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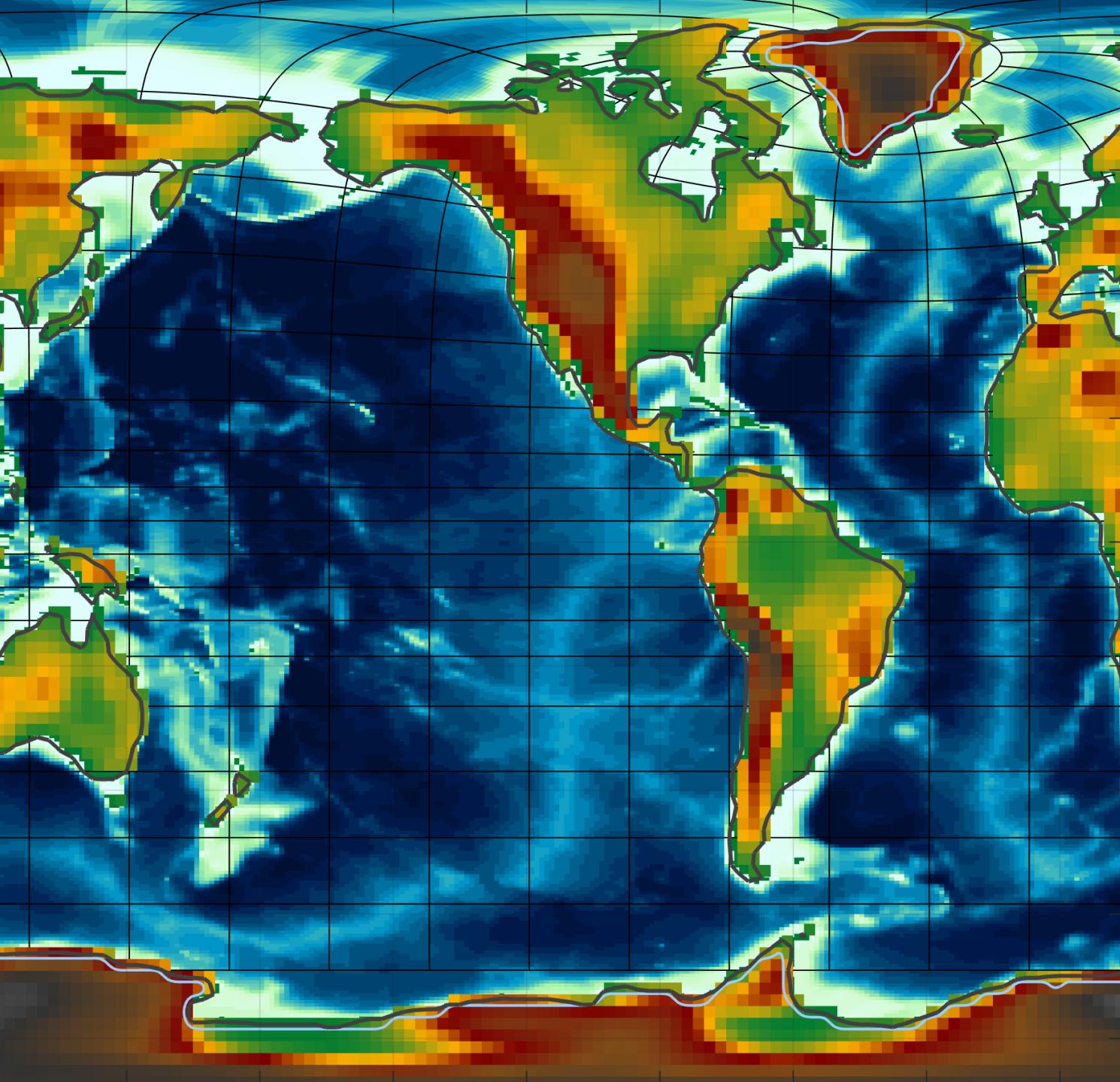
GCM grid Struggles

ESM For Lunch
19 March 2024



Utrecht University

Institute for
Marine and Atmospheric
research Utrecht



Things would be much easier if the earth were flat ...

Some struggles we encounter while analysing GCM output:

- Which *projection* to use;
- *Curvature*: non-uniform distances;
- (*lat,lon*) versus (*x,y*) coordinate;
- Meridian *boundaries*;
- Re-gridding errors;
- Masked values;
- Non-conformal grids.
- Non-uniform vertical coordinate.
- ...

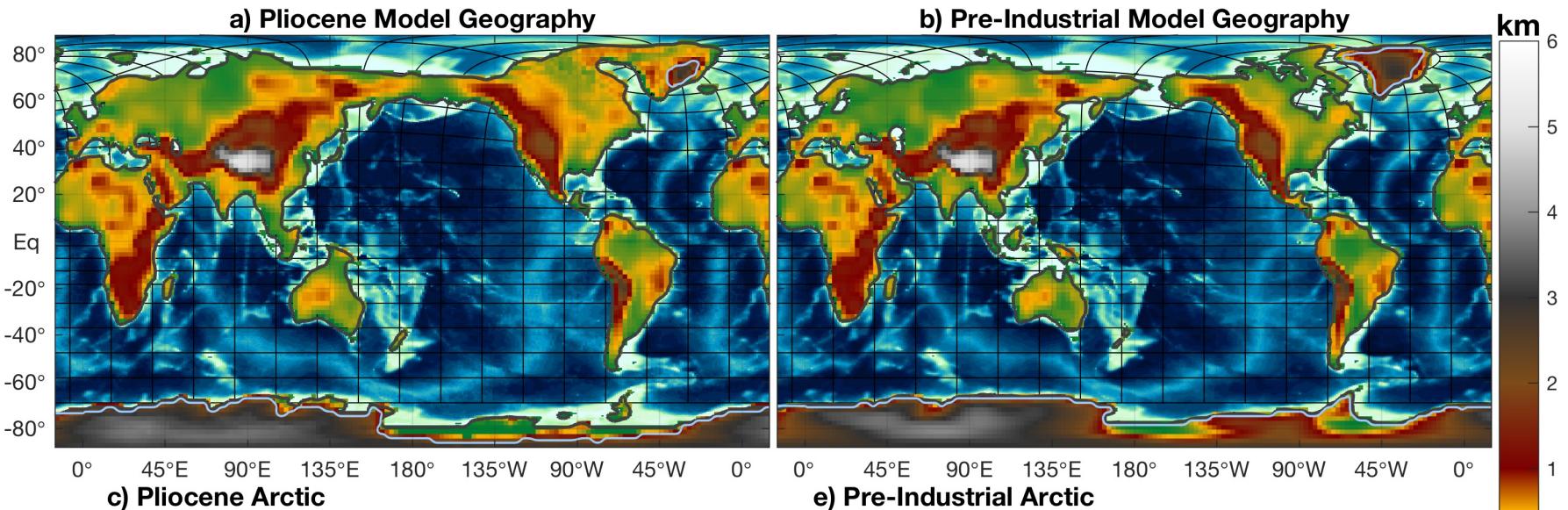
EARTH BEFORE AND AFTER FLAT EARTHER'S OPINION



