



GMT

Generic Mapping Tools or
Gravity, Magnetism and Topography

Lecture # 2

Gridding, Data Analysis, and Processing

Data Processing

- sample1d Resampling of 1-D data
- filter1d Filter 1-D data (time series)
- fitcircle Finds best-fitting great or small circles
- grdtrend Fits polynomial trends to grdfiles ($z = f(x,y)$)
- trend1d Fits polynomial or Fourier trends to $y = f(x)$ series
- trend2d Fits polynomial trends to $z = f(x,y)$ series

Filtering

-F Sets the filter type. Choose among convolution and non-convolution filters. Append the filter code followed by the full filter *width* in same units as time column. Available convolution filters are:

(b) Boxcar: All weights are equal.

(c) Cosine Arch: Weights follow a cosine arch curve.

(g) Gaussian: Weights are given by the Gaussian function.

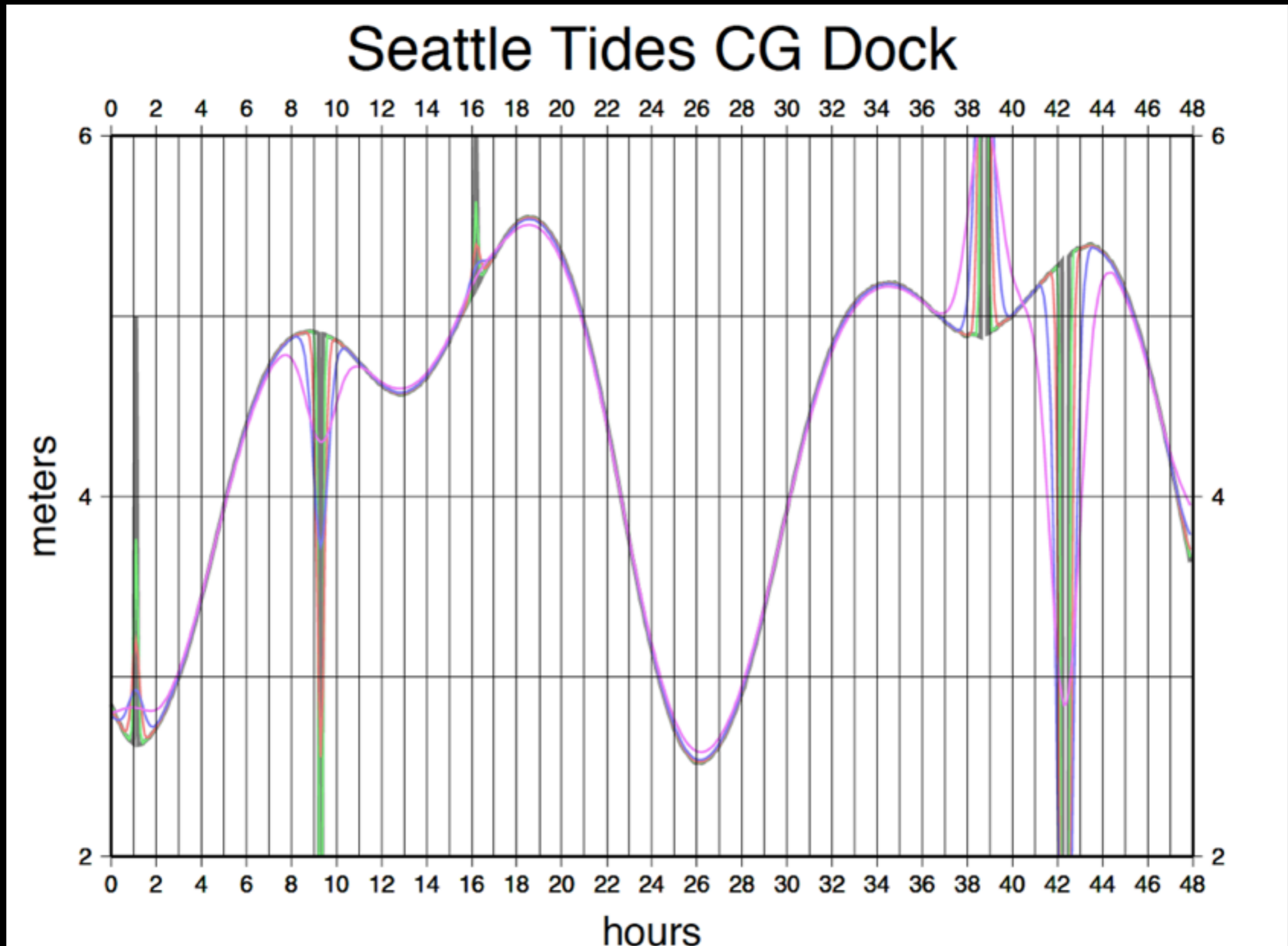
(f) Custom: Instead of *width* give name of a one-column file with your own weight coefficients.

Non-convolution filters are:

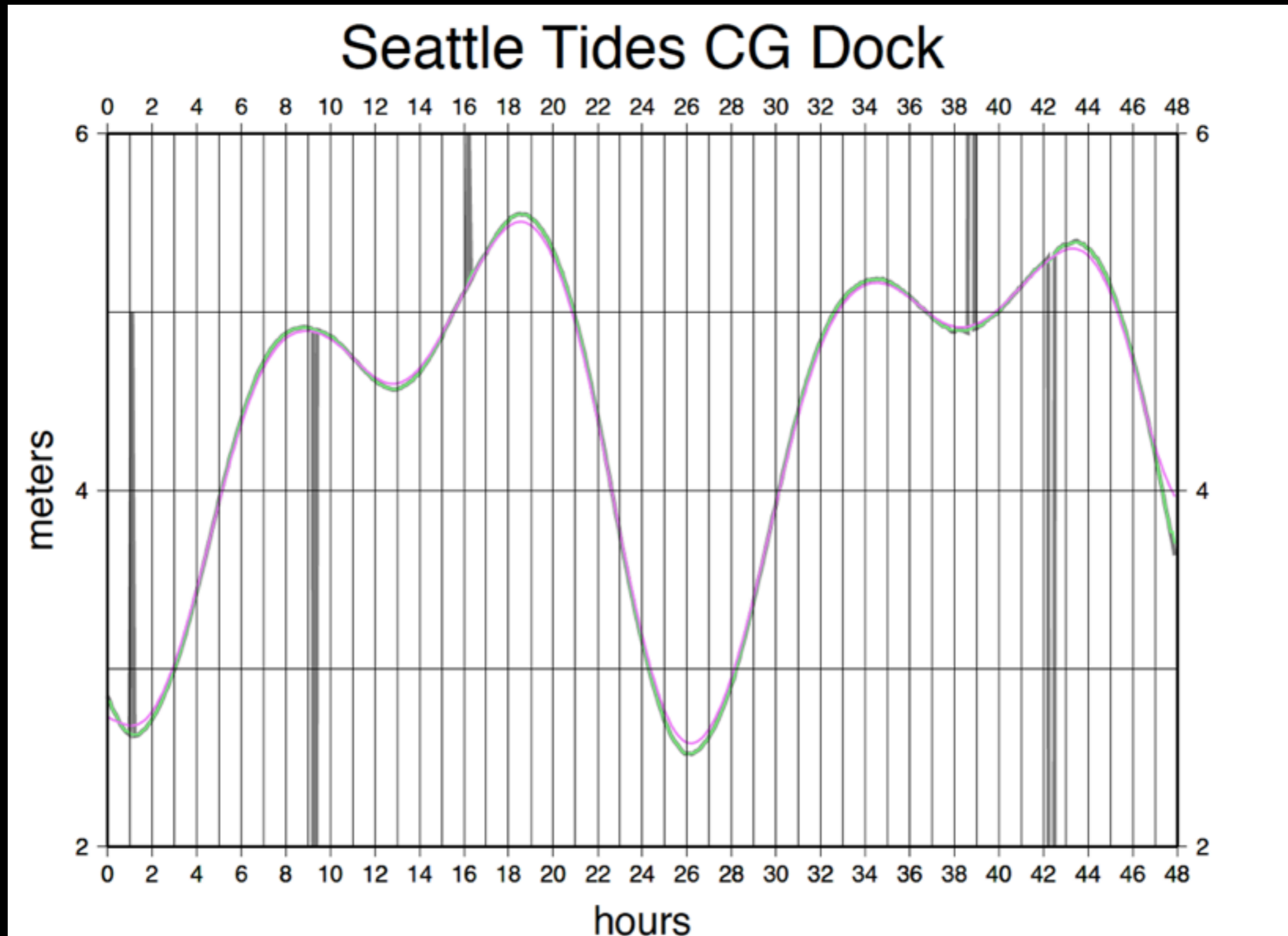
(m) Median: Returns median value.

