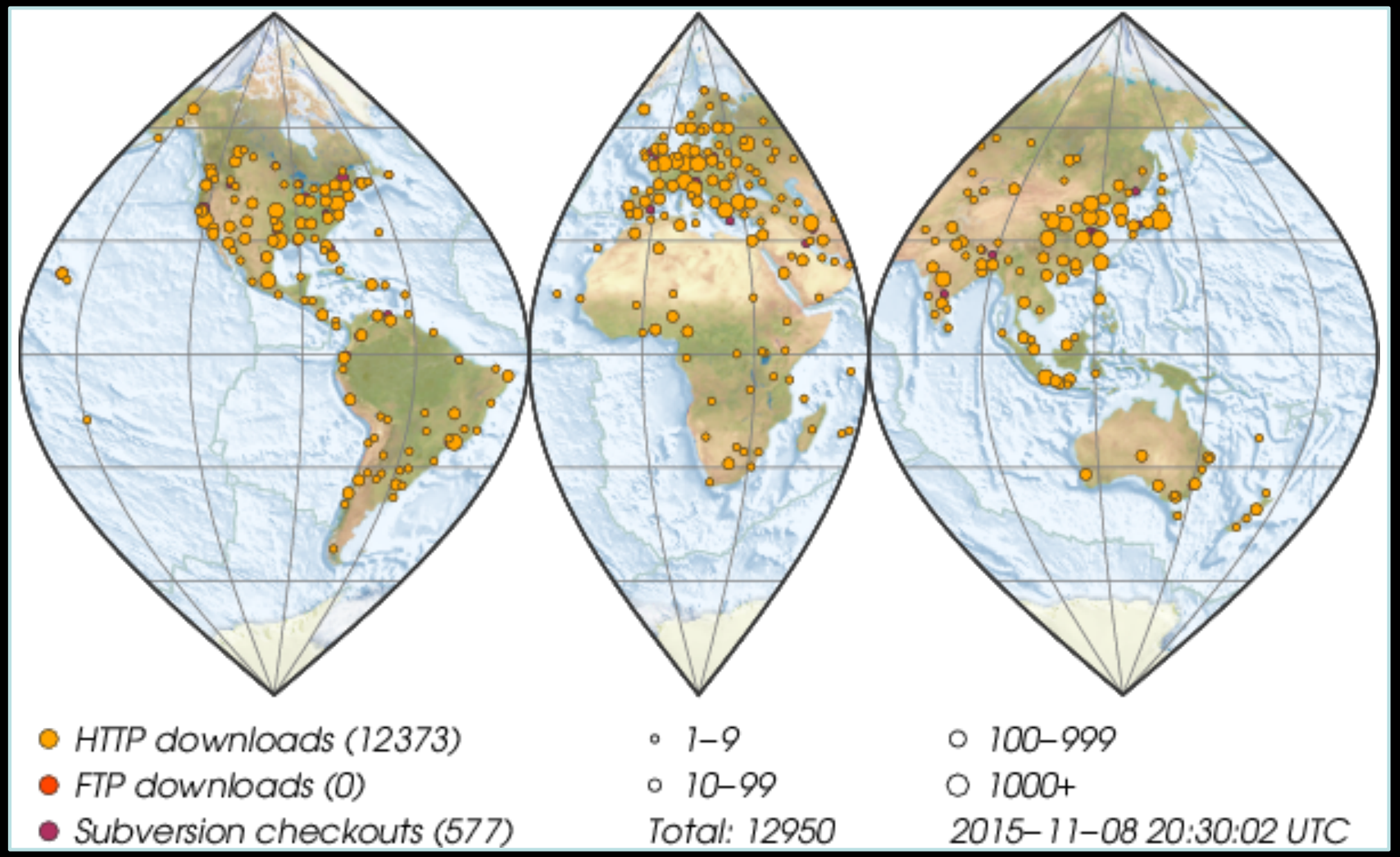
GMT

Generic Mapping Tools or
Gravity, Magnetics and Topography

Lecture #1

Mapping and Plotting with GMT

GMT World Domination



GMT

- 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

Paul Wessel, our hero

RTFM

Read The Effing Manual

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)
- Supplemental programs

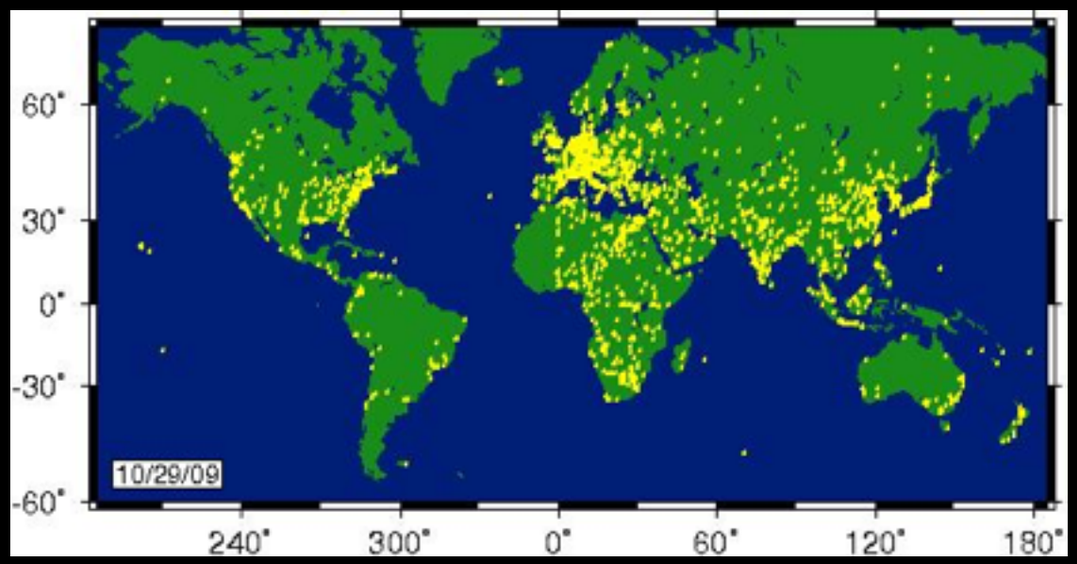
Postscript

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

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



GMT 5.1.2

"*gmt*" is the **only** program executable that is distributed with GMT 5. To avoid problems with namespace conflicts (e.g., there are other, non-GMT programs with generic names like triangulate, surface, etc.) all GMT 5 modules are launched from the gmt executable via "gmt module" calls (e.g, gmt pscoast).

GMT Outputs

- 1-D ASCII Tables — For example, a (*x,y*) series may be filtered and the filtered values output. ASCII output is written to the standard output stream.

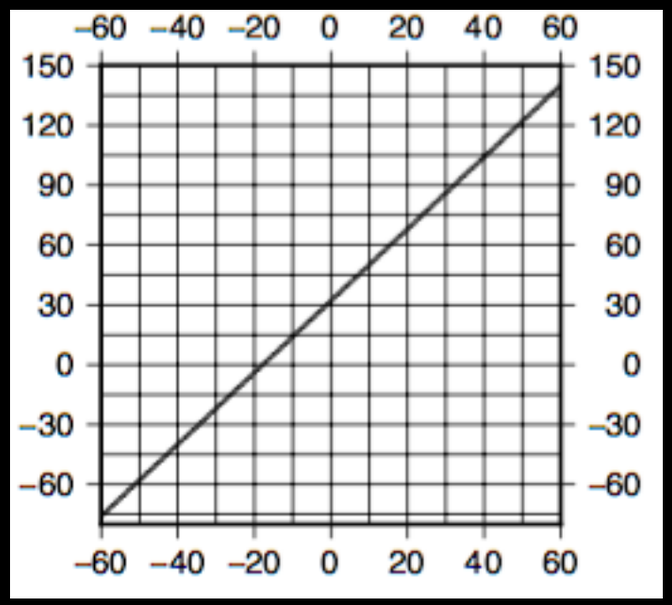
- 2-D binary (netCDF or user-defined) grid files – Programs that grid ASCII (*x,y,z*) data or operate on existing grid files produce this type of output.

- PostScript – The plotting programs all use the PostScriptpage description language to define plots. These commands are stored as ASCII text and can be edited should you want to customize the plot beyond the options available in the programs themselves.

- Reports – Several GMT programs read input files and report statistics and other information. Nearly all programs have an optional “verbose” operation, which reports on the progress of computation. All programs feature usage messages, which prompt the user if incorrect commands have been given. Such text is written to the standard error stream and can therefore be separated from ASCII table output.

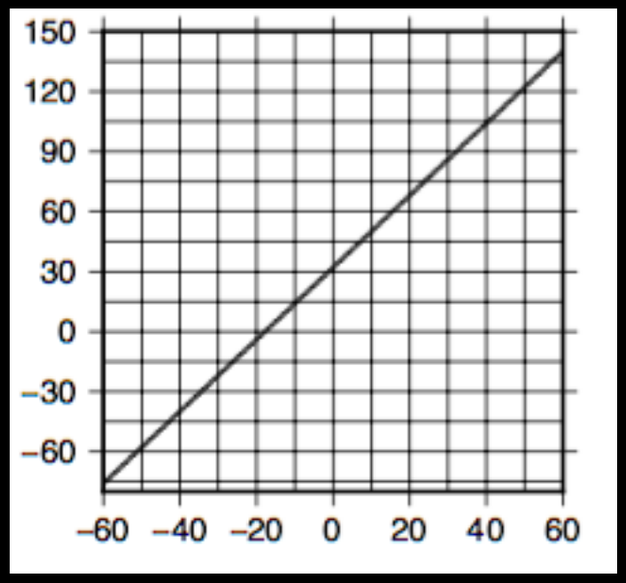
Create a simple plot.