Projection

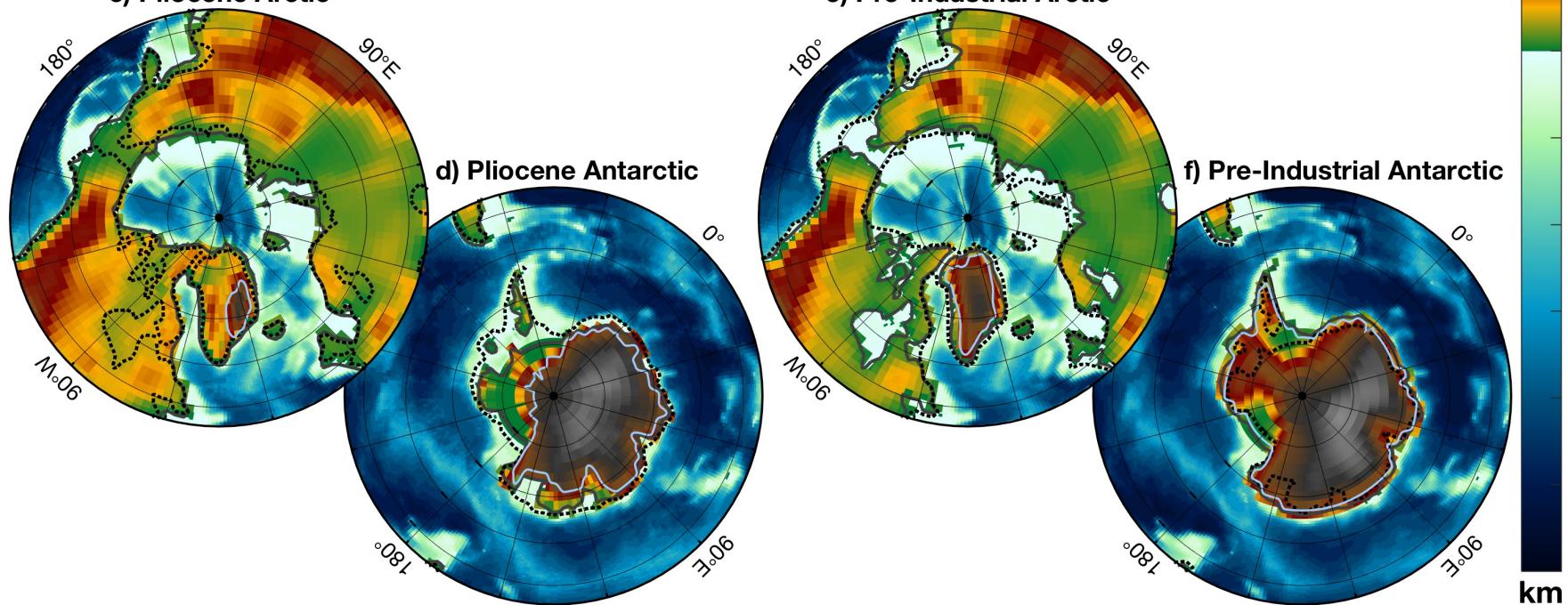
Rectangular

- Easy interpretation.
- Practical.
- Non-conformal.



