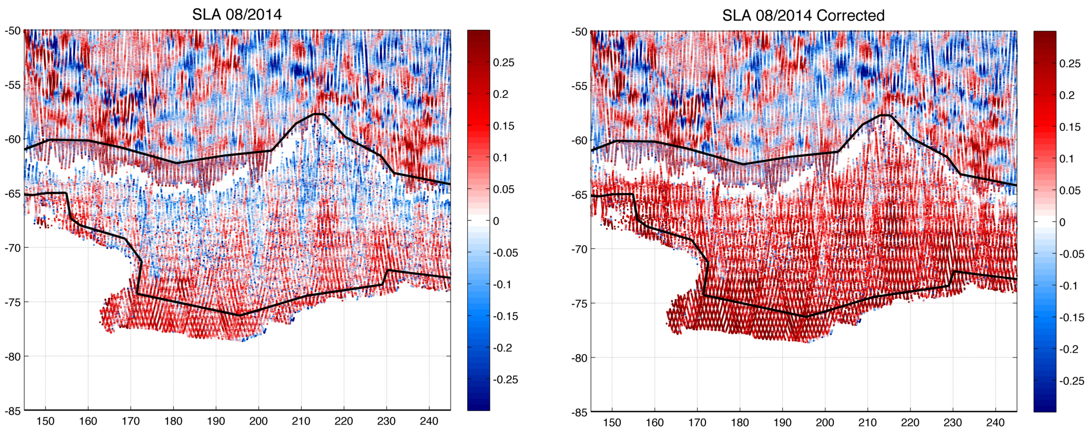
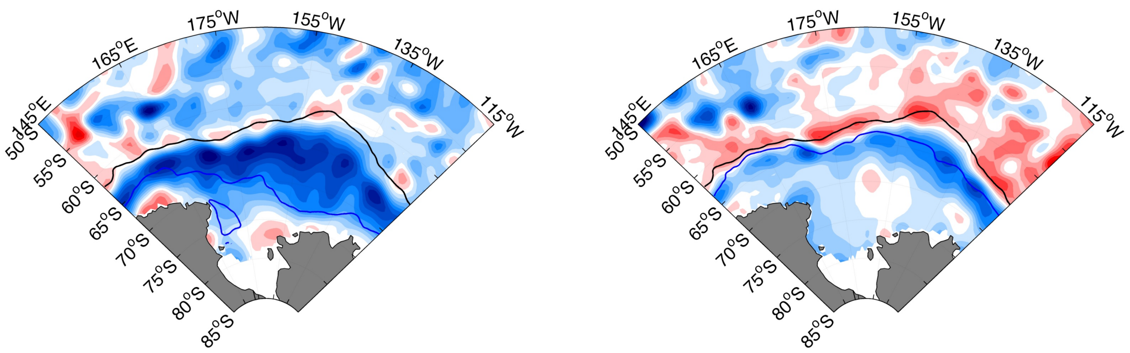
CryoSat-2 processing, creating DOT

a) Correction of modes
b) Choosing the Geoid
c) DOT calculation
d) Gridding the maps

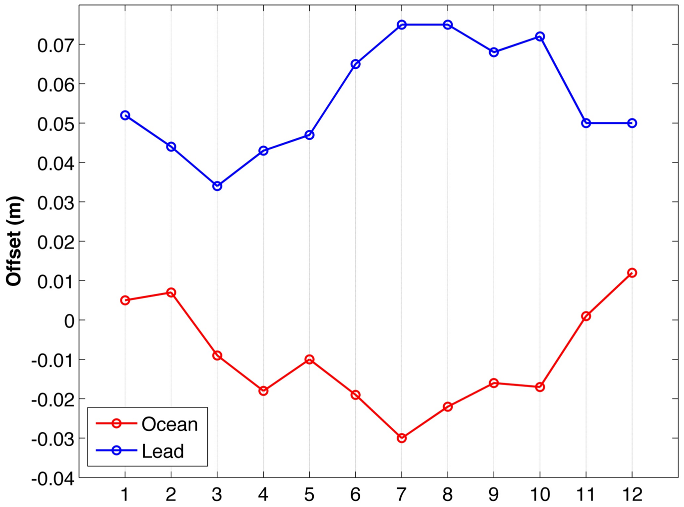
Correction of the modes

- CrySat-2 uses 3 modes → each mode is processes with one retracker
- This, creates steps when crossing from one mode to the other → it must be corrected





