Gridding heterogeneous bathymetric data with stacked continuous curvature splines in tension

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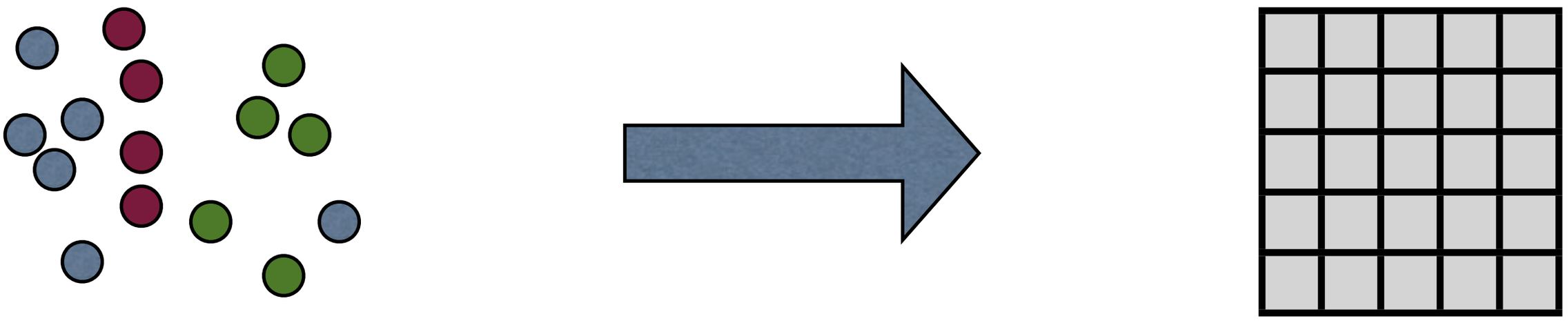
Outline

- Gridding bathymetry
- Problems and challenges
- Stacking spline interpolated surfaces
- Results

Gridding

- Many applications profit from data on regular lattice
- Most soundings acquired irregularly distributed in 2D space
- "Gridding": **Interpolation** and **subsampling** of irregular source data onto a regular lattice



Gridding bathymetry

- Large amounts of source data points (IBCAO: 7 mio; SRTM_30Plus: 300 mio)
- Heterogeneous data quality
- Source data density varying over several orders of magnitude.
- Interpolation of course data on “fine” grid
- Subsampling of dense data on “coarse” grid
- Hard to determine optimal grid resolution

Common methods

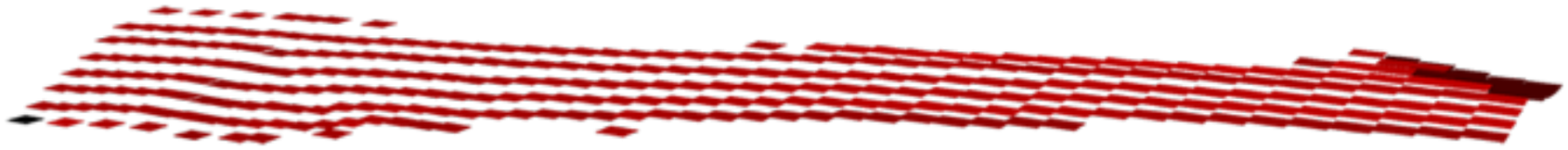
- Weighted averaging
- Nearest neighbor interpolation
- Triangulated irregular networks
- Geostatistics / Kriging
- **(Bi)cubic spline interpolation** (after block median filter); Smith & Wessel (1990); GEBCO, IBCAO, ...
- etc.

Bicubic splines (in tension)

- Minimize total squared curvature of surface
- Tension
- Problems

- Artifacts in areas with coarse data and large data gaps (tracklines), if gridding
- Resolution balancing details and artifacts
- Nature does not minimize curvature
- Are areas naturally smooth or because of lacking data?

Stacking spline surfaces



Idea:

Which areas may reasonably be gridded at a certain resolution?

Stacking spline surfaces

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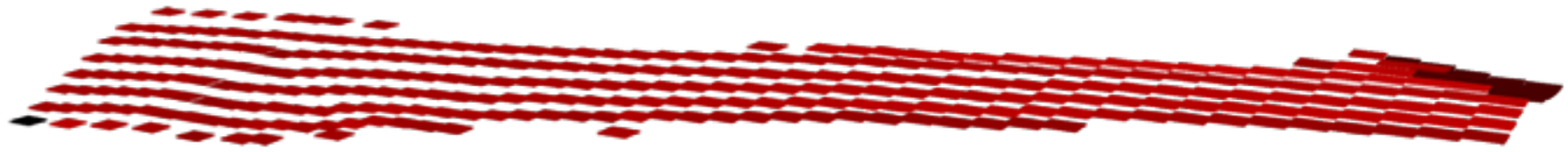
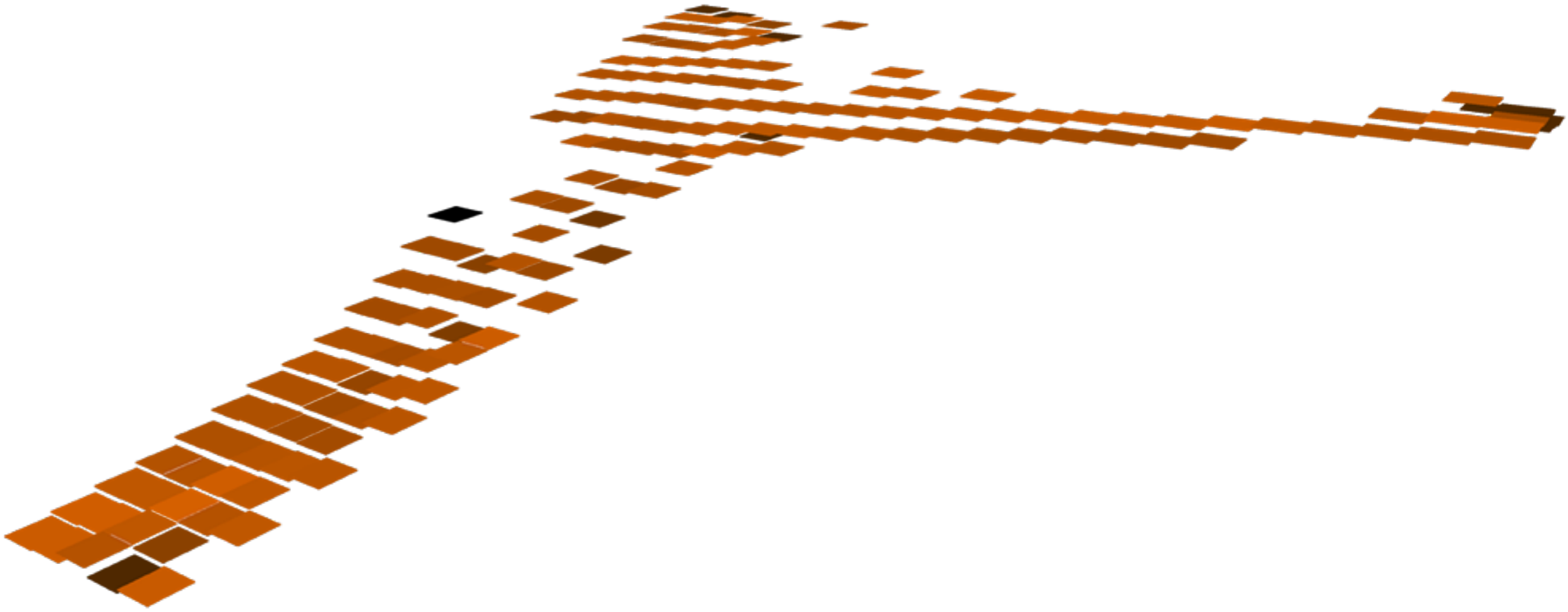
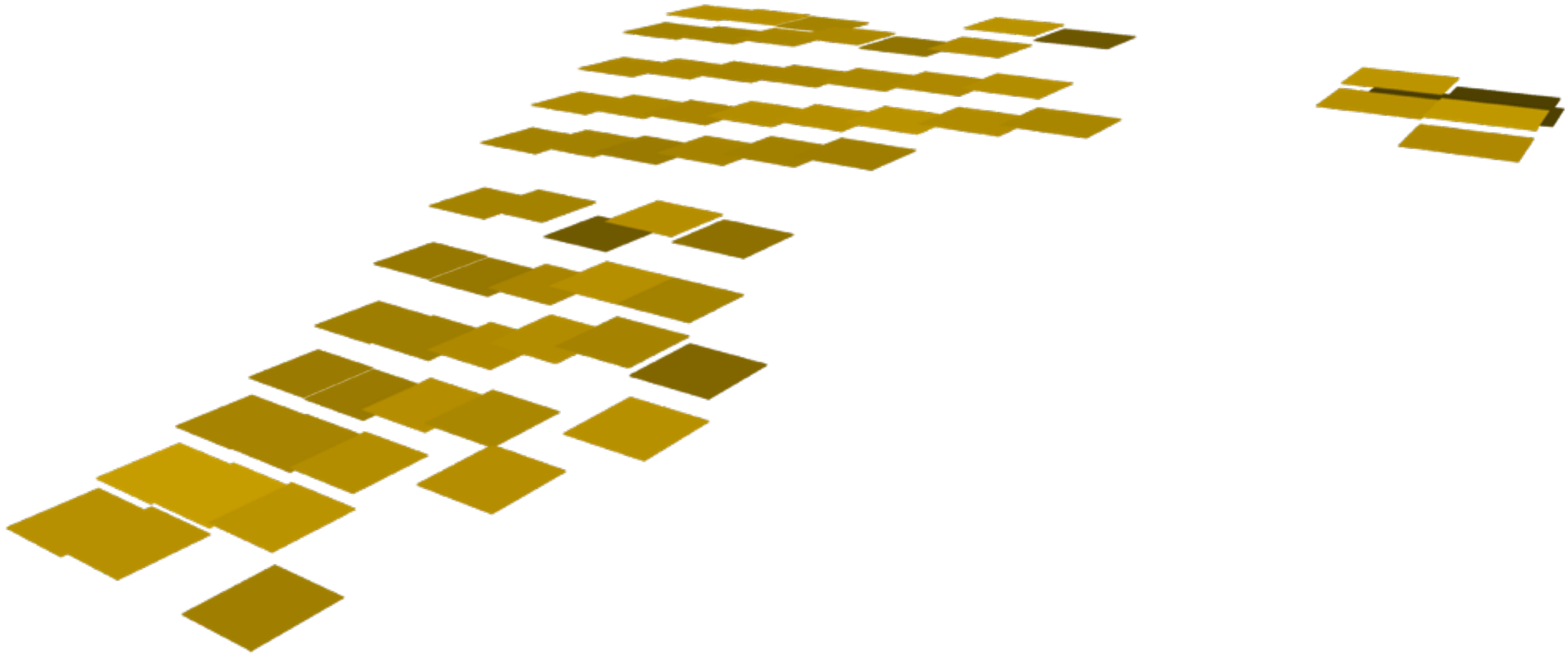


