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About This Book

Using This Document

Prerequisites

This document specifically describes how to produce maps. Document topics describe the maps that are produced by Base SAS and SAS/GRAPH mapping procedures and explain the features of these procedures. This document is written for users who are experienced in using the SAS System with its underlying ODS graphics and its graphics component, SAS/GRAPH. You should understand the concepts of programming in the SAS language. You should understand how to visually present data and output as graphics using ODS Graphics and SAS/GRAPH procedures. The following table summarizes the SAS System concepts that you need to understand in order to use the SAS mapping procedures in this document.

SAS System Concepts Used in This Document

<table>
<thead>
<tr>
<th>To learn how to</th>
<th>Refer to</th>
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<tr>
<td>invoke the SAS System at your site</td>
<td>instructions provided by the on-site SAS support personnel</td>
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<tr>
<td>use Base SAS software</td>
<td>Base documentation library:</td>
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<td>use the DATA step to create and manipulate SAS data sets</td>
<td>• SAS/GRAPH and Base SAS: Mapping Reference</td>
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<tr>
<td>use the SAS windowing environment or SAS Enterprise Guide to enter, edit, and submit program code</td>
<td>• Introduction to SAS Platform Graphing</td>
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<td>• SAS ODS Graphics: Procedures Guide</td>
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<td>• SAS Graph Template Language: User’s Guide</td>
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<td>• SAS Language Reference: Concepts</td>
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<td>• SAS System Options: Reference</td>
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<td>• Base SAS Utilities: Reference</td>
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allocate SAS libraries and assign librefs
create external files and assign filerefs

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<th>Task</th>
<th>Reference</th>
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<td>allocate SAS libraries and assign librefs</td>
<td>documentation for using the SAS System in your operating environment:</td>
</tr>
<tr>
<td>create external files and assign filerefs</td>
<td>• <em>SAS Companion for Windows</em></td>
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<td>• <em>SAS Companion for z/OS</em></td>
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<tr>
<td>manipulate SAS data sets using SAS procedures</td>
<td><em>Base SAS Procedures Guide</em></td>
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<td>use device drivers to generate device-based graphics</td>
<td><em>SAS/GRAPH: Reference</em></td>
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<tr>
<td>enhance the appearance of your graphics output</td>
<td><em>SAS/GRAPH and Base SAS: Mapping Reference</em></td>
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</table>

Particular fonts have special meanings when used in the presentation of SAS/GRAPH syntax in this document. For example, items presented in italics identify arguments or values that you supply. Angle brackets (< >) indicate optional arguments. The conventions used in this document are the same conventions used in Base SAS documentation. For a complete explanation, see the Base SAS documentation listed above.

**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 are provided with a SAS/GRAPH 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 use the MAPSGFK digital vector maps with your existing programs that use other maps, issue the “**INSERT= System Option**” in *SAS System Options: Reference* in conjunction with 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 separately from [http://support.sas.com/md/datavisualization/mapsonline/index.html](http://support.sas.com/md/datavisualization/mapsonline/index.html).

Starting with SAS 9.4M5, MAPIMPORT is a Base SAS procedure that enables the import of map shapefiles from third party sources without having SAS/GRAPH installed.

The GPROJECT procedure, starting with SAS 9.4M5, is a Base SAS procedure that 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 processes imported maps. It also processes maps at a local installation. The SGMAP procedure can render data from OpenStreetMaps and
EsriMaps with multiple plot overlays. See “Map Data Sets, Map Preparation Procedures, and Tools Provided by SAS” on page 7 for more information.

The GEOCODE procedure is moved from SAS/GRAF to Base SAS, starting with SAS 9.4M5. 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 Base SAS GEOCODE procedure requires both input address data sets and lookup data sets. 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 http://support.sas.com/rnd/datavisualization/mapsonline/index.html. An example is the free lookup data for the entire United States. This web site also provides SAS macro code programs 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.

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### 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 output that is shown for the examples was generated in a Windows operating environment. If you are using a different operating environment, you might need to make some minor adjustments to the example programs.

In most cases, the output was sent to the HTML destination and generated using the default style and device for that destination. Exceptions are noted in the text. The output format is PNG for maps rendered with the SGMAP procedure. When MAPSGFK maps are used to render a map, the graph size and resolution is reduced to fit the graphics output area. All other maps are rendered as is.

The dimensions of the graphics output area vary across devices and when using the GRAPH windows. The dimensions can affect aspects of the graphics output – for example, the appearance of axes or the position of graphics elements that use explicit coordinates in units other than percent. You might need to adjust the dimensions of your graphics output area or the size of graphics elements to correct any differences that you see. Most of the images of output in this document were generated with a GOPTIONS statement. The SGMAP procedure image output was created with an ODS GRAPHICS statement. These statements generally specified a size approximately equal 5.5 inches by 4.2 inches. However, some images might be larger, if necessary, to accommodate the content of the graph.

```sas
   goptions hsize=5.5in vsize=4.2in; /* non-SGMAP procedures */
   ods graphics / height=5.5in width=4.2in; /* SGMAP procedure */
```

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.

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.
The way that output is presented on your device depends on the environment in which you are running a Base SAS or SAS/GRAPH procedure.

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 displaying the first five observations in each data set, please 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 into a Windows Internet Explorer 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. 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.
What’s New in SAS/GRAPH and Base SAS 9.4: Mapping Reference

Overview

Note: SAS 9.4M6: The GINSIDE, GPROJECT, GREduce, and GREMOVE procedures have moved from SAS/GRAPH to Base SAS. The %CENTROID macro, which is used in conjunction with mapping procedures, has also moved to Base SAS. GMAP is the only mapping procedure remaining in SAS/GRAPH. This What’s New chapter covers both Base and SAS/GRAPH mapping procedures. See “What’s New in SAS/GRAPH 9.4: Reference” in SAS/GRAPH: Reference for non-mapping SAS/GRAPH procedure updates.

There are many changes and enhancements for SAS/GRAPH 9.4: Mapping. Highlights include the following:

- Many procedures have significant enhancements and new options. See “Mapping Procedures” on page xii for a complete list.
- A topic in the introduction consolidates links for examples and various resources on the SAS website.
- SAS 9.4M2 The TITLE and FOOTNOTE statements now support the ALT="text-string" option. See “Global Statements” in SAS/GRAPH: Reference.
- SAS 9.4M4 For ease of use, the mapping functions are removed from the SAS/GRAPH: Reference, Fifth Edition, and placed in this new document, SAS/GRAPH: Mapping Reference. This document includes the GEOCODE, GINSIDE, GMAP, GPROJECT, GREduce, GREMOVE, and MAPIMPORT procedures, and their supporting documentation.
- SAS 9.4M4 The sample program GEOSTRT.SAS is updated to use the TYPE= option and create a custom GCTYPE lookup data set that includes an uncommon abbreviation for Boulevard.
- SAS 9.4M5 The GEOCODE and MAPIMPORT procedures are moved from SAS/GRAPH to Base SAS. Mapping procedures GINSIDE, GMAP, GPROJECT, GREduce, and GREMOVE remain with SAS/GRAPH.
- SAS 9.4M5 The SAS/GRAPH: Mapping Reference is moved to the Base SAS documentation library. The document is renamed to SAS/GRAPH and Base SAS 9.4: Mapping Reference accordingly. It documents the existing mapping procedures in addition to the new ODS Graphics SGMAP procedure.
- SAS 9.4M5 SGMAP is a new mapping procedure that is based on the functionality of ODS Graphics. It renders maps whose data has been prepared by any number of SAS/GRAPH mapping procedures such as GPROJECT. You can also use the Base SAS procedure MAPIMPORT to import map data from third-party sources, for example, shapefiles from Esri. After your map data sets are obtained and prepared,
use the SGMAP procedure to create maps and then overlay plots such as text, scatter, or bubble plots. SGMAP procedure examples such as “Example 1: Nevada Counties with Bubble Plot of County Seat Populations” show how to create overlaid maps. You can also search for 'SGMAP' on this blog for additional examples: http://blogs.sas.com/content/graphicallyspeaking/

- **SAS 9.4M5** The map data sets in the MAPSGFK library have been updated.
- **SAS 9.4M6**: the GINSIDE, GPROJECT, GREDUCE, and GREMOVE mapping procedures have moved from SAS/GRAPH to Base SAS.
- **SAS 9.4M6**: 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. This macro is useful when adding labels to a map or when computing distances with the Base SAS `GEODIST function`.
- **SAS 9.4M6**: The CHOROMAP statement is at production level.

### Mapping Procedures

#### GEOCODE Procedure

The GEOCODE procedure has the following new functions, options, and enhancements:

Starting with SAS 9.4, the geocoder is updated as follows:

- The GEOCODE procedure now supports street geocoding for Canadian provinces. As a result, new lookup data sets are available, and the existing lookup data sets are reformatted. The format changes include the replacement of FIPS codes with state and city names represented by character variables. The new format data sets must be processed with the SAS 9.4 version of the geocoder. A SAS geocoder from an earlier release must process lookup data sets with a format corresponding to that release of SAS.

- SAS makes available a new import macro program that creates Canadian street lookup data sets in the new format only. `%GEOBASE2GEOCODE` imports Canadian roadways and addresses, creating the lookup data sets used by the GEOCODE procedure’s STREET geocoding method. This macro program can be downloaded from the SAS Maps Online web site. Your SAS profile is required.

- In support of Canadian street geocoding, the new DIRECTION=<data-set> option enables you to specify an alternate data set of street direction names and abbreviations, such as northwest or NW. The default data set is `SASHELP.GCDIRECT`, and it can be updated at any time. The SAS/GRAPH 9.4 version of this data set contains U.S. street directional text strings. The `%GEOBASE2GEOCODE` macro program creates a version of this lookup data set named `GCDIRECT_CAN` for use in Canadian street geocoding.

- Canadian street geocoding is enhanced by a new STATE=<data-set> option. With this option you can specify an alternate data set that contains state or province character names rather than FIPS numeric codes. The default data set is `SASHELP.GCSTATE`, and is installed with SAS/GRAPH 9.4. It can be updated at any time. This data set contains U.S. states and its overseas territories, and all Canadian provinces. As street geocoding data for other nations is acquired, you can
update this data set to include additional state or region names with their abbreviations.

• In support of Canadian geocoding, a new street-type data set for Canadian roadways and addresses is available. The SASHELP.GCTYPE_CAN data set is created by the %GEOBASE2GEOCODE import program, and it can be updated at any time. Specify that the geocoder use this alternate data set with the TYPE= option when geocoding streets in Canada.

• The geocoder now supports street type prefixes as well as suffixes. 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. Prefixes are primarily used in non-U.S. street geocoding. An example is the Canadian address Boulevard Quebec, found in the SASHELP.GCTYPE_CAN data set. This data set is created by the %GEOBASE2GEOCODE import program. To accommodate both prefixes and suffixes, the format of the street type data set differs from that of previous SAS releases. The default version of this data set is SASHELP.GCTYPE. It contains standard U.S. street types and it is installed with SAS/GRAPH.

• The STREET geocoding method, in supporting U.S. and Canadian addresses, now provides a “State mismatch” value for the output variable _MATCHED_. This value indicates that a match was found for the city and country, but the state or province value was not matched.

• The STREET geocoding method, in supporting U.S. and Canadian addresses, now provides several new and changed values for the output variable _NOTES_. The value NOCT was deleted because the FIPS lookup data set is no longer used by street geocoding. The NS and NSM values were added to cover state matches and no matches. With the added support for street type prefixes, the value NOTYA was replaced with NOTPA and NOTSA and the value NOTYM was replaced with NOTPM and NOTSM. The value MZS was replaced with MCS to cover the cases when multiple matches are found for street and city and state.

• The %TIGER2GEOCODE import macro program is updated to create U.S. lookup data sets in the new format. This format is used by the GEOCODE procedure’s STREET geocoding method. This macro program enables you to import the U.S. Census Bureau’s TIGER shapefiles for specific states and counties from the year 2007 or later. This new version of the %TIGER2GEOCODE macro program can be downloaded from the SAS Maps Online web site. Your SAS profile is required. The lookup data sets created from these older macro versions are in the format used only by releases prior to SAS 9.4.

• Several of the data sets used in geocoding are indexed. These data sets need to be moved or copied with the DATASETS or COPY procedure to avoid losing the index file. Do not use local operating system utilities. A new check for these indexes was added to the GEOCODE procedure in SAS 9.4. A warning is printed to the SAS log if the index is missing.

• Because the FIPS codes are replaced with variables containing the state and city names in character format, the SASHELP.PLFIPS lookup data set is no longer accessed by the geocoder. It is still installed with SAS/GRAPH because the data set is accessed by other applications.

• The sample program GEOSTR1.SAS is updated so that the TRACTCE00 variable is no longer requested to be written to the output data set. The variable no longer exists in the lookup data set SASHELP.GEOEXM.

• Starting with SAS 9.4M1, the GEOCODE procedure supports the following street and city geocoding new enhancements and clarifications:
The GROUP variable is added to the SASHELP.GCTYPE and SASHELP.GCTYPE_CAN lookup data sets that contain street type abbreviations for U.S. and Canada geocoding, respectively. This variable contains multiple abbreviations for the same street type. For example, AVENUE is abbreviated as AVE in English-speaking areas and as AV in certain provinces in Canada.

An index is no longer provided or required for the SASHELP.GCTYPE data set. SAS supplies indexes with the SASHELP.GCSTATE lookup data set, and the GEOCODE procedure looks for them when performing street geocoding. If you change the location of the GCSTATE data set, you must also move its associated data set index. If you create a customized version of this data set, you must create the data set indexes as well.

Each of the DIRABRV and DIRECTION variables in the SASHELP.GCDIRECT data set is capable of containing text strings. However, the DIRECTION variable should contain alphabetic characters only.

Three new note value tokens were added. These denote instances where the street geocoder detected different nonmissing city, state, or ZIP code values between the lookup data set and the input address data. The token for a no city match is NOCTM. The token for a no state match is NOSTM. The token for a no ZIP code match is NOZCM. The token strings are contained in the _NOTES_ variable that the street geocoder creates in the output data set.

The missing value point (MVP) note token was added to denote instances where the street geocoder detected that a user-supplied street lookup data set had missing X or Y coordinates.

Two variables now support city geocoding with the SASHELP.ZIPCODE lookup data set. In this data set the CITY2 and STATENAME2 variables are both normalized—containing only uppercase alphanumeric characters.

Starting with SAS 9.4M2, the GEOCODE procedure supports the following enhancements and changes:

- The U.S. CITY geocoding method supports non-abbreviated state names, just as the STREET geocoding method does. As a result of this enhancement, customized versions of the SASHELP.GCSTATE lookup data set no longer need to maintain the original data set's sort order. This data set is used by the CITY method geocoder in determining state name matches. Also, in a customized version of this street state data set, duplicate values are allowed in the variable containing the state or province postal service abbreviations. The geocoder uses these values as the key to grouping equivalent state names. Make sure that you keep the values unique. For example, avoid using an 'MI' abbreviation for both Mississippi and Michigan.

- The geocoder supports optional nonstandard state values; expanding the existing support of two-character postal codes and the non-abbreviated state names. The nonstandard state values are contained in a new variable named StateAlias within the SASHELP.GCSTATE lookup data set. Examples of nonstandard state names or IDs for North Carolina are 'N. Car.' or 'No. Car.'. Multiple values for one state must be separated by a single vertical bar. These nonstandard variable values can be in a customized version of SASHELP.GCSTATE lookup data set, or in the input address data set. Traditional Canadian postal abbreviations for provinces and territories are included in this update.

- The values of the variables MAPIDNAME (state or province name), and MAPIDNAME2 (normalized state or province name) are changed. The MAPIDNAME variable in the SASHELP.GCSTATE lookup data set match the MAPIDNAME2 variable found in the MAPSGFK.WORLD_CITIES data set.
The MAPIDNAME2, ISONAME, and ISONAME2 variables are the same in the lookup data set and in the MAPSGFK.WORLD_CITIES data set.

- An improved %TIGER2GEOCODE import program was used to update street lookup data sets (USM, USS, and USP). This provides the geocoder the opportunity to find better street matches for any given TIGER release from 2009–2013. Download these updated street lookup data sets from the SAS Maps Online web site. The previous data sets were renamed and all are differentiated by version. You can use only the lookup data sets that correspond to your SAS release. The updated TIGER2GEOCODE.sas program is also available for download from SAS Maps Online. This program converts TIGER/Line shapefiles into PROC GEOCODE street method lookup data sets, and this improved version provides more street matches for any specific SAS release.

- Starting with SAS 9.4M3, support is added for range geocoding with IPv6 addresses. A new version of the %MAXMIND autocall macro converts IPv6 geocoding data from MaxMind, Inc. into SAS data sets. Comma-separated-value (CSV) formatted files are available as downloads from MaxMind.

- Starting with SAS 9.4M4, the GEOCODE procedure supports the following street geocoding enhancements:
  - Street geocoding now obtains more accurate locations in areas where the U.S. Postal Service has reassigned local ZIP codes when modifying its delivery routes.
  - The sample program GEOSTRT.SAS is updated to use the TYPE= option and create a custom GCTYPE lookup data set that includes an uncommon abbreviation for Boulevard.

- Starting with SAS 9.4M5, the GEOCODE mapping procedure and its examples are moved from SAS/GRAPH to Base SAS. The procedure is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this procedure.

- SAS 9.4M6: An improvement in the %TIGER2GEOCODE import macro led to an update in the sample geocoding lookup data set SASHELP.GEOEXM for Wake County in the state of North Carolina. The updated TIGER2GEOCODE.sas program is available at the SAS Maps Online web site. Obtain the most current TIGER shapefiles at that website as well.

**GINSIDE Procedure**

The **GINSIDE procedure** has the following changes and enhancements:

- The sample programs **GINSIDE.SAS** and **GINSIDE2.SAS** are rewritten for clarity and standardization.

- Two new options are available to control whether to keep or drop all map data set variables before they are written to the output data set. Although this is the default behavior, you can specify KEEPMAPVARS in the GINSIDE statement to keep all map data set variables in the output data set. Conversely, specify DROPMAPVARS to keep the ID variable but drop all other map data set variables from the output data set.

- A section documenting how to optimize performance is now available in the GINSIDE procedure.

- Starting with SAS 9.4M6, 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.
**GMAP Procedure**

The **GMAP procedure** has the following changes, enhancements, and new options:

- The MAPSGFK map data sets are updated.
- The new LATLON option specifies that the LAT and LONG variables from the map data set are used for coordinate data instead of the Y and X variables. When the LATLON option is specified, the Y and X variables are no longer required by the GMAP procedure statement.
- The new sample program **GMPUSDAT.SAS** shows how to create a choropleth map using the sample response data set SASHELP.US_DATA provided with SAS/GRAPH 9.4.
- The new RESOLUTION= option specifies that the GMAP procedure use those map observations containing a resolution variable with a certain level (value). There are 10 resolution values that specify the screen resolution at which to display a map point. Setting this option to AUTO defaults to the resolution setting of the device being used in the GMAP procedure. RESOLUTION= NONE indicates that the DENSITY option, if specified, is used instead.
- The sample program **GMPSIMPL.SAS** has been updated to use the new RESOLUTION= option instead of referring to the resolution variable directly.
- The CHORO statement in the GMAP procedure supports a production level of the OSM (OpenStreetMap) option. Use this option when displaying maps using a JAVA or JAVAIMG device. This is an appearance option that enables you to use the OpenStreetMap (OSM) map as a background map. You can specify no suboptions, 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. When you specify the STYLE=osmstyle suboption, the GMAP procedure uses one of the supported OSM styles that are appropriate for the map that you are processing. Specifying the AUTOPROJECT suboption causes the GMAP procedure to project the map from latitude and longitude coordinates (in degrees) onto the OpenStreetMap (OSM) map.
- An important distinction to note is that in the MAPSGFK map data sets, the positive values of the LONG variable (eastlong) go to the east from the prime meridian. The opposite is true in the traditional map data sets; they use westlong.

**GPROJECT Procedure**

The **GPROJECT procedure** has the following changes and enhancements:

- The LATLON option specifies that the LAT and LONG variables from the map data set are used for coordinate data instead of the Y and X variables. Now when the LATLON option is specified, the Y and X variables are no longer required by the PROC GPROJECT statement.
- 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 proj.4 on the PROJECT= option for the PROC GPROJECT statement. Proj.4 projection enables the transformation of geographic coordinates from either one projection or datum to another. Specifying the proj.4 projection with the GPROJECT procedure, by default, enables a transformation from latitude and longitude geographic coordinates (EPSG:4326) to an OpenStreetMap (OSM) coordinate.
system. Use the FROM= or TO= options to override either of these defaults. In the PROC GPROJECT statement, both the DEGREES option and the EASTLONG option are used by default with the proj.4 projection method.

- The FROM= option is available for the PROC GPROJECT statement. By specifying the FROM= option, you are automatically invoking the proj.4 projection system, and you are indicating a different coordinate system from which to start the transforming projection. You are overriding the use of the default latitude and longitude geographic coordinates (EPSG:4326).

- The TO= option is available for the PROC GPROJECT statement. By specifying the TO= option, you are automatically invoking the proj.4 projection system, and you are indicating a different coordinate system for the result of the transforming projection. You are overriding the use of the default OpenStreetMap (OSM) coordinate system. This system is also known as the Mercator or 900913 coordinate system.

- The FROM= and TO= options can also be used to reverse a projection. For example, if you already have an OSM projection, you can use the FROM= option in conjunction with the TO= option to revert the projection to EPSG:4326.

- Starting with SAS 9.4M6, 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.

**GREDUCE Procedure**

The GREDUCE procedure has a new option. The LATLON option specifies that the LAT and LONG variables from the map data set are used for coordinate data instead of the Y and X variables. When the LATLON option is specified, the Y and X variables are no longer required by the GREDUCE procedure statement.

Starting with SAS 9.4M6, 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.

**GREMOVE Procedure**

The GREMOVE procedure has a new option. By default, all of the input data set variables are written to the output map data set. The DROPVARS option overrides this default behavior and omits the variables from the output map data set.

Starting with SAS 9.4M6, 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.

**MAPIMPORT Procedure**

Starting with SAS 9.4M5, the MAPIMPORT procedure is moved from SAS/GRAPH to Base SAS. The procedure is no longer part of SAS/GRAPH, nor is SAS/GRAPH required to be installed to use this procedure.

**SGMAP Procedure**

SAS 9.4M6: The ODS Graphics SGMAP procedure in Base SAS has the following enhancements:
• The SERIES statement and several of its options are introduced for series plot creation. Series lines representing such items as streets, railroads, and waterways can now be plotted on top of a map.

• The GRADLEGEND statement and several of its options are added for customizing legends with a numeric response variable. Only discrete key legends were created prior to SAS 9.4M6.

• The LINEATTRS= option on the CHOROMAP and SERIES statements enables the control of color, line style, and line thickness on polygon borders and series lines such as railroads, respectively.

• Legends are generated automatically. The SGMAP procedure statement supports the NOAUTOLEGEND option which disables automatically creating a legend.

• The ability to specify bubble sizes on the BUBBLE statement with the BRADIUSMIN and BRADIUSMAX options.

• The CHOROMAP statement is at production level. Its new DISCRETE option handles response variable values individually and not as continuous data, and affects both the filled polygons and their respective legend entries.

• The CHOROMAP statement processes unprojected map coordinates (LAT, LATITUDE, LONG, LON, and LONGITUDE), in addition to the projected X and Y coordinates. Unprojected choromaps can be overlaid on OpenStreetMaps and Esri maps.

• The GROUP= option has been added to the BUBBLE, SCATTER, and SERIES statements.

• The NOMISSINGGROUP option has been added to the BUBBLE, SCATTER, and SERIES statements. This option enables the use of groups when plotting multiple items that might not be at the same data points, and the skipping of missing plot values when the plot is being drawn.

• You can specify the percentage of transparency of a plot using the TRANSPARENCY option on the CHOROMAP and the BUBBLE statements.

Global Statements Pertaining to Mapping

The global statements documented in this book pertain to controlling the appearance of output from the mapping procedures.

SAS 9.4M2 TITLE and FOOTNOTE statements now support the ALT=“text-string” option. This option enables you to specify descriptive text for the title or footnote. If you use ALT= in conjunction with the LINK= option, you can specify descriptive text for the URL to which the title or footnote links. The “text-string” can also contain occurrences of the variables named in a BY statement.

SAS 9.4M3 The GraphTitle1Text style element is introduced to control and reduce the font size of the output of a TITLE1 statement in order to scale better with the graphs.
Part 1

Getting Started

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Chapter 1

Get Started Mapping Using SAS/GRAPH and Base SAS

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.

Starting with SAS 9.4M6, 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:

- **SAS 9.4M5**: 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).

- **SAS 9.4M5**: 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.

- **SAS 9.4M6**: import map data with the MAPIMPORT procedure. In addition, you can create your own map data sets.

- **SAS 9.4M6**: 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.

- **SAS 9.4M6**: 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

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### 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**

- **SAS 9.4M5**: enables you to create a choropleth map, and overlay it with text, scatter, or bubble plots.

- **SAS 9.4M6**: 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. For the full list of new features and enhancements, see “SGMAP Procedure” on page xvii.

Procedures that prepare data for mapping

SAS 9.4M5: 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.

Note: The procedure is no longer part of SAS/GRAPH. You no longer need SAS/GRAPH installed to use them.

SAS 9.4M5: 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.

Note: The procedure is no longer part of SAS/GRAPH. You no longer need SAS/GRAPH installed to use it.


%CENTROID autocall macro

SAS 9.4M6: The %CENTROID macro that supports the SGMAP procedure has moved from SAS/GRAPH to Base SAS and is now an autocall macro. Running the %ANNOMAC macro before using %CENTROID is no longer necessary.

Map data

SAS 9.4M5: The SGMAP procedure works with map data sets prepared by a third party. It also works with map data sets prepared by the SAS/GRAPH procedures or by the GEOCODE and MAPIMPORT procedures that are now part of Base SAS.

SAS 9.4M5: 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. Prior to SAS 9.4M6: the GINSIDE, GPROJECT, GREDUCE, and GREMOVE procedures that prepare data for mapping were part of SAS/GRAPH. Prior to SAS 9.4M5, the GEOCODE and MAPIMPORT procedures were part of SAS/GRAPH. This document, SAS/GRAPH and Base SAS: Mapping Reference, describes both the SAS/GRAPH GMAP procedure and the Base SAS mapping procedures. 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. “Using Annotate Data Sets” 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 and use them to create maps with SAS programs.

Maps You Can Create Using Mapping Software

Maps You Can Create Using Base SAS ODS Graphics
Starting with SAS 9.4M5, the ODS Graphics SGMAP procedure in Base SAS enables you to create a two-dimensional choropleth map, an OpenStreetMap, or an Esri Maps that can be overlaid with bubble, scatter, or text plots. The capability to overlay a series plot was added in SAS 9.4M6.

See Also
Chapter 16, “SGMAP Procedure,” on page 459, 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 filling 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 11, “GMAP Procedure,” on page 223, 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. SAS Studio provides pared down versions of MAPS, MAPSSAS, and MAPSGFK map data set libraries. 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

SAS 9.4M5: The Chapter 9, “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 Online 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

SAS 9.4M5: The Chapter 15, “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. See “About the Macros” on page 111 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 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). Prior to SAS 9.4M6, when all four coordinate variables are present, X and Y
are always projected values that are used by the SAS/GRAPH and Base SAS
procedures (by default). Starting with SAS 9.4M6, the Base SAS SGMAP procedure
and its CHOROMAP statement use latitude and longitude variables first, if they are
found amongst the coordinate variables present. The SAS/GRAPH GMAP procedure
and the Base SAS procedures continue to use the X and Y projected variable values
by default. However, depending on the procedure you have run, you might want to
use the LONG and LAT variables 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 239. This description excludes the MAPSGFK map library.

  Note: You must install the SAS/GRAPH component in order to have access to the
  map data sets found in the MAPSGFK library. A Base SAS installation gives you
  access to the MAPS library.

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 Online
website. You are required to access the website with your SAS profile. You might be
required to enter your site information.

T I P 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 “Transporting and Converting Graphics Output” in
SAS/GRAPH: Reference.

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 11, “GMAP Procedure,” on page 223.
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: Nevada Counties with Bubble Plot of County Seats and
Populations” on page 498, 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 12, “GPROJECT Procedure,” on page 389 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.

Starting with SAS 9.4M5, the ODS Graphics SGMAP procedure in Base SAS can use OpenStreetMaps. Specify the `OPENSTREETMAP;` statement in your SAS code.

Starting with SAS 9.4M5, 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.

Starting with SAS 9.4M5, 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. Starting with SAS 9.4M6, 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 460 for detailed information.


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 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 \textit{LABEL} column for the X and Y variables in each data set should identify the projection algorithm used.

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

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

### Map Data Set Storage

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, potentially changing the order of the observations. For example, the Teradata server, the SAS Cloud Analytic Services (CAS) server, or the SAS LASR Analytic Server should not be used to store SAS map data sets where the order of observations matter.

With the exception of the MAPIMPORT procedure, the procedures documented in this book are not included in installations that are only SAS Viya, nor can they use data that has been processed in CAS.

Traditional map data sets can be stored as unprojected or projected coordinates. 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 9.4M5 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 SAS/GRAPH procedures such as GPROJECT. You can also use the Base SAS procedure MAPIMPORT 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 text, scatter, or bubble 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.

Starting with SAS 9.4M6, the SGMAP procedure is enhanced with a SERIES statement and a GRADLEGEND statement, and many new options. This procedure works with map data obtained and prepared by the mapping preparation procedures that moved from SAS/GRAPH to Base SAS. The GINSIDE, GPROJECT, GREDUCE, and GREMOVE procedures moved. An installation of SAS/GRAPH is not required to use these 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.

Starting with SAS 9.4M6, 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. Starting with SAS 9.4M5, 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 still use the SGMAP procedure even if SAS/GRAPH is not installed at your site and you do not have the MAPSGFK map polygon data sets. 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 Online. You are required to access the website with your SAS profile. You might be required to enter your site information. SAS Maps Online is located at the following URL:

The procedure and its statements are described in the Chapter 16, “SGMAP Procedure,” on page 459.

Using SAS Procedures That Aid in Map Data Preparation

Depending on the release, Base 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. Starting with SAS 9.4M5, procedures GEOCODE and MAPIMPORT moved from SAS/GRAPH to Base SAS. Continuing the transition with SAS 9.4M6, procedures GINSIDE, GPROJECT, GREDUCE, and GREMOVE moved from SAS/GRAPH to Base SAS. Prior to the release when a particular procedure moved, SAS/GRAPH must be installed before preparing map data sets with that procedure. After a particular procedure moved to Base SAS, a SAS/GRAPH installation is no longer required. 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 in Base SAS.

Base SAS PROC GEOCODE

Starting with SAS 9.4M5, 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 9, “GEOCODE Procedure,” on page 120 for details about geocoding information in preparation for creating a map.
**Base SAS PROC GINSIDE**

Starting with SAS 9.4M6, 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 10, “GINSIDE Procedure,” on page 209 for usage details.

**Base SAS PROC GPROJECT**

Starting with SAS 9.4M6, 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.

Projection is appropriate for map data sets in which the X and Y variable values represent 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.US. If that map data is needed in a different projection, then the unprojected LONG and LAT values can be projected. See Chapter 12, “GPROJECT Procedure,” on page 389 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: Nevada Counties with Bubble Plot of County Seats and Populations” on page 498.

**Base SAS PROC GREDUCE**

Starting with SAS 9.4M6, 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 13, “GREDUCE Procedure,” on page 423 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**

SAS 9.4M6: 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 14.1 on page 436 and Figure 14.2 on page 436 show combined unit areas in a typical map data set by removing state boundaries to create regional census divisions. See Chapter 14, “GREMOVE Procedure,” on page 435 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>
<thead>
<tr>
<th>Map Type</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block</td>
<td>GMAP procedure BLOCK statement</td>
</tr>
<tr>
<td>Choropleth</td>
<td>GMAP procedure CHOROPLETH statement</td>
</tr>
<tr>
<td>Prism</td>
<td>GMAP procedure PRISM statement</td>
</tr>
<tr>
<td>Surface</td>
<td>GMAP procedure SURFACE statement</td>
</tr>
</tbody>
</table>

An example of each of these map types is in “A Quick Look at the Gallery” on page 23. 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 “Overview of Global Statements” on page 41. 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, including SAS/GRAPH. ODS enables you to generate output in various document formats such as HTML, PDF, RTF, and so on. To generate output in ODS, you must open the ODS destination for the document format that you want. By default, SAS opens an ODS destination for HTML output. You can open other ODS destinations as desired. For each destination, the visual attributes of the output such as colors, fonts, plot markers, and so on, are controlled by an ODS style. Several styles are provided with SAS. Each destination has a default style, but you can specify any one of the available ODS styles for your output. ODS is described in SAS Output Delivery System: User’s Guide.

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.

When you use the SAS ODS Graphics procedures in the SAS Windowing environment, ODS GRAPHICS is ON by default. 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 47. The GOPTIONS procedure displays the current value of the graphics options. The GOPTIONS procedure is described in GOPTIONS Procedure.
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. When you have completed either example, you will know the basic steps that are needed to create a map.

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

• Use ODS statements to specify an output document format for your output.
• Use map data sets, including response and plot data, as input to the mapping procedure.
• Use the Base DATA step to create a response data set.
• Subset the response data set to keep only certain dates for bubble markers and labels.
• Use Base SAS 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.

```sas
ods _all_ close; /* 1 */
ods html file="katrina.html"; /* 2 */
data katrina (label='Hurricane Katrina Track'); /* 3 */
length datetime $16;
```
infile datalines dlm=',';
name='Katrina';
input datetime y x wind;
label datetime = 'Date and Time'
y = 'Latitude'
x = 'Longitude'
wind = 'Wind Speed MPH';
datalines;
23AUG05:18:00:00,23.1,-75.1,30
24AUG05:00:00:00,23.4,-75.7,30
24AUG05:06:00:00,23.8,-76.2,30
24AUG05:12:00:00,24.5,-76.5,35
24AUG05:18:00:00,25.4,-76.9,40
25AUG05:00:00:00,26.1,-77.7,45
25AUG05:06:00:00,26.1,-78.4,50
25AUG05:12:00:00,26.2,-79.5,55
25AUG05:18:00:00,26.2,-79.6,60
25AUG05:22:30:00,26,-80.1,70
26AUG05:00:00:00,25.9,-80.3,70
26AUG05:06:00:00,25.4,-81.3,65
26AUG05:12:00:00,25.1,-82,75
26AUG05:18:00:00,24.9,-82.6,85
27AUG05:00:00:00,24.6,-83.3,90
27AUG05:06:00:00,24.4,-84.95
27AUG05:12:00:00,24.4,-84.7,100
27AUG05:18:00:00,24.5,-85.3,100
28AUG05:00:00:00,24.8,-85.9,100
28AUG05:06:00:00,25.2,-86.7,125
28AUG05:12:00:00,25.7,-87.7,145
28AUG05:18:00:00,26.3,-88.6,150
29AUG05:00:00:00,27.2,-89.2,140
29AUG05:06:00:00,28.2,-89.6,125
29AUG05:11:10:00,29.3,-89.6,110
29AUG05:12:00:00,29.5,-89.6,110
29AUG05:14:45:00,30.2,-89.6,105
29AUG05:18:00:00,31.1,-89.6,80
30AUG05:00:00:00,32.6,-89.1,50
30AUG05:06:00:00,34.1,-88.6,40
30AUG05:12:00:00,35.6,-88,30
30AUG05:18:00:00,37,-87,30
31AUG05:00:00:00,38.6,-85.3,30
31AUG05:06:00:00,40.1,-82.9,25
;

data katrina; set katrina end=last;                
if find(datetime,'06:00:00') or _n_=1 or last then do;
  date=substr(datetime,1,7);
  long=x; lat=y;
end;
run;

title1 'Hurricane Katrina';                        
proc sgmap plotdata=katrina;
  openstreetmap;
  run;
The ODS _ALL_ CLOSE statement closes all currently open ODS destinations in order to conserve resources.

The ODS HTML statement opens the HTML destination. Option FILE= specifies filename katrina.htm as the name of the output file.

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

Use the Base SAS DATA step to subset the response data and keep only certain dates and times.

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

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.

The ODS HTML CLOSE statement closes the HTML destination.

The TITLE global statement clears the title.

The ODS HTML statement opens the HTML destination for subsequent procedure executions. This step is not required if you are using SAS Studio.

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.

```sas
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);
footnotel 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;
```

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).
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.

Learning By Example: Create Your First Map
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 1.2  Next Steps**

<table>
<thead>
<tr>
<th>Task</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>If necessary, review the basic concepts of programming in the SAS language.</td>
<td>“Prerequisites” (p. vii)</td>
</tr>
<tr>
<td>Learn more about the basic elements of a SAS/GRAPH program.</td>
<td>“Elements of a SAS/GRAPH Program” in SAS/GRAPH: Reference</td>
</tr>
<tr>
<td>See other maps that you can create using Base SAS and SAS/GRAPH.</td>
<td>“A Quick Look at the Gallery” (p. 23)</td>
</tr>
<tr>
<td>Learn how to perform common tasks that are associated with developing mapping programs.</td>
<td>Chapter 3, “Common Tasks Associated with Developing Mapping Programs,” (p. 29)</td>
</tr>
<tr>
<td>Identify resources that you can use to help you develop your mapping programs.</td>
<td>Chapter 4, “Additional Resources to Help You Develop Your Mapping Programs,” (p. 33)</td>
</tr>
</tbody>
</table>
Chapter 2

Gallery of Maps

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 Esri maps, Open Street Maps (OSM), or with a variety of plots. This section lists each map type and provides a sample of each. The statements that generate the map are also listed.

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

This gallery contains a sample of each of the following chart and plot types:

- Block Maps
- Prism Maps
- Choropleth Maps
- Surface Maps

Gallery of Base SAS ODS Graphics and SAS/GRAPH Maps

**Block Maps**

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 256. 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 3: Using GfK GeoMarketing Map Data to Specify Response Levels in a Block Map” on page 321.

**Choropleth Maps**

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 470. 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: Nevada Counties with Bubble Plot of County Seats and Populations” on page 498.

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 280. 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 9: Using GfK GeoMarketing Map Data to Produce a Simple Choropleth Map” on page 336.

Prism Maps

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 280. 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 15: Using GfK GeoMarketing Map Data to Produce a Simple Prism Map” on page 351.

**Surface Maps**

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 11, “GMAP Procedure,” on page 223. This sample uses the GfK GeoMarketing map data set that is licensed to be used only with SAS/GRAPH.
licensed to be used only with SAS/GRAPH. For an example of a surface map, see “Example 19: Using GfK GeoMarketing Map Data to Produce a Simple Surface Map” on page 360.

**Annotated Maps**

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

*Figure 2.1  Annotate Graphics Applied to a Map*

![Annotated Map](image)

Figure 2.1 on page 27 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. Prior to SAS 9.4M6, it was often used to add text or special elements to the graphics output of the SAS/GRAPH mapping procedures, although it could also be used to construct custom graphics output. Starting with SAS 9.4M6, it can be used to add text or special elements to GMAP procedure output. The other mapping procedures moved to Base SAS. 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 “Using Annotate Data Sets” in SAS/GRAPH: Reference for detailed information.

The program that creates this output is in “Example 26: Labeling Cities on a Map” on page 382.

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

---

**Base SAS Procedures to Prepare Map Data**

**Procedures for Handling Map Data**

SAS 9.4M6: Base SAS provides several utility procedures for handling data sets that contain polygonal and map area data.
### Table 2.1  Base SAS Procedures for Handling Map Data

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOCODE</td>
<td>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.</td>
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</tr>
<tr>
<td>GINSIDE</td>
<td>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.</td>
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</tr>
<tr>
<td>GPROJECT</td>
<td>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 least distorts your map. In addition, you can choose not to display a particular rectangular area of the map.</td>
<td></td>
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</tr>
<tr>
<td>GREDUCE</td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>GREMOVE</td>
<td>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.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAPIMPORT</td>
<td>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.</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
Chapter 3
Common Tasks Associated with Developing Mapping Programs

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.

<table>
<thead>
<tr>
<th>Task</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“SAS/GRAPH Output” in SAS/GRAPH: Reference</td>
</tr>
</tbody>
</table>
Map Creation Tasks

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

<table>
<thead>
<tr>
<th>Task</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine the language elements that you need to use to create your map.</td>
<td>“Gallery of Base SAS ODS Graphics and SAS/GRAPH Maps” (p. 23)</td>
</tr>
<tr>
<td>Create your SAS/GRAPH program.</td>
<td>“Elements of a SAS/GRAPH Program” in SAS/GRAPH: Reference</td>
</tr>
<tr>
<td>Create a choropleth map overlaid with plots using ODS Graphics SGMAP procedure.</td>
<td>Chapter 16, “SGMAP Procedure,” on page 459</td>
</tr>
<tr>
<td>Procedure statement options enable you to control legends, colors, fonts, and other features.</td>
<td>“TITLE, FOOTNOTE, and NOTE Statements” (p. 80)</td>
</tr>
<tr>
<td>Add titles, footnotes, and notes to your map.</td>
<td>“Specifying Fonts in SAS/GRAPH Programs” in SAS/GRAPH: Reference</td>
</tr>
</tbody>
</table>
### Map Enhancement Tasks

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

<table>
<thead>
<tr>
<th>Task</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specify colors in your SAS/GRAPH program.</td>
<td>“Using Colors in SAS/GRAPH Programs” in SAS/GRAPH: Reference</td>
</tr>
<tr>
<td>Generate a map in the SVG format.</td>
<td>“Using SVG Graphics” in SAS/GRAPH: Reference</td>
</tr>
</tbody>
</table>

#### Map Enhancement Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add data tips and a description to your SAS/GRAPH map.</td>
<td>“Enhancing Web Presentations with Chart Descriptions, Data Tips, and Drill-Down Functionality” in SAS/GRAPH: Reference</td>
</tr>
<tr>
<td>Add one or more images to your SAS/GRAPH map.</td>
<td>“Adding Images to SAS/GRAPH Output” in SAS/GRAPH: Reference</td>
</tr>
<tr>
<td>Annotate your SAS/GRAPH map.</td>
<td>“Using Annotate Data Sets” in SAS/GRAPH: Reference</td>
</tr>
<tr>
<td>Add drill-down links to your SAS/GRAPH map.</td>
<td>“Enhancing Web Presentations with Chart Descriptions, Data Tips, and Drill-Down Functionality” in SAS/GRAPH: Reference</td>
</tr>
<tr>
<td>Use procedure statement options to specify attributes for lines, fills, data markers, or text.</td>
<td>See PROC SGMAP “Syntax” on page 461. See PROC GMAP “Syntax” on page 246.</td>
</tr>
<tr>
<td>Use ODS style elements to control map appearance.</td>
<td>“Controlling the Appearance of Your Graphs” in SAS ODS Graphics: Procedures Guide</td>
</tr>
<tr>
<td>Add a legend to your map.</td>
<td>With the SAS/GRAPH global “LEGEND Statement” on page 49</td>
</tr>
<tr>
<td></td>
<td>With PROC SGMAP “GRADLEGEND Statement” on page 477 or “KEYLEGEND Statement” on page 481</td>
</tr>
</tbody>
</table>
Chapter 4

Additional Resources to Help You Develop Your Mapping Programs

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---

**Base SAS and SAS/GRAPH Sample Programs**

The documentation for each procedure, for global statements, and for features such as the SAS/GRAPH Annotate facility provide examples that demonstrate these features. You can copy the example code from the Help, from the SAS website, or from the zipped file of samples on the SAS support website. Paste it into the Program Editor in your SAS session.