(p) Maximum likelihood probability (a mode estimator): Return modal value. If more than one mode is found we return their average value. Append - or + to the filter width if you rather want to

Gaussian Filter



Median Filter



```
#!/bin/csh

# set plotting parameters

set databox = -R0/48/2/6
set scale = -JX9.0i/6.0i

# scale data from timetags to time (hours)
# input format
# 09+019:00:00:00.0000 2.844
# 09+019:00:06:00.0000 2.815
# 09+019:00:12:00.0000 2.780

cat tide.d* | awk '{hour = substr($1,8,2); minute = substr($1,11,2); second = substr($1,13,2); time = hour+(minute + second/60)/60; if (NR > 1 && time < old_time+0) {addhour += 24;} printf "%.2f %.3f\n",time+addhour,$2; old_time=time;}' > hold.data

# plot unfiltered data

cat hold.data | psxy $databox $scale -W10/125 -Bgl a4:hours:/g l a2:meters::"Seattle Tides CG Dock":WeSn -K > filtered1.ps

# plot median (30 minute or half hour) filtered data

cat hold.data | filter l d -Fm0.5 -E | psxy $databox $scale -W5/125/250/125 -Bgl a2 -K -O >> filtered1.ps

# plot median then Gaussian (30 minute or half hour) filtered data

cat hold.data | filter l d -Fm0.5 -E | filter l d -Fg4 -E | psxy $databox $scale -W5/250/125/250 -Bgl a2 -O >> filtered1.ps

# new plot; plot raw data

cat hold.data | psxy $databox $scale -W10/125 -Bgl a4:hours:/g l a2:meters::"Seattle Tides CG Dock":WeSn -K > filtered2.ps

# plot gaussian (0.5, 1, 2, 4 hour filter lengths).

cat hold.data | filter l d -Fg0.5 -E | psxy $databox $scale -W5/125/250/125 -Bgl a2 -K -O >> filtered2.ps

cat hold.data | filter l d -Fg1 -E | psxy $databox $scale -W5/250/125/125 -Bgl a2 -K -O >> filtered2.ps

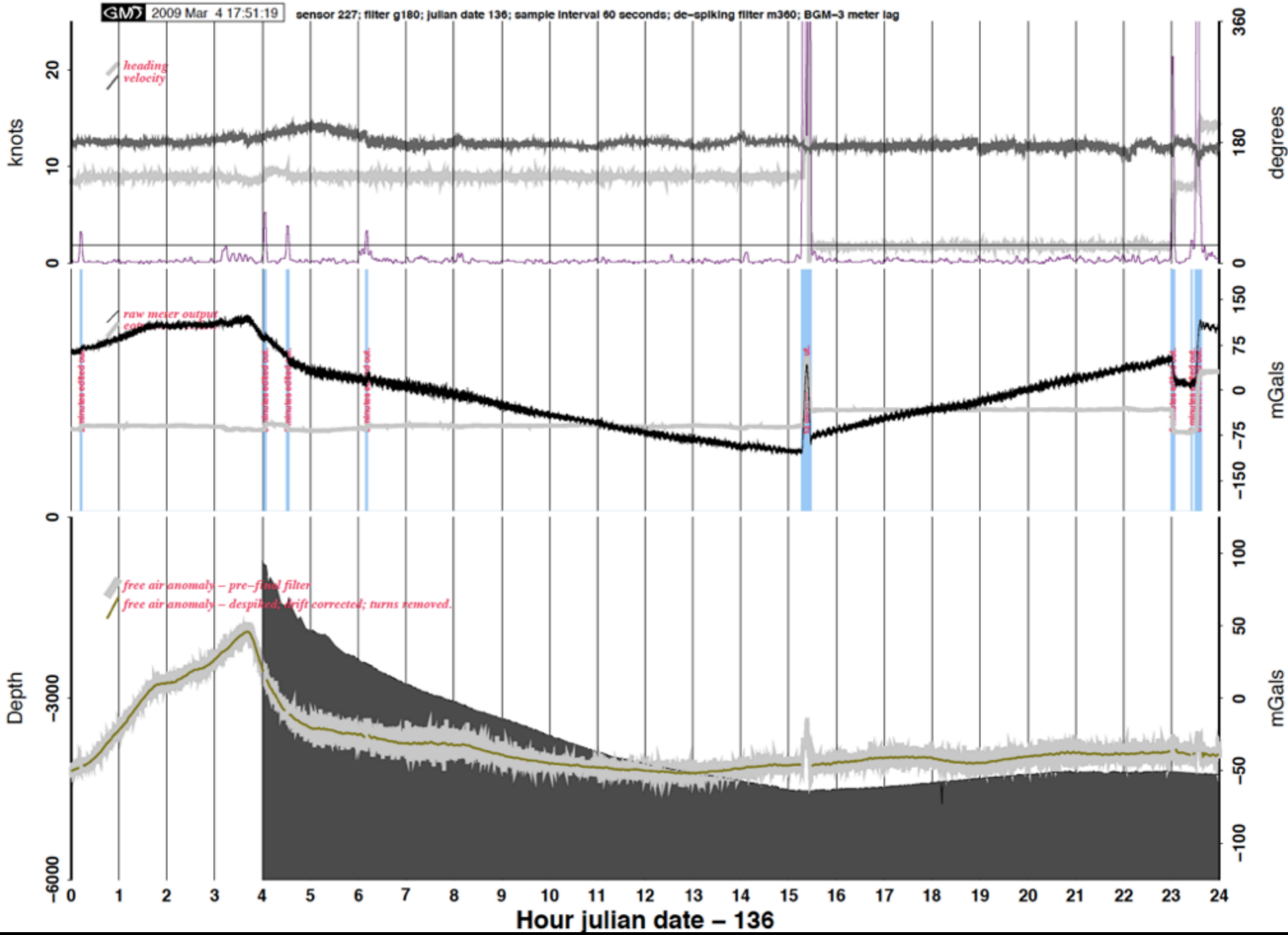
cat hold.data | filter l d -Fg2 -E | psxy $databox $scale -W5/125/125/250 -Bgl a2 -K -O >> filtered2.ps

cat hold.data | filter l d -Fg4 -E | psxy $databox $scale -W5/250/125/250 -Bgl a2 -O >> filtered2.ps
```

Data Processing

Gravity Example

The basic problem is to join a number of data files, containing bathymetry, raw gravity and navigation data, to reduce the gravity values and estimate anomalies along track.