Example of final product SLA **without** offset correction

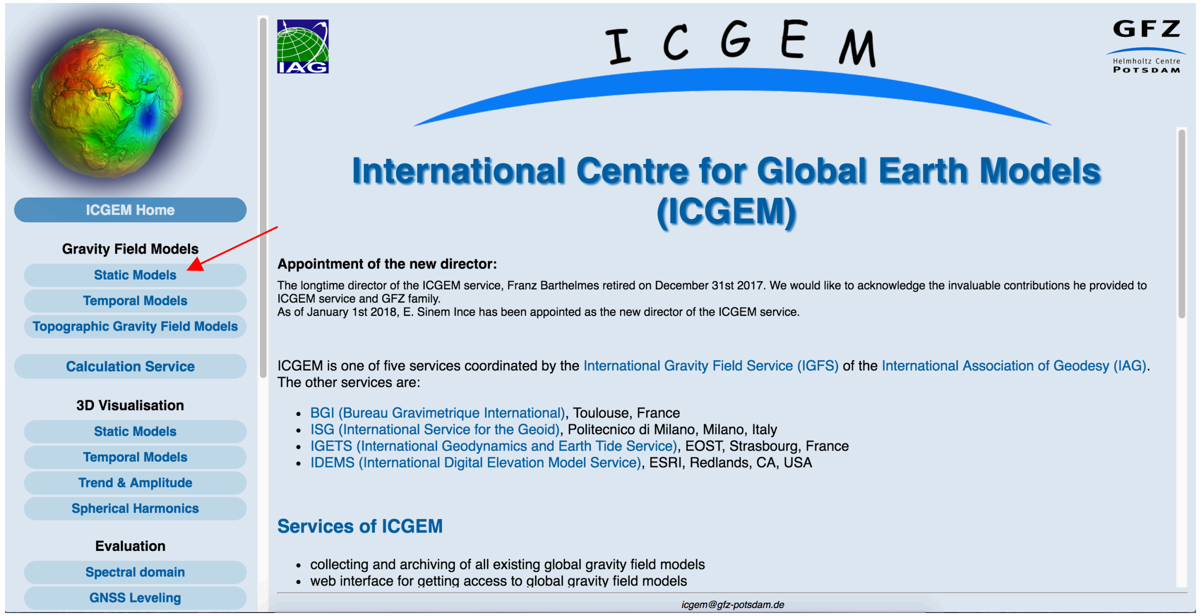


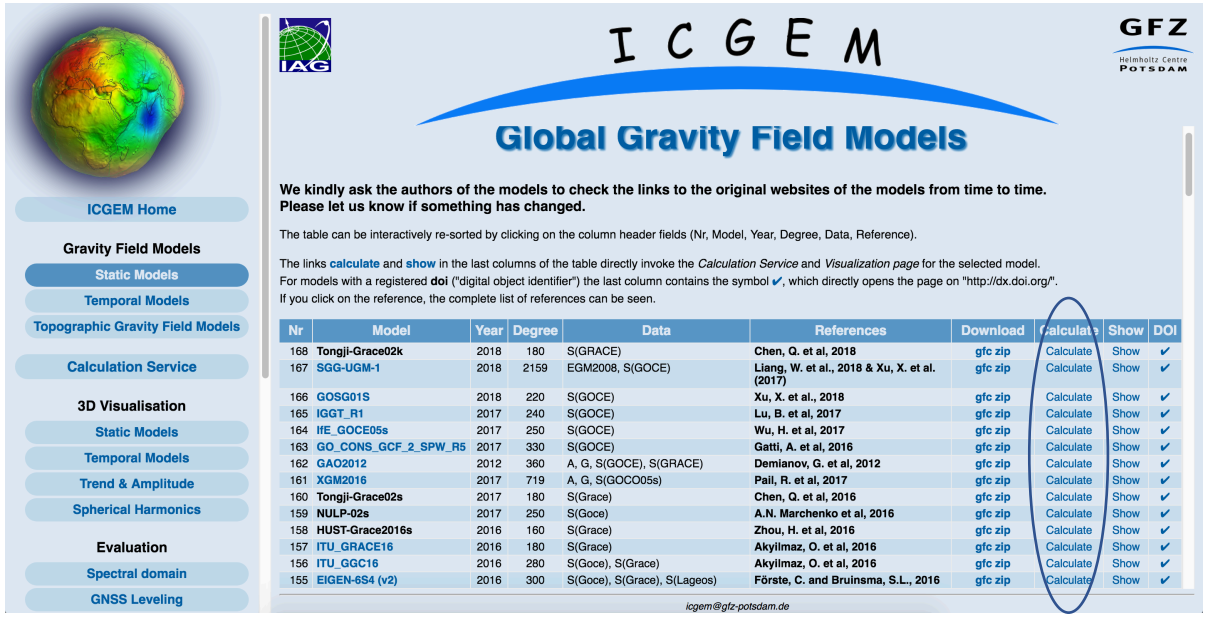
Seasonal offset in CryoSat-2

- LRM uses a proper retracker → it was my "true"
- Differences between the regions where retracker changes
- *Seasonal offset* → in theory, the offset should be a constant value everywhere
- Caution to not include noise in the data
- The difference is added back for correction
- Probably you'll need to apply different offsets for different satellites and an offset between the satellites, after the correction (see Armitage et al. 2016)