Stereographic

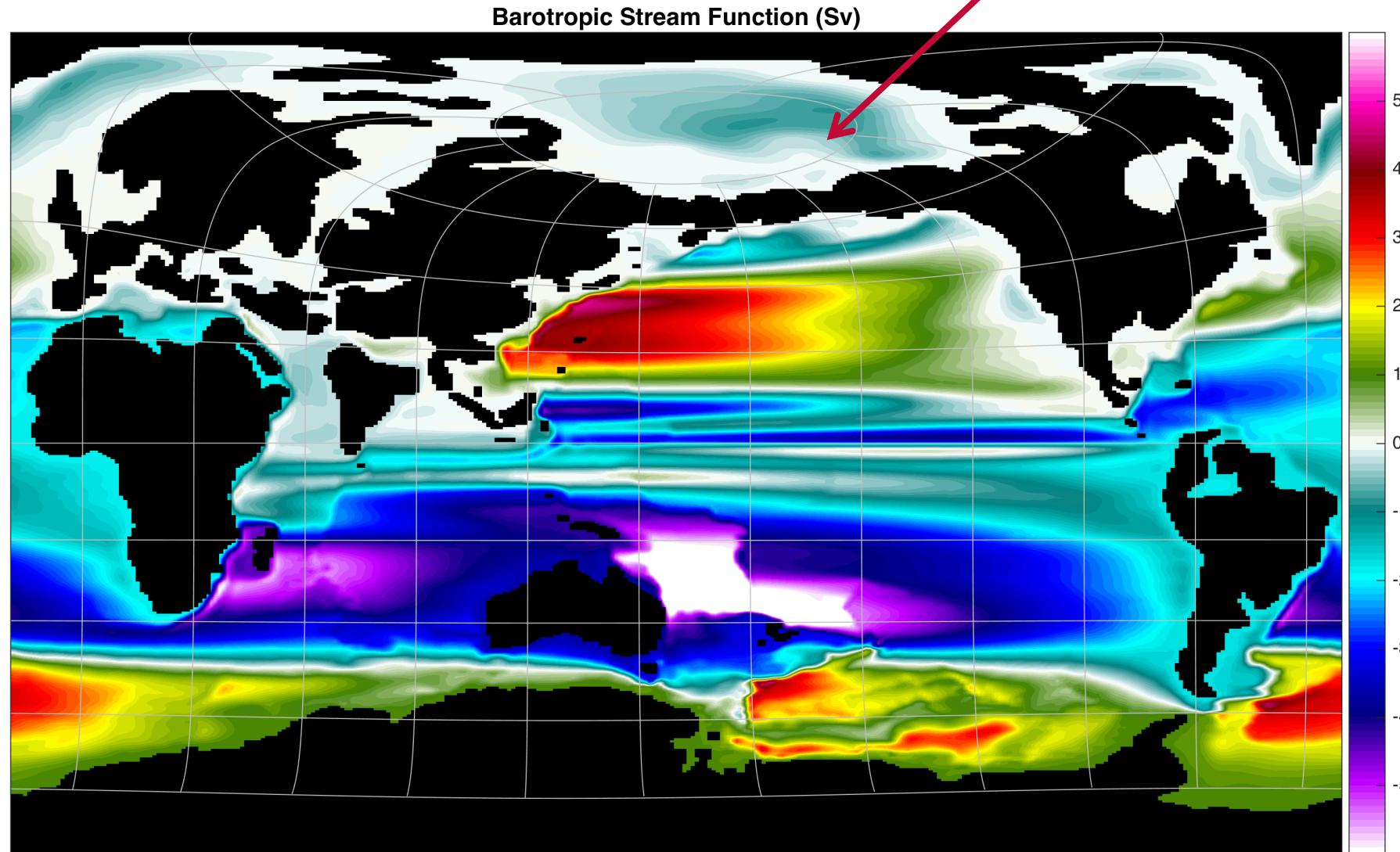
- More realistic.
- More complex.



Curvature – Barotropic stream function

Curvilinear grid

- Distortion, angle and size of grid cells.
- If possible, do any calculations on native grid, then interpolate result.
- Mind (x,y) versus (lat,lon) coordinate.



