # MD
3893 Turkey Point Rd # 19980 # Woodside # DE
;
run;

proc geocode method=zip                          /* Geocoding
method        */
             data=customers                      /* Address
data            */
             out=geocoded_customers              /* Output data
set          */
             attributevar=(statename, countynm); /* Include these
variables */
run;

proc print data=geocoded_customers noobs;
   var x y _matched_ statename countynm address zip;
run;
```

Program Description

Generate the input data set of addresses that the GEOCODE procedure uses.

```
data CUSTOMERS (label="Customer data for geocoding");
   infile datalines dlm='#';
   length address $ 24 city $ 24 state $ 2;
```

```
   input address   /* House number and street name */
      zip          /* Customer ZIP code (numeric)  */
      city         /* City name                    */
      state        /* State abbreviation           */;
   cust_ID = _n_;   /* Assign customer ID number    */
datalines;
555 Junk Street # 99999 # Beverly Hills # CA
115 E. Water St # 19901 # Dover #
760 Moose Lodge Road # 19934 # Camden #
200 S. Madison Str # 19801 # Wilmington # DE
4701 Limestone Road # 19808 # Wilmington #
2117 N 4th St # 19363 # Oxford # PA
1313 Mockingbird Lane # . # Delray # CC
133 Silver Lake Dr # 19971 # Rehoboth Beach # DE
11 SE Front Street # 19963 # Milford # DE
402 Nylon Boulevard # . # Seaford # DE
363 E Commerce St # . # Smyrna # DE
5595 Polly Branch Rd # 19975 # Selbyville # DE
1209 Coastal Highway # 19944 # Fenwick Island # DE
2899 Arthursville Rd # 19953 # Hartly # DE
41 Bramhall St # . #  #
9320 Old Racetrack Rd # . # Delmar # DE
281 W Commerce Str # 19955 # Kenton #
211 Blue Ball Road # 21921 # Elkton # MD
3893 Turkey Point Rd # 19980 # Woodside # DE
;
run;
```

Run the GEOCODE procedure with the generated input data set. Include in the output the state name and county name variables.

```
proc geocode method=zip                          /* Geocoding
method        */
             data=customers                      /* Address
data            */
             out=geocoded_customers              /* Output data
set          */
             attributevar=(statename, countynm); /* Include these
variables */
run;
```

Print the specified variable values from the GEOCODED_CUSTOMERS output data set, suppressing the observation column.

```
proc print data=geocoded_customers noobs;
   var x y _matched_ statename countynm address zip;
run;
```

Example 3: Street Geocoding

Features: STREET geocoding method

Procedure Options
- METHOD=
- DATA=

OUT=
LOOKUPSTREET=
TYPE=

Base SAS functions
SAS DATA step
PRINT procedure

Data set: SASHELP.GEOEXM (primary street lookup data set for Wake County in North Carolina)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example illustrates the STREET geocoding method to obtain coordinates based on street addresses with house numbers. Data set SASHELP.GEOEXM is used as the primary street lookup data set. It contains street addresses in Wake County, North Carolina. To look up addresses in other areas, you can use the USM data set.

Note: The USM data set is not installed with SAS. You can download the USM data in CSV form from the SAS Maps and Geocoding, Geocode Data web page at the following URL:

https://support.sas.com/en/knowledge-base/maps-geocoding/geocodes.html

You can find the download link under Street Geocoding. The download package includes a README file, which provides instructions on how to generate the data sets. For more information about street look-up data, see "About Street Lookup Data" on page 191.

Output

The following output from the PRINT procedure shows the default output variables in the WORK.GEOCODED output data set after running the GEOCODE procedure. For detailed explanations of the token values in the _NOTES_ column, see "Street Geocoding Note Values" on page 200.

Output 11.3 *The WORK.GEOCODED Data Set with STREET Method Output Variables*

address	M_ADDR	M_ZIP	M_OBS	_MATCHED_	_STATUS_	_NOTES_	_SCORE_	X	Y
555 Junk Street		.	12691	City	City/State Match	CT ST	10	-118.399	34.0736
305 Cross Lake Drive	305 Cross Lake Dr	27526	5021	Street	Found	AD ZC NM TS CT ST	75	-78.763	35.6041
2525 Banks Road	2525 Banks Rd	27603	1244	Street	Found	AD ZC NM TS CT ST	75	-78.673	35.6369
2222 SAS Campus Drive	698 Sas Campus Dr	27513	16577	Street	Found	AD ZC ENDNM TS CT ST	67	-78.757	35.8259
1150 SE Maynard Rd.	1150 SE Maynard Rd	27511	12069	Street	Found	AD ZC NM DP TS CT ST	90	-78.764	35.7831
2117 Graceland	4400 Graceland Ct	27606	7872	Street	Found	AD ZC ENDNM NOTSA CT ST	37	-78.711	35.7889
1313 Mockingbird Lane		.	.	None			0	.	.
133 Jade Circle	133 Jade Cir	27545	9681	Street	Found	AD ZC NM TS CT ST	75	-78.461	35.8144
1005 W South St	1005 W South St	27603	17410	Street	Found	AD ZC NM DP TS CT ST	90	-78.654	35.7732
622 Roundabout Road	399 Round About Rd	27540	16176	Street	Found	AD ZC ENDNM TS CT ST	67	-78.828	35.6497
Johnson Family Rd		27526	10732	ZIP	ZIP match	ZC	15	-78.784	35.5985
822 Water Plant Road	822 Water Plant Rd	27597	20017	Street	Found	AD CT ST NM TS CT ST	70	-78.340	35.8312
502 Possum Track Road	11800 Possum Track Rd	27614	15015	Street	Found	AD ZC ENDNM TS ST	62	-78.641	35.9457
2590 Wolfpack Lane	Wolfpack Ln	27604	20889	Street	Found	AD ZC NOLNM TS CT ST	65	-78.609	35.8235
125 Ferris Wheel Ct	125 Ferris Wheel Ct	27513	6840	Street	Found	AD ZC NM TS CT ST	75	-78.800	35.7949
3900 Western Blv	3900 Western Blvd	27606	20234	Street	Found	AD ZC NM TS CT ST	75	-78.690	35.7847

Program

```
data WORK.CUSTOMERS (label='Input data for street geocoding');
   infile datalines dlm='#';
   length address $ 32
          city    $ 24
          state   $ 2;
   input address  /* House number and street name      */
         zip      /* Customer ZIP code (numeric)      */
         city     /* City name                        */
         state;   /* Two-character postal abbreviation */
datalines;
555 Junk Street # 99999 # Beverly Hills # CA
305 Cross Lake Drive # 27526 # Fuquay-Varina # NC
2525 Banks Road # 27603 # Raleigh # NC
2222 SAS Campus Drive # 27513 # Cary # NC
1150 SE Maynard Rd. # 27511 # Cary # NC
2117 Graceland # 27606 # Raleigh # NC
1313 Mockingbird Lane # # Delray # CC
```

```
133 Jade Circle # 27545 # Knightdale # NC
1005 W South St # 27603 # Raleigh # NC
622 Roundabout Road # 27540 # Holly Springs # NC
Johnson Family Rd # 27526 # #
822 Water Plant Road # # Zebulon # NC
502 Possum Track Road # 27614 # # NC
2590 Wolfpack Lane # 27604 # Raleigh # NC
125 Ferris Wheel Ct # 27513 # Cary # NC
3900 Western Blv # 27606 # Raleigh # NC
;
run;

/* Create custom street type data set which includes the non-standard
   abbreviation for 'BOULEVARD' used in the input data. */
data work.gctype;
   set sashelp.gctype;
   output;
   /* Insert non-standard type. */
   if _n_ = 1 then do;
      name  = 'BLV';
      type  = 'BLVD';
      group = 34; /* group number must match other 'BLVD' types */
      output;
   end;
run;

/* Sort the custom gctype dataset.*/
proc sort data=work.gctype;
   by name;
run;

proc geocode                    /* Invoke geocoding procedure        */
   method=STREET                /* Specify geocoding method          */
   data=WORK.CUSTOMERS          /* Input data set of addresses       */
   out=WORK.GEOCODED            /* Output data set with X/Y values   */
   lookupstreet=SASHELP.GEOEXM  /* Primary street lookup data set    */
   type=WORK.GCTYPE;            /* Lookup data set-added street type */
run;

/* Add any missing CT and ST tokens to variable _NOTES_. */
data geocoded;
  set geocoded;
  if _matched_='Street' then do;
    if indexw(_notes_,'NOCTM')=0 and city ne '' then
       _notes_=catx(' ',_notes_,"CT");
    if indexw(_notes_,'NOSTM')=0 and state ne '' then
       _notes_=catx(' ',_notes_,"ST");
  end;
run;

proc print data=WORK.GEOCODED noobs;
   var address m_addr m_zip m_obs _matched_ _status_  _notes_ _score_
x y;
run;
```

Program Description

Generate the WORK_CUSTOMERS input data set of addresses that the GEOCODE procedure uses.

```
data WORK.CUSTOMERS (label='Input data for street geocoding');
   infile datalines dlm='#';
   length address $ 32
          city    $ 24
          state   $ 2;
   input address  /* House number and street name      */
         zip      /* Customer ZIP code (numeric)       */
         city     /* City name                         */
         state;   /* Two-character postal abbreviation */
datalines;
555 Junk Street # 99999 # Beverly Hills # CA
305 Cross Lake Drive # 27526 # Fuquay-Varina # NC
2525 Banks Road # 27603 # Raleigh # NC
2222 SAS Campus Drive # 27513 # Cary # NC
1150 SE Maynard Rd. # 27511 # Cary # NC
2117 Graceland # 27606 # Raleigh # NC
1313 Mockingbird Lane # # Delray # CC
133 Jade Circle # 27545 # Knightdale # NC
1005 W South St # 27603 # Raleigh # NC
622 Roundabout Road # 27540 # Holly Springs # NC
Johnson Family Rd # 27526 # #
822 Water Plant Road # # Zebulon # NC
502 Possum Track Road # 27614 # # NC
2590 Wolfpack Lane # 27604 # Raleigh # NC
125 Ferris Wheel Ct # 27513 # Cary # NC
3900 Western Blv # 27606 # Raleigh # NC
;
run;
```

Create a custom street type lookup data set that includes the nonstandard abbreviation (Blv) for Boulevard used in the input data.

```
/* Create custom street type data set which includes the non-standard
   abbreviation for 'BOULEVARD' used in the input data. */
data work.gctype;
   set sashelp.gctype;
   output;
   /* Insert non-standard type. */
   if _n_ = 1 then do;
      name  = 'BLV';
      type  = 'BLVD';
      group = 34; /* group number must match other 'BLVD' types */
      output;
   end;
run;

/* Sort the custom gctype dataset.*/
proc sort data=work.gctype;
   by name;
run;
```

Run the GEOCODE procedure with the generated input data set. Data set SASHELP.GEOEXM provides the street look-up data. To look up addresses in other areas, use the USM data set in option LOOKUPSTREET= instead. See "About Street Lookup Data" on page 191.

```
proc geocode                    /* Invoke geocoding procedure        */
   method=STREET                /* Specify geocoding method          */
   data=WORK.CUSTOMERS          /* Input data set of addresses       */
   out=WORK.GEOCODED            /* Output data set with X/Y values   */
   lookupstreet=SASHELP.GEOEXM  /* Primary street lookup data set    */
   type=WORK.GCTYPE;            /* Lookup data set-added street type */
run;
```

Add any missing CT and ST tokens to the output data. In some cases, CT and ST tokens might be missing in the _NOTES_ variable values. In those cases, the score that is calculated by the GEOCODE procedure does not match the sum of the token scores that are listed in Table 11.21 on page 200. See "Missing CT and ST Tokens in the Output Data" on page 204 for more information. In this example, the CT and ST tokens are missing in variable _NOTES_ in the majority of the observations in data set WORK.GEOCODED. To correct this issue, the DATA step adds the missing CT and ST tokens to the _NOTES_ variable in data set WORK.GEOCODED.

```
/* Add any missing CT and ST tokens to variable _NOTES_. */
data geocoded;
  set geocoded;
  if _matched_='Street' then do;
    if indexw(_notes_,'NOCTM')=0 and city ne '' then
       _notes_=catx(' ',_notes_,"CT");
    if indexw(_notes_,'NOSTM')=0 and state ne '' then
       _notes_=catx(' ',_notes_,"ST");
  end;
run;
```

Print the specified variable values from the WORK_GEOCODED output data set, suppressing the observation column.

```
proc print data=WORK.GEOCODED noobs;
   var address m_addr m_zip m_obs _matched_ _status_  _notes_ _score_
x y;
run;
```

Example 4: U.S. City Geocoding

Features: CITY geocoding method

Procedure Options
- METHOD=
- DATA=
- OUT=

Base SAS functions
- SAS DATA step
- PRINT procedure

Data set: mapsgfk.uscity_all (lookup data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example illustrates the CITY geocoding method to obtain coordinates based on a United States city and state.

There is no need to use the ADDRESSCOUNTRYVAR= option because all of the cities to be geocoded are located in the United States. The LOOKUPCITY= option is absent, which indicates that no alternate lookup data set is specified. In these circumstances, the GEOCODE procedure uses the default MAPSGFK.USCITY_ALL lookup data set for CITY geocoding within the United States.

Output

The following output from the PRINT procedure shows the output data set after running the GEOCODE procedure.

The output data set contains the LAT and LONG variables from the default lookup data set (MAPSGFK.USCITY_ALL).

Output 11.4 *The GEOCODED_TRAINING Output Data Set*

LAT	LONG	M_OBS	_MATCHED_	city	state
33.749	-84.388	26683	City	Atlanta	GA
40.681	-74.646	80840	City	Bedminster	NJ
35.791	-78.781	93296	City	Cary	NC
41.850	-87.650	32127	City	Chicago	IL
39.759	-84.192	98041	City	Dayton	OH
41.601	-93.609	40738	City	Des Moines	IA
42.331	-83.046	65253	City	Detroit	MI
41.764	-72.686	18450	City	Hartford	CT
25.774	-80.194	22713	City	Miami	FL
42.595	-71.017	60920	City	Middleton	MA
44.980	-93.264	66068	City	Minneapolis	MN
40.714	-74.006	85525	City	New York	NY
38.982	-94.671	42031	City	Overland Park	KS
39.952	-75.164	110514	City	Philadelphia	PA
33.448	-112.073	6593	City	Phoenix	AZ
29.424	-98.493	124161	City	San Antonio	TX
37.775	-122.418	14978	City	San Francisco	CA
47.606	-122.331	143443	City	Seattle	WA

Program

```
data training (label='Selected SAS training locations in USA');
   infile datalines dlm=',';
```

```
   length city   $ 24
          state  $ 2;
   input  city   /* City name                          */
          state; /* Two-character postal abbreviation */
datalines;
Atlanta, GA
Bedminster, NJ
Cary, NC
Chicago, IL
Dayton, OH
Des Moines, IA
Detroit, MI
Hartford, CT
Miami, FL
Middleton, MA
Minneapolis, MN
New York, NY
Overland Park, KS
Philadelphia, PA
Phoenix, AZ
San Antonio, TX
San Francisco, CA
Seattle, WA
;
run;

proc geocode
   method=city               /* Specify geocoding method       */
   data=training             /* Input data set of cities       */
   out=geocoded_training;    /* Output data set with locations */
run;

proc print data=geocoded_training noobs;
run;
```

Program Description

Generate the TRAINING input data set that the GEOCODE procedure uses.

```
data training (label='Selected SAS training locations in USA');
   infile datalines dlm=',';
   length city   $ 24
          state  $ 2;
   input  city   /* City name                          */
          state; /* Two-character postal abbreviation */
datalines;
Atlanta, GA
Bedminster, NJ
Cary, NC
Chicago, IL
Dayton, OH
Des Moines, IA
Detroit, MI
Hartford, CT
Miami, FL
```

```
Middleton, MA
Minneapolis, MN
New York, NY
Overland Park, KS
Philadelphia, PA
Phoenix, AZ
San Antonio, TX
San Francisco, CA
Seattle, WA
;
run;
```

Run the GEOCODE procedure with the generated TRAINING input data set. Specify the CITY method to add the latitude and longitude geographic coordinate values from the lookup data set to the addresses in the input data set. Those values are placed in the GEOCODED_TRAINING data set. The default lookup data set is MAPSGFK.USCITY_ALL.

```
proc geocode
   method=city              /* Specify geocoding method       */
   data=training            /* Input data set of cities       */
   out=geocoded_training;   /* Output data set with locations */
run;
```

Print the entire GEOCODED_TRAINING output data set, suppressing the observation column.

```
proc print data=geocoded_training noobs;
run;
```

Example 5: World City Geocoding

Features: CITY geocoding method

Procedure options
- METHOD=
- DATA=
- OUT=
- ADDRESSCITYVAR=
- ADDRESSCOUNTRYVAR=
- ADDRESSSTATEVAR=PROVINCE
- ATTRIBUTEVAR=

Base SAS functions
- SAS DATA step
- PRINT procedure

Data set: MAPSGFK.WORLD_CITIES.

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example illustrates the CITY geocoding method to obtain coordinates of various international cities.

Output

The following output from the PRINT procedure shows the output data set after running the GEOCODE procedure.

The first two observations of the same city (Bella Vista, Argentina) illustrate how the variable named ADDRESSSTATEVAR is used. Note in the GEOCODED_CITIES output that the LAT and LONG values for the first Bella Vista observation are missing. There are two cities named Bella Vista in Argentina, but they are in different provinces. The first observation in the input data has a missing value for the PROVINCE variable, so the GEOCODE procedure cannot determine which of the matching cities to select. The _MATCHED_ value of '2 cities' shows the number of cities that were found. The second Bella Vista observation has a definite match and contains valid LAT and LONG coordinate variable values from the lookup data set. The GEOCODE procedure uses the province name 'Corrientes' in the input data to determine which of the two matching cities in the lookup data set was wanted.

Output 11.5 *The GEOCODED_CITIES Output Data Set with CITY Method Variables*

LAT	LONG	ISONAME	MAPIDNAME1	M_OBS	_MATCHED_	city	province	countryID
.	.			.	2 cities	Bella Vista		ARG
-28.517	-59.033	Argentina	Corrientes	430	City	Bella Vista	Corrientes	ARG
-34.929	138.598	Australia	South Australia	868	City	Adelaide		AUS
46.813	-71.220	Canada	Quebec	5512	City	Quebec	Quebec	CAN
31.238	121.469	China	Shanghai Shi	7189	City	Shanghai		CHN
56.027	9.926	Denmark	Region Midtjylland	8832	City	Skanderborg		DNK
41.402	2.164	Spain	Cataluna	9586	City	Barcelona		ESP
59.421	24.709	Estonia	Harju maakond	9315	City	Tallinn		EST
55.859	-4.244	United Kingdom	Glasgow City	11558	City	Glasgow		GBR
18.515	73.859	India	Maharashtra	15941	City	Pune		IND
53.349	-6.271	Ireland	Leinster	13444	City	Dublin		IRL
37.535	126.981	Korea, Republic of	Seoul	19535	City	Seoul		KOR
49.611	6.130	Luxembourg	Luxembourg	19951	City	Luxembourg		LUX
54.689	25.290	Lithuania	Vilniaus apskr.	19946	City	Vilnius		LTU
25.662	-100.406	Mexico	Nuevo Leon	20812	City	Garza Garcia		MEX
48.154	17.126	Slovakia	Bratislavsky kraj	25868	City	Bratislava		SVK
59.325	18.073	Sweden	Stockholms lan	25805	City	Stockholm		SWE
13.731	100.521	Thailand	Bangkok	26356	City	Bangkok		THA
29.763	-95.363	United States	Texas	29623	City	Houston	Texas	USA
-26.205	28.050	South Africa	Gauteng	32247	City	Johannesburg		ZAF

Program

```
data cities (label='International cities');
   infile datalines dlm=',';
   length city $32 province $24 countryID $3;
   input city        /* City name                    */
         province    /* State/province/district name */
         countryID;  /* Three-character country code */
```

```
datalines;
Bella Vista, , ARG
Bella Vista, Corrientes, ARG
Adelaide, , AUS
Quebec, Quebec, CAN
Shanghai, , CHN
Skanderborg, , DNK
Barcelona, , ESP
Tallinn, , EST
Glasgow, , GBR
Pune, , IND
Dublin, , IRL
Seoul, , KOR
Luxembourg, , LUX
Vilnius, , LTU
Garza Garcia, , MEX
Bratislava, , SVK
Stockholm, , SWE
Bangkok, , THA
Houston, Texas, USA
Johannesburg, , ZAF
;
run;

proc geocode                              /* Invoke geocoding
procedure            */
   method=city                            /* Specify geocoding
method              */
   data=cities                            /* Input data set of
cities              */
   out=geocoded_cities                    /* Output data set of
locations          */
   addresscityvar=city                    /* City
name                              */
   addresscountryvar=countryID            /* Required for international
geocoding  */
   addressstatevar=province               /* Optional state/province/
district name */
   attributevar=(isoname mapidname1);  /* Values to assign to geocoded
cities   */
run;

proc print data=geocoded_cities noobs;
run;
```

Program Description

This example produces an output data set listing coordinates for various international cities. Because the LOOKUPCITY= data set option is omitted, the GEOCODE procedure uses the default GfK GeoMarketing world lookup data set MAPSGFK.WORLD_CITIES. This data set is an abridged version of world cities. If the more complete version (MAPSGFK.WORLD_CITIES_ALL) is downloaded from the SAS Maps and Geocoding website, use the LOOKUPCITY= option in PROC GEOCODE to reference it. The ADDRESSSTATEVAR=PROVINCE option is used to

specify the input data set variable containing a city's corresponding state, province, or district value.

Generate the CITIES input data set that the GEOCODE procedure uses.

```
data cities (label='International cities');
   infile datalines dlm=',';
   length city $32 province $24 countryID $3;
   input city        /* City name                    */
         province    /* State/province/district name */
         countryID;  /* Three-character country code */
datalines;
Bella Vista, , ARG
Bella Vista, Corrientes, ARG
Adelaide, , AUS
Quebec, Quebec, CAN
Shanghai, , CHN
Skanderborg, , DNK
Barcelona, , ESP
Tallinn, , EST
Glasgow, , GBR
Pune, , IND
Dublin, , IRL
Seoul, , KOR
Luxembourg, , LUX
Vilnius, , LTU
Garza Garcia, , MEX
Bratislava, , SVK
Stockholm, , SWE
Bangkok, , THA
Houston, Texas, USA
Johannesburg, , ZAF
;
run;
```

Run the GEOCODE procedure with the generated CITIES input data set. Specify that GEOCODE use the city method. When geocoding international cities, you are required to use the ADDRESSCOUNTRYVAR= option to indicate that the cities are not all within the United States. Because the LOOKUPCITY= data set option is omitted, the GEOCODE procedure uses the default world lookup data set MAPSGFK.WORLD_CITIES. The procedure produces the GEOCODED_CITIES output data set. The output data set contains the LAT and LONG coordinate variables from the lookup data set.

```
proc geocode                          /* Invoke geocoding
procedure            */
   method=city                        /* Specify geocoding
method              */
   data=cities                        /* Input data set of
cities              */
   out=geocoded_cities                /* Output data set of
locations          */
   addresscityvar=city                /* City
name                              */
   addresscountryvar=countryID        /* Required for international
geocoding  */
```

```
   addressstatevar=province            /* Optional state/province/
district name */
   attributevar=(isoname mapidname1);  /* Values to assign to geocoded
cities   */
run;
```

Print the entire GEOCODED_CITIES output data set, suppressing the observation column.

```
proc print data=geocoded_cities noobs;
run;
```

Example 6: ZIP+4 Geocoding

Features: PLUS4 geocoding method

Procedure Options
- METHOD=
- LOOKUP=
- DATA=
- OUT=

Base SAS functions
- SAS DATA step
- PRINT procedure

Data set: lookup.zip4 (from SAS Maps and Geocoding website)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example illustrates the PLUS4 geocoding method using US Postal Service ZIP and ZIP+4 postal codes. Lookup data can be downloaded from the SAS Geocode Data — Street Geocoding website. You can also purchase from Melissa Data the Geo*Data product containing ZIP+4 centroids (https://www.melissa.com/geodata-reference-data-sets).

Output

The following output from the PRINT procedure shows the GEOCODED_CUSTOMERS output data set after running the GEOCODE procedure.

The example output shows four results for the customer names and addresses submitted as input. These include the location coordinates (X, Y), the matching observation's (row) number from the lookup data set (M_OBS), and the method with which GEOCODE made the match.

The _MATCHED_ column value in the output data set indicates how each address was located:

ZIP+4 - The ZIP and ZIP+4 values were matched. The location is the center of the street segment.

ZIP mean - The ZIP+4 value was not matched and the GEOCODE procedure used the ZIP method where multiple ZIP code matches were averaged.

ZIP - The ZIP+4 value was not matched and the GEOCODE procedure used the ZIP method where a single ZIP code match was found.

City - Neither the ZIP+4 nor the ZIP code were found but the CITY method returned a match.

Output 11.6 *The GEOCODED_CUSTOMERS Output Data Set with PLUS4 Method Variables*

Y	X	M_OBS	_MATCHED_	name	city	state	zip	plus4
35.7472	-78.6747	3615346	ZIP+4	J. Cheever Loophole	Raleigh	NC	27603	2681
29.7709	-95.7551	13324415	ZIP+4	Cuthbert J. Twillie	Katy	TX	77450	3418
39.7424	-75.6931	2556375	ZIP+4	Kaspar Gutman	Wilmington	DE	19808	1927
39.7809	-75.9782	2482823	ZIP+4	Dr. Hugo Z. Hackenbush	Oxford	PA	19363	1735
35.1728	-78.0432	.	ZIP mean	Charlie Allnut	Mount Olive	NC	28365	2277
38.9124	-75.4265	2574841	ZIP+4	Larson E. Whipsnade	Milford	DE	19963	1941
27.4986	-82.5750	22455	City	Guillermo Ugarte	Bradenton	FL	.	2208
38.4644	-75.2211	2579981	ZIP+4	Capt. Geoffrey Spaulding	Selbyville	DE	19975	7504
38.4619	-75.0534	.	ZIP mean	Joel Cairo	Fenwick Island	DE	19944	4401
39.1706	-75.7132	2571896	ZIP+4	Charles Blutoski	Hartly	DE	19953	3141
29.9972	-98.0983	127051	City	Rufus T. Firefly	Wimberley	TX	.	.
39.2282	-75.6658	2572140	ZIP	Otis B. Driftwood	Kenton		19955	53
39.6120	-75.8452	2888589	ZIP+4	Gordon Miller	Elkton	MD	21921	5335

Program

```
libname lookup 'lookup-file-path';

data customers;
   infile datalines dlm=',';
   length name city $32 state $2;
   input name      /* Customer name      */
         zip       /* Customer ZIP code  */
         plus4     /* ZIP+4              */
         city      /* City name          */
         state;    /* State abbreviation */
datalines;
J. Cheever Loophole, 27603, 2681, Raleigh, NC
Cuthbert J. Twillie, 77450, 3418, Katy, TX
Kaspar Gutman, 19808, 1927, Wilmington, DE
Dr. Hugo Z. Hackenbush, 19363, 1735, Oxford, PA
Charlie Allnut, 28365, 2277, Mount Olive, NC
Larson E. Whipsnade, 19963, 1941, Milford, DE
Guillermo Ugarte, ., 2208, Bradenton, FL
Capt. Geoffrey Spaulding, 19975, 7504, Selbyville, DE
Joel Cairo, 19944, 4401, Fenwick Island, DE
Charles Blutoski, 19953, 3141, Hartly, DE
Rufus T. Firefly, ., ., Wimberley, TX
Otis B. Driftwood, 19955, 53, Kenton, ,
```

```
Gordon Miller, 21921, 5335, Elkton, MD
;
run;

proc geocode                /* Invoke geocoding procedure  */
   method=plus4             /* Specify geocoding method    */
   lookup=lookup.zip4       /* Lookup data from MapsOnline */
   data=customers           /* Input data set to geocode   */
   out=geocoded_customers;  /* Specify name of Output data set of
locations */
run;

proc print data=geocoded_customers noobs;
run;
```

Program Description

The LIBNAME statement assigns the library name LOOKUP to the location where the ZIP+4 lookup data is installed. You must edit the '*lookup-file-path*' in the following LIBNAME statement to reference the lookup data location path designated by your installation. *File-path* must be a path that is accessible to the SAS Compute Server.

```
libname lookup 'lookup-file-path';
```

Generate the CUSTOMERS input data set of names and addresses for the GEOCODE procedure to use.

```
data customers;
   infile datalines dlm=',';
   length name city $32 state $2;
   input name      /* Customer name      */
         zip       /* Customer ZIP code  */
         plus4     /* ZIP+4              */
         city      /* City name          */
         state;    /* State abbreviation */
datalines;
J. Cheever Loophole, 27603, 2681, Raleigh, NC
Cuthbert J. Twillie, 77450, 3418, Katy, TX
Kaspar Gutman, 19808, 1927, Wilmington, DE
Dr. Hugo Z. Hackenbush, 19363, 1735, Oxford, PA
Charlie Allnut, 28365, 2277, Mount Olive, NC
Larson E. Whipsnade, 19963, 1941, Milford, DE
Guillermo Ugarte, ., 2208, Bradenton, FL
Capt. Geoffrey Spaulding, 19975, 7504, Selbyville, DE
Joel Cairo, 19944, 4401, Fenwick Island, DE
Charles Blutoski, 19953, 3141, Hartly, DE
Rufus T. Firefly, ., ., Wimberley, TX
Otis B. Driftwood, 19955, 53, Kenton, ,
Gordon Miller, 21921, 5335, Elkton, MD
;
run;
```

Run the GEOCODE procedure with the generated CUSTOMERS input data set. Specify that GEOCODE use the PLUS4 method to look up each address.

```
proc geocode                /* Invoke geocoding procedure  */
   method=plus4             /* Specify geocoding method    */
   lookup=lookup.zip4       /* Lookup data from MapsOnline */
   data=customers           /* Input data set to geocode   */
   out=geocoded_customers;  /* Specify name of Output data set of
locations */
run;
```

Print the entire GEOCODED_CUSTOMERS output data set, suppressing the observation column.

```
proc print data=geocoded_customers noobs;
run;
```

Example 7: British Postcode Geocoding

Features: ZIP geocoding method

Procedure Options
- METHOD=
- DATA=
- OUT=
- LOOKUP=
- ADDRESSZIPVAR=
- LOOKUPZIPVAR=
- LOOKUPLONGVAR=
- LOOKUPLATVAR=
- ATTRIBUTEVAR=

Base SAS functions
- SAS DATA step
- PRINT procedure

Data set: lookup.postcodes (Postcode lookup data from SAS Maps and Geocoding website)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example illustrates the ZIP geocoding method using British Royal Mail postcodes. Free lookup data can be downloaded from the British Ordnance Survey. Use the %CODEPOINT2GEOCODE SAS macro program to import the British postcode data. You can download this macro program from the SAS Geocode Data — Street Geocoding website. Instructions for downloading and importing the British Royal Mail postcodes are included with the %CODEPOINT2GEOCODE macro program. See "Non-U.S. Postcodes" on page 219 for details.

Output

The following output from the PRINT procedure shows the GEOCODED_OFFICES output data set after running the GEOCODE procedure.

Output 11.7 *The GEOCODED_OFFICES Output Data Set with ZIP Method Variables*

Y	X	Y_DMS	X_DMS	M_OBS	_MATCHED_	name	city	postcode	country
53.4704	-2.29431	53° 28' 13.43"	-2° 17' 39.51"	891003	ZIP	Quay Plaza	Manchester	M503BA	UK
51.5573	-0.81687	51° 33' 26.46"	00° 49' 00.73"	1379676	ZIP	Wittington House	Buckinghamshire	SL72EB	UK
55.8639	-4.25513	55° 51' 49.91"	-4° 15' 18.48"	543273	ZIP	Tara House	Glasgow	G21HG	UK
51.5169	-0.08380	51° 31' 01.02"	00° 05' 01.70"	467752	ZIP	New Broad Street	London	EC2M1NH	UK

Program

```
libname lookup 'lookup-file-path';

data offices;
  infile datalines dlm=',';
  length name city $24 postcode $8 country $2;
  input name                          /* Office name              */
        city                          /* Name of city             */
        postcode                      /* Royal Mail postcode      */
        country;                      /* Two-character country ID */
  postcode=upcase(compress(postcode)); /* Normalize postcodes      */
datalines;
Quay Plaza, Manchester, M50 3BA, UK
Wittington House, Buckinghamshire, SL7 2EB, UK
Tara House, Glasgow, G2 1HG, UK
New Broad Street, London, EC2M 1NH, UK
;
run;

proc geocode               /* Invoke geocoding procedure            */
   method=zip              /* Specify geocoding method              */
   data=work.offices       /* Input data set of offices             */
   out=geocoded_offices    /* Output data set of locations          */
   lookup=lookup.postcodes /* Postcode lookup data from MapsOnline  */
   addresszipvar=postcode  /* Postcode variable in input data       */
   lookupzipvar=pc         /* Postcode variable in lookup data      */
   attributevar=(Y_dms     /* Additional variables from lookup data */
                 X_dms);   /* set to assign to geocoded locations   */
run;

proc print data=geocoded_offices noobs;
run;
```

Program Description

The LIBNAME statement assigns the library name LOOKUP to the location where the postcodes lookup data set is installed. This is the lookup data imported from the Ordnance Survey by the %CODEPOINT2GEOCODE macro program. You must edit the '*lookup-file-path*' in the following LIBNAME statement to reference the Brititsh postcode lookup data location path designated by your installation. *File-path* must be a path that is accessible to the SAS Compute Server.

```
libname lookup 'lookup-file-path';
```

Generate the OFFICES input data set of addresses that the GEOCODE procedure uses. Each variable is delimited by a comma. Maximum variable lengths are specified. An important step is to remove spaces and capitalize the postcode values.

```
data offices;
  infile datalines dlm=',';
  length name city $24 postcode $8 country $2;
  input name                          /* Office name              */
        city                          /* Name of city             */
        postcode                      /* Royal Mail postcode      */
        country;                      /* Two-character country ID */
  postcode=upcase(compress(postcode)); /* Normalize postcodes      */
datalines;
Quay Plaza, Manchester, M50 3BA, UK
Wittington House, Buckinghamshire, SL7 2EB, UK
Tara House, Glasgow, G2 1HG, UK
New Broad Street, London, EC2M 1NH, UK
;
run;
```

Run the GEOCODE procedure with the generated OFFICES input data set located in the WORK folder. The GEOCODE procedure uses the postcode from each address in the input data to match observations in the lookup data set.

```
proc geocode               /* Invoke geocoding procedure            */
   method=zip              /* Specify geocoding method              */
   data=work.offices       /* Input data set of offices             */
   out=geocoded_offices    /* Output data set of locations          */
   lookup=lookup.postcodes /* Postcode lookup data from MapsOnline  */
   addresszipvar=postcode  /* Postcode variable in input data       */
   lookupzipvar=pc         /* Postcode variable in lookup data      */
   attributevar=(Y_dms     /* Additional variables from lookup data */
                 X_dms);   /* set to assign to geocoded locations   */
run;
```

Print the entire GEOCODED_OFFICES output data set, suppressing the observation column.

```
proc print data=geocoded_offices noobs;
run;
```

Example 8: Australian Postcode Geocoding

Features:

ZIP geocoding method

Procedure Options

- METHOD=
- DATA=
- OUT=
- LOOKUP=
- ADDRESSZIPVAR=
- LOOKUPZIPVAR=

Base SAS functions

SAS DATA step
PRINT procedure

Data set: lookup.postcodes (Postcode lookup data from SAS Maps and Geocoding website)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example illustrates the ZIP geocoding method using Australian postcodes. Free lookup data can be downloaded from the Australian Bureau of Statistics. Use the %ABS2GEOCODE SAS macro program to import the Australian postcode data. You can download this macro program from the SAS Geocode Data — Street Geocoding website. Instructions for downloading and importing the Australian postcodes are included with the %ABS2GEOCODE macro program. See "Non-U.S. Postcodes" on page 219 for details.

Output

The following output from the PRINT procedure shows the GEOCODED_STADIUMS output data set after running the GEOCODE procedure.

Output 11.8 *The GEOCODED_STADIUIMS Output Data Set with ZIP Method Variables*

y	x	M_OBS	_MATCHED_	team	stadium	city	state	postcode
-33.8393	151.067	136	ZIP	South Sydney Rabbitohs	ANZ Stadium	Sydney	New South Wales	2127
-33.8915	151.229	43	ZIP	Sydney Roosters	Sydney Football Stadium	Moore Park	New South Wales	2021
-33.8393	151.067	136	ZIP	Canterbury Bulldogs	ANZ Stadium	Sydney	New South Wales	2127
-33.8152	151.008	158	ZIP	Parramatta Eels	Parramatta Stadium	Sydney	New South Wales	2150
-33.7462	151.256	111	ZIP	Manly-Warringah Sea Eagles	Brookvale Oval	Brookvale	New South Wales	2100
-34.0647	151.151	224	ZIP	Cronulla-Sutherland Sharks	Toyota Park	Woolooware	New South Wales	2230
-33.7508	150.679	557	ZIP	Penrith Panthers	Centrebet Stadium	Penrith	New South Wales	2750
-35.2284	149.092	475	ZIP	Canberra Raiders	Canberra Stadium	Bruce	Australian Capital Territory	2617
-27.4645	153.000	1360	ZIP	Brisbane Broncos	Suncorp Stadium	Milton	Queensland	4064
-32.9208	151.736	254	ZIP	Newcastle Knights	Hunter Stadium	New Castle	New South Wales	2292
-19.4336	146.212	1704	ZIP	North Queensland Cowboys	Dairy Farmers Stadium	Townsville	Queensland	4817
-37.8114	144.965	661	ZIP	Melbourne Storm	AAMI Park	Melbourne	Victoria	3000
-33.9717	151.141	211	ZIP	St. George Illawarra Dragons	WIN Jubilee Oval	Carlton	New South Wales	2217
-34.1461	150.802	433	ZIP	Wests Tigers	Campbelltown Stadium	Leumeah	New South Wales	2560
-33.8760	151.159	62	ZIP	Wests Tigers	Leichhardt Oval	Leichhardt	New South Wales	2040
-33.8915	151.229	43	ZIP	Wests Tigers	Sydney Football Stadium	Sydney	New South Wales	2021
-28.0626	153.389	1449	ZIP	Gold Coast Titans	Skilled Park	Gold Coast	Queensland	4226

Program

```
libname lookup 'lookup-file-path';

data stadiums (label='Australian National Rugby League (NRL)
stadiums');
   infile datalines dlm=',';
   length team $32 stadium $32 city $ 24 state $32 postcode $4;
   input team        /* NRL team name    */
         stadium     /* Stadium name     */
```

```
        city        /* City name        */
        state       /* State name       */
        postcode;   /* Stadium postcode */
datalines;
South Sydney Rabbitohs, ANZ Stadium, Sydney, New South Wales, 2127
Sydney Roosters, Sydney Football Stadium, Moore Park, New South Wales,
2021
Canterbury Bulldogs, ANZ Stadium, Sydney, New South Wales, 2127
Parramatta Eels, Parramatta Stadium, Sydney, New South Wales, 2150
Manly-Warringah Sea Eagles, Brookvale Oval, Brookvale, New South
Wales, 2100
Cronulla-Sutherland Sharks, Toyota Park, Woolooware, New South Wales,
2230
Penrith Panthers, Centrebet Stadium, Penrith, New South Wales, 2750
Canberra Raiders, Canberra Stadium, Bruce, Australian Capital
Territory, 2617
Brisbane Broncos, Suncorp Stadium, Milton, Queensland, 4064
Newcastle Knights, Hunter Stadium, New Castle, New South Wales, 2292
North Queensland Cowboys, Dairy Farmers Stadium, Townsville,
Queensland, 4817
Melbourne Storm, AAMI Park, Melbourne, Victoria, 3000
St. George Illawarra Dragons, WIN Jubilee Oval, Carlton, New South
Wales, 2217
Wests Tigers, Campbelltown Stadium, Leumeah, New South Wales, 2560
Wests Tigers, Leichhardt Oval, Leichhardt, New South Wales, 2040
Wests Tigers, Sydney Football Stadium, Sydney, New South Wales, 2021
Gold Coast Titans, Skilled Park, Gold Coast, Queensland, 4226
;
run;

proc geocode               /* Invoke geocoding procedure       */
   method=zip              /* Specify geocoding method         */
   data=stadiums           /* Input data of stadiums           */
   out=geocoded_stadiums   /* Output data set of locations     */
   lookup=lookup.postcodes /* Lookup data with postcodes       */
   addresszipvar=postcode  /* Postcode variable in input data  */
   lookupzipvar=poa_code;  /* Postcode variable in lookup data */
run;

proc print data=geocoded_stadiums noobs;
run;
```

Program Description

The LIBNAME statement assigns the library name LOOKUP to the location where the Australian postcode lookup data set is installed. This is the lookup data imported from the Australian Bureau of Statistics by the %ABS2GEOCODE macro program. You must edit the '*lookup-file-path*' in the following LIBNAME statement to reference the Australian postcode lookup data location path designated by your installation.

```
libname lookup 'lookup-file-path';
```

Generate the STADIUMS input data set of names and addresses that the GEOCODE procedure uses. Each variable is delimited by a comma. Maximum variable lengths are specified.

```
data stadiums (label='Australian National Rugby League (NRL)
stadiums');
   infile datalines dlm=',';
   length team $32 stadium $32 city $ 24 state $32 postcode $4;
   input team        /* NRL team name    */
         stadium     /* Stadium name     */
         city        /* City name        */
         state       /* State name       */
         postcode;   /* Stadium postcode */
datalines;
South Sydney Rabbitohs, ANZ Stadium, Sydney, New South Wales, 2127
Sydney Roosters, Sydney Football Stadium, Moore Park, New South Wales,
2021
Canterbury Bulldogs, ANZ Stadium, Sydney, New South Wales, 2127
Parramatta Eels, Parramatta Stadium, Sydney, New South Wales, 2150
Manly-Warringah Sea Eagles, Brookvale Oval, Brookvale, New South
Wales, 2100
Cronulla-Sutherland Sharks, Toyota Park, Woolooware, New South Wales,
2230
Penrith Panthers, Centrebet Stadium, Penrith, New South Wales, 2750
Canberra Raiders, Canberra Stadium, Bruce, Australian Capital
Territory, 2617
Brisbane Broncos, Suncorp Stadium, Milton, Queensland, 4064
Newcastle Knights, Hunter Stadium, New Castle, New South Wales, 2292
North Queensland Cowboys, Dairy Farmers Stadium, Townsville,
Queensland, 4817
Melbourne Storm, AAMI Park, Melbourne, Victoria, 3000
St. George Illawarra Dragons, WIN Jubilee Oval, Carlton, New South
Wales, 2217
Wests Tigers, Campbelltown Stadium, Leumeah, New South Wales, 2560
Wests Tigers, Leichhardt Oval, Leichhardt, New South Wales, 2040
Wests Tigers, Sydney Football Stadium, Sydney, New South Wales, 2021
Gold Coast Titans, Skilled Park, Gold Coast, Queensland, 4226
;
run;
```

Run the GEOCODE procedure with the generated STADIUMS input data set. Specify that GEOCODE use the ZIP method to look up each stadium address. The input data contains address information about Australian National Rugby League stadiums. The GEOCODE procedure uses the postcode from each address in the input data to match observations in the lookup data set.

```
proc geocode                /* Invoke geocoding procedure       */
   method=zip               /* Specify geocoding method         */
   data=stadiums            /* Input data of stadiums           */
   out=geocoded_stadiums    /* Output data set of locations     */
   lookup=lookup.postcodes /* Lookup data with postcodes       */
   addresszipvar=postcode   /* Postcode variable in input data  */
   lookupzipvar=poa_code;   /* Postcode variable in lookup data */
run;
```

Print the entire GEOCODED_STADIUMS output data set, suppressing the observation column.

```
proc print data=geocoded_stadiums noobs;
run;
```

12

GINSIDE Procedure

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Overview: GINSIDE Procedure

What Does the GINSIDE Procedure Do?

The GINSIDE procedure can be used without having SAS/GRAPH installed.

The GINSIDE procedure compares a data set of X and Y coordinates to a map data set containing map polygons. The procedure determines whether the X and Y coordinates for each point fall inside or outside of the map polygons. If the point falls inside a polygon, then the ID variable is set to the ID value of that polygon. For example, if a map contains states, then the ID variable of the output data set is set to the state that contains the point. The GINSIDE procedure can be used with the SAS/GRAPH map data sets.

Note: Avoid unpredictable map results with points that fall on the border of a polygon by using the INCLUDEBORDER option. This option includes points that are on the border of a polygon in the output data set. These points are identified by the variable named _ONBORDER_ with a value of 1.

To run this procedure, the various data sets and essential SAS software must be available in your installation. Storage restrictions apply to map data sets that are used with the SGMAP procedure's CHOROMAP or SERIES statement and to geocoding lookup data sets. Because the map data sets contain sequential polygonal data, storing the mapping data on a distributed system such as aTeradata server, a SAS® LASR™ Analytic Server, or a SAS Cloud Analytic Services (CAS) server is not recommended. Data sequence cannot be guaranteed on distributed systems such as these, which can cause unexpected results. If the criterion is met, you can copy the procedure examples provided in this chapter into your program editor and run them to create the required output. Your IDE might provide additional resources for creating maps. Refer to the documentation for your IDE for more information.

Syntax: GINSIDE Procedure

Requirement: The following input data must be provided:

- One DATA= argument if no points data set was created before issuing the PROC GINSIDE statement
- One MAP= argument
- One ID statement

```
PROC GINSIDE
DATA=points-data-set
MAP=map-data-set
<option(s)>;
   ID id-variable(s);
```

PROC GINSIDE Statement

The GINSIDE procedure compares a data set of X and Y coordinates to a map data set containing map polygons. The procedure determines whether the X and Y points fall inside or outside of the map polygons.

Requirement: Three data sets are required: a data set containing points, a map data set, and an output data set.

Syntax

PROC GINSIDE
DATA=*points-data-set*
MAP=*map-data-set*
<OUT=*output-data-set* >
<DROPMAPVARS>
<INSIDEONLY>
<INCLUDEBORDER>
<KEEPMAPVARS>;

Summary of Optional Arguments

DROPMAPVARS
: specifies that the GINSIDE procedure should keep the ID variable but drop all of the other map data set variables when writing to the output data set.

INCLUDEBORDER
: includes points that are on the border of a polygon in the output data set.

INSIDEONLY
: causes the output data set to contain only points that are inside the map polygons.

KEEPMAPVARS
: specifies that the GINSIDE procedure should include all of the map data set variable names in the output data set.

OUT=*output-data-set*
: specifies the output data set for the GINSIDE procedure.

Required Arguments

DATA=*points-data-set*
specifies an input data set that contains the X and Y coordinates of the individual points that are being compared to the map polygons.

Default
: By default, the procedure uses the most recently created SAS data set.

Restriction
: This statement is required if no points data set was created before issuing the PROC GINSIDE statement.

Note
: If this data set contains the same ID variable (or variables) as does the map data set, the value should be set to MISSING. In this case the points are not considered to be part of the boundary of the polygon. Alternatively, you can rename the ID variable in the points data set, provided that it represents a different value than that of the ID variable in the map data set.

MAP=*map-data-set*
specifies the map data set that contains the polygons that you want to compare the points in the input data set to. This data must conform to the rules for a map data set and contain variables X and Y and one or more ID variables. The ID statement should name that variable or variables.

Restriction The X and Y values in the input data set must be in the same projection system and units as the X and Y in the map data set. If the map data set has unprojected X and Y values in radians, then the point data set X and Y variable values must also be unprojected and in radians.

Optional Arguments

DROPMAPVARS
specifies that the GINSIDE procedure should keep the ID variable but drop all of the other map data set variables when writing to the output data set. The GINSIDE procedure writes to the output data set all variables associated with each point whose X and Y coordinates fall inside the map polygon. Use the DROPMAPVARS option to circumvent this default behavior.

Alias DMV

Default The default behavior is to keep all map data set variables and this option overrides it.

See "KEEPMAPVARS" on page 288

INCLUDEBORDER
includes points that are on the border of a polygon in the output data set. If any points are on the border of a polygon, then the output data set includes a variable named _ONBORDER_. If the value of _ONBORDER_ is 1, then the point is located on the border of a polygon.

Note: A point can be on the border between multiple polygons. In this case the point is assigned to the ID of the first polygon whose border it shares. This is the polygon that is processed first.

INSIDEONLY
causes the output data set to contain only points that are inside the map polygons. By default, the data set contains all points.

KEEPMAPVARS
specifies that the GINSIDE procedure should include all of the map data set variable names in the output data set. The ID variable from the map data set is one of those included. By default, the GINSIDE procedure writes to the output data set all variables associated with each point whose X and Y coordinates fall inside the map polygon. If a point falls inside a polygon, then the ID variable is set to the ID value of that polygon. For example, if a map contains counties, then the ID variable is set to the ID value of that polygon for each data point found inside a county. Other than ID, coordinate, and region variables, all other variable values are blanked out or marked '.' for missing.

Alias KMV

Default The behavior specified by the KEEPMAPVARS option is the default. This option does not need to be specified. If you are running PROC GINSIDE in preparation for use with other SAS/GRAPH or Base SAS mapping procedures, consider using the DROPMAPVARS option.

Restriction When comparing data points with map polygons, like-named variables must be of the same type or the GINSIDE procedure cannot run. For example, a LAKE character variable in a points data set cannot be compared with a numeric LAKE variable contained in a map data set.

See "DROPMAPVARS" on page 288

OUT=*output-data-set*
specifies the output data set for the GINSIDE procedure.

By default, the output data set contains all of the observations and variables from the points data set, and all of the variables identifying the map area. This includes the ID variable from the map data set.

Default If you do not specify a name for an output data set with the OUT= option then PROC GINSIDE creates one for you.

See the option "DROPMAPVARS" on page 288 if you want the output data set to contain only the ID variable from the map data set.

ID Statement

Specifies the identification variables in the map data set whose polygons are checked against the points from the input data set.

Requirement: At least one *id-variable* is required.

Syntax

ID *id-variable(s)*;

Required Argument

id-variable(s)
specifies one or more identification variables from the map data set. For each X and Y point in the input data set and each ID variable that you specify, the procedure determines whether the point lies within a polygon in the map data set. If it does, then the ID value of that polygon is written to the output data set. If the point lies outside of all of the polygons, then a missing value is written to the output data set.

For example, consider an input data set that contains the values `X=1.37` and `Y=.68`. In the PROC GINSIDE statement, you specify the MAPSSAS.COUNTIES map data set. In the ID statement, you specify STATE and COUNTY as the lookup variables. The point (1.37,.68) lies within the polygon where STATE=54 and COUNTY=27. As a result, the value for STATE is 54 and for COUNTY is 27 in the corresponding observation in the output data set.

Usage: GINSIDE Procedure

Optimizing Performance

Limiting the data that is input to PROC GINSIDE decreases the time it takes to run the procedure. This section offers several tips to help you enhance the performance of the GINSIDE procedure.

Limiting the Point Data and the Map Data

> **TIP** Include only areas of interest.

For performance reasons, it is recommended, if possible, that you limit the point data and the map areas to the known area of interest. For example, if you are interested in points that are only in the continental United States (U.S.), then limit your U.S. map to those 48 states. If your map data set includes other areas, such as European data, then eliminate the European areas.

Map Data Integrity

> **TIP** Keep your data precise.

The results from the GINSIDE procedure are only as good as the precision of the data in the map data set that is specified to the procedure. Imprecise map data sets, or map data sets that have been reduced, give the procedure geographical areas with smooth borders rather than the original, jagged land edges. If a data point falls on a tiny piece of land that was smoothed out, then the GINSIDE procedure does not find the point inside the expected polygonal area. This can be especially noticeable with points along the coast.

Removing Duplicate Data Points

> **TIP** Point data should not be repeated.

To increase efficiency, make sure that there is only one occurrence of a data point. If GINSIDE has to process the same data point multiple times, it slows down the performance of the procedure.

Examples: GINSIDE Procedure

About the GINSIDE Procedure Examples

Examples in This Section

This section provides basic examples of how to use the GINSIDE procedure. The following table lists the examples that are provided.

Table 12.1 *GINSIDE Procedure Examples*

Example	Map Data Used	Description
Determining Values By Using the GINSIDE Procedure (p. 292)	GfK	Shows how to use the GINSIDE procedure to determine the state and county for each pair of coordinates in the input data set.
Mapping and Annotating Values from the GINSIDE Procedure (p. 294)	GfK	Shows how to use the GINSIDE procedure with GfK map data to determine which customers are located inside the borders of a county. It also shows how to place markers at each customer's location and how to visually distinguish the inside customers from the outside customers.
Determining Values By Using the	Traditional	Shows how to use the GINSIDE procedure with traditional map data to determine which

Example	Map Data Used	Description
GINSIDE Procedure and Traditional Map Data (p. 299)		customers are located inside the borders of a county. It also shows how to place markers at each customer's location and how to visually distinguish the inside customers from the outside customers.

Examples Available Online

You can find more examples on the Graphically Speaking blog. On the blog page, use **Search Graphically Speaking** to search for GINSIDE to find the GINSIDE procedure examples.

Example 1: Determining Values By Using the GINSIDE Procedure

Features: MAP= required argument referring to map data set
DATA= required argument referring to data points
OUT= optional argument referring to output data set
ID statement
SAS DATA step with assignment statements
SORT procedure
PRINT procedure

Data sets: GPSCOUNTIES (created data set)
MAPSGFK.US_COUNTIES (map data set)
US_COUNTIES (created data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example uses the GINSIDE procedure to determine the state and county for each pair of coordinates in the input data set.

The following table shows the values of STATE and COUNTY for each observation in the input data set.

Output 12.1 *PROC PRINT Results of Output Data Set*

Obs	site	STATE	COUNTY	x	y
1	a	42	133	-77.0348	40.0454
2	b	54	27	-78.4437	39.1623
3	c	54	27	-78.4115	39.3751
4	d	42	21	-78.7646	40.6354

Program

```
goptions border;

data us_counties;
   set mapsgfk.us_all;
   keep segment state county lat long density;
   rename long=x lat=y;
run;

data gpscounties;
   input x y site $;
datalines;
-77.0348 40.0454 a
-78.4437 39.1623 b
-78.4115 39.3751 c
-78.7646 40.6354 d
;
run;

proc ginside data=gpscounties map=us_counties out=gpscounties;
   id state county;
run;

proc sort data=gpscounties;
   by site;
run;

proc print data=gpscounties;
   var site state county x y;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions border;
```

Get the unprojected US county coordinates from MAPSGFK.US_COUNTIES. Variables X and Y contain the projected coordinates, and variables LAT and LONG contain the unprojected coordinates in decimal degrees. Because the GINSIDE procedure requires coordinate variables named X and Y, drop variables X and Y, and then rename LAT and LONG to X and Y, respectively.

```
data us_counties;
   set mapsgfk.us_all;
   keep segment state county lat long density;
   rename long=x lat=y;
run;
```

Create the GPSCOUNTIES data set. The X and Y variables are decimal degrees to match the unprojected values in the US_COUNTIES data set.

```
data gpscounties;
   input x y site $;
datalines;
-77.0348 40.0454 a
-78.4437 39.1623 b
-78.4115 39.3751 c
-78.7646 40.6354 d
;
run;
```

Determine the values of STATE and COUNTY for each data point. Add the values to the created data set.

```
proc ginside data=gpscounties map=us_counties out=gpscounties;
   id state county;
run;
```

Sort and print the output data set.

```
proc sort data=gpscounties;
   by site;
run;

proc print data=gpscounties;
   var site state county x y;
run;
quit;
```

Example 2: Mapping and Annotating Values from the GINSIDE Procedure

Features: MAP= required argument referring to map data set
DATA= required argument referring to data points
OUT= optional argument referring to output data set
ID statement
SAS DATA step with assignment statements
GPROJECT procedure
PRINT procedure
GMAP procedure

Data sets: MAPSGFK.US_COUNTIES (map data set)
MYMAP (created data set)
CUSTOMERS (annotate data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

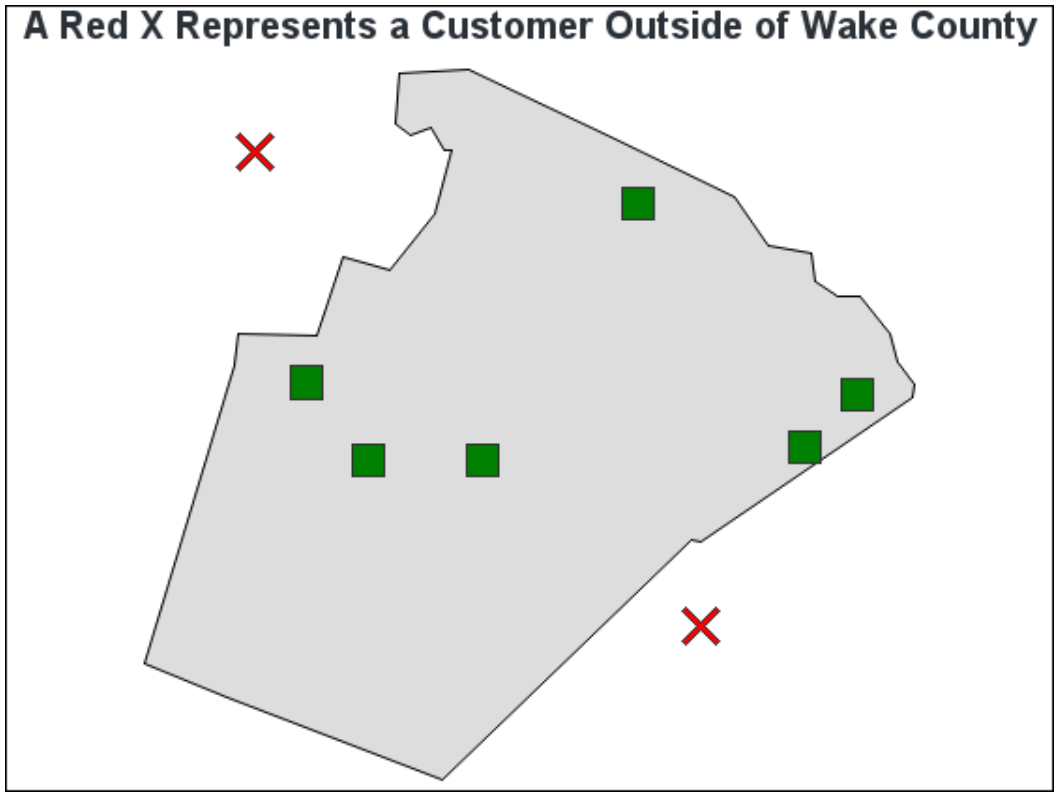
The following example determines which customers are inside Wake County in the state of North Carolina. It then draws a map and colors the markers (representing customers) to distinguish customers inside the county from customers outside the county. It also displays the output data set.

The map of Wake County displayed is the output annotated with customer data points both inside and outside of the county. The second graphic displays the CUSTOMERS data set, the result of running PROC PRINT. Notice that observations 4 and 5 in the printed table have missing values for STATE and COUNTY. This means that those customers are not in Wake County.

Output 12.2 *Table CUSTOMERS*

Obs	lat	long	name	STATE	COUNTY
1	35.77	-78.67	Smith	37	183
2	35.83	-78.84	Jones	37	183
3	35.77	-78.78	Doe	37	183
4	35.64	-78.46	Patel	.	.
5	36.01	-78.89	White	.	.
6	35.97	-78.52	Short	37	183
7	35.78	-78.36	Phillips	37	183
8	35.82	-78.31	Jackson	37	183

Output 12.3 *GMAP Procedure Output*



Program

```
data customers;
   length name $15;
   input lat long name $;
datalines;
35.77 -78.67 Smith
35.83 -78.84 Jones
35.77 -78.78 Doe
35.64 -78.46 Patel
36.01 -78.89 White
35.97 -78.52 Short
35.78 -78.36 Phillips
35.82 -78.31 Jackson
;
run;

data mymap;
   set mapsgfk.us_counties(where=(fipstate(state)='NC' and
county=183));
run;

proc gproject data=mymap
   out=mymap
   latlong eastlong degrees dupok
   parmout=projparm;
   id state county;
```

```
run;

proc gproject data=customers
   out=customers
   latlong eastlong degrees dupok
   parmin=projparm parmentry=mymap;
   id;
run;

proc ginside map=mymap data=customers out=customers;
   id state county;
run;

proc print data=customers;
   var lat long name state county;
run;

data customers;
   set customers;
   length color style $8;
   retain xsys ysys '2' hsys '3' when 'a' position '5' size 5;
   style='marker';
   if missing(county) then do;
      color='red';
      text='X';
      end;
   else do;
      color='green';
      text='U';       /* Marker font for a square */
      end;
   output;
   style='markere';  /* outline the symbols */
   color='gray33';
   output;
 run;

title height=2.5
   "A Red X Represents a Customer Outside of Wake County";
pattern1 v=s c=graydd;

proc gmap data=mymap map=mymap anno=customers;
   id state county;
   choro county / stat=first coutline=black nolegend;
run;
quit;
```

Program Description

Create the CUSTOMERS data set. The LONG and LAT variables represent the unprojected longitude and latitude values in degrees.

```
data customers;
   length name $15;
   input lat long name $;
datalines;
35.77 -78.67 Smith
35.83 -78.84 Jones
```

```
35.77 -78.78 Doe
35.64 -78.46 Patel
36.01 -78.89 White
35.97 -78.52 Short
35.78 -78.36 Phillips
35.82 -78.31 Jackson
;
run;
```

Create the MYMAP data set of Wake County in North Carolina. Use the MAPSGFKS libref to access the counties map data set. The FIPS county number for Wake is 183.

```
data mymap;
   set mapsgfk.us_counties(where=(fipstate(state)='NC' and
county=183));
run;
```

Project the map data set to use Cartesian coordinates.

```
proc gproject data=mymap
   out=mymap
   latlong eastlong degrees dupok
   parmout=projparm;
   id state county;
run;
```

Project the points data set to use Cartesian coordinates, and the same parameters as the map.

```
proc gproject data=customers
   out=customers
   latlong eastlong degrees dupok
   parmin=projparm parmentry=mymap;
   id;
run;
```

Determine which customer points fall inside or outside of the county. Note that GINSIDE can be run before or after the GPROJECT procedure. Taking into account that the GINSIDE procedure process X and Y variables, this example runs the procedure after projecting the map and point data. If you choose to run the GINSIDE procedure before the GPROJECT procedure, you must first rename the LONG and LAT variables to X and Y.

```
proc ginside map=mymap data=customers out=customers;
   id state county;
run;
```

Print the resulting data with a few key variables.

```
proc print data=customers;
   var lat long name state county;
run;
```

Add annotations to the CUSTOMERS data set. Use a green square for any customer data point inside the county map, and a red X if outside.

```
data customers;
   set customers;
   length color style $8;
   retain xsys ysys '2' hsys '3' when 'a' position '5' size 5;
```

```
   style='marker';
   if missing(county) then do;
      color='red';
      text='X';
      end;
   else do;
      color='green';
      text='U';       /* Marker font for a square */
      end;
   output;
   style='markere';  /* outline the symbols */
   color='gray33';
   output;
 run;
```

Define the title and map color for the graph.

```
title height=2.5
   "A Red X Represents a Customer Outside of Wake County";
pattern1 v=s c=graydd;
```

Use the GMAP procedure to display the choropleth map, and annotate it with the variables in the CUSTOMERS data set. The ANNO= option specifies the annotate data set.

```
proc gmap data=mymap map=mymap anno=customers;
   id state county;
   choro county / stat=first coutline=black nolegend;
run;
quit;
```

Example 3: Determining Values By Using the GINSIDE Procedure and Traditional Map Data

Features: MAP= required argument referring to map data set
DATA= required argument referring to data points
OUT= optional argument referring to output data set
ID statement
SAS DATA step with assignment statements
SORT procedure
PRINT procedure

Data sets: MAPSSAS.COUNTIES (map data set)
GPSCOUNTIES (created data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example uses the GINSIDE procedure to determine the state and county for each pair of coordinates in the input data set.

The following table shows the values of STATE and COUNTY for each observation in the input data set.

Output 12.4 *PROC PRINT Results of Output Data Set From Traditional Map Data*

Obs	site	STATE	COUNTY	x	y
1	a	42	133	1.34451	0.69892
2	b	54	27	1.36910	0.68351
3	c	54	27	1.36854	0.68723
4	d	42	21	1.37470	0.70922

Program

```
goptions reset=global border;

data gpscounties;
  input longitude latitude site $;
  x=longitude*arcos(-1)/180;
  x=x*(-1);
  y=latitude*arcos(-1)/180;
datalines;
-77.0348 40.0454 a
-78.4437 39.1623 b
-78.4115 39.3751 c
-78.7646 40.6354 d
;
run;

proc ginside data=gpscounties map=mapssas.counties out=gpscounties;
  id state county;
run;

proc sort data=gpscounties;
  by site;
run;

proc print data=gpscounties;
  var site state county x y;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=global border;
```

Create the GPSCOUNTIES data set. The X and Y variables are converted from decimal degrees to radians. The X variable is also multiplied by –1 to switch the coordinates from east longitude to west longitude, in order to match the values in the MAPSSAS.COUNTIES data set.

```
data gpscounties;
  input longitude latitude site $;
  x=longitude*arcos(-1)/180;
  x=x*(-1);
  y=latitude*arcos(-1)/180;
datalines;
-77.0348 40.0454 a
-78.4437 39.1623 b
-78.4115 39.3751 c
-78.7646 40.6354 d
;
run;
```

Determine the values of STATE and COUNTY for each data point. Add the values to the created data set. Use the MAPS libref to access the counties map data set.

```
proc ginside data=gpscounties map=mapssas.counties out=gpscounties;
  id state county;
run;
```

Sort and print the output data set.

```
proc sort data=gpscounties;
  by site;
run;

proc print data=gpscounties;
  var site state county x y;
run;
quit;
```

13

GMAP Procedure

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Overview: GMAP Procedure

About the GMAP Procedure

The GMAP procedure produces two-dimensional (choropleth) or three-dimensional (block, prism, and surface) maps that show variations of a variable value with respect to an area. Map data sets and response data sets are used in the GMAP procedure. A wide assortment of map data sets is available with SAS/GRAPH software. These include map data sets based on the digital, vector-based maps from GfK GeoMarketing GmBH, in addition to the updated traditional map data sets provided by SAS with SAS/GRAPH.

Use the GMAP procedure to perform the following tasks:

- produce maps
- summarize data that vary by physical area
- show trends and variations of data between geographic areas
- highlight regional differences or extremes

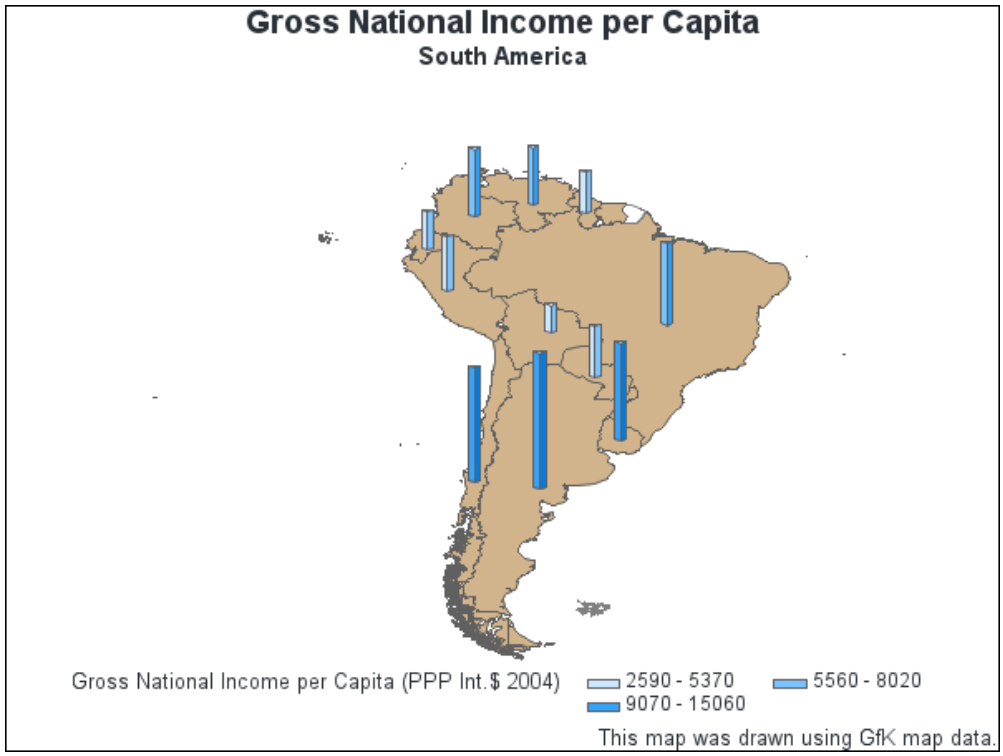
About Block Maps

Block maps display a block at the approximate center of each map area to convey information about response variable values. The height of each block is directly proportional to the value of the response variable.

Note: If the map area consists of multiple, noncontiguous areas, then the block is centered over the largest polygon of the set. For example, in the case of Japan the block is centered over Honshu, which is the largest island.

Figure 13.27 on page 306 shows a simple block map of the gross national income per capita of countries in South America.. The gross national income per capita of each country (the response value) is represented by the height of the block.

Figure 13.1 Block Map



The program for this map is in "Example 1: Producing a Simple Block Map" on page 436. For more information about producing block maps, see "BLOCK Statement" on page 345.

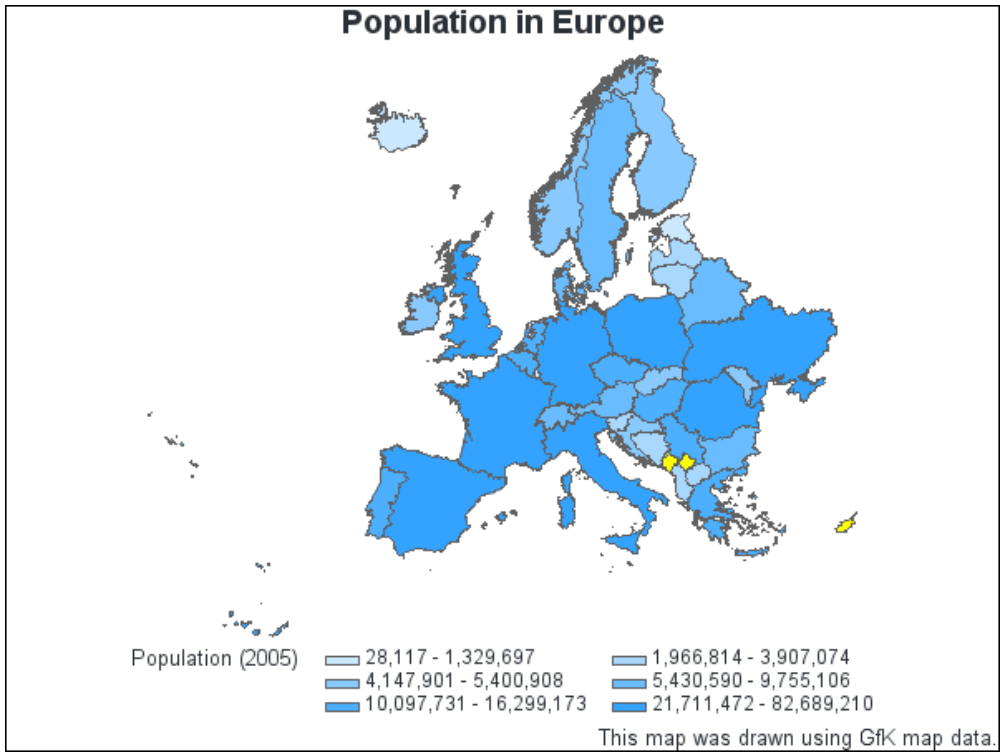
You can assign patterns to the areas in a block map by using the AREA statement. The values of the AREA variable are represented by the pattern of each map area. The values of the response variable in the BLOCK statement are represented by the height of the blocks. For more information, see "AREA Statement" on page 340.

About Choropleth Maps

Two-dimensional (choropleth) maps indicate levels of magnitude or response levels of the corresponding response variable by filling map areas with different colors and patterns.

Figure 13.28 on page 307 shows a choropleth map of the population of countries in Europe. The population of each country (the response value) is represented by the pattern that is assigned to the country.

Figure 13.2 *Two-dimensional (Choropleth) Map*



The program for this map is in "Example 5: Producing a Simple Choropleth Map" on page 448.

You can also produce a simple choropleth map that shows an outline of a map's areas. Do this by specifying your map data set as both the map data set and the response data set in a GMAP statement and adding a PATTERN statement with VALUE=EMPTY. For more information about the PATTERN statement, see "PATTERN Statement" on page 106. For more information about producing choropleth maps, see "CHORO Statement" on page 358.

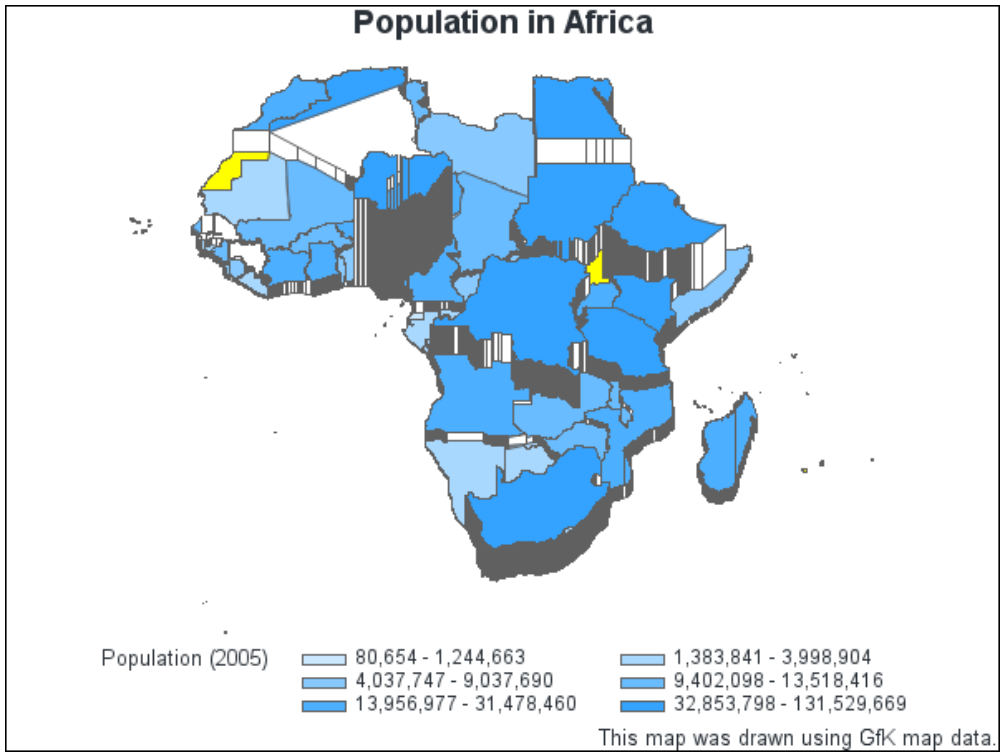
About Prism Maps

Prism maps use polyhedrons (raised polygons) in the shape of each map area to convey information about response variable values. The height of each polyhedron, or prism, is directly proportional to the value of the response variable.

You can alter the perspective of the map by selecting a viewing position (the point in space from which you view the map). You can also change the position of the light source so that the shadowing on the prisms enhances the illusion of height.

Figure 13.29 on page 308 shows a prism map of the populations of countries in Africa. The population of each country (the response value) is represented by the height of the country and the color of the country's map area.

Figure 13.3 Prism Map



The program for this map is in "Example 9: Producing a Simple Prism Map" on page 461. For more information about producing prism maps, see "PRISM Statement" on page 370.

You can also assign patterns to the areas in a prism map by using the AREA statement. The values of the AREA variable are represented by the pattern of each map area. The values of the response variable in the PRISM statement are represented by the height of the map areas. For more information, see "AREA Statement" on page 340.

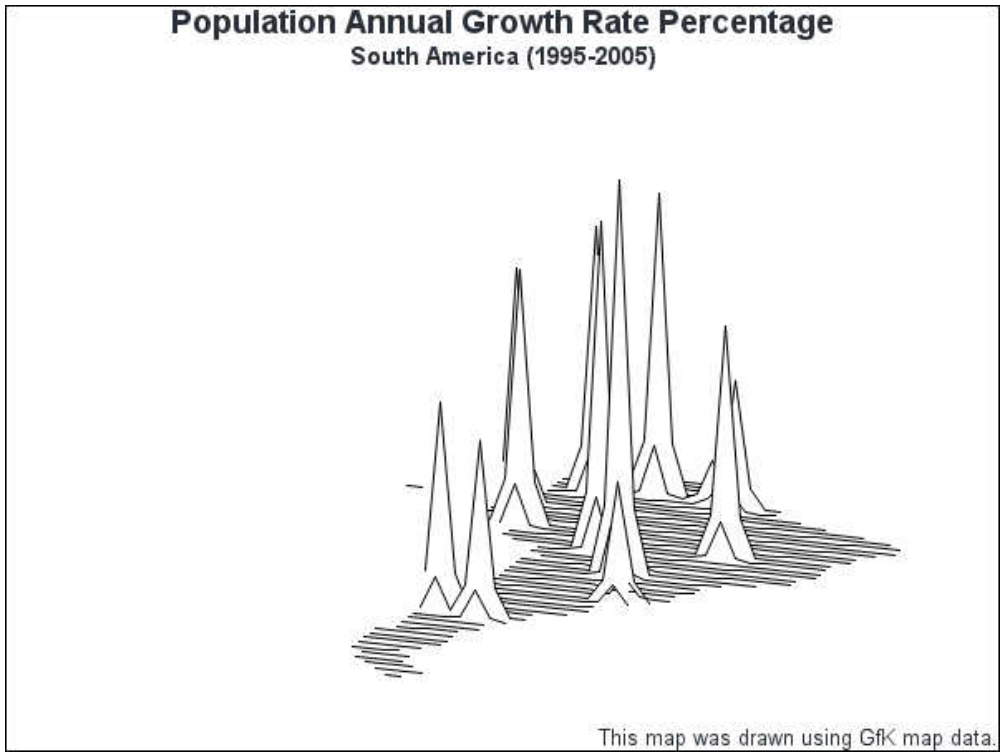
About Surface Maps

Surface maps display a spike at the approximate center of each map area to convey information about response variable values. The height of the spike corresponds to the relative value of the response variable, not to the actual value of the response variable. Thus, a spike that represents a value of 100 might not be exactly 10 times higher than a spike that represents a value of 10. Map area boundaries are not drawn.

Surface maps provide no clear map area boundaries and no legend. Thus, surface maps provide a simple way to judge relative trends in the response data but are an inappropriate way to represent specific response values.

Figure 13.30 on page 309 shows a surface map of the population growth rates of countries in South America. The growth rate for each country (the response value) is represented by the height of the spike for that country.

Figure 13.4 Surface Map



The program for this map is in "Example 11: Producing a Simple Surface Map" on page 466. For more information about producing surface maps, see "SURFACE Statement" on page 384.

Concepts: GMAP Procedure

About Map Data Sets

A map data set is a data set that contains variables whose values are coordinates. These coordinates define the boundaries of map areas such as a state or country. Map data sets are used in the GMAP procedure. Map data sets store spatial information across multiple observations. Each observation contains multiple variables with their specific data values. As such, these data sets should not be stored in a server environment that distributes data amongst server nodes, breaking the sequence of the observations. An example is the SAS LASR Analytic Server.

Map data sets supplied by SAS contain all the variables expected by the GMAP procedure. Map data sets that are not provided by SAS must contain X and Y

boundary point coordinate variables as well as one or more map area identification variables. If these variables are missing, the procedure stops and displays an error message to the SAS log. The GMAP procedure can take as input a map data set and a response data set, provided that both data sets contain the same *id-variable*. Alternatively, you can use as input a single data set to represent both the map and the response data sets. This is true if it contains either the map variables or a variable that references a map data set.

There are two types of data sets that are provided with SAS/GRAPH for mapping: traditional map data sets and GfK GeoMarketing digital, vector-based map data sets. Both can be used with the GMAP procedure. All of the content in the traditional map data sets are represented in the GfK map data sets. However, the traditional map data sets are no longer being updated and, in some cases, are out of date. The GfK data sets provide the most current mapping data. They also provide additional data over the traditional map data sets. SAS licensed the GfK map data sets from GfK GeoMarketing GmbH, and then converted the data into a SAS map data set format. The GfK map data sets are uniform and accurate for the whole world, and are intended to eventually replace the traditional map data sets.

SAS/GRAPH software includes a number of predefined map data sets.The traditional data sets are described in "The METAMAPS Data Set" on page 324.

About GfK GeoMarketing Map Data Sets

Background

GfK GeoMarketing digital, vector-based map data sets are available for use. These map data sets are located in the MAPSGFK library. The library reference (libref) MAPSGFK is set during system configuration and cannot be changed. Use the MAPS= system option within SAS to point to either the GfK map data set library MAPSGFK or the traditional map data set library MAPSSAS. MAPS points to the MAPSSAS library by default.

Updates to GfK Map Data Sets

Updates and changes to the GfK GeoMarketing map data sets are provided by GfK GeoMarketing GmbH. SAS makes these updates available via SAS Maps and Geocoding website. See "Accessing SAS Maps and Geocoding Resources Online" on page 331 for details about downloading data updates, sample SAS/GRAPH programs, and GIF images of maps.

Note: Updates to map data sets might include such things as border changes, the number of ID variables, the renaming of geographic areas, or the entire deletion of a

data set. For meaningful results, ensure that the age of the map data set that you use matches that of the response data set.

About Traditional Map Data Sets

Background

Traditional *map data set*s have been available from the inception of SAS/GRAPH. These map data sets are resident in both the MAPS and MAPSSAS libraries. The library reference (libref) MAPSSAS is set during system configuration and cannot be changed. MAPSSAS is provided for ease-of-use when using the MAPS= system option within SAS. Use the MAPS= system option within SAS to point to either the GfK map data set library MAPSGFK or the traditional map data set library MAPSSAS. MAPS points to the MAPSSAS library by default.

TIP The most current map data is in the GfK map data set library, MAPSGFK. For your new SAS programs, use the map data in MAPSGFK.

Traditional Map Data Sets Containing Only X and Y

The traditional map data sets that contain X and Y variables (and no LONG and LAT variables), are usually projected maps. However, there are a few traditional map data sets for the US and Canada that contain X and Y values that are unprojected longitude and latitude. In this case, you need to use the GPROJECT procedure to project the map. (See Chapter 14, "GPROJECT Procedure," on page 525).

Note: You can determine whether a SAS traditional map data set is projected or unprojected in one of two ways. You can look at the description of each variable that is displayed when you use the CONTENTS procedure. You can also browse the MAPS.METAMAPS data set. An example of using the CONTENTS procedure follows:

```
proc contents data=maps.chile; /*<libref.datatsetname> */
run;
```

Map Data Sets Containing X, Y, LONG, and LAT

All except one of the GfK and most of the traditional map data sets that are provided with SAS/GRAPH software contain four coordinate variables (X, Y, LONG, and LAT). When all four coordinate variables are present, X and Y are always projected values that are used by the SAS/GRAPH procedures (by default). However, you might want to use the LONG and LAT variables to project the map again using a different projection type. If you need to use the unprojected values that are contained in the LONG and LAT variables, then do the following tasks:

1 Project the spherical coordinates (latitude and longitude) by using the GPROJECT procedure with its LATLON option, which uses the LAT and LONG variables instead of the Y and X variables.

Note: LAT and LONG variables in GfK map data sets are in degrees. In traditional map data sets the LAT and LONG variables are in radians or degrees. Specify the DEGREES option to indicate that the LONG and LAT coordinates to project are degrees and not radians. Proj.4 projections use this by default.

Note: In the GfK map data sets, the positive values of the LONG variable go to the east from the prime meridian. It is just the opposite in the traditional map data sets. Specifying the EASTLONG option when projecting traditional map data sets ensures that the positive values of the LONG variable go to the east from the prime meridian. Proj.4 projections use this by default.

Note: Do not attempt to project a data set that is already projected , such as MAPSGFK.US. If the data set does not contain variables with unprojected coordinates, the result could be unpredictable.

2 Use the output data set from GPROJECT, which now contains Cartesian coordinates, as your input map data set by specifying it in the MAP= value in the GMAP procedure

Differences between GfK and Traditional Map Data Sets

This section covers the differences between the traditional and the GfK map data sets, and the benefits of using the GfK data. Usually, you cannot simply replace a traditional map data set in your existing code with the GfK map data set. You must carefully review the map libraries, the map data set filenames, and the variables that they contain. There are also notable projection differences. For example, the **X**

and `Y` variables are always projected in the GfK map data sets. All the details are described next.

License Information

SAS supplies both traditional and GfK map data sets. SAS has licensed the vector-based map data sets representing the world from GfK GeoMarketing GmbH. These map data sets are to be used only with SAS/GRAPH for your internal business purposes.

Anyone with specialized map needs can license map data sets directly from GfK GeoMarketing GmbH. These map data sets match up with the map data sets provided with SAS/GRAPH. SAS customers can access GfK map data sets at https://geodata.gfk.com/maps.

The map data sets in library MAPSGFK are based on the digital, vector-based maps from GfK GeoMarketing GmbH and are covered by their copyright. For additional information, see https://support.sas.com/en/knowledge-base/maps-geocoding/maps-online.html.

Libraries MAPSSAS and MAPS both contain the traditional maps data sets supplied by SAS.

Advantages to Using GfK Map Data Sets

There are some key advantages to using GfK instead of traditional map data sets, including:

Accuracy and consistency	Licensing the map data sets from GfK GeoMarketing GmbH provides a single source for map data sets. This single source ensures that the map data set is accurate and uniform for the entire world. Additional map data sets obtained from GfK GeoMarketing GmbH match seamlessly with SAS/GRAPH map data sets. The GfK map data sets provide the most current mapping data.
Single-source updates	GfK GeoMarketing GmbH is solely responsible for all updates and changes to their map data sets. This includes political boundary updates, which were up to this time hard to obtain. SAS offers the ability to download the updates to map data sets via SAS Maps and Geocoding website (https://support.sas.com/en/knowledge-base/maps-geocoding.html). You are required to access the website with your SAS profile. You might be required to enter your site information.
Ease-of-Use	SAS converts the GfK map data set into a SAS map data set format to avoid unnecessary special processing.

Map Data Set Names

This section describes the differences found when comparing the GfK map data set names to the traditional map data set names.

Longer names
: GfK map data sets have longer names than the traditional map data sets. That is because they are not truncated. The names can exceed eight characters. For example, compare the traditional map data set name of **AFGHANIS** to the GFK map data set name of **AFGHANISTAN**.

Consistent naming convention
: The GfK map data sets also provide a consistent naming convention. For example, compare the traditional map data set name of **STATES**, which could correlate to any country with states, to the GFK map data set name of **US_STATES**.

  Another notable difference is the GfK map data set names of **NORTH_KOREA** and **SOUTH_KOREA** versus the traditional map data set names of **KOREANOR** and **KOREASOU**. GfK map data set names correspond to the common use names in language.

New data sets
: GfK includes new map data sets such as CAYMAN_ISLANDS and the Nomenclature of Territorial Units for Statistics (NUTS) level 0,1,2,3 data sets for Europe. The NUTS classification is a hierarchical system for dividing up the economic territory of the European Union (EU). An example is the data set named EUROPENUTS3.

Data set designations
: Same-named data sets differentiated with numeric qualifiers, such as EUROPE, EUROPE1, and EUROPE2 indicate the level of administrative detail. For example, EUROPE1 indicates countries on the European continent with first administrative level—similar to states in the United States of America.

  The level 1 continent map data sets do not contain all of the corresponding countries that are found in the MAPSGFK.WORLD data set. However, a level 0 continent map data set does contain all of its corresponding countries (for example, MAPSGFK.EUROPE).

New data set files with additional variables
: Each GfK map data set now has a companion data set with a **_ATTR** qualifier. For example, the data set AFRICA_ATTR contains extra variables.

New data set files listing all dependencies
: GfK data sets, where applicable, include an **_ALL** qualifier. These map data sets contain all the territories and islands. For example, compare the traditional map data set **US** that contains Puerto Rico with the GfK map data set of the same name, which does not contain Puerto Rico. You must use the GfK map data set **US_ALL** to include Puerto Rico.

Disputed territories
: Disputed territories occur in the following map data sets:

- **AFRICA** map data sets MAPSGFK.AFRICA and MAPSGFK.AFRICA_ATTR
- **ASIA** map data sets MAPGFK.ASIA and MAPSGFK.ASIA_ATTR
- **SOUTH AMERICA** map data sets MAPSGFK.SAMERICA and MAPSGFK.SAMERICA_ATTR
- **WORLD** map data sets MAPSGFK.WORLD and MAPSGFK.WORLD_ATTR

The disputed territories are not included with individual countries but rather are identified by a blank value in the variables **ISO**, **ISOALPHA2**, **ISOALPHA3**, and **ISONAME**. They are also identified by the **ID** variable values that differ from the ISOALPHA2 variable value. For example, see the following ID values of the disputed territories between the following countries or states:

- Cameroon and Nigeria have ID value of **CM_NG**
- China and India have ID value of **CN_IN**
- China and Taiwan have ID value of **CN_TW**
- China and Vietnam have an ID value of **CN_VN**
- Philippines and Vietnam have an ID value of **PH_VN**
- Suriname and Guyana have an ID value of **SR_GY**

Note: Compared to MAPSGFK.WORLD map data set, the **ID** and **ISOALPHA2** variables in MAPSGFK.WORLD_CITIES are the same.

New data set PROJPARM
SAS provides this data set that contains the GPROJECT procedure information for all GfK map data sets. This information includes values such as the Central Meridian or Standard Longitude, and the Parallel1 and Parallel2 values that were used during the projection procedure.

Correlations between Map Data Sets and Data Sets

The information from some traditional map data sets has been combined in the GfK map data sets. Some data set and map data set names remain the same between traditional and GfK. For example, the map data set **US** maintains the same name between traditional and GfK. The following table lists noteworthy correlations. The left column lists the oldest, traditional SAS map data sets in the MAPSSAS library. The right column lists the latest GfK map data sets in the MAPSGFK library. The rows under each column indicate what data set names can be found in a particular library.

Table 13.1 *Notable Correlations Between Map Data Sets and Data Sets*

Traditional (MAPSSAS)	GfK GeoMarketing (MAPSGFK)
USCITY	USCITY

Traditional (MAPSSAS)	GfK GeoMarketing (MAPSGFK)
Note: Includes towns, villages, hamlets, and other non-city areas that can have the same name as a city. A FEATYPE variable contains the area type.	**Note:** Includes towns, villages, hamlets, and other non-city areas that can have the same name as a city. Does not include a FEATYPE variable.
	USCITY_ALL **Note:** Includes Puerto Rico and the U.S. Virgin Islands.
COUNTIES	US_COUNTIES **Note:** Includes counties that can have the same name as a city.
COUNTY	None
USCOUNTY	USCOUNTY, USCOUNTY_ATTR **Note:** Includes states Alaska and Hawaii, re-sized and relocated below California in order to fit on one graphics output area with minimal unused space. Control the level of detail visible with the density and resolution variables.
CNTYNAME	US_COUNTIES_ATTR
STATES	US_STATES
US	US, US_ATTR **Note:** Includes states Alaska and Hawaii, re-sized and relocated below California in order to fit on one graphics output area with minimal unused space. Control the level of detail visible with the density and resolution variables.
US2	US_STATES_ATTR
USCENTER	USCENTER **Note:** Includes Washington, D.C.
	USCENTER_ALL **Note:** Includes Puerto Rico and the U.S. Virgin Islands.
All data set names beginning with USA	None

Data set names with a numerical suffix (1, 2, 3) do not contain the same information between the traditional and GfK data sets. The MAPSGFK map data sets with a suffix of one (1), for example, contain countries with first administrative level—similar to U.S. states. The MAPSGFK map data sets with a suffix of two (2) contain countries with second administrative level - similar to U.S. counties.

Run the following code to determine whether the map data set name that you are currently using is listed in the MAPSGFK library:

```
proc datasets lib=mapsgfk;
run;
```

New and Changed Variables

The following table describes new variables and compares the changed variables between traditional and GfK map data sets:

Table 13.2 *Variables Specific to GfK Map Data Sets*

Variable Name	Variable Description	Traditional Map Data Set Details	GfK Map Data Set Details
DENSITY	Contains the density values returned from a GREDUCE procedure.	Might contain.	Does contain.
ID	A unique character code for a geographic area. For example, it represents a county or district in _ATTR map data sets, and a country or region in the MAPSGFK.WORLD_CITIES data set.	Might contain. (Numeric format)	Does contain. Character (Length 15 for all map data sets that contain this variable, regardless of the length of the value actually being stored)
IDNAME	A character code for a geographic area. For example, it represents a county or district in _ATTR map data sets, and a country or region in the MAPSGFK.WORLD_CITIES data set.	Does not contain.	Does contain. (Except in the continent map data sets with the numerical suffix of 1 or 2, such as EUROPE1.) **Note:** The text value for the IDNAME variable remains in the

Variable Name	Variable Description	Traditional Map Data Set Details	GfK Map Data Set Details
			attribute data sets, such as EUROPE1_ATTR.
IDNAMEU[2]	A Unicode escape format character version of **IDNAME** in _ATTR map data sets. The note following this table describes how to convert this variable to a UTF-8 format to use it during a SAS UTF-8 session.	Does not contain.	Might contain.
ID1, ID2	A character state or province code in _ATTR map data sets.	Does not contain.	Might contain.
ID1NAME	A character state or province name in _ATTR map data sets.	Does not contain.	Might contain.
ID1NAMEU[2]	A Unicode escape format character version of **ID1NAME** in _ATTR map data sets. The note following this table describes how to convert this variable to a UTF-8 format to use it during a SAS UTF-8 session.	Does not contain.	Might contain.
ISO	A character country or region code in _ATTR map data sets.	Does not contain.	Does contain. (Except in the Nomenclature of Territorial Units for Statistics (NUTS); EUROPE levels 0 through 3. An example data set is EUROPENUTS3.
ISOALPHA2, ISOALPHA3[1]	A character country or region International Organization for Standardization Alpha2– or	Does not contain.	Does contain.

Variable Name	Variable Description	Traditional Map Data Set Details	GfK Map Data Set Details
	Alpha3–code in _ATTR map data sets.		
ISONAME[1]	A character country or region International Organization for Standardization name in _ATTR map data sets. **Note:** the `ISONAME` variable value found in a continent _ATTR map data set is identical to its counterpart in the MAPSGFK.WORLD map data set	Does not contain.	Does contain.
LAT	A numeric variable containing the vertical coordinate of the boundary point. (The value of this variable is unprojected and represents latitude (north-south position).	Might contain. (The value of the variable is in radians or degrees.)	Does contain. (The value of the variable is in degrees.)
LONG	A numeric variable containing the horizontal coordinate of the boundary point. (The value of this variable is unprojected and represents longitude (east-west position).	Might contain. (The value of the variable is in radians or degrees. Positive values indicate west.)	Does contain. (The value of the variable is in degrees. Positive values indicate east.)
POP_RANGE_MIN	A numeric variable containing the minimum value of the population range provided by the third-party vendor GfK GeoMarketing GmbH. For example, the value is 0 (zero) when the population range provided is “Cities under 10K”.	Does not contain.	Does contain. (In the US_CITY, USCITY_ALL, and WORLD_CITIES data sets)
RESOLUTION	A numeric map detail level from 1 to 10 that is based on	Does not contain.	Does contain.

Variable Name	Variable Description	Traditional Map Data Set Details	GfK Map Data Set Details
	desired output display resolution.		
STATE **Note:** Variable occurs only in U.S. data sets	State FIPS code.	Might contain. (Numeric FIPS code.)	Might contain. (Numeric.)
X	A numeric variable that contains the horizontal coordinates of the boundary points.	Does contain. (The longitudinal value can either be projected or unprojected.	Does contain. (The value is always projected and represents longitude.)
Y	A numeric variable that contains the vertical coordinates of the boundary points	Does contain. (The latitudinal value can either be projected or unprojected.)	Does contain. (The value is always projected and represents latitude.)

1 A blank ISO, ISOALPHA, ISOALPHA2, or ISOALPHA3 variable value is used in the MAPSGFK.ASIA, MAPSGFK.ASIA_ATTR, MAPGFK.AFRICA, MAPSGFK.AFRICA_ATTR, MAPSGFK.AMERICA, MAPSGFK.SAMERICA_ATTR, MAPSGFK.WORLD, and MAPSGFK.WORLD_ATTR map data sets to indicate a disputed territory when the ID variable value is: **CM_NG** (Cameroon and Nigeria), **CN_IN** (China and India), **CN_TW** (China and Taiwan),**CN_VN** (China and Vietnam), **CH_PH_VN** (China, Philippines, and Vietnam),**GX** (Golan Heights), **SD_SS** (Sudan and South Sudan), or **SR_GY** (Suriname and Guyana).

2 SAS provides the MAPS.POLAND2 data set that includes columns containing Polish characters. It is encoded as ASCII, and therefore prevents SAS from transcoding the data to a UTF-8 format. The characters are displayed correctly when run in a SAS Polish session. The characters are not displayed correctly when run in a SAS English UTF-8 session. Data sets provided for a few other locales have a similar issue.

Note: The data set containing the variables to be transcoded must not be an ASCII-encoded data set created specifically for the locale. Apply the $uesc50. format to an applicable Unicode variable to view the national characters in an English SAS UTF-8 session. The following example formats the IDNAMEU variable:

```
data my_attr;
set mapsgfk.reunion_attr;
Unicode_idname=input(IDNAMEU, $uesc50.);
run;

goptions ftext='Albany AMT';
proc gmap data=my_attr map=mapsgfk.reunion;
id id;
choro Unicode_idname;
```

```
run;
quit;
```

During reformatting, the column might not be wide enough to contain all of the bytes needed to represent the value of the character variable. In that case, the SAS log issues an ERROR or a WARNING such as:

```
ERROR: Some character data was lost during transcoding in the data set
MY_ATTR. Either the data contains characters that are not representable
in the new encoding or truncation occurred during transcoding.
```

Use the "LIBNAME Statement: CVP Engine" in *SAS Global Statements: Reference* to transcode a SAS data set with character variables into expanded columns. The CVP engine is read-only, requiring you to make a UTF-8 copy of the data set.

Existing Variables Comparison

The following table describes variables that exist in the traditional map data sets and whether they are used in the GfK map data sets:

Variable Name	Variable Description	Traditional Map Data Set Details	GfK Map Data Set Details
CDCODE	Census District.	Does contain. (Character format)	Does not contain.
CONT	Continent.	Does contain. (Numeric format) **Note:** Used in all the continent and WORLD map data sets.	Does contain. (Numeric format) **Note:** Used in all the *continent*_ATTR, WORLD, and WORLD_ATTR map data sets.
COUNTRY	World Geographic Code.	Might contain. (Numeric format)	Does not contain. Replaced by the `ISO` variable that represents the International Organization of Standardization's country code. (Character format)
ID	Identification variable.	Might contain. (Numeric format).	Does contain. (Character format)

Variable Name	Variable Description	Traditional Map Data Set Details	GfK Map Data Set Details
PROVINCE	Character abbreviation for a province.	Might contain. (Character format)	Does not contain. Replaced by the `ID` variable in character format.
RANK	Numeric assignment based on population density, 1 (one) being an example	The City map data sets contain. (Numeric format)	Does not contain. Replaced by the `POP_RANGE_MIN` variable in numeric format.
GLC codes	Geographic Locator Codes (alphanumeric).	Might contain.	Does not contain. Replaced by the ISO codes.

Data Changes

The data changes encompassed in the GfK map data sets include various variables. The changes are detailed in this section.

The `RESOLUTION` variable reduces the points for the display size of a map as indicated in the following table:

Table 13.3 *RESOLUTION Variable Values*

RESOLUTION VALUE	NUMBER OF PIXELS
1	320 x 240
2	400 x 300
3	640 x 480
4	800 x 600
5	1280 x 1024
6	1600 x 1200
7	2400 x 1800
8	6000 x 4800

RESOLUTION VALUE	NUMBER OF PIXELS
9	14400 x 11520
10	28800 x 23040

In data sets with one (1) administrative level, the ID variable concatenates the country code and the administrative_level code. In data sets with two (2) administrative levels, the ID variable concatenates the country code and the lower_administrative_level code. The ID1 variable concatenates the country code and the higher_administrative_level code. Some data sets have three (3) administrative levels. In this case the ID variable concatenates the country code and lowest_administrative_level code. The ID2 variable concatenates the country code and middle_administrative_level code. The ID1 variable concatenates the country code and highest_administrative_level code.

Here are some specific examples. All the traditional U.S. map data sets contain a **STATE** variable. The ID variable in the MAPSGFK US_STATES data set represents a value for state, such as US-37 for NC. However, ID in the US_COUNTIES data set represents a county value, such as US-37183 for Wake County, NC. In the MAPSGFK US_COUNTIES data set the ID1 variable contains the value for state, for example, US-37 for North Carolina. **ID1** concatenated with the country code with the state code.

The traditional **COUNTY** variable is represented as **ID** in GfK map data sets such as **US_COUNTIES**. For example, a **COUNTY** value of **15** in California (CA) is represented by **ID** as **US-06015**. **ID** concatenates the country code, the state code, and the county code.

The X and Y variable values in the GfK map data sets are always projected.

The LAT and LONG variable values in the GfK map data sets are always unprojected eastlong degrees (not radians).

The identification variables (for example, ID and ID1) are character instead of numeric in the GfK map data sets.

GfK map data set variable values that contain special characters are provided in Unicode escape format. The values are encoded using regional characters. In order to use the GfK map data in a UTF-8 session, the MAPSGFK data set must be converted to a UTF-8 format.

GfK map areas contained in the map data sets are projected using appropriate projection methods. For example, the data set MAPSGFK.MEXICO represents a relatively small map area that is near neither pole. These factors make it possible to project data without distortion using the Albers method. The **LABEL** column for the X and Y variables in each data set should identify the projection algorithm used. Use the CONTENTS procedure to view rows and columns in a map data set. To view details of the map data set named MAPSGFK.MEXICO, run the following code:

```
proc contents data=mapsgfk.mexico;
run;
```

Compatibility Information

Substituting the GfK map data sets into an existing application that currently uses the traditional map data sets requires modifications to the application. Without these modifications, using the GfK map data set could cause unexpected results. For example, the GfK map data set names should not be substituted into your existing code's DATA= statement without some additional considerations. Please refer to "Migration Information" on page 324 for tips on converting your existing map-producing code.

Migration Information

When using the GfK map data sets, be aware of the following:

- the map data set filenames can be different
- the **X** and **Y** variables are always projected.
- the unprojected **LAT** and **LONG** variables are in eastlong degrees and not westlong radians.
- the positive values of the LONG variable go east from the prime meridian. In the traditional map data sets, the positive values go west.
- the **ID**, **ID1**, and **ID2** variables are character instead of numeric format.
- A map area crossing the International Date Line is divided into two segments in the displayed graph, indicating the boundaries on either side of the line. Examples of affected regions are Russia, Tonga, and territories and islands in the Pacific ocean.

Refer to "Reworking Code That Uses Traditional Map Data Sets" on page 429 for information and tips.

The METAMAPS Data Set

The maps data set library that is referenced by both the MAPS and MAPSSAS librefs have a data set named METAMAPS. This data set contains metadata about all of the data sets that are delivered in the library. MEMNAME is just one of the variables to find among the metadata in MAPS.METAMAPS and MAPSSAS.METAMAPS:

Note: GfK GeoMarketing GmbH does not include a comparable data set in its MAPSGFK library that SAS has licensed.

Variable
    Description

VAR**x**
identifies the name of the variable in the data set, where **x** is a numerical value.

LABEL**x**
describes **VARx** in the data set.

MEMNAME
identifies the names of all of the data sets that are delivered in the MAPS or MAPSSAS library.

Special GfK Data Sets for Annotating Maps

There are several data sets in the MAPSGFK library that enable you to easily add labels or markers to the maps. Some of their names differ from any traditional data sets that you might have used. Though the non-map data sets contain coordinates for map features such as cities, they cannot be used as map data sets.

The X and Y variables containing projected coordinates in the USCENTER, USCENTER_ALL, USCITY, and USCITY_ALL data sets can be used directly with the map data sets specified in the file header. If you want to use a different map data set, then use the LAT and LONG variables provided in the MAPSGFK data set. Use the Chapter 14, "GPROJECT Procedure," on page 525 to project them using the map data set projection parameters.

MAPSGFK.USCENTER_ALL
contains the coordinates of the visual center of each state in the U.S. and Washington, D.C., Puerto Rico, and the U.S. Virgin Islands. It also contains coordinates in the ocean for states that are too small to contain a label. There are two pairs of variables for locating labels using Annotate data sets. The X and Y variables contain projected coordinates and can be used with the MAPSGFK.US_ALL data set. The LONG and LAT variables contain the unprojected longitude and latitude in degrees (not radians). These can be used to place labels on any US data set, noting that you can subset the data set by state as needed.

MAPSGFK.USCENTER
is similar to USCENTER_ALL, except that it does not include Puerto Rico and the U.S. Virgin Islands. The X and Y variables contain projected coordinates and can be used with the MAPSGFK.US data set.

MAPSGFK.USCITY_ALL
contains the locations of selected cities in the U.S. Many city names occur in more than one state, so you might have to subset by state to avoid duplication. There are two pairs of variables for locating labels using Annotate data sets. The X and Y variables contain projected coordinates using the Miller II projection method. These variables can be used with the MAPSGFK.US_ALL data set. The LONG and LAT variables contain the unprojected longitude and latitude in degrees (not radians). These can be used to place labels on any US data set, noting that you can subset the data set by state as needed.

MAPSGFK.USCITY
is similar to USCITY_ALL, except that it does not include Puerto Rico and the U.S. Virgin Islands. The X and Y variables contain projected coordinates using the Albers projection method. These variables can be used with the MAPSGFK.US data set.

Duplicate observations can be listed in the output data set. This occurs because the map data set includes towns, villages, hamlets, and other non-city areas that can share the same name with a city.

MAPSGFK.US_COUNTIES
contains a projected US county map with Alaska and Hawaii in physical locations. Puerto Rico is not included. Many county names occur in more than one state, so you might have to subset by state to avoid duplication. The LONG and LAT variables contain the unprojected longitude and latitude in degrees (not radians). These can be used to place labels on any US data set, noting that you can subset the data set by state as needed.

MAPSGFK.US_STATES
contains a projected US state map with Alaska and Hawaii in physical locations. Puerto Rico is not included. The LONG and LAT variables contain the unprojected longitude and latitude in degrees (not radians). These can be used to place labels on any US data set, noting that you can subset the data set by state as needed.

MAPSGFK.US
contains a projected US state map with Alaska and Hawaii inset into the map. Puerto Rico is not included. The LONG and LAT variables are not included.

MAPSGFK.US_ALL
contains a projected US county map with Alaska and Hawaii in physical locations. Puerto Rico and the United States Virgin Islands are included. Many county names occur in more than one state, so you might have to subset by state to avoid duplication. The LONG and LAT variables contain the unprojected longitude and latitude in degrees (not radians). These can be used to place labels on any US data set, noting that you can subset the data set by state as needed.

MAPSGFK.WORLD_CITIES
contains the location of more than 200,000 international cities. Many city names occur more than once, so you might want to specify a country, state, province, or region variable to differentiate the cities. This data set does contain local city spellings. The CITY variable has mixed case values. The CITY2 variable values in this data set are normalized. This means that they are uppercase and stripped of all spaces and characters that are not alphabetic or numeric. This CITY2 variable is used by the GEOCODE procedure. The X and Y variables contain projected coordinates. The LONG and LAT variables contain the unprojected longitude and latitude in degrees (not radians). These can be used to place annotation labels on any international data set.

Note:

MAPSGFK.WORLD_CITIES_ALL is an alternate data set that contains the location of more than a million cities worldwide. It contains the same variables as the MAPSGFK.WORLD_CITIES data set. The more comprehensive data set is

available for download from the SAS Maps and Geocoding website. You are required to access the website with your SAS profile. You might be required to enter your site information. This unabridged data set is updated annually.

Special Traditional Data Sets for Annotating Maps

There are several data sets in the MAPSSAS library that enable you to easily label maps. These data sets contain coordinates for map features such as cities, but cannot be used as map data sets.

MAPS.USCENTER
: contains the coordinates of the visual center of each state in the U.S. and Washington, D.C.. It also contains coordinates in the ocean for states that are too small to contain a label. There are two pairs of variables for locating labels using Annotate data sets. The X and Y variables are projected and can be used with the MAPS.US and MAPS.USCOUNTY data sets. The LONG and LAT variables are unprojected longitude and latitude in radians and can be used with the MAPS.STATES, MAPS.COUNTIES, and MAPS.COUNTY data sets.

MAPS.USCITY
: contains the locations of selected cities in the U.S. Many city names occur in more than one state, so you might have to subset by state to avoid duplication. There are two pairs of variables for locating labels using Annotate data sets. The X and Y variables contain projected coordinates and can be used with the MAPS.US and MAPS.USCOUNTY data sets. The LONG and LAT variables contain the unprojected longitude and latitude in radians. These can be used to place labels on the MAPS.STATES, MAPS.COUNTIES, or MAPS.COUNTY data sets.

  Duplicate observations can be listed in the output data set. This occurs because the map data set includes towns, villages, hamlets, and other non-city areas that can share the same name with a city. Differentiate the output with the FEATYPE variable, which contains the area type.

For details about each of these data sets, see the MAPS.METAMAPS data set or the MAPSSAS.METAMAPS data set.

About Response Data Sets

Definition: Response Data Set

A *response data set* is a SAS data set that can contain other variables, but requires the following variables:

- one or more response variables that contain data values that are associated with map areas. Each value of the response variable is associated with a map area in the map data set.
- identification variables that identify the map area to which a response value belongs. These variables must be the same as those that are contained in the map data set.

Using the Response Data Set with the Map Data Sets

The map data set and the response data set must be used independently in the PROC GMAP statement. The response data set is specified by the DATA= option and the map data set is specified by the MAP= option. The values of the map area *id-variables* in the response data set determine the map areas to be included on the map. Unless the ALL option is used in the PROC GMAP statement, only the map areas with response values are shown on the map. As a result, you do not need to subset your map data set if you are mapping only a small section of the map. However, if you map the same small section frequently, then create a subset of the map data set for efficiency.

If you have a response data set named SASHELP.US_DATA, then the syntax for using the GMAP procedure might resemble the following:

```
proc gmap map=mapsgfk.us data=sashelp.us_data;
   id state;
   choro region;
run;
quit;
```

SAS provides sample response data sets in the SASHELP library. These data sets are available for you to use for examples and for testing code. Some of the examples in this chapter use sample response data sets such as SASHELP.US_DATA and SASHELP.DEMOGRAPHICS.

About Response Variables

The GMAP procedure can produce block, choropleth, prism, and surface maps for both numeric and character response variables. Numeric variables fall into two categories: discrete and continuous.

- *Discrete variables* contain a finite number of specific numeric values that are to be represented on the map. For example, a variable that contains only the values 1989 or 1990 is a discrete variable.
- *Continuous variables* contain a range of numeric values that are to be represented on the map. For example, a variable that contains any real value between 0 and 100 is a continuous variable.

Numeric response variables are treated as continuous variables unless the DISCRETE option is used in the action statement.

About Response Levels

Response levels are the values that identify categories of data on the graph. The categories that are shown on the graph are based on the values of the response variable. Based on the type of the response variable, a response level can be determined by any of the following:

- a character value
- the MIDPOINTS= option
- a range of numeric values
- a specific numeric value

When response levels are determined by a character value, the GMAP procedure treats each unique value as a response level. For example, if the response variable contains the names of ten regions, each region is a response level, resulting in ten response levels.

When character response levels are determined by the MIDPOINTS= option, any response variable values that do not match one of the specified response level values are ignored.

When response levels are determined by a range of numeric values, each response level has a similar number of observations. These options are exceptions to this:

- The LEVELS= option specifies the number of response levels to be graphed for the response variable. The LEVELS=*number-of-midpoints* option is ignored if either the DISCRETE or MIDPOINTS= option is used.
- The DISCRETE option causes the numeric variable to be treated as a discrete variable.
- The MIDPOINTS= option chooses specific response level values as medians of the value ranges.

If the response variable values are continuous, then the GMAP procedure assigns response level intervals automatically unless you specify otherwise. The response levels represent a range of values rather than a single value.

When response levels are determined by specific numeric values, and the DISCRETE option is specified, one level is created for each value. If the response variable has an associated format, then each formatted value is represented by a different response level.

The AREA, BLOCK, CHORO, and PRISM statements assign patterns to response levels. In CHORO and PRISM maps, response levels are shown as map areas. However, in BLOCK maps, response levels are shown as blocks. If you specify the AREA statement on a BLOCK map, then the response levels for AREA variable are shown as map areas. The default fill pattern for the response level is solid.

PATTERN statements can define the fill patterns and colors for both blocks and map areas. PATTERN definitions that define valid block patterns are applied to the blocks (response levels), and PATTERN definitions that define valid map patterns are applied to map areas.

See "PATTERN Statement" on page 106 for more information about fill pattern values and default pattern rotation.

About Identification Variables

For map data sets and response data sets, *id-variables* identify the map areas (for example, counties, states, or provinces) that make up the map. A *unit area* or *map area* is a group of observations with the same ID value. The GMAP procedure matches the value of the response variables for each map area in the response data set to the corresponding map area in the map data set. It does this in order to create the display graphs.

Displaying Map Areas and Response Data

Whether the GMAP procedure draws a map area and whether it displays patterns for response values depends on the contents of the response data set and on the ALL and MISSING options. The following table describes the conditions under which the procedure does or does not display map areas and response data.

Table 13.4 *Displaying Map Areas and Response Data*

Characteristic of the response data set	Additional variables	Result
Includes the map area.	The map area has a response value.	The procedure draws the map area and displays the response data.
Includes the map area.	The response value for the map area is a missing value.	The procedure draws the map area but leaves it empty.
Includes the map area.	The response value for the map area is a missing value and the MISSING option is used in the map statement.	The procedure draws the map area and displays a response level for the missing value.
Includes the map area.	The map area has a response value and the MAP= option and the DATA= statement specify the same map data set.	The procedure draws the map area and displays boundary outlines but does not display the value of the response variable or variables.

Characteristic of the response data set	Additional variables	Result
Does not include the map area.	The ALL option is used in the PROC GMAP statement.	The procedure draws the map area but leaves it empty.
Does not include the map area.	The ALL option is not used.	The procedure does not draw the map area.

Summary of Use

To use the GMAP procedure, you must do the following:

1. When using a map data set, determine what processing needs to be done to the map data set before it is displayed. Use the GPROJECT, GREDUCE, and GREMOVE procedures or a DATA step to perform the necessary processing.
2. Issue a LIBNAME statement for the SAS data set that contains the response data set, or use a DATA step to create a response data set.
3. When using a map data set, use the PROC GMAP statement to identify the map data set as the MAP= value and response data set as the DATA= value.
4. Use the ID statement to specify the *id-variable(s)*.
5. Use a BLOCK, CHORO, PRISM, or SURFACE statement to identify the response variable and generate the map.

Accessing SAS Maps and Geocoding Resources Online

Visit SAS Maps and Geocoding online to download data updates, sample SAS/GRAPH programs that use the production-level map data sets delivered with SAS/GRAPH, and GIF images of maps. You are required to access the website with your SAS profile. You might be required to enter your site information. SAS Maps and Geocoding is located at the following URL: https://support.sas.com/en/knowledge-base/maps-geocoding/maps-online.html

After downloading and unzipping map data sets, you must take them out of transport format by running the CIMPORT procedure using your current version of SAS. For more information, see the "CIMPORT Procedure" in *Base SAS Procedures Guide*.

Importing Maps from Esri Shapefiles

You can import Esri shapefiles as map data sets by using the SAS MAPIMPORT procedure. Depending on the type of coordinates that are in your shapefile, you might want to perform additional processing. For example, you might want to project the map with the SAS GPROJECT procedure, or use the SAS GREDUCE procedure to create a DENSITY variable for reducing your data.

For more information, see Chapter 17, "MAPIMPORT Procedure," on page 627.

Syntax: GMAP Procedure

Requirement: The following input data is required:

- An input map data set. If not specified, an input map data set must have been created before issuing the PROC GMAP statement.
- A response data set. If not specified, a response data set must have been created before issuing the PROC GMAP statement.
- One ID statement.
- At least one CHORO, BLOCK, PRISM, or SURFACE statement.

Supported Statements: ATTRIB, BY, FOOTNOTE, FORMAT, GOPTIONS, LABEL, LEGEND, NOTE, PATTERN, TITLE, WHERE

Supports: RUN-group processing

Tip: When using procedures that support RUN-group processing, include a QUIT statement after the last RUN statement. Using the QUIT statement is especially important when the procedure is supposed to completely terminate within the boundaries of an ODS destination (for example, `ODS PDF; procedure-code; ODS PDF CLOSE;`). See "Using Run-Group Processing" in *SAS/GRAPH: Reference* for more information.

PROC GMAP MAP=*map-data-set*
DATA=*response-data-set*
<ALL>
<ANNOTATE=*Annotate-data-set*>
<DENSITY=0-6 | LOW | MEDIUM | HIGH>
<GOUT=<*libref.*>*output-catalog*>
<IMAGEMAP=*output-data-set*>
<LATLON>
<RESOLUTION=1-10 | AUTO | NONE>
<STRETCH>
<UNIFORM>;

ID *id-variable(s)*;

AREA *response-variable* </ *options*>;

BLOCK *response-variable(s)* </ *options*>;

CHORO *response-variable(s)* </ *options*>;

PRISM *response-variable(s)* </ *options*>;

SURFACE *response-variable(s)* </ *options*>;

ATTRIB *variable-list(s) attribute-list(s)*;

BY <DESCENDING> *variable-1*

<... <DESCENDING> *variable-n*>

<NOTSORTED>;

FORMAT *variable-1* <...*variable-n*> <*format-1*> <*variable-1* <...*variable-n*> <*format-2*> > ... <DEFAULT=*default-format*>;

LABEL *variable-1*=*label-1* | ' ' <*variable-n*=*label-n* | ' '> ...;

NOTE<*text-arguments(s)*>;

QUIT;

WHERE *where-expression*;

PROC GMAP Statement

Identifies the map data set and the response data set that contain the variables associated with the map. The statement also provides the option to display all map areas and to specify annotation and an output catalog.

Requirement: Both a map data set and a response data set are required.

Syntax

PROC GMAP MAP=*map-data-set*
DATA=*response-data-set*
<ALL>
<ANNOTATE=*Annotate-data-set*>
<DENSITY=0...6 | LOW | MEDIUM | HIGH>
<GOUT=<*libref.*>*output-catalog*>
<IMAGEMAP=*output-data-set*>
<LATLON>
<RESOLUTION=1 ...10 | AUTO | NONE>
<STRETCH>
<UNIFORM>;

Summary of Optional Arguments

ALL

specifies that the maps generated by the procedure should include all of the map areas from the map data set. This occurs even if the response data set does not include an observation for the map area.

ANNOTATE=*Annotate-data-set*
specifies a data set to annotate all of the maps that are produced by the GMAP procedure.

DENSITY=0...6 | LOW | MEDIUM | HIGH
for maps that have a DENSITY variable, specifies the density of map observations that are used.

GOUT=<*libref*.>*output-catalog*
specifies the SAS catalog in which to save the graphics output that is produced by the GMAP procedure for later replay.

IMAGEMAP=*output-data-set*
creates a temporary SAS data set that is used to generate an image map.

LATLON
specifies that the LAT and LONG variables from the map data set are used for coordinate data instead of the Y and X variables.

RESOLUTION=1...10 | AUTO | NONE
for maps that have a RESOLUTION variable, specifies the resolution level of map observations that are used.

STRETCH
stretches map extents to cover all available space in the device. This might cause the map to be distorted.

UNIFORM
causes the same legend and coloring to be used for all maps produced by the procedure instead of being calculated within each BY group for each map.

Required Arguments

DATA=*response-data-set*
identifies the SAS data set that contains the response values or the response values and the spatial information that are evaluated and represented on the map. If not specified, a response data set must have been created before issuing the PROC GMAP statement.

Default: The GMAP procedure uses the most recently created SAS data set.

Requirements: This statement is required if no response data set was created before issuing the PROC GMAP statement.

A response data set must contain the same identification variable or variables as the specified map data set, along with the values of the response variable.

See: "The SAS Data Set: Your Key to the SAS System" in *Step-by-Step Programming with Base SAS*

"About Data Set Options" in *SAS Data Set Options: Reference*

MAP=*map-data-set*
names a map data set that contains either the X and Y or LAT and LONG coordinates, or all, for the boundary points of each map area. This includes map data sets licensed by SAS from GfK GeoMarketing GmBH and converted by SAS to a SAS data set format.

Requirement This statement is required.

Interaction The map data set must contain the same identification variable or variables as the response data set being used.

See "About Map Data Sets" on page 309

Optional Arguments

PROC GMAP statement options affect all of the graphs that are produced by the procedure.

ALL
specifies that the maps generated by the procedure should include all of the map areas from the map data set. This occurs even if the response data set does not include an observation for the map area. When you use the ALL option and a BY statement in a RUN group, the maps generated for each BY group include every map area from the map data set.

See "Displaying Map Areas and Response Data" on page 330

ANNOTATE=*Annotate-data-set*
specifies a data set to annotate all of the maps that are produced by the GMAP procedure. To annotate individual maps, use the ANNOTATE= option in the action statement.

Alias ANNO=

See "Overview: The Annotate Facility" in *SAS/GRAPH: Reference*

DENSITY=0...6 | LOW | MEDIUM | HIGH
for maps that have a DENSITY variable, specifies the density of map observations that are used. You can specify an integer from 0 to 6 for the DENSITY option, or you can specify one of the descriptors. LOW is equivalent to DENSITY= 1. MEDIUM is equivalent to DENSITY= 3, HIGH is equivalent to DENSITY= 6.

0... 6
The value that you specify indicates the maximum value that the DENSITY variable can have for the observation to be displayed. For example, if you specify DENSITY=5, then only observations in the map data set whose DENSITY value is less than or equal to 5 are displayed.

LOW
LOW is equivalent to DENSITY= 1.

MEDIUM
MEDIUM is equivalent to DENSITY= 3.

HIGH
HIGH is equivalent to DENSITY= 6.

Specifying DENSITY=6 displays all the observations in the map data set.

The DENSITY variable specifies how close a map point is to other map points. If there are many map points in close proximity (high density), then it is possible to eliminate a number of them without seriously degrading the quality of the map. Many map data sets supplied by SAS contain a DENSITY variable. For map data sets that do not contain a DENSITY variable, you can add and populate the variable using the GREDUCE procedure.

If you do not specify the DENSITY= option, nor a RESOLUTION= option, then this is the same as specifying RESOLUTION= AUTO. All of the observations in a map data set are displayed that correspond to the resolution that the device displaying the map is using. This is regardless of whether the input map data set contains a DENSITY variable or not.

Aliases L

MED

M

HI

H

Default DENSITY=6

Restriction If the map data set does not contain a column of DENSITY values, then a warning is issued and the option is ignored.

Interactions When the DENSITY= option is specified, and the RESOLUTION= option is not, the DENSITY= option is used. If the DENSITY= option is not specified, then the RESOLUTION= option is used automatically, regardless of whether it is actually specified. If specified, the RESOLUTION= setting is used. Otherwise, the RESOLUTION= value is set to the numeric level corresponding to the resolution that the device displaying the map is using.

If you specify both the RESOLUTION= and DENSITY= options, and those variables exist in the input map data set, then the RESOLUTION= option takes precedence.

Tip Specifying DENSITY=0 yields a different result than running your code with the DENSITY= option removed.

See Chapter 15, “GREDUCE Procedure,” on page 581 for information about the DENSITY variable.

“RESOLUTION=1...10 | AUTO | NONE” on page 337

Example “Example 9: Producing a Simple Prism Map” on page 461

GOUT=<*libref*.>*output-catalog*

specifies the SAS catalog in which to save the graphics output that is produced by the GMAP procedure for later replay. You can use the GREPLAY procedure to view the graphs stored in the catalog. If you do not use the GOUT= option,

catalog entries are written to the default catalog WORK.GSEG, which is erased at the end of your session.

Restriction Not supported by ActiveX

See "Specifying the Catalog Name and Entry Name for Your GRSEGs " in *SAS/GRAPH: Reference*

IMAGEMAP=*output-data-set*

creates a temporary SAS data set that is used to generate an image map in an SVG file when you are sending output to the LISTING destination. (This option is not necessary when you are sending output to the HTML destination.) The drill-down URLs in the image map must be provided by variables in the input data set. These variables are identified to the procedure with the HTML= and HTML_LEGEND= options.

See "Adding Links and Enhancements with the URL=, HTML=, and HTML_LEGEND= Options" in *SAS/GRAPH: Reference* and "Enhancing Drill-Down Behavior in SVG Presentations Using HTML Attributes" in *SAS/GRAPH: Reference*

LATLON

specifies that the LAT and LONG variables from the map data set are used for coordinate data instead of the Y and X variables. The LAT and LONG variables represent the latitude and longitude coordinates, respectively. All GfK GeoMarketing and most traditional map data sets contain both sets of variables (Y, X, and LAT, LONG) for projected and unprojected maps. By default, the Y and X variables are used to produce a projected map. However, when LATLON is specified, the Y and X variables are no longer required by the GMAP procedure.

Alias LATLONG

Example "Example 4: Projecting an Annotate Data Set" on page 562

RESOLUTION=1...10 | AUTO | NONE

for maps that have a RESOLUTION variable, specifies the resolution level of map observations that are used. The numeric value that you specify indicates the maximum value that the RESOLUTION variable can have for the observation to be displayed. For example, if you specify RESOLUTION=5, then only observations in the map data set whose RESOLUTION value is less than or equal to 5 are displayed.

The RESOLUTION variable specifies the screen resolution at which to display a map point. If there are many map points in close proximity (high density), then it is possible to eliminate a number of them without seriously degrading the quality of the map. Many map data sets supplied by SAS contain a RESOLUTION variable.

You can specify an integer from 1 to 10 for the RESOLUTION option, or you can specify AUTO or NONE.

1...10

The integer correlates to the number of pixels displayed on the map. A low resolution value indicates that a smaller number of pixels is displayed. For example, a RESOLUTION value of 4 equates to 800 x 600 pixels displayed.

AUTO
Specifying AUTO defaults to the resolution setting of the device being used in the GMAP procedure.

NONE
A RESOLUTION set to NONE indicates that the DENSITY option, if specified, is used instead.

If you do not specify the RESOLUTION= option, nor a DENSITY= option, then this is the same as specifying RESOLUTION= AUTO. All of the observations in a map data set are displayed that correspond to the resolution that the device displaying the map is using. This is regardless of whether the input map data set contains a RESOLUTION variable or not.

Alias RES=

Default RESOLUTION=AUTO when the DENSITY option is not specified. When the DENSITY option is specified, RESOLUTION=NONE.

Restriction If the map data set does not contain a column of RESOLUTION values, then a warning is issued and the option is ignored.

Interactions When the DENSITY= option is specified, and the RESOLUTION= option is not, the DENSITY= option is used. If the DENSITY= option is not specified, then the RESOLUTION= option is used automatically, regardless of whether it is actually specified. The RESOLUTION= value is set to the level corresponding to the resolution that the device displaying the map is using.

If you specify both the RESOLUTION= and DENSITY= options, and those variables exist in the input map data set, then the RESOLUTION= option is used. In this case the DENSITY= option is ignored.

See Table 13.33 on page 322 for the correlation between the RESOLUTION value and the number of pixels displayed.

Example “Example 1: Producing a Simple Block Map” on page 436

STRETCH
stretches map extents to cover all available space in the device. This might cause the map to be distorted. When this option is applied to the PROC GMAP statement, it applies to all statements. If applied to a single statement, it applies only to that statement.

Restriction Not supported by ActiveX

UNIFORM
causes the same legend and coloring to be used for all maps produced by the procedure instead of being calculated within each BY group for each map. The UNIFORM option pre-scans the data to generate a categorization across all the data, regardless of BY grouping, and applies that categorization to all maps in the BY group. This results in all maps uniformly displaying legends and coloring such that a single value always has the same color in multiple maps.

When specified in a PROC GMAP statement, UNIFORM applies to all BLOCK, CHORO, AREA, and PRISM statements included within the GMAP run-group.

When omitted from the PROC GMAP statement, and specified on an individual BLOCK, AREA, CHORO, or PRISM statement, UNIFORM applies only to the maps produced by that statement.

ID Statement

Identifies the variable or variables in the input data set(s) that define map areas.

Requirement: At least one *id-variable* is required.

Syntax

ID *id-variable(s)*;

Required Argument

id-variable(s)
identifies one or more variables in the map and response data sets that define a map area. This argument is used only when map and response data sets are specified.

Every variable that is listed in the ID statement must appear in both the map and response data sets. The variable identified by the *id-variable(s)* argument can be of type numeric or character and should have the same name, type, and length in both the response and map data sets.

Note: If the *id-variables* in the response data set and map data set do not have the same length, then your map areas might not be drawn correctly.

See "About Identification Variables" on page 330

Examples "Example 1: Producing a Simple Block Map" on page 436

"Example 3: Assigning a Format to the Response Variable" on page 442

"Example 5: Producing a Simple Choropleth Map" on page 448

AREA Statement

applies color to the regions in BLOCK and PRISM maps based on values of a specified response variable.

Requirement: The response variable is required. The AREA statement must be used in conjunction with either a BLOCK or PRISM statement.

Syntax

AREA *response-variable* </ *options*>;

Summary of Optional Arguments

DISCRETE
: generates a separate response level (color and surface pattern) for each different value of the formatted response variable.

LEGEND=LEGEND<*1...99*>
: specifies the global LEGEND statement to associate with the map.

LEVELS=*number-of-response-levels* | ALL
: specifies the number of response levels to be graphed for the response variable.

MIDPOINTS=*value-list* | OLD
: specifies the response levels for the range of response values that are represented by each level (pattern and color combination).

MISSING
: accepts a missing value as a valid level for the response variable.

NOLEGEND
: suppresses the legend.

PERCENT
: specifies that the GMAP procedure collect all response values (or their statistic) and chart each region as a percentage of the whole.

RANGE
: causes GMAP to display, in the legend, the starting value and ending value of the range around each midpoint specified with the MIDPOINTS= option (instead of displaying just the midpoints).

STATFMT=*format-specification*
: overrides the GMAP default format for percent of PERCENT8.2.

UNIFORM
: causes the same legend and coloring to be used for all maps produced by the procedure instead of being calculated within each BY group for each map.

Mapping options

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for the GMAP procedure to chart.

Required Argument

response-variable
specifies the variable in the response data set. Areas that correspond to response variables with missing values are not colored unless you use the MISSING option in the AREA statement. This variable is represented in all BLOCK and PRISM maps in the same RUN group.

See "About Response Variables" on page 328

Optional Arguments

Options in an AREA statement affect all of the maps that are produced by that statement. You can specify as many options as you want and list them in any order. All of these options are the same as the normal GMAP options except that they apply to the areas of regions only, and not to the bar heights.

DISCRETE
generates a separate response level (color and surface pattern) for each different value of the formatted response variable. The DISCRETE option uses distinct, non-continuous colors for the response values. If, instead, you specify the LEVELS= option, then a color ramp is used to assign each response value a continuous color scheme.

Interaction The LEVELS=*number of midpoints* option is ignored when you use the DISCRETE option.

Note If the data does not contain a value in a particular range of the format, that formatted range is not displayed in the legend.

LEGEND=LEGEND<*1...99*>
specifies the global LEGEND statement to associate with the map. The LEGEND= option is ignored if the specified LEGEND definition is not currently in effect. In the GMAP procedure, the BLOCK statement produces a legend unless you use the NOLEGEND option. If you use the SHAPE= option in a LEGEND statement, only the value BAR is valid. Most of the LEGEND options described in "LEGEND Statement" on page 69 are supported by ActiveX. If a LEGEND option is not supported by ActiveX, it is noted in the LEGEND option definition.

Restriction Partially supported by ActiveX

See "LEGEND Statement" on page 69.

LEVELS=*number-of-response-levels* | ALL
specifies the number of response levels to be graphed for the response variable.

Use LEVELS= to specify the number of response variables when the response variables are numeric. When you specify LEVELS=ALL, all unique numeric or character response variable values are graphed.

Each response level is assigned a different surface pattern and color combination. The prism and block heights are based on the data value of the corresponding response variable.

If you specify the LEVELS= option, then a color ramp is used to assign each response value a continuous color scheme. The response values are assigned lighter and darker values of a color scheme to express lower and higher response values. If you specify the DISCRETE option, then distinct, non-continuous colors are used for the response values.

If neither the LEVELS= option nor the DISCRETE option is used, then the GMAP procedure determines the number of response levels by using the formula FLOOR(1+3.3 log(*n*)), where *n* is the number of response variable values.

The LEVELS=*number-of-response-levels* option is ignored when you use the DISCRETE or MIDPOINTS=*value-list* option. It is also ignored when the response variables are character. When MIDPOINTS=OLD is used with the LEVELS= option, default midpoints are generated using the Nelder algorithm (*Applied Statistics* 25:94–7, 1976).

Default An equal-distribution (quantizing) algorithm is used to determine each level.

Example Here is an example that produces a block map where there are five levels categorized for the blocks.:

```
BLOCK ELECT / LEVELS=5;
AREA CANDIDATE / DISCRETE NOLEGEND;
```

Regions under the blocks are colored by DISCRETE CANDIDATE. No legend is shown for the CANDIDATE values, but a legend is shown for the ELECT values.

MIDPOINTS=*value-list* | OLD

specifies the response levels for the range of response values that are represented by each level (pattern and color combination).

For numeric response variables, *value-list* is either an explicit list of values or a starting value and an ending value with an interval increment, or a combination of both forms:

- *n* < ...*n*>
- *n* TO *n* <BY *increment*>
- *n* < ...*n* > TO *n* <BY *increment*> <*n*< ...*n*>>

By default, the increment value is 1. You can specify discrete numeric values in any order. In all forms, *n* can be separated by blanks or commas. An example is:
`midpoints=(2 4 6) midpoints=(2,4,6) midpoints=(2 to 10 by 2)`

If a numeric variable has an associated format, the specified values must be the *unformatted* values.

For character response variables, *value-list* is a list of unique character values enclosed in quotation marks and separated by blanks:

- *'value-1'* < ...*'value-n'*> `midpoints="Midwest" "Northeast" "Northwest"`

Specify the values in any order. If a character variable has an associated format, the specified values must be the *formatted* values.

You can selectively exclude some response variable values from the map, as shown here: `midpoints="Midwest"`

Only those observations for which the response variable exactly matches one of the values listed in the MIDPOINTS= option are shown on the map. As a result, observations might be excluded inadvertently if values in the list are misspelled or if the case does not match exactly.

Specifying MIDPOINTS=OLD generates default midpoints using the Nelder algorithm (*Applied Statistics* 25:94–7, 1976).

See The RANGE option

MISSING
accepts a missing value as a valid level for the response variable.

NOLEGEND
suppresses the legend.

PERCENT
specifies that the GMAP procedure collect all response values (or their statistic) and chart each region as a percentage of the whole.

Alias PERCENTAGE

Tip You can use the STATISTICS= option to change how the percentage is calculated—whether as a percentage of the SUM, FREQUENCY, or MEAN. If you do not use the STATISTICS= option, then STATISTICS=FIRST is assumed and the response variable of only the first observation of each region is counted. If the response variable is a text field, then STATISTIC=FREQUENCY is used, even if you specify a different value for the STATISTIC= option.

See The "STATFMT=*format-specification*" on page 343 option, and the "STATISTIC=FIRST | SUM | FREQUENCY | MEAN" on page 344 option.

RANGE
causes GMAP to display, in the legend, the starting value and ending value of the range around each midpoint specified with the MIDPOINTS= option (instead of displaying just the midpoints). For example, if MIDPOINTS=15 25 35, then the legend could show 10-20, 20-30, 30-40.

Restrictions The MIDPOINTS= option must be specified for the RANGE option to have any effect.

Not supported by ActiveX.

STATFMT=*format-specification*
overrides the GMAP default format for percent of PERCENT8.2. Use this format when using calculated values. The STATFMT option is typically used when the STATISTIC=FREQUENCY option or the PERCENT option is used.

Aliases SFMT=

SFORMAT=

STATFORMAT=

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for the GMAP procedure to chart. For character variables, FREQUENCY is the only allowed value—any other value is changed to FREQUENCY and a warning is issued. The frequency of a variable does not include missing values unless the MISSING option is specified.

FIRST	GMAP matches the first observation from the DATA= data set and charts the response value from this observation only. This is the default. If more rows exist that are not processed, a warning is issued to the log.
SUM	All observations matching a given ID value are added together and the summed value is charted.
FREQUENCY	A count of all rows with nonmissing values is charted unless you specify the MISSING option.
MEAN	All observations matching a given ID value are added together and then divided by the number of nonmissing observations matched. This value is then charted unless you specify the MISSING option.

Alias STAT=

UNIFORM
causes the same legend and coloring to be used for all maps produced by the procedure instead of being calculated within each BY group for each map. The UNIFORM option prescans the data to generate a categorization across all the data, regardless of BY grouping, and applies that categorization to all maps in the BY group. This results in all maps uniformly displaying legends and coloring such that a single value always has the same color in multiple maps.

When specified in a PROC GMAP statement, the UNIFORM option applies to all AREA, BLOCK, CHORO, and PRISM statements included within the GMAP run-group.

When omitted from the PROC GMAP statement, and specified on an individual AREA, BLOCK, CHORO, or PRISM statement, the UNIFORM option applies only to the maps produced by that statement.

Details

Description

In the case of BLOCK: whereas the BLOCK statement controls the color and appearance of the blocks, the AREA statement controls the color and appearance of the regions under the block.

In the case of PRISM: whereas the PRISM statement controls the height of the prism, the AREA statement controls the color of the region. If you specify an AREA statement, the PRISM statement controls both the color and height.

BLOCK Statement

Creates three-dimensional block maps on which levels of magnitude of the specified response variables are represented by blocks (bars) of varying height, pattern, and color.

Requirement: At least one response variable is required. The ID statement must be used in conjunction with the BLOCK statement.

Supported Statements: FOOTNOTE , LEGEND, PATTERN, TITLE,

Syntax

BLOCK *response-variable(s) </ options>*;

Summary of Optional Arguments

Appearance options

ANNOTATE=*Annotate-data-set*
: specifies a data set to annotate onto maps that are produced by the BLOCK statement.

BLOCKSIZE=*size*
: specifies the width of the blocks.

CBLKOUT=*block-outline-color* | SAME
: outlines all blocks in the specified color.

CDEFAULT=*empty-area-fill-color*
: fills empty map areas in the specified color.

CEMPTY=*empty-area-outline-color*
: outlines empty map areas in the specified color.

COUTLINE=*area-outline-color* | SAME
: outlines non-empty map areas in the specified color.

SHAPE=*3D-block-shape*
: specifies the shape of the blocks.

STRETCH
: stretches map extents to cover all available space in the device.

UNIFORM
: causes the same legend and coloring to be used for all maps produced by the procedure instead of being calculated within each BY group for each map.

WOUTLINE=*block-outline-width*

specifies the width, in pixels, of the outline for all outlined blocks and for the outline of the map areas.

XSIZE=*map-width <units>*
specify the physical width dimension of the map to be drawn.

XVIEW=*x*<YVIEW=*y*><ZVIEW=*z*>
specify coordinates of the viewing position in the reference coordinate system.

YSIZE=*map-height <units>*
specify the physical height dimension of the map to be drawn.

Description options

DESCRIPTION="*description*"
specifies a description of the output.

NAME="*name*"
specifies the name of the GRSEG catalog entry and the name of the graphics output file, if one is created.

Legend options

CTEXT=*text-color*
specifies a color for the text in the legend.

LEGEND=LEGEND<*1-99*>
specifies the global LEGEND statement to associate with the map.

NOLEGEND
suppresses the legend.

Mapping options

AREA=*n* | *column-name*
specifies that a different map pattern be used for the surface of each map area or group of map areas on the map.

DISCRETE
generates a separate response level (color and surface pattern) for each different value of the formatted response variable.

LEVELS=*number-of-response-levels* | ALL
specifies the number of response levels to be graphed for the response variable.

MIDPOINTS=*value-list* | OLD
specifies the response levels for the range of response values that are represented by each level (pattern and color combination).

MISSING
accepts a missing value as a valid level for the response variable.

PERCENT
specifies that the GMAP procedure collect all response values (or their statistic) and chart each region as a percentage of the whole.

RANGE
displays value ranges in the legend.

RELZERO
creates bars and regions that are relative to a zero value.

STATFMT=*format-specification*
overrides the GMAP default format for percent of PERCENT8.2.

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for the GMAP procedure to chart.

ODS options

HTML_LEGEND=*variable*
identifies the variable in the input data set whose values create links or data tips or both.

HTML=*variable*
identifies the variable in the input data set whose values create links or data tips or both.

URL=*character-variable*
specifies a character variable whose values are URLs.

Required Argument

response-variable(s)
specifies one or more variables in the response data set. Each response variable produces a separate map. All variables must be in the input data set. Multiple response variables are separated with blanks. Blocks are not drawn for the response variable with missing values unless you use the MISSING option in the BLOCK statement.

See "About Response Variables" on page 328.

Optional Arguments

Options in a BLOCK statement affect all of the maps that are produced by that statement. You can specify as many options as you want and list them in any order.

ANNOTATE=*Annotate-data-set*
specifies a data set to annotate onto maps that are produced by the BLOCK statement. Annotate coordinate systems 1, 2, 7, and 8 are not valid with block maps.

Alias ANNO=

See "Overview: The Annotate Facility" in *SAS/GRAPH: Reference*.

AREA=*n* | *column-name*
specifies that a different map pattern be used for the surface of each map area or group of map areas on the map. You can specify pattern fills or colors or both with PATTERN statements that specify map and plot patterns. A separate PATTERN definition is needed for each specified area.

n
The value of *n* indicates which variable in the ID statement determines the groups that are distinguished by a surface pattern. By default, all map unit areas are drawn using the same surface fill pattern. If your ID statement has only one map area identification variable, then use AREA=1 to indicate that each map area surface uses a different pattern. If you have more than one variable in your ID statement, then use *n* to indicate the position of the variable that defines groups that share a pattern.

When you use the AREA= option, the map data set should be sorted in order of the variables in the ID statement.

column-name A column name defined in either the MAP= or DATA= data sets might be indicated with the *column-name* value. If the column name exists in both the MAP= and DATA= data sets, the column in the MAP= data set is used. When *column-name* is used, the areas are colored based on the AREA= value. Duplicate AREA= values might be assigned different patterns.

Note The AREA statement provides a greater amount of control than this AREA= option.

See "AREA Statement" on page 340, "PATTERN Statement" on page 106.

BLOCKSIZE=*size*
specifies the width of the blocks. The unit of *size* is the character cell width for the selected output device. By default, BLOCKSIZE=2.

Alias BS=

CBLKOUT=*block-outline-color* | SAME
outlines all blocks in the specified color. The SAME value specifies that the outline color of a block, a block segment, or a legend is the same as the interior pattern color.

The default outline color is determined by the current style.

The CBLKOUT= option is not valid when SHAPE=CYLINDER.

Alias CBLOCK=

Note If you specify empty block patterns (VALUE=EMPTY in a PATTERN statement), you should not change the outline color from the default value, SAME, to a single color. Otherwise, all the outlines are one color and you can distinguish between empty areas only by their size.

CDEFAULT=*empty-area-fill-color*
fills empty map areas in the specified color. This option affects only those map areas that are empty. Empty map areas are generated in block maps only when a map area is omitted from the response data set and the ALL option is included in the PROC GMAP statement.

The default is NONE, which draws the polygon empty, showing the background in the fill area of the polygon.

Aliases CDEF=

DEFCLR=

See The CEMPTY option, the "ALL" on page 335 option, and "Displaying Map Areas and Response Data" on page 330

CEMPTY=*empty-area-outline-color*
outlines empty map areas in the specified color. This option affects only those map areas that are empty. Empty map areas are generated in block maps only

when a map area is omitted from the response data set and the ALL option is included in the PROC GMAP statement.

Alias CE=

Default The default outline color is the same as the default COUTLINE= color.

See The option "ALL" on page 335 and "Displaying Map Areas and Response Data" on page 330.

COUTLINE=*area-outline-color* | SAME

outlines non-empty map areas in the specified color. The SAME value specifies that the outline color of a map area is the same as the interior pattern color.

Alias CO=

Default The default outline color is determined by the current style.

Interaction When COUTLINE= is specified and DEVICE=ACTIVEX, both empty and nonempty map areas are outlined.

Note If you specify empty map patterns (VALUE=EMPTY in a PATTERN statement), then you should not change the outline color from the default value SAME. Otherwise, all the outlines are one color and you cannot distinguish between the empty areas.

CTEXT=*text-color*

specifies a color for the text in the legend. If you omit the CTEXT= option, a color specification is searched for in this order:

- the CTEXT= option in a GOPTIONS statement.
- the default, the text color that is specified in the current style.

The CTEXT= color specification is overridden if you also use the COLOR= suboption of a LABEL= or VALUE= option in a LEGEND definition that is assigned to the map legend. The COLOR= suboption determines the color of the legend label or the color of the legend value descriptions, respectively.

Alias CT=

DESCRIPTION="*description*"

specifies a description of the output. The maximum length for *description* is 256 characters. The description does not appear in the output. The descriptive text is shown in each of the following:

- the chart description for web output (depending on the device driver). See "Chart Descriptions for Web Presentations" in *SAS/GRAPH: Reference* for more information.
- the Table of Contents that is generated when you use the CONTENTS= option in an ODS HTML statement, assuming that the output is generated while the contents page is open.
- the description and the properties for the output in the Results tab.
- the description and properties for the catalog entry in the Explorer.

The *description* can include the #BYLINE, #BYVAL, and #BYVAR substitution options, which work as they do when used on TITLE, FOOTNOTE, and NOTE statements. Refer to "Substituting BY Line Values in a Text String" on page 160. The 256-character limit applies before the substitution takes place for these options. Thus, if in the SAS program the entry-description text exceeds 256 characters, it is truncated to 256 characters, and then the substitution is performed.

Alias DES=

Default BLOCK MAP OF *variable-name*

DISCRETE
generates a separate response level (color and surface pattern) for each different value of the formatted response variable.

The DISCRETE option uses distinct, non-continuous colors for the response values. If, instead, you specify the LEVELS= option, then a color ramp is used to assign each response value a continuous color scheme.

Interaction The LEVELS=*number-of-response-levels* option is ignored when you use the DISCRETE option.

Note If the data does not contain a value in a particular range of the format, that formatted range is not displayed in the legend.

HTML=*variable*
identifies the variable in the input data set whose values create links or data tips or both. The variable values are either links or data tips or both that are created in the HTML file generated by the ODS statement. The links are URLs pointing to web pages to display when the user clicks (drills down) on elements in the graph. Data tips are detailed information or data values that are displayed as pop-up text when a mouse pointer is positioned over elements in the graph.

Interaction When multiple observations exist in the input data set for one variable value, the first observation is used for the data tip. When that same input data set is used for an annotate data set, the last of the multiple observations is used for the annotation. Sort the data one way for the data tip and the opposite way for the annotation to alleviate any mismatch between the data tip and its annotation in the resulting graph.

See "Data Tips for Web Presentations" in *SAS/GRAPH: Reference*

"Adding Links and Enhancements with the URL=, HTML=, and HTML_LEGEND= Options" in *SAS/GRAPH: Reference*

HTML_LEGEND=*variable*
identifies the variable in the input data set whose values create links or data tips or both. Input data set variable values are either links or data tips or both that are created in the HTML file generated by the ODS statement. The links are associated with a legend value and point to the URL to display when the user clicks (drills down) on the value. Data tips are detailed information or data

values that are displayed as pop-up text when a mouse pointer is positioned over values in the legend.

Restriction Not supported by ActiveX

See "Adding Links and Enhancements with the URL=, HTML=, and HTML_LEGEND= Options" in *SAS/GRAPH: Reference*

LEGEND=LEGEND<*1-99*>
specifies the global LEGEND statement to associate with the map. The LEGEND= option is ignored if the specified LEGEND definition is not currently in effect. In the GMAP procedure, the BLOCK statement produces a legend unless you use the NOLEGEND option. If you use the SHAPE= option in a LEGEND statement, only the value BAR is valid. Most of the LEGEND options described in "LEGEND Statement" on page 69 are supported by ActiveX. If a LEGEND option is not supported by ActiveX, it is noted in the LEGEND option definition.

Restriction Partially supported by ActiveX

See "LEGEND Statement" on page 69

LEVELS=*number-of-response-levels* | ALL
specifies the number of response levels to be graphed for the response variable.

If you specify LEVELS=ALL, then all unique numeric or character response variable values are graphed.

Each response level is assigned a different surface pattern and color combination. The block height is based on the data value of the corresponding response variable.

If you specify the LEVELS= option, then a color ramp is used to assign each response value a continuous color scheme. The response values are assigned lighter and darker values of a color scheme to express lower and higher response values. If you specify the DISCRETE option, then distinct, non-continuous colors are used for the response values.

If neither the LEVELS= option nor the DISCRETE option is used, then the GMAP procedure determines the number of response levels by using the formula FLOOR(1+3.3 log(*n*)), where *n* is the number of response variable values.

By default, an equal-distribution (quantizing) algorithm is used to determine each level.

The LEVELS=*number-of-response-levels* option is ignored when you use the DISCRETE or MIDPOINTS=*value-list* option. It is also ignored when the response variables are character. When MIDPOINTS=OLD is used with the LEVELS= option, default midpoints are generated using the Nelder algorithm (*Applied Statistics* 25:94–7, 1976).

MIDPOINTS=*value-list* | OLD
specifies the response levels for the range of response values that are represented by each level (pattern and color combination).

For numeric response variables, *value-list* is either an explicit list of values or a starting value and an ending value with an interval increment, or a combination of both forms:

- *n* < ...*n*>
- *n* TO *n* <BY *increment*>
- *n* < ...*n* > TO *n* <BY *increment*> <*n*< ...*n*>>

By default, the increment value is 1. You can specify discrete numeric values in any order. In all forms, *n* can be separated by blanks or commas. For example: `midpoints=(2 4 6) midpoints=(2,4,6) midpoints=(2 to 10 by 2)`

If a numeric variable has an associated format, the specified values must be the *unformatted* values.

For character response variables, *value-list* is a list of unique character values enclosed in quotation marks and separated by blanks:

- '*value-1*' < ...'*value-n*'> `midpoints="Midwest" "Northeast" "Northwest"`

Specify the values in any order. If a character variable has an associated format, the specified values must be the *formatted* values.

You can selectively exclude some response variable values from the map, as shown here: `midpoints="Midwest"`

Only those observations for which the response variable exactly matches one of the values listed in the MIDPOINTS= option are shown on the map. As a result, observations might be excluded inadvertently if values in the list are misspelled or if the case does not match exactly.

Specifying MIDPOINTS=OLD generates default midpoints using the Nelder algorithm (*Applied Statistics* 25:94–7, 1976).

Restriction Partially supported by ActiveX

See The RANGE option

Example "Example 28: Specifying Midpoints in a Prism Map When Using Traditional Map Data" on page 517

MISSING
accepts a missing value as a valid level for the response variable.

See "Displaying Map Areas and Response Data" on page 330.

NAME="*name*"
specifies the name of the GRSEG catalog entry and the name of the graphics output file, if one is created.

The following applies to *name*:

- The name can be up to 256 characters in length.
- Special characters in the name are converted to underscores.
- **For the GRSEG entry name:**
  - The name is truncated to eight characters.
  - The first character is always represented in uppercase, and all other characters are represented in lowercase.
  - If the name begins with a number, an underscore is prepended to the name.

- If the name duplicates an existing name, SAS/GRAPH appends a number or increments the last number used to create a unique graph name (for example, *name*1, *name*2, and so on). If necessary, the name is truncated so that the name and appended number do not exceed eight characters.

- **For the graphics output filename:**

- The filename is based on the NAME= value except when you use a DEVICE= option and a file reference specifying an output filename. In this case, the file reference specification overrides the NAME= value.
- All characters are represented in lowercase.
- If a number is added to the GRSEG name, the same number is added to the output filename. See "About Filename Indexing" in *SAS/GRAPH: Reference*.
- If the NAME= value is 8 characters or less, the filename is the GRSEG entry name.
- If the NAME= value is greater than 8 characters, the NAME= value is used as the filename. When an index number is used in the GRSEG entry name, that index number is appended to the output filename. See "About Filename Indexing" in *SAS/GRAPH: Reference*.
- The maximum allowable filename length is device-specific. If the length of the name exceeds the maximum for the graphics device, an error results and no graphics output file is generated.

Default GMAP

NOLEGEND
suppresses the legend.

PERCENT
specifies that the GMAP procedure collect all response values (or their statistic) and chart each region as a percentage of the whole. You can use the STATISTIC= option to change how the percentage is calculated—whether as a percentage of the SUM, FREQUENCY, or MEAN. If you do not use the STATISTIC= option, then STATISTIC=FIRST is assumed and the response variable of only the first observation of each region is counted. If the response variable is a text field, then STATISTIC=FREQUENCY is used, even if you specify a different value for the STATISTIC= option.

Alias PERCENTAGE

See The "STATFMT=*format-specification*" on page 354option, and the "STATISTIC=FIRST | SUM | FREQUENCY | MEAN" on page 354 option.

RANGE
causes GMAP to display, in the legend, the starting value and ending value of the range around each midpoint specified with the MIDPOINTS= option (instead of displaying just the midpoints). For example, if MIDPOINTS=15 25 35, then the legend could show 10-20, 20-30, 30-40.

Restriction MIDPOINTS= must be specified for the RANGE option to have any effect. Not supported by ActiveX.

RELZERO
creates bars and regions that are relative to a zero value. With the RELZERO option, zero value bars have no height.

Aliases RELO

RELATIVETOZERO

Default The GMAP procedure creates heights that are relative to the minimum value, which might or might not be zero.

Restriction This option works only for variables that have no negative values.

SHAPE=*3D-block-shape*
specifies the shape of the blocks. Use this option to enhance the look of the block shape, or to specify a different shape. Unless you specify SHAPE=OLD, only solid fill patterns are used. The value of *3D-block-shape* can be one of the following:

- BLOCK | B
- CYLINDER | C
- HEXAGON | H
- OLDBLOCK | OLD

  Note: OLDBLOCK is the same as BLOCK except that with OLDBLOCK the tops and sides of blocks are colored the same as the background. This exception existed prior to the SAS 9.2 release.

- PRISM | P
- STAR | S

Default BLOCK

Interaction The CBLKOUT= option is not valid when SHAPE=CYLINDER.

STATFMT=*format-specification*
overrides the GMAP default format for percent of PERCENT8.2. Use this format when using calculated values. The STATFMT option is typically used when the STATISTIC=FREQUENCY option or the PERCENT option is used.

Aliases SFMT=

SFORMAT=

STATFORMAT=

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for the GMAP procedure to chart. For character variables, FREQUENCY is the only allowed value—any other value is changed to FREQUENCY and a warning is issued. The frequency of a variable does not include missing values unless the MISSING option is specified.

FIRST GMAP matches the first observation from the DATA= data set and charts the response value from this observation only. This is the default. If more rows exist that are not processed, a warning is issued to the log.

SUM All observations matching a given ID value are added together and the summed value is charted.

FREQUENCY A count of all rows with nonmissing values is charted unless you specify the MISSING option.

MEAN All observations matching a given ID value are added together and then divided by the number of nonmissing observations matched. This value is then charted unless you specify the MISSING option.

Alias STAT=

STRETCH
stretches map extents to cover all available space in the device. This might cause the map to be distorted. When this option is applied to the PROC GMAP statement, it applies to all statements. If applied to a single statement, it applies only to that statement.

Aliases STRETCHTOFIT

STR2FIT

Restriction Not supported by ActiveX

UNIFORM
causes the same legend and coloring to be used for all maps produced by the procedure instead of being calculated within each BY group for each map. The UNIFORM option prescans the data to generate a categorization across all the data, regardless of BY grouping, and applies that categorization to all maps in the BY group. This results in all maps uniformly displaying legends and coloring such that a single value always has the same color in multiple maps.

When specified in a PROC GMAP statement, the UNIFORM option applies to all AREA, BLOCK, CHORO, and PRISM statements included within the GMAP run-group.

When omitted from the PROC GMAP statement, and specified on an individual AREA, BLOCK, CHORO, or PRISM statement, the UNIFORM option applies only to the maps produced by that statement.

URL=*character-variable*
specifies a character variable whose values are URLs. The variable values are URLs for web pages to display when the user clicks (drills down) on elements in the graph.

Restriction This option affects graphics output that is created through the ODS HTML destination only.

Interaction If you specify both the HTML= option and URL= option, then the URL= option is ignored.

See "Overview of Enhancing Web Presentations" in *SAS/GRAPH: Reference*

"Example: GIF Output with Drill-Down Links" in *SAS/GRAPH: Reference*

WOUTLINE=*block-outline-width*
specifies the width, in pixels, of the outline for all outlined blocks and for the outline of the map areas.

Default WOUTLINE=1

XSIZE=*map-width <units>*
specify the physical width dimension of the map to be drawn. Valid *units* are CELLS (character cells), CM (centimeters), IN (inches), or PCT (percentage of the graphics output area).

Defaults The default unit is CELLS.

The map uses the entire procedure output area.

Restrictions If you specify a value for *map-width* that is greater than the width dimension of the procedure output area, the map is drawn using the default size.

Not supported by ActiveX

YSIZE=*map-height <units>*
specify the physical height dimension of the map to be drawn. Valid *units* are CELLS (character cells), CM (centimeters), IN (inches), or PCT (percentage of the graphics output area).

Defaults The default unit is CELLS.

The map uses the entire procedure output area.

Restrictions If you specify a value for *map-height* that is greater than the height dimension of the procedure output area, the map is drawn using the default size.

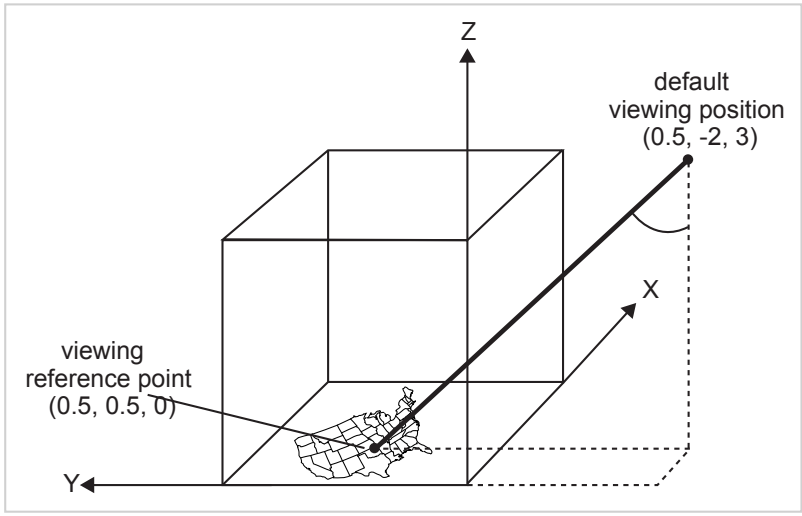
Not supported by ActiveX

XVIEW=*x*<YVIEW=*y*><ZVIEW=*z*>
specify coordinates of the viewing position in the reference coordinate system. You can specify one, two, or all three of the view coordinates. Any that you do not specify are assigned the default values.

The four corners of the map lie on the X-Y plane at coordinates (0,0,0), (0,1,0), (1,1,0), and (1,0,0). No axes are actually drawn on the maps that are produced by the GMAP procedure.

Figure 13.31 on page 357 shows the position of the viewing reference point, as well as the default viewing position.

Figure 13.5 *Viewing Position and Viewing Reference Point*



Aliases XV=

YV=

ZV=

Default If you omit the XVIEW=, YVIEW=, and ZVIEW= options, the default coordinates are (0.5, −2, 3). This viewing position is well above and to the south of the center of the map.

Restrictions Your viewing position cannot coincide with the viewing reference point at coordinates (0.5,0.5,0), the center of the map.

The value for *z* cannot be negative.

Details

Description

The BLOCK statement specifies the variable or variables that contain the data that are represented on the map by blocks of varying height, pattern, and color. This statement automatically performs the following operations:

- determines the midpoints ranges.
- scales the blocks.
- assigns patterns to the block faces and map areas. (See "About Block Maps and Patterns" on page 358 for more information.)

You can use statement options to enhance the appearance of the map. For example, you can specify the width and shape of the blocks, the outline colors for the blocks and the map areas, and the angle of view. Other statement options control the response levels.

In addition, you can use global statements to modify the block patterns, the map patterns, and the legend, as well as to add titles and footnotes to the map. You can also use an Annotate data set to enhance the map.

About Block Maps and Patterns

Block maps are different from other maps in that they display two different types of areas that use patterns:

- the blocks themselves, which represent the response levels
- the map areas from which the blocks rise

By default, block patterns are determined by the current style. When specifying the AREA statement or the AREA= option, the map area colors are determined by the current style and the block colors are determined by the specified attributes.

The BLOCK statement has the following options that explicitly control the outline colors used by the blocks and the map areas:

- CBLKOUT=
- CEMPTY=
- COUTLINE=

In addition, the AREA= option and AREA statement control how the map areas are patterned.

When you use PATTERN statements to define the patterns for the map, you must specify the correct type of pattern for the area. The blocks use bar and block patterns and the map areas use map and plot patterns. See "PATTERN Statement" on page 106 for more information about specifying patterns.

Note: If you specify only one PATTERN statement and include only the COLOR= option, that color is used for both the blocks and the map areas. For example, this statement makes the blocks solid blue and the map areas blue hatch.

```
pattern1 color=blue;
```

Note: If you specify a PATTERN statement to define a non-solid fill pattern but do not specify the BLOCK statement's SHAPE=OLD option, the blocks are filled with solid patterns.

CHORO Statement

Creates two-dimensional maps in which values of the specified response variables are represented by varying patterns and colors.

Requirement: At least one response variable is required. The ID statement must be used in conjunction with the CHORO statement

Supported Statements: FOOTNOTE , NOTE, LEGEND, PATTERN, TITLE

Syntax

CHORO *response-variable(s)* </ *options*>;

Summary of Optional Arguments

Appearance options

ANNOTATE=*Annotate-data-set*
: specifies a data set to annotate onto maps that are produced by the CHORO statement.

CDEFAULT=*empty-area-fill-color*
: fills empty map areas in the specified color.

CEMPTY=*empty-area-outline-color*
: outlines empty map areas in the specified color.

COUTLINE=*area-outline-color* | SAME
: outlines non-empty map areas in the specified color.

OSM<=(STYLE=osmstyle<AUTOPROJECT>)>
: specifies an OpenStreetMap (OSM) style and can project the unprojected map areas from latitude and longitude degrees onto the OSM map.

STRETCH
: stretches map extents to cover all available space in the device.

UNIFORM
: causes the same legend and coloring to be used for all maps produced by the procedure instead of being calculated within each BY group for each map.

WOUTLINE=*area-outline-width*
: specifies the width of all map area outlines, in pixels.

XSIZE=*map-width <units>* | YSIZE=*map-height <units>*
: specify the physical width or height dimension of the map.

Description options

DESCRIPTION="*description*"
: specifies a description of the output.

NAME="*name*"
: specifies the name of the GRSEG catalog entry and the name of the graphics output file, if one is created.

Legend options

CTEXT=*text-color*
: specifies a color for the text in the legend.

LEGEND=LEGEND<*1-99*>

assigns the specified global LEGEND statement that is to be applied to the map.

NOLEGEND
suppresses the legend.

Mapping options

DISCRETE
generates a separate response level (color and surface pattern) for each different value of the formatted response variable.

LEVELS=*number-of-response-levels* | ALL
specifies the number of response levels to be graphed for the response variable.

MIDPOINTS=*value-list* | OLD
specifies the response levels for the range of response values that are represented by each level (pattern and color combination).

MISSING
accepts a missing value as a valid level for the response variable.

PERCENT
specifies that the GMAP procedure collect all response values (or their statistic) and chart each region as a percentage of the whole.

RANGE
displays value ranges in the legend.

STATFMT=*format-specification*
overrides the GMAP default format for percent of PERCENT8.2.

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for the GMAP procedure to chart.

ODS options

HTML_LEGEND=*variable*
identifies the variable in the input data set whose values create links or data tips or both.

HTML=*variable*
identifies the variable in the input data set whose values create links or data tips or both.

URL=*character-variable*
specifies a character variable whose values are URLs.

Required Argument

response-variable(s)
specifies one or more variables in the response data set. Each response variable produces a separate map. All variables must be in the input data set. Multiple response variables are separated with blanks.

Missing values for the response variable are not considered valid response values unless you use the MISSING option in the CHORO statement.

Response variables can be either numeric or character in type. Numeric response variables are normally grouped into ranges, or response levels, as determined by default, or by the MIDPOINTS= or LEVELS=*number-of-response-*

levels options. Each response level is assigned a different combination of pattern and color. With the LEVELS=ALL option, numeric or character response variables are assigned unique response levels, as are numeric variables when the DISCRETE option is specified. The LEVELS=*number-of-response-levels* option is ignored when either the DISCRETE or MIDPOINTS= option is used.

See "About Response Variables" on page 328.

Optional Arguments

Options in a CHORO statement affect all graphs that are produced by that statement. You can specify as many options as you want and list them in any order.

ANNOTATE=*Annotate-data-set*
specifies a data set to annotate onto maps that are produced by the CHORO statement.

Alias ANNO=

See "Overview: The Annotate Facility" in *SAS/GRAPH: Reference*

Example "Example 7: Labeling Provinces on a Map" on page 456

CDEFAULT=*empty-area-fill-color*
fills empty map areas in the specified color. This option affects only those map areas that are empty. Empty map areas are generated in choro maps only when there is no response value for a map area and the MISSING option is not used. They are also generated when a map area is omitted from the response data set and the ALL option is included in the PROC GMAP statement.

The default is NONE, which draws the polygon empty, showing the background in the fill area of the polygon.

Aliases CDEF=

DEFCLR=

See The CEMPTY option, the "ALL" on page 335, and "Displaying Map Areas and Response Data" on page 330

CEMPTY=*empty-area-outline-color*
outlines empty map areas in the specified color. This option affects only the empty map areas, which are generated in choro maps when either of the following is true:

- There is no response value for a map area and the MISSING option is not used.
- A map area is omitted from the response data set and the ALL option is included in the PROC GMAP statement.

Alias CE=

Default The default outline color is the same as the default COUTLINE= color.

See The option "ALL" on page 335 and "Displaying Map Areas and Response Data" on page 330.

COUTLINE=*area-outline-color* | SAME
outlines non-empty map areas in the specified color. When COUTLINE=*area-outline-color* and DEVICE=ACTIVEX, both empty and non-empty map areas are outlined. The value SAME specifies that the outline color of a map area is the same as the interior pattern color.

The default outline color is determined by the current style.

Alias CO=

Note If you specify empty map patterns (VALUE=EMPTY in a PATTERN statement), then you should not change the outline color from the default value SAME to a single color. Otherwise, all the outlines are one color and you cannot distinguish between the empty areas.

CTEXT=*text-color*
specifies a color for the text in the legend. If you omit the CTEXT= option, a color specification is searched for in this order:

- the CTEXT= option in a GOPTIONS statement.
- the default, the text color that is specified in the current style.

Alias CT=

Interaction The CTEXT= color specification is overridden if you also use the COLOR= suboption of a LABEL= or VALUE= option in a LEGEND definition that is assigned to the map legend. The COLOR= suboption determines the color of the legend label or the color of the legend value descriptions, respectively.

DESCRIPTION="*description*"
specifies a description of the output. The maximum length for *description* is 256 characters. The description does not appear in the output. The descriptive text is shown in each of the following:

- the chart description for web output (depending on the device driver). See "Chart Descriptions for Web Presentations" in *SAS/GRAPH: Reference* for more information.
- the Table of Contents that is generated when you use the CONTENTS= option in an ODS HTML statement, assuming that the output is generated while the contents page is open.
- the description and the properties for the output in the Results tab.
- the description and properties for the catalog entry in the Explorer.

The *description* can include the #BYLINE, #BYVAL, and #BYVAR substitution options, which work as they do when used on TITLE, FOOTNOTE, and NOTE statements. Refer to "Substituting BY Line Values in a Text String" on page 160. The 256-character limit applies before the substitution takes place for these options. Thus, if in the SAS program the entry-description text exceeds 256

characters, it is truncated to 256 characters, and then the substitution is performed.

Alias DES=

Default CHOROPLETH MAP OF *variable-name*

DISCRETE
generates a separate response level (color and surface pattern) for each different value of the formatted response variable.

The LEVELS=*number-of-response-levels* option is ignored when you use the DISCRETE option.

The DISCRETE option uses distinct, non-continuous colors for the response values. If, instead, you specify the LEVELS= option, then a color ramp is used to assign each response value a continuous color scheme.

Note If the data does not contain a value in a particular range of the format, that formatted range is not displayed in the legend.

HTML=*variable*
identifies the variable in the input data set whose values create links or data tips or both. The variable values are either links or data tips or both that are created in the HTML file generated by the ODS statement. The links are URLs pointing to web pages to display when the user clicks (drills down) on elements in the graph. Data tips are detailed information or data values that are displayed as pop-up text when a mouse pointer is positioned over elements in the graph.

Interaction When multiple observations exist in the input data set for one variable value, the first observation is used for the data tip. When that same input data set is used for an annotate data set, the last of the multiple observations is used for the annotation. Sort the data one way for the data tip and the opposite way for the annotation to alleviate any mismatch between the data tip and its annotation in the resulting graph.

See "Data Tips for Web Presentations" in *SAS/GRAPH: Reference*

"Adding Links and Enhancements with the URL=, HTML=, and HTML_LEGEND= Options" in *SAS/GRAPH: Reference*

HTML_LEGEND=*variable*
identifies the variable in the input data set whose values create links or data tips or both. Input data set variable values are either links or data tips or both that are created in the HTML file generated by the ODS statement. The links are associated with a legend value and point to the URL to display when the user clicks (drills down) on the value. Data tips are detailed information or data values that are displayed as pop-up text when a mouse pointer is positioned over values in the legend.

Restriction Not supported by ActiveX

See "Adding Links and Enhancements with the URL=, HTML=, and HTML_LEGEND= Options" in *SAS/GRAPH: Reference*

LEGEND=LEGEND<*1-99*>
assigns the specified global LEGEND statement that is to be applied to the map. The LEGEND= option is ignored if the specified LEGEND definition is not currently in effect. In the GMAP procedure, the CHORO statement produces a legend by default unless you specify the NOLEGEND option. If you use the SHAPE= option in a LEGEND statement, then only the value BAR is valid. Most of the LEGEND options described in "LEGEND Statement" on page 69 are supported by both Java and ActiveX. If a LEGEND option is not supported by Java or ActiveX, it is noted in the LEGEND option definition.

Restriction Partially supported by ActiveX

See "LEGEND Statement" on page 69

Example "Example 3: Assigning a Format to the Response Variable" on page 442

LEVELS=*number-of-response-levels* | ALL
specifies the number of response levels to be graphed for the response variable.

If you specify LEVELS=ALL, then all unique numeric or character response variable values are graphed.

Each response level is assigned a different surface pattern and color combination.

If you specify the LEVELS= option, then a color ramp is used to assign each response value a continuous color scheme. The response values are assigned lighter and darker values of a color scheme to express lower and higher response values. If you specify the DISCRETE option, then distinct, non-continuous colors are used for the response values.

If neither the LEVELS= option nor the DISCRETE option is used, then the GMAP procedure determines the number of response levels by using the formula FLOOR(1+3.3 log(*n*)), where *n* is the number of response variable values.

When MIDPOINTS=OLD is used with the LEVELS= option, default midpoints are generated using the Nelder algorithm (*Applied Statistics* 25:94–7, 1976).

Default An equal-distribution (quantizing) algorithm is used to determine each level.

Restriction The LEVELS=*number-of-response-levels* option is ignored when you use the DISCRETE or MIDPOINTS=*value-list* option. It is also ignored when the response variables are character.

Example "Example 2: Specifying Response Levels in a Block Map" on page 439

MIDPOINTS=*value-list* | OLD
specifies the response levels for the range of response values that are represented by each level (pattern and color combination).

For numeric response variables, the *value-list* argument is either an explicit list of values, a starting value and an ending value with an interval increment, or a combination of both forms:

- *n* < ...*n*>
- *n* TO *n* <BY *increment* >
- *n* < ...*n*> TO *n* <BY *increment* > *n* < ...*n*>

By default the increment value is 1. You can specify discrete numeric values in any order. In all forms, *n* can be separated by blanks or commas. For example: `midpoints=(2 4 6) midpoints=(2,4,6) midpoints=(2 to 10 by 2)`

If a numeric variable has an associated format, the specified values must be the *unformatted* values.

For character response variables, *value-list* is a list of unique character values enclosed in quotation marks and separated by blanks:

- *'value-1'* < ...*'value-n'*>

The values are character strings enclosed in single quotation marks and separated by blanks. For example: `midpoints="Midwest" "Northeast" "Northwest"`

Specify the values in any order. If a character variable has an associated format, the specified values must be the *formatted* values.

You can selectively exclude some response variable values from the map, as shown here: `midpoints="Midwest"`

The only observations that are shown on the map are those observations for which the response variable exactly matches one of the values that are listed in the MIDPOINTS= option. As a result, observations might be excluded inadvertently if values in the list are misspelled or if the case does not match exactly.

Specifying MIDPOINTS=OLD generates default midpoints using the Nelder algorithm (*Applied Statistics* 25:94–7, 1976).

See The RANGE option

Example "Example 28: Specifying Midpoints in a Prism Map When Using Traditional Map Data" on page 517

MISSING
accepts a missing value as a valid level for the response variable.

See "Displaying Map Areas and Response Data" on page 330

NAME="*name*"
specifies the name of the GRSEG catalog entry and the name of the graphics output file, if one is created.

The following applies to *name*:

- The name can be up to 256 characters in length.
- Special characters in the name are converted to underscores.
- **For the GRSEG entry name:**
  - The name is truncated to eight characters.

- The first character is always represented in uppercase, and all other characters are represented in lowercase.
- If the name begins with a number, an underscore is prepended to the name.
- If the name duplicates an existing name, SAS/GRAPH appends a number or increments the last number used to create a unique graph name (for example, *name*1, *name*2, and so on). If necessary, the name is truncated so that the name and appended number do not exceed eight characters.

- **For the graphics output filename:**

- The filename is based on the NAME= value except when you use a DEVICE= option and a file reference specifying an output filename. In this case, the file reference specification overrides the NAME= value.
- All characters are represented in lowercase.
- If a number is added to the GRSEG name, the same number is added to the output filename. See "About Filename Indexing" in *SAS/GRAPH: Reference*.
- If the NAME= value is 8 characters or less, the filename is the GRSEG entry name.
- If the NAME= value is greater than 8 characters, the NAME= value is used as the filename. When an index number is used in the GRSEG entry name, that index number is appended to the output filename. See "About Filename Indexing" in *SAS/GRAPH: Reference*.
- The maximum allowable filename length is device-specific. If the length of the name exceeds the maximum for the graphics device, an error results and no graphics output file is generated.

Default GMAP

NOLEGEND
suppresses the legend.

Example "Example 7: Labeling Provinces on a Map" on page 456

OSM<=(STYLE=osmstyle<AUTOPROJECT>)>
specifies an OpenStreetMap (OSM) style and can project the unprojected map areas from latitude and longitude degrees onto the OSM map. This is an appearance option that enables you to use the OpenStreetMap (OSM) map as a background map. You can specify no suboptions, optionally use either a STYLE= suboption or an AUTOPROJECT suboption, or use both suboptions.

If you specify the OSM option without any suboptions, the GMAP procedure by default uses the SASMAPNIK style and does not project the map.

If you specify the STYLE=osmstyle suboption only, the GMAP procedure uses one of the supported OSM styles that are appropriate for the map that you are processing (for example, SASMAPNIK or SASMAPNIK_LITE). Because the AUTOPROJECT suboption is not specified, the GMAP procedure does not project the map.

If you specify the OSM option with the AUTOPROJECT suboption only, the GMAP procedure projects the map area from latitude and longitude coordinates

(in degrees) onto the OSM map. Because the STYLE suboption is not specified, the procedure uses the default SASMAPNIK style.

If you specify the OSM option with both the STYLE= and AUTOPROJECT suboptions, then the GMAP procedure uses one of the supported OSM styles that are appropriate for the map that you are processing. It projects the map area from latitude and longitude coordinates (in degrees) onto the OSM map.

Alias SHOWOSM

Default The default STYLE is SASMAPNIK. The map is not projected unless you specify the AUTOPROJECT suboption.

Restrictions The OSM option supports only the JAVAIMG device.

If the map area is already projected, do not specify the AUTOPROJECT suboption, or you will receive unexpected results.

PERCENT

specifies that the GMAP procedure collect all response values (or their statistic) and chart each region as a percentage of the whole. You can use the STATISTIC= option to change how the percentage is calculated—whether as a percentage of the SUM, FREQUENCY, or MEAN. If you do not use the STATISTIC= option, then STATISTIC=FIRST is assumed–the response variable of only the first observation of each region is counted. If the response variable is a text field, then STATISTIC=FREQUENCY is used, even if you specify a different value for the STATISTIC= option.

Alias PERCENTAGE

See The "STATFMT=*format-specification*" on page 367 option, and the "STATISTIC=FIRST | SUM | FREQUENCY | MEAN" on page 368 option.

RANGE

causes GMAP to display, in the legend, the starting value and ending value of the range around each midpoint specified with the MIDPOINTS= option (instead of displaying just the midpoints). For example, if MIDPOINTS=15 25 35, then the legend could show 10-20, 20-30, 30-40.

Restrictions The MIDPOINTS= option must be specified for the RANGE option to have any effect.

Not supported by ActiveX

STATFMT=*format-specification*

overrides the GMAP default format for percent of PERCENT8.2. Use this format when using calculated values. The STATFMT option is typically used when the STATISTIC=FREQUENCY option or the PERCENT option is used.

Aliases SFMT=

SFORMAT=

STATFORMAT=

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for the GMAP procedure to chart. For character variables, FREQUENCY is the only allowed value—any other value is changed to FREQUENCY and a warning is issued. The frequency of a variable does not include missing values unless the MISSING option is specified.

FIRST	GMAP matches the first observation from the DATA= data set and charts the response value from this observation only. This is the default. If more rows exist that are not processed, a warning is issued to the log.
SUM	All observations matching a given ID value are added together and the summed value is charted.
FREQUENCY	A count of all rows with nonmissing values is charted unless you specify the MISSING option.
MEAN	All observations matching a given ID value are added together and then divided by the number of nonmissing observations matched. This value is then charted unless you specify the MISSING option.

Alias STAT=

STRETCH
stretches map extents to cover all available space in the device. This might cause the map to be distorted. When this option is applied to the PROC GMAP statement, it applies to all statements. If applied to a single statement, it applies only to that statement.

Aliases STRETCHTOFIT

STR2FIT

Restriction Not supported by ActiveX

UNIFORM
causes the same legend and coloring to be used for all maps produced by the procedure instead of being calculated within each BY group for each map. The UNIFORM option prescans the data to generate a categorization across all the data, regardless of BY grouping, and applies that categorization to all maps in the BY group. This results in all maps uniformly displaying legends and coloring such that a single value always has the same color in multiple maps.

When specified in a PROC GMAP statement, UNIFORM applies to all AREA, BLOCK, CHORO, and PRISM statements included within the GMAP run-group.

When omitted from the PROC GMAP statement, and specified on an individual AREA, BLOCK, CHORO, or PRISM statement, UNIFORM applies only to the maps produced by that statement.

URL=*character-variable*
specifies a character variable whose values are URLs. The variable values are URLs for web pages to display when the user clicks (drills down) on elements in the graph. The variable values are URLs for web pages to display when the user clicks (drills down) on elements in the graph.

Restriction This option affects graphics output that is created through the ODS HTML destination only.

Interaction If you specify both the HTML= and URL= options, then the URL= option is ignored

See "Overview of Enhancing Web Presentations" in *SAS/GRAPH: Reference*

"Example: GIF Output with Drill-Down Links" in *SAS/GRAPH: Reference*

WOUTLINE=*area-outline-width*
specifies the width of all map area outlines, in pixels.

Default WOUTLINE=1

XSIZE=*map-width <units>* | YSIZE=*map-height <units>*
specify the physical width or height dimension of the map. Valid *units* are CELLS (character cells), CM (centimeters), IN (inches), or PCT (percentage of the graphics output area).

Defaults The default unit is CELLS.

The map uses the entire procedure output area.

Restrictions You can specify only one of the XSIZE= or YSIZE= options. The GMAP procedure scales the dimension for the unspecified option in order to retain the original shape of the map.

Not supported by ActiveX

Details

Description

The CHORO statement specifies the variable or variables that contain the data represented on the map by patterns that fill the map areas. This statement automatically

- determines the midpoints
- assigns patterns to the map areas

You can use statement options to enhance the appearance of the map (for example, by selecting the colors and patterns that fill the map areas). Other statement options control the selection of ranges for the response variable.

In addition, you can use global statements to modify the map area patterns and legend, as well as add titles and footnotes to the map. You can also use an Annotate data set to enhance the map.

PRISM Statement

Creates three-dimensional prism maps in which levels of magnitude of the specified response variables are represented by polyhedrons (raised polygons) of varying height, pattern, and color.

Requirement: At least one response variable is required. You must use the ID statement in conjunction with the PRISM statement.

Supported Statements: FOOTNOTE , NOTE, LEGEND, PATTERN, TITLE

Note: For best results, use the MAPSSAS library of map data sets.

Syntax

PRISM *response-variable(s)* </ *options*>;

Summary of Optional Arguments

Appearance options

ANNOTATE=*Annotate-data-set*
: specifies a data set to annotate onto the maps that are produced by the PRISM statement.

CDEFAULT=*empty-area-fill-color*
: fills empty map areas in the specified color.

CEMPTY=*empty-area-outline-color*
: outlines empty map areas in the specified color.

COUTLINE=*area-outline-color* | SAME
: outlines nonempty map areas in the specified color.

STRETCH
: stretches map extents to cover all available space in the device.

UNIFORM
: causes the same legend and coloring to be used for all maps produced by the procedure instead of being calculated within each BY group for each map.

WOUTLINE=*area-outline-width*
: specifies the width, in pixels, of all map area outlines.

XLIGHT=*x* YLIGHT=*y*
: specify the coordinates of the imaginary light source in the map coordinate system.

XSIZE=*map-width <units>*
: specify the physical width dimension of the map to be drawn.

XVIEW=*x*<YVIEW=*y*><ZVIEW=*z*>

specify coordinates of the viewing position in the reference coordinate system.

YSIZE=*map-height <units>*
specify the physical height dimension of the map to be drawn.

Description options

DESCRIPTION="*description*"
specifies a description of the output.

NAME="*name*"
specifies the name of the GRSEG catalog entry and the name of the graphics output file, if one is created.

Legend options

CTEXT=*text-color*

LEGEND=LEGEND<*1-99*>
specifies the global LEGEND definition to associate with the map.

NOLEGEND
suppresses the legend.

Mapping options

AREA=*n* | *column-name*
specifies that a different map pattern be used for the surface of each map area or group of map areas on the map.

DISCRETE
generates a separate response level (color and surface pattern) for each different value of the formatted response variable.

LEVELS=*number-of-response-levels* | ALL
specifies the number of response levels to be graphed for the response variable.

MIDPOINTS=*value-list* | OLD
specifies the response levels for the range of response values that are represented by each level (prism height, pattern, and color combination).

MISSING
accepts a missing value as a valid level for the response variable.

PERCENT
specifies that the GMAP procedure collect all response values (or their statistic) and chart each region as a percentage of the whole.

RANGE

RELZERO
creates area heights that are relative to a zero value.

STATFMT=*format-specification*
overrides the GMAP default format for percent of PERCENT8.2.

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for the GMAP procedure to chart.

ODS options

HTML_LEGEND=*variable*
identifies the variable in the input data set whose values create links or data tips or both.

HTML=*variable*
identifies the variable in the input data set whose values create links or data tips or both.

URL=*character-variable*
specifies a character variable whose values are URLs.

Required Argument

response-variable(s)
specifies one or more variables in the response data set. Each response variable produces a separate map. All variables must be in the input data set. Multiple response variables are separated with blanks.

Missing values for the response variable are not considered valid unless you use the MISSING option.

Response variables can be either numeric or character. By default, and as determined by the LEVELS= or MIDPOINTS= values, numeric response variables are grouped into ranges, or response levels. Each response level is assigned a different prism height and a different pattern and color combination. With the LEVELS=ALL option, numeric or character response variables are assigned unique response levels, as are numeric variables when the DISCRETE option is specified. The LEVELS=*number-of-response-levels* option is ignored when either the DISCRETE or MIDPOINTS= option is used.

See "About Response Variables" on page 328.

Optional Arguments

Options in a PRISM statement affect all of the graphs that are produced by that statement. You can specify as many options as you want and list them in any order.

ANNOTATE=*Annotate-data-set*
specifies a data set to annotate onto the maps that are produced by the PRISM statement.

Alias ANNO=

Restriction Annotate coordinate systems 1, 2, 7, and 8 are not valid with Prism maps.

See "Overview: The Annotate Facility" in *SAS/GRAPH: Reference*

AREA=*n* | *column-name*
specifies that a different map pattern be used for the surface of each map area or group of map areas on the map. You can specify pattern fills or colors or both with PATTERN statements that specify map and plot patterns. A separate PATTERN definition is needed for each specified area.

n The value of *n* indicates which variable in the ID statement determines the groups that are distinguished by a surface pattern. By default, all map unit areas are drawn using the same surface fill pattern. If your ID statement has only one map area identification variable, then use AREA=1 to indicate that each

map area surface uses a different pattern. If you have more than one variable in your ID statement, then use *n* to indicate the position of the variable that defines groups that share a pattern. When you use the AREA= option, the map data set should be sorted in order of the variables in the ID statement.

column-name A column name defined in either the MAP= or DATA= data sets might be indicated with the *column-name* value. If the column name exists in both the MAP= and DATA= data sets, the column in the MAP= data set is used. When *column-name* is used, the areas are colored based on the AREA= value. Duplicate AREA= values might be assigned different patterns.

Note The AREA statement provides a greater amount of control than this AREA= option.

See "AREA Statement" on page 340, "PATTERN Statement" on page 106.

CDEFAULT=*empty-area-fill-color*

fills empty map areas in the specified color. Empty map areas are generated in prism maps either

- when there is no response value for a map area and the MISSING option is not used, or
- when a map area is omitted from the response data set and the ALL option is included in the PROC GMAP statement.

Aliases CDEF

DEFCLR

Default NONE, which draws the polygon empty, showing the background in the fill area of the polygon.

Restriction This option affects only those map areas that are empty.

See The CEMPTY option, the "ALL" on page 335, and "Displaying Map Areas and Response Data" on page 330

CEMPTY=*empty-area-outline-color*

outlines empty map areas in the specified color. Empty map areas are generated in prism maps either

- when there is no response value for a map area and the MISSING option is not used, or
- when a map area is omitted from the response data set and the ALL option is included in the PROC GMAP statement.

The default outline color is the same as the default COUTLINE= color.

Alias CE

Restriction This option affects only those map areas that are empty.

See "ALL" on page 335 and "Displaying Map Areas and Response Data" on page 330

COUTLINE=*area-outline-color* | SAME

outlines nonempty map areas in the specified color. SAME specifies that the outline color of a map area is the same as the interior pattern color.

Alias CO

Default The default outline color is determined by the current style.

Note If you specify empty map patterns (VALUE=EMPTY in a PATTERN statement), you should not change the outline color from the default value SAME to a single color. Otherwise, all the outlines are one color and you cannot distinguish between the empty areas.

CTEXT=*text-color*

specifies a color for the text in the legend. If you omit the CTEXT= option, a color specification is searched for in this order:

- the CTEXT= option in a GOPTIONS statement.
- the default, the text color that is specified in the current style.

Alias CT

Interaction The CTEXT= color specification is overridden if you also use the COLOR= suboption of a LABEL= or VALUE= option in a LEGEND definition assigned to the map legend. The COLOR= suboption determines the color of the legend label or the color of the legend value descriptions, respectively.

DESCRIPTION="*description*"

specifies a description of the output. The maximum length for *description* is 256 characters. The description does not appear in the output. The descriptive text is shown in each of the following:

- the chart description for web output (depending on the device driver). See "Chart Descriptions for Web Presentations" in *SAS/GRAPH: Reference* for more information.
- the Table of Contents that is generated when you use the CONTENTS= option in an ODS HTML statement, assuming that the output is generated while the contents page is open.
- the description and the properties for the output in the Results tab.
- the description and properties for the catalog entry in the Explorer.

The *description* can include the #BYLINE, #BYVAL, and #BYVAR substitution options, which work as they do when used on TITLE, FOOTNOTE, and NOTE statements. Refer to "Substituting BY Line Values in a Text String" on page 160. The 256-character limit applies before the substitution takes place for these options. Thus, if in the SAS program the entry-description text exceeds 256 characters, it is truncated to 256 characters, and then the substitution is performed.

Alias DES

Default PRISM MAP OF *variable-name*

DISCRETE
generates a separate response level (color and surface pattern) for each different value of the formatted response variable.

The DISCRETE option uses distinct, non-continuous colors for the response values. If, instead, you specify the LEVELS= option, then a color ramp is used to assign each response value a continuous color scheme.

Interaction The LEVELS=*number-of-response-levels* option is ignored when you use the DISCRETE option.

Note If the data does not contain a value in a particular range of the format, that formatted range is not displayed in the legend.

HTML=*variable*
identifies the variable in the input data set whose values create links or data tips or both. The variable values are either links or data tips or both that are created in the HTML file generated by the ODS statement. The links are URLs pointing to web pages to display when the user clicks (drills down) on elements in the graph. Data tips are detailed information or data values that are displayed as pop-up text when a mouse pointer is positioned over elements in the graph.

Interaction When multiple observations exist in the input data set for one variable value, the first observation is used for the data tip. When that same input data set is used for an annotate data set, the last of the multiple observations is used for the annotation. Sort the data one way for the data tip and the opposite way for the annotation to alleviate any mismatch between the data tip and its annotation in the resulting graph.

See "Data Tips for Web Presentations" in *SAS/GRAPH: Reference*

"Adding Links and Enhancements with the URL=, HTML=, and HTML_LEGEND= Options" in *SAS/GRAPH: Reference*

HTML_LEGEND=*variable*
identifies the variable in the input data set whose values create links or data tips or both. Input data set variable values are either links or data tips or both that are created in the HTML file generated by the ODS statement. The links are associated with a legend value and point to the URL to display when the user clicks (drills down) on the value. Data tips are detailed information or data values that are displayed as pop-up text when a mouse pointer is positioned over values in the legend..

Restriction Not supported by ActiveX

See "Adding Links and Enhancements with the URL=, HTML=, and HTML_LEGEND= Options" in *SAS/GRAPH: Reference*

LEGEND=LEGEND<*1-99*>
specifies the global LEGEND definition to associate with the map. If you use the SHAPE= option in a global LEGEND statement, only the value BAR is valid. Most of the LEGEND options described in the "LEGEND Statement" on page 69 are supported by ActiveX. If a LEGEND option is not supported by ActiveX, it is noted in the LEGEND option definition.

Default LEGEND In the GMAP procedure, the PRISM statement produces a legend unless you use the NOLEGEND option.

Restrictions LEGEND= is ignored if the specified LEGEND definition is not currently in effect.

Partially supported by ActiveX

See "LEGEND Statement" on page 69

Example "Example 28: Specifying Midpoints in a Prism Map When Using Traditional Map Data" on page 517

LEVELS=*number-of-response-levels* | ALL
specifies the number of response levels to be graphed for the response variable.

If you specify LEVELS=ALL, then all unique numeric or character response variable values are graphed.

Each response level is assigned a different surface pattern and color combination. The prism height is based on the data value of the corresponding response variable.

If you specify the LEVELS= option, then a color ramp is used to assign each response value a continuous color scheme. The response values are assigned lighter and darker values of a color scheme to express lower and higher response values.

Default By default, an equal-distribution (quantizing) algorithm is used to determine each level.

Restriction The LEVELS=*number-of-response-levels* option is ignored when you use the DISCRETE or MIDPOINTS=*value-list* option. It is also ignored when the response variables are character.

Interaction When MIDPOINTS=OLD is used with the LEVELS= option, default midpoints are generated using the Nelder algorithm (*Applied Statistics* 25:94–7, 1976).

Notes If, instead of specifying the LEVELS= option, you specify the DISCRETE option, then distinct, non-continuous colors are used for the response values.

If neither the LEVELS= option nor the DISCRETE option is used, then the GMAP procedure determines the number of response levels by using the formula FLOOR(1+3.3 log(*n*)), where *n* is the number of response variable values.

Example "Example 2: Specifying Response Levels in a Block Map" on page 439

MIDPOINTS=*value-list* | OLD

specifies the response levels for the range of response values that are represented by each level (prism height, pattern, and color combination).

For numeric response variables, *value-list* is either an explicit list of values, or a starting value and an ending value with an interval increment, or a combination of both forms:

- *n* < ...*n*>
- *n* TO *n* <BY *increment*>
- *n* < ...*n*> TO *n* <BY *increment* > *n* < ...*n*>

By default the increment value is 1. You can specify discrete numeric values in any order. In all forms, *n* can be separated by blanks or commas. An example is: `midpoints=(2 4 6) midpoints=(2,4,6) midpoints=(2 to 10 by 2)`

If a numeric variable has an associated format, the specified values must be the *unformatted* values.

For character response variables, *value-list* has this form:

- *'value-1'* < ...*'value-n'*>

The values are character strings enclosed in single quotation marks and separated by blanks, as shown here: `midpoints="Midwest" "Northeast" "Northwest"`

Specify the values in any order. If a character variable has an associated format, the specified values must be the *formatted* values.

You can selectively exclude some response variable values from the map, as shown here: `midpoints="Midwest"`

Only those observations for which the response variable exactly matches one of the values listed in the MIDPOINTS= option are shown on the map. As a result, observations might be inadvertently excluded if values in the list are misspelled or if the case does not match exactly.

Specifying MIDPOINTS=OLD generates default midpoints using the Nelder algorithm (*Applied Statistics* 25:94–7, 1976).

See The RANGE option

Example "Example 28: Specifying Midpoints in a Prism Map When Using Traditional Map Data" on page 517

MISSING

accepts a missing value as a valid level for the response variable.

See "Displaying Map Areas and Response Data" on page 330

NAME="*name*"

specifies the name of the GRSEG catalog entry and the name of the graphics output file, if one is created.

The following applies to *name*:

- The name can be up to 256 characters in length.
- Special characters in the name are converted to underscores.
- **For the GRSEG entry name:**
  - The name is truncated to eight characters.
  - The first character is always represented in uppercase, and all other characters are represented in lowercase.
  - If the name begins with a number, an underscore is prepended to the name.
  - If the name duplicates an existing name, SAS/GRAPH appends a number or increments the last number used to create a unique graph name (for example, *name*1, *name*2, and so on). If necessary, the name is truncated so that the name and appended number do not exceed eight characters.
- **For the graphics output filename:**
  - The filename is based on the NAME= value except when you use a DEVICE= option and a file reference specifying an output filename. In this case, the file reference specification overrides the NAME= value.
  - All characters are represented in lowercase.
  - If a number is added to the GRSEG name, the same number is added to the output filename. See "About Filename Indexing" in *SAS/GRAPH: Reference*.
  - If the NAME= value is 8 characters or less, the filename is the GRSEG entry name.
  - If the NAME= value is greater than 8 characters, the NAME= value is used as the filename. When an index number is used in the GRSEG entry name, that index number is appended to the output filename. See "About Filename Indexing" in *SAS/GRAPH: Reference*.
  - The maximum allowable filename length is device-specific. If the length of the name exceeds the maximum for the graphics device, an error results and no graphics output file is generated.

Default GMAP

NOLEGEND
suppresses the legend.

PERCENT
specifies that the GMAP procedure collect all response values (or their statistic) and chart each region as a percentage of the whole. You can use the STATISTIC= option to change how the percentage is calculated—whether as a percentage of the SUM, FREQUENCY, or MEAN. If you do not use the STATISTIC= option, then STATISTIC=FIRST is assumed and the response variable of only the first observation of each region is counted. If the response variable is a text field, then STATISTIC=FREQUENCY is used, even if you specify a different value for the STATISTIC= option.

Alias PERCENTAGE

See The "STATFMT=*format-specification*" on page 379option, and the "STATISTIC=FIRST | SUM | FREQUENCY | MEAN" on page 379 option.

RANGE

causes GMAP to display, in the legend, the starting value and ending value of the range around each midpoint specified with the MIDPOINTS= option (instead of displaying just the midpoints). For example, if MIDPOINTS=15 25 35, then the legend could show 10-20, 20-30, 30-40.

Restrictions MIDPOINTS= must be specified for the RANGE option to have any effect.

Not supported by ActiveX.

RELZERO

creates area heights that are relative to a zero value. By default, GMAP creates heights that are relative to the minimum value, which might or might not be zero. With the RELZERO option, zero value areas have no height.

Aliases REL0

RELATIVETOZERO

Restriction This option works only for variables that have no negative values.

STATFMT=*format-specification*

overrides the GMAP default format for percent of PERCENT8.2. Use this format when using calculated values. The STATFMT option is typically used when the STATISTIC=FREQUENCY option or the PERCENT option is used.

Aliases SFMT

SFORMAT

STATFORMAT

STATISTIC=FIRST | SUM | FREQUENCY | MEAN

specifies the statistic for the GMAP procedure to chart. For character variables, FREQUENCY is the only allowed value—any other value is changed to FREQUENCY and a warning is issued. The frequency of a variable does not include missing values unless the MISSING option is specified.

FIRST	GMAP matches the first observation from the DATA= data set and charts the response value from this observation only. This is the default. If more rows exist that are not processed, a warning is issued to the log.
SUM	All observations matching a given ID value are added together and the summed value is charted.
FREQUENCY	A count of all rows with nonmissing values is charted unless you specify the MISSING option.
MEAN	All observations matching a given ID value are added together and then divided by the number of nonmissing observations matched. This value is then charted unless you specify the MISSING option.

Alias STAT=

STRETCH
stretches map extents to cover all available space in the device. This might cause the map to be distorted. When this option is applied to the PROC GMAP statement, it applies to all statements. If applied to a single statement, it applies only to that statement.

Aliases STRETCHTOFIT

STR2FIT

Restriction Not supported by ActiveX

UNIFORM
causes the same legend and coloring to be used for all maps produced by the procedure instead of being calculated within each BY group for each map. The UNIFORM option prescans the data to generate a categorization across all the data, regardless of BY grouping, and applies that categorization to all maps in the BY group. This results in all maps uniformly displaying legends and coloring such that a single value always has the same color in multiple maps.

When specified in a PROC GMAP statement, the UNIFORM option applies to all AREA, BLOCK, CHORO, and PRISM statements included within the GMAP run-group.

When omitted from the PROC GMAP statement, and specified on an individual AREA, BLOCK, CHORO, or PRISM statement, the UNIFORM option applies only to the maps produced by that statement.

URL=*character-variable*
specifies a character variable whose values are URLs. The variable values are URLs for web pages to display when the user clicks (drills down) on elements in the graph.

Restriction This option affects graphics output that is created through the ODS HTML destination only.

Interaction If you specify both the HTML= option and the URL= option, then the URL= option is ignored.

See "Overview of Enhancing Web Presentations" in *SAS/GRAPH: Reference*

"Example: GIF Output with Drill-Down Links" in *SAS/GRAPH: Reference*

WOUTLINE=*area-outline-width*
specifies the width, in pixels, of all map area outlines.

Default WOUTLINE=1

XLIGHT=*x* YLIGHT=*y*
specify the coordinates of the imaginary light source in the map coordinate system. The position of the light source affects how the sides of the map polygons are shaded. Although you can specify any point for the light source using the XLIGHT= and YLIGHT= options, the light source is actually placed in one of only four positions.

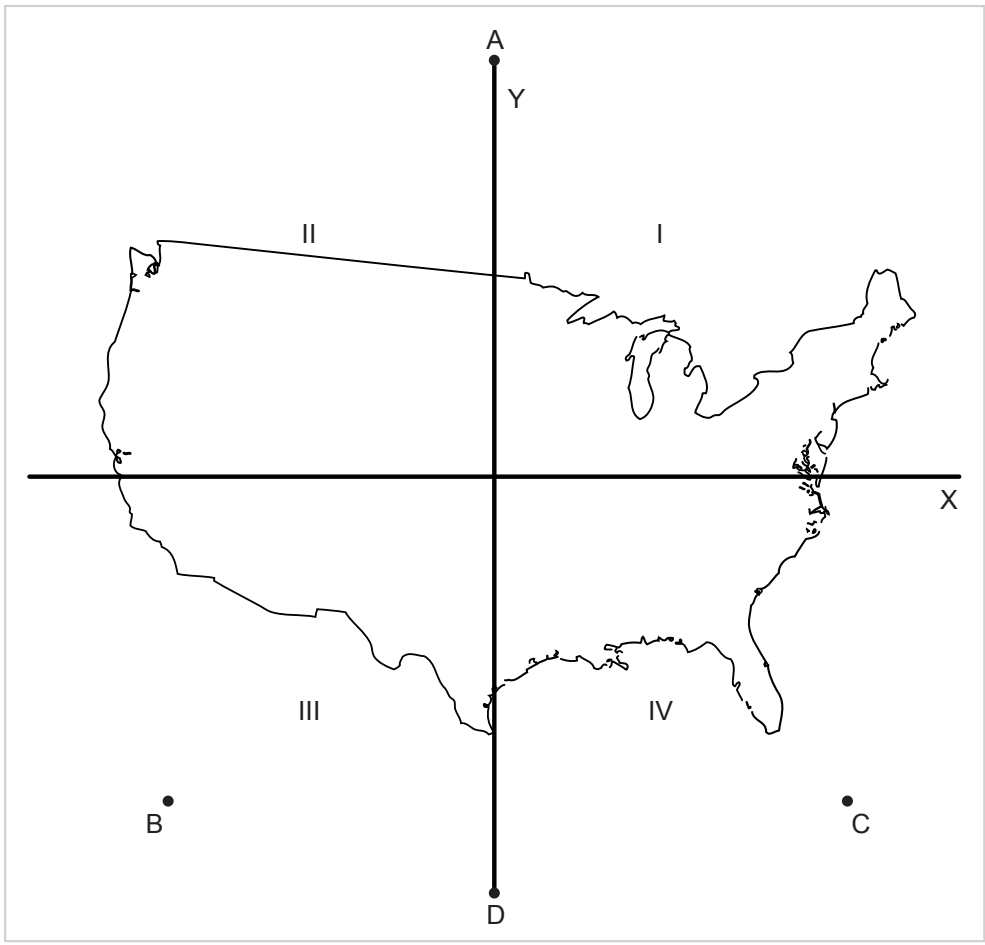
Table 13.35 on page 381 shows how the point that you specify is positioned. It correlates a specified light source in the left column with the coordinate position of that light source in the right column.

Table 13.5 *Light Source Coordinates*

Specified light source	Light source position
In quadrants I or II, or on the X or +Y axis	Behind the map (point A), and all side polygons are shadowed
On or within approximately 10 degrees of the Y axis	The viewing position (point D), and none of the side polygons are shadowed
In quadrant III (except within 10 degrees of the Y axis)	To the left of the map (point B), and the right-facing sides of polygons are shadowed
In quadrant IV (except within 10 degrees of the Y axis)	To the right of the map (point C), and the left-facing side polygons are shadowed

Figure 13.32 on page 382 illustrates the light source positions. Assume that your viewing position, selected by the XVIEW=, YVIEW=, and ZVIEW= options, is point D.

Figure 13.6 Coordinates of Imagined Light Source in a Map Coordinate System



Default By default, the light source position is the same as the viewing position specified by the XVIEW=, YVIEW=, and ZVIEW= options.

Restrictions The light source position cannot coincide with the viewing reference point (0.5,0.5), which corresponds with the position directly above the center of the map.

Not supported by ActiveX

See "XVIEW=*x*<YVIEW=*y*><ZVIEW=*z*>" on page 383

XSIZE=*map-width <units>*

specify the physical width dimension of the map to be drawn. By default, the map uses the entire procedure output area.

Valid *units* are CELLS (character cells), CM (centimeters), IN (inches), or PCT (percentage of the graphics output area). The default unit is CELLS.

If you specify values for *map-width* and *map height* that are greater than the dimensions of the procedure output area, the map is drawn using the default size. If you specify one value and not the other, the dimension is adjusted to maintain the correct aspect ratio.

Defaults The default unit is CELLS.

The map uses the entire procedure output area.

Restrictions If you specify a value for *map-width* that is greater than the width dimension of the procedure output area, the map is drawn using the default size.

Not supported by ActiveX

YSIZE=*map-height <units>*
specify the physical height dimension of the map to be drawn. Valid *units* are CELLS (character cells), CM (centimeters), IN (inches), or PCT (percentage of the graphics output area).

Defaults The default unit is CELLS.

The map uses the entire procedure output area.

Restrictions If you specify a value for *map-height* that is greater than the height dimension of the procedure output area, the map is drawn using the default size.

Not supported by ActiveX

XVIEW=*x*<YVIEW=*y*><ZVIEW=*z*>
specify coordinates of the viewing position in the reference coordinate system. You can specify one, two, or all three of the view coordinates. Any that you do not specify are assigned the default values.

The four corners of the map lie on the X-Y plane at coordinates (0,0,0), (0,1,0), (1,1,0), and (1,0,0). No axes are actually drawn on the maps that are produced by the GMAP procedure.

Figure 13.31 on page 357 shows the position of the viewing reference point, as well as the default viewing position.

To ensure that the polygon edges are distinguishable, the angle from vertical must be less than or equal to 45 degrees. If you specify such a small ZVIEW= value that this condition cannot be satisfied, then PROC GMAP increases the ZVIEW= value automatically so that the angle is 45 degrees or less.

Aliases XV

YV

ZV

Default If you omit the XVIEW=, YVIEW=, and ZVIEW= options, the default coordinates are (0.5, −2, 3). This viewing position is well above and to the south of the center of the map.

Restrictions Your viewing position cannot coincide with the viewing reference point at coordinates (0.5,0.5,0), the center of the map.

The value for *z* cannot be negative.

Details

Description

The PRISM statement specifies the variable or variables that contain the data that are represented on the map by raised map areas. This statement automatically performs the following operations:

- determines the midpoints ranges or midpoints
- assigns patterns to the map areas

You can use statement options to control the ranges of the response values, specify the angle of view, and enhance the appearance of the map.

In addition, you can use global statements to modify the map area patterns and the legend, as well as add titles and footnotes to the map. You can also use an Annotate data set to enhance the map.

Note: PRISM maps do not work well with polygons within polygons (holes). It is recommended that a CHORO or BLOCK map be created for these maps instead.

SURFACE Statement

Creates three-dimensional surface maps in which levels of magnitude of the specified response variables are represented by spikes of varying height.

Restriction: Not supported by ActiveX

Requirement: At least one response variable is required and must be numeric. The ID statement must be used in conjunction with the SURFACE statement.

Supported Statement: TITLE, FOOTNOTE, NOTE

Syntax

SURFACE *response-variable(s) </ options>*;

Summary of Optional Arguments

Appearance options

ANNOTATE=*Annotate-data-set*
: specifies a data set to annotate onto maps that are produced by the SURFACE statement.

CBODY=*surface-map-color*

specifies the color that is used to draw the surface map.

CONSTANT=*n*
specifies a denominator to use in the distance decay function.

NLINES=*number-of-lines*
specifies the number of lines used to draw the surface map.

ROTATE=*degrees*
specifies the degrees of the angle at which to rotate the map about the Z axis in the map coordinate system.

TILT=*degrees*
specifies the degrees of the angle at which to tilt the map about the X axis in the map coordinate system.

XSIZE=*map-width <units>*
specify the physical width dimension of the map to be drawn.

YSIZE=*map-height <units>*
specify the physical height dimension of the map to be drawn.

Description options

DESCRIPTION="*description*"
specifies a description of the output.

NAME="*name*"
specifies the name of the GRSEG catalog entry and the name of the graphics output file, if one is created.

Mapping options

PERCENT
specifies that the GMAP procedure collect all response values (or their statistic) and chart each region as a percentage of the whole.

STATFMT=*format-specification*
overrides the default format for percent of PERCENT8.2 that is used by the GMAP procedure.

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for the GMAP procedure to chart.

Required Argument

response-variable(s)
specifies one or more variables in the response data set. The *response-variable* must be numeric and must contain only positive values. Each response variable produces a separate map. All variables must be in the input data set. Multiple response variables are separated with blanks.

The GMAP procedure scales response variables for presentation on the map. The height of the spikes on the map correspond to the relative value of the response variable, not to the actual value of the response variable. However, when the viewing angle is changed, the spikes might not appear this way. The spikes in the front might appear to be higher than the spikes in the back, which represent greater values.

See "About Response Variables" on page 328.

Optional Arguments

SURFACE statement options affect all maps that are produced by that statement.

ANNOTATE=*Annotate-data-set*
specifies a data set to annotate onto maps that are produced by the SURFACE statement.

Alias ANNO=

Restriction Annotate coordinate systems 1, 2, 7, and 8 are not valid with surface maps.

See "Overview: The Annotate Facility" in *SAS/GRAPH: Reference*

CBODY=*surface-map-color*
specifies the color that is used to draw the surface map.

Alias CB=

Default Regardless of the current ODS style, the default color is the first color in the current color list.

CONSTANT=*n*
specifies a denominator to use in the distance decay function. This function determines the base width of the spike that is drawn at each map area center.

Values greater than 10 yield spikes that are wider at the base. Values less than 10 yield spikes that are narrower at the base.

Alias CON=

Default CONSTANT=10

DESCRIPTION="*description*"
specifies a description of the output. The maximum length for *description* is 256 characters. The description does not appear in the output. The descriptive text is shown in each of the following:

- the chart description for web output (depending on the device driver). See "Chart Descriptions for Web Presentations" in *SAS/GRAPH: Reference* for more information.
- the Table of Contents that is generated when you use the CONTENTS= option in an ODS HTML statement, assuming that the output is generated while the contents page is open.
- the description and the properties for the output in the Results tab.
- the description and properties for the catalog entry in the Explorer.

The *description* can include the #BYLINE, #BYVAL, and #BYVAR substitution options, which work as they do when used on TITLE, FOOTNOTE, and NOTE statements. Refer to "Substituting BY Line Values in a Text String" on page 160. The 256-character limit applies before the substitution takes place for these options. Thus, if in the SAS program the entry-description text exceeds 256 characters, it is truncated to 256 characters, and then the substitution is performed.

Alias DES=

Default SURFACE MAP OF *variable-name*

NAME="*name*"
specifies the name of the GRSEG catalog entry and the name of the graphics output file, if one is created.

The following applies to *name*:

- The name can be up to 256 characters in length.
- Special characters in the name are converted to underscores.
- **For the GRSEG entry name:**
  - The name is truncated to eight characters.
  - The first character is always represented in uppercase, and all other characters are represented in lowercase.
  - If the name begins with a number, an underscore is prepended to the name.
  - If the name duplicates an existing name, SAS/GRAPH appends a number or increments the last number used to create a unique graph name (for example, *name*1, *name*2, and so on). If necessary, the name is truncated so that the name and appended number do not exceed eight characters.
- **For the graphics output filename:**
  - The filename is based on the NAME= value except when you use a DEVICE= option and a file reference specifying an output filename. In this case, the file reference specification overrides the NAME= value.
  - All characters are represented in lowercase.
  - If a number is added to the GRSEG name, the same number is added to the output filename. See "About Filename Indexing" in *SAS/GRAPH: Reference*.
  - If the NAME= value is 8 characters or less, the filename is the GRSEG entry name.
  - If the NAME= value is greater than 8 characters, the NAME= value is used as the filename. When an index number is used in the GRSEG entry name, that index number is appended to the output filename. See "About Filename Indexing" in *SAS/GRAPH: Reference*.
  - The maximum allowable filename length is device-specific. If the length of the name exceeds the maximum for the graphics device, an error results and no graphics output file is generated.

Default GMAP

NLINES=*number-of-lines*
specifies the number of lines used to draw the surface map. Values can range from 50 to 100; the higher the value, the more solid the map appears and the more resources used.

Alias N=

Default NLINES=50

PERCENT
specifies that the GMAP procedure collect all response values (or their statistic) and chart each region as a percentage of the whole.

Alias PERCENTAGE

Tip You can use the STATISTIC= option to change how the percentage is calculated—whether as a percentage of the SUM, FREQUENCY, or MEAN. If you do not use the STATISTIC= option, then STATISTIC=FIRST is assumed and the response variable of only the first observation of each region is counted. If the response variable is a text field, then STATISTIC=FREQUENCY is used, even if you specify a different value for the STATISTIC= option.

See The "STATFMT=*format-specification*" on page 388, and the "STATISTIC=FIRST | SUM | FREQUENCY | MEAN" on page 388.

ROTATE=*degrees*
specifies the degrees of the angle at which to rotate the map about the Z axis in the map coordinate system. The *degrees* value can be any angle. Positive values indicate rotation in the counterclockwise direction. The ROTATE= option also affects the direction of the lines that are used to draw the surface map.

Default ROTATE=70

STATFMT=*format-specification*
overrides the default format for percent of PERCENT8.2 that is used by the GMAP procedure. Use this format when using calculated values.

Aliases SFMT=

SFORMAT=

STATFORMAT=

Interaction The STATFMT option is typically used when the STATISTIC=FREQUENCY option or the PERCENT option is used.

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for the GMAP procedure to chart. For character variables, FREQUENCY is the only allowed value—any other value is changed to FREQUENCY and a warning is issued. The frequency of a variable does not include missing values unless the MISSING option is specified.

FIRST GMAP matches the first observation from the DATA= data set and charts the response value from this observation only. This is the default. If more rows exist that are not processed, a warning is issued to the log.

SUM All observations matching a given ID value are added together and the summed value is charted.

FREQUENCY A count of all rows with nonmissing values is charted unless you specify the MISSING option.

MEAN All observations matching a given ID value are added together and then divided by the number of nonmissing observations matched. This value is then charted unless you specify the MISSING option.

Alias STAT=

TILT=*degrees*

specifies the degrees of the angle at which to tilt the map about the X axis in the map coordinate system. The value of *degrees* can be 0 to 90. As values increase they cause the map to tilt backward and makes the spikes more prominent. As values decrease they make the map shape more distinguishable and the spikes less prominent. TILT=90 corresponds to viewing the map edge-on, whereas TILT=0 corresponds to viewing the map from directly overhead.

Default TILT=70

XSIZE=*map-width <units>*

specify the physical width dimension of the map to be drawn. Valid *units* are CELLS (character cells), CM (centimeters), IN (inches), or PCT (percentage of the graphics output area).

Defaults The default unit is CELLS.

The map uses the entire procedure output area.

Restrictions If you specify a value for *map-width* that is greater than the width dimension of the procedure output area, the map is drawn using the default size.

Not supported by ActiveX

YSIZE=*map-height <units>*

specify the physical height dimension of the map to be drawn. Valid *units* are CELLS (character cells), CM (centimeters), IN (inches), or PCT (percentage of the graphics output area).

Defaults The default unit is CELLS.

The map uses the entire procedure output area.

Restrictions If you specify a value for *map-height* that is greater than the height dimension of the procedure output area, the map is drawn using the default size.

Not supported by ActiveX

Details

Description

The SURFACE statement specifies the variable or variables that contain the data that are represented on the map by raised map areas. This statement automatically determines the midpoints. You can use statement options to control spike proportions, specify the angle of view, and modify the general appearance of the map. For example, you can select the color and number of lines for the representation of the surface area. You can control the selection of spike heights and base widths.

In addition, you can use global statements to add titles and footnotes to the map. You can also enhance the map with an Annotate data set.

ATTRIB Statement

Associates a format, informat, label, and length with one or more variables.

Type: Procedure statement

Syntax

ATTRIB *variable-list(s) attribute-list(s)*;

Arguments

variable-list(s)
names the variables that you want to associate with the attributes.

> **TIP** List the variables in any form that SAS allows.

attribute-list(s)
specifies one or more attributes to assign to *variable-list*. Specify one or more of these attributes in the ATTRIB statement:

FORMAT=*format*
associates a format with variables in *variable-list*.

Tip The format can be either a standard SAS format or a format that is defined with the FORMAT procedure.

INFORMAT=*informat*
associates an informat with variables in *variable-list*.

Tip The informat can be either a standard SAS informat or an informat that is defined with the FORMAT procedure.

LABEL='*label*'
associates a label with variables in *variable-list*.

See Also

"ATTRIB Statement" on page 150 for more information about the ATTRIB statement.

BY Statement

Orders the output according to the BY groups.

Type: Procedure statement

Syntax

BY <DESCENDING> *variable-1*
<-<DESCENDING> *variable-n*>
<NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, then either the observations in the data set must be sorted by all the variables that you specify, or they must be indexed appropriately. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the observations are sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The observations are grouped in another way (for example, chronological order).

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the

NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

You cannot use the NOTSORTED option in a PROC SORT step.

Note: You cannot use the GROUPFORMAT option, which is available in the BY statement in a DATA step, in a BY statement in any PROC step.

See Also

"BY Statement" on page 151 for more information about the BY statement.

FORMAT Statement

Associates formats with variables.

Type: Procedure statement

Syntax

FORMAT *variable-1* <-*variable-n*> <*format-1*> <*variable-1* <-*variable-n*> <*format-2*> > - <DEFAULT=*default-format*>;

Required Argument

variable
names one or more variables for SAS to associate with a format. You must specify at least one *variable*.

Tip To disassociate a format from a variable, use the variable in a FORMAT statement without specifying a format in a DATA step or in PROC DATASETS. In a DATA step, place this FORMAT statement after the SET statement. See "Removing a Format" in *SAS DATA Step Statements: Reference*. You can also use PROC DATASETS.

Optional Arguments

format
specifies the format that is listed for writing the values of the variables.

Tip Formats that are associated with variables by using a FORMAT statement behave like formats that are used with a colon modifier in a subsequent

PUT statement. For more information about using a colon modifier, see "PUT Statement: List" in *SAS DATA Step Statements: Reference*.

See *SAS Formats and Informats: Reference*

DEFAULT=*default-format*
specifies a temporary default format for displaying the values of variables that are not listed in the FORMAT statement. These default formats apply only to the current DATA step; they are not permanently associated with variables in the output data set.

A DEFAULT= format specification applies to

- variables that are not named in a FORMAT or ATTRIB statement
- variables that are not permanently associated with a format within a SAS data set
- variables that are not written with the explicit use of a format.

Default If you omit DEFAULT=, SAS uses BEST*w*. as the default numeric format and $*w*. as the default character format.

Restriction Use this option only in a DATA step.

Tip A DEFAULT= specification can occur anywhere in a FORMAT statement. It can specify either a numeric default, a character default, or both.

Example "Assigning Formats and Defaults" in *SAS DATA Step Statements: Reference*

See Also

"FORMAT Statement" on page 156 for more information about the FORMAT statement.

LABEL Statement

Assigns descriptive labels to variables.

Type: Procedure statement

Syntax

Form 1: Creates a descriptive label for one or more variables.

LABEL *variable-1*='*text-string*' <...*variable-n*='*text-string*'>;

Form 2: Removes the label from one or more variables.

LABEL *variable-1* = *' '* < ...*variable-n*=' '>; | *variable-1* = <...*variable-n*= >

Arguments

variable

specifies the variable that you want to label. You can specify labels for multiple variables in a single LABEL statement:

```
data test;
   L = 5;
   W = 10;
   label L = 'Length' W = 'Width';
run;
```

text-string

specifies a label of up to 256 bytes.

