GEOS 436 / 636
Programming and Automation for Geoscientists

– Week 12: Generic Mapping Tools I –

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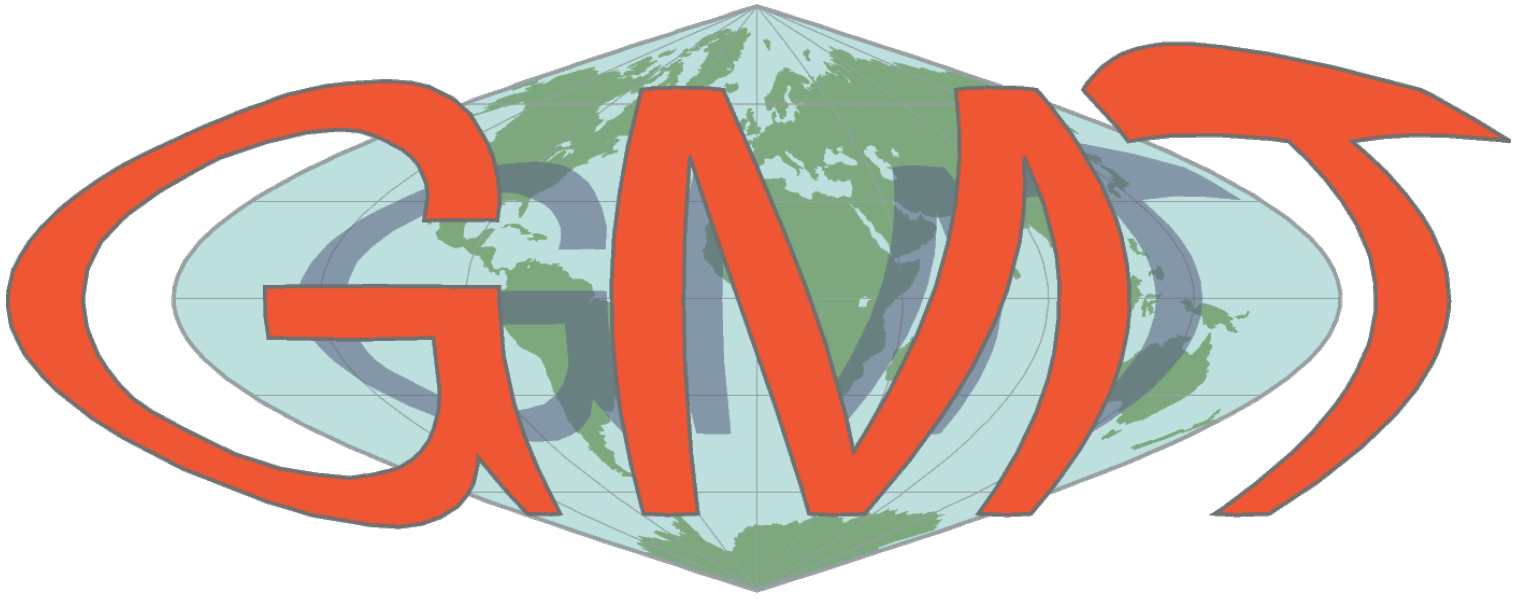
How to automate making publication-quality:

- maps,
- x-y plots,
- animations

using world class base data sets while having maximum flexibility regarding layout of your product?



THE GENERIC MAPPING TOOLS

https://www.generic-mapping-tools.org

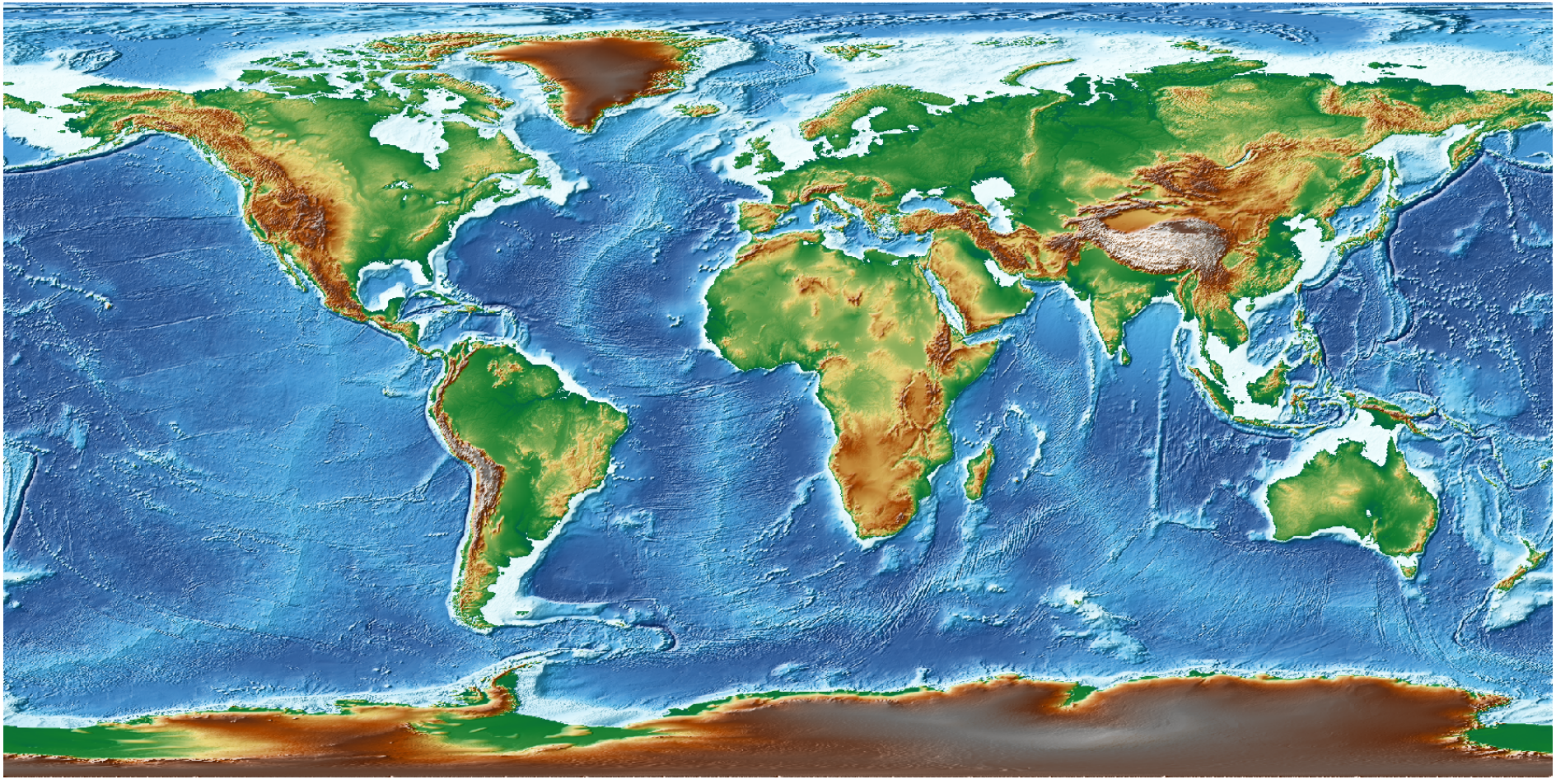
What is GMT?