Why Grid?

- Regular “data” spacing
- Easy to contour
- Amenable to quantitative analysis
- A consistent representation

How grid?

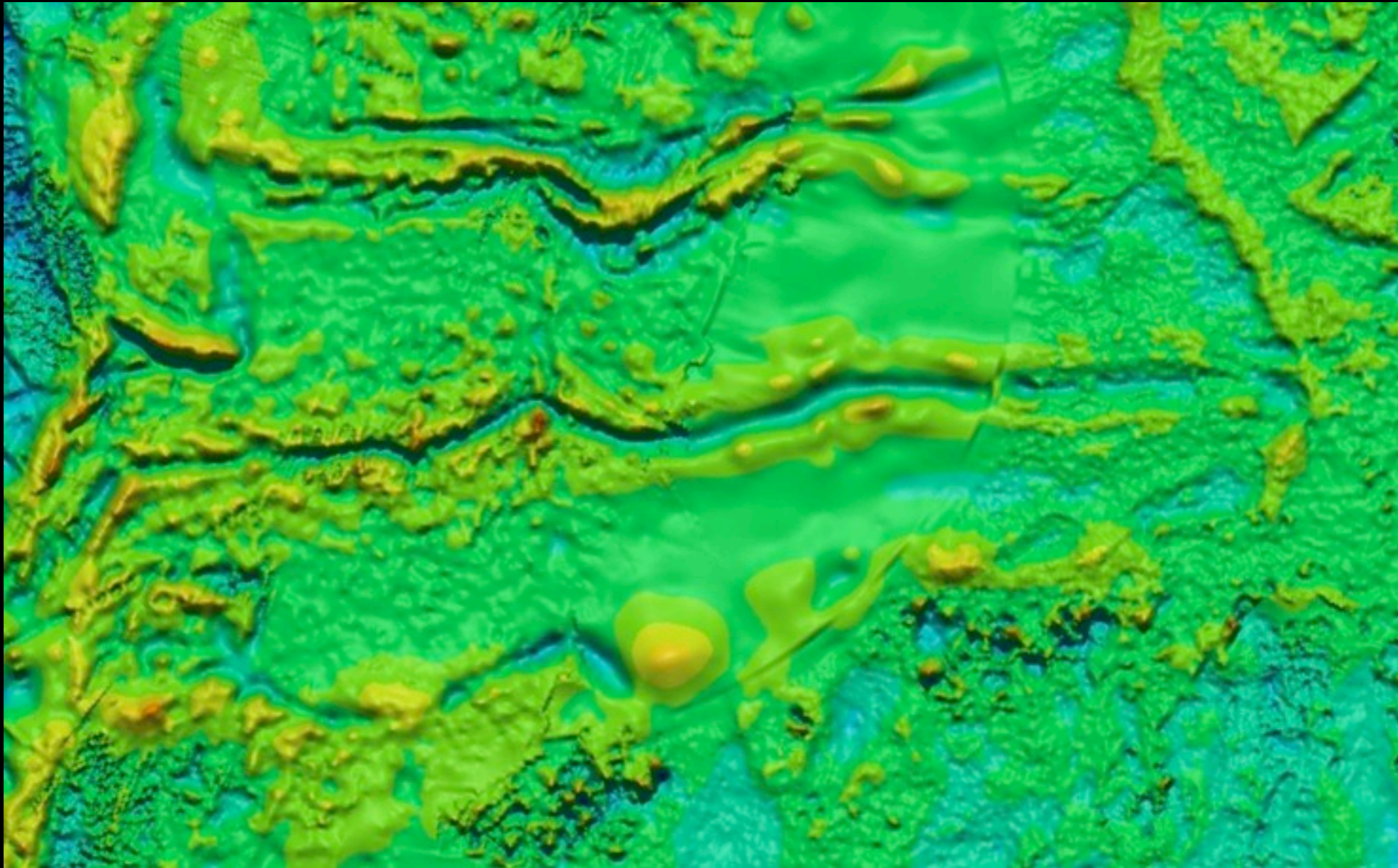
- Combine irregularly sampled data sets from different events
- Ensure same scaling
- Minimize noise
- Recognize grid resolution limits

Problems

- Poor meta-data (scaling issues)
- Crappy data
- Over and under sampling
- Best interpolant?

