Mean Background Gravity Fields for GRACE Processing

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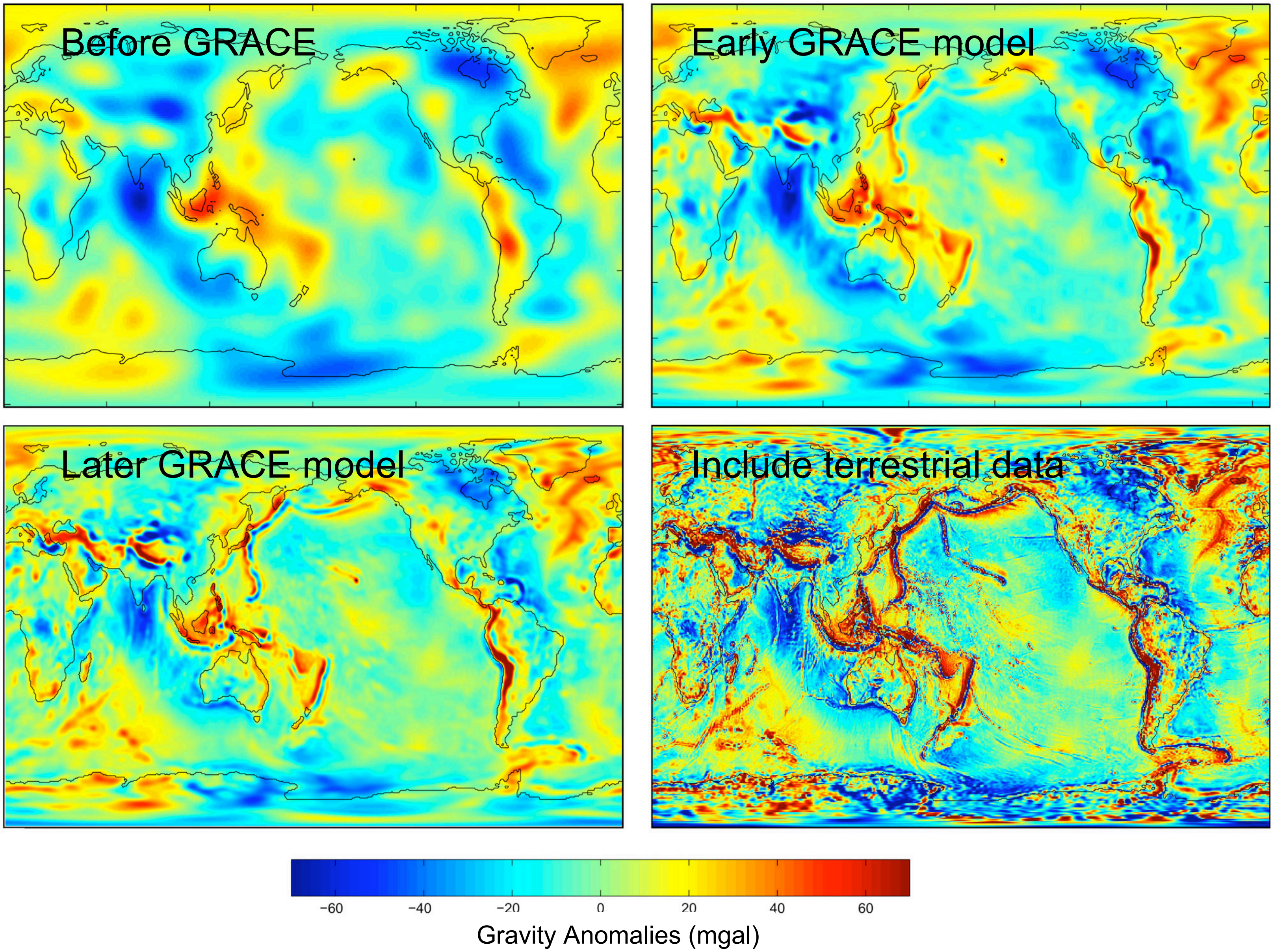
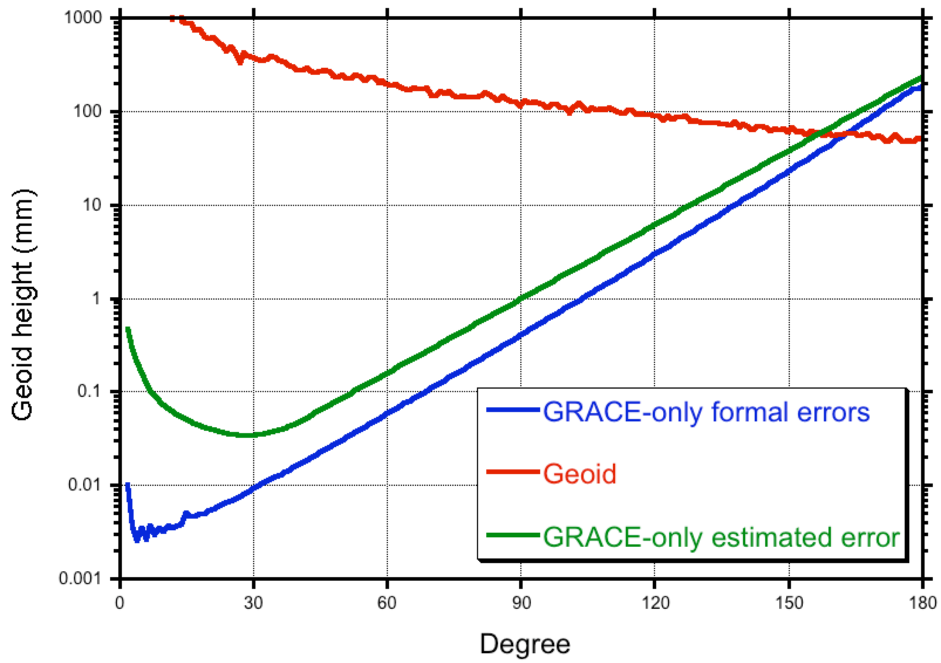
Mean Gravity Field from Space and Ground