About

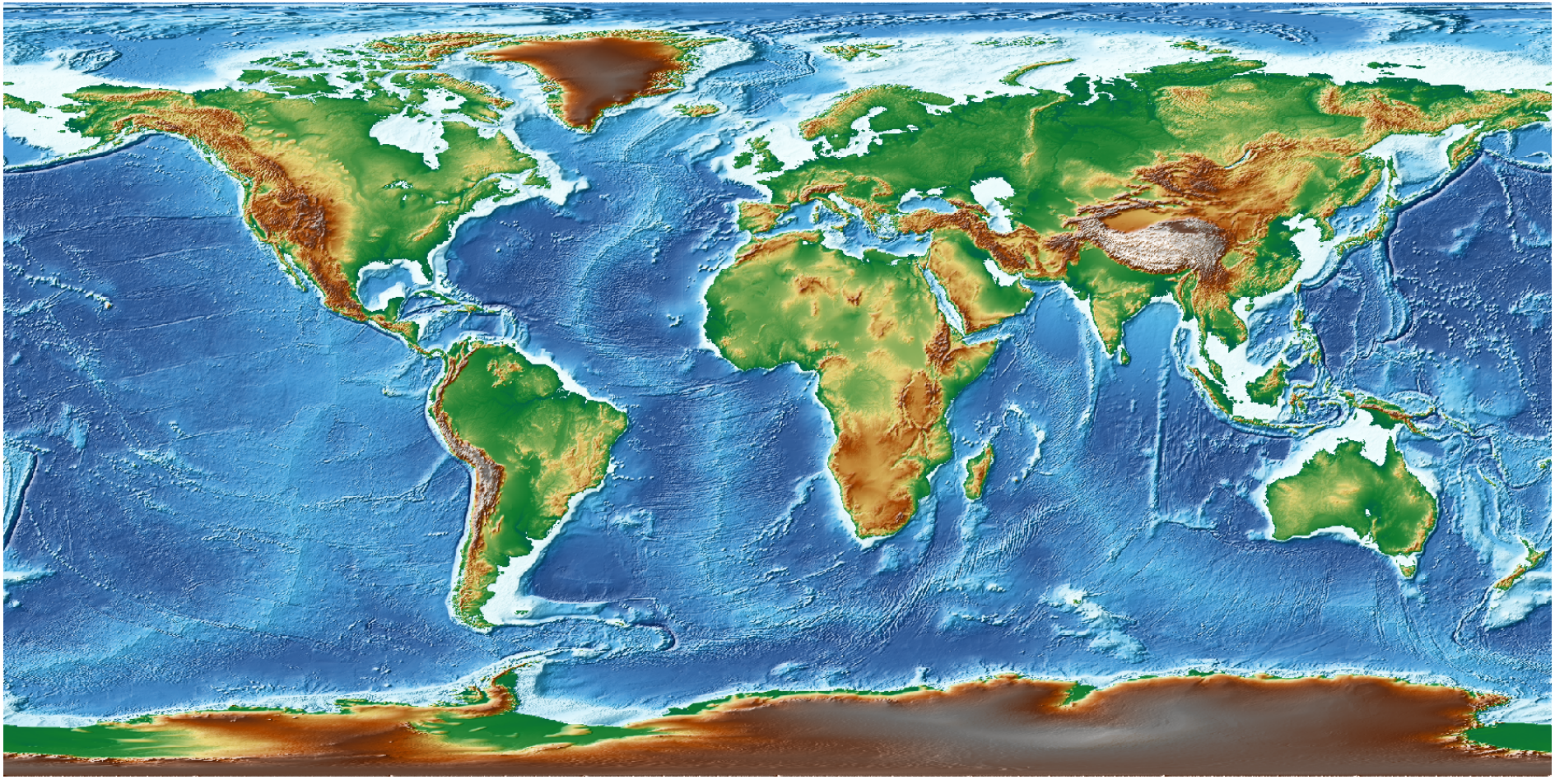
GMT is an open-source collection of command-line tools for manipulating geographic and Cartesian data sets (including filtering, trend fitting, gridding, projecting, etc.) and producing high-quality illustrations ranging from simple x–y plots via contour maps to artificially illuminated surfaces and 3D perspective views. It supports many map projections and transformations and includes supporting data such as coastlines, rivers, and political boundaries and optionally country polygons.