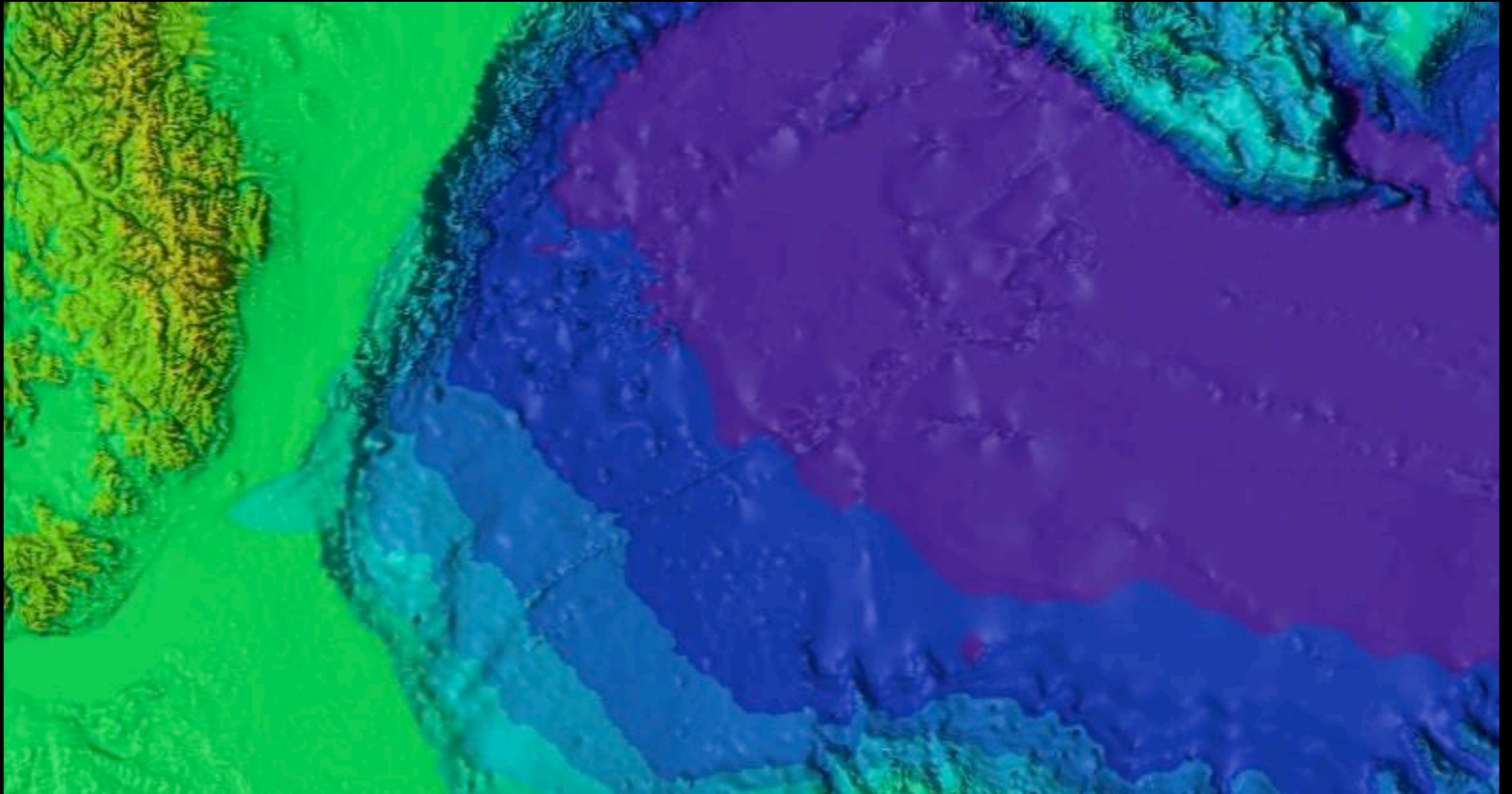
Eurasia Basin

Sampling issues

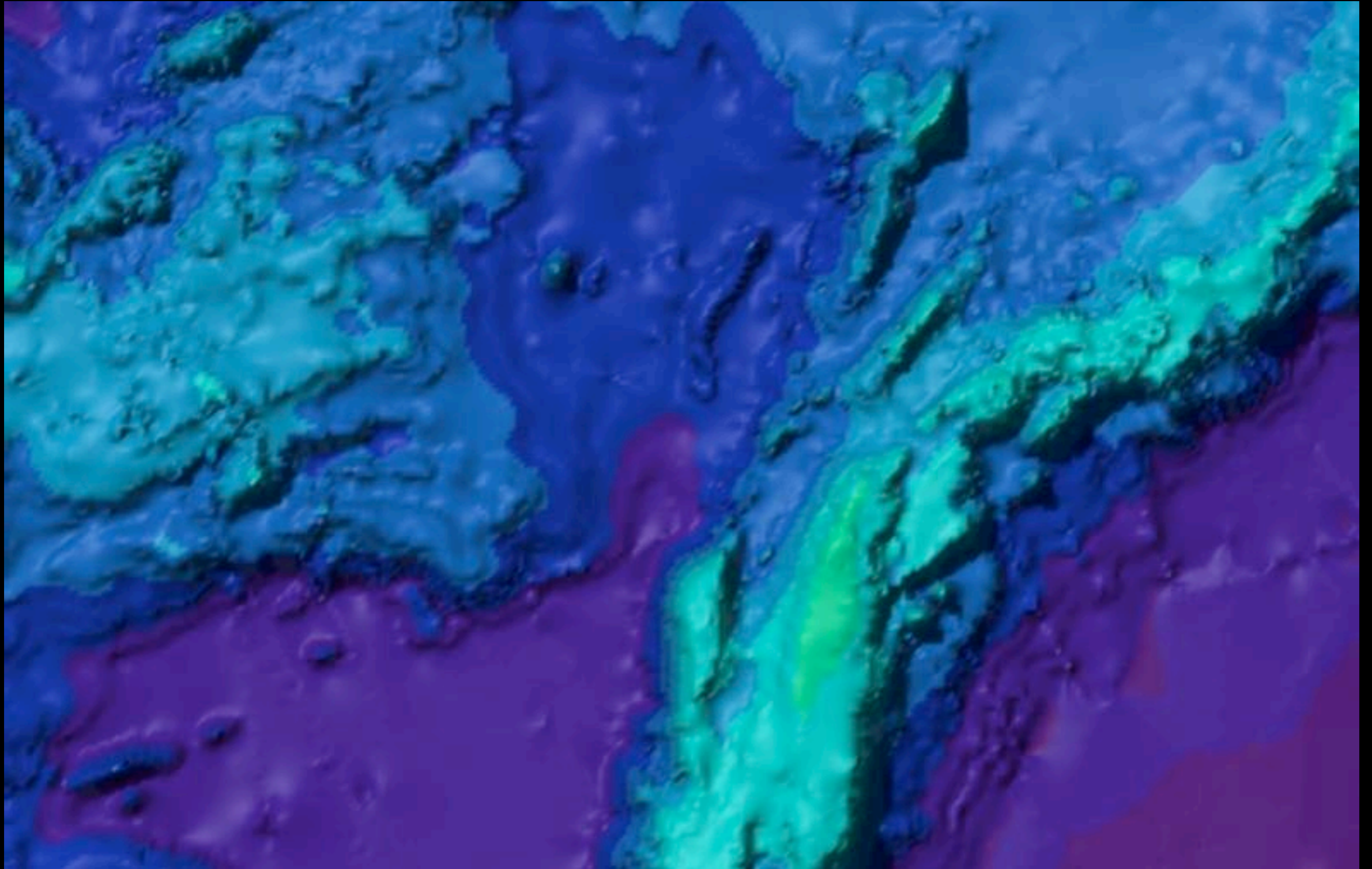


Canada Basin