In the SAS windowing environment, many of these samples are also included in the SAS Sample Library. How you access the code in the sample library depends on how it is installed at your site.

- In most operating environments, you can access the sample code through the SAS Help and Documentation.

- For Base SAS mapping examples, select Help ⇒ SAS Help and Documentation. On the Contents tab, expand Learning to Use SAS ⇒ Sample SAS Programs ⇒ Base SAS Samples ⇒ SGMAP Examples. To illustrate, the code for an example in the SGMAP procedure chapter, “Example 1: Nevada Counties with Bubble Plot of County Seat Populations” on page 494, is stored in sample member SGMPNVBU.

  *Note:* Sample code for the GEOCODE, GPROJECT, and SGMAP procedures are listed under Base SAS Samples, and Proc Geocode, Proc Gproject, or SGMAP Examples, respectively.

- For SAS/GRAPH examples, select Help ⇒ SAS Help and Documentation. On the Contents tab, expand Learning to Use SAS ⇒ Sample SAS Programs ⇒ SAS/GRAPH Samples. To illustrate, the code for an example in the GMAP
procedure chapter, “Example 14: Combining Traditional Map Data and Sample Response Data to Map U.S. Population Statistics” on page 349, is stored in sample member GMPUSDAT.

- In other operating environments, the SAS Sample Library might be installed in your file system. Ask your on-site SAS support personnel where it is located on your system.

The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

This document includes the name of each sample file that it references (for example, SGMPNVBU or GMPGSIMP).

- The naming convention for SGMAP procedure samples in Base SAS is SGpxxxxx, where pc is the product code and xxxx is an abbreviation of the example title.
- The naming convention for SAS/GRAPH samples is Gpxxxxxx, where pc is the product code and xxxxx is an abbreviation of the example title.

The product code can be a code for a procedure or a statement. To illustrate, the code for an example in the GMAP procedure chapter, “Example 1: Using GfK GeoMarketing Map Data to Produce a Simple Block Map” on page 316, is stored in sample member GMPGSIMP.

- In the SAS Sample Library, the sample programs are organized by product. Within each product category, most of the samples are sorted by procedure. Thus, to access the code for an example in the GMAP procedure chapter, select Learning to Use SAS ⇒ SAS/GRAPH Samples, scroll to GMAP Procedure, and select GMPSGIMP-Using GfK GeoMarketing Map Data to Produce.

To access the code for an example in the SGMAP procedure chapter, select Learning to Use SAS ⇒ Base SAS Samples ⇒ SGMAP Examples, and select SGMPNVBU-Nevada County Seat Populations-Bubble Plot.

Note: Sample code for the GEOCODE, GPROJECT, and SGMAP procedures are listed under Base SAS Samples, and Proc Geocode, Proc Gproject, or SGMAP Examples, respectively.

- In your file system, the files that contain the sample code have filenames that match the sample member names. For example, in a directory-based system, the code for sample member GMPGSIMP is located in a file named GMPGSIMP.SAS.

Table 4.1 Product Codes for SAS/GRAPH and Base SAS Mapping Procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>geocode</td>
<td>GE</td>
</tr>
<tr>
<td>ginside</td>
<td>IN</td>
</tr>
<tr>
<td>gmap</td>
<td>MP</td>
</tr>
<tr>
<td>gproject</td>
<td>PJ</td>
</tr>
<tr>
<td>greduce</td>
<td>RD</td>
</tr>
<tr>
<td>gremove</td>
<td>RM</td>
</tr>
</tbody>
</table>
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 frequently contributes to the blog. His posts use SAS/GRAPH and ODS Graphics for data visualization.
  http://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.

  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.

- The Focus Area Graphics site provides a simple interface to business and analytical graphs. The site is maintained by the SAS Data Visualization team.
  http://support.sas.com/rnd/datavisualization/index.htm

In addition, SAS offers instructor-led training and self-paced e-learning courses to help you get started with platform graphics software. For more information about the courses available, see sas.com/training.

**Using Run-Group Processing**

You can use RUN-group processing with the GMAP procedure to produce multiple maps without restarting the procedure every time.

To use RUN-group processing, you start the procedure and then submit multiple RUN-groups. A *RUN-group* is a group of statements that contains at least one action statement and ends with a RUN statement. The procedure can contain other SAS statements such as BY, GOPTIONS, LEGEND, TITLE, or WHERE. As long as you do not terminate the procedure, it remains active and you do not need to resubmit the PROC statement.

To end RUN-group processing and terminate the procedure, submit a QUIT statement or start a new procedure. If you do not submit a QUIT statement, SAS/GRAPH does not terminate RUN-group processing until it reaches another step boundary.

**Note:** When using SAS/GRAPH with the ODS statement, it is best to use a QUIT statement after each procedure that uses RUN-group processing. Do this rather than relying on a new procedure to end the processing. Running too many procedures without an intervening QUIT statement can use up too much memory. Also, note that failing to submit a QUIT statement before submitting an ODS CLOSE statement results in the process memory not being freed at all.

**RUN-group Processing with Global and Local Statements**

Global statements and NOTE statements that are submitted in a RUN-group affect all subsequent RUN-groups until you cancel the statements or exit the procedure.

**RUN-group Processing with BY Statements**

BY statements persist in exactly the same way as global and local statements. Suppose you submit a BY statement within a RUN-group. Then the BY-group processing produces a separate graph for each value of the BY variable for the RUN-group in which you submit it. This continues for all subsequent RUN-groups until you cancel the BY statement or exit the procedure. Thus, as you submit subsequent action statements, you continue to get multiple graphs (one for each value of the BY variable). For more information, see the “BY Statement” on page 43.

For an example that produces three choropleth maps for each value of the BY variables STATECODE and STATENAME within a RUN-group, see “Example 11: Using Traditional Map Data to Produce a Drilldown Choropleth Map” on page 340.
RUN-group Processing with the WHERE Statement

The WHERE statement enables you to graph only a subset of the data in the input data set. If you submit a WHERE statement with a RUN-group, the WHERE definition remains in effect for all subsequent RUN-groups until you exit the procedure or reset the WHERE definition.

Using a WHERE statement with RUN-group processing follows most of the same rules as using the WHERE statement outside of RUN-group processing with one exception. With a procedure that is using an Annotate data set, the following requirements must be met:

- The ANNOTATE= option must be included in the action statement.
- The WHERE variable must occur in both the input data set and the Annotate data set.

Books

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

- *SAS/GRAPH®: Beyond the Basics*
- *Annotate: Simply the Basics* Art Carpenter’s SAS Software Series

For a list of other books that might help you, see “Recommended Reading” on page 515.
Part 2

Mapping: SAS/GRAPH and Base SAS Statements, System Options, and Macros

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Chapter 6
  SAS System Options Used in SAS/GRAPH and Base SAS Mapping ......................................................... 105

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Chapter 5

Dictionary of Statements Used in SAS/GRAPH Mapping

Overview of Global Statements

SAS/GRAPH programs can use some of the SAS language statements that you typically use with the Base SAS procedures or with the DATA step, such as LABEL, WHERE, and FORMAT. These statements are described in the SAS DATA Step Statements: Reference.

In addition, SAS/GRAPH has its own set of statements that affect only graphics output generated by the SAS/GRAPH procedures and the SAS/GRAPH Annotate facility. Most of these statements are global statements. That is, they can be specified anywhere in your program and remain in effect until explicitly changed, overridden, or canceled. These are the SAS/GRAPH global statements:

FOOTNOTE
adds footnotes to graphics output. This statement is like the TITLE statement and is described in that section.

GOPTIONS
submits graphics options that control the appearance of graphics elements by specifying characteristics such as colors, fill patterns, fonts, or text height. Graphics options can also temporarily change device settings.
LEGEND
modifies the appearance and position of legends generated by procedures that produce charts, plots, and maps.

NOTE
adds text to the graphics output. This statement is an exception because it is not global but local, meaning that it must be submitted within a procedure. Otherwise, the NOTE statement is like the TITLE statement and is described in that section.

PATTERN
controls the color and fill of patterns assigned to areas in charts, maps, and plots.

TITLE
adds titles to graphics output. The section describing the TITLE statement includes the FOOTNOTE and NOTE statements.

The above statements are described in this chapter, as well as the following two Base language statements that have a special effect when used with SAS/GRAPH procedures:

BY
processes data according to the values of a classification (BY) variable and produces a separate graph for each BY-group value. This statement is not a global statement. It must be specified within a DATA step or a PROC step.

ODS HTML
generates one or more files written in Hypertext Markup Language (HTML). If you use it with SAS/GRAPH procedures or Base SAS mapping procedures, you can specify one of the device drivers, such as GIF, PNG, or SVG. With the GIF device driver, the graphics output is stored in GIF files. The HTML files that are generated reference the graphics output. When viewed with a web browser, the HTML files can display graphics and non-graphics output together on the same web page.

For more information about the BY, LABEL, and WHERE statements in Base SAS software, see SAS DATA Step Statements: Reference. For more information about the OPTIONS statement, see SAS Global Statements: Reference.

Specify Units of Measurement

When the syntax of an option includes units, use one of these:

CELLS
character cells

CM
centimeters

IN
inches

PCT
percentage of the graphics output area

PT
points

Note: Java applets does not support CM, IN, or PT.

If you omit units, a unit specification is derived in this order:
1. The GUNIT= option in a GOPTIONS statement.
Dictionary

**BY Statement**

Processes data and orders output according to the BY group.

**Used by:**  
GMAP, GREDUCE

**Type:**  
DATA step statement

**Syntax**

```plaintext
BY <DESCENDING> variable-1 <DESCENDING> variable-2 ...>
<NOTSORTED>;
```

**Required Argument**

`variable`

specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. By default, the procedure expects observations in the data set to be sorted in ascending order by all the variables that you specify or to be indexed appropriately.

**Optional Arguments**

**DESCENDING**

indicates that the data set is sorted in descending order by the specified variable. The option affects only the variable that immediately follows the option name, and must be repeated before every variable that is not sorted in ascending order. For example, this BY statement indicates that observations in the input data set are arranged in descending order of VAR1 values and ascending order of VAR2 values:

```plaintext
by descending var1 var2;
```

This BY statement indicates that the input data set is sorted in descending order of both VAR1 and VAR2 values:

```plaintext
by descending var1 descending var2;
```

**NOTSORTED**

specifies that observations with the same BY value are grouped together, but are not necessarily sorted in alphabetical or numeric order. The observations can be grouped in another way (for example, in chronological order).

NOTSORTED can appear anywhere in the BY statement and affects all variables specified in the statement. NOTSORTED overrides DESCENDING if both appear in the same BY statement.

The requirement for ordering or indexing observations according to the values of BY variables is suspended when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. For NOTSORTED, the procedure defines a BY group as a set of contiguous observations that have the same...
values for all BY variables. Observations with the same value for the BY variables might not be contiguous. The procedure treats each new value that it encounters as the first observation in a new BY group. The procedure creates a graph for that value, even if it is only one observation.

Details

**Description: 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.

**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 SAS/GRAPH 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;
```

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 procedure
- 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 variable, see “Example 11: Using Traditional Map Data to Produce a Drilldown Choropleth Map” on page 340.

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.

### FOOTNOTE Statement

Writes up to 10 lines of text at the bottom of the graph.

**Type:** Global

**See:** “TITLE, FOOTNOTE, and NOTE Statements” on page 80

#### Syntax

```plaintext
FOOTNOTE<1 ...10> <text-argument(s)>;
```

### 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

```plaintext
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> <option(s)> ;`

---

**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-argument(s)) | 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-argument(s)) | 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 56

Example  “Example 2: Creating a Simple Web Page with the ODS HTML Statement” on page 102

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).

The Java applet treats the CBLOCK option like the CSHADOW option.

Restrictions  Not supported by Java.

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

See  "OFFSHADOW" in SAS/GRAPH: Reference

“Creating Drop Shadows and Block Effects” on page 66

CBORDER=frame-color draws a colored frame around the legend.
<table>
<thead>
<tr>
<th>Style reference</th>
<th>Color attribute of the GraphBorderLines graph element</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Restriction</strong></td>
<td>This option overrides the FRAME option.</td>
</tr>
<tr>
<td><strong>Interaction</strong></td>
<td>CBORDER= can be used in conjunction with the CFRAME= option.</td>
</tr>
</tbody>
</table>

**CFRAME=background-color**

specifies the background color of the legend. This option overrides the FRAME option.

<table>
<thead>
<tr>
<th>Style reference</th>
<th>Color attribute of the GraphLegendBackground graph element</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Restriction</strong></td>
<td>If both the CFRAME= and FRAME= options are specified, only the solid background produced by the CFRAME= option is displayed.</td>
</tr>
<tr>
<td><strong>Interaction</strong></td>
<td>The CFRAME= option can be used in conjunction with the CBORDER= option.</td>
</tr>
</tbody>
</table>

**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” in SAS/GRAPH: Reference

“Creating Drop Shadows and Block Effects” on page 66

**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 56 |

**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.

| **Restriction** | Not supported by Java and ActiveX |
LABEL=(text-argument(s)) | NONE
modifies a legend label. Text-argument(s) defines the appearance or the text of a
legend label, or both. NONE suppresses the legend label in most instances. 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);

Text-argument(s) can be one or more of these:

"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 and you specify the variable that it
names, you can embed one or both of the following in the string:

#BYVALn | #BYVAL(BY-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:

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. For
example, #BYVAL2 specifies the second variable in the BY statement.

BY-variable-name
names the BY variable. For example, #BYVAL(YEAR) specifies the BY
variable, YEAR. Variable-name is not case sensitive.

Examples

“Combining Graphs and Reports in a Web Page” in
SAS/GRAPH: Reference

#BYVARn | #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.

See  “Substituting BY Line Values in a Text String” on page 66
text-description-suboption

modifies a characteristic such as the font, color, or size of the text strings that follows it. Text-description-suboption can be as follows:

- \text{ANGLE}=\text{degrees}
- \text{COLOR}=\text{text-color}
- \text{FONT}=\text{font | NONE}
- \text{HEIGHT}=\text{text-height <units>}
- \text{JUSTIFY}=\text{LEFT | CENTER | RIGHT}
- \text{POSITION}=(\langle\text{BOTTOM | MIDDLE | TOP} \langle\text{LEFT | CENTER | RIGHT}\rangle)
- \text{ROTATE}=\text{degrees}

For a complete description of these suboptions, see “Text Description Suboptions” on page 60.

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

Style reference

Color attribute of the GraphLabelText graph element

Restrictions

Partially supported by Java and ActiveX

#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.

Starting with SAS 9.4M5, 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.

Note

The Java applet does not support the POSITION= suboption—it draws legend labels at the top left of the legend. Also, it does not support multiple values for the JUSTIFY= suboption (only the first is honored). The ActiveX control supports the POSITION= option but does not support multiple values for the JUSTIFY suboption (only the first is honored).

Examples

“Example 2: Creating a Simple Web Page with the ODS HTML Statement” on page 102

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.

Restriction Not supported by Java and ActiveX

See “Positioning the Legend” on page 64

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.

Restriction Not supported by Java and ActiveX

See “Positioning the Legend” on page 64
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:
  - \( n \ldots n \)
  - \( n \text{ TO } n \text{ BY increment} \)
  - \( n \ldots n \text{ TO } n \text{ BY increment} < n \ldots n > \)

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.

Restrictions
Not supported by Java and ActiveX

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.
Restriction  Not supported by Java and ActiveX

See  “Positioning the Legend” on page 64

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

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

- OUTSIDE or INSIDE specifies the location of the legend in relation to the axis area.
- BOTTOM or MIDDLE or TOP specifies the vertical position.
- LEFT or CENTER or 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.

**Restrictions**  Partially supported by Java

Starting with SAS 9.4M5, 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.

**Note**  The Java applet defaults to BOTTOM-CENTER and supports all possible combinations of BOTTOM | MIDDLE | TOP with LEFT | CENTER | RIGHT except for MIDDLE-CENTER (which would overwrite the map.) The Java applet does not support INSIDE.

**See**  “OFFSET=(<x><,y>)<units> | (<x><units><,y><units>))” on page 54

“MODE=PROTECT | RESERVE | SHARE” on page 53

**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.

**Restriction**  Not supported by Java or ActiveX

**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 50

“DOWN=number-of-rows” on page 51

**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.

**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.

Restriction  
Not supported by Java or ActiveX

**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 Java and ActiveX

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 Presentation for the Web” in SAS/GRAPH: Reference

**VALUE=(text-argument(s)) | NONE** modifies the legend value descriptions. Text-argument(s) defines the appearance or the text of the 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.

NONE suppresses the value descriptions although the legend values (bars, lines, and so on) are still displayed. Text-argument(s) can be one or more of these:

"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 5.1 on page 58:

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

*Figure 5.1 Specifying Value Descriptions with the VALUE= Option*

In addition, if you have a BY statement and you specify the variable that it names, you can embed one or both of the following in the string:

```
#BYVARn | #BYVAR(BY-variable-name)
```

substitutes the current value of the specified BY variable for #BYVAR in the text string and displays the value 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(YEAR) specifies the BY variable, YEAR. Variable-name is not case sensitive.

Examples

“Combining Graphs and Reports in a Web Page” in SAS/GRAPH: Reference
#BYVARn | #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.

See “Substituting BY Line Values in a Text String” on page 66

text-description-suboption
modifies a characteristic such as the font, color, or size of the text string(s) that
follows it. **Text-description-suboption** can be as follows:

- \( \text{ANGLE}=\text{degrees} \)
- \( \text{COLOR}=? \)
- \( \text{FONT}=? \)
- \( \text{HEIGHT}=? \)
- \( \text{JUSTIFY}=\text{LEFT | CENTER | RIGHT} \)
- \( \text{POSITION}=\text{TOP} | \text{MIDDLE} | \text{BOTTOM} <\text{LEFT} | \text{CENTER} | \text{RIGHT}> \)
- \( \text{ROTATE}=\text{degrees} \)
- \( \text{TICK}=n \)

Place text description suboptions before the text strings that they modify.
Suboptions 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= suboption.

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

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

**Restrictions** Partially supported by Java and ActiveX

ActiveX control does not support changing the font in the middle of
specifying descriptive text for a legend.

NONE is not supported by Java or ActiveX

#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 “Text Description Suboptions” on page 60
Text Description Suboptions

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=

Restriction Not supported by Java and ACTIVEX

See “ROTATE=degrees” on page 62

COLOR=text-color
specifies the color of the text. If you omit the COLOR= suboption, 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= suboption, 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=

Restriction ActiveX control does not support changing the font in the middle of
specifying descriptive text for a legend.

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= suboption, a text height specification
is searched for in this order:
1. the HTTEXT= 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= suboption to print multiple lines of text by repeating the suboption before the text string for each line. For example, this statement produces a legend label and value descriptions like those shown in Figure 5.2 on page 61:

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

**Figure 5.2 Specifying Multiple Lines of Text with the JUSTIFY= Suboption**

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Portland, Maine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centers</td>
<td>Paris, France</td>
</tr>
<tr>
<td></td>
<td>Sydney, Australia</td>
</tr>
</tbody>
</table>

Place text description suboptions before the text strings that they modify.

**Alias**  
J=L | C | R

**See**  
“TICK=n” on page 63

**POSITION=(<BOTTOM | MIDDLE | TOP> <LEFT | CENTER | RIGHT>)** places the legend label in relation to the legend entries. The POSITION= suboption 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 5.3 on page 62** shows some of the ways the POSITION= suboption 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= suboption 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= suboption.
### Figure 5.3 Using the POSITION= Suboption with Multiple-line Legend Labels

<table>
<thead>
<tr>
<th>POSITION=LEFT (default)</th>
<th>POSITION=(TOP) JUSTIFY=CENTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>multi-line label</td>
<td>multi-line label</td>
</tr>
<tr>
<td>● ● ● ONE</td>
<td>+ + + ONE</td>
</tr>
<tr>
<td>x x x TWO</td>
<td>● ● ● TWO</td>
</tr>
<tr>
<td># # # THREE</td>
<td>x x x THREE</td>
</tr>
<tr>
<td>$ $ $ FOUR</td>
<td># # # FOUR</td>
</tr>
<tr>
<td>$ $ $ FIVE</td>
<td>$ $ $ FIVE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POSITION=(TOP LEFT)</th>
<th>POSITION=TOP JUSTIFY=LEFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>multi-line label</td>
<td>multi-line label</td>
</tr>
<tr>
<td>+ + + ONE</td>
<td>+ + + ONE</td>
</tr>
<tr>
<td>● ● ● TWO</td>
<td>● ● ● TWO</td>
</tr>
<tr>
<td>x x x THREE</td>
<td>x x x THREE</td>
</tr>
<tr>
<td># # # FOUR</td>
<td># # # FOUR</td>
</tr>
<tr>
<td>$ $ $ FIVE</td>
<td>$ $ $ FIVE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POSITION=(MIDDLE LEFT)</th>
<th>POSITION=TOP JUSTIFY=RIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>multi-line label</td>
<td>multi-line label</td>
</tr>
<tr>
<td>+ + + ONE</td>
<td>+ + + ONE</td>
</tr>
<tr>
<td>● ● ● TWO</td>
<td>● ● ● TWO</td>
</tr>
<tr>
<td>x x x THREE</td>
<td>x x x THREE</td>
</tr>
<tr>
<td># # # FOUR</td>
<td># # # FOUR</td>
</tr>
<tr>
<td>$ $ $ FIVE</td>
<td>$ $ $ FIVE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POSITION=(BOTTOM LEFT)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>multi-line label</td>
<td></td>
</tr>
<tr>
<td>+ + + ONE</td>
<td>+ + + ONE</td>
</tr>
<tr>
<td>● ● ● TWO</td>
<td>● ● ● TWO</td>
</tr>
<tr>
<td>x x x THREE</td>
<td>x x x THREE</td>
</tr>
<tr>
<td># # # FOUR</td>
<td># # # FOUR</td>
</tr>
<tr>
<td>$ $ $ FIVE</td>
<td>$ $ $ FIVE</td>
</tr>
</tbody>
</table>

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

**Restriction**

Not supported by Java. Partially supported by ActiveX

**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=

**Restriction**

Not supported by Java and ACTIVEX

**See**

“ANGLE=degrees” on page 60
TICK=n specifies the n<sup>th</sup> legend entry. The TICK= suboption 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:

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

The characteristics of all other value descriptions remain unchanged.

If you use the TICK= suboption 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:

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

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

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

```markdown
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=

---

**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 5.4  Parts of a Legend**
Using Text Description Suboptions

Text description suboptions affect all the strings that follow them unless the suboption is changed or turned off. If the value of a suboption 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 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).

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 window, 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 5.5 on page 65 shows the legend positions inside the axis area.

**Figure 5.5 Legend Positions inside the Axis Area**

![Legend Positions inside the Axis Area](image)

Figure 5.6 on page 65 shows legend positions outside the axis area.

**Figure 5.6 Legend Positions outside the Axis Area**

![Legend Positions outside the Axis Area](image)

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 43.

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

NOTE Statement

Writes lines of text in the output.

Type: Local

Restriction: Not supported by Java and ActiveX

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 and a note on top of a chart.

```plaintext
filename odsout '.';

goptions device=png; goptions cback=white;

ODS LISTING CLOSE;
ODS HTML path=odsout body="map01.htm" style=htmlblue;

title "Note Text On a Map";
pattern1 v=s color=tan;

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

title "Note Text On a Chart";
proc gchart data=maps.us;
note move=(2,50)pct font="albany amt/bold" height=4pct 
  color=white box=1 blank=yes 
  color=black "Note with 'box' behind it displays on top of chart";
hbar state / type=freq levels=7;
run;
quit;
ODS HTML CLOSE;
ODS LISTING;

See: “TITLE, FOOTNOTE, and NOTE Statements” on page 80
```
Syntax

NOTE <text-arguments(s)>;

ODS HTML Statement
Opens or closes the HTML destination.

**Used by:** GMAP

**Requirement:** On mainframes, either GPATH= or PATH= is required.

Syntax

ODS HTML <(<ID=>identifier)> <<action> | <option(s)>>;

Details

**Description: ODS HTML Statement**
This section describes the ODS HTML statement as it relates to SAS/GRAPH procedures. For complete information about the ODS HTML statement, see the *SAS Output Delivery System: User’s Guide*.

The ODS HTML statement opens or closes the HTML destination. This destination is the default output destination for the Windows and UNIX operating systems. When the destination is open, the procedure produces output that is written in Hypertext Markup Language in the form of an HTML file. If no device is specified, SAS/GRAPH by default, creates a PNG file containing the graph. The HTML file references the PNG file in order to display the graph in a web page.

If DEVICE=JAVAMETA, graphics output is produced as metagraphics data. The browser passes the metacodes as a parameter to the Metaview applet. The Metaview applet renders the output defined by the metacodes, and displays the interactive graph in a web page. For more information about DEVICE=JAVAMETA see “Developing Web Presentations for the Metaview Applet” in *SAS/GRAPH: Java Applets and ActiveX Control User’s Guide*.

You can also use the DEVICE=JAVA and DEVICE=ACTIVEX options to create interactive graphics presentations for the web.

SAS/GRAPH adds data tip text to some graphs depending on the device specified. These data tips are generated by default using the values of fields in a SAS data set. You can specify the DESCRIPTION= option on the SAS/GRAPH procedure to change or remove the data tip text. For more information about using data tips see “Data Tips for Web Presentations” in *SAS/GRAPH: Reference*.

The FILE= option identifies the file that contains the HTML version of the procedure output. With SAS/GRAPH, the body file contains references to the graphs. If DEVICE=PNG, the graphs are stored in separate PNG files. When you view the body file in a browser, the graphs are automatically displayed. By default with ODS processing, both the HTML and PNG files are stored in the current WORK library. To specify a destination for all the HTML and PNG files, use the PATH= option. You can store the PNG files in a different location than the HTML files. Use the GPATH= option to specify a location for the PNG files, and the PATH= option to specify the location of the HTML files. In both cases, the destination must be an aggregate storage location.
Anchors

ODS HTML automatically creates an anchor for every piece of output generated by the SAS procedures. An anchor specifies a particular location within an HTML file. In SAS/GRAPH, an anchor usually defines a link target such as a graph whose location is defined in an IMG element.

In order for the links from the contents, page, or frame file to work, each piece of output in the body files must have a unique anchor to link to. The anchor for the first piece of output in a body file acts as the anchor for that file. These anchors are used by the frame and contents files, if they are created, to identify the targets for the links that ODS HTML automatically generates. For more information about using anchors with the ODS HTML statement, see the SAS Output Delivery System: User’s Guide.

You can specify a name for an HTML anchor with the following code:

```ods html anchor="string";```

This enables you to link directly to that identifying name.

---

**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 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 Java and ActiveX

Note  ActiveX assigns colors in a different order from Java, so the same data can appear differently with those two drivers.

See  “Working with PATTERN Statements” on page 77

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.

Restriction  Partially supported by Java and ActiveX

Notes  When you specify an image file to fill a map, the map is not outlined. Also, the COLOR= and VALUE= options are ignored.

For DEVICE=ACTIVEX and DEVICE=ACTXIMG, if you do not specify a pathname to the image, then the ActiveX control searches a predefined list of locations to try to find the image. If all else fails, the ActiveX control looks for the image on the web. It is recommended that you specify the pathname to the image.

See  “IMAGESTYLE=TILE | FIT” on page 70

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

Restriction  Partially supported by Java and ActiveX

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.
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

**Restriction**  
Partially supported by Java and ActiveX

**See**  
“Understanding Pattern Sequences” on page 78

**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 72.) See
also “About Block Maps and Patterns” on page 269.

Values for block-pattern are as follows:

**EMPTY**

an empty pattern. Neither the Java applet nor the ActiveX control supports
EMPTY.

**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.

*Note: style<density> is not supported by the Java or ActiveX device drivers.*
Figure 5.7 on page 72 shows all of the patterns available for bars and blocks.

**Figure 5.7  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.

<table>
<thead>
<tr>
<th>Alias</th>
<th>V=</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restriction</td>
<td>Partially supported by Java and ActiveX</td>
</tr>
</tbody>
</table>

**VALUE= map-pattern**

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.

<table>
<thead>
<tr>
<th>Alias</th>
<th>ME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restriction</td>
<td>EMPTY or E are not valid aliases when used with the map areas in block maps created by the GMAP procedure.</td>
</tr>
</tbody>
</table>

**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.

\[ \text{Mdensity} \ <style \ <angle \ > \]

specifies a shaded pattern.

\textit{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.

\textit{Style} specifies the type of the pattern lines:

N specifies parallel lines (the default).

X specifies crosshatched lines.

\textit{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, \textit{angle} is 0 (lines are horizontal).

\textbf{Note} \textit{Mdensity<style<angle>>} is not supported by the Java or ActiveX device drivers.

Figure 5.8 on page 73 shows some typical map patterns.

\textit{Figure 5.8 MapPatterns}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{MapPatterns}
\end{figure}

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
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 \( V = \)

Restriction Partially supported by Java and ActiveX

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 75.

**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 77, as well as the descriptions of “COLOR=pattern-color | _style_” on page 69, “IMAGE=fileref | external-file”’on page 70, and “VALUE= map-pattern” on page 72.

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:

```plaintext
pattern4 value=x3 color=red repeat=2;
```

This statement cancels only REPEAT= without affecting the rest of the definition:

```plaintext
pattern4 repeat=;
```

Add or change options in the same way. This statement changes the color of the pattern from red to blue:

```plaintext
pattern4 color=blue;
```

After all these modifications, PATTERN4 has these characteristics:

```plaintext
pattern4 value=x3 color=blue;
```

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

```plaintext
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:

```plaintext
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 window, use the GOPTIONS procedure with the PATTERN option:

```plaintext
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 77 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. The default colors are determined by the current style and the device.

SAS/GRAPH uses default patterns when no PATTERN statements are defined. The default colors are determined by the current style and the device.

Because the system option-GSTYLE-is in effect by default, 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 78.

**Selecting an Appropriate Pattern**
The type of fill you specify depends on the type of graph that you are producing:
Table 5.1  Fill Patterns for Graph Types

<table>
<thead>
<tr>
<th>Type of graph</th>
<th>Appropriate type of fill</th>
</tr>
</thead>
<tbody>
<tr>
<td>block maps (PROC GMAP)</td>
<td>“VALUE=block-pattern” on page 71</td>
</tr>
<tr>
<td>map area surfaces (PROC GMAP)</td>
<td>“VALUE=map-pattern” on page 72</td>
</tr>
</tbody>
</table>

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” 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:

```plaintext
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 shows the color and fill of the PATTERN definitions that would be generated if nine patterns were required:

<table>
<thead>
<tr>
<th>Definition Number</th>
<th>Source</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Color</td>
</tr>
<tr>
<td>1</td>
<td>PATTERN1</td>
<td>Red</td>
</tr>
<tr>
<td>2</td>
<td>PATTERN2</td>
<td>Blue</td>
</tr>
<tr>
<td>3</td>
<td>PATTERN2</td>
<td>Red</td>
</tr>
<tr>
<td>4</td>
<td>PATTERN2</td>
<td>Green</td>
</tr>
<tr>
<td>5</td>
<td>PATTERN3</td>
<td>Blue</td>
</tr>
<tr>
<td>6</td>
<td>First default</td>
<td>Blue</td>
</tr>
<tr>
<td>7</td>
<td>First default</td>
<td>Red</td>
</tr>
<tr>
<td>8</td>
<td>First default</td>
<td>Green</td>
</tr>
<tr>
<td>9</td>
<td>Second default</td>
<td>Blue</td>
</tr>
</tbody>
</table>

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, \texttt{PATTERN1} is used twice and \texttt{PATTERN2} cycles through the list of three colors and then repeats this cycle a second time:

\begin{table}[h]
\centering
\begin{tabular}{|l|l|l|l|}
\hline
\textbf{Sequence Number} & \textbf{Source} & \textbf{Color} & \textbf{Fill} \\
\hline
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 \\
\hline
\end{tabular}
\caption{The Cyclical Use of PATTERN Statements}
\end{table}

\textbf{TITLE, FOOTNOTE, and NOTE Statements}

Control the content, appearance, and placement of text.

\begin{itemize}
\item \textbf{Valid in:} Anywhere
\item \textbf{Used by:} GMAP
\item \textbf{Type:} TITLE and FOOTNOTE are global statements. NOTE is a local statement.
\item \textbf{Restriction:} The cumulative text from the TITLE1-10 statements must not exceed 256 characters for output using the SVG device.
\end{itemize}

\textbf{Syntax}

\begin{itemize}
\item \texttt{TITLE<1 ...10> <text-argument(s)>;}
\item \texttt{FOOTNOTE<1 ...10> <text-argument(s)>;}
\item \texttt{NOTE<text-arguments(s)>;}
\end{itemize}
Summary of Optional Arguments

Appearance options

COLOR=color
specifies the color for the following text, box, or line.

FONT=font
specifies the font for the subsequent text.

HEIGHT=text-height<units>
specifies the height of text characters in number of units.

Baseline angling and character rotation options

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

LANGE=degrees
specifies the angle of the entire text-string(s).

ROTATE=degrees
specifies the angle at which each character of text is rotated.

Boxing, underlining, and line drawing options

BCOLOR=background-color

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

BOX=1 ...4
draws a box around one line of text.

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

DRAW=(x,y ...,x-n,y-n)<units>
draws lines anywhere on the graphics output area.

UNDERLIN=0 ...3
underlines subsequent text.

Linking option

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

LINK="URL"
specifies a uniform resource locator (URL) to which a title or footnote links.

Placement and spacing options

JUSTIFY=LEFT | CENTER | RIGHT
specifies the alignment of the text string.

LSPACE=line-space<units>
specifies the amount of spacing above and below lines of text.

MOVE=(x,y)<units>
positions a text string.

WRAP
wraps the text to a second line if the text does not fit on one line.

Text provision option
text-string(s) is an element of text-argument(s) and specifies one or more strings up to 512 characters. Any of the following text-options that are used to modify a text-string must precede text-string.

Optional Arguments
text-arguments(s) can be one or more of "text-string" and text-options. 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 title or footnote links, or the title or footnote itself. The "text-string" that you use to describe a title or a footnote, or the URL specified by the LINK= option, can contain occurrences of the variables #BYVAL, #BYVAR, and #BYLINE, as described in “text-string(s)” on page 93.

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

Note The title or footnote can be displayed by using an ODS markup destination (such as HTML). Also, the corresponding ODS option NOGTITLE or NOGFOOTNOTE is specified. In this case, the title or 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 title or footnote.

See “Controlling Where Titles and Footnotes Are Rendered” in SAS/GRAPH: Reference “LINK="URL”” on page 91

Example “Example 11: Using Traditional Map Data to Produce a Drilldown Choropleth Map” on page 340

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 titles or footnotes might require more vertical space. Consequently, there might be an increase the size of the title area or 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 98.

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 or footnote. The result depends on the statement in which you use the option:

• With the TITLE statement:
  Figure 5.9 on page 83 shows how ANGLE=90-degrees or ANGLE=–90-degrees positions and rotates the title text.
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 5.9 Positioning Titles with the ANGLE= Option

- With the FOOTNOTE statement:

Figure 5.10 on page 83 shows how ANGLE=90 degrees or ANGLE=−90 degrees positions and rotates footnote text.

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 5.10 Positioning Footnotes with the ANGLE=Option

- With the NOTE statement:

Figure 5.11 on page 84 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 5.11 Positioning Notes with the ANGLE= Option

<table>
<thead>
<tr>
<th>Alias</th>
<th>A=</th>
</tr>
</thead>
</table>

Restriction
Not supported by Java and ActiveX

See
“ LANGLE=degrees” on page 90
“ ROTATE=degrees” on page 93

Example
“Example 1: Enhancing Titles” on page 99

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=.

<table>
<thead>
<tr>
<th>Alias</th>
<th>BC=</th>
</tr>
</thead>
</table>

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 98 for details
“ BOX=1 …4 ” on page 85

Example
“Example 1: Enhancing Titles” on page 99

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 titles and footnotes are written from the highest numbered to the lowest numbered, the BLANK= option only blanks out titles and footnotes of a lower number.

| Alias | BL= |
Restriction  Not supported by Java and ActiveX

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 98 for details

Example  “Example 1: Enhancing Titles” on page 99

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 5.12 on page 86:

  ```
  note font=swiss justify=center box=1
  "Office Hours"      move=(-7,-2)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. See the “NOTE Statement” for a code sample.

- Use the DRAW= option to draw the box and do not use the BOX= option.
Figure 5.12  Using the BOX= Option and the MOVE= Option to Box Multiple Lines of Text

<table>
<thead>
<tr>
<th>Alias</th>
<th>BO=</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restriction</td>
<td>Not supported by Java and ActiveX</td>
</tr>
<tr>
<td>Note</td>
<td>The BOX= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= options with absolute coordinates.</td>
</tr>
<tr>
<td>See</td>
<td>“Using Options That Can Reset Other Options” on page 98 for details</td>
</tr>
<tr>
<td></td>
<td>“BCOLOR=background-color” on page 84</td>
</tr>
<tr>
<td></td>
<td>“BLANK=YES” on page 84</td>
</tr>
<tr>
<td></td>
<td>“BSPACE=box-space&lt;units&gt;” on page 86</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Alias</th>
<th>BS=</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restriction</td>
<td>Not supported by Java and ActiveX</td>
</tr>
<tr>
<td>Interaction</td>
<td>If the BOX= option is not used, the BSPACE= option is ignored</td>
</tr>
<tr>
<td>Note</td>
<td>The BSPACE= option can be reset by the ANGLE= or JUSTIFY= options, or by the MOVE= option with absolute coordinates.</td>
</tr>
<tr>
<td>See</td>
<td>“Using Options That Can Reset Other Options” on page 98 for details</td>
</tr>
<tr>
<td></td>
<td>“BOX=1 ...4” on page 85</td>
</tr>
</tbody>
</table>

**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 title with red text in a box with a blue frame and a cream background:

```plaintext
title color=red "Total Sales" color=blue
  box=3 bcolor=cream;
```

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 default, the first color in the color list.

**Alias**

```
C=
```

**Style reference**

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

**See**

“BCOLOR=background-color” on page 84

“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 5.4 Coordinate Specifications

<table>
<thead>
<tr>
<th>Absolute Coordinates</th>
<th>Relative Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>x&lt;units&gt;</td>
<td>±x&lt;units&gt;</td>
</tr>
<tr>
<td>y&lt;units&gt;</td>
<td>±y&lt;units&gt;</td>
</tr>
</tbody>
</table>
```

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=
```

**Restriction**

Not supported by Java and ActiveX

**Example**

“Example 1: Enhancing Titles” on page 99
**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:

- 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 and the FOOTNOTE and NOTE statements:
  1. the FTEXT= option in a GOPTIONS statement
  2. the default hardware font, NONE

**Alias**  
F=

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

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

If the TITLE or FOOTNOTE is displayed using an ODS markup destination and the corresponding NOGTITLE or 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.

**See**
“Controlling Titles and Footnotes” in *SAS/GRAPH: Reference*

**Example**
“Example 1: Enhancing Titles” on page 99

**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:

- for a TITLE or TITLE1 statement:
  1. the HTITLE= option in a GOPTIONS statement
  2. the HTEXT= option in a GOPTIONS statement
  3. the default value specified by the current ODS style.
- for all other TITLE statements and the FOOTNOTE and NOTE statements:
  1. the HTEXT= option in a GOPTIONS statement
  2. the default value, 1

**Alias**  
H=
<table>
<thead>
<tr>
<th>Default</th>
<th>For TITLE or TITLE1 statements, HEIGHT is determined by the current ODS style. HEIGHT=1 for subsequent TITLE statements.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Style reference</td>
<td>Height attribute of the GraphTitle1Text (TITLE1) and the GraphTitleText (TITLE2...n) elements</td>
</tr>
<tr>
<td>Restriction</td>
<td>Partially supported by Java and ActiveX</td>
</tr>
<tr>
<td>Notes</td>
<td>The Java applet and ActiveX control enable you to control the relative height of text with the HEIGHT= option, but not the absolute height in terms of specific units.</td>
</tr>
<tr>
<td></td>
<td>A TITLE or FOOTNOTE statement without a number is treated as a TITLE1 or FOOTNOTE1 statement.</td>
</tr>
<tr>
<td>See</td>
<td>“Controlling Titles and Footnotes” in SAS/GRAF: Reference</td>
</tr>
<tr>
<td>Examples</td>
<td>“Example 1: Enhancing Titles” on page 99</td>
</tr>
</tbody>
</table>

**JUSTIFY=LEFT | CENTER | RIGHT**

specifies the alignment of the text string. The default depends on the statement with which you use the JUSTIFY= option:

- for a FOOTNOTE statement the default is CENTER
- for a NOTE statement the default is LEFT
- for a TITLE statement the default is CENTER.

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 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.

<table>
<thead>
<tr>
<th>Alias</th>
<th>J=L</th>
<th>C</th>
<th>R</th>
</tr>
</thead>
</table>

**Note**

Using the JUSTIFY= 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 98 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).

Angled titles or footnotes might require more vertical space. Consequently, there might be an increase the size of the title area or 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 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. The result depends on the statement in which you use the option:

• With the TITLE statement:

  Figure 5.13 on page 90 shows how LANGLE=90 degrees and LANGLE=–90 degrees positions and rotates titles.

  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 picture.

  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 bottom of the picture.

• With the FOOTNOTE statement:

  Figure 5.14 on page 91 shows how LANGLE=90 degrees and LANGLE=–90 degrees positions and rotates footnotes.

  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.
• With the NOTE statement:

Figure 5.15 on page 91 shows how LANGLE=90 degrees and LANGLE=–90 degrees positions and rotates notes.

<table>
<thead>
<tr>
<th>Alias</th>
<th>LA=</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restriction</td>
<td>Not supported by Java and ActiveX</td>
</tr>
<tr>
<td>See</td>
<td>“ ANGLE=degrees” on page 82</td>
</tr>
</tbody>
</table>

**LINK=“URL”**

specifies a uniform resource locator (URL) to which a title or 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 “ text-string(s)” on page 93.

<table>
<thead>
<tr>
<th>Supports</th>
<th>The LINK= option can be used in conjunction with the ALT= option.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note</td>
<td>The title or footnote can display using an ODS markup destination (such as HTML). And the corresponding ODS option NOGTITLE or NOGFOOTNOTE can be specified. Then the title or footnote is rendered in the body of the HTML file rather than in the graphic itself. Specifying the NOGTITLE or 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 title or 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.</td>
</tr>
</tbody>
</table>
See  “Controlling Where Titles and Footnotes Are Rendered” in SAS/GRAPH Reference

“ ALT="text-string" on page 82

Example  “Example 11: Using Traditional Map Data to Produce a Drilldown Choropleth Map” on page 340

**LSPACE=**<unit-space><units>
specifies the amount of spacing above lines of note and title text and the amount of spacing below lines of footnote text. For notes and titles, the spacing is measured from the capline of the current line to the font minimum of the line above. For footnotes, the spacing is measured from the font minimum of the current line to the capline of the line below.

**Alias**  LS=

**Default**  LSPACE=0

**Restriction**  Not supported by Java and ActiveX

**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 98 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>
<thead>
<tr>
<th>Absolute Coordinates</th>
<th>Relative Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>x&lt;units&gt;</td>
<td>±x&lt;units&gt;</td>
</tr>
<tr>
<td>y&lt;units&gt;</td>
<td>±y&lt;units&gt;</td>
</tr>
</tbody>
</table>

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.
Restriction
Not supported by Java and ActiveX

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

A NOTE, FOOTNOTE, or 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 next NOTE, FOOTNOTE, or TITLE 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 98 for details

“ BOX=1 …4 ” on page 85 for illustrative code that draws a box around lines of text positioned with relative coordinates

Examples
“Example 1: Enhancing Titles” on page 99

**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 5.16 on page 93 shows how characters are positioned when ROTATE=90 is used with the default (horizontal) baseline.

*Figure 5.16  Tilting Characters with the ROTATE= Option*

---

**Alias**
R=

**Restriction**
Not supported by Java and ActiveX

**See**
“ ANGLE=degrees” on page 82

**Example**
“Example 1: Enhancing Titles” on page 99

**text-string(s)**
is an element of *text-argument(s)* and specifies one or more strings up to 512 characters. Any of the following *text-options* that are used to modify a *text-string* must precede *text-string*. 
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 title, 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 and 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:

```
note color=red "Sales:" color=blue " 2000";
```

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 (\(\alpha = .05\))" 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*.

In addition, if you have a BY statement and you specify the variable that it names, you can embed one or both of the following in the string:

- **#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 footnote, note, or title produced by the statement.

- **#BYVALn | #BYVAL(BY-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:

  - \(n\)
    
    specifies which variable in the BY statement #BYVAL should use. The value of \(n\) indicates the position of the variable in the BY statement. For example, #BYVAL2 specifies the second variable in the BY statement.

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

**Examples**
“Combining Graphs and Reports in a Web Page” 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=

**Restriction**

Partially supported by Java and ActiveX

**Notes**

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 98 for details.

The Java applet and ActiveX control underline text when the UNDERLIN= option is specified, but they do not vary the thickness of the line.

**See**

“ROTATE=degrees” on page 93

**Example**

“Example 1: Enhancing Titles” on page 99
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.

Details

Using TITLE and FOOTNOTE Statements
You can define TITLE and FOOTNOTE statements anywhere in your SAS program.
They are global and remain in effect until you cancel them or until you end your SAS
session. All currently defined FOOTNOTE and TITLE statements are automatically
displayed.

You can define up to ten TITLE statements and ten FOOTNOTE statements in your SAS
session. A TITLE or FOOTNOTE statement without a number is treated as a TITLE1 or
FOOTNOTE1 statement. You do not have to start with TITLE1 and you do not have to
use sequential statement numbers. Skipping a number in the sequence leaves a blank
line.

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” on page 97.

The most recently specified TITLE or FOOTNOTE statement of any number completely
replaces any other TITLE or FOOTNOTE statement of that number. In addition, it
cancels all TITLE or FOOTNOTE statements of a higher number. For example, if you
define TITLE1, TITLE2, and TITLE3, then resubmitting the TITLE2 statement cancels
TITLE3.

To cancel individual TITLE or FOOTNOTE statements, define a TITLE or FOOTNOTE
statement of the same number without options (a null statement):

title4;

But remember that this cancels all other existing statements of a higher number.

To cancel all current TITLE or FOOTNOTE statements, use the RESET= graphics
option in a GOPTIONS statement:

goptions reset=footnote;

Specifying RESET=GLOBAL or RESET=ALL also cancels all current TITLE and
FOOTNOTE statements as well as other settings.

Note: The cumulative text from the TITLE1-10 statements must not exceed 256
characters for output using the SVG device.

Using the NOTE Statement
NOTE statements are local, not global, and they must be defined within a procedure or
RUN-group with which they are used. They remain in effect for the duration of the
procedure that includes NOTE statements in any of its RUN-groups or until you end
your SAS session. 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” on page 97.
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:

```plaintext
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 89 aligns the text string
- "MOVE=(x,y) <units=>" on page 92 positions a line or lines of text anywhere on the
graphics output area using x and y as absolute or relative coordinates.