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



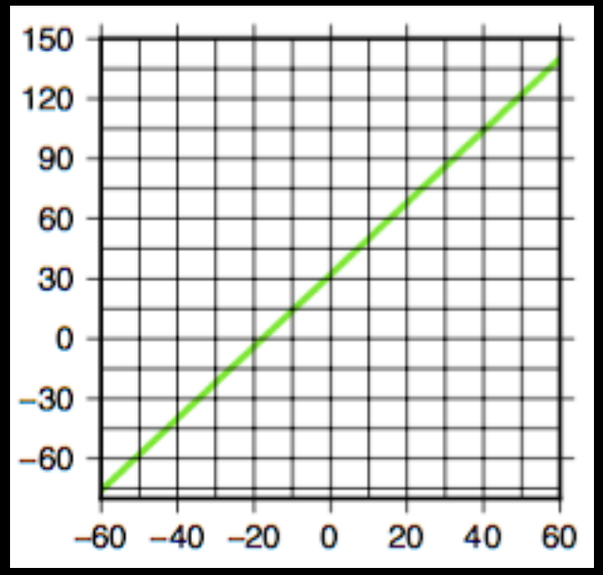
Change it

Change -Ba20g10/a30g15 to -Ba20g10/a30g15WeSn



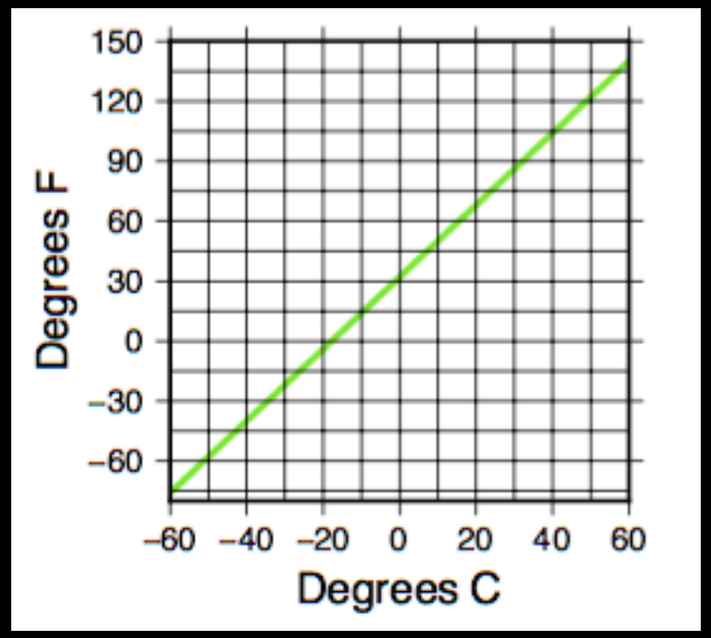
Again

Change -Sc0.05 to -Sc0.10 -G125/230/50



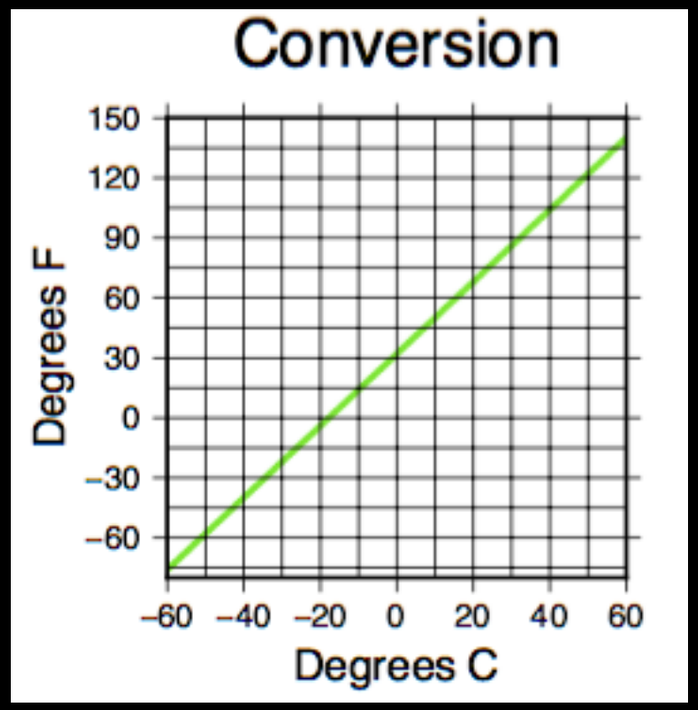
Again

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



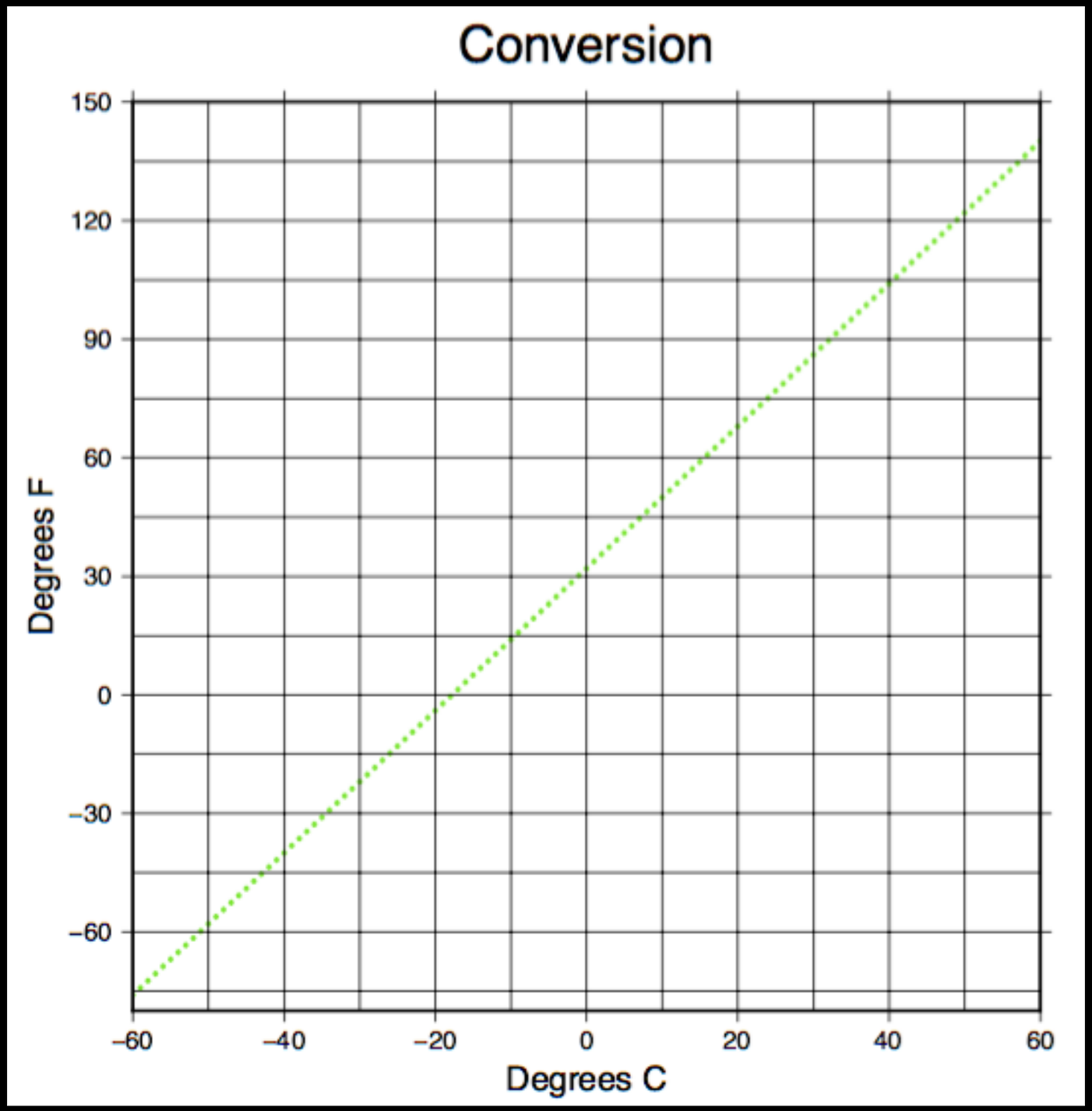
Again

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

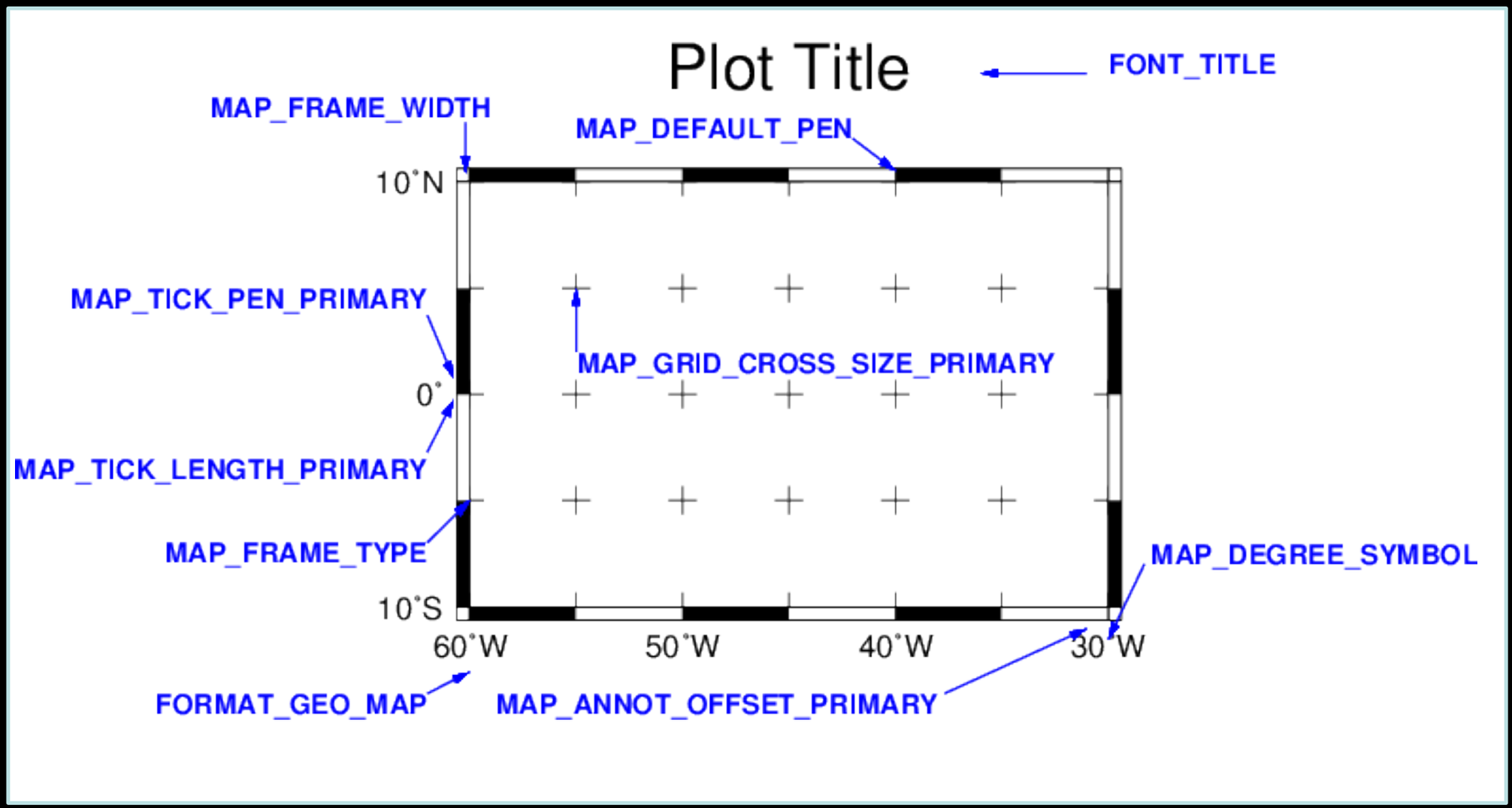


Again

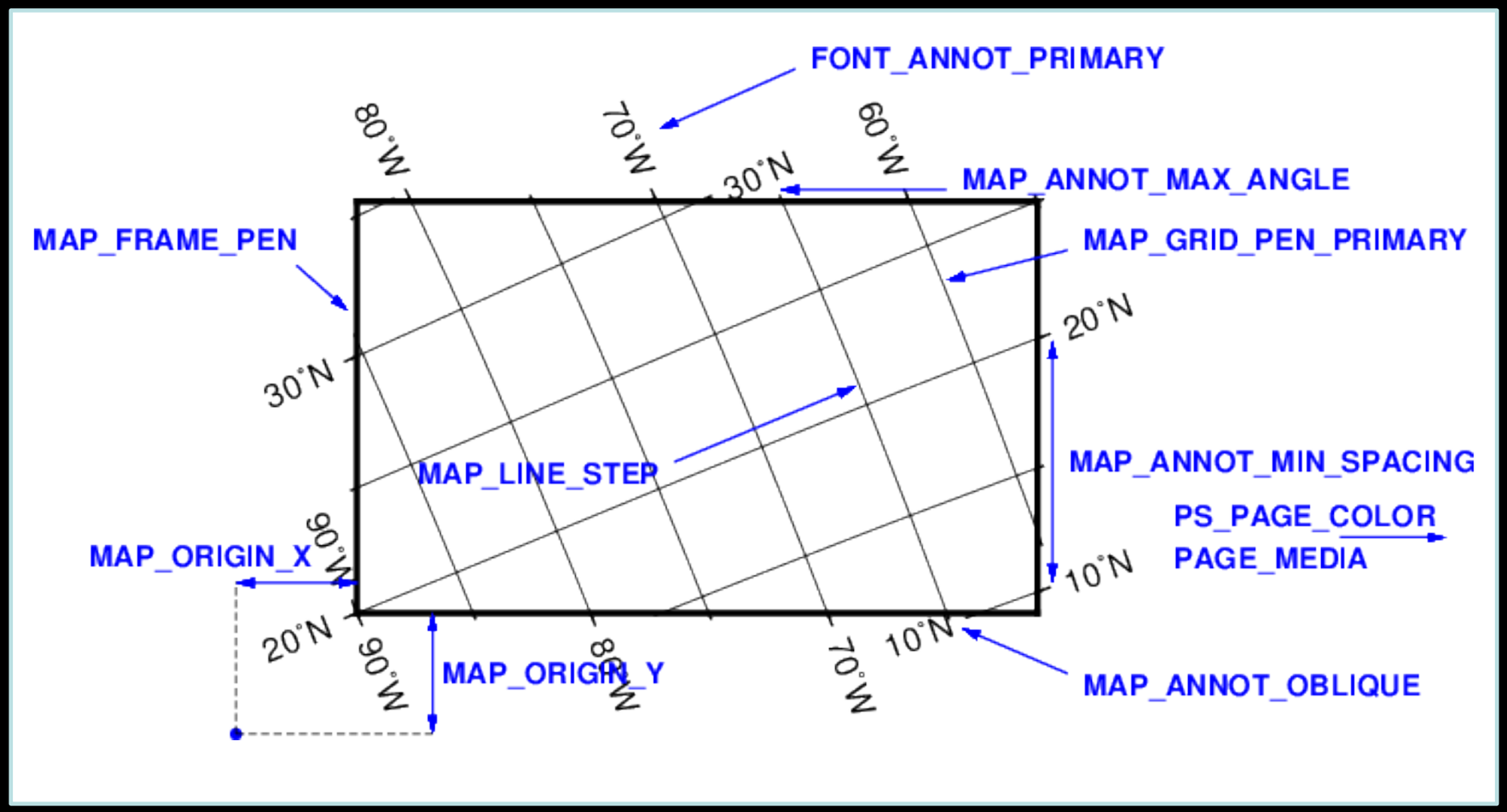
Change -JX6.0 to -JX6.0i



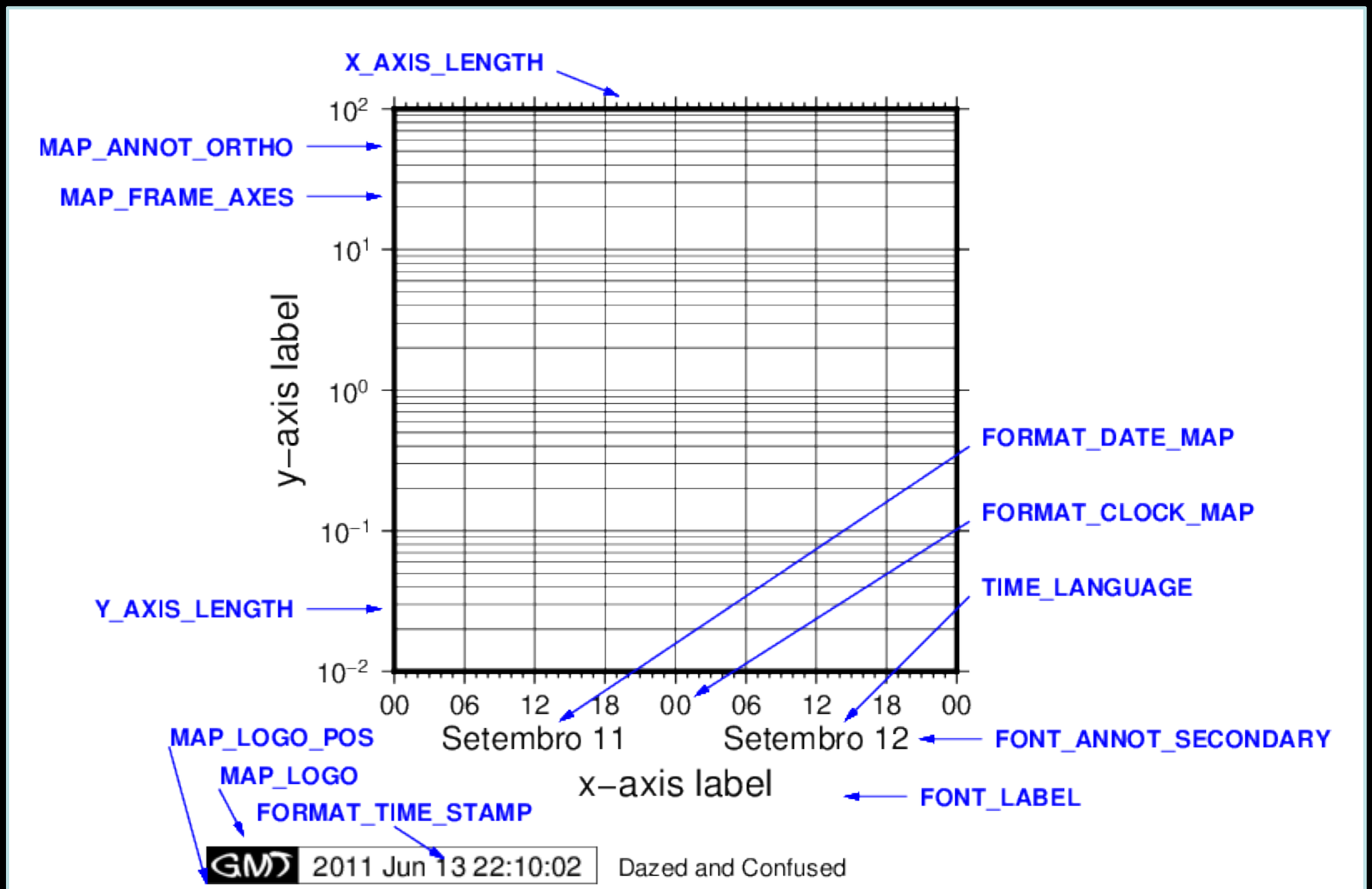
gmtdefaults l



gmtdefaults 2



gmtdefaults 3



gmtdefault categories

- Color Parameters
- Directories
- Font Parameters
- Format Parameters
- Miscellaneous
- Map Parameters
- Projection Parameters
- Postscript Parameters
- Calendar/Time Parameters

- Find out what your defaults are;

gmt gmtdefaults

- Change them

gmt gmtset FONT_ANNOT_PRIMARY 12p,Times-Bold,red

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