Meridian boundaries: gaps and bumps

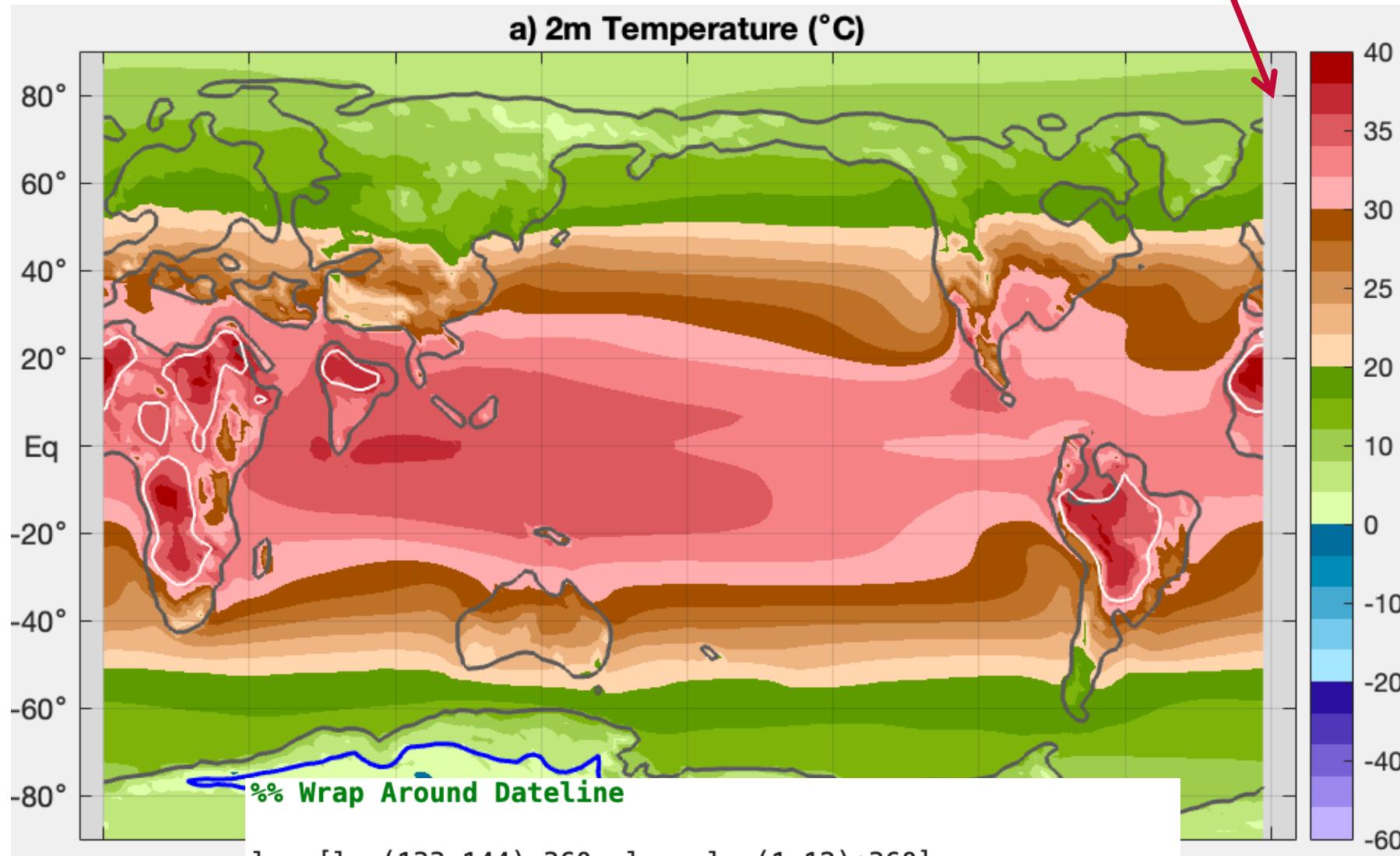
Data gap on dateline

Separation

- Avoids gaps and discontinuities.
- Good for figures

Padding

- Interpolation
- Re-gridding
- Useful for figures



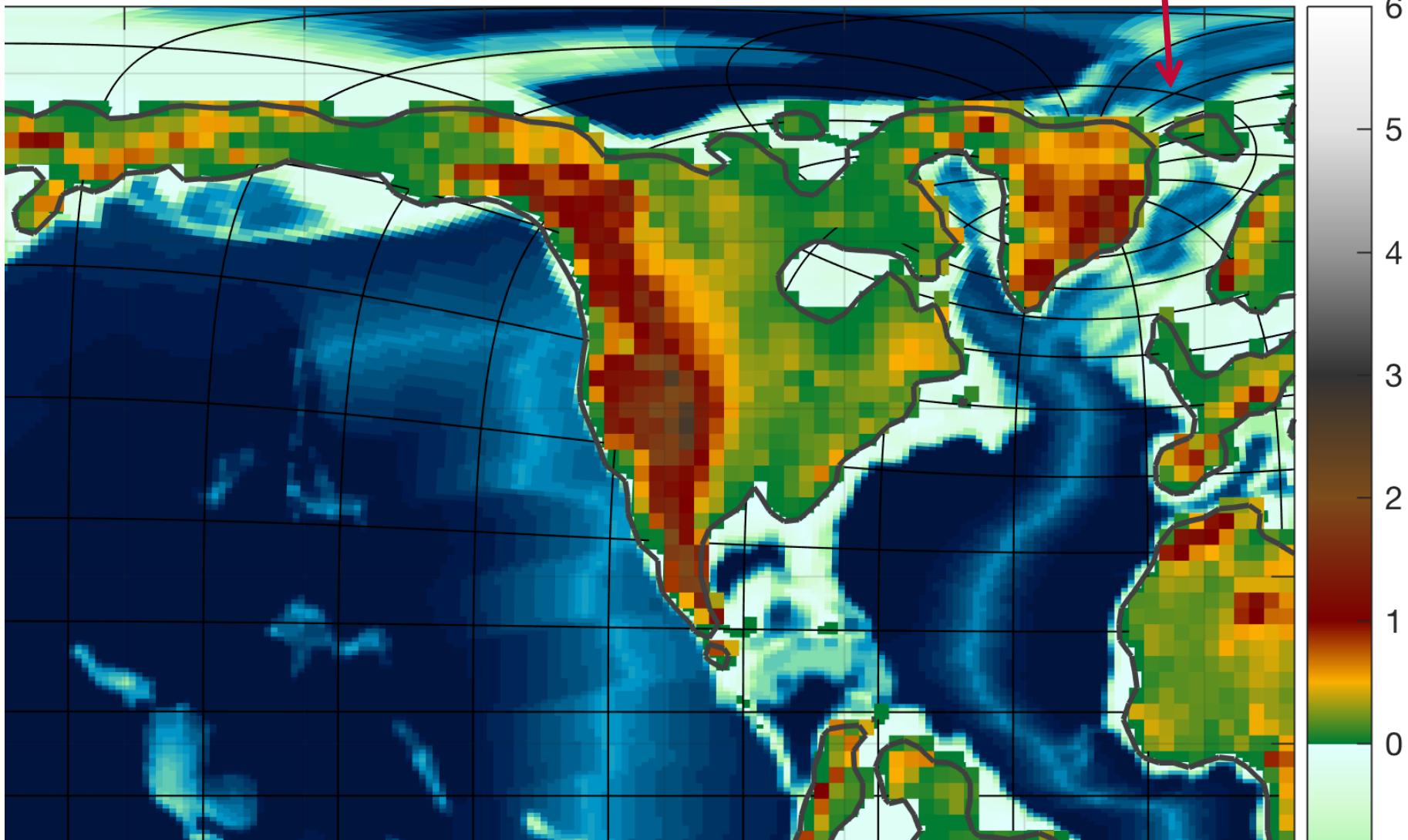
Meridian boundaries: gaps and bumps

Curvilinear grid

- Unstructured grid.
- Discontinuities.

Often still ok in figures.