```
data test;
   L = 5;
   label L = 'Length';
run;
```

Restrictions

If the label includes a semicolon (;) or an equal sign (=), you must enclose the label in either single or double quotation marks.

```
label N = 'Number = ';
```

If the label includes single quotation marks ('), you must enclose the label in double quotation marks.

```
label Name = "Owner's Last Name";
```

There is partial support for variable name substitution with the JAVAIMG device. When the label text for the variable exceeds the space allowed, the variable name is used instead by procedures that are labeling an axis or a legend title. With the exception of the SAS/GRAPH GPLOT procedure, the variable name is not used when the JAVAIMG device is specified.

Notes

Quotation marks are not required unless the label includes a semicolon, quotation marks, or an equal sign.

The LABEL statement expects an equal sign (=) after the first variable. If any other character is found, an error occurs. The LABEL statement considers everything after the equal sign, following the first variable, as part of the label until the statement comes to another variable followed by an equal sign, regardless of quotation marks. In this example, the label for x is **`this is x y 4 = this is y`** because the next variable that is followed by an equal sign is z.

```
data test;
   x = 1;
   y = 1;
   z = 1;
```

```
   label x = 'this is x' y 4 = 'this is y' z = 'This is z';
run;
```

In this LABEL statement, the x variable has the same label:

```
label x = this is x y 4 = this is y  z = This is z;
```

See "Character Constants and Character Variables" in *SAS Programmer's Guide: Essentials*.

''

removes a label from a variable. Enclose a single blank space in quotation marks to remove an existing label. You can remove labels from multiple variables in a single LABEL statement:

```
data test;
   L=5; W=10;
   label L = ' '  W = ' ';
run;
```

Alternatively, you can remove a label by specifying nothing after the equal sign:

```
data test;
   L=5; W=10;
   label L =  W = ;
run;
```

See Also

"LABEL Statement" on page 157 for more information about the LABEL statement.

NOTE Statement

Control the content, appearance, and placement of text.

Used by: GMAP

Type: Procedure statement.

Note: This local statement has limited use with the GMAP procedure or other procedures. The specified note appears behind the map or graph output by default. With some manipulation of coordinates, notes are useful around the perimeter or ocean area of a map.

Tip: By drawing a white box in back of a note, that boxed note can appear on top of the graph instead of behind it. Here is an example of code that outputs a note on top of a map:

```
goptions cback=white;

title font="swiss" "Note Text On a Map";
pattern1 v=s color=lightgoldenrodyellow;
```

```
proc gmap data=mapsgfk.us map=mapsgfk.us;
note move=(2,32)pct height=4pct
color=black font="swiss" "Note with 'box' behind it displays on top of map"
color=black box=2 bcolor=white blank=yes;
id state;
choro state / levels=1 stat=first nolegend;
run;
quit;
```

Syntax

NOTE<*text-options*><'*text-string*'>;

Summary of Optional Arguments

<text-options>

Text provision option

'text-string'
is a text string or strings that can contain up to 512 characters.

Without Arguments

Using NOTE without arguments has no effect.

Optional Arguments

<text-options>
specifies formatting options for the text.

Text options must precede the '*text-string*' that they modify. *text-options* can be one or more of the following optional arguments, in any order:

ALT=*"text-string"*
specifies descriptive text for a URL to which a note links, or the note itself.

The *"text-string"* that you use to describe a note, or the URL specified by the LINK= option, can contain occurrences of the variables #BYVAL and #BYVAR. See "Substituting BY Line Values in a Text String" on page 160.

Supports The ALT= option can be used with the LINK= option.

See "LINK="URL"" in *SAS/GRAPH: Reference*

Example "Example 6: Producing a Drilldown Choropleth Map" on page 451

ANGLE=*degrees*
specifies the angle of the baseline of the entire text string with respect to the horizontal.

A positive *degrees* value angles the *baseline* counterclockwise; a negative value angles it clockwise. By default, ANGLE=0 (horizontal).

Angled notes might require more vertical space. Consequently, there might be an increase the size of the note area, thereby reducing the vertical space in the procedure output area.

Using the BOX= option with angled text does not produce angled boxes; the box is sized to accommodate the angled note.

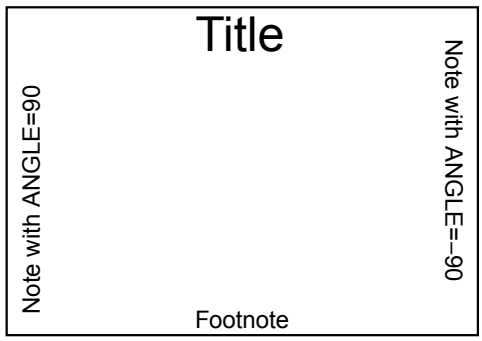
Using the ANGLE= option after one text string and before another can reset some options to their default values. See "Using Options That Can Reset Other Options" on page 139.

The ANGLE= option has the same effect on the text as LANGLE=, except when you specify an angle of 90 degrees or –90 degrees. In these angle specifications, the procedure output area is shrunk from the left or right to accommodate the angled note.

Figure 13.33 on page 397 shows how ANGLE= 90 degrees or -90 degrees positions and rotates note text.

ANGLE=90	positions the note at the bottom of the left edge of the graphics output area, angled 90 degrees (counterclockwise) and reading from bottom to top.
ANGLE=–90	positions the note at the top of the right edge of the graphics output area, angled –90 (clockwise) and reading from top to bottom.

Figure 13.7 *Positioning Notes with the ANGLE= Option*



Alias A=

See "LANGLE=degrees" in *SAS/GRAPH: Reference*

"ROTATE=degrees" in *SAS/GRAPH: Reference*

BCOLOR=*background-color*

specifies the background color of a box produced by the BOX= option.

By default, the background color of the box is the same as the background color for the entire graph. The color of the frame of the box is determined by the color specification used in BOX=.

Alias BC=

Restriction If you omit BOX=, BCOLOR= is ignored.

Note The BCOLOR= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 139 for details

"BOX=1 - 4" in *SAS/GRAPH: Reference*

BLANK=YES

protects the box and its contents from being overwritten by any subsequent graphics elements.

It does this by blanking out the area where the box is displayed. The BLANK= option enables you to overlay graphics elements with boxed text. It is ignored if you omit the BOX= option. Because notes are written from the highest numbered to the lowest numbered, the BLANK= option only blanks out notes of a lower number.

Alias BL=

Note The BLANK= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 139 for details

"BOX=1 - 4" in *SAS/GRAPH: Reference*

BOX=*1 - 4*

draws a box around one line of text.

A value of 1 produces the thinnest box lines; 4 produces the thickest. Boxing angled text does not produce an angled box; the box is sized to include the angled text.

The color of the box is one of the following:

- the color specified by the COLOR= option in the statement
- the default text color

The COLOR= option, preceding the BOX= option, controls the box frame color. To color the background of the box, use the BCOLOR= option. Specify the same color with both the COLOR= option and the BCOLOR= option to effect a box without a frame.

You can include more than one text string in the box as long as no text break occurs between the strings. That is, you cannot use the JUSTIFY= option to create multiple lines of text within a box.

To draw a box around multiple lines of text, you can do either of the following:

- Use the MOVE= option with relative coordinates to position an additional line of text relative to the preceding line and enclose them within the box

drawn by the BOX= option. For example, this statement produces the boxed note shown in Figure 13.34 on page 399:

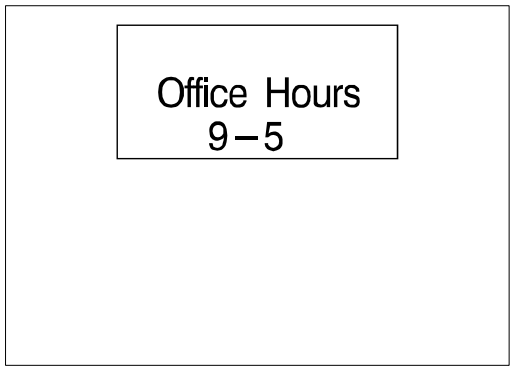
```
note font=swiss justify=center box=1 height=2
   "Office Hours" move=(-11,-4)pct "9-5";
```

The MOVE=option in this NOTE statement overrides the JUSTIFY= option that center-positioned the first line of text. The MOVE= option specifies the *x* and *y* coordinates in percentage units. The text string '9–5' is positioned relative to the first text string 'Office Hours'.

Using the MOVE= option in a NOTE statement enables you to position a note on top of a graph.

- Use the DRAW= option to draw the box and do not use the BOX= option.

Figure 13.8 *Using the BOX= Option and the MOVE= Option to Box Multiple Lines of Text*



Alias BO=

Note The BOX= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= options with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 139 for details

"BCOLOR=background-color" in *SAS/GRAPH: Reference*

"BLANK=YES" in *SAS/GRAPH: Reference*

"BSPACE=box-space<units>" in *SAS/GRAPH: Reference*

BSPACE=*box-space<units>*
specifies the amount of space between the boxed text and the box.

The space above the text is measured from the font maximum, and the space below the text is measured from the font minimum. By default, BSPACE=1.

The spacing is uniform around the box. Notice that BSPACE=.5IN leaves one-half inch of space between the text and the top, bottom, and sides of the box.

Alias BS=

Interaction If the BOX= option is not used, the BSPACE= option is ignored

Note The BSPACE= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 139 for details

"BOX=1 - 4" in *SAS/GRAPH: Reference*

COLOR=*color*
specifies the color for the following text, box, or line.

The COLOR= option affects all text, lines, and boxes that follow it and stays in effect until another COLOR= specification is encountered.

Change colors as often as you like. For example, this statement produces a note with red text in a box with a blue frame and a cream background:

```
proc gslide;
   note color=red height=2 "Total Sales" color=blue
      box=3 bcolor=cream;
run;
quit;
```

Although the BCOLOR= option controls the background color of the box, the frame color is controlled with the COLOR= option that precedes the BOX= option.

If you omit the COLOR= option, a color specification is searched for in this order:

1. the CTITLE= option in a GOPTIONS statement
2. the CTEXT= option in a GOPTIONS statement
3. the current ODS style
4. the first color in the color list.

Alias C=

Style reference GraphValueText Color attribute

See "BCOLOR=background-color" in *SAS/GRAPH: Reference*

"Controlling Titles and Footnotes" in *SAS/GRAPH: Reference*

DRAW=(*x,y - ,x-n,y-n*)<*units*>
draws lines anywhere on the graphics output area.

Lines are drawn using *x* and *y* as absolute or relative coordinates. The following table shows the specifications for absolute and relative coordinates:

Table 13.6 *Coordinate Specifications*

Absolute Coordinates	Relative Coordinates
x<units>	*±x<units>*

Absolute Coordinates	Relative Coordinates
y<units>	*±y<units>*

The coordinate position (0,0) is the lower left corner of the graphics output area. Specify at least two coordinate pairs. Commas between coordinates are optional; blanks can be used instead. The DRAW= option does not affect the positioning of text.

The starting point for lines specified with relative coordinates begins at the end of the most recently drawn text or line in the current statement. If no text or line has been drawn in the current statement, a warning is issued. The relative draw is measured from where a zero-length text string would have ended, given the normal placement for the statement.

You can mix relative and absolute coordinates. For example, DRAW=(+0,+0,+0,1IN) draws a vertical line from the end of the text to one inch from the bottom of the graphics output area.

Alias D=

FONT=*font*
specifies the font for the subsequent text.

See "Specifying Fonts in SAS/GRAPH Programs" in *SAS/GRAPH: Reference* for details about specifying SAS/GRAPH fonts. If you omit this option, a font specification is searched for in this order:

1. the FTEXT= option in a GOPTIONS statement
2. the current ODS style
3. the default hardware font, NONE

Alias F=

Style reference GraphValueText Font attribute

Note Font names greater than eight characters in length must be enclosed in quotation marks.

See "Controlling Titles and Footnotes" in *SAS/GRAPH: Reference*

HEIGHT=*text-height<units>*
specifies the height of text characters in number of units.

Height is measured from the font minimum to the capline. Ascenders can extend above the capline, depending on the font.

If your text line is too long to be displayed in the height specified in the HEIGHT= option, the height specification is reduced so that the text can be displayed. A note in the SAS log tells you what percentage of the specified size was used.

If you omit the HEIGHT= option, a text height specification is searched for in this order:

1 the HTEXT= option in a GOPTIONS statement
2 the default value, 1

Alias H=

Default For NOTE or NOTE1 statements, HEIGHT is determined by the current ODS style. HEIGHT=1 for subsequent NOTE statements.

See "Controlling Titles and Footnotes" in *SAS/GRAPH: Reference*

Example "Ordering Axis Tick Marks with SAS Date Values" in *SAS/GRAPH: Reference*

JUSTIFY=LEFT | CENTER | RIGHT
specifies the alignment of the text string.

LEFT
aligns the text to the left.

Alias L

CENTER
aligns the text in the center.

Alias C

RIGHT
aligns the text to the right.

Alias R

All the text strings following JUSTIFY= are treated as a single string and are displayed as one line that is left-, right-, or center-aligned. You can change the justification within a single line of text. For example, this NOTE statement displays a date on the left side of the output and the page number on the same line on the right:

```
note "June 28, 1997" justify=right "Page 3";
```

In addition, you can use the JUSTIFY= option to produce multiple lines of text by repeating the JUSTIFY= option with the same value before the text string for each line. Multiple lines of text with the same justification are blocked together. For example, this NOTE statement produces a three-line note with each line right-justified:

```
note justify=right "First Line"
      justify=right "Second Line"
      justify=right "Third Line";
```

You can get the same effect with three NOTE statements, each specifying JUSTIFY=RIGHT. You can produce a block of text by specifying the same justification for multiple text strings. You can then change the justification for an additional text string. The result is that the text is placed on the same line as the first string specified in the statement.

Default LEFT

Note Using the JUSTIFY= option after one text string and before another can reset some options to their default values.

Tip Use the WRAP= on page 406 option with JUSTIFY= to fit long text strings.

See "Using Options That Can Reset Other Options" on page 139 for details

Example "Rotating Plot Symbols through the Color List" in *SAS/GRAPH: Reference*

LANGLE=*degrees*

specifies the angle of the *baseline* of the entire text string(s) with respect to the horizontal A positive value for *degrees* moves the *baseline* counterclockwise; a negative value moves it clockwise. By default, LANGLE=0 (horizontal).

Using the BOX= option with angled text does not produce an angled box; the box is sized to accommodate the angled note.

Unlike the ANGLE= option, the LANGLE= option does not reset any other options. Therefore, the LANGLE= option is easier to use because you do not need to repeat options after a text break.

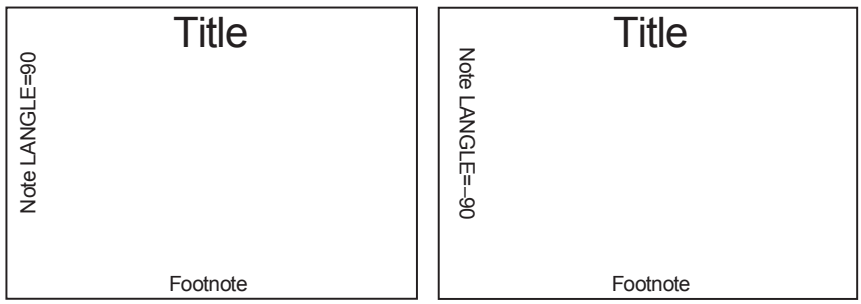
The LANGLE= option has the same effect on the text as the ANGLE= option, except when an angle of 90 degrees or –90 degrees is specified:

LANGLE=90 positions the note at the top of the left edge of the procedure output area, angled 90 degrees (counterclockwise) so that it reads from bottom to top.

LANGLE=–90 positions the note at the top of the left edge of the procedure output area, angled –90 degrees (clockwise) so that it reads from top to bottom.

Figure 13.35 on page 403 shows how LANGLE=90 degrees and LANGLE=–90 degrees positions and rotates notes.

Figure 13.9 *Positioning Notes with the LANGLE= Option*



Alias LA=

See "ANGLE=degrees" in *SAS/GRAPH: Reference*

LINK="*URL*"
specifies a uniform resource locator (URL) to which a note links.

The *text-string* that you use to specify the URL can contain occurrences of the variables #BYVAL, #BYVAR, and #BYLINE, as described in "'*text-string*'" on page 406.

Supports The LINK= option can be used in conjunction with the ALT= option.

See "Controlling Where Titles and Footnotes Are Rendered" in *SAS/GRAPH: Reference*

"ALT="text-string"" in *SAS/GRAPH: Reference*

Example "Example 6: Producing a Drilldown Choropleth Map" on page 451

LSPACE=*line-space <units>*
specifies the amount of spacing above lines of note text. The spacing is measured from the capline of the current line to the font minimum of the line above.

Alias LS=

Default LSPACE=0

Note The LSPACE= option can be reset by the ANGLE= or JUSTIFY= option, or by the MOVE= option with absolute coordinates.

See "Using Options That Can Reset Other Options" on page 139 for details

MOVE=(*x*,*y*) <*units*>
positions an initial or subsequent text string, or lines of text anywhere on the graphics output area. The positioning uses *x* and *y* as absolute or relative coordinates. The following table shows the specifications for absolute and relative coordinates:

Table 13.7 *Coordinate Specifications*

Absolute Coordinates	Relative Coordinates
x<units>	*±x<units>*
y<units>	*±y<units>*

Commas between coordinates are optional; you can use blanks instead.

The starting point for lines specified with absolute coordinates is at the bottom left corner of the graphics output area. For example, the following code fragment uses the NOTE statement to add a simple line of text to the upper right quadrant of the graphics output area:

```
note move=(65,70)pct color=purple "My Note";
```

The starting point for lines specified with relative coordinates is at the end of the most recently drawn text or line in the current statement. If no text or line has been drawn in the current statement, a warning is issued in the SAS log. The relative move is measured from where a zero-length text string would have ended, given the normal placement for the statement.

You can mix relative and absolute coordinates.

Alias M=

Interactions The MOVE= option overrides a JUSTIFY= option specified for the same text string

A NOTE statement can use the MOVE= option to position the text so that the statement does not use its default position. In this case, the text of the next NOTE statement occupies the unused position and no blank lines are displayed

Notes You can specify the MOVE= option with at least one absolute coordinate. If the option follows one text string and precedes another, some options can be reset to their default values.

If you specify the GUNIT graphics option, then that unit is the default unit. If you do not specify the GUNIT= graphics option, then the default unit is CELLS.

See "Using Options That Can Reset Other Options" on page 139 for details

"BOX=1 - 4" in *SAS/GRAPH: Reference* for illustrative code that draws a box around lines of text positioned with relative coordinates

Example "Specifying Logarithmic Axes" in *SAS/GRAPH: Reference*

ROTATE=*degrees*

specifies the angle at which each character of text is rotated with respect to the *baseline* of the text string. The angle is measured from the current text *baseline* angle, which is specified by the ANGLE= or LANGLE= options. By default, the *baseline* is horizontal. A positive value for *degrees* rotates the character counterclockwise; a negative value rotates it clockwise. By default, ROTATE=0 (parallel to the *baseline*).

Figure 13.36 on page 405 shows how characters are positioned when ROTATE=90 is used with the default (horizontal) *baseline*.

Figure 13.10 *Tilting Characters with the ROTATE= Option*

Alias R=

See "ANGLE=degrees" in *SAS/GRAPH: Reference*

UNDERLIN=*0 - 3*
underlines subsequent text.

Values of 1, 2 and 3 underline with an increasingly thicker line. UNDERLIN=0 halts underlining for subsequent text.

Underlines follow the text *baseline*. If you use an LANGLE= or ANGLE= option for the line of text, the underline is drawn at the same angle as the text. Underlines do not break up to follow rotated characters.

To make the text and the underline the same color, specify a COLOR= option before the UNDERLIN= option that precedes the text string. To make the text a different color, specify the COLOR= option after the UNDERLIN= option.

Aliases U=

UNDERLINE=

Note The UNDERLIN= option can be reset by the ANGLE= or JUSTIFY= option, or by the MOVE= option with absolute coordinates. See "Using Options That Can Reset Other Options" on page 139 for details.

See "ROTATE=degrees" in *SAS/GRAPH: Reference*

WRAP
wraps the text to a second line if the text does not fit on one line.

If the WRAP option is omitted, the text font-size is reduced until the text fits on one line. Wrapping occurs at the last blank before the text meets the end of the window. If there are no blanks in the text string, then there is no wrapping.

Restriction The WRAP option does not work with the BOX, BLANK, UNDERLINE, and MOVE options.

Tip Use the JUSTIFY= on page 402 option with WRAP= to justify the lines of text.

'text-string'
is a text string or strings that can contain up to 512 characters.

You must enclose text strings in single or double quotation marks. The text appears exactly as you enter it in the statement, including uppercase and lowercase characters and blanks.

To use single quotation marks or apostrophes within the note, you can do either of the following:

- use a pair of single quotation marks together:

```
note 'All''s Well That Ends Well';
```

- enclose the text in double quotation marks:

```
note "All's Well That Ends Well";
```

You can specify multiple text strings in NOTE statements. If you want each string to be separated by a blank, add a blank to the beginning of the second and subsequent text strings rather than at the end the preceding string, as in this example:

```
note color=red "Sales:" color=blue " 2020";
```

With fonts that support Unicode, you can specify special characters by specifying a hexadecimal constant in quotation marks. A trailing `x` identifies a string as a hexadecimal constant. You must designate the hexadecimal constant as a Unicode specification and escape it: `(*ESC*){Unicode '`*`hexadecimal-value`*`'x}`. For example:

```
note 'Regression with Confidence Limits ((*ESC*){unicode "03B1"x}=.05)';
```

This statement produces the note "Regression with Confidence Limits (α = .05)" because "03B1"x is the hexadecimal value for the lowercase Greek letter alpha in all Unicode fonts.

> **TIP** You can instead specify lowercase Greek letters by name, and uppercase Greek letters by name_u: `(*ESC*){Unicode alpha}=.05` and `(*ESC*){Unicode alpha_u}=.05`.

For more information see "Specifying Special Characters Using Character and Hexadecimal Codes" in *SAS/GRAPH: Reference*.

If you have a BY statement, you can also customize notes by inserting BY variable lines (#BYLINE), BY variable values (#BYVAL), or BY variable names (#BYVAR), in notes that are specified in procedure steps. Embed the items in the specified note text string at the position where you want the substitution text to appear.

#BYLINE
substitutes the entire BY line without leading or trailing blanks for #BYLINE in the text string. It also displays the BY line in the note produced by the statement.

#BYVAL*n*
#BYVAL(*variable-name*)
substitutes the current value of the specified BY variable for #BYVAL in the text string and displays the value produced by the statement. Specify the variable with one of these values:

n
specifies which variable in the BY statement #BYVAL should use. The value of *n* indicates the position of the variable in the BY statement.

Example **`#BYVAL2`** specifies the second variable in the BY statement.

variable-name
names the BY variable.

Tip *Variable-name* is not case sensitive.

Example **`#BYVAL(YEAR)`** specifies the BY variable, YEAR.

#BYVAR*n*
#BYVAR(*BY-variable-name*)
substitutes the name of the BY variable or label associated with the variable (whatever the BY line would normally display) for #BYVAR in the text string and displays the name or label produced by the statement. Specify the variable with one of these:

n
specifies which variable in the BY statement #BYVAR should use. The value of *n* indicates the position of the variable in the BY statement. For example, #BYVAR2 specifies the second variable in the BY statement.

BY-variable-name
names the BY variable. For example, #BYVAR(SITES) specifies the BY variable, SITES. *Variable-name* is not case sensitive.

Note A BY variable name displayed is always in uppercase. If a label is used, it appears as specified in the LABEL statement.

Follow these rules when you use #BYVAL or #BYVAR in the FOOTNOTE, TITLE, or NOTE statement of a procedure step:

- Specify the variable that is used by #BYVAL or #BYVAR in the BY statement.
- Insert #BYVAL or #BYVAR in the specified title text string at the position where you want the substitution text to appear.
- Follow #BYVAL or #BYVAR with a delimiting character, either a space or other non-alphanumeric character (for example, a quotation mark), that ends the text string.
- To enable the #BYVAL or #BYVAR substitution to be followed immediately by other text, with no delimiter, use a trailing dot (as with macro variables).

Restriction #BYVAL or #BYVAR substitution in a text string is not available in the Annotate facility. The reason is that BY lines are not created in a DATA step.

See Also

"NOTE Statement" on page 158 for more information about the NOTE statement.

QUIT Statement

Executes any statements that have not executed and ends the procedure step.

Syntax

QUIT;

WHERE Statement

Subsets the input data set by specifying certain conditions that each observation must meet before it is available for processing.

Type: Procedure statement

Syntax

WHERE *where-expression*;

Required Argument

where-expression
is an arithmetic or logical expression that generally consists of a sequence of operands and operators. For more information about where processing, see *SAS DATA Step Statements: Reference*.

Tip You can specify multiple where-expressions.

See Also

"WHERE Statement" on page 161 for more information about the WHERE statement.

Usage: GMAP Procedure

Using FIPS Codes and Province Codes

The map area identification variable in some SAS/GRAPH map data sets contain standardized numeric codes. The data sets for the United States contain a variable whose values are Federal Information Processing Standards (FIPS) codes.

Traditional data sets for Canada contain standard province codes or census division codes. GfK data sets for Canada contain standard province codes and province names. You can specify a map data set with the GMAP procedure. However, ensure that the map area identification variable values in the map data set are the same as those used in the response data.

If the map area identification variables in your response data set are state or province names or abbreviations, convert them to FIPS codes or province codes before using the response data set with one of the traditional map data sets supplied by SAS. Conversion might not be necessary if one of the GfK map data sets is used. This is because character variables such as `ID` that contain region values, might already match the identification variables in your response data set. Table 13.38 on page 410 lists in two columns the FIPS codes for the United States and Table 13.39 on page 411 lists in two columns the standard codes for Canadian provinces.

Note: Alternatively, you can convert the FIPS code or province codes in your traditional map data set to match the names in your response data.

Table 13.8 *U.S. FIPS Codes*

FIPS code	State	FIPS code	State
01	Alabama	30	Montana
02	Alaska	31	Nebraska
04	Arizona	32	Nevada
05	Arkansas	33	New Hampshire
06	California	34	New Jersey
08	Colorado	35	New Mexico
09	Connecticut	36	New York
10	Delaware	37	North Carolina
11	District of Columbia	38	North Dakota
12	Florida	39	Ohio
13	Georgia	40	Oklahoma
15	Hawaii	41	Oregon
16	Idaho	42	Pennsylvania

FIPS code	State	FIPS code	State
17	Illinois	44	Rhode Island
18	Indiana	45	South Carolina
19	Iowa	46	South Dakota
20	Kansas	47	Tennessee
21	Kentucky	48	Texas
22	Louisiana	49	Utah
23	Maine	50	Vermont
24	Maryland	51	Virginia
25	Massachusetts	53	Washington
26	Michigan	54	West Virginia
27	Minnesota	55	Wisconsin
28	Mississippi	56	Wyoming
29	Missouri	72	Puerto Rico

Table 13.9 *Canadian Province Codes*

Province code	Province
10	Newfoundland and Labrador
11	Prince Edward Island
12	Nova Scotia
13	New Brunswick
24	Quebec
35	Ontario
46	Manitoba
47	Saskatchewan

Province code	Province
48	Alberta
59	British Columbia
60	Yukon
61	Northwest Territories
62	Nunavut

Note: The *id-variables* are numeric in traditional but character in GfK Canadian map data sets.

The MAPS.CNTYNAME data set contains a cross-reference of names and FIPS codes for all counties in the United States. The MAPS.CANCENS data set contains a cross-reference of census district names and codes for Canadian provinces.

Base SAS software provides several functions that convert state names to FIPS codes and vice versa. The following table lists these functions and a brief description of each. See *SAS Functions and CALL Routines: Reference* for more information.

Table 13.10 *FIPS and SAS Postal Code Functions*

Function	Description
STFIPS	Converts state postal code to FIPS state code
STNAME	Converts state postal code to state name in uppercase
STNAMEL	Converts state postal code to state name in mixed case
FIPNAME	Converts FIPS code to state name in uppercase
FIPNAMEL	Converts FIPS code to state name in mixed case
FIPSTATE	Converts FIPS code to state postal code

Using Formats for Traditional Map Data Set Variables

You can specify an output map area name or numeric value using one of the predefined formats for maps. The following prefixes are used in the names of the formats for maps:

CONT
: Continent

CNTRY
: Country

GLC
: Geographic Location Code, distributed by Government Services Administration, USA

ISO
: International Standard Organization

The formats for maps are located in the SASHELP.MAPFMTS catalog. See the MAPS.NAMES table to view all the continent and country names and corresponding GLC, ISO, and numeric representation for the continent values.

To use one of the formats for maps, you must specify the SASHELP.MAPFMTS catalog on the FMTSEARCH= option in a SAS OPTIONS statement:

```
options fmtsearch=(sashelp.mapfmts);
```

In addition to using the PUT statement (as shown in the examples in the following table), the formats can also be invoked using a FORMAT statement. Each table row, from left to right, lists a SAS FORMAT statement, a description of what it does, a code example using the format, and the resulting output.

Note: If the input to a format is invalid, the format is “**” or “***” .

Table 13.11 *Formats for Maps*

FORMAT	DESCRIPTION	EXAMPLE	OUTPUT
contfmt	Use a continent’s numeric value to display the continent’s name	cont= 91 `put(cont,contfmt.);`	North America
glcna	Use the country’s GLC numeric code to display the country’s GLC alpha code	id=460 `put(id,glcna.);`	IR

FORMAT	DESCRIPTION	EXAMPLE	OUTPUT
glcnlu	Use the GLC numeric code to display the country's long name in uppercase	id=460 `put(id,glcnlu.);`	IRAN, ISLAMIC REPUBLIC OF
glcnsu	Use the GLC numeric code to display the country's short name in uppercase	id=460 `put(id,glcnsu.);`	IRAN
glcnsm	Use the GLC numeric code to display the country's name in mixed case	id=460 `put(id,glcnsm.);`	Iran
ison2a	Use the country's ISO numeric code to display the country's ISO alpha2 code	iso=364 `put(iso,ison2a.);`	IR
ison3a	Use the country's ISO numeric code to display the country's ISO alpha3 code	iso=364 `put(iso,ison3a.);`	IRN
isonlu	Use the country's ISO numeric code to display the country's long name in uppercase	iso=364 `put(iso,isonlu.);`	IRAN, ISLAMIC REPUBLIC OF
isonsu	Use the country's ISO numeric code to display the country's short name in uppercase	iso=364 `put(iso,isonsu.);`	IRAN
$cntrysl	Use a country's short name in uppercase to display the country's long name in uppercase	name='IRAN' `put(name,$cntrysl.);`	IRAN, ISLAMIC REPUBLIC OF
$glcalu	Use the GLC alpha code to display the country's long name in uppercase	country='IR' `put(country,$glcalu.);`	IRAN, ISLAMIC REPUBLIC OF

FORMAT	DESCRIPTION	EXAMPLE	OUTPUT
$glcan	Use the country's GLC alpha code to display the country's GLC numeric code	country='IR' `put(country,$glcan.);`	460
$glcsua	Use the country's short name in uppercase to display the GLC alpha code name	name='IRAN' `put(name,$glcsua.);`	IR
$glcsun	Use the country's short name in uppercase to display the country's GLC numeric code	name='IRAN' `put(name,$glcsun.);`	460
$glcsma	Use the country's short name in mixed-case to display the country's GLC alpha code	mixname='Iran' `put(mixname,$glcsma.);`	IR
$glcsmn	Use the country's short name in mixed-case to display the country's GLC numeric code	mixname='Iran' `put(mixname,$glcsmn.);`	460
$glcprov	Use a province or city name appended by || as a delimiter, followed by the country's GLC alpha code. This displays a province||country code, the province or city code, and the country's GLC alpha numeric code	provname='TEHRAN||IR' `put(provname,$glcprov.);`	8250460 8250 — province or city code 460 — country GLC numeric code
$isosu2a	Use the country's short name in uppercase to display the country's ISO alpha2 code	name='IRAN' `put(name,$isosu2a.);`	IR
$isosu3a	Use the country's name in uppercase	name='IRAN' `put(name,$isosu3a.);`	IRN

FORMAT	DESCRIPTION	EXAMPLE	OUTPUT
	to display the country's ISO alpha3 code		
$isosun	Use the country's short name in uppercase to display the country's ISO numeric code	name='IRAN' `put(name,$isosun.);`	364
$isoa2lu	Use the country's ISO alpha2 code to display the country's long name in uppercase	alpha2='IR' `put(alpha2,$isoa2su.);`	IRAN, ISLAMIC REPUBLIC OF
$isoa2n	Use the country's ISO alpha2 code to display the country's ISO numeric code	alpha2='IR' `put(alpha2,$isoa2n.);`	364
$isoa2su	Use the country's ISO alpha2 code to display the country's short name in uppercase	alpha2='IR' `put(alpha2,$isoa2lu.);`	IRAN
$isoa3lu	Use the country's ISO alpha3 code to display the country's long name in uppercase	alpha3='IRN' `put(alpha3,$isoa3lu.);`	IRAN, ISLAMIC REPUBLIC OF
$isoa3n	Use the country's ISO alpha3 code to display the country's ISO numeric code	alpha3='IRN' `put(alpha3,$isoa3n.);`	364
$isoa3su	Use the country's ISO alpha3 code to display the country's short name in uppercase	alpha3='IRN' `put(alpha3,$isoa3su.);`	IRAN
$isosm2a	Use the country's short name in mixed-case to	mixname='Iran' `put(mixname,$isosm2a.);`	IR

FORMAT	DESCRIPTION	EXAMPLE	OUTPUT
	display the country's ISO alpha2 code		
$isosm3a	Use the country's short name in mixed-case to display the country's ISO alpha3 code	mixname='Iran' `put(mixname,$isosm3a.);`	IRN
$isosmn	Use the country's short name in mixed-case to display the country's ISO numeric code	mixname='Iran' `put(mixname,$isosmn.);`	364

Using SAS/GRAPH Map Data Sets

Specifying the Location of Map Data Sets

There are three library references (librefs) associated with the location of a SAS library; each library containing map data sets used by SAS/GRAPH. The three are as follows:

- MAPS
- MAPSGFK
- MAPSSAS

You can download the latest map data sets from the SAS Maps and Geocoding website at https://support.sas.com/en/knowledge-base/maps-geocoding/maps-online.html. You are required to access the website with your SAS profile. You might be required to enter your site information.

MAPS references the library containing the latest set of SAS traditional maps. This library is defined in a configuration file with the value set to the same physical name (path) as MAPSSAS. For example, when specifying **MAPS.UK**, MAPS is the libref, and UK is a file in the SAS MAPS library.The libref is assigned through the "MAPS= System Option" on page 166. It can also be set or changed with a LIBNAME statement, which enables each client to set their own definition for MAPS. This client setting would override the server setting defined at start-up time. Note that using the "APPEND= System Option" in *SAS System Options: Reference* or the "INSERT= System Option" in *SAS System Options: Reference*with the "MAPS= System Option" on page 166 allows an additional libref to be assigned to MAPS

without changing its original definition. In this way existing programs can reference either the latest SAS or the MAPSGFK digital, vector map data sets.

MAPSGFK references the library containing the digital, vector map data sets at a location separate from the latest non-digital, vector SAS map data sets. This library is defined in a configuration file as a single physical path. This definition is set at installation time and should not be changed. The libref is assigned through the "MAPSGFK= System Option" on page 167.

MAPSSAS references the library containing the latest set of SAS traditional map files. This library is defined in a configuration file as a single physical name (path). It is the same path that MAPS references. This definition is set at installation time and should not be changed. The libref is assigned through the "MAPSSAS= System Option" on page 168.

Accessing Detailed Descriptions of Map Data Sets

You might need detailed information about the map data sets in order to determine their type, size, or the variables that they contain. In the case of traditional map data sets, use detailed information to determine whether map data sets are projected or unprojected. You can get this information by doing the following:

- using the CONTENTS or DATASETS procedure
- browsing the MAPS.METAMAPS data set in the MAPS library
- browsing the MAPSSAS.METAMAPS data set in the MAPSSAS library.
- browsing the library where your map data sets supplied by SAS reside

See "The METAMAPS Data Set" on page 324. Once the libref MAPS has been assigned, you can see a complete list of map data sets by viewing the MAPS.METAMAPS data set.

Run the following statements to list the map data sets in the SAS library that is assigned to the libref MAPS: Alternatively, you can substitute the libref MAPSGFK or MAPSSAS.

```
proc data sets lib=maps;
run;
```

Run the following statements to provide detailed information about a map data set, including the number of observations, the variables in each data set, and a description of each variable:

```
proc contents data=maps.canada3;
run;
```

To see the contents and descriptions of all of the map data sets associated with one of the three map libraries supplied by SAS, specify one of the following statements in the CONTENTS procedure:

- DATA=MAPS._ALL_
- DATA=MAPSSAS._ALL_
- DATA=MAPSGFK._ALL_

See the *Base SAS Procedures Guide* for more information about the CONTENTS and DATASETS procedures..

Customizing SAS/GRAPH Map Data Sets

Overview of Customizing Map Data Sets

You can customize the area that is displayed on your map by using only part of a particular map data set. There are several ways to accomplish this. You can use WHERE processing or a DATA step to subset the map data to be used by the GMAP procedure.

You can also use the GPROJECT procedure with the map data set to create a rectangular subset of a map data set. Do this by using the minimum and maximum longitude and latitude values in the map data set. For more information, see Chapter 14, "GPROJECT Procedure," on page 525.

You can combine map data sets in either of these situations:

- The map data sets to be combined were originally projected together.
- The map data sets all contain the same type of coordinates. That is, all are in radians or all are in degrees, and the longitude coordinates are measured in the same direction.

Map data sets supplied by SAS that contain coordinates expressed only as longitude and latitude, with variable names LONG and LAT, must be renamed X and Y. They should also be projected before you use them with the GMAP procedure. Map data sets from GfK GeoMarketing GmBH already contain projected coordinates expressed as longitude and latitude in degrees, with variable names LONG and LAT.

Subsetting Map Data Sets

Some of the SAS/GRAPH map data sets contain a large number of observations. Programs that use only a few states or provinces run faster if you exclude the unused portion of the map data set or use a reduced map data set. SAS provides several ways to accomplish this. One is to use the WHERE statement or WHERE= data set option within the GMAP procedure to select only the states or provinces that you want.

The WHERE statement and WHERE= data set option are most useful when you produce a simple map and do not need to make any other changes to the data set. For example, to use only the observations for Quebec in the CANADA map data set, begin the GMAP procedure with this statement:

```
proc gmap map=maps.canada(where=(province="24"));
```

The WHERE= data set option applies only to the data set that you specify in the argument in which the WHERE= option appears. If you use the WHERE statement, the WHERE condition applies to the map data set and the response data set.

Another approach is to use a DATA step to create a subset of the larger data set. This code illustrates a way to extract the observations for Quebec from the CANADA map data set:

```
data quebec;
   set maps.canada(where=(province="24"));
```

This approach is most useful when you want to create a permanent subset of a map data set. It is also useful when you need to make additional changes to the map data set.

See Chapter 16, "GREMOVE Procedure," on page 597 for an example of how to use GREMOVE to create a regional map from one of the map data sets that are supplied with SAS/GRAPH.

Reducing Map Data Sets

A *reduced map data set* is one that can be used to draw a map that retains the overall appearance of the original map but that contains fewer points. It requires considerably less storage space and can be drawn much more quickly. You can improve performance by plotting fewer observations for each map area. You reduce a map data set when you subset it on the variable DENSITY. You can add the variable DENSITY to a map data set by using the GREDUCE procedure. For more information, see Chapter 15, "GREDUCE Procedure," on page 581.

Note: Many of the map data sets in the MAPS library are supplied with a DENSITY variable.

An *unreduced map data set* contains all of the coordinates that were produced when the map was digitized. This type of map data set has more observations than most graphics output devices can accurately plot. Some unreduced map data sets already contain a DENSITY variable like the one calculated by the GREDUCE procedure. Therefore, it is not necessary to use the GREDUCE procedure to process these data sets. Values for DENSITY range from 0 through 6 (the lower the density, the coarser the boundary line).

You can set the DENSITY value by using the DENSITY= option in the PROC GMAP statement. For example, the following statement excludes all points with a density level of 2 or greater:

```
proc gmap map=maps.states density=2;
```

The resulting map is much coarser than one drawn by using all of the observations in the data set, but it is drawn much faster.

Another way to create a reduced map data set is to use a DATA step to exclude observations with larger density values:

```
data states;
   set maps.states(where=(density<2));
```

Projecting Traditional Map Data Sets

Traditional map data sets can be stored as unprojected or projected coordinates. GfK map data sets are stored as only projected. Unprojected map data sets contain

spherical coordinates, that is, longitude and latitude values usually expressed in radians.[1]

Many of the map data sets in the MAPS library are projected. However, these map data sets contain only unprojected coordinates and should be projected before you use them.

- CANADA3
- CANADA4
- COUNTIES
- COUNTY
- STATES

If the projection supplied with the map data set does not meet your needs, then you can use the GPROJECT procedure (on unprojected map coordinates) to create a different projection. For more information about map data sets with unprojected coordinates, see "Map Data Sets Containing X, Y, LONG, and LAT" on page 312. You should select a projection method that least distorts the regions that you are mapping. (All projection methods inherently distort map regions.) See Chapter 14, "GPROJECT Procedure," on page 525 for more information.

Note: Using an unprojected map data set with the GMAP procedure can cause your map to be reversed.

Controlling the Display of Lakes

Some countries contain a lake or a polygonal area that is located completely within a single unit area. Occasionally these areas can be a problem when working with map data sets. In addition, displaying these areas might not be appropriate for some applications. In these cases, you might want to remove them from the map data set before you proceed.

In traditional and GfK map data sets that contain coordinates for a lake or area that is located within a single internal division, the area is identified with the numeric variable LAKE. The value of LAKE is 1 for points that correspond to water. A value of 2 indicates land points. A value of 0 corresponds to a landlocked area — an area within an internal region. Such an area would be visible as a hole in the resulting map graph. It is best to remove all lakes from the map data set by using LAKE=0. In the following programming code, the DATA step statements illustrate the inclusion of a lake in Denmark region DK-101. Then WHERE processing is used to delete the lake from that Denmark region. The first graph shows the Denmark region DK-101 with its lake, and second shows the same region without the lake.

```
data subset_map;
set mapsgfk.denmark;
if id in:('DK-101') then output;
run;
proc gmap map=subset_map
          data=subset_map res=none;
```

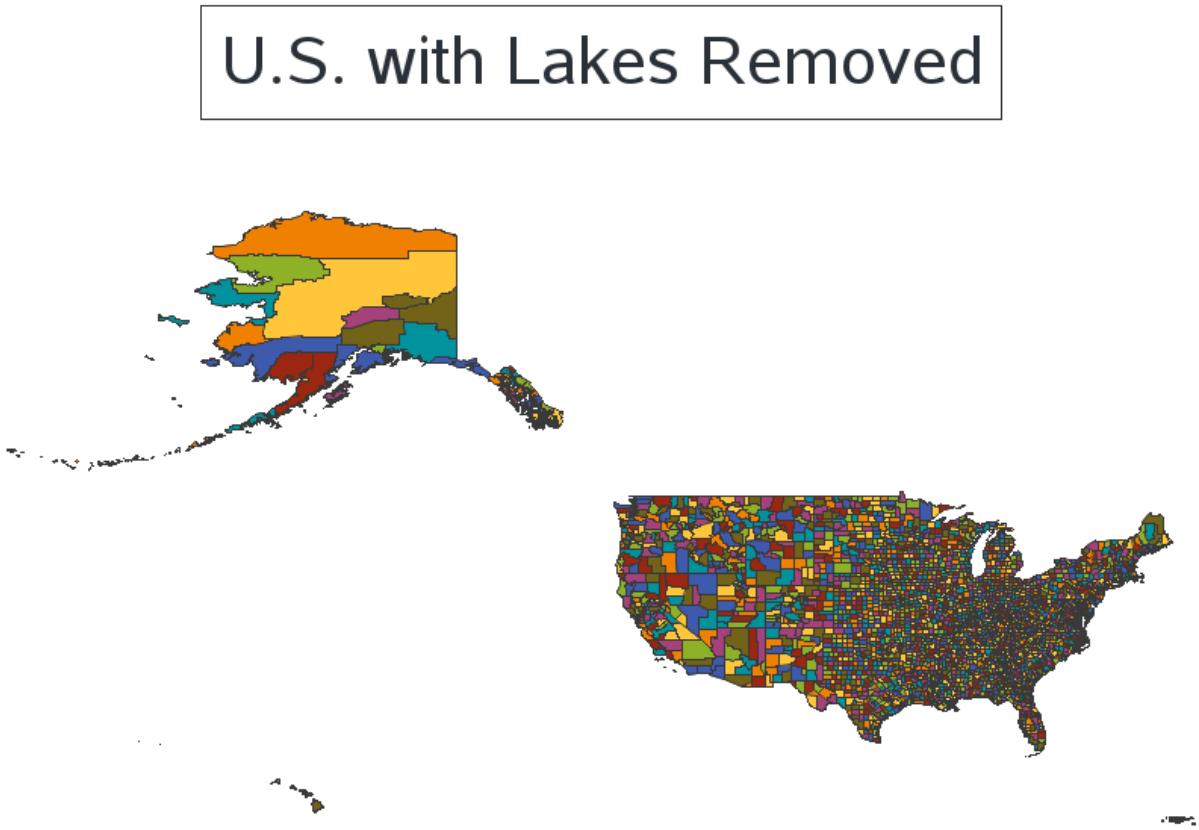
1. If your data is in degrees, then it can be converted to radians by multiplying by the degree-to-radian constant [atan(1)/45].

```
   id id;
   choro id / discrete stat=first;
   title "Lake in Denmark";
run;
   where lake=0;
title "Denmark with Lake Removed (Lake=0)";
run;
quit;
```

Output 13.1 *The DK-101 Region of Denmark with and without Its Lake*

The following statements illustrate how to delete the lakes from your GfK map data sets using WHERE processing: The STAT=FIRST option processes only the first observation that matches the geographic region in the MAPSGFK map data set.

```
proc gmap map=mapsgfk.us_all(where=(lake=0))
          data=mapsgfk.us_all;
   id id;
   choro id / levels=1 stat=first nolegend;
   title box=1 f=none h=4
         "U.S. with Lakes Removed";
run;
quit;
```



You can also create a new traditional map data set that is a subset of the traditional map data set:

```
data nolake;
   set maps.chile(where=(lake=0));
run;
```

Creating SAS Map Data Sets

Creating Map Data Sets

Overview

In addition to using map data sets that are supplied with SAS/GRAPH software, you can also create your own map data sets. Map data sets are not limited to geographic data; you use them to define other spaces such as floor plans.

When creating map data sets, the following variables must be included:

- a numeric variable named X that contains the horizontal coordinates of the boundary points. The value of this variable is projected and represents longitude when your data is geographic. When your data is not geographic but defines

spaces such as floor plans, this variable might not be projected and might not represent longitude. This variable is required by the GMAP procedure.

- a numeric variable named Y that contains the vertical coordinates of the boundary points. The value of this variable is projected and represents latitude when your data is geographic. When your data is not geographic but defines spaces such as floor plans, this variable might not be projected and might not represent latitude. This variable is required by the GMAP procedure.
- one or more variables that uniquely identify the areas in the map. Map area identification variables can be either character or numeric and are indicated in the ID statement. An identification variable is required by the GMAP procedure.

The X and Y variable values in the map data set do not have to be in any specific units. They are rescaled by the GMAP procedure based on the minimum and maximum values in the data set. The minimum X and Y values are in the lower left corner of the map, and the maximum X and Y values are in the upper right corner.

The GMAP procedure uses the values of the X and Y variables to draw the map. To use the unprojected values to produce a custom map, follow the tasks in "Map Data Sets Containing X, Y, LONG, and LAT" on page 312.

Map data sets in which the X and Y variables contain unprojected longitude and latitude should be projected before you use them with PROC GMAP. See Chapter 14, "GPROJECT Procedure," on page 525 for details.

Here are optional variables to consider including in map data sets:

- a numeric variable named DENSITY that holds the density values returned from a GREDUCE procedure.
- a numeric variable named LONG that contains the horizontal coordinate of the boundary point in degrees or radians. The value of this variable is unprojected and represents longitude (east-west position).
- a numeric variable named LAT that contains the vertical coordinate of the boundary point in degrees or radians. The value of this variable is unprojected and represents latitude (north-south position).
- a variable named SEGMENT to identify map areas that include noncontiguous polygons. Each unique value of the SEGMENT variable within a single map area defines a distinct polygon. If the SEGMENT variable is not present, each map area is drawn as a separate closed polygon that is regarded as a single segment.

  The observations for each segment of a map area in the map data set must occur in the order in which the points are to be connected. The GMAP procedure forms map area outlines by connecting the boundary points of each segment in the order in which they appear in the data set. Eventually the last point is joined to the first point to complete the polygon. All the segments for each ID value must be contiguous within the map data set. The observations must be specified in a clockwise direction. However, an enclosed polygon (a hole representing a lake, for example) must be specified in a counter-clockwise direction—opposite from the direction in which the containing polygon is drawn.
- a variable named RESOLUTION to map detail level based on output resolution. Refer to Table 13.33 on page 322 for a list of the output resolutions associated with a RESOLUTION variable value.

A unit area is defined by observations in the map data set that have the same identification (ID) variable value. A unit area might include a single polygon or a collection of polygons. A polygon is defined by all of the observations that have the same SEGMENT variable value within the same unit area.

- If the unit area is a single polygon, then all values of SEGMENT are the same (alternatively, you can omit the SEGMENT variable).
- If the unit area contains multiple polygons, such as islands, then the SEGMENT variable has multiple values. For example, in the MAPS.US data set, the state of Hawaii (a unit area) contains six different values in the SEGMENT variable, one for each island in the state.
- If the unit area contains enclosed polygons (holes), such as lakes, then the SEGMENT variable has one value but the interior polygon is defined by separate boundaries. To separate boundaries, a missing X and Y value must be inserted at the separation point. For example, in the CANADA2 data set supplied with SAS/GRAPH, the map area for the Northwest Territories (a unit area) use enclosed polygons for two lakes.

Creating a Unit Area That Is a Single Polygon

This DATA step creates a SAS data set that contains coordinates for a unit area with a single polygon, a square:

```
data square;
   input id x y;
   datalines;
1 0 0
1 0 40
1 40 40
1 40 0
;
```

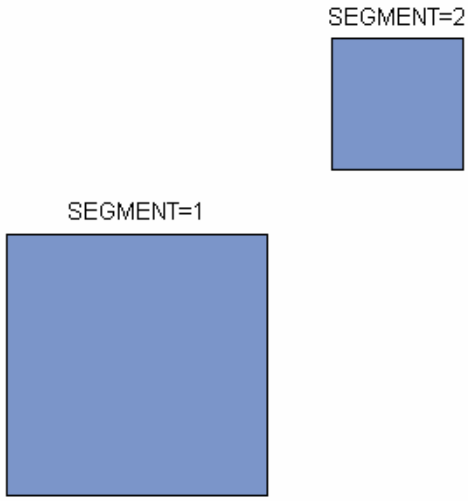
This data set does not have a SEGMENT variable.

Creating a Unit Area That Contains Multiple Polygons

Use different values of the SEGMENT variable to create separate polygons within a single unit area. For example, this DATA step assigns two values to the SEGMENT variable. The resulting data set produces a single unit area that contains two polygons, as shown in Figure 13.37 on page 427:

```
data map;
   input id $ segment x y;
   datalines;
square   1 0 0
square   1 0 4
square   1 4 4
square   1 4 0
square   2 5 5
square   2 5 7
square   2 7 7
square   2 7 5
;
```

Figure 13.11 *Single Unit Area with Two Segments (Polygons)*

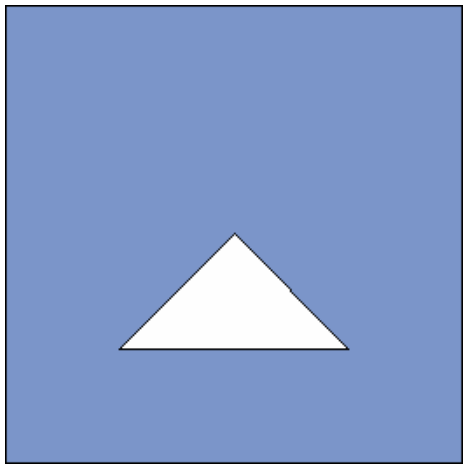


Creating a Unit Area That Contains Enclosed Polygons as Holes

Use separate boundaries to create an enclosed polygon (that is, a polygon that falls within the primary polygon for a single segment). The boundary for the hole is separated from the primary polygon boundary by inserting a missing value for X and Y. The last three observations are drawn counter-clockwise, in the opposite direction from the primary polygon. This enables an HTML image of the map to render correctly in all web browsers. For example, the data set that is created by this DATA step produces the map shown in Figure 13.38 on page 428:

```
data map;
   input id $ segment x y;
   datalines;
square   1 0 0
square   1 0 4
square   1 4 4
square   1 4 0
square   1 . .
square   1 3 1
square   1 2 2
square   1 1 1
;
```

Figure 13.12 Single Unit Area with Hole



Note: A single map segment is a section of a unit area with a single value of the SEGMENT variable. A single map segment cannot contain multiple polygons without having at least one observation with missing values for X and Y. All segments within the map data sets supplied by SAS/GRAPH contain a single polygon that can have one or more separate boundaries. Each boundary is separated by an observation with missing values for X and Y.

Creating a Unit Area That Contains Another Area

Sometimes rather than a hole or lake, an enclosed polygon represents a separate map area. For example, in MAPS.AFRICA, the country of Lesotho is surrounded by the country of South Africa.

Note: As in some Traditional map data sets, MAPS.AFRICA specifies the coordinates to draw both country polygons in a clockwise direction. This might adversely affect the rendering of the HTML image of the map in some web browsers.

To create an enclosed map area:

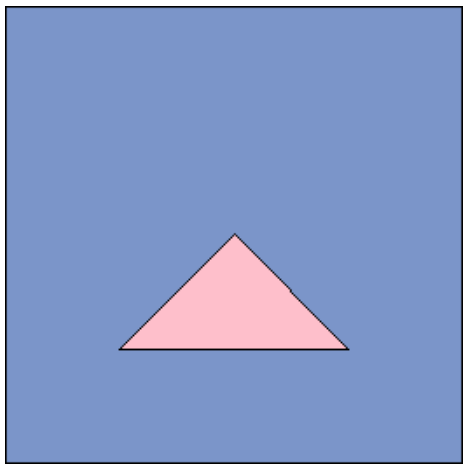
1. Create an observation with missing values for X and Y for the surrounding area.
2. Define the boundary as part of the surrounding area by the using ID value for the surrounding area.
3. Define the boundary as part of the enclosed area by using the ID value for the enclosed area.

The triangle observations are drawn counter-clockwise, in the opposite direction from the hole in the primary (square) polygon. This enables an HTML image of the map to render correctly in all web browsers.

For example, this DATA step creates a data set that produces the map shown in Figure 13.39 on page 429:

```
data map;
   input id $ segment x y;
   datalines;
square   1 0 0
square   1 0 4
square   1 4 4
square   1 4 0
square   1 . .
square   1 1 1
square   1 2 2
square   1 3 1
triangle 1 3 1
triangle 1 2 2
triangle 1 1 1
;
```

Figure 13.13 *Unit Area within a Unit Area*



Using GfK Map Data Sets with Existing Code

Reworking Code That Uses Traditional Map Data Sets

Overview

This section presents several examples of existing code that uses traditional map data sets, with tips for repurposing the code to use a GfK map data set and variables. The existing code fragment is shown first, followed by the code rewritten with the recommended changes. The tips and details of the change are presented as `/* comments */` within each section of rewritten code.

Code to Prepare a Choropleth Map of Afghanistan

If you have existing code similar to the following:

```
proc gmap data=mydata map=maps.afghanis;
id id;
choro id / nolegend;
run;
```

Rewrite the code as follows to use a GfK map data set and ensure that the *id-variable*, in this case ID, is a matching character format between the response data set and the input data set:

```
/* Change the traditional map data set name (maps.afghanis) */
/* to the GfK map data set name (mapsgfk.afghanistan). */
/* The id-variable value in mydata must match the */
/* GfK id-variable character format. */
/* GfK id-variables ID and ID1 are character format. */
proc gmap data=mydata map=mapsgfk.afghanistan;
id id;
choro id / nolegend;
run;
```

Code to Prepare a Map of Europe for Annotation

If you have existing code similar to the following:

```
proc gmap data=mydata map=maps.europe;
id id;
choro id / levels=1
           nolegend
           anno=mypoints;
run;
```

Rewrite the code as follows to use a GfK map data set and a different *id-variable* because ID is now character format:

```
/* Change the traditional map data set name (maps.europe) */
/* to the GfK map data set name (mapsgfk.europe).          */
/* If the id-variable value in 'mydata' is numeric choose the */
/* GfK id-variable SEGMENT, which is also numeric format, or create */
/* your own variable. */
/* Note that GfK id-variables ID and ID1 are character format. */
/* The LEVELS=<number-of-midpoints> option will only work with numeric
*/
/* response variable values. */
proc gmap data=mydata map=mapsgfk.europe;
id;
choro segment / levels=1
           nolegend
           anno=mypoints;
run;
```

Code to Prepare a United States Map After Projecting Spherical Coordinates (Longitude and Latitude)

If you have existing code similar to the following, which projects the X and Y coordinate units in radians:

```
proc gproject data=maps.states out=mystates project=lambert;
id state;
run;

proc gmap data=mydata map=mystates;
id state;
choro state / nolegend;
run;
```

Rewrite the code as follows to use the GfK map data set and the projected X and Y coordinates (in degrees) provided in the input data set:

```
/* Change the traditional map data set name (maps.states) to the */
/* GfK map data set name mapsgfk.us_states. */
/* Remove Proc GPROJECT and use the provided projected coordinates in
degrees. */
proc gmap data=mydata map=mapsgfk.us_states;
id state;
choro state / nolegend;
run;
```

Code to Project Annotate Data with a GfK Map Data Set

Use the following code to project only the Annotate data and not the already projected map:

```
/* The mapsgfk.projparm data set contains input projection parameters.
*/

/* Project the points using the map's projection parameters stored
that data set. */
/* The us_states entry in the projection parameters data set is used
for  */
/* input parameters. */
 /* mapsgfk.us_states is the GfK map data set for the United States
that */
/* contains unprojected longitude (X) and latitude (Y) variables in
radians. */

proc gproject data=anno out=annoproj parmin=mapsgfk.projparm
parmentry=us_states;
run;

proc gmap data=mydata map=mapsgfk.us_states anno=annoproj;
id state;
choro state / nolegend;
run;
```

Usage Tips with GfK Map Data Sets

Best Practices

When using the GfK map data set named **US_ALL**, the character identification variable **ID** uniquely refers to the state_county in the United States as well as other U.S. Territories. Specifying the variable **ID** instead of **STATE** ensures that the polygons are drawn correctly. For example:

```
proc gmap data=mydata map=mapsgfk.us_all;
id id;
choro id;
run;
```

If you want to use the **STATE** variable, use it in combination with the **COUNTY** identification variable:

```
proc gmap data=mydata map=mapsgfk.us_all;
id state county;
choro id;
run;
```

To more accurately create a map for the island nation of Maldives in the Indian Ocean, use the most current MAPSGFK.WORLD or the MAPSGFK.MALDIVES data sets. You might have existing code that uses the traditional MAPS.WORLD data set. In that case, you can achieve the same level of map detail by using this data set version from SAS 9.1M3.

It is a requirement that each GfK map data set completes any enclosed polygons (holes) it contains in a counter-clockwise direction. This is the opposite direction from which the hole in the containing polygon is drawn. This enables an HTML map image to render correctly in all web browsers. It also enables any HTML hover-text to display correctly for an area containing a hole without interfering with that hole.

Note: Traditional map data sets vary in the direction in which they complete enclosed polygons (holes). For example, the MAPS.AFRICA data set completes enclosed polygons in a clockwise direction. Traditional map data sets were created before the setting of map data set requirements to enable viewing HTML in web browsers.

Examples: GMAP Procedure

About the GMAP Procedure Examples

Examples in This Section

This section provides basic examples of how to use the GMAP procedure. The following tables list the examples that are provided for GfK map data and for traditional map data.

Table 13.12 *GMAP Procedure GfK GeoMarketing Map Data Examples*

Example	Description
Producing a Simple Block Map (p. 436)	Shows how to produce a block map that shows the population of countries in Asia.
Specifying Response Levels in a Block Map (p. 439)	Shows how to use the LEVELS= option to specify the number of response levels for the blocks.
Assigning a Format to the Response Variable (p. 442)	Shows how to create a user-defined format and how to apply the format to the response variable values in a map.
Specifying the Statistic for the Response Variable (p. 446)	Shows how to specify the statistic for the response variable that is displayed by the block map.
Producing a Simple Choropleth Map (p. 448)	Shows how to produce a choropleth (two-dimensional) map that shows the population of countries in Europe.
Producing a Drilldown Choropleth Map (p. 451)	Shows how to produce three choropleth (two-dimensional) maps, where each map shows the population of a southeastern state in the United States and provides a link to that state's home page.

Example	Description
Labeling Provinces on a Map (p. 456)	Shows how to use the SAS/GRAPH Annotate facility to add labels to each area in a map of Belarus.
Combining GfK GeoMarketing Map Data and Sample Response Data to Map U.S. Population Statistics (p. 459)	Shows how to use the sample response data set SASHELP.US_DATA with map data set MAPSGFK.US to display population details for each state in the United States.
Producing a Simple Prism Map (p. 461)	Shows how to create a simple prism map of the population in Africa.
Specifying Midpoints in a Prism Map (p. 463)	Shows how to specify a set of midpoints that are used to create the response levels in a prism map of Africa.
Producing a Simple Surface Map (p. 466)	Shows how to create a surface map that shows the annual population growth rate of countries in South America.
Mapping an Individual Country By Subsetting MAPSGFK.WORLD (p. 469)	Shows how to subset a single country from the MAPSGFK.WORLD data set.
Specifying Country Subdivisions on a Continent (p. 471)	Shows how to use the first-level administrative detail, when available in the map data, to show the subdivisions within countries in the African continent.
Producing a Choropleth Map By Combining Three Map Data Sets (p. 473)	Shows how to combine map data sets.
Producing a Choropleth Map Annotating Cities (p. 475)	Shows how to use the SAS/GRAPH Annotate facility to place the names of cities and a symbol for each on a choropleth map of Austria, Czech Republic, and Hungary.
Producing a Choropleth County Map Annotating Roads and Water (p. 479)	Shows how to display the names and locations of the fishing areas in Wake County, North Carolina.
Labeling Cities on a Map (p. 489)	Shows how to use the SAS/GRAPH Annotate facility to place the names of selected cities and a symbol for each on a choropleth map of the United States.

Table 13.13 GMAP Procedure Traditional Map Data Examples

Example	Description
Producing a Simple Block Map Using Traditional Map Data (p. 495)	Shows how to produce a block map that shows the population of countries in Asia.
Specifying Response Levels in a Block Map Using Traditional Map Data (p. 497)	Shows how to use the LEVELS= option to specify the number of response levels for the blocks.
Assigning a Format to the Response Variable when Using Traditional Map Data (p. 499)	Shows how to create a user-defined format and how to apply the format to the response variable values in a map.
Specifying the Statistic for the Response Variable When Using Traditional Map Data (p. 502)	Shows how to specify the statistic for the response variable that is displayed by the block map.
Producing a Simple Choropleth Map Using Traditional Map Data (p. 504)	Shows how to produce a choropleth (two-dimensional) map that shows the population of countries in Europe.
Producing a Drilldown Choropleth Map Using Traditional Map Data (p. 506)	Shows how to produce three choropleth (two-dimensional) maps, where map each shows the population of a southeastern state in the United States and provides a link to that state's home page.
Labeling Provinces on a Map When Using Traditional Map Data (p. 511)	Shows how to use the SAS/GRAPH Annotate facility to add labels to each area in a map of Belarus.
Combining Traditional Map Data and Sample Response Data to Map U.S. Population Statistics (p. 513)	Shows how to use the sample response data set SASHELP.US_DATA with map data set MAPSSAS.US to display population details for each state in the United States.
Producing a Simple Prism Map Using Traditional Map Data (p. 515)	Shows how to create a simple prism map of the population in Africa.
Specifying Midpoints in a Prism Map When Using Traditional Map Data (p. 517)	Shows how to specify a set of midpoints that are used to create the response levels in a prism map of Africa.
Producing a Simple Surface Map Using Traditional Map Data (p. 519)	Shows how to create a surface map that shows the annual population growth rate of countries in South America.

Example	Description
Mapping an Individual Country By Subsetting MAPSSAS.WORLD (p. 521)	Shows how to subset a single country from the MAPSSAS.WORLD data set.
Producing an SVG File That Displays a European Map (p. 492)	Shows how to create an SVG file named europepop.svg and an HTML file named europe.htm that display a map of Europe in a web browser.

Examples Available Online

You can find more examples on the Graphically Speaking blog. On the blog page, use **Search Graphically Speaking** to search for GMAP to find the GMAP procedure examples.

> **TIP** Specify GMAP -SGMAP to eliminate examples for the SGMAP procedure.

You can also find examples in the Graph Samples Gallery. Click PROC GMAP to see the examples.

Example 1: Producing a Simple Block Map

Features:
- MAP= required argument referring to GfK map data
- DATA= argument referring to response data
- ID statement
- RESOLUTION= option
- BLOCK statement options
  - BLOCKSIZE=
  - COUTLINE=
  - RELZERO
- System option FMTSEARCH=
- SQL procedure
- PATTERN statement

Data sets:
- MAPSGFK.ASIA (map data set)
- DEMOGRAPHICS (table of response data)

Format: ison2a

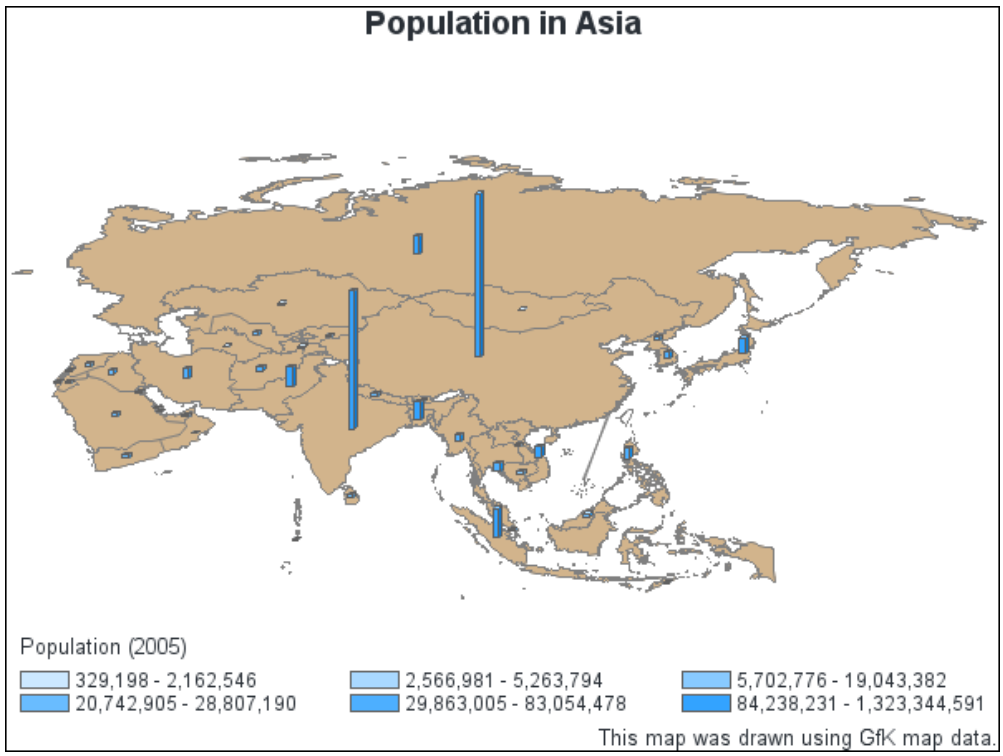
Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Notes: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

The ISO codes that are in the sashelp.demographics data set are not as recent as the ISO codes found in the MAPSGFK data set.

Output

This example uses a GfK map data set to produce a block map that shows the population of countries in Asia. Because the DISCRETE option is not used, the response variable is assumed to have a continuous range of values. Because neither the LEVELS= nor MIDPOINTS= option is used, the GMAP procedure selects a number of levels based on the number of map areas. It then calculates the appropriate response levels. The elongated countries in the displayed map indicate that a different projection method was used with this GfK map than was used with the traditional Asia map data set.



Program

```
options fmtsearch=(sashelp.mapfmts);

proc sql;
```

```
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;

goptions reset=all border;

title1 "Population in Asia";
legend1 label=(position=top) shape=bar(.3in,.1in);
pattern1 value=msolid color=tan;

proc gmap data=demographics(where=(cont=95))
   map=mapsgfk.asia resolution=4 all;
   id iso;
   block pop / blocksize=1 relzero coutline=gray legend=legend1;
run;
quit;
```

Program Description

Specify the format catalog to search that has the predefined ISO alpha2 code.

```
options fmtsearch=(sashelp.mapfmts);
```

Create a table named demographics using sashelp.demographics as the base and change its variables to match GfK variable types and lengths. This table is used as the response data set. This step makes two changes to the sashelp.demographics data set. The ISO variable is converted from numeric to character. Secondly, a character ID variable is created. This ID value matches the character variable ISOALPHA2 value in the GfK map data set. The format 'ison2a' is used to convert the numeric ISO code to its equivalent ISOALPHA2 code.

```
proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;
```

Set the graphics environment.

```
goptions reset=all border;
```

Define the title, legend, and color for the map. The PATTERN statement specifies a solid tan color pattern for the Asian continent, differentiating it from the block colors.

```
title1 "Population in Asia";
legend1 label=(position=top) shape=bar(.3in,.1in);
pattern1 value=msolid color=tan;
```

Produce the block map. Specify the demographics table just created as the response data set. Specify a GfK map data set named mapsgfk.asia. Specifically use the Asia continent. The RESOLUTION= option specifies that all map observations with a RESOLUTION variable value of 4 or less be used. The 4 value corresponds to a resolution of 800 x 600 pixels. ALL specifies that the generated map should include all the map areas from the map data set, even if there is no observation for that map area. The ID statement specifies the variable that is in both the map data set and the response data set and defines map areas. Note that the ISO variable is character. The BLOCK statement specifies the population variable in the response data set that contains the response values for each of the map areas. The BLOCKSIZE= option specifies the width of the blocks. The RELZERO option specifies that the block values are relative to zero. The COUTLINE= option specifies a gray color for the map outline so that the blocks are highly visible.

```
proc gmap data=demographics(where=(cont=95))
   map=mapsgfk.asia resolution=4 all;
   id iso;
   block pop / blocksize=1 relzero coutline=gray legend=legend1;
run;
quit;
```

Example 2: Specifying Response Levels in a Block Map

Features: MAP= required argument referring to a GfK map data set

DATA= argument referring to response data

ID statement

BLOCK statement options
- LEVELS=
- SHAPE=
- RELZERO
- CEMPTY=

System option FMTSEARCH=

SQL procedure

PATTERN statement

Data sets: MAPSGFK.SAMERICA (map data set)

DEMOGRAPHICS (table of response data)

Format: ison2a

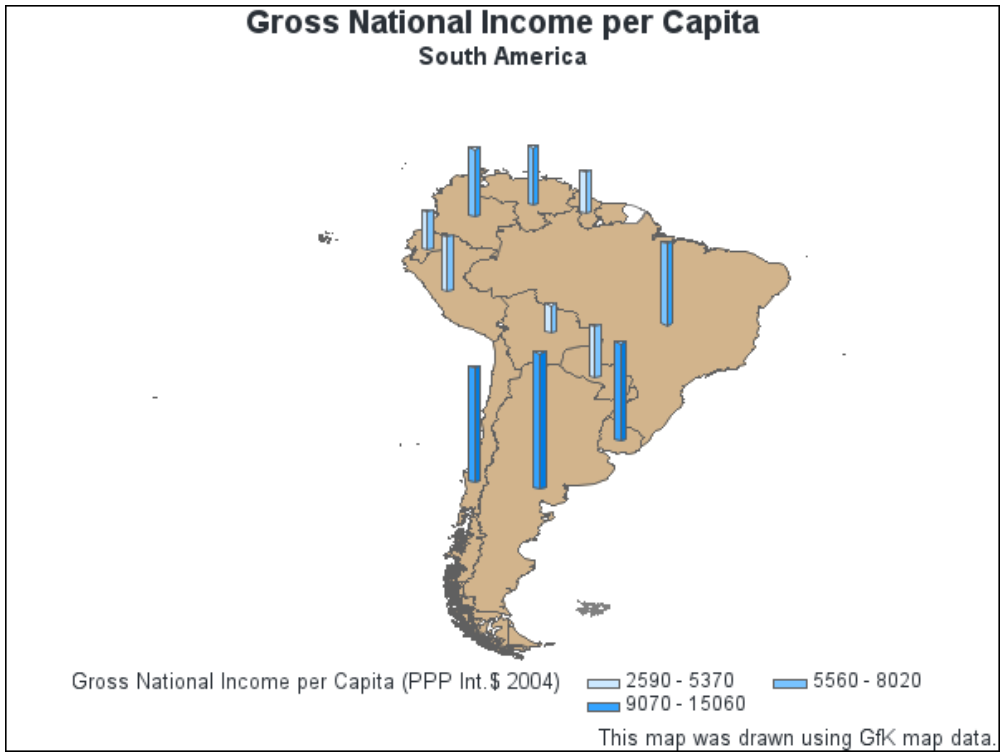
Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Notes: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

The ISO codes that are in the sashelp.demographics data set are not as recent as the ISO codes found in the MAPSGFK data set.

Output

This example uses the LEVELS= option to specify the number of response levels for the blocks. The LEVELS= option tells GMAP how many response levels and the GMAP procedure calculates the quantiles.



Program

```
options fmtsearch=(sashelp.mapfmts);

proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
```

```
quit;

goptions reset=all border;

title1 "Gross National Income per Capita";
title2 "South America";
pattern1 value=msolid color=tan;

proc gmap data=demographics(where=(cont=92))
   map=mapsgfk.samerica all;
   id iso;
   block gni / levels=3 shape=prism relzero cempty=gray;
run;
quit;
```

Program Description

Specify the format catalog to search that has the predefined ISO alpha2 code.

```
options fmtsearch=(sashelp.mapfmts);
```

Create a table named demographics using sashelp.demographics as the base and change its variables to match GfK variable types and lengths. This table is used as the response data set. This step makes two changes to the sashelp.demographics data set. The ISO variable is converted from numeric to character. Secondly, a character ID variable is created. This ID value matches the character variable ISOALPHA2 value in the GfK map data set. The format 'ison2a' is used to convert the numeric ISO code to its equivalent ISOALPHA2 code.

```
proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;
```

Set the graphics environment.

```
goptions reset=all border;
```

Define the titles and color for the map. The PATTERN statement specifies a solid tan color pattern for the South American continent, differentiating it from the block colors.

```
title1 "Gross National Income per Capita";
title2 "South America";
pattern1 value=msolid color=tan;
```

Produce the block map. The ALL argument specifies that the output should include all of the map areas from the map data set. This happens even if the response data set DEMOGRAPHICS does not include an observation for the map area. The LEVELS= option specifies the number of response levels for the graph. The SHAPE= option draws the blocks as prisms. The RELZERO option specifies that the

block values are relative to zero. The CEMPTY= option specifies the outline color for map areas that have missing data. Note that the block map does not include the Caribbean islands. GfK offers the map variables for those islands in a separate data set.

```
proc gmap data=demographics(where=(cont=92))
   map=mapsgfk.samerica all;
   id iso;
   block gni / levels=3 shape=prism relzero cempty=gray;
run;
quit;
```

Example 3: Assigning a Format to the Response Variable

Features:
MAP= required argument referring to a GfK map data set
DATA= argument referring to response data
FORMAT statement
ID statement
AREA statement option MIDPOINTS=
BLOCK statement options
- LEGEND=
- RELZERO
- LEVELS=

System option FMTSEARCH=
SQL procedure
FORMAT procedure
LEGEND statement
PATTERN statement

Data sets:
MAPSGFK.ASIA (map data set)
DEMOGRAPHICS (table of response data)

Format:
ison2a

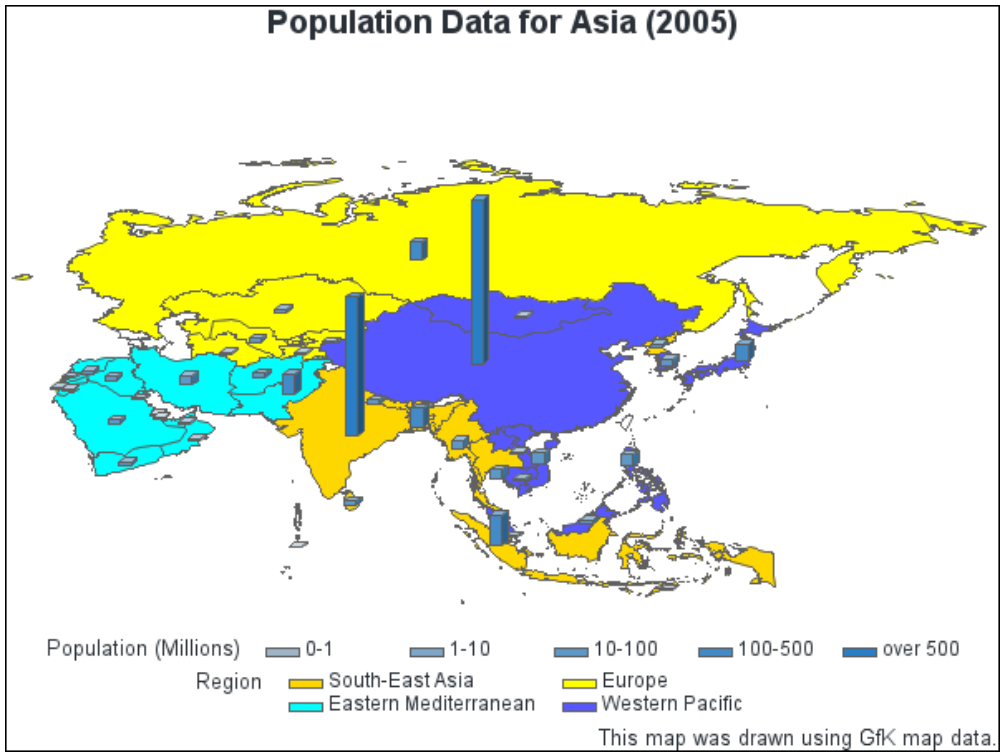
Restriction:
The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Notes:
The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

The ISO codes that are in the sashelp.demographics data set are not as recent as the ISO codes found in the MAPSGFK data set.

Output

This example creates formats for the response variables. The format for the POP variable defines and labels ranges of values. These ranges appear in the legend and make the map easier to understand. The example also uses the AREA statement to patterns the map areas by region. The elongated countries in the output indicate that a different projection method was used with this GfK map than was used with the traditional Asia map data set.



Program

```
options fmtsearch=(sashelp.mapfmts);

proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;

goptions reset=all border;

proc format;
  value popfmt low-1000000="0-1"
```

```
                1000001-10000000="1-10"
                10000001-100000000="10-100"
                100000001-500000000="100-500"
                500000001-high="over 500";
run;

proc format;
  value $ regionfmt "SEAR" = "South-East Asia"
                    "EUR" = "Europe"
                    "EMR" = "Eastern Mediterranean"
                    "WPR" = "Western Pacific";
run;

title1 "Population Data for Asia (2005)";
pattern1 color=gold value=msolid;
pattern2 color=yellow value=msolid;
pattern3 color=cyan value=msolid;
pattern4 color=light_blue value=msolid;

legend1 label=("Population (Millions)");

proc gmap data=demographics(where=(cont=95))
   map=mapsgfk.asia all;
   format pop popfmt.;
   format region $regionfmt.;
   id id;
   area region / midpoints="SEAR" "EUR" "EMR" "WPR";
   block pop / legend=legend1 relzero levels=all;
run;
quit;
```

Program Description

Specify the format catalog to search that has the predefined ISO alpha2 code.

```
options fmtsearch=(sashelp.mapfmts);
```

Create a table named demographics using sashelp.demographics as the base and change its variables to match GfK variable types and lengths. This table is used as the response data set. This step makes two changes to the sashelp.demographics data set. The ISO variable is converted from numeric to character. Secondly, a character ID variable is created. This ID value matches the character variable ISOALPHA2 value in the GfK map data set. The format 'ison2a' is used to convert the numeric ISO code to its equivalent ISOALPHA2 code.

```
proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;
```

Set the graphics environment.

```
goptions reset=all border;
```

Create a format for the POP variable. POPFMT. defines the ranges of values for POP and labels the values.

```
proc format;
  value popfmt low-1000000="0-1"
               1000001-10000000="1-10"
               10000001-100000000="10-100"
               100000001-500000000="100-500"
               500000001-high="over 500";
run;
```

Create a format for the REGION variable. REGIONFMT. labels the values for REGION.

```
proc format;
  value $ regionfmt "SEAR" = "South-East Asia"
                    "EUR" = "Europe"
                    "EMR" = "Eastern Mediterranean"
                    "WPR" = "Western Pacific";
run;
```

Define the title and colors for the map. The PATTERN statement specifies a unique solid color pattern for each country of the Asian continent, differentiating it from the block colors.

```
title1 "Population Data for Asia (2005)";
pattern1 color=gold value=msolid;
pattern2 color=yellow value=msolid;
pattern3 color=cyan value=msolid;
pattern4 color=light_blue value=msolid;
```

Assign the legend label.

```
legend1 label=("Population (Millions)");
```

Produce the block map. The ALL argument specifies that the map displayed should include all of the map areas from the map data set. This happens even if the response data set DEMOGRAPHICS does not include an observation for the map area. The map displayed shows one such area. The FORMAT statements assign POPFMT. to the POP variable and $REGIONFMT. to the REGION variable. The ID statement assigns the variable ID—which represents the ISOALPHA2 variable after the variable rename when the demographics table was set up. The AREA statement assigns patterns to the map areas according to the values of the REGION variable. The RELZERO option specifies that the blocks values are relative to zero. The LEVELS= option is used to graph all unique ID response variable values.

```
proc gmap data=demographics(where=(cont=95))
   map=mapsgfk.asia all;
   format pop popfmt.;
   format region $regionfmt.;
   id id;
   area region / midpoints="SEAR" "EUR" "EMR" "WPR";
   block pop / legend=legend1 relzero levels=all;
run;
quit;
```

Example 4: Specifying the Statistic for the Response Variable

Features: MAP= required argument referring to a GfK map data set
DATA= required argument referring to response data
ID statement
BLOCK statement options
STATISTIC=
LEVELS=
RELZERO
PATTERN statement

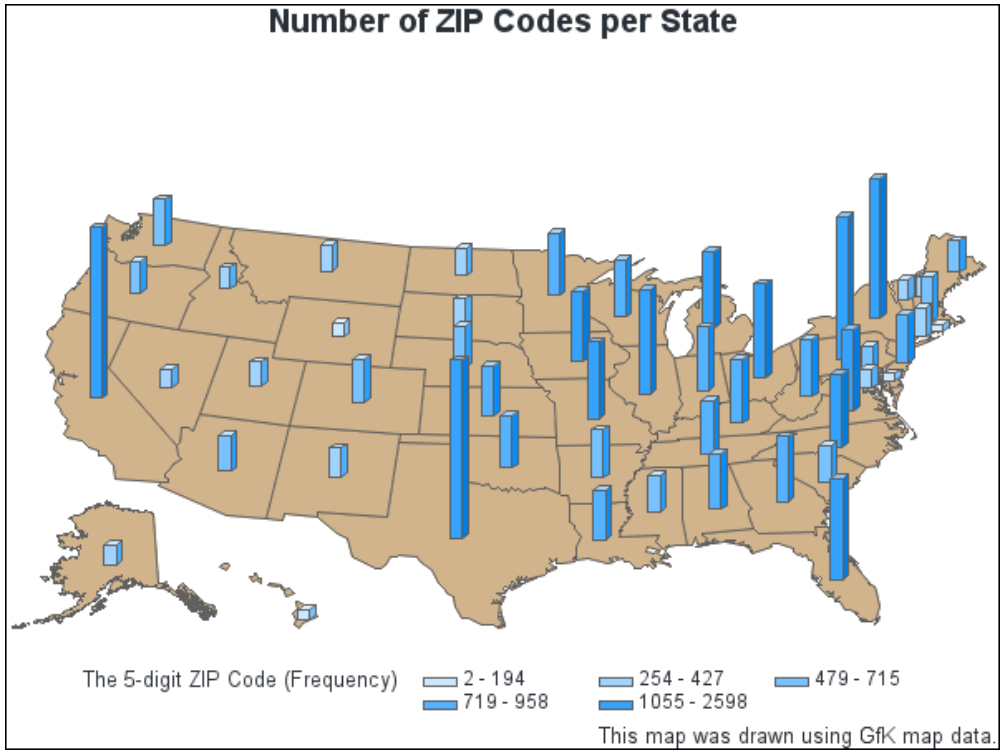
Data sets: MAPSGFK.US (map data set)
SASHELP.ZIPCODE (response data)

Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example specifies the statistic for the response variable that is displayed by the block map. The STATISTIC= option specifies that the statistic is frequency rather than the default statistic (sum).



Program

```
goptions reset=all border;

title1 "Number of ZIP Codes per State";
pattern1 value=msolid color=tan;

proc gmap map=mapsgfk.us data=sashelp.zipcode all;
   id state;
   block zip / statistic=frequency levels=5 relzero;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title and color for the map.

```
title1 "Number of ZIP Codes per State";
pattern1 value=msolid color=tan;
```

Produce the block maps. The ALL argument specifies that the map displayed should include all of the map areas from the map data set. This happens even if the response data set SASHELP.ZIPCODE does not include an observation for the map area. The STATISTIC= option specifies the statistic for the response variable. The LEVELS= option specifies the number of response levels. The RELZERO option

specifies that the blocks values are relative to zero. Note that the MAPSGFK.US map data set does not include Puerto Rico or the District of Columbia. Block maps created with the traditional MAPS.US map data set include these map areas.

```
proc gmap map=mapsgfk.us data=sashelp.zipcode all;
   id state;
   block zip / statistic=frequency levels=5 relzero;
run;
quit;
```

Example 5: Producing a Simple Choropleth Map

Features: MAP= required argument referring to a GfK map data set
DATA= argument referring to response data
ID statement
CHORO statement options
STAT=
CDEFAULT=
System option FMTSEARCH=
SQL procedure

Data sets: MAPSGFK.EUROPE (map data set)
DEMOGRAPHICS (table of response data)

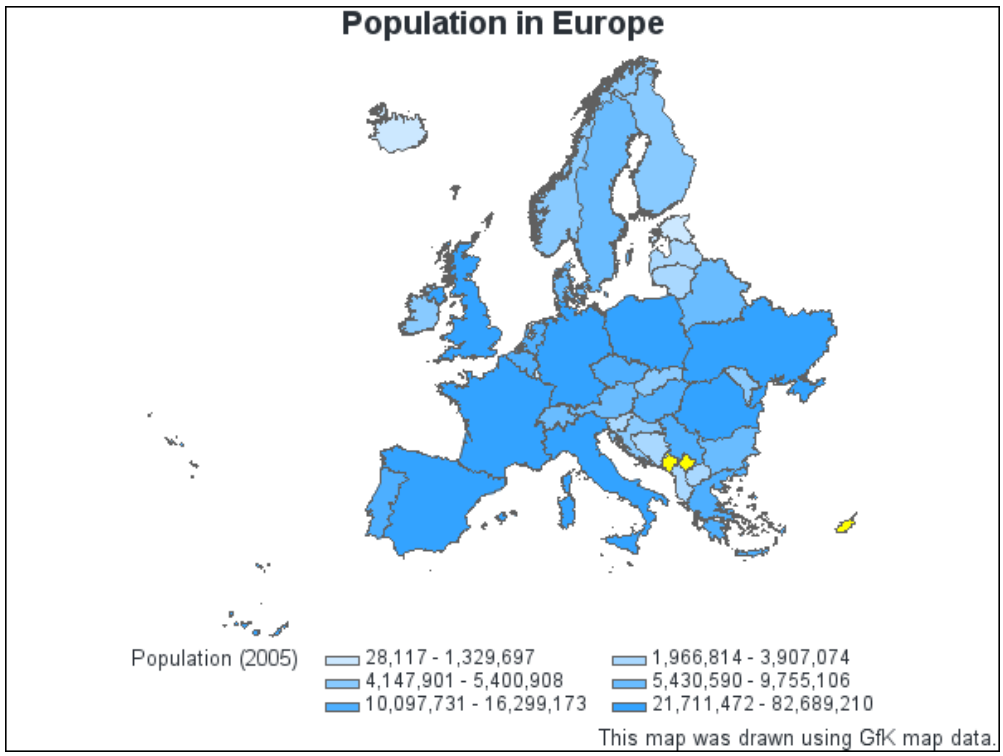
Format: ison2a

Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Notes: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.
The ISO codes that are in the sashelp.demographics data set are not as recent as the ISO codes found in the MAPSGFK data set.

Output

This example produces a choropleth (two-dimensional) map that shows the population of countries in Europe. Because the DISCRETE option is not used, the response variable is assumed to have a continuous range of values. Because neither the LEVELS= nor MIDPOINTS= options are used, the GMAP procedure selects a number of levels based on the number of map areas. It then calculates the appropriate response levels. The legend shows the range of values for each level.



Program

```
options fmtsearch=(sashelp.mapfmts);

proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;

goptions reset=all border;

title1 "Population in Europe";

proc gmap map=mapsgfk.europe(where=(id not in:('SJ' 'TR')))
   data=demographics(where=(cont=93)) all;
   id id;
   choro pop / cdefault=yellow stat=first;
run;
quit;
```

Program Description

Specify the format catalog to search that has the predefined ISO alpha2 code.

```
options fmtsearch=(sashelp.mapfmts);
```

Create a table named demographics using sashelp.demographics as the base and change its variables to match GfK variable types and lengths. This table is used as the response data set. This step makes two changes to the sashelp.demographics data set. The ISO variable is converted from numeric to character. Secondly, a character ID variable is created. This ID value matches the character variable ISOALPHA2 value in the GfK map data set. The format 'ison2a' is used to convert the numeric ISO code to its equivalent ISOALPHA2 code.

```
proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;
```

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the map.

```
title1 "Population in Europe";
```

Produce the choropleth map. The ALL argument specifies that the output should include all of the map areas from the map data set. This happens even if the response data set DEMOGRAPHICS does not include an observation for the map area. The output shows three such areas. The ID statement specifies the variable that is in both the map data set and the response data set that defines map areas. CDEFAULT= specifies the color for the map areas that have missing data. In this map Montenegro, Kosovo, and the island of Cyprus are yellow, indicating missing data. The STATISTIC= option specifies that the GMAP procedure is to match the first observation from MAPSGFK.EUROPE data set and display the response value from this observation only. The WHERE= data set option on the MAP= option excludes the islands of Svalbard, the country Turkey and Jan Mayen Islands, and these map areas have no data in the DEMOGRAPHICS data set. The data set MAPSGFK.EUROPE does not contain the Russian countries of Azerbaijan, Armenia and Georgia, and therefore these countries are not shown in the map.

```
proc gmap map=mapsgfk.europe(where=(id not in:('SJ' 'TR')))
   data=demographics(where=(cont=93)) all;
   id id;
   choro pop / cdefault=yellow stat=first;
run;
quit;
```

Example 6: Producing a Drilldown Choropleth Map

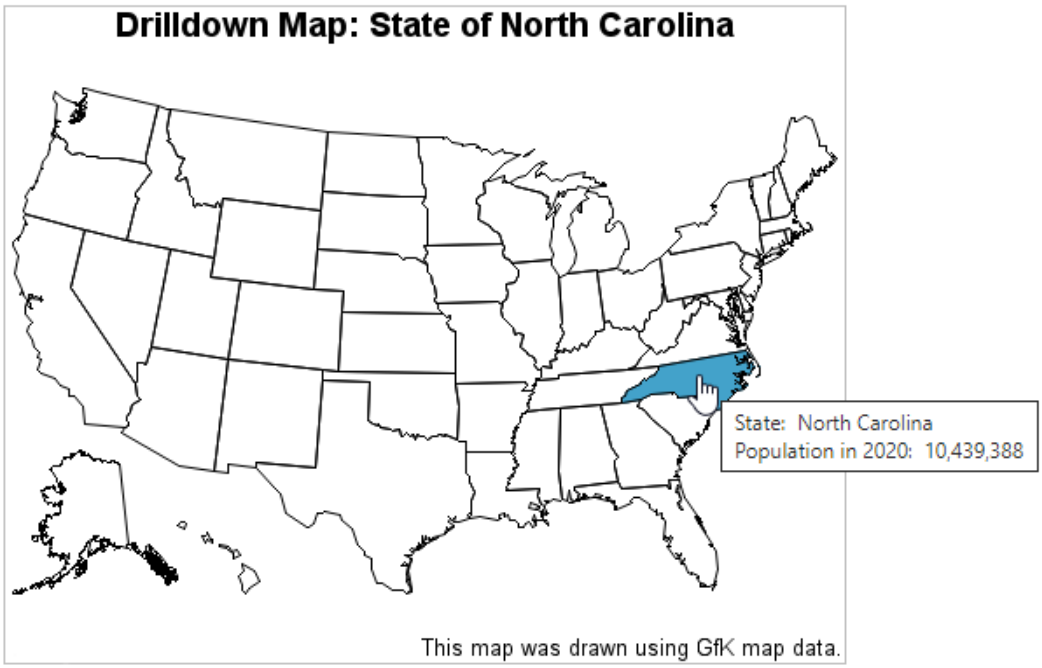
Features:
MAP= required argument referring to a traditional map data set
DATA= required argument referring to response data
BY statement
ID statement
CHORO statement options
- LEVELS=
- NOLEGEND
- COUTLINE=
- HTML=
- DES=
- NAME=

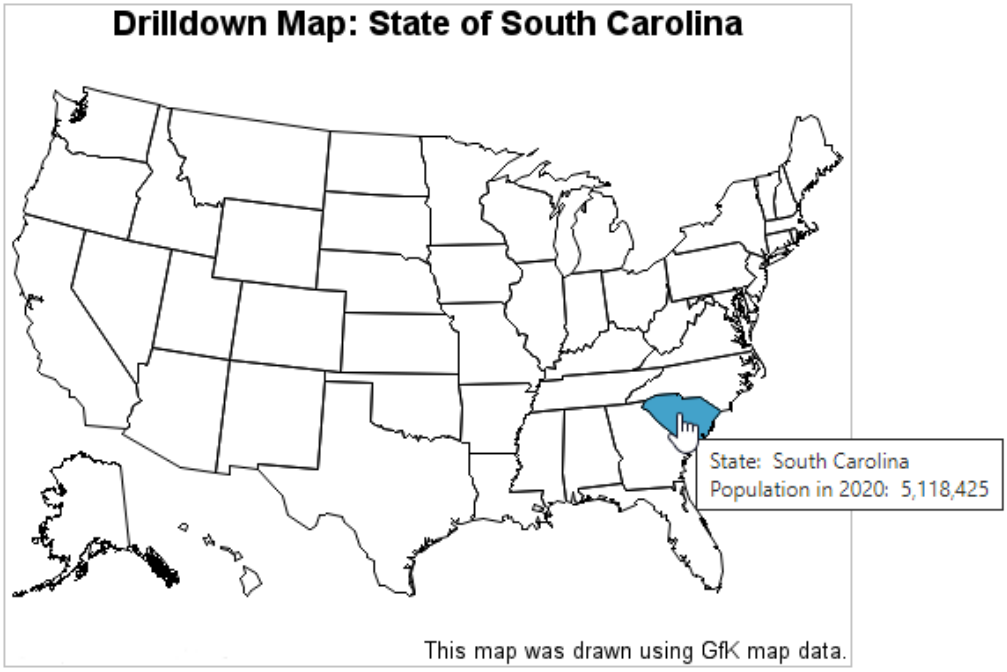
Data sets:
MAPSGFK.US (map data set)
SASHELP.US_DATA (data set)
MYDATA (response data)

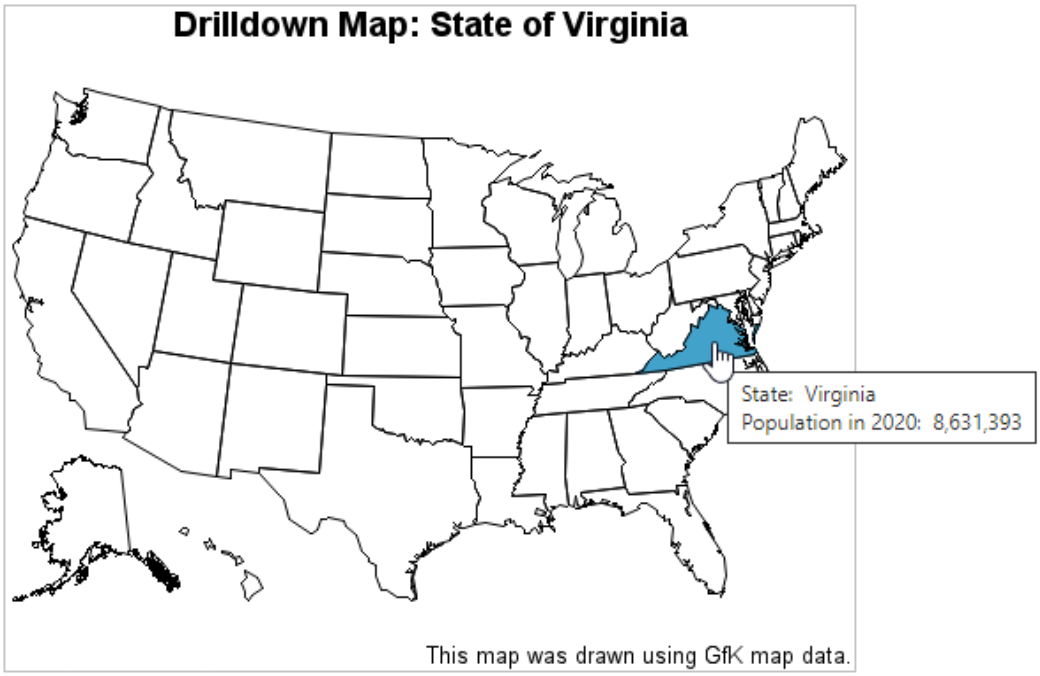
Note:
The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example produces three choropleth (two-dimensional) maps, each showing the population of a southeastern state in America. Each graph's title includes the state name. The LEVELS= option enables the GMAP procedure to graph one response level for the population. This population number is part of the text description as your mouse pointer is held over the state colored in blue.


Drilldown Map: State of North Carolina
State: North Carolina
Population in 2020: 10,439,388
This map was drawn using GfK map data.


Drilldown Map: State of South Carolina
State: South Carolina
Population in 2020: 5,118,425
This map was drawn using GfK map data.



Program

```
%let year=2020;
data population;
   year=&year;
   set sashelp.us_data;
   where statecode in ("VA" "NC" "SC");
   rename population_&year=population;
   label statename="State Name" statecode="State Code"
      population_&year="Population";
   keep statename statecode year population_&year;
run;

data mydata;
   format population comma12.0;
   length htmlvar $500 datatip $120;
   set population;
   datatip = 'title='||quote(
      'State:  '|| trim(statename) ||'0D'x ||
      'Population in '|| trim(left(year)) || left(':  ') ||
      trim(left(put(population,comma12.0))));
   select(statecode);
      when("VA")
         htmlvar=trim(datatip)||
         ' href="https://www.virginia.gov" target="_blank"';
      when("NC")
         htmlvar=trim(datatip)||
         ' href="https://www.nc.gov" target="_blank"';
      when("SC")
         htmlvar=trim(datatip)||
         ' href="https://www.sc.gov" target="_blank"';
      otherwise htmlvar="";
```

```
   end;
   drop datatip;
run;

proc sort data=mydata out=mydata;
   by statecode statename;
run;

axis1 label=none;
axis2 label=none minor=none offset=(0,0);

pattern v=solid color=cx43a2ca;

options nobyline;
title1 "Drilldown Map: " "State of #byval(statename)";

proc gmap data=mydata map=mapsgfk.us all;
   by statecode statename;
   id statecode;
   choro population / levels=1 nolegend
      coutline=black
      html=htmlvar
      des=''
      name="map01_#byval(statecode)";
run;
quit;

goptions reset=all;
```

Program Description

Get the 2020 population data for NC, SC, and VA from SASHELP.US_DATA. Using macro variable YEAR makes it easy to specify a different year at a later time.

```
%let year=2020;
data population;
   year=&year;
   set sashelp.us_data;
   where statecode in ("VA" "NC" "SC");
   rename population_&year=population;
   label statename="State Name" statecode="State Code"
      population_&year="Population";
   keep statename statecode year population_&year;
run;
```

Create the response data set MYDATA with the U.S. states to map. This data set contains the POPULATION data. Variable HTMLVAR is added for each state's home page. This variable provides data-tip text and the link URL for each home page. When clicked, the link opens in a new browser window.

```
data mydata;
   format population comma12.0;
   length htmlvar $500 datatip $120;
   set population;
   datatip = 'title='||quote(
      'State:  '|| trim(statename) ||'0D'x ||
      'Population in '|| trim(left(year)) || left(':  ') ||
      trim(left(put(population,comma12.0))));
```

```
   select(statecode);
      when("VA")
         htmlvar=trim(datatip)||
         ' href="https://www.virginia.gov" target="_blank"';
      when("NC")
         htmlvar=trim(datatip)||
         ' href="https://www.nc.gov" target="_blank"';
      when("SC")
         htmlvar=trim(datatip)||
         ' href="https://www.sc.gov" target="_blank"';
      otherwise htmlvar="";
   end;
   drop datatip;
run;
```

Sort the response data.

```
proc sort data=mydata out=mydata;
   by statecode statename;
run;
```

Suppress the axis labels.

```
axis1 label=none;
axis2 label=none minor=none offset=(0,0);
```

Set the color to highlight the state.

```
pattern v=solid color=cx43a2ca;
```

Define the title for the map. NOBYLINE suppresses the output of both BY variables indicated in the BY statement. #BYVAL substitutes the current value of BY variable statename in the text string.

```
options nobyline;
title1 "Drilldown Map: " "State of #byval(statename)";
```

Produce the choropleth map. for each state. The BY statement specifies the variables in the response data set to work with. The ID statement specifies the FIPS state code variable that is in both the map data set and the response data set that defines map areas. The LEVELS= option enables the GMAP procedure to graph one response level for the population. COUTLINE= specifies that the map area be outlined in black. HTML= sets up the link that is displayed as your mouse pointer is held over the state in the output. NAME= defines the name of the GRSEG catalog entry and the name of the graphics output file.

```
proc gmap data=mydata map=mapsgfk.us all;
   by statecode statename;
   id statecode;
   choro population / levels=1 nolegend
      coutline=black
      html=htmlvar
      des=''
      name="map01_#byval(statecode)";
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

Example 7: Labeling Provinces on a Map

Features:
- MAP= required argument referring to a GfK map data set
- DATA= required argument referring to response data
- ID statement
- CHORO statement options
  - ANNOTATE=
  - NOLEGEND
  - COUTLINE=
  - STAT=
- GREMOVE procedure
- SORT procedure
- Annotate Facility

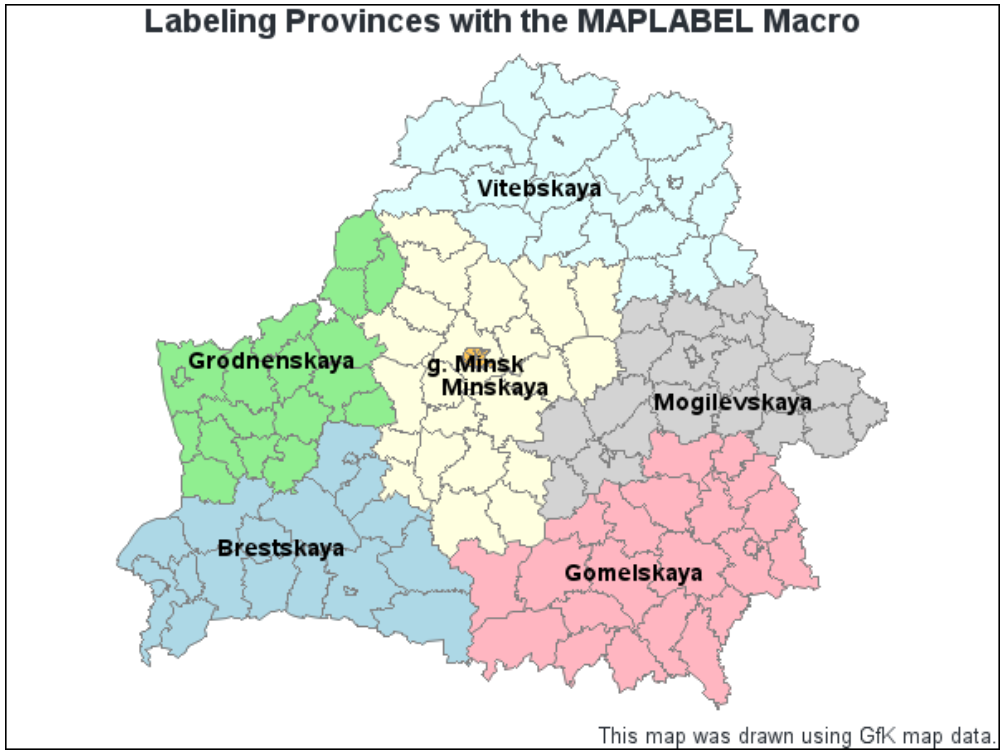
Data set: MAPSGFK.BELARUS (map data set)

Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example uses the Annotate facility to add labels to each area in a map of Belarus. The CHORO statement assigns the Annotate data set to the map. The %MAPLABEL Annotate macro is used to create and position the map labels. For more information about this macro, see "%MAPLABEL Annotate Macro" in *SAS/GRAPH: Reference*.



Program

```
goptions reset=all border;

title "Labeling Provinces with the MAPLABEL Macro";

proc sort data=mapsgfk.belarus out=belarus;
   by id1 id;
run;

proc gremove data=belarus out=belarus_outline;
   by id1;
   id id;
run;

%annomac;
%maplabel (belarus_outline, mapsgfk.belarus_attr, work.labelout,
id1name, id1,
           font=Albany AMT/Bold, color=black, size=3, hsys=3);

pattern1 c=lightblue;
pattern2 c=lightcyan;
pattern3 c=lightpink;
pattern4 c=lightgreen;
pattern5 c=lightbrown;
pattern6 c=lightyellow;
pattern7 c=lightgrey;

proc gmap map=belarus data=belarus;
   id id1 id;
   choro id1 / stat=first nolegend annotate=labelout coutline=gray;
run;
```

```
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the map.

```
title "Labeling Provinces with the MAPLABEL Macro";
```

Sort the GfK data by region and district variables.

```
proc sort data=mapsgfk.belarus out=belarus;
   by id1 id;
run;
```

Use the GREMOVE procedure to remove the internal boundaries from the Belarus map. The output data set from GREMOVE is used by the %MAPLABEL macro to determine the centroid of each province for positioning the province label.

```
proc gremove data=belarus out=belarus_outline;
   by id1;
   id id;
run;
```

Create the Annotate data set. The %ANNOMAC macro enables the Annotate macros. The %MAPLABEL macro calculates the centroid and creates the Annotate data set.

```
%annomac;
%maplabel (belarus_outline, mapsgfk.belarus_attr, work.labelout,
id1name, id1,
           font=Albany AMT/Bold, color=black, size=3, hsys=3);
```

Define fill pattern colors for the provinces.

```
pattern1 c=lightblue;
pattern2 c=lightcyan;
pattern3 c=lightpink;
pattern4 c=lightgreen;
pattern5 c=lightbrown;
pattern6 c=lightyellow;
pattern7 c=lightgrey;
```

Produce the choropleth map. The NOLEGEND option suppresses the legend. The ANNOTATE= option specifies the data set to annotate the map. The COUTLINE= option outlines each province in gray. The STATISTIC= option specifies that the GMAP procedure match the first observation from the BELARUS data set and display the response value from this observation only.

```
proc gmap map=belarus data=belarus;
   id id1 id;
   choro id1 / stat=first nolegend annotate=labelout coutline=gray;
run;
quit;
```

Example 8: Combining GfK GeoMarketing Map Data and Sample Response Data to Map U.S. Population Statistics

Features: MAP= required argument referring to a traditional map data set

DATA= required argument referring to response data in a sample data set

ID statement

CHORO statement options

- LEVELS=
- LEGEND=

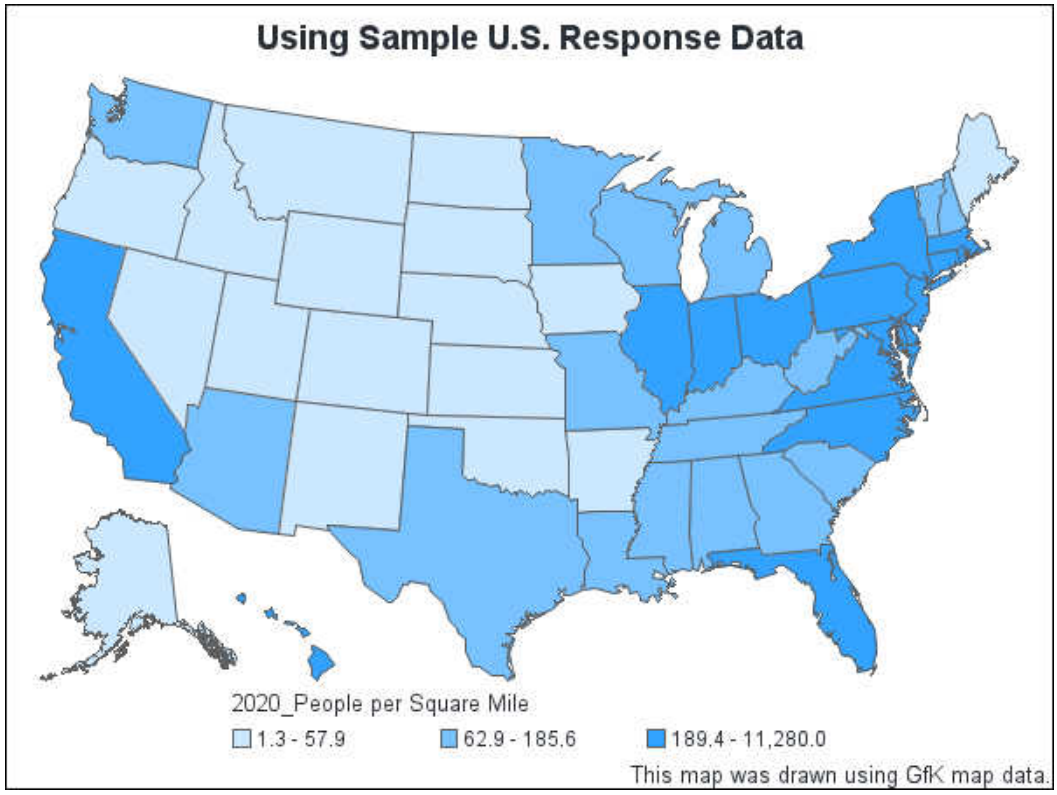
Data sets: MAPSGFK.US (map data set)

SASHELP.US_DATA (response data)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example uses a sample response data set named SASHELP.US_DATA that can be used with map data set MAPSGFK.US. In this example, population details per state are mapped.



