GMT

Generic Mapping Tools or Gravity, Magnetics and Topography

Lecture #1
Mapping and Plotting with GMT
I added the text labels by hand.
Maps and Time Series

- Plotting data vectors with faults
- Plotting time series as an x-y plot
Fancy colorized maps
GMT 4.5.1

- Began as a set of subroutines to write Postscript commands
- Grew with Paul’s and Walter’s Ph.D. Theses
- Encompassed map projections (30!)
- Data Analysis
- Cross-Over Errors
GMT resources

- Web site - gmt.soest.hawaii.edu
- User Group
- Open source project
- Windows, OS X, Unix and OS/2
- Extensive documentation (html and pdf)
- Examples and “cookbook”
- Ancillary data sets included (eg. coastlines)
Postscript

- Vector graphic language
- Rasterizes for output to various devices
- Scale set by dots-per-inch (dpi)
- Typically 300-1200
How does GMT work?

- Scripted language for vector graphics
- Facilitates automated plotting
- Relates graphic space to the data space
- Sequential commands create a plot or map
Create a simple plot.

```
pwd |
awk '{for (i = -60; i < 61; ++i) {printf:"%d %.2f\n",i,32+9/5*i}}' | psxy -R-60/60/-80/150 -JX6.0 -Sc0.05 -Ba20g10/a30g15 > test.ps
```
Change it

Change -Ba20g10/a30g15 to -Ba20g10/a30g15WeSn
Again

Change -Sc0.10 to -Sc0.10 -G125/230/50
Again

Change -Ba20g10/a30g15WeSn to -Ba20g10:"Degrees C"./a30g15:"Degrees F".WeSn
Again

Change -Ba20g10:"Degrees C":/a30g15:"Degrees F":WeSn to -Ba20g10:"Degrees C":/a30g15:"Degrees F":::Conversion:WeSn

Conversion

![Conversion Chart]

Degrees F

-60 -40 -20 0 20 40 60

Degrees C

-60 -30 0 30 60 90 120 150

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Graphic Programs

- **grdcontour** Contouring of 2-D gridded data
- **grdimage** Produce images from 2-D gridded data
- **grdvector** Plot vector fields from 2-D gridded data
- **grdview** 3-D perspective imaging of 2-D gridded data
- **psbasemap** Create a basemap frame
- **psclip** Use polygon files as clipping paths
- **pscoast** Plot coastlines, filled continents, rivers, and political borders
- **pscontour** Direct contouring or imaging of xyz-data by triangulation
- **pshistogram** Plot a histogram
- **psimage** Plot Sun rasterfiles on a map
- **pslegend** Plot legend on a map
- **psmask** Create overlay to mask specified regions of a map
- **psrose** Plot sector or rose diagrams
- **psscale** Plot grayscale or colorscale
- **pstext** Plot textstrings
- **pswiggle** Draw anomalies along track
- **psxy** Plot symbols, polygons, and lines in 2-D
- **psxyz** Plot symbols, polygons, and lines in 3-D
Create a simple map

pscoast -Jc190/68/0.50 -R180/225/50/72 -Di -N1 -G125 -Bg5a10 > Alaska.ps
The 17 standardized **GMT** command line switches

- **-B**  Defines tickmarks, annotations, and labels for basemaps and axes
- **-H**  Specifies that input/output tables have header record(s)
- **-J**  Selects a map projection or coordinate transformation
- **-K**  Allows more plot code to be appended to this plot later
- **-O**  Allows this plot code to be appended to an existing plot
- **-P**  Selects Portrait plot orientation [Default is landscape]
- **-R**  Defines the extent of the map/plot region
- **-U**  Plots a time-stamp, by default in the lower left corner of page
- **-V**  Selects verbose operation; reporting on progress
- **-X**  Sets the $x$-coordinate for the plot origin on the page
- **-Y**  Sets the $y$-coordinate for the plot origin on the page
- **-b**  Selects binary input and/or output
- **-c**  Specifies the number of plot copies
- **-f**  Specifies the data format on a per column basis
- **-g**  Identify data gaps based on supplied criteria
- **-m**  Specifies data in multiple segment format
- **-:**  Assumes input geographic data are ($lat$, $lon$) and not ($lon$, $lat$)
pscoast -Jc190/68/0.50 -R180/225/50/72 -Di -N1 -G125 -Bg5a10 > test.ps

