

Where in the World Are SAS/GRAPH® Maps? An Exploration of the Old and New SAS® Mapping Capacities

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ABSTRACT

SAS® has an amazing arsenal of tools to use and display geographic information that is relatively unknown and underutilized. This presentation highlights both new and existing capacities for creating stunning, informative maps as well as using geographic data in other ways. SAS provided map data files, functions, format libraries and other geographic data files are explored in detail. Custom mapping of geographic areas are discussed. Maps produced include use of both the annotate facility (including some new functions) and PROC GREPLAY. Products used are Base SAS® and SAS/GRAPH®. SAS programmers of any skill level will benefit from this presentation.

INTRODUCTION

The intention of this paper and presentation is to briefly identify and describe some resources for mapping with SAS/GRAPH and to act as an information clearinghouse on creating maps with SAS. SAS/GRAPH maps and the SAS tools around this capacity are definitely the poor step-children of the SAS documentation family. I hope to bring some valuable resources to light! Prior to each topic I will provide some useful links for further information.

The first topic to be discussed is SAS MAPS ONLINE, as it is the access point for many helpful tools and data downloads. Subtopics include SASHELP.ZIPCODE, SASHELP.MAPFMTS, and new GfK maps. The second topic is custom mapping and PROC GEOCODE, including new annotate features, new capabilities of PROC GEOCODE, road maps data set and some samples of custom map construction.

SAS MAPS ONLINE

Links:

<http://support.sas.com/rnd/datavisualization/mapsonline/index.html>

http://www.sascommunity.org/wiki/ZIP_Code_411:_Decoding_SASHELP.ZIPCODE_and_Other_SAS%C2%AE_Map_s_Online_Mysteries#Online_Materials

<http://www2.sas.com/proceedings/sugi31/143-31.pdf>

<http://support.sas.com/techsup/unotes/SN/005/005325.html>

<http://www2.sas.com/proceedings/sugi30/137-30.pdf>

http://www.sascommunity.org/wiki/County_Validation_of_ZIP_Codes

<http://robslink.com/SAS/Home.htm>

<http://support.sas.com/documentation/cdl/en/graphref/59607/HTML/default/a002230502.htm>

http://www.gfk-geomarketing.com/en/digital_maps/software-specific_maps/maps_for_sas_graph.html

<http://support.sas.com/rnd/papers/sasgf13/GfKMaps2013.pdf>

SAS MAPS ONLINE is truly a buried treasure. It is a SAS-provided web page with a number of useful tools regarding mapping, including both traditional and the new GfK map data sets and updates, related data sets (such as SASHELP.ZIPCODE, SASHELP.MAPFMTS, the new GfK WORLD_CITIES_ALL, and WORLDCTS), and sample programs. SAS MAPS ONLINE archives older map data sets and versions of SASHELP.ZIPCODE so that users can match their response data and/or software version appropriately. The files do change over time so it is important to visit SAS MAPS ONLINE on a regular basis to download newer versions of files, or, you may wish to download an older file which matches the timing of your response data or software. Or maybe you'd just like to see the cool new samples that are available.

You can subscribe to an RSS feed so that you will be notified of updates on the page. This is essential as the zip code files are refreshed every quarter, and are not included in SAS "Hot Fixes", and other important map, sample

[illegible]

Click on the map to drill down to the next level, use the form below to select a country, [view all country images](#) or [see a list of countries](#).

1. Select a Continent 2. Select a Country

AFRICA ALGERIA [View Image](#)

What's New

Downloads



The screenshot shows the SAS Maps Online website. The browser's address bar displays the URL <http://maps.sas.com>. The website's navigation bar includes links for Home, What's New, Downloads, and Resources. The main content area is titled "Current Maps" and lists several map products: Country Map, County Map, and City Map. Each product has a brief description and a link to download the map. The "Country Map" section is highlighted, showing a list of available maps for various countries, including the United States, Canada, and the United Kingdom. The "Downloads" section is also visible, providing information on how to download the maps and the software required to view them.

Current Maps

The links in this section will provide the following information:

- Current Maps contains a list of the new GIK Maps at V3.360.
- Archived Maps contains tables for comparing data at previous releases.
- Country Map contains links updates to country boundary data.
- After Unlink from other map related data and information.
- GIS Content Boundary Data.
- Geocoding Information.
- Importing TIGER properties into GIS.
- About the service team.

We value your opinions about SAS Maps Online, and will use them to develop and improve the site. Please share your opinions by taking a brief survey at the following link: [MapsOnline Survey](#)

The screenshot shows the SAG Maps Online website in a web browser. The browser's address bar displays the URL <http://maps.sag.ac.za/>. The website's header features the 'SAG' logo and the text 'Maps Online Knowledge'. A navigation menu includes links for 'Home', 'Maps', 'What's New', 'Downloads', and 'Resources'. A left-hand sidebar contains links for 'Sample Data', 'Sample Programs', 'Tools', and 'Useful Links'. The main content area is titled 'The links in this section will provide the following information:' and contains a bulleted list of resources: 'Sample Data that can be used for mapping', 'SAG/SAGINS Sample Programs that use the map data', and 'Tools that might be useful to you'. Below this list, a note mentions 'Some Useful Links of data providers about mosaic maps.' At the bottom of the page, a text box encourages visitors to share their opinions by taking a survey, with a link to 'MapOnline Survey'. The background of the website features a faint world map.

[illegible]

GfK World Maps under Current Maps

Misc Updates (Includes SASHELP.ZIPCODE)

Geocoding

Archived Maps

GIS US State Boundary Data

USRoads Files

The SASHELP.ZIPCODE file is a SAS data set containing ZIPCODE level information for the United States including ZIPCODE centroids (x, y coordinates), Area Codes, city names, FIPS codes, and more. The file is indexed on ZIPCODE to facilitate processing, and is updated on a regular basis by SAS. It is provided in transport format so that installations with dissimilar releases of SAS and operating systems can make use of the file. The source of the zip code data in the file is <http://www.zipcodedownload.com/>, which is a subscription service that users can purchase. It is available for free to licensed SAS users as a SAS data set through SAS MAPS Online. You do not need to have a

SAS/GRAPH license to take advantage of this data set; indeed, a number of geographic functions are based on this file.

A content listing of a recent (April 2013) file is provided below. As of the writing of this paper, the July 2013 update is also available. SAS periodically adds variables to the file to aid users. SAS ships with the latest versions of the SASHELP.ZIPCODE file, SASHELP.MAPFMTS file, and all SAS-provided maps. As of SAS 9.3M2, users also receive the GsK map files.