Stacking spline surfaces



Stacking spline surfaces



Stacking spline surfaces

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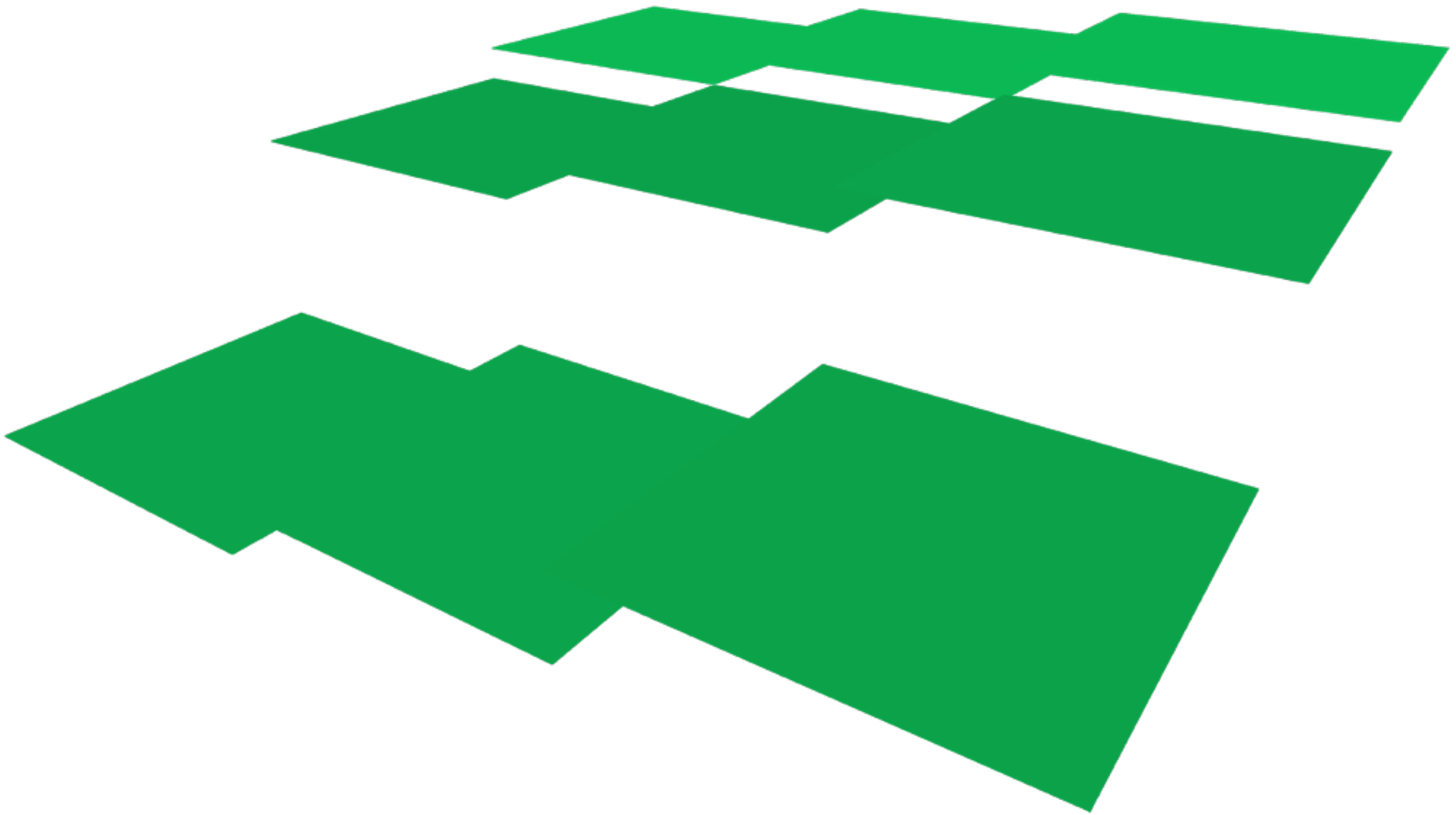
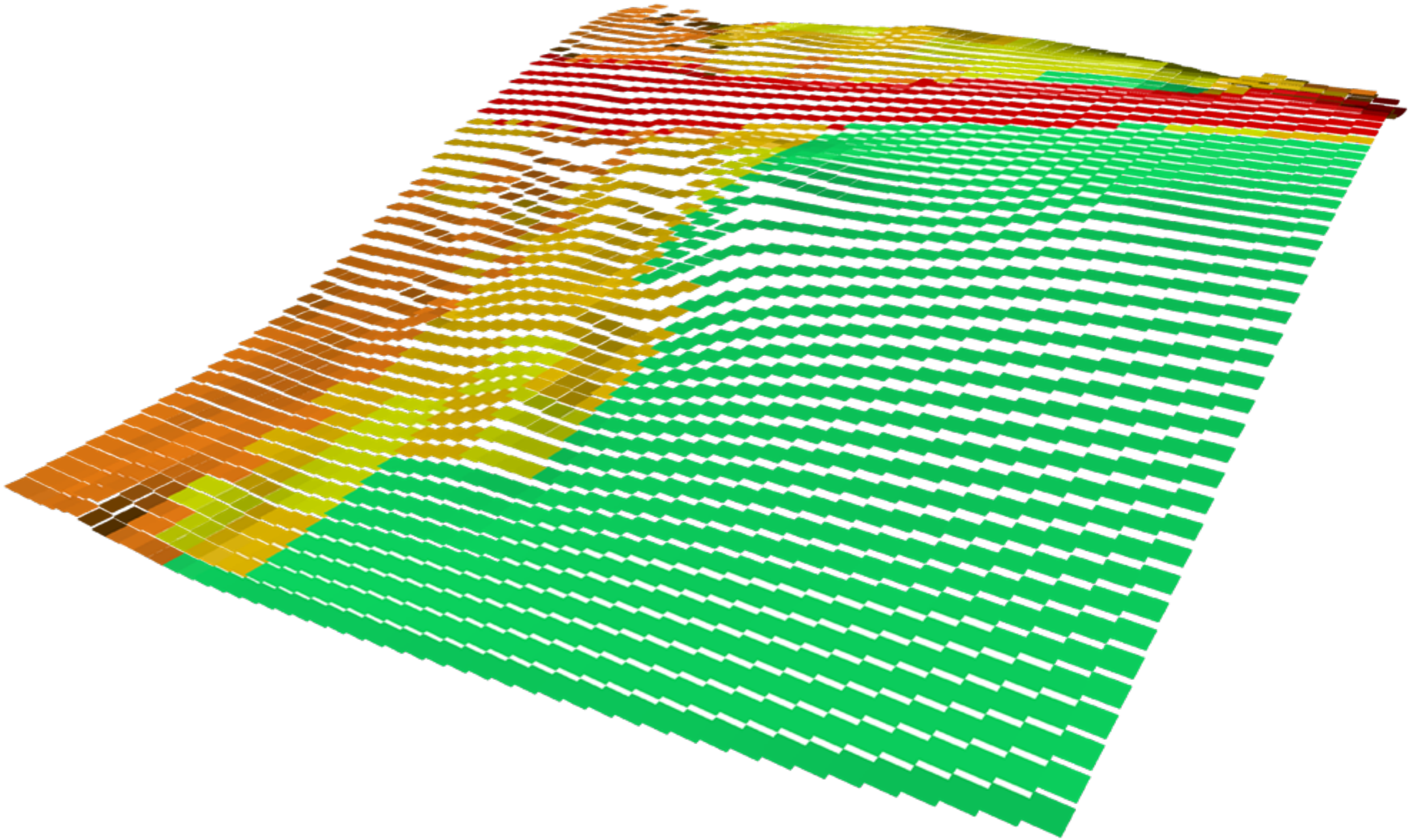