Program

```
goptions reset=all border;

title1 ls=1.5 "Using Sample U.S. Response Data";

legend1 label=(position=top) shape=bar(.1in,.1in);

proc gmap data=sashelp.us_data map=mapsgfk.us;
   id state;
   choro density_2020 / levels=3 legend=legend1;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the map.

```
title1 ls=1.5 "Using Sample U.S. Response Data";
```

Define the legend for the map.

```
legend1 label=(position=top) shape=bar(.1in,.1in);
```

Produce the choropleth map of the United States. 2020 population densities are mapped per state. Use the sample response data set SASHELP.US_DATA, and the traditional map data set for the United States. The LEVELS= option specifies that 3 ranges of population values from the response data are graphed.

```
proc gmap data=sashelp.us_data map=mapsgfk.us;
   id state;
   choro density_2020 / levels=3 legend=legend1;
run;
quit;
```

Example 9: Producing a Simple Prism Map

Features:
MAP= required argument referring to a GfK map data set
DATA= argument referring to response data
ID statement
PRISM statement options
CDEFAULT=
RELZERO
System option FMTSEARCH=
SQL procedure

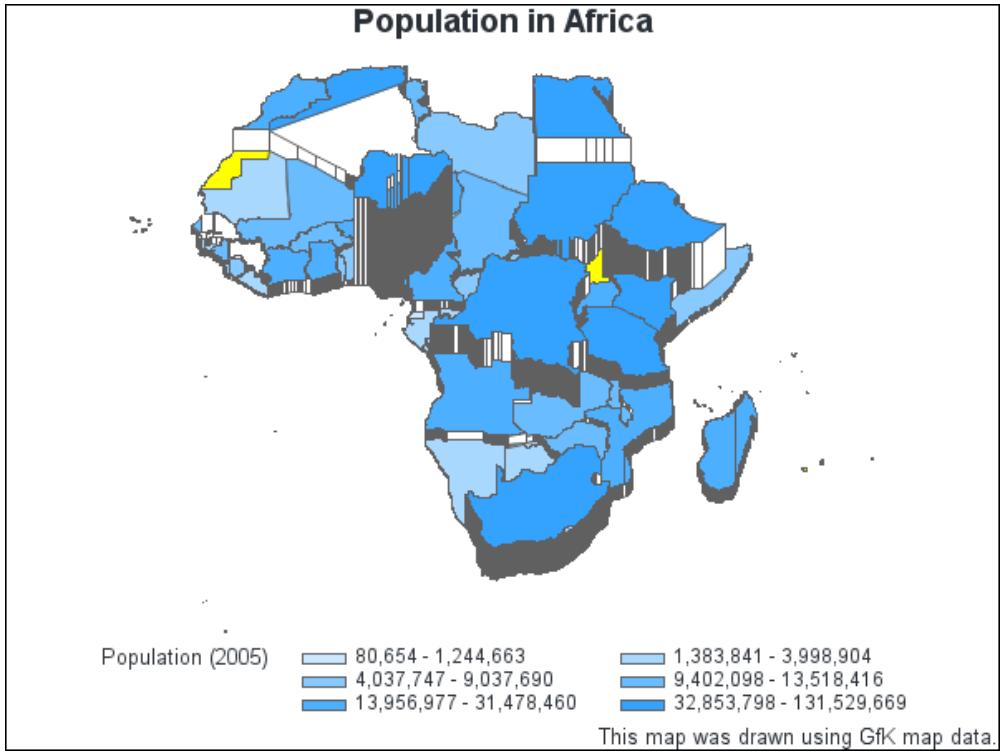
Data sets:
MAPSGFK.AFRICA (map data set)
DEMOGRAPHICS (table of response data)

Format:
ison2a

Restriction:
The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Note:
The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output



Program

```
options fmtsearch=(sashelp.mapfmts);

proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;

goptions reset=all border;

title1 "Population in Africa";

proc gmap data=demographics(where=(cont=94))
   map=mapsgfk.africa(where=(lake=0)) density=4 all;
   id id;
   prism pop / cdefault=yellow relzero;
run;
quit;
```

Program Description

Specify the format catalog to search that has the predefined ISO alpha2 code.

```
options fmtsearch=(sashelp.mapfmts);
```

Create a table named demographics using sashelp.demographics as the base and changing its variables to match GfK variable types and lengths. This table is used as the response data set. Note that the ISO variable was numeric in the original sashelp.demographics data but is the character variable OISO in the GfK map data set. The format 'ison2a' uses the country's ISO numeric code to display the country's ISO alpha2 code. Also note that the ID variable was a numeric geographic locator code (glc) in the original sashelp.demographics data. However, it is represented by the ISOALPHA2 variable in the GfK map data set.

```
proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;
```

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the map

```
title1 "Population in Africa";
```

Produce the prism map. The WHERE= data set option in the DATA= statement includes the countries that are part of the continent of Africa. The WHERE= data set option in the MAP= statement excludes lake areas. The ALL argument specifies that the map displayed should include all of the map areas from the map data set. This happens even if the response data set DEMOGRAPHICS does not include an observation for the map area. The map shows one such area. The ID statement specifies the variable in the map data set and the response data set that defines map areas. The CDEFAULT= option sets the color of map areas that have missing data. The RELZERO option makes the prism heights relative to zero.

```
proc gmap data=demographics(where=(cont=94))
   map=mapsgfk.africa(where=(lake=0)) density=4 all;
   id id;
   prism pop / cdefault=yellow relzero;
run;
quit;
```

Example 10: Specifying Midpoints in a Prism Map

Features: MAP= required argument referring to a GfK map data set

DATA= argument referring to response data

ID statement

FORMAT statement

PRISM statement options
- MIDPOINTS=
- CDEFAULT=

System option FMTSEARCH=

SQL procedure

PERCENTN format

Data sets: MAPSGFK.AFRICA (map data set)
DEMOGRAPHICS (table of response data)

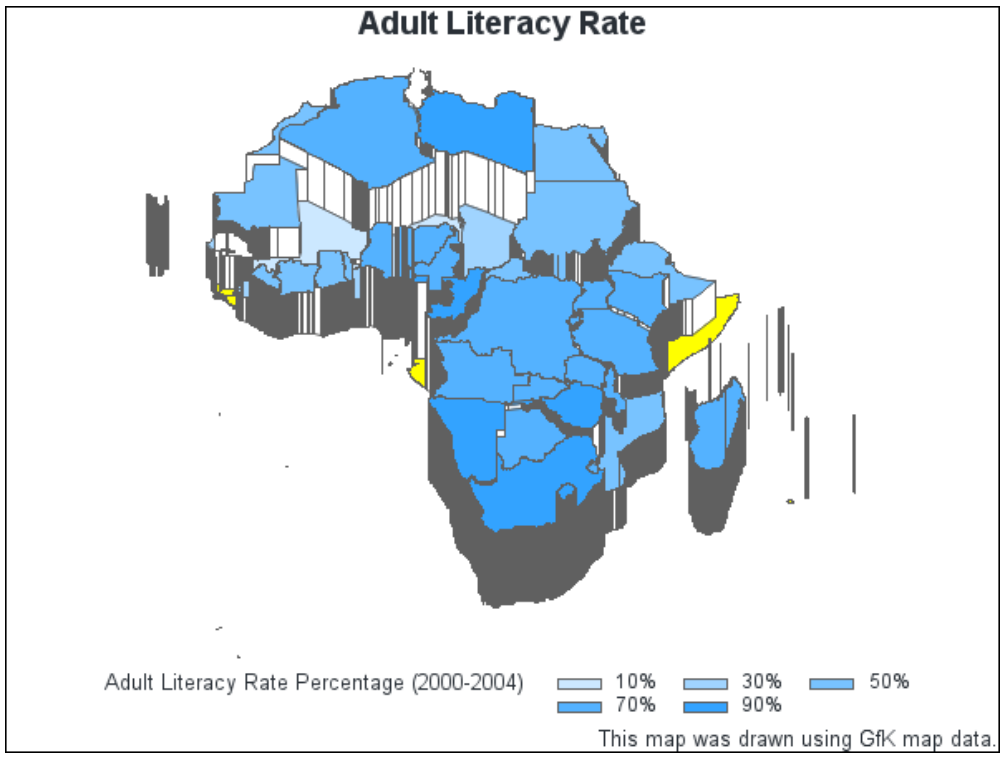
Format: ison2a

Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example specifies a set of midpoints that are used to create the response levels.



Program

```
options fmtsearch=(sashelp.mapfmts);

proc sql;
create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
select demo.*,
put(demo.iso,z3.) as newiso format=$3.,
put(demo.iso,ison2a.) as newid
from sashelp.demographics as demo
;
alter table demographics
modify ID char(15) label='Alpha2 Country Code';
run;
quit;

goptions reset=all border;

title1 "Adult Literacy Rate";

proc gmap data=demographics(where=(cont=94))
map=mapsgfk.africa(where=(lake=0)) density=4 all;
id id;
format adultliteracypct percentn5.0;
prism adultliteracypct / midpoints=.10 to .90 by .20
                         cdefault=yellow;
run;
quit;
```

Program Description

Specify the format catalog to search that has the predefined ISO alpha2 code.

```
options fmtsearch=(sashelp.mapfmts);
```

Create a table named demographics using sashelp.demographics as the base and change its variables to match GfK variable types and lengths. This table is used as the response data set. This step makes two changes to the sashelp.demographics data set. The ISO variable is converted from numeric to character. Secondly, a character ID variable is created. This ID value matches the character variable ISOALPHA2 value in the GfK map data set. The format 'ison2a' is used to convert the numeric ISO code to its equivalent ISOALPHA2 code.

```
proc sql;
create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
select demo.*,
put(demo.iso,z3.) as newiso format=$3.,
put(demo.iso,ison2a.) as newid
from sashelp.demographics as demo
;
alter table demographics
modify ID char(15) label='Alpha2 Country Code';
run;
quit;
```

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the map.

```
title1 "Adult Literacy Rate";
```

Produce the prism map. The WHERE= data set option in the MAP= option excludes lake regions from the map. The DENSITY= option specifies that only observations in the map data set whose DENSITY value is less than or equal to 4 are displayed. The ALL argument specifies that the map displayed should include all of the map areas from the map data set. This happens even if the response data set DEMOGRAPHICS does not include an observation for the map area. The map shows three such areas. The MIDPOINTS= option specifies the response levels for the map. The CDEFAULT= option sets the color of map areas that have missing data.

```
proc gmap data=demographics(where=(cont=94))
map=mapsgfk.africa(where=(lake=0)) density=4 all;
id id;
format adultliteracypct percentn5.0;
prism adultliteracypct / midpoints=.10 to .90 by .20
                         cdefault=yellow;
run;
quit;
```

Example 11: Producing a Simple Surface Map

Features: MAP= required argument referring to a GfK map data set
DATA= argument referring to response data
ID statement
SURFACE statement option STAT=
System option FMTSEARCH=
SQL procedure

Data sets: MAPSGFK.SAMERICA (map data set)
DEMOGRAPHICS (table of response data)

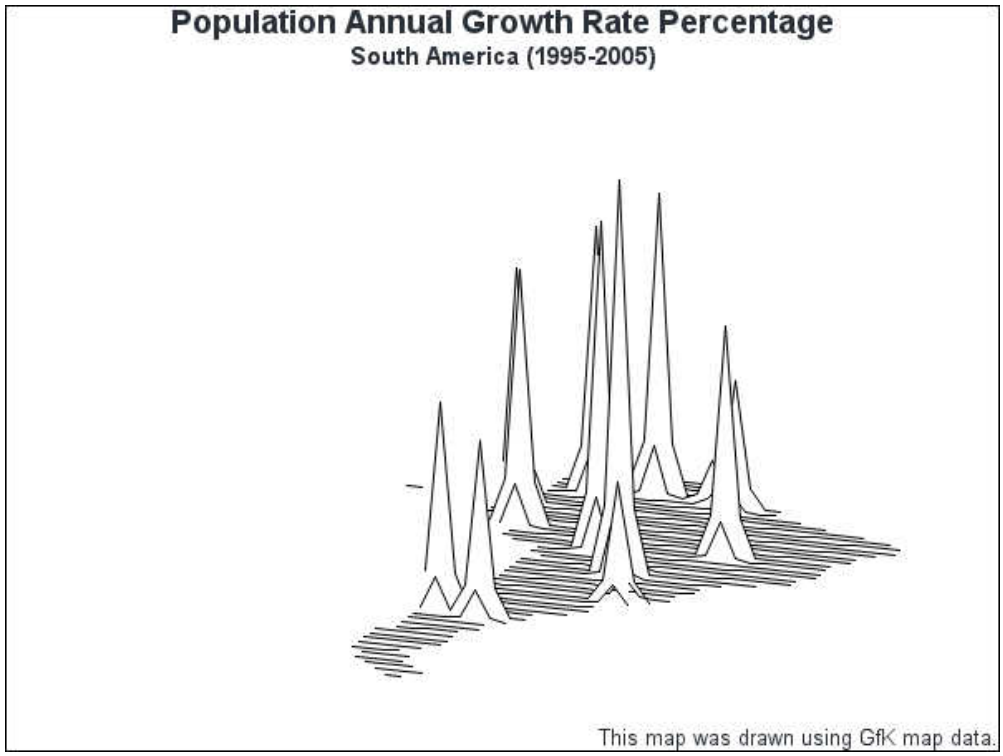
Format: ison2a

Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example produces a surface map that shows the annual population growth rate of countries in South America. Not all the countries that are represented in the GfK map data set have demographic data in the response data set. The CONSTANT= and NLINES= options are not used. Therefore, the GMAP procedure draws a surface that consists of 50 lines and uses the default decay function to calculate spike height and base width. And because the ROTATE= and TILT= options are not used, the map is rotated 70 degrees around the Z axis and tilted 70 degrees with respect to the X axis.



Program

```
options fmtsearch=(sashelp.mapfmts);

proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;

goptions reset=all border;
```

```
title1 "Population Annual Growth Rate Percentage";
title2 "South America (1995-2005)";

proc gmap map=mapsgfk.samerica data=demographics;
   id id;
   surface popagr / stat=sum;
run;
quit;
```

Program Description

Specify the format catalog to search that has the predefined ISO alpha2 code.

```
options fmtsearch=(sashelp.mapfmts);
```

Create a table named demographics using sashelp.demographics as the base and changing its variables to match GfK variable types and lengths. This table is used as the response data set. Note that the ISO variable was numeric in the original sashelp.demographics data but is the character variable OISO in the GfK map data set. The format 'ison2a' uses the country's ISO numeric code to display the country's ISO alpha2 code. Also note that the ID variable was a numeric geographic locator code (GLC) in the original sashelp.demographics data. However, it is represented by the ISOALPHA2 variable in the GfK map data set.

```
proc sql;
   create table demographics(rename=(iso=oiso newiso=iso id=oldid
newid=ID)) as
      select demo.*,
      put(demo.iso,z3.) as newiso format=$3.,
      put(demo.iso,ison2a.) as newid
      from sashelp.demographics as demo;
   alter table demographics
      modify ID char(15) label='Alpha2 Country Code';
run;
quit;
```

Set the graphics environment.

```
goptions reset=all border;
```

Define the titles for the map

```
title1 "Population Annual Growth Rate Percentage";
title2 "South America (1995-2005)";
```

Produce the surface map. Use the option STATISTIC=SUM to chart the summed value of all observations with a given matching ID. The ID statement specifies the variable in the map data set and the response data set that defines the map areas.

```
proc gmap map=mapsgfk.samerica data=demographics;
   id id;
   surface popagr / stat=sum;
run;
quit;
```

Example 12: Mapping an Individual Country By Subsetting MAPSGFK.WORLD

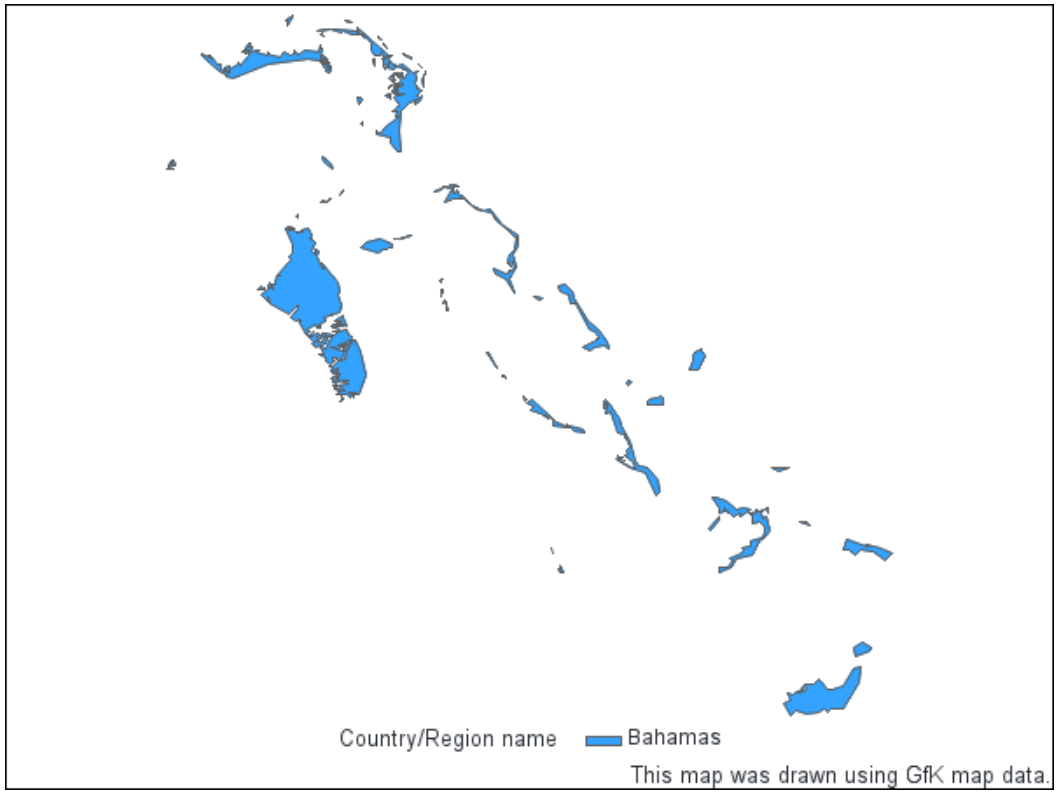
Features: OPTIONS statement
MAPS= required argument referring to a traditional map data set
DATA= required argument referring to response data
FORMAT statement
ID statement
CHORO statement option STAT=
SQL procedure

Data sets: MAPGFK.WORLD (map data set)
MYDATA (table with a subsetted map data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example shows how to subset a single country from the MAPSGFK.WORLD data set. This is useful for mapping smaller countries that do not have an individual map data set in the MAPSGFK library.



Program

```
goptions reset=all border;

proc sql;
   create table mymap as
      select * from mapsgfk.world
      where idname eq "Bahamas";
run;
quit;

proc gmap map=mymap data=mymap density=6;
   id idname;
   choro idname / stat=first;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Subset the MAPSGFK.WORLD map data set for the Bahamas by using the SQL procedure.

```
proc sql;
   create table mymap as
```

```
      select * from mapsgfk.world
      where idname eq "Bahamas";
run;
quit;
```

Create the map by using the GMAP procedure. The STATISTIC= option specifies that the GMAP procedure is to match the first observation from the MYMAP data set and display the response value from this observation only.

```
proc gmap map=mymap data=mymap density=6;
   id idname;
   choro idname / stat=first;
run;
quit;
```

Example 13: Specifying Country Subdivisions on a Continent

Features: MAP= required argument referring to a GfK map data set

DATA= argument referring to response data

ID statement

CHORO statement options
- STATISTIC=
- DISCRETE
- NOLEGEND

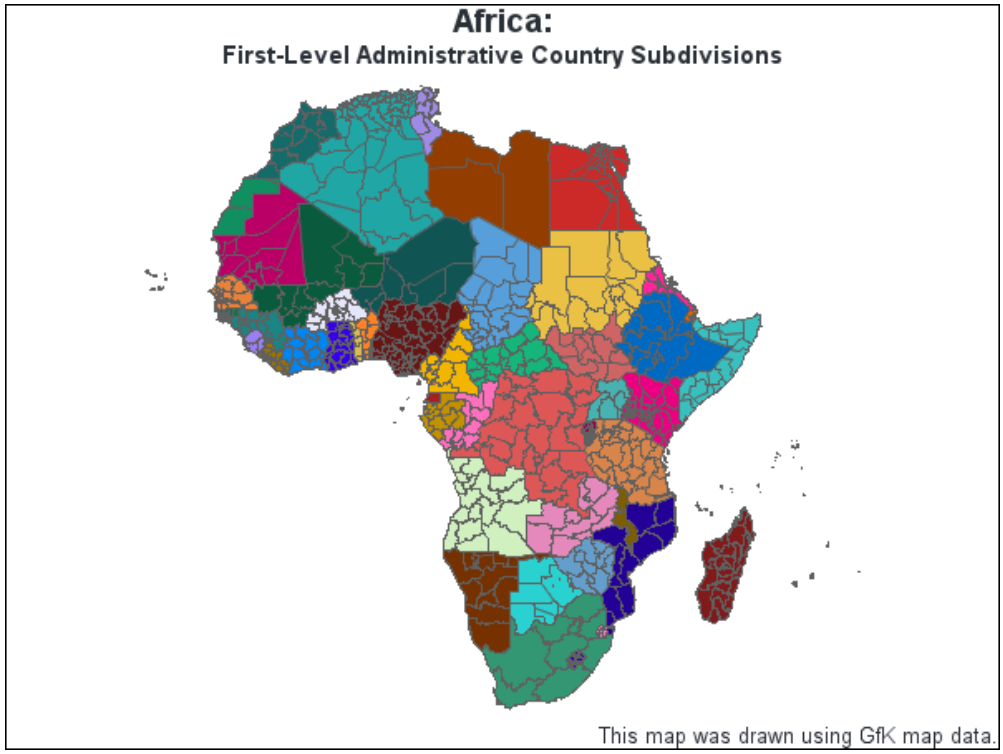
Data set: MAPSGFK.AFRICA1 (map and response data sets)

Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example uses the first-level administrative detail in countries offering that detail in the GfK map data set to show the subdivisions within countries in the African continent. This level of detail is available only by country and not at a continent level with the traditional map data sets.



Program

```
goptions reset=all border;

title1 j=c 'Africa:';
title2 j=c 'First-Level Administrative Country Subdivisions';

pattern1 value=msolid color=CXD0F0C0;
pattern2 value=ms color=CXE6E6FA;
pattern3 value=ms color=CXE7FEFF;

proc gmap map=mapsgfk.africa1 data=mapsgfk.africa1;
   id isoalpha2 id;
   choro isoalpha2 / stat=first discrete nolegend;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the titles for the map.

```
title1 j=c 'Africa:';
title2 j=c 'First-Level Administrative Country Subdivisions';
```

Change the color in some indistinguishable areas.

```
pattern1 value=msolid color=CXD0F0C0;
pattern2 value=ms color=CXE6E6FA;
pattern3 value=ms color=CXE7FEFF;
```

Produce the choropleth map. The DISCRETE= option generates a separate color for each different response variable value. The NOLEGEND= option specifies that no legend statement is associated with the map. The STATISTIC= option specifies that the GMAP procedure is to match the first observation from MAPSGFK.AFRICA1 data set and display the response value from this observation only.

```
proc gmap map=mapsgfk.africa1 data=mapsgfk.africa1;
   id isoalpha2 id;
   choro isoalpha2 / stat=first discrete nolegend;
run;
quit;
```

Example 14: Producing a Choropleth Map By Combining Three Map Data Sets

Features:
MAP= required argument referring to a GfK map data set
DATA= argument referring to response data
ID statement
CHORO statement options
- STATISTIC=
- DISCRETE
- LEGEND

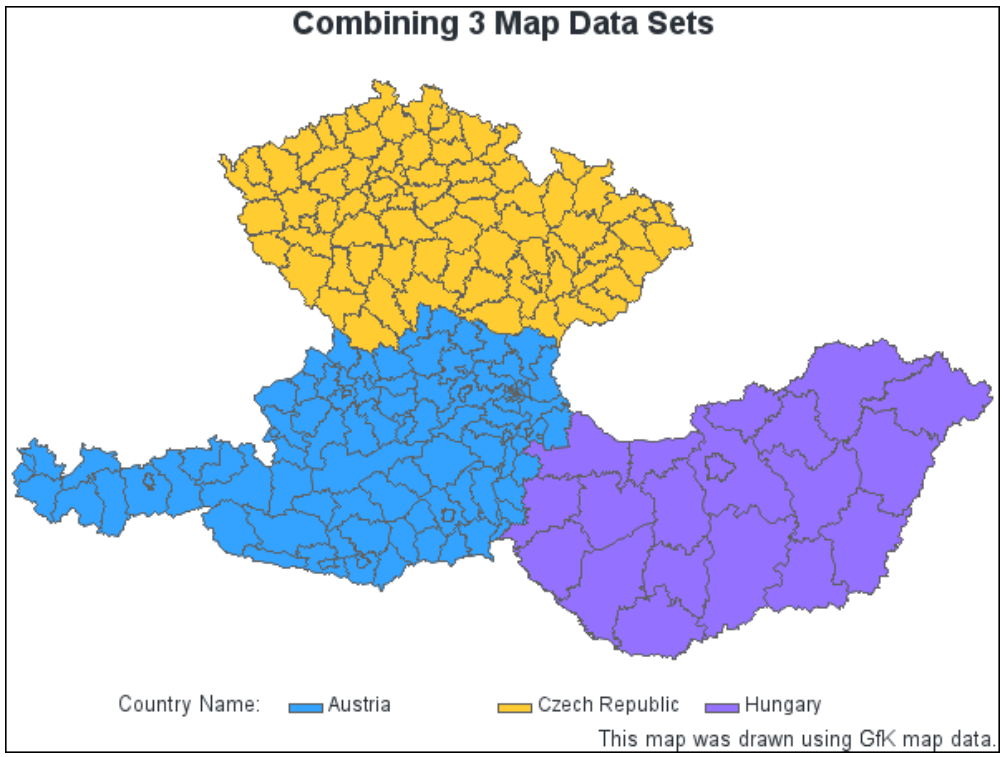
SAS DATA step with assignment statements
GPROJECT procedure

Data sets:
MAPSGFK.AUSTRIA (map data set)
MAPSGFK.CZECH_REPUBLIC (map data set)
MAPSGFK.HUNGARY (map data set)

Restriction:
The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Note:
The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output



Program

```
data all;
   length name $18;
   set mapsgfk.austria(in=k1) mapsgfk.czech_republic(in=k2)
mapsgfk.hungary;
   if k1 then name='Austria';
   else if k2 then name='Czech Republic';
      else name='Hungary';
   x=long;
   y=lat;
run;

proc gproject data=all out=map degrees eastlong parmout;
   id name id;
run;

goptions reset=all border;

title1 "Combining 3 Map Data Sets";
legend1 label=("Country Name:");

proc gmap map=map data=map;
   id name id;
   choro name / stat=first discrete legend=legend1;
run;
quit;
```

Program Description

Specify the countries to combine.

```
data all;
   length name $18;
   set mapsgfk.austria(in=k1) mapsgfk.czech_republic(in=k2)
mapsgfk.hungary;
   if k1 then name='Austria';
   else if k2 then name='Czech Republic';
      else name='Hungary';
   x=long;
   y=lat;
run;
```

Project the map and store the projection parameters.

```
proc gproject data=all out=map degrees eastlong parmout;
   id name id;
run;
```

Set the graphics environment.

```
goptions reset=all border;
```

Define the title and legend for the map. The LEGEND= statement relabels the NAME variable.

```
title1 "Combining 3 Map Data Sets";
legend1 label=("Country Name:");
```

Produce the choropleth map that combines 3 European countries. The DISCRETE= option generates a separate color for each different response variable value. The STATISTIC= option specifies that the GMAP procedure is to match the first observation from each of the three MAPSGFK data sets. It displays the response value from that observation only. The LEGEND= option pulls in the LEGEND statement's label assignment.

```
proc gmap map=map data=map;
   id name id;
   choro name / stat=first discrete legend=legend1;
run;
quit;
```

Example 15: Producing a Choropleth Map Annotating Cities

Features:

MAP= required argument referring to a GfK map data set

DATA= argument referring to response data

ID statement

CHORO statement options

COUTLINE=

ANNOTATE=
DESCRIPTION=
NAME=
STATISTIC=
LEGEND=

SAS DATA step with assignment statements

GPROJECT procedure

Annotate facility

Data sets: MAPSGFK.AUSTRIA (map data set)

MAPSGFK.CZECH_REPUBLIC (map data set)

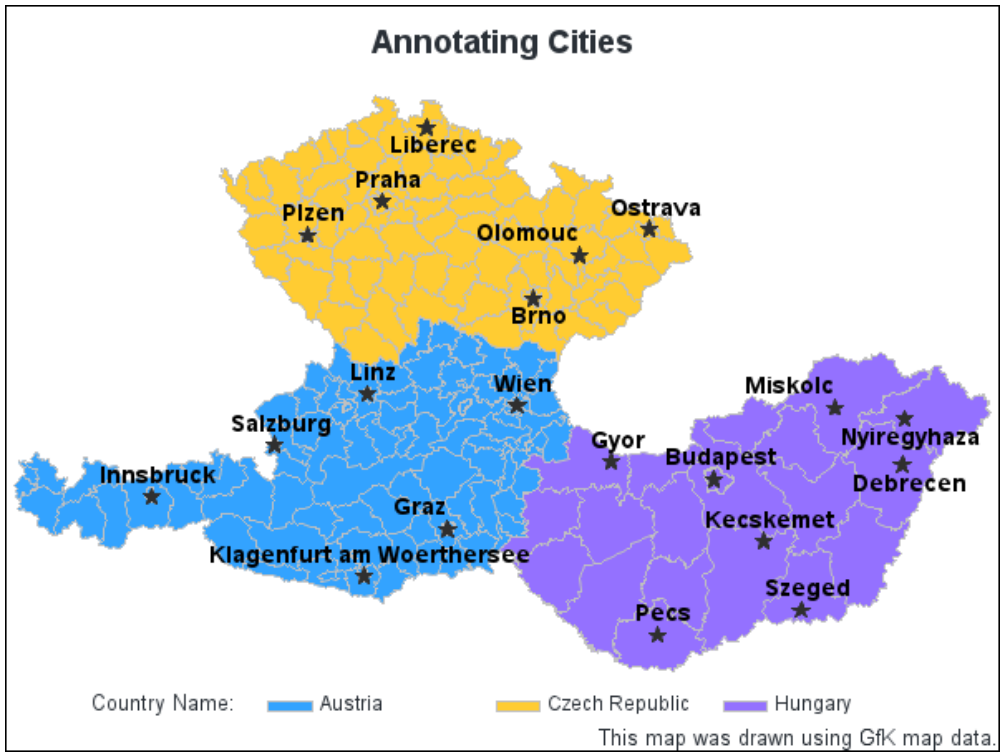
MAPSGFK.HUNGARY (map data set)

Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Notes: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

The program code uses the POP_RANGE_MIN variable rather than the RANK variable. And the LATLONG option was used rather than renaming the LAT and LONG variables to X and Y.

Output



Program

```
data all;
length name $18;
set mapsgfk.austria(in=k1) mapsgfk.czech_republic(in=k2)
mapsgfk.hungary;

if k1 then name='Austria';
else if k2 then name='Czech Republic';
else name='Hungary';
run;

proc gproject data=all out=map degrees latlong eastlong parmout;
   id name id;
run;

data cities;
set mapsgfk.world_cities(where=(pop_range_min>50000 and
   isoname in:('Austria' 'Czech' 'Hung')));
run;

proc gproject data=cities out=cities latlong eastlong degrees
   parmin=projparm parmentry=map dupok;
   id;
run;

data anno_cities;
   length color $15 text $55 color $15 style $18;
   retain function 'label' xsys ysys '2' hsys '3' when 'a';
   set cities;
   text='V';
   style='marker';
   color='darkslategrey';
   size=2.8;
   position='5';
   output;
   text='  '||trim(left(city));
   position='2';
   size=3;
   style=Albany AMT/Bold';
   color='black';
   if city in ('Liberec' 'Ostrav') then position='E';
   if city in ('Olomouc' 'Szekesfehervar' 'Graz') then position='1';
   if city in ('Inns' 'Szek' 'Kecs' 'Salz') then position='6';
   if city eq 'Miskolc' then position='1';
   if city in ('Nyiregyhaza' 'Debrecen' 'Brno') then position='E';
   output;
run;

goptions reset=all border device=png;

title1 ls=1.5 "Annotating Cities";
legend1 label=("Country Name:");

proc gmap data=map map=map anno=anno_cities;
   id id;
   choro name / stat=first
                coutline=grayC0
                des=''
```

```
                name='eursub'
                legend=legend1;
run;
quit;
```

Program Description

Specify the countries to map.

```
data all;
length name $18;
set mapsgfk.austria(in=k1) mapsgfk.czech_republic(in=k2)
mapsgfk.hungary;

if k1 then name='Austria';
else if k2 then name='Czech Republic';
else name='Hungary';
run;
```

Project the map and store the projection parameters.

```
proc gproject data=all out=map degrees latlong eastlong parmout;
   id name id;
run;
```

Create the CITIES data set specifying cities to label (Annotate).

```
data cities;
set mapsgfk.world_cities(where=(pop_range_min>50000 and
   isoname in:('Austria' 'Czech' 'Hung')));
run;
```

Project the annotation data set using the projection parameters stored in the prior map projection.

```
proc gproject data=cities out=cities latlong eastlong degrees
   parmin=projparm parmentry=map dupok;
   id;
run;
```

Add Annotate variables and markers to the CITIES data set.

```
data anno_cities;
   length color $15 text $55 color $15 style $18;
   retain function 'label' xsys ysys '2' hsys '3' when 'a';
   set cities;
   text='V';
   style='marker';
   color='darkslategrey';
   size=2.8;
   position='5';
   output;
   text='  '||trim(left(city));
   position='2';
   size=3;
   style=Albany AMT/Bold';
   color='black';
   if city in ('Liberec' 'Ostrav') then position='E';
```

```
   if city in ('Olomouc' 'Szekesfehervar' 'Graz') then position='1';
   if city in ('Inns' 'Szek' 'Kecs' 'Salz') then position='6';
   if city eq 'Miskolc' then position='1';
   if city in ('Nyiregyhaza' 'Debrecen' 'Brno') then position='E';
   output;
run;
```

Set the graphics environment.

```
goptions reset=all border device=png;
```

Define the title and legend for the map. The LEGEND= statement relabels the NAME variable.

```
title1 ls=1.5 "Annotating Cities";
legend1 label=("Country Name:");
```

Produce the choropleth map that annotates cities in 3 European countries. The ANNO= statement specifies the ANNO_CITIES data set to annotate onto the map produced by the CHORO statement. The COUTLINE= option outlines the map area regions in each country. The DESCRIPTION= option specifies that there is to be no chart description for web output. The NAME= option specifies the name of the graphics output file. The STATISTIC= option specifies that the GMAP procedure is to match the first observation from the projected data set and display the response value from that observation only. The LEGEND= option pulls in the LEGEND statement's label assignment.

```
proc gmap data=map map=map anno=anno_cities;
   id id;
   choro name / stat=first
                coutline=grayC0
                des=''
                name='eursub'
                legend=legend1;
run;
quit;
```

Example 16: Producing a Choropleth County Map Annotating Roads and Water

Features:

MAP= required argument referring to a GfK map data set

DATA= argument referring to response data

ANNOTATE= argument referring to Annotate data

ID statement

CHORO statement options

- DISCRETE
- NOLEGEND
- ANNOTATE=

Annotate Facility

MAPIMPORT procedure

FREQ procedure

PATTERN statement
NOTE statement
FOOTNOTE statement

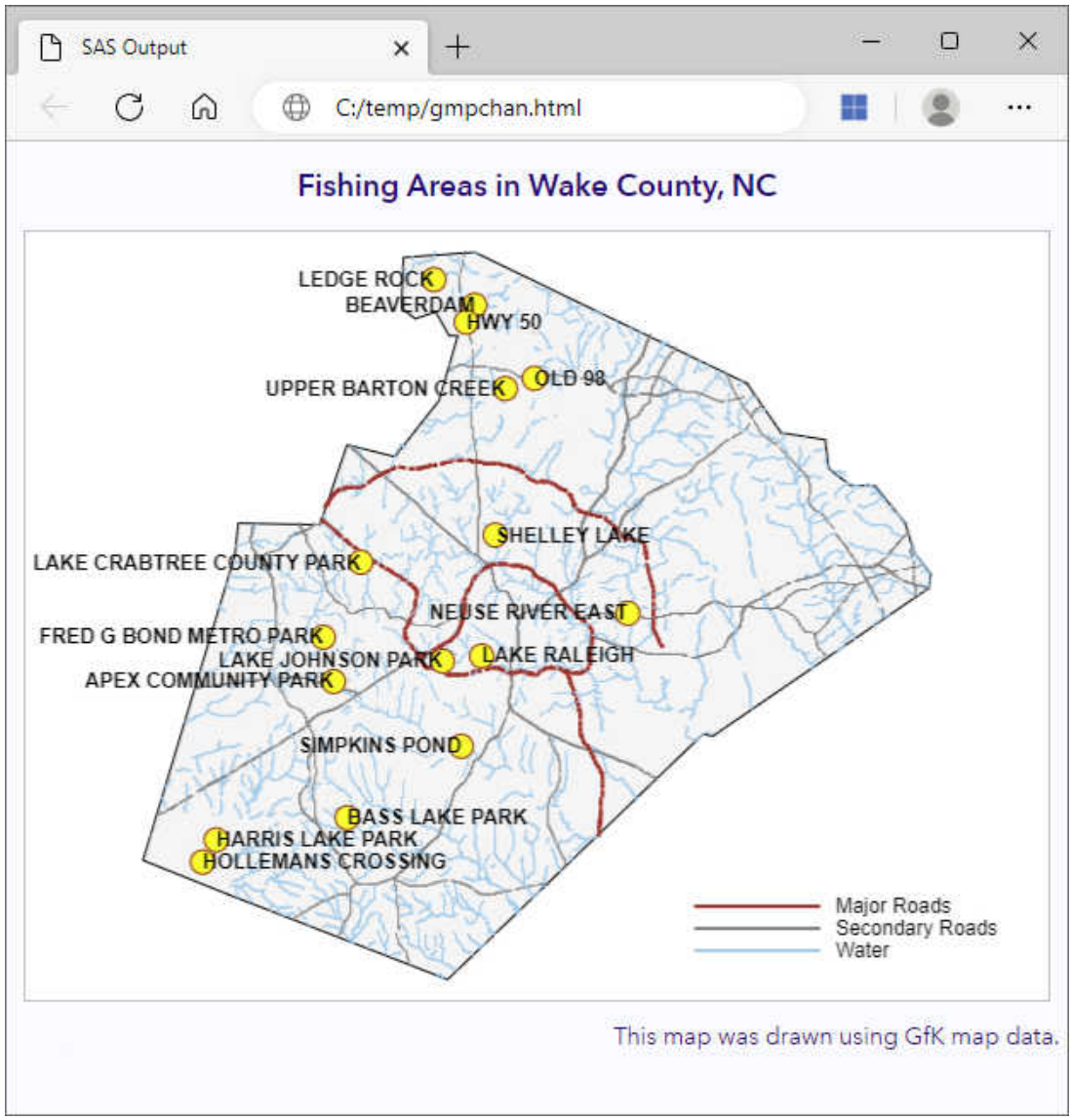
Data sets: MAPSGFK.US_COUNTIES (map data set)
MAP (response data)

Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example displays all the fishing areas in Wake County, in the state of North Carolina. A subset of a GfK map displays just Wake County, and then downloaded data displaying roads and water are annotated onto the map. You can download a zipped file of the TIGER/Line shapefile data from the SAS Misc Datasets website. You are required to access the website with your SAS profile. You might be required to enter your site information. Look for the filename GMPGCHAN.ZIP. Or you can download the most recent TIGER/Line shapefile data from the U.S. Census Bureau website. The files used in the following example are named *tl_2012_37183_edges.xxx*, where *xxx* specifies the various shapefile extensions. See *SAS/GIS: Spatial Data and Procedure Guide* for more information about downloading and preparing the data. You must update the following code to specify the path where you stored the downloaded files before running this example.



Program

```
%let shapefilepath=path-to-shapefile;
%let mapwidth=600;  /* Pixels */
%let mapheight=450; /* Pixels */
%let majroadcolor=firebrick;
%let secroadcolor=gray;
%let watercolor=skyblue;
%let pointcolor=yellow;
%let pointoutlinecolor=brown;
%let pointsize=.6;
%let labelfont=Albany AMT;

goptions border device=svg xpixels=&mapwidth ypixels=&mapheight;
options svgheight="&mapheight.px" svgwidth="&mapwidth.px"
   papersize=("%sysfunc(cat(&mapwidth/96, in))",
   "%sysfunc(cat(&mapheight/96, in))");
```

```
data ncwake;
   length dsn $8;
   set mapsgfk.us_counties(where=(fipstate(state)="NC" and
county=183));
   x=long;
   y=lat;
   dsn="map";
run;

proc mapimport datafile="&shapefilepath"
   out=work.wake;
run;

data roads;
   set work.wake(where=(mtfcc in:("S1100" "S1200" "H")));
run;

/*
proc ginside map=ncwake data=roads out=rdsinwake insideonly;
   id id;
run;
*/

data annor(drop=statefp countyfp);
   length STATE COUNTY 5 text color $15;
   retain xsys ysys "2" when "A";
   /*set rdsinwake;*/ /* Uncomment this if you run the GINSIDE proc.*/
   set roads; /* Comment out this data set if you run GINSIDE proc.*/
   dsn="lines";
   /* Define SAS variables: SAS data sets have */
   /* state and county defined as numeric     */
   STATE=statefp; county=countyfp;
   id="US-"||put(state,z2.)||put(county,z3.);
   LONG=X;  LAT=Y;
   by TLID notsorted;
   text=mtfcc;
   if mtfcc="S1100" then do; line=3; color="&majroadcolor"; size=2;
end;
   else if mtfcc="S1200" then do; line=2; color="&secroadcolor";end;
        else if mtfcc=:"H" then do; line=4; color="&watercolor"; end;
   if first.TLID then do;
      function="MOVE";
      output;
   end;
   else do;
      function="DRAW";
      output;
  end;
run;

/* Create the data set WORK.WRC_FISHING that contains the
   NC fishing areas.                                        */
data WORK.WRC_FISHING;
   infile cards dsd;
   input X Y Fishing_Area_Name : $25.
          FishingPier
          ShorelineAccess
          BoatRamp
          CanoeAccess
```

```
          UniveralAccess
          WaterbodyName : $32.;
datalines;
-78.5392,35.7987,NEUSE RIVER EAST,0,1,0,1,0,NEUSE RIVER
-78.6275,35.9791,OLD 98,0,1,0,0,0,FALLS RESERVOIR
-78.6540,35.9705,UPPER BARTON CREEK,0,1,0,1,0
FALLS RESERVOIR
-78.7226,36.0536,LEDGE ROCK,.,0,1,0,0,FALLS RESERVOIR
-78.6843,36.0342,BEAVERDAM,0,1,1,1,0,FALLS RESERVOIR
-78.6915,36.0215,HWY 50,0,1,1,1,0,FALLS RESERVOIR
-78.8166,35.7468,APEX COMMUNITY PARK,1,1,0,1,0,PINE LAKE
-78.8042,35.6429,BASS LAKE PARK,1,1,0,1,0,BASS LAKE PARK
-78.9390,35.6086,HOLLEMANS CROSSING,.,0,1,0,0
SHEARON HARRIS RESERVOIR
-78.6957,35.6972,SIMPKINS POND,0,1,0,0,0
SIMPKINS POND / LAKE WHEELER
-78.6635,35.8585,SHELLEY LAKE,1,1,1,1,1,SHELLEY LAKE
-78.6775,35.7668,LAKE RALEIGH,1,1,0,1,1,LAKE RALEIGH
-78.7907,35.8384,LAKE CRABTREE COUNTY PARK,1,1,1,1,1
LAKE CRABREE COUNTY PARK
-78.7137,35.7627,LAKE JOHNSON PARK,1,0,0,1,0
LAKE JOHNSON
-78.9259,35.6258,HARRIS LAKE PARK,1,1,0,1,0
HARRIS LAKE & HARRIS PARK POND
-78.8259,35.7812,FRED G BOND METRO PARK,1,1,0,1,0
BOND PARK POND
;

data wrc;
   length STATE 5 COUNTY 5 text $45 font $8 color $8 style $18
      function $8 dsn $8;
   retain STATE 37 COUNTY 183 xsys ysys "2" when "A"
      font "marker";
   set wrc_fishing;
   dsn="points";
   text=fishing_area_name;
   style="&labelfont/bold";
   size=1;
   function="label";
   position="<";
   /* reposition overlapping and crowded labels */
   if text in("LAKE RALEIGH" "OLD 98" "HWY 50"
      "HOLLEMANS CROSSING" "SHELLEY LAKE" "BASS LAKE PARK")
      then position=">";
   output;
   function="pie";
   rotate=360;
   style="psolid";
   color="&pointcolor";
   position="5";
   size=&pointsize;
   output;
   /* Draw a dark ring around pie, to help */
   /* distinguish overlapping ones         */
   style="pempty";
   color="&pointoutlinecolor";
   line=1;
```

```
   html=" ";
   output;
run;

data all;
   length function $8 text $45 style $20;
   set ncwake annor wrc;
run;

proc gproject data=all out=prj degrees eastlong dupok;
   id dsn id;
run;

data map lines points;
   set prj;
   if dsn="map" then output map;
   else if dsn="lines" then output lines;
        else output points;
run;

data choroanno;
   set points end=last;
   if (last) then do;
      output;
      color="black"; ysys=1; xsys=1; line=1; size=2;
      function="move"; x=75; y=10; output;
      color="&majroadcolor"; function="draw"; x=90; y=10; output;
      function="move"; x=75; y=7; output;
      color="&secroadcolor"; function="draw"; x=90; y=7; output;
      function="move"; x=75; y=4; output;
      color="&watercolor"; function="draw"; x=90; y=4; output;
      size=1.2; color="black"; position='>'; style="&labelfont";
      x=92; y=10; function="label"; text="Major Roads"; output;
      x=92; y=7; function="label"; text="Secondary Roads"; output;
      x=92; y=4; function="label"; text="Water"; output;
   end;
   else output;
   keep x y function text style color xsys ysys when
      line size font position rotate;
run;

proc gmap map=map data=map anno=lines;
   id id;
   choro state/discrete nolegend anno=choroanno stat=sum;
   pattern v=s r=100 color=whitesmoke;
   title1 height=2 "Fishing Areas in Wake County, NC";
run;
quit;

options svgheight="" svgwidth=""
   %sysfunc(getoption(papersize,keyword,defaultvalue));;
```

Program Description

Specify the path to the shape file that you downloaded from the U.S. Census Bureau TIGER website and specify attributes of the map such as map dimensions,

colors, and label font. An example shapefile name is "tl_2012_37183_edges". The data includes roads and water. Using macro variables makes it easy to change the shape-file path and the attributes of the map at a later time.

```
%let shapefilepath=path-to-shapefile;
%let mapwidth=600;  /* Pixels */
%let mapheight=450; /* Pixels */
%let majroadcolor=firebrick;
%let secroadcolor=gray;
%let watercolor=skyblue;
%let pointcolor=yellow;
%let pointoutlinecolor=brown;
%let pointsize=.6;
%let labelfont=Albany AMT;
```

Set the graphics environment. Use the %SYSFUNC macro function and the CAT SAS function to convert the pixel dimensions to inch dimensions for the PAPERSIZE= system option.

```
goptions border device=svg xpixels=&mapwidth ypixels=&mapheight;
options svgheight="&mapheight.px" svgwidth="&mapwidth.px"
   papersize=("%sysfunc(cat(&mapwidth/96, in))",
   "%sysfunc(cat(&mapheight/96, in))");
```

Subset Wake County in the state of North Carolina from the GfK map data set.

```
data ncwake;
   length dsn $8;
   set mapsgfk.us_counties(where=(fipstate(state)="NC" and
county=183));
   x=long;
   y=lat;
   dsn="map";
run;
```

Use the MAPIMPORT procedure to produce an output map data set from data that you downloaded from the U.S. Census Bureau TIGER website. Macro variable SHAPEFILEPATH contains the path and filename of the downloaded shapefiles.

```
proc mapimport datafile="&shapefilepath"
   out=work.wake;
run;
```

Keep the primary and secondary roads and the water lines from the downloaded shapefile.

```
data roads;
   set work.wake(where=(mtfcc in:("S1100" "S1200" "H")));
run;
```

Optional step. Running the GINSIDE procedure is necessary only if the Annotate step that is run next results in "observation mapping errors". In order to run GINSIDE, you must first remove the comments. Run this procedure to keep those road points that are only within Wake County map boundaries.

```
/*
proc ginside map=ncwake data=roads out=rdsinwake insideonly;
   id id;
run;
*/
```

Create an Annotate data set so that the roads and fishing areas can be displayed on top of the map. Note: If you chose to run the prior GINSIDE procedure, then switch the data set that is designated. See the comment text in the code for directions. TLID is the edge ID, which can be used to connect to other TIGER files.

```
data annor(drop=statefp countyfp);
   length STATE COUNTY 5 text color $15;
   retain xsys ysys "2" when "A";
   /*set rdsinwake;*/ /* Uncomment this if you run the GINSIDE proc.*/
   set roads; /* Comment out this data set if you run GINSIDE proc.*/
   dsn="lines";
   /* Define SAS variables: SAS data sets have */
   /* state and county defined as numeric     */
   STATE=statefp; county=countyfp;
   id="US-"||put(state,z2.)||put(county,z3.);
   LONG=X;  LAT=Y;
   by TLID notsorted;
   text=mtfcc;
   if mtfcc="S1100" then do; line=3; color="&majroadcolor"; size=2;
end;
   else if mtfcc="S1200" then do; line=2; color="&secroadcolor";end;
        else if mtfcc=:"H" then do; line=4; color="&watercolor"; end;
   if first.TLID then do;
      function="MOVE";
      output;
   end;
   else do;
      function="DRAW";
      output;
  end;
run;
```

Create the data set WORK.WRC_FISHING that contains the NC fishing areas. The source is the North Carolina Wildlife Resource Center.

```
/* Create the data set WORK.WRC_FISHING that contains the
   NC fishing areas.                                        */
data WORK.WRC_FISHING;
   infile cards dsd;
   input X Y Fishing_Area_Name : $25.
          FishingPier
          ShorelineAccess
          BoatRamp
          CanoeAccess
          UniveralAccess
          WaterbodyName : $32.;
datalines;
-78.5392,35.7987,NEUSE RIVER EAST,0,1,0,1,0,NEUSE RIVER
-78.6275,35.9791,OLD 98,0,1,0,0,0,FALLS RESERVOIR
-78.6540,35.9705,UPPER BARTON CREEK,0,1,0,1,0
FALLS RESERVOIR
-78.7226,36.0536,LEDGE ROCK,.,0,1,0,0,FALLS RESERVOIR
-78.6843,36.0342,BEAVERDAM,0,1,1,1,0,FALLS RESERVOIR
-78.6915,36.0215,HWY 50,0,1,1,1,0,FALLS RESERVOIR
-78.8166,35.7468,APEX COMMUNITY PARK,1,1,0,1,0,PINE LAKE
-78.8042,35.6429,BASS LAKE PARK,1,1,0,1,0,BASS LAKE PARK
-78.9390,35.6086,HOLLEMANS CROSSING,.,0,1,0,0
```

```
SHEARON HARRIS RESERVOIR
-78.6957,35.6972,SIMPKINS POND,0,1,0,0,0
SIMPKINS POND / LAKE WHEELER
-78.6635,35.8585,SHELLEY LAKE,1,1,1,1,1,SHELLEY LAKE
-78.6775,35.7668,LAKE RALEIGH,1,1,0,1,1,LAKE RALEIGH
-78.7907,35.8384,LAKE CRABTREE COUNTY PARK,1,1,1,1,1
LAKE CRABREE COUNTY PARK
-78.7137,35.7627,LAKE JOHNSON PARK,1,0,0,1,0
LAKE JOHNSON
-78.9259,35.6258,HARRIS LAKE PARK,1,1,0,1,0
HARRIS LAKE & HARRIS PARK POND
-78.8259,35.7812,FRED G BOND METRO PARK,1,1,0,1,0
BOND PARK POND
;
```

Add the Annotate variables.

```
data wrc;
   length STATE 5 COUNTY 5 text $45 font $8 color $8 style $18
      function $8 dsn $8;
   retain STATE 37 COUNTY 183 xsys ysys "2" when "A"
      font "marker";
   set wrc_fishing;
   dsn="points";
   text=fishing_area_name;
   style="&labelfont/bold";
   size=1;
   function="label";
   position="<";
   /* reposition overlapping and crowded labels */
   if text in("LAKE RALEIGH" "OLD 98" "HWY 50"
      "HOLLEMANS CROSSING" "SHELLEY LAKE" "BASS LAKE PARK")
      then position=">";
   output;
   function="pie";
   rotate=360;
   style="psolid";
   color="&pointcolor";
   position="5";
   size=&pointsize;
   output;
   /* Draw a dark ring around pie, to help */
   /* distinguish overlapping ones         */
   style="pempty";
   color="&pointoutlinecolor";
   line=1;
   html=" ";
   output;
run;
```

Combine the map and roads data sets so that they can be projected together.

```
data all;
   length function $8 text $45 style $20;
   set ncwake annor wrc;
run;

proc gproject data=all out=prj degrees eastlong dupok;
```

```
   id dsn id;
run;
```

Separate the map and Annotate data sets.

```
data map lines points;
   set prj;
   if dsn="map" then output map;
   else if dsn="lines" then output lines;
        else output points;
run;
```

Create an annotation data set that includes POINTS and annotation instructions for a map legend. After the last observation in POINTS, append the instructions for the choro map legend.

```
data choroanno;
   set points end=last;
   if (last) then do;
      output;
      color="black"; ysys=1; xsys=1; line=1; size=2;
      function="move"; x=75; y=10; output;
      color="&majroadcolor"; function="draw"; x=90; y=10; output;
      function="move"; x=75; y=7; output;
      color="&secroadcolor"; function="draw"; x=90; y=7; output;
      function="move"; x=75; y=4; output;
      color="&watercolor"; function="draw"; x=90; y=4; output;
      size=1.2; color="black"; position='>'; style="&labelfont";
      x=92; y=10; function="label"; text="Major Roads"; output;
      x=92; y=7; function="label"; text="Secondary Roads"; output;
      x=92; y=4; function="label"; text="Water"; output;
   end;
   else output;
   keep x y function text style color xsys ysys when
      line size font position rotate;
run;
```

Display the choropleth map.

```
proc gmap map=map data=map anno=lines;
   id id;
   choro state/discrete nolegend anno=choroanno stat=sum;
   pattern v=s r=100 color=whitesmoke;
   title1 height=2 "Fishing Areas in Wake County, NC";
run;
quit;
```

Reset system options SVGWIDTH=, SVGHEIGHT=, and PAPERSIZE= to their default values. Resetting these options helps prevent unexpected results in subsequent jobs.

```
options svgheight="" svgwidth=""
   %sysfunc(getoption(papersize,keyword,defaultvalue));;
```

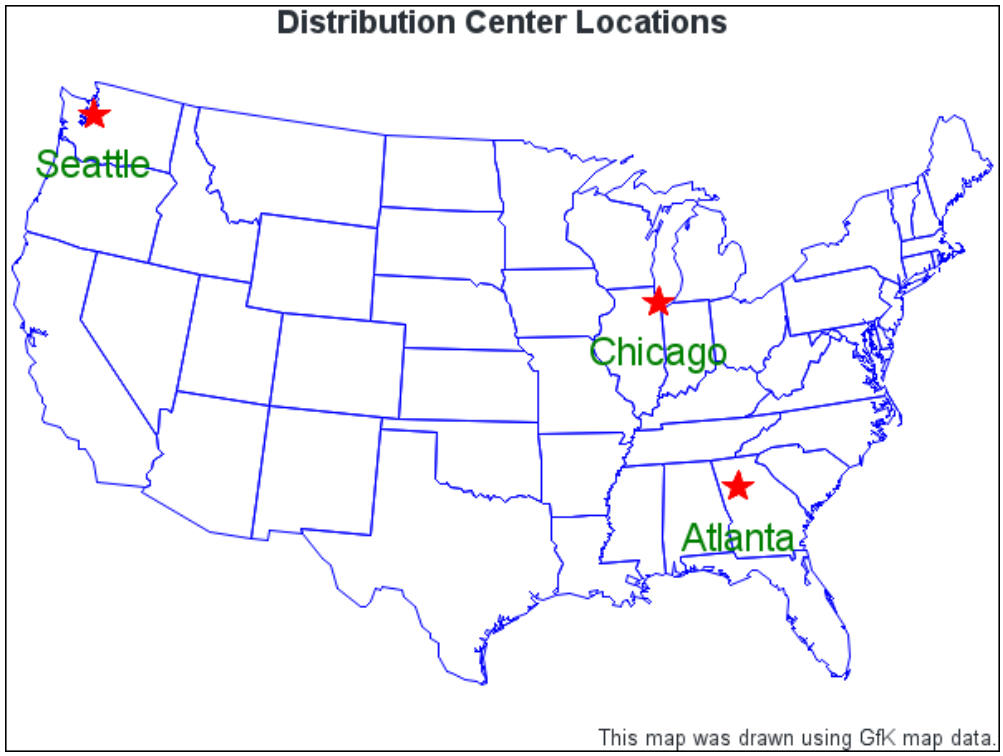
Example 17: Labeling Cities on a Map

Features:
- Annotate functions
  - LABEL
  - SYMBOL
- Annotate variables
  - HSYS
  - POSITION
  - SIZE
  - TEXT
  - WHEN
  - X and Y
  - XSYS
  - YSYS

Data set: MAPSGFK.USCITY

This example labels a map of the continental United States with the location and names of three cities. The GMAP procedure draws a map of the U.S. and an Annotate data set adds the stars and labels. The DATA step that creates the Annotate data set gets the *x* and *y* coordinates of the cities to be labeled from the MAPSGFK.USCITY data set. Because MAPSGFK.USCITY stores projected coordinates in the X and Y variables, the DATA step does not need to reassign the variable values. Also, because X and Y contain data values (the map data set coordinates), the XSYS and YSYS variables specify coordinate system 2, absolute data values. However, the HSYS variable that controls text height uses coordinate system 3, percent of the graphics output area.

Output 13.2 *Map with Labeled Cities*



Program

```
goptions reset=all border;

data lower48;
   set mapsgfk.us;
   if state ne stfips("AK");
   if state ne stfips("HI");
   if state ne stfips("PR");
run;

data citystar;
   length function style color $ 8 position $ 1 text $ 20;
   retain xsys ysys "2" hsys "3" when "a";

   set mapsgfk.uscity(keep=x y city state);
   if (city="Atlanta" and state=13)
   or (city="Chicago" and state=17)
   or (city="Seattle" and state=53);

   function="symbol"; style="marker"; text="V"; color="red"; size=5;
   output;

   function="label"; style=""; text=city; color="green";
      size=5; position="8"; output;
run;

title "Distribution Center Locations";

pattern value=mempty color=blue repeat=49;
```

```
proc gmap data=lower48 map=lower48;
   id state;
   choro state / stat=first annotate=citystar discrete nolegend;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Subset the U.S. map data set by omitting Alaska, Hawaii, and Puerto Rico.

```
data lower48;
   set mapsgfk.us;
   if state ne stfips("AK");
   if state ne stfips("HI");
   if state ne stfips("PR");
run;
```

Create the Annotate data set, CITYSTAR. CITYSTAR contains the commands that draw a star and a label at each of the three cities. Setting WHEN to A draws the annotation after the map.

```
data citystar;
   length function style color $ 8 position $ 1 text $ 20;
   retain xsys ysys "2" hsys "3" when "a";
```

Include the values of selected variables from MAPSGFK.USCITY. X and Y contain projected coordinates; CITY contains names; STATE contains FIPS codes. Because there are several instances of Atlanta, a STATE value is necessary. To avoid multiple symbols being displayed for the same city name in different states, a STATE value specifies the target state.

```
   set mapsgfk.uscity(keep=x y city state);
   if (city="Atlanta" and state=13)
   or (city="Chicago" and state=17)
   or (city="Seattle" and state=53);
```

Create the observation that draws the star. The text string V is the character code for the star figure in the MARKER font assigned by the STYLE variable.

```
   function="symbol"; style="marker"; text="V"; color="red"; size=5;
   output;
```

Create the observation that labels the city. TEXT is assigned the value of CITY. The default font is used. SIZE uses the units assigned by HSYS, so text height is 5% of the height of the graphics output area. POSITION 8 places the label directly below the city location.

```
   function="label"; style=""; text=city; color="green";
      size=5; position="8"; output;
run;
```

Define the title for the map.

```
title "Distribution Center Locations";
```

Define patterns for the map areas. MEMPTY colors only the state borders.

```
pattern value=mempty color=blue repeat=49;
```

Generate the map and assign the annotate data set to the CHORO statement.

```
proc gmap data=lower48 map=lower48;
   id state;
   choro state / stat=first annotate=citystar discrete nolegend;
run;
quit;
```

See Also

- "Example 4: Projecting an Annotate Data Set" on page 562 for an example of labeling a map using map coordinates in units of latitude and longitude.
- "Differences between GfK and Traditional Map Data Sets " on page 312 provides more information about using map data sets.

Example 18: Producing a Stand-Alone SVG File That Displays a European Map

Features:

MAP= required argument referring to a MAPSSAS map data set

DATA= argument referring to response data

ANNOTATE= argument referring to Annotate data

ID statement

WHERE= argument

CHORO statement options
- NAME=

Other features
- TITLE statement
- ODS HTML5 statement
- options(bitmap_mode="embed")
- GOPTIONS statement with DEVICE= option

Data sets:

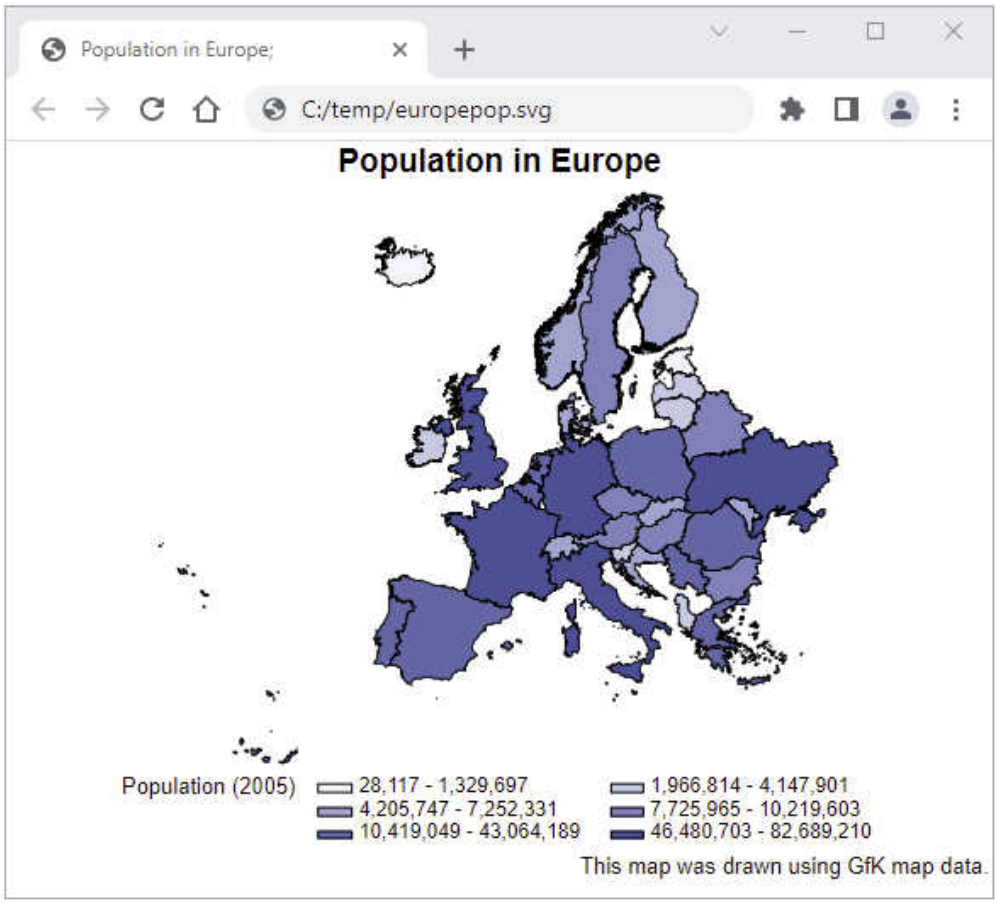
MAPSGFK.EUROPE

SASHELP.DEMOGRAPHICS

Output

In the HTML5 destination, SVG graphics are created as inline graphics in the HTML file by default. You can generate a stand-alone SVG image file in the ODS HTML5 destination by specifying option `svg_mode='embed'` in the ODS HTML5 statement.

This option embeds the SVG image file into the HTML file using the `<embed>` tag. This example produces a stand-alone SVG file named `europepop.svg` and an HTML5 file named `europe.htm`. You can view the SVG graphic by opening `europepop.svg` or `europe.htm` in your SVG-enabled browser. If your browser does not render the graphic, see "Browser Support for Viewing SVG Files" in *SAS/GRAPH: Reference*.



Program

```
options fmtsearch=(sashelp.mapfmts);
data demographics;
   length tip $60;
   length idname $55;
   set sashelp.demographics(where=(cont = 93));
   idname = put(id,glcnsm.);
   tip = "title=" || "'" || trim(idname) || "'";
run;

filename odsout "output-path";

goptions reset=all device=svg xpixels=580 ypixels=435;
options svgwidth="580px" svgheight="435px";

ods _all_ close;
ods html5 path=odsout file="europe.htm" options(svg_mode='embed');
```

```
title "Population in Europe";

proc gmap map=mapsgfk.europe
    data=work.demographics;
    id idname;
    choro pop / name="europePop" html=tip;
run;
quit;

ods html5 close;
goptions reset=all;
options svgwidth=" " svgheight=" ";
filename odsout clear;
```

Program Description

Get the population data from SASHELP.DEMOGRAPHICS. Use the GLCNSM format in a PUT statement to convert the GLC ID to the country name and assign the result to variable IDNAME. Add variable TIP to provide the country names as data tips.

```
options fmtsearch=(sashelp.mapfmts);
data demographics;
   length tip $60;
   length idname $55;
   set sashelp.demographics(where=(cont = 93));
   idname = put(id,glcnsm.);
   tip = "title=" || "'" || trim(idname) || "'";
run;
```

Specify the ODS output path.

```
filename odsout "output-path";
```

Set the graphics environment. Specify the SVG graphics device and the dimensions of the output.

```
goptions reset=all device=svg xpixels=580 ypixels=435;
options svgwidth="580px" svgheight="435px";
```

Set the output destination to HTML5, specify the path to which the file is written, and specify a name for the output file. The output filename is "europe.htm."

```
ods _all_ close;
ods html5 path=odsout file="europe.htm" options(svg_mode='embed');
```

Set a title to display on the graphic output.

```
title "Population in Europe";
```

Use the GMAP procedure to produce a choropleth map from the MAPSGFK European map data set, using population statistics from the WORK.DEMOGRAPHICS data set.

```
proc gmap map=mapsgfk.europe
    data=work.demographics;
    id idname;
    choro pop / name="europePop" html=tip;
run;
```

```
quit;
```

Close the ODS HTML5 destination, and reset the graphics options to their default values.

```
ods html5 close;
goptions reset=all;
options svgwidth=" " svgheight=" ";
filename odsout clear;
```

Example 19: Producing a Simple Block Map Using Traditional Map Data

Features: MAP= required argument referring to traditional map data set

DATA= required argument referring to response data

ID statement

BLOCK statement options
- BLOCKSIZE=
- RELZERO

PATTERN statement

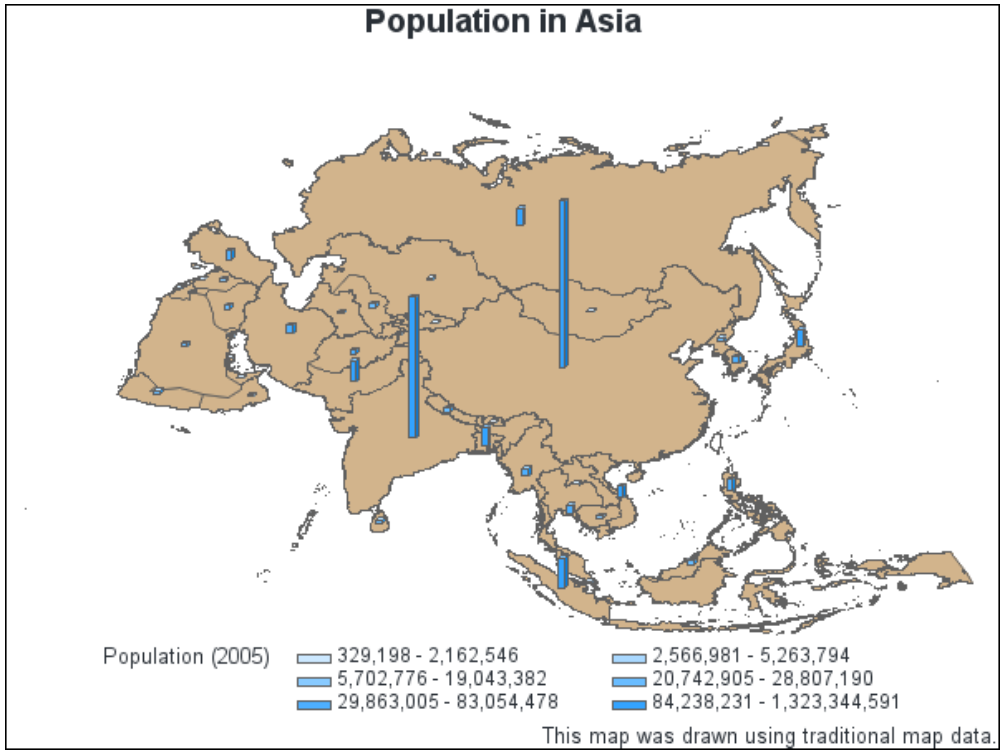
Data sets: MAPS.ASIA (map data set)

SASHELP.DEMOGRAPHICS (response data)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example produces a block map that shows population of countries in Asia. Because the DISCRETE option is not used, the response variable is assumed to have a continuous range of values. Because neither the LEVELS= nor MIDPOINTS= option is used, the GMAP procedure selects a number of levels based on the number of map areas. It then calculates the appropriate response levels.



Program

```
goptions reset=all border;

title1 "Population in Asia";
pattern1 value=msolid color=tan;

proc gmap data=sashelp.demographics(where=(cont=95))
   map=mapssas.asia all;
   id id;
   block pop / blocksize=1 relzero;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title and the color for the map. The PATTERN statement specifies a solid tan color pattern for the Asian continent, differentiating it from the block colors.

```
title1 "Population in Asia";
pattern1 value=msolid color=tan;
```

Produce the block map. The ALL argument specifies that the output should include all of the map areas from the map data set. This happens even if the response data

set SASHELP.DEMOGRAPHICS does not include an observation for the map area. The ID statement specifies the variable that is in both the map data set and the response data set and defines map areas. The BLOCK statement specifies the variable in the response data set that contains the response values for each of the map areas. The BLOCKSIZE= option specifies the width of the blocks. The RELZERO option specifies that the block values are relative to zero.

```
proc gmap data=sashelp.demographics(where=(cont=95))
   map=mapssas.asia all;
   id id;
   block pop / blocksize=1 relzero;
run;
quit;
```

Example 20: Specifying Response Levels in a Block Map Using Traditional Map Data

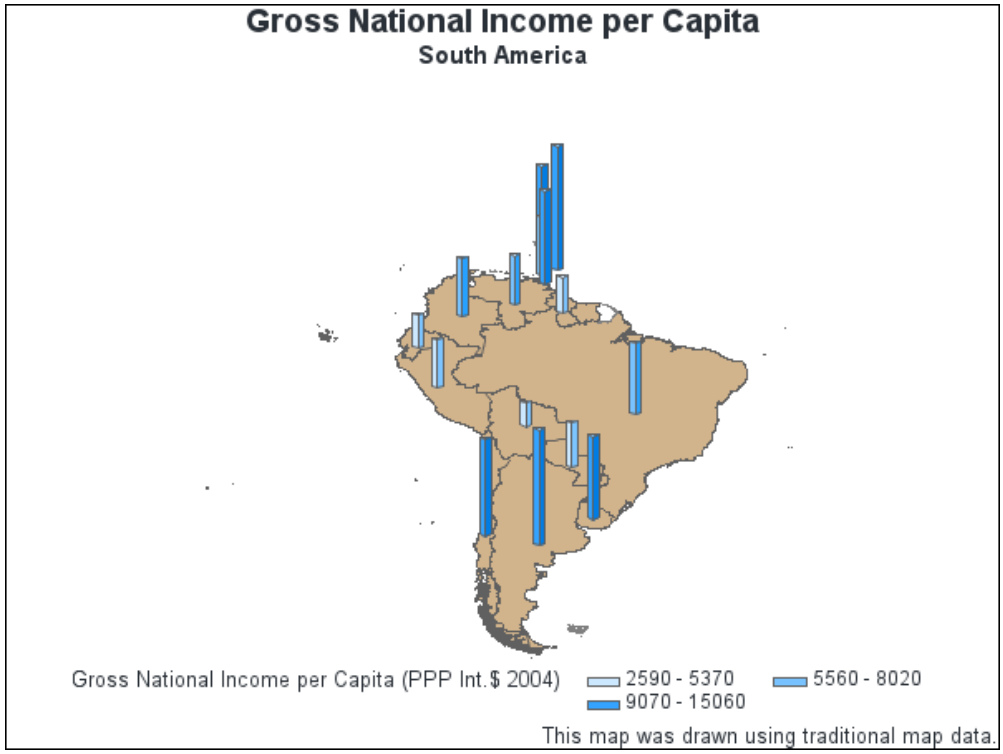
Features:
- MAP= required argument referring to a traditional map data set
- DATA= required argument referring to response data
- ID statement
- BLOCK statement options
  - LEVELS=
  - SHAPE=
  - RELZERO
  - CEMPTY=
- PATTERN statement

Data sets:
- MAPSSAS.SAMERICA (map data set)
- SASHELP.DEMOGRAPHICS (response data)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example uses the LEVELS= option to specify the number of response levels for the blocks. The LEVELS= option tells GMAP how many response levels and the GMAP procedure calculates the quantiles.



Program

```
goptions reset=all border;

title1 "Gross National Income per Capita";
title2 "South America";
pattern1 value=msolid color=tan;

proc gmap data=sashelp.demographics(where=(cont=92))
   map=mapssas.samerica all;
   id id;
   block gni / levels=3 shape=prism
      relzero cempty=gray;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the titles and color for the map. The PATTERN statement specifies a solid tan color pattern for the South American continent, differentiating it from the block colors.

```
title1 "Gross National Income per Capita";
title2 "South America";
pattern1 value=msolid color=tan;
```

Produce the block map, which includes the Caribbean islands. The ALL argument specifies that the output should include all of the map areas from the map data set. This happens even if the response data set DEMOGRAPHICS does not include an observation for the map area. The LEVELS= option specifies the number of response levels for the graph. The SHAPE= option draws the blocks as prisms. The RELZERO option specifies that the block values are relative to zero. The CEMPTY= option specifies the outline color for map areas that have missing data.

```
proc gmap data=sashelp.demographics(where=(cont=92))
   map=mapssas.samerica all;
   id id;
   block gni / levels=3 shape=prism
      relzero cempty=gray;
run;
quit;
```

Example 21: Assigning a Format to the Response Variable when Using Traditional Map Data

Features:
MAP= required argument referring to a traditional map data set
DATA= required argument referring to response data
FORMAT statement
ID statement
AREA statement option MIDPOINTS=
BLOCK statement options
- LEGEND=
- RELZERO

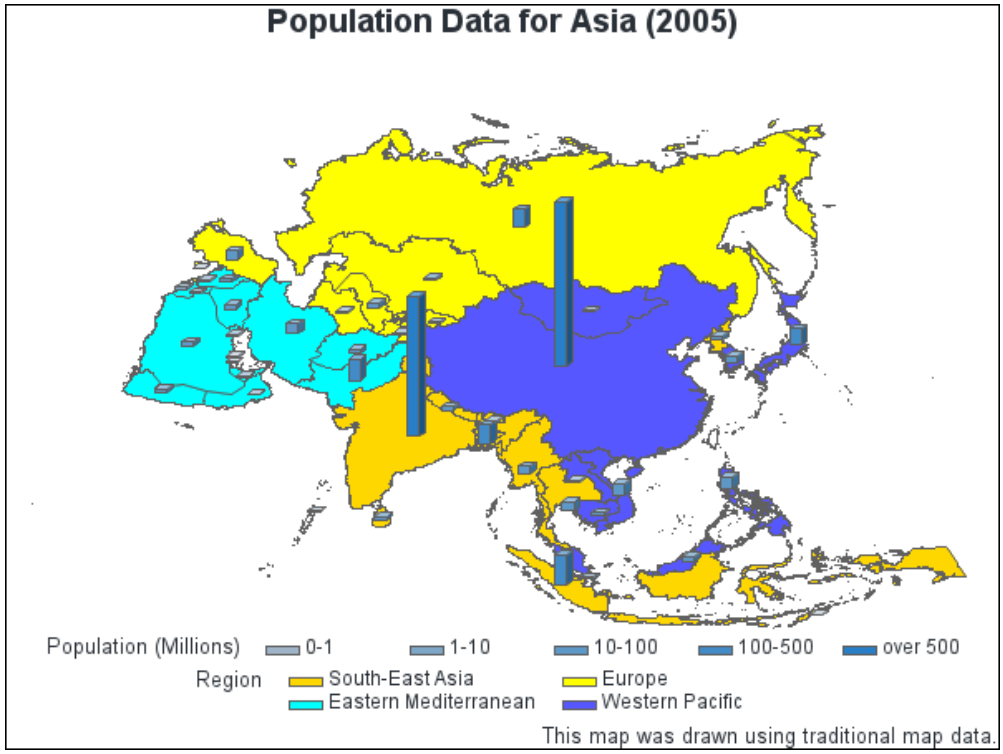
FORMAT procedure
LEGEND statement
PATTERN statement

Data sets:
MAPSSAS.ASIA (map data set)
SASHELP.DEMOGRAPHICS (response data)

Note:
The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example creates formats for the response variables. The format for the POP variable defines and labels ranges of values. These ranges appear in the legend and make the map easier to understand. The example also uses the AREA statement to patterns the map areas by region.



Program

```
goptions reset=all border;

proc format;
  value popfmt low-1000000="0-1"
               1000001-10000000="1-10"
               10000001-100000000="10-100"
               100000001-500000000="100-500"
               500000001-high="over 500";
run;

proc format;
  value $ regionfmt "SEAR" = "South-East Asia"
                    "EUR" = "Europe"
                    "EMR" = "Eastern Mediterranean"
                    "WPR" = "Western Pacific";
run;

title1 "Population Data for Asia (2005)";
pattern1 color=gold value=msolid;
pattern2 color=yellow value=msolid;
pattern3 color=cyan value=msolid;
pattern4 color=light_blue value=msolid;

legend1 label=("Population (Millions)");

proc gmap data=sashelp.demographics(where=(cont=95))
          map=mapssas.asia all;
   format pop popfmt.;
   format region $regionfmt.;
   id id;
```

```
   area region / midpoints="SEAR" "EUR" "EMR" "WPR";
   block pop / legend=legend1
               relzero
               levels=all;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Create a format for POP. POPFMT. defines the ranges of values for POP and labels the values.

```
proc format;
  value popfmt low-1000000="0-1"
               1000001-10000000="1-10"
               10000001-100000000="10-100"
               100000001-500000000="100-500"
               500000001-high="over 500";
run;
```

Create a format for REGION. REGIONFMT. labels the values for REGION.

```
proc format;
  value $ regionfmt "SEAR" = "South-East Asia"
                    "EUR" = "Europe"
                    "EMR" = "Eastern Mediterranean"
                    "WPR" = "Western Pacific";
run;
```

Define the title and colors for the map. The PATTERN statement specifies a unique solid color pattern for each country of the Asian continent, differentiating it from the block colors.

```
title1 "Population Data for Asia (2005)";
pattern1 color=gold value=msolid;
pattern2 color=yellow value=msolid;
pattern3 color=cyan value=msolid;
pattern4 color=light_blue value=msolid;
```

Assign the legend label.

```
legend1 label=("Population (Millions)");
```

Produce the block maps. The ALL argument specifies that the map displayed should include all of the map areas from the map data set. This happens even if the response data set DEMOGRAPHICS does not include an observation for the map area. The FORMAT statements assign POPFMT. to the POP variable and $REGIONFMT. to the REGION variable. The AREA statement assigns patterns to the map areas according to the values of the REGION variable. The RELZERO option specifies that the blocks values are relative to zero. The LEVELS= option is used to graph all unique ID response variable values.

```
proc gmap data=sashelp.demographics(where=(cont=95))
          map=mapssas.asia all;
```

```
   format pop popfmt.;
   format region $regionfmt.;
   id id;
   area region / midpoints="SEAR" "EUR" "EMR" "WPR";
   block pop / legend=legend1
               relzero
               levels=all;
run;
quit;
```

Example 22: Specifying the Statistic for the Response Variable When Using Traditional Map Data

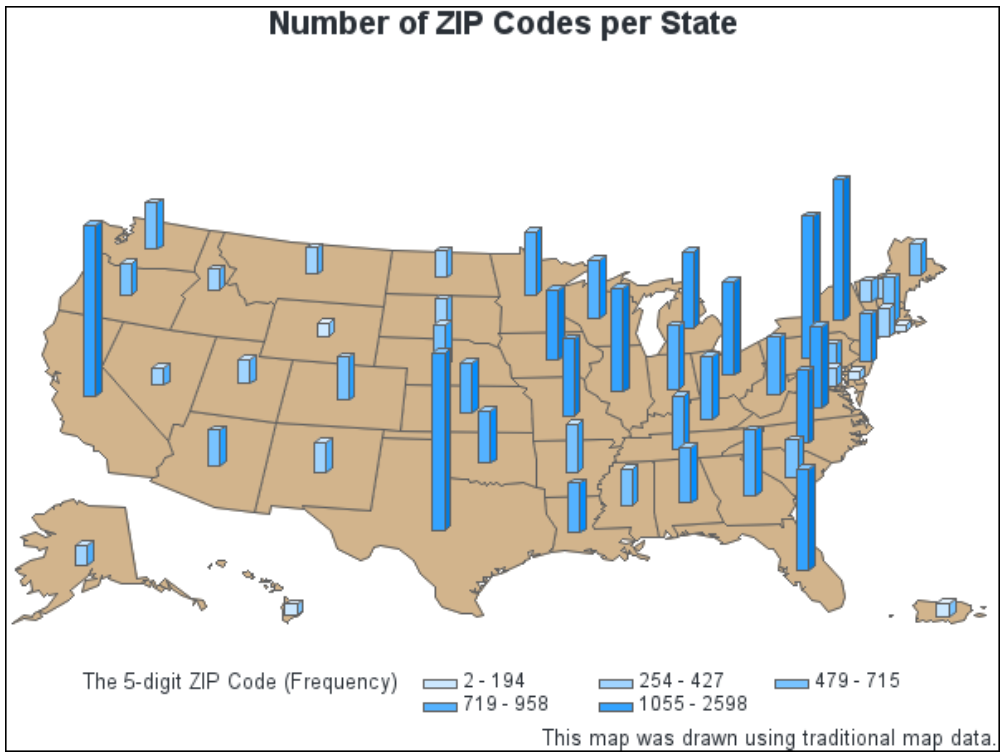
Features:
- MAP= required argument referring to a traditional map data set
- DATA= required argument referring to response data
- ID statement
- BLOCK statement options
  - STATISTIC=
  - LEVELS=
  - RELZERO
- PATTERN statement

Data sets:
- MAPSSAS.US (map data set)
- SASHELP.ZIPCODE (response data)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example specifies the statistic for the response variable that is displayed by the block map. The STATISTIC= option specifies that the statistic is frequency rather than the default statistic (sum).



Program

```
goptions reset=all border;

title1 "Number of ZIP Codes per State";
pattern1 value=msolid color=tan;

proc gmap map=mapssas.us data=sashelp.zipcode all;
   id state;
   block zip / statistic=frequency
               levels=5 relzero;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title and the color for the map.

```
title1 "Number of ZIP Codes per State";
pattern1 value=msolid color=tan;
```

Produce the block maps. These include Puerto Rico and the District of Columbia. The ALL argument specifies that the map displayed should include all of the map areas from the map data set. This happens even if the response data set SASHELP.ZIPCODE does not include an observation for the map area. The

STATISTIC= option specifies the statistic for the response variable. The LEVELS= option specifies the number of response levels. The RELZERO option specifies that the blocks values are relative to zero.

```
proc gmap map=mapssas.us data=sashelp.zipcode all;
   id state;
   block zip / statistic=frequency
               levels=5 relzero;
run;
quit;
```

Example 23: Producing a Simple Choropleth Map Using Traditional Map Data

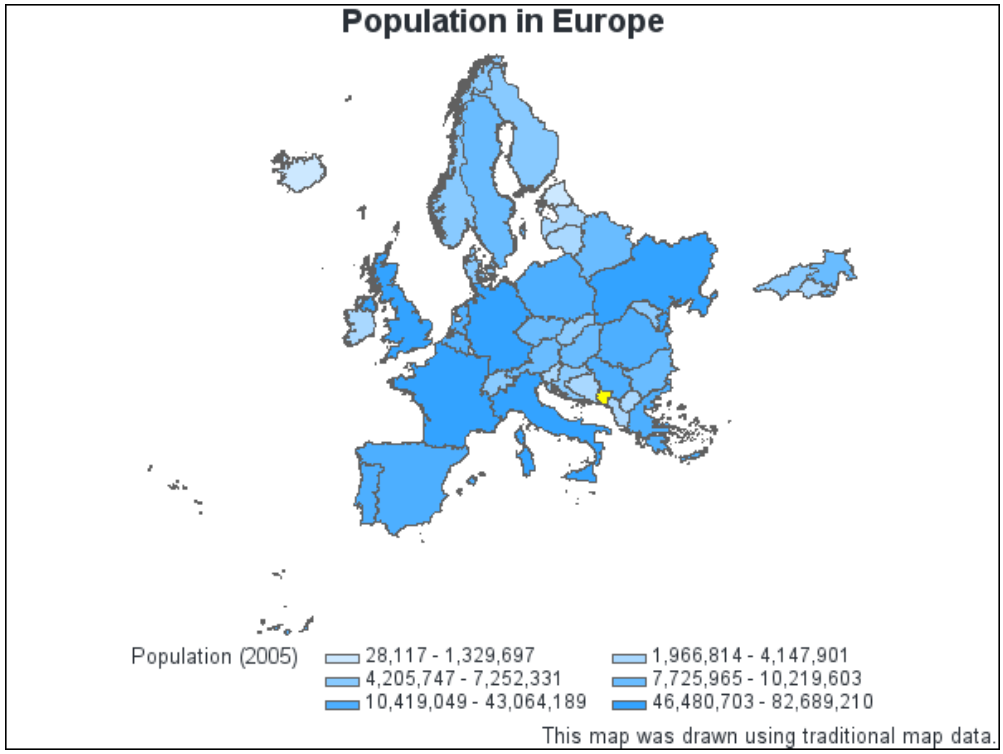
Features: MAP= required argument referring to a traditional map data set
DATA= required argument referring to response data
ID statement
CHORO statement option CDEFAULT=

Data sets: MAPSSAS.EUROPE (map data set)
SASHELP.DEMOGRAPHICS (response data)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example produces a choropleth (two-dimensional) map that shows the population of countries in Europe. Because the DISCRETE option is not used, the response variable is assumed to have a continuous range of values. Because neither the LEVELS= nor MIDPOINTS= options are used, the GMAP procedure selects a number of levels based on the number of map areas. It then calculates the appropriate response levels. The legend shows the range of values for each level.



Program

```
goptions reset=all border;

title1 "Population in Europe";

proc gmap map=mapssas.europe(where=(id ne 405 and id ne 845))
   data=sashelp.demographics(where=(cont=93)) all;
   id id;
   choro pop / cdefault=yellow;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the map.

```
title1 "Population in Europe";
```

Produce the choropleth map. The ALL argument specifies that the map displayed should include all of the map areas from the map data set. This happens even if the response data set DEMOGRAPHICS does not include an observation for the map area. The map shows one such area. The ID statement specifies the variable that is in both the map data set and the response data set that defines map areas. CDEFAULT= specifies the color for the map areas that have missing data. The

WHERE= data set option on the MAP= option excludes the islands of Greenland and Svalbard, which have no data in DEMOGRAPHICS data set. The data sets MAPS.EUROPE and SASHELP.DEMOGRAPHICS include the Russian region countries Azerbaijan, Armenia, and Georgia.

```
proc gmap map=mapssas.europe(where=(id ne 405 and id ne 845))
   data=sashelp.demographics(where=(cont=93)) all;
   id id;
   choro pop / cdefault=yellow;
run;
quit;
```

Example 24: Producing a Drilldown Choropleth Map Using Traditional Map Data

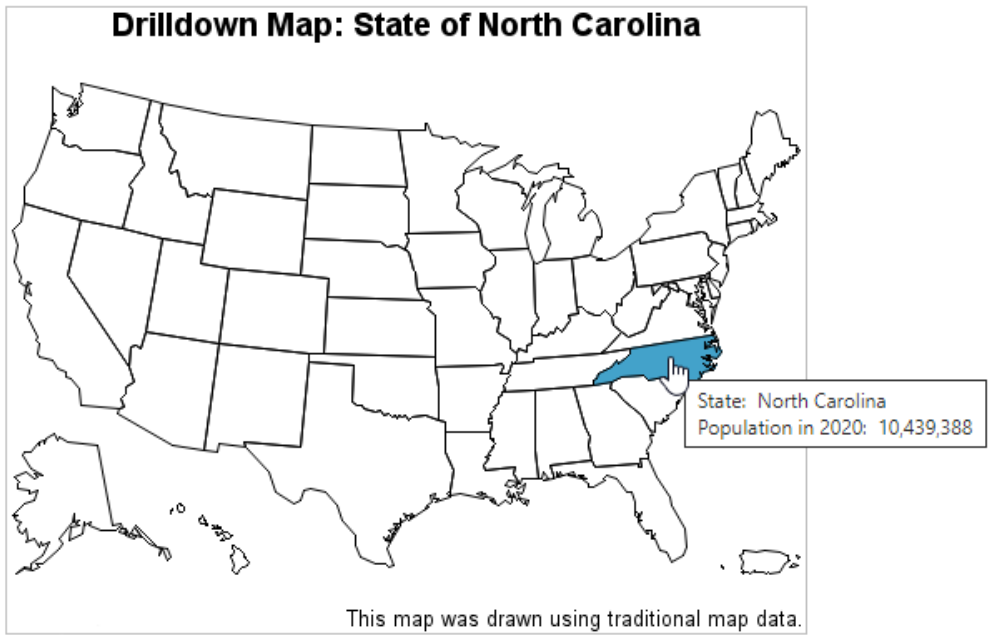
Features:
- MAP= required argument referring to a traditional map data set
- DATA= required argument referring to response data
- BY statement
- ID statement
- CHORO statement options
  - LEVELS=
  - NOLEGEND
  - COUTLINE=
  - HTML=
  - DES=
  - NAME=

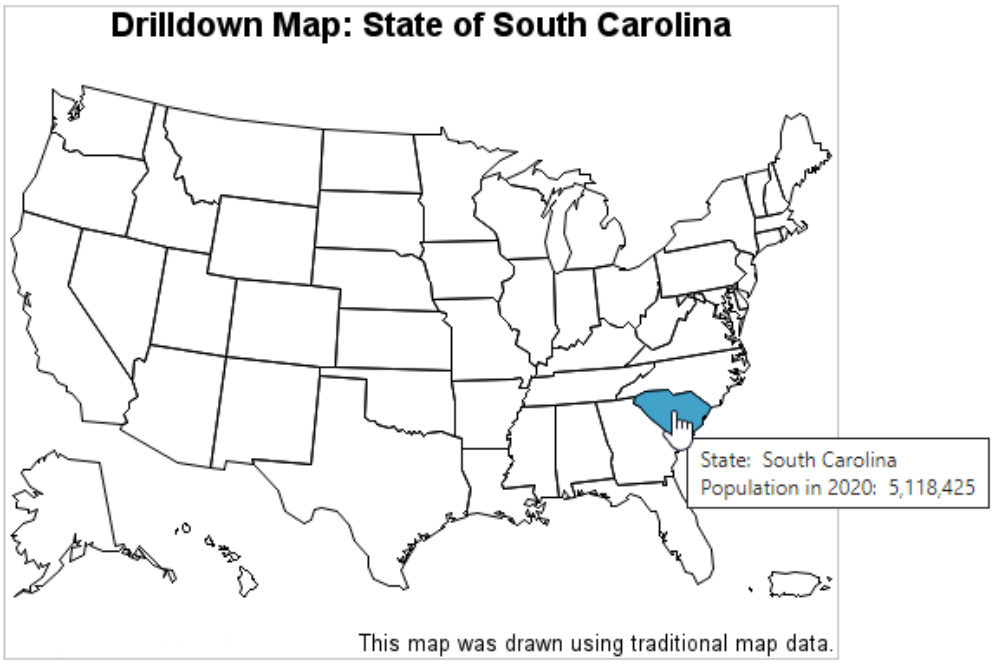
Data sets:
- MAPSSAS.US (map data set)
- MYDATA (response data)

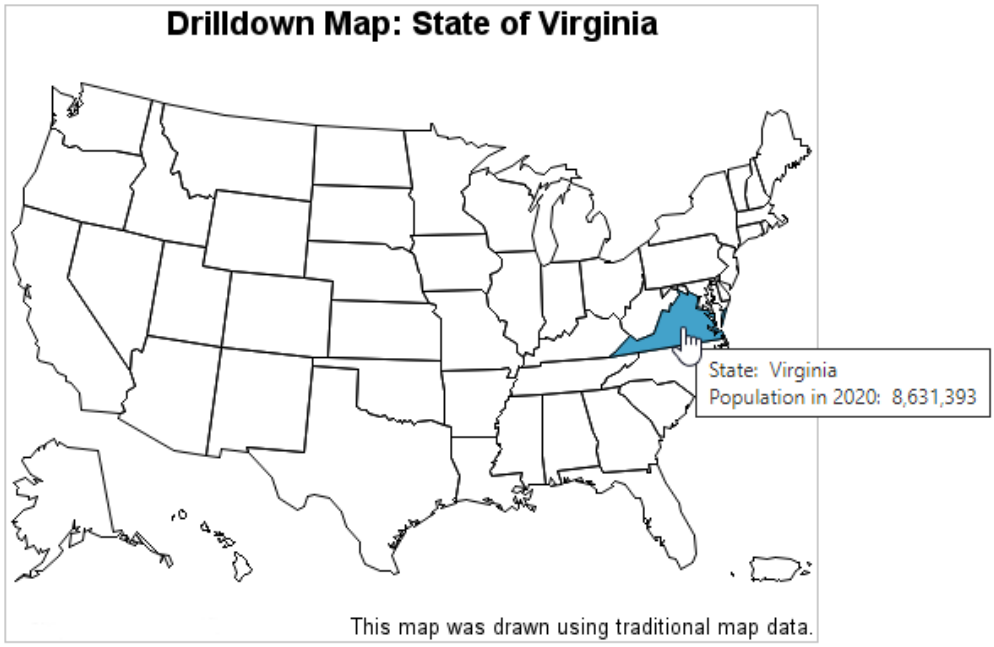
Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example produces three choropleth (two-dimensional) maps, each showing the population of a southeastern state in America. Each graph's title includes a link for drilling down to that particular state's home page on the web. The 'ALT=' option text description on each map title changes with a BY variable substitution to match the state being highlighted. The LEVELS= option enables the GMAP procedure to graph one response level for the population. This population number is part of the text description as your mouse pointer is held over the state colored in blue.


Drilldown Map: State of North Carolina
State: North Carolina
Population in 2020: 10,439,388
This map was drawn using traditional map data.


Drilldown Map: State of South Carolina
State: South Carolina
Population in 2020: 5,118,425
This map was drawn using traditional map data.



Program

```
goptions reset=all border device=png;
options nobyline;

%let year=2020;
data population;
   year=&year;
   set sashelp.us_data;
   where statecode in ("VA" "NC" "SC");
   rename population_&year=population;
   label statename="State Name" statecode="State Code"
      population_&year="Population";
   keep statename statecode year population_&year;
run;

data mydata;
   format population comma12.0;
   length htmlvar $500 datatip $120;
   set population;
   datatip = 'title='||quote(
      'State:  '|| trim(statename) ||'0D'x ||
      'Population in '|| trim(left(year)) || left(':  ') ||
      trim(left(put(population,comma12.0))));
   select(statecode);
      when("VA")
         htmlvar=trim(datatip)||
         ' href="https://www.virginia.gov" target="_blank"';
      when("NC")
         htmlvar=trim(datatip)||
         ' href="https://www.nc.gov" target="_blank"';
      when("SC")
         htmlvar=trim(datatip)||
         ' href="https://www.sc.gov" target="_blank"';
```

```
      otherwise htmlvar="";
   end;
   drop datatip;
run;

proc sort data=mydata out=mydata;
by statecode statename;
run;

axis1 label=none;
axis2 label=none minor=none offset=(0,0);

pattern v=solid color=cx43a2ca;

title1 "Drilldown Map: " "State of #byval(statename)";

proc gmap data=mydata map=mapssas.us all;
   by statecode statename;
   id statecode;
   choro population / levels=1 nolegend
      coutline=black
      html=htmlvar
      des=''
      name="map01_#byval(statecode)";
run;
quit;

goptions reset=all;

options byline;
```

Program Description

Set the graphics environment.

```
goptions reset=all border device=png;
options nobyline;
```

Get the population data for NC, SC, and VA from SASHELP.US_DATA. The population data from the 2020 census is obtained. Using macro variable YEAR makes it easy to specify a different year at a later time.

```
%let year=2020;
data population;
   year=&year;
   set sashelp.us_data;
   where statecode in ("VA" "NC" "SC");
   rename population_&year=population;
   label statename="State Name" statecode="State Code"
      population_&year="Population";
   keep statename statecode year population_&year;
run;
```

Create the response data set MYDATA with the U.S. states to map. This data set contains the POPULATION data. Variable HTMLVAR is added for each state's home page. This variable provides data-tip text and the link URL for each home page. When clicked, the link opens in a new browser window.

```
data mydata;
```

```
   format population comma12.0;
   length htmlvar $500 datatip $120;
   set population;
   datatip = 'title='||quote(
      'State:  '|| trim(statename) ||'0D'x ||
      'Population in '|| trim(left(year)) || left(':  ') ||
      trim(left(put(population,comma12.0))));
   select(statecode);
      when("VA")
         htmlvar=trim(datatip)||
         ' href="https://www.virginia.gov" target="_blank"';
      when("NC")
         htmlvar=trim(datatip)||
         ' href="https://www.nc.gov" target="_blank"';
      when("SC")
         htmlvar=trim(datatip)||
         ' href="https://www.sc.gov" target="_blank"';
      otherwise htmlvar="";
   end;
   drop datatip;
run;
```

Sort the response data.

```
proc sort data=mydata out=mydata;
by statecode statename;
run;
```

Suppress the axis labels.

```
axis1 label=none;
axis2 label=none minor=none offset=(0,0);
```

Set the color to highlight the state.

```
pattern v=solid color=cx43a2ca;
```

Define the title and its drilldown link for the map. NOBYLINE suppresses the output of both BY variables indicated in the BY statement. #BYVAL substitutes the current value of BY variable statename in the text string.

```
title1 "Drilldown Map: " "State of #byval(statename)";
```

Produce the choropleth map. for each state. The BY statement specifies the variables in the response data set to work with. The ID statement specifies the FIPS state code variable that is in both the map data set and the response data set that defines map areas. The LEVELS= option enables the GMAP procedure to graph one response level for the population. COUTLINE= specifies that the map area be outlined in black. HTML= sets up the link that is displayed as your mouse pointer is held over the state in the output. NAME= defines the name of the GRSEG catalog entry and the name of the graphics output file.

```
proc gmap data=mydata map=mapssas.us all;
   by statecode statename;
   id statecode;
   choro population / levels=1 nolegend
      coutline=black
      html=htmlvar
      des=''
      name="map01_#byval(statecode)";
```

```
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

Restore BY lines.

```
options byline;
```

Example 25: Labeling Provinces on a Map When Using Traditional Map Data

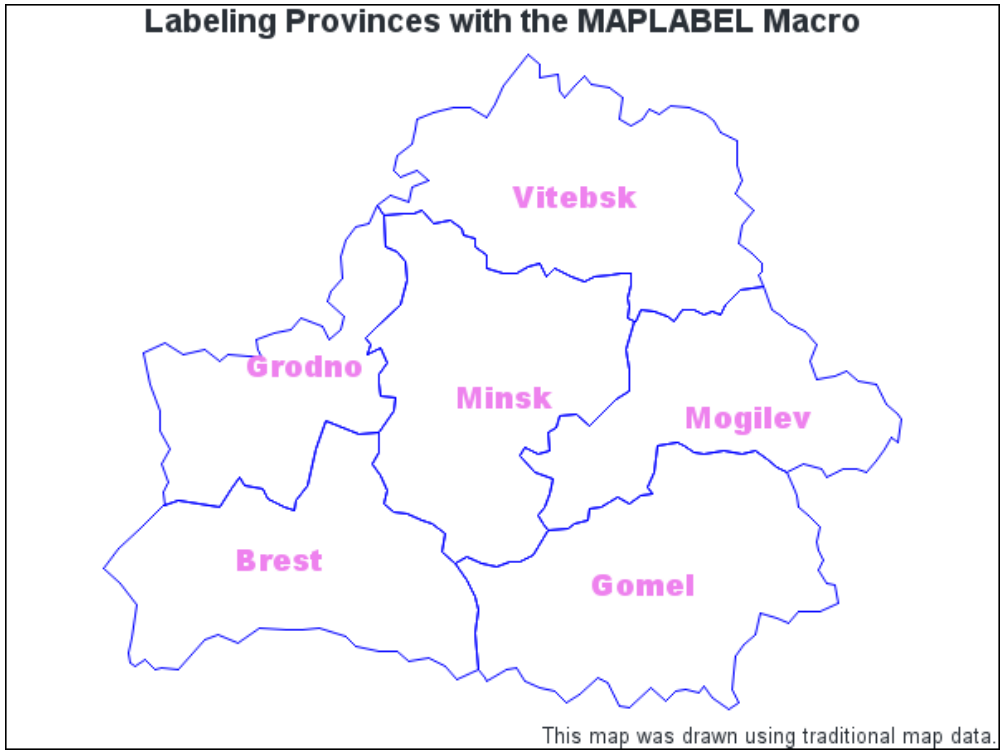
Features: MAP= required argument referring to a traditional map data set
DATA= required argument referring to response data
ID statement
CHORO statement options
STAT=
ANNOTATE=
NOLEGEND
The global PATTERN statement
Annotate Facility

Data set: MAPSSAS.BELARUS (map data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example uses the Annotate facility to add labels to each area in a map of Belarus. The CHORO statement assigns the Annotate data set to the map. The %MAPLABEL Annotate macro is used to create and position the map labels. For more information about this macro, see "%MAPLABEL Annotate Macro" in *SAS/GRAPH: Reference*.