Plotting algorithm deals well with ocean grid



Meridian boundaries: gaps and bumps

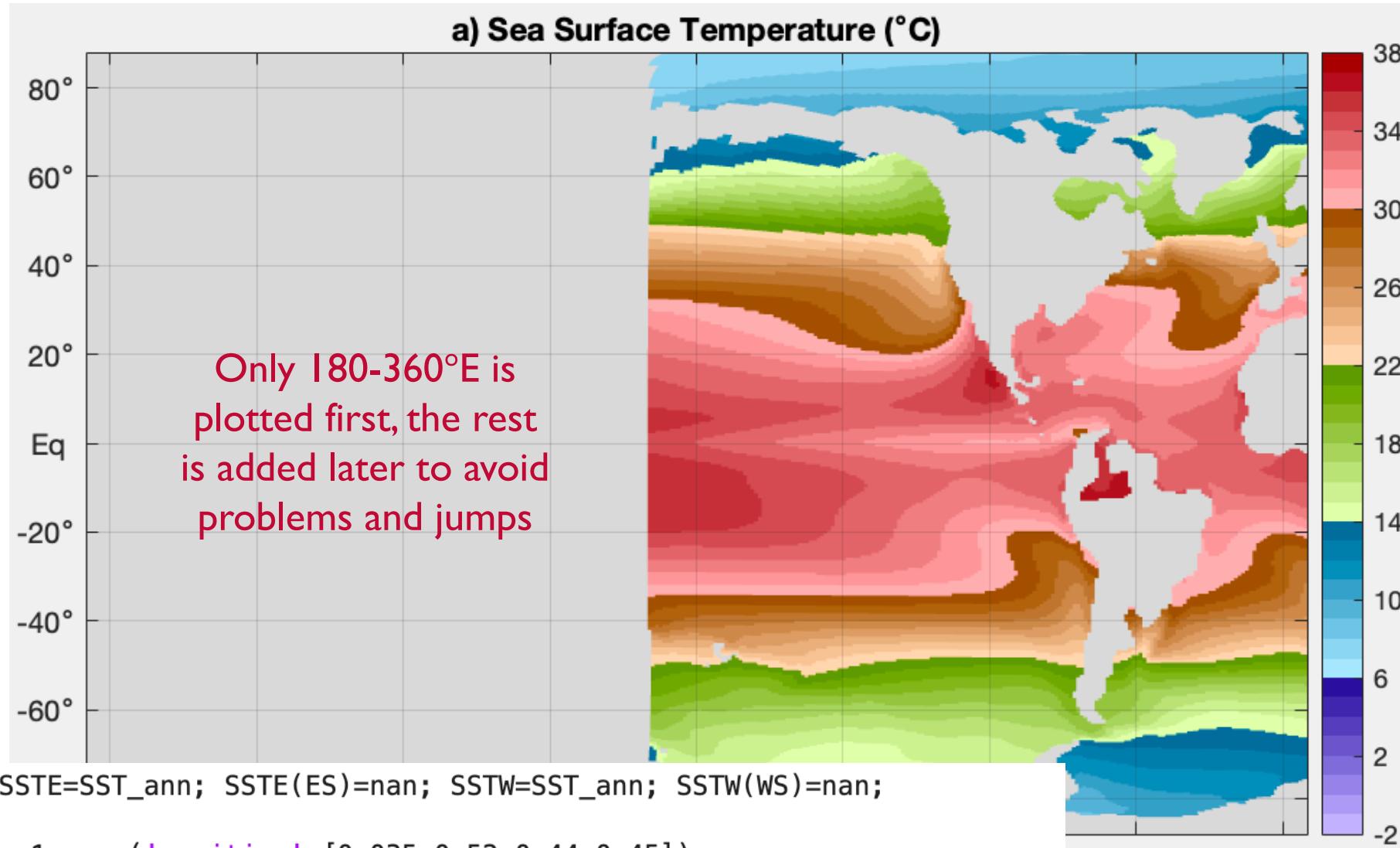
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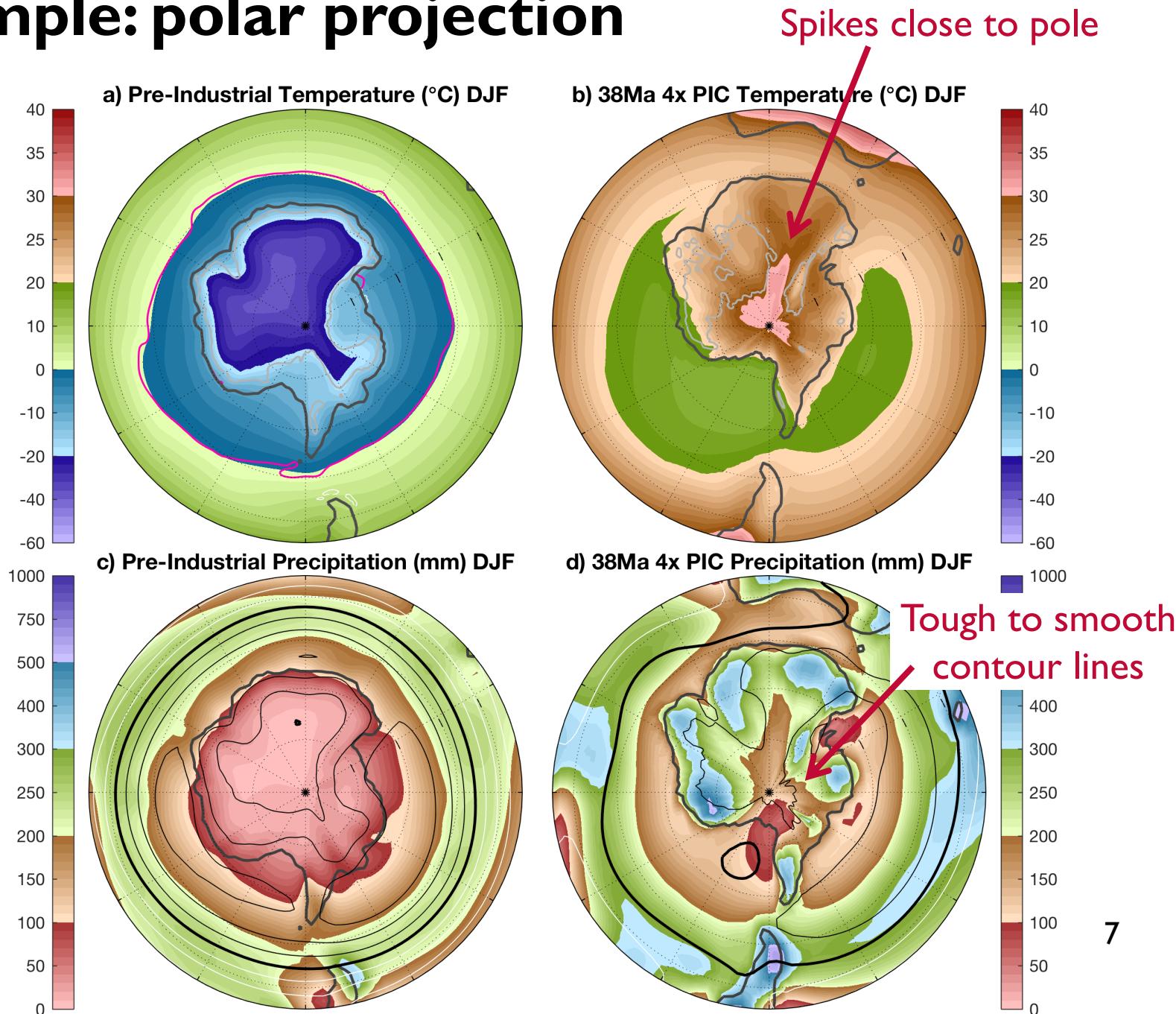
A little trick:

Plot western/eastern
Longitudes separately



Re-gridding example: polar projection

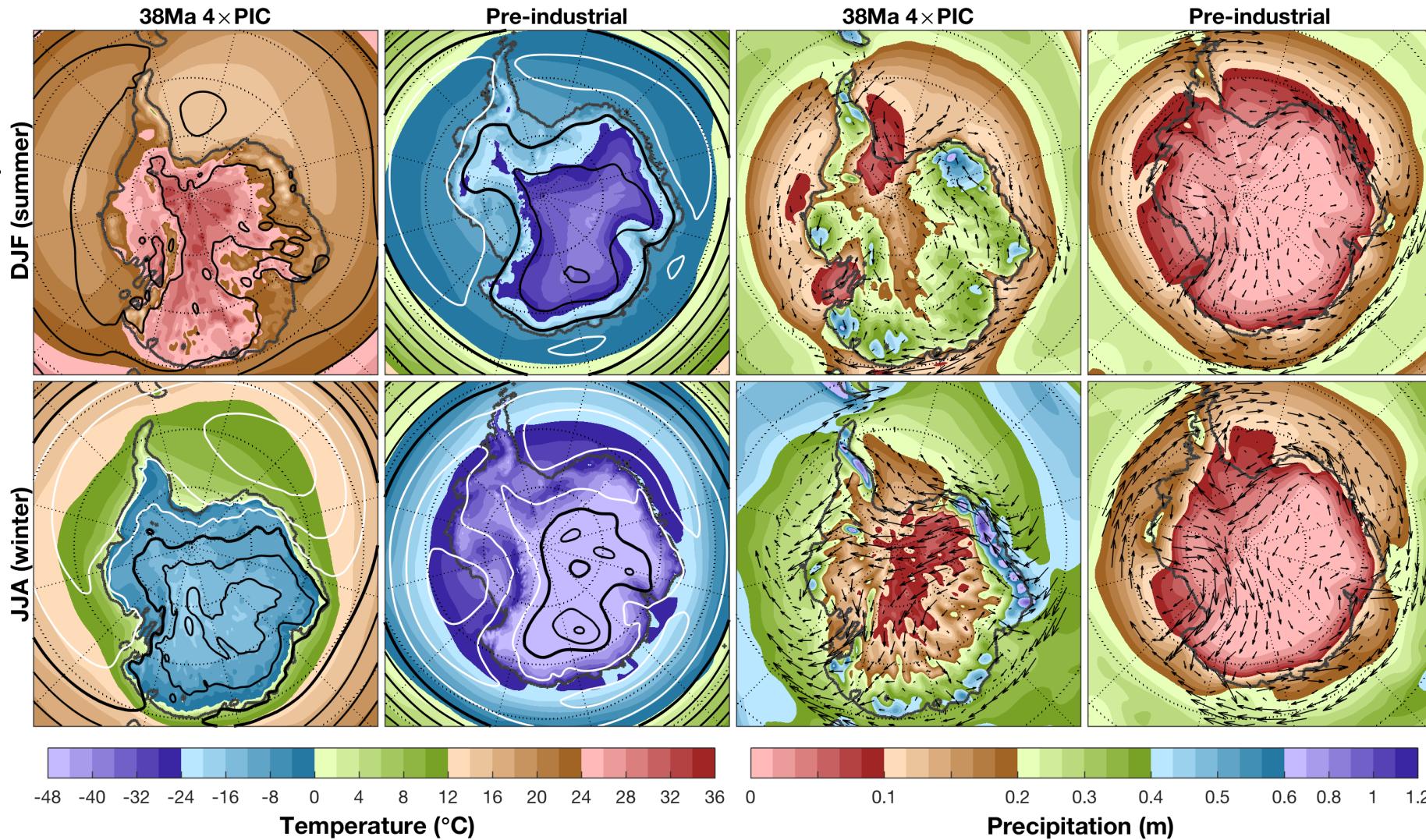
- Most analyses can be done on the native grid, but for figures it is often better to interpolate the data.
- Here: data on (lat, lon) grid. Works ok, but some artefacts around the pole.
- Contours can give trouble, particularly around dateline.
- Smoothing also needs padding of the original data.



Re-gridding example: polar projection

Polar equidistant
projection; $0.25 \times 0.25^\circ$.

- Useful for data on different grids.
- No pole problem.
- Better contours.
- Much more suitable for quivers.