Figure 5.12 on page 86 illustrates using the MOVE= option with relative coordinates
to position a subsequent line of text

- "WRAP" on page 96 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 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 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";
```

**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 43.

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

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=

**Sample library member:** GTIENT11

**Details**

The code for this example is in SAS Sample Library member GTIENT11. The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

This example illustrates some ways that you can format title text. The same options can be used to format footnotes.
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=blue
draw=(20,35 20,27 58,27 58,35 20,35 20,35)
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
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.

```plaintext
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.

```plaintext
title10 color=purple
    draw=(20,35 20,27 58,27 58,35 20,35)
    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.

```plaintext
proc gslide;
run;
quit;
```

**Example 2: Creating a Simple Web Page with the ODS HTML Statement**

**Features:**
- ODS HTML statement options
  - BODY=
- GOPTIONS statement options
  - BORDER
  - RESET=
- LEGEND statement options
  - ACROSS=
  - LABEL=

**Sample library member:**
- GONCSWB1
Details

The code for this example is in SAS Sample Library member GONCSWB1. The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

This example illustrates the simplest way to use the ODS HTML statement to create an HTML file and a PNG file that you can display in a web browser. This example also illustrates:

- the default pattern behavior with maps and explicit placement of the legend on the graph
- how the default solid map pattern uses different shades of the default style color to differentiate between countries
- how to use a LEGEND statement to arrange and position a legend so that it fits well with the graph's layout.

This example generates one body file that displays one piece of SAS/GRAPH output a map of average per capita income.

Output

Output 5.1 Displaying a Map in a Web Page

Program

goptions reset=all border;
ods html body="na_body.html";

title1 "North America Gross National Income per Capita 2004";

legend across=2
   origin=(8,5)
   mode=share
   label=(position=top
       justify=left
       "Gross National Income per Capita")
;

proc gmap map=maps.namerica data=sashelp.demographics;
   id cont id;
   format gni dollar10.0;
   choro gni / levels=10 legend=legend1;
run;
quit;

Program Description

Set the graphics environment.

goptions reset=all border;

Set the ODS HTML destination. The BODY= option names the file for storing HTML output.

ods html body="na_body.html";

Define title for the map. By default, any defined title is included in the graphics output (PNG file).

   title1 "North America Gross National Income per Capita 2004";

Define legend characteristics. The ACROSS= option defines the number of columns in the legend. The ORIGIN= option specifies on the procedure output area the position of the lower left corner of the legend box. 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.

   legend across=2
      origin=(8,5)
      mode=share
      label=(position=top
          justify=left
          "Gross National Income per Capita")
   ;

Generate the prism map. Because the NAME= option is omitted, SAS/GRAPH assigns the default name GMAP to the GRSEG entry in the graphics catalog. This is the name that is assigned to the PNG file created by the ODS HTML statement.

   proc gmap map=maps.namerica data=sashelp.demographics;
      id cont id;
      format gni dollar10.0;
      choro gni / levels=10 legend=legend1;
run;
quit;
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.

<table>
<thead>
<tr>
<th>Valid in:</th>
<th>SAS 9.4: Configuration file, SAS invocation, OPTIONS statement, SAS System Options window</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAS Viya: Configuration file, SAS invocation, OPTIONS statement, SASV9_OPTIONS environment variable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category:</th>
<th>Graphics: Driver Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROC OPTIONS</td>
<td>GRAPHICS</td>
</tr>
<tr>
<td>GROUP=</td>
<td></td>
</tr>
</tbody>
</table>
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 304

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: SAS 9.4: Configuration file, SAS invocation
SAS Viya: 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. It also cannot be saved by using the DMOPTSAVE command in the SAS windowing environment.

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 105
- “MAPSSAS= System Option” on page 107
- “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 non-digital map data sets. The libref MAPSSAS is assigned using the option value specified by the MAPSSAS system option.

Valid in: SAS 9.4: Configuration file, SAS invocation
SAS Viya: 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. Nor can it be saved by using the DMOPTSAVE command in the SAS windowing environment.

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 non-digital vector 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 105
• “MAPSGFK= System Option” on page 106
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 “Commonly Used 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 “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 “Controlling the Appearance of Your Graphs” in SAS ODS Graphics: Procedures Guide and “Specifying Styles” in SAS ODS Graphics: Procedures Guide for more information.
Chapter 8
SAS Macros Used in Mapping

About the Macros

You can use the Annotate %CENTROID macro within a SAS DATA step to simplify the process of creating Annotate observations. You add these observations to a map created with the SAS/GRAPH GMAP procedure. See other Annotate Facility macros, including the “%MAPLABEL 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. The GEOCODE procedure was released with Base SAS in SAS SAS 9.4M6, and is available with SAS/GRAPH in prior releases. 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\( parameter1, parameter2, \ldots \);

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

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 Online website contains this program macro and detailed usage instructions. Click on the world image on the page to enter Maps Online. You are required to access the website with your SAS profile. You might be required to enter your site information. Click the Downloads link in the banner. Then click Geocoding in the left navigation bar to obtain this geocoding download.

\%CENTROID Macro

Retrieves the centroid positions of map data set polygons.

Variables written out: X, Y, ID variables

Requirement: In SAS 9.4M5 and in earlier releases, you must run the \%ANNOMAC macro before using the \%CENTROID annotate macro. See “Making the Macros Available” in SAS/GRAPH: Reference. Starting with SAS 9.4M6, it is not necessary to run the \%ANNOMAC macro before using the \%CENTROID macro.

Note: Starting with SAS 9.4M6, 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 nth 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
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 Online website contains this program macro and detailed usage instructions. Click on the world image on the page to enter Maps Online. You are required to access the website with your SAS profile. You might be required to enter your site information. Click the Downloads link in the banner. Then click Geocoding in the left navigation bar to obtain this geocoding download.

%GCDMEL9
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/direct/reference-data/geo-data. For more information, see “%GCDMEL9 Autocall Macro” on page 154.

%GEOBASE2GEOCODE
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. The SASHELP.GCDIRECT data set is installed with Base SAS starting with SAS 9.4M5, and with SAS/GRAPH prior to SAS 9.4M5. The ZIPCodeDownload2Geocode.zip file on the SAS Maps Online website contains this program macro and detailed usage instructions. Click on the world image on the page to enter Maps Online. You are required to access the website with your SAS profile. You might be required to enter your site information. Click the Downloads link in the banner. Then click Geocoding in the left navigation bar to obtain this geocoding downloadable file.

%MAXMIND
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 157.

%TIGER2GEOCODE
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 Online website contains the version-specific program macro and detailed usage instructions. Click on the world image on the page to enter Maps Online. You are required to access the website with your SAS profile. You might be required to enter your site information. Click the Downloads link in the banner. Then click Geocoding in the left navigation bar to obtain either of these geocoding downloadable files.
Part 3

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Chapter 9

GEOCODE Procedure

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Overview: GEOCODE Procedure

About the GEOCODE Procedure

Starting with SAS 9.4M5, 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.

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 155.

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 Teradata server, a SAS LASR Analytic server, or a SAS Cloud Analytic Services (CAS) server as the repository for geocoding lookup data sets. Essential polygonal data sequencing is lost as the data is distributed amongst the nodes of these servers. 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. Use cloud storage as long as it is a Windows or Linux system that is not installed on a SAS LASR or CAS server. 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 Online website.

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 Online website. For more information, see “SAS Maps Online Website” on page 122.
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 Online 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 Online Website” on page 122.

See Also

• “%GCDMEL9 Autocall Macro” on page 154
• “%MAXMIND Autocall Macro” on page 157
• %GEOBASE2GEOCODE macro program for importing Canadian roadway and address data is described in “Obtaining Street Lookup Data Sets” on page 133
• %TIGER2GEOCODE macro program for importing TIGER shapefiles for specific states and counties is described in “Obtaining Street Lookup Data Sets” on page 133
• %ABS2GEOCODE and %CODEPOINT2GEOCODE macro programs for importing postcode data from Australia and Great Britain are described in “Non-U.S. Postcodes” on page 151
• “Deciding Which Lookup Data to Use” on page 124

SAS Maps Online Website

The SAS Maps Online 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

The SAS Maps Online website can be accessed at http://support.sas.com/rnd/datavisualization/mapsonline/index.html. Click on the world image on the page to enter Maps Online.

Click the Downloads link in the banner and then click Geocoding in the left navigation bar to obtain the geocoding downloads and the SAS macro code programs mentioned in this chapter.
Click the **Geocoding** link in the left navigation bar on the Downloads page to access the geocoding downloads.

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You can click on any of the available links in the left navigation bar to access other information, such as archived maps or recent mapping and geocoding updates.

---

**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 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 124.
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.

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 9.1  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,
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 178.

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 134.

**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 ATTRIBUTEV AR= 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**

“ATTRIBUTEV AR=(variable-1, variable-2, …)” on page 169

**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 133 for more information.

The STREET geocoding method requires several lookup data sets:

- the ‘M’ or “street matching data set” on page 127
- the ‘S’ or “street segment data set” on page 128
- the ‘P’ or “street coordinate data set” on page 129
- the “street state data set” on page 129
- the “street type data set” on page 130
- the “street directional data set” on page 132

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 data set from the SAS Maps Online 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 174

For more information about these macros, and the default, installed, and created data sets, see “Obtaining Street Lookup Data Sets” on page 133.

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 data set from the SAS Maps Online 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 126.

“ATTRIBUTEVAR=(variable-1, variable-2, …)” on page 169

For more information about these macros, and the default, installed, and created data sets, see “Obtaining Street Lookup Data Sets” on page 133.

**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 data set from the SAS Maps Online 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 133.

**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 MapIDNameAbbrv 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 179

For more information about these macros, and the installed and the created data sets, see “Obtaining Street Lookup Data Sets” on page 133.

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, which is installed with Base SAS after SAS 9.4M5, and with SAS/GRAPH prior to SAS 9.4M5.

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:

```sas
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 190. 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 'BLUFE'.

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 179

For more information about these macros, and the installed, alternate, and created data sets, see “Obtaining Street Lookup Data Sets” on page 133.

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**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 is installed with Base SAS after SAS 9.4M5, and with SAS/GRAPH prior to SAS 9.4M5. This data set 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 170
For more information about these macros, and the installed, alternate, and created data sets, see “Obtaining Street Lookup Data Sets” on page 133.

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 Maps Online website. For more information, see “SAS Maps Online Website” on page 122.

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 Maps Online 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 Maps Online 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 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 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 Online Website” on page 122.
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 135.

_SCORE_
Contains a numeric value indicating the relative accuracy of the match.

Note: SAS 9.4M6: 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 and their scores:

Table 9.1 Tokens for the _NOTES_ Variable

<table>
<thead>
<tr>
<th>Token</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD</td>
<td>20</td>
<td>The street name matched.</td>
</tr>
<tr>
<td>ADSDP</td>
<td>5</td>
<td>Address Direction Suffix matched lookup data Direction Prefix.</td>
</tr>
<tr>
<td>Token</td>
<td>Score</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>ADPDS</td>
<td>5</td>
<td>Address Direction Prefix matched lookup data Direction Suffix.</td>
</tr>
<tr>
<td>CT</td>
<td>5</td>
<td>The city name matched.</td>
</tr>
<tr>
<td>DP</td>
<td>15</td>
<td>The street direction prefix matched.</td>
</tr>
<tr>
<td>DS</td>
<td>15</td>
<td>The street direction suffix matched.</td>
</tr>
<tr>
<td>ENDM</td>
<td>SAS 9.4M6: 2</td>
<td>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.</td>
</tr>
<tr>
<td>MCS</td>
<td>0</td>
<td>Multiple matches were found for the input street address and the street, city, and state in the street segment lookup data set.</td>
</tr>
<tr>
<td>MVP</td>
<td>0</td>
<td>The street geocoder detected missing values for the X or Y coordinates in the user-supplied lookup data set.</td>
</tr>
<tr>
<td>MZC</td>
<td>0</td>
<td>Multiple matches were found for the street address and ZIP code.</td>
</tr>
<tr>
<td>NM</td>
<td>10</td>
<td>The house number matched on the correct side of the street.</td>
</tr>
<tr>
<td>NMOS</td>
<td>5</td>
<td>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.</td>
</tr>
<tr>
<td>NOADD</td>
<td>0</td>
<td>An invalid street address was input.</td>
</tr>
</tbody>
</table>
| 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 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.
<table>
<thead>
<tr>
<th>Token</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NODPA</td>
<td>-10</td>
<td>The input address had no direction prefix but the matching street did have a direction prefix. For example, the input street name was &quot;Main St.&quot; but the matching street was &quot;N Main St.&quot;</td>
</tr>
<tr>
<td>NODPM</td>
<td>-15</td>
<td>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 &quot;North Main St.&quot; but the matching street was &quot;Main St.&quot;</td>
</tr>
<tr>
<td>NODSA</td>
<td>-10</td>
<td>The input address had no direction suffix but the matching street did have a direction suffix. For example, the input street name was &quot;Johnson Ave&quot; but the matching street was &quot;Johnson Ave S.&quot;</td>
</tr>
<tr>
<td>NODSM</td>
<td>-15</td>
<td>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 &quot;Johnson Ave South&quot; but the matching street was &quot;Johnson Ave.&quot;</td>
</tr>
<tr>
<td>NOLNM</td>
<td>0</td>
<td>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.</td>
</tr>
<tr>
<td>NONM</td>
<td>0</td>
<td>The input address has no house number. The geocoded coordinates for the center of the matching street were used.</td>
</tr>
<tr>
<td>NOSTM</td>
<td>0</td>
<td>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, &quot;100 Main St., Cary, ND 27513&quot;. However, the matching lookup data set observation had the correct state value, &quot;100 Main St., Cary, NC 27513&quot;.</td>
</tr>
<tr>
<td>NOTPA</td>
<td>-10</td>
<td>The input address had no street type prefix, but the matching address did have a street type prefix. For example, the input address was &quot;110 Quebec.&quot; but the matching address was &quot;110 Boulevard Quebec&quot;</td>
</tr>
<tr>
<td>Token</td>
<td>Score</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>NOTPM</td>
<td>-20</td>
<td>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 &quot;Boulevard Quebec&quot; but the matching street name was &quot;Avenue Quebec&quot;.</td>
</tr>
<tr>
<td>NOTSA</td>
<td>-10</td>
<td>The input address had no street type suffix, but the matching address did have a street type suffix. For example, the input address was &quot;110 Main.&quot; but the matching address was &quot;110 Main St.&quot;</td>
</tr>
<tr>
<td>NOTSM</td>
<td>-20</td>
<td>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 &quot;Park St.&quot; but the matching street name was &quot;Park Ave.&quot;</td>
</tr>
<tr>
<td>NS</td>
<td>0</td>
<td>The input address had no state value.</td>
</tr>
<tr>
<td>NSM</td>
<td>0</td>
<td>An initial match was found for the input city and country pair in the CITY lookup data set. However, the state variable value of the matching observation was not a match.</td>
</tr>
<tr>
<td>NOZC</td>
<td>0</td>
<td>No ZIP code was provided.</td>
</tr>
<tr>
<td>NOZCM</td>
<td>0</td>
<td>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, &quot;100 Main St., Cary, NC 25713&quot;. However, the matching lookup data set had the correct ZIP code value, &quot;100 Main St., Cary, NC 27513&quot;.</td>
</tr>
<tr>
<td>ST</td>
<td>5</td>
<td>The two-character state abbreviation matched.</td>
</tr>
<tr>
<td>TP</td>
<td>20</td>
<td>The street type prefix matched.</td>
</tr>
<tr>
<td>TS</td>
<td>20</td>
<td>The street type suffix matched.</td>
</tr>
<tr>
<td>ZC</td>
<td>15</td>
<td>The five-digit ZIP code or non-U.S. postal code matched.</td>
</tr>
</tbody>
</table>
## Tips for Street Geocoding

### Table 9.2  Suggestions and Comments for the STREET Geocoding Method

<table>
<thead>
<tr>
<th>Category</th>
<th>Suggestions and Comments</th>
</tr>
</thead>
</table>
| 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 Maps Online 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 Maps Online 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 Maps Online 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 Online Website” on page 122. |
<table>
<thead>
<tr>
<th>Category</th>
<th>Suggestions and Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct data</td>
<td>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:</td>
</tr>
<tr>
<td></td>
<td>- The address is a P.O. box or contains apartment information.</td>
</tr>
<tr>
<td></td>
<td>- The direction suffix (or prefix) is positioned such that it is not detected. For example, the input address might be ‘Green Level West Road ’ instead of ‘Green Level Road West.’</td>
</tr>
<tr>
<td></td>
<td>- The street name is not in the TIGER or GeoBase data that is being used.</td>
</tr>
<tr>
<td></td>
<td>- The city or street name in the lookup data uses an alternate spelling. An example is Hillsboro versus Hillsborough.</td>
</tr>
<tr>
<td></td>
<td>- Data is misspelled for street or city names.</td>
</tr>
<tr>
<td></td>
<td>- 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.</td>
</tr>
<tr>
<td></td>
<td>Note: Do not remove house numbers.</td>
</tr>
<tr>
<td>Adequate amount of data</td>
<td>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.</td>
</tr>
</tbody>
</table>
### Category: 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.

### Category: 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 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 Online website. For more information, see “SAS Maps Online Website” on page 122.

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 Online website. Another alternative is to specify your lookup data set as the SASHELP.ZIPCODE data set in your SAS code, like this:

```sas
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 Online 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 Online Website” on page 122.

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 149 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 Online 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 Online 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 Online 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**

**Table 9.3  Suggestions and Comments for Using the CITY Geocoding Method**

<table>
<thead>
<tr>
<th>Category</th>
<th>Suggestions and Comments</th>
</tr>
</thead>
</table>
| 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 Online Website” on page 122 for details.  
You can also download quarterly updates of SASHELP.ZIPCODE from the SAS Maps Online website. See “SAS Maps Online Website” on page 122 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 Online Website” on page 122 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 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 152.

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 151.

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 the 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 Online website. For more information, see “SAS Maps Online Website” on page 122.

SASHELP.ZIPCODE contains the following variables:

<table>
<thead>
<tr>
<th>Name</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZIP</td>
<td>The five-digit ZIP code.</td>
</tr>
<tr>
<td>Y</td>
<td>Latitude (decimal degrees) of the center of the ZIP code.</td>
</tr>
<tr>
<td>X</td>
<td>Longitude (decimal degrees) of the center of the ZIP code.</td>
</tr>
<tr>
<td>ZIP_CLASS</td>
<td>ZIP code Classification: P=PO Box, U=Unique zip used for large organizations or businesses or buildings, Blank=Standard or non-unique.</td>
</tr>
<tr>
<td>CITY</td>
<td>Name of the city or organization.</td>
</tr>
<tr>
<td>STATE</td>
<td>Two-digit number (FIPS code) for the state or territory.</td>
</tr>
<tr>
<td>STATECODE</td>
<td>Two-letter abbreviation for the state name.</td>
</tr>
<tr>
<td>STATENAME</td>
<td>Full name of the state or territory.</td>
</tr>
<tr>
<td>COUNTY</td>
<td>FIPS county code.</td>
</tr>
<tr>
<td>COUNTYNM</td>
<td>Name of county or parish.</td>
</tr>
<tr>
<td>MSA</td>
<td>Metropolitan Service Area code by common population pre-2003; no MSA for rural areas.</td>
</tr>
<tr>
<td>AREACODE</td>
<td>Single Area Code for the ZIP code.</td>
</tr>
<tr>
<td>AREACODES</td>
<td>Multiple Area Codes for the ZIP code.</td>
</tr>
</tbody>
</table>
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 170 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 169 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 Online website. For more information, see “SAS Maps Online Website” on page 122.
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

Table 9.4  Suggestions and Comments for the ZIP Geocoding Method

<table>
<thead>
<tr>
<th>Category</th>
<th>Suggestions and Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most recent software</td>
<td>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</td>
</tr>
<tr>
<td>and lookup data</td>
<td>SASHELP.ZIPCODE from SAS Maps Online. See “SAS Maps Online Website” on page 122.</td>
</tr>
<tr>
<td>Correct data</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Non-U.S. postal codes</td>
<td>Remove any spaces and punctuation and uppercase any characters.</td>
</tr>
</tbody>
</table>

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 Online 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 Online Website” on page 122.

You can also purchase the GEO*Data product containing current ZIP+4 centroids, available from Melissa Data at this website: https://www.melissa.com/direct/reference-data/geo-data.

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 Maps Online website at http://support.sas.com/rnd/datavisualization/mapsonline/index.html. On the Downloads page, select Geocoding from the left navigation to access the downloads that are related to geocoding.
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 154.

%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. The default path is the path for the WORK library.

Usage Example for the %GCDMEL9 Autocall Macro
In this example, a Geo*Data file for the state of Delaware (DE.txt) was extracted to C:\Mydata. The lookup data set is created in an existing directory C:\Geocode and assigned the libref ZIP4. The resulting data set is named ZIP4.DELAWARE.

The following code imports the data:

```sas
/* Define macro variables */
%let UNZIPPEDPATH=C:\Mydata;
%let DATASETPATH=C:\Geocode;
%let DATASETNAME=Delaware;
%let LIBNAME=ZIP4;
%let DATASETLABEL=ZIP+4 lookup data for Delaware;
/* Submit autocall macro */
%GCDMEL9
```
Tips for ZIP+4 Geocoding

Table 9.5  Suggestions and Comments for the PLUS4 Geocoding Method

<table>
<thead>
<tr>
<th>Category</th>
<th>Suggestions and Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most recent lookup data</td>
<td>Check the SAS Maps Online 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.) See “SAS Maps Online Website” on page 122. 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.</td>
</tr>
</tbody>
</table>
| 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). However, an updated version of this import macro is planned after the release of SAS 9.4M6. Check for the update on the SAS Maps Online website at http://support.sas.com/rnd/datavisualization/mapsonline/index.html.

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 filename for the CSV file that contains IPv4 address range values. The file that you specify must contain the startIpNum and endIpNum variables. The default filename is GeoLiteCity-Blocks.csv.

CSVLOCATIONFILE
specifies the filename for the CSV file that contains longitude and latitude values. The default filename is GeoLiteCity-Location.csv.

CSV_COUNTRYFILE (Optional)
specifies the name of the optional MaxMind CSV file that contains country names. The default filename is GeoIPCountryWhoIs.csv.

WORKPATH (Optional)
specifies the path where temporary files are written. The default path is the path for the WORK library.

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 filename for the CSV file that contains IPv6 address range values. The file that you specify must contain the startIpNum and endIpNum variables. The default filename is GeoIPv6.csv.

CSVLOCATIONFILE6
specifies the filename for the CSV file that contains longitude and latitude values. The default filename is GeoLiteCityv6.csv.

CSV_COUNTRYFILE6 (Optional)
specifies the name of the optional MaxMind CSV file that contains country names. The default filename is GeoIPASNum2v6.csv.

WORKPATH (Optional)
specifies the path where temporary files are written. The default path is the path for the WORK library.

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 C:\Mydata. The output SAS data sets are created in the directory C:\Geocode.

The following code imports the data:
%let CSVPATH=C:\Mydata;
%let IPDATAPATH=C:\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 `C:\Mydata`. The output SAS data sets are created in the directory `C:\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.

The following code imports all the required data:

```sas
%global CSVPATH;
%let CSVPATH=C:\Mydata;
%let IPDATAPATH=C:\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](https://tools.ietf.org/html/rfc3927), 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::/10` prefix

  `FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF` prefix (FE80::/10 prefix)
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 internets:

- **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)

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**

**Table 9.6**  
**Suggestions and Comments for the RANGE Geocoding Method**

<table>
<thead>
<tr>
<th>Category</th>
<th>Suggestions and Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most recent lookup data, in its original format</td>
<td>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 filenames. 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 located in the designated directory. The website is located at <a href="https://www.maxmind.com/en/home">https://www.maxmind.com/en/home</a>. Neither import macro supports MaxMind’s next generation file format (GeoLite2). If you change the filenames of the MaxMind data, the %MAXMIND autocall macro and its sub-macro programs cannot recognize or import the file data.</td>
</tr>
</tbody>
</table>
| 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. |
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 reinstalling 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 9.7 on page 163.

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 Maps Online 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 “Understanding SAS Indexes” in SAS Language Reference: Concepts.

### Index Names Used By Geocoding Data Sets

Here is a comprehensive list of the indexes used by geocoding data sets.

**Table 9.7 Geocoding Data Set Index Names and Variables**

<table>
<thead>
<tr>
<th>Default Data Set Name/Description*</th>
<th>Index Filename</th>
<th>Default Index Variable(s)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Lookup for U.S. Streets (Default name: SASHELP.USM)</td>
<td>Name2_Zip, Name2_Zcta, Name2_MapIDNameAbrv_City2</td>
<td>NAME2, ZIP, NAME2, ZCTA, NAME2, MAPIDNAMEABRV, CITY2</td>
</tr>
<tr>
<td>Primary Lookup for Canadian Streets (Default name: Canada_m)</td>
<td>Name2_MapIDNameAbrv_City2, Name2_MapIDName_City2</td>
<td>NAME2, MAPIDNAMEABRV, CITY2, NAME2, MAPIDNAME, CITY2</td>
</tr>
<tr>
<td>SASHELP.ZIPCODE</td>
<td>City2_StateCode, ZIP, City2_StateName2</td>
<td>CITY2, STATECODE, ZIP, CITY2, STATENAME2</td>
</tr>
<tr>
<td>Australian Postal Codes</td>
<td>POA_CODE</td>
<td>POA_CODE</td>
</tr>
<tr>
<td>British Postal Codes</td>
<td>PC</td>
<td>PC</td>
</tr>
<tr>
<td>MAPSGFK.US_CITY_ALL</td>
<td>StateCode_City2</td>
<td>STATECODE, CITY2</td>
</tr>
<tr>
<td>MAPSGFK.WORLD_CITIES or WORLD_CITIES_ALL (from SAS MapsOnline)</td>
<td>ISOalpha2_City2, ISOalpha3_City2, ISOname2_City2, ID</td>
<td>ISOALPHA2, CITY2, ISOALPHA3, CITY2, ISONAME2, CITY2, ID</td>
</tr>
<tr>
<td>ZIP4 (PLUS4 method)</td>
<td>ZIP_PLUS4, ZIP</td>
<td>ZIP, PLUS4, ZIP</td>
</tr>
<tr>
<td>CITYLOCATION</td>
<td>CITYLOCATION</td>
<td>LocId</td>
</tr>
<tr>
<td>Default Data Set Name/ Description*</td>
<td>Index Filename</td>
<td>Default Index Variable(s)**</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>SASHELP.GCDIRECT</td>
<td>DIRECTION</td>
<td>DIRECTION</td>
</tr>
</tbody>
</table>

* 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.

** 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

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

**Restriction:** This procedure is not included in SAS Viya-only installation, nor can it use data that has been processed in CAS. For more information, see “Plotting a Cloud Analytic Services (CAS) In-Memory Table” in *SAS/GRAPH: Reference*.

**PROC GEOCODE**

```plaintext
PROC GEOCODE DATA=address-data-set <option(s)>;
```

**PROC GEOCODE Statement**

Identifies the data set that contains the address data that you want to geocode and optionally, 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**

```plaintext
PROC GEOCODE DATA=address-data-set <option(s)>;
```

**Summary of Optional Arguments**

```plaintext
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

ADRESSEXCOUNTRYVAR=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.

Tip
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.

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 25. 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 151 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=(STATE_NAME, 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” on page 114

**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 150.

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.
For the ZIP geocoding method, the default lookup data set SASHELP.ZIPCODE is used.

This option is not valid when using the CITY geocoding method. Use the LOOKUPCITY= option instead.

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.

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 145 or “About Alternate World City Lookup Data” on page 146 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 “ATTRIBUTEV AR=(variable-1, variable-2, …)” option.

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 ADDRESSCOUNTRYVV AR= 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.

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.

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.)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note</td>
<td>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.</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note</td>
<td>This option can also reference a lookup data set variable containing complete country names instead of abbreviations.</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Restrictions</th>
<th>The data type of the key variable must match the variable that you specify for the RANGEKEYVAR= option.</th>
</tr>
</thead>
</table>

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. |

---

See “ADDRESSCOUNTRYVAR=character-variable” on page 168
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.

**LOOKUPLUS4VAR=**

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 127.

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 Maps Online website at http://support.sas.com/rnd/datavisualization/mapsonline/index.html.

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 (ADDRESSZIPV AR=).

**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 151 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 126.

**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 180.

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. If you are using the SAS Windowing environment, you can use the ALTLOG system option to specify a log file. In this case, only the external ALTLOG file is written immediately. The Log window 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 134 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, 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.

```sas
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.

RANDEDECIMAL
specifies that the values of the ADDRESSVAR= variable are in decimal or
hexadecimal format. IPv6 addresses in hexadecimal format are supported.
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” on page 114

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 9.8 Required and Optional Arguments for Each Geocoding Method

<table>
<thead>
<tr>
<th>Geocoding Method</th>
<th>Arguments</th>
</tr>
</thead>
</table>
| 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=  
  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. |
Geocoding Method | Arguments
--- | ---
RANGE | RANGE geocoding requires the following:
- ADDRESSVAR=
- BEGINRANGEVAR=
- ENDRANGEVAR=
- LOOKUP=
- LOOKUPOPTIONS=
- 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.
<table>
<thead>
<tr>
<th>Geocoding Method</th>
<th>Arguments</th>
</tr>
</thead>
</table>
| STREET           | STREET geocoding can use the following options:  
|                  | • ADDRESSCITYVAR=  
|                  | • ADDRESSSTATEVAR=  
|                  | • ADDRESSZIPVAR=  
|                  | • ADDRESSVAR=  
|                  | • 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 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=
- LOOKUPCITYVAR=
- LOOKUPSTATEVAR=

Examples: GEOCODE Procedure

Example 1: Geocoding Using Default Values

Features:
- ZIP geocoding method
- Procedure options
  - OUT=

Other features:
- Base SAS functions
- SAS DATA step
- PRINT procedure

Data set:
- SASHELP.ZIPCODE (lookup data set)

Sample library member:
- GEOSMPL

Notes:
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) 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 outputs 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.

The following output from PROC PRINT shows the output data set after running the GEOCODE procedure. Notice that the following geocoding variables have been added:

- coordinate variables X and Y from the lookup data set (SASHELP.ZIPCODE).
- 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).

Your X and Y or M_OBS values might differ depending on the version of SASHELP.ZIPCODE that is installed at your site.

### Output

The following output from the PRINT procedure shows the GEOCODED_CUSTOMERS output data set after running the GEOCODE procedure.

#### Output 9.1 The GEOCODED_CUSTOMERS Output Data Set

<table>
<thead>
<tr>
<th>Y</th>
<th>X</th>
<th>M_OBS</th>
<th><em>MATCHED</em></th>
<th>address</th>
<th>city</th>
<th>state</th>
<th>zip</th>
<th>cust_ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.0736</td>
<td>-118.399</td>
<td>12550</td>
<td>City</td>
<td>555 Junk Street</td>
<td>Beverly Hills</td>
<td>CA</td>
<td>99999</td>
<td>1</td>
</tr>
<tr>
<td>39.1500</td>
<td>-76.532</td>
<td>7558</td>
<td>ZIP</td>
<td>115 E. Water St</td>
<td>Dover</td>
<td></td>
<td>19001</td>
<td>2</td>
</tr>
<tr>
<td>39.0053</td>
<td>-75.570</td>
<td>7575</td>
<td>ZIP</td>
<td>760 Moose Lodge Road</td>
<td>Camden</td>
<td></td>
<td>19034</td>
<td>3</td>
</tr>
<tr>
<td>39.7366</td>
<td>-75.549</td>
<td>7541</td>
<td>ZIP</td>
<td>200 S. Madison Str</td>
<td>Wilmington</td>
<td>DE</td>
<td>19001</td>
<td>4</td>
</tr>
<tr>
<td>39.7317</td>
<td>-75.669</td>
<td>7548</td>
<td>ZIP</td>
<td>4701 Limestone Road</td>
<td>Wilmington</td>
<td></td>
<td>19006</td>
<td>5</td>
</tr>
<tr>
<td>39.7677</td>
<td>-75.961</td>
<td>7378</td>
<td>ZIP</td>
<td>2117 N 4th St</td>
<td>Oxford</td>
<td>PA</td>
<td>19363</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>None</td>
<td>1313 Mockingbird Lane</td>
<td>Delray</td>
<td></td>
<td>CC</td>
<td>7</td>
</tr>
<tr>
<td>38.7265</td>
<td>-75.081</td>
<td>7604</td>
<td>ZIP</td>
<td>133 Silver Lake Dr</td>
<td>Rahoboth Beach</td>
<td>DE</td>
<td>19971</td>
<td>8</td>
</tr>
<tr>
<td>38.9035</td>
<td>-75.432</td>
<td>7597</td>
<td>ZIP</td>
<td>11 SE Front Street</td>
<td>Millford</td>
<td></td>
<td>19683</td>
<td>9</td>
</tr>
<tr>
<td>38.6141</td>
<td>-75.811</td>
<td>20665</td>
<td>City</td>
<td>402 Nylon Boulevard</td>
<td>Seaford</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>39.2907</td>
<td>-76.905</td>
<td>19424</td>
<td>City</td>
<td>363 E Commerce St</td>
<td>Smyrna</td>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>38.4663</td>
<td>-75.150</td>
<td>7605</td>
<td>ZIP</td>
<td>5595 Polly Branch Rd</td>
<td>Selbyville</td>
<td>DE</td>
<td>1975</td>
<td>12</td>
</tr>
<tr>
<td>38.4593</td>
<td>-75.065</td>
<td>7582</td>
<td>ZIP</td>
<td>1209 Coastal Highway</td>
<td>Fenwick Island</td>
<td>DE</td>
<td>19944</td>
<td>13</td>
</tr>
<tr>
<td>39.1509</td>
<td>-75.683</td>
<td>7589</td>
<td>ZIP</td>
<td>2699 Arthursville Rd</td>
<td>Hanly</td>
<td></td>
<td></td>
<td>19953</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>None</td>
<td>41 Bramhall St</td>
<td></td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>38.4554</td>
<td>-75.578</td>
<td>20323</td>
<td>City</td>
<td>9320 Old Racetrack Rd</td>
<td>Delmar</td>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>39.2282</td>
<td>-75.666</td>
<td>7591</td>
<td>ZIP</td>
<td>281 W Commerce Str</td>
<td>Kenton</td>
<td></td>
<td></td>
<td>19955</td>
</tr>
<tr>
<td>39.6284</td>
<td>-75.850</td>
<td>8564</td>
<td>ZIP</td>
<td>211 Blue Ball Road</td>
<td>Elkton</td>
<td>MD</td>
<td>21921</td>
<td>18</td>
</tr>
<tr>
<td>39.0695</td>
<td>-75.657</td>
<td>7619</td>
<td>ZIP</td>
<td>3893 Turkey Point Rd</td>
<td>Woodside</td>
<td>DE</td>
<td>19880</td>
<td>19</td>
</tr>
</tbody>
</table>
Program

```plaintext
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 # DB
402 Nylon Boulevard # # Seafood # DE
363 E Commerce St # # Smyrna # DE
5595 Polly Branch Rd # 19975 # Selbyville # DE
1209 Coastal Highway # 19944 # Penwick Island # DE
2899 Arthursville Rd # 19953 # Hartly # DE
41 Bramhall St # # #
9320 Old Racetrack Rd # # Delmar # DB
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.**

```plaintext
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 #
```
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.

```sas
proc geocode out=geocoded_customers;
run;
```

Print the entire GEOCODED_CUSTOMERS output data set, suppressing the observation column.

```sas
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=

**Other features:**
- Base SAS functions
- SAS DATA step
- PRINT procedure

**Sample library member:** GEOVARS

**Notes:**
- The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
- The SAS-supplied map data set(s) 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 the output data set after running the GEOCODE procedure. Notice that the following variables have been added to the output data set:

- 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.

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.

### Output

The following output from the PRINT procedure shows the GEOCODED_CUSTOMERS output data set after running the GEOCODE procedure

#### Output 9.2 The GEOCODED_CUSTOMERS Output Data Set with Additional Variables

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th><em>MATCHED</em></th>
<th>STATENAME</th>
<th>COUNTYNM</th>
<th>address</th>
<th>zip</th>
</tr>
</thead>
<tbody>
<tr>
<td>-118.399</td>
<td>34.0736</td>
<td>City</td>
<td></td>
<td></td>
<td>555 Junk Street</td>
<td>99999</td>
</tr>
<tr>
<td>-75.532</td>
<td>39.1500</td>
<td>ZIP</td>
<td>Delaware</td>
<td>Kent</td>
<td>115 E. Water St</td>
<td>19901</td>
</tr>
<tr>
<td>-75.570</td>
<td>39.0963</td>
<td>ZIP</td>
<td>Delaware</td>
<td>Kent</td>
<td>760 Moose Lodge Road</td>
<td>19934</td>
</tr>
<tr>
<td>-75.549</td>
<td>39.7366</td>
<td>ZIP</td>
<td>Delaware</td>
<td>New Castle</td>
<td>200 S. Madison Str</td>
<td>19801</td>
</tr>
<tr>
<td>-75.669</td>
<td>39.7317</td>
<td>ZIP</td>
<td>Delaware</td>
<td>New Castle</td>
<td>4701 Limestone Road</td>
<td>19808</td>
</tr>
<tr>
<td>-75.961</td>
<td>39.7877</td>
<td>ZIP</td>
<td>Pennsylvania</td>
<td>Chester</td>
<td>2117 N 4th St</td>
<td>19363</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
<td></td>
<td></td>
<td>1313 Mockingbird Lane</td>
<td></td>
</tr>
<tr>
<td>-75.081</td>
<td>39.7265</td>
<td>ZIP</td>
<td>Delaware</td>
<td>Sussex</td>
<td>133 Silver Lake Dr</td>
<td>19971</td>
</tr>
<tr>
<td>-75.432</td>
<td>39.9036</td>
<td>ZIP</td>
<td>Delaware</td>
<td>Sussex</td>
<td>11 SE Front Street</td>
<td>19963</td>
</tr>
<tr>
<td>-75.611</td>
<td>38.6411</td>
<td>City</td>
<td></td>
<td></td>
<td>402 Nylon Boulevard</td>
<td></td>
</tr>
<tr>
<td>-75.605</td>
<td>39.2997</td>
<td>City</td>
<td></td>
<td></td>
<td>363 E Commerce St</td>
<td></td>
</tr>
<tr>
<td>-75.150</td>
<td>38.4963</td>
<td>ZIP</td>
<td>Delaware</td>
<td>Sussex</td>
<td>5595 Polly Branch Rd</td>
<td>19975</td>
</tr>
<tr>
<td>-75.053</td>
<td>38.4593</td>
<td>ZIP</td>
<td>Delaware</td>
<td>Sussex</td>
<td>1209 Coastal Highway</td>
<td>19944</td>
</tr>
<tr>
<td>-75.693</td>
<td>39.1509</td>
<td>ZIP</td>
<td>Delaware</td>
<td>Kent</td>
<td>2899 Arthursville Rd</td>
<td>19953</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
<td></td>
<td></td>
<td>41 Bramhall St</td>
<td></td>
</tr>
<tr>
<td>-75.578</td>
<td>38.4564</td>
<td>City</td>
<td></td>
<td></td>
<td>9320 Old Racetrack Rd</td>
<td></td>
</tr>
<tr>
<td>-75.666</td>
<td>39.2282</td>
<td>ZIP</td>
<td>Delaware</td>
<td>Kent</td>
<td>281 W Commerce Str</td>
<td>19955</td>
</tr>
<tr>
<td>-75.850</td>
<td>39.6264</td>
<td>ZIP</td>
<td>Maryland</td>
<td>Cecil</td>
<td>211 Blue Ball Road</td>
<td>21921</td>
</tr>
<tr>
<td>-75.567</td>
<td>39.0595</td>
<td>ZIP</td>
<td>Delaware</td>
<td>Kent</td>
<td>3693 Turkey Point Rd</td>
<td>19980</td>
</tr>
</tbody>
</table>
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 */
```
Run the GEOCODE procedure with the generated input data set. Include in the output the state name and county name variables.

```sas
proc geocode method=zip data=customers out=geocoded_customers attributevar=(statename, countynm); run;
```

Print the specified variable values from the GEOCODED_CUSTOMERS output data set, suppressing the observation column.