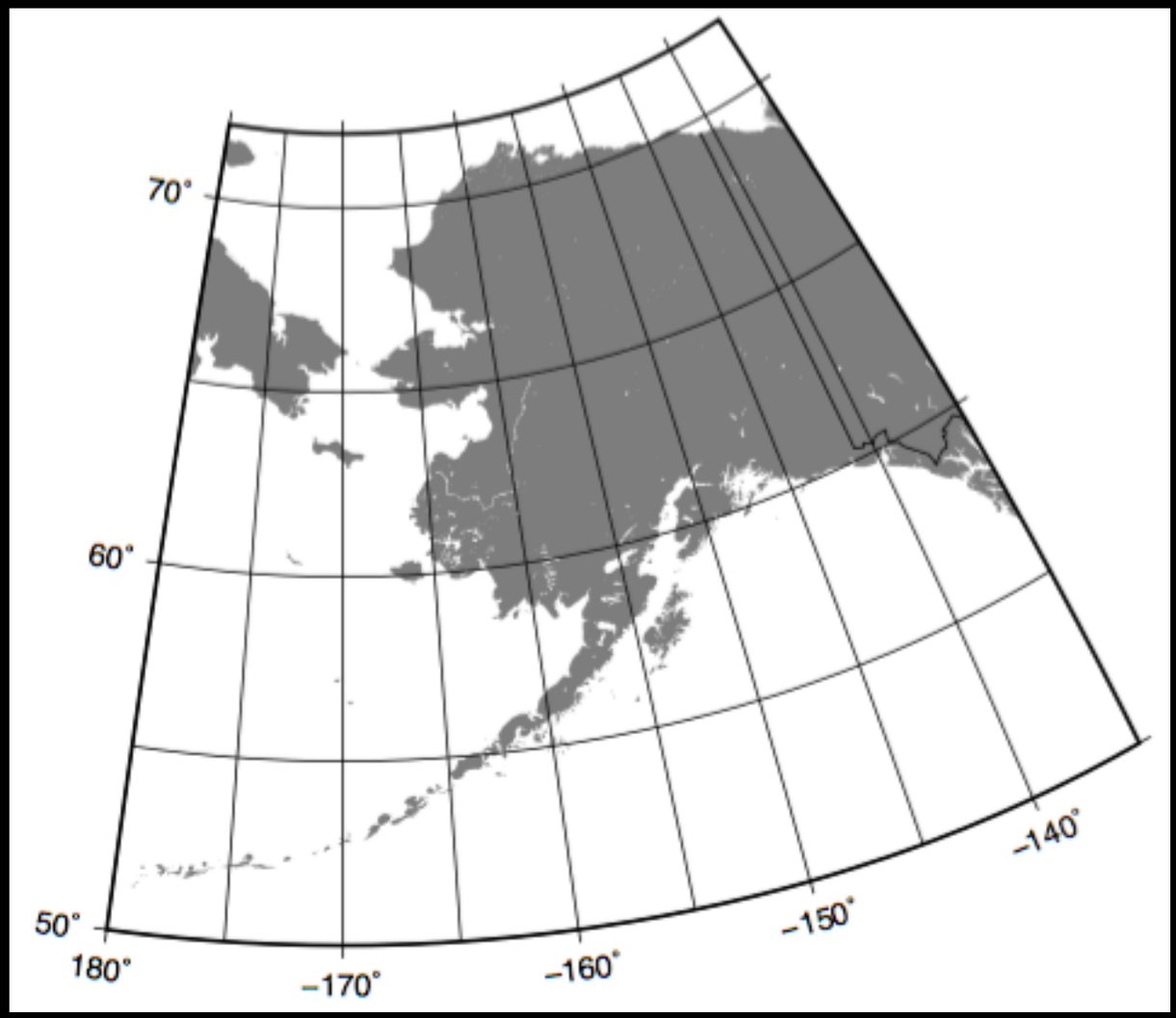
gmt gmtset D_FORMAT %.6f

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

gmt pscoast -Jc190/68/0.50 -R180/225/50/72 -Di -N1 -G125 -Bg5a10 > Alaska.ps



Command line on 1st plot

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

The 23 standardized GMT command line switches

-B	Define tickmarks, annotations, and labels for basemaps and axes
-J	Select a map projection or coordinate transformation
-K	Allow more plot code to be appended to this plot later
-O	Allow this plot code to be appended to an existing plot
-P	Select Portrait plot orientation [Default is landscape]
-R	Define the extent of the map/plot region
-U	Plot a time-stamp, by default in the lower left corner of page
-V	Select verbose operation; reporting on progress
-X	Set the *x*-coordinate for the plot origin on the page
-Y	Set the *y*-coordinate for the plot origin on the page
-a	Associate aspatial data from OGR/GMT files with data columns
-b	Select binary input and/or output
-c	Specify the number of plot copies
-f	Specify the data format on a per column basis
-g	Identify data gaps based on supplied criteria
-h	Specify that input/output tables have header record(s)
-i	Specify which input columns to read
-n	Specify grid interpolation settings
-o	Specify which output columns to write
-p	Control perspective views for plots
-r	Set the grid registration to pixel [Default is gridline]
-s	Control output of records containing one or more NaNs
-t	Change layer PDF transparency
-:	Assume input geographic data are (*lat,lon*) and not (*lon,lat*)

It looks easy, but...

-B Specify both (1) basemap frame settings and (2) axes parameters.
(1) Frame settings are modified via an optional single invocation of
-B[<axes>][+g<fill>][+o<lon>/<lat>][+t<title>]
(2) Axes parameters are specified via one or more invocations of
-B[p|s][x|y|z]<intervals>[+l<label>][+p<prefix>][+u<unit>]
<intervals> is composed of concatenated [<type>]<stride>[<unit>][l|p] sub-strings
See psbasemap man page for more details and examples of all settings.