Mean Field as Background Model

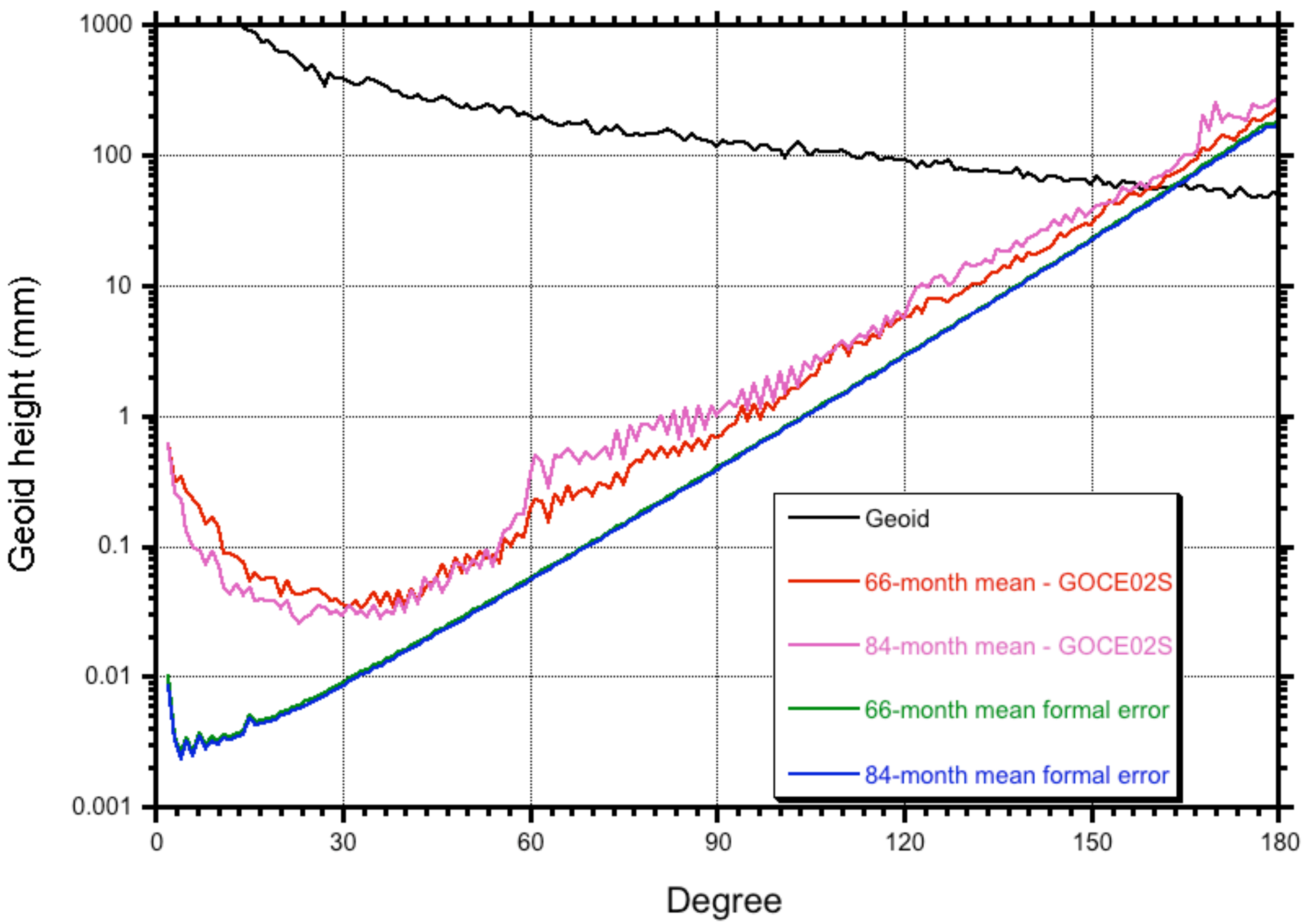
- We need an accurate, high resolution mean gravity field as part of the background model for the monthly GRACE estimates so that errors at the higher degrees do not alias down to harmonics at lower degrees of interest.
- GRACE itself is not able to fully resolve the mean field, so a combination of the GRACE mean field with terrestrial gravity information is required.



- This combination involves two challenges:
  - Realistically calibrating the GRACE mean field errors
  - Weighting the combination of the calibrated GRACE mean field relative to the terrestrial data.
- The nature of the errors in the GRACE mean fields leads to having to balance the overall accuracy of the mean field against artifacts that can appear in the resulting geoid.

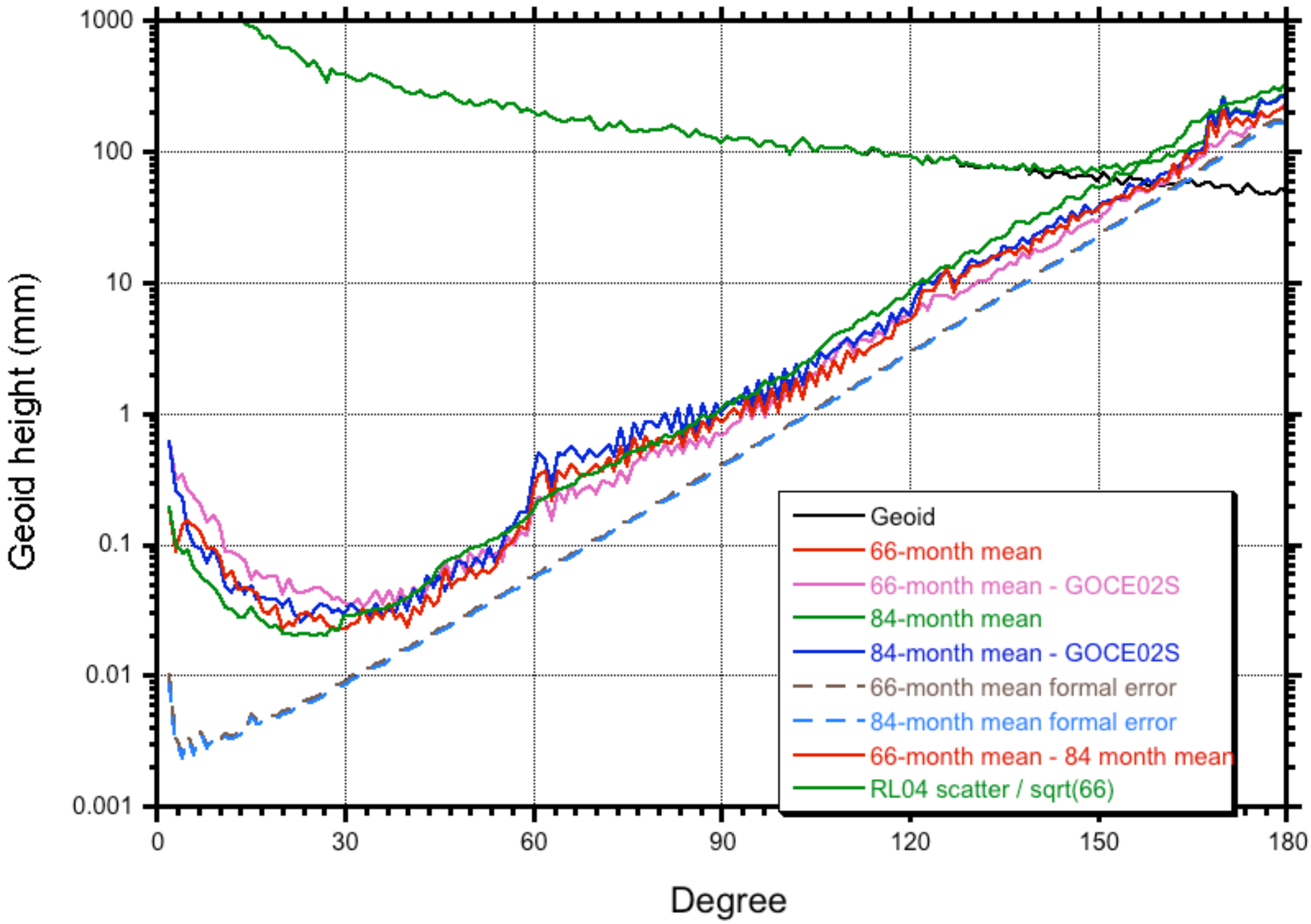
Mean Field Calibration (1)