https://www.generic-mapping-tools.org/about/

Make this with ONE command?

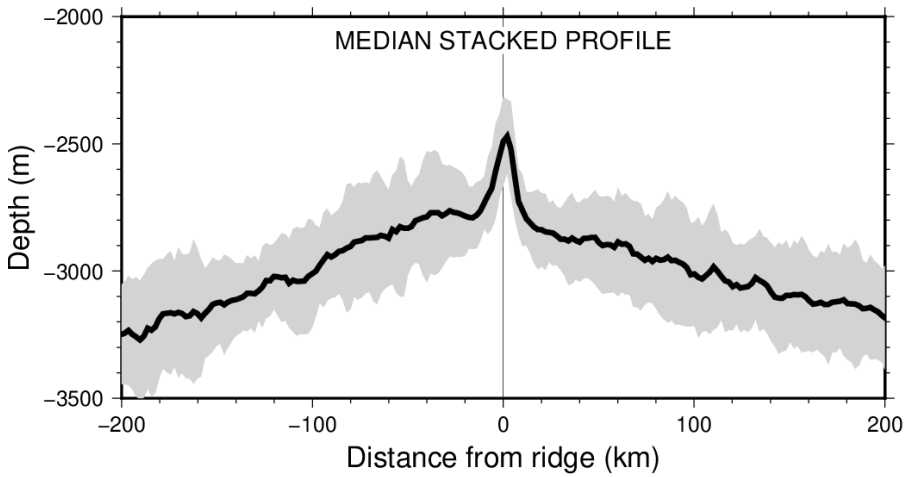


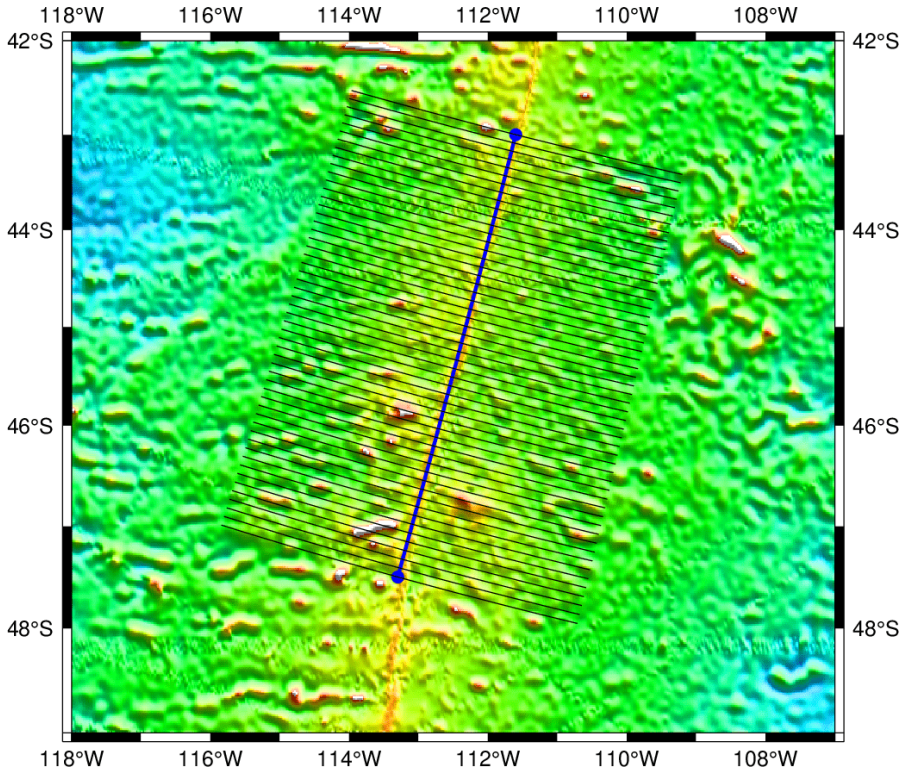
Make this with ONE command?



```
$> gmt grdimage @earth_relief_10m -Rg -I+d -png world_map
```

What is GMT?