Variables in Creation Order					
#	Variable	Type	Len	Format	Label
1	ZIP	Num	8	Z5.	The 5-digit ZIP Code
2	Y	Num	8	11.6	Latitude (degrees) of the center (centroid) of ZIP Code.
3	X	Num	8	11.6	Longitude (degrees) of the center (centroid) of ZIP Code.
4	ZIP_CLASS	Char	1		ZIP Code Classification: P=PO Box U=Unique zip used for large orgs/businesses/bldgs Blank=Standard/non-unique
5	CITY	Char	35		Name of city/org
6	STATE	Num	8		Two-digit number (FIPS code) for state/territory
7	STATECODE	Char	2		Two-letter abbrev. for state name.
8	STATENAME	Char	25		Full name of state/territory
9	COUNTY	Num	8		FIPS county code.
10	COUNTYNM	Char	25		Name of county/parish.
11	MSA	Num	8		Metro Statistical Area code by common pop-pre 2003; no MSA for rural
12	AREACODE	Num	8		Single Area Code for ZIP Code.
13	AREACODES	Char	12		Multiple Area Codes for ZIP Code.
14	TIMEZONE	Char	9		Time Zone for ZIP Code.
15	GMTOFFSET	Num	8		Diff (hrs) between GMT and time zone for ZIP Code
16	DST	Char	1		ZIP Code obeys Daylight Savings: Y-Yes N-No
17	PONAME	Char	35		USPS Post Office Name: same as City
18	ALIAS_CITY	Char	300		USPS - alternate names of city separated by
19	ALIAS_CITYN	Char	300		Local - alternate names of city separated by

*Alphabetic List of
Indexes and
Attributes*

#	Index	# of Unique Values
1	ZIP	41257

For users with SAS version 9 and above, the SASHELP.ZIPCODE file is located in your SASHELP folder, and may be accessed by using SASHELP as the library reference, just as you would access SAS map data sets by using MAPS (more on this later!) as the library reference. For 9.3 PC-SAS installations, the SASHELP folder is usually located at: C:\Program Files\SASHome\SASFoundation\9.3\core\sashep. Updated versions of SASHELP.ZIPCODE and SAS map data sets may also be obtained from SAS MAPS ONLINE for versions 8 and above.

Don't be intimidated by the fact that the data set is maintained by the SAS MAPS ONLINE staff! The file can be and is used by SAS for more than mapping. The SASHELP.ZIPCODE FILE can be used to enable SAS-written functions, calculate distances between zip codes, to annotate SAS/GRAPH maps with information in the file, to develop user-defined formats, and much, much more. If you do not have a current ZIPCODE file in your SASHELP subdirectory, these uses are not possible!

9.1 and above SAS-written functions utilizing the SASHELP.ZIPCODE file include ZIPCITY, ZIPSTATE, ZIPNAME, ZIPNAMEL and ZIPFIPS. For example, the ZIPCITY function takes ZIPCODE as its argument and returns a proper case city name and a two character postal state abbreviation.

ZIPCITY('02138') returns 'Cambridge, MA'

ZIPSTATE('02138') returns 'MA'

ZIPNAME('02138') returns 'MASSACHUSETTS'

ZIPNAMEL('02138') returns 'Massachusetts'

ZIPFIPS('02138') returns 25 (FIPS state code for Massachusetts)

The SASHELP.ZIPCODE file can also be used to calculate distances between Zip Code centroids. [support.sas.com](http://support.sas.com/techsup/unotes/SN/005/005325.html) has provided an example of this use at <http://support.sas.com/techsup/unotes/SN/005/005325.html>.

```
/* calculate the distance between zip code centroids */

%macro geodist(lat1,long1,lat2,long2);
%let pi180=0.0174532925199433;
7921.6623*arsin(sqrt((sin((&pi180*&lat2-&pi180*&lat1)/2))**2+
cos(&pi180*&lat1)*cos(&pi180*&lat2)*(sin((&pi180*&long2-
&pi180*&long1)/2))**2));
%mend;
```

In 9.2, SAS builds on this functionality by adding new functions and procedures. In 9.1, SAS did not provide any functions to calculate distance between longitude and latitude pairs, but this changes with the addition of the ZIPCITYDIST() and GEODIST() functions in 9.2. ZIPCITYDIST() calculates the number of miles between 2 US Zip Codes. GEODIST() allows the user to specify 2 sets of longitude and latitude coordinates, and calculates the distance between the pairs. You can specify the units for the results, such as miles or kilometers. ZIPCITYDIST() only works on US Zip Codes, while GEODIST() can be used for coordinates anywhere around the globe. The example above shows the use of both new functions.

```
%let zip1=27513;
%let zip2=21202;

/* latitude and longitude coordinates */

proc sql;
create table zip1 as select * from sashelp.zipcode where zip=&zip1;
create table zip2 as select * from sashelp.zipcode where zip=&zip2;
select x into :long1 from zip1;
select y into :lat1 from zip1;
select x into :long2 from zip2;
select y into :lat2 from zip2;
quit; run;

%let city1=%sysfunc(zipcity(&zip1));
%let city2=%sysfunc(zipcity(&zip2));

/* two new 9.2 functions */

%let zipdist=%sysfunc(zipcitydistance(&zip1,&zip2));

%let geodist=%sysfunc(geodist(&lat1, &long1, &lat2, &long2, 'M'),comma10.5);
```

The ZIPCITYDISC() function can be used in conjunction with PROC GMAP, PROC MAPIMPORT, Annotate and the SASHELP.ZIPCODE file to highlight zips within 25 miles (or the distance of your choice) from a central point (zip code.) The red star indicates the central zip code centroid. Such maps could be used to graphically demonstrate sales penetration in target areas, map out sales regions or delivery areas, etc.

Mike Zdeb and Robert Allison presented a similar sample (for the state of Pennsylvania) at a Hands-On Workshop at SUGI 30. PROC GMAP is used in combination with the Annotate facility to create a map of Washington with: fake transparent effects; 'shadows' behind the map; a gradient shaded background. The example starts with a fairly basic map, a county map, with Annotate markers and labels, based on longitude/latitude coordinates from SASHELP.ZIPCODE. Then, the all of the 'extras' listed above are added.