Stacking spline surfaces

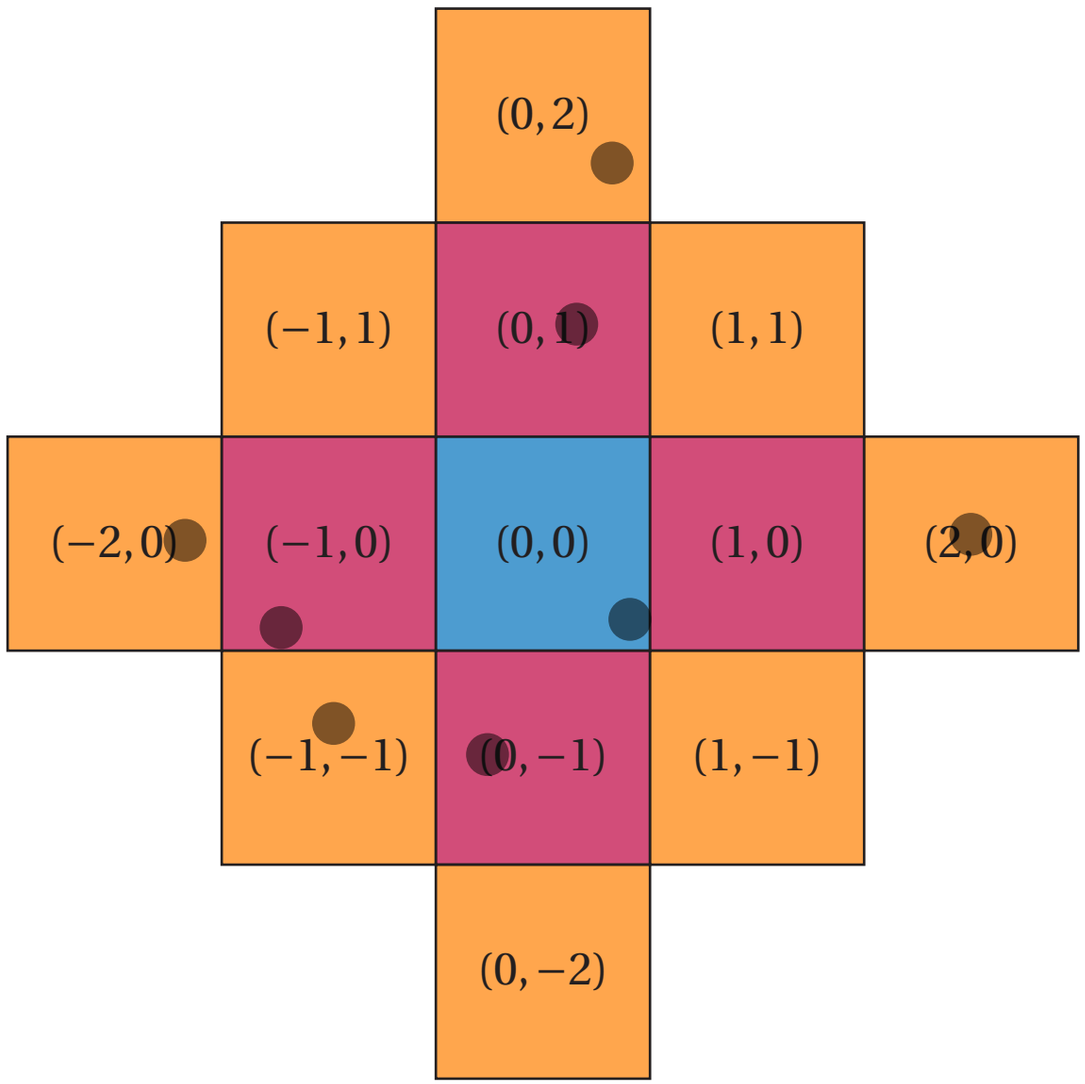


Implementation

- GMT (Generic Mapping Tools)
- `blockmedian`
- `surface` (masking functionality added)
- `grdstack` (this one is new)
- GMT is open source, our code too.