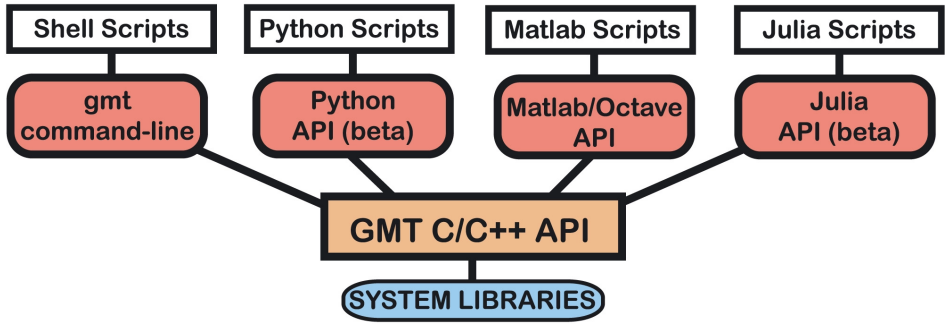


https://docs.generic-mapping-tools.org/latest/gallery/ex33.html

What is GMT?

Some history:

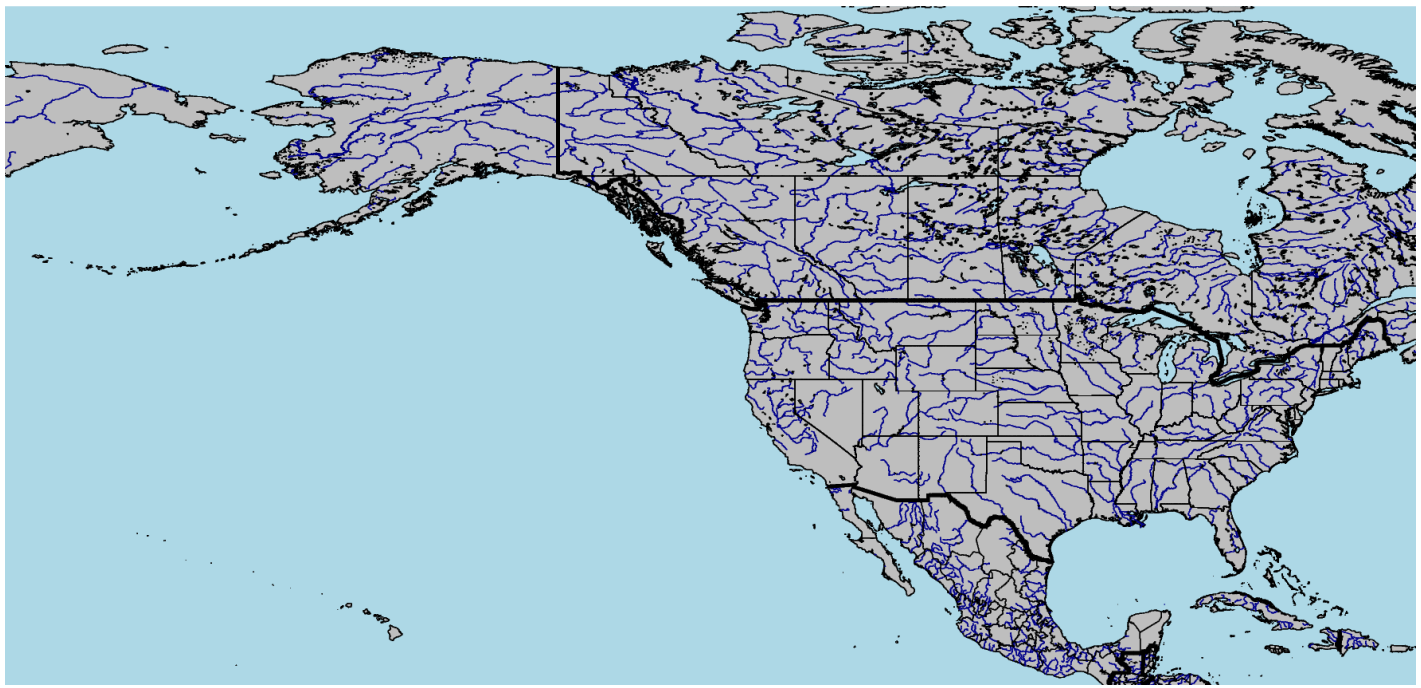
- Initiated in 1987 at Lamont-Doherty Earth Observatory by then graduate students Paul Wessel and Walter Smith
- Began as set of Unix command-line tools that generated PostScript
- Evolved to provide shell script, Matlab, and beginning Python and Julia support



Wessel et al., 2019

GMT comes loaded

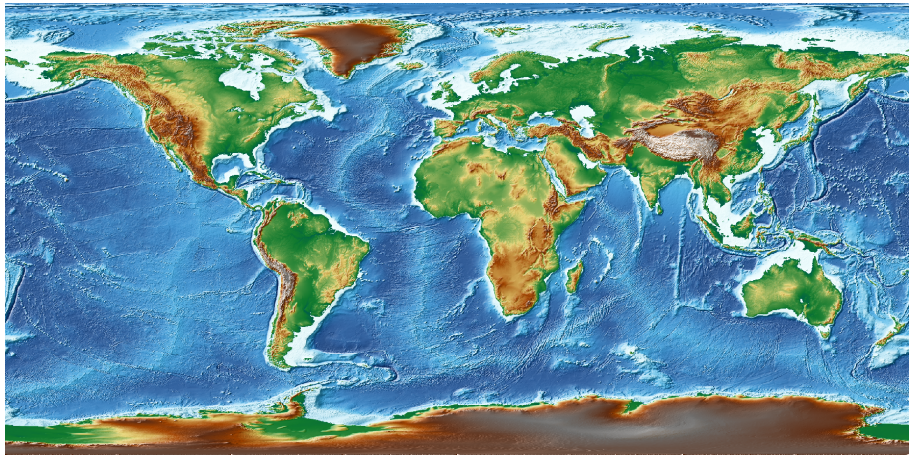
- Includes GSHHG – Global Self-consistent, Hierarchical, High-resolution Geography Database and DCW-GMT – The Digital Chart of the World
  - coastlines
  - national and state (for some countries) borders
  - rivers / fresh-water bodies