Try it again with a script

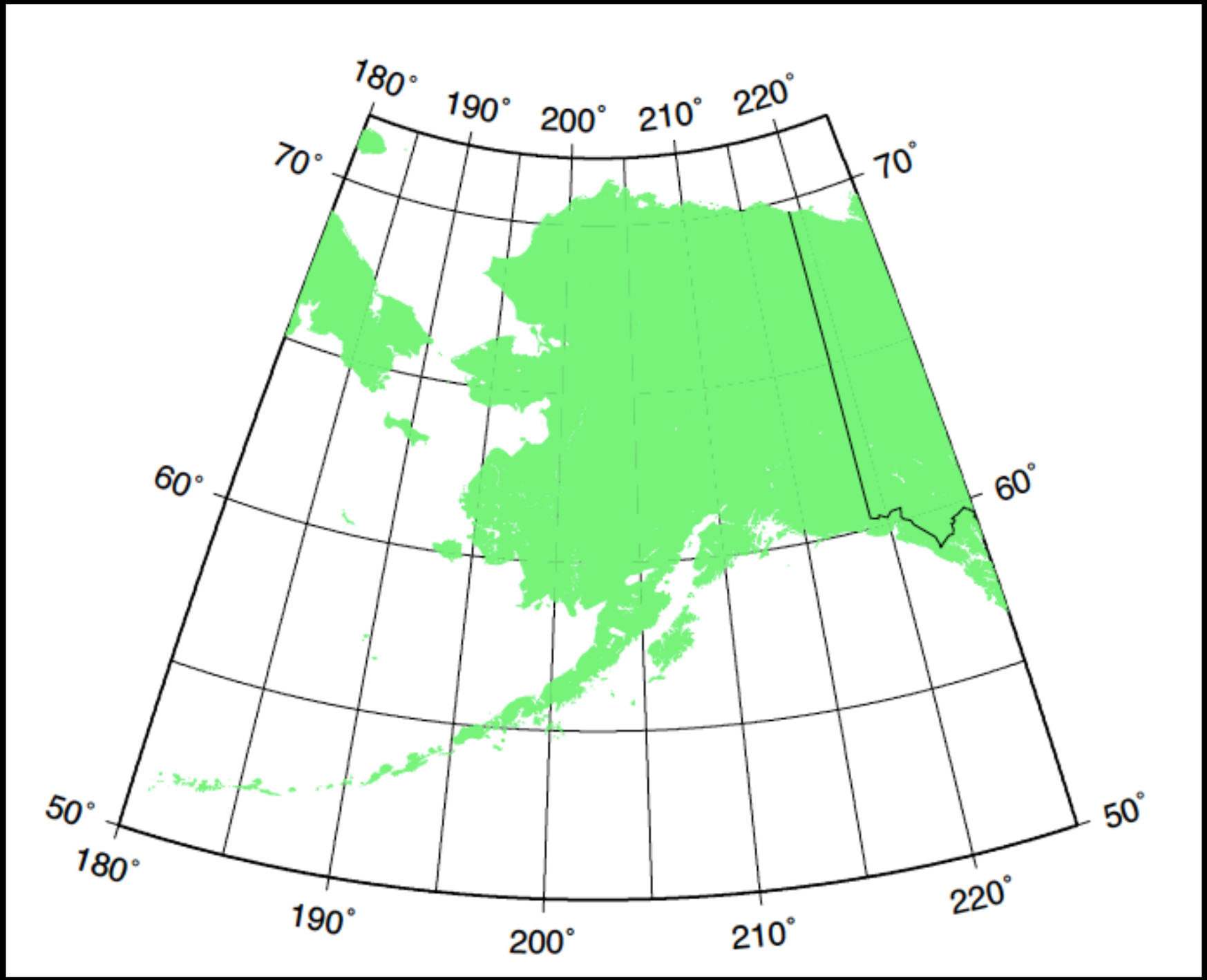
create with text editor or, better, Xcode on a Mac
"chmod +x" to make it executable

```
#!/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

```
gmt psbasemap $map_pro $map_box -Bg5a10 -K -P > $filename
gmt pscoast $map_pro $map_box -Di -N1 -G125/255/125 -O
>> $filename
```

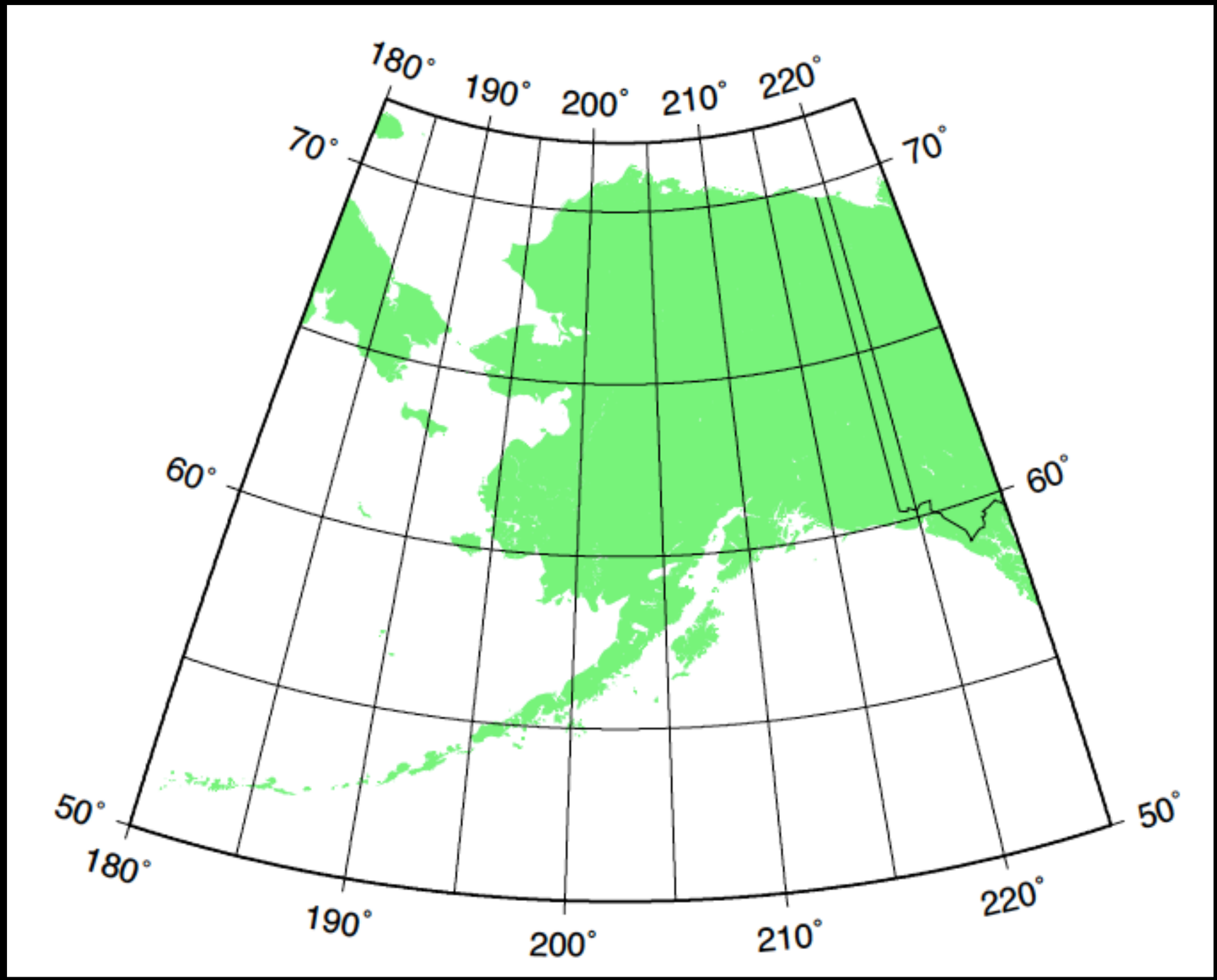
the map.....



sequence is important