Comparing 66-month ‘selected’ mean vs 84-month ‘full’ mean to GOC02S



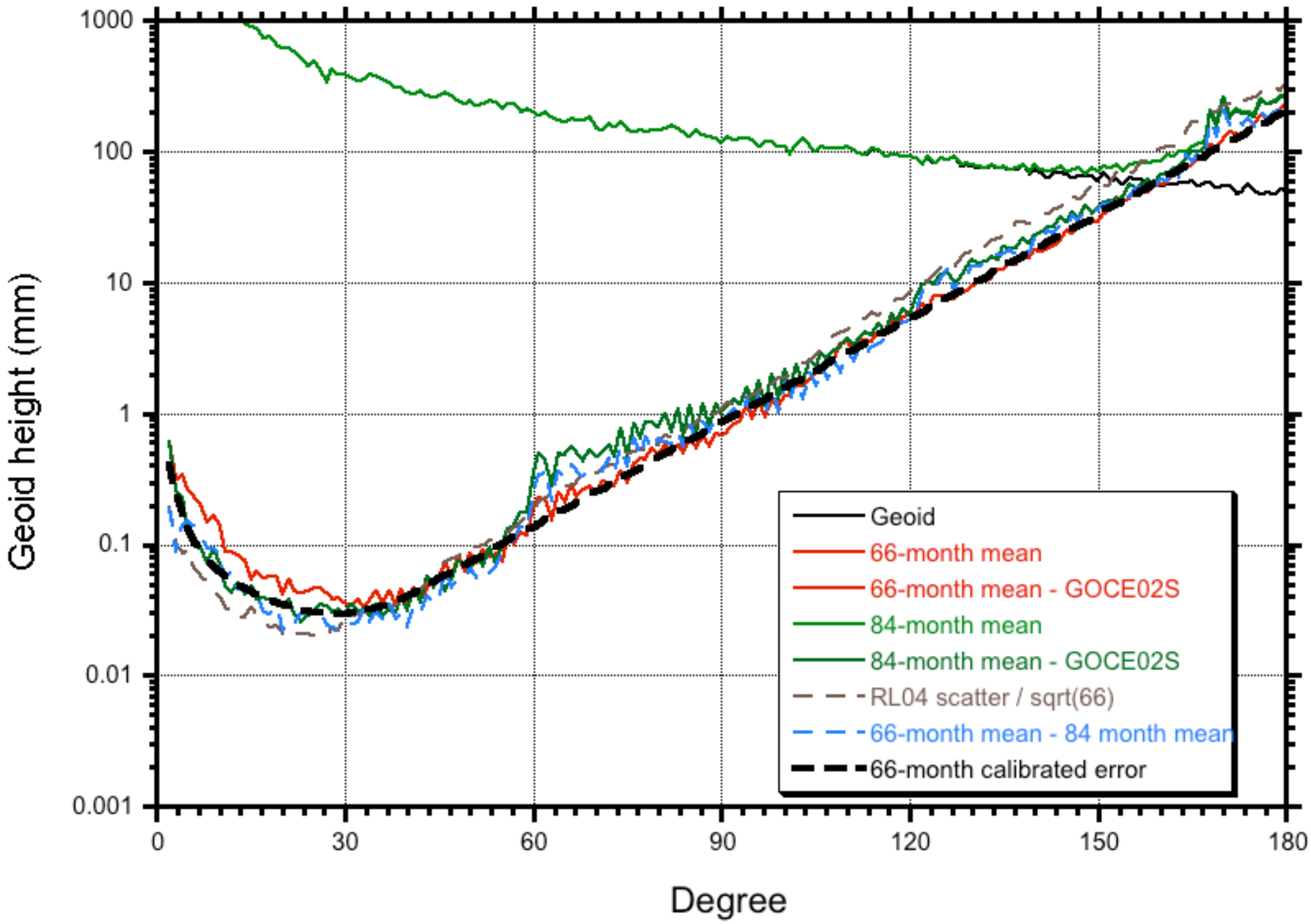
Mean Field Calibration (2)