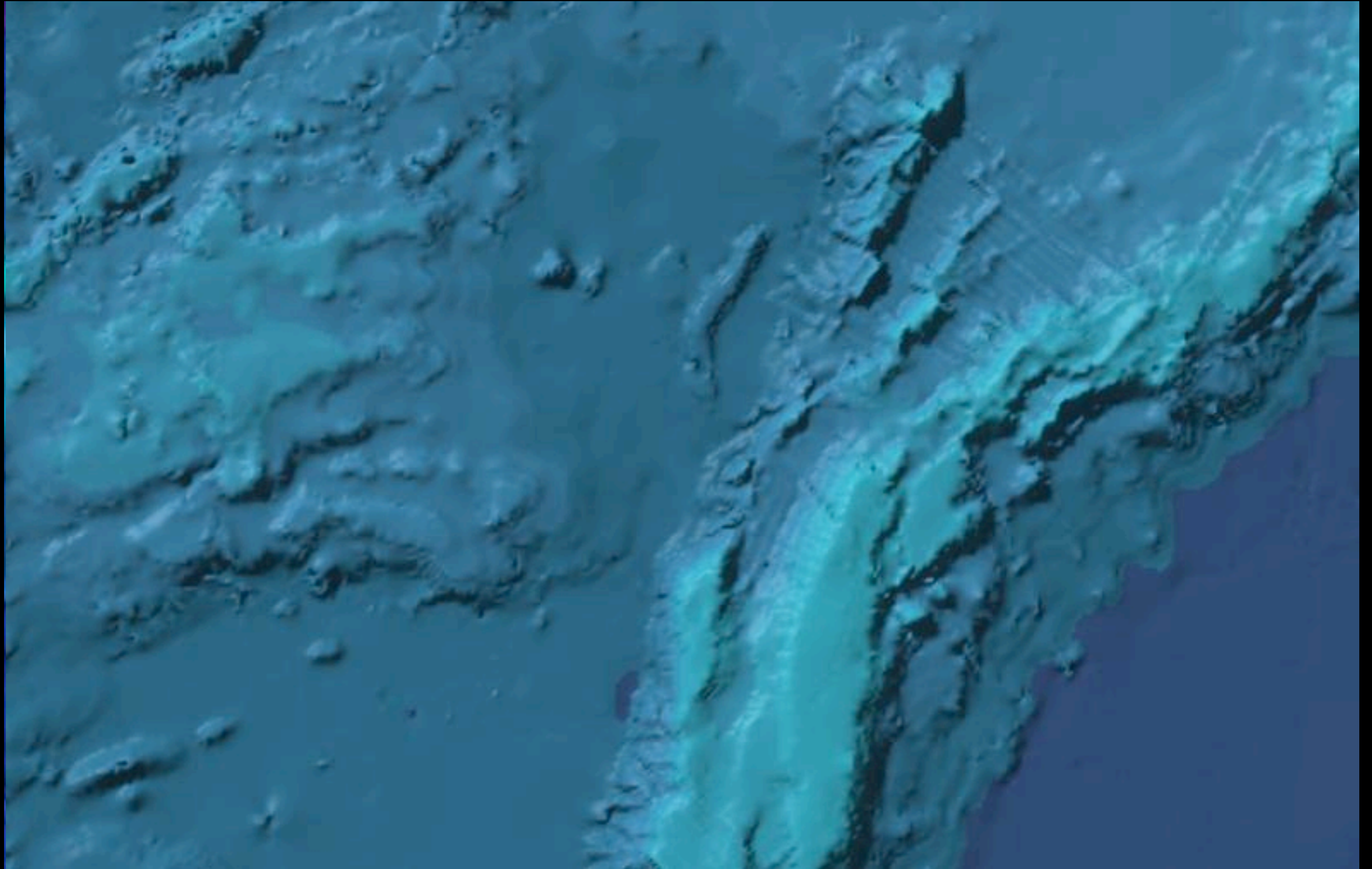
Trackline artifacts



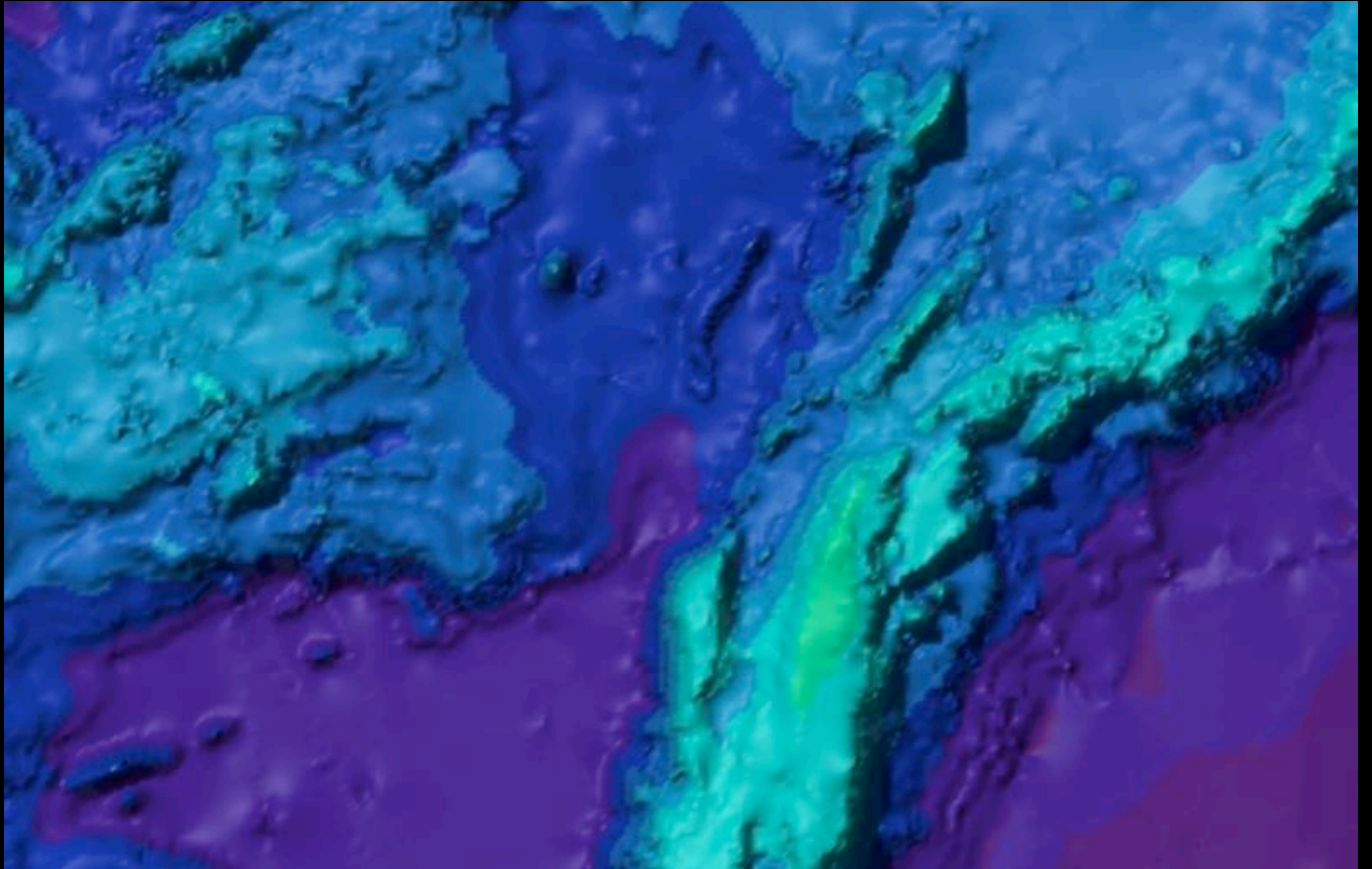
More data better?