```
gmt pscoast $map_pro $map_box -Di -N1 -G125/255/125 -K -P >
$filename
gmt psbasemap $map_pro $map_box -Bg5a10 -O >> $filename
```

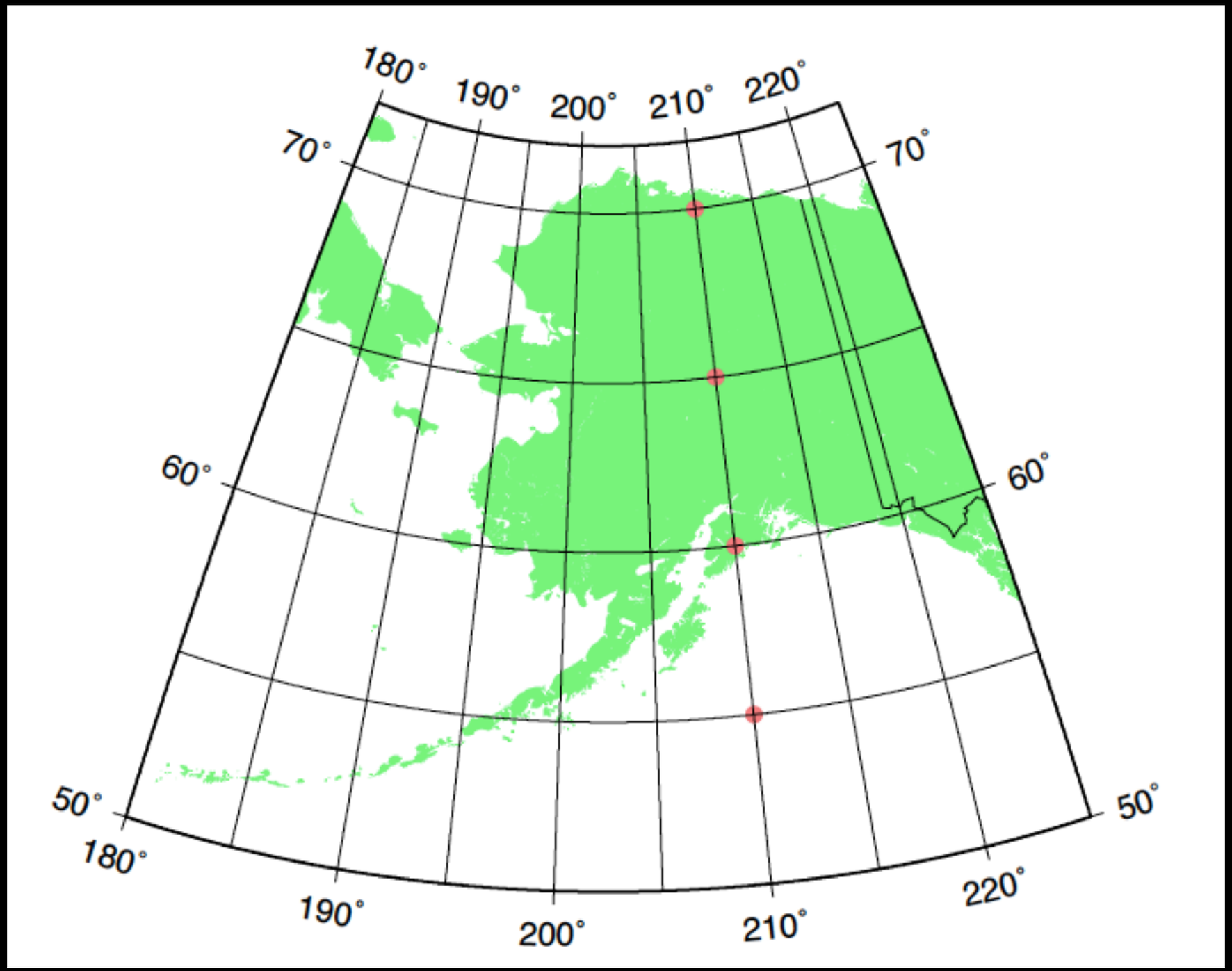
a somewhat different map



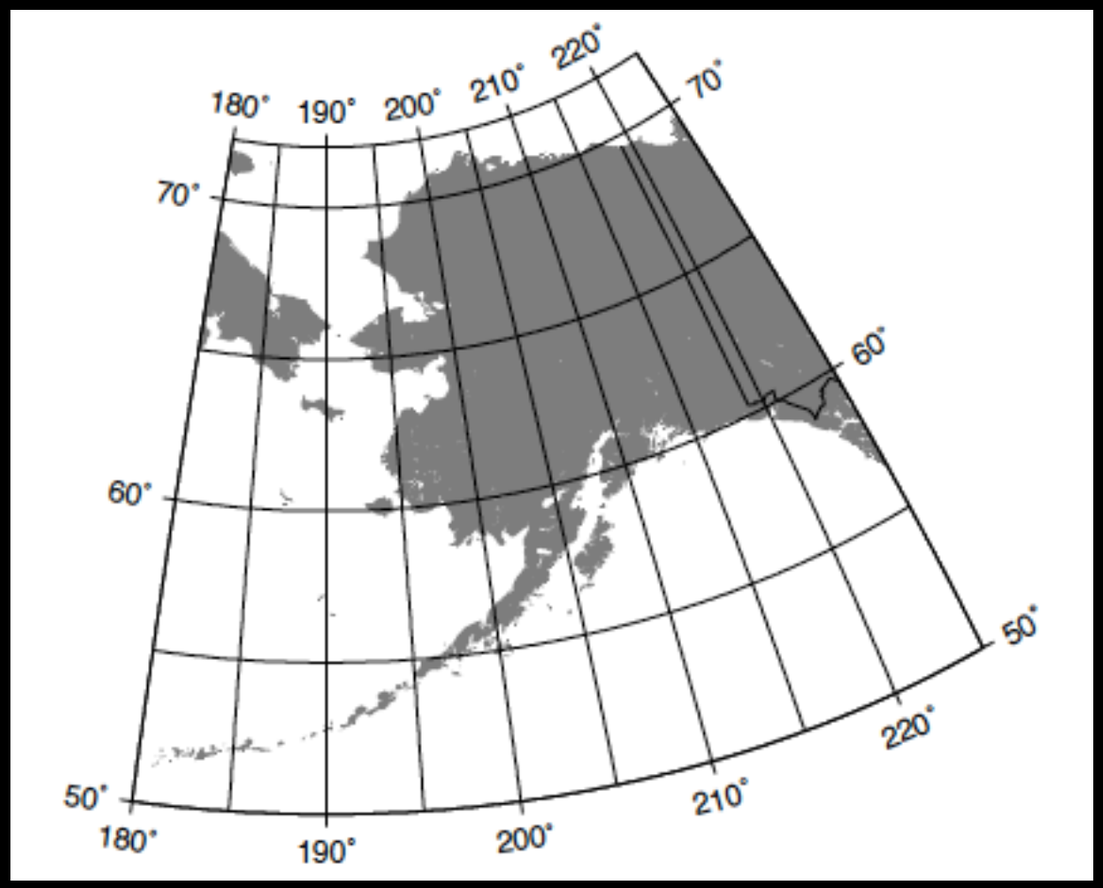
add some data points?

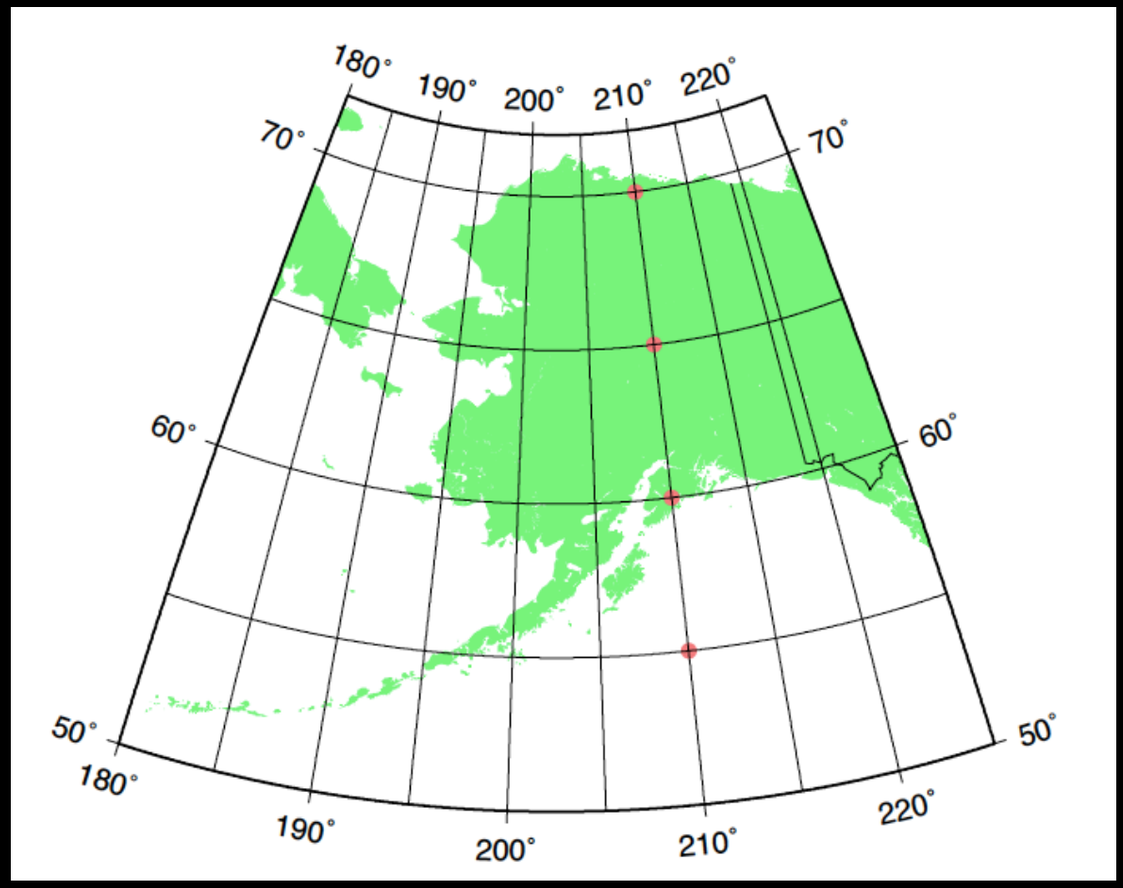
```
gmt pscoast $map_pro $map_box -Di -N1 -G125/255/125 -K -P > $filename

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

gmt 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

%!PS-Adobe-3.0%%BoundingBox: 0 0 595 842%%Title: GMT v4.2.0 Document from pscoast%%Creator: GMT%%For: bernardcoakley%%DocumentNeededResources: font Helvetica%%CreationDate: Thu Oct 29 06:47:11 2009% %LanguageLevel: 1%%DocumentData: Clean7Bit%%Orientation: Portrait%%Pages: 1%%EndComments% %BeginProlog250 dict begin/A /setgray load def/B /setdash load def/C /setrgbcolor load def/D /rlineto load def/E {dup stringwidth pop} bind def/F /fill load def