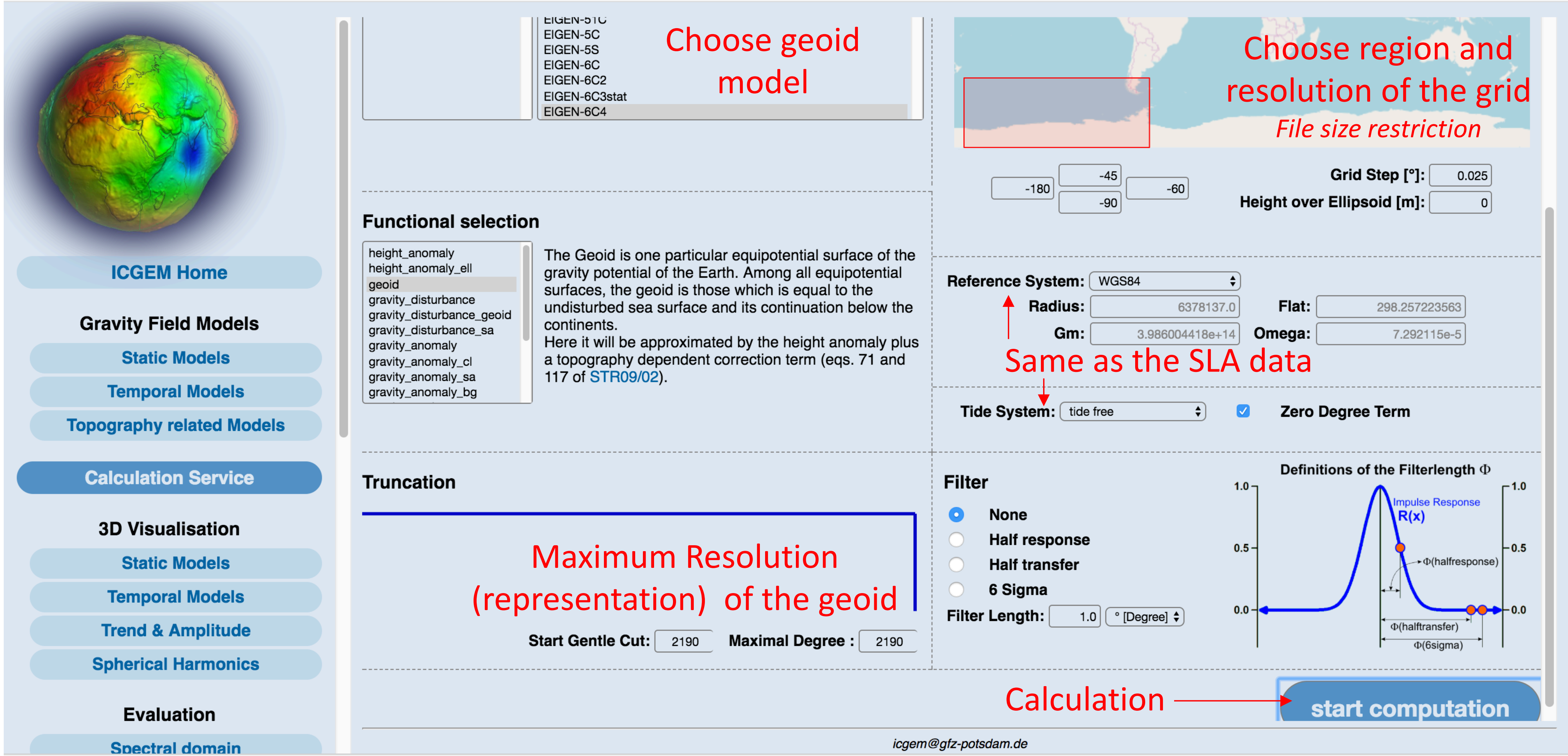
Choosing the geoid

- The best geoids have resolution of O(10) km. However, in ice-covered regions, relies on GRACE and GOCE (footprint of 100-200 km) → actual resolution in the Southern Ocean is >10 km, mainly on the continental shelves [Equation for maximum resolution of the geoid = 20000/degree]. See the papers below:
  - Hughes & Bingham (2008), *An Oceanographer's Guide to GOCE and the Geoid*
  - Bingham et al (2008), *Calculating the Ocean's Mean Dynamic Topography from a Mean Sea Surface and a Geoid*
- The choice of the geoid depends on what you want to show → main changes are at the coast
- New geoids include GOCE data, which improves the resolution at the coast
- EGM2008 → high resolution at open ocean, but errors increase toward the Southern Ocean
- Website for geoid calculation → http://icgem.gfz-potsdam.de/home