Program

```
goptions reset=all border;

title "Labeling Provinces with the MAPLABEL Macro";

pattern1 value=empty color=blue repeat=6;

%annomac;
%maplabel (mapssas.belarus, mapssas.belarus2, work.labelout, idname,
id,
          font=Albany AMT/Bold, color=violet, size=4, hsys=3);

proc gmap map=mapssas.belarus data=mapssas.belarus;
   id id;
   choro id / stat=first nolegend annotate=labelout;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the map.

```
title "Labeling Provinces with the MAPLABEL Macro";
```

Define pattern characteristics. PATTERN1 defines a single map pattern that is repeated for each of the six map areas (provinces). The pattern is an empty fill with a blue border. The VALUE= option defines a map or plot pattern. Specifying a color causes PATTERN1 to generate only one pattern definition. The REPEAT= option specifies the number of times to repeat the pattern definition.

```
pattern1 value=empty color=blue repeat=6;
```

Create the Annotate data set. The %ANNOMAC macro enables the Annotate macros. The %MAPLABEL macro calculates the centroid and creates the Annotate data set.

```
%annomac;
%maplabel (mapssas.belarus, mapssas.belarus2, work.labelout, idname,
id,
          font=Albany AMT/Bold, color=violet, size=4, hsys=3);
```

Produce the choropleth map. Use the option STATISTIC=SUM to chart the summed value of all observations with a given matching ID. The NOLEGEND option suppresses the legend. The ANNOTATE= option specifies the data set to annotate the map.

```
proc gmap map=mapssas.belarus data=mapssas.belarus;
   id id;
   choro id / stat=first nolegend annotate=labelout;
run;
quit;
```

Example 26: Combining Traditional Map Data and Sample Response Data to Map U.S. Population Statistics

Features:

MAP= required argument referring to a traditional map data set

DATA= required argument referring to response data in a sample data set

ID statement

CHORO statement options

- LEVELS=
- LEGEND=

Data sets:

MAPSSAS.US (map data set)

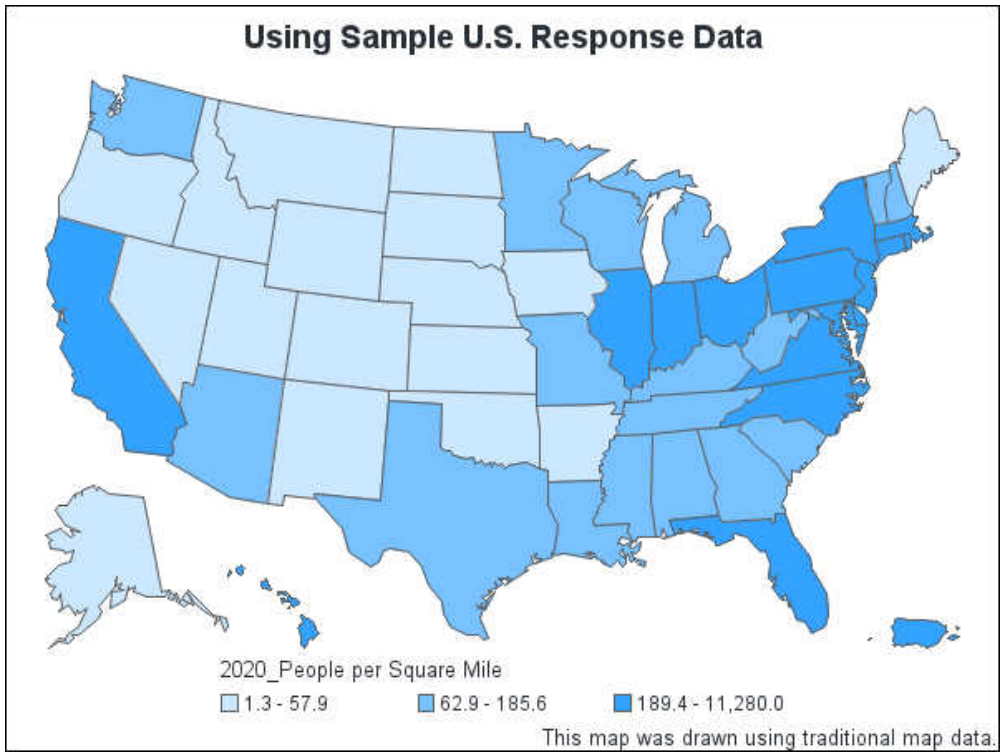
SASHELP.US_DATA (response data)

Note:

The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example uses a sample response data set named SASHELP.US_DATA that is specifically designed to be used with the traditional map data set MAPS.US or MAPSSAS.US. In this example, population details per state are mapped.



Program

```
goptions reset=all border device=png;

title1 ls=1.5 "Using Sample U.S. Response Data";

legend1 label=(position=top) shape=bar(.1in,.1in);

proc gmap data=sashelp.us_data map=mapssas.us;
id state;
choro density_2020 / levels=3 legend=legend1;
run;
quit;

goptions reset=all;
```

Program Description

Set the graphics environment.

```
goptions reset=all border device=png;
```

Define the title for the map.

```
title1 ls=1.5 "Using Sample U.S. Response Data";
```

Define the legend for the map.

```
legend1 label=(position=top) shape=bar(.1in,.1in);
```

Produce the choropleth map of the United States. Census data for 2020 is available in SASHELP.US_DATA. In this example, 2020 population densities are mapped per state (variable density_2020). Use the sample response data set SASHELP.US_DATA, and the traditional map data set for the United States. The LEVELS= option specifies that 3 ranges of population values from the response data are graphed.

```
proc gmap data=sashelp.us_data map=mapssas.us;
id state;
choro density_2020 / levels=3 legend=legend1;
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

Example 27: Producing a Simple Prism Map Using Traditional Map Data

Features:
- MAP= required argument referring to a traditional map data set
- DATA= required argument referring to response data
- ID statement
- PRISM statement options
  - CDEFAULT=
  - RELZERO
- SAS DATA step with assignment statements

Data sets:
- MAPSSAS.AFRICA (map data set)
- SASHELP.DEMOGRAPHICS (response data)

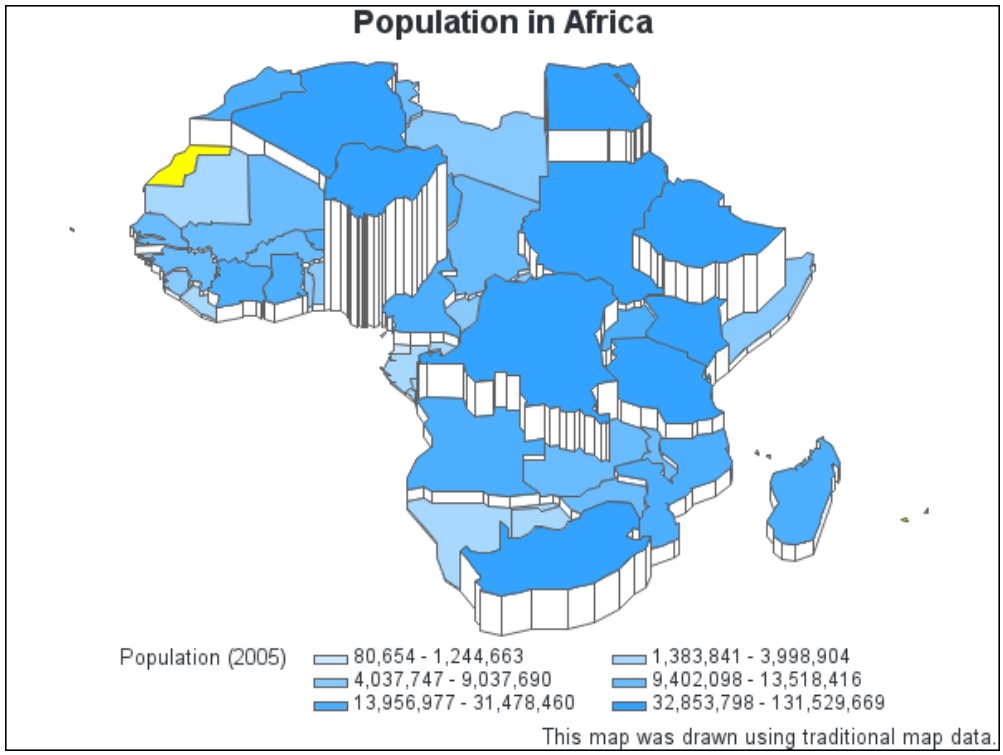
Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example produces a prism map of the population of countries in Africa. Because the DISCRETE option is not used, the response variable is assumed to have a continuous range of values. Because neither the LEVELS= nor MIDPOINTS= option is used, the GMAP procedure selects a number of levels based on the number of map areas. It then calculates the appropriate response levels.

Because the XVIEW=, YVIEW=, and ZVIEW= options are not used, the default viewing position, above and to the east and south of the center of the map, is used. Because the XLIGHT= and YLIGHT= options are not used, none of the side

polygons of the prisms are shadowed. The light source is the same as the viewing position.

Output



Program

```
goptions reset=all border;

title1 "Population in Africa";

data africa;
set mapssas.africa;
by id segment;
if first.id then lake=0;
if x=. then lake+1;
retain lake;
run;

proc gmap data=sashelp.demographics(where=(cont=94))
          map=africa(where=(lake=0)) density=low all;
   id id;
   prism pop / cdefault=yellow relzero;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the map.

```
title1 "Population in Africa";
```

Identify lake regions in the map data set.

```
data africa;
set mapssas.africa;
by id segment;
if first.id then lake=0;
if x=. then lake+1;
retain lake;
run;
```

Produce the prism map. The WHERE= data set option on the MAP= option excludes lake regions from the map. The DENSITY= option specifies that only observations in the map data set whose DENSITY value is zero (0) or one (1) are displayed. The ALL argument specifies that the map displayed should include all of the map areas from the map data set. This happens even if the response data set DEMOGRAPHICS does not include an observation for the map area. The map shows one such area. The ID statement specifies the variable in the map data set and the response data set that defines map areas. The CDEFAULT= option sets the color of map areas that have missing data. The RELZERO option makes the prism heights relative to zero.

```
proc gmap data=sashelp.demographics(where=(cont=94))
          map=africa(where=(lake=0)) density=low all;
   id id;
   prism pop / cdefault=yellow relzero;
run;
quit;
```

Example 28: Specifying Midpoints in a Prism Map When Using Traditional Map Data

Features:

MAP= required argument referring to a traditional map data set

DATA= required argument referring to response data

ID statement

FORMAT statement

PRISM statement options
- MIDPOINTS=
- CDEFAULT=

SAS DATA step with assignment statements

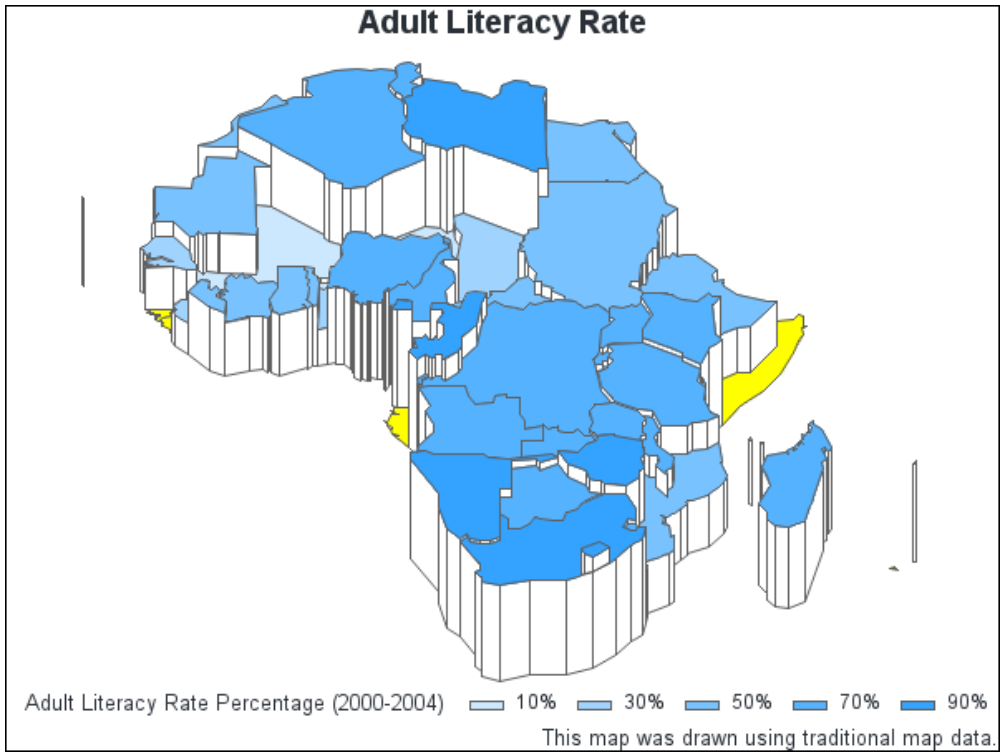
PERCENTN format

Data sets: MAPSSAS.AFRICA (map data set)
SASHELP.DEMOGRAPHICS (response data)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example specifies a set of midpoints that are used to create the response levels.



Program

```
goptions reset=all border;

title1 "Adult Literacy Rate";

data africa;
set mapssas.africa;
by id segment;
if first.id then lake=0;
if x=. then lake+1;
retain lake;
run;

proc gmap data=sashelp.demographics(where=(cont=94))
          map=africa(where=(lake=0)) density=low all;
```

```
   id id;
   format adultliteracypct percentn5.0;
   prism adultliteracypct / midpoints=.1 to .9 by .2
                            cdefault=yellow;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the map.

```
title1 "Adult Literacy Rate";
```

Identify lake regions in the map data set.

```
data africa;
set mapssas.africa;
by id segment;
if first.id then lake=0;
if x=. then lake+1;
retain lake;
run;
```

Produce the prism map. The ALL argument specifies that the map displayed should include all of the map areas from the map data set. This happens even if the response data set DEMOGRAPHICS does not include an observation for the map area. The map shows three such areas. The MIDPOINTS= option specifies the response levels for the map. The CDEFAULT= option sets the color of map areas that have missing data.

```
proc gmap data=sashelp.demographics(where=(cont=94))
          map=africa(where=(lake=0)) density=low all;
   id id;
   format adultliteracypct percentn5.0;
   prism adultliteracypct / midpoints=.1 to .9 by .2
                            cdefault=yellow;
run;
quit;
```

Example 29: Producing a Simple Surface Map Using Traditional Map Data

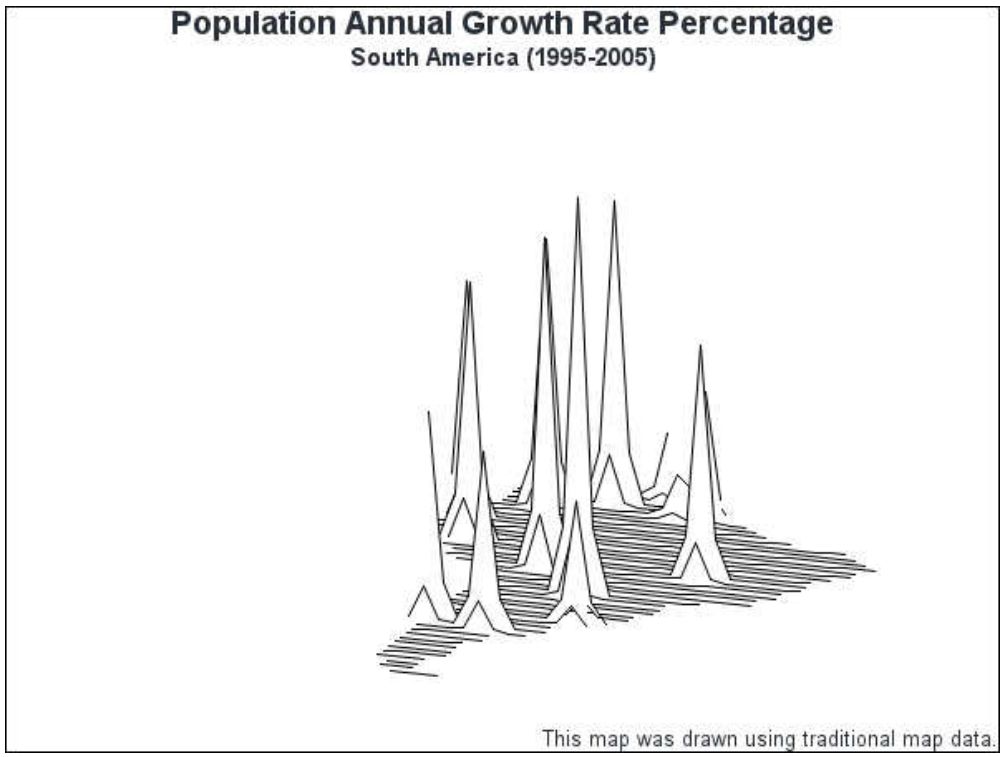
Features: MAP= required argument referring to a traditional map data set
DATA= required argument referring to response data
ID statement
SURFACE statement

Data sets: MAPSSAS.SAMERICA (map data set)
SASHELP.DEMOGRAPHICS (response data)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example produces a surface map that shows the annual population growth rate of countries in South America. Not all the countries that are represented in the traditional map data set have demographic data in the response data set. The CONSTANT= and NLINES= options are not used. Therefore, the GMAP procedure draws a surface that consists of 50 lines and uses the default decay function to calculate spike height and base width. And because the ROTATE= and TILT= options are not used, the map is rotated 70 degrees around the Z axis and tilted 70 degrees with respect to the X axis.



Program

```
goptions reset=all border;

title1 "Population Annual Growth Rate Percentage";
title2 "South America (1995-2005)";

proc gmap map=mapssas.samerica data=sashelp.demographics;
   id id;
```

```
   surface popagr;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the map.

```
title1 "Population Annual Growth Rate Percentage";
title2 "South America (1995-2005)";
```

Produce the surface map. The ID statement specifies the variable in the map data set and the response data set that defines the map areas.

```
proc gmap map=mapssas.samerica data=sashelp.demographics;
   id id;
   surface popagr;
run;
quit;
```

Example 30: Mapping an Individual Country By Subsetting MAPSSAS.WORLD

Features: OPTIONS statement
MAPS= required argument referring to a traditional map data set
DATA= required argument referring to response data
FORMAT statement
ID statement
CHORO statement option STAT=
SQL procedure

Data sets: MAPSSAS.WORLD (map data set)
MYDATA (table with a subsetted map data set)

Format: GLCNSM

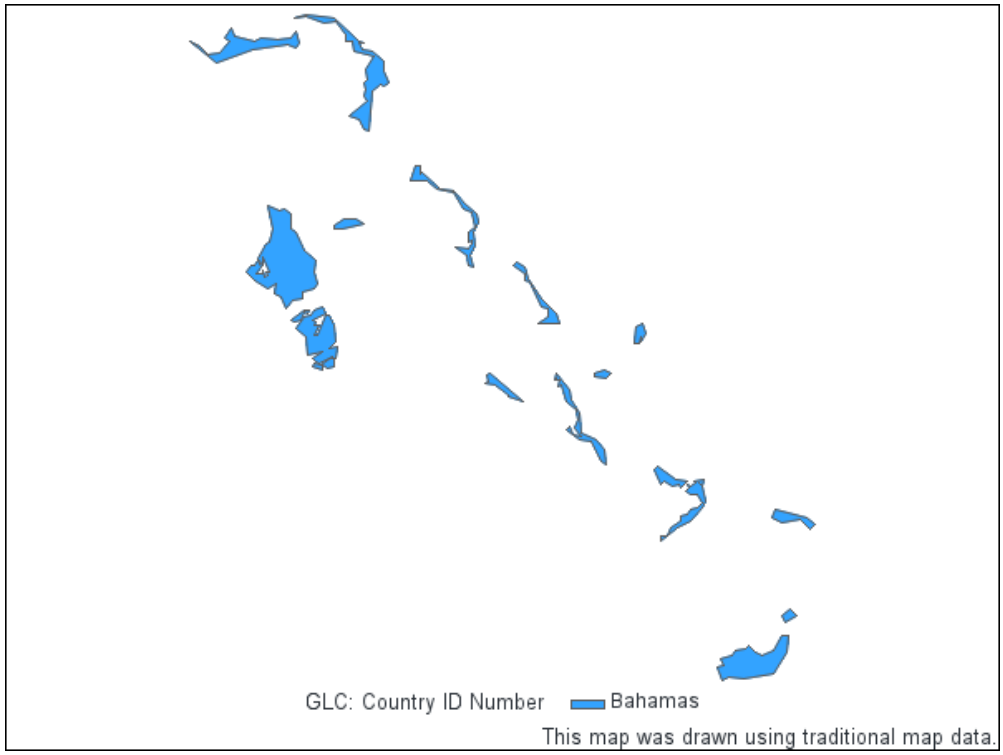
Notes: You can download the mapping samples in the SAS Sample Library in zipped format from the Documentation portion of the Base SAS Learn and Support page on support.sas.com and from the Documentation portion of the SAS/GRAPH Learn and Support page on support.sas.com.

The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

Output

This example shows how to subset a single country from the MAPSSAS.WORLD data set. This is useful for mapping smaller countries that do not have an individual map data set in the MAPS or MAPSSAS library.

This example also demonstrates how to use the GLCNSM. format to specify a country by name rather than by its ID value.



Program

```
goptions reset=all border device=png;

%let originalfmtsearch = %sysfunc(getoption(fmtsearch,keyword));
options insert=(fmtsearch=(sashelp.mapfmts));

proc sql;
 create table mymap as
 select * from mapssas.world
 where put(id,glcnsm.) eq "Bahamas"
 ;
 run;

proc gmap map=mymap data=mymap;
 format id glcnsm.;
 id id;
 choro id / stat=first;
run;
quit;
```

```
goptions reset=all;

options &originalfmtsearch;
```

Program Description

Set the graphics environment.

```
goptions reset=all border device=png;
```

Enable the formats from the SASHELP.MAPFMTS catalog.

```
%let originalfmtsearch = %sysfunc(getoption(fmtsearch,keyword));
options insert=(fmtsearch=(sashelp.mapfmts));
```

Subset the MAPSSAS.WORLD map data set for the Bahamas by using the SQL procedure and the geographic locator code format (GLCNSM).

```
proc sql;
 create table mymap as
 select * from mapssas.world
 where put(id,glcnsm.) eq "Bahamas"
 ;
 run;
```

Create the map by using the GMAP procedure. The STATISTIC= option specifies that the GMAP procedure is to match the first observation from the MYMAP data set and display the response value from this observation only.

```
proc gmap map=mymap data=mymap;
 format id glcnsm.;
 id id;
 choro id / stat=first;
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

Restore the original FMTSEARCH system option value.

```
options &originalfmtsearch;
```

14

GPROJECT Procedure

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Overview: GPROJECT Procedure

What Does the GPROJECT Procedure Do?

The GPROJECT procedure is available with Base SAS. The procedure is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this procedure.

The GPROJECT procedure processes map data sets by converting spherical coordinates (longitude and latitude) into Cartesian coordinates for use by the GMAP procedure in SAS/GRAPH, or the ODS Graphics SGMAP procedure in Base SAS. The process of converting coordinates from spherical to Cartesian is called projecting. All of the GfK and many of the traditional map data sets that are available with SAS/GRAPH contain unprojected longitude and latitude coordinates. When these coordinates are plotted by the GMAP procedure, the resulting map is often reversed and distorted as a result of forcing the spherical map coordinates onto a flat plane. That is because the GMAP procedure is designed to plot points on a two-dimensional plane.

The GPROJECT procedure enables you to use one of several map projection techniques to project the latitude and longitude coordinates onto a two-dimensional plane. It does this while attempting to minimize the distortion of area, distance, direction, and shape properties of the original sphere. The GPROJECT procedure does not produce any graphics output. Instead, it produces an output map data set. This output map data set contains Cartesian coordinates that can be used as the input map data set to the GMAP procedure in SAS/GRAPH, on page 303 or to the ODS Graphics SGMAP procedure in Base SAS on page 637. Either of these procedures display the projected map.

The GPROJECT procedure can also trim your map region by creating a rectangular subset of the input map data set. It does this by excluding all points with longitude and latitude values that fall outside of a specified range. This provides a simple way to reduce the size of the map data set if you need only a portion of a larger map.

Figure 14.40 on page 527 and Figure 14.41 on page 527 illustrate the effect of using GPROJECT defaults (Albers projection with standard parallels that are calculated by the procedure) to project a typical map data set with coordinates that are stored as longitude and latitude.

The program for the following maps can be seen in “Example 1: Using Default Projection Method” on page 552.

Figure 14.1 Map With Westlong Longitude Coordinates (GPJDEFLT(a))

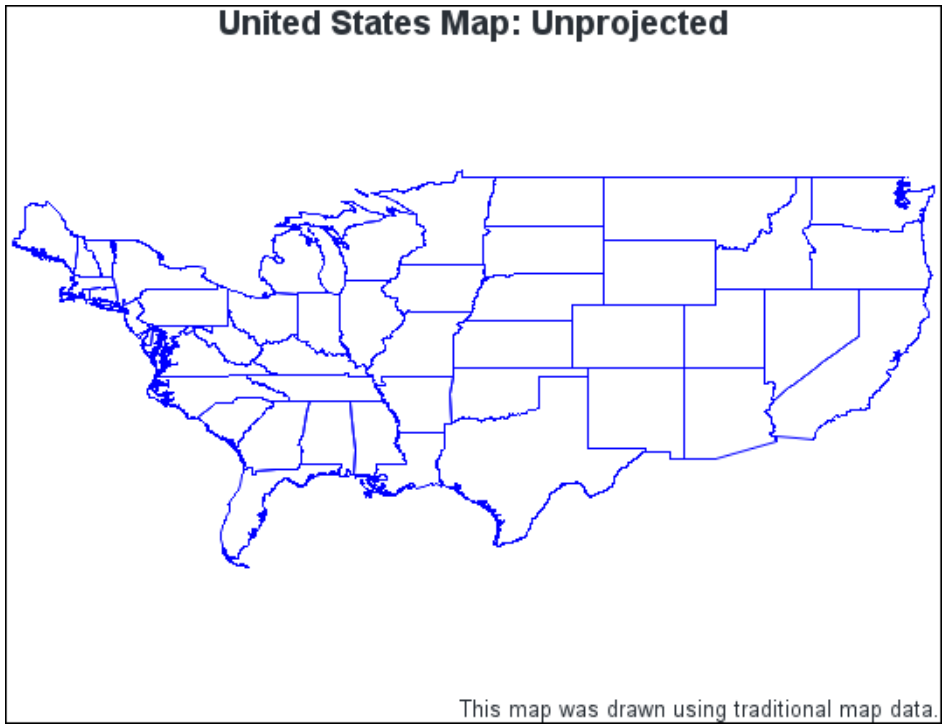
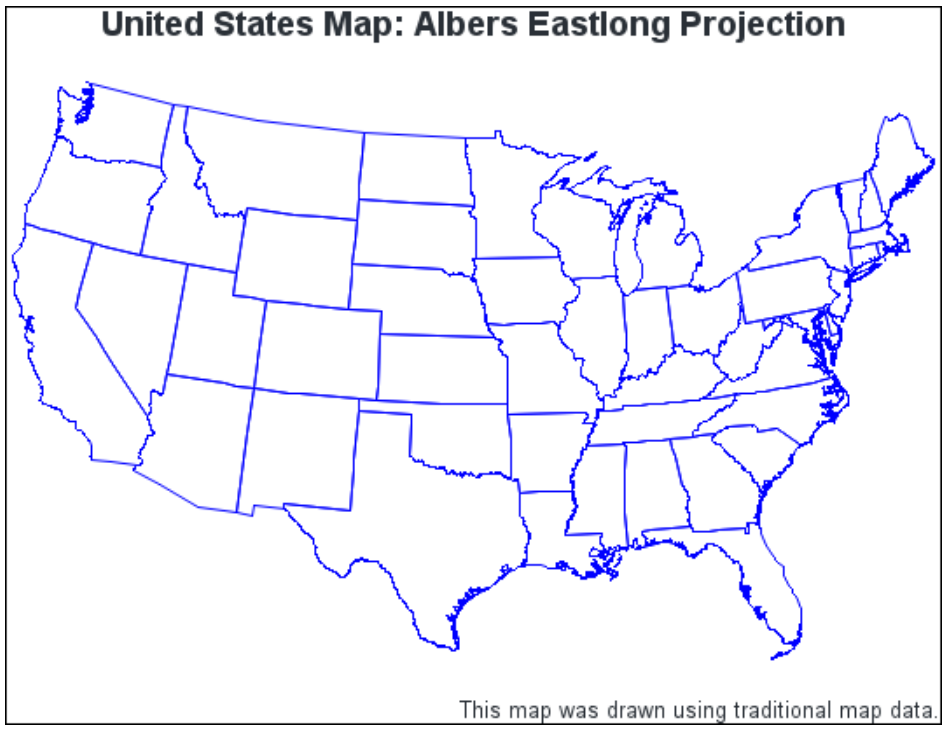


Figure 14.2 Map After Projection (GPJDEFLT(b))



To run this procedure, the various data sets and essential SAS software must be available in your installation. Storage restrictions apply to map data sets that are used with the SGMAP procedure's CHOROMAP or SERIES statement and to geocoding lookup data sets. Because the map data sets contain sequential

polygonal data, storing the mapping data on a distributed system such as aTeradata server, a SAS® LASR™ Analytic Server, or a SAS Cloud Analytic Services (CAS) server is not recommended. Data sequence cannot be guaranteed on distributed systems such as these, which can cause unexpected results. If the criterion is met, you can copy the procedure examples provided in this chapter into your program editor and run them to create the required output. Your IDE might provide additional resources for creating maps. Refer to the documentation for your IDE for more information.

Concepts: GPROJECT Procedure

About the Input Map Data Set

Input Map Data Set Variables

The input map data set must be in a SAS data set format (see "About Map Data Sets" on page 309), and it must contain these variables:

- a numeric variable named either X or LONG that contains the longitude coordinates of the map boundary points.
- a numeric variable named either Y or LAT that contains the latitude coordinates of the map boundary points.
- one or more identification variables that uniquely identify the unit areas in the map. These variables are listed in the ID statement.

The X or LONG and Y or LAT variables contain the values that are to be projected.

In addition, the input map data set can also contain these variables:

- a numeric variable named SEGMENT that distinguishes nonconterminous segments of the unit areas.
- a numeric variable named DENSITY that can be used to affect the output from PROC GPROJECT. See "Clipping Map Data Sets" on page 549 for more information.

Other variables in the input map data set do not affect the GPROJECT procedure.

Input Map Data Sets That Contain Only Unprojected Values

Here is a list of all of the data sets supplied by SAS that contain X and Y variables whose values are unprojected:

- CANADA3
- CANADA4
- COUNTIES
- COUNTY
- STATES

See "Example 1: Using Default Projection Method" on page 552 for an illustration of this type of input map data set and the variables that it contains.

Note: Projection is appropriate for map data sets in which the X and Y variable values represent longitude and latitude. Some of the map data sets that are supplied with SAS/GRAPH have already been projected; such data set should not be projected again.

Input Map Data Sets That Contain Both Projected and Unprojected Values

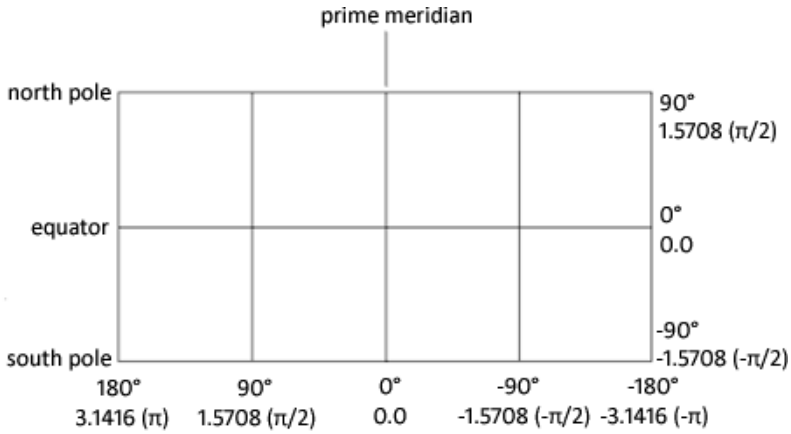
All GfK GeoMarketing and most traditional map data sets contain both sets of variables (X, Y, and LONG, LAT) for projected and unprojected maps. If X and Y variables in your map data set contain unprojected coordinates, PROC GPROJECT replaces these with projected values. If your data set contains LONG and LAT variables, you can use the LATLON option to project the data set. In this case PROC GPROJECT adds 2 variables (X and Y), containing the newly projected coordinates.

For additional information about the supplied SAS/GRAPH map data sets, see "About Map Data Sets" on page 309 and the METAMAPS data set in your maps data set directory.

About Coordinate Values

Figure 14.42 on page 530 shows the standard coordinate system for map data sets with coordinates in longitude and latitude. For the longitude and latitude values (below and to the right of the figure, respectively) the upper value is expressed in degrees and the lower value is expressed in radians. A radian is approximately 57.3 degrees.

Figure 14.3 Longitude and Latitude Coordinates



By default, for all projection methods except proj.4, the GPROJECT procedure assumes that the units for the input coordinate values are radians. Proj.4 expects, by default, that the LAT and LONG coordinate values are degrees. It also assumes that values for the horizontal coordinate increase from east to west across the map. If your map coordinates are stored as degrees of arc, use the DEGREE option in the PROC GPROJECT statement. If the horizontal coordinate values in the map increase west to east rather than east to west, use the EASTLONG option in the PROC GPROJECT statement.

The traditional unprojected map data sets that are provided with SAS/GRAPH can be projected if you use the default procedure characteristics: coordinate units in the data sets are radians, and horizontal values increase east to west. The MAPSGFK map data sets that are provided with SAS/GRAPH use degrees as the coordinate units, and horizontal values (longitude) increase from west to east.

About Types of Map Projections

Projection Types

The GPROJECT procedure performs four different types of projection:

- Albers' equal-area projection with two standard parallels (the default method)

  Note: The GPROJECT procedure occasionally uses a more optimal projection method than Albers when it knows that the resulting map to be displayed warrants it.

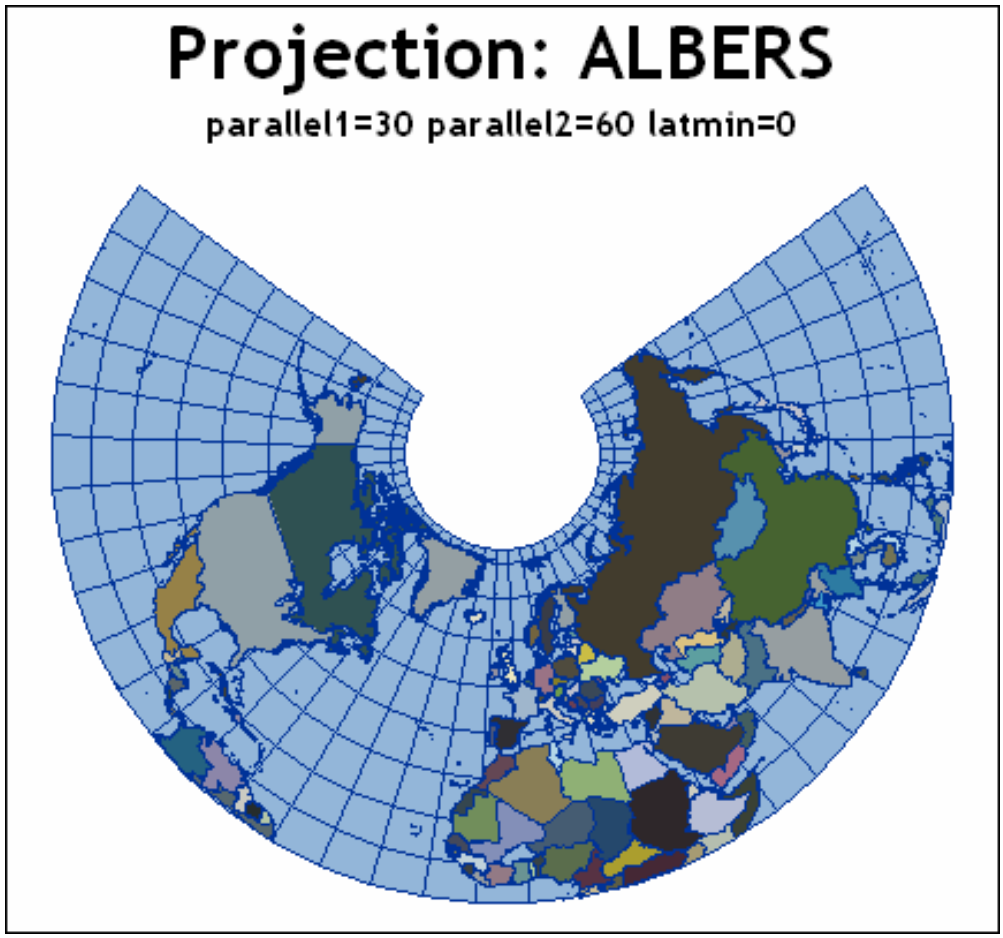
- Lambert's conformal projection with two standard parallels
- gnomonic projection (an azimuthal equidistant projection)

- proj.4 projection enables the transformation of geographic coordinates from one projection or datum to another projection or datum.

Keeping in mind that one radian is equivalent to 57.295 degrees, the X or LONG and Y or LAT variable values in a map data set help to indicate whether a projection method was used. View the PROJPARM data set to see all of the projection parameters used. MAPSGFK.PROJPARM is an example projection parameter data set found in the MAPSGFK library. One of those projection parameters, PROJ_NAME, contains the name of the projection method used per map data set.

Albers' Equal-Area Projection

Figure 14.4 *Albers' Projection*



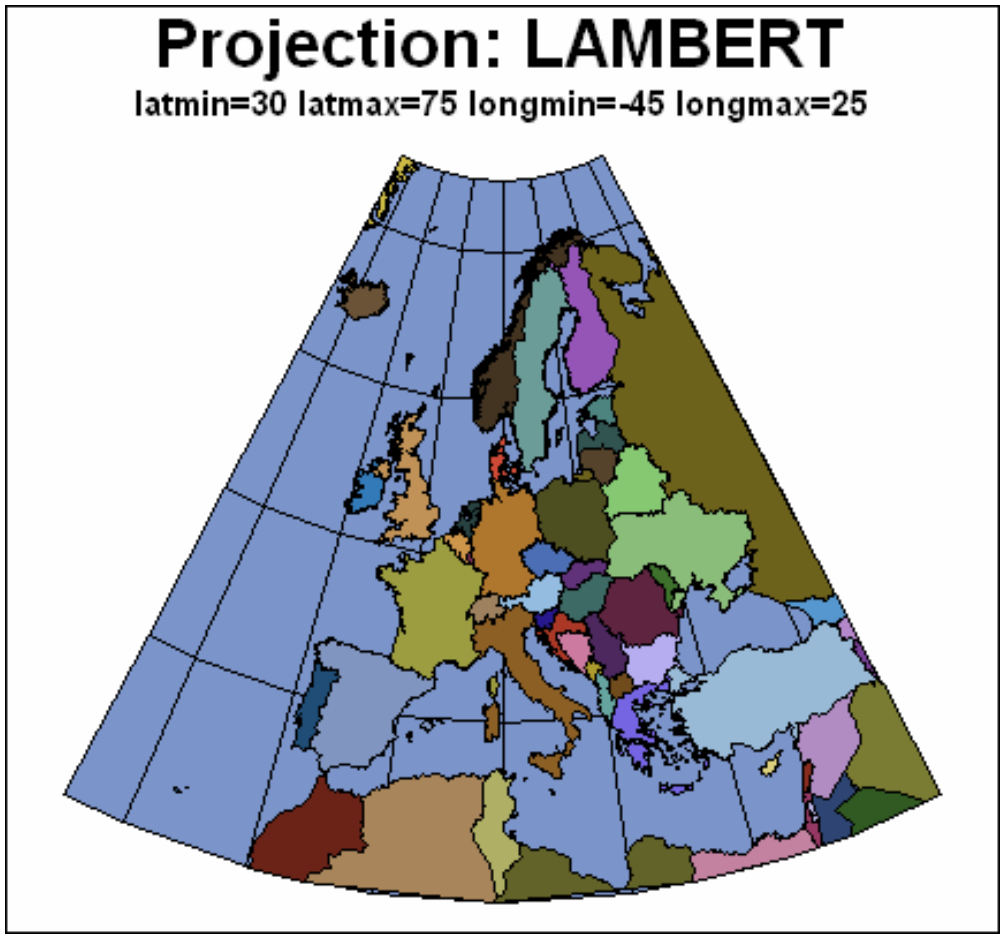
The Albers' projection is a conic projection from the surface of the sphere to a cone secant to the sphere, cutting it at two standard parallels of latitude. The axis of the cone coincides with an extension of the polar axis of the sphere. Each section of the resulting map bears a constant ratio to the area of the sphere. In general, distortion in shape tends to increase toward the poles in latitudes outside of the two standard parallels.

Figure 14.43 on page 531 illustrates an Albers' equal-area projection of the northern hemisphere.[1]

The Albers' projection is suitable for portraying large and small areas that extend east to west and produces satisfactory results in most cases. However, both standard parallels must lie on the same side of the equator, so this method might not be suitable for map data sets that extend north to south and span the equator. For those map data sets, use the gnomonic projection method.

Lambert's Conformal Projection

Figure 14.5 *Lambert's Projection*



The Lambert's projection is obtained from a secant cone in the same manner as Albers' projection. In the Lambert's projection, meridians of longitude are straight lines that radiate from the apex of the cone, whereas parallels of latitude are concentric circles. The Lambert's projection is somewhat better than the Albers'

1. The projection examples in this topic include grid lines that were added with the Annotate facility. See the Samples area at support.sas.com for an example of adding latitude and longitude lines to a map.

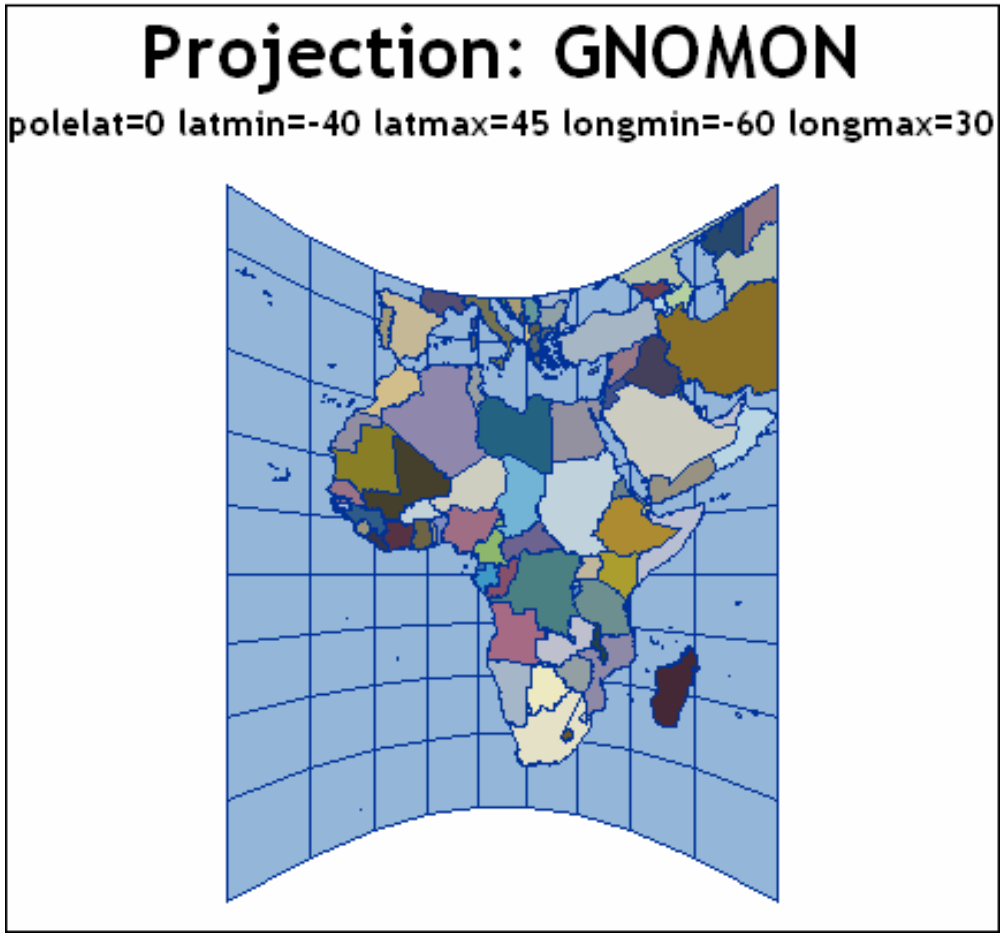
projection at representing the original shape of projected unit areas. The Albers' projection is somewhat better at representing relative sizes of projected unit areas.

Figure 14.44 on page 532 illustrates a Lambert's conformal projection of Europe.

The Lambert's projection is ideal for navigational charts and relatively small maps that extend east to west. However, as in the Albers' projection, both standard parallels must lie on the same side of the equator. As a result, this method might not be suitable for map data sets that span the equator. For those map data sets, use the gnomonic projection method.

Gnomonic Projection

Figure 14.6 *Gnomonic Projection*



The gnomonic projection is a planar projection from the surface of the sphere directly onto an imaginary plane tangent to the sphere at the map projection pole. By default, the projection pole is placed at the center of the map data set that is to be projected. However, you can specify the projection pole to be anywhere on the surface of the sphere. (See the options POLELAT=latitude and POLELONG=longitude on page 545.)

Figure 14.45 on page 533 illustrates a gnomonic projection of Africa.

In the gnomonic projection, distortion increases as the distance from the map pole increases. Because of this distortion, the PROC GPROJECT procedure deletes all of the observations that lie more than 85 degrees from the map pole. The gnomonic projection is most appropriate for mapping small areas that extend east to west.

Proj.4 Enables Conversion of Geographic Coordinates from One Projection or Datum to Another

The GPROJECT procedure can perform projections between any number of different projection types using the proj.4 system of projection strings. To do this specify PROJ4 on the PROJECT= option for the PROC GPROJECT statement. The proj.4 projection allows the transformation of geographic coordinates from one projection or datum to another projection or datum.

Proj.4 LAT and LONG to OSM (also known as Mercator or UTM) Projection, and Vice Versa

The proj.4 projection, by default, enables a transformation from latitude and longitude geographic coordinates (EPSG:4326) into a Web Mercator projection (EPSG:3857, sometimes known as EPSG:900913). This projection is used by the OpenStreetMap (OSM) coordinate system. The Web Mercator projection is also known as the Universal Transverse Mercator (UTM) coordinate system. Use the FROM or TO options on PROC GPROJECT to override either of these defaults. For example, if you have a Mercator projection, you can use these options to revert the projection to EPSG:4326. For more information see the options “FROM="*coordinate-system*"” on page 539 and “TO="*coordinate-system*"” on page 546.

The EPSG:4326, or LAT and LONG, is a common latitude and longitude coordinate reference system that is also referred to as the World Geodetic System 1984 (WGS84). The 900913, or Web Mercator, is a cylindrical projection that maps meridians and parallels straight and perpendicular. Google and OSM use Web Mercator in their maps system.

> **TIP** Make sure that all options begin with a plus sign "+".

Proj.4 Convert State Plane Coordinates to LAT and LONG Geographic Coordinates

Use the PROJ4 option of the GPROJECT procedure to convert state plane coordinates to latitude and longitude geographic coordinates (EPGS:4326), or World Geodetic System 1984 (WGS84). The map data sets provided by SAS use LAT and LONG coordinates. For example, convert North Carolina state plane

coordinates to EPGS:4326 latitude and longitude coordinates with the following code:

```
data hydroa;
  infile datalines dsd;
  input x y objectid;
datalines;
554997.7503,27578.50066,2282
;
proc gproject
    from="+proj=lcc +lat_1=34.33333333333334 +lat_2=36.16666666666666
    +lat_0=33.75 +lon_0=-79 +x_0=609601.22 +y_0=0 +ellps=GRS80
+datum=NAD83
    +units=m" to="EPGS:4326"
;
```

Search for "Proj.4" at https://spatialreference.org to find other examples of state plane proj.4 strings.

Tips When Using Proj.4

Proj.4 projection types are not to be used in conjunction with the Albers, gnomonic, and Lambert projection types. Proj.4 parameters are not stored in the PARMOUT= data set and cannot be retrieved using the PARMIN= option. Furthermore, the PARMENTRY and FROM= options are not compatible.

About Projection Parameters

Use projection parameters in the GPROJECT procedure. The PARMOUT= and PARMIN= options enable you to store and retrieve all but proj.4 projection parameters from a data set. By using projection parameters, you can project two data sets in exactly the same way (for example, to project annotation points and a map separately for an overlay effect).

Parameters data sets contain the following variables:

PROJ_MAP	identifies the map data set for the current observation.
PROJ_NAME	specifies the projection method
PROJ_OPTS	contains a space-delimited list of options.
PROJ_P1	specifies the value for the PARALLEL1 option.
PROJ_P2	specifies the value for the PARALLEL2 option.
PROJ_STDLAT	specifies the standard latitude for the equirectangular projection method.
PROJ_STDLONG	specifies the central meridian or standard longitude for the projection.
PROJ_XMIN	specifies the minimum X value for the projection.
PROJ_YMIN	specifies the minimum Y value for the projection.

Note: If any of the variable values are a missing value, then the values are calculated by the GPROJECT procedure.

Note: You can override the values of input projection parameters by specifying options in the PROC GPROJECT statement.

By default, the GPROJECT procedure automatically uses parameters from any data set named PROJPARM that is in the same library as the input data set. To disable input parameters, specify the NOPARMIN option.

Syntax: GPROJECT Procedure

Requirement: Exactly one ID statement is required.

PROC GPROJECT DATA=*input-map-data-set* <*options*>;
ID *id-variable(s)*;

PROC GPROJECT Statement

Identifies the input and output map data sets. Can specify the type of projection, and the criteria for clipping and projection.

Requirement: An input map data set is required.

Syntax

PROC GPROJECT DATA=*input-map-data-set* <*options*>;

Summary of Optional Arguments

DATELINE
: specifies that projections wrap from right to left at the international dateline.

DEGREES
: specifies that the units for the longitude (X variable) and latitude (Y variable) coordinates are degrees.

DUPOK

specifies that observations are retained when their projected X and Y values are identical to those in the previous observation.

EASTLONG
specifies that the longitude (X variable) values in the input map data set increase to the east.

FROM="*coordinate-system*"
invokes a proj.4 projection and specifies a coordinate system from which to start the projection.

LATLON
specifies that the LAT and LONG variables from the map data set are used for coordinate data instead of the Y and X variables.

LATMAX=*max-latitude*
specifies the maximum latitude that is included in the projection.

LATMIN=*min-latitude*
specifies the minimum latitude that is included in the projection.

LONGMAX=*max-longitude*
specifies the maximum longitude to be included in the projection.

LONGMIN=*min-longitude*
specifies the minimum longitude to be included in the projection.

MERIDIAN=*longitude-value*
specifies the longitude value in degrees for the center of the projection.

NODATELINE
enables contiguous projections for maps that cross the line between 180 degrees and -180 degrees longitude.

NODUP
specifies that observations are deleted when their projected X and Y values are identical to those in the previous observation.

NOPARMIN
specifies that parameters should not be used from the PROJPARM data set.

OUT=*output-map-data-set*
names the output map data set.

PARADIV=*n*
specifies the divisor that computes the values used for standard parallels for the Albers' or Lambert's projections when explicit values are not provided.

PARALLEL1=*latitude*
specifies the value for the standard latitude parallel that is used in the Albers' or Lambert's projection.

PARALLEL2=*latitude*
specifies the value for the standard latitude parallel that is used in the Albers' or Lambert's projection.

PARMENTRY=*entry-name*
specifies the entry in the projection parameters data set that is used for input parameters.

PARMIN=*data-set*
specifies a data set that contains input projection parameters.

PARMOUT=*data-set*

PARMOUT
: creates a data set that contains the projection parameters for the current PROC GPROJECT statement.

POLELAT=*latitude*

POLELONG=*longitude*
: each specifies a projection pole to use for the gnomonic projection.

PROJECT=ALBERS | LAMBERT | GNOMON | PROJ4 | NONE
: specifies the projection method to apply to the map data set.

RADIANS
: specifies that the units for the longitude (X variable) and latitude (Y variable) coordinates are radians.

TO="*coordinate-system*"
: invokes the proj.4 projection and specifies a coordinate system for the result of the transforming projection.

WESTLONG
: specifies that the longitude (X variable) values in the input map data set increase to the west.

Required Argument

DATA=*input-map-data-set*
: identifies the map data set that you want to process. If not specified, an input map data set must have been created before issuing the PROC GPROJECT statement.

Default
: The GPROJECT procedure uses the most recently created SAS data set.

Requirement
: This statement is required if no input map data set was created before issuing the PROC GPROJECT statement.

See
: "About the Input Map Data Set" on page 528

  "The SAS Data Set: Your Key to the SAS System" in *Step-by-Step Programming with Base SAS*

  "About Data Set Options" in *SAS Data Set Options: Reference*

Example
: "Example 4: Projecting an Annotate Data Set" on page 562

Optional Arguments

DATELINE
: specifies that projections wrap from right to left at the international dateline.

  This option does not alter the longitude values that are provided in the input data, and assumes that these values are in the –180- to 180-degree range.

Default
: The DATELINE option is in effect by default. You can use DATELINE to override the NODATELINE option from an input parameters file.

Interaction If you specified both DATELINE and NODATELINE, then the last option that you specified is used.

DEGREES
specifies that the units for the longitude (X variable) and latitude (Y variable) coordinates are degrees. The GPROJECT procedure stops processing the data set if coordinates are out of range.

Alias DEG

Default Coordinate units are considered to be radians unless this option is specified.

Interactions If you specify both DEGREES and RADIANS, then the last option that you specified is used.

The DEGREES option is used by default with the proj.4 projection method.

DUPOK
specifies that observations are retained when their projected X and Y values are identical to those in the previous observation. By default, successive identical observations are deleted.

Alias ASIS

Interaction If you specify both NODUP and DUPOK, then the last option that you specified is used.

Note This option is useful when you want to add annotation to a map that contains duplicate coordinates.

EASTLONG
specifies that the longitude (X variable) values in the input map data set increase to the east (that is, positive longitude values are east of the prime meridian.)

Alias EAST

Default Longitude values increase to the west unless this option is specified.

Interactions If you specify both EASTLONG and WESTLONG, then the last option that you specified is used.

The EASTLONG option is used by default with the proj.4 projection method.

FROM="*coordinate-system*"
invokes a proj.4 projection and specifies a coordinate system from which to start the projection. By default, the proj.4 projection enables a transformation from latitude and longitude geographic coordinates (EPSG:4326) to a Mercator (900913) coordinate system. You can use the FROM= option to specify a transformation from a coordinate system different from EPSG:4326.

Restriction When using a fully expanded string, avoid interjecting extraneous characters such as spaces or a carriage return (also known as line break).

Requirement Quotation marks are required when specifying *"coordinate-system"*. You can specify *"coordinate-system"* as a shortcut name or as a fully expanded string that the proj.4 projection mode understands. For example, use either of the following two equivalent specifications:

```
FROM="900913"

FROM="+proj=merc +a=6378137 +b=6378137 +lat_ts=0.0
+lon_0=0.0 +x_0=0.0 +y_0=0 +k=1.0 +units=m
+nadgrids=@null +wktext  +no_defs"
```

The data set SASHELP.PROJ4DEF contains the possible *"coordinate-system"* values. Values from the EPSG, ESRI, and Mercator systems are included. Specifically, this data set contains shortcut names, the proj.4 strings that the shortcuts are translated into, and a short description of each coordinate-system. To view this data set, run the following code:

```
proc print data=sashelp.proj4def;
run;
```

Interaction Specify both the FROM= and TO= options to reverse a projection. For example, if you already have a Mercator projection, you can use the FROM= option in conjunction with the TO= option to revert the projection to EPSG:4326. You can also use the TO= option to specify a transformation to a coordinate system different from Mercator.

Note The Mercator coordinate system is used by Google and OpenStreetMap (OSM) in their maps.

See "TO="*coordinate-system*"" on page 546

LATLON

specifies that the LAT and LONG variables from the map data set are used for coordinate data instead of the Y and X variables. The LAT and LONG variables represent the unprojected latitude and longitude coordinates, respectively. All GfK GeoMarketing and most traditional map data sets contain both sets of variables (Y, X, and LAT, LONG) for projected and unprojected maps. By default, the Y and X variables are used to produce a projected map. However, when LATLON is specified, the Y and X variables are no longer required by the GPROJECT procedure statement.

Alias LATLONG

Example "Example 4: Projecting an Annotate Data Set" on page 562

LATMAX=*max-latitude*

specifies the maximum latitude that is included in the projection. Any unit areas that cross the selected latitude are clipped and closed along the specified

parallels. The LATMAX= and LATMIN= options do not have to be paired; you can specify a maximum latitude without specifying a minimum.

When PROJECT=ALBERS, LAMBERT, GNOMON, or PROJ4, the GPROJECT procedure treats the value of *max-latitude* as degrees. When PROJECT=NONE, the procedure treats the value as a Cartesian coordinate.

Example "Example 3: Clipping an Area from the Map" on page 559

LATMIN=*min-latitude*
specifies the minimum latitude that is included in the projection. Any unit areas that cross the selected latitude are clipped and closed along the specified parallels. The LATMAX= and LATMIN= options do not have to be paired; you can specify a minimum latitude without specifying a maximum.

When PROJECT=ALBERS, LAMBERT, GNOMON, or PROJ4, the GPROJECT procedure treats the value of *min-latitude* as degrees. When PROJECT=NONE, the procedure treats the value as a Cartesian coordinate.

Example "Example 3: Clipping an Area from the Map" on page 559

LONGMAX=*max-longitude*
specifies the maximum longitude to be included in the projection. Any unit areas that cross the selected longitude are clipped and closed along the specified meridians. The LATMAX= and LATMIN= options do not have to be paired; you can specify a maximum longitude without specifying a minimum.

When PROJECT=ALBERS, LAMBERT, GNOMON, or PROJ4, the GPROJECT procedure treats the value of *max-longitude* as degrees. When PROJECT=NONE, the procedure treats the value as a Cartesian coordinate.

Example "Example 3: Clipping an Area from the Map" on page 559

LONGMIN=*min-longitude*
specifies the minimum longitude to be included in the projection. Any unit areas that cross the selected longitude are clipped and closed along the specified meridians. The LATMAX= and LATMIN= options do not have to be paired; you can specify a minimum longitude without specifying a maximum.

When PROJECT=ALBERS, LAMBERT, GNOMON, or PROJ4, the GPROJECT procedure treats the value of *min-longitude* as degrees. When PROJECT=NONE, the procedure treats the value as a Cartesian coordinate.

Example "Example 3: Clipping an Area from the Map" on page 559

MERIDIAN=*longitude-value*
specifies the longitude value in degrees for the center of the projection. By default, the meridian value is the center of the map area or clip region.

Note: MERIDIAN= is functionally equivalent to POLELONG=.

NODATELINE
enables contiguous projections for maps that cross the line between 180 degrees and -180 degrees longitude.

This option assumes that the longitude values that are provided in the input data are in the range of –180 to 180 degrees. The NODATELINE option adjusts the longitude values to a range of 0 to 360 degrees by adding 360 degrees to any value less than 0 degrees.

For example, if you project a map of Asia, then the eastern tip of the continent might be projected on the left side of the map by default. The NODATELINE option enables the entire continent to be projected as a contiguous area.

Restriction Before using this option with a map region that crosses the prime meridian—a longitudinal line of 0 degrees—you must adjust the data in your input map data set. Divide the region up into polygons drawn on either side of the prime meridian. Otherwise, the GMAP or the SGMAP procedure, when using as input the projected output map data set, produces a map with an inaccurate, distorted appearance.

Interaction If you specified both DATELINE and NODATELINE, then the last option that you specified is used.

NODUP
specifies that observations are deleted when their projected X and Y values are identical to those in the previous observation.

Note: The NODUP option is in effect by default. You can use NODUP to override the DUPOK option from an input parameters file.

Alias NOASIS

Interaction If you specify both NODUP and DUPOK, then the last option that you specified is used.

NOPARMIN
specifies that parameters should not be used from the PROJPARM data set. By default, the GPROJECT procedure reads input parameters from the PROJPARM data set of the library that contains the input data set.

OUT=*output-map-data-set*
names the output map data set, which contains the coordinates of the new unit areas that are created by the GPROJECT procedure.

By default, the GPROJECT procedure names the new data set that uses the DATA*n* naming convention. That is, the procedure uses the name WORK.DATA*n*, where *n* is the next unused number in sequence. Thus, the first automatically named data set is DATA1, the second is DATA2, and so on.

Example "Example 4: Projecting an Annotate Data Set" on page 562

PARADIV=*n*
specifies the divisor that computes the values used for standard parallels for the Albers' or Lambert's projections when explicit values are not provided. By default PARADIV=4, which causes the standard parallels to be set at 1/4 and 3/4 of the range of latitude values in the input map data set.

See "PARALLEL1=*latitude*" on page 543

PARALLEL1=*latitude*
specifies the value for the standard latitude parallel that is used in the Albers' or Lambert's projection. *Latitude* must be in degrees. A positive value indicates north of the equator, and a negative value indicates south of the equator. This option is ignored for the gnomonic projection.

By default, the GPROJECT procedure calculates values for the standard parallels. The defaults are chosen to minimize the distortion inherent in the projection process. The algorithm used is as follows:

PARALLEL1 = minlat + R / P_D

where:

R
is the range of latitude values in the input map data set.

P_D
is the PARADIV= value. (See the discussion of the "PARADIV=*n*" on page 542 option.)

minlat
is the minimum latitude value in the input map data set.

Alias PARALEL1

Restriction The standard parallels, whether explicitly specified by the PARALLEL1= option and the PARALLEL2= option, or supplied by the procedure, must lie on the same side of the equator. If they do not, PROC GPROJECT prints an error message and stops. Otherwise, the procedure might calculate standard parallels that lie on opposite sides of the equator. There might be cases where you are projecting a map data set that contains unit areas that cross the equator. You might have to explicitly specify standard parallels that both lie on the same side of the equator. If this causes excessive distortion of the map, you might be able to use the gnomonic projection instead of the Albers' or Lambert's projection. This is because the gnomonic technique has no such limitations at the equator.

Interactions If you do not use the PARALLEL1= option, or you omit it, the GPROJECT procedure uses the calculated value for the missing parameter.

Use the PARALLEL1= option in conjunction with the PARALLEL2= option.

PARALLEL2=*latitude*
specifies the value for the standard latitude parallel that is used in the Albers' or Lambert's projection. *Latitude* must be in degrees. A positive value indicates north of the equator, and a negative value indicates south of the equator. This option is ignored for the gnomonic projection.

By default, the GPROJECT procedure calculates values for the standard parallels. The defaults are chosen to minimize the distortion inherent in the projection process. The algorithm used is as follows:

PARALLEL2= maxlat - R / P_D

where:

R
is the range of latitude values in the input map data set.

P_D
is the PARADIV= value. (See the discussion of the "PARADIV=*n*" on page 542 option.)

maxlat
is the maximum latitude value in the input map data set.

Alias PARALEL2

Restriction The standard parallels, whether explicitly specified by the PARALLEL1= option and the PARALLEL2= option, or supplied by the procedure, must lie on the same side of the equator. If they do not, PROC GPROJECT prints an error message and stops. Otherwise (the procedure might calculate standard parallels that lie on opposite sides of the equator. There might be cases where you are projecting a map data set that contains unit areas that cross the equator. You might have to explicitly specify standard parallels that both lie on the same side of the equator. If this causes excessive distortion of the map, you might be able to use the gnomonic projection instead of the Albers' or Lambert's projection. This is because the gnomonic technique has no such limitations at the equator.

Interactions If you do not use the PARALLEL2= option, or you omit it, the GPROJECT procedure uses the calculated value for the missing parameter.

Use the PARALLEL2= option in conjunction with the PARALLEL1= option.

PARMIN=*data-set*
specifies a data set that contains input projection parameters.

Alias PIN

Default The PROJPARM data set of the library that contains the input data set.

Restriction PARMIN= is not compatible with the proj.4 projection type.

PARMOUT=*data-set*
PARMOUT
creates a data set that contains the projection parameters for the current PROC GPROJECT statement. If you specify a data set, then the parameters are

created in that data set. If you do not specify a data set, then the parameters are created in PROJPARM data set of the library that contains the output data set.

Alias POUT

Restriction PARMOUT= is not compatible with the proj.4 projection type.

PARMENTRY=*entry-name*
specifies the entry in the projection parameters data set that is used for input parameters. By default, the entry with the same name as the input data set is used. For example, if you specify `data=MYMAPS.MAP5`, then the GPROJECT procedure uses parameters from an entry named MAP5 in the parameters data set.

Alias PENTRY

Restriction PARMENTRY is not compatible with the proj.4 projection type.

POLELAT=*latitude*
POLELONG=*longitude*
each specifies a projection pole to use for the gnomonic projection. The projection pole is the point at which the surface of the sphere touches the surface of the imaginary plane onto which the map is projected. The POLELAT= option specifies the latitude of the projection point.

Units for latitude are degrees; positive values indicate north of the equator, and negative values indicate south of the equator. The POLELONG= option gives the longitude for the projection point. Units for longitude are degrees; positive values indicate west of the prime meridian, and negative values indicate east of the prime meridian. This is true unless EASTLONG also has been used in the PROC GPROJECT statement.

You might choose not to use the POLELAT= or POLELONG= option, or you might omit either option. In these cases, PROC GPROJECT uses values for the position of the center of the unit areas that are defined by the DATA= data set for the missing parameter.

Note The map that is defined by the input map data set should not contain points more than 85 degrees (1.48353 radians) from the projection pole; all points that exceed this value are deleted from the output map data set.

Example "Example 2: Emphasizing Map Areas" on page 557

PROJECT=ALBERS | LAMBERT | GNOMON | PROJ4 | NONE
specifies the projection method to apply to the map data set. Values for the PROJECT= option are as follows:

ALBERS
specifies Albers' equal-area projection with two standard parallels.

LAMBERT
specifies Lambert's conformal projection with two standard parallels.

GNOMON
specifies the gnomonic projection, which is an azimuthal projection.

PROJ4
specifies a transformation projection, the default being from EPSG:4386 (LAT and LONG) to 900913 (Mercator) coordinate system. These defaults can be overridden with the FROM= and TO= options.

Default The DEGREES and EASTLONG options are enabled with the proj.4 projection method.

Restriction The options available with the Proj.4 projection type are not compatible with options from the other projection types (Albers, gnomonic, and Lambert).

See "TO="*coordinate-system*"" on page 546

"FROM="*coordinate-system*"" on page 539

NONE
specifies that no projection should be performed. Use this option in conjunction with the LATMIN=, LATMAX=, LONGMIN=, and LONGMAX= options to perform clipping without projection.

By default, PROJECT=ALBERS.

Note There are several additional projections available. These projections are experimental and are not supported by SAS Technical Support. The experimental projections are: ADAMS, AITOFF, APIANUS, ARAGO, BEHRMANN, BRAUN, CYLINDRI, ECKERT1, ECKERT3, ECKERT5, EQUIRECT or MARINUS, GALL, HAMMER, KVRSKY7, MERCAT(OR), MILLER1, MILLER2, ORTHO, PARABOLI, PETERS, PUTNINS4, ROBINSON, STEREO, WINKEL2.

See "About Types of Map Projections" on page 530

Example "Example 2: Emphasizing Map Areas" on page 557

RADIANS
specifies that the units for the longitude (X variable) and latitude (Y variable) coordinates are radians.

Note: The RADIANS option is in effect by default. You can use RADIANS to override the DEGREES option from an input parameters file.

Alias NODEG

Interaction If you specify both RADIANS and DEGREES, then the last option that you specified is used.

TO="*coordinate-system*"
invokes the proj.4 projection and specifies a coordinate system for the result of the transforming projection. By default, the proj.4 projection enables a transformation from latitude and longitude geographic coordinates (EPSG:4326) to a Mercator (900913) coordinate system. You can use the TO=

option to specify a transformation to a coordinate system different from Mercator.

Restriction When using a fully expanded string, avoid interjecting extraneous characters such as spaces or carriage return (also known as line break) symbols.

Requirement Quotation marks are required when specifying *"coordinate-system"*. You can specify *"coordinate-system"* as a shortcut name or as a fully expanded string that the proj.4 projection mode understands. For example, use either of the following two equivalent specifications:

```
TO="EPSG:4326"

TO="+proj=longlat +datum=WGS84 +no_defs"
```

The data set SASHELP.PROJ4DEF contains the possible *"coordinate-system"* values. Values from the EPSG, ESRI, and Mercator systems are included. Specifically, this data set contains shortcut names, the proj.4 strings that the shortcuts are translated into, and a short description of each coordinate-system. To view this data set, run the following code:

```
proc print data=sashelp.proj4def;
run;
```

Interaction Specify both the FROM= and TO= options to reverse a projection. For example, if you already have a Mercator projection, you can use the TO= option in conjunction with the FROM= option to revert the projection to EPSG:4326. You can also use the FROM= option to specify a transformation from a coordinate system different from EPSG:4326.

Note The Mercator coordinate system is used by Google and OpenStreetMap (OSM) in their maps.

See "FROM="coordinate-system"" on page 539

WESTLONG

specifies that the longitude (X variable) values in the input map data set increase to the west (that is, positive longitude values are west of the prime meridian.)

Note: The WESTLONG option is in effect by default. You can use WESTLONG to override the EASTLONG option from an input parameters file.

Alias WEST

Interaction If you specify both WESTLONG and EASTLONG, then the last option that you specified is used.

ID Statement

Identifies the variable or variables that define the hierarchy of the current unit areas in the input map data set.

See: "Example 1: Using Default Projection Method" on page 552

Syntax

ID <*id-variable(s)*>;

Optional Argument

id-variable(s)
specifies one or more variables in the input map data set that identify unit areas. *Id-variable* can be either numeric or character.

Each group of observations with a different ID variable value is evaluated as a separate unit area.

Details

TIP You can use the ID statement without specifying an ID variable to project non-polygonal data (for example, annotation points.)

Usage: GPROJECT Procedure

About the GPROJECT Procedure

You can use PROC GPROJECT statement options to do the following actions:

- select the map projection method
- specify the map projection criteria

- create a rectangular subset of the input map data set

The following sections describe how you can use PROC GPROJECT statement options to select your own projection method and projection criteria.

Selecting Projections

Except when projecting map data sets that cover large areas, all three types of projections (Albers', Lambert's, and gnomonic) produce relatively similar results when you use default projection criteria. Therefore, you usually do not need to be concerned about which projection method to use when you produce maps of small regions.

However, the default projection criteria might be unsuitable in some circumstances. In particular, the default specifications fail when the map that is being projected extends on both sides of the equator. On other occasions, you might want to select a projection method to achieve a particular effect.

For the Albers' and Lambert's projections, the two standard parallels must both lie on the same side of the equator. PROC GPROJECT stops and gives an error message if this condition is not met, regardless of whether you explicitly specify parallel values or let the procedure calculate default values. See the descriptions of the PARALLEL1= and PARALLEL2= options on page 543 for more information about how to specify the two standard parallels.

Controlling Projection Criteria

For both the Albers' and Lambert's projections, PROC GPROJECT calculates appropriate standard parallels. You can override either or both of these selections if you explicitly specify values for the PARALLEL1= or PARALLEL2= option. You can influence the selection of default parallels if you use the PARADIV= option.

For the gnomonic projection, PROC GPROJECT determines the longitude and latitude of the approximate center of the input map data set area. You can override either or both of these selections if you explicitly specify values for the POLELAT= or POLELONG= option.

The clipping options, discussed in "Clipping Map Data Sets" on page 549, can also influence the calculations of the default standard parallels by changing the minimum and maximum coordinate values.

Clipping Map Data Sets

The GPROJECT procedure can create rectangular subsets of the input map data set. This capability provides a way to extract a portion of a larger map if you do not need all the original unit areas for your graph. The procedure enables you to clip

unit area boundaries at specified latitude values, longitude values, or both. Unit areas that fall completely outside of the specified clipping limits are excluded from the output map data set. Unit areas bisected by the clipping limits are closed along the clipping parallels and meridians, and all points outside of the clipping limits are excluded.

If the input map data set contains the DENSITY variable, any new vertex points and corners that are created by PROC GPROJECT are assigned a DENSITY value of 0 in the output map data set. This enables you to use a subset of the clipped map without using PROC GREDUCE to assign new DENSITY values. (See Chapter 15, "GREDUCE Procedure," on page 581 for information about how to reduce the number of points that you need to draw a map.)

You can specify the minimum latitude to be retained in the output map data set with the LATMIN= option and the maximum latitude with LATMAX= option. Minimum and maximum longitude values are specified with the LONGMIN= and LONGMAX= options, respectively.

This is how the PROC GPROJECT interprets the clipping longitude and latitude values:

- If you specify PROJECT=NONE in the PROC GPROJECT statement, the procedure assumes that the input map data set is already projected and the clipping longitude and latitude values are Cartesian coordinates. In this case, the LATMAX= and LATMIN= options specify the top and bottom edges, respectively, of the area that you want to extract, and the LONGMAX= and LONGMIN= options specify right and left edges, respectively.

  You must be familiar with the range of values in the X and Y variables in order to select appropriate clipping limits. Use the MEANS or SUMMARY procedure in Base SAS to determine the range of values in X and Y. See the *Base SAS Procedures Guide* for more information.

- In all other projections, the clipping values are treated as degrees.

Depending on the size and position of the clipped area and the type of projection that is performed, the resulting map might not be exactly rectangular. PROC GPROJECT performs clipping before projection, so the clipped area might be distorted by the projection process.

To produce a clipped area with a rectangular shape, use PROC GPROJECT in two steps:

1. Project the map using the appropriate projection method and projection criteria.
2. Project the map using PROJECT=NONE, and use the LATMIN=, LATMAX=, LONGMIN=, and LONGMAX= options to clip the map.

See "Example 3: Clipping an Area from the Map" on page 559, for an example of clipping an area from an unprojected map data set.

Examples: GPROJECT Procedure

About the GPROJECT Procedure Examples

Examples in This Section

This section provides basic examples of how to use the GPROJECT procedure. The following tables list the examples that are provided for GfK map data and for traditional map data.

Table 14.1 *GPROJECT Procedure GfK GeoMarketing Map Data Examples*

Example	Description
Using Default Projection Method (p. 552)	Shows the effect of using the GPROJECT procedure on an unprojected map data set without specifying a projection method.
Emphasizing Map Areas (p. 557)	Shows how to use the gnomonic projection method to create a map in which the east coast of the United States appears disproportionately large compared to the west coast.
Clipping an Area from the Map (p. 559)	Shows how to use the clipping capabilities of the GPROJECT procedure to create a map of the states in the United States that border the Gulf of Mexico.
Projecting an Annotate Data Set (p. 562)	Shows how to project an Annotate data set for use with a map data set.

Table 14.2 *GPROJECT Procedure Traditional Map Data Examples*

Example	Description
Using Default Projection Specifications with Traditional Map Data (p. 566)	Shows the effect of using the GPROJECT procedure on an unprojected traditional map data set without specifying a projection method.
Emphasizing Map Areas Using Traditional Map Data (p. 570)	Shows how to use the gnomonic projection method to create a map in which the east coast of the United States appears disproportionately large compared to the west coast.
Clipping an Area from the Map Using Traditional Map Data (p. 573)	Shows how to use the clipping capabilities of the GPROJECT procedure to create a map of the states in the United States that border the Gulf of Mexico.
Projecting an Annotate Data Set Using Traditional Map Data (p. 575)	Shows how to project an Annotate data set for use with a map data set.

Examples Available Online

You can find more examples on the Graphically Speaking blog. On the blog page, use **Search Graphically Speaking** to search for GPROJECT to find the GPROJECT procedure examples.

Example 1: Using Default Projection Method

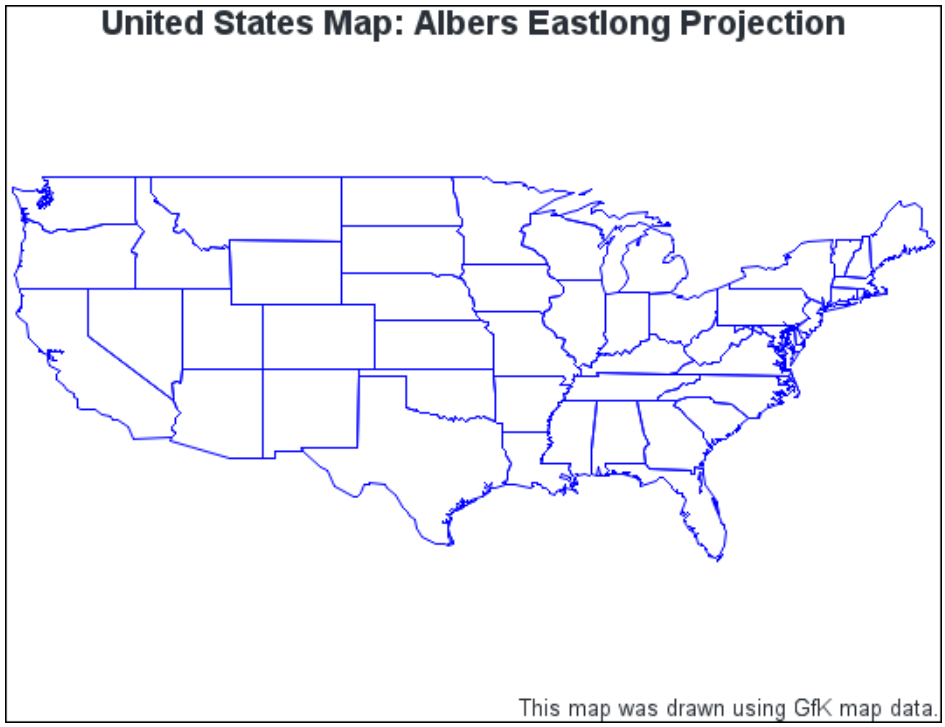
Features: PROC GPROJECT options
DATA= required argument
OUT= optional argument
ID statement
PATTERN statement
DATA step
PROC GMAP statement
CHORO statement

Data sets: MAPSGFK.US_STATES (input map data set for DATA step)
WORK.US48UNPROJ (input map data set of unprojected data)
WORK.US48PROJ (input map data set and map data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example demonstrates the effect of using PROC GPROJECT on an unprojected map data set without specifying a projection method. Because the PROJECT= option is not used in the PROC GPROJECT statement, the Albers' equal-area projection method is used by default. PROC GPROJECT supplies defaults for the standard parallels that minimize the distortion of the projected map areas. The GPROJECT procedure also supplies default RADIANS, WESTLONG, X, and Y coordinate values. In this example, unprojected data from MAPSGFK.US_STATES is used, which is Eastlong longitude coordinates in degrees. Options EASTLONG and DEGREES are used in the PROC GPROJECT statement.

Output 14.1 *Unprojected Map with Eastlong Longitude Coordinates*



Output 14.16 on page 553 illustrates the output produced by the US48UNPROJ map data set, which contains unprojected values in the X and Y variables. The X values are measured in eastlong degrees. In GfK map data sets, the unprojected longitude (LONG) coordinate values are also measured in eastlong degrees. Using the GPROJECT procedure with GfK values without the EASTLONG option results in a United States map with the east coast on the left side. Without the DEGREES option, an error results because the GPROJECT procedure expects radians by default. Output 14.17 on page 554 shows the variables in the data set.

Output 14.2 *Partial Listing of Data Set WORK.US48UNPROJ*

Obs	ID	SEGMENT	STATE	STATECODE	x	y	ISO	ISOALPHA2	RESOLUTION	DENSITY	LAKE
1	US-01	1	1	AL	-85.605	34.985	840	US	1	0	0
2	US-01	1	1	AL	-85.184	32.861	840	US	2	3	0
3	US-01	1	1	AL	-85.156	32.851	840	US	9	6	0
4	US-01	1	1	AL	-85.168	32.812	840	US	9	6	0
5	US-01	1	1	AL	-85.122	32.774	840	US	7	5	0
6	US-01	1	1	AL	-85.143	32.760	840	US	7	5	0
7	US-01	1	1	AL	-85.113	32.736	840	US	8	5	0
8	US-01	1	1	AL	-85.117	32.692	840	US	9	6	0
9	US-01	1	1	AL	-85.088	32.658	840	US	9	6	0
10	US-01	1	1	AL	-85.105	32.641	840	US	7	5	0
11	US-01	1	1	AL	-85.083	32.636	840	US	9	6	0
12	US-01	1	1	AL	-85.068	32.580	840	US	9	6	0
13	US-01	1	1	AL	-85.007	32.524	840	US	8	6	0

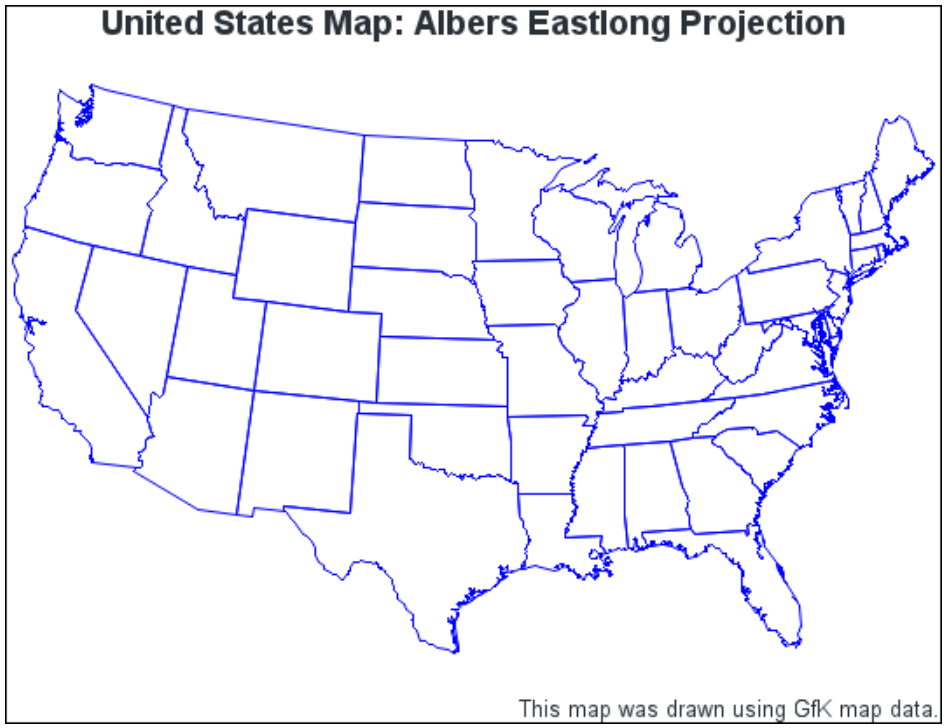
The GPROJECT procedure is used with the US48UNPROJ map data set as input to create the projected map data set, US48PROJ. The values for X and Y in this new data set are projected (Cartesian). Output 14.18 on page 554 shows the variables in the data set.

Output 14.3 *Partial Listing of Data Set WORK.US48PROJ (Projected Data)*

Obs	x	y	DENSITY	RESOLUTION	ID	SEGMENT	STATE	STATECODE	ISO	ISOALPHA2	LAKE
1	0.145	-0.027	0	1	US-01	1	1	AL	840	US	0
2	0.155	-0.063	3	2	US-01	1	1	AL	840	US	0
3	0.156	-0.064	6	9	US-01	1	1	AL	840	US	0
4	0.156	-0.064	6	9	US-01	1	1	AL	840	US	0
5	0.157	-0.065	5	7	US-01	1	1	AL	840	US	0
6	0.156	-0.065	5	7	US-01	1	1	AL	840	US	0
7	0.157	-0.066	5	8	US-01	1	1	AL	840	US	0
8	0.157	-0.066	6	9	US-01	1	1	AL	840	US	0
9	0.157	-0.067	6	9	US-01	1	1	AL	840	US	0
10	0.157	-0.067	5	7	US-01	1	1	AL	840	US	0
11	0.157	-0.067	6	9	US-01	1	1	AL	840	US	0
12	0.158	-0.068	6	9	US-01	1	1	AL	840	US	0
13	0.159	-0.069	6	8	US-01	1	1	AL	840	US	0

The new projected map data set, US48PROJ, is used to create the projected map, Output 14.19 on page 555.

Output 14.4 *Map after Projection*



Program

```
data us48unproj;
   set mapsgfk.us_states;
   if state not in (2 15 72);
   drop x y;
   rename long=x lat=y;
run;

title "United States Map: Unprojected";

pattern value=mempty color=blue;

proc gmap map=us48unproj data=us48unproj all;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;


proc gproject data=us48unproj out=us48proj degrees eastlong;
   id state;
run;

title "United States Map: Albers Eastlong Projection";
proc gmap map=us48proj data=us48proj all density=4;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;
```

Program Description

Create a reduced continental U.S. map data set and remove Alaska, Hawaii, and Puerto Rico. Because the projected values are not needed, drop variables X and Y, and then rename variables LONG and LAT to X and Y, respectively.

```
data us48unproj;
   set mapsgfk.us_states;
   if state not in (2 15 72);
   drop x y;
   rename long=x lat=y;
run;
```

Define the title for the unprojected map.

```
title "United States Map: Unprojected";
```

Define the pattern characteristics.

```
pattern value=mempty color=blue;
```

Show the unprojected map. The STATISTIC= option indicates that the GMAP procedure is to match and graph only the first observation from the US48 data set. The NOLEGEND option suppresses the automatic legend. The LEVELS= option specifies that one response level is graphed.

```
proc gmap map=us48unproj data=us48unproj all;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;
```

Project the map data set using the default method. Because the X and Y values are specified in degrees and the X values are eastlong, the DEGREES and EASTLONG options are specified. The ID statement identifies the variable in the input map data set that defines unit areas.

```
proc gproject data=us48unproj out=us48proj degrees eastlong;
   id state;
run;
```

Show the projected map. The STATISTIC= option indicates that the GMAP procedure is to match and graph only the first observation from the SKEW data set. The NOLEGEND option suppresses the automatic legend. The LEVELS= option specifies that one response level is graphed.

```
title "United States Map: Albers Eastlong Projection";
proc gmap map=us48proj data=us48proj all density=4;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;
```

Example 2: Emphasizing Map Areas

Features:
PROC GPROJECT options
- DATA= required argument
- OUT= optional argument
- LATLON
- POLELAT=
- POLELONG=
- PROJECT=

ID statement

PATTERN statement

DATA step

PROC GMAP statement

CHORO statement

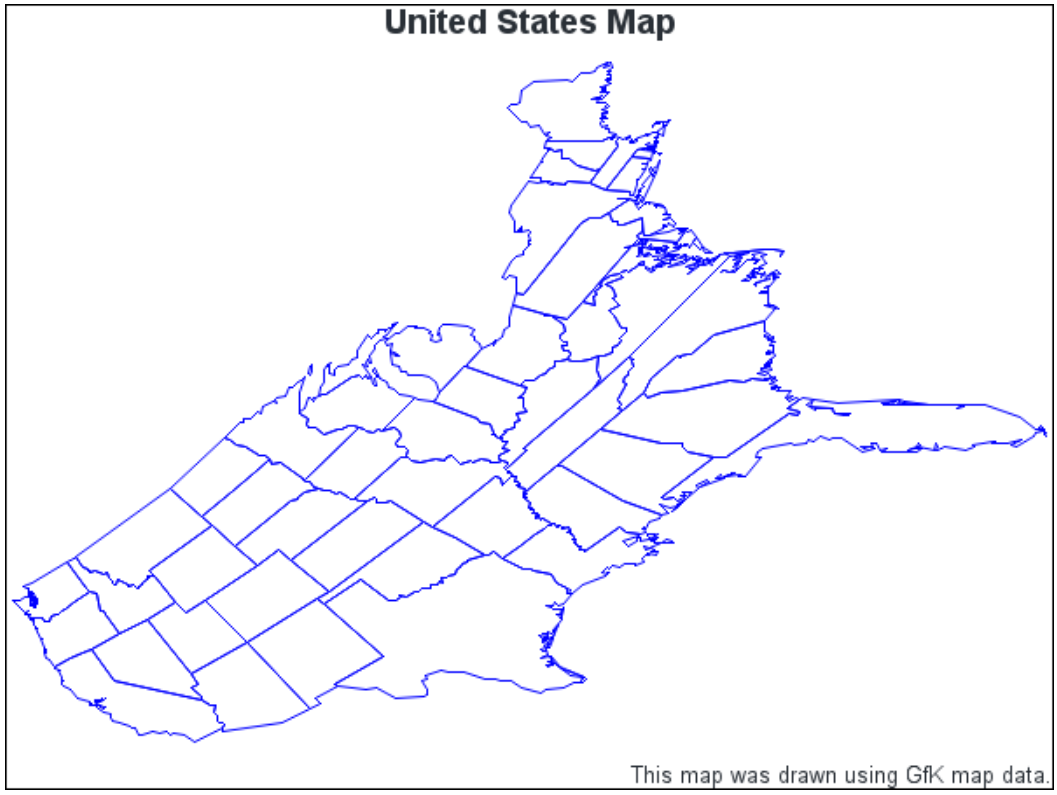
Data sets:
MAPSGFK.US_STATES (input map data set for DATA step)

WORK.US48 (input map data set of lower 48 U.S. states)

SKEW (input map data set and map data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example uses the gnomonic projection method to create a map in which the east coast of the United States appears disproportionately large compared to the west coast.



Program

```
data us48;
   set mapsgfk.us_states;
   if state not in (2 15 72);
run;

proc gproject data=us48
              latlon
              degrees eastlong
              out=skew
              project=gnomon
              polelong=200
              polelat=50;
   id state;
run;

title "United States Map";

pattern value=mempty color=blue;

proc gmap map=skew data=skew all;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;
```

Program Description

Create a reduced continental U.S. map data set that excludes Alaska, Hawaii, and Puerto Rico.

```
data us48;
   set mapsgfk.us_states;
   if state not in (2 15 72);
run;
```

Project the map onto a plane centered in the Pacific. The LATLON option specifies that the unprojected coordinate data in the LAT and LONG variables in the map data set are used instead of the Y and X variables. The PROJECT= option specifies the projection method for the map data set. The POLELONG= and POLELAT= option specify a projection pole for the gnomonic projection. In this example, the pole is positioned in the Pacific Ocean.

```
proc gproject data=us48
              latlon
              degrees eastlong
              out=skew
              project=gnomon
              polelong=200
              polelat=50;
   id state;
run;
```

Define the title for the map.

```
title "United States Map";
```

Define the pattern characteristics.

```
pattern value=mempty color=blue;
```

Show the projected map. The STATISTIC= option indicates that the GMAP procedure is to match and graph only the first observation from the SKEW data set. The NOLEGEND option suppresses the automatic legend. The LEVELS= option specifies that one response level is graphed.

```
proc gmap map=skew data=skew all;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;
```

Example 3: Clipping an Area from the Map

Features: PROC GPROJECT options
- DATA= required argument
- OUT= optional argument
- LATLON
- LONGMAX=
- LONGMIN=
- LATMAX=

LATMIN=

ID statement

PATTERN statement

PROC GMAP statement

CHORO statement

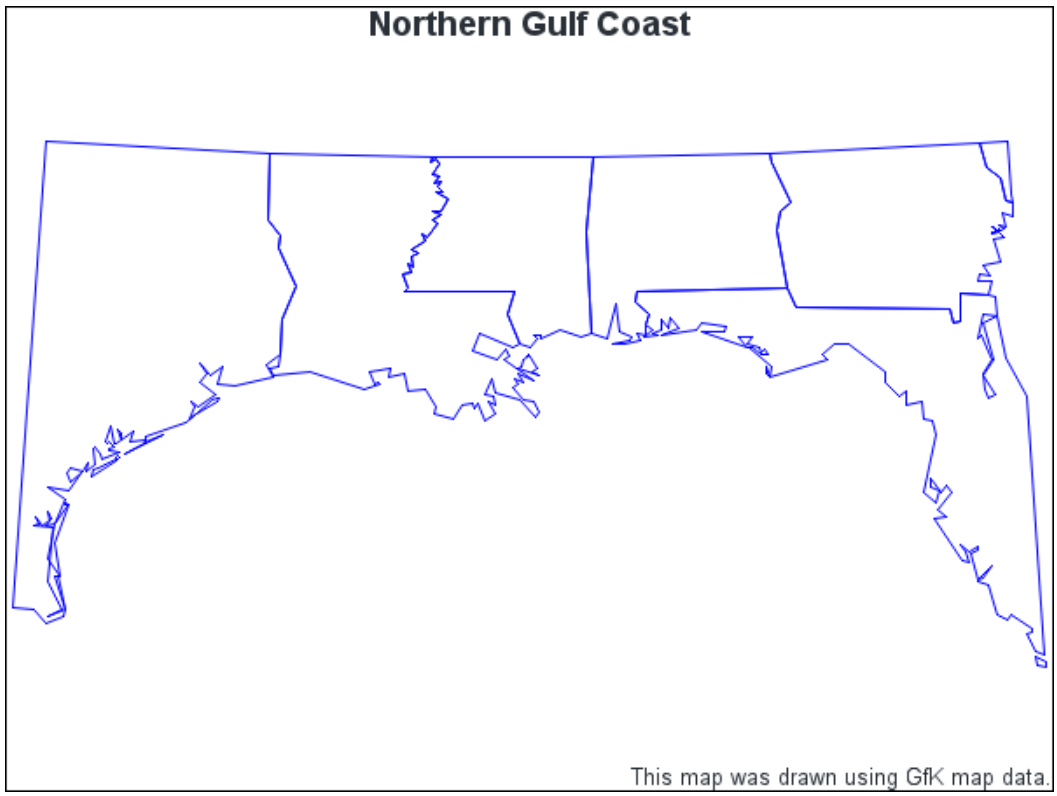
Data sets: MAPSGFK.US_STATES (input map data set for DATA step)

WORK.US48UNPROJ (input map data set of unprojected data)

GULF (input map data set and map data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example uses the clipping capabilities of PROC GPROJECT to create a map of the states in the United States that border the Gulf of Mexico. Because the PROJECT= option is not used in the GPROJECT procedure, the Albers' equal-area projection method is used by default.



Program

```
data us48;
   set mapsgfk.us_states;
   if state not in (2 15 72);
run;

proc gproject data=us48
```

```
                latlon
                degrees eastlong
                out=gulf
                longmin=-98
                longmax=-81
                latmin=25
                latmax=33;
   where density<5;
   id state;
run;

title "Northern Gulf Coast";

pattern value=mempty color=blue;

proc gmap map=gulf data=gulf all;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;
```

Program Description

Create a reduced continental U.S. map data set that excludes Alaska, Hawaii, and Puerto Rico.

```
data us48;
   set mapsgfk.us_states;
   if state not in (2 15 72);
run;
```

Clip and project a rectangular subset of the map. The LATLON option specifies that the unprojected coordinate data in the LAT and LONG variables in the map data set are used instead of the Y and X variables. The LONGMIN= and LONGMAX= options specify the minimum and maximum longitudes to be included in the map projection. The LATMIN= and LATMAX= options specify the minimum and maximum latitudes to be included in the map projection.

```
proc gproject data=us48
                latlon
                degrees eastlong
                out=gulf
                longmin=-98
                longmax=-81
                latmin=25
                latmax=33;
   where density<5;
   id state;
run;
```

Define the title for the map.

```
title "Northern Gulf Coast";
```

Define the pattern characteristics.

```
pattern value=mempty color=blue;
```

Show the clipped map. The STATISTIC= option indicates that the GMAP procedure is to match and graph only the first observation from the GULF data set. The NOLEGEND option suppresses the automatic legend. The LEVELS= option specifies that one response level is graphed.

```
proc gmap map=gulf data=gulf all;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;
```

Example 4: Projecting an Annotate Data Set

Features:

PROC GPROJECT options
- DATA= required argument
- DEGREES
- LATLON
- OUT= optional argument
- PROJECT=
- POLELONG
- POLELAT
- PARMENTRY= optional argument
- PARMOUT
- DUPOK

ID statement

PATTERN statement

DATA step

PROC GMAP statement

CHORO statement

Annotate data set

Data sets:

MAPSGFK.US_STATES (input map data set for DATA step)

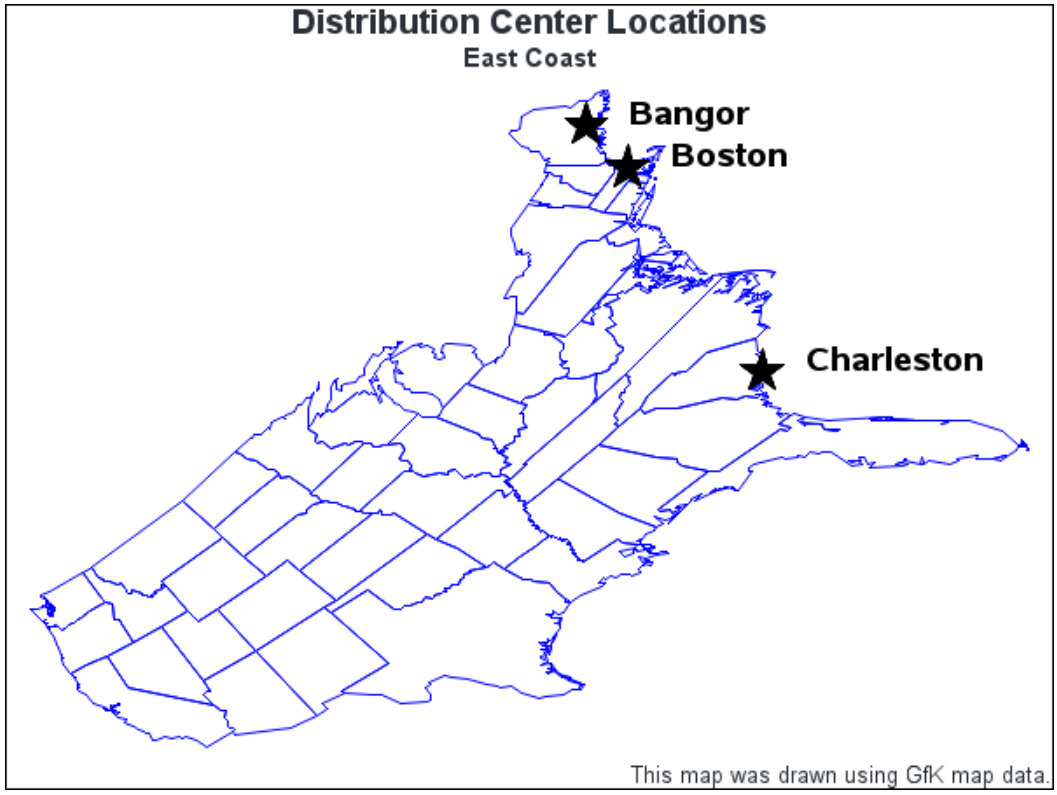
MAPSGFK.USCITY (input map data set for DATA step)

US48P (input map data set and map data set)

WORK.PROJPARM (projection parameters data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example illustrates how to project an Annotate data set for use with a map data set. It labels the locations of Charleston, Boston, and Bangor on the map shown in the second example. Note that the Y and X variables in the MAPSGFK.USCITY data set have already been projected to match the US data set. Therefore, they cannot be used with the map that is produced by the second example. Instead, the LATLON option signals the GPROJECT procedure to use the unprojected LAT and LONG coordinate variables. To properly label the projected map, the example uses the same projection method for the city coordinates that is used for the map coordinates. This example illustrates how to use the same projection method for both data sets.



Program

```
data us48;
   set mapsgfk.us_states;
   if state not in (2 15 72);
run;

proc gproject data=us48
              out=us48p
              latlon
              degrees eastlong
              project=gnomon
              polelong=200
              polelat=50
              parmout;
id state;
run;

data cities;
   set mapsgfk.uscity(keep=lat long city state);
   length function style color $ 15
          position $ 1 text $ 20;
   retain function "label" xsys ysys "2"
          hsys "1" when "a";
   if (state=45 and city="Charleston") or
      (state=25 and city="Boston") or
      (state=23 and city="Bangor");
   state+100; color="black"; size=8;
      text="V";
```

```
      position="5";
      style="marker";
      output;
   state+1; color="black"; size=5;
      text="     "||city;
      position="C";
      style="Albany AMT/Bo";
      output;
run;

proc gproject data=cities
              degrees
              latlon
              out=citiesp
              parmentry=us48p
              dupok;
id;
run;

title1 "Distribution Center Locations";
title2 "East Coast";

pattern value=mempty color=blue;

proc gmap data=us48p map=us48p all;
   id state;
   choro state / stat=first nolegend levels=1
                 annotate=citiesp;
run;
quit;
```

Program Description

Create a reduced continental U.S. map data set that excludes Alaska, Hawaii, and Puerto Rico.

```
data us48;
   set mapsgfk.us_states;
   if state not in (2 15 72);
run;
```

Project the US48 data set. The DATA= option specifies the data set to be projected. The OUT= option specifies the name of the new projected data set that is created. The LATLON option specifies that the unprojected coordinate data in the LAT and LONG variables in the map data set are used instead of the Y and X variables. The PROJECT= option specifies that PROC GPROJECT use the GNOMON projection method for the city coordinates. This is the projection method used for both the city coordinates and the map coordinates. The POLELONG and POLELAT options each specify a projection pole to use for the gnomonic projection. The PARMOUT option creates the WORK.PROJPARM projection parameters data set. See “About Projection Parameters” on page 535 for details. The ID statement identifies the variable in the input map data set that defines the U.S. state map areas.

```
proc gproject data=us48
              out=us48p
```

```
                latlon
                degrees eastlong
                project=gnomon
                polelong=200
                polelat=50
                parmout;
   id state;
   run;
```

Create the Annotate data set CITIES from the MAPSGFK.USCITY data set. The unprojected LONG and LAT variable values are kept for use instead of the projected X and Y variable values. The value of STATE is modified for each label to ensure that it is unique.

```
   data cities;
      set mapsgfk.uscity(keep=lat long city state);
      length function style color $ 15
             position $ 1 text $ 20;
      retain function "label" xsys ysys "2"
             hsys "1" when "a";
      if (state=45 and city="Charleston") or
         (state=25 and city="Boston") or
         (state=23 and city="Bangor");
      state+100; color="black"; size=8;
         text="V";
         position="5";
         style="marker";
         output;
      state+1; color="black"; size=5;
         text="     "||city;
         position="C";
         style="Albany AMT/Bo";
         output;
   run;
```

Project the annotate data set. The DATA= option specifies the data set to be projected. The DEGREES option specifies that the coordinates are in degrees rather than radians. The LATLON option specifies that the unprojected LAT and LONG variables from the map data set are used for coordinate data instead of the projected Y and X variables. The OUT= option specifies the name of the new projected data set that is created. The PARMENTRY= option specifies the entry in the projection parameters data set that is used. The empty ID statement specifies that the data is not polygonal. Note that the PARMIN= option is not needed because the WORK.PROJPARM data set is used by default.

```
   proc gproject data=cities
                degrees
                latlon
                out=citiesp
                parmentry=us48p
                dupok;
   id;
   run;
```

Define the titles for the map.

```
   title1 "Distribution Center Locations";
   title2 "East Coast";
```

Define the pattern characteristics.

```
pattern value=mempty color=blue;
```

Display the annotated map. The CHORO statement displays the projected map and annotates it using the projected Annotate data set. The NOLEGEND option suppresses the automatic legend. The LEVELS= option specifies that one response level is graphed. The STATISTIC= option indicates that the GMAP procedure is to match and graph only the first observation from the US48P data set.

```
proc gmap data=us48p map=us48p all;
   id state;
   choro state / stat=first nolegend levels=1
                 annotate=citiesp;
run;
quit;
```

Example 5: Using Default Projection Specifications with Traditional Map Data

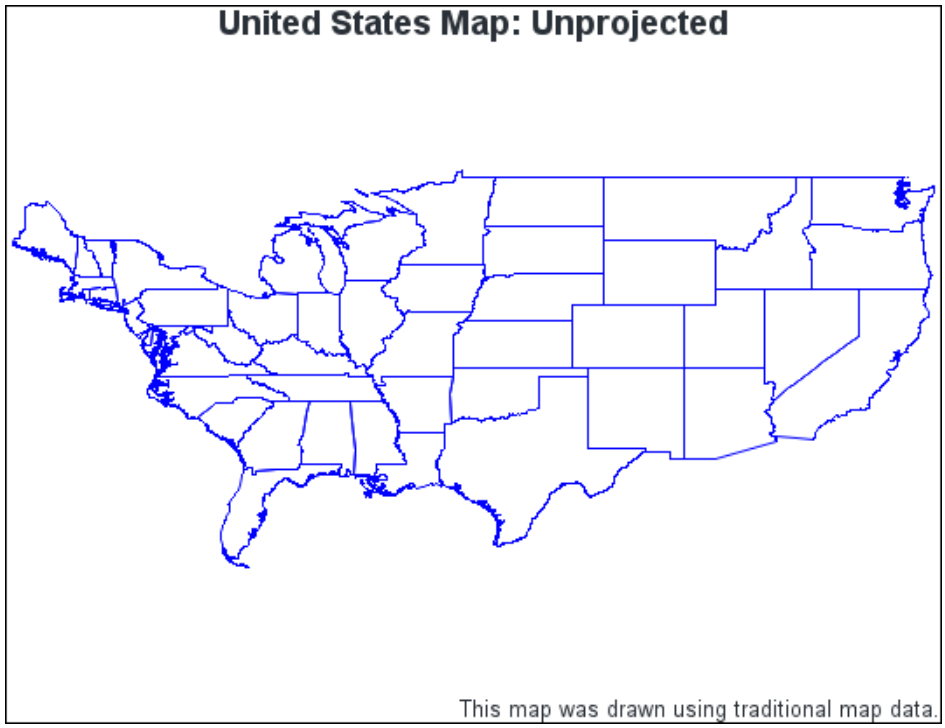
Features: PROC GPROJECT options
DATA= required argument
OUT= optional argument
ID statement
PATTERN statement
DATA step
PROC GMAP statement
CHORO statement

Data sets: MAPSSAS.STATES (input map data set for DATA step)
US48PROJ (input map data set and map data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example demonstrates the effect of using PROC GPROJECT on an unprojected traditional map data set without specifying any options. Because the PROJECT= option is not used in the PROC GPROJECT statement, the Albers' equal-area projection method is used by default. PROC GPROJECT supplies defaults for the standard parallels that minimize the distortion of the projected map areas. The GPROJECT procedure also supplies default RADIANS, WESTLONG, X, and Y coordinate values.

Output 14.5 *Unprojected Map With Westlong Longitude Coordinates*



Output 14.16 on page 553 illustrates the output produced by the US48UNPROJ map data set, which contains unprojected values in the X and Y variables. The X values are measured in westlong degrees. Note that in GfK map data sets the unprojected longitude (LONG) coordinate values are measured in eastlong degrees. Using the GPROJECT procedure with GfK values would result in a map with the east coast on the right side. Output 14.21 on page 568 shows the variables in the unprojected data set.