Use internal and external comparisons to calibrate GRACE errors



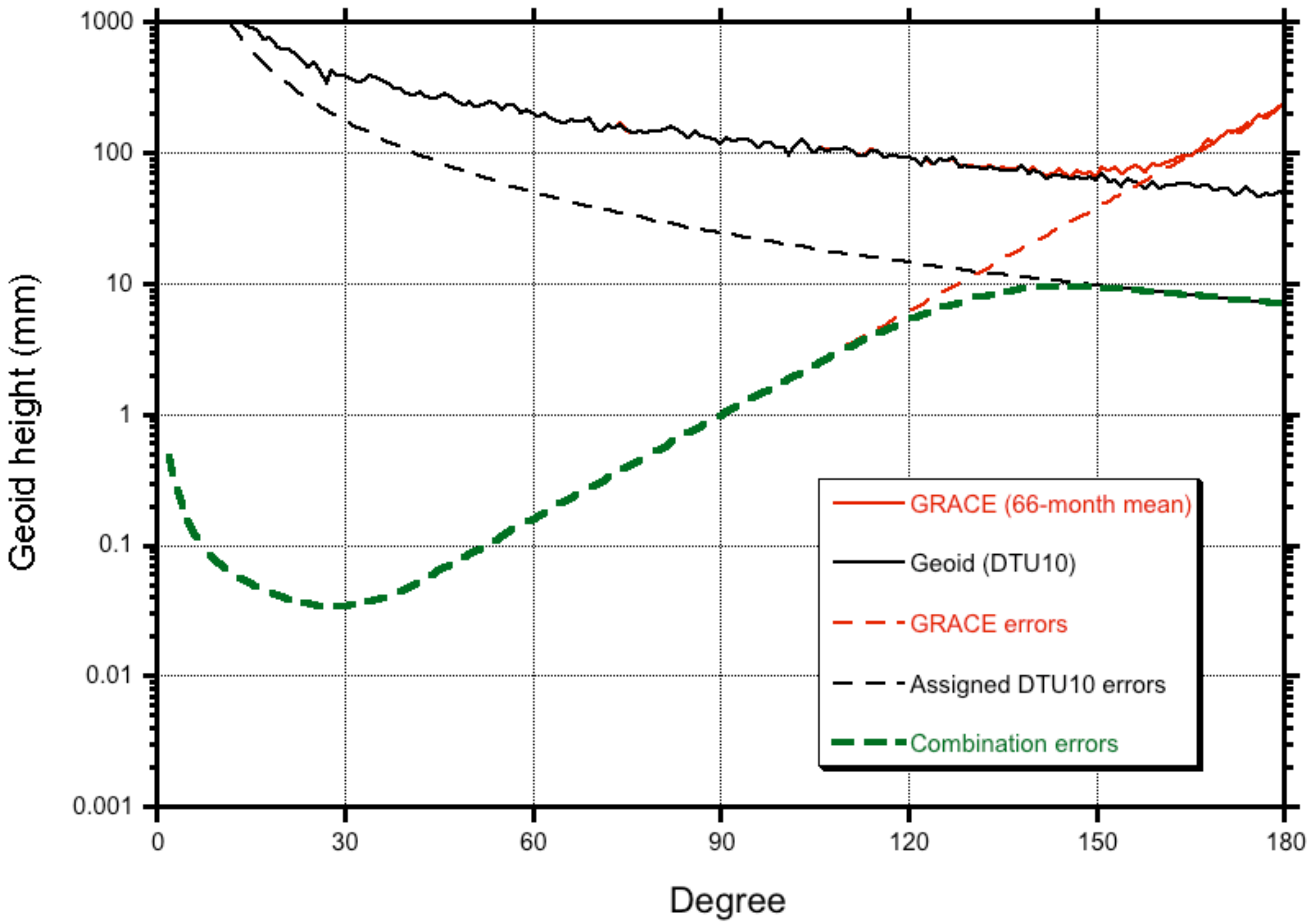
Mean Field Calibration (3)

Use calibration curve to scale formal sigmas to more realistic values



Combination with Terrestrial Gravity (1)

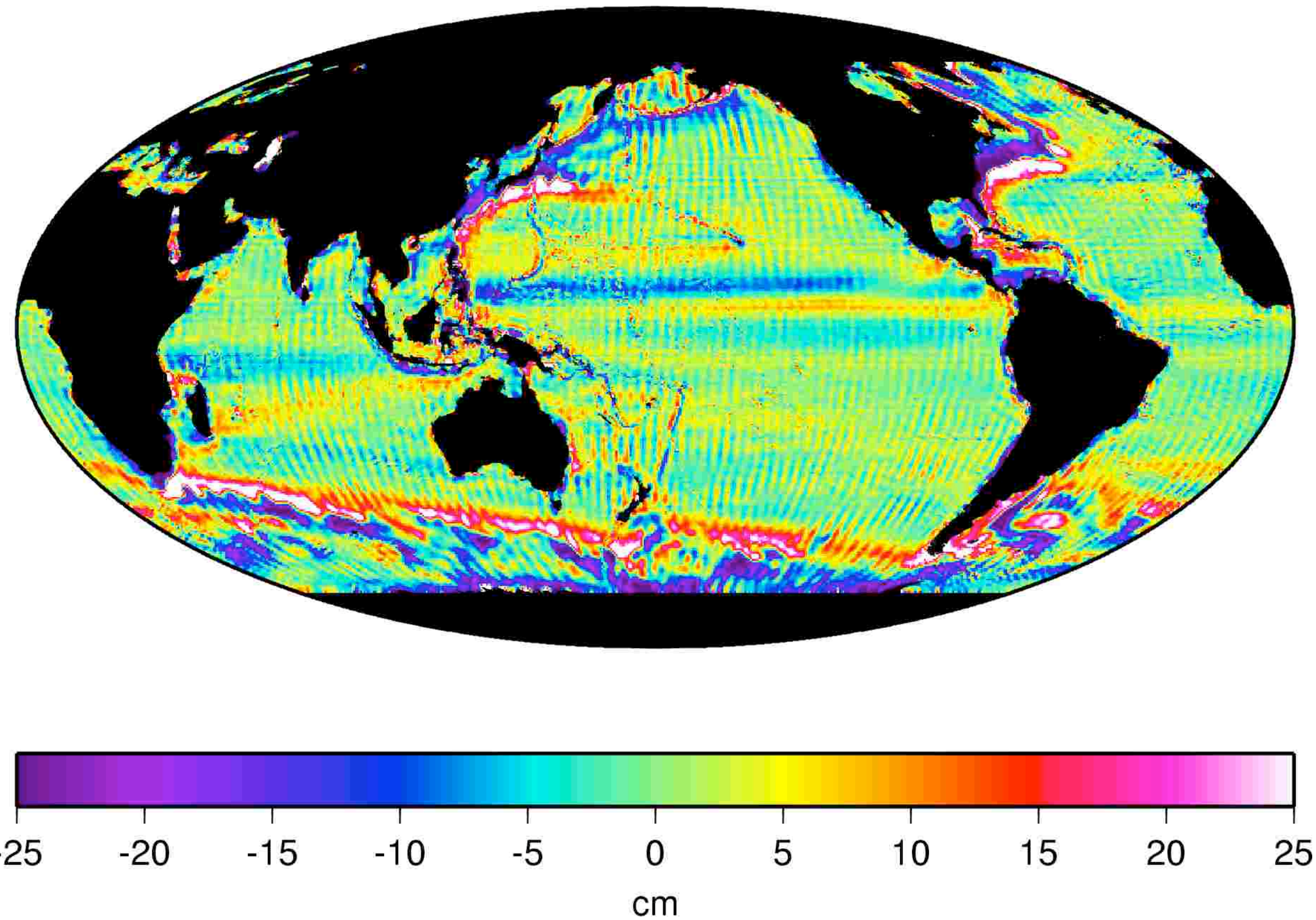
Use simple weighted combinations to test effects of relative weighting (results remarkably consistent with full covariance combinations)