surface masking

`surface -M<N1>/<N2>/<N3> ...`



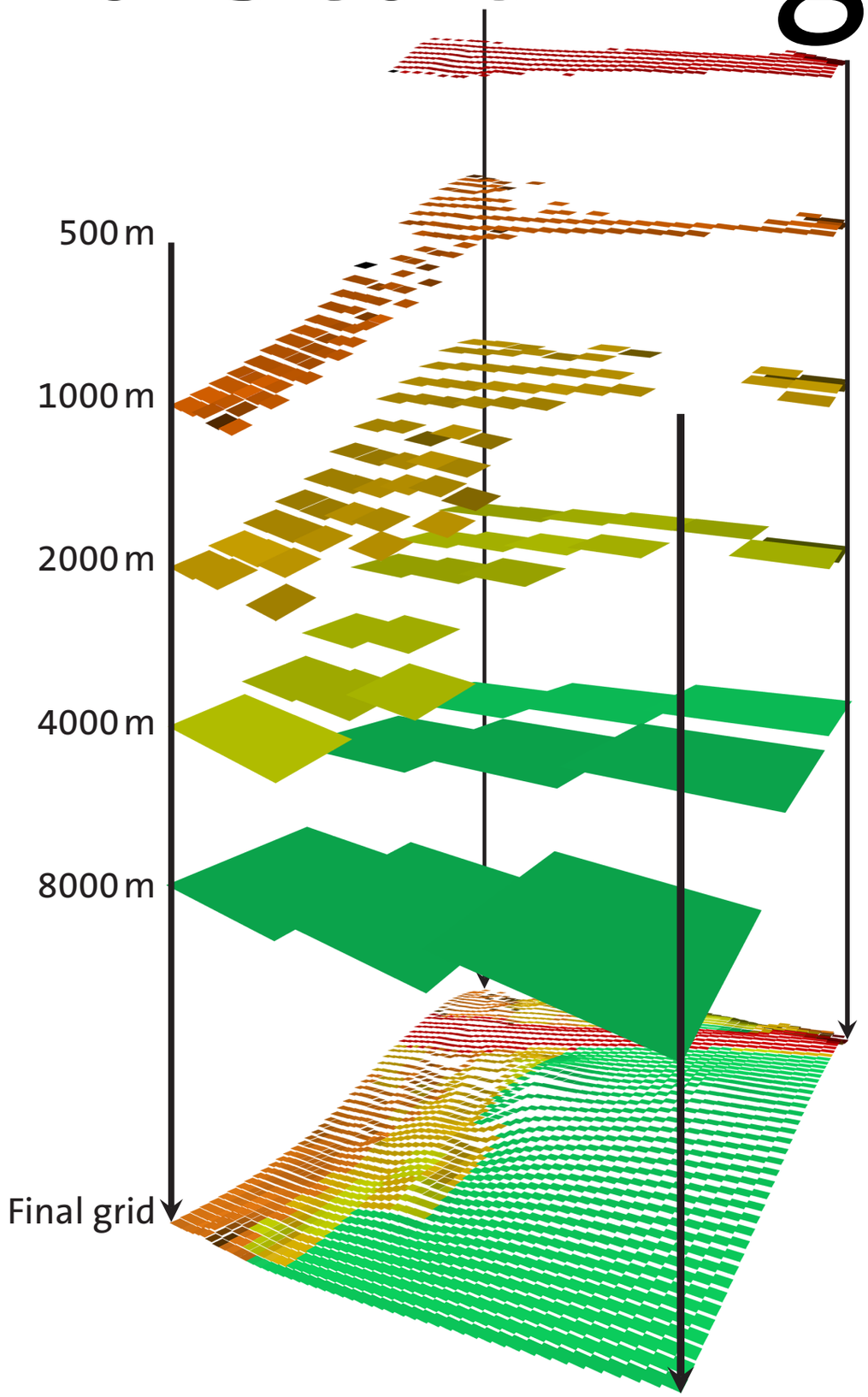
$N_1 \in \{0,1\}$

$N_2 \in \{0,1,\ldots,4\}$

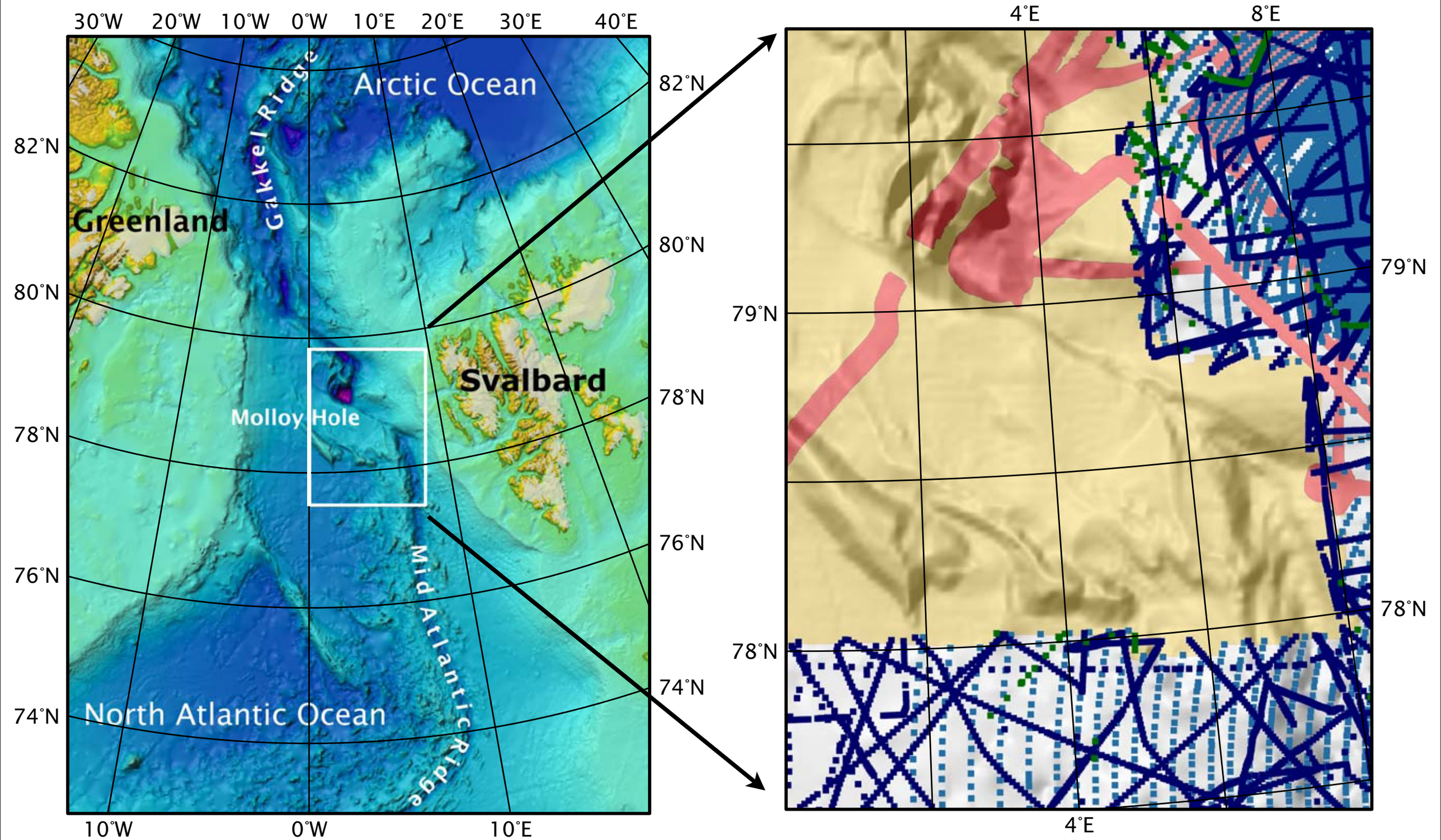
$N_3 \in \{0,1,\ldots,8\}$

`grdstack` grid stacking

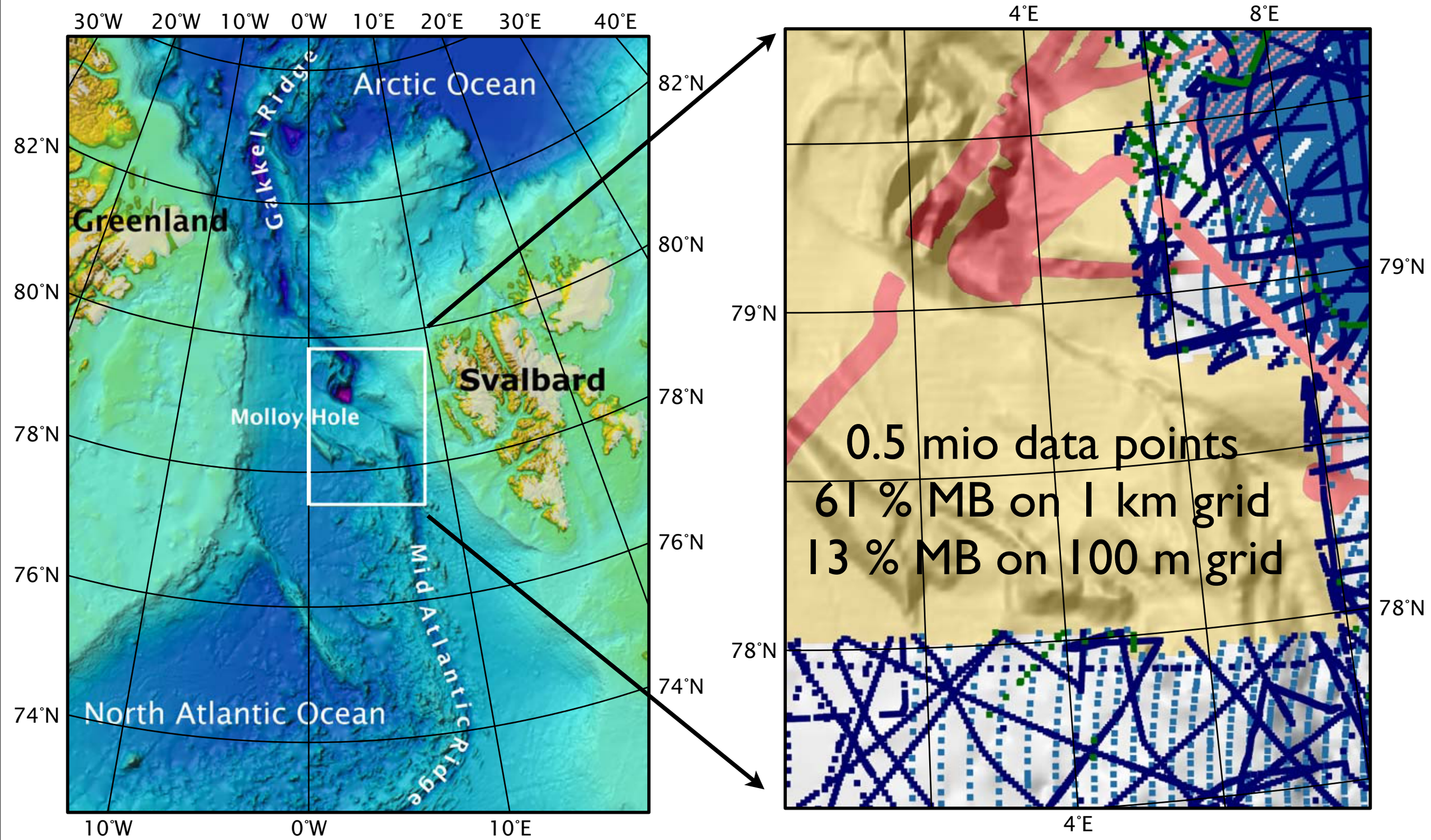
- Stack all grids
- Higher resolution nodes overrule lower resolution ones
- Optionally re-grid the (irregular) nodes onto a constant cell size grid