ZIPS WITHIN 25 MILES

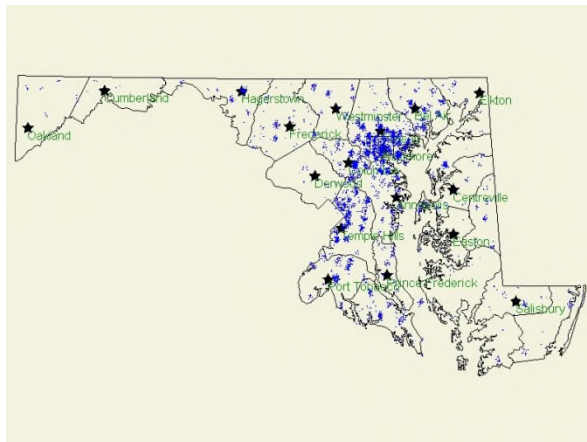


HIGHLIGHT SPECIAL ZIPS

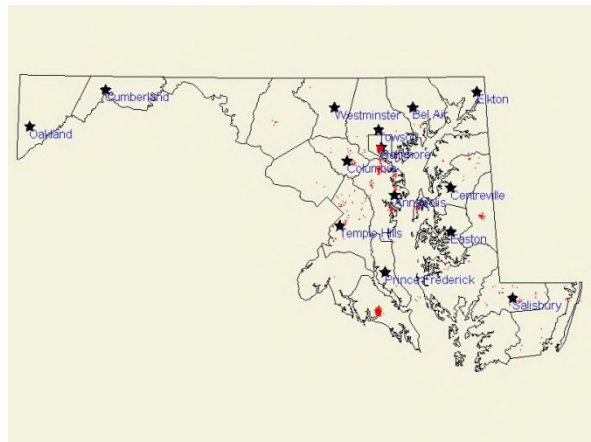


Dot density maps can be created using the zip code centroids provided in SASHELP.ZIPCODE. This type of map would be ideal to show sales penetration, number of providers available in a given area, etc. The annotation (dots) can be color-coded and sized to match response data. The “dot density” effect is achieved by randomly distributing multiple records per zip code centroid with small adjustments. Two samples of such a map follow below. Sample code to create these maps is available from the author.

Beneficiaries in Maryland

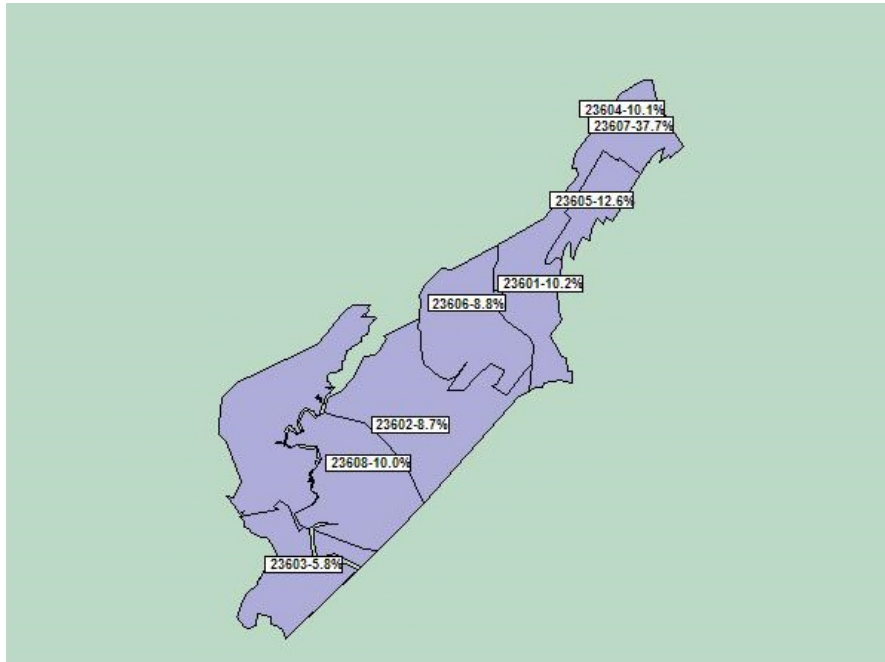


Counseling Locations in Maryland



Response data can be annotated on a zip code level map, using zip code centroids provided in SASHELP.ZIPCODE. This type of map could be used to inform locations of residential, industrial and commercial developments, as well as target sales, etc. In the map presented below, poverty data by zip code were used to annotate zip codes in Newport News, VA with poverty rates to inform choice of a focus group location.

Focus Group Zip Codes in Newport News, VA



The

variables in the

SASHELP.ZIPCODE file can also be used to create user-defined formats. Potential user-written formats include: conversion of zip code to MSA code (and by extension, urban/rural status); conversion of zip code to FIPS county code; conversion of zip code to county name; conversion of zip code to latitude and longitude; conversion of zip code to telephone area codes; conversion of zip code to daylight savings time flag; and conversion of zip code to time zones.

Example:

```
Data zip2msa (rename=(zipcode=start msacode=label));
  Set sashelp.zipcode end=last;
  Msacode=put(msa,z4.);
  Zipcode=put(zip,z5.);
  Retain fmtname '$zip2msa' type 'c' hlo=' ';
  If last then hlo='h';
Run;

Proc format library=library cntlin=zip2msa;
Run;

Data x;
  Length msacode $ 4;
  Zipcode='02138';
  Msacode=put(zipcode,$zip2msa.);
Run;

Proc print data=x;
Run;
```

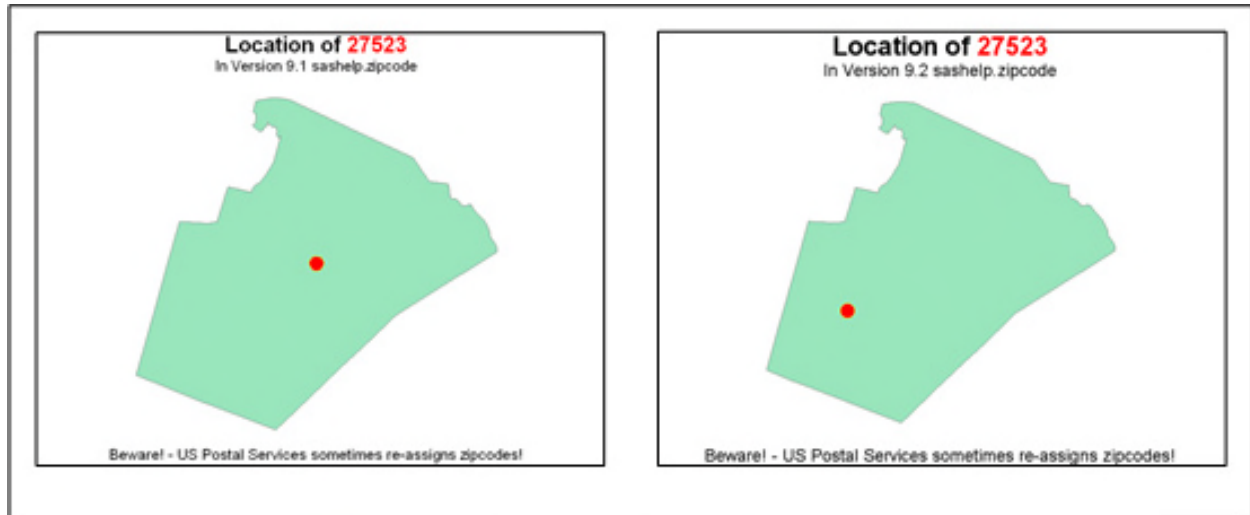
Result:

Obs	msacode	Zipcode
1	1120	02138

SAS MAPS ONLINE also provides code for those who want to create their own version of the SASHELP.ZIPCODE file with geographic data or update the file. The SASHELP.ZIPCODE file contains unique records for zip code, while zip codes may (for example) span counties and/or states.