GIF48

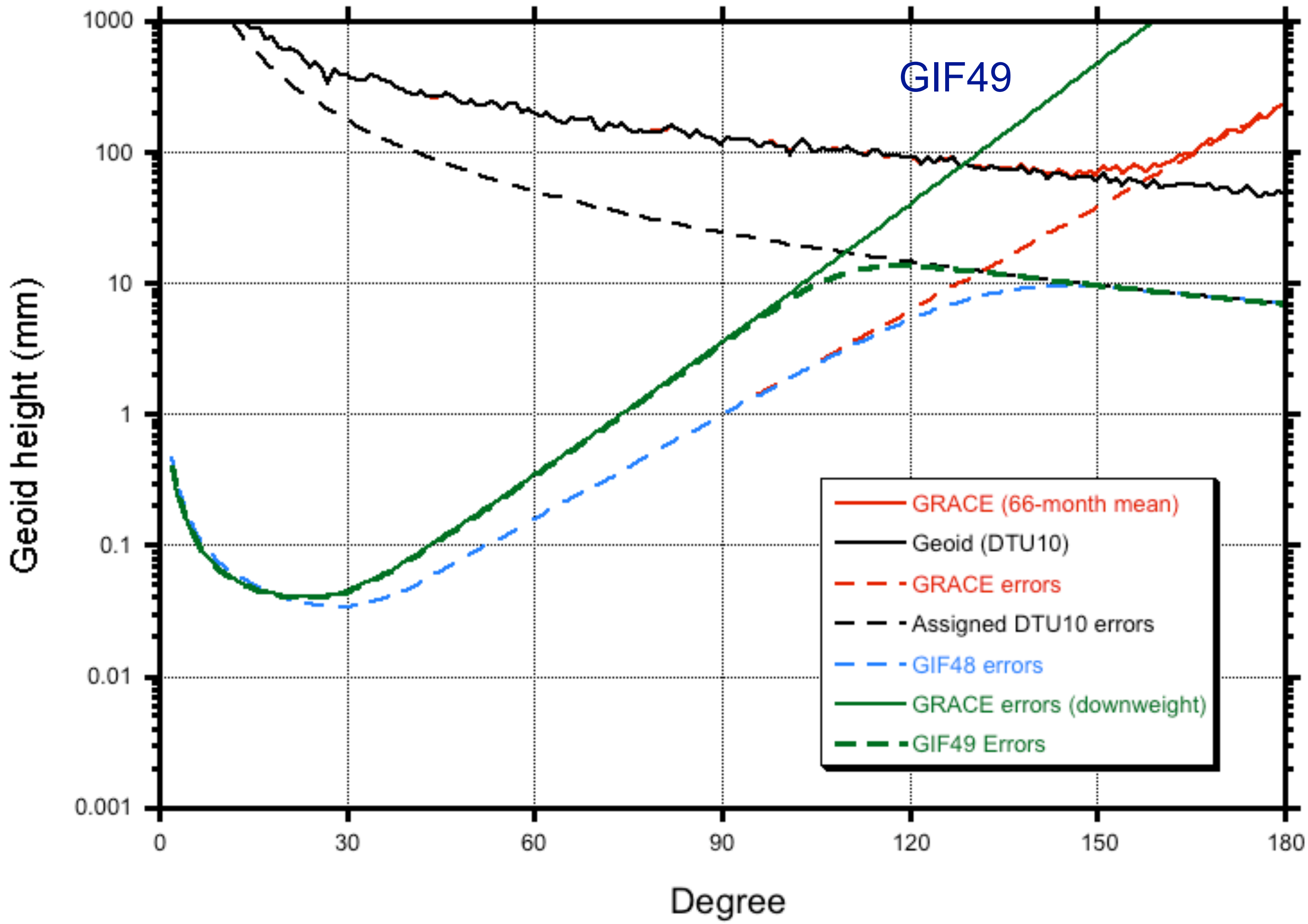
Short Wavelength Geoid Residuals
GIF48

The residuals are the difference between a ‘high-frequency DOT’ defined as (GSFCMSS00 – geoid) and the same DOT smoothed to ~900 km



Combination with Terrestrial Gravity (2)