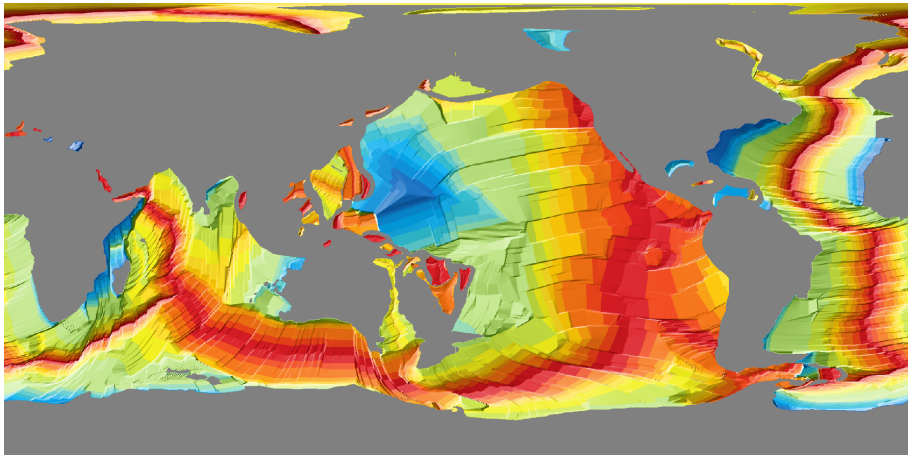


```
$> gmt coast -RUS+r5 -Ir/0.25p,darkblue \
             -N1/1p,black -N2/0.25p,black -W.25p,black \
             -Ggray -Slightblue -Df -png coastlines
```

GMT comes loaded

- Provides access to external data grids via remote file mechanism (will download file on first access then read locally)
  - Global Earth Relief Grids (`earth_relief`)
  - Global Earth Seafloor Crustal Age Grids (`earth_age`)
  - Global Earth Day/Night Images (`earth_day` and `earth_night`)
  - Global Earth Mask Grids (`earth_mask`)
- use default preferred color palette.

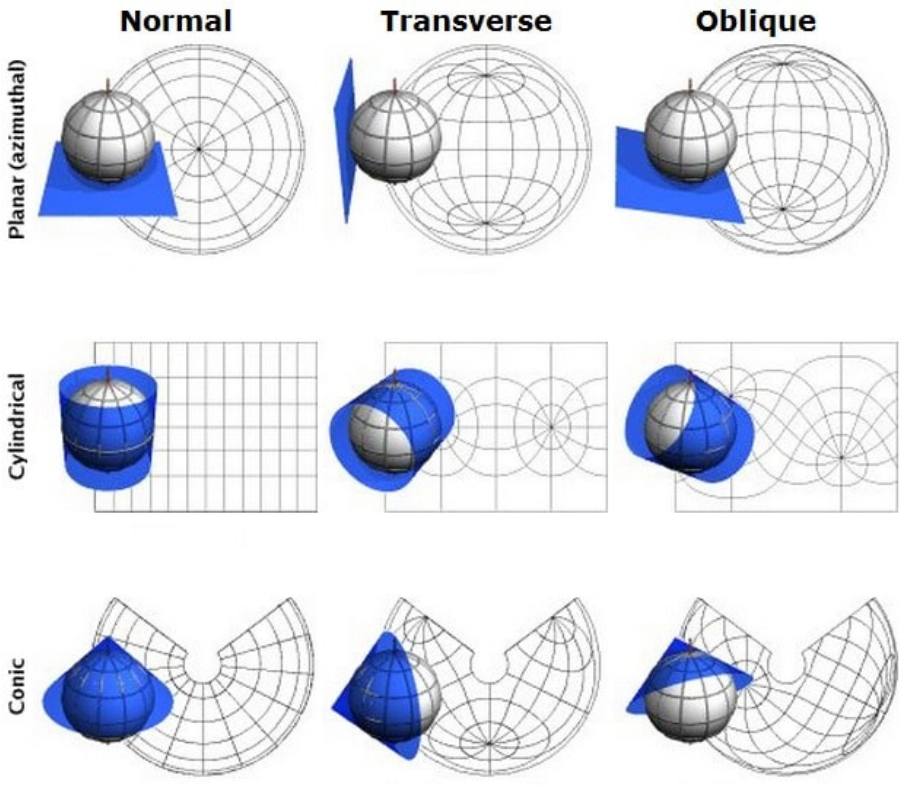




```
$> gmt grdimage @earth_relief_10m -Rg -I+d -png world_map
$> gmt grdimage @earth_age_10m -Rg -I+d -png world_map_age
```

GMT comes loaded

- More than 30 map projections to project globe onto flat paper, basic categories:
  - azimuthal/planar map projections (near poles)
  - cylindrical map projections (near equator)
  - conic map projections (in between)
  - miscellaneous projections (xy plots, etc.)



https://eipd.dcs.wisc.edu/for-credit/GIS-cert/summer2017/geog370_m1/lesson_4.html

How does GMT work?