In such cases, there is little information as to which part of a zip code area is predominant; however, this data is available on the web. Users may wish to update their copy of SASHELP.ZIPCODE to adjust for such instances.

To reinforce the wisdom of updating your SASHELP.ZIPCODE file on a regular basis, consider this: Zip Codes are occasionally reassigned by the US Postal Service. The two Wake County maps below graphically demonstrate how Zip Code 27523 was used for the city of Eagle Rock (central Wake County, NC) a few years ago, and as of 2010, it is used for the city of Apex (in western Wake County, NC.)

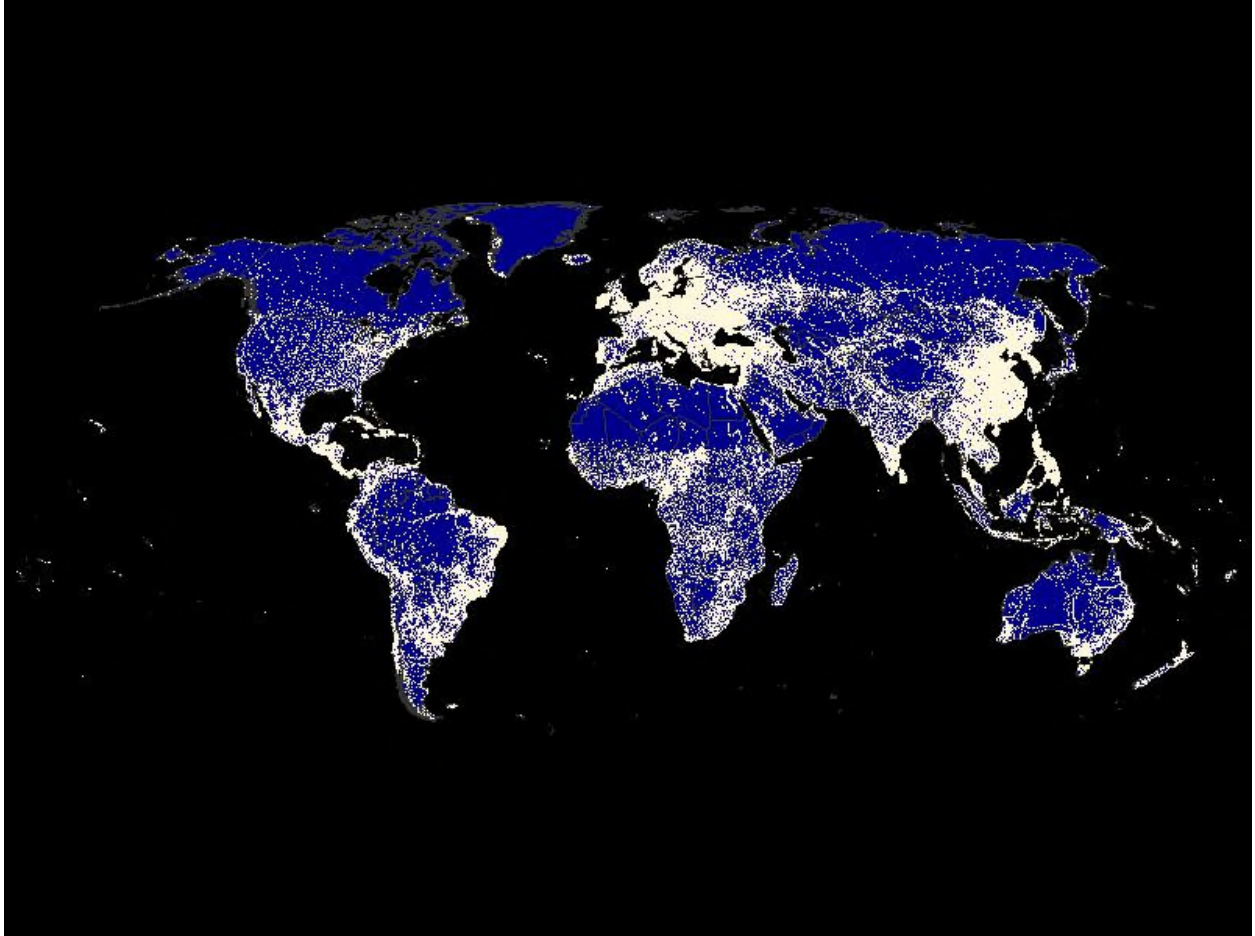


As discussed above, SAS also uses SASHELP.ZIPCODE as the basis of some geographic functions. In the example above, an older version of SASHELP.ZIPCODE would return the value "Eagle Rock" for the ZIPCITY function for zip code 27523, while using the newer version of SASHELP.ZIPCODE with ZIPCITY and the zip code 27523 would yield "Apex." Similarly, distance calculations accomplished with ZIPCITYDIST would be incorrect using an older version of SASHELP.ZIPCODE.

As well as the current and archived SASHELP.ZIPCODE files, SAS MAPS ONLINE has a wealth of useful datasets, sample programs, relevant links, and helpful tips. This paper will discuss a few useful but little known files the authors have encountered. Users are encouraged to explore the site on their own!

Traditional (non-GfK) SAS map data sets have been updated on a regular basis. GfK map data sets are also updated. Note that you must have a valid license for SAS 9.3 M2 or above and SAS/GRAPH in order to download GfK map data sets. Please check SAS MAPS ONLINE regularly for updates to your favorite map data sets.

The traditional WORLDCTS and the GfK WORLD_CITIES_ALL data sets are highly useful. The example below is created by creating an annotate data base with light dots representing world cities sized according to population overlaid on a world map (excluding Antarctica.) The world map is created from the traditional SAS-supplied world map data set, while the latitude, longitude, and population of world cities comes from the traditional SAS-supplied WORLDCTS (world cities) data set. [Note: this file is badly outdated as the GfK WORLD_CITIES_ALL data set has now replaced it.] This technique can be used in conjunction with GfK maps and WORLD_CITIES_ALL offers an excellent way to represent various statistics on a world-wide basis.