Downweight GRACE information further to see effect on marine geoid



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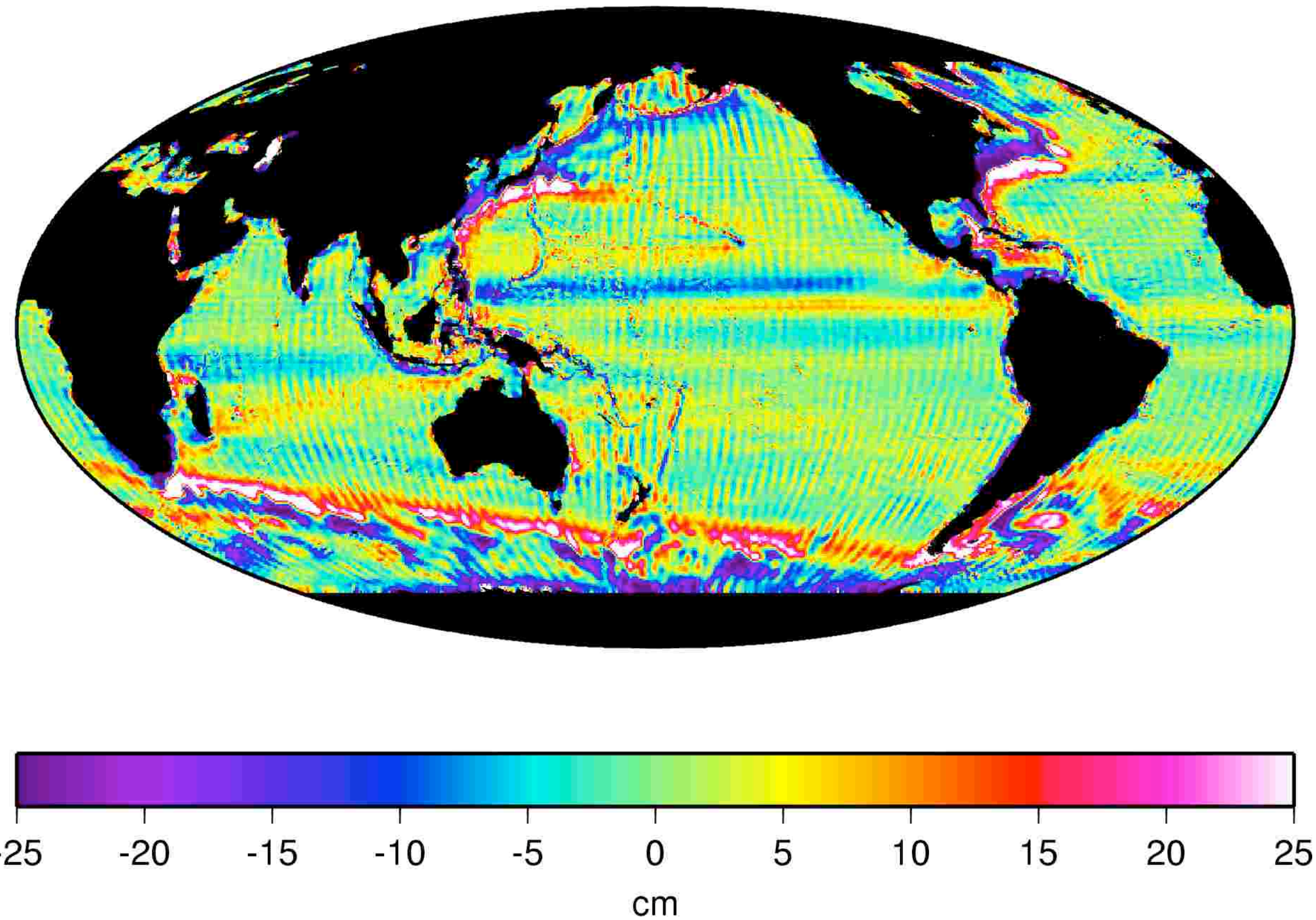
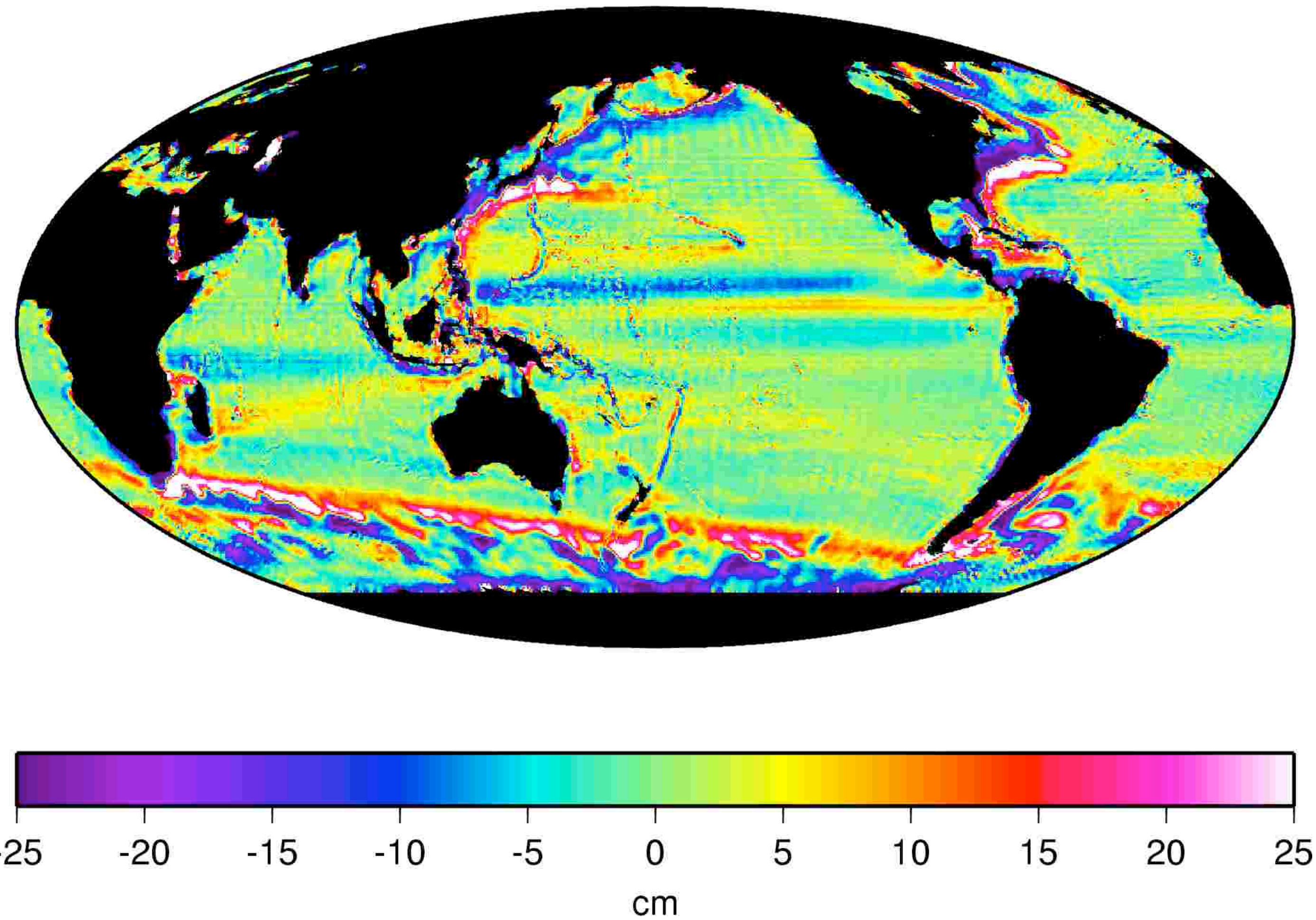