Output 14.6 *Partial Listing of the US48UNPROJ Data Set*

Obs	STATE	SEGMENT	DENSITY	X	Y
1	1	1	4	1.48181	0.56301
2	1	1	4	1.48192	0.56284
3	1	1	3	1.48221	0.56286
4	1	1	4	1.48217	0.56276
5	1	1	4	1.48207	0.56279
6	1	1	4	1.48202	0.56270
7	1	1	4	1.48219	0.56253
8	1	1	4	1.48218	0.56242
9	1	1	3	1.48226	0.56234
10	1	1	3	1.48304	0.56231
11	1	1	4	1.48318	0.56215
12	1	1	4	1.48290	0.56204
13	1	1	3	1.48288	0.56194
14	1	1	4	1.48374	0.56164

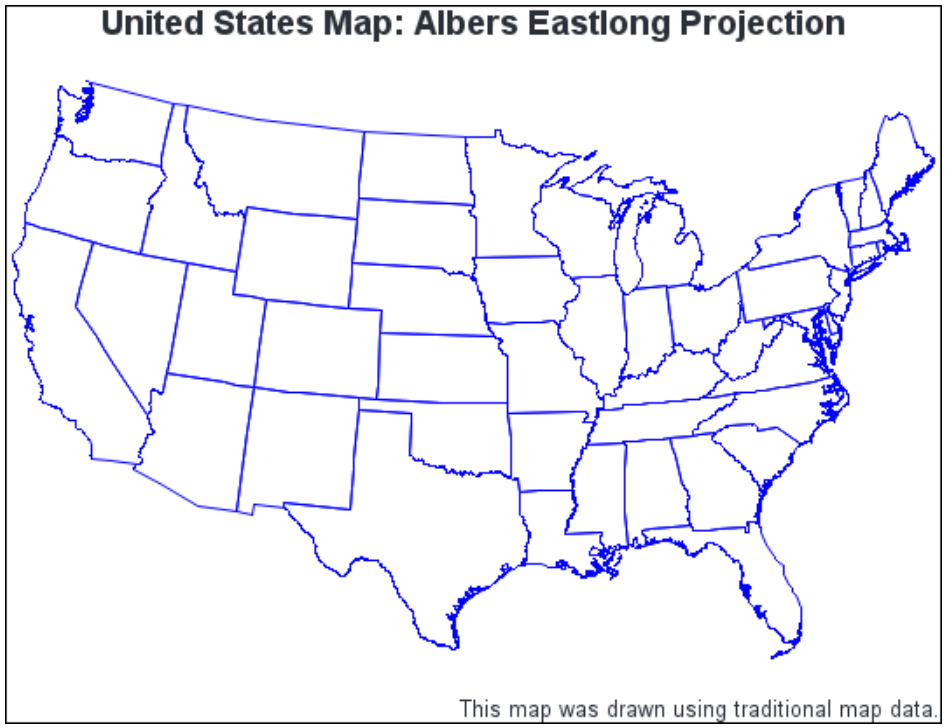
The GPROJECT procedure is used with the US48UNPROJ map data set as input to create the projected map data set, US48PROJ. The values for X and Y in this new data set are projected (Cartesian). Output 14.22 on page 568 shows the variables in the data set.

Output 14.7 *Partial Listing of the US48PROJ Data Set*

Obs	X	Y	DENSITY	STATE	SEGMENT
1	0.16099	-0.073282	4	1	1
2	0.16092	-0.073462	4	1	1
3	0.16068	-0.073470	3	1	1
4	0.16072	-0.073566	4	1	1
5	0.16080	-0.073526	4	1	1
6	0.16085	-0.073611	4	1	1
7	0.16073	-0.073797	4	1	1
8	0.16075	-0.073905	4	1	1
9	0.16069	-0.073993	3	1	1
10	0.16004	-0.074097	3	1	1
11	0.15994	-0.074270	4	1	1
12	0.16019	-0.074353	4	1	1
13	0.16022	-0.074450	3	1	1
14					1

The new projected map data set, US48PROJ, is used to create the projected map, Output 14.19 on page 555.

Output 14.8 *Map After Projection*



Program

```
goptions reset=all border device=png;

data us48unproj;
   set mapssas.states;
   if state not in (2 15 72);
run;

title "United States Map: Unprojected";

pattern value=mempty color=blue;

proc gmap map=us48unproj data=us48unproj all density=4;
   id state;
   choro state / stat=first nolegend levels=1;
run;

proc gproject data=us48unproj
              out=us48proj;
   id state;
run;

title "United States Map: Albers Eastlong Projection";
proc gmap map=us48proj
          data=us48proj all density=4;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;

goptions reset=all;
```

Program Description

Set the graphics environment.

```
goptions reset=all border device=png;
```

Create a reduced continental U.S. map data set and remove Alaska, Hawaii, and Puerto Rico.

```
data us48unproj;
   set mapssas.states;
   if state not in (2 15 72);
run;
```

Define the title for the unprojected map.

```
title "United States Map: Unprojected";
```

Define the pattern characteristics.

```
pattern value=mempty color=blue;
```

Show the unprojected map.

```
proc gmap map=us48unproj data=us48unproj all density=4;
   id state;
   choro state / stat=first nolegend levels=1;
run;
```

Project the map data set using all default criteria. The ID statement identifies the variable in the input map data set that defines unit areas.

```
proc gproject data=us48unproj
              out=us48proj;
   id state;
run;
```

Show the projected map.

```
title "United States Map: Albers Eastlong Projection";
proc gmap map=us48proj
          data=us48proj all density=4;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

Example 6: Emphasizing Map Areas Using Traditional Map Data

Features: PROC GPROJECT options
DATA= required argument
OUT= optional argument

POLELAT=
POLELONG=
PROJECT=

ID statement

PATTERN statement

DATA step

PROC GMAP statement

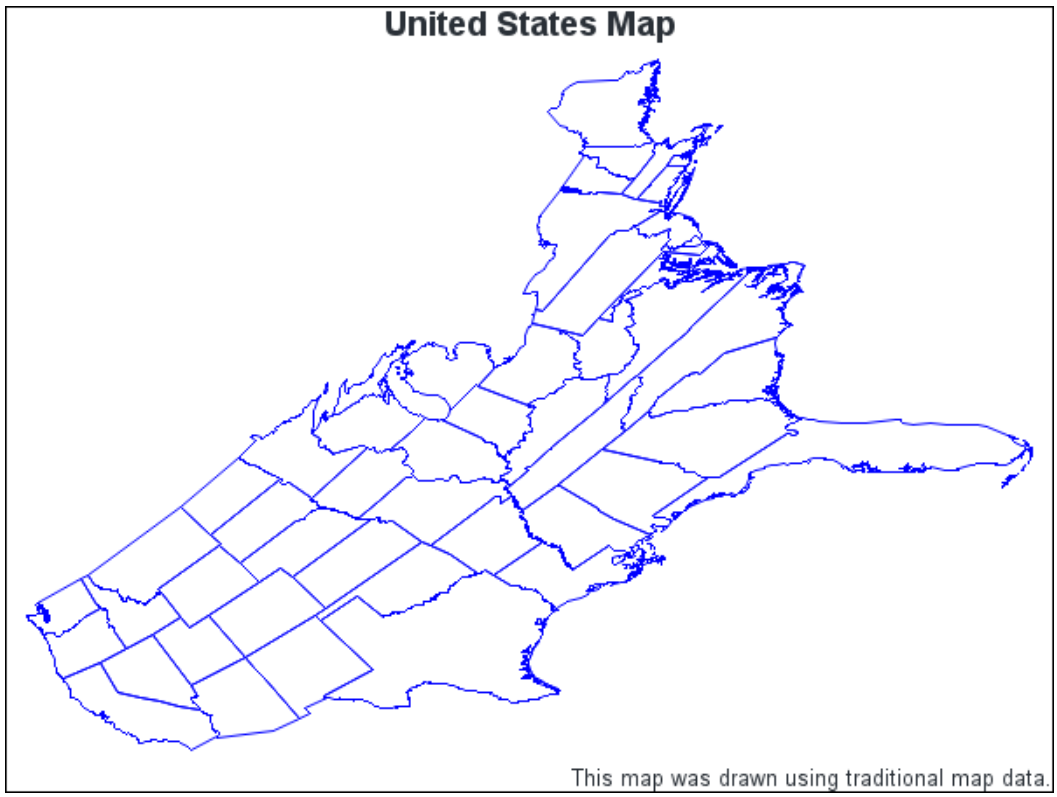
CHORO statement

Data sets: MAPSSAS.STATES (input map data set for DATA step)

SKEW (input map data set and map data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example uses the gnomonic projection method to create a map in which the east coast of the United States appears disproportionately large compared to the west coast.



Program

```
goptions reset=all border device=png;

data us48;
   set mapssas.states;
   if state ne 2 and state ne 15 and state ne 72;
```

```
   if density<4;
run;

proc gproject data=us48
              out=skew
              project=gnomon
              polelong=160
              polelat=45;
   id state;
run;

title "United States Map";

pattern value=mempty color=blue;

proc gmap map=skew data=skew all;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;

goptions reset=all;
```

Program Description

Set the graphics environment.

```
goptions reset=all border device=png;
```

Create a reduced continental U.S. map data set and remove Alaska, Hawaii, and Puerto Rico.

```
data us48;
   set mapssas.states;
   if state ne 2 and state ne 15 and state ne 72;
   if density<4;
run;
```

Project the map onto a plane centered in the Pacific. The PROJECT= option specifies the projection method for the map data set. The POLELONG= and POLELAT= option specify a projection pole for the gnomonic projection. In this example, the pole is positioned in the Pacific Ocean.

```
proc gproject data=us48
              out=skew
              project=gnomon
              polelong=160
              polelat=45;
   id state;
run;
```

Define the title for the map.

```
title "United States Map";
```

Define the pattern characteristics.

```
pattern value=mempty color=blue;
```

Show the projected map.

```
proc gmap map=skew data=skew all;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

Example 7: Clipping an Area from the Map Using Traditional Map Data

Features: PROC GPROJECT options
- DATA= required argument
- OUT= optional argument
- LONGMAX=
- LONGMIN=
- LATMAX=
- LATMIN=

ID statement

PATTERN statement

PROC GMAP statement

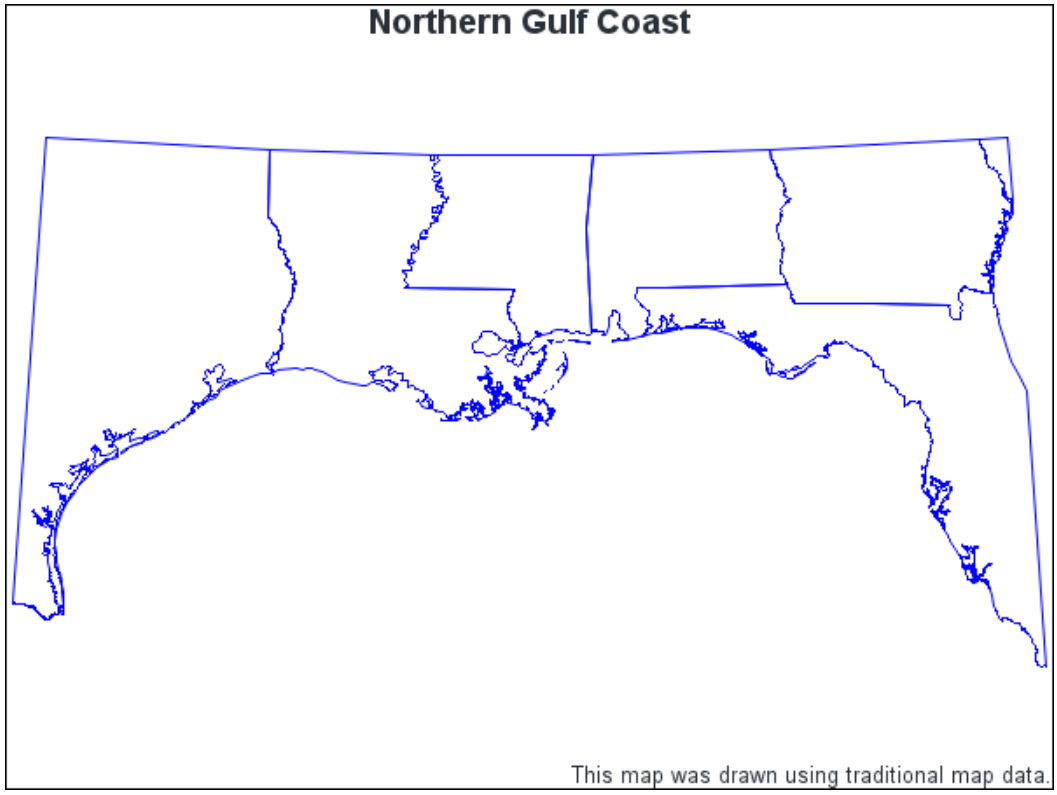
CHORO statement

Data sets: MAPSSAS.STATES (input map data set for DATA step)

GULF (input map data set and map data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example uses the clipping capabilities of PROC GPROJECT to create a map of the states in the United States that border the Gulf of Mexico. Because the PROJECT= option is not used in the GPROJECT procedure, the Albers' equal-area projection method is used by default.



Program

```
goptions reset=all border device=png;

proc gproject data=mapssas.states
              out=gulf
              longmin=81
              longmax=98
              latmin=25
              latmax=33;
   where density<5;
   id state;
run;

title "Northern Gulf Coast";

pattern value=mempty color=blue;

proc gmap map=gulf data=gulf all;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;

goptions reset=all;
```

Program Description

Set the graphics environment.

```
goptions reset=all border device=png;
```

Clip and project a rectangular subset of the map. The LONGMIN= and LONGMAX= options specify the minimum and maximum longitudes to be included in the map projection. The LATMIN= and LATMAX= options specify the minimum and maximum latitudes to be included in the map projection.

```
proc gproject data=mapssas.states
              out=gulf
              longmin=81
              longmax=98
              latmin=25
              latmax=33;
   where density<5;
   id state;
run;
```

Define the title for the map.

```
title "Northern Gulf Coast";
```

Define the pattern characteristics.

```
pattern value=mempty color=blue;
```

Show the clipped map.

```
proc gmap map=gulf data=gulf all;
   id state;
   choro state / stat=first nolegend levels=1;
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

Example 8: Projecting an Annotate Data Set Using Traditional Map Data

Features:

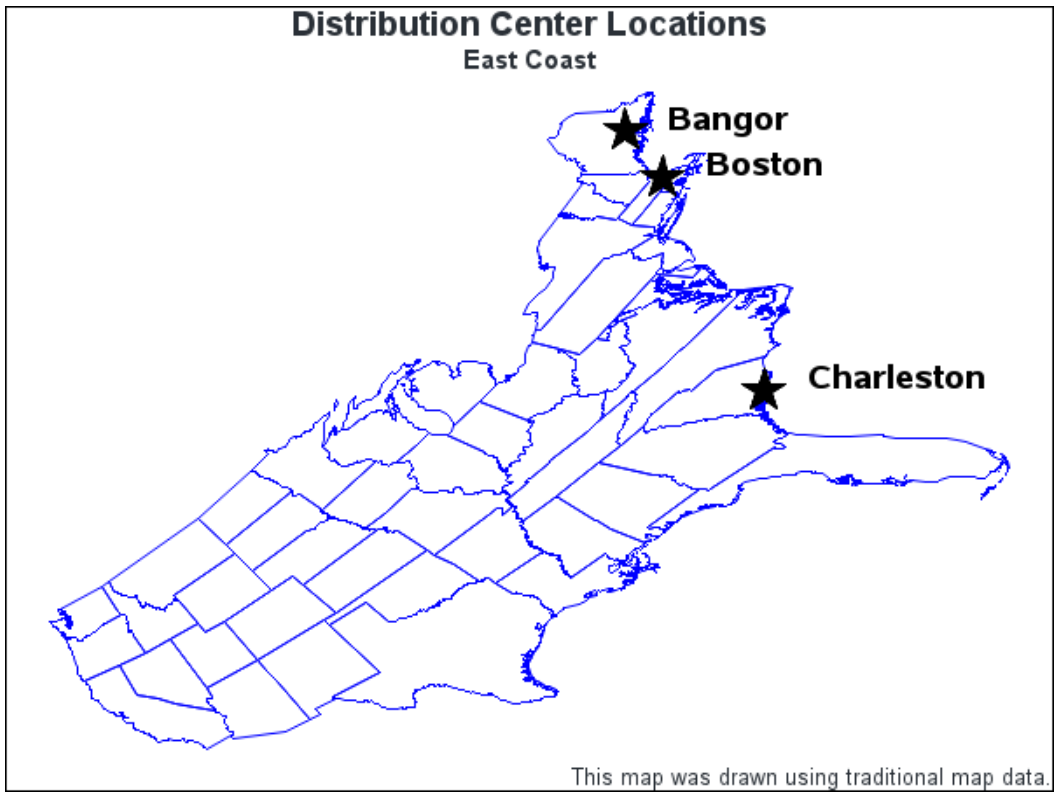
PROC GPROJECT options
- DATA= required argument
- DEGREES
- LATLON
- OUT= optional argument
- PROJECT=
- POLELONG
- POLELAT
- PARMENTRY= optional argument
- PARMOUT

DUPOK
ID statement
PATTERN statement
DATA step
PROC GMAP statement
CHORO statement
Annotate data set

Data sets: MAPSSAS.STATES (input map data set for DATA step)
MAPSSAS.USCITY (input map data set for DATA step)
US48P (input map data set and map data set)
WORK.PROJPARM (projection parameters data set)

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example illustrates how to project an Annotate data set for use with a map data set. It labels the locations of Charleston, Boston, and Bangor on the map shown in the second example. Note that the Y and X variables in the MAPSSAS.USCITY data set have already been projected to match the US data set. Therefore, they cannot be used with the map that is produced by the second example. Instead, the LATLON option signals the GPROJECT procedure to use the unprojected LAT and LONG coordinate variables. To properly label the projected map, the example uses the same projection method for the city coordinates that is used for the map coordinates. This example illustrates how to use the same projection method for both data sets.



Program

```
goptions reset=all border device=png;

data us48;
   set mapssas.states;
   if state not in (2 15 72);
   if density<4;
run;

proc gproject data=us48
              out=us48p
              project=gnomon
              polelong=160
              polelat=45
              parmout;
id state;
run;

data cities;
   set mapssas.uscity(keep=lat long city state);
   length function style color $ 15
          position $ 1 text $ 20;
   retain function "label" xsys ysys "2"
          hsys "1" when "a";
   if (state=45 and city="Charleston") or
      (state=25 and city="Boston") or
      (state=23 and city="Bangor");
    state+100; color="black"; size=8;
      text="V";
      position="5";
      style="marker";
      output;
    state+1; color="black"; size=5;
      text="     "||city;
      position="C";
      style="Albany AMT/Bo";
      output;
run;

proc gproject data=cities
              degrees
              latlon
              out=citiesp
              parmentry=us48p
              dupok;
id;
run;

title1 "Distribution Center Locations";
title2 "East Coast";

pattern value=mempty color=blue;

proc gmap data=us48p map=us48p all;
   id state;
   choro state / levels=1 nolegend stat=first
                 annotate=citiesp;
run;
```

```
quit;
goptions reset=all;
```

Program Description

Set the graphics environment.

```
goptions reset=all border device=png;
```

Create a reduced continental U.S. map data set and remove Alaska, Hawaii, and Puerto Rico.

```
data us48;
   set mapssas.states;
   if state not in (2 15 72);
   if density<4;
run;
```

Project the US48 data set. The DATA= option specifies the data set to be projected. The OUT= option specifies the name of the new projected data set that is created. The PROJECT= option specifies that PROC GPROJECT use the GNOMON projection method for the city coordinates. This is the projection method used for both the city coordinates and the map coordinates. The POLELONG and POLELAT options each specify a projection pole to use for the gnomonic projection. The PARMOUT option creates the WORK.PROJPARM projection parameters data set. See “About Projection Parameters” on page 535 for details. The ID statement identifies the variable in the input map data set that defines the U.S. state map areas.

```
proc gproject data=us48
              out=us48p
              project=gnomon
              polelong=160
              polelat=45
              parmout;
id state;
run;
```

Create the Annotate data set CITIES from the MAPSSAS.USCITY data set. The unprojected LONG and LAT variable values are kept for use instead of the projected X and Y variable values. The value of STATE is modified for each label to ensure that it is unique.

```
data cities;
   set mapssas.uscity(keep=lat long city state);
   length function style color $ 15
          position $ 1 text $ 20;
   retain function "label" xsys ysys "2"
          hsys "1" when "a";
   if (state=45 and city="Charleston") or
      (state=25 and city="Boston") or
      (state=23 and city="Bangor");
    state+100; color="black"; size=8;
      text="V";
      position="5";
```

```
      style="marker";
      output;
    state+1; color="black"; size=5;
      text="     "||city;
      position="C";
      style="Albany AMT/Bo";
      output;
run;
```

Project the annotate data set. The DATA= option specifies the data set to be projected. The DEGREES option specifies that the coordinates are in degrees rather than radians. The LATLON option specifies that the unprojected LAT and LONG variables from the map data set are used for coordinate data instead of the projected Y and X variables. The OUT= option specifies the name of the new projected data set that is created. The PARMENTRY= option specifies the entry in the projection parameters data set that is used. The empty ID statement specifies that the data is not polygonal. Note that the PARMIN= option is not needed because the WORK.PROJPARM data set is used by default.

```
proc gproject data=cities
              degrees
              latlon
              out=citiesp
              parmentry=us48p
              dupok;
id;
run;
```

Define the titles for the map.

```
title1 "Distribution Center Locations";
title2 "East Coast";
```

Define the pattern characteristics.

```
pattern value=mempty color=blue;
```

Display the annotated map. The CHORO statement displays the projected map and annotates it using the projected Annotate data set.

```
proc gmap data=us48p map=us48p all;
   id state;
   choro state / levels=1 nolegend stat=first
                 annotate=citiesp;
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

References

Pearson, F., II. 1977. *Map Projection Equations (Report Number TR-3624)*. Dahlgren, VA: Naval Surface Weapons Center, Dahlgren Laboratory.

Richardus, P. and Adler, R.K. 1972. *Map Projections*. Amsterdam, Netherlands: North-Holland Publishing Company; New York: American Elsevier Publishing Company.

Robinson, A.H. 1978. *Elements of Cartography*. New York, USA: John Wiley & Sons, Inc.

15

GREDUCE Procedure

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Overview: GREDUCE Procedure

What Does the GREDUCE Procedure Do?

The GREDUCE procedure is available with Base SAS. The procedure is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this procedure.

The GREDUCE procedure processes map data sets so that they can draw simpler maps with fewer boundary points. It creates an output map data set that contains

all of the variables in the input map data set plus a new variable named DENSITY. For each observation in the input map data set, the procedure determines the significance of that point for maintaining a semblance of the original shape. It also gives the observation a corresponding DENSITY value.

You can then use the value of the DENSITY variable to create a subset of the original map data set. The observations in the subset can draw a map that retains the overall appearance of the original map. However, the difference is that it contains fewer points, requires considerably less storage space, and can be drawn much more quickly.

GREDUCE does not produce any graphics output. Instead, it produces an output map data set that can become either one of the following:

- the input map data set for either the GMAP or SGMAP procedure
- the input map data set for a DATA step that removes points from the map

Figure 15.46 on page 582 and Figure 15.47 on page 583 illustrate the effect of reduction on a typical map data set. Figure 15.46 on page 582 uses observations with all DENSITY values as input to the GMAP procedure.

Figure 15.1 *CANADA Map before Reduction*

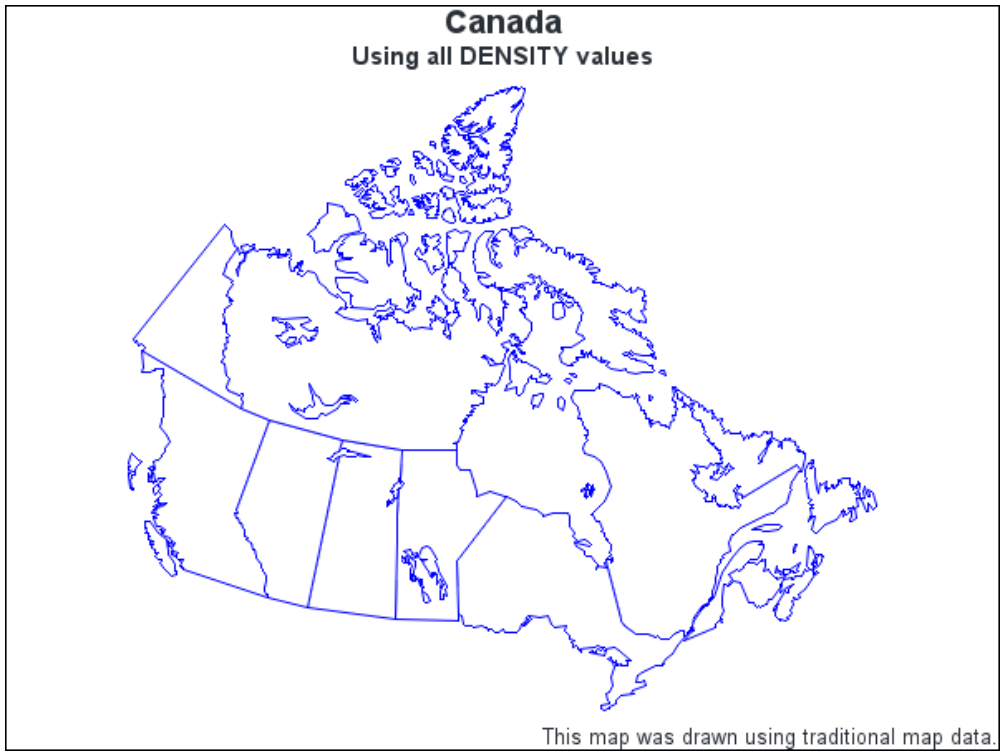
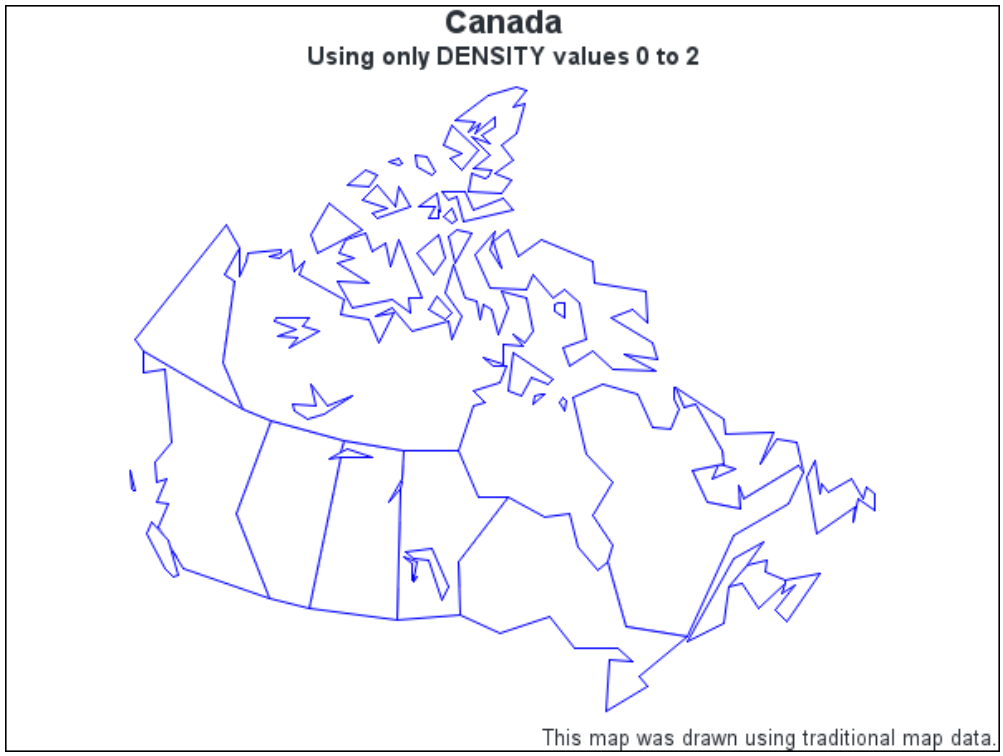


Figure 15.47 on page 583 uses only those observations with a DENSITY value of 0 to 2 as input to the GMAP procedure.

Figure 15.2 CANADA Map after Reduction



The program for these maps is in "Example: Reducing the Map of Canada Using Traditional Map Data" on page 593.

The reduced map shown in Figure 15.47 on page 583 retains the overall shape of the original but requires only 463 observations compared to the 4302 observations that are needed to produce the map in Figure 15.46 on page 582.

Note: Many of the map data sets that are supplied by SAS already have been processed by GREDUCE. If the map data set contains a DENSITY variable, you do not need to process the data set using GREDUCE.

See also Chapter 16, "GREMOVE Procedure," on page 597 for more information about how to do the following:

- combine groups of unit areas into larger unit areas to create regional maps
- remove some of the boundaries in a map and create a subset of a map that combines the original areas

To run this procedure, the various data sets and essential SAS software must be available in your installation. Storage restrictions apply to map data sets that are used with the SGMAP procedure's CHOROMAP or SERIES statement and to geocoding lookup data sets. Because the map data sets contain sequential polygonal data, storing the mapping data on a distributed system such as aTeradata server, a SAS® LASR™ Analytic Server, or a SAS Cloud Analytic Services (CAS) server is not recommended. Data sequence cannot be guaranteed on distributed systems such as these, which can cause unexpected results. If the criterion is met, you can copy the procedure examples provided in this chapter into your program

editor and run them to create the required output. Your IDE might provide additional resources for creating maps. Refer to the documentation for your IDE for more information.

Concepts: GREDUCE Procedure

About the Input Map Data Set

The input map data set must be a data set supplied by SAS and contain these variables:

- a numeric variable named X that contains the horizontal coordinates of the map boundary points.
- a numeric variable named Y that contains the vertical coordinates of the map boundary points.
- one or more identification variables that uniquely identify the unit areas in the map. These variables are listed in the ID statement.

It can also contain the following:

- one or more variables that identify groups of unit areas (for BY-group processing)
- the variable SEGMENT, which distinguishes nonconterminous segments of the unit areas.

Any other variables in the input map data set do not affect the GREDUCE procedure.

About Unmatched Area Boundaries

You might be using map data sets in which area boundaries do not match precisely. For example, the boundaries were digitized with a different set of points. In this case PROC GREDUCE is unable to identify common boundaries properly. This results in abnormalities in your maps. These abnormalities include mismatched borders, missing vertex points, stray lines, gaps, and distorted polygons.

If the points in the area boundaries match up except for precision differences, round each X and Y value in your map data set accordingly. To accomplish this use the DATA step function ROUND before using PROC GREDUCE. (See *SAS Functions and CALL Routines: Reference* for information about the ROUND function.)

An example is the map data set APPROX. It has horizontal and vertical coordinate values for interior boundaries of unit areas that are exactly equal only to three decimal places. The following DATA step creates a new map data set named EXACT. The data set created is better suited for use with the GREDUCE procedure:

```
data exact;
      set approx;
      if x ne . then x=round(x,.001);
      if y ne . then y=round(y,.001);
   run;
```

See "About Map Data Sets" on page 309 for additional information about map data sets.

Syntax: GREDUCE Procedure

Requirement: Exactly one ID statement is required.

PROC GREDUCE DATA=*input-map-data-set* <*options*>;

ID *id-variable(s)*;

BY*variable(s)*
<DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...>
<NOTSORTED>;

PROC GREDUCE Statement

Identifies the input and output map data sets. Can specify the reduction criteria.

Requirement: An input map data set is required. If not specified, an input map data set must have been created before issuing the PROC GREDUCE statement.

Syntax

PROC GREDUCE DATA=*input-map-data-set* <*options*>;

Summary of Optional Arguments

E1=*min-distance*

E2=*min-distance*

E3=*min-distance*

E4=*min-distance*

E5=*min-distance*
specify the minimum distance that a point must lie from a straight line segment to be included at density level 1, 2, 3, 4, or 5, respectively.

LATLON
specifies that the LAT and LONG variables from the map data set are used for coordinate data instead of the Y and X variables.

N1=*max-points*

N2=*max-points*

N3=*max-points*

N4=*max-points*

N5=*max-points*
specifies that for density level 1, 2, 3, 4, or 5, the boundary of a unit area should contain no more than *max-points* points.

NOCLEAN
disables post-processing cleanup of the output data set.

NORETRY
prevents additional reduction of polygons in the output map data set.

OUT=*output-data-set*
names the new map data set, which contains all of the observations and variables in the original map data set plus the new DENSITY variable.

Required Argument

DATA=*input-map-data-set*
identifies the map data set that you want to process. If not specified, an input map data set must have been created before issuing the PROC GREDUCE statement.

Default: The GREDUCE procedure uses the most recently created SAS data set.

Requirement: This statement is required if no response data set was created before issuing the PROC GREDUCE statement.

See: "About the Input Map Data Set" on page 584

"The SAS Data Set: Your Key to the SAS System" in *Step-by-Step Programming with Base SAS*

"About Data Set Options" in *SAS Data Set Options: Reference*

Optional Arguments

E1=*min-distance*
E2=*min-distance*
E3=*min-distance*
E4=*min-distance*
E5=*min-distance*
specify the minimum distance that a point must lie from a straight line segment to be included at density level 1, 2, 3, 4, or 5, respectively. For example, in a

reduced curve of three points, the middle point is at least a distance that is *min-distance* from a straight line between the two outside points.

Specify *min-distance* values in the units for the coordinate system of the input map data set. For example, if the input map data set contains coordinates that are expressed in radians, specify the *min-distance* values in radians.

Specify the E*n*= values in decreasing order. For example, the E2= value should be less than the E1= value, and so on.

LATLON
specifies that the LAT and LONG variables from the map data set are used for coordinate data instead of the Y and X variables. The LAT and LONG variables represent the latitude and longitude coordinates, respectively. All GfK Marketing and most traditional map data sets contain both sets of variables (Y, X, and LAT, LONG) for projected and unprojected maps. By default, the Y and X variables are used to produce an output data set. However, when LATLON is specified, the Y and X variables are no longer required by the GREDUCE procedure statement.

Alias LATLONG

Example "Example 4: Projecting an Annotate Data Set" on page 562

N1=*max-points*
N2=*max-points*
N3=*max-points*
N4=*max-points*
N5=*max-points*
specifies that for density level 1, 2, 3, 4, or 5, the boundary of a unit area should contain no more than *max-points* points. Specify the N*n*= values in increasing order. For example, the N2= value should be greater than or equal to the N1= value, and so on.

By default, if you omit N*n*= and E*n*= , the GREDUCE procedure calculates values for the five N*n*= parameters using this formula:

$$\mathrm{N}n = n^2 \times \mathrm{N}_{\max}/36$$

Here $\mathrm{N}_{\max}$ is the maximum number of points in any unit area in the input map data set.

Restriction When calculating $\mathrm{N}_{\max}$, the number of points for any level cannot be less than the number of points in level 0.

Interaction After the N*n*= values are calculated or specified, E*n*= values are calculated. The procedure uses Newton's method of determining the value of a function in the vicinity of a point. This computation yields a reduction on the polygon chosen by the procedure. This reduction ensures that the N= target values are not exceeded. It also ensures that the resultant E*n*= values are computed to within a 10 % margin of the N*n*= values.

Note The GREDUCE procedure always computes N*n*= values before beginning a reduction. Less than five N*n*= values are derived in instances where the input map data set contains coordinates for

low-resolution maps. The procedure also uses less than five N*n*= values when reducing maps with simple boundaries.

NOCLEAN
disables post-processing cleanup of the output data set. By default, the GREDUCE procedure post-processes the output data set to ensure that at least three vertices are present for each polygon at each density level. Specifying NOCLEAN overrides the default behavior. The shapes with only one or two points are included in the output data set.

NORETRY
prevents additional reduction of polygons in the output map data set.

The NORETRY option ensures efficient processing in cases when certain devices might experience performance degradation with the input of large polygons containing many coordinate points.

The NORETRY option works in conjunction with N*n*= criteria to prevent additional reductions by exceeding the target values.

Default NORETRY is not enabled. By default, the GREDUCE procedure reduces the input map data set polygons until no target values are exceeded. Target values are indicated by the procedure's default criteria or by specifying the N*n*= values.

Interaction When specified, NORETRY works in conjunction with the N*n*= values. The N*n*= values, if not specified, are automatically generated by the GREDUCE procedure. The procedure computes the N*n*= value from the most geometrically complex polygon in the input map data set. This polygon is typically the one with the most coordinate points.

Note Results with the NORETRY option can be less than optimal if the input map data set contains both simple and complex polygon boundaries.

OUT=*output-data-set*
names the new map data set, which contains all of the observations and variables in the original map data set plus the new DENSITY variable. If the input map data set contains a variable named DENSITY, the GREDUCE procedure replaces the values of the variable in the output map data set. The original values of the DENSITY variable from the input map data set are not included in the output map data set.

By default, the GREDUCE procedure names the new data set that uses the DATA*n* naming convention. That is, the procedure uses the name WORK.DATA*n*, where *n* is the next unused number in sequence. Thus, the first automatically named data set is DATA1, the second is DATA2, and so on.

ID Statement

Identifies the variable or variables that define the hierarchy of the current unit areas in the input map data set.

Requirement: At least one *id-variable* is required.

See: "Example: Reducing the Map of Canada Using Traditional Map Data" on page 593

Syntax

ID *id-variable(s)*;

Required Argument

id-variable(s)
specifies one or more variables in the input map data set that identify unit areas. *Id-variable(s)* can be either numeric or character.

Each group of observations with a different ID variable value is evaluated as a separate unit area.

BY Statement

Lists the variable or variables that identify the new unit areas.

Requirement: At least one variable is required.

Example: "Example 1: Removing State Boundaries from U.S. Map" on page 608

Syntax

BY *variable(s)*
<DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...>
<NOTSORTED>;

Summary of Optional Arguments

DESCENDING
indicates that the input map data set is sorted in descending order.

NOTSORTED

specifies that observations with the same BY-variable values are to be grouped as they are encountered without regard for whether the values are in alphabetical or numerical order.

Required Argument

variable(s)
specifies one or more variables in the input map data set that define the new unit areas. *Variable(s)* can be either numeric or character.

The BY variables in the input map data set become the ID variables for the output map data set.

Optional Arguments

DESCENDING
indicates that the input map data set is sorted in descending order. By default, the GREDUCE procedure expects all BY-variable values to appear in ascending order.

This option affects only the variable that immediately follows the option.

NOTSORTED
specifies that observations with the same BY-variable values are to be grouped as they are encountered without regard for whether the values are in alphabetical or numerical order. NOTSORTED can appear anywhere in the BY statement. It affects all of the variables that are specified in the statement.

Interaction The NOTSORTED option overrides the DESCENDING option if both appear in the same BY statement.

Usage: GREDUCE Procedure

Specifying Density Levels

GREDUCE uses default criteria for determining the appropriate DENSITY variable value for each observation in the input map data set. If you do not want to use the default criteria, use PROC GREDUCE options to select the following:

- the maximum number of observations for each DENSITY level
- the minimum distance that an intermediate point must lie from a line between two end points to be included in the level

If you do not explicitly specify criteria, the procedure computes and uses default values.

GREDUCE creates seven density levels, numbered 0 through 6. Specify criteria for density levels 1 through 5. You cannot define criteria for level 0. Level 0 is reserved for map vertex points, such as common corners of unit areas. You also cannot define criteria for level 6. Level 6 is assigned to those points that do not meet the criteria for any lower level.

Specify the maximum number of observations per density level using N*n*= in the PROC GREDUCE statement, and specify the minimum point distance using E*n*= . You must have knowledge of the X and Y variable values in the particular input map data set to determine appropriate values for E*n*=. See the En= option on page 586 for details.

Figure 15.48 on page 591 illustrates how to use the minimum distance parameter to determine which points belong in a particular density level. At density level *n*, only point C lies at a distance greater than the E*n*= value (70) from a line between points A and B. Thus, after reduction only point C remains between points A and B at density level *n*, and the resulting reduced boundary is shown in Figure 15.49 on page 591. See Douglas and Peucker (1973) for details of the algorithm used.

Figure 15.3 *Points in Data Set before Reduction*

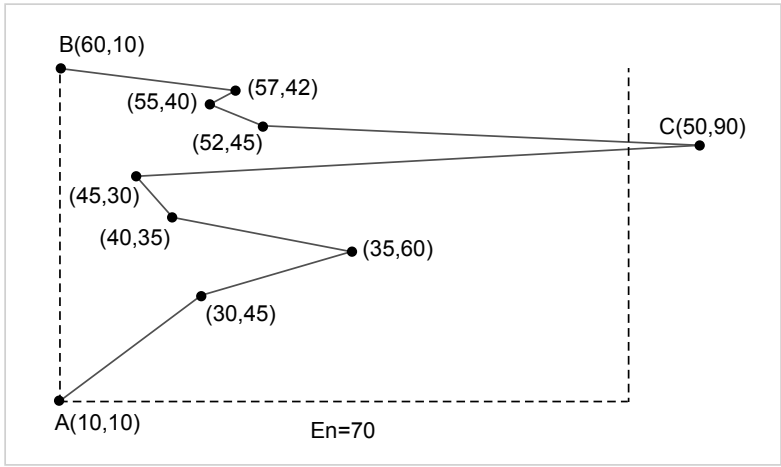
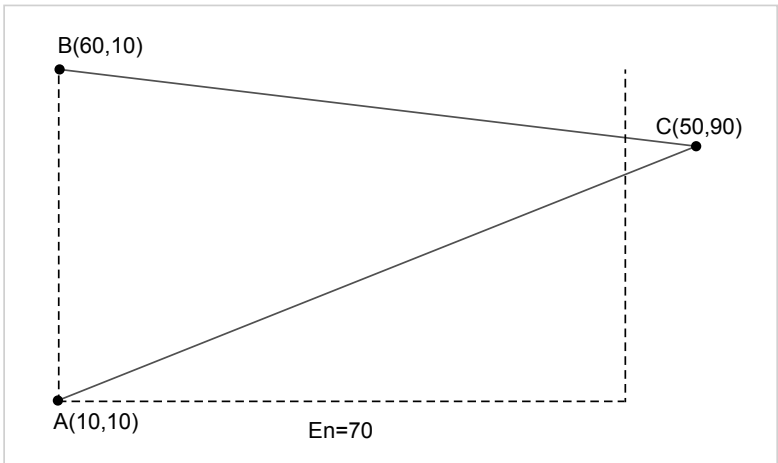


Figure 15.4 *Points in Data Set at Density n after Reduction*



GREDUCE uses the usual Euclidean distance formula to determine the distance between points. For example, the distance d between the points (x_0,y_0) and (x_1,y_1) is

$$d = \sqrt{(x_1 - x_0)^2 + (y_1 - y_0)^2}$$

This distance function might not suitable for the coordinate system in your input map data set. In that case, transform the X and Y values to an appropriate coordinate system before using GREDUCE. An example of inappropriate coordinates is latitude and longitude values around one of the poles. In this case, the data values should be projected before they are reduced. See Chapter 14, "GPROJECT Procedure," on page 525 for more information about map projection.

If you specify both N*n*= and E*n*= values for a density level, GREDUCE attempts to satisfy both criteria. However, the number of points for any level is never reduced below the number of points in density level 0. If you specify a combination of N*n*= or E*n*= values such that the resulting DENSITY values are not in order of increasing density, a note is printed in the SAS log. In this case the DENSITY values are calculated in increasing order of density.

Subsetting a Map Data Set

A map data set that is processed by GREDUCE does not automatically result in a map that uses fewer points. By default, the GMAP procedure produces a map that uses all of the points in the map data set. This occurs even if the data set has been processed by the GREDUCE procedure. To decrease the number of points that produce the map, you must create a subset of the original data set using a DATA step or the WHERE= data set option. For example, to create a subset of a map that uses only the DENSITY values 0, 1, and 2, use this DATA step:

```
data smallmap;
   set map;
   if density <= 2;
run;
```

Alternatively, you can use WHERE= in the PROC GMAP statement:

```
proc gmap map=map(where=(density<=2))
          data=response;
```

Note: GREDUCE does not reduce the size of the output map data set compared to the input map data set. By default, the output map data set from PROC GREDUCE is either equal in size or larger than the input map data set. The output map data set contains all of the variables and observations from the original data set. The output map data set also contains the derived DENSITY variable if it was not present in the original data set.

Example: Reducing the Map of Canada Using Traditional Map Data

About the GREDUCE Procedure Examples

Example in This Section

This section provides example "Example: Reducing the Map of Canada Using Traditional Map Data" on page 593, which demonstrates the major features of the GREDUCE procedure using traditional map data.

Examples Available Online

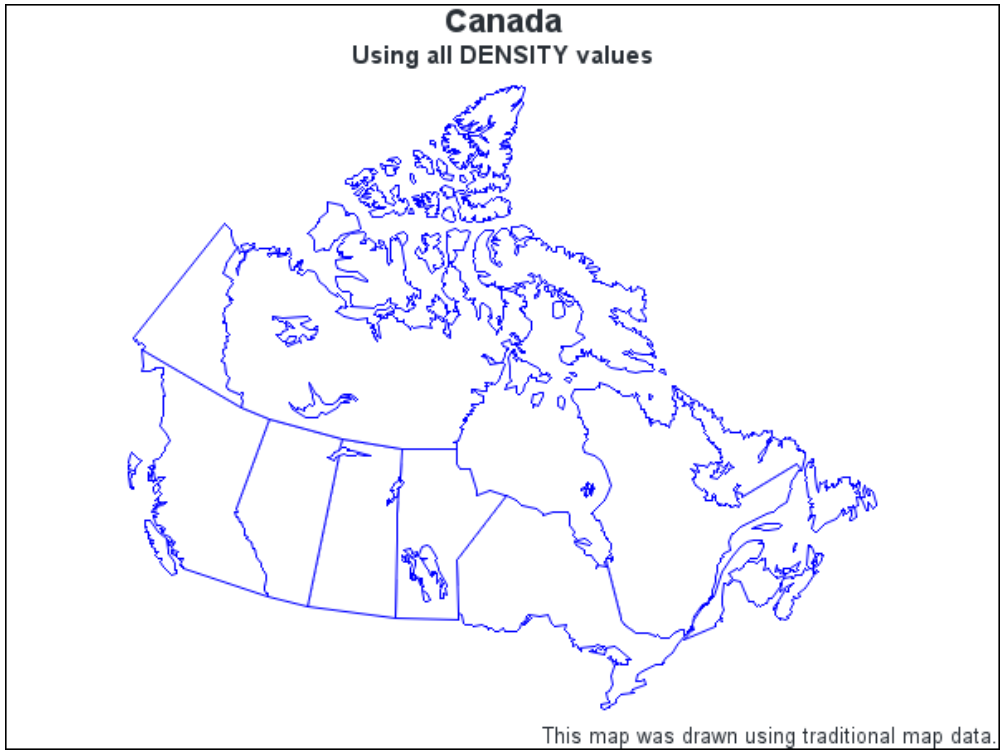
You can find more examples on the Graphically Speaking blog. On the blog page, use **Search Graphically Speaking** to search for GREDUCE to find the GREDUCE procedure examples.

Features: ID statement

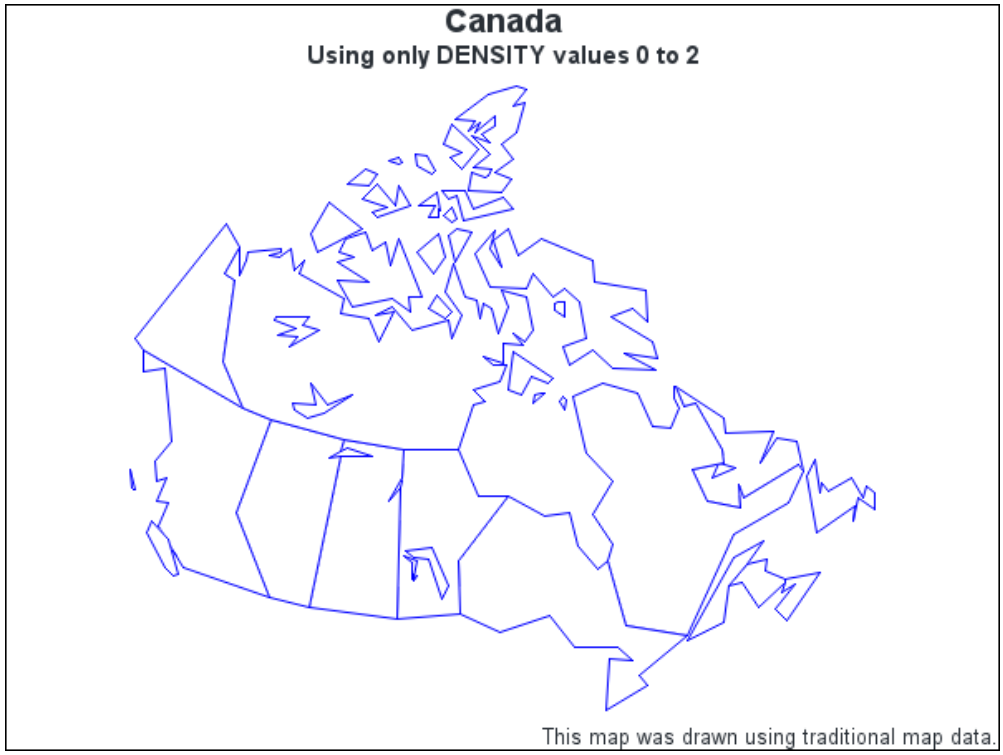
Data set: MAPS.CANADA2

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

In this example, the GREDUCE procedure creates the DENSITY variable for the CANADA2 map data set that is provided with SAS/GRAPH. First, the map is displayed at its original density by using the GMAP procedure.



Second, the map is displayed by using density values of 0 to 2.



Program

```
goptions reset=all border;
```

```
title1 "Canada";
title2 "Using all DENSITY values";

pattern value=msolid repeat=12 color=white;

proc gmap map=maps.canada2 data=maps.canada2 all;
   id province;
   choro province / stat=first nolegend coutline=blue;
run;

proc greduce data=maps.canada2 out=can2;
   id province;
run;

title2 "Using only DENSITY values 0 to 2";

proc gmap map=can2
          data=can2 all density=2;
   id province;
   choro province / stat=first nolegend coutline=blue;
run;
quit;
```

Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the title for the first map.

```
title1 "Canada";
title2 "Using all DENSITY values";
```

Define pattern characteristics.

```
pattern value=msolid repeat=12 color=white;
```

Show the unreduced map. The ID statement specifies the variable in the map data set that defines unit areas.

```
proc gmap map=maps.canada2 data=maps.canada2 all;
   id province;
   choro province / stat=first nolegend coutline=blue;
run;
```

The GREDUCE procedure creates a new map data set, CAN2, containing a DENSITY variable. The ID statement specifies the variable in the map data set that defines unit areas.

```
proc greduce data=maps.canada2 out=can2;
   id province;
run;
```

Define the title for the second map.

```
title2 "Using only DENSITY values 0 to 2";
```

Show reduced map with density levels 0-2. The DENSITY= option specifies the density levels that are used.

```
proc gmap map=can2
          data=can2 all density=2;
   id province;
   choro province / stat=first nolegend coutline=blue;
run;
quit;
```

See Also

Use PROC GREMOVE and GREDUCE for Nice SGMAP Regions on blogs.sas.com for another example

References

Douglas, D.H. and Peucker, T.K. 1973. “Algorithms for the Reduction of the Number of Points Required to Represent a Digitized Line or Its Caricature.” *The Canadian Cartographer* 10: 112–122.

16

GREMOVE Procedure

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Overview: GREMOVE Procedure

What Does the GREMOVE Procedure Do?

The GREMOVE procedure is available with Base SAS. The procedure is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this procedure.

The GREMOVE procedure processes a map data set that is used as input. It does not produce any graphics output. Instead, it produces an output data set that typically becomes the input map data set for either the GMAP or the SGMAP procedure. (See Chapter 13, "GMAP Procedure," on page 303, or Chapter 18, "SGMAP Procedure," on page 637). The GREMOVE procedure combines unit areas defined in a map data set into larger unit areas by removing internal borders between the original unit areas. For example, Figure 16.50 on page 598 and Figure 16.51 on page 599 show combined unit areas in a typical map data set by removing state boundaries to create a regional map.

Figure 16.1 *U.S. Map Before Removing Boundaries*

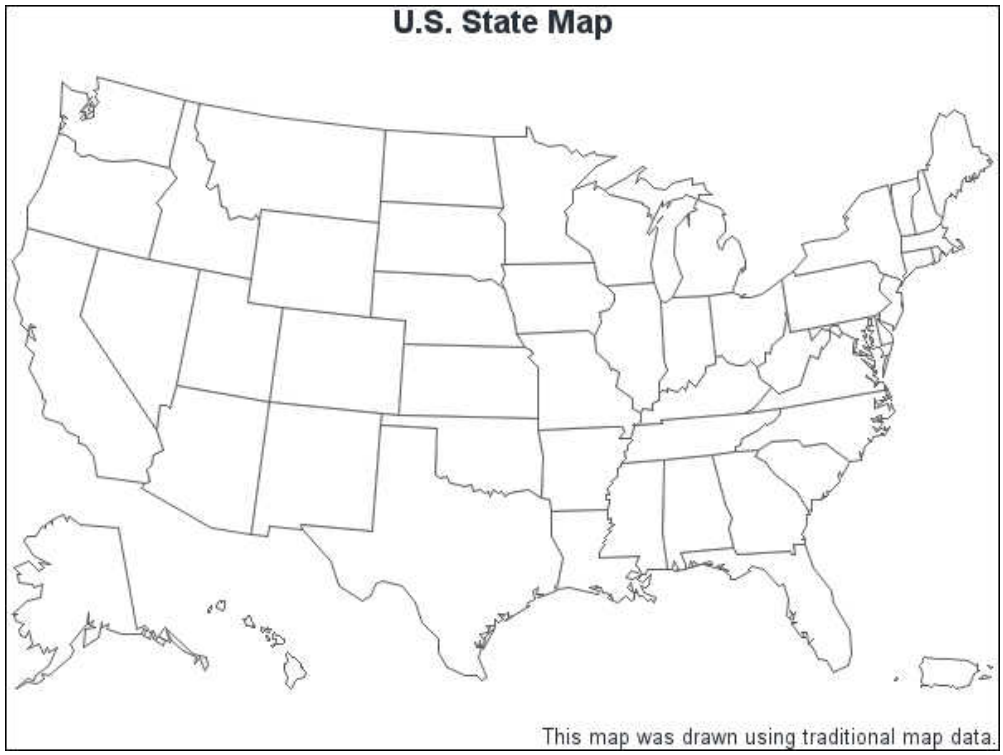
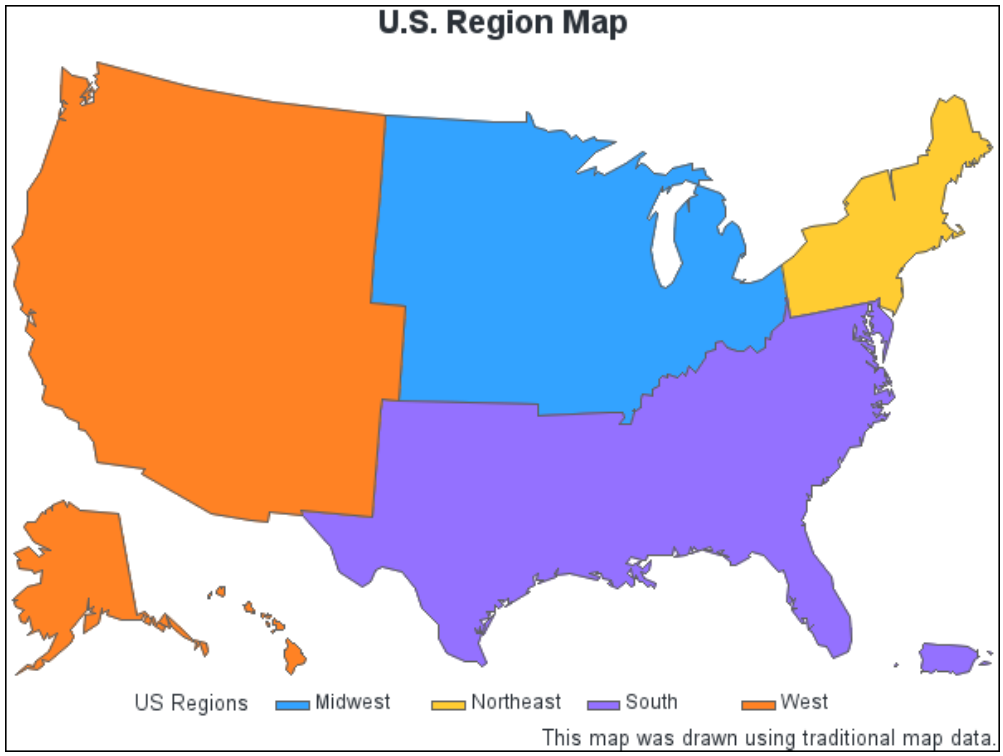


Figure 16.2 *U.S. Map After Removing Boundaries*



The program for these maps is shown in "Program" on page 610.

To run this procedure, the various data sets and essential SAS software must be available in your installation. Storage restrictions apply to map data sets that are used with the SGMAP procedure's CHOROMAP or SERIES statement and to geocoding lookup data sets. Because the map data sets contain sequential polygonal data, storing the mapping data on a distributed system such as aTeradata server, a SAS® LASR™ Analytic Server, or a SAS Cloud Analytic Services (CAS) server is not recommended. Data sequence cannot be guaranteed on distributed systems such as these, which can cause unexpected results. If the criterion is met, you can copy the procedure examples provided in this chapter into your program editor and run them to create the required output. Your IDE might provide additional resources for creating maps. Refer to the documentation for your IDE for more information.

Concepts: GREMOVE Procedure

About the GREMOVE Procedure

The GREMOVE procedure processes the input map data set to remove internal boundaries and creates a new map data set. The PROC GREMOVE statement identifies the input and output map data sets. The ID statement identifies the variable or variables in the input map data set that define the current unit areas. The BY statement identifies the variable or variables in the input map data set that define the new unit areas.

About the Input Map Data Set

The input map data set must be in a SAS data set format (see "About Map Data Sets" on page 309) and it must contain these variables:

- a numeric variable named X that contains the horizontal coordinates of the map boundary points.
- a numeric variable named Y that contains the vertical coordinates of the map boundary points.
- one or more variables that uniquely identify the current unit areas in the map. These variables are listed in the ID statement. Each group of observations with a different ID variable value is evaluated as a separate unit area.
- one or more variables that identify the new unit areas to be created in the output map data set. These variables are listed in the BY statement.

It might also contain the variable SEGMENT, which is used to distinguish non-conterminous segments of the same unit areas. Other variables might exist in the input map data set and by default they are carried into the output map data set. The other variables do not affect the GREMOVE procedure, but they can be used by other mapping procedures. If these other variables are not needed, use the DROPVARS option to override this default inclusion behavior and omit them from the output map data set.

About the Output Map Data Set

The output map data set contains the newly defined unit areas. These new unit areas are created by removing all interior line segments from the original unit areas. All variables in the input map data set including X, Y, SEGMENT, and the variables listed in the BY statement are carried into the output map data set by default. Use the DROPVARS option to omit the variables from the output map data set.

The output map data set might contain missing X, Y coordinates that are necessary to construct any polygons with enclosed boundaries. This includes lakes or combined regions that have one or more hollow interior regions.

The SEGMENT variable in the output map data set is ordered according to the size of the bounding box around the polygon that it describes. A SEGMENT value of 1 describes the polygon whose bounding box is the largest in the unit area, and each additional SEGMENT value describes a smaller polygon. This information is useful for removing small polygons that clutter up maps.

All current unit areas with common BY-variable values are combined into a single unit area in the output map data set. The new unit area contains the following:

- all boundaries that are not shared, such as islands and lakes
- all boundaries that are shared by two different BY groups

All other variables can be used by other mapping procedures.

About Unmatched Area Boundaries

If you are using map data sets in which area boundaries do not match precisely (for example, if the boundaries were digitized with a different set of points), PROC GREMOVE is unable to identify common boundaries properly. This results in abnormalities in your output data set.

If the points in the area boundaries match up except for precision differences, round each X and Y value in your map data set accordingly. To accomplish this use the DATA step function ROUND before using PROC GREMOVE. See *SAS Functions and CALL Routines: Reference* for information about the ROUND function.

Take, for example, the map data set APPROX, which has horizontal and vertical coordinate values for interior boundaries of unit areas that are exactly equal only to three decimal places. The following DATA step creates a new map data set, EXACT, that is better suited for use with the GREMOVE procedure:

```
data exact;
   set approx;
   if x ne . then x=round(x,.001);
   if y ne . then y=round(y,.001);
run;
```

You can also use the FUZZ option to specify a level of tolerance so that the boundaries do not need to match precisely.

Syntax: GREMOVE Procedure

Requirements: An input map data set is required. If not specified, an input map data set must have been created before issuing the PROC GREMOVE statement.

The BY and ID statements are required.

PROC GREMOVE DATA=*input-map-data-set*
<DROPVARS>
<FUZZ=*fuzz-factor*>
<OUT=*output-map-data-set*>
<NODECYCLE>;

BY *variable(s)*
<DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...>
<NOTSORTED>;

ID *variable(s)*;

PROC GREMOVE Statement

Identifies the input and output map data sets.

Requirement: An input map data set is required. If not specified, an input map data set must have been created before issuing the PROC GREMOVE statement.

Syntax

PROC GREMOVE DATA=*input-map-data-set*
<DROPVARS>
<FUZZ=*fuzz-factor*>
<NODECYCLE>
<OUT=*output-map-data-set*>;

Summary of Optional Arguments

DROPVARS
requests the removal of most of the variables from the input map data set.

FUZZ=*fuzz-factor*

specifies a tolerance for possible error in the data.

NODECYCLE
specifies that the GREMOVE procedure use a topological algorithm for closing the resulting polygons.

OUT=*output-data-set*
names the new map data set, which contains the coordinates of the new unit areas created by the GREMOVE procedure.

Required Argument

DATA=*input-map-data-set*
specifies the map data set that is to be processed. The GREMOVE procedure expects the observations in the input map data set to be sorted in ascending order of the BY-variable values.

Default The GREMOVE procedure uses the most recently created SAS data set.

Requirement The DATA= statement is required if no input map data set was created before issuing the PROC GREMOVE statement.

See "About the Input Map Data Set" on page 600

"The SAS Data Set: Your Key to the SAS System" in *Step-by-Step Programming with Base SAS*

"About Data Set Options" in *SAS Data Set Options: Reference*

Example "Example 2: Creating an Outline Map of Africa" on page 612

Optional Arguments

DROPVARS
requests the removal of most of the variables from the input map data set. The only variables that are not removed are the variables specified in the ID statement and the X, Y, and SEGMENT variables. It also keeps any variables specified by the DROP and KEEP statements on the DATA step.

Use the DROP statement on the DATA step instead of specifying the DROPVARS option to selectively DROP certain variables. Conversely, indicate any variables that you want to retain by using the KEEP statement on the DATA step along with the DROPVARS option in the PROC GREMOVE statement. Do not use both DROP and KEEP statements within the same DATA step.

Alias DROPV

Default Variable values are kept unless option DROPVARS is specified.

FUZZ=*fuzz-factor*
specifies a tolerance for possible error in the data. This allows for points that are very close but not quite equal to be considered as the same point. The fuzz-factor can be any nonnegative number. A fuzz-factor of 0.0 would indicate that the points have to be exactly the same. The unit represented by the fuzz-factor

(degrees, radians, feet, meters, kilometers, miles) is the same as that represented by the X and Y values of the points.

The error is computed the same in both X and Y directions using the following formula: `Point_is_equal = (ABS(x1 - x2) <= fuzz-factor) && (ABS(y1 - y2) <= fuzz-factor)`

NODECYCLE
specifies that the GREMOVE procedure use a topological algorithm for closing the resulting polygons. By default, PROC GREMOVE simply removes internal boundaries without using any polygon information. This might cause errors in closing the resulting polygons in certain cases—specifically when two resulting polygons intersect at a single point. Using a topological algorithm allows PROC GREMOVE to traverse the resulting polygons for proper closure of the polygons. When the single point intersection is encountered, the algorithm uses the topology to correctly interpret which existing segment to choose in closing the polygon. Therefore, using the NODECYCLE option requires that the data contain polygons that do not overlap themselves or each other and that there are no anomalies in the boundaries such as a repeated series of points.

Alias NC

Requirement The NODECYCLE option requires that the data be topologically correct.

Tip Certain SAS/GRAPH procedures, such as PROC GREDUCE, which have no knowledge of topology and do not maintain topology, can produce topologically incorrect polygons. Therefore, it is recommended that you do not use PROC GREDUCE if you are going to use PROC GREMOVE with NODECYCLE specified.

OUT=*output-data-set*
names the new map data set, which contains the coordinates of the new unit areas created by the GREMOVE procedure. By default, the GREMOVE procedure names the new data set using the DATA*n* naming convention. That is, the procedure uses the name WORK.DATA*n*, where *n* is the next unused number in sequence. Thus, the first automatically named data set is DATA1, the second is DATA2, and so on.

See “About the Output Map Data Set” on page 601.

Example “Example 2: Creating an Outline Map of Africa” on page 612

BY Statement

Lists the variable or variables that identify the new unit areas.

Requirement: At least one variable is required.

Example: “Example 1: Removing State Boundaries from U.S. Map” on page 608

Syntax

BY *variable(s)*
<DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...>
<NOTSORTED>;

Summary of Optional Arguments

DESCENDING
: indicates that the input map data set is sorted in descending order.

NOTSORTED
: specifies that observations with the same BY-variable values are to be grouped as they are encountered without regard for whether the values are in alphabetical or numerical order.

Required Argument

variable(s)
: specifies one or more variables in the input map data set that define the new unit areas. *Variable(s)* can be either numeric or character.

  The BY variables in the input map data set become the ID variables for the output map data set.

Optional Arguments

DESCENDING
: indicates that the input map data set is sorted in descending order. By default, the GREMOVE procedure expects all BY-variable values to appear in ascending order.

  This option affects only the variable that immediately follows the option.

NOTSORTED
: specifies that observations with the same BY-variable values are to be grouped as they are encountered without regard for whether the values are in alphabetical or numerical order. NOTSORTED can appear anywhere in the BY statement. It affects all of the variables that are specified in the statement.

  Interaction The NOTSORTED option overrides the DESCENDING option if both appear in the same BY statement.

Details

Ordering Observations

To sort the input map data set, use the SORT procedure in Base SAS, for example:

```
/* arrange the observations in desired order */
proc sort data=mapdata out=mapsort;
   by state;
run;
   /* remove the county boundaries              */
proc gremove data=mapsort out=newmap;
   by state;
   id county;
run;
```

Notice that the GREMOVE procedure uses the same BY statement as the SORT procedure.

See the *Base SAS Procedures Guide* for more information about the SORT procedure.

Note: If an observation is encountered for which the BY-variable value is out of the proper order, the GREMOVE procedure stops and issues an error message.

ID Statement

Identifies the variable or variables that define the hierarchy of the current unit areas in the input map data set.

Requirement: At least one *id-variable* is required.

See: "Example 1: Removing State Boundaries from U.S. Map" on page 608

Syntax

ID *id-variable(s)*;

Required Argument

id-variable(s)
specifies one or more variables in the input map data set that identify the unit areas to be combined. These variables are not included in the output map data set. *Id-variable(s)* can be either numeric or character.

See "About the Input Map Data Set" on page 600

Examples: GREMOVE Procedure

About the GREMOVE Procedure Examples

Examples in This Section

This section provides basic examples of how to use the GREMOVE procedure. The following table lists the examples that are provided.

Table 16.1 *GREMOVE Procedure Examples*

Example	Map Data Used	Description
Removing State Boundaries from U.S. Map (p. 608)	GfK	Shows how to process the MAPSGFK.US map data set to produce a new map data set that contains regional boundaries instead of state boundaries.
Creating an Outline Map of Africa (p. 612)	GfK	Shows how to process the MAPSGFK.AFRICA map data set to produce a new map data set that contains no internal boundaries.
Removing State Boundaries from U.S. Map Using Traditional Map Data (p. 618)	Traditional	Shows how to process the MAPSSAS.US map data set to produce a new map data set that contains regional boundaries instead of state boundaries.
Creating an Outline Map of Africa Using Traditional Map Data (p. 622)	Traditional	Shows how to process the MAPSSAS.AFRICA map data set to produce a new map data set that contains no internal boundaries.

Examples Available Online

You can find more examples on the Graphically Speaking blog. On the blog page, use **Search Graphically Speaking** to search for GREMOVE to find the GREMOVE procedure examples.

Example 1: Removing State Boundaries from U.S. Map

Features:
GREMOVE procedure
- BY statement
- ID statement

Global statements
- TITLE
- FOOTNOTE
- PATTERN

SQL procedure

GMAP procedure with CHOROPLETH statement

GOPTIONS statement

Data set: MAPSGFK.US

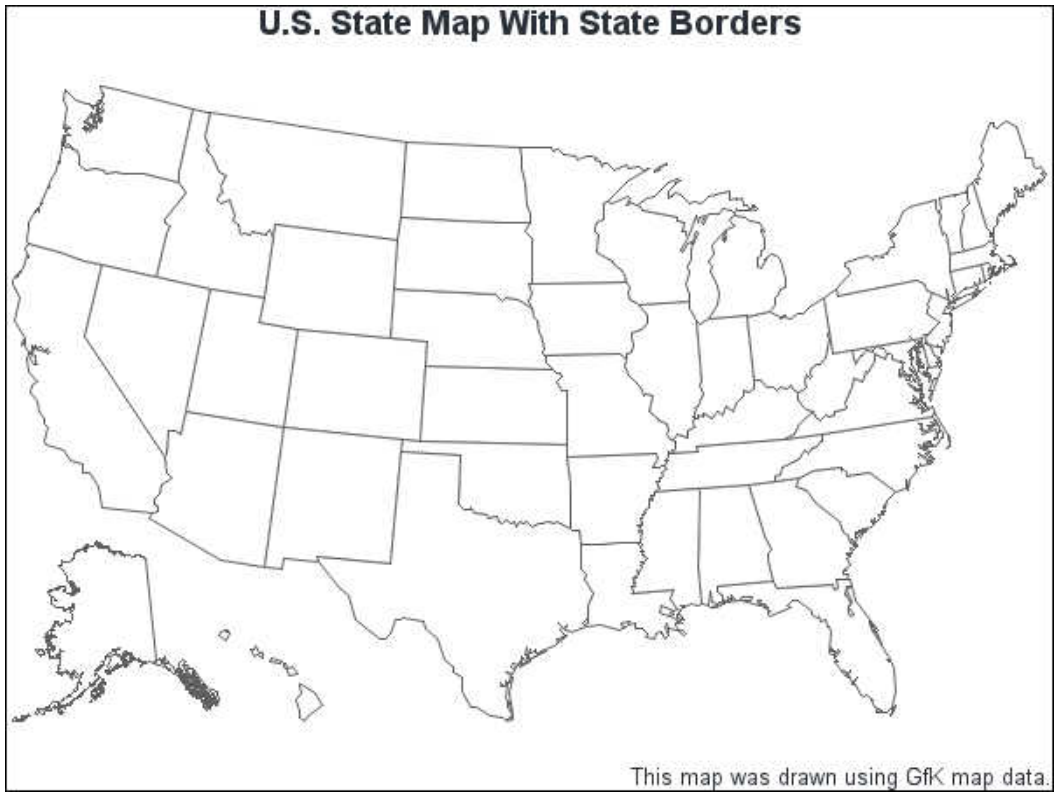
Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example processes the MAPSGFK.US map data set to produce a new map data set containing regional boundaries. Because the MAPSGFK.US map data set does not contain a variable to identify any unit area other than states, this example creates a map data set that contains the regions. These regions are retrieved from the SASHELP.US_DATA data set. The MY_MAP data set is created by keying off of the common STATECODE variable to combine the MAPSGFK.US map data set with the regions from the SASHELP.US_DATA data set. The MY_MAP data set can then be processed with the GREMOVE procedure to remove state boundaries.

By matching STATECODES common to both data sets, the SQL procedure combines regions and these STATECODES from SASHELP.US_DATA with the MAPSSAS.US map data set that is now called MY_MAP. The SQL procedure orders the MY_MAP map data set by region. The GREMOVE procedure uses REGION as the BY-variable to remove the state boundaries within the MY_MAP data set.

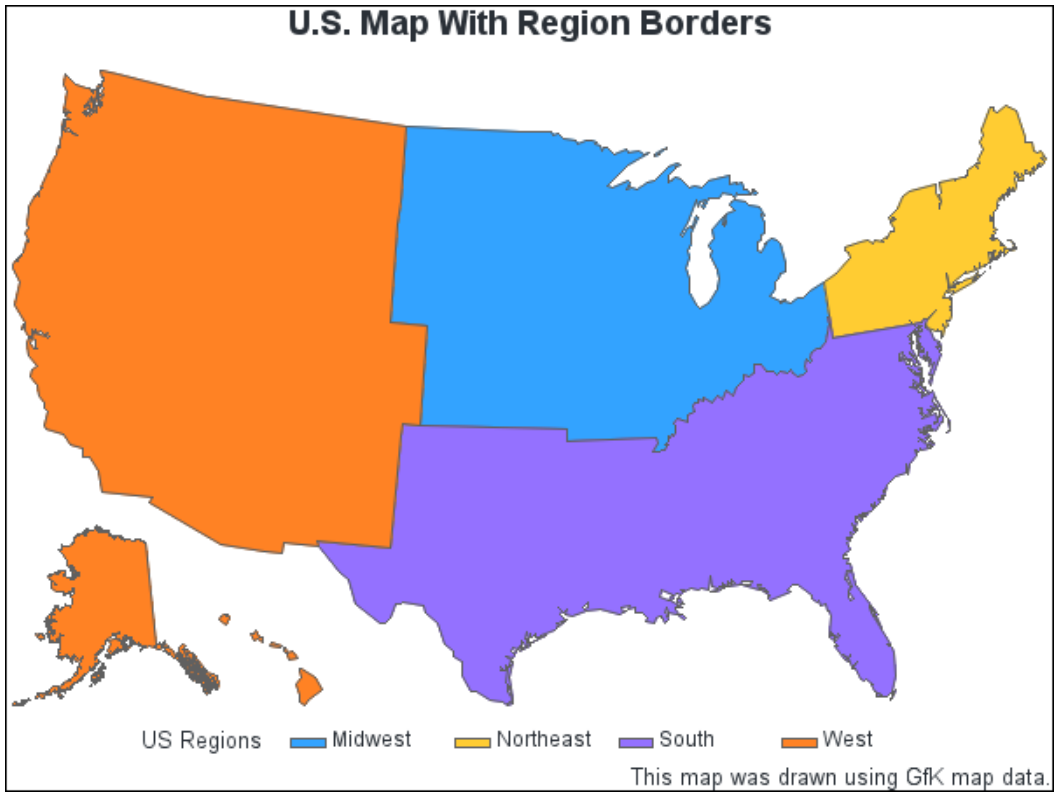
This example produces two PNG files named grmusma1.png and grmusmap.png. An HTML5 file named grmusmap.htm is also produced. You can view the PNG graphics by right-clicking on the filename to download them and view them in your PNG-enabled image browser. The HTML5 file that contains both PNG files is viewable in the same way.

Output 16.1 *Map Before Removing Borders*



Output 16.25 on page 610 shows the resulting map after PROC GREMOVE has removed interior state boundaries.

Output 16.2 *Map After Removing Borders*



Program

```
goptions border;

data myMap;
   set mapsgfk.us;
   original_order=_n_;
run;

proc sql noprint;
   create table myRegionMap as
   select myMap.*, us_data.region
   from myMap left join sashelp.us_data
   on myMap.statecode=us_data.statecode
   order by region, statecode, original_order;
run;

proc gremove data=myRegionMap out=myRegionMap;
   by region;
   id statecode;
run;

title "U.S. State Map With State Borders";

pattern value=s color=white;

proc gmap map=mapsgfk.us data=mapsgfk.us all;
   id state;
   choro segment / stat=first levels=1 nolegend
```

```
   des='' name="grmgusmA";
run;
quit;

title "U.S. Map With Region Borders";

goptions reset=pattern;

proc gmap map=myRegionMap data=sashelp.us_data all;
   id region;
   choro region / stat=first cdefault=red
   des='' name="grmgusmB";
run;
quit;

goptions reset=all;
```

Program Description

Set the graphics environment.

```
goptions border;
```

Create data set MYMAP. This data set is a mirror of the MAPS.US data set and maintains the original order of its variables.

```
data myMap;
   set mapsgfk.us;
   original_order=_n_;
run;
```

Create a sorted data set, MYMAP. Combine the MYMAP data set and the SASHELP.US_DATA data set using their common STATECODE variable. The regions from the SASHELP.US_DATA data set are now part of MYMAP. Sort the data set into regions by state.

```
proc sql noprint;
   create table myRegionMap as
   select myMap.*, us_data.region
   from myMap left join sashelp.us_data
   on myMap.statecode=us_data.statecode
   order by region, statecode, original_order;
run;
```

Remove interior boundaries within regions. BY specifies the REGION variable in the input map data set that identifies the new unit areas. ID specifies the variable STATECODE in the MYMAP input map data set. That variable identifies the current unit areas.

```
proc gremove data=myRegionMap out=myRegionMap;
   by region;
   id statecode;
run;
```

Define the title for the map.

```
title "U.S. State Map With State Borders";
```

Define the state pattern characteristics.

```
pattern value=s color=white;
```

Show the original map.

```
proc gmap map=mapsgfk.us data=mapsgfk.us all;
   id state;
   choro segment / stat=first levels=1 nolegend
   des='' name="grmgusmA";
run;
quit;
```

Define the new title for the map with state boundaries removed.

```
title "U.S. Map With Region Borders";
```

Reset the pattern to use the default color pattern before creating the map with state boundaries removed.

```
goptions reset=pattern;
```

Show the regional map. ID specifies the REGION variable that identifies the unit areas in the processed data set. CHORO specifies REGION as the response variable.

```
proc gmap map=myRegionMap data=sashelp.us_data all;
   id region;
   choro region / stat=first cdefault=red
   des='' name="grmgusmB";
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

Example 2: Creating an Outline Map of Africa

Features: PROC GREMOVE options DATA= and OUT=
GMAP procedure

Data set: MAPSGFK.AFRICA

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example processes the MAPSGFK.AFRICA map data set to produce a new map data set that contains no internal boundaries. This is done by adding a new variable, REGION, to the map data set and setting it equal to 1. Unit areas from the input map data set that have the same BY-variable value are combined into one unit area in the output map data set.

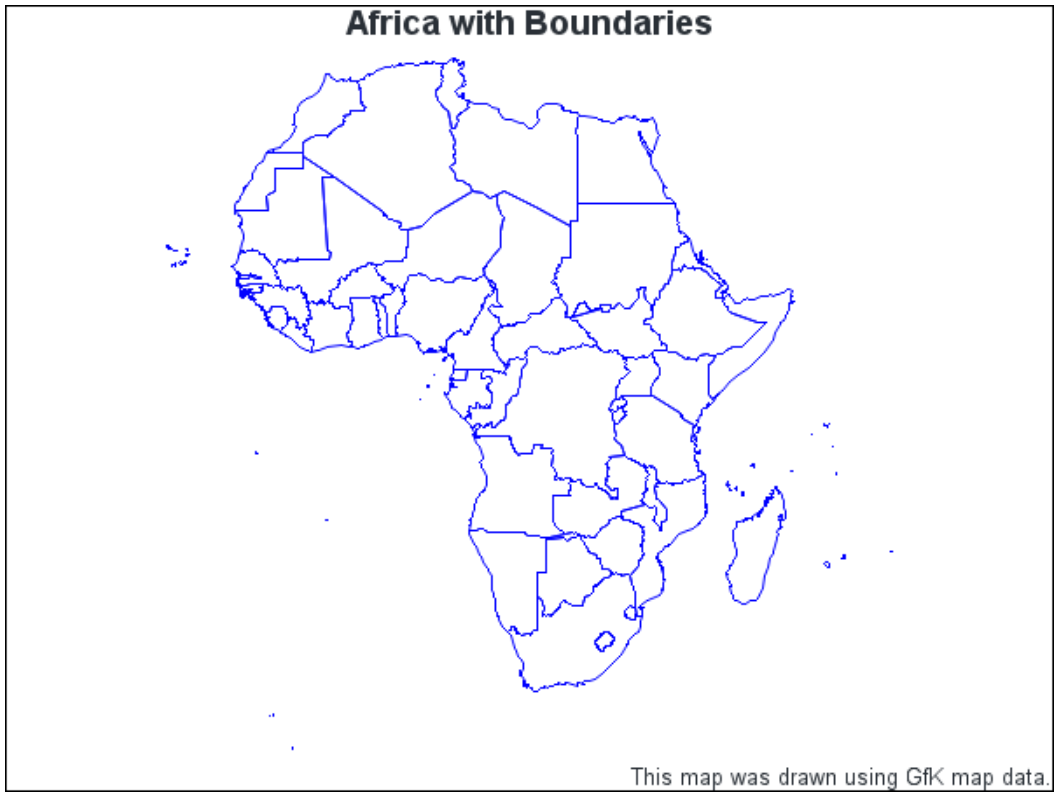
Output 16.26 on page 613 shows some of the variables that are present in the original map data set:

Output 16.3 *Partial Listing of Selected Columns from the MAPSGFK.AFRICA Data Set*

Obs	ID	SEGMENT	X	Y
1	AO	1	-1364.7376	1148.59783
2	AO	1	-1364.9158	1147.38517
3	AO	1	-1364.0938	1146.53074
4	AO	1	-1364.1300	1145.79894
5	AO	1	-1363.9044	1145.60118
6	AO	1	-1363.9306	1144.49428
7	AO	1	-1364.3513	1143.70219
8	AO	1	-1364.3465	1142.60166
9	AO	1	-1363.9636	1140.97950
10	AO	1	-1364.5740	1140.49788
11	AO	1	-1364.5299	1139.92987
12	AO	1	-1363.5126	1139.68323
13	AO	1	-1363.4045	1138.55196

Output 16.27 on page 614 shows the map before processing:

Output 16.4 *Africa Map Before Removing Boundaries*



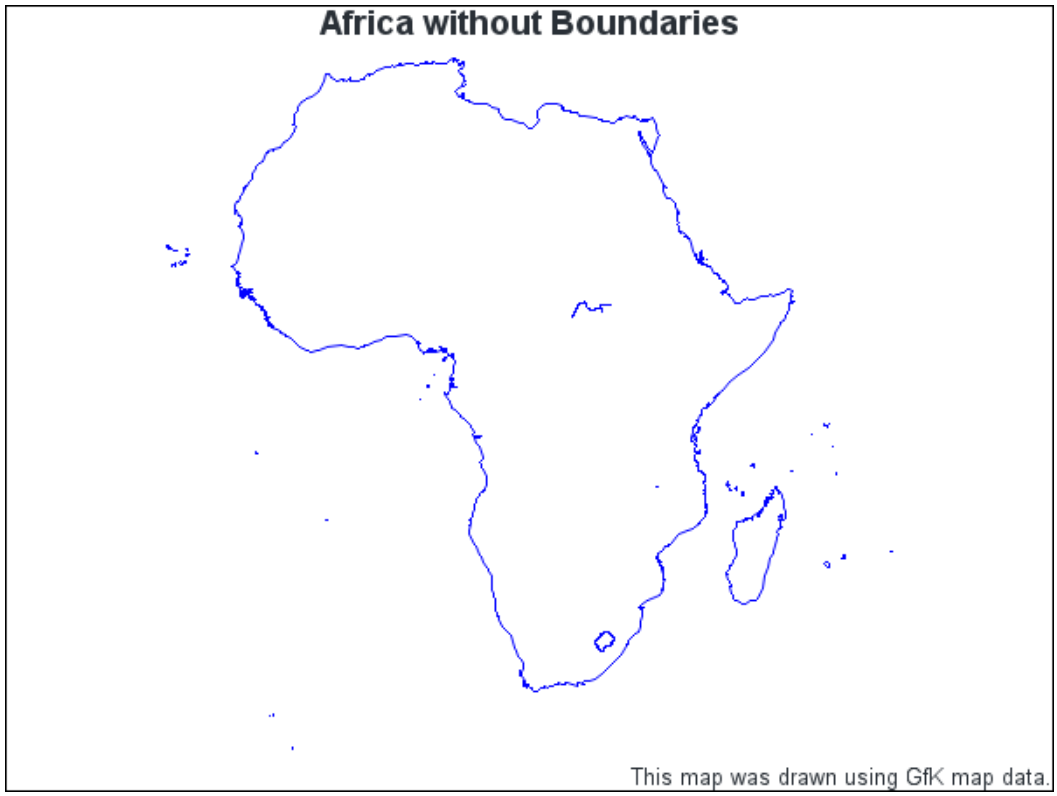
The new AFRICA map data set is created with a new variable, REGION. Output 16.28 on page 615 shows some of the variables that are present in the new map data set created by the GREMOVE procedure:

Output 16.5 *Partial Listing of Selected Columns from the WORK.AFRICA Data Set*

Obs	X	Y	SEGMENT	region
1	-2799.4234	2041.82514	1	1
2	-2798.9119	2041.71480	1	1
3	-2798.5024	2041.04511	1	1
4	-2798.0597	2040.88481	1	1
5	-2797.4816	2040.26348	1	1
6	-2797.5874	2040.07584	1	1
7	-2797.3514	2039.88006	1	1
8	-2797.3518	2039.43772	1	1
9	-2797.0387	2039.59939	1	1
10	-2796.5886	2039.34416	1	1
11	-2796.0723	2038.44608	1	1
12	-2796.1122	2038.91910	1	1
13	-2795.6828	2039.29688	1	1

Output 16.29 on page 616 shows the new map after PROC GREMOVE has removed all of the interior boundaries:

Output 16.6 *Africa Map After Removing Boundaries*



Program

```
data newaf;
   set mapsgfk.africa;
   region=1;
run;

proc gremove data=newaf out=africa;
   by region;
   id id;
run;

title "Africa with Boundaries";

pattern value=mempty color=blue;

proc gmap map=mapsgfk.africa data=mapsgfk.africa all;
   id id;
   choro segment / stat=first nolegend levels=1;
run;
quit;

title "Africa without Boundaries";

proc gmap data=africa map=africa;
   id region;
   choro region / stat=first nolegend levels=1;
run;
quit;
```

Program Description

Create the NEWAF data set. This new map data set contains all the variables in the MAPSGFK.AFRICA map data set plus the added variable REGION.

```
data newaf;
   set mapsgfk.africa;
   region=1;
run;
```

Remove the unit areas from the AFRICA data set. DATA= specifies the input map data set and OUT= specifies the output map data set. The input map data set has a variable called REGION that is used as the BY-variable to identify the new unit areas. The ID statement specifies the current unit areas from the input map data set.

```
proc gremove data=newaf out=africa;
   by region;
   id id;
run;
```

Define a title for the map.

```
title "Africa with Boundaries";
```

Define pattern characteristics.

```
pattern value=mempty color=blue;
```

Display the original map.

```
proc gmap map=mapsgfk.africa data=mapsgfk.africa all;
   id id;
   choro segment / stat=first nolegend levels=1;
run;
quit;
```

Define a new title for the map.

```
title "Africa without Boundaries";
```

Display the map with no boundaries. ID specifies the variable, REGION, that identifies the unit areas in the processed data set. The STATISTIC= option indicates that the GMAP procedure is to match and graph only the first observation from the AFRICA data set. The NOLEGEND option suppresses the automatic legend. The LEVELS= option specifies that one response level is graphed.

```
proc gmap data=africa map=africa;
   id region;
   choro region / stat=first nolegend levels=1;
run;
quit;
```

See Also

Use PROC GREMOVE and GREDUCE for Nice SGMAP Regions on blogs.sas.com for another example

Example 3: Removing State Boundaries from U.S. Map Using Traditional Map Data

Features:

GREMOVE procedure
- BY statement
- ID statement

Global statements
- TITLE
- FOOTNOTE
- PATTERN

SQL procedure

GMAP procedure with CHOROPLETH statement

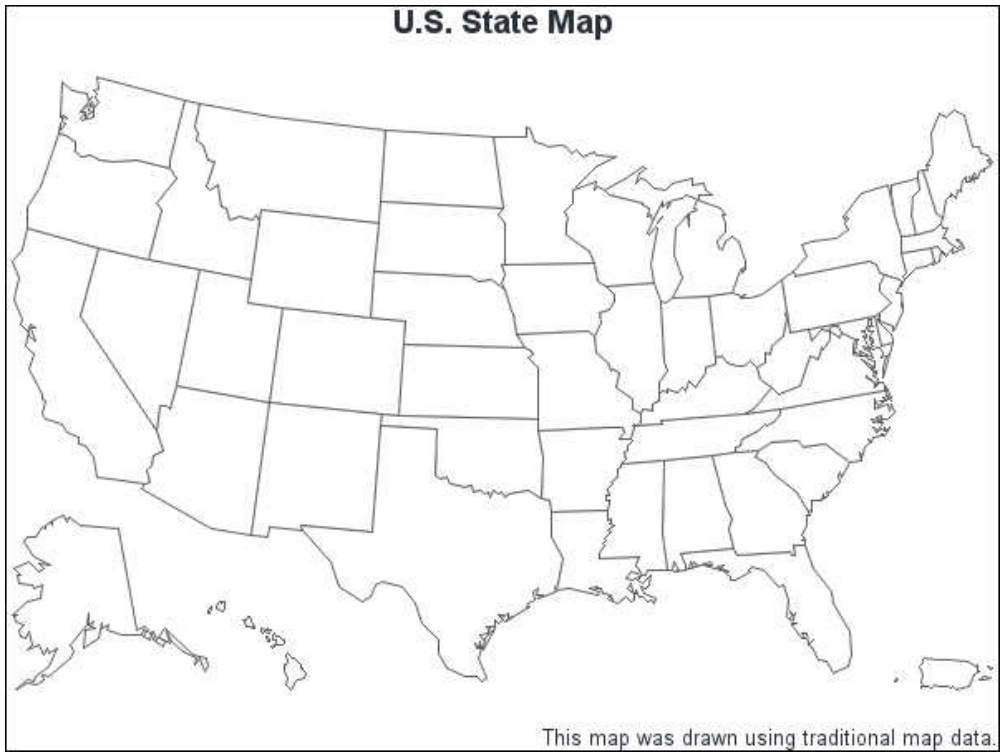
GOPTIONS statement

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example processes the MAPSSAS.US map data set, supplied with SAS/GRAPH, to produce a new map data set containing regional boundaries. Because the MAPSSAS.US map data set does not contain a variable to identify any unit area other than states, this example creates a map data set that contains the regions. These regions are retrieved from the SASHELP.US_DATA data set. Data set MYMAP is created from MAPSSAS.US. Variable ORIGINAL_ORDER is added to record the original data order. The MYREGIONMAP data set is created by keying off of the common STATECODE variable to combine the MAPSSAS.US map data set with the regions from the SASHELP.US_DATA data set. The MYREGIONMAP is then processed with the GREMOVE procedure to remove state boundaries.

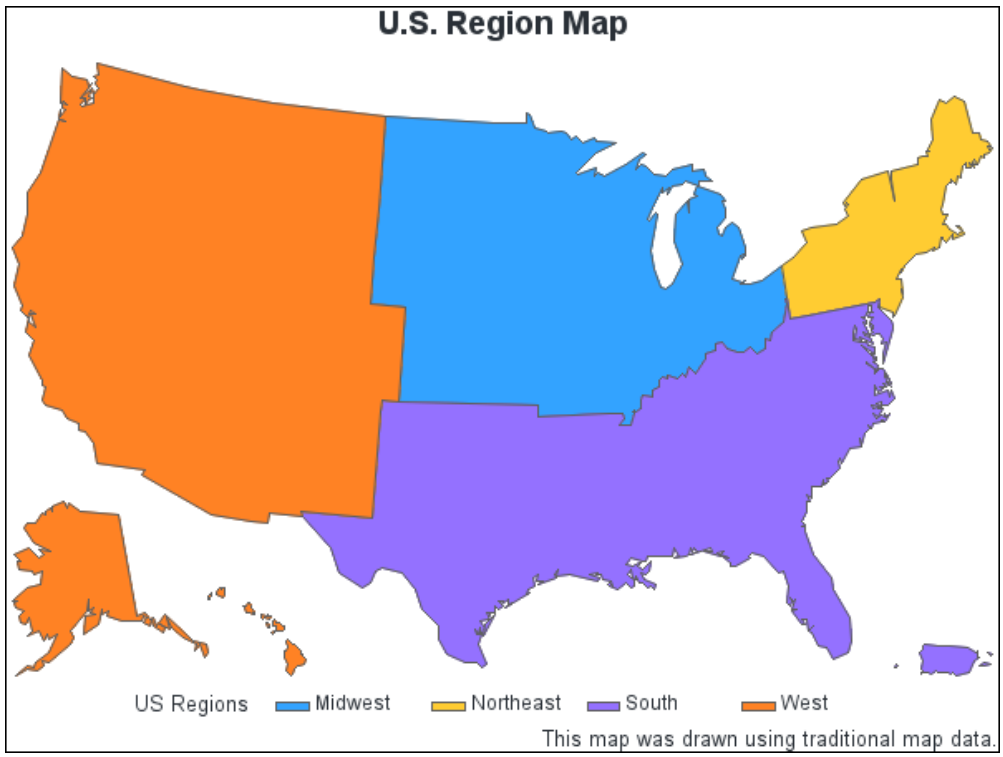
By matching STATECODES common to both data sets, the SQL procedure combines regions and these STATECODES from SASHELP.US_DATA with the MAPSSAS.US map data set that is now called MYREGIONMAP. The SQL procedure orders the MYREGIONMAP map data set by region. The GREMOVE procedure uses REGION as the BY-variable to remove the state boundaries within the MYREGIONMAP data set.

Output 16.7 *Map Before Removing Borders*



Output 16.25 on page 610 shows the resulting map after PROC GREMOVE has removed interior state boundaries.

Output 16.8 *Map After Removing Borders*



Program

```
goptions reset=all border device=png;

data mymap;
   set mapssas.us;
   original_order=_n_;
run;

proc sql noprint;
   create table myregionmap as
   select mymap.*, us_data.region
   from mymap left join sashelp.us_data
   on mymap.statecode=us_data.statecode
   order by region, statecode, original_order;
run;


proc gremove data=myregionmap out=myregionmap;
   by region;
   id statecode;
run;

title "U.S. State Map";

pattern value=s color=white;

proc gmap map=mapssas.us data=mapssas.us all;
   id state;
   choro segment / stat=first levels=1 nolegend des='' name="grmusmaA";
run;

title "U.S. Region Map";

goptions reset=pattern;

proc gmap map=myregionmap data=sashelp.us_data all;
   id region;
   choro region / stat=first cdefault=red
   des='' name="grmusmaB";
run;
quit;

goptions reset=all;
```

Program Description

Set the graphics environment.

```
goptions reset=all border device=png;
```

Create data set MYMAP. This data set is a mirror of the MAPSSAS.US data set and maintains the original order of its variables.

```
data mymap;
   set mapssas.us;
   original_order=_n_;
run;
```

Create data set MYREGIONMAP. Combine the MYMAP data set and the SASHELP.US_DATA data set using their common STATECODE variable. The regions from the SASHELP.US_DATA data set are now part of MYREGIONMAP. Sort the data set into regions by state.

```
proc sql noprint;
   create table myregionmap as
   select mymap.*, us_data.region
   from mymap left join sashelp.us_data
   on mymap.statecode=us_data.statecode
   order by region, statecode, original_order;
run;
```

Remove interior boundaries within regions. BY specifies the variable, REGION, in the input map data set that identifies the new unit areas. ID specifies the variable STATECODE in the MYREGIONMAP input map data set. That variable identifies the current unit areas.

```
proc gremove data=myregionmap out=myregionmap;
   by region;
   id statecode;
run;
```

Define the title for the map.

```
title "U.S. State Map";
```

Define the state pattern characteristics.

```
pattern value=s color=white;
```

Show the original map.

```
proc gmap map=mapssas.us data=mapssas.us all;
   id state;
   choro segment / stat=first levels=1 nolegend des='' name="grmusmaA";
run;
```

Define the new title for the map with state boundaries removed.

```
title "U.S. Region Map";
```

Reset the pattern to use the default color pattern before creating the map with state boundaries removed.

```
goptions reset=pattern;
```

Show the regional map. ID specifies the variable, REGION, that identifies the unit areas in the processed data set. CHORO specifies REGION as the response variable.

```
proc gmap map=myregionmap data=sashelp.us_data all;
   id region;
   choro region / stat=first cdefault=red
   des='' name="grmusmaB";
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

Example 4: Creating an Outline Map of Africa Using Traditional Map Data

Features: PROC GREMOVE options DATA= and OUT=
GMAP procedure

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example processes the MAPSSAS.AFRICA map data set, supplied with SAS/GRAPH, to produce a new map data set that contains no internal boundaries. This is done by adding a new variable, REGION, to the map data set and setting it equal to 1. Unit areas from the input map data set that have the same BY-variable value are combined into one unit area in the output map data set.

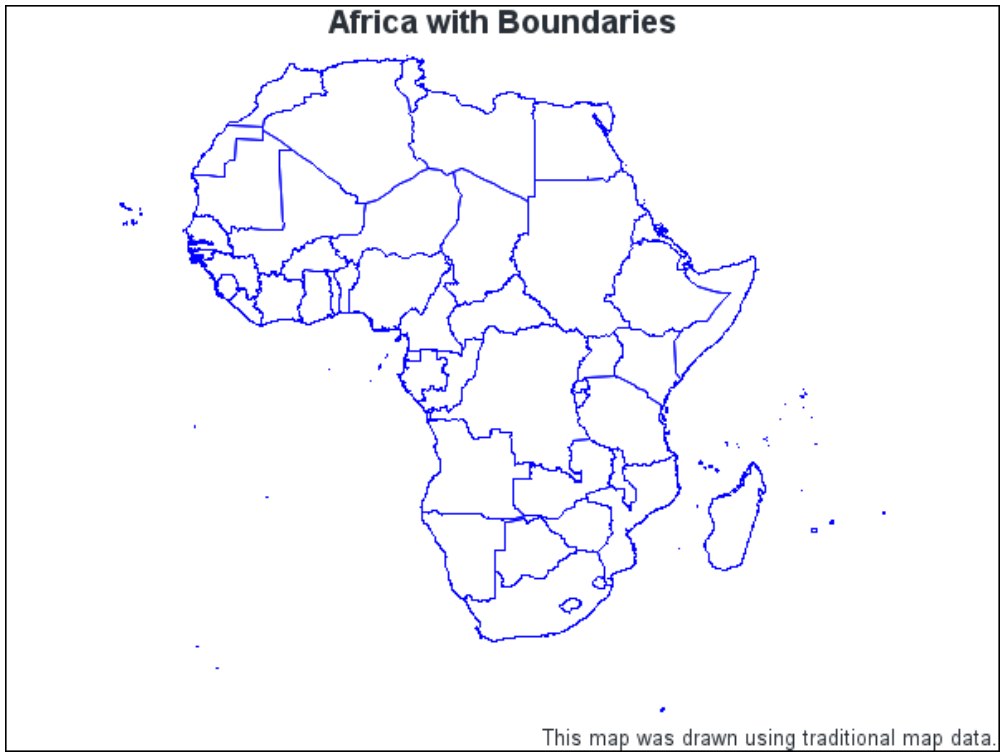
Output 16.32 on page 622 shows some of the variables that are present in the original map data set:

Output 16.9 *Partial Listing of Selected Columns from the MAPSSAS.AFRICA Data Set*

Obs	ID	SEGMENT	X	Y
1	125	1	-0.45415	0.35555
2	125	1	-0.43879	0.34538
3	125	1	-0.42249	0.33434
4	125	1	-0.40917	0.32516
5	125	1	-0.39305	0.31380
6	125	1	-0.38219	0.30602
7	125	1	-0.37168	0.29836
8	125	1	-0.35551	0.28638
9	125	1	-0.34435	0.27798
10	125	1	-0.33463	0.27056
11	125	1	-0.32389	0.26228
12	125	1	-0.31642	0.25643
13	125	1	-0.29740	0.24320

Output 16.27 on page 614 shows the map before processing:

Output 16.10 *Africa Map Before Removing Boundaries*



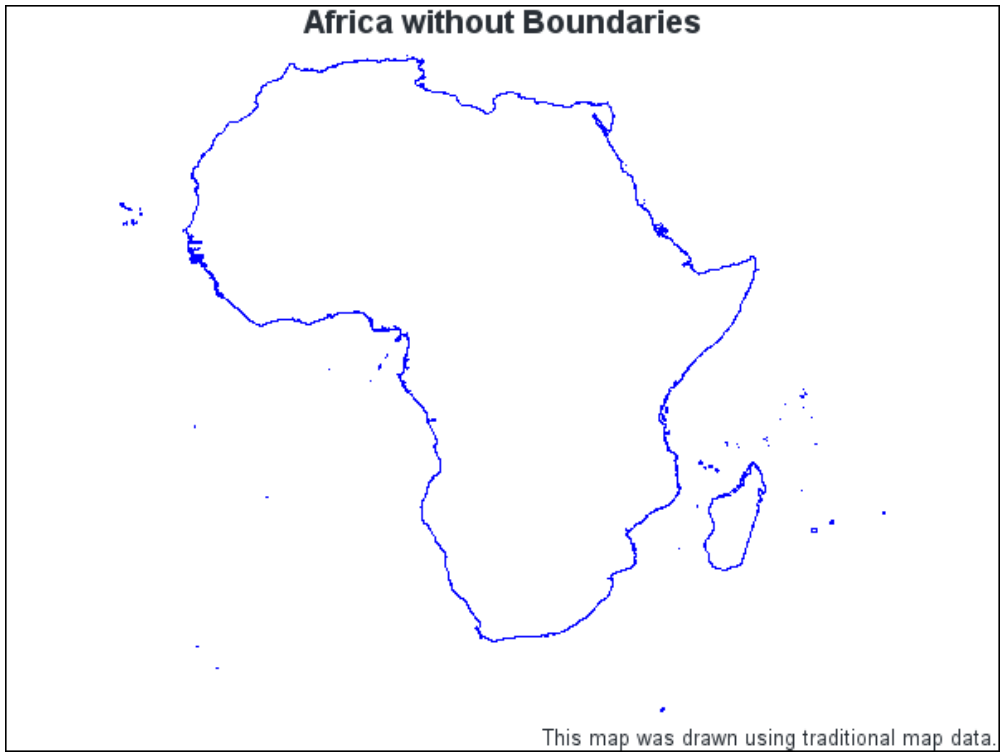
The new AFRICA map data set is created with a new variable, REGION. Output 16.34 on page 623 shows some of the variables that are present in the new map data set created by the GREMOVE procedure:

Output 16.11 *Partial Listing of Selected Columns from the WORK.AFRICA Data Set*

Obs	X	Y	SEGMENT	region
1	-0.61677	0.15291	1	1
2	-0.61639	0.15299	1	1
3	-0.61619	0.15297	1	1
4	-0.61588	0.15314	1	1
5	-0.61536	0.15309	1	1
6	-0.61413	0.15340	1	1
7	-0.61249	0.15414	1	1
8	-0.61083	0.15473	1	1
9	-0.61011	0.15509	1	1
10	-0.60966	0.15539	1	1
11	-0.60949	0.15557	1	1
12	-0.60920	0.15601	1	1
13	-0.60846	0.15684	1	1
14	-0.60694	0.15807		

Output 16.29 on page 616 shows the new map after PROC GREMOVE has removed all of the interior boundaries:

Output 16.12 *Africa Map After Removing Boundaries*



Program

```
goptions reset=all border device=png;

data newaf;
   set mapssas.africa;
   region=1;
run;

proc gremove data=newaf out=africa;
   by region;
   id id;
run;

title "Africa with Boundaries";

pattern value=mempty color=blue;

proc gmap map=mapssas.africa data=mapssas.africa all;
   id id;
   choro id / stat=first nolegend levels=1;
run;

title "Africa without Boundaries";

proc gmap data=africa map=africa;
   id region;
   choro region / stat=first nolegend levels=1;
run;
quit;
```

```
goptions reset=all;
```

Program Description

Set the graphics environment.

```
goptions reset=all border device=png;
```

Create the NEWAF data set. This new map data set contains all the variables in the MAPSSAS.AFRICA map data set supplied with SAS/GRAPH plus the added variable REGION.

```
data newaf;
   set mapssas.africa;
   region=1;
run;
```

Remove the unit areas from the AFRICA data set. DATA= specifies the input map data set and OUT= specifies the output map data set. The input map data set has a variable called REGION that is used as the BY-variable to identify the new unit areas. The ID statement specifies the current unit areas from the input map data set.

```
proc gremove data=newaf out=africa;
   by region;
   id id;
run;
```

Define a title for the map.

```
title "Africa with Boundaries";
```

Define pattern characteristics.

```
pattern value=mempty color=blue;
```

Display the original map.

```
proc gmap map=mapssas.africa data=mapssas.africa all;
   id id;
   choro id / stat=first nolegend levels=1;
run;
```

Define a new title for the map.

```
title "Africa without Boundaries";
```

Display the map with no boundaries. ID specifies the variable, REGION, that identifies the unit areas in the processed data set.

```
proc gmap data=africa map=africa;
   id region;
   choro region / stat=first nolegend levels=1;
run;
quit;
```

Reset the graphics environment.

```
goptions reset=all;
```

17

MAPIMPORT Procedure

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Overview: MAPIMPORT Procedure

What Does the MAPIMPORT Procedure Do?

The MAPIMPORT procedure enables you to import Esri shapefiles (spatial data formats) and process the SHP files into map data sets that are made available with SAS/GRAPH or through third-party sources. See "About Traditional Map Data Sets" on page 311 for more information.

The MAPIMPORT procedure does not produce any graphics output. Instead, it produces an output map data set, which can be used with the ODS Graphics

SGMAP procedure or other mapping procedures in Base SAS, or the GMAP procedure in SAS/GRAPH.

The MAPIMPORT procedure can also import shapefiles of linear map features, such as highways, railways, or waterways. These shapefiles can be specified as plot data in the SGMAP procedure's SERIES statement.

The shapefiles file types are described in the following table:

Table 17.1 *Shapefiles File Types*

File Extension	Description
.dbf	Identification information (field-identifier names and values) assigned to specific polygons
.shx	Shape information for the polygons that compose the map. [1]
.shp	Combines the shape information for the polygons that compose the map and the identification information (field-identifier names and values) assigned to the specific polygons **Note:** For best results, use shapefiles containing polygons with complete borders.

Note: If you import a very highly detailed map, then the GMAP procedure might produce extraneous lines when drawing it. To avoid this issue, use the GREDUCE procedure to reduce the number of map points.

To run this procedure, the various data sets and essential SAS software must be available in your installation. Storage restrictions apply to map data sets that are used with the SGMAP procedure's CHOROMAP or SERIES statement and to geocoding lookup data sets. Because the map data sets contain sequential polygonal data, storing the mapping data on a distributed system such as aTeradata server, a SAS® LASR™ Analytic Server, or a SAS Cloud Analytic Services (CAS) server is not recommended. Data sequence cannot be guaranteed on distributed systems such as these, which can cause unexpected results. If the criterion is met, you can copy the procedure examples provided in this chapter into your program editor and run them to create the required output. Your IDE might provide additional resources for creating maps. Refer to the documentation for your IDE for more information.

1. These files are used with SHP files and cannot be imported by themselves.

Syntax: MAPIMPORT Procedure

Requirement: The name and location of an output data set and the complete path for the input data file.

Note: The single quotation marks surrounding field identifiers are optional when the field identifiers follow the SAS naming convention. Single quotation marks are required for field identifiers that are nonstandard SAS names. When field identifiers placed in single quotation marks are nonstandard SAS names, the field identifiers are converted to a standard SAS name in the traditional map data set. For more information about the standard SAS naming convention, see "SAS Names" in *SAS Programmer's Guide: Essentials* in the *SAS Programmer's Guide: Essentials* . For more information about how invalid field identifiers placed in single quotation marks are renamed, see "VALIDVARNAME= System Option" in *SAS/ACCESS for Relational Databases: Reference* in the *SAS/ACCESS for Relational Databases: Reference*.

PROC MAPIMPORT OUT=*map-data-set* DATAFILE= '*path-to-shapefile*' | *shapefile-file-reference*
<CONTENTS>
<CREATE_ID_>;

EXCLUDE '*field-identifier(s)*';

ID '*field-identifier(s)*';

RENAME '*field-identifier-1*'=*variable-name-1* < '*field-identifier-2*'=*variable-name-2* ...>;

SELECT '*field-identifier(s)*';

PROC MAPIMPORT Statement

Identifies the input Esri shapefile and converts this map into a SAS/GRAPH map data set.

Requirement: The name and location of an output data set and the complete path for the input data file.

Syntax

PROC MAPIMPORT OUT=*map-data-set* DATAFILE='*path-to-shapefile*' | *shapefile-file-reference*
<CONTENTS>
<CREATE_ID_>;

Summary of Optional Arguments

CONTENTS
: displays information about the shapefile, including field identifier names and types.

CREATE_ID_
: creates a map ID variable named _ID_ with a unique value for each polygon in the map.

Required Arguments

OUT=*map-data-set*
specifies the name of the output map data set that is created.

DATAFILE='*path-to-shapefile*' | *shapefile-file-reference*
specifies the shapefile that is read and processed.

'path-to-shapefile'
: specifies the path to the shapefile, including the file name and file extension, enclosed in quotation marks.

shapefile-file-reference
: specifies a file reference that is assigned to the shapefile.

See "FILENAME Statement" in *SAS Global Statements: Reference*.

Alias INFILE=

Tip By default, all of the fields in a shapefile are included in the output map data set. To include only specific fields in the output map data set, use the SELECT statement.To exclude specific fields from the output map data set, use the EXCLUDE statement.

Optional Arguments

CONTENTS
displays information about the shapefile, including field identifier names and types.

CREATE_ID_
creates a map ID variable named _ID_ with a unique value for each polygon in the map. This variable is created automatically if the DBF file is missing.

Interaction This statement has no effect if you also specify the ID statement.

EXCLUDE Statement

Specifies one or more fields from the shapefile that are excluded from the output map data set.