The overlay map example below is based on one of Robert Allison's samples and employs GREPLAY. It also utilizes a relatively obscure SAS-provided dataset, SASHELP.MAPFMTS, to produce current world country names matching the world map data set. This dataset can be downloaded from [SAS MAPS ONLINE](#).

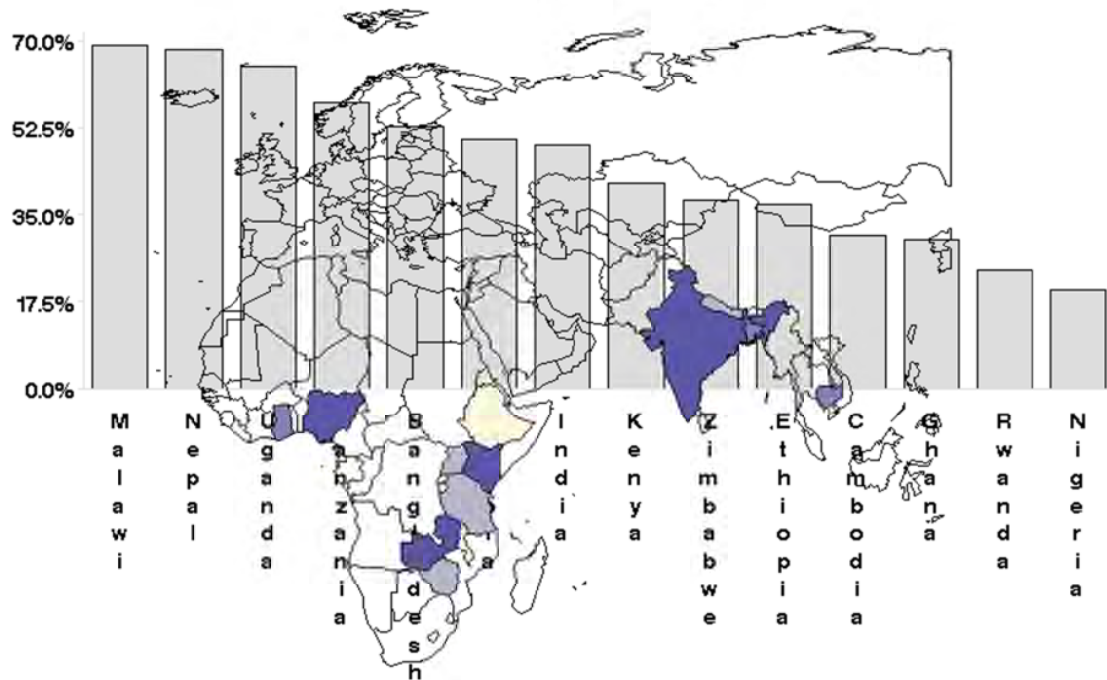
To use one of the formats for maps, you must specify the SASHELP.MAPFMTS catalog on the FMTSEARCH= option on a SAS OPTIONS statement:

```
options fmtsearch=(sashelp.mapfmts);

data work.world;
  set work.world;
  length country_name $20;
  country_name=put(country,glcnsm.);
  country_name=propcase(country_name);
run;
```

Note that SASHELP.MAPFMTS is based on the TRADITIONAL SAS map data, and must be used with the traditional world map data set.

Decline in Exclusive Breastfeeding from 0 to 5 Months (based on DHS data)



Other features of the program are use of PROC TEMPLATE to define colors used in the GMAP procedure as discussed above, reduction of the map area and density using PROC SQL; a PROC GMAP (using nodisplay) to create the underlying map; a PROC GCHART to create the overlay bar chart (again using nodisplay), and a PROC GREPLAY to display both images in the same space. The HTML file accompanying the PNG file has additional functionality. Mousing over the colored countries provides additional information on breastfeeding rates and GNI in a tooltip for each country.

Under Resources->Sample Programs, users can select from attractive thumbnails showing various examples. These sample programs are extremely useful and can be run right “out of the box.” Clicking on a thumbnail gets you to a screen where you can choose to download sample code, data, etc.

Users can also contribute their own examples, which is a great way to give back to SAS MAPS ONLINE.

GfK maps are new as of SAS 9.3 M2. Sources for inexpensive map data have become rare, leading SAS to enter into a partnership with a 3rd party source, GfK GeoMarketing, which specializes in map data. The vendor will update the map data sets on a yearly basis. The GfK maps require a lot of changes, but also have their benefits (not the least of which is greater accuracy!) For now, SAS releases are shipping with both the new GfK maps and the traditional map data sets, recognizing that there will need to be an extended transition period.

LIBNAME CHANGES

The traditional maps will be the default maps. To reuse existing code, you do not need to make any changes as the traditional maps are the default. You can point to either map library if desired using the following code:

```
LIBNAME MAPS (MAPSSAS);
```

```
LIBNAME MAPS(MAPSGFK);
```

FILE AND FILENAME CHANGES

Added Longer, more informative and consistent names (i.e. AFGHANISTAN vs AFGHANIS)

Added NUTS level files for Europe

Added _ATTR suffix for attribute files (ARGENTINA_ATTR vs ARGENTI2)

Added PROJPARM (GPROJECT information for all projected maps)

Eliminated some data sets (such as COUNTY and US2)

Some maps will be at a different levels of political data (for example COUNTY instead of STATE)

VARIABLE CHANGES

Many changes to variable names

Added RESOLUTION variable

ID variables are now character and unique world wide

X and Y are ALWAYS projected

Lat and Long are ALWAYS unprojected, based on the eastern Hemisphere and in degrees (PROC GPROJECT will require the DEGREES and EASTLONG options)

For more detailed information on transitioning to using the new map data sets, please read the excellent paper GfKMaps2013 by Liz Simon and Darrell Massengill in the links above.

PROC GEOCODE AND CUSTOM MAPS

Links:

<http://robslink.com/SAS/Home.htm>

<http://www.colorbrewer2.org>

<http://support.sas.com/rnd/papers/sasgf13/Geocode2013.pdf>

http://support.sas.com/rnd/datavisualization/papers/sgf2013/Handouts/SGF2013_MapHandout.pdf

<http://support.sas.com/resources/papers/proceedings13/377-2013.pdf>

<http://support.sas.com/documentation/cdl/en/graphref/65004/HTML/default/viewer.htm#n17k5bnax0zd6qn1p4qvzqd8uz2d.htm>

<http://support.sas.com/documentation/cdl/en/graphref/65004/HTML/default/viewer.htm#p1vmhtkal691qwn16vr2ymshzwzy.htm>

<http://support.sas.com/documentation/cdl/en/graphref/65004/HTML/default/viewer.htm#n1swjm92f71uaon1mza0lodc6iun.htm>

PROC GEOCODE was introduced in SAS 9.2. It is the process by which you can convert address information into map locations. It is a part of the SAS/GRAPH product. It was originally for U.S. data points, but you can now import free postal code (lookup) data (and map shp files to present geocoded data points on if desired) from Great Britain and Australia as well. The procedure (and the data behind it) has been updated as of SAS 9.3M2. In 9.3M2, you can use PROC GEOCODE with international cities, and in SAS 9.4, Canadian street-level geocoding is available.