```sas
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=

**Other features:** Base SAS functions
- SAS DATA step
- PRINT procedure

**Data set:** SASHELP.GEOEXM (primary street lookup data set)

**Sample library member:** GEOSTRT
Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) 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.

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 135.

Output 9.3 The WORK.GEOCODED Data Set with STREET Method Output Variables

<table>
<thead>
<tr>
<th>address</th>
<th>M_ADDR</th>
<th>M_ZIP</th>
<th>M_OBS</th>
<th>MATCHED</th>
<th><em>STATUS</em></th>
<th><em>NOTES</em></th>
<th><em>SCORE</em></th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>555 Junk Street</td>
<td></td>
<td>12550</td>
<td></td>
<td>City</td>
<td>City/St...</td>
<td>CT ST</td>
<td>10</td>
<td>-118.399</td>
<td>34.6736</td>
</tr>
<tr>
<td>305 Cross Lake Drive</td>
<td>305</td>
<td>27526</td>
<td>5021</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C NM TS</td>
<td>75</td>
<td>-78.763</td>
<td>35.6641</td>
</tr>
<tr>
<td>2526 Banks Road</td>
<td>2526</td>
<td>27060</td>
<td>1244</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C NM TS</td>
<td>75</td>
<td>-78.573</td>
<td>35.6369</td>
</tr>
<tr>
<td>2222 SAS Campus Drive</td>
<td>2222</td>
<td>27513</td>
<td>10577</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C ENDM NTSA</td>
<td>67</td>
<td>-78.757</td>
<td>35.8259</td>
</tr>
<tr>
<td>1150 SE Maynard Rd</td>
<td>1150 SE Maynard R...</td>
<td>27511</td>
<td>12069</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C NM DP TS</td>
<td>90</td>
<td>-78.764</td>
<td>35.7831</td>
</tr>
<tr>
<td>2117 Geoceland Ct</td>
<td>4400 Geoceland Ct</td>
<td>27066</td>
<td>7872</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C ENDM NOTSA</td>
<td>37</td>
<td>-78.711</td>
<td>35.7809</td>
</tr>
<tr>
<td>1313 Mockingbird Lane</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>-78.748</td>
<td>35.5593</td>
</tr>
<tr>
<td>133 Jade Circle</td>
<td>133 Jade Cir</td>
<td>27546</td>
<td>9617</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C NM TS</td>
<td>75</td>
<td>-78.461</td>
<td>35.8144</td>
</tr>
<tr>
<td>1006 W South St</td>
<td>1006 W South St</td>
<td>27663</td>
<td>17310</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C NM DP TS</td>
<td>90</td>
<td>-78.554</td>
<td>35.7732</td>
</tr>
<tr>
<td>306 Roundabout Rd</td>
<td>306 Roundabout Rd</td>
<td>27590</td>
<td>16716</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C ENDM TS</td>
<td>67</td>
<td>-78.828</td>
<td>35.6497</td>
</tr>
<tr>
<td>Johnson Family Rd</td>
<td></td>
<td>27626</td>
<td>19756</td>
<td>ZIP</td>
<td>ZIP match</td>
<td>2C</td>
<td>15</td>
<td>-78.784</td>
<td>35.5593</td>
</tr>
<tr>
<td>822 Water Plant Road</td>
<td>822 Water Plant Rd</td>
<td>27587</td>
<td>29017</td>
<td>Street</td>
<td>Found</td>
<td>AD CT ST NM TS</td>
<td>70</td>
<td>-78.340</td>
<td>35.8312</td>
</tr>
<tr>
<td>502 Possom Track Road</td>
<td>502 Possom Track Rd</td>
<td>27614</td>
<td>15915</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C ENDM TS</td>
<td>62</td>
<td>-78.641</td>
<td>35.5457</td>
</tr>
<tr>
<td>2600 Volpack Lane</td>
<td>Volpack Ln</td>
<td>27604</td>
<td>20209</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C NOLNM TS</td>
<td>65</td>
<td>-78.609</td>
<td>35.8236</td>
</tr>
<tr>
<td>125 Farlos Wheel Ct</td>
<td>125 Farlos Wheel Ct</td>
<td>27513</td>
<td>6840</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C NM TS</td>
<td>75</td>
<td>-78.600</td>
<td>35.7849</td>
</tr>
<tr>
<td>3900 Western Blvd</td>
<td>3900 Western Blvd</td>
<td>27606</td>
<td>29234</td>
<td>Street</td>
<td>Found</td>
<td>AD 2C NM TS</td>
<td>75</td>
<td>-78.600</td>
<td>35.7847</td>
</tr>
</tbody>
</table>

Program

```plaintext
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
2526 Banks Road # 27603 # Raleigh # NC
2222 SAS Campus Drive # 27513 # Cary # NC
```

Example 3: Street Geocoding 191
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;
\* 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
  /* Invo\new 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;
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) */

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;
  if _n_ = 1 then do;
    name = 'BLV';
    type = 'BLVD';
    group = 34; /* group number must match other 'BLVD' types */
    output;
  end;
run;

Run the GEOCODE procedure with the generated input data set.

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;

Print the specified variable values from the WORK_GEOCODED output data set, suppressing the observation column.

proc print data=WORK.GEOCODED noobs;
Example 4: U.S. City Geocoding

Features: CITY geocoding method

Procedure Options
METHOD=
DATA=
OUT=

Other features: Base SAS functions
SAS DATA step
PRINT procedure

Data set: mapsgfk.uscity_all (lookup data set)

Sample library member: GEOCITY

Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) 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 9.4  The GEOCODED_TRAINING Output Data Set

<table>
<thead>
<tr>
<th>LAT</th>
<th>LONG</th>
<th>M_OBS</th>
<th>MATCHED</th>
<th>city</th>
<th>state</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.7489</td>
<td>-84.368</td>
<td>26936</td>
<td>City</td>
<td>Atlanta</td>
<td>GA</td>
</tr>
<tr>
<td>40.6806</td>
<td>-74.646</td>
<td>81289</td>
<td>City</td>
<td>Bedminster</td>
<td>NJ</td>
</tr>
<tr>
<td>36.7914</td>
<td>-78.781</td>
<td>93782</td>
<td>City</td>
<td>Cary</td>
<td>NC</td>
</tr>
<tr>
<td>41.8500</td>
<td>-87.650</td>
<td>32440</td>
<td>City</td>
<td>Chicago</td>
<td>IL</td>
</tr>
<tr>
<td>39.7589</td>
<td>-84.192</td>
<td>98332</td>
<td>City</td>
<td>Dayton</td>
<td>OH</td>
</tr>
<tr>
<td>41.6006</td>
<td>-93.609</td>
<td>40883</td>
<td>City</td>
<td>Des Moines</td>
<td>IA</td>
</tr>
<tr>
<td>42.3314</td>
<td>-83.046</td>
<td>65729</td>
<td>City</td>
<td>Detroit</td>
<td>MI</td>
</tr>
<tr>
<td>41.7636</td>
<td>-72.666</td>
<td>18459</td>
<td>City</td>
<td>Hartford</td>
<td>CT</td>
</tr>
<tr>
<td>25.7739</td>
<td>-80.194</td>
<td>22855</td>
<td>City</td>
<td>Miami</td>
<td>FL</td>
</tr>
<tr>
<td>42.5950</td>
<td>-71.017</td>
<td>61375</td>
<td>City</td>
<td>Middleton</td>
<td>MA</td>
</tr>
<tr>
<td>44.9800</td>
<td>-93.264</td>
<td>66548</td>
<td>City</td>
<td>Minneapolis</td>
<td>MN</td>
</tr>
<tr>
<td>40.7142</td>
<td>-74.006</td>
<td>85948</td>
<td>City</td>
<td>New York</td>
<td>NY</td>
</tr>
<tr>
<td>38.9922</td>
<td>-94.671</td>
<td>42171</td>
<td>City</td>
<td>Overland Park</td>
<td>KS</td>
</tr>
<tr>
<td>39.9922</td>
<td>-75.164</td>
<td>110328</td>
<td>City</td>
<td>Philadelphia</td>
<td>PA</td>
</tr>
<tr>
<td>33.4483</td>
<td>-112.073</td>
<td>6610</td>
<td>City</td>
<td>Phoenix</td>
<td>AZ</td>
</tr>
<tr>
<td>29.4239</td>
<td>-98.493</td>
<td>123723</td>
<td>City</td>
<td>San Antonio</td>
<td>TX</td>
</tr>
<tr>
<td>37.7750</td>
<td>-122.418</td>
<td>14956</td>
<td>City</td>
<td>San Francisco</td>
<td>CA</td>
</tr>
<tr>
<td>47.6064</td>
<td>-122.331</td>
<td>142724</td>
<td>City</td>
<td>Seattle</td>
<td>WA</td>
</tr>
</tbody>
</table>

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
output to 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.

```sas
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=

**Other features:**
- Base SAS functions
- SAS DATA step
- PRINT procedure

**Data set:** MAPSGFK.WORLD_CITIES.

**Sample library member:** GEOWCITY

**Notes:**
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) 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.
Chapter 9 • GEOCODE Procedure

Output 9.5  The GEOCODED_CITIES Output Data Set with CITY Method Variables

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
**Example 5: World City Geocoding**

Johannesburg, , ZAF
;
run;

```sas
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 SAS MapsOnline ([http://support.sas.com/rnd/datavisualization/mapsonline/html/downloads.html](http://support.sas.com/rnd/datavisualization/mapsonline/html/downloads.html)), 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.**

```sas
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 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.

```sas
proc geocode
   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.

```sas
proc print data=geocoded_cities noobs;
run;
```

**Example 6: ZIP+4 Geocoding**

**Features:** PLUS4 geocoding method

**Procedure Options**
- METHOD=  
- LOOKUP=  
- DATA=  
- OUT=  

**Other features:** Base SAS functions  
- SAS DATA step  
- PRINT procedure

**Data set:** lookup.zip4 (from SAS MapsOnline)

**Sample library member:** GEOZIP4

**Notes:** The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) 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 SAS MapsOnline (http://support.sas.com/rnd/datavisualization/mapsonline/html/downloads.html). You can also

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 9.6 The GEOCODED_CUSTOMERS Output Data Set with PLUS4 Method Variables

<table>
<thead>
<tr>
<th>Y</th>
<th>X</th>
<th>M_OBS</th>
<th><em>MATCHED</em></th>
<th>name</th>
<th>city</th>
<th>state</th>
<th>zip</th>
<th>plus4</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.7472</td>
<td>-78.6747</td>
<td>3615346</td>
<td>ZIP+4</td>
<td>J. Cheever Loop hole</td>
<td>Raleigh</td>
<td>NC</td>
<td>27603</td>
<td>2681</td>
</tr>
<tr>
<td>29.7709</td>
<td>-95.7551</td>
<td>1332415</td>
<td>ZIP+4</td>
<td>Cathbert J. Twillie</td>
<td>Katy</td>
<td>TX</td>
<td>77450</td>
<td>3438</td>
</tr>
<tr>
<td>39.7424</td>
<td>-75.6931</td>
<td>2563375</td>
<td>ZIP+4</td>
<td>Kenneth Gutman</td>
<td>Wilmington</td>
<td>DE</td>
<td>19808</td>
<td>1927</td>
</tr>
<tr>
<td>39.7800</td>
<td>-75.9762</td>
<td>2482283</td>
<td>ZIP+4</td>
<td>Dr. Hugo Z. Hackenbush</td>
<td>Oxford</td>
<td>PA</td>
<td>19363</td>
<td>1735</td>
</tr>
<tr>
<td>35.1726</td>
<td>-78.0432</td>
<td>ZIP mean</td>
<td>Charlie Allnut</td>
<td>Mount Olive</td>
<td>NC</td>
<td>28655</td>
<td>2377</td>
<td></td>
</tr>
<tr>
<td>35.9124</td>
<td>-75.4265</td>
<td>2574984</td>
<td>ZIP+4</td>
<td>Larson E. Wipmsnade</td>
<td>Millford</td>
<td>DE</td>
<td>19953</td>
<td>1941</td>
</tr>
<tr>
<td>27.4986</td>
<td>-92.5750</td>
<td>22387</td>
<td>City</td>
<td>Guillermo Urgarte</td>
<td>Bradenton</td>
<td>FL</td>
<td>32908</td>
<td>2208</td>
</tr>
<tr>
<td>38.4044</td>
<td>-75.2211</td>
<td>2579988</td>
<td>ZIP+4</td>
<td>Capt. Geoffrey Spaulding</td>
<td>Selbyville</td>
<td>DE</td>
<td>19975</td>
<td>7504</td>
</tr>
<tr>
<td>38.4019</td>
<td>-75.0534</td>
<td>ZIP mean</td>
<td>Joel Cairo</td>
<td>Fenwick Island</td>
<td>DE</td>
<td>19944</td>
<td>4001</td>
<td></td>
</tr>
<tr>
<td>39.1706</td>
<td>-75.7132</td>
<td>2571936</td>
<td>ZIP+4</td>
<td>Charles Blotzer</td>
<td>Hardy</td>
<td>DE</td>
<td>19953</td>
<td>3141</td>
</tr>
<tr>
<td>29.9972</td>
<td>-98.0963</td>
<td>129544</td>
<td>City</td>
<td>Rufus T. Firefly</td>
<td>Wilmington</td>
<td>TX</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39.2262</td>
<td>-75.6658</td>
<td>2572140</td>
<td>ZIP</td>
<td>Otis B. Driftwood</td>
<td>Kinston</td>
<td>NC</td>
<td>19855</td>
<td>53</td>
</tr>
<tr>
<td>39.6120</td>
<td>-75.8452</td>
<td>2888389</td>
<td>ZIP+4</td>
<td>Gordon Miller</td>
<td>Ellenton</td>
<td>MD</td>
<td>21921</td>
<td>5335</td>
</tr>
</tbody>
</table>

Program

libname lookup 'pathname';

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;
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 'pathname' in the following
LIBNAME statement to reference the lookup data location on your system.

libname lookup 'pathname';

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;

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;
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=
- Other features:
  - Base SAS functions
  - SAS DATA step
  - PRINT procedure

**Data set:**
- lookup.postcodes (Postcode lookup data from MapsOnline)

**Sample library member:**
- GEOZIPUK

**Notes:**
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) 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 SAS MapsOnline (http://support.sas.com/rnd/datavisualization/mapsonline/html/downloads.html). Instructions for downloading and importing the British Royal Mail postcodes are included with the
%CODEPOINT2GEOCODE macro program. See “Non-U.S. Postcodes” on page 151 for details.

Output

The following output from the PRINT procedure shows the GEOCODED_OFFICES output data set after running the GEOCODE procedure.

**Output 9.7 The GEOCODED_OFFICES Output Data Set with ZIP Method Variables**

<table>
<thead>
<tr>
<th>Y</th>
<th>X</th>
<th>Y_DMS</th>
<th>X_DMS</th>
<th>M_OBS</th>
<th>MATCHED</th>
<th>name</th>
<th>city</th>
<th>postcode</th>
<th>country</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.4762</td>
<td>-2.29362</td>
<td>53° 29' 12.59&quot;</td>
<td>-2° 17' 40.65&quot;</td>
<td>877702</td>
<td>ZIP</td>
<td>Quay Plaza</td>
<td>Manchester</td>
<td>M50 3BA</td>
<td>UK</td>
</tr>
<tr>
<td>51.5573</td>
<td>-0.81686</td>
<td>51° 33' 26.39&quot;</td>
<td>0° 49' 06.68&quot;</td>
<td>1356011</td>
<td>ZIP</td>
<td>Wittington House</td>
<td>Buckinghamshire</td>
<td>SL2 2EB</td>
<td>UK</td>
</tr>
<tr>
<td>50.2639</td>
<td>-0.52021</td>
<td>55° 51' 49.83&quot;</td>
<td>-4° 15' 18.77&quot;</td>
<td>535160</td>
<td>ZIP</td>
<td>Tara House</td>
<td>Glasgow</td>
<td>G2 1HG</td>
<td>UK</td>
</tr>
<tr>
<td>51.5172</td>
<td>-0.08385</td>
<td>51° 31' 01.76&quot;</td>
<td>0° 09' 01.87&quot;</td>
<td>460699</td>
<td>ZIP</td>
<td>New Broad Street</td>
<td>London</td>
<td>EC2M 1NH</td>
<td>UK</td>
</tr>
</tbody>
</table>

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 ‘pathname’ in the following LIBNAME statement to reference the lookup data location on your system.

    libname lookup 'pathname'; /* Location of British postcode lookup data */

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=

Other features: Base SAS functions
SAS DATA step
PRINT procedure

Data set: lookup.postcodes (Postcode lookup data from MapsOnline)

Sample library member: GEOZIPAU

Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) 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 SAS MapsOnline (http://support.sas.com/rnd/datavisualization/mapsonline/html/downloads.html). Instructions for downloading and importing the Australian postcodes are included with the %ABS2GEOCODE macro program. See “Non-U.S. Postcodes” on page 151 for details.

Output
The following output from the PRINT procedure shows the GEOCODED_STADIUMS output data set after running the GEOCODE procedure.

Output 9.8 The GEOCODED_STADIUMS Output Data Set with ZIP Method Variables

<table>
<thead>
<tr>
<th>y</th>
<th>x</th>
<th>M_OBS</th>
<th>_MATCHED</th>
<th>team</th>
<th>stadium</th>
<th>city</th>
<th>state</th>
<th>postcode</th>
</tr>
</thead>
<tbody>
<tr>
<td>-33.8393</td>
<td>151.067</td>
<td>150</td>
<td>ZIP</td>
<td>South Sydney Rabbitohs</td>
<td>ANZ Stadium</td>
<td>Sydney</td>
<td>New South Wales</td>
<td>2127</td>
</tr>
<tr>
<td>-33.8915</td>
<td>151.229</td>
<td>43</td>
<td>ZIP</td>
<td>Sydney Roosters</td>
<td>Sydney Football Stadium</td>
<td>Moore Park</td>
<td>New South Wales</td>
<td>2021</td>
</tr>
<tr>
<td>-33.8393</td>
<td>151.067</td>
<td>150</td>
<td>ZIP</td>
<td>Canterbury Bulldogs</td>
<td>ANZ Stadium</td>
<td>Sydney</td>
<td>New South Wales</td>
<td>2127</td>
</tr>
<tr>
<td>-33.8152</td>
<td>151.008</td>
<td>158</td>
<td>ZIP</td>
<td>Parramatta Eels</td>
<td>Parramatta Stadium</td>
<td>Sydney</td>
<td>New South Wales</td>
<td>2150</td>
</tr>
<tr>
<td>-33.7400</td>
<td>151.256</td>
<td>111</td>
<td>ZIP</td>
<td>Manly-Warringah Sea Eagles</td>
<td>Brookvale Oval</td>
<td>Brookvale</td>
<td>New South Wales</td>
<td>2100</td>
</tr>
<tr>
<td>-34.0647</td>
<td>151.146</td>
<td>224</td>
<td>ZIP</td>
<td>Cronulla-Sutherland Sharks</td>
<td>Toyota Park</td>
<td>Woolloomooloo</td>
<td>New South Wales</td>
<td>2230</td>
</tr>
<tr>
<td>-33.7508</td>
<td>150.679</td>
<td>557</td>
<td>ZIP</td>
<td>Penrith Panthers</td>
<td>Centrepoint Stadium</td>
<td>Penrith</td>
<td>New South Wales</td>
<td>2750</td>
</tr>
<tr>
<td>-35.2284</td>
<td>149.092</td>
<td>475</td>
<td>ZIP</td>
<td>Canberra Raiders</td>
<td>Canberra Stadium</td>
<td>Bruce</td>
<td>Australian Capital Territory</td>
<td>2617</td>
</tr>
<tr>
<td>-27.4646</td>
<td>153.000</td>
<td>1360</td>
<td>ZIP</td>
<td>Brisbane Broncos</td>
<td>Suncorp Stadium</td>
<td>Milton</td>
<td>Queensland</td>
<td>4064</td>
</tr>
<tr>
<td>-32.9206</td>
<td>151.736</td>
<td>254</td>
<td>ZIP</td>
<td>Newcastle Knights</td>
<td>Hunter Stadium</td>
<td>New Castle</td>
<td>New South Wales</td>
<td>2292</td>
</tr>
<tr>
<td>-19.4336</td>
<td>146.212</td>
<td>1704</td>
<td>ZIP</td>
<td>North Queensland Cowboys</td>
<td>Dairy Farmers Stadium</td>
<td>Townsville</td>
<td>Queensland</td>
<td>4817</td>
</tr>
<tr>
<td>-37.8114</td>
<td>144.965</td>
<td>661</td>
<td>ZIP</td>
<td>Melbourne Storm</td>
<td>AAMI Park</td>
<td>Melbourne</td>
<td>Victoria</td>
<td>3000</td>
</tr>
<tr>
<td>-33.9717</td>
<td>151.141</td>
<td>211</td>
<td>ZIP</td>
<td>St. George Illawarra Dragons</td>
<td>WIN Jubilee Oval</td>
<td>Carlton</td>
<td>New South Wales</td>
<td>2217</td>
</tr>
<tr>
<td>-34.1641</td>
<td>150.802</td>
<td>433</td>
<td>ZIP</td>
<td>Wests Tigers</td>
<td>Campbelltown Stadium</td>
<td>Leumeah</td>
<td>New South Wales</td>
<td>2560</td>
</tr>
<tr>
<td>-33.8760</td>
<td>151.159</td>
<td>62</td>
<td>ZIP</td>
<td>Wests Tigers</td>
<td>Leichhardt Oval</td>
<td>Leichhardt</td>
<td>New South Wales</td>
<td>2040</td>
</tr>
<tr>
<td>-33.8915</td>
<td>151.229</td>
<td>43</td>
<td>ZIP</td>
<td>Wests Tigers</td>
<td>Sydney Football Stadium</td>
<td>Sydney</td>
<td>New South Wales</td>
<td>2021</td>
</tr>
<tr>
<td>-28.0626</td>
<td>153.389</td>
<td>1449</td>
<td>ZIP</td>
<td>Gold Coast Titans</td>
<td>Skilled Park</td>
<td>Gold Coast</td>
<td>Queensland</td>
<td>4226</td>
</tr>
</tbody>
</table>

Program

    libname lookup 'pathname'; /* Location of Australian postcode lookup data */

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
South 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, Wollongong, 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
Canberra Raiders, 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 'pathname' in the following LIBNAME statement to reference the lookup data location on your system.

libname lookup 'pathname'; /* Location of Australian postcode lookup data */

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 */
postal_code; /* 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, Woonooloo, 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;
Overview: GINSIDE Procedure

Starting with SAS 9.4M6, 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. 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.
Syntax: GINSIDE Procedure

Restriction: This procedure is not included in SAS Viya-only installation, nor can it use data that has been processed in CAS. For more information, see “Plotting a Cloud Analytic Services (CAS) In-Memory Table” in SAS/GRAPH: Reference.

Requirement: • 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=\texttt{output-data-set} specifies the output data set for the GINSIDE procedure.

**Required Arguments**

**DATA=\texttt{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.

<table>
<thead>
<tr>
<th>Default</th>
<th>By default, the procedure uses the most recently created SAS data set.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restriction</td>
<td>This statement is required if no points data set was created before issuing the PROC GINSIDE statement.</td>
</tr>
<tr>
<td>Note</td>
<td>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.</td>
</tr>
</tbody>
</table>

**MAP=\texttt{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.

<table>
<thead>
<tr>
<th>Alias</th>
<th>DMV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default</td>
<td>The default behavior is to keep all map data set variables and this option overrides it.</td>
</tr>
<tr>
<td>See</td>
<td>“KEEPMAPVARS” on page 212</td>
</tr>
</tbody>
</table>

**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 211

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 211 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.

---

**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

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

**Other features:**
- SAS DATA step with assignment statements
- SORT procedure
- PRINT procedure

**Data sets:**
- MAP=SSAS.COUNTIES (map data set)
- GPSCOUNTIES (created data set)

**Sample library member:**
- GINSIDE2

**Notes:**
- The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
- The SAS-supplied map data set(s) 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 10.1 PROC PRINT Results of Output Data Set**

<table>
<thead>
<tr>
<th>Obs</th>
<th>site</th>
<th>STATE</th>
<th>COUNTY</th>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>a</td>
<td>42</td>
<td>133</td>
<td>1.34451</td>
<td>0.69892</td>
</tr>
<tr>
<td>2</td>
<td>b</td>
<td>54</td>
<td>27</td>
<td>1.36910</td>
<td>0.68351</td>
</tr>
<tr>
<td>3</td>
<td>c</td>
<td>54</td>
<td>27</td>
<td>1.36854</td>
<td>0.68723</td>
</tr>
<tr>
<td>4</td>
<td>d</td>
<td>42</td>
<td>21</td>
<td>1.37470</td>
<td>0.70922</td>
</tr>
</tbody>
</table>

**Program**

```sas
goptions reset=global border;
data gpscounties;
  input longitude latitude site $;
  x=longitude*arccos(-1)/180;
  x=x*(-1);
  y=latitude*arccos(-1)/180;
datalines;
-77.0348 40.0454 a
```
Example 1: Determining Values By Using the GINSIDE Procedure

-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 MAPSSAS 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;
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

Other features:
- SAS DATA step with assignment statements
- GPROJECT procedure
- PRINT procedure
- GMAP procedure

Data sets:
- MAPSSAS.COUNTIES (map data set)
- MYMAP (created data set)
- CUSTOMERS (created data set)

Sample library member: GINSIDE

Notes:
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. In that case, you can download the map data set from the Maps Online website.
The SAS-supplied map data set(s) 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. This example is featured in the SAS Sample Library under the name GINSIDE.

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 the last two observations in the printed table have missing values for COUNTY because they are not in Wake County.

```
Program

options reset=global border;

data customers;
  length city $20;
  input lastname$ zip x y city $;

datelines;
  Smith  27611 1.374164 0.623436 Raleigh
  Jones  27560 1.375948 0.625278 Morrisville
  Doe    27513 1.375279 0.624922 Cary
  Patel  27520 1.369120 0.621970 Clayton
  White  27705 1.377910 0.628629 Durham
  Short  27587 1.370373 0.627680 WakeForest
  Phillips 27591 1.368124 0.624705 Wendell
  Jackson 27597 1.367264 0.625629 Zebulon
;
run;
```
data mymap;
  set mapssas.counties(where=(fipstate(state)='NC' and county=183));
run;

data combined;
  set customers mymap;
run;

proc gproject data=combined out=combined dupok;
  id state county;
run;

data mymap customers;
  set combined;
  if missing(zip) = 1 then output mymap;
  else output customers;
run;

proc ginside map=mymap data=customers out=customers;
  id state county;
run;

proc print data=customers;
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 'X Represents Customers Outside Wake County';
pattern1 v=s c=graydd;

proc gmap data=mymap map=mymap anno=customers;
  id state county;
  choro county / stat=sum coutline=black nolegend;
run;
quit;

Program Description

Set the graphics environment.

goptions reset=global border;
Create the CUSTOMERS data set. The X and Y variables represent the unprojected longitude and latitude values in radians.

```sas
data customers;
  length city $20;
  input lastname$ zip x y city $;
datalines;
Smith    27611 1.374164 0.623436 Raleigh
Jones    27560 1.375948 0.625278 Morrisville
Doe      27513 1.375279 0.624922 Cary
Patel    27520 1.369120 0.621970 Clayton
White    27705 1.377910 0.628629 Durham
Short    27587 1.370373 0.627680 WakeForest
Phillips 27591 1.368124 0.624705 Wendell
Jackson  27597 1.367264 0.625629 Zebulon;
run;
```

Create the MYMAP data set of Wake County in North Carolina. Use the MAPSSAS libref to access the counties map data set. The FIPS county number for Wake is 183.

```sas
data mymap;
  set mapssas.counties(where=(fipstate(state)='NC' and county=183));
run;
```

Combine the CUSTOMERS and MYMAP data sets just created.

```sas
data combined;
  set customers mymap;
run;
```

Project the map and points data sets to both use Cartesian coordinates.

```sas
proc gproject data=combined out=combined dupok;
id state county;
run;
```

Split the data.

```sas
data mymap customers;
  set combined;
  if missing(zip) = 1 then output mymap;
  else output customers;
run;
```

Determine which customer points fall inside or outside of the county. Note that GINSIDE can be run before or after the GPROJECT procedure.

```sas
proc ginside map=mymap data=customers out=customers;
id state county;
run;
```

Print the resulting data.

```sas
proc print data=customers;
run;
```
Add annotations to the CUSTOMERS data set, using 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 'X Represents Customers Outside 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=sum coutline=black nolegend;
run;
quit;
Chapter 11

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 11.1 on page 224 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.

The program for this map is in “Example 1: Using GfK GeoMarketing Map Data to Produce a Simple Block Map” on page 316. For more information about producing block maps, see “BLOCK Statement” on page 256.

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 252.

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 11.2 on page 225 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.
The program for this map is in “Example 9: Using GfK GeoMarketing Map Data to Produce a Simple Choropleth Map” on page 336.

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 69. For more information about producing choropleth maps, see “CHORO Statement” on page 270.

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 11.3 on page 226 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 11.3  Prism Map

The program for this map is in “Example 15: Using GfK GeoMarketing Map Data to Produce a Simple Prism Map” on page 351. For more information about producing prism maps, see “PRISM Statement” on page 280.

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 252.

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 11.4 on page 227 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.
The program for this map is in “Example 19: Using GfK GeoMarketing Map Data to Produce a Simple Surface Map” on page 360. For more information about producing surface maps, see “SURFACE Statement” on page 293.

About Map Data Sets

Map Data Set

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. GfK GeoMarketing digital, vector-based map data sets are available for use in addition to the traditional map data sets. All of the content in the traditional map data sets are represented in the GfK map data sets, and GfK also provides additional data. SAS licensed the 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 239.

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 Online. See “Accessing SAS Maps Online” on page 245 for details about downloading data updates, sample SAS/GRAPH programs, and GIF images of maps.

About Traditional Map Data Sets

**Background**

Traditional map data sets 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 option to point to either the traditional map data set library MAPSSAS or the GfK map data set library 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 12, “GPROJECT Procedure,” on page 389).

**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:

```sas
proc contents data=maps.chile; /*<libref.datasetname> */
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...
Advantages to Using GfK Map Data Sets

There are some key advantages to using GfK instead of traditional map data sets, including:

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 matches seamlessly with SAS/GRAPH map data sets.

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 Online (http://support.sas.com/rnd/datavisualization/mapsonline/index.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 APGHANIS 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 US states.

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 an _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:

Table 11.1  Notable Eliminated Map Data Sets and Data Sets

<table>
<thead>
<tr>
<th>Traditional (MAPSSAS)</th>
<th>GfK GeoMarketing (MAPSGFK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USCITY</td>
<td>USCITY</td>
</tr>
<tr>
<td><strong>Note:</strong> 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.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Note:</strong> Includes towns, villages, hamlets, and other non-city areas that can have the same name as a city. Does not include a FEATYPE variable.</td>
</tr>
<tr>
<td>USCITY_ALL</td>
<td>USCITY_ALL</td>
</tr>
<tr>
<td><strong>Note:</strong> Includes Puerto Rico and the U.S. Virgin Islands.</td>
<td></td>
</tr>
<tr>
<td>COUNTIES</td>
<td>US_COUNTIES</td>
</tr>
<tr>
<td><strong>Note:</strong> Includes counties that can have the same name as a city.</td>
<td></td>
</tr>
<tr>
<td>COUNTY</td>
<td>None</td>
</tr>
<tr>
<td>USCOUNTY</td>
<td>None</td>
</tr>
<tr>
<td>CNTYNAME</td>
<td>US_COUNTIES_ATTR</td>
</tr>
<tr>
<td>STATES</td>
<td>US_STATES</td>
</tr>
<tr>
<td>US</td>
<td>US</td>
</tr>
<tr>
<td>US2</td>
<td>US_STATES_ATTR</td>
</tr>
<tr>
<td>USCENTER</td>
<td>USCENTER</td>
</tr>
<tr>
<td><strong>Note:</strong> Includes Washington, D.C.</td>
<td></td>
</tr>
<tr>
<td>USCENTER_ALL</td>
<td>USCENTER_ALL</td>
</tr>
<tr>
<td><strong>Note:</strong> Includes Puerto Rico and the U.S. Virgin Islands.</td>
<td></td>
</tr>
<tr>
<td>All data set names beginning with USA</td>
<td>None</td>
</tr>
</tbody>
</table>

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:

```sas
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>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable Description</th>
<th>Traditional Map Data Set Details</th>
<th>GfK Map Data Set Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>DENSITY</td>
<td>Contains the density values returned from a GREDUCE procedure.</td>
<td>Might contain.</td>
<td>Does contain.</td>
</tr>
<tr>
<td>ID</td>
<td>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.</td>
<td>Might contain. (Numeric format)</td>
<td>Does contain. Character (Length 15 for all map data sets that contain this variable, regardless of the length of the value actually being stored)</td>
</tr>
<tr>
<td>IDNAME</td>
<td>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.</td>
<td>Does not contain.</td>
<td>Does contain.</td>
</tr>
<tr>
<td>IDNAMEU**</td>
<td>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.</td>
<td>Does not contain.</td>
<td>Might contain.</td>
</tr>
<tr>
<td>Variable Name</td>
<td>Variable Description</td>
<td>Traditional Map Data Set Details</td>
<td>GfK Map Data Set Details</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>---------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>ID1, ID2</td>
<td>A character state or province code in _ATTR map data sets.</td>
<td>Does not contain.</td>
<td>Might contain.</td>
</tr>
<tr>
<td>ID1NAME</td>
<td>A character state or province name in _ATTR map data sets.</td>
<td>Does not contain.</td>
<td>Might contain.</td>
</tr>
<tr>
<td>ID1NAMEU</td>
<td>A Unicode escape format character version of ID1NAME in _ATTR map data sets.</td>
<td>Does not contain.</td>
<td>Might contain.</td>
</tr>
<tr>
<td>!ISO</td>
<td>A character country or region code in _ATTR map data sets.</td>
<td>Does not contain.</td>
<td>Does contain.</td>
</tr>
<tr>
<td>ISOALPHA2, ISOALPHA3</td>
<td>A character country or region International Organization for Standardization Alpha2– or Alpha3– code in _ATTR map data sets.</td>
<td>Does not contain.</td>
<td>Does contain.</td>
</tr>
<tr>
<td>ISONAME</td>
<td>A character country or region International Organization for Standardization name in _ATTR map data sets.</td>
<td>Does not contain.</td>
<td>Does contain.</td>
</tr>
</tbody>
</table>

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.
<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable Description</th>
<th>Traditional Map Data Set Details</th>
<th>GfK Map Data Set Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAT</td>
<td>A numeric variable containing the vertical coordinate of the boundary point. (The value of this variable is unprojected and represents latitude (north-south position).</td>
<td>Might contain. (The value of the variable is in radians or degrees.)</td>
<td>Does contain. (The value of the variable is in degrees.)</td>
</tr>
<tr>
<td>LONG</td>
<td>A numeric variable containing the horizontal coordinate of the boundary point. (The value of this variable is unprojected and represents longitude (east-west position).</td>
<td>Might contain. (The value of the variable is in radians or degrees. Positive values indicate west.)</td>
<td>Does contain. (The value of the variable is in degrees. Positive values indicate east.)</td>
</tr>
<tr>
<td>RESOLUTION</td>
<td>A numeric map detail level from 1 to 10 that is based on desired output display resolution.</td>
<td>Does not contain.</td>
<td>Does contain.</td>
</tr>
<tr>
<td>STATE</td>
<td>State FIPS code.</td>
<td>Might contain. (Numeric FIPS code.)</td>
<td>Might contain. (Numeric.)</td>
</tr>
<tr>
<td>Note: Variable occurs only in U.S. data sets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>A numeric variable that contains the horizontal coordinates of the boundary points.</td>
<td>Does contain. (The longitudinal value can either be projected or unprojected.)</td>
<td>Does contain. (The value is always projected and represents longitude.)</td>
</tr>
<tr>
<td>Y</td>
<td>A numeric variable that contains the vertical coordinates of the boundary points</td>
<td>Does contain. (The latitudinal value can either be projected or unprojected.)</td>
<td>Does contain. (The value is always projected and represents latitude.)</td>
</tr>
</tbody>
</table>

* 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), PH_VN (Philippines and Vietnam), or SR_GY (Suriname and Guyana).

** 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 display correctly when run in a SAS Polish session. The characters do not display correctly when run in a SAS English UTF-8 session. Data sets provided for a few other locales have a similar situation.
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:

```sas
data my_attr;
set mapsgfk.reunion_attr;
Unicode_idname=input(IDNAMEU, $uesc50.);
run;
```

```sas
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 character variable value. 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.

**Eliminated Variables**

The following table describes the traditional map data set variables that are not used in the GfK map data sets, as well as their replacement, where applicable, in the GfK map data sets:

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable Description</th>
<th>Traditional Map Data Set Details</th>
<th>GfK Map Data Set Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDCODE</td>
<td>Census District.</td>
<td>Does contain. (Character format)</td>
<td>Does not contain.</td>
</tr>
<tr>
<td>CONT</td>
<td>Continent.</td>
<td>Does contain. (Numeric format)</td>
<td>Does contain. (Numeric format)</td>
</tr>
<tr>
<td></td>
<td>Note: Used in all the continent and WORLD map data sets.</td>
<td>Note: Used in all the continent_ATTR, WORLD, and WORLD_ATTR map data sets.</td>
<td></td>
</tr>
</tbody>
</table>
### Differences between GfK and Traditional Map Data Sets

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>
<thead>
<tr>
<th>RESOLUTION VALUE</th>
<th>NUMBER OF PIXELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>320 x 240</td>
</tr>
<tr>
<td>2</td>
<td>400 x 300</td>
</tr>
<tr>
<td>3</td>
<td>640 x 480</td>
</tr>
<tr>
<td>4</td>
<td>800 x 600</td>
</tr>
<tr>
<td>5</td>
<td>1280 x 1024</td>
</tr>
<tr>
<td>6</td>
<td>1600 x 1200</td>
</tr>
<tr>
<td>7</td>
<td>2400 x 1800</td>
</tr>
<tr>
<td>8</td>
<td>6000 x 4800</td>
</tr>
</tbody>
</table>

---

**Variable Name** | **Variable Description** | **Traditional Map Data Set Details** | **GfK Map Data Set Details**
---|---|---|---
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)
PROVINCE | Character abbreviation for a province. | Might contain. (Character format) | Does not contain. Replaced by the ID variable in character 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 11.3  RESOLUTION Variable Values*
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** concatenates 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:

```plaintext
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 239 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 \( \text{LAT} \) and \( \text{LONG} \) variables are in degrees and not radians.
- the positive values of the \( \text{LONG} \) variable go east from the prime meridian. In the traditional map data sets, the positive values go west.
- the \( \text{ID}, \text{ID1}, \text{and ID2} \) 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 313 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, which 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:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{VAR}x )</td>
<td>identifies the name of the variable in the data set, where ( x ) is a numerical value.</td>
</tr>
<tr>
<td>( \text{LABEL}x )</td>
<td>describes ( \text{VAR}x ) in the data set.</td>
</tr>
<tr>
<td>MEMNAME</td>
<td>identifies the names of all of the data sets that are delivered in the MAPS or MAPSSAS library.</td>
</tr>
</tbody>
</table>

**Special GfK Data Sets for Annotating Maps**

There are several data sets in the MAPSGFK library that enable you to easily label 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 \( \text{LAT} \) and \( \text{LONG} \) variables provided in the MAPSGFK data set. Use the
Chapter 12, “GPROJECT Procedure,” on page 389 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 Online 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 69 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 11.4  Displaying Map Areas and Response Data

<table>
<thead>
<tr>
<th>Characteristic of the response data set</th>
<th>Additional variables</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes the map area.</td>
<td>The map area has a response value.</td>
<td>The procedure draws the map area and displays the response data.</td>
</tr>
<tr>
<td>Includes the map area.</td>
<td>The response value for the map area is a missing value.</td>
<td>The procedure draws the map area but leaves it empty.</td>
</tr>
<tr>
<td>Includes the map area.</td>
<td>The response value for the map area is a missing value and the MISSING option is used in the map statement.</td>
<td>The procedure draws the map area and displays a response level for the missing value.</td>
</tr>
<tr>
<td>Includes the map area.</td>
<td>The map area has a response value and the MAP= option and the DATA= statement specify the same map data set.</td>
<td>The procedure draws the map area and displays boundary outlines but does not display the value of the response variable or variables.</td>
</tr>
<tr>
<td>Does not include the map area.</td>
<td>The ALL option is used in the PROC GMAP statement.</td>
<td>The procedure draws the map area but leaves it empty.</td>
</tr>
<tr>
<td>Does not include the map area.</td>
<td>The ALL option is not used.</td>
<td>The procedure does not draw the map area.</td>
</tr>
</tbody>
</table>
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 Online

Visit SAS Maps 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 Online is located at the following URL: http://support.sas.com/rnd/datavisualization/mapsonline/index.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 “Transporting and Converting Graphics Output” in SAS/GRAPH: Reference.

Importing Maps from Esri Shapefiles

Starting with SAS 9.4M5, you can import Esri shapefiles as map data sets by using the Base SAS MAPIMPORT procedure. Prior to SAS 9.4M5, this procedure is part of SAS/GRAPH, and you must have SAS/GRAPH installed to use it. Depending on the type of coordinates that are in your shapefile, you might want to perform additional processing. SAS 9.4M6: For example, you might want to project the map with the Base SAS GPROJECT procedure, or use the Base SAS GREDUCE procedure to create a DENSITY variable for reducing your data. Prior to SAS 9.4M6, the GPROJECT procedure and the GREDUCE procedure were part of SAS/GRAPH, and you had to have SAS/GRAPH installed to use either of them.

For more information, see Chapter 15, “MAPIMPORT Procedure,” on page 451.
Restrictions: This procedure is not included in SAS Viya-only installation, nor can it use data that has been processed in CAS. For more information, see “Plotting a Cloud Analytic Services (CAS) In-Memory Table” in SAS/GRAPH: Reference.

A SAS LASR Analytic server should not be used as the repository for map data sets. Essential data sequencing is lost as the data is distributed amongst this server’s nodes.

Requirement: • An input map data set is required. If not specified, an input map data set must have been created before issuing the PROC GMAP statement.

• A response data set is required. 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

Global statements: TITLE, FOOTNOTE, NOTE, LEGEND, PATTERN, GOPTIONS

Supports: RUN-group processing

Note: The procedure can include the SAS/GRAPH statements BY on page 43 and NOTE on page 80, as well as the Base SAS statements FORMAT, LABEL, and WHERE. See “SAS/GRAPH Statements” in SAS/GRAPH: Reference and SAS DATA Step Statements: 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 </option(s)>;
   BLOCK response-variable(s) </option(s)>;
   CHORO response-variable(s) </option(s)>;
   PRISM response-variable(s) </option(s)>;
   SURFACE response-variable(s) </option(s)>;

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 227

### 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 244

**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**

- “Using Annotate Data Sets” in *SAS/GRAPH: Reference*

**DENSITY=** 0 | LOW | MEDIUM | HIGH

for maps that have a DENSITY variable, specifies the density of map observations that are used. 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.
Intuitively, 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.

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.

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.

### Alias

| 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 13, “GREDUCE Procedure,” on page 423 for information about the DENSITY variable.

“RESOLUTION=1 …10 | AUTO | NONE” on page 250

### Example

“Example 15: Using GfK GeoMarketing Map Data to Produce a Simple Prism Map” on page 351

---

**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 Java and 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 418

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. 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. Specifying AUTO defaults to the resolution setting of the device being used in the GMAP procedure. 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 11.3 on page 237 for the correlation between the RESOLUTION value and the number of pixels displayed.

Example

“Example 1: Using GfK GeoMarketing Map Data to Produce a Simple Block Map” on page 316

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 Java and 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.