-Jc specifies the Cassini projection, centered at 190 longitude, 68 latitude and scale at 0.50 inches per map unit

-R defines the map area in WESN form

-Di says to use the intermediate resolution coastline

-N1 says to plot international boundaries

-G says to fill the continents with a medium gray

-Bg5a10 says to put a grid on the map at every 5 map units and annotate it every 10 map units
-B Sets map boundary annotation and tickmark intervals. The format of tickinfo is [p]xinfo[yinfo][zinfo][[:"Title":][W|w][E|e][S|s][N|n][Z|z][+][-]]. The leading p [Default] or s selects the primary or secondary annotation information. Each of the ?info segments are textstrings of the form info["Axial label":][="prefix"][" unit label "]. The info string is made up of one or more concatenated substrings of the form [which]stride[+phase][u]. The optional which can be either a for annotation tick spacing [Default], f for frame tick spacing, and g for gridline spacing. If frame interval is not set, it is assumed to be the same as annotation interval. stride is the desired stride interval. The optional phase shifts the annotation interval by that amount. The optional u indicates the unit of the stride and can be any of Y (year, plot with 4 digits), y (year, plot with 2 digits), O (month, plot using PLOT_DATE_FORMAT), o (month, plot with 2 digits), U (ISO week, plot using PLOT_DATE_FORMAT), u (ISO week, plot using 2 digits), r (Gregorian week, 7-day stride from start of week TIME_WEEK_START), K (ISO weekday, plot name of day), D (date, plot using PLOT_DATE_FORMAT), d (day, plot day of month 0-31 or year 1-366, via PLOT_DATE_FORMAT), R (day, same as d, aligned with TIME_WEEK_START), H (hour, plot using PLOT_CLOCK_FORMAT), h (hour, plot with 2 digits), M (minute, plot using PLOT_CLOCK_FORMAT), m (minute, plot with 2 digits), C (second, plot using PLOT_CLOCK_FORMAT), s (second, plot with 2 digits). Note for geographic axes m and c instead mean arc minutes and arc seconds. All entities that are language-specific are under control by TIME_LANGUAGE. To specify separate x and y ticks, separate the substrings that apply to the x and y axes with a slash [/] (If a 3-D basemap is selected with -E and -Jz, a third substring pertaining to the vertical axis may be appended.) For linear/log/power projections (-JxN): Labels for each axis can be added by surrounding them with colons (:). If the first character in the label is a period, then the label is used as plot title; if it is a comma (,) then the label is appended to each annotation; if it is an equal sign (=) the prefix is prepended to each annotation (start label/prefix with - to avoid space between annotation and item); else it is the axis label. If the label consists of more than one word, enclose the entire label in double quotes (e.g., "my label"). If you need to use a colon (:) as part of your label you must specify it using its octal code (072). By default, all 4 boundaries are plotted (referred to as W, E, S, N). To change the default, append the code for only those axes you want (e.g., WS for standard lower-left x- and y-axis system). Upper case (e.g., W) means draw axis/tickmarks and annotate it, whereas lower case (e.g., w) will only draw axis/tickmarks. (If a 3-D basemap is selected with -E and -Jz, append Z or z to control the appearance of the vertical axis. Append + to draw the outline of the cube defined by -R. Note that for 3-D views the title, if given, will be suppressed.) For non-geographical projections: Give negative scale (in -Jx) or axis length (in -JX) to change the direction of increasing coordinates i.e. to make the y-axis positive down). For log10 axes: Annotations can be specified in one of three ways: (1) stride can be 1, 2, 3, or -n. Annotations will then occur at 1, 2 or 3, or every n'th magnitude. This option can also be used for the frame and grid intervals. (2) An l is appended to the tickinfo string. Then, log10 of the tick value is plotted at every integer log10 value. (3) A p is appended to the tickinfo string. Then, annotations appear as 10 raised to log10 of the tick value. For power axes: Annotations can be specified in one of two ways: (1) stride sets the regular annotation interval. (2) A p is appended to the tickinfo string. Then, the annotation interval is expected to be in transformed units, but the annotation value will be plotted as untransformed units. E.g., if stride = 1 and power = 0.5 (i.e., sqrt), then equidistant annotations labeled 1-4-9... will appear. These GMT parameters can affect the appearance of the map boundary: ANNOT_MIN_ANGLE, ANNOT_MIN_SPACING, ANNOT_FONT_PRIMARY, ANNOT_FONT_SECONDARY, ANNOT_FONT_SIZE_PRIMARY, ANNOT_FONT_SIZE_SECONDARY, ANNOT_OFFSET_PRIMARY, ANNOT_OFFSET_SECONDARY, BASEMAP_AXES, BASEMAP_FRAME, RGB, BASEMAP_TYPE, DEGREE_FORMAT, FRAME_PEN, FRAME_WIDTH, GRID_CROSS_SIZE_PRIMARY, GRID_PEN_PRIMARY, GRID_CROSS_SIZE_SECONDARY, GRID_PEN_SECONDARY, HEADER_FONT, HEADER_FONT_SIZE, LABEL_FONT, LABEL_FONT_SIZE, LINE_STEP, OBLIQUE_ANNOTATION, PLOT_CLOCK_FORMAT, PLOT_DATE_FORMAT, TIME_FORMAT_PRIMARY, TIME_FORMAT_SECONDARY, TIME_LANGUAGE, TIME_WEEK_START, TICK_LENGTH, TICK_PEN, and Y_AXIS_TYPE; see the gmtdefaults man page for details.
gmtdefaults