Short Wavelength Geoid Residuals GIF49

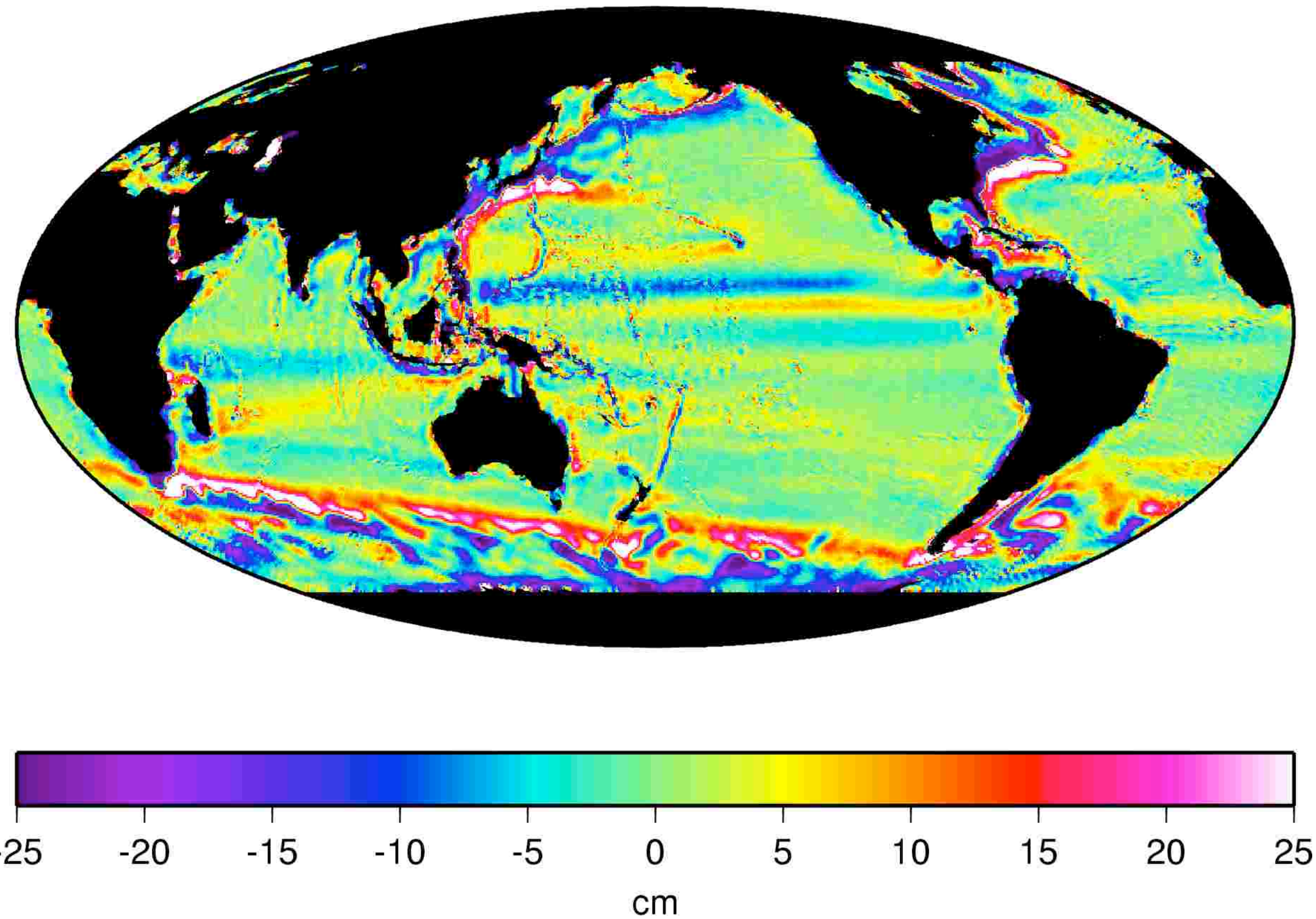
Meridional ‘striations’ nearly eliminated