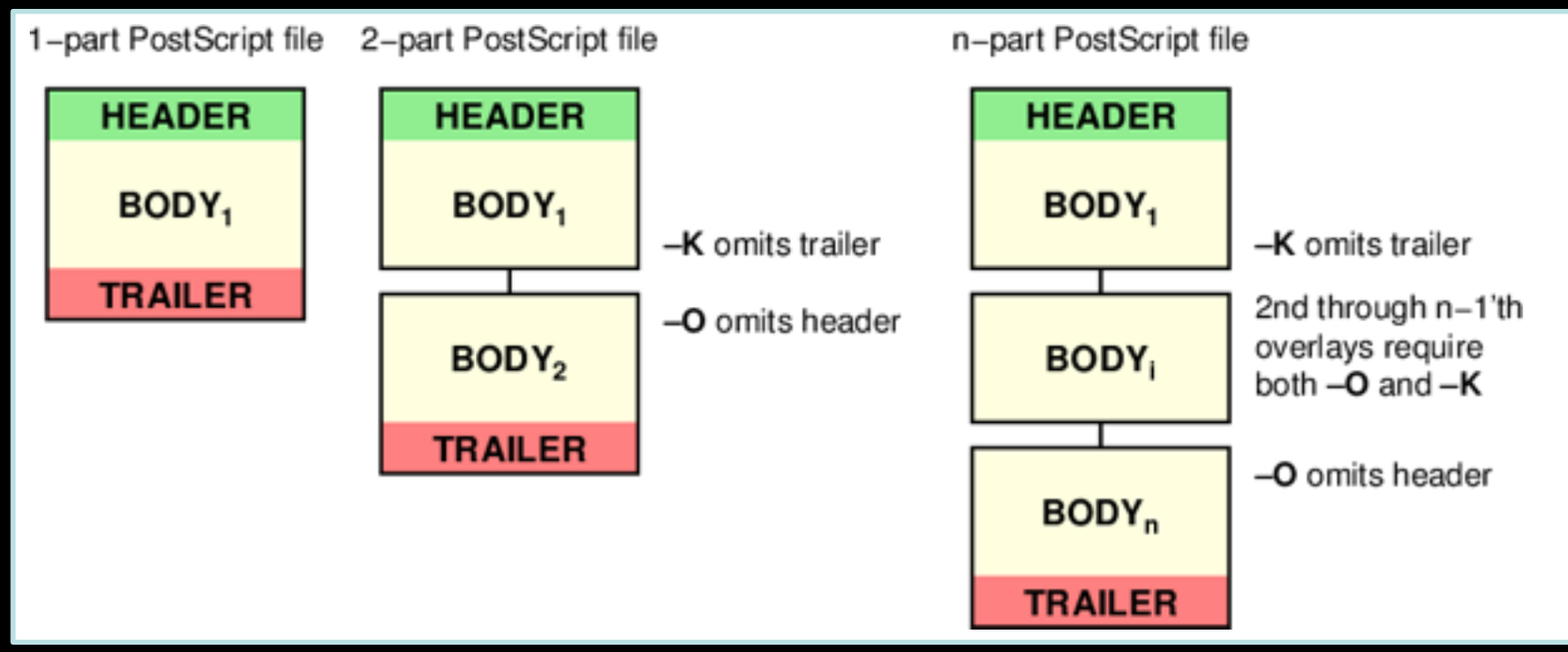
-K suppresses the trailer

a lot of text Postscript precedes these last few lines;

1 0 D S%%PageTrailerS -0 -0 T 4.16667 4.16667 scale 0 Ashowpage%%Trailerend%%EOF

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

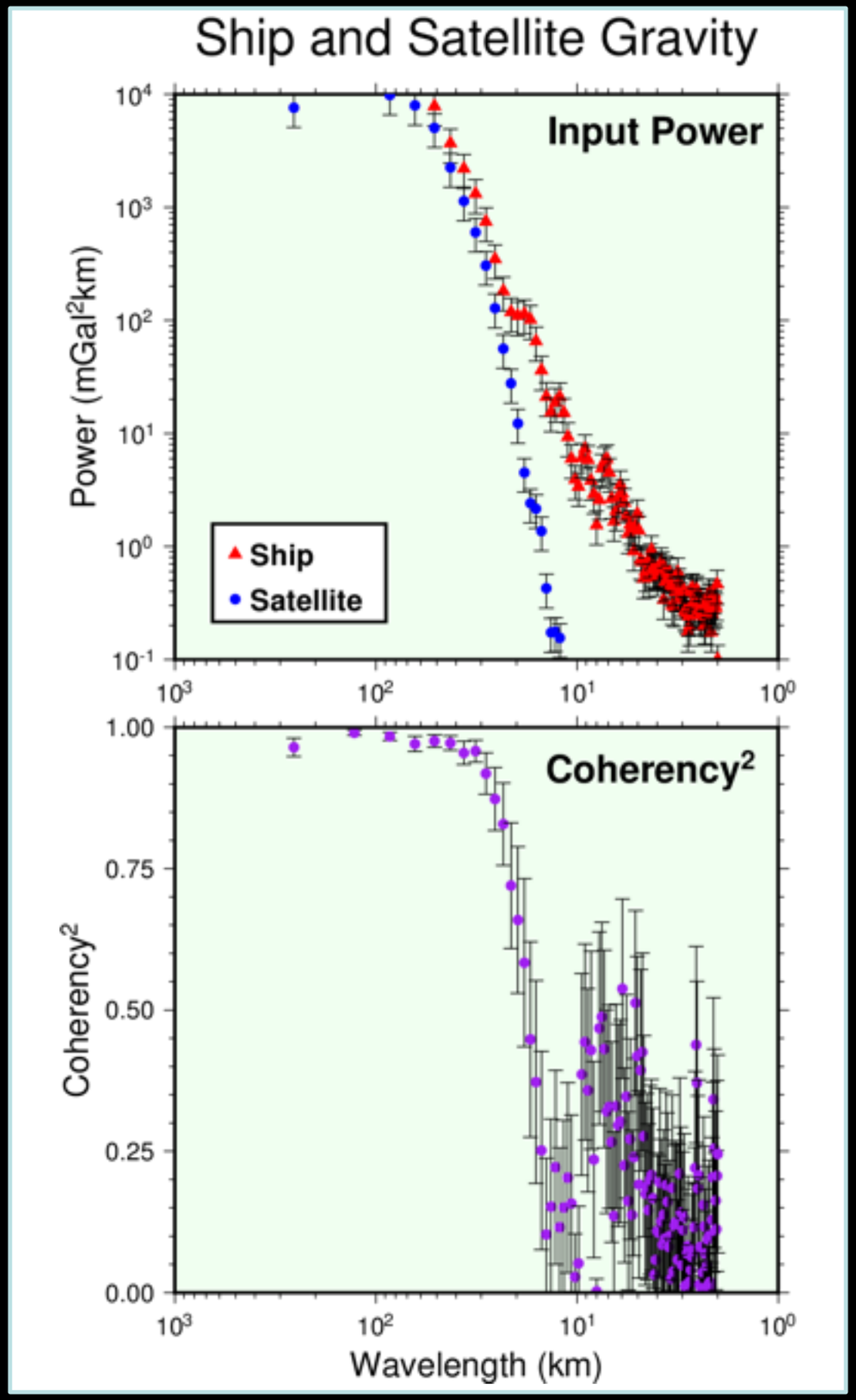
By using -K and -O we can use GMT commands in series to create a single plot.