Restriction

Not supported by Java.

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 244

Examples

“Example 1: Using GfK GeoMarketing Map Data to Produce a Simple Block Map” on page 316

“Example 5: Using GfK GeoMarketing Map Data to Assign a Format to the Response Variable” on page 325

“Example 9: Using GfK GeoMarketing Map Data to Produce a Simple Choropleth Map” on page 336

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 [/ option(s)];
```

**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 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
causes GMAP to 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=\texttt{format-specification}
overrides the GMAP default format for percent of PERCENT8.2.

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for GMAP to chart.

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.

\textbf{Required Argument}
\textit{response-variable}

\textit{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 242

\textbf{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 LEVELS=\texttt{number of midpoints} option is ignored when you use the DISCRETE option.

If you specify the DISCRETE option, then distinct, non-continuous colors are used for the response values. If you specify the LEVELS= 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.

LEGEND=\texttt{LEGEND<1 ...99>}
specifies the 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 49 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 Java and ActiveX
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.

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:

- $n < ... n$
- $n \text{ TO } n < \text{BY increment}>$
- $n < ... n \text{ TO } n < \text{BY increment}> <n< ... n>$

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. With numeric response values, DEVICE=JAVA uses only midpoints that fall in the range of the data being used. Thus, if your data ranged from 30–80, but midpoints were specified at 25, 50, 75, and 100, only 50 and 75 are used.

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. Character response values specified with the MIDPOINTS= option are not supported by DEVICE=JAVA.

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.


**Restriction** Partially supported by Java

**See** The RANGE option

**MISSING**
accepts a missing value as a valid level for the response variable.

**NOLEGEND**
suppresses the legend.

**PERCENT**
causes GMAP to collect all response values (or their statistic) and chart each region as a percentage of the whole. 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.

**Alias** PERCENTAGE

**See** The “STATFMT=format-specification” on page 255, and the “STATISTIC=FIRST | SUM | FREQUENCY | MEAN” on page 255.

**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.

**Alias** SFMT=, SFORMAT=, STATFORMAT=

**STATISTIC=FIRST | SUM | FREQUENCY | MEAN**
specifies the statistic for GMAP to chart. For nonnumeric 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.

**Restriction**

Not supported by Java.

**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.

Global statements: FOOTNOTE, LEGEND, PATTERN, TITLE,

Syntax

BLOCK response-variable(s) <\ option(s)>

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>

YSIZE=map-height <units>
specify the physical dimensions of the map to be drawn.

XVIEW=x
YVIEW=y
ZVIEW=z
specify coordinates of the viewing position in the reference coordinate system.

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 \ldots 99>
specifies the LEGEND statement to associate with the map.

NOLEGENDen
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
causes GMAP to 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 GMAP 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 242.

**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 “Using Annotate Data Sets” 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.

**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.

**AREA=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.

See “AREA Statement” on page 252, “PATTERN Statement” on page 69.

**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=\textit{block-outline-color} | \textit{SAME}

Outlines all blocks in the specified color. The \textit{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. If you specified the \texttt{NOGSTYLE} system option, then the default color is black for Java and ActiveX and the first color in the color list for all other devices.

The \texttt{CBLKOUT=} option is not valid when \texttt{SHAPE=CYLINDER}.

Alias \texttt{CBLOCK=}

Restriction Partially supported by Java

Note If you specify empty block patterns (\texttt{VALUE=EMPTY} in a \texttt{PATTERN} statement), you should not change the outline color from the default value, \textit{SAME}, to a single color. Otherwise, all the outlines are one color and you can distinguish between empty areas only by their size. Empty block patterns (\texttt{VALUE=EMPTY} in a \texttt{PATTERN} statement) are not supported by \texttt{DEVICE=JAVA}.

CDEFAULT=\textit{empty-area-fill-color}

Fills empty map areas in the specified color. This option affects only 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 \texttt{ALL} option is included in the \texttt{PROC GMAP} statement.

The default is \texttt{NONE}, which draws the polygon empty, showing the background in the fill area of the polygon.

Alias \texttt{CDEF=}, \texttt{DEFCLR=}

Restriction Not supported by Java

See The \texttt{CEMPTY} option, the \texttt{“ALL” on page 248} option, and “Displaying Map Areas and Response Data” on page 244.

CEMPTY=\textit{empty-area-outline-color}

Outlines empty map areas in the specified color. This option affects only 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 \texttt{ALL} option is included in the \texttt{PROC GMAP} statement.

The default outline color is the same as the default \texttt{COUTLINE=} color.

Alias \texttt{CE=}

Restriction Not supported by Java

See The option \texttt{“ALL” on page 248} and “Displaying Map Areas and Response Data” on page 244.

COUTLINE=\textit{area-outline-color} | \textit{SAME}

Outlines non-empty map areas in the specified color. When \texttt{COUTLINE=area-outline-color} and \texttt{DEVICE=JAVA} or \texttt{ACTIVEX}, both empty and nonempty map areas are outlined. The \textit{SAME} value 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. If you specified the NOGSTYLE system option, then the default color is black for Java and ActiveX and the first color in the color list for all other devices.

Alias        CO=

Restriction  Partially supported by Java

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. Empty block patterns (VALUE=EMPTY in a PATTERN statement) are not supported by DEVICE=JAVA.

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.
- if you specify NOGSTYLE, then the default color is black for Java and ActiveX and the first color in the color list for all other devices.

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 window.
- the description and properties for the catalog entry in the Explorer.
- the Description field of the PROC GREPLAY window.

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 98. 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 LEVELS=number-of-response-levels option is ignored when you use the DISCRETE option.

If you specify the DISCRETE option, then distinct, non-continuous colors are used for the response values. If 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.

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 Java and ActiveX

See “Adding Links and Enhancements with the URL=, HTML=, and HTML_LEGEND= Options” in SAS/GRAPH: Reference

LEGEND=LEGEND<1 ...99>
specifies the 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 49 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 Java and ActiveX

See “LEGEND Statement” on page 49
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).

Note If you specified the NOGSTYLE system option, then noncontinuous colors are used by default.

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. With numeric response values, DEVICE=JAVA uses only midpoints that fall in the range of the data being used. Thus, if your data ranged from 30–80, but midpoints were specified at 25, 50, 75, and 100, only 50 and 75 are used.
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. Character response values specified with the MIDPOINTS= option are not supported by DEVICE=JAVA.
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.


Restriction Partially supported by Java

See The RANGE option

Example “Example 17: Using GfK GeoMarketing Map Data When Specifying Midpoints in a Prism Map” on page 355

MISSING

accepts a missing value as a valid level for the response variable.

See “Displaying Map Areas and Response Data” on page 244.

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, `name1`, `name2`, 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 an ODS LISTING destination, a DEVICE= option, and a file reference specifying an output filename. In this case, the file reference specification overrides the NAME= value. See “Controlling Graphics Output for ODS LISTING” in SAS/GRAPH: Reference.
  - 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.

**Note:** If the name begins with a number, an underscore is prepended to the filename.

- 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.

**CEMPTY=**\(\text{empty-area-outline-color}\)

outlines empty map areas in the specified color. This option affects only 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 outline color is the same as the default COUTLINE= color.

**Alias**

**CE=**

**Restriction**

Not supported by Java

**See**

The option “ALL” on page 248 and “Displaying Map Areas and Response Data” on page 244.

**COUTLINE=**\(\text{area-outline-color} \mid \text{SAME}\)

outlines non-empty map areas in the specified color. When COUTLINE=\(\text{area-outline-color}\) and DEVICE=JAVA or ACTIVEX, both empty and nonempty map areas are outlined. The SAME value 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. If you specified the NOGSTYLE system option, then the default color is black for Java and ActiveX and the first color in the color list for all other devices.

**Alias**

**CO=**

**Restriction**

Partially supported by Java

**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. Empty block patterns (VALUE=EMPTY in a PATTERN statement) are not supported by DEVICE=JAVA.

**PERCENT**

causes GMAP to 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.
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. 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 bars have no height.

Alias REL0, RELATIVETOZERO

Restrictions This option works only for variables that have no negative values.

Not supported by Java

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
- PRISM | P
- STAR | S

SHAPE=BLOCK is the default. 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.

The CBLKOUT= option is not valid when SHAPE=CYLINDER.

Default BLOCK

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= option is used.

Alias SFMT=, SFORMAT=, STATFORMAT=

STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for GMAP 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.

<table>
<thead>
<tr>
<th>Alias</th>
<th>STAT=</th>
</tr>
</thead>
</table>

**Example**
“Example 7: Using GfK GeoMarketing Map Data When Specifying the Statistic for the Response Variable” on page 332

**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.

<table>
<thead>
<tr>
<th>Alias</th>
<th>STRETCHTOFIT, STR2FIT</th>
</tr>
</thead>
</table>

**Restriction**
Not supported by Java and 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.

<table>
<thead>
<tr>
<th>Restriction</th>
<th>Not supported by Java</th>
</tr>
</thead>
</table>

**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 1

**XSISE=** *map-width <units>*

**YSIZE=** *map-height <units>*

specify the physical dimensions 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* or *map-height* that are greater than the dimensions of the procedure output area, the map is drawn using the default size.

**Restriction** Not supported by Java and ActiveX

**XVIEW=** *x*

**YVIEW=** *y*

**ZVIEW=** *z*

specify coordinates of the viewing position in the reference coordinate system. In this system, 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 PROC GMAP. 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.

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. You can specify one, two, or all three of the view coordinates; any that you do not specify are assigned the default values. Although you can use the XVIEW= and YVIEW= options with DEVICE=JAVA, ZVIEW= cannot be used with DEVICE=JAVA.

Figure 11.5 on page 269 shows the position of the viewing reference point, as well as the default viewing position.
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 269 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.

Note: If you specified the NOGSTYLE system option, then solid patterns are used for blocks and hatch patterns are used for the map areas. The map areas and their outlines use the first color in the color list.
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 69 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.

```
pat1 color=blue;
```

Note: Empty block patterns (VALUE=EMPTY in a PATTERN statement) are not supported by DEVICE=JAVA.

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

**Global statements:** FOOTNOTE, NOTE, LEGEND, PATTERN, TITLE

**Syntax**

```
CHORO response-variable(s) / option(s);
```

**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 dimensions 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 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
causes GMAP to 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 GMAP 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 242.

**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.
Restriction Not supported by Java

See The CEMPTY option, the “ALL” on page 248, and “Displaying Map Areas and Response Data” on page 244

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.

The default outline color is the same as the default COUTLINE= color.

Alias CE=

Restriction Not supported by Java

See The option “ALL” on page 248 and “Displaying Map Areas and Response Data” on page 244.

COUTLINE=area-outline-color | SAME outlines non-empty map areas in the specified color. When COUTLINE=area-outline-color and DEVICE=JAVA or 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. If you specified the NOGSTYLE system option, then the default color is black for Java and ActiveX and the first color in the color list for all other devices.

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.
- If you specified the NOGSTYLE system option, then the default color is black for Java and ActiveX and the first color in the color list for all other devices.

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 window.

• the description and properties for the catalog entry in the Explorer.

• the Description field of the PROC GREPLAY window.

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 98. 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.

If you specify the DISCRETE option, then distinct, non-continuous colors are used for the response values. If 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.

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 Java and 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 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 49 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 Java and ActiveX

**See**  “LEGEND Statement” on page 49

**Example**  “Example 5: Using GfK GeoMarketing Map Data to Assign a Format to the Response Variable” on page 325

**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.

By default, an equal-distribution (quantizing) algorithm is used to determine each level.

When MIDPOINTS=OLD is used with the LEVELS= option, default midpoints are generated using the Nelder algorithm (*Applied Statistics* 25:94–7, 1976).

**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.

**Note**  If you specified the NOGSTYLE system option, then noncontinuous colors are used by default.

**Example**  “Example 3: Using GfK GeoMarketing Map Data to Specify Response Levels in a Block Map” on page 321
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. With numeric response values, DEVICE=JAVA uses only midpoints that fall in the range of the data being used. Thus, if your data ranged from 30–80, but midpoints were specified at 25, 50, 75, and 100, only 50 and 75 are used.

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. Character response values specified with the MIDPOINTS= option are not supported by DEVICE=JAVA.

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.


Restriction
Partially supported by Java

See
The RANGE option

Example
“Example 17: Using GfK GeoMarketing Map Data When Specifying Midpoints in a Prism Map” on page 355

MISSING
accepts a missing value as a valid level for the response variable.

See
“Displaying Map Areas and Response Data” on page 244

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, name1, name2, 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 an ODS LISTING destination, a DEVICE= option, and a file reference specifying an output filename. In this case, the file reference specification overrides the NAME= value. See “Controlling Graphics Output for ODS LISTING” in *SAS/GRAPH: Reference*.
- 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*.

*Note:* If the name begins with a number, an underscore is prepended to the filename.

- 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 12: Using GfK GeoMarketing Map Data When Labeling Provinces on a Map” on page 345

**OSM**

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, or use either a STYLE= suboption or an AUTOPROJECT suboption, or 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 JAVA and JAVAIMG devices.

If the map area is already projected, do not specify the AUTOPROJECT suboption, or you will receive unexpected results.

### PERCENT
causes GMAP to 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 278 and the “STATISTIC=FIRST | SUM | FREQUENCY | MEAN” on page 279.

### 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.

### Alias
SFMT=, SFORMAT=, STATFORMAT=
STATISTIC=FIRST | SUM | FREQUENCY | MEAN
specifies the statistic for GMAP 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.

Alias STRETCHTOFIT, STR2FIT

Restriction Not supported by Java and 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.

Restriction Not supported by Java

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  1

XSIZE=map-width <units>
YSIZE=map-height <units>
specify the physical dimensions of the map. 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 units that are greater than the dimensions of the procedure output area, the map is drawn using the default size.

You can specify only one of the XSIZE= or YSIZE= options. In this case the GMAP procedure scales the dimension for the unspecified option in order to retain the original shape of the map.

Restriction  Not supported by Java and 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.

Global statements: FOOTNOTE, NOTE, LEGEND, PATTERN, TITLE

Syntax

PRISM response-variable(s) <\ option(s)>;

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>
YSIZE=map-height <units>
specify the dimensions of the map that you are drawing.

XVIEW=x
YVIEW=y
ZVIEW=z
specify the viewing position coordinates for 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
LEGEND=LEGEND<1 ...99>
specifies the 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
causes GMAP to 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 GMAP 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 242.

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. Annotate coordinate systems 1, 2, 7, and 8 are not valid with Prism maps.

**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.

**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.

**AREA=column-name**
A column name defined in either the MAP= or DATA= data sets can 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.

**CDEFAULT=empty-area-fill-color**
fills empty map areas in the specified color. This option affects only map areas that are empty. Empty map areas are generated in prism 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.

**Alias**   
CDEF=, DEFCLR=

**Restriction**   
Not supported by Java

**See**   
The CEMPTY option, the “ALL” on page 248, and “Displaying Map Areas and Response Data” on page 244

**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**   
Not supported by Java

**See**   
“ALL” on page 248 and “Displaying Map Areas and Response Data” on page 244

**CDEFAULT=empty-area-fill-color**   
fills empty map areas in the specified color. This option affects only map areas that are empty. Empty map areas are generated in prism 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.

**Alias**   
CDEF=, DEFCLR=

**Restriction**   
Not supported by Java

**See**   
The CEMPTY option, the “ALL” on page 248, and “Displaying Map Areas and Response Data” on page 244

**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.

The default outline color is determined by the current style. If you specified the NOGSTYLE system option, then the default color is the first color in the color list.

**Alias**   
CO=

**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. Empty block patterns (VALUE=EMPTY in a PATTERN statement) are not supported by DEVICE=JAVA.

**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.
- If you specified the NOGSTYLE system option, then the default color is black for Java and ActiveX and the first color in the color list for all other devices.

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.

**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 window.
- the description and properties for the output in the Catalog window.
- the Description field of the PROC GREPLAY window.

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 98. 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 LEVELS=number-of-response-levels option is ignored when you use the DISCRETE option.

If you specify the DISCRETE option, then distinct, non-continuous colors are used for the response values. If 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.

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 Java and ActiveX

See “Adding Links and Enhancements with the URL=, HTML=, and HTML_LEGEND= Options” in SAS/GRAPH: Reference

**LEGEND=LEGEND<1 …99>**
specifies the LEGEND definition to associate with the map. LEGEND= is ignored if the specified LEGEND definition is not currently in effect. In the GMAP procedure, the PRISM 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 49 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 Java and ActiveX

See “LEGEND Statement” on page 49

Example: “Example 17: Using GfK GeoMarketing Map Data When Specifying Midpoints in a Prism Map” on page 355

**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. 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.

When MIDPOINTS=OLD is used with the LEVELS= option, default midpoints are generated using the Nelder algorithm (Applied Statistics 25:94–7, 1976).

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 3: Using GfK GeoMarketing Map Data to Specify Response Levels in a Block Map” on page 321

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. With numeric response values, DEVICE=JAVA uses only midpoints that fall in the range of the data being used. Thus, if your data ranged from 30–80, but midpoints were specified at 25, 50, 75, and 100, only 50 and 75 are used.

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. Character response values specified with the MIDPOINTS= option are not supported by DEVICE=JAVA.

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.

**Restriction**

Partially supported by Java

**See**

The RANGE option

**Example**

“Example 17: Using GfK GeoMarketing Map Data When Specifying Midpoints in a Prism Map” on page 355

**MISSING**

accepts a missing value as a valid level for the response variable.

**See**

“Displaying Map Areas and Response Data” on page 244

**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, name1, name2, 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 an ODS LISTING destination, a DEVICE= option, and a file reference specifying an output filename. In this case, the file reference specification overrides the NAME= value. See “Controlling Graphics Output for ODS LISTING” in *SAS/GRAPH: Reference*.
- 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*.

**Note:** If the name begins with a number, an underscore is prepended to the filename.
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**

causes GMAP to 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 289, and the “**STATISTIC=FIRST | SUM | FREQUENCY | MEAN**” on page 289.

**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 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.

Alias **REL0, RELATIVETOZERO**

Restrictions This option works only for variables that have no negative values.

Not supported by Java

**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.

Alias **SFMT=, SFORMAT=, STATFORMAT=**

**STATISTIC=FIRST | SUM | FREQUENCY | MEAN**

specifies the statistic for GMAP 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.

Alias STRETCHTOFIT, STR2FIT

Restriction Not supported by Java and 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.

Restriction Not supported by Java

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 `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 11.5 on page 291 shows how the point that you specify is positioned.

**Table 11.5 Light Source Coordinates**

<table>
<thead>
<tr>
<th>Specified light source</th>
<th>Light source position</th>
</tr>
</thead>
<tbody>
<tr>
<td>In quadrants I or II, or on the X or +Y axis</td>
<td>Behind the map (point A), and all side polygons are shadowed</td>
</tr>
<tr>
<td>On or within approximately 10 degrees of the Y axis</td>
<td>The viewing position (point D), and none of the side polygons are shadowed</td>
</tr>
<tr>
<td>In quadrant III (except within 10 degrees of the Y axis)</td>
<td>To the left of the map (point B), and the right-facing sides of polygons are shadowed</td>
</tr>
<tr>
<td>In quadrant IV (except within 10 degrees of the Y axis)</td>
<td>To the right of the map (point C), and the left-facing side polygons are shadowed</td>
</tr>
</tbody>
</table>

Figure 11.6 on page 292 illustrates the light source positions. Assume that your viewing position, selected by the XVIEW=, YVIEW=, and ZVIEW= options, is point D.
By default, the light source position is the same as the viewing position specified by the XVIEW=, YVIEW=, and ZVIEW= options. 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.

Restriction: Not supported by Java and ActiveX

See “XVIEW=x YVIEW=y ZVIEW=z” on page 292

\[\text{XSIZE=map-width <units>}\]
\[\text{FSIZE=map-height <units>}\]

specify the dimensions of the map that you are drawing. 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.

Restriction: Not supported by Java and ActiveX

\[\text{XVIEW=x}\]
\[\text{YVIEW=y}\]
\[\text{ZVIEW=z}\]

specify the viewing position coordinates for the map. In this system, the four corners of the map lie on the X–Y plane at coordinates \((0, 0, 0)\), \((0, 1, 0)\), \((1, 1, 0)\), and \((1, 0, 0)\).

The viewing position cannot coincide with the viewing reference point at coordinates \((0.5, 0.5, 0)\).

The value for \(z\) cannot be negative.
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. One, two, or all three view coordinates can be specified; any that are not specified are assigned the default values.

Figure 11.5 on page 269 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. Although you can use the XVIEW= and YVIEW= options with DEVICE=JAVA, ZVIEW= cannot be used with DEVICE=JAVA.

 Alias XV=, YV=, ZV=

 Restriction Partially supported by Java

 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 Java and 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.

 Global statement: TITLE, FOOTNOTE, NOTE

 Syntax

 SURFACE response-variable(s) < / option(s)>;
### 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>**
  **YSIZE=map-height <units>**
  specify the physical dimensions 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.

**Mapping options**

- **PERCENT**
  causes GMAP to collect all response values (or their statistic) and chart each region as a percentage of the whole.

- **STATFMT=format-specification**
  overrides the GMAP default format for percent of PERCENT8.2.

- **STATISTIC=FIRST | SUM | FREQUENCY | MEAN**
  specifies the statistic for GMAP 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 242.
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. Annotate coordinate systems 1, 2, 7, and 8 are not valid with surface maps.

Alias ANNO=
See “Using Annotate Data Sets” in SAS/GRAPH: Reference

CBODY=surface-map-color
specifies the color that is used to draw the surface map. Regardless of the current ODS style, the default color is the first color in the current color list.

Alias CB=

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.

By default, CONSTANT=10. 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=

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 window.
- the description and properties for the catalog entry in the Explorer.
- the Description field of the PROC GREPLAY window.

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 98. 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, `name1`, `name2`, 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 an ODS LISTING destination, a DEVICE= option, and a file reference specifying an output filename. In this case, the file reference specification overrides the NAME= value. See “Controlling Graphics Output for ODS LISTING” in *SAS/GRAPH: Reference*.
- 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*.

*Note:* If the name begins with a number, an underscore is prepended to the filename.

- 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. By default, NLINES=50.

**Alias**

```
N=
```

**PERCENT**

causes GMAP to 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=formatSpecification” on page 297, and the “STATISTIC=FIRST | SUM | FREQUENCY | MEAN” on page 297.

**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 argument can be any angle. Positive values indicate rotation in the counterclockwise direction. By default, ROTATE=70. The ROTATE= option also affects the direction of the lines that are used to draw the surface map.

**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.

Alias SFMT=, SFORMAT=, STATFORMAT=

**STATISTIC=FIRST | SUM | FREQUENCY | MEAN**

specifies the statistic for GMAP 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. Increasing values cause the map to tilt backward and makes the spikes more prominent. Decreasing values 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. By default, TILT=70.

**XSIZE=map-width <units>**

**YSIZE=map-height <units>**

specify the physical dimensions of the map. 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. And if you specify only one dimension, the other is scaled to maintain the aspect ratio.

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.

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 11.6 on page 298 lists the FIPS codes for the United States and Table 11.7 on page 300 lists 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 11.6  U.S. FIPS Codes

<table>
<thead>
<tr>
<th>FIPS code</th>
<th>State</th>
<th>FIPS code</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Alabama</td>
<td>30</td>
<td>Montana</td>
</tr>
<tr>
<td>02</td>
<td>Alaska</td>
<td>31</td>
<td>Nebraska</td>
</tr>
<tr>
<td>04</td>
<td>Arizona</td>
<td>32</td>
<td>Nevada</td>
</tr>
<tr>
<td>FIPS code</td>
<td>State</td>
<td>FIPS code</td>
<td>State</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------</td>
<td>-----------</td>
<td>---------------</td>
</tr>
<tr>
<td>05</td>
<td>Arkansas</td>
<td>33</td>
<td>New Hampshire</td>
</tr>
<tr>
<td>06</td>
<td>California</td>
<td>34</td>
<td>New Jersey</td>
</tr>
<tr>
<td>08</td>
<td>Colorado</td>
<td>35</td>
<td>New Mexico</td>
</tr>
<tr>
<td>09</td>
<td>Connecticut</td>
<td>36</td>
<td>New York</td>
</tr>
<tr>
<td>10</td>
<td>Delaware</td>
<td>37</td>
<td>North Carolina</td>
</tr>
<tr>
<td>11</td>
<td>District of Columbia</td>
<td>38</td>
<td>North Dakota</td>
</tr>
<tr>
<td>12</td>
<td>Florida</td>
<td>39</td>
<td>Ohio</td>
</tr>
<tr>
<td>13</td>
<td>Georgia</td>
<td>40</td>
<td>Oklahoma</td>
</tr>
<tr>
<td>15</td>
<td>Hawaii</td>
<td>41</td>
<td>Oregon</td>
</tr>
<tr>
<td>16</td>
<td>Idaho</td>
<td>42</td>
<td>Pennsylvania</td>
</tr>
<tr>
<td>17</td>
<td>Illinois</td>
<td>44</td>
<td>Rhode Island</td>
</tr>
<tr>
<td>18</td>
<td>Indiana</td>
<td>45</td>
<td>South Carolina</td>
</tr>
<tr>
<td>19</td>
<td>Iowa</td>
<td>46</td>
<td>South Dakota</td>
</tr>
<tr>
<td>20</td>
<td>Kansas</td>
<td>47</td>
<td>Tennessee</td>
</tr>
<tr>
<td>21</td>
<td>Kentucky</td>
<td>48</td>
<td>Texas</td>
</tr>
<tr>
<td>22</td>
<td>Louisiana</td>
<td>49</td>
<td>Utah</td>
</tr>
<tr>
<td>23</td>
<td>Maine</td>
<td>50</td>
<td>Vermont</td>
</tr>
<tr>
<td>24</td>
<td>Maryland</td>
<td>51</td>
<td>Virginia</td>
</tr>
<tr>
<td>25</td>
<td>Massachusetts</td>
<td>53</td>
<td>Washington</td>
</tr>
<tr>
<td>26</td>
<td>Michigan</td>
<td>54</td>
<td>West Virginia</td>
</tr>
<tr>
<td>27</td>
<td>Minnesota</td>
<td>55</td>
<td>Wisconsin</td>
</tr>
<tr>
<td>28</td>
<td>Mississippi</td>
<td>56</td>
<td>Wyoming</td>
</tr>
<tr>
<td>29</td>
<td>Missouri</td>
<td>72</td>
<td>Puerto Rico</td>
</tr>
</tbody>
</table>
### Table 11.7 Canadian Province Codes

<table>
<thead>
<tr>
<th>Province code</th>
<th>Province</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Newfoundland and Labrador</td>
</tr>
<tr>
<td>11</td>
<td>Prince Edward Island</td>
</tr>
<tr>
<td>12</td>
<td>Nova Scotia</td>
</tr>
<tr>
<td>13</td>
<td>New Brunswick</td>
</tr>
<tr>
<td>24</td>
<td>Quebec</td>
</tr>
<tr>
<td>35</td>
<td>Ontario</td>
</tr>
<tr>
<td>46</td>
<td>Manitoba</td>
</tr>
<tr>
<td>47</td>
<td>Saskatchewan</td>
</tr>
<tr>
<td>48</td>
<td>Alberta</td>
</tr>
<tr>
<td>59</td>
<td>British Columbia</td>
</tr>
<tr>
<td>60</td>
<td>Yukon</td>
</tr>
<tr>
<td>61</td>
<td>Northwest Territories</td>
</tr>
<tr>
<td>62</td>
<td>Nunavut</td>
</tr>
</tbody>
</table>

**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 11.8 FIPS and SAS Postal Code Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STFIPS</td>
<td>Converts state postal code to FIPS state code</td>
</tr>
<tr>
<td>STNAME</td>
<td>Converts state postal code to state name in uppercase</td>
</tr>
<tr>
<td>STNAMEL</td>
<td>Converts state postal code to state name in mixed case</td>
</tr>
<tr>
<td>FIPNAME</td>
<td>Converts FIPS code to state name in uppercase</td>
</tr>
</tbody>
</table>
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:

```sas
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.

*Note:* If the input to a format is invalid, the format is “***” or “****”.

**Table 11.9  Formats for Maps**

<table>
<thead>
<tr>
<th>FORMAT</th>
<th>DESCRIPTION</th>
<th>EXAMPLE</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>contfmt</td>
<td>Use a continent's numeric value to output the continent's name</td>
<td>cont= 91 put(cont,contfmt.);</td>
<td>North America</td>
</tr>
<tr>
<td>glcna</td>
<td>Use the country's GLC numeric code to output the country's GLC alpha code</td>
<td>id=460 put(id,glcna.);</td>
<td>IR</td>
</tr>
<tr>
<td>FORMAT</td>
<td>DESCRIPTION</td>
<td>EXAMPLE</td>
<td>OUTPUT</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>glcnlu</td>
<td>Use the GLC numeric code to output the country's long name in uppercase</td>
<td>id=460</td>
<td>IRAN, ISLAMIC REPUBLIC OF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(id,glcnlu.);</td>
<td></td>
</tr>
<tr>
<td>glcnsu</td>
<td>Use the GLC numeric code to output the country's short name in uppercase</td>
<td>id=460</td>
<td>IRAN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(id,glcnsu.);</td>
<td></td>
</tr>
<tr>
<td>glcnsm</td>
<td>Use the GLC numeric code to output the country's name in mixed case</td>
<td>id=460</td>
<td>Iran</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(id,glcnsm.);</td>
<td></td>
</tr>
<tr>
<td>ison2a</td>
<td>Use the country's ISO numeric code to output the country's ISO alpha2 code</td>
<td>iso=364</td>
<td>IR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(iso,ison2a.);</td>
<td></td>
</tr>
<tr>
<td>ison3a</td>
<td>Use the country's ISO numeric code to output the country's ISO alpha3 code</td>
<td>iso=364</td>
<td>IRN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(iso,ison3a.);</td>
<td></td>
</tr>
<tr>
<td>isonlu</td>
<td>Use the country's ISO numeric code to output the country's long name in uppercase</td>
<td>iso=364</td>
<td>IRAN, ISLAMIC REPUBLIC OF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(iso,isonlu.);</td>
<td></td>
</tr>
<tr>
<td>isonsu</td>
<td>Use the country's ISO numeric code to output the country's short name in uppercase</td>
<td>iso=364</td>
<td>IRAN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(iso,isonsu.);</td>
<td></td>
</tr>
<tr>
<td>$cntrysl</td>
<td>Use a country's short name in uppercase to output the country's long name in uppercase</td>
<td>name='IRAN'</td>
<td>IRAN, ISLAMIC REPUBLIC OF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(name,$cntrysl.);</td>
<td></td>
</tr>
<tr>
<td>$glcalu</td>
<td>Use the GLC alpha code to output the country's long name in uppercase</td>
<td>country='IR'</td>
<td>IRAN, ISLAMIC REPUBLIC OF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(country,$glcalu.);</td>
<td></td>
</tr>
<tr>
<td>$glcan</td>
<td>Use the country's GLC alpha code to output the country's GLC numeric code</td>
<td>country='IR'</td>
<td>460</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(country,$glcan.);</td>
<td></td>
</tr>
<tr>
<td>$glcsua</td>
<td>Use the country's short name in uppercase to output the GLC alpha code name</td>
<td>name='IRAN'</td>
<td>IR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>put(name,$glcsua.);</td>
<td></td>
</tr>
<tr>
<td>FORMAT</td>
<td>DESCRIPTION</td>
<td>EXAMPLE</td>
<td>OUTPUT</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>$glcsun</td>
<td>Use the country's short name in uppercase to output the country's GLC numeric code</td>
<td>name='IRAN' put(name,$glcsun.);</td>
<td>460</td>
</tr>
<tr>
<td>$glcsma</td>
<td>Use the country's short name in mixed-case to output the country's GLC alpha code</td>
<td>mixname='Iran' put(mixname,$glcsma.);</td>
<td>IR</td>
</tr>
<tr>
<td>$glcsmn</td>
<td>Use the country's short name in mixed-case to output the country's GLC numeric code</td>
<td>mixname='Iran' put(mixname,$glcsmn.);</td>
<td>460</td>
</tr>
<tr>
<td>$glcprov</td>
<td>Use a province or city name appended by</td>
<td></td>
<td>as a delimiter, followed by the country's GLC alpha code. This displays a province</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8250 — province or city code</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>460 — country GLC numeric code</td>
<td></td>
</tr>
<tr>
<td>$isosu2a</td>
<td>Use the country's short name in uppercase to display the country's ISO alpha2 code</td>
<td>name='IRAN' put(name,$isosu2a.);</td>
<td>IR</td>
</tr>
<tr>
<td>$isosu3a</td>
<td>Use the country's name in uppercase to display the country's ISO alpha3 code</td>
<td>name='IRAN' put(name,$isosu3a.);</td>
<td>IRN</td>
</tr>
<tr>
<td>$isosun</td>
<td>Use the country's short name in uppercase to display the country's ISO numeric code</td>
<td>name='IRAN' put(name,$isosun.);</td>
<td>364</td>
</tr>
<tr>
<td>$isoa2lu</td>
<td>Use the country's ISO alpha2 code to display the country's long name in uppercase</td>
<td>alpha2='IR' put(alpha2,$isoa2lu.);</td>
<td>IRAN, ISLAMIC REPUBLIC OF</td>
</tr>
<tr>
<td>$isoa2n</td>
<td>Use the country's ISO alpha2 code to display the country's ISO numeric code</td>
<td>alpha2='IR' put(alpha2,$isoa2n.);</td>
<td>364</td>
</tr>
<tr>
<td>$isoa2su</td>
<td>Use the country's ISO alpha2 code to display the country's short name in uppercase</td>
<td>alpha2='IR' put(alpha2,$isoa2su.);</td>
<td>IRAN</td>
</tr>
</tbody>
</table>
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 Online website at http://support.sas.com/rnd/datavisualization/mapsonline/index.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 105. 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 105 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 106.

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 107.

Accessing Detailed Descriptions of Map Data Sets

You might need detailed information about the map data sets in order to determine their type, size, the variables that they contain, or, in the case of traditional map data sets, whether they 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 239. 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 12, “GPROJECT Procedure,” on page 389.

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 14, “GREMOVE Procedure,” on page 435 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 13, “GREDUCE Procedure,” on page 423.

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 229. You should select a projection method that least distorts the regions that you are mapping. (All projection methods inherently distort map regions.) See Chapter 12, “GPROJECT Procedure,” on page 389 for more information.

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].
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 that is located completely within a single unit area. Occasionally these lakes can be a problem when working with map data sets. In addition, displaying lakes might not be appropriate for some applications. In these cases, you might want to remove the lakes 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 lakes and 0 otherwise. STAT=FIRST processes only the first observation that matches the geographic region. The following statements illustrate how to delete the lakes from your traditional map data sets using WHERE processing:

```sas
proc gmap map=maps.chile(where=(lake=0))
data=maps.chile;
id id;
choro id / levels=1 stat=first nolegend;
title box=1 f=none h=4
   "Chile with Lakes Removed";
run;
quit;
```

The following statements illustrate how to delete the lakes from your GfK map data sets using WHERE processing:

```sas
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:

```sas
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 229.

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 12, “GPROJECT Procedure,” on page 389 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 comprise 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 11.3 on page 237 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 be composed of 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:

```sas
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 11.7 on page 311:

```sas
data map;
  input id $ segment x y;
datalines;
square   1 0 0
square   1 4 4
square   1 4 0
square   2 5 5
square   2 5 7
square   2 7 7
square   2 7 5;
;```
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 11.8 on page 312:

```sas
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 11.7  Single Unit Area with Two Segments (Polygons)*
Figure 11.8  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 11.9 on page 313:

```r
   data map;
      input id $ segment x y;
   datalines;
   square   1 0 0
   square   1 0 4
```
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:

```sas
proc gmap data=mydata map=maps.afghanis;
id id;
choro id / nolegend;
run;
```

Figure 11.9  Unit Area within a Unit Area
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:

```sas
/* 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:

```sas
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:

```sas
/* 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:

```sas
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
In this 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**

**Example 1: Using GfK GeoMarketing Map Data to Produce 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**

**Other features:**
- 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.

**Sample library member:**
- GMPGSIMP

**Notes:**
- The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
- The SAS-supplied map data set(s) 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.
Example 1: Using GfK GeoMarketing Map Data to Produce a Simple Block Map

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';
quit;
goptions reset=all border;
title1 "Population in Asia";
legend1 label=(position=top) shape=bar(.3in,.1in); footnote1 j=r "This map drawn with GfK map data";
pattern1 value=msolid color=tan;

Population in Asia

This map drawn with GfK map data

Population (2005)

- 329,198 - 2,162,546
- 5,702,776 - 19,043,382
- 29,803,005 - 83,054,479
- 2,566,981 - 5,263,794
- 20,742,905 - 28,607,190
- 64,238,231 - 1,323,344,591

This map drawn with GfK map data
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';
quit;

Set the graphics environment.

goptions reset=all border;

Define the title, legend, footnote, 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);
footnote1 j=r "This map drawn with GfK map data";
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: Using Traditional Map Data to Produce a Simple Block Map**

**Features:**
- MAP= required argument referring to traditional map data set
- DATA= required argument referring to response data
- ID statement
- BLOCK statement options
  - BLOCKSIZE=
  - RELZERO

**Other features:**
- PATTERN statement

**Data sets:**
- MAPS.ASIA (map data set)
- SASHELP.DEMOGRAPHICS (response data)

**Sample library member:**
- GMPSIMPL

**Notes:**
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) 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=maps.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=maps.asia all;
   id id;
   block pop / blocksize=1 relzero;
run;
quit;
```

---

**Example 3: Using GfK GeoMarketing Map Data to Specify 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=

**Other features:**
- 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.

**Sample library member:** GMGPINGLEVL

**Notes:**
- The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
- The SAS-supplied map data set(s) 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

```plaintext
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';
quit;
goptions reset=all border;
title1 "Gross National Income per Capita";
title2 "South America";
footnote1 j=r "This map drawn with GfK map data";
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';
quit;

Set the graphics environment.

goptions reset=all border;

Define the titles, footnote, 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";
   footnote1 j=r "This map drawn with GfK map data";
   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 4: Using Traditional Map Data to Specify Response Levels in a Block Map

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=

Other features: PATTERN statement

Data sets: MAPS.SAMERICA (map data set)
           SASHELP.DEMOGRAPHICS (response data)

Sample library member: GMLEVEL

Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) 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";

    Gross National Income per Capita
    South America

Gross National Income per Capita (PPP Int $ 2004)
    2590 - 5370
    5560 - 8020
    9070 - 15060
Program Description

Set the graphics environment.

```
goptions reset=all border;
```

Define the titles, footnote, 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=maps.samerica all;
  id id;
  block gni / levels=3 shape=prism
    relzero cempty=gray;
run;
quit;
```
Other features: 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.

Sample library member: GMPGFRMT

Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
The SAS-supplied map data set(s) 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';
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)";
footnote j=r "This map drawn with GfK map data";
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';
   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.

```sas
proc format;
  value $ regionfmt "SEAR" = "South-East Asia"
      "EUR" = "Europe"
      "EMR" = "Eastern Mediterranean"
      "WPR" = "Western Pacific";
run;
```

Define the title, footnote, 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.

```sas
title1 "Population Data for Asia (2005)";
footnote j=r "This map drawn with GfK map data";
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.

```sas
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 SREGIONFMT. 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.

```sas
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;
```
ID statement
AREA statement option MIDPOINTS=
BLOCK statement options
   LEGEND=
   RELZERO

Other features:
FORMAT procedure
LEGEND statement
PATTERN statement

Data sets:
MAPS.ASIA (map data set)
SASHELP.DEMOGRAPHICS (response data)

Sample library member:
GMPFORMT

Notes:
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
The SAS-supplied map data set(s) 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.

Population Data for Asia (2005)
Program

goptions reset=all border;
proc format;
  value popfmt low-1000000="0-1"
     10000001-100000000="1-10"
     100000001-1000000000="10-100"
     1000000001-5000000000="100-500"
     5000000001-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=maps.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"
     10000001-100000000="1-10"
     100000001-1000000000="10-100"
     1000000001-5000000000="100-500"
     5000000001-high="over 500";
run;

Create a format for REGION. REGIONFMT. labels the values for REGION.

proc format;
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.

```sas
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.

```sas
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.

```sas
proc gmap data=sashelp.demographics(where=(cont=95))
   map=maps.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 7: Using GfK GeoMarketing Map Data When 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

- **Other features:**
  - PATTERN statement

- **Data sets:**
  - MAPSGFK.US (map data set)
  - SASHELP.ZIPCODE (response data)
Example 7: Using GfK GeoMarketing Map Data When Specifying the Statistic for the Response Variable

Restriction: The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

Sample library member: GMPGSTAT

Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) 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

```sas
options reset=all border;

title1 "Number of ZIP Codes per State";
footnote j=r "This map drawn with GfK map data";
pattern1 value=msolid color=tan;

proc gmap map=mapsgfk.us data=sashelp.zipcode all;
id state;
block zip / statistic=frequency
  levels=5
  relzero;
run;
```

The 5-digit ZIP Code (Frequency)

- 2 - 195
- 470 - 719
- 1055 - 2003
- 253 - 433
- 723 - 1023

This map drawn with GfK map data
Program Description

Set the graphics environment.

   goptions reset=all border;

Define the title, footnote, and color for the map.

   title1 "Number of ZIP Codes per State";
   footnote j=r "This map drawn with GfK map data";
   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 8: Using Traditional Map Data When Specifying the Statistic for the Response Variable

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

Other features:

   PATTERN statement

Data sets:

   MAPS.US (map data set)
   SASHELP.ZIPCODE (response data)

Sample library member:

   GMPSTAT

Notes:

   The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) used in this program might not be an available resource on your system.
Example 8: Using Traditional Map Data When Specifying the Statistic for the Response Variable

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=maps.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.

```sas
proc gmap map=maps.us data=sashelp.zipcode all;
  id state;
  block zip / statistic=frequency
    levels=5 relzero;
run;
quit;
```

Example 9: Using GfK GeoMarketing Map Data to Produce 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=

**Other features:**
- System option FMTSEARCH=
- SQL procedure

**Data sets:**
- MAPSGFK.EUROPE (map data set)
- DEMOGRAPHICS (table of response data)

**Format:**
- iso2a

**Restriction:**
The GfK GeoMarketing map data set used in this example is licensed to be used only with SAS/GRAPH.

**Sample library member:**
- GMPGCHOR

**Notes:**
- The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
- The SAS-supplied map data set(s) 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.

**Population in Europe**

![Population Map](image)

<table>
<thead>
<tr>
<th>Population (2005)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>28,117 - 1,329,697</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,147,901 - 5,400,908</td>
<td>1,966,814 - 3,607,074</td>
<td></td>
</tr>
<tr>
<td>5,430,590 - 9,755,105</td>
<td>10,097,731 - 16,299,173</td>
<td></td>
</tr>
<tr>
<td>21,711,472 - 82,689,210</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This map drawn with GfK map data

**Program**

```sas
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';
quit;

goptions reset=all border;
title1 "Population in Europe";
footnote j=r "This map drawn with GfK map data";
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.
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';
quit;

Set the graphics environment.

goptions reset=all border;

Define the title and the footnote for the map.

title1 "Population in Europe";
footnote j=r "This map drawn with GfK map data";

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 10: Using Traditional Map Data to Produce a Simple Choropleth Map

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: MAPS.EUROPE (map data set)
SASHELP.DEMOGRAPHICS (response data)

Sample library member: GMPCHORO

Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) 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=maps.europe(where=(id ne 405 and id ne 845))
   data=sashelp.demographics(where=(cont=93)) all;
Program Description

Set the graphics environment.

```sas
goptions reset=all border;
```

Define the title for the map.

```sas
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.