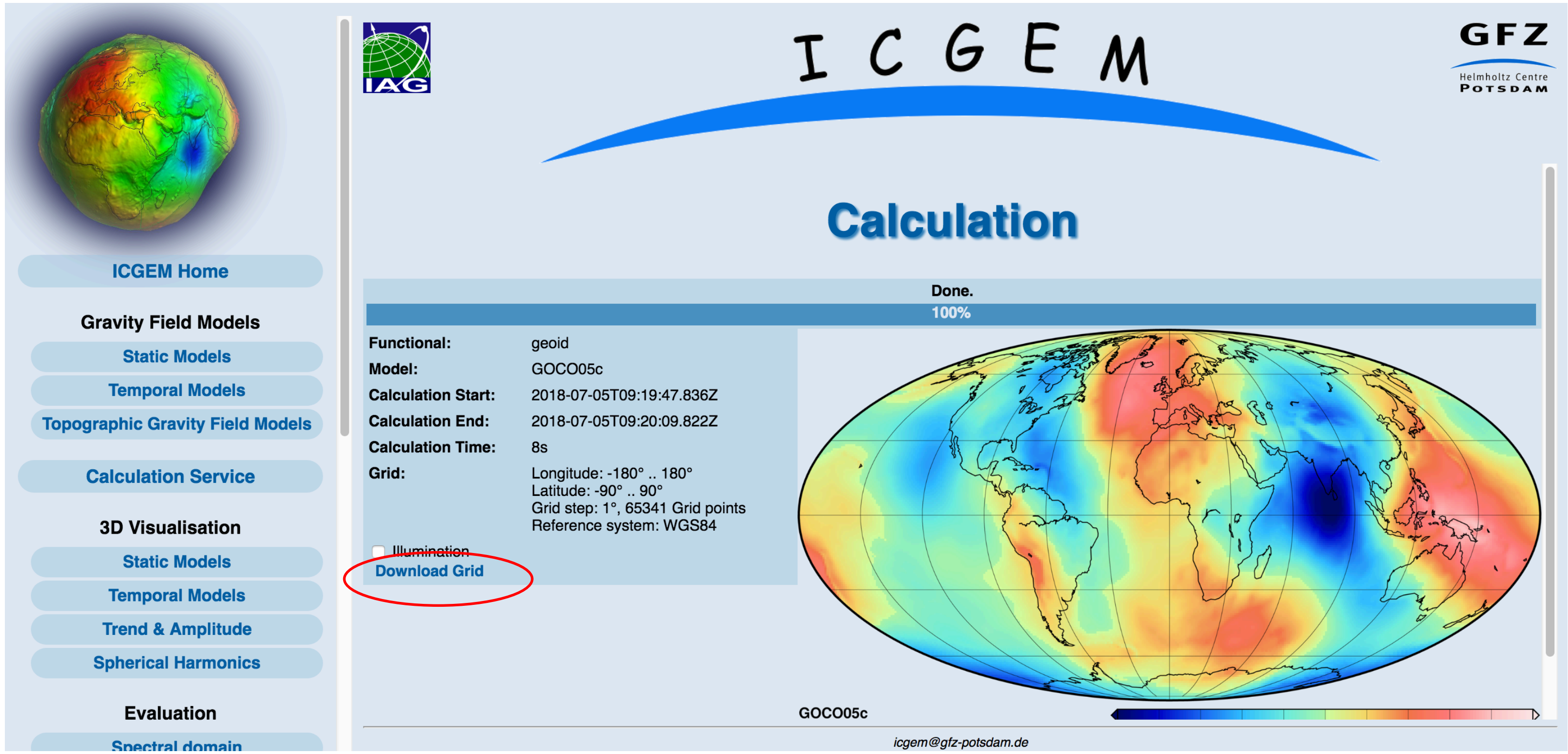




Choosing the geoid



Choosing the geoid

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generating_institute     gfz-potsdam
     generating_date     2018/07/05
        product_type     gravity_field
                body     earth
           modelname     GOCO05c
     max_used_degree           720
         tide_system     zero_tide
          functional     geoid
    zero_degree_term     included
                unit     meter
       crust_density     2670.0 kg/m**3
          refsysname     WGS84
            gmrefpot      3.98600441800E+14 m**3/s**2
        radiusrefpot     6378137.000 m
          flatrefpot      3.352810664747480E-03   (1/298.25722356300)
         omegarefpot      7.29211500000E-05 1/s
     normal_potential     6.263685171456948E+07 m**2/s**2
        long_lat_unit     degree
       latlimit_north       90.000000000000
       latlimit_south      -90.000000000000
       longlimit_west     -180.00000000000
       longlimit_east      180.00000000000
             gridstep       1.000000000000
    latitude_parallels           181
   longitude_parallels           361
number_of_gridpoints           65341
             gapvalue             999.0000
        weighted_mean     -3.1993218E-02 meter
             maxvalue      8.4729459E+01 meter
             minvalue     -1.0611245E+02 meter
          signal_wrms      3.0586831E+01 meter
          grid_format     long_lat_value