Data example



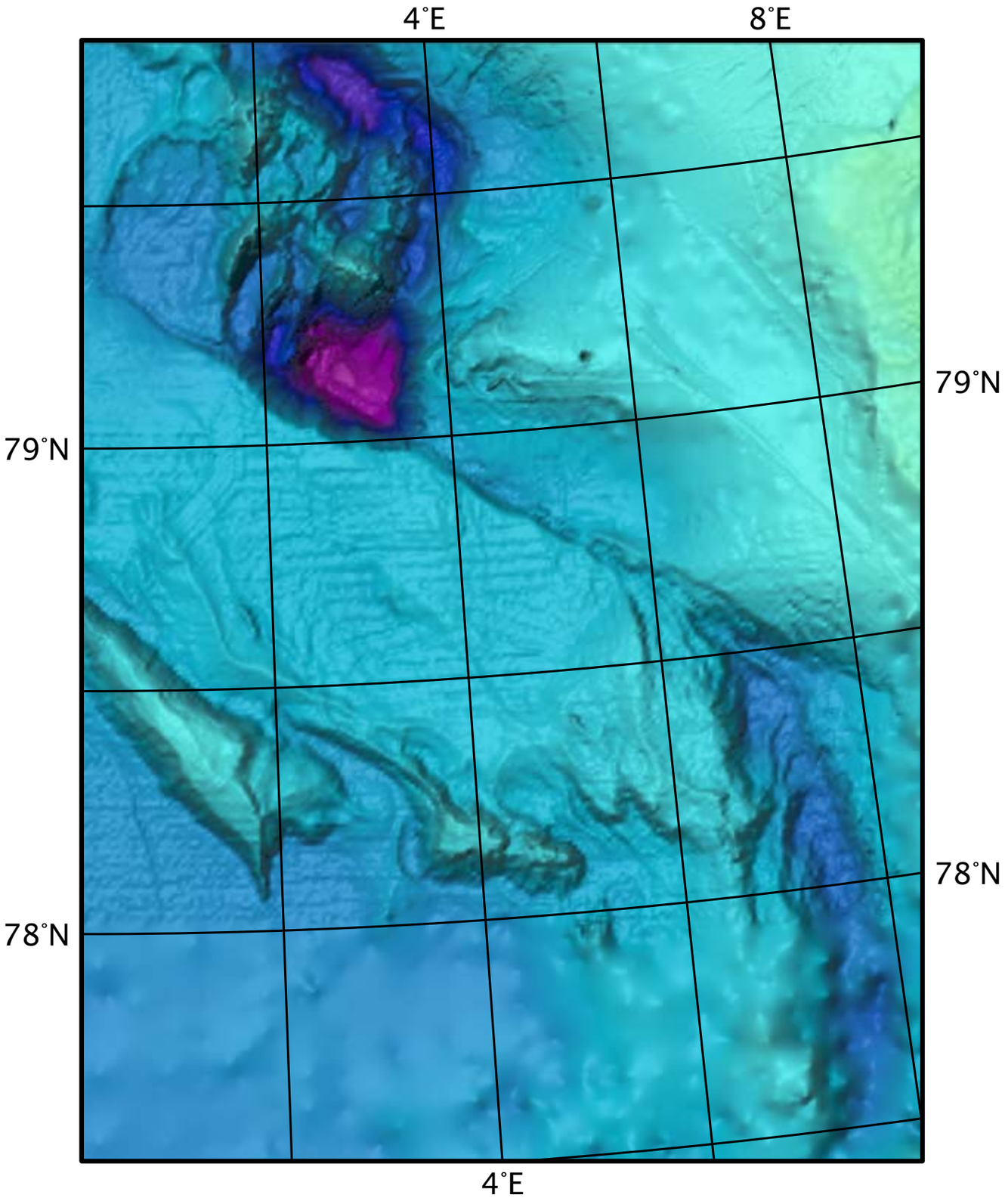
Data example



Comparison

- Stacked splines in tension: 500 m
- Remove-restore grid (“SRTM_30+”): 500m
- Cont. curvature splines (“IBCAO style”): 1000 m