```sas
proc gmap map=maps.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 11: Using Traditional Map Data to Produce 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:**
- MAPSSAS.US (map data set)
- MYDATA (response data)

**Sample library member:**
- GMPCHORD
Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) 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 for North Carolina
Drilldown Map for **South Carolina**

Drilldown Map for **Virginia**

**Program**

```
%let name=map001;
filename odsout '.';
data mydata;
  format population comma12.0;
  input statecode $ 1-2 population;
```
year=2000;
statename=fipnamel(stfips(statecode));
datalines;
VA 7078515
NC 8049313
SC 4012012
;
run;
proc sort data=mydata out=mydata;
by statecode statename;
run;
data mydata; set mydata;
length htmlvar $500;
htmlvar='title='||quote(
   'State: '||trim(left(statename)) ||'0D'x||
   'Population: '|| trim(left(put(population,comma12.0)))
)||
   ' href="http://www.state.'||trim(left(lowcase(statecode)))||'.us"';
run;
goptions device=png gunit=pct htitle=6 htext=4 border;
ods _all_ close;
ods html path=odsout body="&name..htm" (title="SAS/Graph ODS HTML Drilldown Map")
   style=sasweb;
axis1 label=none;
axis2 label=none minor=none offset=(0,0);
pattern v=solid color=cx43a2ca;
options nobyline;
title1 "Drilldown Map for ",
   color=blue underlin=1
   link="http://www.state.#byval(statecode)_.us"
   alt="Click to drilldown to #byval(statename) home page"
   "#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="&name._#byval(statecode)"
run;
quit;
ods html close;
ods html;

Program Description

Set up the output filename.

%let name=map001;
filename odsout '.';
Create the response data set MYDATA with the U.S. states to map.

```sas
data mydata;
format population comma12.0;
input statecode $ 1-2 population;
year=2000;
statename=fipnamel(stfips(statecode));
datalines;
VA  7078515
NC  8049313
SC  4012012;
run;
```

Sort the response data.

```sas
proc sort data=mydata out=mydata;
by statecode statename;
run;
```

Set up the text when holding your mouse pointer over a highlighted state.

```sas
data mydata; set mydata;
length htmlvar $500;
htmlvar='title='||quote('State: '||trim(left(statename)) ||'0D'||'Population: '||trim(left(put(population,comma12.0)))) ||' href="http://www.state.'||trim(left(lowcase(statecode)))||'.us"';
run;
```

Set the graphics environment. The following ODS statements close all previously open destinations and store PNG output in your working directory. From there you can open the file in a web browser.

```sas
options nobyline;
title1 "Drilldown Map for ";
```

```sas
goptions device=png gunit=pct htitle=6 htext=4 border;
ods _all_ close;
ods html path=odsout body="&name..htm" (title="SAS/Graph ODS HTML Drilldown Map") style=sasweb;
```

Suppress the axis labels.

```sas
axis1 label=none;
axis2 label=none minor=none offset=(0,0);
```

Set the color to highlight the state.

```sas
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. The individual BY variables are used in the LINK= and ALT= option specifications. #BYVAL substitutes the current value of the BY variable, (statecode) or (statename), for #BYVAL in the text string and displays it.

```sas
options nobyline;
title1 "Drilldown Map for "
    color=blue underlin=1
```
 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.

```sas
proc gmap data=mydata map=mapssas.us all;
  by statecode statename;
  id statecode;
  choro population / levels=1 nolegend
      coutline=black
      html=htmlvar
      des=''
      name="&name._#byval(statecode)";
  run;
quit;
```

 Reset the graphics environment. Run ODS HTML to close the output file, and then reopen ODS HTML. Reopening the HTML destination is not required when running the code in SAS Studio.

```sas
ods html close;
ods html;
```

---

**Example 12: Using GfK GeoMarketing Map Data When 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=

**Other features:**
- 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.

**Sample library member:** GMPGLABL
Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) 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 Macro” in SAS/GRAPH: Reference.

Program

goptions reset=all border;

title "Labeling Provinces with the MAPLABEL Macro";
footnote j=r "This map drawn with GfK map data";

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, color=black, size=2.5, hsys=3);
Example 13: Using Traditional Map Data When Labeling Provinces on a Map

Features:

- **MAP=** required argument referring to a traditional map data set
- **DATA=** required argument referring to response data

```sas
proc gmap map=belarus data=belarus;
   id id1 id;
   choro id1 / nolegend annotate=labelout coutline=gray stat=first;
run;
quit;
```

**Program Description**

**Set the graphics environment.**

```sas
goptions reset=all border;
```

**Define the title and the footnote for the map.**

```sas
title "Labeling Provinces with the MAPLABEL Macro";
footnote j=r "This map drawn with GfK map data";
```

**Sort the GfK data by region and district variables.**

```sas
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.

```sas
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.

```sas
%annomac;
%maplabel (belarus_outline, mapsgfk.belarus_attr, work.labelout, id1name, id1, font=Albany AMT, color=black, size=2.5, hsys=3);
```

**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.

```sas
proc gmap map=belarus data=belarus;
   id id1 id;
   choro id1 / nolegend annotate=labelout coutline=gray stat=first;
run;
quit;
```
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 Macro” in *SAS/GRAPH: Reference*.

Program

```sas
goptions reset=all border;
title "Labeling Provinces with the MAPLABEL Macro";
```
pattern1 value=empty color=blue repeat=6;

%annomac;
%maplabel (maps.belarus, maps.belarus2, work.labelout, idname, id,
  font=Arial Black, color=crimson, size=4, hsys=3);

proc gmap map=maps.belarus data=maps.belarus;
id id;
  choro id / stat=sum 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 (maps.belarus, maps.belarus2, work.labelout, idname, id,
  font=Arial Black, color=crimson, 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=maps.belarus data=maps.belarus;
id id;
  choro id / stat=sum nolegend annotate=labelout;
run;
quit;

---

Example 14: 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)

Sample library member:
- GMPUSDAT

Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) 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;
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_2010 / levels=3 legend=legend1;
run;
quit;
```
Program Description

Set the graphics environment.

```sas
goptions reset=all border;
```

Define the title for the map.

```sas
title1 ls=1.5 "Using Sample U.S. Response Data";
```

Define the legend for the map.

```sas
legend1 label=position=top shape=bar(.1in,.1in);
```

Produce the choropleth map of the United States. 2010 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.

```sas
proc gmap data=sashelp.us_data map=mapssas.us;
  id state;
  choro density_2010 / levels=3 legend=legend1;
run;
quit;
```

Example 15: Using GfK GeoMarketing Map Data to Produce 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

**Other features:**
- 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.

**Sample library member:**
- GMPGPRSM

**Notes:**
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) used in this program might not be an available resource on your system.
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';
quit;
goptions reset=all border;
title1 "Population in Africa";
footnote1 j=r "This map drawn with GfK map data";
proc gmap data=demographics(where=(cont=94))
  map=mapsgfk.africa(where=(lake=0)) density=low 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.

```plaintext
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';
quit;
```

Set the graphics environment.

```plaintext
goptions reset=all border;
```

Define the title and footnote for the map

```plaintext
title1 "Population in Africa";
footnote1 j=r "This map drawn with GfK map data";
```

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.

```plaintext
proc gmap data=demographics(where=(cont=94))
    map=mapsgfk.africa(where=(lake=0)) density=low all;
id id;
prism pop / cdefault=yellow relzero;
run;
quit;
```

Example 16: Using Traditional Map Data to Produce a Simple Prism Map

**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**
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 maps.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 maps.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 17: Using GfK GeoMarketing Map Data When 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=

Other features:
   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.

Sample library member:
   GMPGMDPT

Notes:
   The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
   The SAS-supplied map data set(s) 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.

Adult Literacy Rate

[Image of a map showing adult literacy rate]
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';
quit;

goptions reset=all border;
title1 "Adult Literacy Rate";
footnote1 j=r "This map drawn with GfK map data";
proc gmap data=demographics(where=(cont=94))
map=mapsgfk.africa(where=(lake=0)) density=low 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';
quit;

Set the graphics environment.

goptions reset=all border;

Define the title and footnote for the map.
title1 "Adult Literacy Rate";
footnote1 j=r "This map drawn with GfK map data";

**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 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 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.

```sas
proc gmap data=demographics(where=(cont=94))
   map=mapsgfk.africa(where=(lake=0))
      density=low all;
   id id;
   format adultliteracy pct percentn5.0;
   prism adultliteracy pct / midpoints=.10 to .90 by .20
      cdefault=yellow;
run;
quit;
```

**Example 18: Using Traditional Map Data When Specifying Midpoints in a Prism Map**

**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=

**Other features:**
- SAS DATA step with assignment statements
- PERCENTN format

**Data sets:**
- MAPS.AFRICA (map data set)
- SASHELP.DEMOGRAPHICS (response data)

**Sample library member:**
- GMPMIDPT

**Notes:**
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) 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 maps.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.

```sas
data africa;
set maps.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.

```sas
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 19: Using GfK GeoMarketing Map Data to Produce 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=

**Other features:**
- 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.

**Sample library member:**
- GMPGSURF

**Notes:**
- The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
- The SAS-supplied map data set(s) 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';
quit;

goptions reset=all border;
title1 "Population Annual Growth Rate Percentage";
title2 "South America (1995-2005)";
footnote1 j=r "This map drawn with GfK map data";
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';
quit;

Set the graphics environment.

goptions reset=all border;

Define the titles and the footnote for the map

title1 "Population Annual Growth Rate Percentage";
title2 "South America (1995-2005)";
footnotet1 j=r "This map drawn with GfK map data";

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 20: Using Traditional Map Data to Produce a Simple Surface Map

Features: MAP= required argument referring to a traditional map data set
DATA= required argument referring to response data
ID statement
Example 20: Using Traditional Map Data to Produce a Simple Surface Map

Data sets:  MAPSSAS.SAMERICA (map data set)
            SASHELP.DEMOGRAPHICS (response data)

Sample library member:  GMPSURFA

Notes:  The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) 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

options reset=all border;

title1 "Population Annual Growth Rate Percentage";
title2 "South America (1995-2005)";

proc gmap map=mapssas.samerica data=sashelp.demographics;
   id id;

---

Population Annual Growth Rate Percentage
South America (1995-2005)
Program Description

Set the graphics environment.

```plaintext
goptions reset=all border;
```

Define the title for the map.

```plaintext
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.

```plaintext
proc gmap map=mapssas.samerica data=sashelp.demographics;
id id;
surface popagr;
run;
quit;
```

Example 21: Mapping an Individual Country By Subsetting MAPS.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=

Other features:
- SQL procedure

Data sets:
- MAPS.WORLD (map data set)
- MYDATA (table with a subsetted map data set)

Format: GLCNSM

Sample library member: GMPCOUNT

Notes:
- This example cannot be run with a GfK map data set. The GLC codes are replaced by ISO codes and are not supported for GfK mapping.
- The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
- The SAS-supplied map data set(s) 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 MAPS.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

```sas
options reset=all border;
options fmtsearch=(sashelp.mapfmts);
proc sql;
create table mymap as
select * from maps.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;
```

Program Description

Set the graphics environment.
goptions reset=all border;

Enable the formats from the SASHELP.MAPFMTS catalog.

options fmtsearch=(sashelp.mapfmts);

Subset the MAPS.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 maps.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;

Example 22: Using GfK GeoMarketing Map Data to Specify 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.

Sample library member: GMPGCON1

Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) 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.

Example 22: Using GfK GeoMarketing Map Data to Specify Country Subdivisions on a Continent

This map drawn with GfK map data

Program

goptions reset=all border;

    title1 j=c 'Africa:';
    title2 j=c 'First-Level Administrative Country Subdivisions';
    footnote1 j=r 'This map drawn with GfK map data';

    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/discrete nolegend stat=first;
    run;
    quit;

Program Description

Set the graphics environment.

goptions reset=all border;

Define the titles and footnote for the map.

    title1 j=c 'Africa:';
    title2 j=c 'First-Level Administrative Country Subdivisions';
    footnote1 j=r 'This map drawn with GfK map data';
Change the color in some indistinguishable areas.

```plaintext
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.

```plaintext
proc gmap map=mapsgfk.africa1 data=mapsgfk.africa1;
id isoalpha2 id;
choro isoalpha2/discrete nolegend stat=first;
run;
quit;
```

---

**Example 23: Using GfK GeoMarketing Map Data to Produce a Choropleth Map 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

**Other features:**
- 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.

**Sample library member:**
- GMPGCONC

**Notes:**
- The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
- The SAS-supplied map data set(s) used in this program might not be an available resource on your system.
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";
footnote j=r "This map drawn with GfK map data";
legend1 label=(*Country Name:*);
proc gmap map=map data=map;
id name id;
choro name/discrete stat=first 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, footnote, and legend for the map. The LEGEND= statement relabels the NAME variable.

title1 "Combining 3 Map Data Sets";
footnote j=r "This map drawn with GfK map data";
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/discrete stat=first legend=legend1;
run;
quit;

Example 24: Using GfK GeoMarketing Map Data to Produce 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
DISCRETE
XSIZE=
COUTLINE=
Example 24: Using GfK GeoMarketing Map Data to Produce a Choropleth Map

**Annotating Cities**

---

**INTER  
STATISTIC=  
DESCRIPTION=  
NAME=  
LEGEND=

**Other features:**
- 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.

**Sample library member:**
GMPGCITA

**Notes:**
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) used in this program might not be an available resource on your system.

---

**Output**

---

**Annotating Cities**

---

**Program**

```sas
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;
data cities;
set mapsgfk.world_cities(where=(rank=1 and isoname in:('Austria' 'Czech' 'Hung')));
x=long;
y=lat;
run;
data labels;
length color $8 text $55;
retain style 'Thorndale AMT' function 'label' xsys ysys '2' hsys '3' when 'a';
set cities;
text='V';
style='marker';
color='CX0BB5FF';
size=2;
position='5';
output;
text= ' '||city;
position='2';
size=2.25;
style=' '; 
color='black';
style='Thorndale AMT';
if city in:('Gyor' 'Ostrav' 'Inns' 'Kecs') then position='8';
if city in:('Salz') then position='6';
output;
run;
proc gproject parmentry=map data=labels out=oudset dupok;
id;
run;
goptions reset=all border;
title1 "Annotating Cities";
footnote j=r "This map drawn with GfK map data";
legend1 label=("Country Name: ");
proc gmap data=map map=map;
id id;
choro name / discrete
xsize=95 pct
coutine=gray88
annotate=oudset
des=''

Program Description

Specify the countries to map.

```plaintext
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.

```plaintext
proc gproject data=all out=map degrees eastlong parmout;
id name id;
run;
```

Create the CITIES data set specifying cities to label (Annotate).

```plaintext
data cities;
set mapsgfk.world_cities(where=(rank=1 and isoname in:('Austria' 'Czech' 'Hung')));
x=long;
y=lat;
run;
```

Add Annotate variables to the CITIES data set.

```plaintext
data labels;
length color $8 text $55;
retain style 'Thorndale AMT' function 'label' xsys ysys '2' hsys '3' when 'a';
set cities;
text='V';
style='marker';
color='CX0BB5FF';
size=2;
position='5';
output;
text='|city';
position='2';
size=2.25;
style='';
color='black';
style='Thorndale AMT';
if city in:('Gyor' 'Ostrav' 'Inns' 'Kecs') then position='8';
if city in:('Salz') then position='6';
output;
```
Project the annotation data set using the projection parameters stored in the prior
map projection.

```plaintext
proc gproject parmentry=map data=labels out=outdset dupok;
    id;
run;
```

Set the graphics environment.

```plaintext
goptions reset=all border;
```

Define the title, footnote, and legend for the map. The LEGEND= statement relabels
the NAME variable.

```plaintext
title1 "Annotating Cities";
    footnote j=r "This map drawn with GfK map data";
    legend1 label=(*Country Name:*)
```

Produce the choropleth map that annotates cities in 3 European countries. The
DISCRETE= option generates a separate color for each different response variable value
(country name). The XSIZE= option specifies the width of the map being drawn. The
COUTLINE= option outlines the map area regions in each country. The ANNOTATE= specifies
the OUTDSET data set to annotate onto the map produced by the CHORO
statement. 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.

```plaintext
proc gmap data=map map=map;
    id id;
    choro name / discrete
        xsize=95 pct
        coutline=gray88
        annotate=outdset
        des=''
        name='eursub'
        stat=first
        legend=legend1;
run;
quit;
```

Example 25: Using GfK GeoMarketing Map Data to Produce a
Choropleth County Map Annotating Roads and Water

<table>
<thead>
<tr>
<th>Features:</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP= required argument referring to a GfK map data set</td>
<td></td>
</tr>
<tr>
<td>DATA= argument referring to response data</td>
<td></td>
</tr>
<tr>
<td>ANNOTATE= argument referring to Annotate data</td>
<td></td>
</tr>
<tr>
<td>ID statement</td>
<td></td>
</tr>
<tr>
<td>CHORO statement options</td>
<td></td>
</tr>
<tr>
<td>DISCRETE</td>
<td></td>
</tr>
<tr>
<td>NOLEGEND</td>
<td></td>
</tr>
<tr>
<td>ANNOTATE=</td>
<td></td>
</tr>
</tbody>
</table>
Example 25: Using GfK GeoMarketing Map Data to Produce a Choropleth County Map

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 SAS Maps Online, located at the following URL: http://support.sas.com/rnd/datavisualization/mapsonline/html/sampledata.html. 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

goptions reset=all border;

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='path-to-shapefile'
   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;
*/
Example 25: Using GfK GeoMarketing Map Data to Produce a Choropleth County Map

Annotating Roads and Water  377

data annot(drop=statefp countyfp);
length STATE COUNTY 5 text color $8;
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='red'; size=1.25; end;
  else if mtfcc='S1200' then do; line=2; color='green';end;
  else if mtfcc=:'H' then do; line=4; color='blue'; end;
  if first.TLID then do;
    function='MOVE';
    output;
  end;
  else do;
    function='DRAW';
    output;
  end;
run;

data WORK.WRC_FISHING;
  infile cards dsd missover;
  input X Y Fishing_Area_Name : $25.
    FishingPier
    ShorelineAccess
    BoatRamp
    CanoeAccess
    UniversalAccess
    WaterbodyName & $29.;
cards;
-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
-78.6977, 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
-78.6770, 35.7668,LAKE RALEIGH,1, 1, 0, 1, 1, LAKE RALEIGH
DATA WRCL
LENGTH STATE 5 COUNTY 5 TEXT $45 FONT $8 COLOR $8
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='ALBANY AMT/BOLD';
FUNCTION='LABEL';
/* reposition overlapping points */
IF TEXT IN ('LAKE RALEIGH') THEN POSITION='6';
ELSE IF TEXT IN ('LAKE JOHNSON') THEN POSITION='4';
ELSE IF TEXT IN ('OLD 98') THEN POSITION='3';
OUTPUT;
FUNCTION='PIE';
ROTEATE=360;
STYLE='PSOLID';
COLOR='YELLOW';
POSITION='5';
SIZE=.75;
OUTPUT;
/* Draw a dark ring around pie, to help */
/* distinguish overlapping ones */
STYLE='PEMPTY';
COLOR='CYAN';
LINE=1;
HTML='';
OUTPUT;

RUN;
DATA ALL;
LENGTH FUNCTION $8 TEXT $45 STYLE $20;
SET NCWAKE ANOR 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;

proc gmap map=map data=map anno=lines;
   id id; choro state/discrete nolegend anno=points stat=sum;
   pattern v=s r=100 color=cream;
   title1 j=left font='Albany AMT/bold' height=2 'Fishing areas in';
   title2 j=left font='Albany AMT/bold' height=2 'Wake County, NC';
   footnote j=1 c=red '- Primary Road';
   footnote2 j=1 c=green '- Secondary Road';
   footnote3 j=1 c=blue '- Water';
run;
quit;

Program Description

Set the graphics environment.

goptions reset=all border;

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. Specify the path and
filename of the downloaded shapefiles. An example shapefile name is
"tl_2012_37183_edges". The data includes roads and water.

proc mapimport datafile='path-to-shapefile'
   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.

```sas
data annor(drop=statefp countyfp);
length STATE COUNTY 5 text color $8;
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='red'; size=1.25; end;
  else if mtfcc='S1200' then do; line=2; color='green';end;
  else if mtfcc=:'H' then do; line=4; color='blue'; 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.

```sas
data WORK.WRC_FISHING;
infile cards dsd missover;
input X Y Fishing_Area_Name : $25. FishingPier ShorelineAccess BoatRamp CanoeAccess UniversalAccess WaterbodyName & $29.;
cards;
  -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, BEAVERTAM,0, 1, 1, 0, 0, FALLS RESERVOIR
  -78.6915, 36.0215, HWY 50,0, 1, 1, 0, FALLS RESERVOIR
```

---

Chapter 11 • GMAP Procedure
Example 25: Using GfK GeoMarketing Map Data to Produce a Choropleth County Map
Annotating Roads and Water

```
-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, SHELLEY LAKE
-78.6775, 35.7668, LAKE RALEIGH,1, 1, 1, 1, LAKE RALEIGH
-78.7907, 35.8384, LAKE CRABTREE COUNTY PARK,1, 1, 1, 1, LAKE CRABTREE COUNTY PARK
-78.7137, 35.7627, LAKE JOHNSON PARK,1, 0, 1, 0, LAKE JOHNSON PARK
-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
;
run;
```

Add the Annotate variables.
```
data wrc;
  length STATE 5 COUNTY 5 text $45 font $8 color $8
    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='Albany AMT/bold';
  function='label';
  /* reposition overlapping points */
  if text in('LAKE RALEIGH') then position='6';
  else if text in:('LAKE JOHNSON') then position='4';
  else if text='OLD 98' then position='3';
  output;
  function='pie';
  rotate=360;
  style='pdsolid';
  color='yellow';
  position='5';
  size=.75;
  output;
  /* Draw a dark ring around pie, to help */
  /* distinguish overlapping ones */
  style='pempty';
  color='cyan';
  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;

Display the choropleth map.
proc gmap map=map data=map anno=lines;
id id; choro state/discrete nolegend anno=points stat=sum;
pattern v=s r=100 color=cream;
title1 j=left font='Albany AMT/bold' height=2 'Fishing areas in';
title2 j=left font='Albany AMT/bold' height=2 'Wake County, NC';
footnote j=1 c=red '- Primary Road';
footnote2 j=1 c=green '- Secondary Road';
footnote3 j=1 c=blue '- Water';
run;
quit;

Example 26: 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
Sample library member:  GANCITY
Note:  The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
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 \( \text{XSYS} \) and \( \text{YSYS} \) variables specify coordinate system 2, absolute data values. However, the \( \text{HSYS} \) variable that controls text height uses coordinate system 3, percent of the graphics output area.

See “Example 4: Projecting an Annotate Data Set” on page 418 for an example of labeling a map using map coordinates in units of latitude and longitude.

See “Differences between GfK and Traditional Map Data Sets ” on page 229 for more information about using map data sets.

**Output 11.1  Map with Labeled Cities**

```
Distribution Center Locations

This map drawn with GfK map data
```

**Program**

```plaintext
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";

footnote j=r "This map drawn with GFK map data";

proc gmap data=lower48 map=lower48;
   id state;
   choro state / 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.

```plaintext
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.

```plaintext
function="label"; style=""; text=city; color="green";
size=5; position="8"; output;
run;
```

Define the title for the map.

```plaintext
title "Distribution Center Locations";
```

Define patterns for the map areas. MEMPTY colors only the state borders.

```plaintext
pattern value=mempty color=blue repeat=49;
```

Define the footnote for the map.

```plaintext
footnote j=r "This map drawn with GFK map data";
```

Generate the map and assign the annotate data set to the CHORO statement.

```plaintext
proc gmap data=lower48 map=lower48;
id state;
choro state / annotate=citystar discrete nolegend;
run;
quit;
```

---

Example 27: Producing an 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 HTML statement
  - GOPTIONS statement with DEVICE= option

**Data sets:**
- MAPSSAS.EUROPE
- SASHELP.DEMOGRAPHICS
Output

This example produces an SVG file named `europepop.svg` and an HTML4 file named `europe.htm`. You can view the SVG graphic by opening `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*.

You can view the SVG coding by opening the SVG file, `europepop.svg`, in a text editor.

---

Specify the ODS output path. The SVG file is written to the path designated by your installation.

```
filename odsout ";."
```

Set the graphics environment and set the output device to SVG.

```
goptions reset=all device=svg;
```

Set the output destination to HTML4, specify the path to file the output, and specify a name for the output file. The output filename is “europe.htm”.

```
ods _all_ close;
ods html4 path=odsout file="europe.htm"
```

Set a title to display on the graphic output.

```
title "Population in Europe"
```

Use the GMAP procedure to produce a choropleth map from the MAPSSAS European map data set, using population statistics from the SASHELP.DEMOGRAPHICS data set. The map is to exclude certain countries like Greenland.
proc gmap map=mapssas.europe(where=(id ne 405 and id ne 845))
    data=sashelp.demographics(where=(cont=93)) all;
    id id;
    choro pop / name="europePop";
run;
quit;
ods html4 close;
ods html; /* Not required in SAS Studio */

Example 28: Producing a Stand-Alone SVG File in HTML5 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 HTML statement
- SVG_MODE=embed option
- GOPTIONS statement with DEVICE= option

Data sets:
- MAPSSAS.EUROPE
- SASHELP.DEMOGRAPHICS

Output

In the HTML4 destination, SVG graphics are created as stand-alone files by default. In the HTML5 destination, SVG graphics are created as inline graphics in the HTML file. By default, the ODS HTML statement refers to the latest HTML destination in effect. For example, starting with SAS 9.4M4, the ODS HTML statement refers to an HTML5 destination by default. You can generate a stand-alone SVG image file in the ODS HTML destination by specifying svg_mode='embed' in the ODS HTML statement. This option embeds the SVG image file into the HTML file using the <embed> tag. In the following example, the code shown in “Example 27: Producing an SVG File That Displays a European Map” on page 385 is modified to use this option.

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 europe.htm in your SVG-enabled browser. If your browser does not render the graphic, see “Browser Support for Viewing SVG Files” in SAS/GRAF: Reference.

You can view the SVG coding by opening the SVG file, europepop.svg, in a text editor.
Specify the ODS output path. The SVG file is written to the path designated by your installation.

```
filename odsout ".";
```

Set the graphics environment and set the output device to SVG.

```
goptions reset=all device=svg;
```

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 html options(svg_mode='embed') path=odsout file="europe.htm";
```

Set a title to display on the graphic output.

```
title "Population in Europe";
```

Use the GMAP procedure to produce a choropleth map from the MAPSSAS European map data set, using population statistics from the SASHELP.DEMOGRAPHICS data set. The map is to exclude certain countries like Greenland.

```
proc gmap map=mapssas.europe(where=(id ne 405 and id ne 845))
    data=sashelp.demographics(where=(cont=93)) all;
    id id;
    choro pop / name="europePop";
run;
quit;
ods html close;
ods html; /* Not required in SAS Studio */
```
Overview: GPROJECT Procedure

Starting with SAS 9.4M6, 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 GiK 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 output map data set that is produced by the GPROJECT procedure contains Cartesian coordinates that can be displayed using the GMAP procedure in SAS/GRAPH, or the ODS Graphics SGMAP procedure in Base SAS.

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.

The GPROJECT procedure does not produce any graphics output. Instead, it produces an output map data set. This in turn can be used as the input map data set for the GMAP procedure in SAS/GRAPH, or the ODS Graphics SGMAP procedure in Base SAS. See Chapter 11, “GMAP Procedure,” on page 223 or Chapter 16, “SGMAP Procedure,” on page 459.

Figure 12.1 on page 390 and Figure 12.2 on page 391 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 Specifications” on page 410.

**Figure 12.1** Map With Westlong Longitude Coordinates (GPJDEFLT(a))
Figure 12.2  Map After Projection (GPJDEFLT(b))

United States Map

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 227), 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 409 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 Specifications” on page 410 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. In these cases, the X and Y variables produce a projected map, so you do not need to use the GPROJECT procedure. However, you might want to use the LONG and LAT variables to reproject the map using a different projection type. The LATLON option specifies that the GPROJECT procedure uses the LONG and LAT variables instead of X and Y.

For additional information about the supplied SAS/GRAPH map data sets, see “About Map Data Sets” on page 227 and the METAMAPS data set in your maps data set directory.

About Coordinate Values

Figure 12.3 on page 393 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.
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.

**Projection Types**

The GPROJECT procedure performs four different types of projection:

- Albers’ equal-area projection with two standard parallels (the default method)
- 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.

**Albers’ Equal-Area 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 12.4 on page 394 illustrates an Albers' equal-area projection of the northern hemisphere.  

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

---

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.
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' 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 12.5 on page 395 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.
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 405.)

Figure 12.6 on page 396 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 the `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 401 and “TO=coordinate-system” on page 407.

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 utilize LAT and LONG coordinates. For example, convert North Carolina state plane coordinates to EPGS:4326 latitude and longitude coordinates with the following code:

```sas
data hydroa;
  infile datalines dsd;
  input x y objectid;
  datalines;
  554997.7503,27578.50066,2282;
  proc gproject
    from="+proj=lcc +lat_1=34.3333333333333 +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 [http://spatialreference.org](http://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 Data Sets**

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).

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 NOPARMIN.

### Syntax: GPROJECT Procedure

**Restriction:** This procedure is not included in SAS Viya-only installation, nor can it use data that has been processed in CAS. For more information, see "Plotting a Cloud Analytic Services (CAS) In-Memory Table" in SAS/GRAPH: Reference.

**Requirement:** Exactly one ID statement is required.

```
PROC GPROJECT DATA=input-map-data-set <option(s)>;
   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 <option(s)>;
```

### 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**

**PARALLEL2=latitude**
specify values for the standard parallels that are 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 391
    “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 418

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.

<table>
<thead>
<tr>
<th>Alias</th>
<th>ASIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction</td>
<td>If you specify both NODUP and DUPOK, then the last option that you specified is used.</td>
</tr>
<tr>
<td>Note</td>
<td>This option is useful when you want to add annotation to a map that contains duplicate coordinates.</td>
</tr>
</tbody>
</table>

---

**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.)

<table>
<thead>
<tr>
<th>Alias</th>
<th>EAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default</td>
<td>Longitude values increase to the west unless this option is specified.</td>
</tr>
<tr>
<td>Interactions</td>
<td>If you specify both EASTLONG and WESTLONG, then the last option that you specified is used.</td>
</tr>
<tr>
<td>Note</td>
<td>The EASTLONG option is used by default with the proj.4 projection method.</td>
</tr>
</tbody>
</table>

---

**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.

| 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
interaction, 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 407

**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 418

**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 416

**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 416

**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 416

LONGMIN=\text{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 416

MERIDIAN=\text{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 418

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=latitudePARALLEL2=latitude” on page 405

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.
PARALLEL1=\textit{latitude} \\
\text{PARALLEL2=\textit{latitude}} \\
\text{specify values for the standard parallels that are used in the Albers' or Lambert's projection. \textit{Latitude} must be in degrees. Positive values indicate north of the equator, and negative values indicate south of the equator. These options are 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:

\begin{align*}
\text{PARALLEL1} &= \text{minlat} + \frac{R}{P_D} \\
\text{PARALLEL2} &= \text{maxlat} - \frac{R}{P_D}
\end{align*}

where:

\begin{align*}
R &= \text{the range of latitude values in the input map data set.} \\
P_D &= \text{the PARADIV= value. (See the discussion of the "PARADIV=\textit{n}" on page 404 option.)} \\
\text{minlat} &= \text{the minimum latitude value in the input map data set.} \\
\text{maxlat} &= \text{the maximum latitude value in the input map data set.}
\end{align*}

If you do not use PARALLEL1= or PARALLEL2=, or you omit either option, the GPROJECT procedure uses the calculated value for the missing parameter.

The standard parallels, whether explicitly specified 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 (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.

\text{Alias} \quad \text{PARALEL1, PARALEL2}

POLELAT=\textit{latitude} \\
POLELONG=\textit{longitude} \\
\text{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 414

\[\text{PROJECT=} \text{ALBERS | LAMBERT | GNOMON | PROJ4 | NONE}\]

specifies the projection method to apply to the map data set. Values for the PROJECT= option are as follows:

\begin{itemize}
  \item **ALBERS** specifies Albers' equal-area projection with two standard parallels.
  \item **LAMBERT** specifies Lambert's conformal projection with two standard parallels.
  \item **GNOMON** specifies the gnomonic projection, which is an azimuthal projection.
  \item **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.
\end{itemize}

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 407

“FROM="coordinate-system"" on page 401

\[\text{NONE}\]

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 Institute Technical Support. The experimental projections are: ADAMS, AITOFF, APIANUS, ARAGO, BEHRMANN, BRAUN, CYLINDRI, ECKERT1, ECKERT3, ECKERT5, EQUIRECT, or MARINUS, GALL, HAMMER, KVRSKY7, MILLER1, MILLER2, ORTHO, PARABOLI, PETERS, PUTNINS4, ROBINSON, STEREO, WINKEL2.

See “About Types of Map Projections” on page 393

Example “Example 2: Emphasizing Map Areas” on page 414
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.

**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:

```sas
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 401

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 Specifications” on page 410

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.)

Using the 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 405 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 409, 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 13, “GREDUCE Procedure,” on page 423 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 416, for an example of clipping an area from an unprojected map data set.

Examples: GPROJECT Procedure

Example 1: Using Default Projection Specifications

Features:
- PROC GPROJECT options
  - DATA= required argument
  - OUT= optional argument
- ID statement
- PATTERN statement

Other features:
- DATA step
- PROC GMAP statement
- CHORO statement

Data sets:
- MAPS.STATES (input map data set for DATA step)
- US48PROJ (input map data set and map data set)

Sample library member:
- GPJDEFLT

Notes:
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
The SAS-supplied map data set(s) 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 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.
Output 12.1  Map With Westlong Longitude Coordinates (GPJDEFLT(a))

Output 12.1 on page 411 illustrates the output produced by the US48 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 12.2 on page 411 shows the variables in the data set.

Output 12.2  The US48 Data Set

The GPROJECT procedure is used with the US48 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 12.3 on page 412 shows the variables in the data set.
The new projected map data set, US48PROJ, is used to create the projected map, Output 12.4 on page 412.

**Output 12.4  Map After Projection (GPJDEFLT(b))**

```
Program

goptions reset=all border;

data us48;
  set maps.states;
  if state ne 2 and state ne 15 and state ne 72;
run;
title "United States Map";
pattern value=mempty color=blue;
proc gmap map=us48 data=us48 all density=4;
  id state;
  choro state / nolegend levels=1;
run;
proc gproject data=us48
  out=us48proj;
```
id state;
run;

proc gmap map=us48proj
data=us48proj all density=4;
id state;
choro state / nolegend levels=1;
run;
quit;

Program Description

Set the graphics environment.

goptions reset=all border;

Create a reduced continental U.S. map data set and remove Alaska, Hawaii, and Puerto Rico.

data us48;
set maps.states;
if state ne 2 and state ne 15 and state ne 72;
run;

Define the title for the unprojected map.

title "United States Map";

Define the pattern characteristics.

pattern value=mempty color=blue;

Show the unprojected map.

proc gmap map=us48 data=us48 all density=4;
id state;
choro state / 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=us48
out=us48proj;
id state;
run;

Show the projected map.

proc gmap map=us48proj
data=us48proj all density=4;
id state;
choro state / nolegend levels=1;
run;
quit;
Example 2: Emphasizing Map Areas

Features:
- PROC GPROJECT options
  - DATA= required argument
  - OUT= optional argument
  - POLELAT=
  - POLELONG=
  - PROJECT=
- ID statement
- PATTERN statement

Other features:
- DATA step
- PROC GMAP statement
- CHORO statement

Data sets:
- MAPS.STATES (input map data set for DATA step)
- SKEW (input map data set and map data set)

Sample library member:
- GPJEMPHS

Notes:
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
The SAS-supplied map data set(s) 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;
data us48;
  set maps.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";
footnote j=r "GPJEMPHS ";
pattern value=mempty color=blue;
proc gmap map=skew data=skew all;
  id state;
  choro state / nolegend levels=1;
run;
quit;

Program Description

Set the graphics environment.
goptions reset=all border;

Create a reduced continental U.S. map data set and remove Alaska, Hawaii, and Puerto Rico.
data us48;
  set maps.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 and footnote for the map.
  title "United States Map";
  footnote j=r "GPJEMPHS ";

Define the pattern characteristics.
pattern value=mempty color=blue;

Show the projected map.

proc gmap map=skew data=skew all;
   id state;
   choro state / nolegend levels=1;
run;
quit;

Example 3: Clipping an Area from the Map

Features:
- PROC GPROJECT options
  - DATA= required argument
  - OUT= optional argument
  - LONGMAX=
  - LONGMIN=
  - LATMAX=
  - LATMIN=
- ID statement
- PATTERN statement

Other features:
- PROC GMAP statement
- CHORO statement

Data sets:
- MAPS.STATES (input map data set for DATA step)
- GULF (input map data set and map data set)

Sample library member:
- GPJCLIPP

Notes:
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
The SAS-supplied map data set(s) 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;

proc gproject data=maps.states
   out=gulf
   longmin=81
   longmax=98
   latmin=25
   latmax=33;
      where density<5;
      id state;
   run;
   title "Northern Gulf Coast";
   footnote j=r "GPJCLIPP ";
   pattern value=mempty color=blue;
proc gmap map=gulf data=gulf all;
   id state;
   choro state / nolegend levels=1;
   run;
   quit;

Program Description

Set the graphics environment.
   goptions reset=all border;

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=maps.states
out=gulf
longmin=81
longmax=98
latmin=25
latmax=33;
where density<5;
   id state;
run;

Define the title and footnote for the map.

title "Northern Gulf Coast"
footnote j=r "GPJCLIPP ";

Define the pattern characteristics.

pattern value=mempty color=blue;

Show the clipped map.

proc gmap map=gulf data=gulf all;
   id state;
   choro state / 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

**Other features:**
- 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)

**Sample library member:**
GPJANNOT
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) 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.

Distribution Center Locations
East Coast

Program

goptions reset=all border;

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=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 $ 8
    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="#6";
  style="swissb";
  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 / nolegend levels=1 stat=first
    annotate=citiesp;
run;
quit;

Program Description

Set the graphics environment.

goptions reset=all border;

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;

### Project the US48 data set

The data set to be projected. The `DATA=` option specifies the name of the new projected data set that is created. The `OUT=` option specifies that PROC GPROJECT use the Gnomonic 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` creates the projection parameters data set. 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 $ 8
       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="6";
   style="swissb";
   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 / nolegend levels=1 stat=first
      annotate=citiesp;
   run;
quit;

___
References

VA: Naval Surface Weapons Center, Dahlgren Laboratory.


Overview: GREDUCE Procedure

Starting with SAS 9.4M6, 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 13.1 on page 424 and Figure 13.2 on page 424 illustrate the effect of reduction on a typical map data set. Figure 13.1 on page 424 uses observations with all DENSITY values as input to the GMAP procedure.

**Figure 13.1** CANADA2 Map before Reduction

![Canada Map before Reduction](image)

Figure 13.2 on page 424 uses only those observations with a DENSITY value of 0 to 2 as input to the GMAP procedure.

**Figure 13.2** CANADA2 Map after Reduction

![Canada Map after Reduction](image)

The program for these maps is in “Example: Reducing the Map of Canada” on page 432.
The reduced map shown in Figure 13.2 on page 424 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 13.1 on page 424.

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 14, “GREMOVE Procedure,” on page 435 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

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 noncontiguous 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 227 for additional information about map data sets.

Syntax: GREDUCE Procedure

Restriction: This procedure is not included in SAS Viya-only installation, nor can it use data that has been processed in CAS. For more information, see “Plotting a Cloud Analytic Services (CAS) In-Memory Table” in SAS/GRAPH: Reference.

Requirement: Exactly one ID statement is required.

Note: The procedure can include the “BY Statement” on page 43.

PROC GREDUCE DATA=input-map-data-set <option(s)>;
   ID id-variable(s);

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 <option(s)>;

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 \textit{max-points} points.

\textbf{NOCLEAN} \\
disables post-processing cleanup of the output data set.

\textbf{NORETRY} \\
prevents additional reduction of polygons in the output map data set.

\textbf{OUT=\textit{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 \textit{DENSITY} variable.

\textbf{Required Argument}

\textbf{DATA=\textit{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 \texttt{PROC GREDUCE} statement.

\textit{Default} \\
The \texttt{GREDUCE} procedure uses the most recently created SAS data set.

\textit{Requirement} \\
This statement is required if no response data set was created before issuing the \texttt{PROC GREDUCE} statement.

\textit{See} \\
“About the Input Map Data Set” on page 425

“The SAS Data Set: Your Key to the SAS System” in \textit{Step-by-Step Programming with Base SAS}

“About Data Set Options” in \textit{SAS Data Set Options: Reference}

\textbf{Optional Arguments}

\textbf{E1=\textit{min-distance}} \\
\textbf{E2=\textit{min-distance}} \\
\textbf{E3=\textit{min-distance}} \\
\textbf{E4=\textit{min-distance}} \\
\textbf{E5=\textit{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 \textit{min-distance} from a straight line between the two outside points.

Specify \textit{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 \textit{min-distance} values in radians.

Specify the \textit{E}n= values in decreasing order. For example, the E2= value should be less than the E1= value, and so on.

\textbf{LATLON} \\
specifies that the \textit{LAT} and \textit{LONG} variables from the map data set are used for coordinate data instead of the \textit{Y} and \textit{X} variables. The \textit{LAT} and \textit{LONG} variables represent the latitude and longitude coordinates, respectively. All GfK Marketing and most traditional map data sets contain both sets of variables (\textit{Y}, \textit{X}, and \textit{LAT}, \textit{LONG}) for projected and unprojected maps. By default, the \textit{Y} and \textit{X} variables are used to produce an output data set. However, when \textit{LATLON} is specified, the \textit{Y} and \textit{X} variables are no longer required by the \texttt{GREDUCE} procedure statement.
Alias       LATLONG

Example     “Example 4: Projecting an Annotate Data Set” on page 418

\( N1 = \text{max-points} \)
\( N2 = \text{max-points} \)
\( N3 = \text{max-points} \)
\( N4 = \text{max-points} \)
\( N5 = \text{max-points} \)

specifies that for density level 1, 2, 3, 4, or 5, the boundary of a unit area should contain no more than \( \text{max-points} \) 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:

\[
N_n = n^2 \times \frac{N_{\text{max}}}{36}
\]

Here \( N_{\text{max}} \) is the maximum number of points in any unit area in the input map data set.

Restriction When calculating \( N_{\text{max}} \), 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” on page 432

## Syntax

```plaintext
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.
Using the 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 Nn= in the PROC GREDUCE statement, and specify the minimum point distance using En= . You must have knowledge of the X and Y variable values in the particular input map data set to determine appropriate values for En=. See the En= option on page 427 for details.

Figure 13.3 on page 430 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 En= 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 13.4 on page 431. See Douglas and Peucker (1973) for details of the algorithm used.