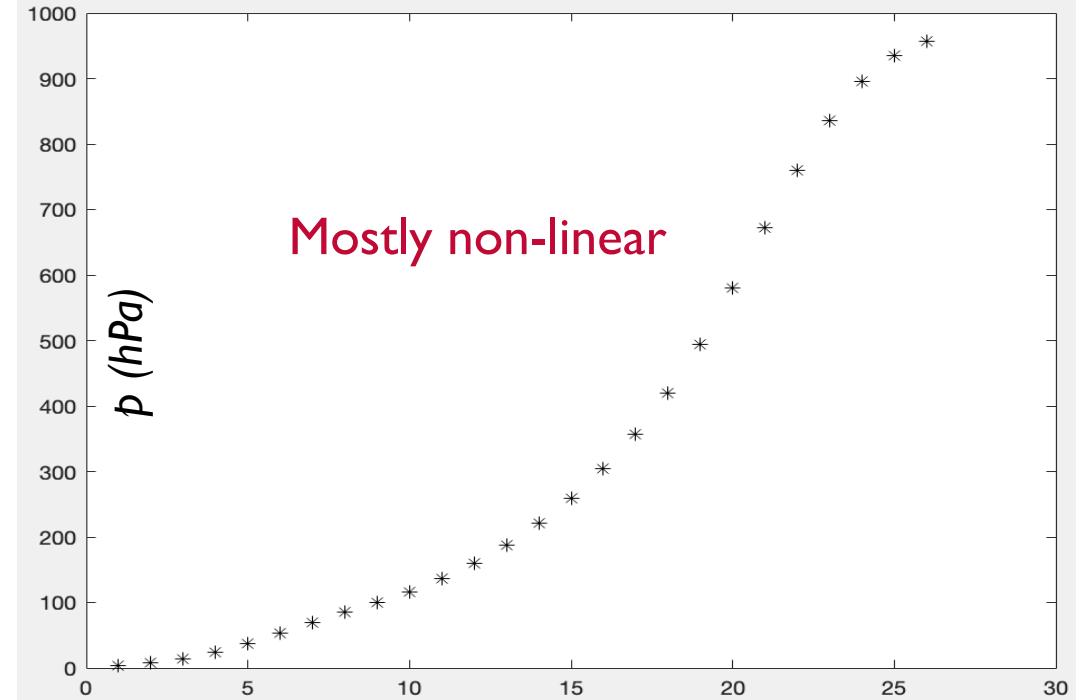
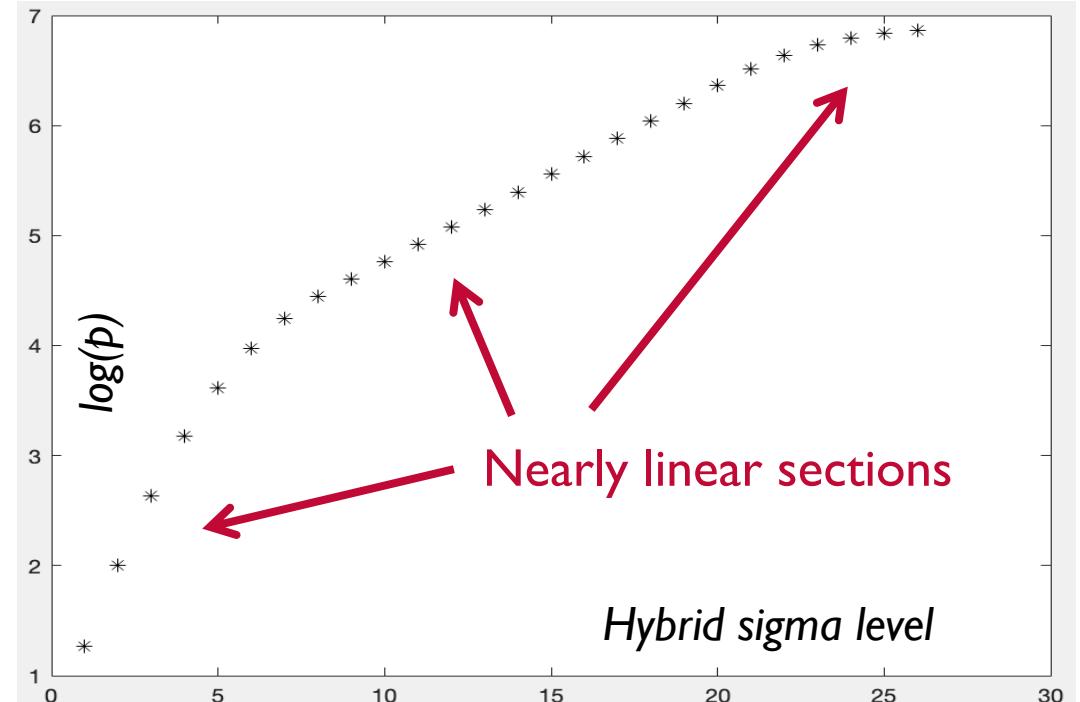
Vertical grid struggles

Re-gridding from hybrid sigma levels

- Pressure level figures;
- Isentropic levels;
- Zonal averages, stream functions;
- Vertically integrated measures.