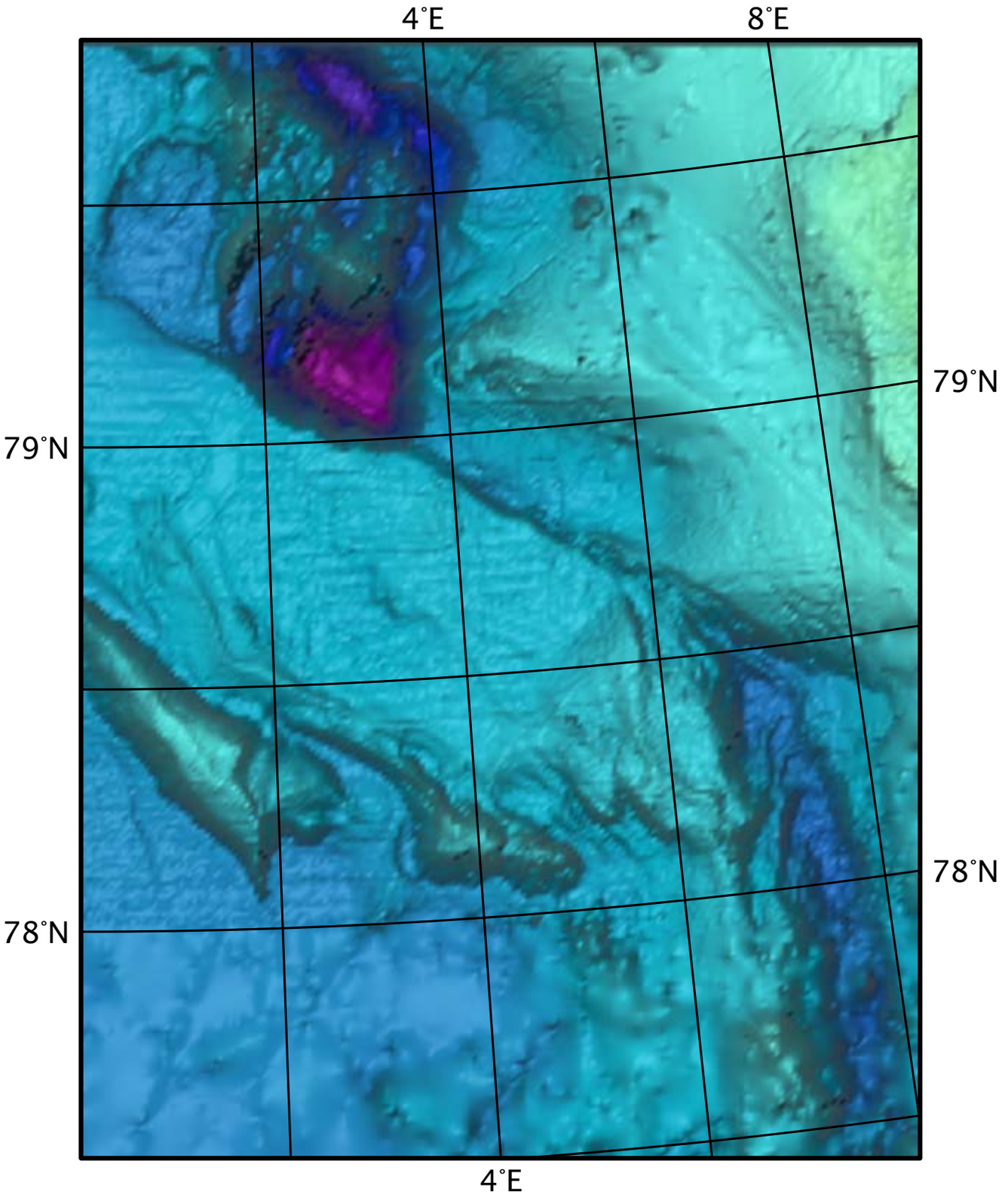
Overview



Stacked splines

Overview

Overview



Splines in tension

Overview

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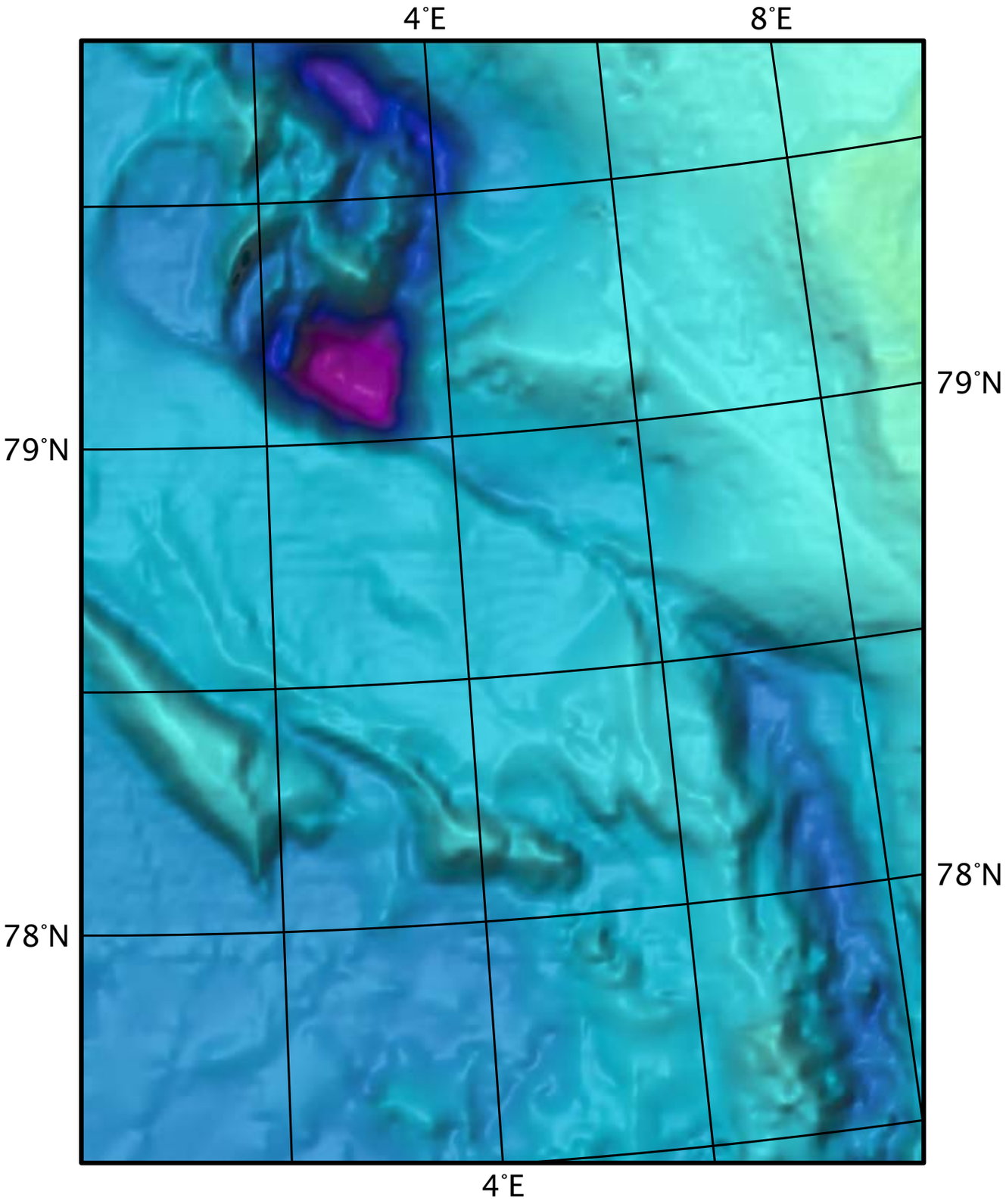
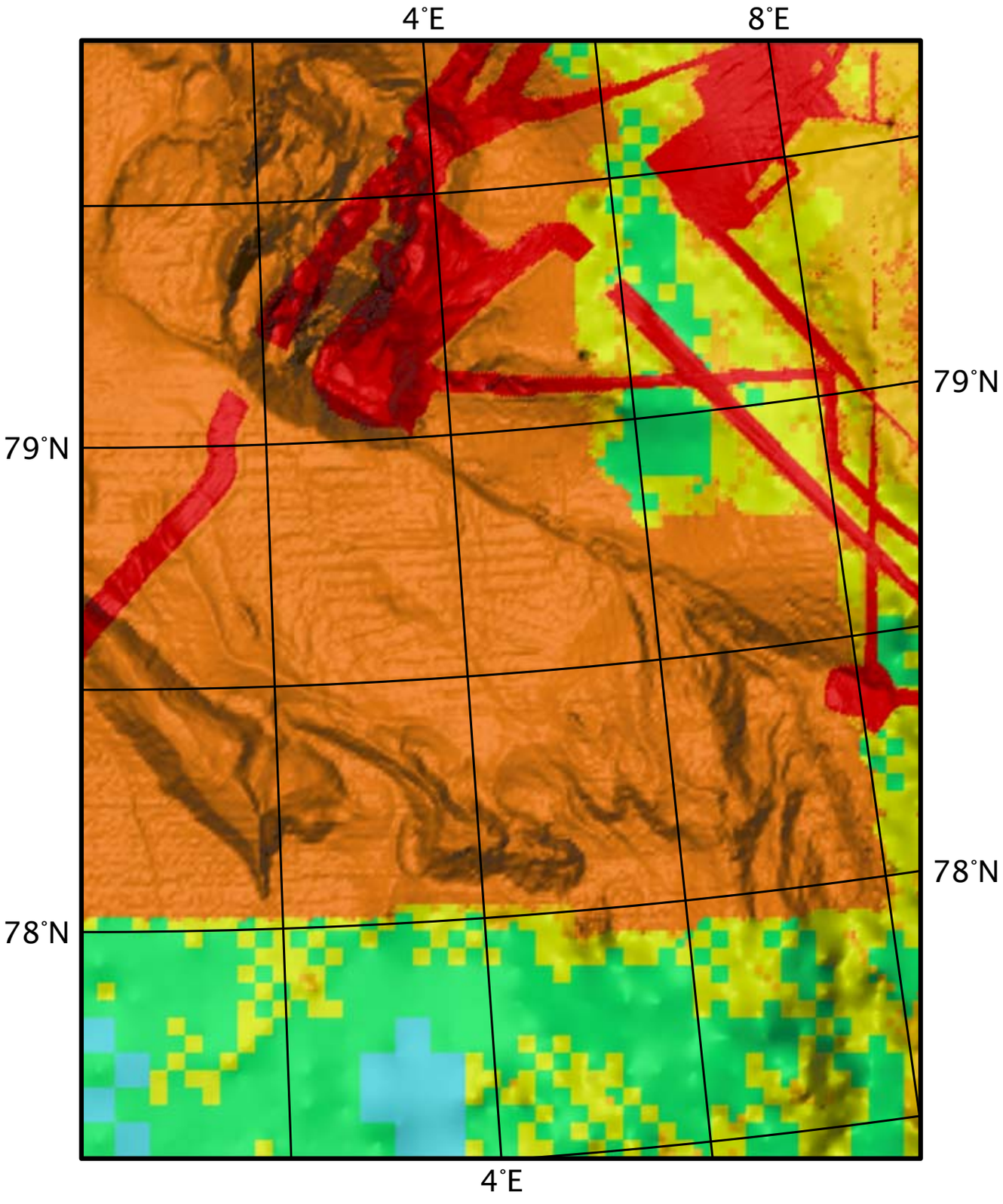