Figure 13.3 Points in Data Set before Reduction

---

[Figure 13.3 and Figure 13.4 images are not included in the text representation.]
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 be 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 12, “GPROJECT Procedure,” on page 389 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:

```sas
data smallmap;
    set map;
    if density <= 2;
run;
```

Alternatively, you can use WHERE= in the PROC GMAP statement:

```sas
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**

| Features: | ID statement |
| Data set: | MAPS.CANADA2 |
| Sample library member: | GRDCANAD |
| Notes: | The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com. The SAS-supplied map data set(s) used in this program might not be an available resource on your system. |

This example illustrates major features of the GREDUCE procedure. The example uses one of the map data sets that are supplied with the SAS/GRAPH MAPS library. If you do not have SAS/GRAPH installed, add a LIBNAME statement to the beginning of this example. Use the location of an Canadian map that is installed at your site or downloaded to your local PC. Your statement could be similar to this:

```sas
libname mymaps 'path-to-Canadian-map';
```

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 / 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 / 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.

\[
\text{pattern value=msolid repeat=12 color=white;}
\]

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 / 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 / nolegend coutline=blue;
run;
quit;
```

References

Overview: GREMOVE Procedure

Starting with SAS 9.4M6, 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 11, “GMAP Procedure,” on page 223, or Chapter 16, “SGMAP Procedure,” on page 459). 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 14.1 on page 436 and Figure 14.2 on page 436 show combined unit areas in a typical map data set by removing state boundaries to create regional census divisions.
The program for these maps is shown in “Example 1: Removing State Boundaries from U.S. Map” on page 442.

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 227) 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:

```sas
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

**Restriction:** This procedure is not included in SAS Viya-only installation, nor can it use data that has been processed in CAS. For more information, see “Plotting a Cloud Analytic Services (CAS) In-Memory Table” in SAS/GRAPH: Reference.

**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.

```sas
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>
<OUT=output-map-data-set>
<NODECYCLE>;

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 | NC tells PROC GREMOVE to 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 437

“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 447

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:

\[
\text{Point is equal} = (\text{ABS}(x1 - x2) \leq \text{fuzz-factor}) \land (\text{ABS}(y1 - y2) \leq \text{fuzz-factor})
\]

NODECYCLE | NC

tells PROC GREMOVE to 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, the use of NODECYCLE requires that the data be topologically correct. In other words, polygons do not overlap themselves or each other and there are no anomalies in the boundaries such as a repeated series of points.

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 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 437.

Example “Example 2: Creating an Outline Map of Africa” on page 447

BY Statement

Lists the variable or variables that identify the new unit areas.

Requirement: At least one variable is required.
See: “BY Statement” on page 43.

Example: “Example 1: Removing State Boundaries from U.S. Map” on page 442

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
indicates 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)
identifies 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
indicates 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. NOTSORTED overrides DESCENDING 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 442

---

**Syntax**

```plaintext
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 437

---

**Examples: GREMOVE Procedure**

---

**Example 1: Removing State Boundaries from U.S. Map**

**Features:**
- BY statement
- ID statement

**Other features:**
- SORT procedure, MERGE statement, and LIBNAME statement

**Sample library member:**
- GRMUSMAP

**Notes:**
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) used in this program might not be an available resource on your system.
This example processes the MAPS.US map data set, supplied with SAS/GRAPH, to produce a new map data set containing boundaries for the U.S. Bureau of the Census divisions. Because the MAPS.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 census divisions. That map data set can then be processed with the GREMOVE procedure.

The STATE variable in the MAPS.US data set, containing numeric FIPS codes for each state, is used as the BY-variable to merge the CBSTATES and MAPS.US data sets. Output 14.1 on page 443 shows some of the variables that are present in the data set before using the GREMOVE procedure:

Output 14.1  The MAPS.US Data Set

<table>
<thead>
<tr>
<th>OBS</th>
<th>STATE</th>
<th>SEGMENT</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.16175</td>
<td>-0.10044</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0.12305</td>
<td>-0.10415</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0.12296</td>
<td>-0.10678</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>1524</td>
<td>56</td>
<td>1</td>
<td>-0.18757</td>
<td>0.15035</td>
</tr>
<tr>
<td>1525</td>
<td>56</td>
<td>1</td>
<td>-0.10158</td>
<td>0.13997</td>
</tr>
<tr>
<td>1526</td>
<td>56</td>
<td>1</td>
<td>-0.30398</td>
<td>0.11343</td>
</tr>
</tbody>
</table>

And Output 14.2 on page 443 shows the map before processing:

Output 14.2  Map Before Removing Borders

Output 14.3 on page 444 shows the variables that are present in the data set after you use the GREMOVE procedure. Notice that the new map data set contains a new variable called DIVISION:
Output 14.3  The REMSTATE Data Set

<table>
<thead>
<tr>
<th>OBS</th>
<th>X</th>
<th>Y</th>
<th>SEGMENT</th>
<th>DIVISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.29825</td>
<td>0.17418</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>0.29814</td>
<td>0.17820</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>0.30206</td>
<td>0.18045</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1082</td>
<td>-0.18715</td>
<td>-0.16010</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>1083</td>
<td>-0.18747</td>
<td>-0.15971</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>1084</td>
<td>-0.18747</td>
<td>-0.15951</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Output 14.4 on page 444 shows the new map after PROC GREMOVE has removed interior state boundaries.

Output 14.4  Map After Removing Borders

Program

goptions reset=all border;

data cbstates;
  length state 8 stcode $ 2 division 4;
  input stcode division @@;
  state=stfips(stcode);
  drop stcode;
datalines;
CT 1 MA 1 ME 1 NH 1 RI 1 VT 1 PA 2 NJ 2 NY 2 IL 3 IN 3 MI 3 OH 3 WI 3 IA 4 KS 4 MN 4 MO 4 ND 4 NE 4 SD 4 DC 5 DE 5 FL 5 GA 5 MD 5 NC 5 SC 5 VA 5 WV 5 AL 6 KY 6 MS 6 TN 6 AR 7 LA 7 OK 7 TX 7 AZ 8 CO 8 ID 8 MT 8 NM 8 NV 8 UT 8 WY 8 AK 9 CA 9 HI 9 OR 9 WA 9
;
proc sort data=cbstates out=cbsort;
by state;
run;
data uscb;
merge cbsort maps.us;
by state;
run;
proc sort data=uscb out=divstate;
   by division;
run;
proc gremove data=divstate out=remstate;
   by division;
   id state;
run;
title "U.S. State Map";
footnote j=r "GRMUSMAP(a) ";
pattern value=mempty color=blue;
proc gmap map=maps.us data=maps.us all;
   id state;
   choro state / nolegend levels=1;
run;
title "U.S. Census Division Map";
footnote j=r "GRMUSMAP(b) ";
proc gmap map=remstate data=remstate all;
   id division;
   choro division / nolegend levels=1;
run;
quit;

**Program Description**

---

**Set the graphics environment.**

goptions reset=all border;

**Create data set CBSTATES.** This data set includes a variable, DIVISION, that contains the number of the U.S. Bureau of the Census division for the state. This DATA step converts letter codes to numeric FIPS codes that match those in the STATE variable of MAPS.US.

data cbstates;
   length state 8 stcode $ 2 division 4;
   input stcode division @@;
   state=statefips(stcode);
   drop stcode;
datalines;
CT 1 MA 1 ME 1 NH 1 RI 1 VT 1 PA 2 NY 2 IL 3 IN 3 OH 3 WI 3 IA 4 KS 4 MN 4 MO 4 ND 4 NE 4 SD 4 DC 5 DE 5 FL 5 GA 5 MD 5 NC 5 PR 5 SC 5 VA 5 WV 5 AL 6 KY 6 MS 6 TN 6 AR 7 LA 7 OK 7 TX 7 AZ 8 CO 8 ID 8 MT 8 NM 8 NV 8 UT 8 WY 8 AK 9 CA 9 HI 9 OR 9 WA 9 ;

Sort data set in FIPS-code order. Create a sorted data set, CBSORT. It can be properly match-merged with the MAPS.US map data set, which is already sorted in FIPS-code order.

```sas
proc sort data=cbstates out=cbsort;
   by state;
run;
```

Add DIVISION variable to map data set by merging the CBSORT data set with MAPS.US. Create a new map data set, USCB, that contains all of the state boundary coordinates from the MAPS.US data set plus the added variable DIVISION.

```sas
data uscb;
   merge cbsort maps.us;
   by state;
run;
```

Sort data set in DIVISION order. Sort USCB by the DIVISION variable to create the DIVSTATE data set.

```sas
proc sort data=uscb out=divstate;
   by division;
run;
```

Remove interior boundaries within divisions. BY specifies the variable, DIVISION, in the input map data set that identifies the new unit areas. ID specifies the variable, STATE, in the input map data set that identifies the current unit areas.

```sas
proc gremove data=divstate out=remstate;
   by division;
   id state;
run;
```

Define title and footnote for map.

```sas
title "U.S. State Map";
footnote j=r "GRMUSMAP(a) ";
```

Define pattern characteristics.

```sas
pattern value=mempty color=blue;
```

Show the original map.

```sas
proc gmap map=maps.us data=maps.us all;
   id state;
   choro state / nolegend levels=1;
run;
```

Define new title and footnote for map.

```sas
title "U.S. Census Division Map";
footnote j=r "GRMUSMAP(b) ";
```

Show the regional map. ID specifies the variable, DIVISION, that identifies the unit areas in the processed data set. CHORO specifies DIVISION as the response variable.

```sas
proc gmap map=remstate data=remstate all;
   id division;
```
Example 2: Creating an Outline Map of Africa

**Features:**
- PROC GREMOVE options DATA= and OUT=

**Other features:**
- GMAP procedure

**Sample library member:**
- GRMAFRIC

**Notes:**

The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) used in this program might not be an available resource on your system.

This example processes the MAPS.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 14.5 on page 447** shows some of the variables that are present in the original map data set:

<table>
<thead>
<tr>
<th>OBS</th>
<th>ID</th>
<th>SEGMENT</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>125</td>
<td>1</td>
<td>0.57679</td>
<td>1.43730</td>
</tr>
<tr>
<td>2</td>
<td>125</td>
<td>1</td>
<td>0.57668</td>
<td>1.43467</td>
</tr>
<tr>
<td>3</td>
<td>125</td>
<td>1</td>
<td>0.58515</td>
<td>1.42363</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>3462</td>
<td>990</td>
<td>1</td>
<td>1.04249</td>
<td>0.50398</td>
</tr>
<tr>
<td>3463</td>
<td>990</td>
<td>1</td>
<td>1.04184</td>
<td>0.50713</td>
</tr>
<tr>
<td>3464</td>
<td>990</td>
<td>1</td>
<td>1.04286</td>
<td>0.50841</td>
</tr>
</tbody>
</table>

**Output 14.6 on page 448** shows the map before processing:
The new AFRICA map data set is created with a new variable, REGION. Output 14.7 on page 448 shows the variables that are present in the new map data set created by the GREMOVE procedure:

**Output 14.7 The AFRICA Data Set**

<table>
<thead>
<tr>
<th>OBS</th>
<th>X</th>
<th>Y</th>
<th>SEGMENT</th>
<th>REGION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.24826</td>
<td>1.02167</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>0.25707</td>
<td>1.02714</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>0.26553</td>
<td>1.03752</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>982</td>
<td>1.19071</td>
<td>1.30043</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>983</td>
<td>1.18675</td>
<td>1.30842</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>984</td>
<td>1.18518</td>
<td>1.32822</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Output 14.8 on page 449 shows the new map after PROC GREMOVE has removed all of the interior boundaries:
Program

goptions reset=all border;

data newaf;
    set maps.africa;
    region=1;
run;

proc gremove data=newaf out=africa;
    by region;
    id id;
run;

title "Africa with Boundaries";
footnote j=r "GRMAFRIC(a) ";

pattern value=mempty color=blue;

proc gmap map=maps.africa data=maps.africa all;
    id id;
    choro id / nolegend levels=1;
run;

title "Africa without Boundaries";
footnote j=r "GRMAFRIC(b) ";

proc gmap data=africa map=africa;
    id region;
    choro region / nolegend levels=1;
run;
quit;

Program Description

Set the graphics environment.
**Create the NEWAF data set.** This new map data set contains all the variables in the MAPS.AFRICA map data set supplied with SAS/GRAPH plus the added variable REGION.

```sas
data newaf;
  set maps.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.

```sas
proc gremove data=newaf out=africa;
  by region;
  id id;
run;
```

**Define the title and footnote.**

```sas
title "Africa with Boundaries";
footnote j=r "GRMAFRIC(a) ";
```

**Define pattern characteristics.**

```sas
pattern value=mempty color=blue;
```

**Display the original map.**

```sas
proc gmap map=maps.africa data=maps.africa all;
  id id;
  choro id / nolegend levels=1;
run;
```

**Define a new title and footnote for the map.**

```sas
title "Africa without Boundaries";
footnote j=r "GRMAFRIC(b) ";
```

**Display the map with no boundaries.** ID specifies the variable, REGION, that identifies the unit areas in the processed data set.

```sas
proc gmap data=africa map=africa;
  id region;
  choro region / nolegend levels=1;
run;
quit;
```
Overview: MAPIMPORT Procedure

Starting with SAS 9.4M5, the MAPIMPORT 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 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 228 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 15.1  Shapefiles File Types

<table>
<thead>
<tr>
<th>File Extension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>.dbf</td>
<td>Identification information (field-identifier names and values) assigned to specific polygons</td>
</tr>
<tr>
<td>.shx</td>
<td>Shape information for the polygons that compose the map. ¹</td>
</tr>
<tr>
<td>.shp</td>
<td>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</td>
</tr>
</tbody>
</table>

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.

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 “Names in the SAS Language” in SAS Language Reference: Concepts in the SAS Language Reference: Concepts. For more information about how invalid field identifiers placed in single quotation marks are renamed, see “VALIDVARNAME= SAS 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’
<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.

¹ These files are used with SHP files and cannot be imported by themselves.
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'
<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'
specifies the path and filename of the shapefile that is read and processed.

Note: 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.

Alias INFILE=

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 “Names in the SAS Language” in SAS Language Reference: Concepts in the SAS Language Reference: Concepts.

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 “Names in the SAS Language” in SAS Language Reference: Concepts in the SAS Language Reference: Concepts.
Examples: MAPIMPORT Procedure

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. Specify your shapefiles locations and replace the example filenames and field identifiers with information from your shapefiles in order to run these examples.

```OCUSAP
PROC MAPIMPORT OUT=myworld
   DATAFILE="pathname-of-shapefile-location
    '\‘ or '/world30.shp";
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.

```OCUSAP
PROC MAPIMPORT OUT=mystates
   DATAFILE="pathname-of-shapefile-location
    '\‘ or '/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. The variable OTHER is excluded from the traditional map data set, MYSTATES2.

```OCUSAP
PROC MAPIMPORT OUT=mystates2
   DATAFILE="pathname-of-shapefile-location
    '\‘ or '/states.shp";
   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.

```plaintext
PROC MAPIMPORT OUT=myzcta
  DATAFILE="pathname-of-shapefile-location/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.

```plaintext
PROC MAPIMPORT OUT=mydata
  DATAFILE="pathname-of-shapefile-location/states.dbf";
  SELECT STATE_FIPS STATE_NAME STATE_ABBR;
  RENAME STATE_FIPS=FIPS STATE_NAME=STATE STATE_ABBR=ABBREV;
run;
```
Overview: SGMAP Procedure

An introduction with SAS 9.4M5, 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 enhancing the appearance of your output by selecting ODS Graphics text fonts, colors, patterns, and line styles, and controls 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 the SAS/GRAPH procedures or by the GEOCODE and MAPIMPORT procedures that are now part of Base SAS. The MAPIMPORT procedure imports map data from third-party sources. An example is shapefiles from Esri. Prior to SAS 9.4M5, the GEOCODE and MAPIMPORT procedures were provided with SAS/GRAPH, and required a SAS/GRAPH installation to run them.
Starting with SAS 9.4M6, 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 SGMAP procedure can now render maps with unprojected longitude and latitude coordinates. It can also render maps whose data is prepared by any number of Base SAS mapping procedures such as GPROJECT. Prior to SAS 9.4M6, GPROJECT and other mapping data preparation procedures were provided with SAS/GRAPH, and required a SAS/GRAPH installation to run them. Starting with SAS 9.4M6, the GINSIDE, GPROJECT, GREduce, and GREMOVE procedures that prepare data for mapping moved from SAS/GRAPH to Base SAS. 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. For the full list of new features and enhancements, see “SGMAP Procedure” on page xvii.

SGMAP procedure examples such as “Example 1: Nevada Counties with Bubble Plot of County Seat Populations” show how to create overlaid maps. You can also search for ‘SGMAP’ on this blog for additional examples: http://blogs.sas.com/content/graphicallyspeaking/

SAS 9.4M6: An installation of SAS Studio 3.8 enables you to use this SGMAP procedure to create a choropleth map overlaid with bubble, scatter, series, or text plots. You can do this as a SAS programmer or as a visual programmer. The various data sets and essential SAS software must be available with your installation. If the criterion is met, you can cut and paste the procedure examples provided in this chapter into SAS Studio 3.8 and run them to create map output. Access the Help button in SAS Studio and choose SAS Studio: Task Reference to review the About topic for each map task. The About topic lists the software that is required to run the task.

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: Nevada Counties with Bubble Plot of County Seat Populations” on page 494.

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.

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 Windows or Linux network proxy machine request that you might need to make.

**TIP** On a Windows operating system, check your proxy settings by entering the map service URL into a Windows Internet Explorer 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.

**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:** Do not use a Teradata server, a SAS LASR Analytic server, or a SAS Cloud Analytic Services (CAS) server as the repository for map data sets used with the CHOROMAP statement or the SERIES statement, or for geocoding lookup data sets. Essential polygonal data sequencing is lost as the data is distributed amongst the nodes of these servers. (The BUBBLE, SCATTER, and TEXT statements can use data stored in CAS). SAS 9.4M6: The SGMAP procedure does not use any CAS actions, but it can reference map response data sets that are stored on a Teradata, a SAS LASR, or a CAS server. The same is true for plot data sets, unless you are using the SGMAP procedure with its SERIES statement. Unlike map data sets that contain polygonal data whose observation order must be maintained, data order in map response and plot data sets is not relevant. The exception is plot data used by the SERIES statement, where the sequence of line segments must be maintained. Examples of line segments are streets or waterways.

The SGMAP procedure requires multi-data model functionality that is available only on 64-bit Windows and 64-bit Linux operating systems. If you attempt to run the procedure on any other operating system, it exits upon detection of an unsupported operating system.

ODS Graphics Editor (SGE) files can be rendered to any ODS destination on any platform. However, SGE files that contain map content from the SGMAP procedure are generated with a different rendering technology and are not supported by the SAS ODS Graphics Editor. However, it is possible to load the image output into the ODS Graphics Editor to interactively add annotations on top of the image.

Vector-based destination outputs such as SVG, PDF, or EMF are not supported by the SGMAP procedure when either the OPENSTREETMAP or ESRIMAP statements are specified. These statements render maps as tile-based output. You can specify an ODS destination of SVG, PDF, or EMF in conjunction with either of these statements. However, the SGMAP procedure converts the destination request to a PNG image-based format and displays PNG output. As the SGMAP procedure concludes, the ODS destination that you specified is reinstated.

**Interactions:** In order to successfully create a map, statements used by the SGMAP procedure must be used in the proper sequence. First issue the PROC SGMAP statement, identifying at least one data set to use. A map data set is required to generate polygonal outline areas for a map. To display response values for the map polygons,
a response data set must be specified. Next, issue one or more CHOROMAP, ESRIMAP, or OPENSTREETMAP statements to create a map or a choropleth map overlaying another map. Then, to overlay a plot on the map image, a plot data set and at least one plot statement (BUBBLE, SERIES, SCATTER, or TEXT), must be specified. Lastly, specify a KEYLEGEND statement or GRADLEGEND statement for any legend text. If either legend statement and the NOAUTOLEGEND option is not specified, then an automatic legend is created.

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.

**PROC SGMAP Statement**

Identifies the data sets needed for map areas, map response values, and overlay plots.

**Default:** SAS 9.4M6: The SGMAP procedure generates a legend unless the NOAUTOLEGEND option is specified on the SGMAP statement. See the “Rules for Generating Legends” on page 493.

**Restrictions:** Do not use a Teradata server, a SAS LASR Analytic server, or a SAS Cloud Analytic Services (CAS) server as the repository for map data sets or for geocoding lookup data sets. Essential polygonal data sequencing is lost as the data is distributed amongst the nodes of these servers. An error message in the SAS log stops any attempt to use a map data set sourced from these servers.

The SGMAP procedure prohibits specifying the map data set as the response data set.

Does not support RUN-group processing.

**Requirement:** You must specify one of the arguments identifying a data set to use (MAPDATA=, PLOTDATA=, or MAPRESPDATA=). A map data set is required to generate polygonal outline areas for a map. To display points on a base map, a plot data set is required. To display response values for the map polygons, a map response data set must be specified. The SGMAP procedure can reference plot or map response data sets that are stored on a Teradata server, a SAS LASR server, or a CAS server.

**Notes:** The SGMAP procedure can include several Base SAS statements. For more information, see the “WHERE Statement” in SAS DATA Step Statements: Reference, the “BY Statement” in SAS DATA Step Statements: Reference, the “FORMAT Statement” in SAS DATA Step Statements: Reference, and the “LABEL Statement” in SAS DATA Step Statements: Reference.
SAS 9.4M6: If you specify a map response data set with MAPRESPDATA=, but do not specify a response variable on the CHOROMAP statement, the map response data set is ignored.

You can store map or geocoding lookup data sets locally on any Windows or Linux system that does not use a Teradata, a SAS LASR, or a CAS server. This maintains the sequence of observations with polygonal data. These 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. Use cloud storage as long as it has a Windows or a Linux system that is not installed on a Teradata, a SAS LASR, or a CAS server. You have the option of maximizing 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: Nevada Counties with Bubble Plot of County Seats and Populations” on page 498.

SAS 9.4M6: The SGMAP procedure does not use any CAS actions, but it can reference map response data sets that are stored on a Teradata, a SAS LASR, or a CAS server. The same is true for plot data sets, unless you are using the SGMAP procedure with its SERIES statement. Unlike map data sets that contain polygonal data whose observation order must be maintained, data order in map response and plot data sets is not relevant. The exception is plot data used by the SERIES statement, where the sequence of line segments must be maintained. Examples of line segments are streets or waterways.

**Tip:** PROC SGMAP prevents using the map data set as the response data set. This avoids the performance hit of 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 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.

```sas
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.

**Syntax**

```sas
PROC SGMAP MAPDATA=map-data-set | PLOTDATA=plot-data-set |
   MAPRESPDATA=response-data-set
   </option(s)>;
```

**Summary of Optional Arguments**

- **DESCRIPTION=**="text-string"
  
specifies a description for the output.

- **NOAUTOLEGEND**
  
disables automatic legends from being generated.
Required Arguments

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 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 Online 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. Starting with SAS 9.4M5, you can create the latter with the Base SAS MAPIMPORT procedure. Use SAS data set options such as WHERE= to subset the map data.

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 Online 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.

9.4M6: 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 use a plot data set in conjunction with a plot statement such as BUBBLE, SERIES, SCATTER, or TEXT.

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.

Optional Arguments

DESCRIPTION="text-string"
specifies a description for the output. The description is used in the following locations:

• the Results window
• the alternate text for the image in HTML 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
NOAUTOLEGEND

disables automatic legends from being generated. SAS 9.4M6: The
NOAUTOLEGEND option overrides the default behavior. Specify this option on 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.

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 <option(s)>;

Summary of Optional Arguments

Appearance options

FILL | NOFILL
specifies whether the bubbles are filled.

FILLATTRS=style-element <(options)> | (option(s))
specifies the fill color and transparency.

OUTLINE
specifies whether the outlines of the bubbles are visible.

SAS 9.4M6 BRADIUSMAX=n<units>
specifies the size of the radius of the largest bubble.

SAS 9.4M6 BRADIUSMIN=n<units>
specifies the size of the radius of the smallest bubble.

TRANSPARENCY=value
specifies the degree of transparency for the plot.

Group options

GROUP=variable
specifies a discrete variable that is used to group the data.

SAS 9.4M6: 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=(option(s))
specifies the appearance of the labels in the plot when you use the
DATALABEL= option.

DATALABELPOS=position
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 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

SAS 9.4M6 BRADIUSMAX=n<units>
specifies the size of the radius of the largest bubble. You can specify any positive
number for n, including decimals, as the dimension of the size.

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. Viable units of measure are
CM, IN, MM, PCT or %, PT, or PX.

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.
**SAS 9.4M6 BRADIUSMIN=n<units>**

specifies the size of the radius of the smallest bubble. You can specify any positive number for n, including decimals, as the dimension of the size.

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*. Viable units of measure are CM, IN, MM, PCT or %, PT, or PX.

**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.

**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.

**DATALABELATTRS=(option(s))**

specifies the appearance of the labels in the plot when you use the DATALABEL= option.

For a description of the appearance of the labels in the plot when you use the DATALABELATTRS= option, see “Text Attributes” in *SAS ODS Graphics: Procedures Guide*.

**Default**

GraphLabelText style element in the current style. The style attributes in use are Color, FontFamily, FontSize, FontStyle, and FontWeight. Any options for label text that not specified are derived from this default style element.

**Interactions**

You can specify one or more options for the label 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.

The DATALABELATTRS= option has no effect unless the DATALABEL option is also specified.

**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=GraphValueText
```

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:
**DATALABELPOS=**position

specifies the location of the data label with respect to the plot. *position* can be one of the following values:

<table>
<thead>
<tr>
<th>Bottom</th>
<th>Center</th>
<th>Top</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottomleft</td>
<td>Left</td>
<td>Topleft</td>
</tr>
<tr>
<td>Bottomright</td>
<td>Right</td>
<td>Topright</td>
</tr>
</tbody>
</table>

Interaction: This option has no effect unless you also specify the DATALABEL option.

**FILL | NOFILL**

specifies whether the bubbles are filled. The FILL option displays the fill color. The NOFILL option hides 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.

**FILLATTRS=**style-element <(options)> | (option(s))

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.

For a description of fill attributes, see “Fill Attributes” in *SAS ODS Graphics: Procedures Guide*.

Defaults: Color attribute of the GraphDataDefault style element in the current style for ungrouped data. SAS 9.4M6: GraphData1 ... GraphData n style elements in the current style for grouped data.

Range: 0.0 transparency. This is the same default setting as the TRANSPARENCY= option.

Interactions: SAS 9.4M6: 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 or the OUTLINE option.

**GROUP=**variable

specifies a discrete variable that is used to group the data.

SAS 9.4M6: 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.

<table>
<thead>
<tr>
<th>Default</th>
<th>The label for the Size variable is used for ungrouped data.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactions</td>
<td>This option has no effect unless you also specify the NAME= option in the BUBBLE statement.</td>
</tr>
<tr>
<td></td>
<td>This option has no effect if you also specify the GROUP= option in the BUBBLE statement.</td>
</tr>
</tbody>
</table>

**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. |

**SAS 9.4M6: 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. |

**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) |
**CHOROMAP Statement**

Specifies a two-dimensional map of polygonal areas that can be empty or in which values of the specified response variable are represented by varying patterns and colors.

**Default:** The CHOROMAP statement uses a set of rules to plot the coordinate variables in a map data set. See “Details” on page 476. The SAS log lists what the CHOROMAP statement used for coordinate variables.

**Restrictions:** Do not use a Teradata, a SAS LASR Analytic server, or a SAS Cloud Analytic Services (CAS) server as the repository for map data sets or for geocoding lookup data sets. Essential polygonal data sequencing is lost as the data is distributed amongst the nodes of these servers. An error message in the SAS log stops any attempt to use a map data set sourced from these servers.

The MAPDATA= option must specify a map data set of polygon boundaries on the SGMAP statement in order to give the CHOROMAP statement data to process.

**Notes:** SAS 9.4M6: If you specify a map response data set with MAPRESPDATA=, but do not specify a response variable on the CHOROMAP statement, the map response data set is ignored.

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> / <option(s)>;`

**Summary of Optional Arguments**

**SAS 9.4M6: DISCRETE**

generates a separate response level (color and surface pattern) for each different value of the formatted response variable.

**Appearance options**

**SAS 9.4M6: LINEATTRS=style-element (option(s))**

specifies the appearance of the polygon border line attributes.

**TRANSPARENCY=value**

specifies the degree of transparency for the plot.

**Label options**

**SAS 9.4M6: 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 | LOW | MEDIUM | HIGH

for maps that have a DENSITY variable, specifies the density of map observations that are used.

**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.

**Optional Arguments**

response-variable

specifies a variable in the map response data set. 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.

**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 on 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".

**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 MAPRESPPDATA= 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.

SAS 9.4M6: 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.

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.

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 MAPRESPPDATA= 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.

**DENSITY=0 ...6 | LOW | MEDIUM | HIGH**

for maps that have a DENSITY variable, specifies the density of map observations that are used. 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.

Intuitively, 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. Starting with SAS 9.4M6, the GREDUCE procedure is available to use with Base SAS. Prior to SAS 9.4M6, a SAS/GRAPH license is required before you can use the GREDUCE procedure.

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.

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.

**Alias**  
L | MED | M | HI | H

**Default**  
DENSITY=6

**Restrictions**  
If the map data set does not contain a column of DENSITY values, then a warning is issued and the option is ignored.

The DENSITY= option is ignored if you have also specified a WHERE clause to subset the map data set.

**Tip**  
Specifying DENSITY=0 yields a different result than running your code with the DENSITY= option removed.

**See**  
Chapter 13, “GREDUCE Procedure,” on page 423 for information about the DENSITY variable.

**SAS 9.4M6: 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 494.

**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 labelled.

### SAS 9.4M6: LINEATTRS=style-element (option(s))

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/GRAPH: Reference.

**Default** The default color is specified by 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>
<thead>
<tr>
<th>Pattern Number</th>
<th>Pattern Name</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Solid</td>
<td>..........................</td>
</tr>
<tr>
<td>2</td>
<td>ShortDash</td>
<td>..........................</td>
</tr>
<tr>
<td>4</td>
<td>MediumDash</td>
<td>..........................</td>
</tr>
</tbody>
</table>
### Table 16.2 Measurement Units

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM</td>
<td>centimeters</td>
</tr>
<tr>
<td>IN</td>
<td>inches</td>
</tr>
<tr>
<td>MM</td>
<td>millimeters</td>
</tr>
<tr>
<td>PCT or %</td>
<td>percentage</td>
</tr>
<tr>
<td>PT</td>
<td>point size, calculated at 100 dots per inch</td>
</tr>
<tr>
<td>PX</td>
<td>pixels</td>
</tr>
</tbody>
</table>

For a description of the line options, see “Line Attributes and Patterns” in SAS ODS Graphics: Procedures Guide.

**Default**
The default line pattern is specified by the LineStyle attribute of the GraphOutlines style element in the current style.

**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:
Defaults

The default line thickness is specified by the LineThickness attribute of the GraphOutlines style element in the current style.

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);
```

TRANSARENCY=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)

Details

The CHOROMAP statement plots the coordinate variables in a map data set according to the following rules:

- Searches for, and uses unprojected coordinate variables in the order of LAT, then LATITUDE, and LONG, then LON, then LONGITUDE.
- In the absence of these unprojected coordinate variables, uses projected coordinate variables Y and X.
- Does not use unprojected and projected coordinate variables in combination.
- If the LAT, LATITUDE, and Y coordinate variable are all missing then the CHOROMAP 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.

This way of handling the coordinate variables enables an unprojected choromap to be overlaid 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: The ESRIMAP statement must be specified in conjunction with either a CHOROMAP statement or a plot overlay statement such as BUBBLE, SCATTER, or TEXT.

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.
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.

**Syntax**

```sas
ESRIMAP URL='map-service';
```

**Required Argument**

**URL='map-service’**

Specify the Esri base map that you want to use. An example is:

```sas
esrimap
  url='http://services.arcgisonline.com/arcgis/rest/services/World_Physical_Map';
```

**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 Windows or Linux network proxy machine request that you might need to make.

**Tips**

On a Windows operating system, check your proxy settings by entering the map service URL into a Windows Internet Explorer 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.

---

**GRADLEGEND Statement**

SAS 9.4M6: 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**

```sas
GRADLEGEND <"name"> <option(s)>;
```

**Summary of Optional Arguments**

**Appearance options**
**Legend options**

"name"

specifies the name of the plot that you want to include in the legend.

**Scale options**

**EXTRACTSCALE**

extracts a scale factor from the tick values and uses it to reduce the tick value width.

### Optional Arguments

"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.

**Default**

If you do not specify a name, then the legend contains references to all of the plots in the graph.

**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 on the plot statements.

**BORDER | NOBORDER**

specifies whether a border is visible around the legend. The BORDER option shows the border. The NOBORDER option hides the border.

**Default**

NOBORDER

**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.

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.

The following examples show a continuous legend before and after EXTRACTSCALE is specified:

<table>
<thead>
<tr>
<th>Default Scale</th>
<th>EXTRACTSCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Default Scale Image" /></td>
<td><img src="image2.png" alt="EXTRACTSCALE Image" /></td>
</tr>
</tbody>
</table>

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.

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"
specifies a 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 those cases, the title is placed above the legend body.

Defaults The title is the name of the response variable.
No title unless the legend shows group values.

If the legend shows group values, then the group variable is displayed by default as the title. In this case, to remove the title, specify \texttt{TITLE=""}.

Text

\textbf{Requirement} \
\textit{text-string} must be enclosed in quotation marks.

\textbf{TITLEATTRS=style-element | style-element<br>(option(s)) | (option(s))}

specifies the appearance of the title. For the KEYLEGEND statement, this option affects the inset 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.

For a description of the text options, see “Text Attributes” in \textit{SAS ODS Graphics: Procedures Guide}.

\textbf{Defaults} \
GraphValueText style element in the current style. The style attributes in use are Color, FontFamily, FontSize, FontStyle, and FontWeight. Any unspecified options for inset title text appearance are derived from this default style element.

GraphLabelText style element in the current style. The style attributes in use are Color, FontFamily, FontSize, FontStyle, and FontWeight. Any unspecified options for inset (KEYLEGEND) or legend (GRADLEGEND) title text appearance are derived from this default style element.

\textbf{Restriction} \
You can specify one font family name, but not more than one.

\textbf{Interactions} \
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.

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.

\textbf{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.

\textbf{Examples} \
\texttt{TITLEATTRS={Color=Green Family=Arial Size=8 Style=Italic Weight=Bold}}

Here is an example that specifies a style element: \texttt{TITLEATTRS=GraphTitleText}

Here is an example that specifies a style element other than the default, and overrides the size option: \texttt{titleattrs=GraphLabelText\{size=10pt\}}

Here is an example that specifies a style element other than the default, and overrides the size option:
KEYLEGEND Statement

Adds a legend to the plot.


Syntax

KEYLEGEND <"name-1" ..."name-n"> <option(s)>;

Summary of Optional Arguments

Appearance options

TITLE="text-string"
specifies a title for the legend.

TITLEATTRS=style-element | style-element <(option(s)> | (option(s))
specifies the appearance of the title.

VALUEATTRS=style-element <(options)> | (options)
specifies the appearance of the legend value labels.

Legend options

“name-1” ... “name-n”
specifies the names of one or more plots that you want to include in the legend.

Optional Arguments

“name-1” ... “name-n”
specifies the names of one or more plots that you want to include in the legend. Each name that you specify must correspond to a value that you entered for the NAME= option in a plot statement. Each name must be enclosed in quotation marks. If more than one name is specified, separate each by a space.

Default

If you do not specify a name, then the legend contains references to all of the plots in the graph.

Interaction | Interaction

When the KEYLEGEND 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 on the plot statements.

TITLE="text-string"
specifies a 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 those cases, the title is placed above the legend body.

Requirement  text-string must be enclosed in quotation marks.

**TITLEATTRS=style-element | style-element <(option(s))> | (option(s))**

specifies the appearance of the title. For the KEYLEGEND statement, this option affects the inset 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.

For a description of the text options, see “Text Attributes” in *SAS ODS Graphics: Procedures Guide*.

### Defaults

GraphValueText style element in the current style. The style attributes in use are Color, FontFamily, FontSize, FontStyle, and FontWeight. Any unspecified options for inset title text appearance are derived from this default style element.

GraphLabelText style element in the current style. The style attributes in use are Color, FontFamily, FontSize, FontStyle, and FontWeight. Any unspecified options for inset (KEYLEGEND) or legend (GRADLEGEND) title text appearance are derived from this default style element.

### Restriction

You can specify one font family name, but not more than one.

### Interactions

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.

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=GraphLabelText(size=10pt)**

Here is an example that specifies a style element other than the default, and overrides the size option:

**titleattrs=GraphValueText(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.

For a description of the text options, see “Text Attributes” in SAS ODS Graphics: Procedures Guide.

Defaults
Color attribute of the GraphValueText style element in the current style (ungrouped data).

GraphValueText style element in the current style. The style attributes in use are Color, FontFamily, FontSize, FontStyle, and FontWeight. Any options for the legend value label text that not specified are derived from this default style element.

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: The OPENSTREETMAP statement must be specified in conjunction with either a CHOROMAP statement or a plot overlay statement such as BUBBLE, SCATTER, or TEXT.
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.

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 Windows or Linux network proxy machine request that you might need to make.

---

**Syntax**

OPENSTREETMAP;

---

**SCATTER Statement**

Creates a scatter plot.

---

**Syntax**

SCATTER X=variable Y=variable <option(s)>;

**Summary of Optional Arguments**

**Appearance options**

TRANSPARENCY=value

specifies the degree of transparency for the plot.

**Group options**

GROUP=variable

specifies a variable that is used to group the data.

**SAS 9.4M6: 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=(option(s))

specifies the appearance of the labels in the plot when you use the DATALABEL= option.

DATALABELPOS=position
specifies the location of the data label with respect to the plot.

\text{LEGENDLABEL}="text-string"

specifies a label that identifies the markers from the plot in the legend.

**Marker options**

\text{MARKERATTRS=\text{style-element} \text{ <\textit{options}>} | \text{ <\textit{options}>}}

specifies the appearance of the markers in the plot.

**Plot reference options**

\text{NAME="text-string"}

assigns a name to a plot overlay.

**Required Arguments**

\text{X=\textit{variable}}

specifies the variable for the X axis (longitude).

\text{Y=\textit{variable}}

specifies the variable for the Y axis (latitude).

**Optional Arguments**

\text{DATALABEL=\textit{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.

\text{DATALABELATTRS=(option(s))}

specifies the appearance of the labels in the plot when you use the \text{DATALABEL=} option.

For a description of the text options, see “Text Attributes” in \textit{SAS ODS Graphics: Procedures Guide}.

**Default**

GraphLabelText style element in the current style. The style attributes in use are Color, FontFamily, FontSize, FontStyle, and FontWeight. Any options for label text that not specified are derived from this default style element.

**Interactions**

You can specify one or more options for the label 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.

The \text{DATALABELATTRS=} option has no effect unless the \text{DATALABEL} option is also specified.

**Examples**

Here is an example that specifies options for the text of the label:

\text{DATALABELATTRS=} \begin{align*}
\text{(Color=Green} & \text{ Family=Arial} \text{ Size=8} \\
\text{ Style=Italic} & \text{ Weight=Bold})
\end{align*}

Here is an example that specifies, in this case, the default style element:

\text{DATALABELATTRS=} \text{GraphValueText}
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:

\[
\text{DATALABELATTRS=}\text{GRAPHVALUETEXT(SIZE=10pt)}
\]

### DATALABELPOS=position

specifies the location of the data label with respect to the plot. *position* can be one of the following values:

- BOTTOM
- CENTER
- TOP
- BOTTOMLEFT
- LEFT
- TOpleft
- BOTTOMRIGHT
- RIGHT
- TOPRIGHT

**Interaction** This option has no effect unless you also specify the DATALABEL option.

### GROUP=variable

specifies a variable that is used to group the data. SAS 9.4M6: 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 marker color. Marker 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 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.

For a description of marker attributes, see “Marker Attributes and Symbols” in *SAS ODS Graphics: Procedures Guide*.

**Default** GraphDataDefault style element in the current style for ungrouped data. The affected attributes are ContrastColor and MarkerSymbol.

### 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.

**SAS 9.4M6: 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.

**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)

---

**SERIES Statement**

SAS 9.4M6: 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 Teradata, a SAS LASR Analytic server, or a SAS Cloud Analytic Services (CAS) server as the repository for map data sets or for plot data sets. Essential polygonal data and line segment sequencing is lost as the data is distributed amongst the nodes of these servers. An error message in the SAS log stops any attempt to use a map data set sourced from these servers.

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 on 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 <option(s)>;
```

**Summary of Optional Arguments**

**Appearance options**

**SAS 9.4M6: LINEATTRS=**\(style-element (option(s))\)

specifies the appearance of the series line attributes.

**Group options**

```
GROUP=variable
```
specifies a discrete variable that is used to group the data.

**SAS 9.4M6: 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 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**

GROUP= *variable*

specifies a discrete variable that is used to group the data.

**SAS 9.4M6:** 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 line color. Line 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 of the Y variable.

**Interaction**

The LEGENDLABEL= option has no effect if you also specify the GROUP= option in the same plot statement.

**SAS 9.4M6: LINEATTRS=style-element(option(s))**

specifies the appearance of the series line attributes. **SAS 9.4M6:** The LINEATTRS= option is added to the SERIES statement of the SGMAP procedure.

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=graphdatadefault;

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=**<br>(style-reference | color)<br>specifies the color of the series line. You can specify colors using a number of different color-naming schemes. For more information, see “Color-Naming Schemes” in SAS/GRAPH: Reference.

**Default**<br>For line colors, the ContrastColor style reference of the GraphDataDefault style element in the current style for ungrouped data. For grouped data, the color of lines is determined by the ContrastColor attribute of the GraphData1 ... GraphData n style elements in the current style.

**Interaction**<br>With grouped data, the COLOR= color setting has the effect of holding the line color constant across all group values.

**Example**<br>If you want to override the color attribute of the default style element, specify an alternative style-reference like the following:<br>lineattrs=GraphOutlines (color=graphoutlines:contrastcolor);

**PATTERN=**<br>(line-pattern-name | line-pattern-number)<br>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 16.3 Commonly Used Line Patterns**

<table>
<thead>
<tr>
<th>Pattern Number</th>
<th>Pattern Name</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Solid</td>
<td>____________________________</td>
</tr>
<tr>
<td>2</td>
<td>ShortDash</td>
<td>................................</td>
</tr>
<tr>
<td>4</td>
<td>MediumDash</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>5</td>
<td>LongDash</td>
<td>______________________________</td>
</tr>
<tr>
<td>8</td>
<td>MediumDashShortDash</td>
<td>- - - - - - - - - - - - - - - -</td>
</tr>
</tbody>
</table>

SERIES Statement 489
<table>
<thead>
<tr>
<th>Pattern Number</th>
<th>Pattern Name</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>DashDashDot</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>DashDotDot</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Dash</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>LongDashShortDash</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Dot</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>ThinDot</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>ShortDashDot</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>MediumDashDotDot</td>
<td></td>
</tr>
</tbody>
</table>

For a description of the line options, see “Line Attributes and Patterns” in SAS ODS Graphics: Procedures Guide.

**Default**
For line styles, GraphDataDefault style element in the current style for ungrouped data. For grouped data, the cycling of line styles is determined by the LineStyle attribute of the GraphData1 ... GraphDataN style elements in the current style.

**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 16.4 Measurement Units*

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM</td>
<td>centimeters</td>
</tr>
<tr>
<td>IN</td>
<td>inches</td>
</tr>
<tr>
<td>MM</td>
<td>millimeters</td>
</tr>
<tr>
<td>PCT or %</td>
<td>percentage</td>
</tr>
<tr>
<td>PT</td>
<td>point size, calculated at 100 dots per inch</td>
</tr>
<tr>
<td>PX</td>
<td>pixels</td>
</tr>
</tbody>
</table>
Defaults
The default line thickness is specified by the LineThickness attribute of the GraphDataDefault style element in the current style.

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.

SAS 9.4M6: 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.
TEXT Statement
Displays the associated text values at (X, Y) locations in the graph. The text can be numbers or characters.

Syntax

TEXT X=variable Y=variable TEXT=variable </option(s)>;

Summary of Optional Arguments

Text options

POSITION=position-option
specifies the position of the text with respect to the location of the data point.