Ocean grids

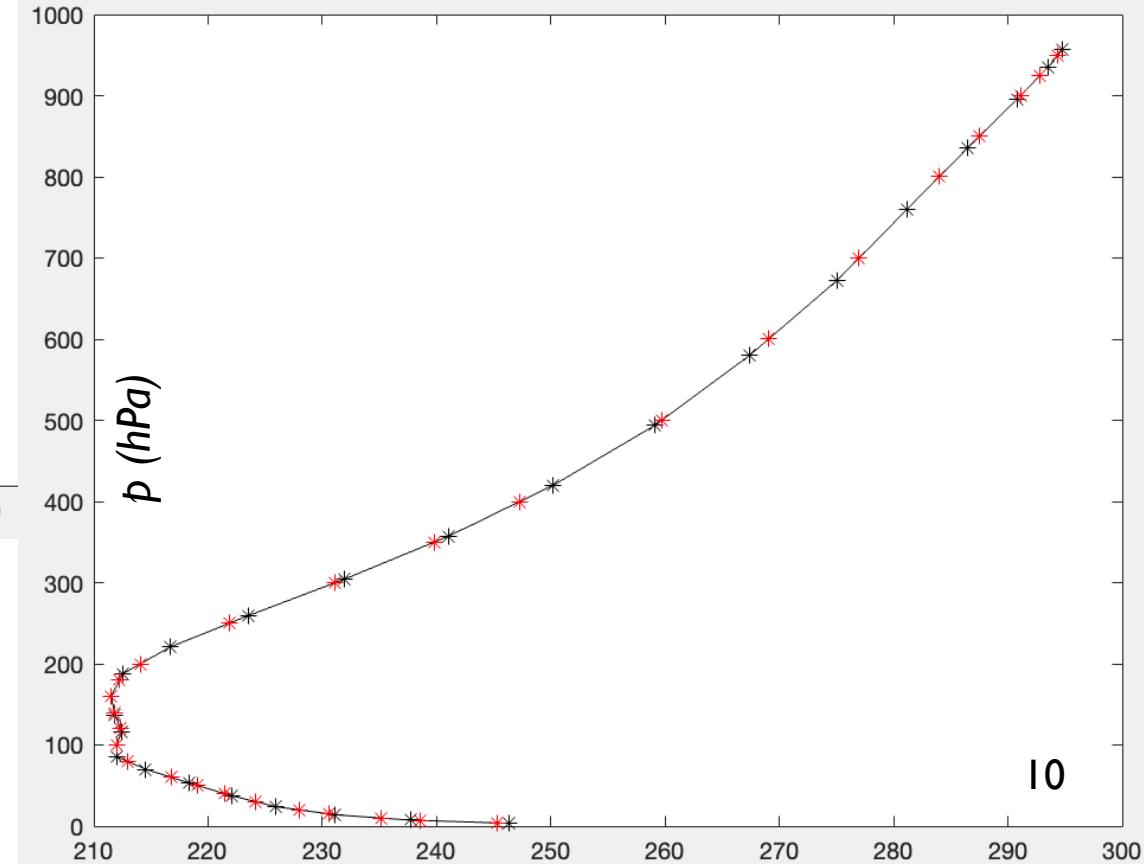
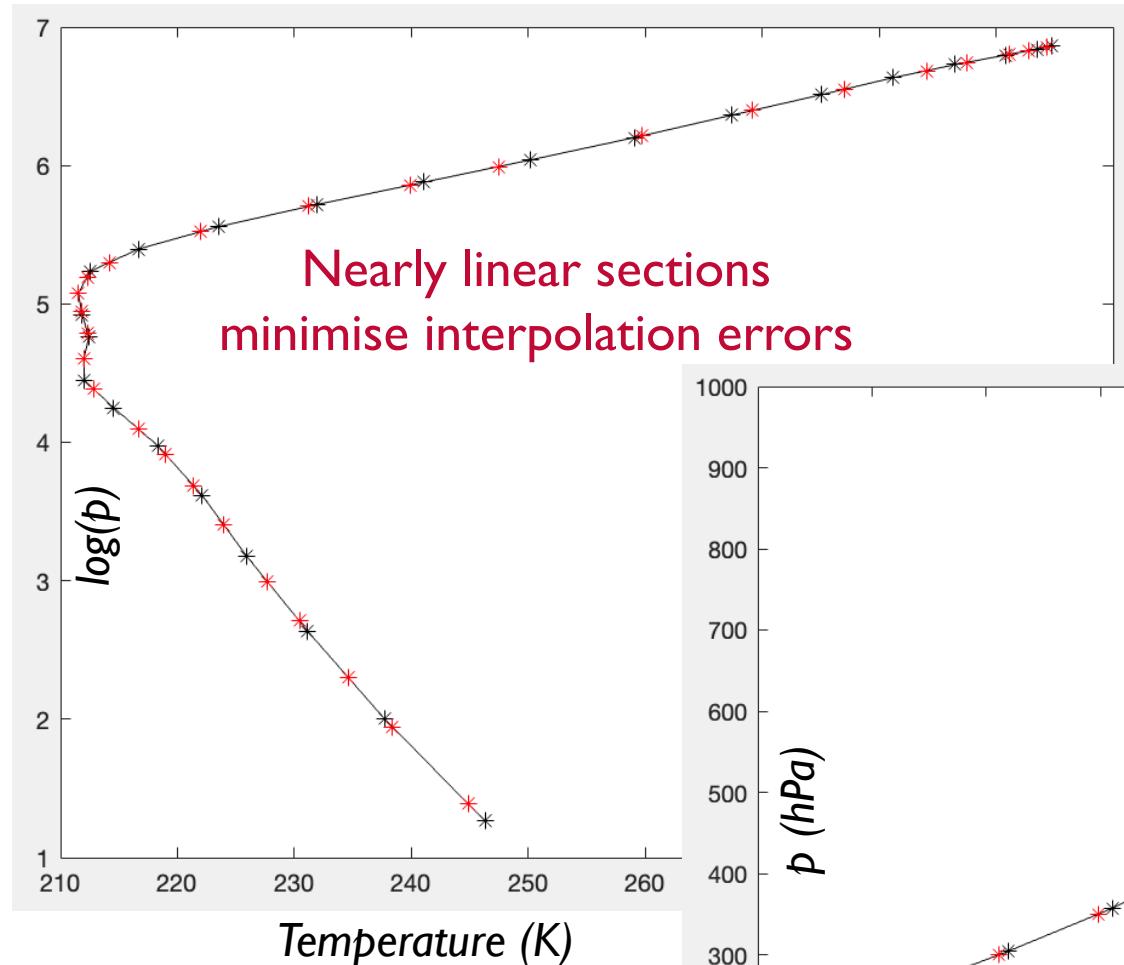
- Vertical integrals need cell thickness;
- Volume-weighted averages can be tricky.



Vertical grid struggles

Re-gridding from hybrid sigma levels

- Pressure level figures;
- Isentropic levels;
- Zonal averages, stream functions;
- Vertically integrated measures.



Thank you

Any questions?