gmtset `cat $workingdir/gmt.plot.parameters` D_FORMAT %.0f MEASURE_UNIT inch

gmtset D_FORMAT %.6f

USE gmtdefaults -D to see default settings
USE gmtdefaults -L to see your current settings
Try it again with a script
create with text editor
“chmod +x” to make it executable

#!/bin/csh
# plot a Cassini projected map of Alaska with a user-defined scale

set workingdir = `pwd`
gmtset `cat $workingdir/gmt.plot.parameters`

set scale = $1

set w_lon = 180
set e_lon = 225
set s_lat = 50
set n_lat = 72

set map_box = -R$w_lon/$e_lon/$s_lat/$n_lat
set filename = alaska.ps

set pro_lon = `echo $w_lon $e_lon | awk '{printf"%.2f",($1+$2)/2.0}'`
set pro_lat = `echo $n_lat $s_lat | awk '{printf"%.2f",($1+$2)/2.0}'`

set map_pro = -Jc$pro_lon/$pro_lat/$scale
the commands

psbasemap $map_pro $map_box -Bg5a10 -K -P > $filename

pscoast $map_pro $map_box -Di -N1 -G125/255/125 -O >> $filename
the map.....
sequence is important

pscoast $map_pro $map_box -Di -N1 -G125/255/125 -K -P > $filename

psbasemap $map_pro $map_box -Bg5a10 -O >> $filename
a somewhat different map
add some data points?

pscoast $map_pro $map_box -Di -N1 -G125/255/125 -K -P > $filename

psxy $map_pro $map_box -Sc0.25 -G255/125/125 -K -O >> $filename << END
210 70
210 65
210 60
210 55
END

psbasemap $map_pro $map_box -Bg5a10 -O >> $filename
map with data points
so where did we go?
what are -K and -O?

-O suppresses the header, which defines a number of aliases to make a more compact file
-K suppresses the trailer

a lot of text Postscript precedes these last few lines;

```
1 0 D
S
%%PageTrailer
S -0 -0 T 4.16667 4.16667 scale 0 A
showpage

%%Trailer
end
%%EOF
```

The simplest state uses neither -K or -O and results in a complete plot with both header and trailer.

By using -K and -O we can use GMT commands in series to create a single plot.
most common errors in GMT scripts

• misuse of -K and -O options
• using “>” instead of “>>” as a redirect
• not specifying -R or -J correctly
• incorrect sequencing of commands
• trying to plot incorrectly scaled data
• trying the write the whole script at once
USCGC Ship track

HLY-08-222; from 08+199:00:00 to 08+199:23:59

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Gravity data from USCGC Healy
some people are really good at this...
Assignment -

Write a script to plot some data on a map.

Write a 2nd script to do an x, y plot of the same data.

suggestion - use awk to scale or select column data for your plots

Next time, data analysis and gridding, a lot of gridding with GMT