Remove-restore

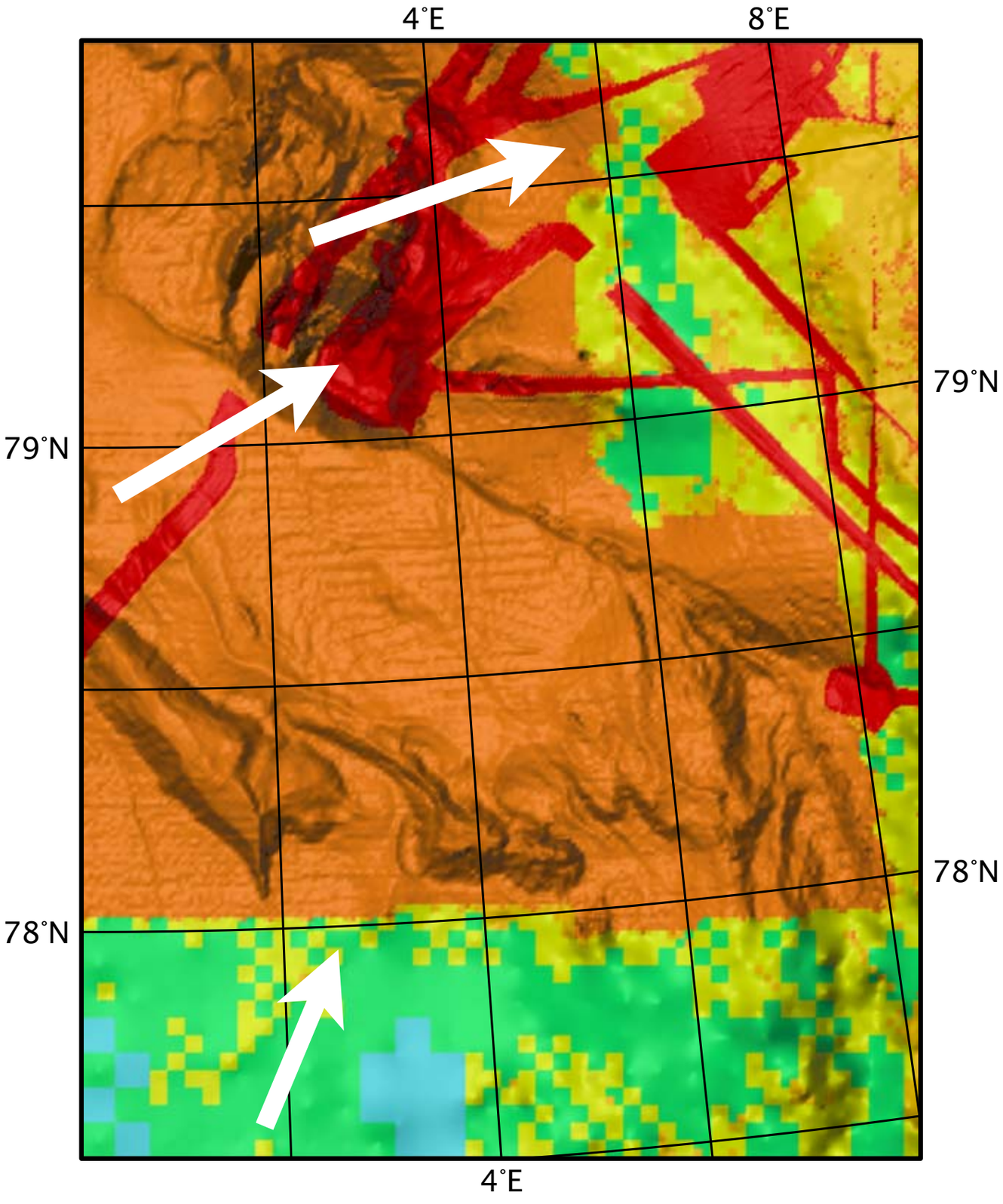
Overview

Overview



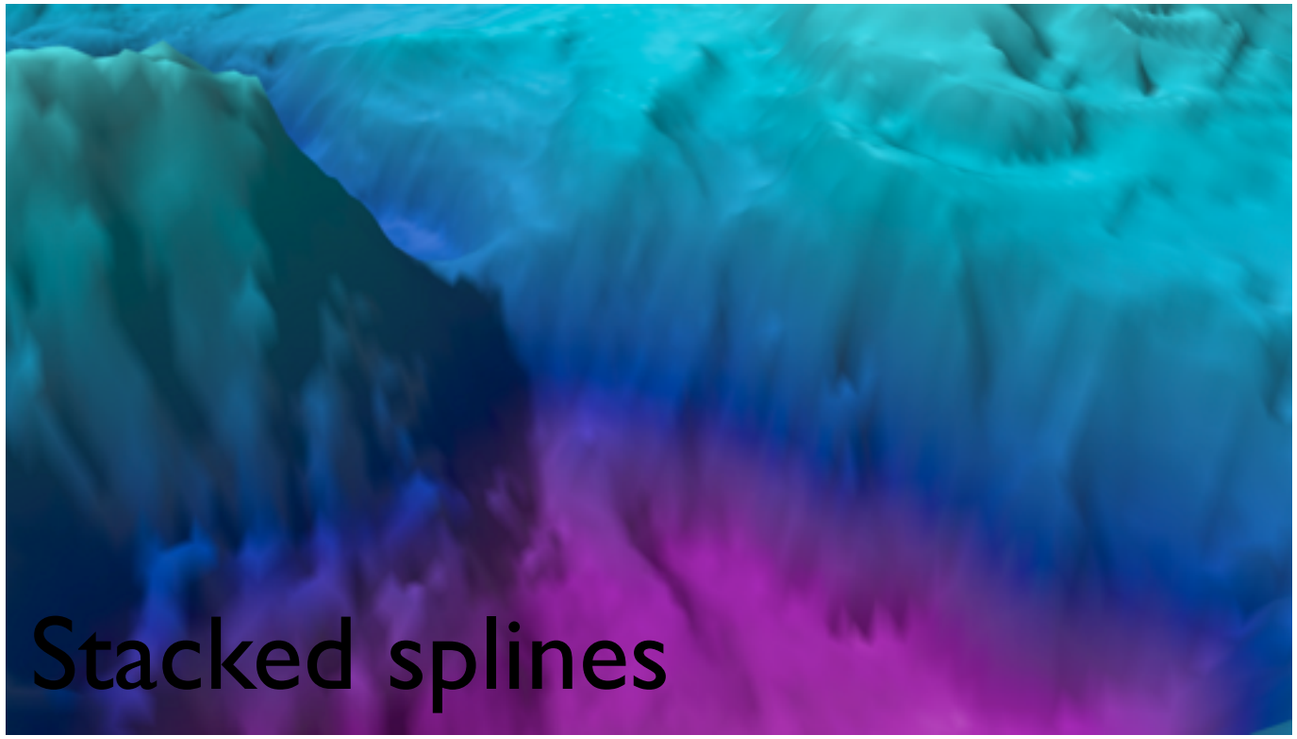
Resolution factor

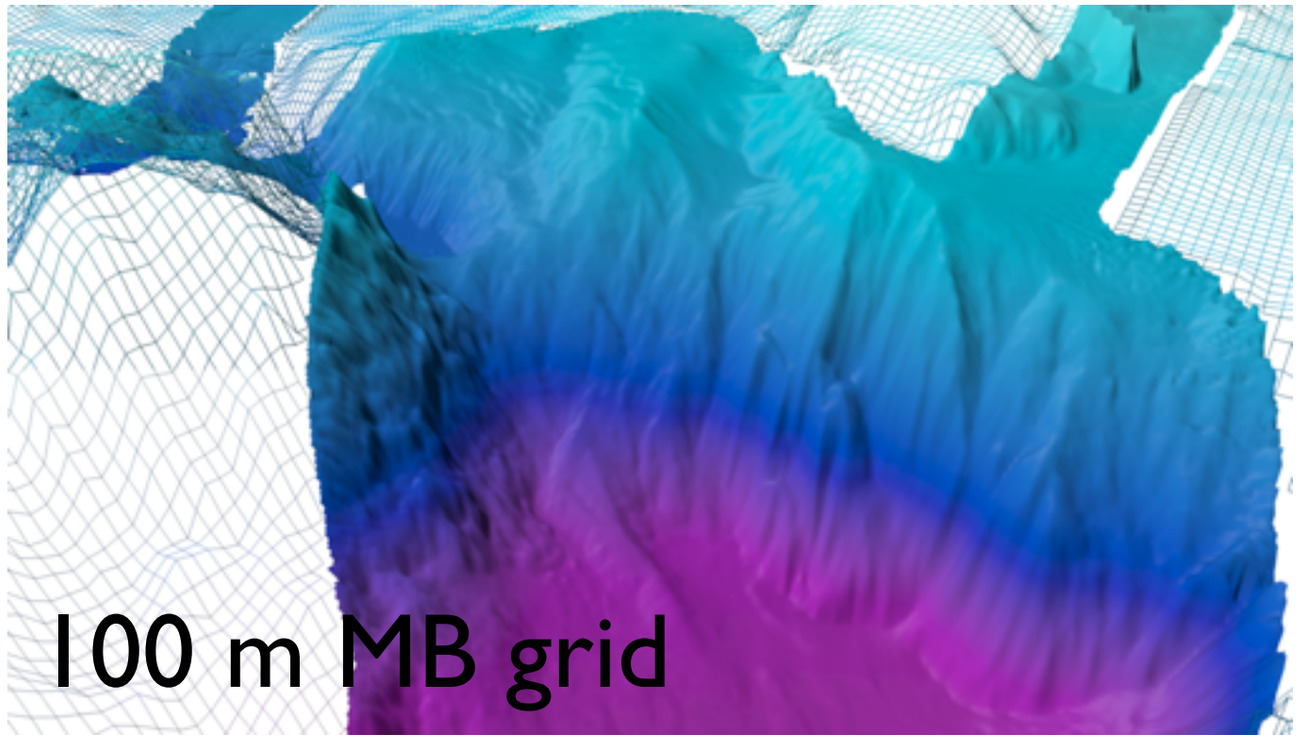
Overview



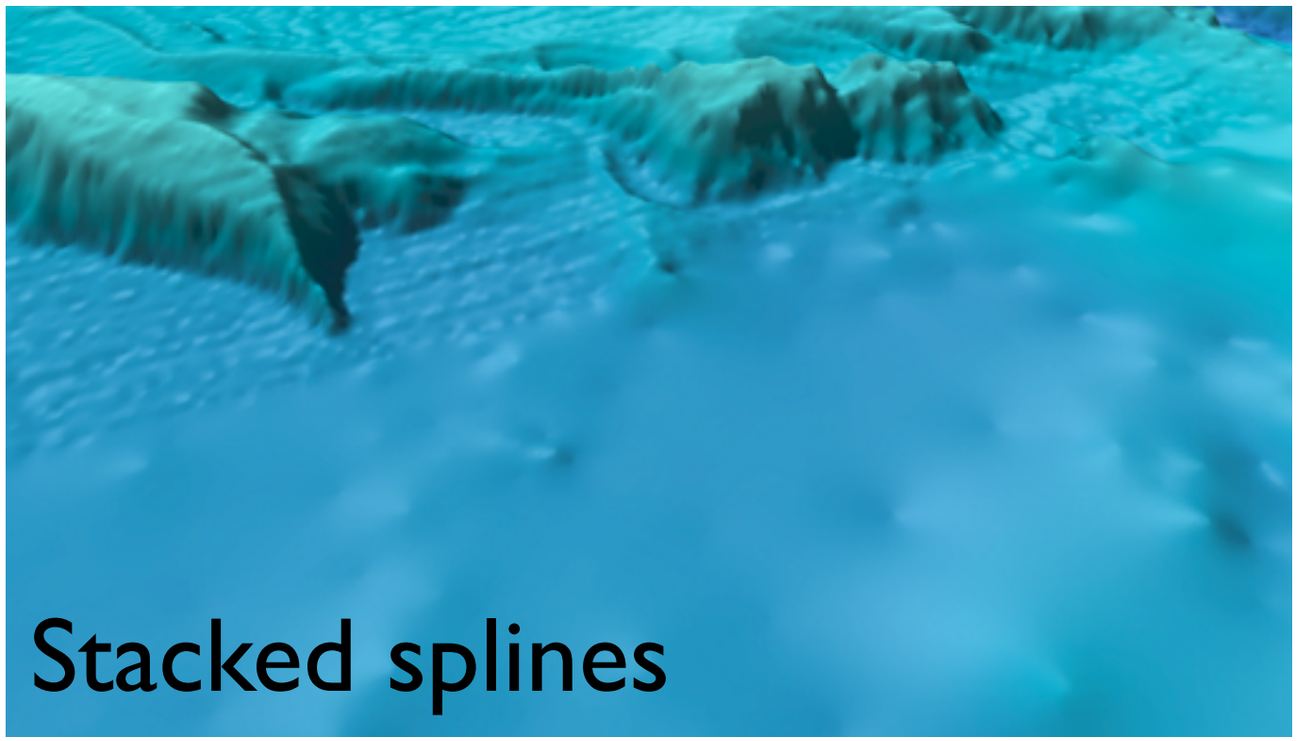
Resolution factor

Details 1: Resolution

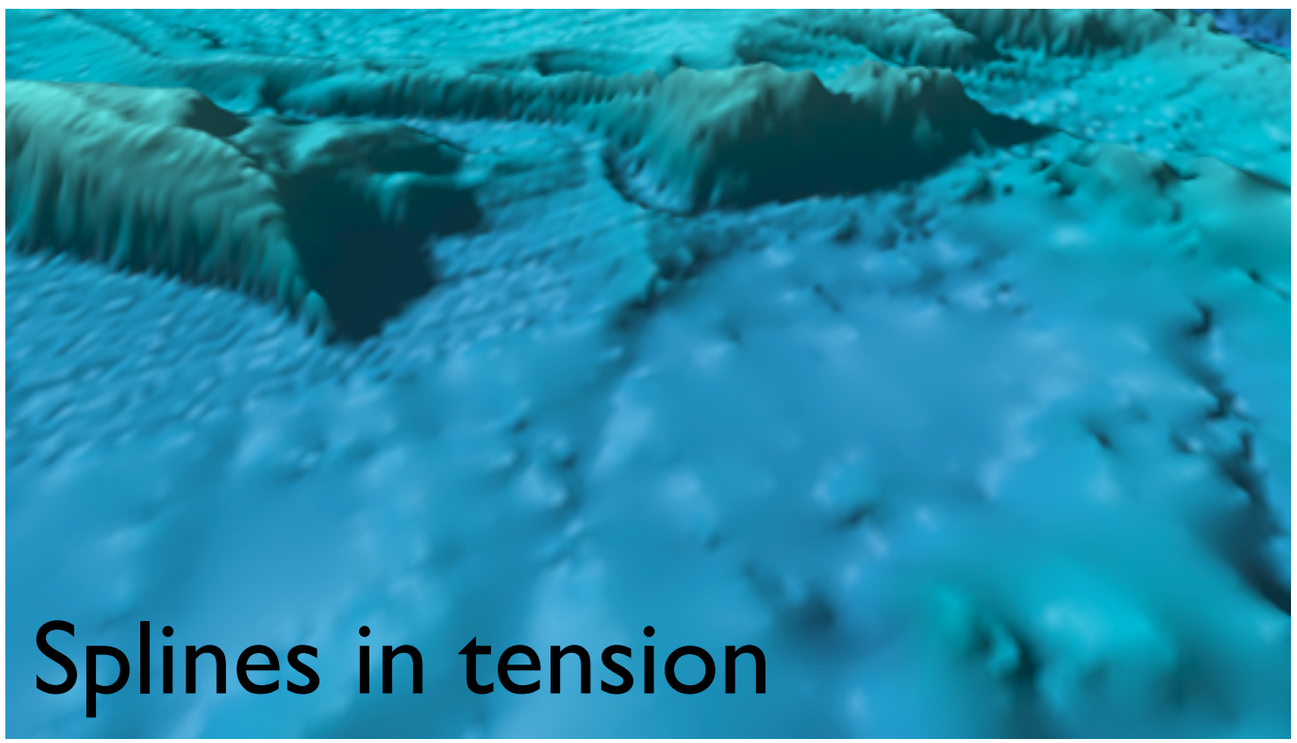