          longitude      latitude     geoid
             [deg.]        [deg.]            [meter]
end_of_head ==================================================
          -180.0000      90.0000      15.193039154762
          -179.0000      90.0000      15.193039154762
          -178.0000      90.0000      15.193039154762
          -177.0000      90.0000      15.193039154762
          -176.0000      90.0000      15.193039154762
          -175.0000      90.0000      15.193039154762
          -174.0000      90.0000      15.193039154762
          -173.0000      90.0000      15.193039154762
          -172.0000      90.0000      15.193039154762
          -171.0000      90.0000      15.193039154762
          -170.0000      90.0000      15.193039154762
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          -165.0000      90.0000      15.193039154762
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          -156.0000      90.0000      15.193039154762
          -155.0000      90.0000      15.193039154762
          -154.0000      90.0000      15.193039154762
```

- It will download a gdf file with the information of the geoid and the options you chose previously
- You can open this file in a txt reader
- Lon/Lat/Height → it is a grid
- GMT software to open it and create the along-track

Geoid processing

- To create a netCDF with the grid in the GMT (remove the header from the files and save it in .txt). Ex:

xyz2grd GOCO05s_140180E.txt(table x y z) **-G**GRID.nc(new netCDF to be saved) **-R**145/180/-85/-60(geographical limits) **-I**0.1[d]/0.1[d] (resolution that you want)

- If you have more than one file, you'll need to merge them in one single netCDF file (e.g. matlab or GMT or python)

- Now you have a single file with the geoid grid. You'll need to interpolate this grid into the along-track coordinates of the satellite (in GMT, it is fast):

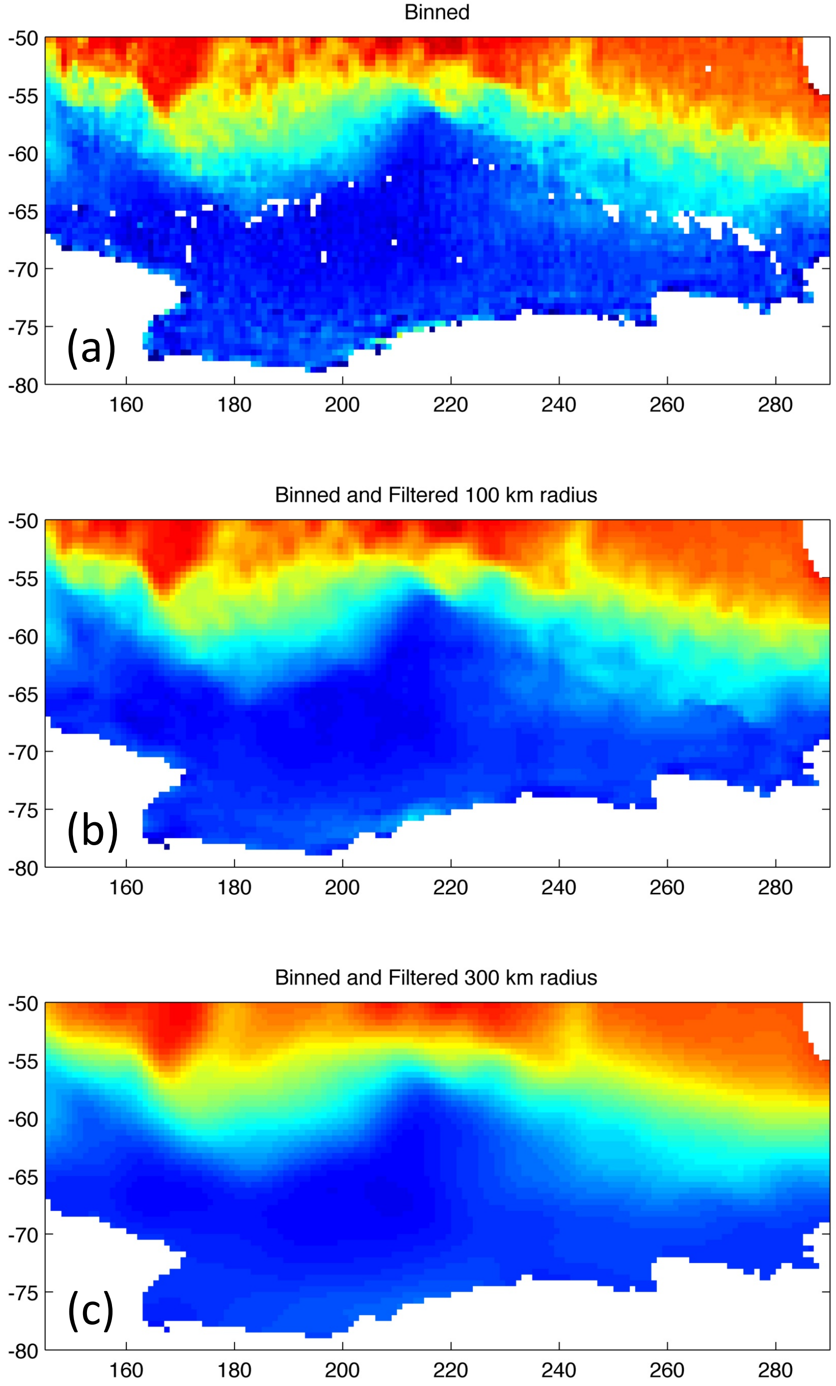
grdtrack INPUT.txt(satellite along-track lon/lat) **-G**GRID.nc(netCDF file you created above) **>** output_test.txt(file with the geoid height interpoalted onto the along-track lon/lat/geoid)