- Some things can be done via simple one-liners (see above)
- Real strength of GMT arises from the ability to layer data
- Done via GMT “sessions”
- Best done in shell scripts (for reproduciblilty)
- sessions “begin” and “end”, things happen in between

https://docs.generic-mapping-tools.org/latest/

An example . . . Mt. St. Helens

```
#!/bin/bash

gmt begin sthelens_map png,pdf

  #add DEM, Lambert projection, 4inches wide
  #image, default illumination
  gmt grdimage @earth_relief_01s \
        -R-122.4/-121.95/46.0/46.33 \
        -JL-122.2/46.15/46.0/46.3/4i -I+d

gmt end
```

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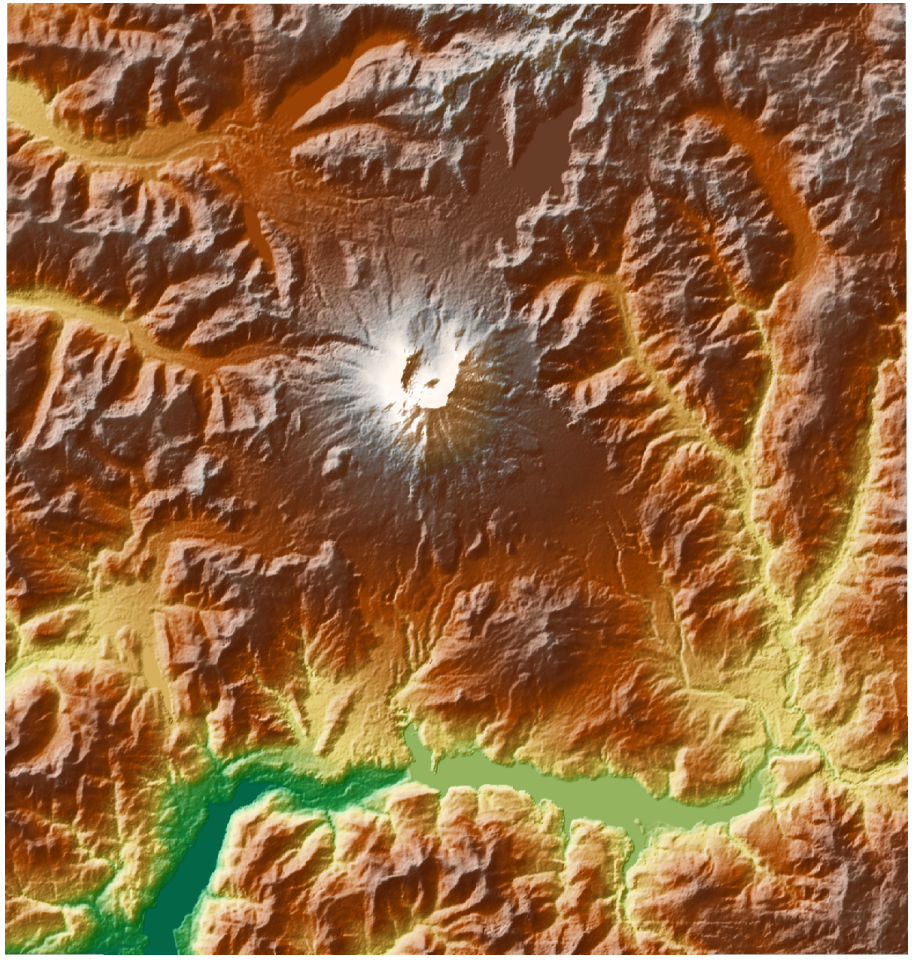
gmt end
```



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        -JL-122.2/46.15/46.0/46.3/4i -I+d

  #add map frame, scale bar
  gmt coast -Wthin -Ba0.1f0.01 -BWSne \
        -Lg-122.0/46.05+w5k+l+c46.1

gmt end
```

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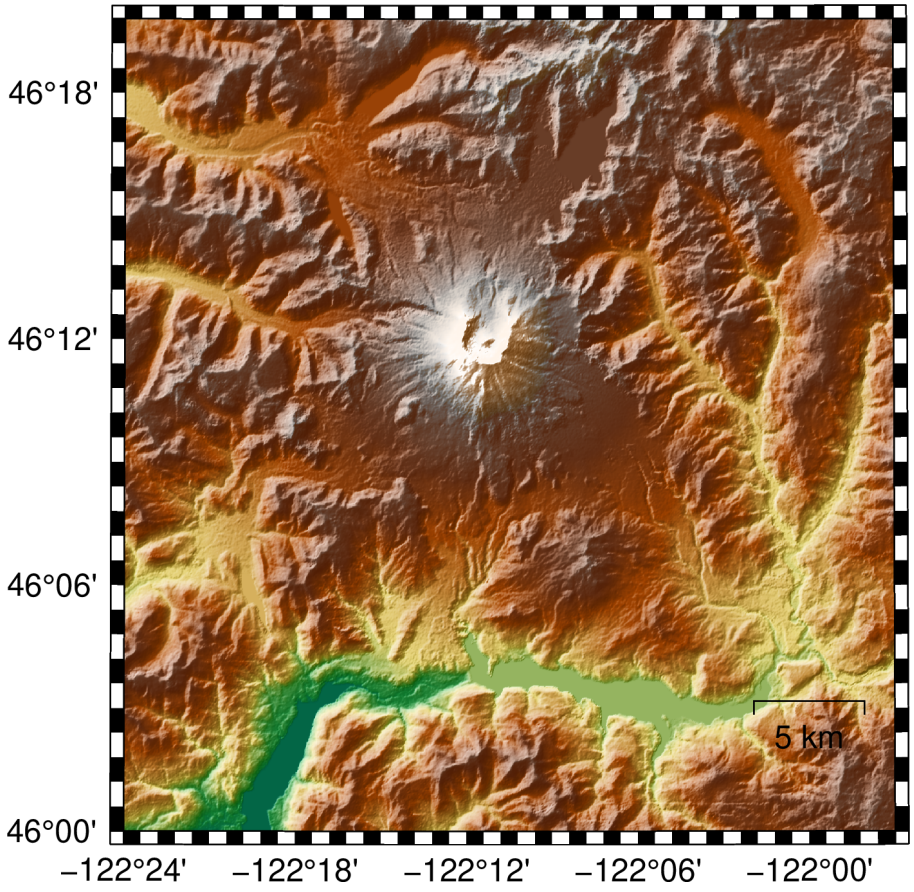