Geocoding is available on a number of levels, From City to Street to IP Address. For more detailed information on new (and old) PROC GEOCODE capabilities, please read the excellent paper by Darrell Massengill and Ed Odom in the links above. Incidentally this paper has an excellent ZIP CODE FAQ and SAS Spatial Capability Summary in the

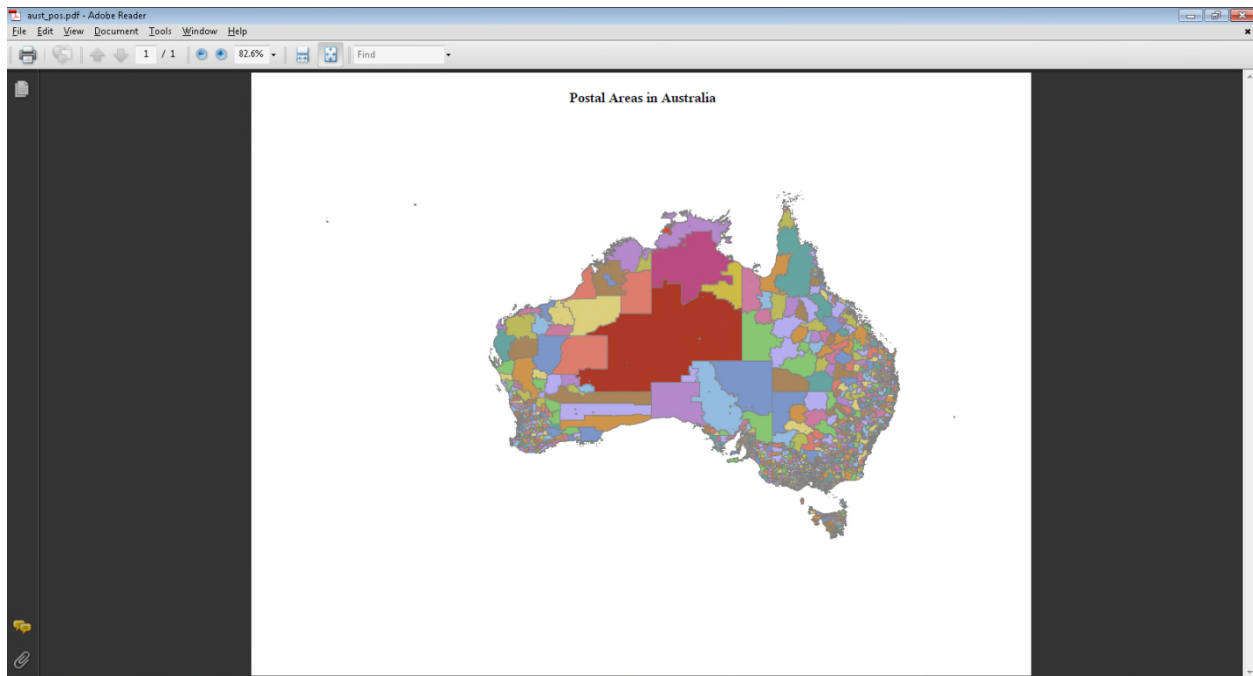
Appendices. To import a custom map data set to use with PROC GEOCODE, such as postal codes in Australia, use PROC MAPIMPORT.

```
proc format;
  value      $ p2state '2'='New South Wales'
                '0'='Northern Territory'
                '4'='Queensland'
                '5'='South Australia'
                '7'='Tasmania'
                '3'='Victoria'
                '6'='Western Australia';
  value $ p2stab '2'='NSW' '0'='NT' '4'='QLD' '5'='SA' '7'='TAS' '3'='VIC' '6'='WA';
run;

proc mapimport datafile='.\poa_2011_aust.shp' out=dd.pos_2011_aust_map;
  id poa_code; /* new in 9.4 - add contents, add create_id statements */
run;

data dd.pos_2011_aust_map;
  length state_name $ 30 st_abbr $ 4;
  st dd.pos_2011_aust_map;
  state_name=put(substr(left(poa_code),1,1),$p2state.);
  st_abbr=put(substr(left(poa_code),1,1),$p2stab.);
  if poa_code='9191' then state_name='Unclassified SAls';
  if poa_code='9494' then state_name='No Usual Address SAls';
  if poa_code='9797' then state_name='Migratory/Off-Shore/Shipping SAls';
run;

ods pdf file='aust_pos.pdf' notoc;
goptions reset=all device=png hsize=9in vsize=7.5in;
title1 "Postal Areas in Australia";
proc gmap map=dd.pos_2011_aust_map
  data=dd.pos_2011_aust_map all;
  id poa_code;
  choro poa_code / coutline=gray levels=10;
run;
quit;
ods pdf close;
```



SAS MAPS ONLINE also provides road maps for the United States in its entirety (primary and secondary roads only) and primary, secondary and 'S' category roads in the Downloads tab. The road maps are from the 2009 TIGER files. Helpful sample programs are also provided.

Maps Online Downloads > GIS Census Data

Home Maps What's New Downloads Resources Feedback

Current Maps
Archived Maps
Country Map
Data Updates
Misc Updates
GIS US State
Boundary Data
Geocoding
USRoads Files