Restrictions: If you specify conflicting values for the EXCLUDE and SELECT statements, then the MAPIMPORT procedure produces an error.

If you specify the same field identifier in the EXCLUDE statement and in the ID statement, then the MAPIMPORT procedure produces an error.

Requirement: At least one *field-identifier* is required.

Syntax

EXCLUDE '*field-identifier(s)*';

Required Argument

'field-identifier(s)'
specifies one or more fields from the shapefile that are excluded from the output map data set. All of the fields that you do not specify are included in the output map data set.

If you do not specify the EXCLUDE statement or the SELECT statement, then all of the fields from the shapefile are included in the output map data set.

ID Statement

Reorders the map polygons by one or more identifier fields.

Requirement: At least one *field-identifier* is required.

Interaction: The CREATE_ID option in the PROC MAPIMPORT statement has no effect when you also specify the ID option.

Syntax

ID '*field-identifier(s)*';

Required Argument

'field-identifier(s)'
specifies one or more fields in the shape file that identify the polygons in the map. The values of the fields that you specify are used to reorder the map polygons and assign segment numbers in the output map data set.

When you do not specify the ID statement, the MAPIMPORT procedure uses the existing polygon order for the output map data set.

You might want to use the ID statement when the default output map data set does not draw properly in the GMAP procedure. If the ID variable that you specify in the GMAP procedure is not unique for each polygon, then extraneous

lines might appear in your GMAP output. To ensure that the ID variable is unique for each polygon, specify the same ID statement in both the MAPIMPORT and GMAP procedures.

RENAME Statement

Renames variables in the output map data set that correspond to specific fields in the shapefile.

Requirement: At least one *field-identifier* and *variable-name* pair are required.

Syntax

RENAME '*field-identifier-1*'=*variable-name-1* < '*field-identifier-2*'=*variable-name-2* ... >;

Required Argument

'field-identifier'=variable-name
assigns a variable name in the output map data set for a field in the shapefile. You can specify multiple field identifier and variable name pairs, separated by a space.

For example, the following code renames the STNAME field to STATE, and the FIPSTATE field to STATE_FIPS: `rename "stname" = state "fipstate" = state_fips;`

By default, when you do not specify the RENAME statement, the MAPIMPORT procedure uses the field name in the shapefile as the variable name in the output map data set. However, if the field name is not a valid SAS variable name, then the variable name is modified in the output map data set. For more information about valid SAS variable names, see "Rules for Variable Names" in *SAS Programmer's Guide: Essentials* in the *SAS Programmer's Guide: Essentials*.

SELECT Statement

Selects the fields from the shapefile that are included in the output map data set.

Restriction: If you specify conflicting values for the EXCLUDE and SELECT statements, then the MAPIMPORT procedure produces an error.

Requirement: At least one *field-identifier* is required.

Syntax

SELECT '*field-identifier(s)*';

Required Argument

'field-identifier(s)'
specifies one or more fields from the shapefile that are included in the output map data set. If you do not use the SELECT statement or the EXCLUDE statement, then all of the fields from the shapefile are included in the output map data set.

For field identifiers that are not valid SAS variable names, the MAPIMPORT procedure changes the name of the variable in the output map data set automatically. For more information about valid SAS variable names, see "Rules for Variable Names" in *SAS Programmer's Guide: Essentials* in the *SAS Programmer's Guide: Essentials*.

Examples: MAPIMPORT Procedure

About the MAPIMPORT Procedure Examples

Examples in This Section

This section provides basic examples of how to use the MAPIMPORT procedure. The following table lists the examples that are provided.

Table 17.2 *MAPIMPORT Procedure Examples*

Example	Description
Including All Variables from the SHP Shapefile (p. 634)	Shows how to import shapefile World30.shp, which contains polygons that compose a political boundary world map.
Including Selected Variables from the SHP Shapefile (p. 635)	Show how to include selected variables from shapefile STATES.SHP, which contains polygons that compose the political boundaries of a U.S. states map.

Example	Description
Excluding a Variable from the SHP Shapefile (p. 635)	Show how to exclude a variable from shapefile STATES.SHP, which contains polygons that compose the political boundaries of a U.S. states map.
Using the ID Statement (p. 635)	Shows how to use the MAPIMPORT procedure ID statement.
Including Selected Variables from the DBF Shapefile (p. 636)	Show how to include selected variables from shapefile STATES.DBF, which contains the identification information (field-identifier names and values) applied to the U.S. states polygon map.

Examples Available Online

You can find more examples on the Graphically Speaking blog. On the blog page, use **Search Graphically Speaking** to search for GINSIDE to find the GINSIDE procedure examples.

Example 1: Including All Variables from the SHP Shapefile

In the following example, World30.shp contains polygons that compose a political boundary world map. All the field identifiers in the World30.shp file are included in the traditional map data set, MYWORLD.

This example and the remaining examples in this section use shapefiles with the .shp and .dbf extensions. To run these examples, specify your shapefile in the DATAFILE= option. Use a path that is appropriate for your operating environment. Where field identifiers are used, replace the identifiers with information from your shapefiles, if necessary.

The following examples demonstrate how to specify your shapefile location on Linux systems.

Example Code 17.1 *Specifying the Path to Your Shapefile*

```
PROC MAPIMPORT OUT=myworld
   DATAFILE="~sasdemo/data/mapping/world30.shp";
run;
```

Example Code 17.2 *Using a File Reference to Your Shapefile*

```
filename shapefile "~sasdemo/data/mapping/world30.shp";
```

```
PROC MAPIMPORT OUT=myworld
   DATAFILE=shapefile;
run;
```

Example 2: Including Selected Variables from the SHP Shapefile

In the following example, the STATES.SHP file contains polygons that compose the political boundaries of a U.S. states map. Only the STATE_FIPS (the state FIPS codes), STATE_NAME (the state name), and STATE_ABBR (the two letter state abbreviation) variables are included in the traditional map data set, MYSTATES. STATE_FIPS is renamed FIPS, STATE_NAME is renamed STATE, and STATE_ABBR is renamed ABBREV in the MYSTATES map data set.

```
PROC MAPIMPORT OUT=mystates
DATAFILE="~sasdemo/data/mapping/states.shp";
     SELECT STATE_FIPS STATE_NAME STATE_ABBR;
     RENAME STATE_FIPS=FIPS STATE_NAME=STATE STATE_ABBR=ABBREV;
run;
```

Example 3: Excluding a Variable from the SHP Shapefile

In the following example, the STATES.SHP file contains polygons that compose the political boundaries of a U.S. state map. File reference states is assigned to the states.shp file. The variable OTHER is excluded from the traditional map data set, MYSTATES2.

```
filename states "~sasdemo/data/mapping/states.shp";
PROC MAPIMPORT OUT=mystates2
DATAFILE=states;
     EXCLUDE OTHER;
run;
```

Example 4: Using the ID Statement

In the following example, the shapefile is a ZCTA file from the US Census Bureau that contain polygons that are based on ZIP codes. The ZCTA field is the identifier that you want to use, but the polygons in the shapefile do not have unique values for ZCTA. If you do not specify the ID statement, then the GMAP procedure draws extra lines between the map areas for ZCTA.

Identify the ZCTA field in the ID statement. This ensures that the polygons for each value of ZCTA are grouped together and assigned different SEGMENT values in the output map data set. The GMAP procedure can now draw the map areas for ZCTA correctly.

```
PROC MAPIMPORT OUT=myzcta
DATAFILE="~sasdemo/data/mapping/zt06_d00.shp";
  ID zcta;
run;
```

Example 5: Including Selected Variables from the DBF Shapefile

In the following example, the STATES.DBF file contains the identification information (field-identifier names and values) applied to the U.S. states polygon map. Only the STATE_FIPS (the state FIPS codes), STATE_NAME (the state names), and STATE_ABBR (the two letter state abbreviations) variables are included in the traditional map data set, MYDATA. STATE_FIPS is renamed FIPS, STATE_NAME is renamed STATE, and STATE_ABBR is renamed ABBREV in the MYDATA map data set.

```
PROC MAPIMPORT OUT=mydata
DATAFILE="~sasdemo/data/mapping/states.dbf";
     SELECT STATE_FIPS STATE_NAME STATE_ABBR;
     RENAME STATE_FIPS=FIPS STATE_NAME=STATE STATE_ABBR=ABBREV;
run;
```

18

SGMAP Procedure

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Overview: SGMAP Procedure

What Does the SGMAP Procedure Do?

The Base SAS ODS Graphics SGMAP mapping procedure uses the functionality of template-based Output Delivery System (ODS) Graphics to render maps and then overlay plots such as text, scatter, or bubble plots. It enables you to enhance the appearance of your output by selecting ODS Graphics text fonts, colors, patterns, and line styles, and controlling the size and position of many graphics elements. The SGMAP procedure works with map data sets prepared by a third party. It also works with map data sets prepared by Base SAS procedures such as GREDUCE or GREMOVE. The MAPIMPORT procedure imports map data from third-party sources. An example is shapefiles from Esri.

Base SAS offers an enhanced SGMAP mapping procedure. The SGMAP procedure adds the GRADLEGEND and SERIES statements, and numerous options. The CHOROMAP statement is at production level. The CHOROMAP statement first processes unprojected map coordinates (LAT, LATITUDE, LONG, LON, and LONGITUDE), in addition to the projected X and Y coordinates. An unprojected choropleth map can be overlaid on OpenStreetMaps and Esri maps. The SGMAP procedure can also render maps whose data is prepared by any number of Base SAS mapping procedures such as GPROJECT. After your map data sets are obtained and prepared, use the SGMAP procedure to create maps and then overlay plots such as bubble, scatter, series, or text plots. With the enhanced SGMAP procedure, automatic legends are now generated, and the option that disables them is provided. Continuous or discrete legends are now possible, as well as legend customization, grouping capability, and the ability to customize polygon borders and series plot lines.

SGMAP procedure examples such as “Example 1: Creating a Map of Nevada Counties with a Bubble Plot of County Seat Populations” show how to create overlaid maps. You can also search for 'SGMAP' on this blog for additional examples: https://blogs.sas.com/content/graphicallyspeaking/

To run this procedure, the various data sets and essential SAS software must be available in your installation. Storage restrictions apply to map data sets that are used with the SGMAP procedure's CHOROMAP or SERIES statement and to geocoding lookup data sets. Because the map data sets contain sequential polygonal data, storing the mapping data on a distributed system such as aTeradata server, a SAS® LASR™ Analytic Server, or a SAS Cloud Analytic Services (CAS) server is not recommended. Data sequence cannot be guaranteed on distributed systems such as these, which can cause unexpected results. If the criterion is met, you can copy the procedure examples provided in this chapter into your program editor and run them to create the required output. Your IDE might provide

additional resources for creating maps. Refer to the documentation for your IDE for more information.

Concepts: SGMAP Procedure

Optimizing Performance

Sometimes only a portion of a map data set is needed when creating a map. The WHERE= option in the DATA step is used to extract only the required data. For an example using the WHERE= option in the DATA step, see "Example 1: Creating a Map of Nevada Counties with a Bubble Plot of County Seat Populations" on page 738.

Occasionally you might want to use the map data set as your response data set. However, the SGMAP procedure prevents using the map data set as the response data set. This restriction eliminates the performance hit you experience when processing duplicate observations between the same data set used in two different roles. If you have SAS/GRAPH installed and are using a MAPSGFK map data set, then you can specify its companion _attr map data set as the response data set. The _attr data set contains unique ID country or region code observations to match against the multiple polygonal country or region data observations in the map data set. An example is Mapsgfk.Africa and its companion Mapsgfk.Africa_attr. When MAPSGFK is not available, you can create a response data set by running PROC SORT with its NODUPKEY option in the map data set. This reduces the number of observations in the map response data set to the minimum number required. Extract into a separate map response data set only those observations that contain the variable or variables that you plan to use for plotting. An example is extracting ZIP code numbers from a county map data set.

```
proc sort data=map-data-set out=map-response-data-set nodupkey;
by polygon-id-var;
run;
```

You can assign any additional response variable values to those polygon IDs.

When running the SGMAP procedure's CHOROMAP statement with map data sets, size can affect processing speed. For example, if you specify a MAPSGFK map data set sized less than or equal to 20 MB and a DENSITY= option, set the DENSITY= value to 2. For MAPSGFK map data sets greater than 20 MB in size, an option value of DENSITY=1 yields better performance results.

Note: Examples documented in this procedure include network requests. Note that the SGMAP procedure does not authenticate any services that you specify, such as the map services and portal hosted by Esri. Check with your system administrator

regarding the authentication setup for any Linux network proxy machine request that you might need to make.

TIP On a Linux operating system, if the SAS code to create an SGMAP times out, you can try the `curl` command with the map service URL. This might enable the SAS code to run to completion.

Note: The SGMAP procedure performs automatic resolution adjustment when creating a choropleth map. This happens when the map data set contains a RESOLUTION variable, and when the WHERE clause is not in use. However, specifying the DENSITY= option in the CHOROMAP statement overrides the automatic resolution adjustment.

Syntax: SGMAP Procedure

Restrictions: The SGMAP procedure does not support vector-based output such as SVG, PDF, or EMF. If a vector-based format is requested, the SGMAP procedure generates PNG output instead and writes a note to the SAS log indicating that PNG output was generated.

The SGMAP procedure does not support BY-group processing.

Requirement: The data order of the input data must be maintained. Do not use input data that is stored in a library that cannot guarantee data order.

Supported Statements: ATTRIB, FOOTNOTE, FORMAT, LABEL, TITLE, WHERE

Interaction: When you create a tile-based map using either the ESRIMAP or OPENSTREETMAP statement, any plot statement that you specify overlays their plot data on the map tiles.

See: "Creating a Map Using the SGMAP Procedure" on page 728

PROC SGMAP < *options* >;
  STYLEATTRS < */ options* >
  CHOROMAP < *response-variable* > < */ options* >;
  ESRIMAP URL='*map-service*';
  OPENSTREETMAP;
  BUBBLE X=*variable* Y=*variable* SIZE=*numeric-variable* < */ options* >;
  SCATTER X=*variable* Y=*variable* < */ options* >;
  SERIES X=*variable* Y=*variable* < */ options* >;
  TEXT X=*variable* Y=*variable* TEXT=*variable* < */ options* >;
  GRADLEGEND < *"name"* > < */ options* >;

KEYLEGEND < *"name-1" "name-2" ...* > < */ options* >;

ATTRIB *variable-list(s) attribute-list(s)*;

FORMAT *variable-1* <...*variable-n*> <*format-1*> <*variable-1* <...*variable-n*> <*format-2*> > ... < DEFAULT=*default-format* >;

LABEL *variable-1*=*label-1* | ' ' <*variable-n*=*label-n* | ' '> ...;

WHERE *where-expression*;

PROC SGMAP Statement

Identifies the data sets needed for map areas, map response values, and overlay plots.

Restrictions: The SGMAP procedure prohibits specifying map data that is stored in a library that cannot guarantee data order. See "Storing Mapping Data on Distributed Systems" on page 729.

The SGMAP procedure prohibits specifying the map data set as the response data set.

The SGMAP procedure does not support BY-group processing.

Requirement: You must specify the required data in the appropriate data options in the PROC SGPLOT statement, and you must issue the required procedure statements in the proper order in the SGMAP procedure step. See "Creating a Map Using the SGMAP Procedure" on page 728.

Notes: The SGMAP procedure generates a legend unless the NOAUTOLEGEND option is specified in the PROC SGMAP statement.See "Rules for Generating Legends" on page 730.

If you specify a map response data set with MAPRESPDATA= but do not specify a response variable in the CHOROMAP statement, the map response data set is ignored.

You can store map or geocoding lookup data sets locally on any Linux system on a local (client) drive, a network server, or a USB plug-in drive. You can use cloud storage if it is a Linux system that is not installed on a distributed system.

Tip: You can maximize your storage by compressing either the map data sets or the geocoding lookup data sets. See how to use the compress feature of the DATA step in "Example 2: Creating a Map of Nevada Counties with a Bubble Plot of County Seats and Populations" on page 742.

Syntax

PROC SGMAP < *options* >;

Summary of Optional Arguments

CYCLEATTRS

specifies that plots are drawn with unique attributes in the graph.

DATTRMAP=*discrete-attribute-map-data-set*
specifies the discrete attribute map data set that you want to use with the procedure.

DESCRIPTION="*text-string*"
specifies a description for the output.

MAPCS="*coordinate-system*"
specifies an alternate coordinate space for the MAPDATA input data set

MAPDATA=*map-data-set*
specifies a data set that contains the coordinates for the boundary points of each map area drawn with a CHOROMAP statement.

MAPRESPDATA=*response-data-set*
identifies the data set that contains the response values for the polygonal map areas drawn with the CHOROMAP statement.

NOAUTOLEGEND
disables automatic legends from being generated.

NOCYCLEATTRS
specifies that no plots are drawn with unique attributes in the graph.

OPAQUE

NOOPAQUE
specifies whether the graph background is opaque or transparent.

PLOTCS="*coordinate-system*"
specifies an alternate coordinate space for the PLOTDATA input data set

PLOTDATA=*plot-data-set*
specifies a data set that contains data for the plot overlay.

RATTRMAP=*range-attribute-map-data-set*
specifies the range attribute map data set that you want to use with the procedure.

Optional Arguments

CYCLEATTRS
specifies that plots are drawn with unique attributes in the graph.

Default — By default, the SGMAP procedure automatically assigns unique attributes in many situations, depending on the types of plots that you specify. If the plots do not have unique attributes by default, then the CYCLEATTRS option assigns unique attributes to each plot in the graph.

Restrictions — The CYCLEATTRS option has no effect on any map generated by a PROC SGMAP map statement, such as the CHOROMAP statement.

The CYCLEATTRS option has no effect when the GROUP option is specified on a plot statement.

Note — When all overlaid plots are the same, the attributes automatically cycle.

See To prevent the SGMAP procedure from assigning unique attributes, use the "NOCYCLEATTRS" on page 645 option. The NOCYCLEATTRS option disables the automatic cycling of attributes.

Example If you specify the CYCLEATTRS option and you create a graph with a SERIES statement and a SCATTER statement, then the two plots have different colors.

DATTRMAP=*discrete-attribute-map-data-set*

specifies the discrete attribute map data set that you want to use with the procedure. You specify this option only if you are using a discrete attribute map to control visual attributes of the graph.

Restrictions The SGMAP procedure does not support attribute maps that are stored in a library that cannot guarantee data order.

Use the DATTRMAP= option in conjunction with the ATTRID= option supported on various PROC SGMAP statements, such as CHOROMAP. You need to specify the discrete attribute map data set as well as the value of the ID variable that it contains.

Requirement The values in the DATTRMAP data set must be sorted by ID. If they are not, only the first value is found.

Note When you create a BUBBLE or a SCATTER plot and want their marker and corresponding data label text colors to match, include the TEXTCOLOR= option value or the TEXTSTYLEELEMENT option in the DATTRMAP file. For example, if you specified MarkerColor in your DATTRMAP file, then also specify TextColor to ensure that the marker fill colors match the color of their labels.

See "Using Discrete Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

"Overview of Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

DESCRIPTION="*text-string*"

specifies a description for the output. The description is used in the following locations:

- the Results tab
- the alternate text for the image in HTML5 output
- the table of contents that is created by the CONTENTS option in an ODS statement

The default description is "The SGMAP Procedure".

Alias DES

MAPCS="*coordinate-system*"

specifies an alternate coordinate space for the MAPDATA input data set Enclose the *coordinate-system* in single or double quotation marks.

The MAPCS= option replaces the need to run PROC GPROJECT before mapping data onto an Esri Map or an OpenStreetMap. The coordinate system of the input map data set is specified directly to PROC SGMAP with this option.

coordinate-system

A coordinate system is a reference system that is used to represent the locations of geographic features, imagery, and observations within a common geographic framework. It enables you to integrate map data sets. For example, you can overlay data layers from disparate sources and coordinate systems. Specify one of the following string values as the coordinate system:

- A Proj.4 string (as in the following example). The 900913 (Mercator) coordinate system is another that is supported.
- A Well-Known Text (WKT) string. WKT is a text markup language for representing vector geometry objects on a map. This string is typically found packaged with a shape file (.shp). When you download a shape file, the WKT string is included in the file with the .prj extension. These strings are available in different formats, such as ESRI, HTML, or Open Geospatial Consortium (OGC).
- An EPSG or ESRI code, such as "EPSG:4326" or "ESRI:102531".

Requirement In order to specify this option you are required to indicate a map data set with the MAPDATA= argument. Otherwise, MAPCS= has no effect.

See EPSG Geodetic Parameter Dataset to register for EPSG files, or to download ZIP files containing them.

Example Using an EPSG:4326 coordinate-system:

```
proc sgmap mapdata=mapdataset noautolegend

mapcs = "+proj=aea +datum=NAD83 +ellps=GRS80
  +x_0=1000000.0 +y_0=0.0
        +lon_0=-126.0
  +lat_0=45.0 +lat_1=50.0 +lat_2=58.5
  +units=m +no_defs";

  openstreetmap;

...
```

MAPDATA=*map-data-set*

specifies a data set that contains the coordinates for the boundary points of each map area drawn with a CHOROMAP statement.

You can specify map data sets licensed by SAS from GfK GeoMarketing GmBH and converted by SAS to a SAS data set format. You must have a SAS/GRAPH license in order to have access to this MAPSGFK map library. This and other map libraries are made available for downloading from the SAS Maps and Geocoding website. You are required to access the website with your SAS profile. You might be required to enter your site information. You can also specify a local map data set, or use a map data set from a third-party source.

You can create the latter with the Base SAS MAPIMPORT procedure. Use SAS data set options such as WHERE= to subset the map data.

Requirement You must specify this option when the CHOROMAP statement is used.

MAPRESPDATA=*response-data-set*
identifies the data set that contains the response values for the polygonal map areas drawn with the CHOROMAP statement.

Restriction The SGMAP procedure prohibits specifying the map data set as the response data set.

Requirement You must specify this option when the CHOROMAP statement is used and a response variable is specified.

NOAUTOLEGEND
disables automatic legends from being generated. The NOAUTOLEGEND option overrides the default behavior. Specify this option in the SGMAP procedure statement.

Default By default, legends are created automatically for some plots, depending on their content.

Interaction This option has no effect if you specify a KEYLEGEND statement or a GRADLEGEND statement.

OPAQUE | NOOPAQUE
specifies whether the graph background is opaque or transparent.

Default OPAQUE

Interaction When the NOOPAQUE option is specified, the background color is not used.

NOCYCLEATTRS
specifies that no plots are drawn with unique attributes in the graph.

Default By default, the SGMAP procedure automatically assigns unique attributes in many situations, depending on the types of plots that you specify. The NOCYCLEATTRS option prevents the procedure from assigning unique attributes. The NOCYCLEATTRS option disables the automatic cycling of attributes.

Note When all overlaid plots are the same, the attributes automatically cycle.

See By default, the "CYCLEATTRS" on page 642 option automatically draws plots with unique attributes.

Example If you specify the NOCYCLEATTRS option, then plots have the same attributes unless you specify appearance options such as the LINEATTRS= option.

PLOTCS="*coordinate-system*"
specifies an alternate coordinate space for the PLOTDATA input data set Enclose the *coordinate-system* in single or double quotation marks.

The PLOTCS= option replaces the need to run PROC GPROJECT before mapping data onto an Esri Map or an OpenStreetMap. The coordinate system of the input plot data set is specified directly to PROC SGMAP with this option.

coordinate-system
A coordinate system is a reference system that is used to represent the locations of geographic features, imagery, and observations within a common geographic framework. It enables you to integrate map data sets. For example, you can overlay data layers from disparate sources and coordinate systems. Specify one of the following string values as the coordinate system:

- A Proj.4 string (as in the following example). The 900913 (Mercator) coordinate system is another that is supported.
- A Well-Known Text (WKT) string. WKT is a text markup language for representing vector geometry objects on a map. This string is typically found packaged with a shape file (.shp). When you download a shape file, the WKT string is included in the file with the .prj extension. These strings are available in different formats, such as ESRI, HTML, or Open Geospatial Consortium (OGC).
- An EPSG or ESRI code, such as "EPSG:4326" or "ESRI:102531".

Requirement In order to specify this option you are required to indicate a plot data set with the PLOTDATA= argument. Otherwise, PLOTCS= has no effect.

See EPSG Geodetic Parameter Dataset to register for EPSG files, or to download ZIP files containing them.

Example Using an EPSG:4326 coordinate-system:

```
proc sgmap plotdata=plotdatamap noautolegend

plotcs = "+proj=aea +datum=NAD83 +ellps=GRS80
  +x_0=1000000.0 +y_0=0.0
        +lon_0=-126.0
  +lat_0=45.0 +lat_1=50.0 +lat_2=58.5
  +units=m +no_defs";

  openstreetmap;

...
```

PLOTDATA=*plot-data-set*
specifies a data set that contains data for the plot overlay.

You can specify map data sets licensed by SAS from GfK GeoMarketing GmBH and converted by SAS to a SAS data set format. You must install the SAS/GRAPH component in order to have access to this MAPSGFK map library. This and other map libraries are made available for downloading from the SAS Maps and Geocoding website. You are required to access the website with your SAS profile. You might be required to enter your site information. You can also

specify a local map data set, or use a map data set from a third-party source. The GEOCODE procedure can be used to determine the LAT and LONG values for addresses.

CHOROMAP looks for LATITUDE and LONGITUDE first, then LAT and LONG or LON, and if not found, then X and Y. The coordinate variables used from the PLOTDATA are specified by each plot overlay statement. You can have separate coordinate variables for each overlay statement.

Requirement You must specify this option when one or more plot statements such as BUBBLE, SERIES, SCATTER, and TEXT are used.

RATTRMAP=*range-attribute-map-data-set*

specifies the range attribute map data set that you want to use with the procedure. You specify this option only if you are using an ID variable in a range attribute map to control visual attributes of the graph.

Restrictions The procedures do not support attribute maps that are stored in a library that cannot guarantee data order.

This option must be used in conjunction with the "RATTRID=character-value " option.

Requirement The values in the RATTRMAP data set must be sorted by ID. If they are not, only the first value is found.

See "Using Range Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

"Overview of Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

STYLEATTRS Statement

Specifies global style attributes for a graph. The statement enables you to change colors, markers, and so on, within the procedure, without having to change the ODS style template.

Requirement: The procedure must include at least one plot statement.

Interaction: The following options apply only when the GraphData1–GraphData*n* style elements are used: DATACOLORS=, DATACONTRASTCOLORS=, DATALINEPATTERNS=, and DATASYMBOLS=.

Syntax

STYLEATTRS <*options*>;

Summary of Optional Arguments

Background and wall options

BACKCOLOR=*color*
: specifies the background color of the graph area.

Style options

DATACOLORS=(*color-list*)
: specifies the fill colors for the graphics elements.

DATACONTRASTCOLORS=(*color-list*)
: specifies the contrast colors for the graphics elements, such as lines and markers.

DATALINEPATTERNS=(*line-pattern-list*)
: specifies the list of line patterns for the graph data lines.

DATASYMBOLS=(*marker-symbol-list*)
: specifies the list of marker symbols for the graph data.

Optional Arguments

BACKCOLOR=*color*
specifies the background color of the graph area.

Note: This feature applies to SAS 9.4M3 and later releases.

For more information, see "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

Default The Color attribute of the GraphBackground style element

Examples backcolor=CXFF0000

backcolor=light_blue

DATACOLORS=(*color-list*)
specifies the fill colors for the graphics elements. The graphics elements can be in grouped plots or in overlaid multiple plots with the CYCLEATTRS option in effect.

Provide a space-separated list of colors enclosed in parentheses. You can specify colors using a number of different color-naming schemes. For more information, see "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

Default The GraphData*n* style element Color attribute.

Requirement For this option to have an effect, at least one plot statement in the procedure must specify the GROUP= option.

Interaction Where applicable, the COLOR= suboption of any plot option related to fill color overrides the DATACOLORS= option.

Note When this option is specified, the colors cycle through *color-list* rather than the colors that are defined in the GraphData1–GraphData*n* style elements. When the colors in *color-list* are exhausted, the colors repeat.

Example datacolors=(CXFF0000 green blue)

DATACONTRASTCOLORS=(*color-list*)
specifies the contrast colors for the graphics elements, such as lines and markers. The lines and markers can be in grouped plots or in overlaid multiple plots with the CYCLEATTRS option in effect.

Provide a space-separated list of colors enclosed in parentheses. You can specify colors using a number of different color-naming schemes. For more information, see "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

Default The GraphData*n* style element ContrastColor attribute.

Requirement For this option to have an effect, at least one plot statement in the procedure must specify the GROUP= option.

Interaction Where applicable, the COLOR= suboption of any plot option related to a marker or line color overrides the DATACONTRASTCOLORS= option.

Note When this option is specified, the colors cycle through *color-list* rather than the contrast colors that are defined in the GraphData1–GraphData*n* style elements. When the colors in *color-list* are exhausted, the colors repeat.

Example datacontrastcolors=(orange cyan CXFF0000)

DATALINEPATTERNS=(*line-pattern-list*)
specifies the list of line patterns for the graph data lines. You can reference SAS patterns by number or by name. See the list of line patterns. Provide a space-separated list of line patterns enclosed in parentheses.

Default The GraphData*n* style element LineStyle attribute.

Requirement For this option to have an effect, at least one plot statement in the procedure must specify the GROUP= option.

Interactions Where applicable, the PATTERN= suboption of any plot option related to line attributes overrides the DATALINEPATTERNS= option.

Use the ATTRPRIORITY= COLOR option in the ODS GRAPHICS statement to control the rotation of line patterns specified by the DATALINEPATTERNS= option. Specifying both options causes colors to cycle through before moving to the next line pattern. See "How the Attributes Are Cycled" on page 650 for details.

Note When this option is specified, the line patterns cycle through *line-pattern-list* rather than the line patterns that are defined in the

GraphData1–GraphData*n* style elements. When the patterns in *line-pattern-list* are exhausted, the patterns repeat.

Example datalinepatterns=(dot solid longdash 26)

DATASYMBOLS=(*marker-symbol-list*)
specifies the list of marker symbols for the graph data. See marker symbols. Provide a space-separated list of symbols enclosed in parentheses.

Default The GraphData*n* style element MarkerSymbol attribute.

Requirement For this option to have an effect, at least one plot statement in the procedure must specify the GROUP= option.

Interaction Where applicable, the SYMBOL= suboption of the MARKERATTRS= option overrides the DATASYMBOLS= option.

Note When this option is specified, the symbols cycle through *marker-symbol-list* rather than the symbols that are defined in the GraphData1–GraphData*n* style elements. When the symbols in *marker-symbol-list* are exhausted, the symbols repeat.

Example datasymbols=(circle square triangle star)

Details

When the Style Options Take Effect

The following style options apply only when the GraphData1–GraphData*n* style elements are used: DATACOLORS=, DATACONTRASTCOLORS=, DATALINEPATTERNS=, and DATASYMBOLS=.

The corresponding attributes for the style options take effect when any one of the following is true:

- a GROUP= option is specified in at least one plot statement.
- the procedure contains at least two plot statements that cycle the respective attribute.
- a plot specifies a GraphData*n* style reference for the respective attribute. This example uses a list of color attributes to distinguish regions in a discrete map of the U.S.:

```
proc sgmap maprespdata=sashelp.us_data mapdata=mapsgfk.us;
styleattrs datacolors=(pink purple red dodgerblue);
choromap region / mapid=statecode colormodel=GraphData4;
run;
quit;
```

For more information, see the following blog Attrs, attrs, everywhere: The interaction between ATTRPRIORITY, CYCLEATTRS, and STYLEATTRS in ODS Graphics

How the Attributes Are Cycled

The STYLEATTRS feature cycles the attributes in the order specified in your attribute list until the group values are exhausted. If the specified attribute list is exhausted first, then the list is repeated. If you specify multiple options, the STYLEATTRS feature combines the options as it cycles through.

In the following example, the DATACONTRASTCOLORS= option specifies three contrast colors used for lines. The DATALINEPATTERNS= option specifies two line patterns, and the DATASYMBOLS= option specifies two marker symbols.

```
proc sort data=sashelp.class out=class;
   by age;
run;
proc sgplot data=class;
   styleattrs
      datacontrastcolors=(red green blue)
      datalinepatterns=(dot solid)
      datasymbols=(circlefilled squarefilled);
   needle x=height y=weight / group=age markers;
   keylegend / across=3;
run;
```

In this example, the Illuminate style is used, so the procedure uses a color-priority rotation pattern.

With the color-priority rotation pattern, marker symbols and line patterns are held constant while each color in the list is applied to the marker symbol and line.

In the example, the dotted line pattern is held constant while the procedure applies red, green, and blue colors to the dotted lines and circlefilled marker symbols for the consecutive group values. If there are more group values, the options apply the red, green, and blue colors to solid lines and squarefilled markers.

The following figure shows an example rotation for an age grouping.

You can change this rotation pattern by using the ATTRPRIORITY= option in the ODS GRAPHICS statement. The ATTRPRIORITY= option controls the rotation pattern for the attributes derived from the GraphData1–GraphData*n* style elements for the style that is in effect.

Here is the general syntax for the option.

ATTRPRIORITY=COLOR | NONE

The default behavior for this option depends on the ODS style that is in use. For styles such as Illuminate and HTMLBlue, ATTRPRIORITY in the style is set to COLOR. For some of the other styles, ATTRPRIORITY in the style is set to NONE.

You can use the ATTRPRIORITY= option to control the rotation pattern for the attributes that you specify with the STYLEATTRS feature.

To change the rotation pattern in the previous example, specify the following before you invoke the procedure:

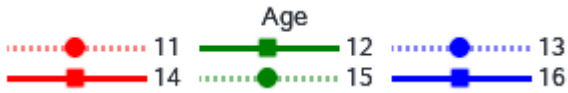
```
ods graphics / attrpriority=none;
```

Now, the following options in the STYLEATTRS statement are applied in alternating order:

```
proc sgplot data=class;
   styleattrs
      datacontrastcolors=(red green blue)
      datalinepatterns=(dot solid)
      datasymbols=(circlefilled squarefilled);
   needle x=height y=weight / group=age markers;
   keylegend / across=3;
run;
```

In the output, a red dotted line pattern and a red circlefilled marker are applied for the first group crossing, a solid green line pattern and a green squarefilled marker are applied for the second, a blue dotted line pattern and a blue circlefilled marker are applied for the third, and so on.

The following figure shows the rotation for the age grouping with no priority rotation.



See Also

"ODS GRAPHICS Statement" in *SAS ODS Graphics: Procedures Guide*

BUBBLE Statement

Creates a bubble plot in which two variables determine the location of the bubble centers and a third variable controls the size of the bubble.

Requirement: All three variables (X=, Y=, and SIZE=), specified in the BUBBLE statement must exist in the PLOTDATA= data set.

Syntax

BUBBLE X=*variable* Y=*variable* SIZE=*numeric-variable* < */ options* >;

Summary of Optional Arguments

Appearance options

ATTRID=*character-value*

specifies the value of the ID variable in a discrete attribute map data set.

BRADIUSMAX=*number<units>*
specifies the radius of the largest bubble.

BRADIUSMIN=*number<units>*
specifies the radius of the smallest bubble.

COLORMODEL=*style-element* | (*color-list*)
specifies a color ramp that is to be used when mapping numeric response values.

COLORRESPONSE=*numeric-column*
specifies the numeric column that is used to map colors to a gradient legend.

FILL
specifies that the plot bubbles are filled.

FILLATTRS=*style-element*<(*options*)> | (*options*)
specifies the fill color and transparency.

NOFILL
specifies that plot bubbles are not filled.

OUTLINE
specifies whether the outlines of the bubbles are visible.

RATTRID=*character-value*
specifies the value of the ID variable in a range attribute map data set.

TRANSPARENCY=*value*
specifies the degree of transparency for the plot.

Data tip options

TIP=(*variable-list*) | NONE
specifies the data tip information to be displayed when the cursor is positioned over the graphics element.

TIPFORMAT=(*format-list*)
applies formats to the list of data tip variables that you specify in the TIP= option.

TIPLABEL=(*label-list*)
applies labels to the list of data tip variables that you specify in the TIP= option.

Group options

GROUP=*variable*
specifies a discrete variable that is used to group the data.

NOMISSINGGROUP
specifies that missing values of the group variable are not included in the plot.

Label options

DATALABEL=*variable*
displays a label for each data point.

DATALABELATTRS=(*options*)
specifies the appearance of the labels in the plot when you use the DATALABEL= option.

DATALABELPOS=BOTTOM | BOTTOMLEFT | BOTTOMRIGHT | CENTER | LEFT | RIGHT | TOP | TOPLEFT | TOPRIGHT
specifies the location of the data label with respect to the plot.

LEGENDLABEL="*text-string*"
specifies a label that identifies the plot in the legend.

Plot options

URL=*character-variable*
specifies an HTML page to be displayed when parts of the plot are selected.

Plot reference options

NAME="*text-string*"
assigns a name to a plot overlay.

Required Arguments

X=*variable*
specifies the variable for the X axis (longitude). The variable can have a character or numeric value.

Y=*variable*
specifies the variable for the Y axis (latitude). The variable can have a character or numeric value.

SIZE=*numeric-variable*
specifies the variable that controls the size of the bubbles. The minimum and maximum values automatically provide the range that is used to determine bubble sizes. You can control this range manually by using the BRADIUSMAX and BRADIUSMIN options.

Requirement The SIZE= argument must be a numeric variable. Specifying characters results in an error.

Interaction The GROUP option specifies a grouping variable for classification effects. When a group variable is used, the bubbles change appearance (size) for each group value.

Optional Arguments

ATTRID=*character-value*
specifies the value of the ID variable in a discrete attribute map data set. You specify this option only if you are using an attribute map to control visual attributes of the graph.

Requirement Use the ATTRID= option in conjunction with the SGMAP procedure's DATTRMAP= option. You need to specify both the value of the ID variable and the discrete attribute map data set that contains it.

See Specify a discrete attribute map data set with the "DATTRMAP=*discrete-attribute-map-data-set*" on page 643 option.

"Using Discrete Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

"Overview of Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

BRADIUSMAX=*number<units>*
specifies the radius of the largest bubble. You can specify any positive number for *number*, including decimals, as the radius of the largest bubble.

If you want to specify a dimension in a unit other than the default, then you must specify the desired unit with the dimension value. An example is `BRADIUSMAX=5PX`. For a list of measurement units that are supported, see "Units of Measurement" in *SAS ODS Graphics: Procedures Guide*.

Default Three times the markerSize in the GraphDataDefault style element.

Restriction The BRADIUSMAX= value must be greater than the BRADIUSMIN= value if one is specified. If BRADIUSMAX is not greater, an error is generated and a message is written to the SAS log.

Note If you specify the maximum size as a percentage, this is interpreted as a percentage of the graph's height. A graph's height can be specified by the HEIGHT= option of the ODS GRAPHICS statement.

BRADIUSMIN=*number<units>*
specifies the radius of the smallest bubble. You can specify any positive number for *number*, including decimals, as the radius of the smallest bubble.

If you want to specify a dimension in a unit other than the default, then you must specify the desired unit with the dimension value. An example is `BRADIUSMIN=3PX`. For a list of measurement units that are supported, see "Units of Measurement" in *SAS ODS Graphics: Procedures Guide*.

Default 2 PCT (or %). Note that for the standard 640px by 480px output size, this percentage is about the same as 10px.

Restriction The BRADIUSMIN= value must be smaller than the BRADIUSMAX= value, if one is specified. If BRADIUSMIN is not smaller, then the default value is used for both the BRADIUSMIN= and the BRADIUSMAX= options..

Note If you specify the minimum size as a percentage, this is interpreted as a percentage of the graph's height. A graph's height can be specified by the HEIGHT= option of the ODS GRAPHICS statement.

COLORMODEL=*style-element* | (*color-list*)
specifies a color ramp that is to be used when mapping numeric response values.

style-element
specifies the name of a style element that defines a two-color ramp or a three-color ramp. A style element that defines a color ramp contains these style attributes:

STARTCOLOR	specifies the color for the smallest numeric response data value.
NEUTRALCOLOR	specifies the color for the midpoint of the range of the numeric response data. This attribute applies only to three-color ramps.
ENDCOLOR	specifies the color for the highest numeric response data value.

Note If the specified style element does not contain at least the STARTCOLOR and ENDCOLOR attributes, a NOTE is generated in the SAS log. In that case, the colors are derived from the TwoColorRamp style element.

Example
```
colormodel=ThreeColorAltRamp
```

(*color-list*)
specifies a space-separated list of colors to use in the color ramp. The list can contain a mix of color names and color codes.

- You can specify colors using a number of different color-naming schemes. For more information, see "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.
- You can use two different color names. All bin colors are calculated as a gradient color between the specified colors.

Requirement The list of colors must be enclosed in parentheses.

Examples
```
colormodel=(blue yellow)

colormodel=(CX00FF00 blue)/* where CX00FF00 is green */
```

Defaults The TwoColorRamp style element for filled bubbles

The TwoColorAltRamp style element for unfilled bubbles

Requirement For this option to take effect, the COLORRESPONSE= option must also be specified.

COLORRESPONSE=*numeric-column*
specifies the numeric column that is used to map colors to a gradient legend. The fill colors are assigned according to the legend gradient.

Interaction When the GROUP= option is specified with the COLORRESPONSE= option, the color attributes are controlled by the COLORRESPONSE= option.

Tips The GRADLEGEND statement controls the title, position, and border of the legend. If you want only the colors and not the legend, then you can specify NOGRADLEGEND.

The color ramp is specified by the "COLORMODEL=style-element | (color-list)" option. The color ramp represents the range of unique response values.

See "GRADLEGEND Statement" on page 679

"Using Gradient Color Legends" in *SAS ODS Graphics: Procedures Guide*

DATALABEL=*variable*
displays a label for each data point. If you specify a variable, the values of that variable are used for the data labels. If you do not specify a variable, then no labels are displayed and an error message is issued in the SAS log. The position of the labels is automatically adjusted to prevent the labels from overlapping.

Tip You might want to avoid specifying as a variable the X or Y coordinate variables. Using these projected values in the label causes mismatches with the resultant graph that is created with the unprojected variable values in the map input data set.

DATALABELATTRS=(*options*)
specifies the appearance of the labels in the plot when you use the DATALABEL= option.

You can specify one or more options for the label text. They might not include all the style attributes in use for font (color, family, size, style, weight). Any options for label text that are not specified are derived from the default style element. *options* can be one or more of the following:

COLOR=*color*
specifies the color of the text. You can specify colors using a number of different color-naming schemes. See "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

FAMILY= *"font-family "*
specifies the font family for the text. The SAS ODS styles use TrueType system fonts.

SIZE= *n<units>*
specifies the font size of the text. You can also specify the unit of measurement. The default unit is pixels.

STYLE= ITALIC | NORMAL
specifies the font style of the text.

WEIGHT=BOLD | NORMAL
specifies the font weight of the text.

For a description of the text options, see "Text Attributes" in *SAS ODS Graphics: Procedures Guide*.

Default The GraphDataText style element in the current style.

Interaction The DATALABELATTRS= option has no effect unless the DATALABEL option is also specified.

Note If you specify a size for the SCATTER label text that is smaller than the system minimum font size, the system minimum font size is used instead.

Examples Here is an example that specifies options for the text of the label:

```
DATALABELATTRS=(Color=Green Family=Arial Size=8
        Style=Italic Weight=Bold)
```

Here is an example that specifies, in this case, the default style element:

```
DATALABELATTRS=GraphDataText
```

Here is an example that specifies the default style element, and specifies a size option to override the specific appearance attributes in that style element:

```
DATALABELATTRS=GRAPHDATATEXT(SIZE=10pt)
```

DATALABELPOS=BOTTOM | BOTTOMLEFT | BOTTOMRIGHT | CENTER | LEFT | RIGHT | TOP | TOPLEFT | TOPRIGHT

specifies the location of the data label with respect to the plot. Choose one of the position values.

Default The label text position adheres to the position specified, and might result in the overlapping of data text labels with the bubbles marking data points.

Interactions When the DATALABELPOS= option is not specified, the default behavior adjusts data text label positions on the graph to avoid collision with bubbles marking data. Specifying the DATALABELPOS= option overrides the default collision avoidance behavior.

The DATALABELPOS= option has no effect unless you also specify the DATALABEL option.

Data label collision avoidance does not occur when the number of data labels identifying the DATALABEL option variable values exceeds the LABELMAX value specified in the ODS GRAPHICS statement.

This option displays group values for each category when GROUP= is also specified.

FILL

specifies that the plot bubbles are filled. The FILL option displays the fill color.

Default Determined by the DisplayOpts attribute of the GraphBubble style element. FILL is the default.

Interaction Specifying FILL also hides the outlines.

See To specify empty plot bubbles, use the “NOFILL” on page 660 option.

FILLATTRS=*style-element*<(*options*)> | (*options*)

specifies the fill color and transparency.

You can specify the appearance by using a style element or by specifying specific options. If you specify a style element, you can also specify options to override specific appearance attributes.

When specifying the suboptions, use a *name=value* pair format enclosed in parentheses. If you specify more than one *name=value* pair, separate them by a space. For example:

```
(color=red transparency=.5)
```

You can use a style element or specify specific suboptions. If you specify a style element, you can also specify options to override specific appearance attributes. These suboptions can be one or more of the following:

COLOR=*color*
specifies the fill color. You can specify colors using a number of different color-naming schemes. See "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

TRANSPARENCY=*number*
specifies the degree of the transparency of the filled area.

For a description of fill attributes, see "Fill Attributes" in *SAS ODS Graphics: Procedures Guide*.

Defaults
For ungrouped data, the Color attribute of the GraphDataDefault style element in the current style. For grouped data, the Color attribute of a GraphData1–GraphData*n* style element in the current style.

0 for transparency

Range
0 (opaque) to 1 (entirely transparent). The range of the TRANSPARENCY= option that controls the degree of the transparency of the bubble fill.

Interactions
If you specify a COLOR= option with grouped data, the bubble fill color is the same across all group values.

Using a transparency FILLATTRS= option overrides a specified TRANSPARENCY= option in the BUBBLE statement only for the bubble fill. The bubble outline is not overridden.

This option has no effect if you specify the NOFILL option.

This option has no effect if you specify the OUTLINE option.

See
"Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide* for more information.

"Fill Attributes" in *SAS ODS Graphics: Procedures Guide* for further details.

Example
Use the color and transparency suboptions in the FILLATTRS= option:

```
fillattrs=(color=green transparency=.2)
```

GROUP=*variable*
specifies a discrete variable that is used to group the data.

The plot elements for each group value are automatically distinguished by different visual attributes. Each distinct group value is represented in the graph by a different bubble color. Bubble fill patterns are not changed across groups.

Tips ODS Graphics limits the number of groups to 1000. Use the GROUPMAX= option in the ODS GRAPHICS statement to change the maximum number of groups that can be processed.

You can use the NOMISSINGGROUP option to omit missing values of the group variable from the plot.

LEGENDLABEL="*text-string*"
specifies a label that identifies the plot in the legend.

Default The label for the Size variable is used for ungrouped data.

Interactions This option has no effect unless you also specify the NAME= option in the BUBBLE statement.

This option has no effect if you also specify the GROUP= option in the BUBBLE statement.

NAME="*text-string*"
assigns a name to a plot overlay.

You can use the name to refer to this plot in other statements.

Note The *text-string* is case-sensitive and must define a unique name within the procedure. When you refer to this specified name in other statements within the SGMAP procedure, you must use the identical name.

Tip This option is often used with legend statements in order to coordinate the use of colors and patterns between the graph and the legend.

NOFILL
specifies that plot bubbles are not filled. The NOFILL option hides the fill color.

Default Determined by the DisplayOpts attribute of the GraphBubble style element. FILL is the default.

See To fill bubbles with color, rely on the default, or use the "FILL" on page 658 option.

NOMISSINGGROUP
specifies that missing values of the group variable are not included in the plot.

Interaction This option has no effect unless GROUP= is also specified.

OUTLINE
specifies whether the outlines of the bubbles are visible. The OUTLINE option shows the outlines.

Default GraphOutlines style element in the current style. The style attributes in use are Color, FontFamily, FontSize, FontStyle, and FontWeight. Any options for inset title text that not specified are derived from this default style element.

Interaction Specifying OUTLINE also hides the fill color.

RATTRID=*character-value*
specifies the value of the ID variable in a range attribute map data set. You specify this option only if you are using a range attribute map to control visual attributes of the graph.

Restriction This option must be used in conjunction with PROC SGMAP's "RATTRMAP=range-attribute-map-data-set" option.

See "Using Range Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

"Overview of Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

TIP=(*variable-list*) | NONE
specifies the data tip information to be displayed when the cursor is positioned over the graphics element.

(*variable-list*)
a space-separated list of variables enclosed in parentheses. Data tips are displayed using the data obtained from the specified variables.

NONE
suppresses the data tips from this plot.

Requirement You must specify the IMAGEMAP=ON option in the ODS GRAPHICS statement in order to generate data tips. For example, add the following statement before your procedure:

```
ODS GRAPHICS / IMAGEMAP=ON;
```

Interaction This option replaces all of the information that is displayed by default.

Tips You might want to avoid specifying as a variable the X or Y coordinate variables. Using these projected values in the label causes mismatches with the resultant graph that is created with the unprojected variable values in the map input data set.

Use the TIPFORMAT= option and the TIPLABEL= option to assign formats and labels, respectively, to the list of variables.

Example tip=(age weight)

TIPFORMAT=(*format-list*)
applies formats to the list of data tip variables that you specify in the TIP= option. Provide a space-separated list of formats enclosed in parentheses. This option provides a way to control the format of the variable data that appears in the data tips.

A one-to-one correspondence exists between the *format-list* and the *variable-list* that is specified for the TIP= option. A format must be provided for each variable, using the same order as the *variable-list*. If you do not want to apply a format to a variable, use the AUTO keyword instead.

Default The column format of the tip variable, or BEST6 if no format is assigned to a numeric column.

Requirements A format or the keyword AUTO must be provided for each variable that is listed in the TIP= option.

This option has no effect unless the TIP= option is also specified.

Tip Use the TIPLABEL= option to assign labels to the list of variables.

See *SAS Formats and Informats: Reference*

Example tipformat=(auto F5.2)

TIPLABEL=(*label-list*)
applies labels to the list of data tip variables that you specify in the TIP= option. Provide a space-separated list of quoted "text strings" enclosed in parentheses. This option provides a way to specify labels for the variable data that appears in the data tips.

A one-to-one correspondence exists between the *label-list* and the *variable-list* that is specified for the TIP= option. A label must be provided for each variable, using the same order as the *variable-list*. If you do not want to apply a custom label to a variable, use the AUTO keyword instead.

Requirements A label or the keyword AUTO must be provided for each variable that is listed in the TIP= option. When AUTO is used, the label is obtained from the variable.

This option has no effect unless the TIP= option is also specified.

Tip Use the TIPFORMAT= option to assign formats to the list of variables.

Example tiplabel=(auto "Class Weight")

TRANSPARENCY=*value*
specifies the degree of transparency for the plot. The transparency that you specify applies to all aspects of the plot statement. For example, you can specify the amount of transparency applied to any displayed bubble fills and bubble outlines.

Default 0.0

Range 0 (completely opaque) to 1 (completely transparent)

URL=*character-variable*
specifies an HTML page to be displayed when parts of the plot are selected.

character-variable
specifies a variable that contains a valid HTML page reference (HREF) for each plot element that is to have an active link.

Example `https://www.sas.com/en_us/home.html`

Default By default, no HTML links are created.

Interactions This option affects graphics output that is created through the ODS HTML destination only. For more information about ODS destinations, see "Specifying ODS Destinations" in *SAS ODS Graphics: Procedures Guide*.

This option has no effect unless you also specify IMAGEMAP in the ODS GRAPHICS statement. For example, add the following statement before your procedure:

```
ODS GRAPHICS ON / IMAGEMAP=ON;
```

Tip Use the DRILLTARGET= option in the ODS GRAPHICS statement in order to specify the browser window that displays the drill-down output.

CHOROMAP Statement

Specifies a two-dimensional map of polygonal areas that can be an outline map or a choropleth map.

Restrictions: Map data sets or geocoding lookup data sets that are stored on a system that does not guarantee data order cannot be used with the SGMAP procedure. Essential polygonal data sequencing in the input data must be maintained. The SGMAP procedure prohibits specifying in the MAPDATA= option data that is stored in a library that cannot guarantee data order. Use map data that is stored locally.

The MAPDATA= option must specify a map data set of polygon boundaries in the SGMAP statement in order to give the CHOROMAP statement data to process.

Requirement: The CHOROMAP statement must be specified when an ESRIMAP or OPENSTREETMAP statement is not specified.

Notes: The CHOROMAP statement uses a set of rules to plot the coordinate variables in a map data set. See "Details" on page 677. The SAS log lists what the CHOROMAP statement used for coordinate variables.

If you specify a map response data set with MAPRESPDATA=, but do not specify a response variable in the CHOROMAP statement, the map response data set is not used.

If neither the ID= option or the MAPID= option are specified, the SGMAP procedure uses the variable name 'ID' for both options. If the variable named 'ID' is not found in their respective data sets, an error is issued in the SAS log. If MAPID= is specified but ID= is not specified, then the MAPID= variable name is used for the ID= variable name, by default.

Occasionally you might want to use the map data set as your response data set. Instead, use the map data set's companion _attr data set if you have SAS/GRAPH installed and are using the MAPSGFK library. An example is Mapsgfk.Africa and its companion Mapsgfk.Africa_attr. Or consider using PROC SORT with its NODUPKEY option to reduce the number of duplicate observations in a new version of the map data set before running the SGMAP procedure. Ideally the map response data set should contain only one observation per polygon, and the observation should correspond to a map polygon.

Syntax

CHOROMAP < *response-variable* > </*options*>;

Summary of Optional Arguments

Appearance options

ATTRID=*character-value*
: specifies the value of the ID variable in a discrete attribute map data set.

COLORMODEL=*style-element* | (*color-list*)
: specifies a color ramp that is to be used when mapping numeric response values.

LINEATTRS=*style-element* (*options*)
: specifies the appearance of the polygon border line attributes.

RATTRID=*character-value*
: specifies the value of the ID variable in a range attribute map data set.

TRANSPARENCY=*value*
: specifies the degree of transparency for the plot.

Data tip options

TIP=(*variable-list*) | NONE
: specifies the data tip information to be displayed when the cursor is positioned over the graphics element.

TIPFORMAT=(*format-list*)
: applies formats to the list of data tip variables that you specify in the TIP= option.

TIPLABEL=(*label-list*)
: applies labels to the list of data tip variables that you specify in the TIP= option.

Label options

DISCRETE
: generates a separate response level (color and surface pattern) for each different value of the formatted response variable.

LEGENDLABEL="*text-string*"
: specifies a label that identifies the plot in the legend.

Map description option

NAME="*text-string*"
: assigns a name for the map.

Map variable option

DENSITY=0... 6 | LOW | MEDIUM | HIGH
: for maps that have a DENSITY variable, specifies the density of map observations that are used.

Mapping options

LEVELTYPE=NONE | INTERVAL | QUANTILE
: specifies the binning algorithm to use in determining each response variable level.

NUMLEVELS=*number-of-response-levels*
: specifies the number of response levels to be graphed for the response area.

Plot options

URL=*character-variable*
: specifies an HTML page to be displayed when parts of the plot are selected.

Plot variable options

ID=*variable*
: specifies a variable in the MAPRESPDATA= data set that links to the polygons in the map data set.

MAPID=*variable*
: specifies a variable in the MAPDATA= data set that is used to draw the CHOROMAP polygons.

Response variable option

response-variable
: specifies a variable in the map response data set to use to generate a choropleth map.

Optional Response Variable Argument

response-variable

specifies a variable in the map response data set to use to generate a choropleth map. Response variables can be either numeric or character. Numeric response variables are normally grouped into ranges, or response levels, as determined by default. Each response level is assigned a different combination of pattern and color.

Note If a response variable is not specified, an outline map is generated.

Tip The ID= option variable must be specified when a *response-variable* option is specified unless the linking variable matches one of the default names. The CHOROMAP statement needs the ID= option to link the response data set to the map data set. Use the ID= variable to link the MAPDATA= observations to the MAPRESPDATA= observations for the CHOROMAP response variable. If the ID= option is not specified in the

CHOROMAP statement and a MAPID= variable is specified, the MAPID= variable name is used as the ID= name by default. However, when neither MAPID= nor ID= options are specified, the defaults for both are variables named "ID".

Optional Arguments

options can be one or more of the following attributes.

ATTRID=*character-value*
specifies the value of the ID variable in a discrete attribute map data set. You specify this option only if you are using an attribute map to control visual attributes of the graph.

Requirement Use the ATTRID= option in conjunction with the SGMAP procedure's DATTRMAP= option. You need to specify both the value of the ID variable and the discrete attribute map data set that contains it.

See Specify a discrete attribute map data set with the "DATTRMAP=*discrete-attribute-map-data-set*" on page 643 option.

"Using Discrete Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

"Overview of Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

COLORMODEL=*style-element* | (*color-list*)
specifies a color ramp that is to be used when mapping numeric response values.

style-element
specifies the name of a style element that defines a two-color ramp or a three-color ramp. A style element that defines a color ramp contains these style attributes:

STARTCOLOR	specifies the color for the smallest numeric response data value.
NEUTRALCOLOR	specifies the color for the midpoint of the range of the numeric response data. This attribute applies only to three-color ramps.
ENDCOLOR	specifies the color for the highest numeric response data value.

Note If the specified style element does not contain at least the STARTCOLOR and ENDCOLOR attributes, a NOTE is generated in the SAS log. In that case, the colors are derived from the TwoColorRamp style element.

Example
```
colormodel=ThreeColorAltRamp
```

(*color-list*)

specifies a space-separated list of colors to use in the color ramp. The list can contain a mix of color names and color codes.

- You can specify colors using a number of different color-naming schemes. For more information, see "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.
- You can use two different color names. All bin colors are calculated as a gradient color between the specified colors.
- You can use a number of color names that is equal to greater than the number of requested levels specified in the NUMLEVELS= option.

Note: When NUMLEVELS=1, the first color in effect for the COLORMODEL= option is used.

Note: When NUMLEVELS=2 and three colors are specified with COLORMODEL=*color-list* option, the first two colors are used. An example is COLORMODEL=(cxff0000 cx004400 cx0000ff). When NUMLEVELS=2 and three colors are specified with COLORMODEL=*style-element*, the first and last colors are used if the *style-element* is a color ramp other than the default TwoColorRamp. An example is COLORMODEL=ThreeColorRamp.

Restrictions The COLORMODEL= option has no effect when the number of colors specified is not two, or is not equal to or greater than the number of levels specified with the NUMLEVELS= option. A WARNING is issued in the SAS log, and the colors will be derived from the TWOCOLORRAMP default style.

When COLORMODEL=*style-element* specifies a color ramp that uses a number of colors that is not equal to the number of levels indicated with the NUMLEVELS= option, colors are applied in order to each level. If there are not enough colors, or at least two colors required for a color ramp, the COLORMODEL= specification has no effect and the colors will be derived from the TWOCOLORRAMP default style.

Requirement The list of colors must be enclosed in parentheses.

Examples

```
colormodel=(blue yellow)

colormodel=(CX00FF00 blue)/* where CX00FF00 is green */

numlevels=3 colormodel=(blue yellow green)

numlevels=4 leveltype=quantile colormodel=(
   red green yellow blue purple);
```

Default The TwoColorRamp style element

Restrictions The COLORMODEL= option has no effect when the options LEVELTYPE=INTERVAL and NUMLEVELS=1 are specified, because

at least two response variables are required to graph a range of colors with INTERVAL binning.

The COLORMODEL= option is used when the option LEVELTYPE=NONE and option NUMLEVELS=1 are specified, but NUMLEVELS= is bypassed.

Tip Use this option to specify colors to differentiate continuous response variables. The "NUMLEVELS=number-of-response-levels " option in the CHOROMAP statement indicates continuous response variables. When using discrete response variables indicated by the CHOROMAP statement's DISCRETE option, specify colors with the STYLEATTRS statement's DATACOLORS= option.

DENSITY=0... 6 | LOW | MEDIUM | HIGH

for maps that have a DENSITY variable, specifies the density of map observations that are used. You can specify an integer from 0 to 6 for the DENSITY option, or you can specify one of the descriptors.

0... 6

The value that you specify indicates the maximum value that the DENSITY variable can have for the observation to be displayed. For example, if you specify DENSITY=5, then only observations in the map data set whose DENSITY value is less than or equal to 5 are displayed. Specifying DENSITY=6 displays all the observations in the map data set.

> **TIP** Specifying DENSITY=0 yields a different result than running your code with the DENSITY= option removed.

LOW

LOW is equivalent to DENSITY= 1.

MEDIUM

MEDIUM is equivalent to DENSITY= 3.

HIGH

HIGH is equivalent to DENSITY= 6.

The DENSITY variable specifies how close a map point is to other map points. If there are many map points in close proximity (high density), then it is possible to eliminate a number of them without seriously degrading the quality of the map. A low density value indicates that a smaller number of pixels is displayed. Many map data sets supplied by SAS contain a DENSITY variable. For map data sets that do not contain a DENSITY variable, you can add and populate the variable using the GREDUCE procedure.

You can omit the DENSITY= option. In this case, all of the observations in a map data set are displayed that correspond to the resolution that the device displaying the map is using.

Aliases L

MED

M

HI

H

Default DENSITY=6 when a RESOLUTION variable does not exist in the input map data set

Restrictions If the map data set does not contain a column of DENSITY values, then a warning is issued and the option has no effect.

The DENSITY= option has no effect if you have also specified a WHERE clause to subset the map data set.

Interaction The SGMAP procedure, by default, uses the RESOLUTION variable rather than the DENSITY variable to determine the number of map data points to use, if they exist in the input map data set.

See Chapter 15, "GREDUCE Procedure," on page 581 for information about the DENSITY variable.

DISCRETE

generates a separate response level (color and surface pattern) for each different value of the formatted response variable. If you specify the DISCRETE option, then distinct, non-continuous colors are used for the response values. This option affects both the filled polygons and their respective legend entries.If you specify the NUMLEVELS= option instead, then a color ramp is used to assign each response value a continuous color scheme.

Note If the data does not contain a value in a particular range of the format, that formatted range is not displayed in the legend.

ID=*variable*

specifies a variable in the MAPRESPDATA= data set that links to the polygons in the map data set.

Requirement The *response-variable* option must be specified when a ID= option variable is specified, unless the linking variable matches one of the default names. The CHOROMAP statement needs the ID= option to link the response data set to the map data set.

Notes If the ID= variable is not found in the MAPRESPDATA= data set, an error is issued in the SAS log.

If the *response-variable* option is specified but the ID= option is not specified, the SGMAP procedure uses the variable specified in the MAPID= option as the default. If the MAPID= variable is not found in the MAPRESPDATA= data set, an error is issued in the SAS log.

If neither the ID= option or the MAPID= option are specified, the SGMAP procedure uses the variable name 'ID' for both options. If the variable named 'ID' is not found in their respective data sets, an error is issued in the SAS log. If MAPID= is specified but ID= is not

specified, then the MAPID= variable name is used for the ID= variable name, by default.

The ID= variable should correspond to the MAPID= variable specified in the MAPDATA= data set used by the CHOROMAP statement. The ID= and MAPID= variables do not have to be identical, but they both must be either character or numeric variable types. A mismatch is identified as an error in the SAS log.

Tip When specifying a character variable, do not include leading spaces that could prevent map data set matches to the ID= variable.

LEGENDLABEL="*text-string*"
specifies a label that identifies the plot in the legend.

Defaults The label for the response variable is used for ungrouped data.

The CHOROMAP statement supports the label in a legend according to interaction rules listed in "Applying a Label in a Legend on a CHOROMAP" on page 731.

Interactions The LEGENDLABEL= option has no effect if you specify a response variable.

When the CHOROMAP statement does not specify a response variable, you can specify a custom legend label with this option.

When the CHOROMAP statement does not specify a response variable, and any plot statements used do not specify a GROUP= option, the legend is labeled.

LEVELTYPE=NONE | INTERVAL | QUANTILE
specifies the binning algorithm to use in determining each response variable level.

NONE
maps the numeric values across a continuous color range.

Default NONE indicates that no binning method is applied. This is in effect when you specify LEVELTYPE=NONE, or when both NUMLEVELS= and LEVELTYPE= options are not specified.

INTERVAL
bins the numeric values into equal intervals.

Note: An exception might be the handling of the last interval. This might be extended to include values that fall just outside of the maximum interval.

QUANTILE
specifies a binning of the numeric values into equivalent (or close thereto), collections of the same number of observations per bin.

Note When LEVELTYPE=QUANTILE is specified, the actual number of levels generated might vary from the value that is specified in NUMLEVELS= on page 674, depending on the input data.

Defaults The number of levels is computed from the numeric values when the LEVELTYPE= option is specified but the NUMLEVELS= option is not.

The default COLORMODEL style of TWOCOLORRAMP is used for each LEVELTYPE. Specify the "COLORMODEL=style-element | (color-list)" option to change this default.

Restrictions The LEVELTYPES= option is applicable only when the response variables are numeric. This option has no effect when the response variables are character.

When LEVELTYPE=QUANTILE or =INTERVAL and the COLORMODEL= option specifies three colors, and the NUMLEVELS= option specifies more than three levels, a WARNING is issued in the SAS Log. The COLORMODEL= specification has no effect.

Interaction The LEVELTYPE= option can be used in conjunction with the "NUMLEVELS=number-of-response-levels " option and the "COLORMODEL=style-element | (color-list)" option.

Note The response variable level information is shown in a legend when you specify either a GRADLEGEND statement or a KEYLEGEND statement.

LINEATTRS=*style-element* (*options*)
specifies the appearance of the polygon border line attributes.

> **TIP** To create invisible lines between your polygons, set the THICKNESS= option to zero (0), and visible lines are not drawn.

You can specify the appearance by using a style element or by specifying specific options. If you specify a style element, you can also specify options to override specific appearance attributes.For a description of the line options, see "Line Attributes and Patterns" in *SAS ODS Graphics: Procedures Guide*.

Any option specified controls both the outline and empty outline attributes.

The LINEATTRS= option is not affected by grouped data.

When specifying more than one option, separate the options with a space. The group of options must be surrounded by parentheses.

(options) can be one or more of the following:

COLOR=*style-reference* | *color*
specifies the color of the polygon border line. You can specify colors using a number of different color-naming schemes. For more information, see "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

Default The ContrastColor attribute of the GraphOutlines style element in the current style.

Example If you want to override the color attribute of the default style element, specify an alternative *style-reference* like the following:

```
lineattrs=GraphDataDefault(color=graphdatadefault:contrastcolor);
```

PATTERN=*line-pattern-name* | *line-pattern-number*
specifies the line pattern for the border line.

Line patterns can be specified as a *line-pattern-name* or as a *line-pattern-number*. Not all line patterns have identifying names. However, the line patterns with names have been optimized. This provides the ability to visually discriminate different lines that might be used in the same plot. Valid line pattern (identification) numbers range from 1–46. The following table shows the patterns for each of the possible combinations.

Table 18.1 *Named Line Patterns*

Pattern Number	Pattern Name	Example
1	Solid	
2	ShortDash	
4	MediumDash	
5	LongDash	
8	MediumDashShortDash	
14	DashDashDot	
15	DashDotDot	
20	Dash	
26	LongDashShortDash	
34	Dot	
35	ThinDot	
41	ShortDashDot	
42	MediumDashDotDot	

For a description of the line options, see "Line Attributes and Patterns" in *SAS ODS Graphics: Procedures Guide*.

Default The GraphOutlines style element LineStyle attribute.

THICKNESS=*n <units>*
specifies the thickness of the line. You can also specify the unit of measure.

The following table contains the units that are available:

Table 18.2 *Measurement Units*

Unit	Description
CM	centimeters
IN	inches
MM	millimeters
PCT or %	percentage
PT	point size, calculated at 100 dots per inch
PX	pixels

Defaults The GraphOutlines style element LineThickness attribute.

The default unit of measure is pixels, abbreviated as PX.

Default For color, line pattern, and line thickness, GraphOutlines style element in the current style. The affected attributes are ContrastColor, LineStyle, and LineThickness.

Examples Here is an example that specifies a style element:

```
lineattrs=GraphDataDefault
```

Here is an example that overrides the line attributes:

```
lineattrs=(color=cxff0000 pattern=dash thickness=4px);
```

MAPID=*variable*
specifies a variable in the MAPDATA= data set that is used to draw the CHOROMAP polygons. The MAPID= option also links to the map response data set if a response variable is specified.

Notes If the MAPID= variable is not found in the MAPDATA= data set, an error is issued in the SAS log.

If the MAPID= option is not specified, the SGMAP procedure uses the variable named ID as the default. If no variable named ID is found in the MAPDATA= data set, an error is issued in the SAS log.

The MAPID= variable should correspond to the ID= variable specified in the MAPRESPDATA= data set used by the CHOROMAP statement. The

MAPID= and ID= variables do not have to be identical, but they both must be either character or numeric variable types. A mismatch is identified as an error in the SAS log.

Tip When specifying a character variable, do not include leading spaces that could prevent map data set matches to the ID= variable.

NAME="*text-string*"

assigns a name for the map. You can use the name to refer to this map in other statements.

Note The *text-string* is case-sensitive and must define a unique name within the procedure. When you refer to this specified name in other statements within the SGMAP procedure, you must use the identical name.

Tip This option is often used with legend statements in order to coordinate the use of colors and line patterns between the graph and the legend.

NUMLEVELS=*number-of-response-levels*

specifies the number of response levels to be graphed for the response area. Each response level is assigned a different surface pattern and color combination.

Defaults When you specify the NUMLEVELS= option an ODS style TWOCOLORRAMP is used as the default COLORMODEL to assign each numeric response value a continuous color scheme. The response values are assigned lighter and darker values of a color scheme to express lower and higher response values. Use the "COLORMODEL=style-element | (color-list)" option to change this default and assign each numeric response value a discrete color.

An equal-distribution (quantizing) algorithm is used to determine each level when only the NUMLEVELS= option is specified and the LEVELTYPE= option is not.To change the default binning method, specify the "LEVELTYPE=NONE | INTERVAL | QUANTILE" option.

Restrictions Use a positive integer to specify the *number-of-response-levels* .

This option is applicable only when the response variables are numeric. This option has no effect when the response variables are character.

The NUMLEVELS= option has no effect when you use the DISCRETE option.

Restrictions apply when using the NUMLEVELS= option along with either the COLORMODEL= option or the LEVELTYPE= option. See the "COLORMODEL=style-element | (color-list)" option and the "LEVELTYPE=NONE | INTERVAL | QUANTILE" option for details.

Interaction If you specify the DISCRETE option, then distinct, non-continuous colors are used for the response values.

Notes If neither the NUMLEVELS= option nor the DISCRETE option is used, then the SGMAP procedure determines the number of

response levels by using the formula FLOOR(1+3.3 log(n)), where n is the number of response variable values.

The response variable level information is shown in a legend when you specify either a GRADLEGEND statement or a KEYLEGEND statement.

When LEVELTYPE=QUANTILE on page 670 is specified, the actual number of levels generated might vary from the value that is specified in NUMLEVELS=, depending on the input data.

RATTRID=*character-value*
specifies the value of the ID variable in a range attribute map data set. You specify this option only if you are using a range attribute map to control visual attributes of the graph.

Restriction This option must be used in conjunction with PROC SGMAP's "RATTRMAP=range-attribute-map-data-set" option.

See "Using Range Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

"Overview of Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

TIP=(*variable-list*) | NONE
specifies the data tip information to be displayed when the cursor is positioned over the graphics element.

(*variable-list*)
a space-separated list of variables enclosed in parentheses. Data tips are displayed using the data obtained from the specified variables.

NONE
suppresses the data tips from this plot.

Requirements You must specify the IMAGEMAP=ON option in the ODS GRAPHICS statement in order to generate data tips. For example, add the following statement before your procedure:

```
ODS GRAPHICS / IMAGEMAP=ON;
```

You must specify a MAPRESPDATA data set in the CHOROMAP statement in order to generate data tips.

Interaction This option replaces all of the information that is displayed by default.

Tips You might want to avoid specifying as a variable the X or Y coordinate variables. Using these projected values in the label causes mismatches with the resultant graph that is created with the unprojected variable values in the map input data set.

Use the TIPFORMAT= option and the TIPLABEL= option to assign formats and labels, respectively, to the list of variables.

Example tip=(age weight)

TIPFORMAT=(*format-list*)
applies formats to the list of data tip variables that you specify in the TIP= option. Provide a space-separated list of formats enclosed in parentheses. This option provides a way to control the format of the variable data that appears in the data tips.

A one-to-one correspondence exists between the *format-list* and the *variable-list* that is specified for the TIP= option. A format must be provided for each variable, using the same order as the *variable-list*. If you do not want to apply a format to a variable, use the AUTO keyword instead.

Default The column format of the tip variable, or BEST6 if no format is assigned to a numeric column.

Requirements A format or the keyword AUTO must be provided for each variable that is listed in the TIP= option.

This option has no effect unless the TIP= option is also specified.

Tip Use the TIPLABEL= option to assign labels to the list of variables.

See *SAS Formats and Informats: Reference*

Example tipformat=(auto F5.2)

TIPLABEL=(*label-list*)
applies labels to the list of data tip variables that you specify in the TIP= option. Provide a space-separated list of quoted “text strings” enclosed in parentheses. This option provides a way to specify labels for the variable data that appears in the data tips.

A one-to-one correspondence exists between the *label-list* and the *variable-list* that is specified for the TIP= option. A label must be provided for each variable, using the same order as the *variable-list*. If you do not want to apply a custom label to a variable, use the AUTO keyword instead.

Requirements A label or the keyword AUTO must be provided for each variable that is listed in the TIP= option. When AUTO is used, the label is obtained from the variable.

This option has no effect unless the TIP= option is also specified.

Tip Use the TIPFORMAT= option to assign formats to the list of variables.

Example tiplabel=(auto "Class Weight")

TRANSPARENCY=*value*
specifies the degree of transparency for the plot. The transparency that you specify applies to all aspects of the plot statement. For example, you can specify the amount of transparency applied to the map.

Default 0.0

Range 0 (completely opaque) to 1 (completely transparent)

URL=*character-variable*
specifies an HTML page to be displayed when parts of the plot are selected.

character-variable
specifies a variable that contains a valid HTML page reference (HREF) for each plot element that is to have an active link.

Example **`https://www.sas.com/en_us/home.html`**

Default By default, no HTML links are created.

Interactions This option affects graphics output that is created through the ODS HTML destination only. For more information about ODS destinations, see "Specifying ODS Destinations" in *SAS ODS Graphics: Procedures Guide*.

This option has no effect unless you also specify IMAGEMAP in the ODS GRAPHICS statement. For example, add the following statement before your procedure:

```
ODS GRAPHICS ON / IMAGEMAP=ON;
```

Tip Use the DRILLTARGET= option in the ODS GRAPHICS statement in order to specify the browser window that displays the drill-down output.

Details

The CHOROMAP statement plots the coordinate variables in a map data set according to the following rules:

- The CHOROMAP statement searches for, and uses unprojected coordinate variables in the order of LAT, then LATITUDE, and LONG, then LON, then LONGITUDE.
- If there are none of these unprojected coordinate variables, the CHOROMAP statement uses projected coordinate variables Y and X.
- The CHOROMAP statement does not use unprojected and projected coordinate variables in combination.
- If the LAT, LATITUDE, and Y coordinate variable are all missing, then the CHOROMAP statement creates a choromap with empty polygons. Please ensure that the map data set specified does not have missing coordinates that the CHOROMAP statement expects to use.

Handling the coordinate variables in this manner enables you to overlay an unprojected choromap on an unprojected Open Street Map or an Esri Map. The SAS log indicates the coordinate variables used by the CHOROMAP statement.

ESRIMAP Statement

Creates a map based on Esri maps.

Requirements: At a minimum, the ESRIMAP statement must be specified with either a CHOROMAP statement or a plot overlay statement such as BUBBLE, SCATTER, SERIES, or TEXT. It can be specified with a CHOROMAP statement and one or more plot overlay statements.

Use only unprojected LAT and LONG variable values with any type of plot overlay statement when you specify an Esri Map. The map tiles returned are based on the spatial extent of your plot overlay data.

Notes: The SGMAP procedure enables you to overlay a CHOROMAP on an Esri Map, and then overlay one or more BUBBLE or SCATTER plots. If you also specify a legend, space limitations might prevent the legend from being displayed.

Map elements are drawn in the order submitted. Place the ESRIMAP statement first to ensure that the other map elements are drawn on top of the map tiles.

If both ESRIMAP and OPENSTREETMAP statements are submitted, the first statement specified is the only one used.Likewise, when multiple ESRIMAP or OPENSTREETMAP statements are submitted, the first statement specified is the only one used.

Syntax

ESRIMAP URL='*map-service*';

Required Argument

URL='*map-service*'

Specify the Esri base map that you want to use. An example is:

```
esrimap url='https://services.arcgisonline.com/arcgis/rest/services/
World_Physical_Map/MapServer';
```

Requirement Quotation marks are required when specifying *map-service*.

Note This request for a map service is a network request. The SGMAP procedure does not authenticate any services that you specify, such as the map services and portal hosted by Esri. Check with your system administrator regarding the authentication setup for any Linux network proxy machine request that you might need to make.

Tip On a Linux operating system, if the SAS code to create an SGMAP times out, you can try the "curl" command with the map service URL. This might enable the SAS code to run to completion.

GRADLEGEND Statement

generates a continuous legend that maps the data range of a numeric response variable to a range of colors. You can use up to four GRADLEGEND statements in a procedure.

See: "Using Gradient Color Legends" in *SAS ODS Graphics: Procedures Guide*

Syntax

GRADLEGEND < *"name"* > < */ options* >;

Summary of Optional Arguments

Legend options

"name"
specifies the name of the plot that you want to include in the legend.

Optional Argument

"name"
specifies the name of the plot that you want to include in the legend. The name that you specify must correspond to a value that you entered for the NAME= option in a plot statement. The name must be enclosed in quotation marks. The plot statement must also specify the COLORRESPONSE= option.

Default: If you do not specify a name, then the legend contains references to all of the plots in the graph.If no name is specified for the GRADLEGEND statement, the legend references whichever plot statement specifies the COLORRESPONSE= option. If the procedure contains more than one plot with a COLORRESPONSE= option and you do not specify a GRADLEGEND name, then the COLORRESPONSE= option can affect the separate legends of each plot.

Restriction: Only one name can be specified. If you want a continuous legend for more than one plot, you can use multiple GRADLEGEND statements. You can use up to four GRADLEGEND statements in a procedure.

Interaction: When the GRADLEGEND statement is used, automated legend generation is disabled.

Note: The names specified here determine which plots are included, but not the labels that appear in the legend for those plots. To specify labels, use the LEGENDLABEL= option in the plot statements.

Option Values for the GRADLEGEND Statement

BORDER
specifies that a visible border is drawn around the legend. The BORDER option shows the border.

Default NOBORDER

See To hide the border around a legend, rely on the default, or use the "NOBORDER" on page 681 option.

EXTRACTSCALE
extracts a scale factor from the tick values and uses it to reduce the tick value width. The scale used is appended to the legend title as shown in the following example.

```
Total Sales (millions)
```

For long legend titles, if the scale does not fit the available space, then the title is truncated, and the scale is appended to the truncated title. Ellipses indicate that the label was truncated as shown in the following example.

```
Total Sales for the Fourth Quarter Of ... (millions)
```

In extreme cases where the title does not fit even with truncation, the title is dropped.

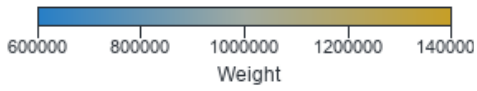
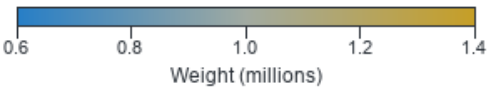
You can also specify whether to use a named scale or a scientific-notation scale.

The EXTRACTSCALE option extracts a named scale. A named scale can be millions, billions, or trillions for values of 999 trillion or less, or a multiple of 10 (denoted as 10^*n*) for values over 999 trillion. For small fractional tick values, the scale factor is set to ensure that the absolute value of the smallest value is greater than 1. The scale can be millionth, billionth, or trillionth for values of 1 trillionth or more, or a multiple of 1/10 (10^–*n*) for values less than 1 trillionth.

DEFAULT
extracts a named scale. A named scale can be millions, billions, or trillions for values of 999 trillion or less, or a multiple of 10 (denoted as 10^*n*) for values over 999 trillion. For small fractional tick values, the scale factor is set to ensure that the absolute value of the smallest value is greater than 1. The scale can be millionth, billionth, or trillionth for values of 1 trillionth or more, or a multiple of 1/10 (10^–*n*) for values less than 1 trillionth.

SCIENTIFIC
extracts a scientific-notation scale. A scientific-notation scale is a multiple of 10 expressed as 10^*n* for values greater than 1, or a multiple of 1/10 expressed as 10^–*n* for values less than 1.

The following examples show a continuous legend before and after EXTRACTSCALE is specified:

Default Scale	EXTRACTSCALE
	

Restriction The scale that is extracted by the EXTRACTSCALE option is derived from the English locale.

INTEGER
specifies that integers are used for the gradient legend.

NOBORDER
specifies that no border is visible around the legend. The NOBORDER option hides the border.

Default NOBORDER

See To draw a border around the legend, use the "BORDER" on page 680 option.

POSITION=*position-value*
specifies the position of the legend within the graph. The positions are as follows:

BOTTOM
places the legend at the bottom of the graph.

LEFT
places the legend at the left side of the graph.

RIGHT
places the legend at the right side of the graph.

TOP
places the legend at the top of the graph.

Notes By default, if you use more than one GRADLEGEND statement, then each legend is placed in a different position.

If you specify more than one legend with the same position, then those legends are placed at that position.

TITLE="*text-string*" | NOTITLE
specifies whether a title overrides the default title for the legend or is removed altogether. The title is placed to the left of the legend body, except in the following cases:

- the legend contains two or more rows of items
- the legend title length exceeds the space that is available on the left side of the legend

In either case, the title is placed above the legend body.

Defaults The legend title is the name of the response variable unless otherwise specified with the TITLE= option.

The NOTITLE option removes the legend title unless the legend shows group values. If the legend shows group values, then the group variable is displayed by default as the title. To remove a group variable title, specify TITLE="".

Requirement *text-string* must be enclosed in matching quotation marks.

TITLEATTRS=*style-element* | *style-element*< (*options*) > | (*options*)
specifies the appearance of the title. For the GRADLEGEND statement, this option affects the legend title.

You can specify the appearance by using a style element or by specifying specific options. If you specify a style element, you can also specify options to override specific appearance attributes.

You can specify one or more of the following for *options*:

COLOR=*color*
specifies the color of the text. You can specify colors using a number of different color-naming schemes. See "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

FAMILY= "*font-family* "
specifies the font family for the text. The SAS ODS styles use TrueType system fonts.

SIZE= *n*<*units*>
specifies the font size of the text. You can also specify the unit of measurement. The default unit is pixels.

STYLE= ITALIC | NORMAL
specifies the font style of the text.

WEIGHT=BOLD | NORMAL
specifies the font weight of the text.

Any options that are not specified are derived from the default style element. For a description of the text options, see "Text Attributes" in *SAS ODS Graphics: Procedures Guide*.

Default The Color, FontFamily, FontSize, FontStyle, and FontWeight attributes of the GraphLabelText style element in the current style. Any unspecified options for the GRADLEGEND legend title text appearance are derived from this default style element.

Restriction You can specify one font family name, but not more than one.

Interaction You can specify one or more options for the legend title text. They might not include all the font properties (color, family, size, weight, style). Any non-specified properties are derived from the GraphLabelText style element.

Note If you specify a size for the title text that is smaller than the system minimum font size, the system minimum font size is used instead.

Examples
```
TITLEATTRS=(Color=Green Family=Arial Size=8
        Style=Italic Weight=Bold)
```

Here is an example that specifies a style element:
```
TITLEATTRS=GraphTitleText
```

Here is an example that specifies a style element other than the default, and overrides the size option:
```
titleattrs=GraphValueText(size=10pt)
```

KEYLEGEND Statement

Adds a legend to the plot.

See: "Using Discrete Legends" in *SAS ODS Graphics: Procedures Guide*

Syntax

KEYLEGEND < *"name-1" "name-2" ...* > < */ options* >;

Summary of Optional Arguments

Legend options

"name-1" "name-2" ...
specifies the name of the plot that you want to include in the legend.

Optional Argument

"name-1" "name-2" ...
specifies the name of the plot that you want to include in the legend. The name that you specify must correspond to a value that you entered for the NAME= option in a plot statement. The name must be enclosed in quotation marks. The plot statement must also specify the COLORRESPONSE= option.

Default If you do not specify a name, then the legend contains references to all of the plots in the graph.If no name is specified for the GRADLEGEND statement, the legend references whichever plot statement specifies the COLORRESPONSE= option. If the procedure contains more than one plot with a COLORRESPONSE= option and you do not specify a GRADLEGEND name, then the COLORRESPONSE= option can affect the separate legends of each plot.

Restriction Only one name can be specified. If you want a continuous legend for more than one plot, you can use multiple GRADLEGEND statements. You can use up to four GRADLEGEND statements in a procedure.

Interaction When the GRADLEGEND statement is used, automated legend generation is disabled.

Note The names specified here determine which plots are included, but not the labels that appear in the legend for those plots. To specify labels, use the LEGENDLABEL= option in the plot statements.

Option Values for the KEYLEGEND Statement

AUTOITEMSIZE

specifies that all markers in the legend are sized in proportion to the font size used for the legend value labels. If you do not use AUTOITEMSIZE, the markers might be smaller compared to the labels. These proportional sizes take effect regardless of the attributes that are used in the plot.

The following figures show a legend with fairly large labels. In the first figure, the markers are small compared to the labels. The second figure uses AUTOITEMSIZE to size the markers in proportion to the labels.

Table 18.3 *Marker Size Before and After Using AUTOITEMSIZE*

Default Marker Size	AUTOITEMSIZE Used in the Statement

Restriction This option supports proportional scaling of all markers in a discrete KEYLEGEND.

Tip Use the VALUEATTRS= option to control the font size for the legend value labels.

TITLE="*text-string*"

specifies a title to override the default title for the legend. The title is placed to the left of the legend body, except in the following cases:

- the legend contains two or more rows of items
- the legend title length exceeds the space that is available on the left side of the legend

In either case, the title is placed above the legend body.

Default The legend title is the name of the response variable unless otherwise specified with the TITLE= option.

Requirement *text-string* must be enclosed in matching quotation marks.

TITLEATTRS=*style-element* | *style-element*< (*options*) > | (*options*)
specifies the appearance of the title. For the KEYLEGEND statement, this option affects the inset title

You can specify the appearance by using a style element or by specifying specific options. If you specify a style element, you can also specify options to override specific appearance attributes.

You can specify one or more of the following for *options*:

COLOR=*color*
specifies the color of the text. You can specify colors using a number of different color-naming schemes. See "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

FAMILY= *"font-family "*
specifies the font family for the text. The SAS ODS styles use TrueType system fonts.

SIZE= *n<units>*
specifies the font size of the text. You can also specify the unit of measurement. The default unit is pixels.

STYLE= ITALIC | NORMAL
specifies the font style of the text.

WEIGHT=BOLD | NORMAL
specifies the font weight of the text.

Any options that are not specified are derived from the default style element. For a description of the text options, see "Text Attributes" in *SAS ODS Graphics: Procedures Guide*.

Default The Color, FontFamily, FontSize, FontStyle, and FontWeight attributes attributes of the GraphValueText style element in the current style. Any unspecified options for the KEYLEGEND inset title text appearance are derived from this default style element.

Restriction You can specify one font family name, but not more than one.

Interaction You can specify one or more options for the inset title text. They might not include all the font properties (color, family, size, weight, style). Any non-specified properties are derived from the GraphValueText style element.

Note If you specify a size for the title text that is smaller than the system minimum font size, the system minimum font size is used instead.

Examples
```
TITLEATTRS=(Color=Green Family=Arial Size=8
        Style=Italic Weight=Bold)
```

Here is an example that specifies a style element:
```
TITLEATTRS=GraphTitleText
```

Here is an example that specifies a style element other than the default, and overrides the size option:
```
titleattrs=GraphLabelText(size=10pt)
```

VALUEATTRS=*style-element*< (*options*) > | (*options*)
specifies the appearance of the legend value labels. You can specify the appearance by using a style element or by specifying specific options. If you specify a style element, you can also specify options to override specific appearance attributes.

You can specify one or more of the following for *options*:

COLOR=*color*
specifies the color of the text. You can specify colors using a number of different color-naming schemes. See "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

FAMILY= "*font-family*"
specifies the font family for the text. The SAS ODS styles use TrueType system fonts.

SIZE= *n*<*units*>
specifies the font size of the text. You can also specify the unit of measurement. The default unit is pixels.

STYLE= ITALIC | NORMAL
specifies the font style of the text.

WEIGHT=BOLD | NORMAL
specifies the font weight of the text.

Any options that are not specified are derived from the default style element. For a description of the text options, see "Text Attributes" in *SAS ODS Graphics: Procedures Guide*.

Defaults
The FontFamily, FontSize, FontStyle, and FontWeight attributes of the GraphValueText style element in the current style. Any options for the legend value label text that not specified are derived from this default style element.

For ungrouped data, the Color attribute of the GraphValueText style element in the current style. For grouped data, the Color attribute of a GraphData1–GraphData*n* style element in the current style.

Restriction
You must specify one font family name, but not more than one.

Interaction
You can specify one or more options for the legend value label text. They might not include all the font properties (color, family, size, weight, style). Any non-specified properties are derived from the GraphValueText style element.

Notes
If you specify a size for the legend value label text that is smaller than the system minimum font size, the system minimum font size is used instead.

The KEYLEGEND values are shown in data order by default. To display them in value order, use PROC SORT on the MAPRESPDATA= data set. This sorts the CHOROMAP response variable values into ascending or descending order.

Examples

Here is an example that specifies an override of the default style element for each style attribute:

```
valueattrs=(Color=Green Family=Arial Size=8
        Style=Italic Weight=Bold)
```

Here is an example that specifies a style element:

```
valueattrs=GraphTitleText
```

Here is an example that specifies the default style element, and specifies a size option to override the specific appearance attributes in that style element:

```
valueattrs=GRAPHVALUETEXT(SIZE=10pt)
```

OPENSTREETMAP Statement

Creates a map based on OpenStreetMap (OSM).

Alias: OSM

Requirements: At a minimum, the OPENSTREETMAP statement must be specified with either a CHOROMAP statement or a plot overlay statement such as BUBBLE, SCATTER, SERIES, or TEXT. It can be specified with a CHOROMAP statement and one or more plot overlay statements.

Use only unprojected LAT and LONG variable values with any type of plot overlay statement when you specify an OpenStreetMap statement. The map tiles returned are based on the spatial extent of your plot overlay data.

Notes: The SGMAP procedure enables you to overlay a CHOROMAP on an OpenStreetMap map, and then overlay one or more BUBBLE or SCATTER plots. If you also specify a legend, space limitations might prevent the legend from being displayed.

Map elements are drawn in the order submitted. Place the OPENSTREETMAP statement first to ensure that the other map elements are drawn on top of the map tiles.

If both OPENSTREETMAP and ESRIMAP statements are submitted, the first statement specified is the only one used. Likewise, when multiple OPENSTREETMAP or ESRIMAP statements are submitted, the first statement specified is the only one used.

This request for a map service is a network request. The SGMAP procedure does not authenticate any services that you specify, such as the map services and portal hosted by Google. Check with your system administrator regarding the authentication setup for any Linux network proxy machine request that you might need to make.

Tip: You can use the GraphBaseMap ODS style element to change the theme of the OpenStreetMap base map from light to dark or high contrast. See “Controlling the Theme of an OpenStreetMap Base Map” on page 734.

Syntax

OPENSTREETMAP;

SCATTER Statement

Creates a scatter plot.

Syntax

SCATTER X=*variable* Y=*variable* < */ options* >;

Summary of Optional Arguments

Appearance options

ATTRID=*character-value*
: specifies the value of the ID variable in a discrete attribute map data set.

COLORMODEL=*style-element* | (*color-list*)
: specifies a color ramp that is to be used when mapping numeric response values.

COLORRESPONSE=*numeric-column*
: specifies the numeric column that is used to map colors to a gradient legend.

CONTRIBUTEOFFSETS=ALL | NONE | (*axis-offset-list*)
: specifies whether this plot's space requirements contribute to the calculation of the axis offsets.

RATTRID=*character-value*
: specifies the value of the ID variable in a range attribute map data set.

TRANSPARENCY=*value*
: specifies the degree of transparency for the plot.

Data tip options

TIP=(*variable-list*) | NONE
: specifies the data tip information to be displayed when the cursor is positioned over the graphics element.

TIPFORMAT=(*format-list*)
: applies formats to the list of data tip variables that you specify in the TIP= option.

TIPLABEL=(*label-list*)
: applies labels to the list of data tip variables that you specify in the TIP= option.

Group options

GROUP=*variable*
specifies a discrete variable that is used to group the data.

NOMISSINGGROUP
specifies that missing values of the group variable are not included in the plot.

Label options

DATALABEL=*variable*
displays a label for each data point.

DATALABELATTRS=(*options*)
specifies the appearance of the labels in the plot when you use the DATALABEL= option.

DATALABELPOS=BOTTOM | BOTTOMLEFT | BOTTOMRIGHT | CENTER | LEFT | RIGHT | TOP | TOPLEFT | TOPRIGHT
specifies the location of the data label with respect to the plot.

LEGENDLABEL="*text-string*"
specifies a label that identifies the markers from the plot in the legend.

Marker options

MARKERATTRS=*style-element*< (***options***) > | (*options*)
specifies the appearance of the markers in the plot.

Plot options

URL=*character-variable*
specifies an HTML page to be displayed when parts of the plot are selected.

Plot reference options

NAME="*text-string*"
assigns a name to a plot overlay.

Required Arguments

X=*variable*
specifies the variable for the X axis (longitude).

Y=*variable*
specifies the variable for the Y axis (latitude).

Optional Arguments

ATTRID=*character-value*
specifies the value of the ID variable in a discrete attribute map data set. You specify this option only if you are using an attribute map to control visual attributes of the graph.

Requirement Use the ATTRID= option in conjunction with the SGMAP procedure's DATTRMAP= option. You need to specify both the value of the ID variable and the discrete attribute map data set that contains it.

See Specify a discrete attribute map data set with the "DATTRMAP=*discrete-attribute-map-data-set*" on page 643 option.

"Using Discrete Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

"Overview of Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

COLORMODEL=*style-element* | (*color-list*)

specifies a color ramp that is to be used when mapping numeric response values.

style-element

specifies the name of a style element that defines a two-color ramp or a three-color ramp. A style element that defines a color ramp contains these style attributes:

STARTCOLOR	specifies the color for the smallest numeric response data value.
NEUTRALCOLOR	specifies the color for the midpoint of the range of the numeric response data. This attribute applies only to three-color ramps.
ENDCOLOR	specifies the color for the highest numeric response data value.

Note If the specified style element does not contain at least the STARTCOLOR and ENDCOLOR attributes, a NOTE is generated in the SAS log. In that case, the colors are derived from the TwoColorRamp style element.

Example
```
colormodel=ThreeColorAltRamp
```

(*color-list*)

specifies a space-separated list of colors to use in the color ramp. The list can contain a mix of color names and color codes.

- You can specify colors using a number of different color-naming schemes. For more information, see "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.
- You can use two different color names. All bin colors are calculated as a gradient color between the specified colors.

Requirement The list of colors must be enclosed in parentheses.

Examples
```
colormodel=(blue yellow)

colormodel=(CX00FF00 blue)/* where CX00FF00 is green */
```

Default The TwoColorAltRamp style element

Requirement For this option to take effect, the COLORRESPONSE= option must also be specified.

COLORRESPONSE=*numeric-column*
specifies the numeric column that is used to map colors to a gradient legend. The fill colors are assigned according to the legend gradient.

Interaction When the GROUP= option is specified with the COLORRESPONSE= option, the color attributes are controlled by the COLORRESPONSE= option.

Tips The GRADLEGEND statement controls the title, position, and border of the legend. If you want only the colors and not the legend, then you can specify NOGRADLEGEND.

The color ramp is specified by the "COLORMODEL=style-element | (color-list)" option. The color ramp represents the range of unique response values.

See "GRADLEGEND Statement" on page 679

"Using Gradient Color Legends" in *SAS ODS Graphics: Procedures Guide*

CONTRIBUTEOFFSETS=ALL | NONE | (*axis-offset-list*)
specifies whether this plot's space requirements contribute to the calculation of the axis offsets. This value determines which axis offsets can be affected by the plot.

The area in which the map is drawn is adjusted to accommodate the area needed for specifications of data points text labels. The plot statement can implement an offset that prevents clipping of any text strings that appear at the ends of the axes. The offset is based on the longest string. If the character lengths vary significantly, this can result in wasted space when the shorter strings appear near the ends of the axes. In that case, you can use the CONTRIBUTEOFFSETS= option to modify or eliminate this plot's contribution to the offset calculations in order to reclaim that space.

If you are using multiple plot statements, you can selectively apply the CONTRIBUTEOFFSETS= option to the plot statement that is adversely affecting the text strings overlaid on the map.

ALL
the space requirements for this plot are contributed to the axis offset calculations.

NONE
the space requirements for this plot are not contributed to the axis offset calculations.

(*axis-offset-list*)
a space-delimited list of specific contributions that this plot makes to the axis offset calculations. The list is one or more of the following values enclosed in parentheses:

RIGHT the space requirements for this plot are contributed to the X-axis offset calculation for the maximum end.

LEFT — the space requirements for this plot are contributed to the X-axis offset calculation for the minimum end.

TOP — the space requirements for this plot are contributed to the Y-axis offset calculation for the maximum end.

BOTTOM — the space requirements for this plot are contributed to the Y-axis offset calculation for the minimum end.

Default — ALL is used by the plot statement if the CONTRIBUTEOFFSETS= option is not specified.

Interaction — This option helps minimize white space that can occur when a map adjusts the space that it occupies in the graphical output area as text label specifications are applied. A map area adjusts as you use the DATALABEL= option to specify labels for data points, use the DATALABELPOS= option to specify a different text position, and vary the text size with the MARKERATTRS= option.

DATALABEL=*variable*

displays a label for each data point. If you specify a variable, the values of that variable are used for the data labels. If you do not specify a variable, then no labels are displayed and an error message is issued in the SAS log. The position of the labels is automatically adjusted to prevent the labels from overlapping.

Tip — You might want to avoid specifying as a variable the X or Y coordinate variables. Using these projected values in the label causes mismatches with the resultant graph that is created with the unprojected variable values in the map input data set.

DATALABELATTRS=(*options*)

specifies the appearance of the labels in the plot when you use the DATALABEL= option.

You can specify one or more options for the label text. They might not include all the style attributes in use for font (color, family, size, style, weight). Any options for label text that are not specified are derived from the default style element. *options* can be one or more of the following:

COLOR=*color*

specifies the color of the text. You can specify colors using a number of different color-naming schemes. See “Color-Naming Schemes” in *SAS ODS Graphics: Procedures Guide*.

FAMILY= "*font-family* "

specifies the font family for the text. The SAS ODS styles use TrueType system fonts.

SIZE= *n<units>*

specifies the font size of the text. You can also specify the unit of measurement. The default unit is pixels.

STYLE= ITALIC | NORMAL

specifies the font style of the text.

WEIGHT=BOLD | NORMAL
specifies the font weight of the text.

For a description of the text options, see "Text Attributes" in *SAS ODS Graphics: Procedures Guide*.

Default The GraphDataText style element in the current style.

Interaction The DATALABELATTRS= option has no effect unless the DATALABEL option is also specified.

Note If you specify a size for the BUBBLE label text that is smaller than the system minimum font size, the system minimum font size is used instead.

Examples Here is an example that specifies options for the text of the label:

```
DATALABELATTRS=(Color=Green Family=Arial Size=8
        Style=Italic Weight=Bold)
```

Here is an example that specifies, in this case, the default style element:

```
DATALABELATTRS=GraphDataText
```

Here is an example that specifies the default style element, and specifies a size option to override the specific appearance attributes in that style element:

```
DATALABELATTRS=GRAPHDATATEXT(SIZE=10pt)
```

DATALABELPOS=BOTTOM | BOTTOMLEFT | BOTTOMRIGHT | CENTER | LEFT | RIGHT | TOP | TOPLEFT | TOPRIGHT
specifies the location of the data label with respect to the plot. Choose one of the position values.

Default The label text position adheres to the position specified, and might result in the overlapping of data text labels with the data markers.

Interactions When the DATALABELPOS= option is not specified, the default behavior adjusts data text label positions on the graph to avoid collision with data markers. Specifying the DATALABELPOS= option overrides the default collision avoidance behavior.

The DATALABELPOS= option has no effect unless you also specify the DATALABEL option.

Data label collision avoidance does not occur when the number of data labels identifying the DATALABEL option variable values exceeds the LABELMAX value specified in the ODS GRAPHICS statement.

This option displays group values for each category when GROUP= is also specified.

GROUP=*variable*
specifies a discrete variable that is used to group the data.

The plot elements for each group value and each distinct group value are automatically distinguished by different visual attributes — either marker symbols or colors or some combination of those attributes.

Tips ODS Graphics limits the number of groups to 1000. Use the GROUPMAX= option in the ODS GRAPHICS statement to change the maximum number of groups that can be processed.

You can use the NOMISSINGGROUP option to omit missing values of the group variable from the plot.

LEGENDLABEL="*text-string*"
specifies a label that identifies the markers from the plot in the legend.

Default The label of the Y variable.

Interaction The LEGENDLABEL= option has no effect if you also specify the GROUP= option in the same plot statement.

MARKERATTRS=*style-element*< (*options*) > | (*options*)
specifies the appearance of the markers in the plot. You can specify the appearance by using a style element or by specifying specific options. If you specify a style element, you can also specify options to override specific appearance attributes.

You can specify one or more of the following for *options*:

COLOR=*color*
specifies the color of the markers. You can specify colors using a number of different color-naming schemes. See "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

SIZE=*n<units>*
specifies the size of the markers. You can also specify the unit of measurement. The default unit is pixels.

SYMBOL=*symbol-name*
specifies the symbol to use for the marker. The following table shows the marker symbols that you can use.

Table 18.4 *Supported Marker Symbols*

Symbol Name	Plot Symbol	Symbol Name	Plot Symbol
ArrowDown	↓	StarFilled	★
Asterisk	✳	Tack	⊤
Circle	○	Tilde	∿
CircleFilled	●	Triangle	△

Symbol Name	Plot Symbol	Symbol Name	Plot Symbol
Diamond	◇	TriangleFilled	▲
DiamondFilled	◆	TriangleDown	▽
GreaterThan	>	TriangleDownFilled	▼
Hash	#	TriangleLeft	◁
HomeDown	⌂	TriangleLeftFilled	◀
HomeDownFilled	⌂	TriangleRight	▷
IBeam	I	TriangleRightFilled	▶
LessThan	<	Union	∪
Plus	+	X	×
Square	□	Y	Y
SquareFilled	■	Z	Z
Star	☆		

Any options for markers that are not specified are derived from the default style element.

Default The ContrastColor and MarkerSymbol attributes of the GraphDataDefault style element in the current style.

NAME="*text-string*"
assigns a name to a plot overlay.

You can use the name to refer to this plot in other statements.

Note The *text-string* is case-sensitive and must define a unique name within the procedure. When you refer to this specified name in other statements within the SGMAP procedure, you must use the identical name.

Tip This option is often used with legend statements in order to coordinate the use of colors and patterns between the graph and the legend.

NOMISSINGGROUP
specifies that missing values of the group variable are not included in the plot.

Interaction This option has no effect unless GROUP= is also specified.

RATTRID=*character-value*
specifies the value of the ID variable in a range attribute map data set. You specify this option only if you are using a range attribute map to control visual attributes of the graph.

Restriction This option must be used in conjunction with PROC SGMAP's "RATTRMAP=range-attribute-map-data-set" option.

See "Using Range Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

"Overview of Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

TIP=(*variable-list*) | NONE
specifies the data tip information to be displayed when the cursor is positioned over the graphics element.

(*variable-list*)
a space-separated list of variables enclosed in parentheses. Data tips are displayed using the data obtained from the specified variables.

NONE
suppresses the data tips from this plot.

Requirement You must specify the IMAGEMAP=ON option in the ODS GRAPHICS statement in order to generate data tips. For example, add the following statement before your procedure:

```
ODS GRAPHICS / IMAGEMAP=ON;
```

Interaction This option replaces all of the information that is displayed by default.

Tips You might want to avoid specifying as a variable the X or Y coordinate variables. Using these projected values in the label causes mismatches with the resultant graph that is created with the unprojected variable values in the map input data set.

Use the TIPFORMAT= option and the TIPLABEL= option to assign formats and labels, respectively, to the list of variables.

Example tip=(age weight)

TIPFORMAT=(*format-list*)
applies formats to the list of data tip variables that you specify in the TIP= option. Provide a space-separated list of formats enclosed in parentheses. This option provides a way to control the format of the variable data that appears in the data tips.

A one-to-one correspondence exists between the *format-list* and the *variable-list* that is specified for the TIP= option. A format must be provided for each variable, using the same order as the *variable-list*. If you do not want to apply a format to a variable, use the AUTO keyword instead.

Default The column format of the tip variable, or BEST6 if no format is assigned to a numeric column.

Requirements A format or the keyword AUTO must be provided for each variable that is listed in the TIP= option.

This option has no effect unless the TIP= option is also specified.

Tip Use the TIPLABEL= option to assign labels to the list of variables.

See *SAS Formats and Informats: Reference*

Example tipformat=(auto F5.2)

TIPLABEL=(*label-list*)
applies labels to the list of data tip variables that you specify in the TIP= option. Provide a space-separated list of quoted "text strings" enclosed in parentheses. This option provides a way to specify labels for the variable data that appears in the data tips.

A one-to-one correspondence exists between the *label-list* and the *variable-list* that is specified for the TIP= option. A label must be provided for each variable, using the same order as the *variable-list*. If you do not want to apply a custom label to a variable, use the AUTO keyword instead.

Requirements A label or the keyword AUTO must be provided for each variable that is listed in the TIP= option. When AUTO is used, the label is obtained from the variable.

This option has no effect unless the TIP= option is also specified.

Tip Use the TIPFORMAT= option to assign formats to the list of variables.

Example tiplabel=(auto "Class Weight")

TRANSPARENCY=*value*
specifies the degree of transparency for the plot. The transparency that you specify applies to all aspects of the plot statement. For example, you can specify the amount of transparency applied to any displayed marker fills and marker outlines.

Default 0.0

Range 0 (completely opaque) to 1 (completely transparent)

URL=*character-variable*
specifies an HTML page to be displayed when parts of the plot are selected.

character-variable
specifies a variable that contains a valid HTML page reference (HREF) for each plot element that is to have an active link.

Example `https://www.sas.com/en_us/home.html`

Default By default, no HTML links are created.

Interactions This option affects graphics output that is created through the ODS HTML destination only. For more information about ODS destinations, see "Specifying ODS Destinations" in *SAS ODS Graphics: Procedures Guide*.

This option has no effect unless you also specify IMAGEMAP in the ODS GRAPHICS statement. For example, add the following statement before your procedure:

```
ODS GRAPHICS ON / IMAGEMAP=ON;
```

Tip Use the DRILLTARGET= option in the ODS GRAPHICS statement in order to specify the browser window that displays the drill-down output.

SERIES Statement

creates a line plot.

Default: The SERIES statement breaks lines being drawn when it detects a missing Y variable value in the PLOTDATA= data set. These break points prevent one continuous line from being drawn. The observation following that observation with a missing Y variable begins a new line.

Restrictions: Do not use a system that cannot guarantee data order as the repository for map data sets or for plot data sets. Essential polygonal data and line segment sequencing in the input data must be maintained. The SGMAP procedure prohibits specifying in the MAPDATA= option data that is stored in a library that cannot guarantee data order. Use map data that is stored locally.

The number of vertices for a patterned line cannot exceed the maximum specified by the ODS GRAPHICS statement option LINEPATTERNOBSMAX=. The default is 10,000. If the limit is exceeded, the plot is not drawn and a note is written to the SAS log stating that the limit has been exceeded. In that case, increase LINEPATTERNOBSMAX= to the value suggested in the note or change the line pattern to SOLID using the LINEATTRS= option.

Interaction: When the GROUP= option is specified in the SERIES statement, a separate line is drawn for each GROUP variable value. Each line appears in a different color.

Syntax

SERIES X=*variable* Y=*variable* < / *options* >;

Summary of Optional Arguments

Appearance options

ATTRID=*character-value*
: specifies the value of the ID variable in a discrete attribute map data set.

LINEATTRS=*style-element* (*options*)
: specifies the appearance of the series line attributes.