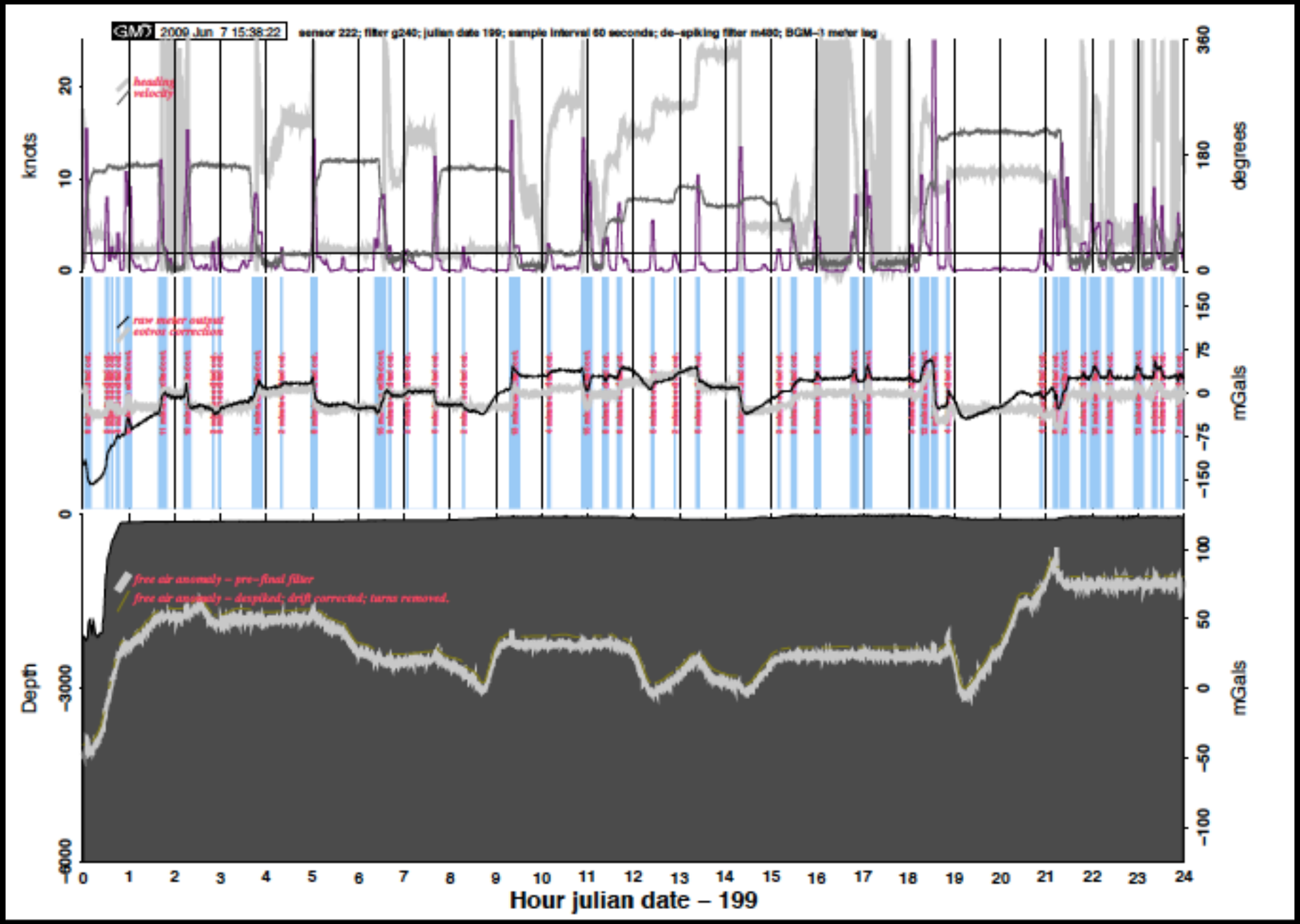
most common errors in GMT scripts

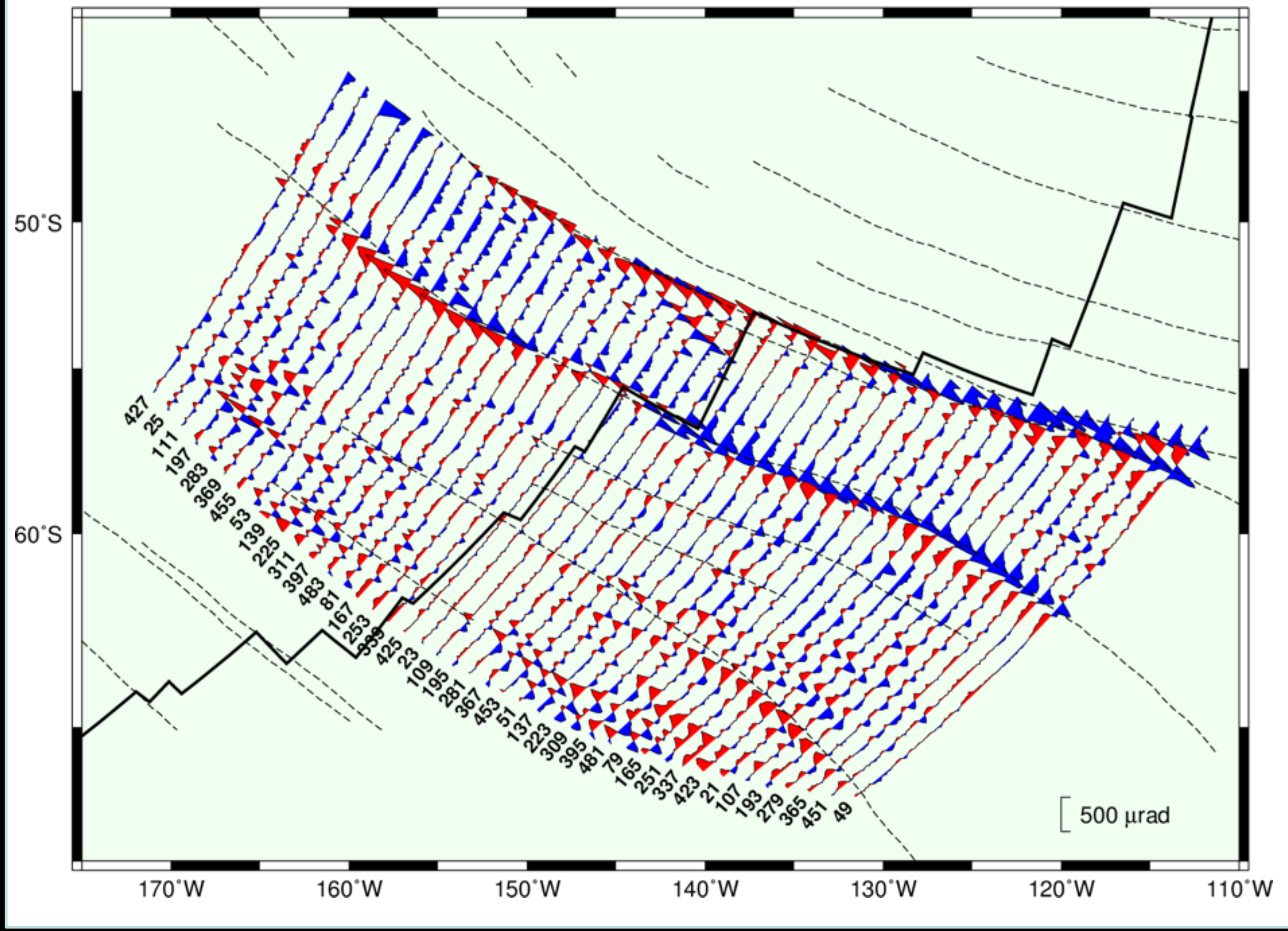
- misuse of -K and -O options
- using “>” instead of “>>” as a redirect
- not specifying -R or -J correctly
- incorrect sequencing of commands
- trying to plot incorrectly scaled data
- trying the write the whole script at once

Examples

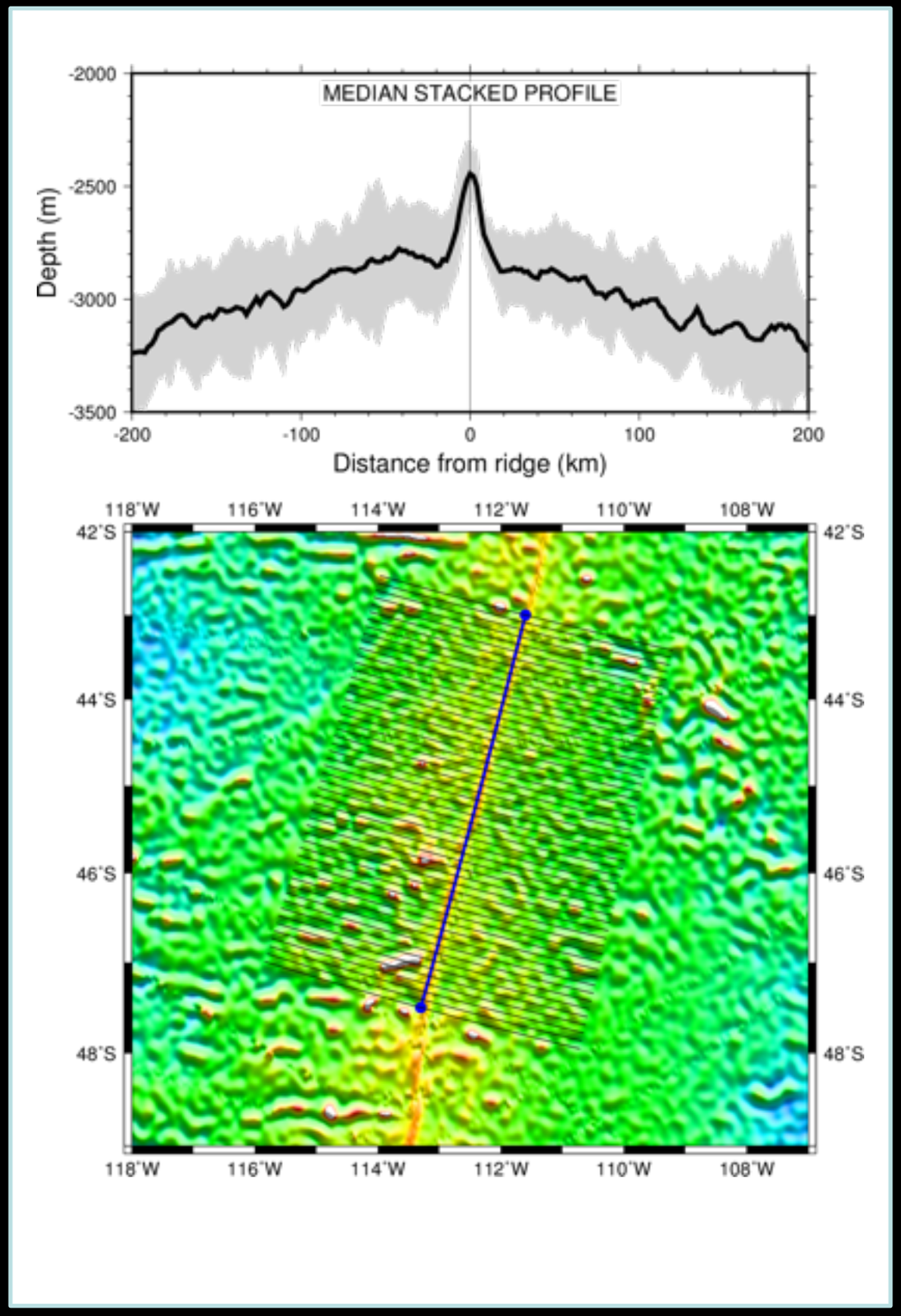

Ship and Satellite Gravity
Input Power
Power (mGal²km)
Ship
Satellite
Coherency²
Coherency²
Wavelength (km)

Gravity data from USCGC Healy




50˚S
60˚S
170˚W
160˚W
150˚W
140˚W
130˚W
120˚W
110˚W
427
25
111
197
283
369
455
53
139
225
311
397
483
81
167
253
339
425
23
109
195
281
367
453
51
137
223
309
395
481
79
165
251
337
423
21
107
193
279
365
451
49
500 µrad

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