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.

Optional Arguments

POSITION=position-option
specifies the position of the text with respect to the location of the data point. Specify one of the following position options:

BOTTOM CENTER TOP
BOTTOMLEFT LEFT TOPLEFT
BOTTOMRIGHT RIGHT TOPRIGHT

Default CENTER

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, FONTCOLOR, 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.
Any options specified override the properties from the style-element. For a description of the text options, see “Text Attributes” in SAS ODS Graphics: Procedures Guide.

Default
For non-grouped data, the GraphDataText style element. This default style sets attributes for COLOR, FONTFAMILY, FONTSIZE, FONTSTYLE, and FONTWEIGHT.

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};

Interaction
You can specify one or more options for the text. They might not include all the font properties (color, family, size, weight, style). Any non-specified properties are derived from the GraphDataText style element.

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}

Controlling Legends with the SGMAP Procedure

Rules for Generating Legends

SAS 9.4M6: By default, the SGMAP procedure 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.
- 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 is discrete, a discrete 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.
Specifying the OpenStreetMap and ESRIMAP statements have no effect on these rules.

Suppressing Legends

Starting with SAS 9.4M6, the NOAUTOLEGEND option specified on the SGMAP statement, overrides the default behavior.

Starting with SAS 9.4M6, 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.

Starting with SAS 9.4M6, when the CHOROMAP statement does not specify a response variable and it is the only statement used, the autolegend is suppressed.

See “NOAUTOLEGEND” on page 465 for details.

Applying a Label in a Legend on a CHOROMAP

Starting with SAS 9.4M6, 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 chiclets 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 chiclet 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.

• The LEGENDLABEL= option is ignored if you also specify the GROUP= option in the same plot statement.


Examples: SGMAP Procedure

Example 1: Nevada Counties with Bubble Plot of County Seat Populations

Features: MAPDATA= required argument referring to GfK map data set
Example 1: Nevada Counties with Bubble Plot of County Seat Populations

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=
  DATALABLEATTRS= option with COLOR=, SIZE=, and STYLE= suboptions

Other features:
  ODS destination statement
  DATA step
  TITLE global statement

Data sets:
  MAPS (configured as MAPSSAS)
  OpenStreetMap
  SASHELP.ZIPCODE (Lookup data set)

ODS destination:
  HTML

Sample library member:
  SGMPNVBU

Notes:
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
The SAS-supplied map data set(s) 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. HTML output is displayed.

The Base SAS GEOCODE procedure is used to find the latitude and longitude city locations.

Note: This example can be run without having SAS/GRAPH installed.
output

Program

ods _all_ close;
ods html file='bubble_nevada.html';
data city_pop (label='Nevada County Seat Populations');
  length city $80;
  format population comma8.;
infile datalines dlm=',';
  state = 'NV';
in input city population;
  label city = 'County Seat'
    population = 'City Population'
    state = 'State';
cards;
  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
;
proc geocode method=city
  data=city_pop
  out=city_pop_xy
  lookupcity=sashelp.zipcode; /* Use this if you don’t have SAS GRAPH */
run;

data nevada;
  set maps.counties(where=(state=32));
  x = -x * 45/atan(1);
  y = y * 45/atan(1);
run;

title 'Nevada County Seat Populations';
proc sgmap mapdata=nevada       /* Map boundaries */
  plotdata=city_pop_xy /* Bubble response & location data */
  des='Nevada';
  openstreetmap;
  choromap / mapid=county lineattrs=(color=blue) legendlabel='Counties';
  bubble x=x y=y size=population /
    name='cities' datalabel=city
    datalabelattrs=(color=red size=9 style=italic);
run;
quit;
ods _all_ close;

Program Description
Plot BUBBLES as county seat populations and map polygons are Nevada county boundaries.

Define the output filename and set the map output ODS destination to HTML.
ods _all_ close;
  ods html file='bubble_nevada.html';

Create city population response data for bubbles.

data city_pop (label='Nevada County Seat Populations');
  length city $80;
  format population comma8.;
  infile datalines dlm=',';
  state = 'NV';
  input city population;
  label city = 'County Seat'
    population = 'City Population'
    state = 'State';
cards;
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

Determine city locations. 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_xy
   lookupcity=sashelp.zipcode; /* Use this if you don't have SAS GRAPH */
run;
```

Retrieve the Nevada county boundaries for the choropleth map. Convert the existing X and Y coordinate variable values from radians (projected) to degrees (unprojected). The choropleth map of counties can then be overlaid on an unprojected OpenStreetMap of the Nevada portion of the United States.

```
data nevada;
   set maps.counties(where=(state=32));
   x = -x * 45/atan(1);
   y = y * 45/atan(1);
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.

```
title 'Nevada County Seat Populations';
proc sgmap mapdata=nevada       /* Map boundaries */
   plotdata=city_pop_xy /* Bubble response & location data */
   des='Nevada';
openstreetmap;
choromap / mapid=county lineattrs=(color=blue) legendlabel='Counties';
bubble x=x y=y size=population /
   name='cities'  datalabel=city
   datalabelattrs=(color=red size=9 style=italic);
run;
quit;
ods _all_ close;
```

Example 2: Nevada Counties with Bubble Plot of County Seats and Populations

**Features:**
- MAPDATA= required argument referring to GfK map data set
- MAPRESPDATA= county population response data
- PLOTDATA= argument referring to bubble location and response data
CHOROMAP statement options
  MAPID=
  ID=

BUBBLE statement options
  NAME=
  DATALABEL=
  DATALABLEATTRS= option with COLOR=, SIZE=, and STYLE= suboptions

KEYLEGEND statement

Other features:
  ODS statement
  DATA step
  SORT procedure
  TITLE global statement

Data set:
  MAPSGFK

ODS destination:
  HTML

Sample library member:
  SGMPNVB2

Notes:
The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
The SAS-supplied map data set(s) 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 populations. The bubbles are sized based on the county seat population. PNG output is displayed.
Program

```
ods _all_ close;

data city_xy (label='Nevada Cities'
    keep=county city city2 x y county_name);
    set mapsgfk.uscity_all(where=(state=32) drop=x y
        rename=(long=x lat=y));
run;

proc sort data=city_xy;
    by city2;
run;

data city_pop (label='Nevada County Seat Populations');
    length city $65 city2 $55;
    infile datalines dlm=',';
    input city population_city county;
    label city            = 'County Seat'
        city2           = 'Normalized city name'
        population_city = 'City Population'
        county          = 'County FIPS Code';
    city2 = upcase(compress(city));
cards;
    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
;
proc sort data=city_pop;
  by city2;
run;
data city_pop_xy;
  merge city_pop (in=a) city_xy;
  by city2;
  if a;
run;
data county_pop (label='Nevada Counties');
  length county_name $55;
  infile datalines dlm=',';
  state=32;
  input county_name county population_county;
  label state             = 'State FIPS Code'
                    county_name       = 'County Name'
                    county            = 'County FIPS Code'
                    population_county = '2010 Census County Population'
                    group             = 'Population range';
/* 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';
cards;
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
PROC SORT DATA=COUNTY_POP;
  BY POPULATION_COUNTY;
RUN;

PROC TEMPLATE;
  DEFINE STYLE STYLES.MAP; PARENT = STYLES.LISTING;
  STYLE GRAPHCOLORS FROM GRAPHCOLORS /
    "GDATA5" = CY2F2F5F
    "GDATA4" = CY4F4F7F
    "GDATA3" = CY5F5F9F
    "GDATA2" = CY9F9FD3
    "GDATA1" = CXDFDFFF;
  END;
RUN;

DATA NEVADA;
  SET MAPSGFK.US_COUNTIES(WHERE=(STATE=32)
    DROP=X Y
    RENAME=(LONG=X LAT=Y));
RUN;
TITLe;

ODS HTML FILE='BUBBLE_POLY_NEVADA.HTM' STYLE=STYLES.MAP;

PROC SGMAP MAPDATA=NEVADA /* Map polygon geometry        */
  MAPRESPDATA=COUNTY_POP  /* Map polygon response data   */
  PLOTDATA=CITY_POP_XY    /* Bubble response & location data */
  DES='NEVADA';
TITLe 'NEVADA COUNTY SEATS AND POPULATIONS';
CHORMAP GROUP / MAPID=COUNTY ID=COUNTY NAME='COUNTIES';
BUBBLE X=X Y=Y SIZE=POPULATION_CITY / NAME='CITIES' DATALABEL=CITY
  DATALABELATR={COLOR=CYAN
    SIZE=9
    STYLE=ITALIC};
KEYLEGEND 'COUNTIES' / TITLE='COUNTY POPULATION';
KEYLEGEND 'CITIES' / ;
RUN;
QUIT;
ODS HTML CLOSE;

Program Description

Produce a choropleth map with the map polygon data of the state of Nevada and the
CHORMAP statement’s response values displaying each county’s population. Plot
BUBBLES as county seat populations.

Close all output destinations.

ODS _ALL_ CLOSE;
Retrieve all Nevada city locations. You cannot plot these existing X and Y values with the X and Y values in the county map data set used below. This is because the two data sets use different projections. The city bubbles would not align with the county boundaries. Avoid this by plotting the unprojected LONG and LAT values. Rename LONG and LAT variables to be X and Y, respectively.

```sas
data city_xy (label='Nevada Cities'
    keep=county city2 x y county_name);
set mapsgfk.uscity_all(where=(state=32) drop=x y
    rename=(long=x lat=y));
run;
```

Sort the data by Nevada cities.

```sas
proc sort data=city_xy;
    by city2;
run;
```

Create population response data for city bubbles.

```sas
data city_pop (label='Nevada County Seat Populations');
    length city $65 city2 $55;
    infile datalines dlm=',';
    input city population_city county;
    label city            = 'County Seat'
        city2           = 'Normalized city name'
        population_city = 'City Population'
        county          = 'County FIPS Code';
    city2 = upcase(compress(city));
cards;
    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
;
```

Sort the data by population of Nevada cities.

```sas
proc sort data=city_pop;
    by city2;
run;
```

Combine city locations with population response data for bubbles. Keep only the county seats.
data city_pop_xy;
  merge city_pop (in=a) city_xy;
  by city2;
  if a;
run;

Create response data for Nevada county polygons. Add five population ranges as groups to map response data.

data county_pop (label='Nevada Counties');
  length county_name $55;
  infile datalines dlm=',';
  state=32;
  input county_name county population_county;
  label state             = 'State FIPS Code'
                  county_name       = 'County Name'
                  county            = 'County FIPS Code'
                  population_county = '2010 Census County Population'
                  group             = 'Population range';
/* 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';
cards;
  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
;
Sort the county population response data.

proc sort data=county_pop;
  by population_county;
run;

Create the Graph style for county colors specifying by population ranges.

proc template;
  define Style Styles.map; parent = styles.listing;
  style GraphColors from graphcolors /
      "gdata5" = cx2f2f5f
Retrieve county boundaries for the choropleth map.

data nevada;
  set mapsgfk.us_counties(where=(state=32)
    drop=x y
    rename=(long=x lat=y));
run;

Clear the title. Define the output filename and specify the map style as defined in the PROC TEMPLATE step. Generate the title, the map, and the legend. MAPDATA contains the state of Nevada's polygon coordinates. MAPRESPDATA contains the population response data and PLOTDATA contains the BUBBLE response data and location data.

title;
ods html file='bubble_poly_nevada.htm' style=Styles.map;

proc sgmap mapdata=nevada          /* Map polygon geometry            */
    maprespdata=county_pop  /* Map polygon response data       */
    plotdata=city_pop_xy    /* Bubble response & location data */
    des='Nevada';
title 'Nevada County Seats and Populations';
choromap group / mapid=county id=county name='counties';
bubble x=x y=y size=population_city / name='cities' datalabel=city
datalabelattrs=(color=cyan
  size=9
  style=italic);
keylegend 'counties' / title='County Population';
keylegend 'cities'  / ;
run;
quit;
ods html close;

Example 3: 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=
    DATALABELATTRS= option with COLOR=, SIZE=, and STYLE= suboptions
    LEGENDLABEL=

Other features: ODS destination statement
DATA step
TITLE global statement

Data set: OpenStreetMap
ODS destination: HTML
Sample library member: SGMPBUSE

Notes: The SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.
The SAS-supplied map data set(s) 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 Open StreetMap of the southeast United States. The bubble sizes are based on the wind speed. HTML output is displayed.

Output

Program

ods _all_ close;
ods html file="katrina.html";

data katrina (label='Hurricane Katrina Track');
  length datetime $16;

infile datalines dlm=',';
n=Katrina;
input datetime y x wind;
label datetime = 'Date and Time'
y = 'Latitude'
x = 'Longitude'
wind = 'Wind Speed MPH';
datalines;
23AUG05:18:00:00,23.1,-75.1,30
24AUG05:00:00:00,23.4,-75.7,30
24AUG05:06:00:00,23.8,-76.2,30
24AUG05:12:00:00,24.5,-76.5,35
24AUG05:18:00:00,24.4,-76.9,40
25AUG05:00:00:00,26,-77.7,45
25AUG05:06:00:00,26.1,-78.4,50
25AUG05:12:00:00,26.2,-79.5,55
25AUG05:18:00:00,26.2,-79.6,60
25AUG05:22:30:00,26,-80.1,70
26AUG05:00:00:00,25.9,-80.3,70
26AUG05:06:00:00,25.4,-81.3,65
26AUG05:12:00:00,25.1,-82,75
26AUG05:18:00:00,24.9,-82.6,85
27AUG05:00:00:00,24.6,-83.3,90
27AUG05:06:00:00,24.4,-84,95
27AUG05:12:00:00,24.4,-84.7,100
27AUG05:18:00:00,24.5,-85.3,100
28AUG05:00:00:00,24.8,-85.9,100
28AUG05:06:00:00,25.2,-86.7,125
28AUG05:12:00:00,25.7,-87.7,145
28AUG05:18:00:00,26.3,-88.6,150
29AUG05:00:00:00,27.2,-89.2,140
29AUG05:06:00:00,28.2,-89.6,125
29AUG05:11:10:00,29.3,-89.6,110
29AUG05:12:00:00,29.5,-89.6,110
29AUG05:14:45:00,30.2,-89.6,105
29AUG05:18:00:00,31.1,-89.6,80
30AUG05:00:00:00,32.6,-89.1,50
30AUG05:06:00:00,34.1,-88.6,40
30AUG05:12:00:00,35.6,-88,30
30AUG05:18:00:00,37,-87,30
31AUG05:00:00:00,38.6,-85.3,30
31AUG05:06:00:00,40.1,-82.9,25
;

data katrina; set katrina end=last;
if find(datetime,'06:00:00') or _n_=1 or last then do;
  date=substr(datetime,1,7);
  long=x; lat=y;
end;
run;
title1 'Hurricane Katrina';
proc sgmap plotdata=katrina;
  openstreetmap;
  series x=x y=y / legendlabel='Storm Track'
Program Description
Plot bubbles as hurricane wind speeds and plot series lines as hurricane tracking locations. Overlay plots on the southeast United States OpenStreetMap.

Define the output filename and set the map output ODS destination to HTML.

```sas
ods _all_ close;
ods html file="katrina.html";
```

Create hurricane location response data for the series lines and wind speed for the bubbles.

```sas
data katrina (label='Hurricane Katrina Track');
length datetime $16;
infile datalines dlm=',';
nname='Katrina';
input datetime y x wind;
label datetime = 'Date and Time'
y = 'Latitude'
x = 'Longitude'
wind = 'Wind Speed MPH';
datalines;
23AUG05:18:00:00,23.1,-75.1,30
24AUG05:00:00:00,23.4,-75.7,30
24AUG05:06:00:00,23.8,-76.2,30
24AUG05:12:00:00,24.5,-76.5,35
24AUG05:18:00:00,25.4,-76.9,40
25AUG05:00:00:00,26,-77.7,45
25AUG05:06:00:00,26.1,-78.4,50
25AUG05:12:00:00,26.2,-79,55
25AUG05:18:00:00,26.2,-79.6,60
25AUG05:22:30:00,26,-80.1,70
26AUG05:00:00:00,25.9,-80.3,70
26AUG05:06:00:00,25.4,-81.3,65
26AUG05:12:00:00,25.1,-82,75
26AUG05:18:00:00,24.9,-82.6,85
27AUG05:00:00:00,24.6,-83.3,90
27AUG05:06:00:00,24.4,-84,95
27AUG05:12:00:00,24.4,-84.7,100
27AUG05:18:00:00,24.5,-85.3,100
28AUG05:00:00:00,24.8,-85.9,100
28AUG05:06:00:00,25.2,-86.7,125
28AUG05:12:00:00,25.7,-87.7,145
28AUG05:18:00:00,26.3,-88.6,150
29AUG05:00:00:00,27.2,-89.2,140
```

29AUG05:06:00:00,28.2,-89.6,125
29AUG05:11:10:00,29.3,-89.6,110
29AUG05:12:00:00,29.5,-89.6,110
29AUG05:14:45:00,30.2,-89.6,105
29AUG05:18:00:00,31.1,-89.6,80
30AUG05:00:00:00,32.6,-89.1,50
30AUG05:06:00:00,34.1,-88.6,40
30AUG05:12:00:00,35.6,-88,30
30AUG05:18:00:00,37,-87,30
31AUG05:00:00:00,38.6,-85.3,30
31AUG05:06:00:00,40.1,-82.9,25

Only keep some dates for bubbles and labels. Track locations at 6:00 am, as well as at the first and last time record.

data katrina; set katrina end=last;
  if find(datetime,'06:00:00') or _n_=1 or last then do;
    date=substr(datetime,1,7);
    long=x; lat=y;
  end;
run;

Assign a title to the graph. Use the global TITLE statement.

title1 'Hurricane Katrina';

Create the graph. Run the SGMAP procedure starting with the OpenStreetMap statement. Overlay the series plot of hurricane tracking locations. 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=x y=y / legendlabel='Storm Track'
    lineattrs=(color=red thickness=2);

  bubble x=long y=lat size=wind /
    datalabel=date datalabelpos=left
    datalabelattrs=(color=red size=10)
    legendlabel='Relative Wind Speed';
run;
quit;
ods _all_ close;

Example 4: Gradient Legend Showing 2010 U.S. 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

Other features:
  ODS destination statement
  DATA step
  TITLE global statement

Data sets:
  MAPS.USCENTER (available without SAS/GRAPH)
  Esri map service

ODS destination:
  HTML

Sample library member: SGMPGRAD

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 Internet Explorer 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 SAS Sample Library is not available in SAS Studio. You can download the mapping samples in the SAS Sample Library in zipped format from the Base SAS product documentation page on support.sas.com.

The SAS-supplied map data set(s) 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.
Program

ods _all_ close;
ods html file="usPopgradlmgnd.html";

data states;
  set maps.states;
  if state ^=in(2,15,72);
  x = -x * 45/atan(1);
  y = y * 45/atan(1);
run;

data plot_data;
  set maps.uscenter;
  if state ^=in(2,15,72);
  long = -long;
  statename = fipstate(state);
run;

title 'Population from 2010 US Census';

proc sgmap mapdata=states
  maprespdata=sashelp.us_data
  plotdata=plot_data;

  esrimap
  url='http://services.arcgisonline.com/arcgis/rest/services/Canvas/World_Light_Gray_Base';
Program Description

Plot 2010 U.S. Census Bureau population densities of the lower 48 states of the United States onto an Esri map.

Define the output filename and set the map output ODS destination to HTML.

ods _all_ close;
ods html file="usPopgradlgnnd.html";

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 maps.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. Only keep the lower 48 U.S. states, collecting the state FIPS codes.

data plot_data;
  set maps.uscenter;
  if state ^=in(2,15,72);
  long = -long;
  statename = fipstate(state);
run;

Assign a title to the graph. Use the global TITLE statement.

title 'Population from 2010 US Census';

Create the graph. Run the SGMAP procedure, using as input the states map data set, the U.S. Census Bureau 2010 population response data set, and the plot data set. Create the base Esri 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
  mapespdata=sashelp.us_data
  choromap population_2010 / mapid=state density=2
    name='choro';

text x=long y=lat text=statename /
  textattrs=(size=6pt);

  gradlegend 'choro' / title='2010 Population'
    extractscale;

run;
quit;
ods _all_ close;
Example 4: Gradient Legend Showing 2010 U.S. Population

```
plotdata=plot_data;

esrimap
  url='http://services.arcgisonline.com/arcgis/rest/services/
      Canvas/World_Light_Gray_Base';

choromap population_2010 / mapid=state density=2
  name='choro';

  text x=long y=lat text=statename /
    textattrs=(size=6pt);

gradlegend 'choro' / title='2010 Population'
  extractscale;

run;

quit;
ods _all_ close;
```
Recommended Reading

Here is the recommended reading list for this title:

- **SAS/GRAPH: Beyond the Basics**
- **SAS/GRAPH: Network Visualization Workshop User’s Guide**
  
  *Note:* SAS/GRAPH® Network Visualization Workshop is no longer available starting with SAS 9.4M5.
- **SAS/GRAPH: Reference**
- **Base SAS Procedures Guide**
- **Base SAS Utilities: Reference**
- **Output Delivery System: The Basics and Beyond**
- **SAS Data Set Options: Reference**
- **SAS Formats and Informats: Reference**
- **SAS Functions and CALL Routines: Reference**
- **SAS Language Reference: Concepts**
- **SAS DATA Step Statements: Reference**
- **SAS Global Statements: Reference**
- **SAS System Options: Reference**
- **Statistical Graphics Procedures by Example: Effective Graphs Using SAS**
- **Statistical Graphics in SAS: An Introduction to the Graph Template Language and the Statistical Graphics Procedures**
- SAS offers instructor-led training and self-paced e-learning courses to help you get started with SAS/GRAPH. For more information about the courses available, see [sas.com/training](http://sas.com/training).

For a complete list of SAS publications, go to [sas.com/store/books](http://sas.com/store/books). If you have questions about which titles you need, please contact a SAS Representative:

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Cary, NC 27513-2414
Phone: 1-800-727-0025
Fax: 1-919-677-4444
Email: sasbook@sas.com
Web address: sas.com/store/books
Glossary

**absolute coordinate**

a coordinate that is measured from the origin of a coordinate system.

**ActiveX**

a technology developed by Microsoft that is used to add interactivity to web pages.

**ActiveX control**

a type of web application that is developed specifically for the Windows operating environment. ActiveX controls can provide web users with interactive capabilities.

**area bar chart**

a bar chart that applies an additional magnitude of width to the bars that results in categorized bars. Each bar has both a height and a width measure that can be independent of each other.

**aspect ratio**

the ratio of a shape's width to its height in an output area such as a display, plotter, or film recorder.

**axis area**

an area bounded by axes, which might be enclosed by an axis line.

**baseline**

in a font, the imaginary line upon which the characters rest.

**block map**

a three-dimensional map that uses blocks of varying heights to represent the value of a variable for each map area.

**boundary**

in the GMAP procedure, a separating line or point that distinguishes between two or more unit areas or segments.

**capline**

the highest point of a normal uppercase letter. In some fonts, the capline might be above the top of the letter to allow room for an accent.
**Cartesian coordinate system**

the two- or three-dimensional coordinate system in which perpendicular axes meet at the origin (0,0) or (0,0,0). Typically, Cartesian coordinate axes are called X, Y, and Z.

**cell**

See character cell.

**center point**

the location in the GRAPH window that, in conjunction with a radius point, defines the placement and shape of an ellipse or a pie.

**CGM**

See computer graphics metafile.

**character cell (cell)**

in device-based SAS/GRAPH procedures, a unit of measure whose size and shape are determined by both the size of the graphics output area and by the number of rows and columns in the graphics output area.

**character up vector**

the angle at which a character is positioned. The character up vector has two components, x and y, which determine the angle.

**chart statistic**

the statistical value calculated for the chart variable: frequency, cumulative frequency, percentage, cumulative percentage, sum, or mean.

**chart variable**

a variable in the input data set whose values are categories of data represented by bars, blocks, slices, or spines.

**chart vertex**

a point on a radar chart where a statistical value intersects the spokes.

**choropleth map**

a two-dimensional map that uses color and fill pattern combinations to represent different categories or levels of magnitude.

**class variable**

See classification variable.

**classification variable (class variable)**

a variable whose values are used to classify the observations in a data set into different groups that are meaningful for analysis. A classification variable can have either character or numeric values. Classification variables include group, subgroup, category, and BY variables.

**CMYK**

a color coding scheme that specifies a color in terms of the levels of cyan, magenta, yellow, and black components. The level of each component ranges from 0 to 255.

**color list**

the list of foreground colors that are available for graphics output. The color list is either the default list established from the style, the list created from the device entry, or the list established from the colors specified with the COLORS= graphics option.
The colors are derived from either the main color scheme models (NAME, RGB, RGBA, HLS), or from the secondary color scheme models (CMYK, GRAY, HSV).

color map
in SAS/GRAPH software, a table that is used to translate the original colors in graphics output to different colors when replaying graphics output using the GREPLAY procedure. The table is contained in a catalog entry.

color map

computer graphics metafile (CGM)
a graphics output file written in the internationally recognized format for describing computer graphics images. This standardization allows any image in a CGM to be imported and exported among different systems without error or distortion.

confidence limits
the upper and lower values of a (usually 95%) confidence interval. In repeated sampling, approximately (1-alpha)*100% of the resulting intervals would contain the true value of the parameter that the interval estimates (where alpha is the confidence level associated with the interval).

contour plot
a three-variable plot that uses line styles or patterns to represent levels of magnitude of z corresponding to x and y coordinates.

coordinate
a value that represents the location of a data point or a graphics element with respect to a coordinate system.

coordinate system
the context in which to interpret coordinates. Coordinate systems vary according to their origin, limits, and units.

data area
the portion of the graphics output area in which data values are displayed. The data area is bounded by axes or map areas. In the Annotate facility, the data area defines a coordinate system. See also graphics output area, procedure output area, coordinate system.

data tip
data or other detailed information that is displayed when a user positions a mouse pointer over an element in a graph. For example, a data tip typically displays the data value that is represented by a bar, a plot point, or some other element.

density value
a value assigned to each observation in a map data set reflecting the amount of detail (resolution) contributed by the observation.

device driver
in SAS/GRAPH software, a routine that generates the specific machine-language commands needed to display graphics output on a particular device. SAS/GRAPH device drivers take device-independent graphics information produced by SAS/GRAPH procedures and create the commands required to produce the graph on the particular device.

device entry
a SAS catalog entry of type DEV that stores the values of device parameters (or the characteristics) that are used with a particular output device.
device map
a catalog entry used to convert the SAS/GRAPH internal encoding for one or more characters to the device-specific encoding needed to display the characters in hardware text on a particular graphics output device. See also hardware character set.

device parameter
a value in a device entry that defines a default behavior or characteristic of a device driver. Some device parameters can be overridden by graphics options. See also graphics option.

device-independent catalog entry
a SAS catalog entry that contains graphics output in a generic format (not device-specific). A device-independent catalog entry can be replayed on any device supported by SAS/GRAPH software.

device-resident font
a font stored in an output device.

document file
a file output by the Output Delivery System (ODS) that contains an image or is used to view an image. Examples include HTML, PDF, RTF, SVG, and PostScript files.

drill down
to explore data and access information by moving from summary information to more detailed data from which the summary is derived. For example, you could click folders in a hierarchy from the top downward to find a specific file. Drilling down provides a method of exploring multidimensional data by moving from one level of detail to the next.

fill color
the color of a pattern in a filled, closed graphics object, such as a bar segment, a pie slice, or a map area.

font
a typeface with a specific character shape, spacing, weight, and size. The characters in a font can be figures, symbols, or alphanumeric.

font family
a set of one or more typefaces that share common design characteristics such as serifs, proportional or uniform spacing, or special symbols. For example, Helvetica, Arial, and Albany AMT are members of a sans-serif, proportional font family.

font maximum
in the GFONT procedure, the highest vertical coordinate in a font.

font minimum
in the GFONT procedure, the lowest vertical coordinate in a font.

font unit
in the GFONT procedure, a unit within a range that is defined by coordinates specified in the font data set. For example, a font in which the vertical coordinates range from 10 to 100 has 90 font units.
FreeType font-rendering
a method of rendering fonts that uses the FreeType engine to access the content of font files in order to render high-quality fonts for ODS and SAS/GRAH. The FreeType engine can be used in all SAS operating environments.

geo-variable
in a feature table, the $GEOREF formatted variable that stores the spatial information as a geometry object.

geocoding
the process of assigning geographic coordinates (often expressed as latitude and longitude) to other geographic data such as street addresses, or postal codes.

global statement
a SAS statement that you can specify anywhere in a SAS program.

graphics device
See graphics output device.

graphics element
a discrete visual part of a picture. For example, a bar in a chart and a plot's axis label are both graphics elements.

graphics object
a discrete visual element of a graph or picture (for example, a bar in a chart, a polygon, a plot's axis, and so on).

graphics option
in a SAS GOPTIONS statement, an option that controls some attribute of the graphics output. The specified value remains in effect only for the duration of the SAS session. Some graphics options override parameters that have been specified for a graphics output device.

graphics output
output from a graphics program that can be stored as a catalog GRSEG entry or as a graphics stream file. See also device-independent catalog entry, graphics output device.

graphics output area
the area of a graphics output device where the graphics output is displayed or drawn. Typically, the graphics output area occupies the full drawing area of the device, but the dimensions of the graphics output area can be changed with graphics options or device parameters. See also procedure output area, graphics output device.

graphics output device (graphics device, hard-copy device)
any terminal, printer, or other output device that is capable of displaying or producing graphical output.

graphics output file
a file that contains bitmapped or vector graphic information.

graphics primitive
a function that draws a graphics element.
graphics stream file (GSF)
a file that contains device-dependent graphics commands from a SAS/GRAPH device driver. This file can be sent to a graphics device or to other software applications.

graphics template
See ODS template.

gray scale
a color-coding scheme that specifies a color in terms of gray components. Gray-scale color codes are commonly used with some laser printers and PostScript devices.

grid point
a grid location in the GRAPH window that is marked by a dot. Grid points are used for precision placement of objects.

grid request
in the G3GRID procedure, the request specified in a GRID statement that identifies the horizontal variables that identify the x, y plane and one or more z variables for the interpolation.

group variable
a variable in the input data set that is used to categorize chart variable values into groups. A group variable enables the data for each distinct group value to be rendered in a visually different manner. For example, a grouped scatter plot displays a distinct marker and color for each group value.

GRSEG
a SAS catalog entry that contains graphic output in a generic, rather than device-specific, format.

GSF
See graphics stream file.

handshaking
the exchange of signals between two devices over an interface for control or synchronization purposes. Data flow control is needed to ensure that data are not sent faster than the receiving device can process them. Handshaking usually involves sending signals between the device and the host computer in order to start and stop transmission of data.

hardcopy device
See graphics output device.

hardware character set
a set of character definitions held internally in a graphics output device. When a hardware character set is used, SAS/GRAPH software does not have to send the device all the commands to draw characters, only the corresponding character codes. Some devices have more than one hardware character set. See also font.

hardware handshaking
a method of data flow control in which the flow of data between the computer and device is regulated by signals sent over separate wires in the connecting cable. See also handshaking.
hatch
a fill pattern consisting of parallel lines at any specified angle.

HLS color model
a color-coding scheme that specifies a color in terms of its hue, lightness, and saturation components. Hue is the color, lightness is the percentage of white, and saturation is the attribute of a color that determines its relative strength and its departure from gray. Lightness and saturation added to the hue produce a specific shade.

host computer
a workstation or minicomputer accessed by a terminal or another workstation.

host font-rendering
a method of rendering fonts that relies on the capabilities of the operating environment.

HSV model
a color-coding scheme that specifies a color in terms of its hue, saturation, and value components. Hue is the color. Saturation is the aspect of a color that determines its relative strength and departure from gray. And value, or brightness, is the color's departure from black.

identification variable
a variable common to both the map data set and the response data set that the GMAP procedure uses to associate each pair of map coordinates and each response value with a unique map area.

image file
a file that contains bitmapped graphic information. Examples include GIF, PNG, TIFF, and JPEG files. Image files are a subset of graphics output files.

image map
a diagram that associates graphics elements with HTML links to implement drill-down functionality. The graphics elements are represented by sets of coordinates. See also data tip.

import
to restore a SAS transport file to its original form (a SAS library, a SAS catalog, or a SAS data set) in the format that is appropriate for the host operating system. You use the CIMPORT procedure to import a SAS transport file that was created by the CPORT procedure.

interactive graph
output that features user controls such as menus, buttons, and pictures that a user can manipulate. The controls are driven by a Java applet or an ActiveX control.

interpolate
to estimate values that are between two or more known values.

Joint Photographic Experts Group
See JPEG.
**JPEG (Joint Photographic Experts Group)**
the name of an industry-standard file format for compressed images. Saving an image in JPEG format typically provides 10:1 compression with little perceptible loss in image quality.

**justify**
to position text in relation to the left or right margin or the center of the line.

**key map**
a SAS catalog entry used to translate the codes generated by the keys on a keyboard into their corresponding SAS/GRAPH internal character encoding. See also device map.

**latitude**
used with maps, the angular measure between the equator and the circle of parallel on which a point lies.

**library reference**
See libref.

**libref (library reference)**
a SAS name that is associated with the location of a SAS library. For example, in the name MYLIB.MYFILE, MYLIB is the libref, and MYFILE is a file in the SAS library.

**longitude**
used with maps, the angular measure between the reference meridian and the plane intersecting both poles and a point. The reference meridian, called the prime meridian, is assigned a longitude of 0, and other longitude values are measured from there in appropriate angular units (degrees or radians, for example).

**major axis**
in the graphics editor, the longest axis of a graphics object.

**major tick mark**
one of a series of points on an axis that mark the major divisions of the axis scale.

**map**
a graphic representation of an area. The area is often a geographic area, but it can also be any other area of any size. See also device map, key map.

**map area**
See unit area.

**map data set**
a data set provided by SAS that contains variables whose values are coordinates that define the boundaries of map areas, such as a state or country.

**mapping**
the process of displaying data values on a map.

**marker**
a symbol such as a diamond, a circle, or a triangle that is used to indicate the location of, or annotate, a data point in a plot or graph.
meridian
an imaginary circle of constant longitude around the surface of the earth perpendicular to the equator. See also parallel.

metafile
a file, produced by the Metagraphics facility internal driver, that contains device-independent graphics commands in a special format. A user-written external driver routine is required to read and process the metafile.

Metagraphics driver
a type of SAS/GRAPH device driver that can be written by users. A Metagraphics driver consists of an internal driver (supplied with SAS/GRAPH software), which writes a metafile in a special format, and an external driver (written by the user), which decodes the metafile and writes device-specific commands.

midpoint
a value that represents the middle of a range of data values.

minor axis
in the graphics editor, the shortest axis of a graphics object.

minor tick mark
one of a series of points that fall between major tick marks on an axis scale.

needle plot
a plot in which data points are connected by a vertical line that connects to a horizontal baseline. The baseline intersects the 0 value, or the minimum value on the vertical axis.

node
a connection point between two or more links. In a node/link diagram, nodes are typically represented as a box and enable you to access information and possibly to traverse the graph by drilling up or down in the structure.

ODS template (graphics template)
a description of how output should appear when it is formatted. ODS templates are stored as compiled entries in a template store (item store). Common template types include STATGRAPH, STYLE, CROSSTABS, TAGSET, and TABLE.

offset
the distance between a graphics object's original position and its new position when it is moved. Offsets can be specified for legends, axes, an entire graph, or other graphics object.

origin
in a three-dimensional graph, the point at which the X, Y, and Z axes intersect. In a two-dimensional graph, the point at which the X and Y axes intersect.

parallel
an imaginary circle of constant latitude around the surface of the earth parallel to the equator. See also meridian.

pattern type
in SAS/GRAPH software, the set of fill patterns that are valid for a particular type of graph. The PATTERN statement supports three pattern types: bar and block patterns, map and plot patterns, and pie and star patterns.
pie chart
a circular chart that is divided into slices by radial lines. Each slice represents the relative contribution of each part to the whole.

pixel
an element of an electronic image. A pixel is the smallest element on a display that can be assigned a separate color.

plot
a visual representation of data such as a scatter plot, needle plot, or contour plot.

plot line
the line joining the data points in a plot.

plotter
a class of graphics devices that typically use pens to draw hard-copy output.

PNG
See Portable Network Graphic.

polygon font
a SAS/GRAPH font in which the characters are drawn with enclosed areas that can be either filled or empty. See also stroked font.

polyline
in SAS/GRAPH software, a graphics object composed of connected line segments that might have attributes. A polyline is not a closed object. Therefore, it cannot be filled with a pattern.

Portable Network Graphic (PNG)
a file format that returns the graphical output in separate files and that produces a non-interactive image. This format is similar to the GIF format, but has additional features, such as support for true-color images and better compression.

PostScript
a device-independent page description language for printing high-resolution integrated text and graphics.

predefined color
one of the set of colors for which SAS/GRAPH software defines and recognizes names (for example, BLACK, BLUE, and CYAN).

prism map
a three-dimensional map that uses prisms (polyhedrons with two parallel surfaces) of varying height to indicate the ordinal magnitude of a response variable.

procedure output area
the portion of the graphics output area where the output from a graphics procedure is displayed. See also graphics output area, data area.

projection
a two-dimensional map representation of unit areas on the surface of a sphere (for example, geographic regions on the surface of the Earth).
prompt character

A character sent by the host computer to a device to signal that the host has finished transmitting data and is ready for a response from the device.

protocol

A set of rules that govern data communications between computers, between computers and peripheral devices, and between software applications. TCP/IP, FTP, and HTTP are examples of protocols.

radar chart

A chart that shows the relative frequency of data measures with statistics displayed along spokes that radiate from the center of the chart. The charts are often stacked on top of one another with circular reference lines, thus giving them the appearance of a radar screen. Variations of the radar chart have names based on what they look like; these include star charts, spider charts, wind rose charts, and calendar charts.

rasterizer

A device that accepts commands (such as moves and draws) as input and that converts those commands into a bit-map. Rasterizers are connected between host computers and graphics output devices that require bitmapped input.

regression analysis

An analysis that models a dependent (or response) variable as a function of one or more independent (or predictor) variables. The regression line, which is the set of predictions from the model, appears as a line or curve in a plot of the dependent variable against an independent variable.

relative coordinate

A coordinate that is measured from a point other than the origin. In the Annotate facility, this point is usually the endpoint of the last graphics element that was drawn. See also absolute coordinate.

replay

In SAS/GRAPH software, to display graphics output that is stored in a catalog entry using the GREPLAY procedure.

response data set

A SAS data set used by the GMAP procedure that contains data values associated with map areas and one or more identification variables. See also identification variable, response variable.

response levels

The individual values or ranges of values into which the GMAP or GCHART procedure divides the response variable. See also midpoint.

response value

Any value of a response variable that the GMAP procedure represents on a map as different pattern/color combinations, or as raised map areas (prisms), spikes, or blocks of different heights. The GCHART procedure represents response values as bars, slices, spines, or blocks. See also midpoint.

response variable

In the GMAP procedure, a variable in the response data set that contains data values that are associated with a map area. See also chart variable, response data set, response levels.
RGB color model
a color-coding scheme that specifies a color in terms of amounts of red, green, and blue components.

RGBA color space
a color-coding scheme that specifies a color in terms of amounts of red, green, and blue components, along with an alpha channel that controls the color opacity. See also RGB color model.

SAS/GRAPH font
a font stored in the SASHELP.FONTS catalog, and a font created by the user and stored in a GFONTn catalog. These fonts can be used only by SAS/GRAPH procedures or other procedures that generate GRSEG output files. Examples of SAS/GRAPH fonts include Swiss, Simulate, and Marker. These fonts are provided for specialized purposes only.

scatter plot
a two- or three-dimensional plot that shows the joint variation of two (or three) variables from a group of table rows. The coordinates of each point in the plot correspond to the data values for a single table row (observation).

snap
in the graphics editor, to automatically place graphics objects in the grid display area with precision.

spine
a line on a star chart used to represent the relative value of the chart statistic for a midpoint. Spines are drawn outward from the center of the chart.

spline
a method of interpolation in which a smooth line or surface connects data points.

spoke
any of a number of lines that radiate from the center of a radar chart or a star chart. These lines represent statistical information.

standard deviation
a statistical measure of the variability of a group of data values. This measure, which is the most widely used measure of the dispersion of a frequency distribution, is equal to the square root of the variance.

star chart
a type of radar chart that features lines drawn to connect the chart statistics for each spoke, resulting in a star-like appearance.

stroked font
in SAS/GRAPH software, a font in which the characters are drawn with discrete line segments or circular arcs. See also polygon font.

style attribute
a visual property, such as color, font properties, and line characteristics, that is defined in ODS with a reserved name and value. Style attributes are collectively referenced by a style element within a style template.
**subgroup variable**
the variable in the input data set for a chart that is used to proportionally fill areas of the bars or blocks on a bar chart, or to identify separate rings of a pie chart.

**summary variable**
a variable in an input data set whose values some SAS/GRAPH procedures total or average to produce the sum or mean statistics, respectively.

**surface map**
a three-dimensional map that uses spikes of varying heights to indicate levels of relative magnitude.

**surface plot**
a three-dimensional graph that displays values of a vertical Z variable based on gridded X and Y variables.

**system font**
a font that can be used by any SAS procedure and by other software such as Microsoft Word. These fonts include TrueType and Type1 fonts. Examples of system fonts include Albany AMT, Monotype Sorts, and Arial.

**Tagged Image File Format**
*See TIFF.*

**template**
a specification of an area or areas on a page. A GREPLAY template defines a layout in which you can display one or more graphs on a single page.

**template panel**
in the GREPLAY procedure, a part of the template in which one or more graphics can be displayed. A template can contain one or more panels.

**thumbnail**
a small image that can be selected in order to display a larger image.

**TIFF (Tagged Image File Format)**
An industry-standard file format for storing compressed images. The Tagged Image File Format specifies compression routines and file formats for a variety of image types, including bilevel, grayscale, and color.

**tile chart**
*See treemap.*

**tilt angle**
the measure in degrees from the horizontal axis to the major axis of an object.

**tool palette**
the collection of icons that represent functions in the interface.

**tooltip**
descriptive text that appears when a cursor is placed over certain elements of a graphical user interface, such as the tool icons in a toolbar.

**translate**
to change the location of a graphics object.
**treemap (tile chart)**
a graph that represents the relative values of data by using nested rectangular areas. The color or pattern of each area represents the value of one measure in the query. The size of each area represents the value of another measure in the query.

**typeface**
a set of characters with a common design, represented by one or more fonts that differ in weight, orientation, width, size, and spacing. For example, Arial, Arial Bold, Arial Italic, and Arial Bold Italic share the same typeface (Arial), but differ in their orientation and weight.

**unit**
a single quantity of measurement. In SAS/GRAPH software, units can represent any of the following: centimeters, percentages, points, inches, or cells.

**unit area (map area)**
a polygon or group of polygons on a map. For example, states, provinces, and countries are typical map areas. In a map data set, a map area consists of all the observations that have the same values for the identification variable or variables. See also identification variable.

**view**
a definition of a virtual data set that is named and stored for later use. A view contains no data; it merely describes or defines data that is stored elsewhere.

**web server**
a computer program that delivers (serves) content, such as web pages, over the World Wide Web. It can also refer to the computer or virtual machine that runs the program.

**wind rose chart**
a type of radar chart that depicts how wind speed and direction are typically distributed at a particular location. The cardinal directions or subdirections with the longest spokes indicate the wind direction that has the greatest frequency. See also radar chart.

**XON/XOFF handshaking**
a method of data flow control in which the flow of data between a computer and a device is regulated by the transmission of XON (DC1) and XOFF (DC3) control characters between the device and the computer.
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