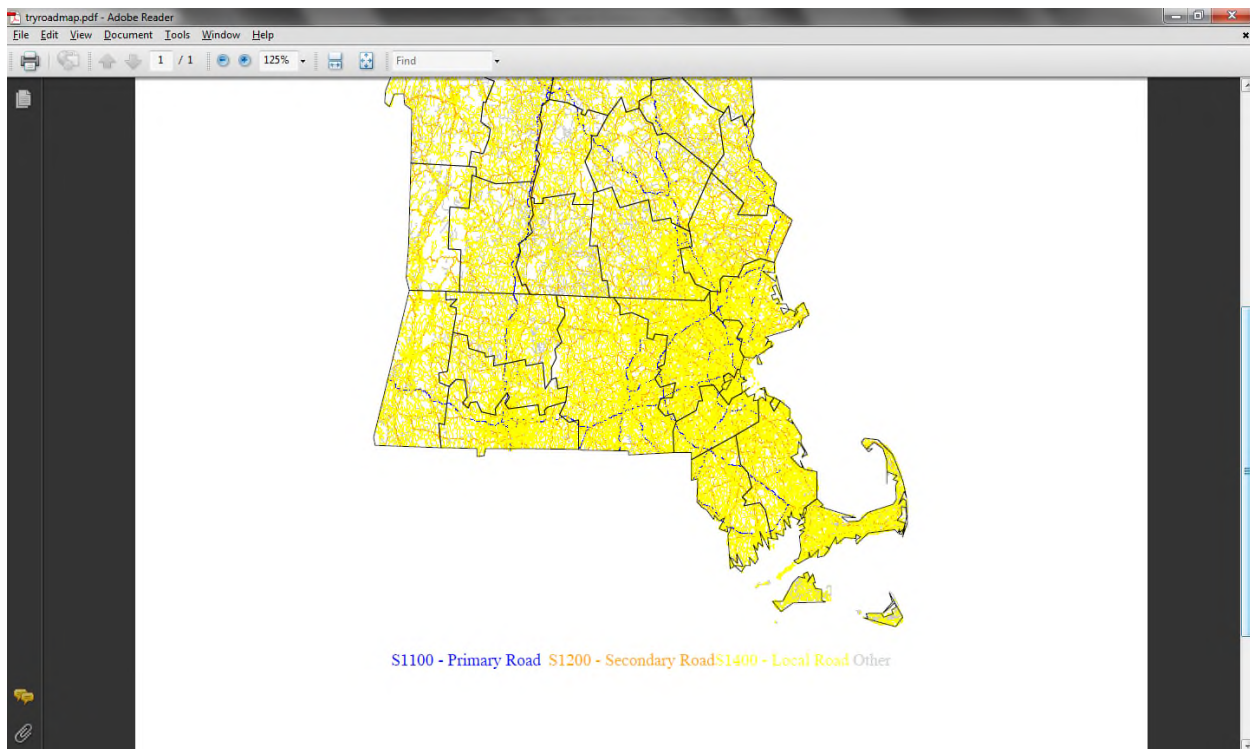
Note: The datasets listed below are **US STATE ROADS**, stored in SAS 9 format and available for download. These are 2009 TIGER Files, imported into SAS and ready to be used. Each zipped file **includes a sample SAS program** to display the roads on the state map. Individual state road files contain primary, secondary and other "S" category roads. [Check out the census doc](#), for a description of roads.

The following program, `combine_states`, is available if you will need to combine states. *The included example, combines the road files of Massachusetts (MA), Vermont (VT) and New Hampshire (NH) and uses SAS/GMAP to display the roads on a map of the three states. To run this sample, first download the roadfiles for those 3 states*. The process could be slow depending on the size of the state files.

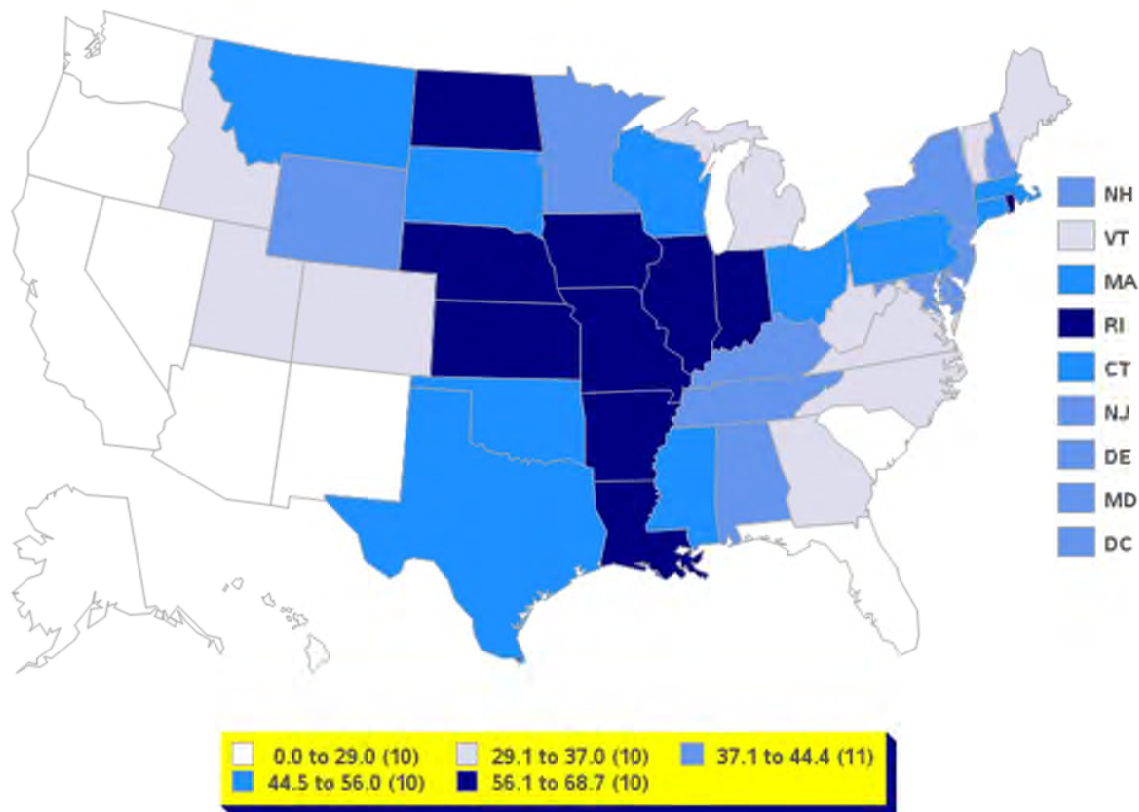
The **USRoads2009_US** file contains only the primary and secondary roads for the entire US.

Name of State	ROAD files zipped(MB)	ROAD files unzipped(MB)
Usroads2009_US	293.24	2957.77
Alaska_AK_2	14.59	132.75
Alabama_AL_1	94.61	854.08
Arkansas_AR_5	91.03	854.16
Arizona_AZ_4	116.51	1076.99
California_CA_6	342.78	3204.96
Colorado_CO_8	104.15	981.14
Connecticut_CT_9	29.69	270.54
District of Columbia_DC_11	4KB	15.55
Delaware_DE_10	8.10	71.58
Florida_FL_12	139.23	1254.04
Georgia_GA_13	119.21	1071.66
Hawaii_HI_15	11.90	113.05
Iowa_IA_19	61.73	563.70
Idaho_ID_16	96.98	923.43
Illinois_IL_17	109.63	981.29
Indiana_IN_18	84.66	771.69
Kansas_KS_20	67.65	612.08
Kentucky_KY_21	106.76	1002.21
Louisiana_LA_22	61.98	562.35

Running the included sample program `combine_states.sas` yeilds a fairly dense map of roads in Massachusetts, Vermont and New Hampshire. Smaller areas could be mapped to better effect.