Details 2: Tracklines

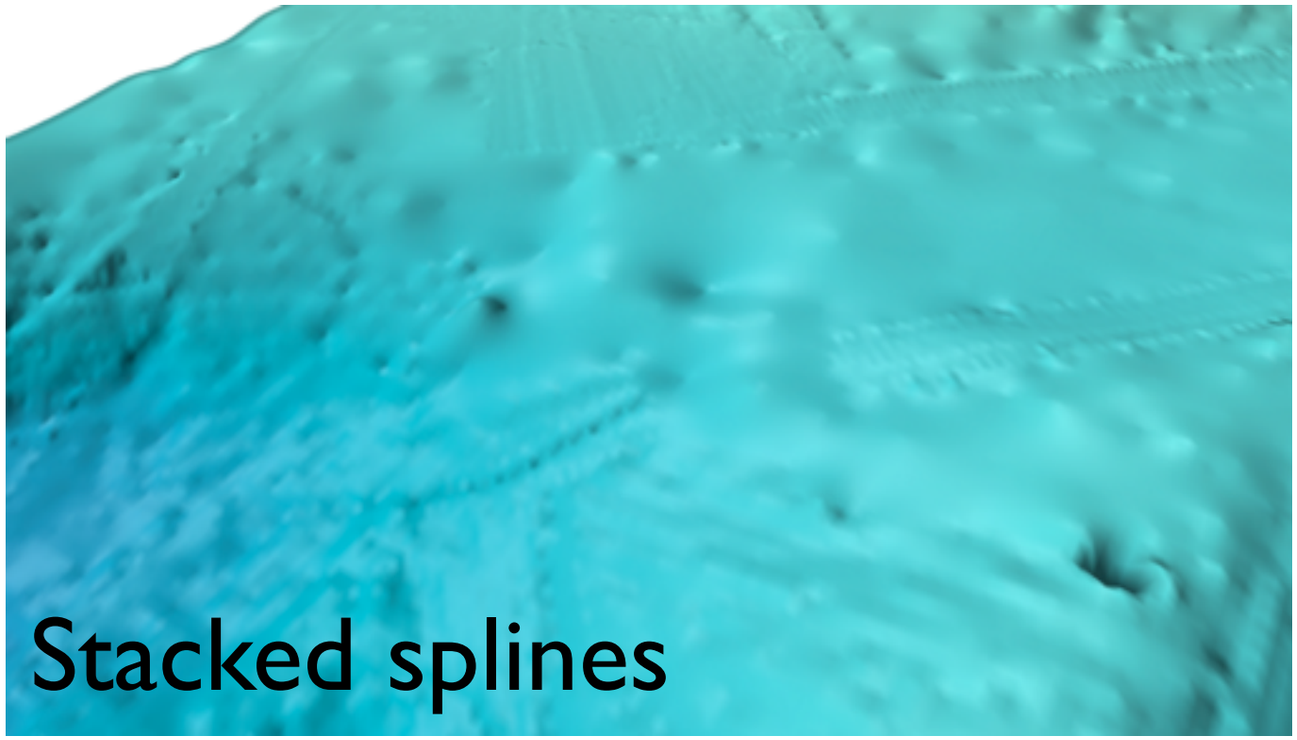


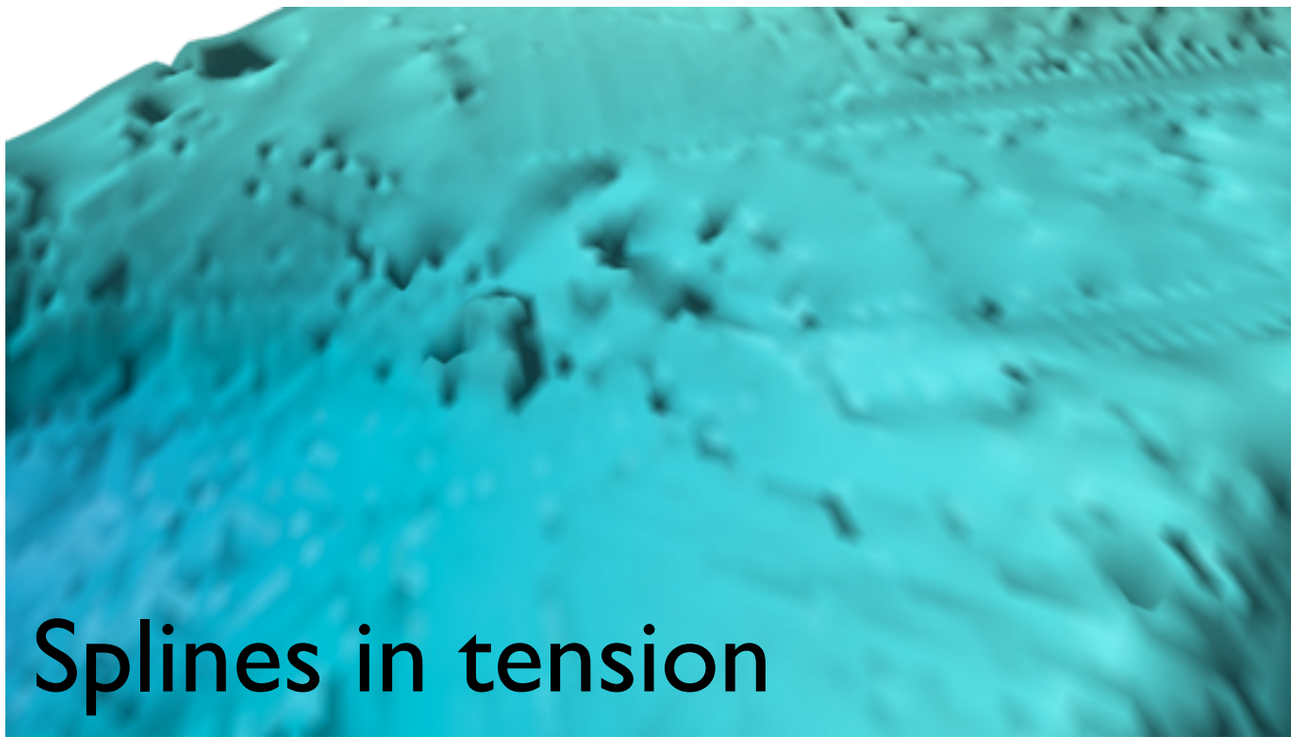
Stacked splines



Splines in tension

Details 3: Dataset edges





Outlook

- Test on larger data set
- Test on IBCAO
- Solve problems?
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- Solve problems?
- Repeat…