INPUT.txt is the monthly location of the along-track (lon/lat) and GRID.nc should contain files named x y z (see grdtrack for information in the GMT docs)

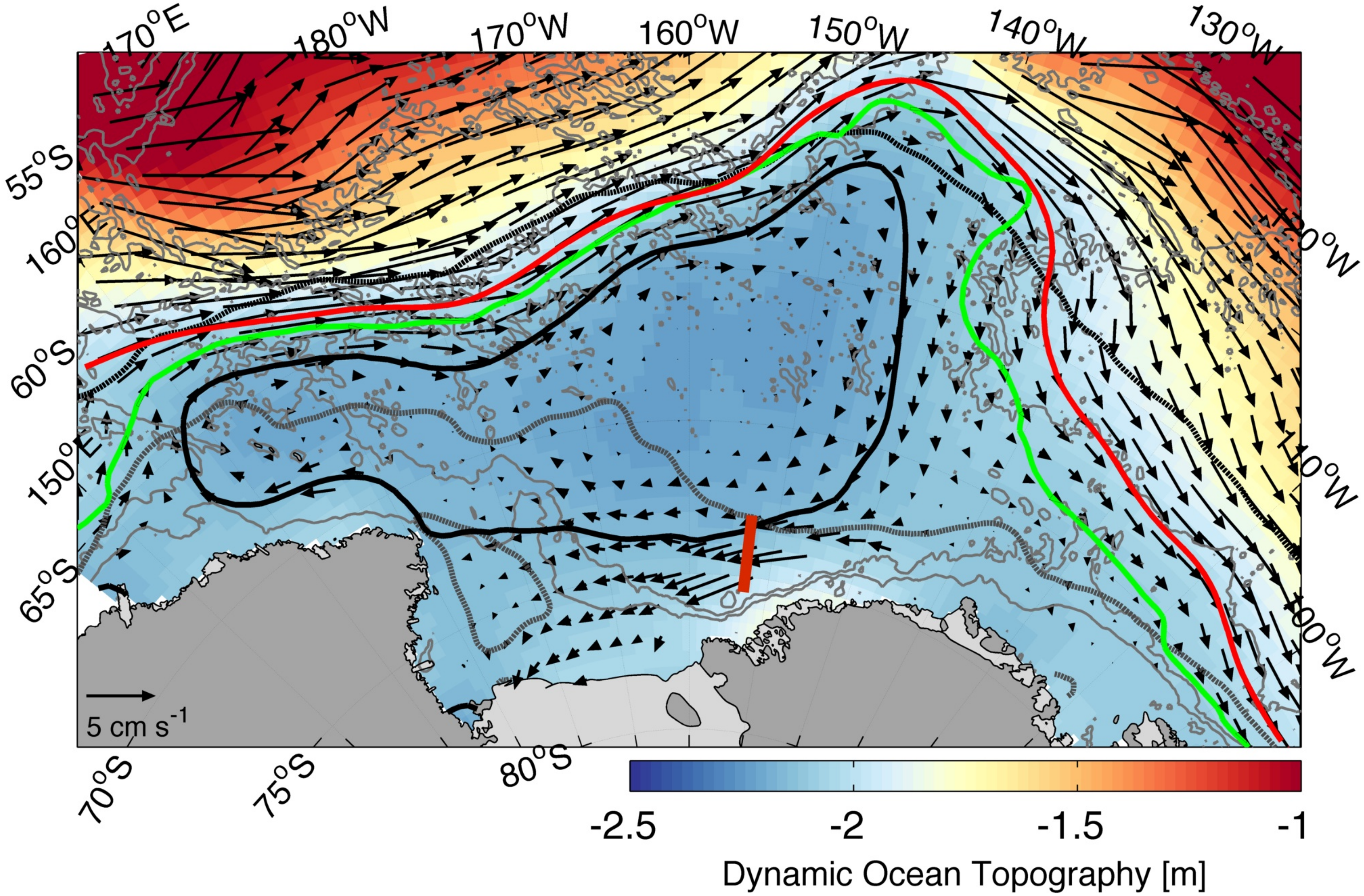
- Finally, open the along-track and subtract the geoid [DOT = SSH – H_{geoid}]

Gridding processing

- Open the DOT along-track and bin into the grid you want → filtering is needed, mainly if you want to work with geostrophic velocity
    - In this case, the data were binned into a grid of 1˚ lon x 0.5˚ lat. The higher the resolution, more white cells with no data
    - With more satellite tracks, the resolution can be enhanced
    - Or, new interpolation technique
- Filtering is a balance between oceanographic features that are important and removing artificial features (e.g. big gradients and jets)
    - Caution to avoid filtering too little or too much



At the end...


170°E
180°W
170°W
160°W
150°W
140°W
130°W
55°S
160°E
60°S
150°E
65°S
70°S
75°S
80°S
5 cm s⁻¹
-2.5
-2
-1.5
-1
Dynamic Ocean Topography [m]