ANNOTATE has some interesting new features, including the ability to annotate images on map output. Below follow several examples of custom maps enhanced with annotate features. The map below is a map of the United States (excluding Puerto Rico, Guam and the U.S. Virgin Islands) with various measures in 2011 state-level data coded into quintiles. This method (based on one of Robert Allison's amazing examples) features "boxes" for smaller eastern seaboard states color-coded based on the state's quintile for a measure, and a customized legend.



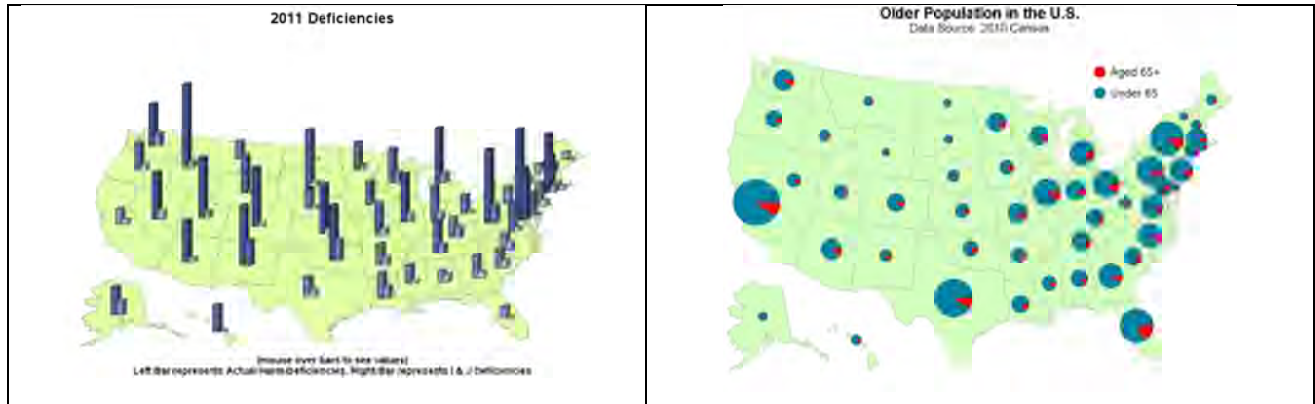
Both of these maps are also based on Robert Allison's examples using annotate. The pie chart map is particularly interesting, as the size of the pies vary with the state population, as well as the slices representing the 65+ population in each state. The pie charts are drawn using the PIE function.

```
/* Create annotate dataset containing the pie slices */
data anno_pies; set anno_pies;
  length function color $8 html $500;
  state_name=fipnamel(state);
  non_pct=nonage85p_2010/total_2010;
  age85p_pct=age85p_2010/total_2010;
  xsys='2'; ysys='2'; hsys='3'; when='A'; html='';
  function='PIE'; line=0; style='psolid';
/* Draw the age85+ slice last - otherwise if it's a small slice,
the larger blue slice will basically obscure it. */
/* non-85+ pie slice */
  rotate=non_pct*360;
  color="%c_non";
  output;
/* hispanic pie slice */
  rotate=age85p_pct*360;
  color="%c_age85p";
  output;
/* circle around whole pie (with html mouse-over text) */
  html='title=|| quote(
trim(left(state_name))||'0D'x||
```

```

'85+:                                '||trim(left(put(age85p_2010,comma20.0)))||'
('||put(age85p_pct,percent6.0)||')'||'0D'x|
'Under 85:                            '||trim(left(put(nonage85p_2010,comma20.0)))||
('||put(non_pct,percent6.0)||')'||'0D'x|
'-----'||'0D'x|
'Total population: '||trim(left(put(total_2010,comma20.0)))||
' href="aged_population_info.htm";
style='pempty'; color='gray44';
angle=0; rotate=360;
output;
run;

```



Below is a very interesting map. Creating it was very educational. The grid is created in a data step adding x and y values for each corner of each square. The response data (percent of each deficiency type and the marginal percents) is annotated into each box, as are the "row" and "column" labels and the deficiency code. In the process I found that SAS/GRAPH "draws" maps starting from the bottom left hand corner!

	Isolated	Pattern	Widespread	Total
Immediate Jeopardy	0.3 J	0.4 K	0.1 L	0.8
Actual Harm	2.4 G	0.3 H	0.0 I	2.6
Greater Than Minimal Harm	55.8 D	27.5 E	6.2 F	89.6
Minimal Harm	N/A A	3.6 B	3.4 C	7.0
Total	58.5	28.2	6.3	100.0

We can glimpse the future of SAS Mapping in SAS 9.4 and Visual Analytics. In 9.4, SAS provides us with a stunning array of helpful macros, code samples, “white papers”, and map data sets that make our jobs easier and make our maps more attractive and informative.

CONCLUSION

The mysteries of SAS MAPS ONLINE are well worth exploring, incorporating both new and old capacities for producing beautiful and useful maps. Many of the data files, functions, format libraries and procedures having to do with mapping with SAS are little-known and underutilized. I hope this paper will inspire others to try out the wealth of amazing SAS mapping and geographic tools!

ACKNOWLEDGMENTS

Darrell Massengill and Liz Simon of SAS who work tirelessly to improve and facilitate the use of SAS/GRAPH and mapping with SAS and maintain the SAS MAPS ONLINE site; Robert Allison of SAS who provides wonderful examples of using SAS/GRAPH and mapping tools, including some of the examples shown in this paper; and Mike Zdeb, extraordinary mapping guru..

ADDITIONAL REFERENCES AND RECOMMENDED READING

<http://support.sas.com/rnd/papers>

<http://support.sas.com/samples>

<http://support.sas.com/techsup/technote/ts688/ts688.html>

Hadden, Louise S. “Behind the Scenes with SAS®: Using Custom Graphics in SAS® Output.” Proceedings of SAS Global Forum 2009 Conference. April 2009.

Zdeb, Mike, Allison, Robert and Hadden, Louise. “Wow! You Did That Map with SAS/GRAPH®?” Proceedings of SAS Global Forum 2009 Conference. April 2009.

Zdeb, Mike. 2002. Maps Made Easy Using SAS. Cary, NC: SAS Institute Inc.



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