An example . . . Mt. St. Helens

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#!/bin/bash

gmt begin sthelens_map png,pdf
  #nicer map frame
  gmt set MAP_FRAME_TYPE plain

  #add DEM, Lambert projection, 4inches wide
  #image, default illumination
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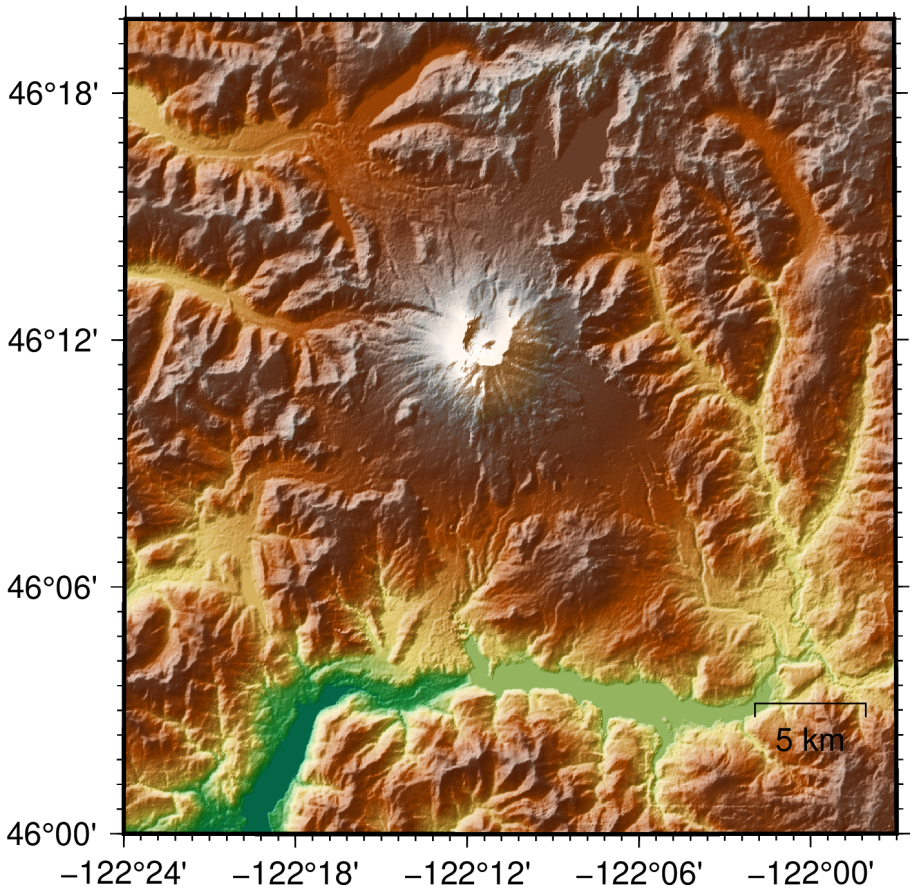
```



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  #add map frame, scale bar
  gmt coast -Wthin -Ba0.1f0.01 -BWSne \
        -Lg-122.0/46.05+w5k+l+c46.1

  #add GPS stations
  gmt plot -St0.2 -Gred -Wthin,red sites.xy

gmt end
```