Data tip options

TIP=(*variable-list*) | NONE
: specifies the data tip information to be displayed when the cursor is positioned over the graphics element.

TIPFORMAT=(*format-list*)
: applies formats to the list of data tip variables that you specify in the TIP= option.

TIPLABEL=(*label-list*)
: applies labels to the list of data tip variables that you specify in the TIP= option.

Group options

GROUP=*variable*
: specifies a discrete variable that is used to group the data.

NOMISSINGGROUP
: specifies that missing values of the group variable are not included in the plot.

Label options

LEGENDLABEL="*text-string*"
: specifies a label that identifies the plot in the legend.

Plot options

URL=*character-variable*
: specifies an HTML page to be displayed when parts of the plot are selected.

Plot reference options

NAME="*text-string*"
: assigns a name to a line plot.

Series options

SMOOTHCONNECT
: specifies that a smoothed line passes through all vertices.

Required Arguments

X=*variable*
specifies the variable for the X axis.

Y=*variable*
specifies the variable for the Y axis.

Optional Arguments

ATTRID=*character-value*
specifies the value of the ID variable in a discrete attribute map data set. You specify this option only if you are using an attribute map to control visual attributes of the graph.

Requirement Use the ATTRID= option in conjunction with the SGMAP procedure's DATTRMAP= option. You need to specify both the value of the ID variable and the discrete attribute map data set that contains it.

See Specify a discrete attribute map data set with the "DATTRMAP=*discrete-attribute-map-data-set*" on page 643 option.

"Using Discrete Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

"Overview of Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

GROUP=*variable*
specifies a discrete variable that is used to group the data.

The plot elements for each group value and each distinct group value are automatically distinguished by different visual attributes — either color or line patterns or some combination of those attributes.

Tips ODS Graphics limits the number of groups to 1000. Use the GROUPMAX= option in the ODS GRAPHICS statement to change the maximum number of groups that can be processed.

You can use the NOMISSINGGROUP option to omit missing values of the group variable from the plot.

LEGENDLABEL="*text-string*"
specifies a label that identifies the plot in the legend.

Default The label of the Y variable.

Interaction The LEGENDLABEL= option has no effect if you also specify the GROUP= option in the same plot statement.

LINEATTRS=*style-element* (*options*)
specifies the appearance of the series line attributes. You can specify the appearance by using a style element or by specifying specific options. If you specify a style element, you can also specify options to override specific

appearance attributes.For a description of the line options, see "Line Attributes and Patterns" in *SAS ODS Graphics: Procedures Guide*.

The LINEATTRS= option enables you to control the appearance of the lines that are drawn on top of a map. Examples of these lines include streets, railroads, and waterways.

The LINEATTRS= option is affected by grouped data. Each attribute section (COLOR=, PATTERN=, and THICKNESS=), describes the details.

For the SERIES statement, style element GraphDataDefault is used to associate the ContrastColor, LineStyle, and LineThickness attributes. By default, `lineattrs=grapdatadefault;`.

When specifying more than one option, separate the options with a space. The group of options must be surrounded by parentheses.

(options) can be one or more of the following:

COLOR=*color*
specifies the color of the series line.You can specify colors using a number of different color-naming schemes. See "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

Default For ungrouped data, the ContrastColor attribute of the GraphDataDefault style element in the current style. For grouped data, the ContrastColor attribute attribute of a GraphData1–GraphData*n* style element in the current style.

Interaction With grouped data, the COLOR= *color* setting has the effect of holding the line color constant across all group values.

Example If you want to override the color attribute of the default style element, specify an alternative *style-reference* like the following:
`lineattrs=GraphOutlines (color=graphoutlines:contrastcolor);`

PATTERN=*line-pattern-name* | *line-pattern-number*
specifies the line pattern for the line.

Line patterns can be specified as a *line-pattern-name* or as a *line-pattern-number*. Not all line patterns have identifying names. However, the line patterns with names have been optimized. This provides the ability to visually discriminate different lines that might be used in the same plot. Valid line pattern (identification) numbers range from 1–46. The following table shows the patterns for each of the possible combinations.

Table 18.5 *Named Line Patterns*

Pattern Number	Pattern Name	Example
1	Solid	
2	ShortDash	
4	MediumDash	

Pattern Number	Pattern Name	Example
5	LongDash	
8	MediumDashShortDash	
14	DashDashDot	
15	DashDotDot	
20	Dash	
26	LongDashShortDash	
34	Dot	
35	ThinDot	
41	ShortDashDot	
42	MediumDashDotDot	

For a description of the line options, see "Line Attributes and Patterns" in *SAS ODS Graphics: Procedures Guide*.

Default For ungrouped data, the GraphDataDefault style element LineStyle attribute. For grouped data, the GraphData*n* style element LineStyle attribute.

Interaction With grouped data, the PATTERN= setting has the effect of holding the line pattern constant across all group values.

THICKNESS=*n* <*units*>
specifies the thickness of the line. You can also specify the unit of measure.

The following table contains the units that are available:

Table 18.6 *Measurement Units*

Unit	Description
CM	centimeters
IN	inches
MM	millimeters
PCT or %	percentage

Unit	Description
PT	point size, calculated at 100 dots per inch
PX	pixels

Defaults The GraphDataDefault style element LineThickness attribute.

The default unit of measure is pixels, abbreviated as PX.

Interaction With grouped data, the THICKNESS= setting has the effect of holding the line thickness constant across all group values.

Default For the SERIES statement, style element GraphDataDefault is used to associate the ContrastColor, LineStyle, and LineThickness attributes. The affected attributes are LineThickness for ungrouped data, and ContrastColor and LineStyle for grouped data.

Examples Here is an example that specifies a style element:

```
lineattrs=GraphDataDefault
```

Here is an example that overrides the line attributes:

```
lineattrs=(color=cxff0000 pattern=dash thickness=4px);
```

NAME="*text-string*"
assigns a name to a line plot. You can use the name to refer to this plot in other statements.

Note The *text-string* is case-sensitive and must define a unique name within the procedure. When you refer to this specified name in other statements within the SGMAP procedure, you must use the identical name.

Tip This option is often used with legend statements in order to coordinate the use of colors and line patterns between the graph and the legend.

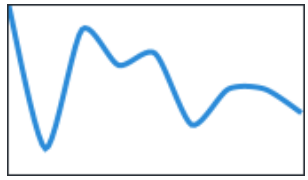
NOMISSINGGROUP
specifies that missing values of the group variable are not included in the plot.

Interaction This option has no effect unless GROUP= is also specified.

SMOOTHCONNECT
specifies that a smoothed line passes through all vertices.

CAUTION
Results can be affected when using this option. Specifying the SMOOTHCONNECT option might cause the series plot line to be drawn outside of the data points on the graph.

The following graphics fragments show the effect of using SMOOTHCONNECT.

Default Series	SMOOTHCONNECT Specified
	

Default NOSMOOTHCONNECT, which draws straight lines between the vertices of a plot.

TIP=(*variable-list*) | NONE
specifies the data tip information to be displayed when the cursor is positioned over the graphics element.

(*variable-list*)
a space-separated list of variables enclosed in parentheses. Data tips are displayed using the data obtained from the specified variables.

NONE
suppresses the data tips from this plot.

Requirement You must specify the IMAGEMAP=ON option in the ODS GRAPHICS statement in order to generate data tips. For example, add the following statement before your procedure:

```
ODS GRAPHICS / IMAGEMAP=ON;
```

Interaction This option replaces all of the information that is displayed by default.

Tips You might want to avoid specifying as a variable the X or Y coordinate variables. Using these projected values in the label causes mismatches with the resultant graph that is created with the unprojected variable values in the map input data set.

Use the TIPFORMAT= option and the TIPLABEL= option to assign formats and labels, respectively, to the list of variables.

Example tip=(age weight)

TIPFORMAT=(*format-list*)
applies formats to the list of data tip variables that you specify in the TIP= option. Provide a space-separated list of formats enclosed in parentheses. This option provides a way to control the format of the variable data that appears in the data tips.

A one-to-one correspondence exists between the *format-list* and the *variable-list* that is specified for the TIP= option. A format must be provided for each variable, using the same order as the *variable-list*. If you do not want to apply a format to a variable, use the AUTO keyword instead.

Default The column format of the tip variable, or BEST6 if no format is assigned to a numeric column.

Requirements A format or the keyword AUTO must be provided for each variable that is listed in the TIP= option.

This option has no effect unless the TIP= option is also specified.

Tip Use the TIPLABEL= option to assign labels to the list of variables.

See *SAS Formats and Informats: Reference*

Example tipformat=(auto F5.2)

TIPLABEL=(*label-list*)
applies labels to the list of data tip variables that you specify in the TIP= option. Provide a space-separated list of quoted "text strings" enclosed in parentheses. This option provides a way to specify labels for the variable data that appears in the data tips.

A one-to-one correspondence exists between the *label-list* and the *variable-list* that is specified for the TIP= option. A label must be provided for each variable, using the same order as the *variable-list*. If you do not want to apply a custom label to a variable, use the AUTO keyword instead.

Requirements A label or the keyword AUTO must be provided for each variable that is listed in the TIP= option. When AUTO is used, the label is obtained from the variable.

This option has no effect unless the TIP= option is also specified.

Tip Use the TIPFORMAT= option to assign formats to the list of variables.

Example tiplabel=(auto "Class Weight")

URL=*character-variable*
specifies an HTML page to be displayed when parts of the plot are selected.

character-variable
specifies a variable that contains a valid HTML page reference (HREF) for each plot element that is to have an active link.

Example `https://www.sas.com/en_us/home.html`

Default By default, no HTML links are created.

Interactions This option affects graphics output that is created through the ODS HTML destination only. For more information about ODS destinations, see "Specifying ODS Destinations" in *SAS ODS Graphics: Procedures Guide*.

This option has no effect unless you also specify IMAGEMAP in the ODS GRAPHICS statement. For example, add the following statement before your procedure:

```
ODS GRAPHICS ON / IMAGEMAP=ON;
```

Tip Use the DRILLTARGET= option in the ODS GRAPHICS statement in order to specify the browser window that displays the drill-down output.

TEXT Statement

Displays the associated text values at (X, Y) locations in the graph. The text can be numbers or characters.

Tips: A text plot overlay is useful for placing custom text and titles on the map.

Use the TEXT statement when you want more control over the appearance of the text. The TEXT statement enables you to manage the text position and the color and font properties of the marker text. Additional controls enable you to rotate the text to any angle, split the text into multiple lines, display a bounding box around the text, and add a back-light effect to the text, and so on.

See: "About Text Plots" in *SAS ODS Graphics: Procedures Guide*

Syntax

TEXT X=*variable* Y=*variable* TEXT=*variable* < / *options* >;

Summary of Optional Arguments

Appearance options

ATTRID=*character-value*
: specifies the value of the ID variable in a discrete attribute map data set.

BACKFILL
: displays filled bounding boxes around the text.

BACKLIGHT=*number*
: specifies that the text should have a back light of a contrasting color.

COLORMODEL=*style-element* | (*color-list*)
: specifies a color ramp that is to be used when mapping numeric response values.

COLORRESPONSE=*numeric-column*
: specifies the numeric column that is used to map colors to a gradient legend.

CONTRIBUTEOFFSETS=ALL | NONE | (*axis-offset-list*)
: specifies whether this plot's space requirements contribute to the calculation of the axis offsets.

DISCRETEOFFSET=*numeric-value*
: specifies an amount to offset all markers from discrete X or Y values.

FILLATTRS=*style-element*<(*options*)> | (*options*)
specifies the fill color and transparency.

OUTLINE
displays outlined bounding boxes around the text.

OUTLINEATTRS=*style-element* <(ContrastColor=*color*)> | (color=*color*)
specifies the color of the outlines around the text boxes.

PAD=*dimension*<*units*> | *(pad-options)*
specifies the amount of extra space that is added inside the text-marker border.

TRANSPARENCY=*value*
specifies the degree of transparency for the plot.

Data tip options

TIP=(*variable-list*) | NONE
specifies the data tip information to be displayed when the cursor is positioned over the graphics element.

TIPFORMAT=(*format-list*)
applies formats to the list of data tip variables that you specify in the TIP= option.

TIPLABEL=(*label-list*)
applies labels to the list of data tip variables that you specify in the TIP= option.

Group options

GROUP=*variable*
specifies a discrete variable that is used to group the data.

Label options

LEGENDLABEL="*text-string*"
specifies a label that identifies the plot in the legend.

SPLITCHAR="*character-list*"
specifies one or more characters on which the text is always split.

SPLITCHARNODROP
specifies that the split characters are included in the displayed value.

SPLITJUSTIFY=LEFT | CENTER | RIGHT
specifies the horizontal alignment of the value text that is being split.

Plot options

URL=*character-variable*
specifies an HTML page to be displayed when parts of the plot are selected.

Plot reference options

NAME="*text-string*"
assigns a name to a plot overlay.

Text options

POSITION=BOTTOM | BOTTOMLEFT | BOTTOMRIGHT | CENTER | LEFT | RIGHT | TOP | TOPLEFT | TOPRIGHT

specifies the position of the text with respect to the location of the data point.

ROTATE=*number | numeric-column*
specifies the angle of rotation in degrees for the text markers.

SIZEMAX=*dimension<unit>*
specifies the maximum font size for the largest text marker when a response variable is used to size the text-marker font.

SIZEMAXRESPONSE=*number*
specifies the response value that corresponds to the maximum font size for text markers.

SIZEMIN=*dimension<unit>*
specifies the minimum font size for text markers when a response variable is used to size the font for text values.

SIZERESPONSE=*numeric-variable*
specifies a response variable that is used to determine the font size for each data value.

SPLITPOLICY=NONE | SPLIT | SPLITALWAYS
specifies a policy for avoiding collisions among the text markers.

SPLITWIDTH=*width-in-characters*
specifies the maximum width of each split line, expressed as a character count.

STRIP
specifies that leading and trailing blanks should be stripped from the marker text before it is displayed.

TEXTATTRS=*style-element*< (***options***) > | (*options*)
specifies the color and font properties of the marker text.

Required Arguments

X=*variable*
specifies the variable for the X axis (longitude).

Y=*variable*
specifies the variable for the Y axis (latitude).

TEXT=*variable*
specifies the variable for the text values.

Tip You might want to avoid specifying as a variable the X or Y coordinate variables. Using these projected values in the label causes mismatches with the resultant graph that is created with the unprojected variable values in the map input data set.

Optional Arguments

ATTRID=*character-value*
specifies the value of the ID variable in a discrete attribute map data set. You specify this option only if you are using an attribute map to control visual attributes of the graph.

Requirement Use the ATTRID= option in conjunction with the SGMAP procedure's DATTRMAP= option. You need to specify both the value of the ID variable and the discrete attribute map data set that contains it.

Interactions This option applies to grouped data as specified with the GROUP= option in the TEXT statement.

This option is used in conjunction with the assigned TEXTCOLOR attributes in the discrete attribute map data set that is specified with the DATTRMAP= option on PROC SGMAP.

See Specify a discrete attribute map data set with the "DATTRMAP=*discrete-attribute-map-data-set*" on page 643 option.

"Using Discrete Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

"Overview of Attribute Maps" in *SAS ODS Graphics: Procedures Guide*

BACKFILL
displays filled bounding boxes around the text.

Tips Use the OUTLINE option to specify outlined boxes around the text.

Use the TRANSPARENCY= option to change the transparency of the backfill and the text. To change the transparency of only the backfill, use the TRANSPARENCY= suboption of the FILLATTRS= OPTION.

BACKLIGHT=*number*
specifies that the text should have a back light of a contrasting color. The effect is applied to the marker text only. *number* specifies the degree of the back-light effect.

The following figures show the effect of applying back light to the text. In these examples, both BACKFILL and OUTLINE have also been specified.

Table 18.7 *The Comparative Effects of No Versus Full BACKLIGHT Option*

BACKLIGHT=0	BACKLIGHT=1

The back light is based on text color. For dark colors, a white back-light effect is used. For lighter colors, a black back-light effect is used. The following figures show the back-light effects when full back light is applied (BACKLIGHT=1). In the first two examples, BACKFILL and OUTLINE have been specified. The third example shows green text against a white background.

Table 18.8 *Three Effects Using the Full BACKLIGHT Option*

Black Text	Gray Text	Green Text

Defaults 0.5 when no GROUP= option or COLORRESPONSE= option is specified.

0.75 when the GROUP= option or the COLORRESPONSE= option is specified.

Range 0.0–1.0, where 0.0 specifies no effect and 1.0 specifies maximum effect

Note This option is most effective when text color has a low level of contrast with the background. It is also effective when the background is cluttered.

COLORMODEL=*style-element* | (*color-list*)

specifies a color ramp that is to be used when mapping numeric response values.

style-element

specifies the name of a style element that defines a two-color ramp or a three-color ramp. A style element that defines a color ramp contains these style attributes:

STARTCOLOR specifies the color for the smallest numeric response data value.

NEUTRALCOLOR specifies the color for the midpoint of the range of the numeric response data. This attribute applies only to three-color ramps.

ENDCOLOR specifies the color for the highest numeric response data value.

Note If the specified style element does not contain at least the STARTCOLOR and ENDCOLOR attributes, a NOTE is generated in the SAS log. In that case, the colors are derived from the TwoColorRamp style element.

Example `colormodel=ThreeColorAltRamp`

(*color-list*)

specifies a space-separated list of colors to use in the color ramp. The list can contain a mix of color names and color codes.

- You can specify colors using a number of different color-naming schemes. For more information, see "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

- You can use two different color names. All bin colors are calculated as a gradient color between the specified colors.

Requirement The list of colors must be enclosed in parentheses.

Examples
```
colormodel=(blue yellow)

colormodel=(CX00FF00 blue)/* where CX00FF00 is green */
```

Default The TwoColorAltRamp style element

Requirement For this option to take effect, the COLORRESPONSE= option must also be specified.

COLORRESPONSE=*numeric-column*
specifies the numeric column that is used to map colors to a gradient legend. The fill colors are assigned according to the legend gradient.

Interaction When the GROUP= option is specified with the COLORRESPONSE= option, the color attributes are controlled by the COLORRESPONSE= option.

Tips The GRADLEGEND statement controls the title, position, and border of the legend. If you want only the colors and not the legend, then you can specify NOGRADLEGEND.

The color ramp is specified by the "COLORMODEL=style-element | (color-list)" option. The color ramp represents the range of unique response values.

See "GRADLEGEND Statement" on page 679

"Using Gradient Color Legends" in *SAS ODS Graphics: Procedures Guide*

CONTRIBUTEOFFSETS=ALL | NONE | (*axis-offset-list*)
specifies whether this plot's space requirements contribute to the calculation of the axis offsets. This value determines which axis offsets can be affected by the plot.

The area in which the map is drawn is adjusted to accommodate the area needed for specifications of data points text labels. The plot statement can implement an offset that prevents clipping of any text strings that appear at the ends of the axes. The offset is based on the longest string. If the character lengths vary significantly, this can result in wasted space when the shorter strings appear near the ends of the axes. In that case, you can use the CONTRIBUTEOFFSETS= option to modify or eliminate this plot's contribution to the offset calculations in order to reclaim that space.

If you are using multiple plot statements, you can selectively apply the CONTRIBUTEOFFSETS= option to the plot statement that is adversely affecting the text strings overlaid on the map.

ALL
the space requirements for this plot are contributed to the axis offset calculations.

NONE
the space requirements for this plot are not contributed to the axis offset calculations.

(*axis-offset-list*)
a space-delimited list of specific contributions that this plot makes to the axis offset calculations. The list is one or more of the following values enclosed in parentheses:

RIGHT	the space requirements for this plot are contributed to the X-axis offset calculation for the maximum end.
LEFT	the space requirements for this plot are contributed to the X-axis offset calculation for the minimum end.
TOP	the space requirements for this plot are contributed to the Y-axis offset calculation for the maximum end.
BOTTOM	the space requirements for this plot are contributed to the Y-axis offset calculation for the minimum end.

Default ALL is used by the plot statement if the CONTRIBUTEOFFSETS= option is not specified.

Interaction This option helps minimize white space that can occur when a map adjusts the space that it occupies in the graphical output area as text label specifications are applied. A map area adjusts as you use the TEXT= option to specify labels for data points, use the POSITION= option to specify a different text position, and vary the text size with the TEXTATTRS= option.

DISCRETEOFFSET=*numeric-value*
specifies an amount to offset all markers from discrete X or Y values.

Default 0.0 (no offset)

Requirement This option is applicable only when the X axis (longitude) or Y axis (latitude) is discrete.

FILLATTRS=*style-element*<(*options*)> | (*options*)
specifies the fill color and transparency.

You can specify the appearance by using a style element or by specifying specific options. If you specify a style element, you can also specify options to override specific appearance attributes.

When specifying the suboptions, use a *name=value* pair format enclosed in parentheses. If you specify more than one *name=value* pair, separate them by a space. For example:

```
(color=red transparency=.5)
```

You can use a style element or specify specific suboptions. If you specify a style element, you can also specify options to override specific appearance attributes. These suboptions can be one or more of the following:

COLOR=*color*
specifies the fill color. You can specify colors using a number of different color-naming schemes. See "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

TRANSPARENCY=*number*
specifies the degree of the transparency of the filled area.

For a description of fill attributes, see "Fill Attributes" in *SAS ODS Graphics: Procedures Guide*.

Defaults: For ungrouped data, the Color attribute of the GraphDataDefault style element in the current style. For grouped data, the Color attribute of a GraphData1–GraphData*n* style element in the current style.

0 for transparency

Range: 0 (opaque) to 1 (entirely transparent). The range of the TRANSPARENCY= option that controls the degree of the transparency of the bubble fill.

Requirement: This option has no effect unless you also specify the BACKFILL option.

Interaction: This option has no effect if you specify the OUTLINE option.

See: "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide* for more information.

"Fill Attributes" in *SAS ODS Graphics: Procedures Guide* for further details.

Example: Use the color and transparency suboptions in the FILLATTRS= option:

```
fillattrs=(color=green transparency=.2)
```

GROUP=*variable*
specifies a discrete variable that is used to group the data.

The plot elements for each group value are automatically distinguished by different visual attributes. Each distinct group value is represented in the graph by a different color in the legend.

Interaction: Use the GROUP= option in conjunction with the TEXT statement's LEGENDLABEL= option.

Tip: ODS Graphics limits the number of groups to 1000. Use the GROUPMAX= option in the ODS GRAPHICS statement to change the maximum number of groups that can be processed.

LEGENDLABEL="*text-string*"
specifies a label that identifies the plot in the legend.

Default: The label for the Y variable is used for ungrouped data, and the group values are used for grouped data.

Interactions Use the LEGENDLABEL= option to control the graph's legend by specifying the name of the group whose legend is to be used with the TEXT statement's NAME= option. In addition, specify that same name in the KEYLEGEND statement.

The LEGENDLABEL= option has no effect if the GROUP= option is specified in the same plot statement.

NAME="*text-string*"
assigns a name to a plot overlay.

You can use the name to refer to this plot in other statements.

Note The *text-string* is case-sensitive and must define a unique name within the procedure. When you refer to this specified name in other statements within the SGMAP procedure, you must use the identical name.

Tip This option is often used with legend statements in order to coordinate the use of colors and patterns between the graph and the legend.

OUTLINE
displays outlined bounding boxes around the text.

Tip Use the BACKFILL option to display filled bounding boxes around the text.

OUTLINEATTRS=*style-element* <(ContrastColor=*color*)> | (color=*color*)
specifies the color of the outlines around the text boxes. For information about specifying a value for *color*, see "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

Defaults For ungrouped data, the ContrastColor attribute of the GraphOutlines style element in the current style.

For grouped data, the ContrastColor attribute of a GraphData1–GraphData*n* style element in the current style.

Interaction This option has no effect unless OUTLINE is also specified.

PAD=*dimension<units>* | *(pad-options)*
specifies the amount of extra space that is added inside the text-marker border.

dimension
specifies a dimension to use for the extra space at the left, right, top, and bottom of the text-marker border.

(*pad-options*)
a space-separated list of one or more of the following name-value-pair options enclosed in parentheses:

LEFT=*dimension<units>* TOP=*dimension<units>*
RIGHT=*dimension<units>* BOTTOM=*dimension<units>*

Default Padding is a fraction of the font height.

Note Sides that are not assigned padding are padded with the default amount.

Tips This option is meaningful only when you also specify either the OUTLINE option, the BACKFILL option, or both.

Use *pad-options* to create non-uniform padding.

Note The default units for *dimension* are pixels. If you want to specify values in other units, then you must specify the desired units with the value. For a list of measurement units that are supported, see "Units of Measurement" in *SAS ODS Graphics: Procedures Guide*.

POSITION=BOTTOM | BOTTOMLEFT | BOTTOMRIGHT | CENTER | LEFT | RIGHT | TOP | TOPLEFT | TOPRIGHT

specifies the position of the text with respect to the location of the data point. Specify one of the position values.

Default CENTER

ROTATE=*number* | *numeric-column*

specifies the angle of rotation in degrees for the text markers. Positive angles are measured in the counter-clockwise direction, and negative angles are measured in clockwise direction. An angle that exceeds 360 degrees in absolute value can be used.

Default 0

SIZEMAX=*dimension<unit>*

specifies the maximum font size for the largest text marker when a response variable is used to size the text-marker font. This option controls the size of the text font based on the weight of the response variable.

The following table contains the units that are available:

Table 18.9 *Measurement Units*

Unit	Description
CM	centimeters
IN	inches
MM	millimeters
PCT or %	percentage
PT	point size, calculated at 72 dots per inch
PX	pixels

Defaults Three times the size specified in the GraphDataText style element for the maximum response variable value marker.

The font size of the text values that are associated with the maximum response variable value is set to the value specified by this option.

Interactions The SIZERESPONSE= option must be specified for this option to have any effect.

The SIZEMAXRESPONSE= option specifies the response value at which the maximum font size for a text marker is reached. The font size for all text values that exceed the SIZEMAXRESPONSE= value is set to the value specified in this option.

Note Specify the value for the SIZEMAX= option as greater than or equal to the value specified for the SIZEMIN= option. If the SIZEMAX= value is less than the SIZEMIN= value, the results can display missing text values. For example, a positive numeric value is required in order to map response variable values to a response font size. The label is dropped when mapping is attempted with a negative font size.

Tips Use the SIZEMAXRESPONSE= option to specify the response value at which the maximum font size for a text marker is reached.

Use the SIZEMIN= option to specify the minimum font size for text markers.

SIZEMAXRESPONSE=*number*
specifies the response value that corresponds to the maximum font size for text markers.

Default The maximum value in the response column specified in the SIZERESPONSE= option.

Interaction The SIZERESPONSE= option must be specified for this option to have any effect.

Note When this option is used with the SIZEMAX= option, the response value is set at the maximum size. Any response values larger than SIZEMAXRESPONSE= are constrained to the SIZEMAX= font size.

SIZEMIN=*dimension<unit>*
specifies the minimum font size for text markers when a response variable is used to size the font for text values.

The following table contains the units that are available:

Table 18.10 *Measurement Units*

Unit	Description
CM	centimeters

Unit	Description
IN	inches
MM	millimeters
PCT or %	percentage
PT	point size, calculated at 72 dots per inch
PX	pixels

Default The size specified in the GraphDataText style element for the minimum response column value marker.

Interaction The SIZERESPONSE= option must be specified for this option to have any effect.

Note Specify the value for the SIZEMIN= option as less than or equal to the value specified for the SIZEMAX= option. If the SIZEMIN= value is greater than the SIZEMAX= value, the results can display missing text values. For example, a positive numeric value is required in order to map response variable values to a response font size. The label is dropped when mapping is attempted with a negative font size.

Tip Use the SIZEMAX= option to specify the maximum text size.

SIZERESPONSE=*numeric-variable*
specifies a response variable that is used to determine the font size for each data value.

Default The size specified in the GraphDataText style element for all data values.

Notes When the variable value for an observation is 0, the font size for the data value for that observation is set to the SIZEMIN= option value.

When the variable value for an observation is negative or missing, the data value for that observation is not displayed in the text plot. However, that observation still contributes to the axis ranges, legend, and so on.

When all the variable values are 0 or missing, this option has no effect. In that case, the default font size is used for all of the data values.

Tip Use the SIZEMIN= and SIZEMAX= options to limit the minimum and maximum font size for the data values.

SPLITCHAR=*"character-list"*
specifies one or more characters on which the text is always split. The text is split at every occurrence of the specified split character or characters.

"character-list" is one or more characters with no delimiter between each character and enclosed in quotation marks. For example, to specify the split characters a, b, and c, use the following option:

```
SPLITCHAR="abc"
```

When multiple split characters are specified, each character in the list is treated as a separate split character unless the specified characters appear consecutively in the value. In that case, all of the specified split characters together are treated as a single split character.

If the value does not contain any of the specified split characters, a split does not occur.

Default Values are not split.

Restriction This option has no effect unless you use discrete data labels.

Interactions This option has no effect unless the DATALABEL= option is specified.

When the text is split, the split characters are not included in the displayed value by default. If you want the split characters to appear in the values, then also specify SPLITCHARNODROP.

You can specify the justification of the text by using the SPLITJUSTIFY= option.

Notes When multiple characters are specified, the order of the characters in the list is not significant.

The split characters are case sensitive.

See "Fit Policies for Axis Tick Values, Curve Labels, and Data Labels" in *SAS ODS Graphics: Procedures Guide*

SPLITCHARNODROP
specifies that the split characters are included in the displayed value.

Interaction This option has no effect unless SPLITCHAR= is also specified.

See "Fit Policies for Axis Tick Values, Curve Labels, and Data Labels" in *SAS ODS Graphics: Procedures Guide*

SPLITJUSTIFY=LEFT | CENTER | RIGHT
specifies the horizontal alignment of the value text that is being split.

Default LEFT

Interaction This option has no effect unless you specify the SPLITCHAR= option.

See "Fit Policies for Axis Tick Values, Curve Labels, and Data Labels" in *SAS ODS Graphics: Procedures Guide*

SPLITPOLICY=NONE | SPLIT | SPLITALWAYS
specifies a policy for avoiding collisions among the text markers.

NONE
does not split the text for text markers that collide.

SPLIT
splits the marker text at a split character only if a split is needed at that character in order to make the text fit the available space. No split occurs at split characters that occur where a split is not needed. If the text does not contain any of the specified split characters, then a split does not occur. In that case, if the text does not fit the available space, then it might collide with the adjoining text markers.

SPLITALWAYS
splits the marker text at every occurrence of a split character. If the text does not contain any of the specified split characters, then a split does not occur.

Default NONE

See See the SPLITCHAR= option for information about specifying the split characters.

SPLITWIDTH=*width-in-characters*
specifies the maximum width of each split line, expressed as a character count. When a width is specified, the marker text is split unconditionally after every *width-in-characters* characters.

Default Uses the width of the longest inter-split-character substring.

Restriction This option has no effect unless the option SPLITPOLICY=SPLIT is specified.

STRIP
specifies that leading and trailing blanks should be stripped from the marker text before it is displayed.

Default Blanks are not stripped

Tip Stripping the blanks from numeric value strings helps center each string relative to its data point.

TEXTATTRS=*style-element*< (*options*) > | (*options*)
specifies the color and font properties of the marker text. Style elements are used to associate groups of appearance attributes with graph elements. The style attributes in use are COLOR, FONTFAMILY, FONTSIZE, FONTSTYLE, and FONTWEIGHT.

You can specify the appearance by using a style element or by specifying specific options. If you specify a style element, you can also specify options to override specific appearance attributes.

You can specify one or more of the following for *options*:

COLOR=*color*
specifies the color of the marker text. You can specify colors using a number of different color-naming schemes. See "Color-Naming Schemes" in *SAS ODS Graphics: Procedures Guide*.

FAMILY="*font-family*"
specifies the font family for the marker text. The SAS ODS styles use TrueType system fonts.

SIZE=*n<units>*
specifies the font size of the marker text. You can also specify the unit of measurement. The default unit is pixels.

STYLE= ITALIC | NORMAL
specifies the font style of the marker text.

WEIGHT=BOLD | NORMAL
specifies the font weight of the marker text.

Any *options* specified override the properties from the style-element. Any options that are not specified are derived from the default style element. For a description of the text options, see "Text Attributes" in *SAS ODS Graphics: Procedures Guide*.

Defaults
For ungrouped data, the Color, FontFamily, FontSize, FontStyle, and FontWeight attributes of the GraphDataText style element in the current style.

For grouped data, the FontFamily, FontSize, FontStyle, and FontWeight attributes of the GraphDataText style element, and the ContrastColor attribute of a GraphData1–GraphData*n* style element in the current style.

Requirement
When specifying the options, use a *name=value* pair format enclosed in parentheses. If you specify more than one *name=value* pair, separate them by a space. For example:

```
(family="Arial" size=10pt color=red);
```

Interactions
You can specify one or more options for the text. They might not include all the font properties (color, family, size, weight, style). Any unspecified *options* are derived from the default GraphDataText style element.

When this option's COLOR= suboption is used with the GROUP= option, the color of all of the marker text is specified by the COLOR= suboption.

This option's COLOR= suboption overrides the COLORRESPONSE= option. In that case, if a continuous legend is requested for the plot, the legend is not drawn.

Tip
When the GROUP= option is used, each distinct group value is represented by a different color. The text that is associated with the group is assigned the group color. The COLOR= option can be

used to specify a single color for all marker text in a graph, without affecting items that have the group color. Such items can include error bars and marker symbols.

Examples Here the style element GRAPHVALUETEXT is specified to set the text properties:

```
TEXTATTRS=GRAPHVALUETEXT
```

GRAPHVALUETEXT overrides the default style element.

Here the text option overrides the properties from the GRAPHVALUETEXT style element:

```
TEXTATTRS=GRAPHVALUETEXT(SIZE=10pt)
```

TIP=(*variable-list*) | NONE

specifies the data tip information to be displayed when the cursor is positioned over the graphics element.

(*variable-list*)

a space-separated list of variables enclosed in parentheses. Data tips are displayed using the data obtained from the specified variables.

NONE

suppresses the data tips from this plot.

Default The tip variable is the MAPID= option variable specified in the CHOROMAP statement, unless otherwise specified with this TIP= option.

Restriction Data tips in text plots are not supported in the SVG output format. To generate a text plot with data tips, use a bitmapped output format such as PNG. For example, add the following statement before your procedure:

```
ODS GRAPHICS / IMAGEMAP=ON OUTPUTFMT=PNG;
```

Requirement You must specify the IMAGEMAP=ON option in the ODS GRAPHICS statement in order to generate data tips. For example, add the following statement before your procedure:

```
ODS GRAPHICS / IMAGEMAP=ON;
```

Interaction This option replaces all of the information that is displayed by default.

Tips You might want to avoid specifying as a variable the X or Y coordinate variables. Using these projected values in the label causes mismatches with the resultant graph that is created with the unprojected variable values in the map input data set.

Use the TIPFORMAT= option and the TIPLABEL= option to assign formats and labels, respectively, to the list of variables.

Example tip=(age weight)

TIPFORMAT=(*format-list*)
applies formats to the list of data tip variables that you specify in the TIP= option. Provide a space-separated list of formats enclosed in parentheses. This option provides a way to control the format of the variable data that appears in the data tips.

A one-to-one correspondence exists between the *format-list* and the *variable-list* that is specified for the TIP= option. A format must be provided for each variable, using the same order as the *variable-list*. If you do not want to apply a format to a variable, use the AUTO keyword instead.

Default The column format of the tip variable, or BEST6 if no format is assigned to a numeric column.

Requirements A format or the keyword AUTO must be provided for each variable that is listed in the TIP= option.

This option has no effect unless the TIP= option is also specified.

Tip Use the TIPLABEL= option to assign labels to the list of variables.

See *SAS Formats and Informats: Reference*

Example tipformat=(auto F5.2)

TIPLABEL=(*label-list*)
applies labels to the list of data tip variables that you specify in the TIP= option. Provide a space-separated list of quoted “text strings” enclosed in parentheses. This option provides a way to specify labels for the variable data that appears in the data tips.

A one-to-one correspondence exists between the *label-list* and the *variable-list* that is specified for the TIP= option. A label must be provided for each variable, using the same order as the *variable-list*. If you do not want to apply a custom label to a variable, use the AUTO keyword instead.

Requirements A label or the keyword AUTO must be provided for each variable that is listed in the TIP= option. When AUTO is used, the label is obtained from the variable.

This option has no effect unless the TIP= option is also specified.

Tip Use the TIPFORMAT= option to assign formats to the list of variables.

Example tiplabel=(auto "Class Weight")

TRANSPARENCY=*value*
specifies the degree of transparency for the plot. The transparency that you specify applies to all aspects of the plot statement.

Default 0.0

Range 0 (completely opaque) to 1 (completely transparent)

URL=*character-variable*
specifies an HTML page to be displayed when parts of the plot are selected.

character-variable
specifies a variable that contains a valid HTML page reference (HREF) for each plot element that is to have an active link.

Example `https://www.sas.com/en_us/home.html`

Default By default, no HTML links are created.

Interactions This option affects graphics output that is created through the ODS HTML destination only. For more information about ODS destinations, see "Specifying ODS Destinations" in *SAS ODS Graphics: Procedures Guide*.

This option has no effect unless you also specify IMAGEMAP in the ODS GRAPHICS statement. For example, add the following statement before your procedure:

```
ODS GRAPHICS ON / IMAGEMAP=ON;
```

Tip Use the DRILLTARGET= option in the ODS GRAPHICS statement in order to specify the browser window that displays the drill-down output.

ATTRIB Statement

Associates a format, informat, label, and length with one or more variables.

Type: Procedure statement

Syntax

ATTRIB *variable-list(s) attribute-list(s)*;

Arguments

variable-list(s)
names the variables that you want to associate with the attributes.

> **TIP** List the variables in any form that SAS allows.

attribute-list(s)
specifies one or more attributes to assign to *variable-list*. Specify one or more of these attributes in the ATTRIB statement:

FORMAT=*format*
associates a format with variables in *variable-list*.

Tip The format can be either a standard SAS format or a format that is defined with the FORMAT procedure.

INFORMAT=*informat*
associates an informat with variables in *variable-list*.

Tip The informat can be either a standard SAS informat or an informat that is defined with the FORMAT procedure.

LABEL='*label*'
associates a label with variables in *variable-list*.

See Also

"ATTRIB Statement" on page 150 for more information about the ATTRIB statement.

FORMAT Statement

Associates formats with variables.

Type: Procedure statement

Syntax

FORMAT *variable-1* <-*variable-n*> <*format-1*> <*variable-1* <-*variable-n*> <*format-2*> > - <DEFAULT=*default-format*>;

Required Argument

variable
names one or more variables for SAS to associate with a format. You must specify at least one *variable*.

Tip To disassociate a format from a variable, use the variable in a FORMAT statement without specifying a format in a DATA step or in PROC DATASETS. In a DATA step, place this FORMAT statement after the SET statement. See "Removing a Format" in *SAS DATA Step Statements: Reference*. You can also use PROC DATASETS.

Optional Arguments

format
specifies the format that is listed for writing the values of the variables.

Tip Formats that are associated with variables by using a FORMAT statement behave like formats that are used with a colon modifier in a subsequent PUT statement. For more information about using a colon modifier, see "PUT Statement: List" in *SAS DATA Step Statements: Reference*.

See *SAS Formats and Informats: Reference*

DEFAULT=*default-format*
specifies a temporary default format for displaying the values of variables that are not listed in the FORMAT statement. These default formats apply only to the current DATA step; they are not permanently associated with variables in the output data set.

A DEFAULT= format specification applies to

- variables that are not named in a FORMAT or ATTRIB statement
- variables that are not permanently associated with a format within a SAS data set
- variables that are not written with the explicit use of a format.

Default If you omit DEFAULT=, SAS uses BEST*w*. as the default numeric format and $*w*. as the default character format.

Restriction Use this option only in a DATA step.

Tip A DEFAULT= specification can occur anywhere in a FORMAT statement. It can specify either a numeric default, a character default, or both.

Example "Assigning Formats and Defaults" in *SAS DATA Step Statements: Reference*

See Also

"FORMAT Statement" on page 156 for more information about the FORMAT statement.

LABEL Statement

Assigns descriptive labels to variables.

Type: Procedure statement

Syntax

Form 1: Creates a descriptive label for one or more variables.

LABEL *variable-1*='*text-string*' <...*variable-n*='*text-string*>;

Form 2: Removes the label from one or more variables.

LABEL *variable-1* = ' ' < ...*variable-n*=' '>; | *variable-1* = <...*variable-n*= >

Arguments

variable

specifies the variable that you want to label. You can specify labels for multiple variables in a single LABEL statement:

```
data test;
   L = 5;
   W = 10;
   label L = 'Length' W = 'Width';
run;
```

text-string

specifies a label of up to 256 bytes.

```
data test;
   L = 5;
   label L = 'Length';
run;
```

Restrictions

If the label includes a semicolon (;) or an equal sign (=), you must enclose the label in either single or double quotation marks.

```
label N = 'Number = ';
```

If the label includes single quotation marks ('), you must enclose the label in double quotation marks.

```
label Name = "Owner's Last Name";
```

There is partial support for variable name substitution with the JAVAIMG device. When the label text for the variable exceeds the space allowed, the variable name is used instead by procedures that are labeling an axis or a legend title. With the exception of the SAS/GRAPH GPLOT procedure, the variable name is not used when the JAVAIMG device is specified.

Notes

Quotation marks are not required unless the label includes a semicolon, quotation marks, or an equal sign.

The LABEL statement expects an equal sign (=) after the first variable. If any other character is found, an error occurs. The LABEL statement considers everything after the equal sign, following the first variable, as part of the label until the statement comes to another variable followed by an equal sign, regardless of quotation marks. In this example, the label for x is

this is x y 4 = this is y because the next variable that is followed by an equal sign is z.

```
data test;
   x = 1;
   y = 1;
   z = 1;
   label x = 'this is x' y 4 = 'this is y' z = 'This is z';
run;
```

In this LABEL statement, the x variable has the same label:

```
label x = this is x y 4 = this is y  z = This is z;
```

See "Character Constants and Character Variables" in *SAS Programmer's Guide: Essentials*.

''

removes a label from a variable. Enclose a single blank space in quotation marks to remove an existing label. You can remove labels from multiple variables in a single LABEL statement:

```
data test;
   L=5; W=10;
   label L = ' '  W = ' ';
run;
```

Alternatively, you can remove a label by specifying nothing after the equal sign:

```
data test;
   L=5; W=10;
   label L =  W = ;
run;
```

See Also

"LABEL Statement" on page 157 for more information about the LABEL statement.

WHERE Statement

Subsets the input data set by specifying certain conditions that each observation must meet before it is available for processing.

Type: Procedure statement

Syntax

WHERE *where-expression*;

Required Argument

where-expression
is an arithmetic or logical expression that generally consists of a sequence of operands and operators. For more information about where processing, see *SAS DATA Step Statements: Reference*.

Tip You can specify multiple where-expressions.

See Also

"WHERE Statement" on page 161 for more information about the WHERE statement.

Usage: SGMAP Procedure

Creating a Map Using the SGMAP Procedure

In order to successfully create a map using the SGMAP procedure, do the following:

- Determine which statements you need to use in the SGMAP procedure step to generate your map:
  - Use the ERSIMAP statement or the OPENSTREETMAP statement to provide an Esri map or an OpenStreetMap as the base map, if desired. At a minimum, the ESRIMAP or OPENSTREEMAP statement must be followed by a CHOROMAP statement or at least one plot statement such as BUBBLE, SERIES, SCATTER, and TEXT.
  - Use the CHOROMAP statement to create an outline map or choropleth map. If you use an ESRIMAP or OPENSTREETMAP statement to create a base map, the outline map or choropleth map overlays the base map. If you do not use an ESRIMAP or OPENSTREETMAP statement, you must specify a CHORMAP statement to draw a base map.
  - Use plot statements such as BUBBLE, SCATTER, SERIES, and TEXT to overlay one or more plots on the map that is generated by the ESRIMAP, OPENSTREETMAP, or CHOROMAP statement.
  - Use a KEYLEGEND on page 683 statement or a GRADLEGEND on page 679 statement to add text to the legend, if desired. By default, an automatic legend is created, unless the NOAUTOLEGEND on page 645 option is specified in the PROC SGMAP statement. See "Controlling Legends with the SGMAP Procedure" on page 730.

- Specify the statements in your SGMAP procedure step, where applicable, in the following order:

  1. Specify the PROC SGMAP statement with the appropriate options:
     - If you use the CHOROMAP statement, specify the map polygon data in the MAPDATA= option. If you specify a response variable in the CHOROMAP statement, specify the response data in the MAPRESPDATA= option.

       Note: The map polygon data specified in the MAPDATA= option must not be stored on a system that cannot guarantee data order. See "Storing Mapping Data on Distributed Systems" on page 729.

     - If you specify one or more plot statements, specify the plot data in the PLOTDATA= option.
     - If you want to suppress the automatic legend, specify the NOAUTOLEGEND option.
  2. Specify the ESRIMAP statement or the OPENSTREETMAP statement.
  3. Specify the CHOROMAP statement.
  4. Specify the plot statements. The plots are drawn in the order in which the plot statements are specified.
  5. Specify the KEYLEGEND or the GRADLEGEND statement.
  6. Specify other supported statements such as WHERE, LABEL, FORMAT, and so on, as needed.

For examples, see "Examples" on page 737.

Storing Mapping Data on Distributed Systems

Mapping data includes the following:

- polygon data that is required to draw the polygon outline areas for the map. This data is specified in the MAPDATA= option.
- response data that is required to add response values to the polygonal map areas that are drawn with the CHOROMAP statement. This data is specified in the MAPRSPDATA= option.
- plot data that is required to overlay plots such as bubble plots, scatter plots, text plots, and series plots on a map. This data is specified in the PLOTDATA= option.

For the polygon data that is specified in the MAPDATA= option, data order is essential. If the data order is altered, unexpected results might occur. For the data specified in the MAPSRSPDATA= option and in the PLOTDATA= option, data order is not important.

Map data sets or geocoding lookup data sets that are stored on a system that does not guarantee data order cannot be used with the SGMAP procedure. Essential

polygonal data sequencing in the input data must be maintained. The SGMAP procedure prohibits specifying in the MAPDATA= option data that is stored in a library that cannot guarantee data order. Use map data that is stored locally.

The data that you specify in the MAPSRSPDATA= and PLOTDATA= options can be stored on a distributed system because data order is not important for the response and plot data.

Controlling Legends with the SGMAP Procedure

This section defines the rules for generating legends while using the SGMAP procedure. The rules vary depending on the statements used within the procedure. It also discusses ways to suppress legends, and the rules of applying a legend label when using a CHOROMAP statement.

Rules for Generating Legends

The SGMAP procedure by default generates a legend, dependent on the statement or statements issued. Here are the rules for generating an automatic legend:

- An automatic legend is generated using the first statement following the SGMAP procedure statement.
- A discrete automatic legend is generated by default with a CHOROMAP statement when the data is categorized into distinct ranges. In other words, a KEYLEGEND is the default legend generated when you specify one of the LEVELTYPE= INTERVAL, LEVELTYPE= QUANTILE, or NUMLEVELS= options in the CHOROMAP statement. To override the default and generate a continuous legend, use a GRADLEGEND statement in conjunction with the CHOROMAP statement.

  A gradient (GRADLEGEND) legend is generated with the use of numeric data and a specification of the LEVELTYPE=NONE option in the CHOROMAP statement. In this case, a KEYLEGEND cannot be requested.
- The use of character data generates an automatic discrete (KEYLGEND) legend.
- Specify a discrete legend with the KEYLEGEND statement or a continuous legend with the GRADLEGEND statement.
- When a CHOROMAP statement is invoked during an SGMAP procedure run and a numeric response variable is specified, a gradient legend is generated. When the response variable represents discrete values, a discrete legend is generated.
- When a CHOROMAP statement is specified and indicates a response variable, and either includes or excludes a TEXT statement, and excludes a KEYLEGEND statement, an automatic legend is generated.
- When a CHOROMAP statement is specified without indicating a response variable, the automatic legend shows information from the first plot statement that contains a GROUP option variable.

- When a CHOROMAP statement is specified without indicating a response variable and no plot statements contain a GROUP option variable, the automatic legend shows information from the CHOROMAP statement and all plot statements except the TEXT statement. Information from the TEXT statement is used in this case only when a KEYLEGEND statement is included.

  When a CHOROMAP statement is specified without indicating a response variable, and no plot statements contain a GROUP= option variable, the automatic legend shows information from the CHOROMAP statement and all plot statements, including the TEXT statement.
- When a CHOROMAP statement is specified without indicating a response variable, and there are one or more map or plot statements, a region item is generated in the automatic legend.
- When a CHOROMAP statement is specified without indicating a response variable, and there are no plot statements, no automatic legend is generated.
- Specifying the OpenStreetMap and ESRIMAP statements have no effect on these rules.

Suppressing Legends

- The NOAUTOLEGEND option specified in the SGMAP statement overrides the default behavior.
- An automatic legend is suppressed when a CHOROMAP statement is specified without indicating a response variable and the only other statement is a TEXT statement.

  Note: A region item is generated in the automatic legend when a CHOROMAP statement is specified without indicating a response variable, and there are one or more map or plot statements, including a TEXT statement.
- When the CHOROMAP statement does not specify a response variable and it is the only statement used, the automatic legend is suppressed.

See "NOAUTOLEGEND" for details.

Applying a Label in a Legend on a CHOROMAP

The CHOROMAP statement supports adding a label in a legend according to these rules:

- When the CHOROMAP statement specifies a response variable and that response variable has a label, that label is used as the legend label.
- When the CHOROMAP statement specifies a response variable and that response variable has no label, that variable name is used as the legend label.
- When the CHOROMAP statement specifies a discrete response variable, the legend items are drawn in the order of the response data. Sorting the response

data set prior to running the SGMAP procedure can help control the legend output.

- When the CHOROMAP statement does not specify a response variable, you can specify a custom legend label on this statement.
- When the CHOROMAP statement does not specify a response variable but a KEYLEGEND statement is specified, the legend uses a single item named 'Regions' instead of 'Map'.
- When the CHOROMAP statement does not specify a response variable and there are no plot statements containing a GROUP= option variable, CHOROMAP and all of the plot statements excepting TEXT statement are labeled in the automatic legend.

  When the CHOROMAP statement does not specify a response variable and there are no plot statements containing a GROUP= option variable, CHOROMAP and all of the plot statements are labeled in the automatic legend.
- The LEGENDLABEL= option has no effect if you also specify the GROUP= option in the same plot statement.

See "LEGENDLABEL="*text-string*"" on page 670 for details.

Controlling the Display of Lakes

Some countries contain a lake or a polygonal area that is located completely within a single unit area. Occasionally these areas can be a problem when working with map data sets. In addition, displaying these areas might not be appropriate for some applications. In these cases, you might want to remove them from the map data set before you proceed.

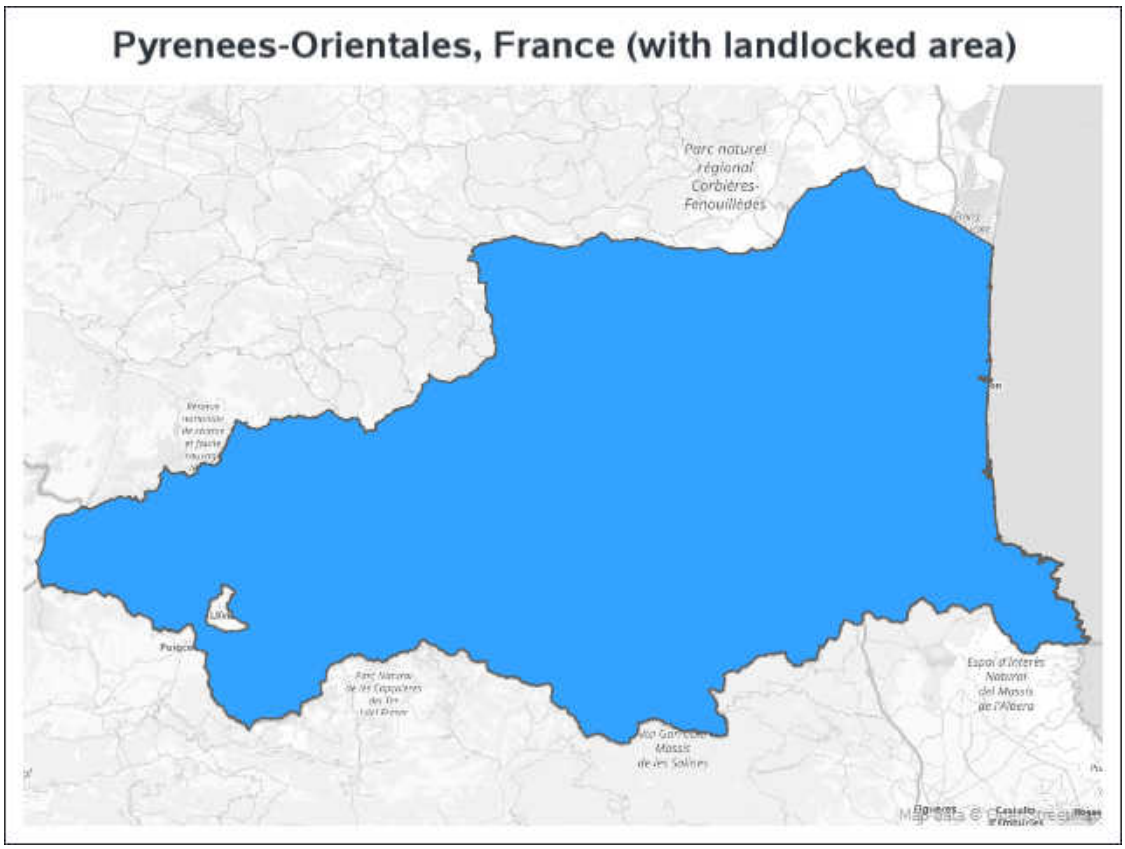
In traditional and GfK map data sets that contain coordinates for a lake that is located within a single internal division, the lake is identified with the numeric variable LAKE. The value of LAKE is 1 for points that correspond to water. A value of 2 indicates land points. A value of 0 corresponds to a body of water completely surrounded by land — an area within an internal region. Such an area would be visible as a hole in the resulting map graph. It is best to remove all such areas from the map data set by using LAKE=0. In the programming code that follows, the first set of procedure statements illustrate the inclusion of the landlocked Spanish town of Llivia in the Pyrenees-Orientale region of France. The second set of procedure statements illustrates how to delete this area from that region. WHERE processing is used in both sets of code.

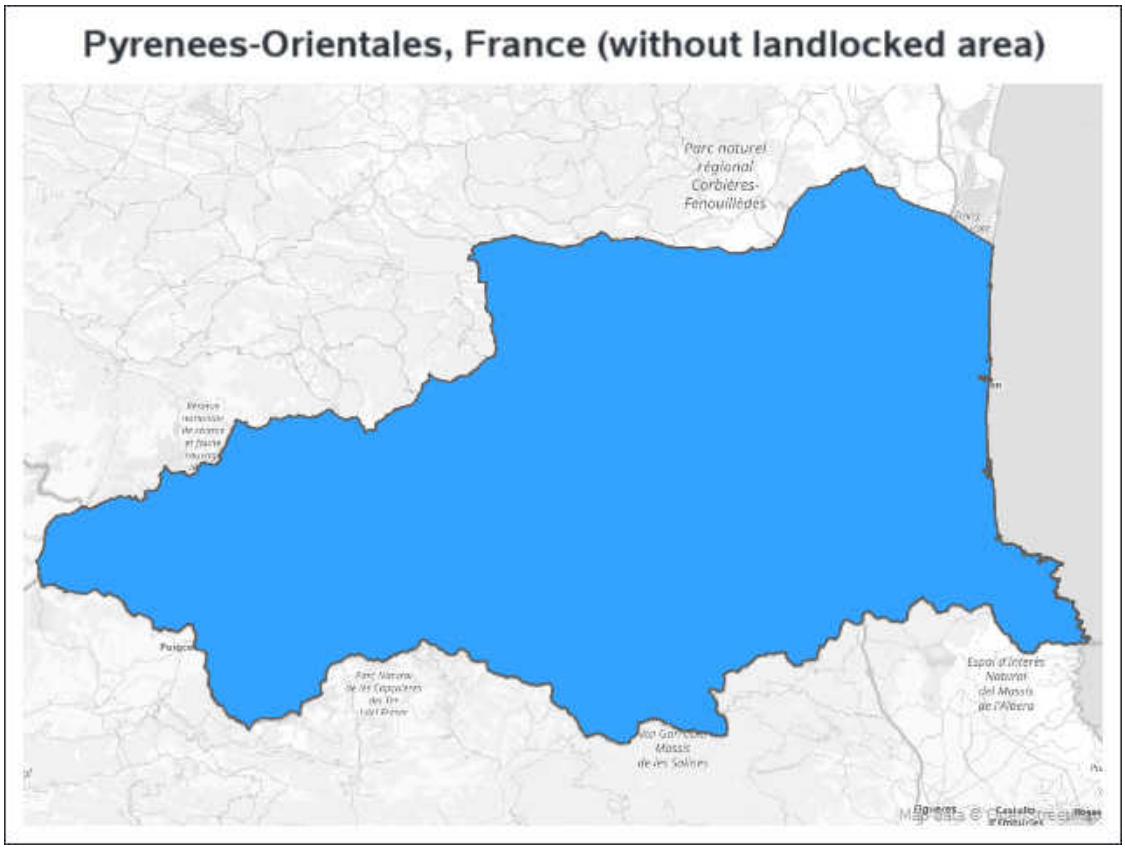
```
title1 h=16pt "Pyrenees-Orientales, France (with landlocked area)";
proc sgmap noautolegend
 mapdata=mapsgfk.france
 maprespdata=mapsgfk.france_attr (where=(idname='Pyrenees-
Orientales'));
openstreetmap;
choromap idname / mapid=id density=4;
run;

title1 h=16pt "Pyrenees-Orientales, France (without landlocked area)";
```

```
proc sgmap noautolegend
 mapdata=mapsgfk.france (where=(lake=0))
 maprespdata=mapsgfk.france_attr (where=(idname='Pyrenees-
Orientales'));
openstreetmap;
choromap idname / mapid=id density=4;
run;
quit;
```

Output 18.1 *The Pyrenees-Orientales Region of France with and without Its Landlocked Area*





Controlling the Theme of an OpenStreetMap Base Map

The TileSet attribute controls the OpenStreetMap theme. You can set it to LIGHT, DARK, or HIGHCONTRAST. The default is LIGHT. See "Style Elements for Use with ODS Graphics" in *SAS ODS Graphics: Procedures Guide* for information about ODS Graphics style elements and their attributes.

Each dark and high-contrast ODS style sets GraphBaseMap:TileSet appropriately for that style's theme. The following table lists the TileSet attribute setting for each of the dark and high-contrast ODS styles.

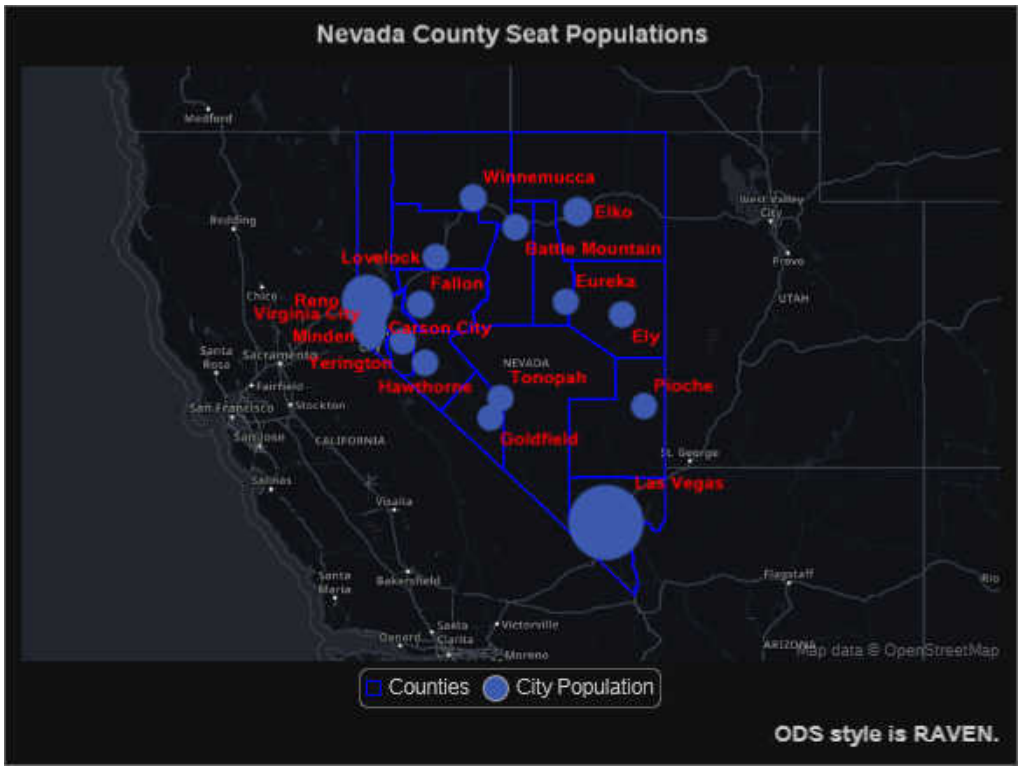
Table 18.11 *GraphBaseMap:TileSet Setting for Dark and High-Contrast ODS Styles*

ODS Style	GraphBaseMap:TileSet Setting
ExcelHighContrast	HIGHCONTRAST
ExcelIgnite	DARK
ExcelMidnight	DARK

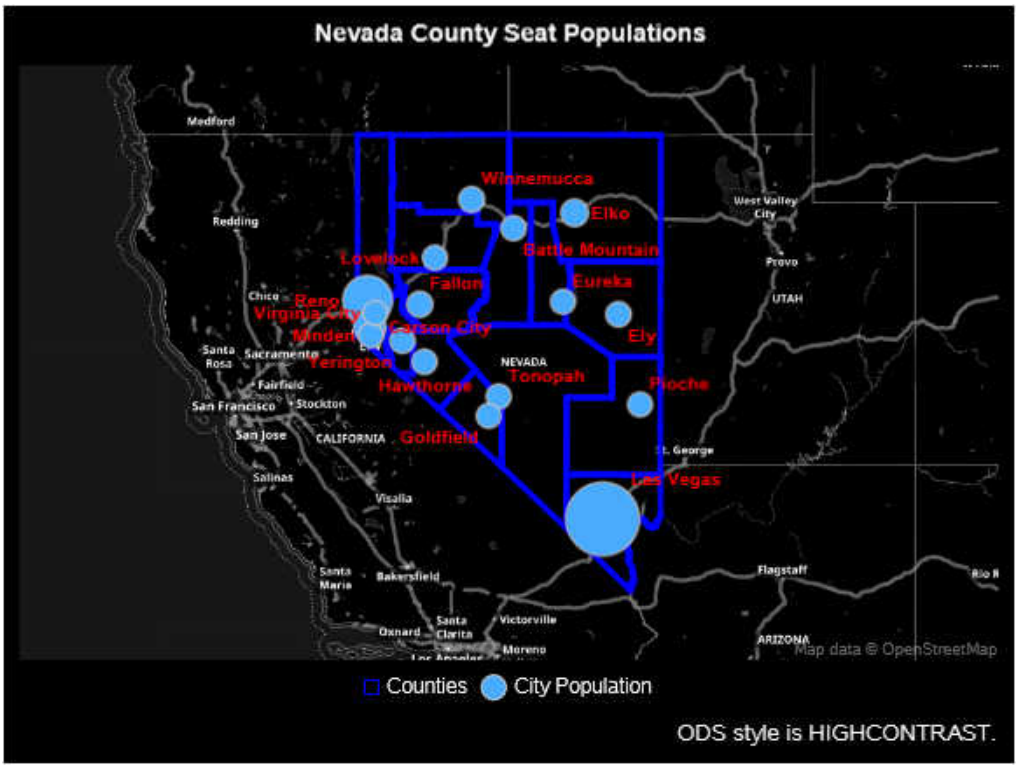
ODS Style	GraphBaseMap:TileSet Setting
HighContrast	HIGHCONTRAST
HighContrastLarge	HIGHCONTRAST
Ignite	DARK
Midnight	DARK
Moonflower	DARK
PowerPointDark	DARK
PowerPointHighContrast	HIGHCONTRAST
PowerPointIgnite	DARK
PowerPointMidnight	DARK
Raven	DARK
WordHighContrast	HIGHCONTRAST
WordIgnite	DARK
WordMidnight	DARK
vaDark	DARK
vaHighContrast	HIGHCONTRAST

The remaining ODS styles default to LIGHT.

For an example of the LIGHT tile set, see "Example 1: Creating a Map of Nevada Counties with a Bubble Plot of County Seat Populations" on page 738. For an example of the DARK tile set, here is the same map rendered using the Raven ODS style:



For an example of the HIGHCONTRAST tile set, here is the same map rendered using the HighContrast ODS style:



If you want to override the GraphBaseMap:TileSet setting in an ODS style, you can create a custom style that changes the TileSet attribute setting. The following

example overrides the default LIGHT tile set that is used in the HTMLEncore style with the HIGHCONTRAST tile set:

```
proc template;
   define style DarkMapHtml;
      parent=Styles.HTMLEncore;
      class GraphBaseMap /
         TileSet=HIGHCONTRAST;
   end;
run;
```

Examples: SGMAP Procedure

About the SGMAP Procedure Examples

Examples in This Section

This section provides basic examples of how to use the SGMAP procedure. The following table lists the examples that are provided.

Table 18.12 *SGMAP Procedure Examples*

Example	Map Data Used	Description
Creating a Map of Nevada Counties with a Bubble Plot of County Seat Populations (p. 738)	GfK	Shows how to use GfK map data to create a choropleth map of the state of Nevada overlaid with a bubble plot of county seat populations.
Creating a Map of Nevada Counties with a Bubble Plot of County Seats and Populations (p. 742)	GfK	Shows how to use GfK map data to create a choropleth map of the state of Nevada overlaid with a bubble plot of each county's population.
Creating a Series Plot of Hurricane Katrina's Path (p. 747)	GfK	Shows how to overlay a bubble plot of wind speeds and a series plot of hurricane Katrina tracking locations onto an OpenStreetMap of the southeast United States.

Example	Map Data Used	Description
Adding a Gradient Legend Showing Population (p. 750)	GfK	Shows how to overlay a choropleth map of population densities of the lower 48 states of the United States onto an Esri Map of the world.
Creating a U.S. Map with Active URL Links (p. 753)	GfK	Shows how to use GfK map data to generate an HTML map of the United States with active data tips and URL links.
Adding a Gradient Legend Showing Population Using Traditional Map Data (p. 755)	Traditional	Shows how to use traditional map data to overlay a choropleth map of population densities of the lower 48 states of the United States onto an Esri Map of the world.

Examples Available Online

You can find more examples on the Graphically Speaking blog. On the blog page, use **Search Graphically Speaking** to search for SGMAP to find the SGMAP procedure examples.

Example 1: Creating a Map of Nevada Counties with a Bubble Plot of County Seat Populations

Features:

MAPDATA= required argument referring to GfK map data set

PLOTDATA= argument referring to bubble location and response data

OPENSTREETMAP (OSM)

GEOCODE procedure (CITY Method)

CHOROMAP statement options
- MAPID=
- LINEATTRS=
- LEGENDLABEL=

BUBBLE statement options
- NAME=
- DATALABEL=
- DATALABELATTRS= option with COLOR=, SIZE=, and STYLE= suboptions

ODS destination statement

DATA step

TITLE global statement

Data sets: MAPSGFK.US_COUNTIES

OpenStreetMap

SASHELP.ZIPCODE (Lookup data set)

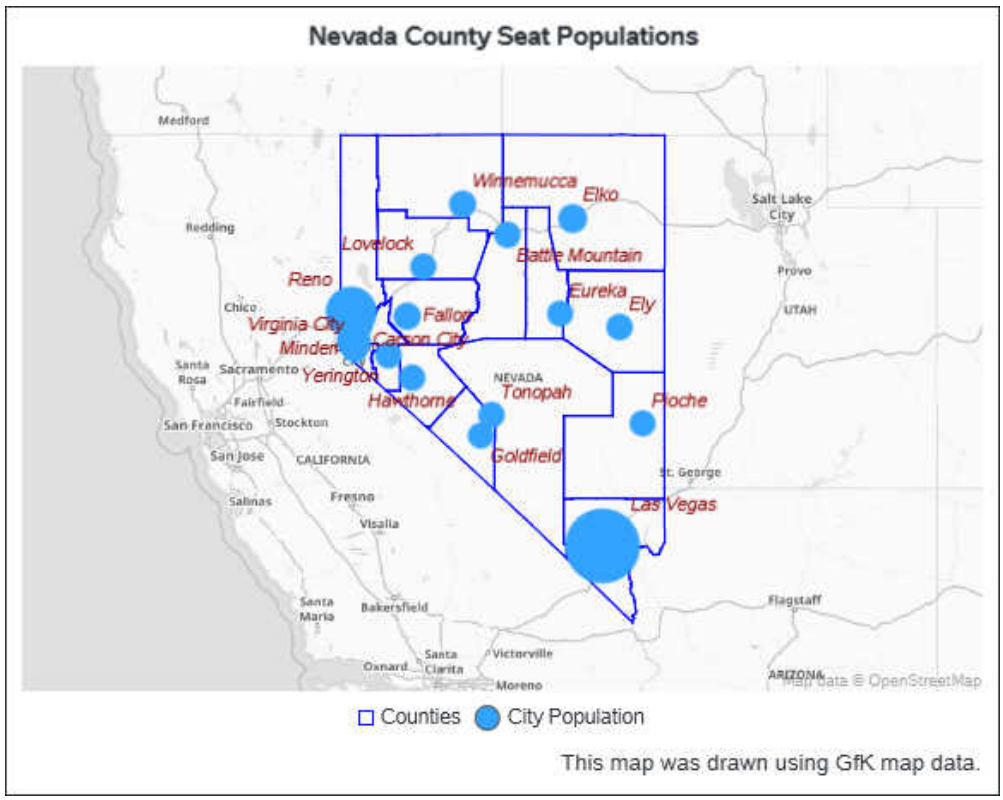
ODS destination: HTML5

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example produces a choropleth map of the state of Nevada overlaid with a bubble plot of county seat populations. The bubbles are sized based on the county seat population. HTML5 and PNG output are generated. You can view the PNG graphic by right-mouse clicking on the file name to download it and then view it in your PNG-enabled image browser. The Base SAS GEOCODE procedure is used to find the latitude and longitude city locations.

Note: This example cannot be run without having SAS/GRAPH and the optional MAPSGFK maps library installed.

Output



Program

```
data city_pop;
   length city $80;
   infile datalines dlm=',';
   state = 'NV';
   input city population;
datalines;
Fallon, 8458
Las Vegas, 623747
Minden, 3180
Elko, 20279
Goldfield, 443
Eureka, 487
Winnemucca, 7887
Battle Mountain, 3276
Pioche, 911
Yerington, 3064
Hawthorne, 3095
Tonopah, 2360
Lovelock, 1878
Virginia City, 717
Reno, 241445
Ely, 4134
Carson City, 54521
;
run;

proc geocode method=city
   data=city_pop
   out=city_pop (rename=(x=long y=lat))
   lookupcity=sashelp.zipcode; /* Use this if you don't have SAS GRAPH
*/
run;

data nevada;
   set mapsgfk.us_counties(where=(statecode='NV'));
run;

title 'Nevada County Seat Populations';
proc sgmap mapdata=nevada     /* Map boundaries */
           plotdata=city_pop  /* Bubble response & location data */
           des='Nevada';
   openstreetmap;
   choromap / mapid=county lineattrs=(color=blue)
legendlabel='Counties';
   bubble x=long y=lat size=population /
      datalabel=city legendlabel='City Population'
      datalabelattrs=(family="Albany AMT" color=darkred size=9);
run;
```

Program Description

Plot BUBBLES as county seat populations. Map polygons are Nevada county boundaries.

Create the county seat population response data set for bubbles.

```
data city_pop;
   length city $80;
   infile datalines dlm=',';
   state = 'NV';
   input city population;
datalines;
Fallon, 8458
Las Vegas, 623747
Minden, 3180
Elko, 20279
Goldfield, 443
Eureka, 487
Winnemucca, 7887
Battle Mountain, 3276
Pioche, 911
Yerington, 3064
Hawthorne, 3095
Tonopah, 2360
Lovelock, 1878
Virginia City, 717
Reno, 241445
Ely, 4134
Carson City, 54521
;
run;
```

Determine city locations of the county seats. Use the GEOCODE procedure to find the city longitude and latitude. The input data set is the population data. The lookup data set is SASHELP.ZIPCODE.

```
proc geocode method=city
   data=city_pop
   out=city_pop (rename=(x=long y=lat))
   lookupcity=sashelp.zipcode; /* Use this if you don't have SAS GRAPH
*/
run;
```

Retrieve the Nevada county boundaries for the choropleth map. In this MAPSGFK data set, coordinates are in eastlong degrees and the character STATECODE variables are available. The choropleth map of counties can then be overlaid on an unprojected OpenStreetMap of the Nevada portion of the United States.

```
data nevada;
   set mapsgfk.us_counties(where=(statecode='NV'));
run;
```

Generate the title, map, and the legend. MAPDATA contains the state of Nevada's county boundary coordinates. PLOTDATA contains the population response data and the city location data. Overlay the choropleth map on the OpenStreetMap of Nevada. Bubble markers indicate country seat populations.

```
title 'Nevada County Seat Populations';
proc sgmap mapdata=nevada     /* Map boundaries */
           plotdata=city_pop  /* Bubble response & location data */
           des='Nevada';
   openstreetmap;
   choromap / mapid=county lineattrs=(color=blue)
legendlabel='Counties';
   bubble x=long y=lat size=population /
      datalabel=city legendlabel='City Population'
      datalabelattrs=(family="Albany AMT" color=darkred size=9);
run;
```

Example 2: Creating a Map of Nevada Counties with a Bubble Plot of County Seats and Populations

Features:

MAPDATA= required argument referring to a GfK map data set

MAPRESPDATA= county population response data

PLOTDATA= argument referring to bubble location and response data

DATTRMAP= argument referring to an attribute map data set

CHOROMAP statement options
- MAPID=
- ID=
- ATTRID=

BUBBLE statement options
- NAME=
- DATALABEL=
- DATALABELATTRS= option with COLOR=, SIZE=, and STYLE= suboptions

KEYLEGEND statement

DATA step

SORT procedure

TITLE global statement

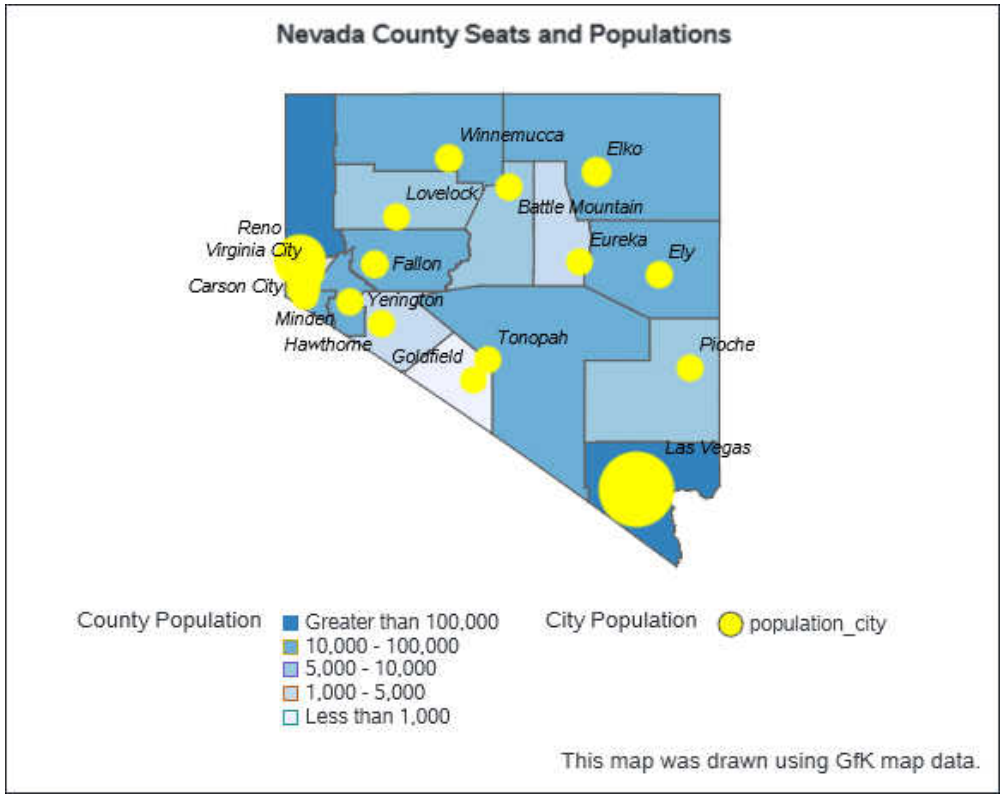
Data set: MAPSGFK.US_COUNTIES

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example expands on the first example. It produces a choropleth map of the state of Nevada, and it displays response values of each county's population. This map is overlaid with a bubble plot of county seat (city) populations. The bubbles are sized based on the county seat (city) population.

Note: This example cannot be run without having SAS/GRAPH and the optional MAPSGFK maps library installed.

Output



Program

```
data city_pop (label='Nevada County Seat Populations');
   length city $65;
   infile datalines dlm=',';
   input city population_city county;
   state='NV';
datalines;
Fallon, 8458, 1
Las Vegas, 623747, 3
Minden, 3180, 5
Elko, 20279, 7
Goldfield, 443, 9
Eureka, 487, 11
Winnemucca, 7887, 13
Battle Mountain, 3276, 15
Pioche, 911, 17
Yerington, 3064, 19
Hawthorne, 3095, 21
Tonopah, 2360 , 23
Lovelock, 1878, 27
Virginia City, 717, 29
Reno, 241445, 31
Ely, 4134, 33
Carson City, 54521, 510
```

```
;
run;

proc geocode method=city
   data=city_pop
   out=city_pop (rename=(x=long y=lat))
   lookupcity=sashelp.zipcode; /* Use this if you don't have SAS GRAPH
*/
run;

data county_pop (label='Nevada Counties');
   length county_name $55;
   infile datalines dlm=',';
   input county_name county population_county;
   statecode='NV';
   /* Add five population ranges as groups to map response data. */
   if      population_county > 100000
           then group='Greater than 100,000';
   else if population_county > 10000
           then group='10,000 - 100,000';
   else if population_county > 5000
           then group='5,000 - 10,000';
   else if population_county > 1000
           then group='1,000 - 5,000';
   else
           group='Less than 1,000';
datalines;
Churchill, 1, 24877
Clark, 3, 2069681
Douglas, 5, 47710
Elko, 7, 52766
Esmeralda, 9, 783
Eureka, 11, 1987
Humboldt, 13, 17019
Lander, 15, 5775
Lincoln, 17, 5036
Lyon, 19, 52585
Mineral, 21, 4772
Nye, 23, 43946
Pershing, 27, 6753
Storey, 29, 3987
Washoe, 31, 446903
White Pine, 33, 10030
Carson City, 510, 54521
;
run;

proc sort data=county_pop;
   by descending population_county;
run;

data nevada;
   set mapsgfk.us_counties(where=(statecode='NV'));
run;

data attrmap;
   input id $1  value $3-22 fillcolor $24-40;
datalines;
A Greater than 100,000 cx3182bd
```

```
A 10,000 - 100,000     cx6baed6
A 5,000 - 10,000       cx9ecae1
A 1,000 - 5,000        cxc6dbef
A Less than 1,000      cxeff3ff
;
run;

title 'Nevada County Seats and Populations';

proc sgmap mapdata=nevada         /* Map polygon geometry            */
           maprespdata=county_pop /* Map polygon response data       */
           plotdata=city_pop      /* Bubble response & location data */
           dattrmap=attrmap;      /* Choropleth color information    */
   choromap group / mapid=county id=county name='counties' attrid=A;
   bubble x=long y=lat size=population_city / fillattrs=(color=yellow)
                                      name='cities' datalabel=city
                                      datalabelattrs=(color=black
                                                      size=9
                                                      style=italic);
   keylegend 'counties' / title='County Population';
   keylegend 'cities'   / title='City Population';
run;
```

Program Description

Create population response data for city bubbles.

```
data city_pop (label='Nevada County Seat Populations');
   length city $65;
   infile datalines dlm=',';
   input city population_city county;
   state='NV';
datalines;
Fallon, 8458, 1
Las Vegas, 623747, 3
Minden, 3180, 5
Elko, 20279, 7
Goldfield, 443, 9
Eureka, 487, 11
Winnemucca, 7887, 13
Battle Mountain, 3276, 15
Pioche, 911, 17
Yerington, 3064, 19
Hawthorne, 3095, 21
Tonopah, 2360 , 23
Lovelock, 1878, 27
Virginia City, 717, 29
Reno, 241445, 31
Ely, 4134, 33
Carson City, 54521, 510
;
run;
```

Determine city locations of the county seats. Use the GEOCODE procedure to find the city longitude and latitude. The input data set is the population data. The lookup data set is SASHELP.ZIPCODE.

```
proc geocode method=city
   data=city_pop
   out=city_pop (rename=(x=long y=lat))
   lookupcity=sashelp.zipcode; /* Use this if you don't have SAS GRAPH
*/
run;
```

Create response data for Nevada county polygons. Add five population ranges as groups to the map response data.

```
data county_pop (label='Nevada Counties');
   length county_name $55;
   infile datalines dlm=',';
   input county_name county population_county;
   statecode='NV';
   /* Add five population ranges as groups to map response data. */
   if      population_county > 100000
           then group='Greater than 100,000';
   else if population_county > 10000
           then group='10,000 - 100,000';
   else if population_county > 5000
           then group='5,000 - 10,000';
   else if population_county > 1000
           then group='1,000 - 5,000';
   else
           group='Less than 1,000';
datalines;
Churchill, 1, 24877
Clark, 3, 2069681
Douglas, 5, 47710
Elko, 7, 52766
Esmeralda, 9, 783
Eureka, 11, 1987
Humboldt, 13, 17019
Lander, 15, 5775
Lincoln, 17, 5036
Lyon, 19, 52585
Mineral, 21, 4772
Nye, 23, 43946
Pershing, 27, 6753
Storey, 29, 3987
Washoe, 31, 446903
White Pine, 33, 10030
Carson City, 510, 54521
;
run;
```

Sort the county population response data in descending order. This controls the order of the population groups in the legend.

```
proc sort data=county_pop;
   by descending population_county;
run;
```

Retrieve county boundaries for the choropleth map.

```
data nevada;
   set mapsgfk.us_counties(where=(statecode='NV'));
run;
```

Create an attribute map data set that specifies a color for each of the population ranges. The ID variable specifies the attribute map ID. This value must be specified in the CHOROMAP statement ATTRID= option. The FILLCOLOR variable specifies a fill color for each value of GROUP in the COUNTY_POP data set.

```
data attrmap;
   input id $1  value $3-22 fillcolor $24-40;
datalines;
A Greater than 100,000 cx3182bd
A 10,000 - 100,000     cx6baed6
A 5,000 - 10,000       cx9ecae1
A 1,000 - 5,000        cxc6dbef
A Less than 1,000      cxeff3ff
;
run;
```

Set the title of the map.

```
title 'Nevada County Seats and Populations';
```

Create the choropleth map and the legends. MAPDATA contains the state of Nevada's polygon coordinates. MAPRESPDATA contains the county population response data and PLOTDATA contains the BUBBLE city response data and location data. ATTRMAP contains the choropleth color information.

```
proc sgmap mapdata=nevada         /* Map polygon geometry            */
           maprespdata=county_pop /* Map polygon response data       */
           plotdata=city_pop      /* Bubble response & location data */
           dattrmap=attrmap;      /* Choropleth color information    */
   choromap group / mapid=county id=county name='counties' attrid=A;
   bubble x=long y=lat size=population_city / fillattrs=(color=yellow)
                                      name='cities' datalabel=city
                                      datalabelattrs=(color=black
                                                      size=9
                                                      style=italic);
   keylegend 'counties' / title='County Population';
   keylegend 'cities'   / title='City Population';
run;
```

Example 3: Creating a Series Plot of Hurricane Katrina's Path

Features:

PLOTDATA= argument referring to plot data

OPENSTREETMAP (OSM) statement

SERIES statement options
- LEGENDLABEL=
- LINEATTRS=

BUBBLE statement options
- DATALABEL=

DATALABELPOS=
DATALABELATTRS= with COLOR=, SIZE=, and STYLE= suboptions
LEGENDLABEL=

ODS destination statement

DATA step with datetime format and informat, and datestring

TITLE global statement

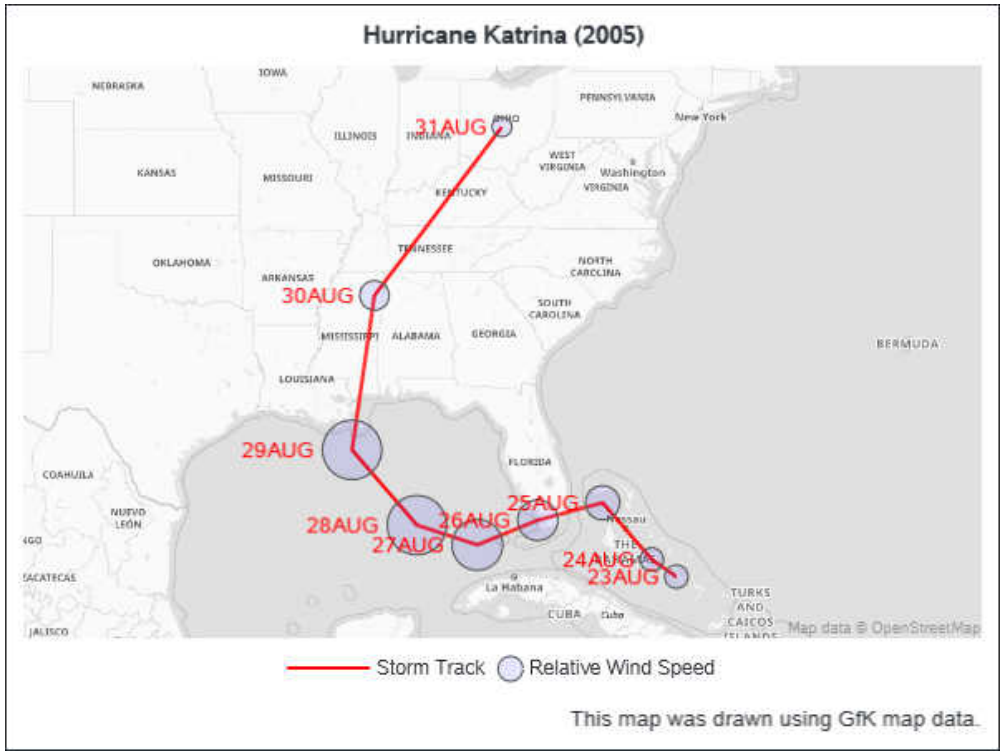
Data set: OpenStreetMap

ODS destination: HTML5

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example overlays a bubble plot of wind speeds and a series plot of hurricane Katrina tracking locations onto an OpenStreetMap of the southeast United States. The bubble sizes are based on the wind speed. HTML5 output is displayed.

Output



Program

```
data katrina;
   format datetime datetime18.;
   informat datetime datetime18.;
```

```
   infile datalines dlm=',';
   input datetime lat long wind;
   datestring=substr(put(datepart(datetime),date9.),1,5);
datalines;
23AUG2005:18:00:00,23.1,-75.1,30
24AUG2005:06:00:00,23.8,-76.2,30
25AUG2005:06:00:00,26.1,-78.4,50
26AUG2005:06:00:00,25.4,-81.3,65
27AUG2005:06:00:00,24.4,-84,95
28AUG2005:06:00:00,25.2,-86.7,125
29AUG2005:06:00:00,28.2,-89.6,125
30AUG2005:06:00:00,34.1,-88.6,40
31AUG2005:06:00:00,40.1,-82.9,25
;
run;

title1 'Hurricane Katrina (2005)';

proc sgmap plotdata=katrina;
   openstreetmap;
   series x=long y=lat /
      lineattrs=(color=red thickness=2)
      legendlabel='Storm Track';
   bubble x=long y=lat size=wind /
      fillattrs=(color=blue transparency=.9)
      datalabel=datestring datalabelpos=left
      datalabelattrs=(color=red size=10)
      legendlabel='Relative Wind Speed';
run;
```

Program Description

Plot bubbles as hurricane wind speeds and plot series lines as hurricane tracking locations. Overlay plots on the southeast United States OpenStreetMap.

Create hurricane location response data for the series lines and wind speed for the bubbles. The data includes the track locations at 6:00 am, as well as the first and last time record.

```
data katrina;
   format datetime datetime18.;
   informat datetime datetime18.;
   infile datalines dlm=',';
   input datetime lat long wind;
   datestring=substr(put(datepart(datetime),date9.),1,5);
datalines;
23AUG2005:18:00:00,23.1,-75.1,30
24AUG2005:06:00:00,23.8,-76.2,30
25AUG2005:06:00:00,26.1,-78.4,50
26AUG2005:06:00:00,25.4,-81.3,65
27AUG2005:06:00:00,24.4,-84,95
28AUG2005:06:00:00,25.2,-86.7,125
29AUG2005:06:00:00,28.2,-89.6,125
30AUG2005:06:00:00,34.1,-88.6,40
31AUG2005:06:00:00,40.1,-82.9,25
```

```
;
run;
```

Set the title for the graph. Use the global TITLE statement.

```
title1 'Hurricane Katrina (2005)';
```

Create the OpenStreetMap and plot overlays. Run the SGMAP procedure starting with the OpenStreetMap statement. Overlay the series plot of hurricane tracking locations in longitude and latitude coordinates. Assign a legend label for the series line depicting the hurricane's track. Overlay the bubble plot of wind speeds. Use the BUBBLE statement options to specify the appearance of the bubble markers. Assign a legend label for the bubble markers with the BUBBLE statement's LEGENDLABEL= option.

```
proc sgmap plotdata=katrina;
   openstreetmap;
   series x=long y=lat /
      lineattrs=(color=red thickness=2)
      legendlabel='Storm Track';
   bubble x=long y=lat size=wind /
      fillattrs=(color=blue transparency=.9)
      datalabel=datestring datalabelpos=left
      datalabelattrs=(color=red size=10)
      legendlabel='Relative Wind Speed';
run;
```

Example 4: Adding a Gradient Legend Showing Population

Features:

MAPDATA= argument for the map polygon data

PLOTDATA= argument referring to plot data

MAPRESPDATA= argument referring to response data

OPENSTREETMAP (OSM) statement

ESRIMAP statement (includes URL to service)

TEXT statement

CHOROMAP statement options
- DENSITY=
- NAME= data descriptor referenced by GRADLEGEND statement

TEXT statement options
- TEXTATTRS= option with SIZE= suboption

GRADLEGEND statement options
- TITLE= for the gradient legend
- EXTRACTSCALE option reduces tick value width with the tick value scale factor

ODS destination statement

DATA step

TITLE global statement

Data sets: MAPSGFK.US_STATES
MAPSGFK.USCENTER
Esri Map service

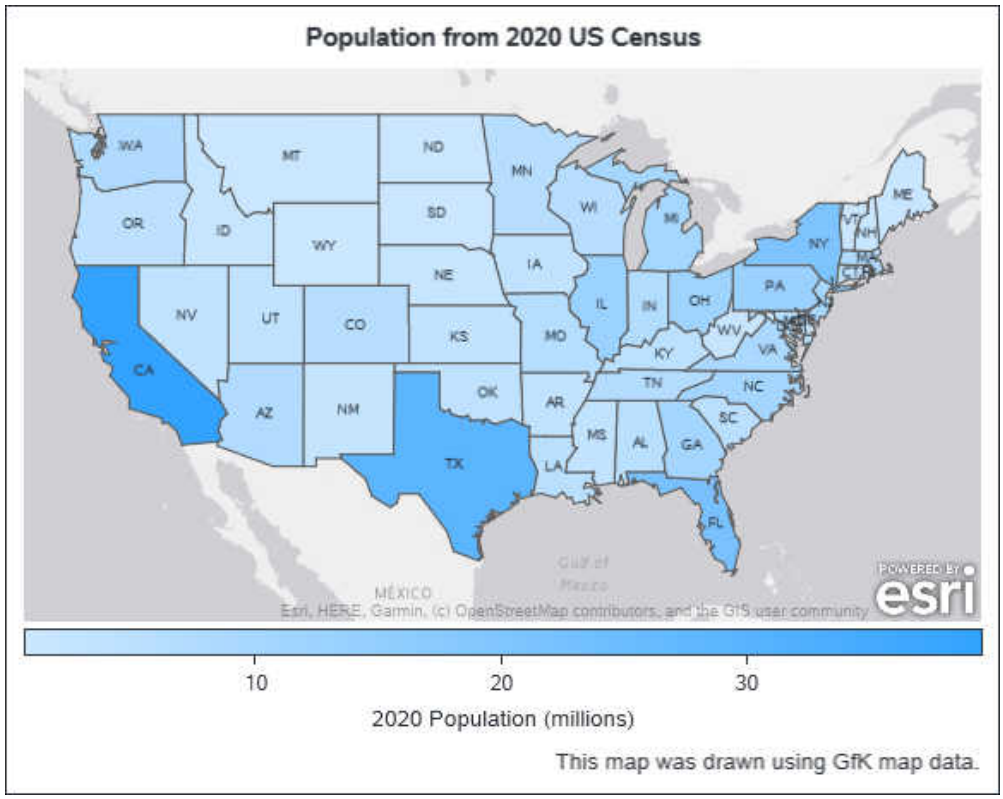
ODS destination: HTML5

Notes: This example includes a network request. Note that these procedures do not authenticate any services that you specify, such as the map services and portal hosted by Esri. On a Linux operating system, if the SAS code to create an SGMAP times out, you can try the "curl" command with the map service URL. This might enable the SAS code to run to completion. Otherwise, check with your system administrator regarding the authentication setup for any Linux network proxy machine request that you might need to make.

The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example overlays a choropleth map of population densities of the lower 48 states of the United States onto an Esri Map of the world. The state population variations are displayed by a gradient legend of ever darkening color as the population density increases.

Output



Program

```
data states;
   set mapsgfk.us_states;
   if state ^in(2,15,72);
run;

data plot_data;
   set mapsgfk.uscenter;
   if state ^in(2,15,72) and ocean^='Y';
   statename = fipstate(state);
run;

title 'Population from 2020 US Census';

proc sgmap mapdata=states
   maprespdata=sashelp.us_data
   plotdata=plot_data;
   esrimap
   url='https://services.arcgisonline.com/arcgis/rest/services/Canvas/
World_Light_Gray_Base/MapServer';
   choromap population_2020 / mapid=state density=2
      name='choro';
   text x=long y=lat text=statename /
      textattrs=(size=6pt);
   gradlegend 'choro' / title='2020 Population' extractscale;
run;
```

Program Description

Plot 2020 U.S. Census Bureau population densities of the lower 48 states of the United States onto an Esri map.

The CHOROMAP statement plots the X (longitude) and Y (latitude) variables from the MAPSGFK.US_STATES data set that contains unprojected latitude and longitude values. To match the projection types, convert the X and Y variables from radians to degrees.

```
data states;
   set mapsgfk.us_states;
   if state ^in(2,15,72);
run;
```

Create the plot data, used by the SGMAP procedure statement and the TEXT statement. Keep only the lower 48 U.S. states, collecting the state FIPS codes.

```
data plot_data;
   set mapsgfk.uscenter;
   if state ^in(2,15,72) and ocean^='Y';
   statename = fipstate(state);
run;
```

Assign a title to the graph. Use the global TITLE statement.

```
title 'Population from 2020 US Census';
```

Create the graph. Run the SGMAP procedure, using as input the states map data set, the U.S. Census Bureau 2020 population response data set, and the plot data set. Use the ESRIMAP statement to create the base map. Use the CHOROMAP statement to plot state populations. Assign state names using the TEXT statement. Use the GRADLEGEND statement and its options to assign a gradient legend for the states.

```
proc sgmap mapdata=states
   maprespdata=sashelp.us_data
   plotdata=plot_data;
   esrimap
   url='https://services.arcgisonline.com/arcgis/rest/services/Canvas/
World_Light_Gray_Base/MapServer';
   choromap population_2020 / mapid=state density=2
      name='choro';
   text x=long y=lat text=statename /
      textattrs=(size=6pt);
   gradlegend 'choro' / title='2020 Population' extractscale;
run;
```

Example 5: Creating a U.S. Map with Active URL Links

Features: MAPDATA= argument referring to map data
MAPRESPDATA= argument referring to map response data
CHOROMAP statement with URL= option
NOAUTOLEGEND option
DATA step
TITLE global statement

Data set: MAPSGFK.US

Note: The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

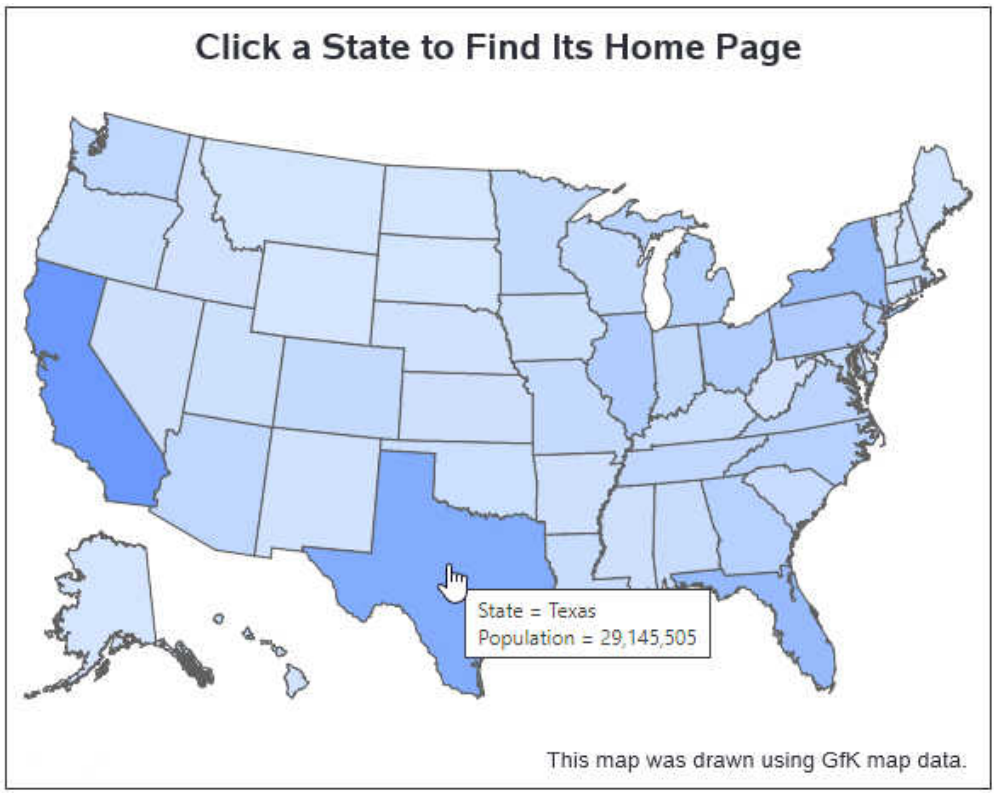
This example generates a map of the United States. As your cursor hovers over a state, population data and the state abbreviation is revealed. You can click on any state to launch a web search for that state's home page.

Note: This example cannot be run without having SAS/GRAPH and the optional MAPSGFK maps library installed.

Output

The following graphic displays the state of Texas with its state name and its 2020 population data. When you move your mouse pointer over a state, the data tip for

that state is displayed. When viewing the output in your IDE, the link might not open when you click a state. In that case, to see the links open, download the output to your local machine, and then open it in your browser. Refer to the documentation for your IDE for information about how to download your output.



Program

```
ods graphics /
   imagemap
   width=500px height=375px
   drilltarget="_blank";

title1 h=20pt "Click a State to Find Its Home Page";

data my_data;
   set sashelp.us_data;
   length my_link $100;
   my_link='https://www.google.com/search?q=home+page+state+of '||
   trim(left(statecode));
run;

proc sgmap maprespdata=my_data mapdata=mapsgfk.us noautolegend;
   choromap population_2020 /
      mapid=statecode
      id=statecode
      url=my_link
      tip=(statename population_2020)
      tiplabel=("State" "Population");
run;
```

Program Description

Specify the graphics options. Specify IMAGEMAP to enable data tips and drill-down links. Specify the map size and the drill-down link target.

```
ods graphics /
   imagemap
   width=500px height=375px
   drilltarget="_blank";
```

Assign a title to the graph. Use the global TITLE statement.

```
title1 h=20pt "Click a State to Find Its Home Page";
```

Create the response data set of search URLs. In the MY_LINK variable, specify a search URL to find the website address for each state. Not every state uses the same URL address format. The search string is "home page state of *state-name*." Specify a different search engine, search string, or both, if desired.

```
data my_data;
   set sashelp.us_data;
   length my_link $100;
   my_link='https://www.google.com/search?q=home+page+state+of '||
   trim(left(statecode));
run;
```

Generate the choropleth U.S. map with active links. Run the SGMAP procedure with the map data set and the response data set. Override the default automatic legend. The CHOROMAP statement creates the choropleth map with 2020 population census data, the two–character state code, and the URL per state. Use TIP= and TIPLABEL= to override the default data tips. In the output, as your cursor hovers over a state, the population and the state name are revealed. When you click on a state, a web search for that state's home website is launched.

```
proc sgmap maprespdata=my_data mapdata=mapsgfk.us noautolegend;
   choromap population_2020 /
      mapid=statecode
      id=statecode
      url=my_link
      tip=(statename population_2020)
      tiplabel=("State" "Population");
run;
```

Example 6: Adding a Gradient Legend Showing Population Using Traditional Map Data

Features:

MAPDATA= argument for the map polygon data

PLOTDATA= argument referring to plot data

MAPRESPDATA= argument referring to response data

OPENSTREETMAP (OSM) statement

ESRIMAP statement (includes URL to service)

TEXT statement

CHOROMAP statement options
- DENSITY=
- NAME= data descriptor referenced by GRADLEGEND statement

TEXT statement options
- TEXTATTRS= option with SIZE= suboption

GRADLEGEND statement options
- TITLE= for the gradient legend
- EXTRACTSCALE option reduces tick value width with the tick value scale factor

ODS destination statement

DATA step

TITLE global statement

Data sets: MAPSSAS.USCENTER (available without SAS/GRAPH)

Esri Map service

ODS destination: HTML

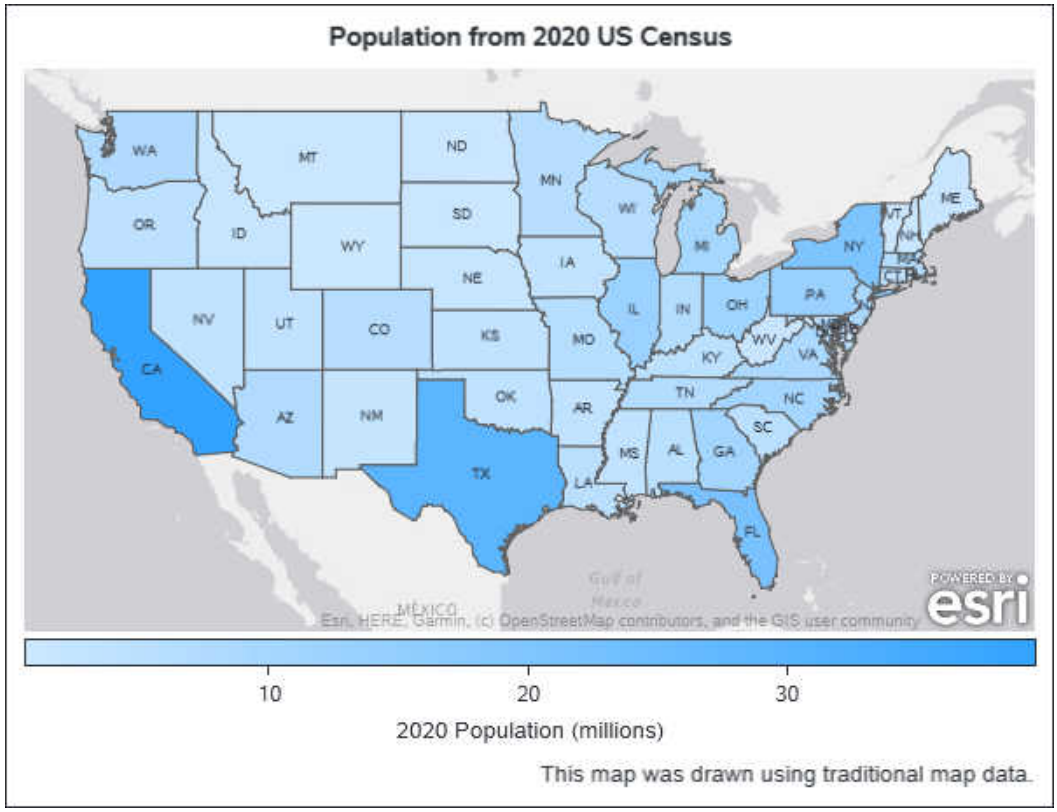
Notes: This example includes a network request. Note that these procedures do not authenticate any services that you specify, such as the map services and portal hosted by Esri. On a Windows operating system, check your proxy settings by entering the map service URL into a Windows Edge browser. This browser uses the same proxy settings as those set by the SAS installation system administrator. If the URL resolves, then you can use the URL in your SAS code without triggering a time-out. On a Linux operating system, if the SAS code to create an SGMAP times out, you can try the "curl" command with the map service URL. This might enable the SAS code to run to completion. Otherwise, check with your system administrator regarding the authentication setup for any Windows or Linux network proxy machine request that you might need to make.

The map data set or data sets supplied by SAS and used in this program might not be an available resource on your system.

This example overlays a choropleth map of population densities of the lower 48 states of the United States onto an Esri Map of the world. The state population variations are displayed by a gradient legend of ever darkening color as the population density increases.

Note: This example can be run without having SAS/GRAPH installed.

Output



Program

```
ods graphics / border outputfmt=png;

data states;
  set mapssas.states;
  if state ^in(2,15,72);
  x = -x * 45/atan(1);
  y =  y * 45/atan(1);
run;

data plot_data;
set mapssas.uscenter;
  if state ^in(2,15,72) and ocean^='Y';
  long = -long;
  statename = fipstate(state);
run;

title 'Population from 2020 US Census';

proc sgmap mapdata=states
  maprespdata=sashelp.us_data
  plotdata=plot_data;
  esrimap
  url='https://services.arcgisonline.com/arcgis/rest/services/Canvas/
World_Light_Gray_Base/MapServer';
  choromap population_2020 / mapid=state density=2
```

```
    name='choro';
  text x=long y=lat text=statename /
    textattrs=(size=6pt);
  gradlegend 'choro' / title='2020 Population'
       extractscale;
run;

ods graphics / reset;
title;
```

Program Description

Plot 2020 U.S. Census Bureau population densities of the lower 48 states of the United States onto an Esri map.

Set the graphics environment.

```
ods graphics / border outputfmt=png;
```

The CHOROMAP statement plots the X (longitude) and Y (latitude) variables from the MAPS data set that contains unprojected latitude and longitude values. To match the projection types, convert the X and Y variables from radians to degrees.

```
data states;
  set mapssas.states;
  if state ^in(2,15,72);
  x = -x * 45/atan(1);
  y =  y * 45/atan(1);
run;
```

Create the plot data, used by the SGMAP procedure statement and the TEXT statement. Keep only the lower 48 U.S. states, collecting the state FIPS codes.

```
data plot_data;
set mapssas.uscenter;
  if state ^in(2,15,72) and ocean^='Y';
  long = -long;
  statename = fipstate(state);
run;
```

Assign a title to the graph. Use the global TITLE statement.title 'Population from 2010 US Census';

```
title 'Population from 2020 US Census';
```

Create the graph. Run the SGMAP procedure, using as input the states map data set, the U.S. Census Bureau 2020 population response data, and the plot data set. Use the ESRIMAP statement to create the base map. The 2020 population response data is available in SASHELP.US_DATA (variable population_2020). Use the CHOROMAP statement to plot state populations. Assign state names using the TEXT statement. Use the GRADLEGEND statement and its options to assign a gradient legend for the states.

```
proc sgmap mapdata=states
  maprespdata=sashelp.us_data
  plotdata=plot_data;
```

```
  esrimap
  url='https://services.arcgisonline.com/arcgis/rest/services/Canvas/
World_Light_Gray_Base/MapServer';
  choromap population_2020 / mapid=state density=2
    name='choro';
  text x=long y=lat text=statename /
    textattrs=(size=6pt);
  gradlegend 'choro' / title='2020 Population'
       extractscale;
run;
```

Reset the graphics environment.

```
ods graphics / reset;
title;
```