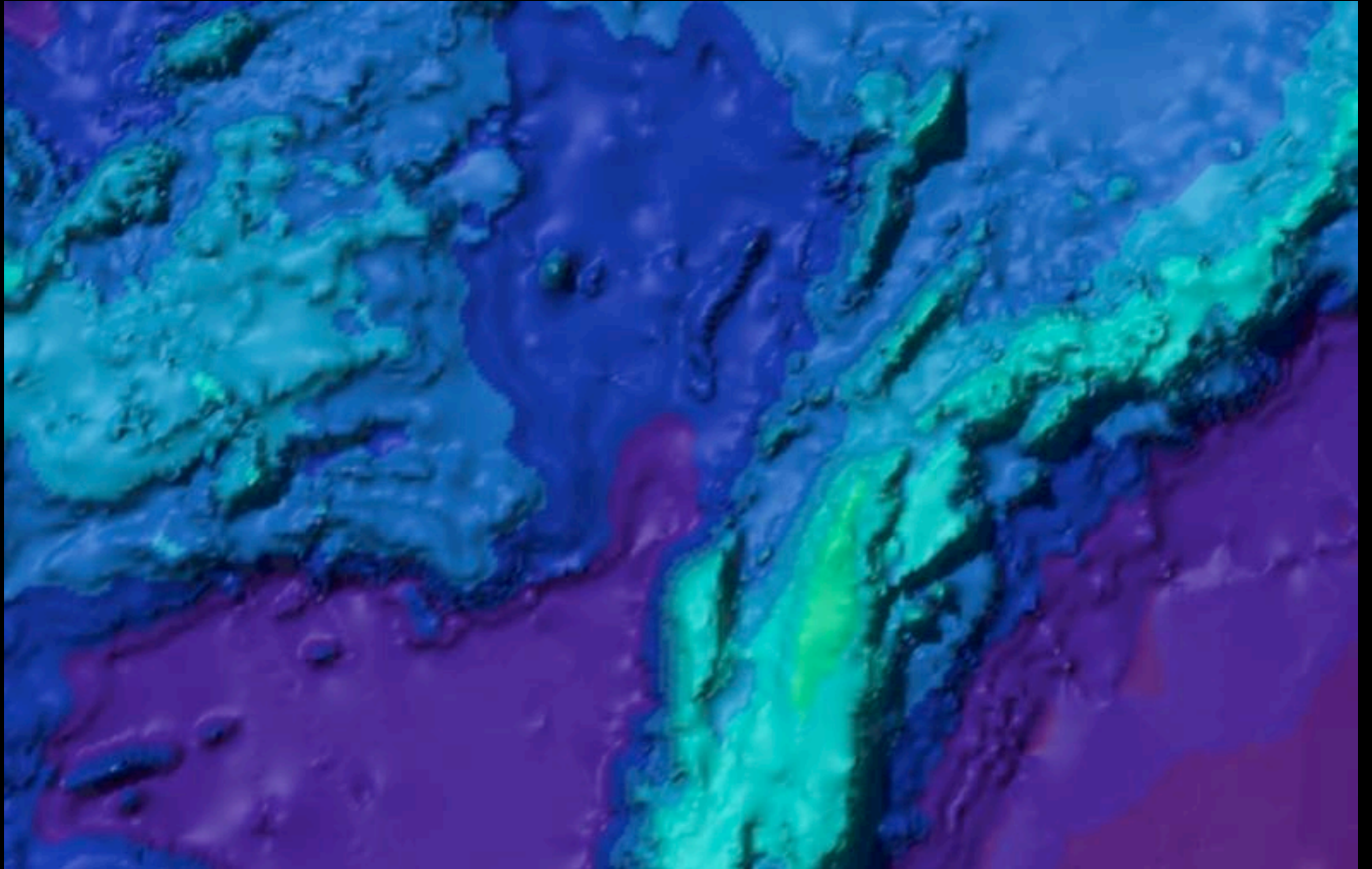
More data better?



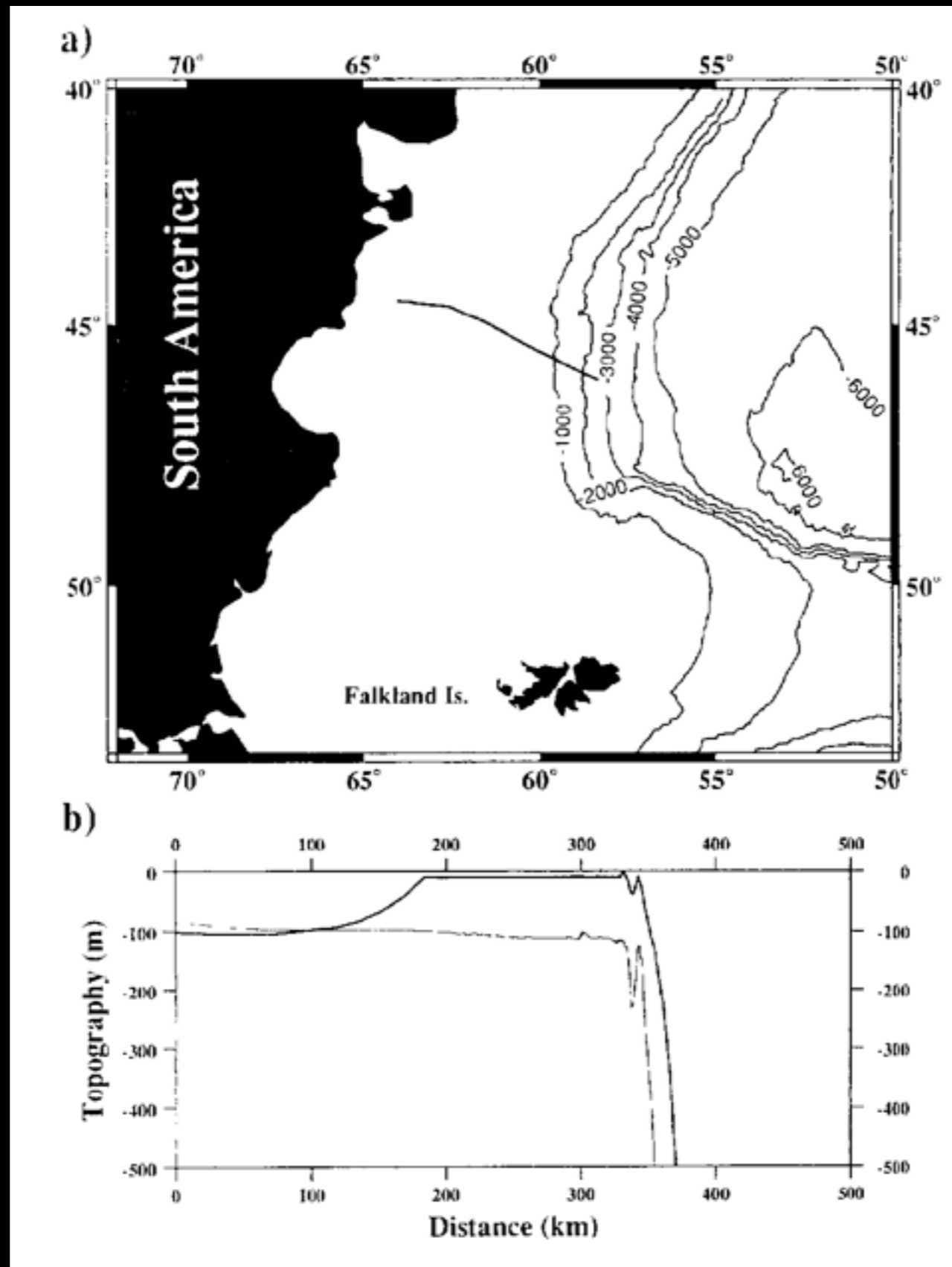
More data better?



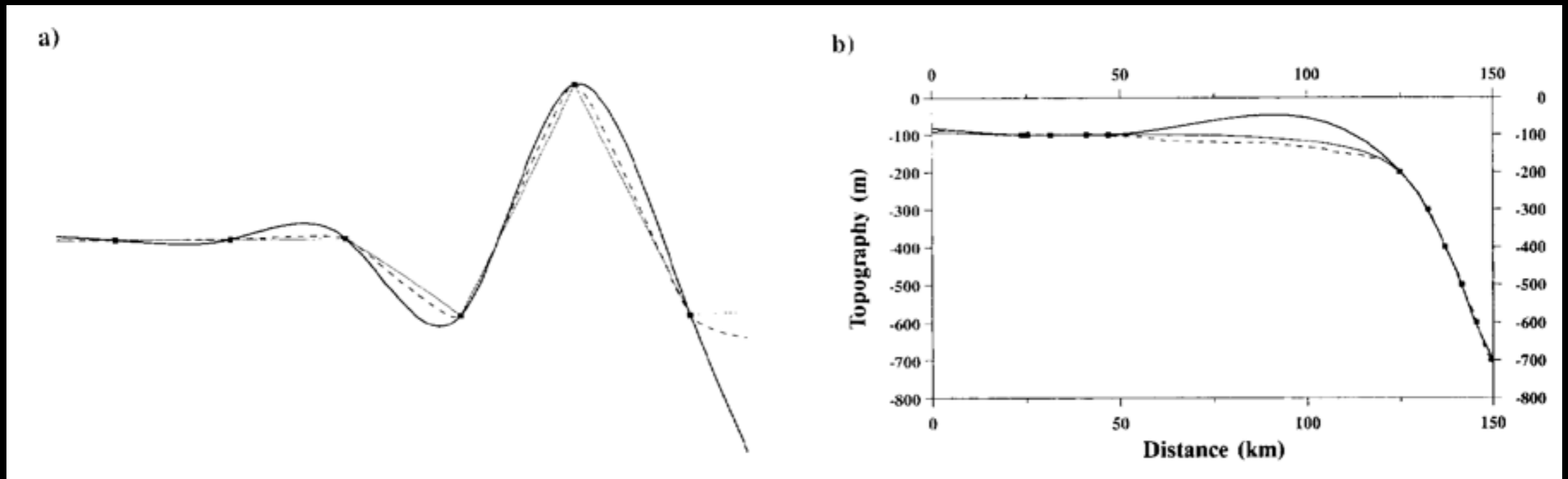
More data better?