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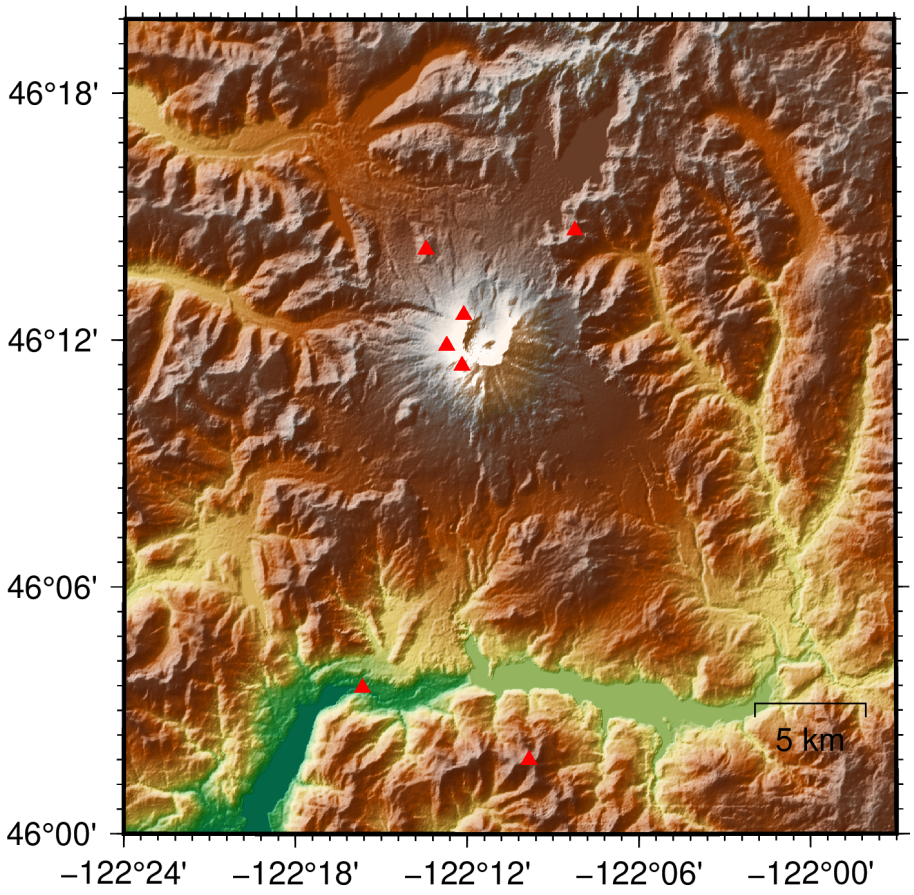

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        -Lg-122.0/46.05+w5k+l+c46.1

  #add GPS stations
  gmt plot -St0.2 -Gred -Wthin,red sites.xy

  #add station names
  gmt text -F+f8p,Helvetica-Bold,black+jRB \
        sites.xy
gmt end
```

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  gmt text -F+f8p,Helvetica-Bold,black+jRB \
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gmt end
```

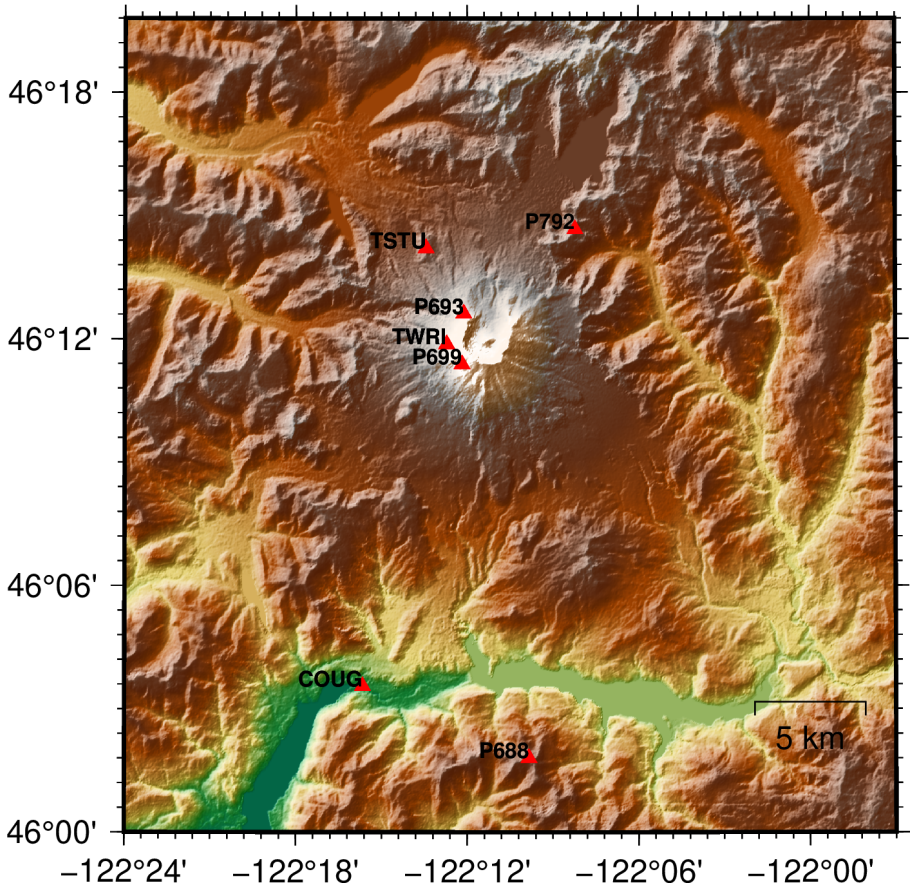

Common Problems

- By default: longitude first, then latitude . . . use `-:` to reverse the order
- Definitions of some command line arguments are quite involved. (–R, –J)
- Read the documentation!
  `https://docs.generic-mapping-tools.org/latest/`
- Start from:
  - Tutorial: `https://docs.generic-mapping-tools.org/latest/tutorial.html`
  - Cookbook: `https://docs.generic-mapping-tools.org/latest/cookbook.html`
  - Examples: `https://docs.generic-mapping-tools.org/latest/gallery.html`
- BUILD YOUR MAPS STEP BY STEP! Don't try to do it all at once.