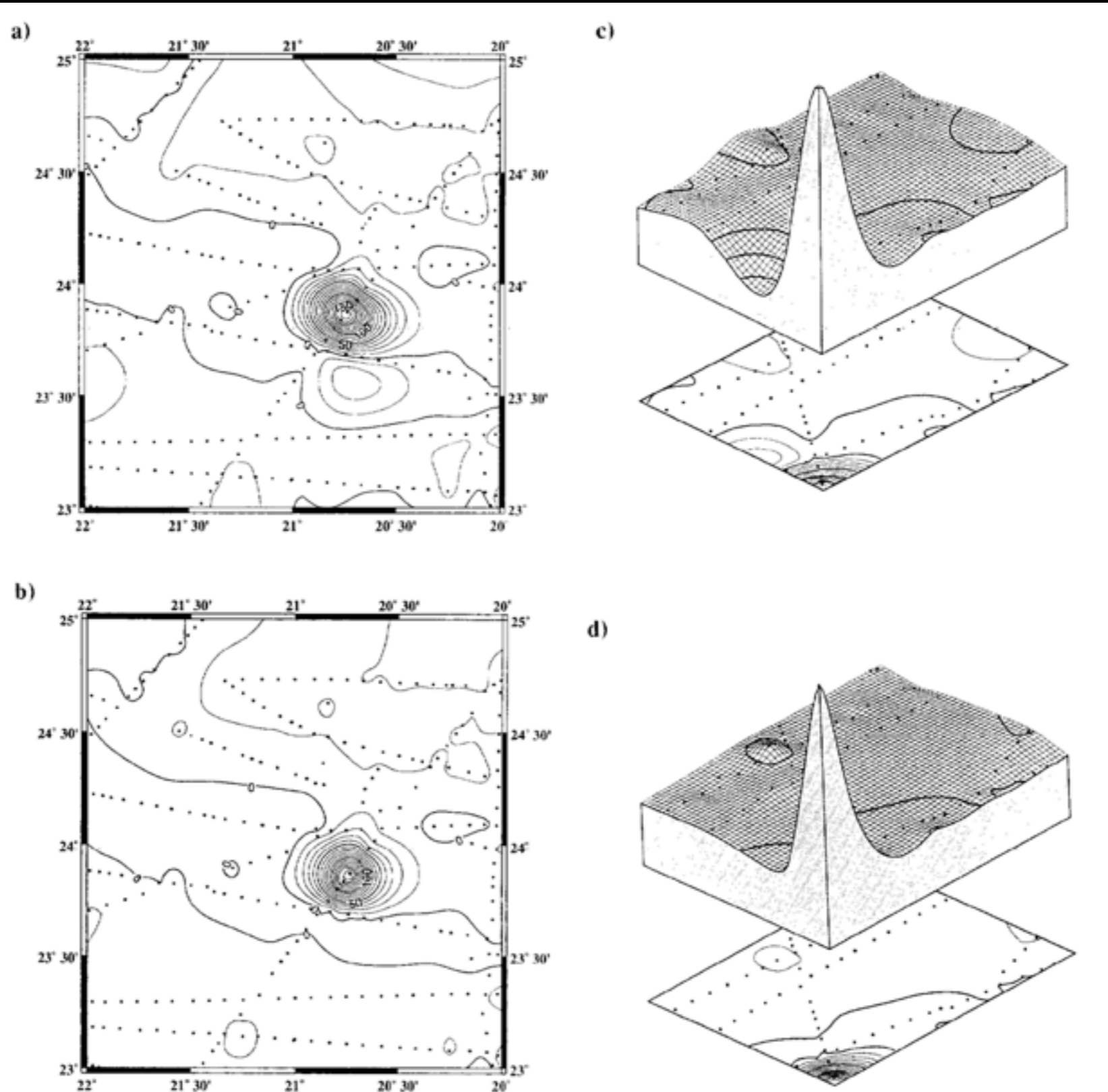
Minimum Curvature vs New Data



I-D Interpolation

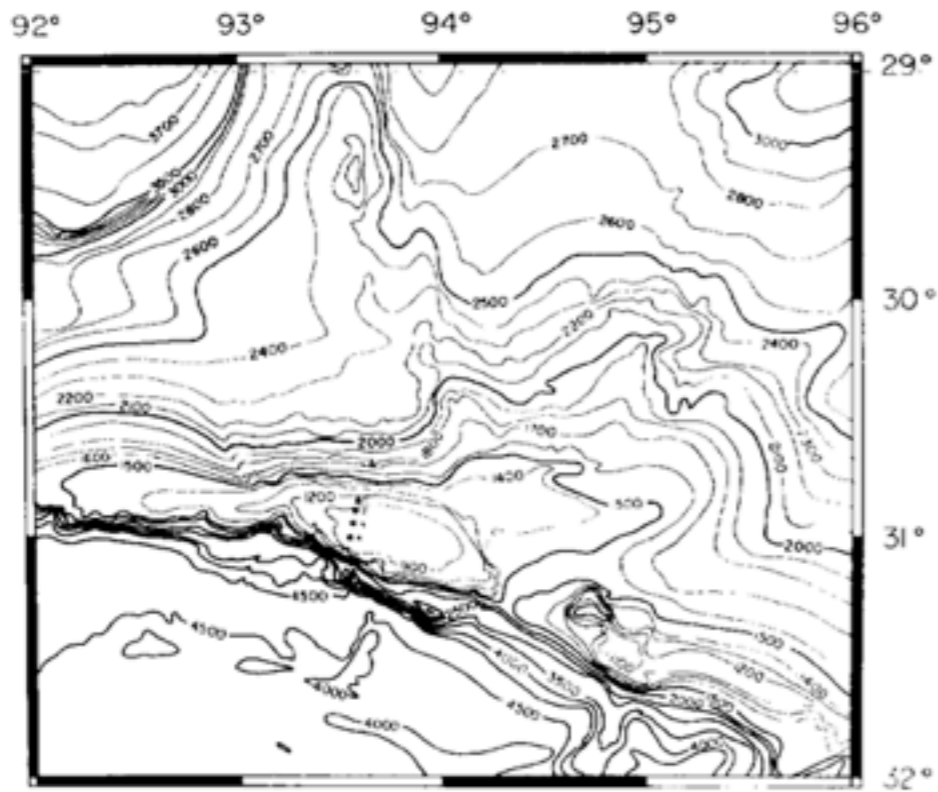


Splines in Tension

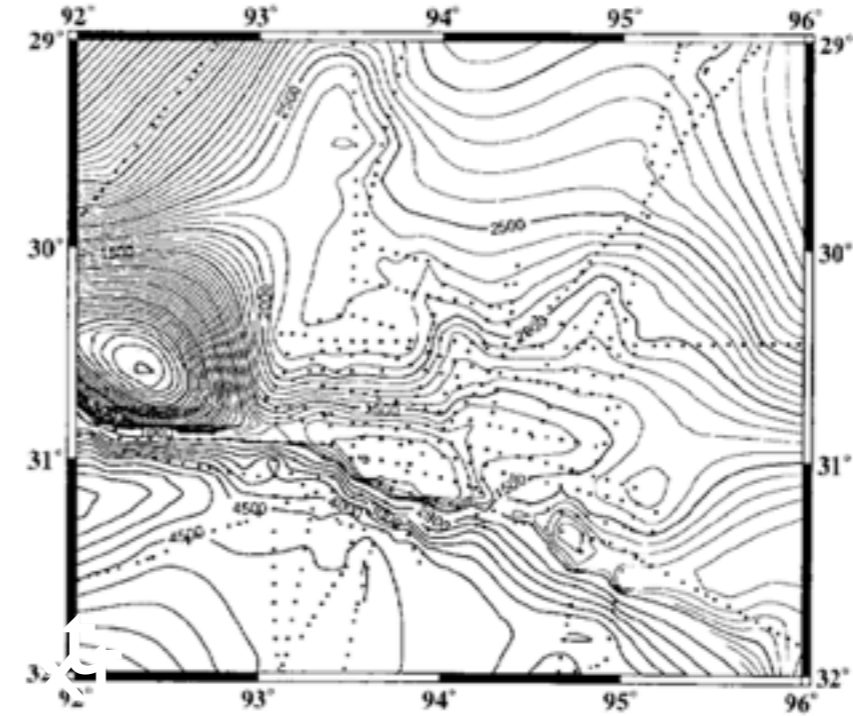


Broken Ridge

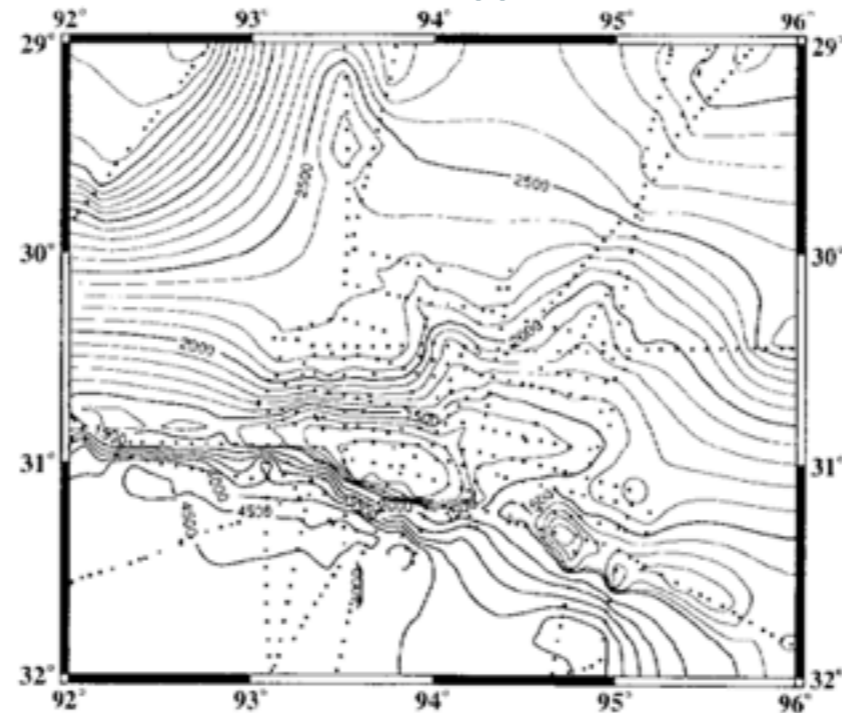
a) Hand Countoured



b) Minimum Curvature



c) Tension Applied



Gridding Programs

- blockmean L2 (x,y,z) data filter/decimator
- blockmedian L1 (x,y,z) data filter/decimator
- blockmode Mode-estimating (x,y,z) data filter/decimator

- greenspline Gridding using Green's function splines
- nearneighbor Nearest-neighbor gridding scheme
- surface Continuous curvature gridding algorithm
- triangulate Perform optimal Delauney triangulation on xyz data

Workflow

- Decide!
- Select data (probably not everything)
- Pre-process data (scaling, get rid of the garbage, NaN)
- Block process it to reduce aliasing
- Grid it (set parameters)
- Plot it

Parameters

- *Surface [xyzfile] -Goutputfile.grd*
- *-Ixinc/yinc*
- *-Rwest/east/south/north[r]*
- *-Cconvergence_limit*
- *-Lllower -Luupper*
- *-Nmax_iterations*
- *-Q*
- *-Ssearch_radius*
- *-Ttension_factor*
- *-Zover-relaxation_factor*

Grid Manipulations

- grd2cpt Make color palette table from grdf file
- grdfilter Filter 2-D data in space domain
- grdsample Resample a 2-D gridded data onto new grid
- grdtrack Sampling of 2-D data along 1-D track

- grdblend Blend several gridded data sets into one
- grdclip Limit the z-range in gridded data sets
- grdedit Modify grd header information
- grdffft Operate on grdf files in frequency domain
- grdgradient Compute directional gradient from grdf files
- grdhisteq Histogram equalization for grdf files
- grdlandmask Creates mask grdf file from coastline database
- grdmask Set nodes outside a clip path to a constant
- grdmath Reverse Polish calculator for grdf files

NETCDF Grids

(**Network Common Data Form**)

a set of software libraries and self-describing, machine-independent data formats

supports the creation, access, and sharing of array-oriented scientific data.

Characteristics

- Data should be self-describing, without external tables needed for interpretation.
- Conventions should be developed only as needed, rather than anticipating possible needs.
- Conventions should not be onerous to use for either data-writers or data-readers.
- Metadata should be readable by humans as well as interpretable by programs.
- Redundancy should be avoided to prevent inconsistencies when writing data
- Data provenance: title, institution, contact, source (e.g. model), history (audit trail of operations), references, comment
- Description of associated activity: project, experiment
- Description of data: units, standard_name, long_name, auxiliary_variables, missing_value, valid_range, flag_values, flag_meanings
- Description of coordinates: coordinates, bounds, grid_mapping (with formula_terms); time specified with reference_time ("time since T0") and calendar attributes.
- Meaning of grid cells: cell_methods, cell_measures, and climatological statistics.

Other grid functions

- [gmt2rgb](#) Convert Sun raster or grdf file to red, green, blue component grids
- [gmtconvert](#) Convert table data from one format to another
- [gmtmath](#) Reverse Polish calculator for table data
- [gmtselect](#) Select table subsets based on multiple spatial criteria
- [grd2xyz](#) Convert 2-D gridded data to table
- [grdcut](#) Cut a sub-region from a grd file
- [grdpaste](#) Paste together grdf files along common edge
- [grdreformat](#) Convert from one grdf format to another
- [splitxyz](#) Split xyz files into several segments
- [xyz2grd](#) Convert table to 2-D grd file