Indicates that errors in sectorials and ‘near-sectorials’ are underestimated



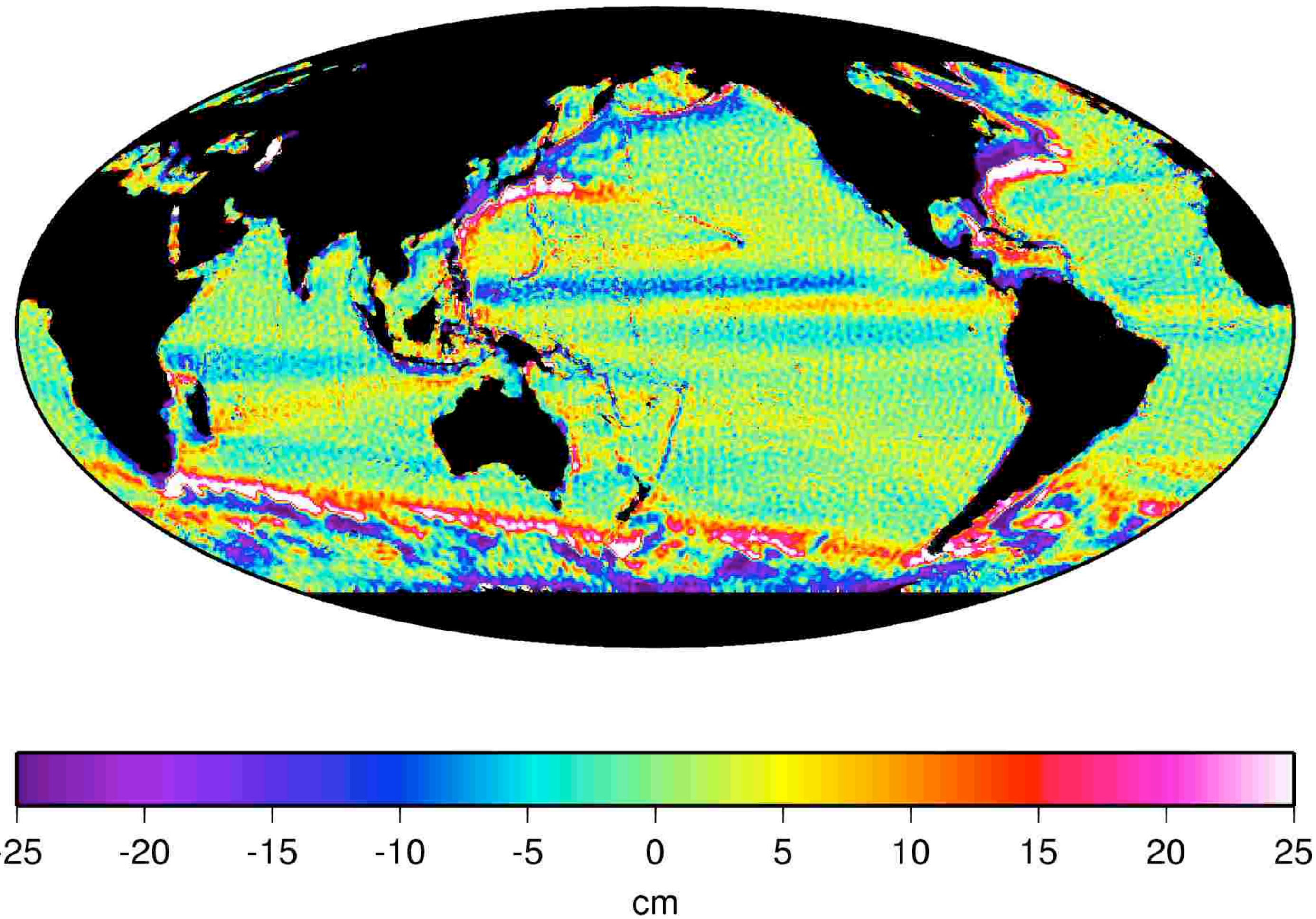
Short Wavelength Geoid Residuals EGM2008

GRACE data strongly downweighted in EGM2008 combination but results in very smooth marine geoid with little evidence of meridional artifacts



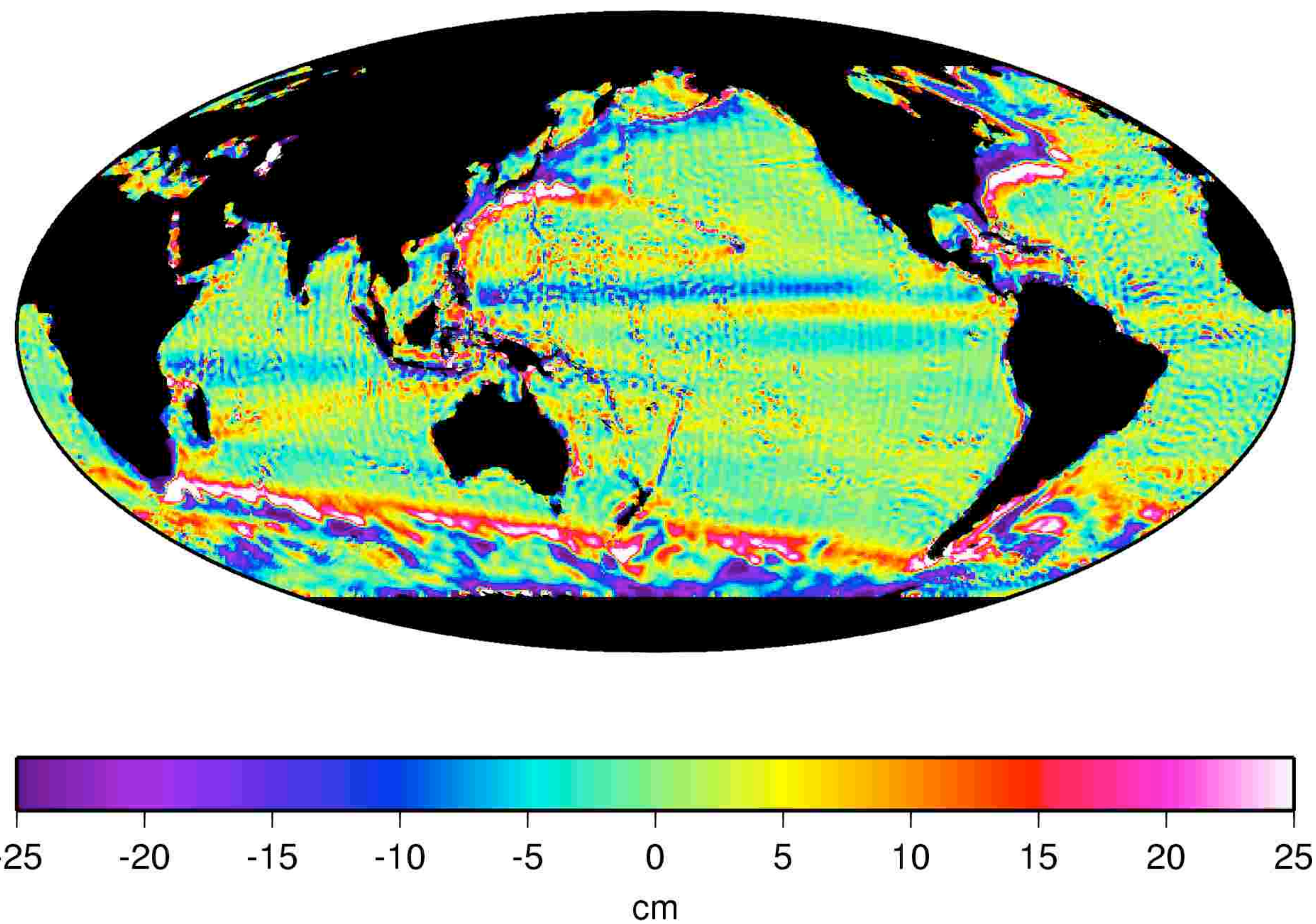
Short Wavelength Geoid Residuals
EIGEN-6C

'Orange peel' effect can result from interaction of GRACE and terrestrial data errors

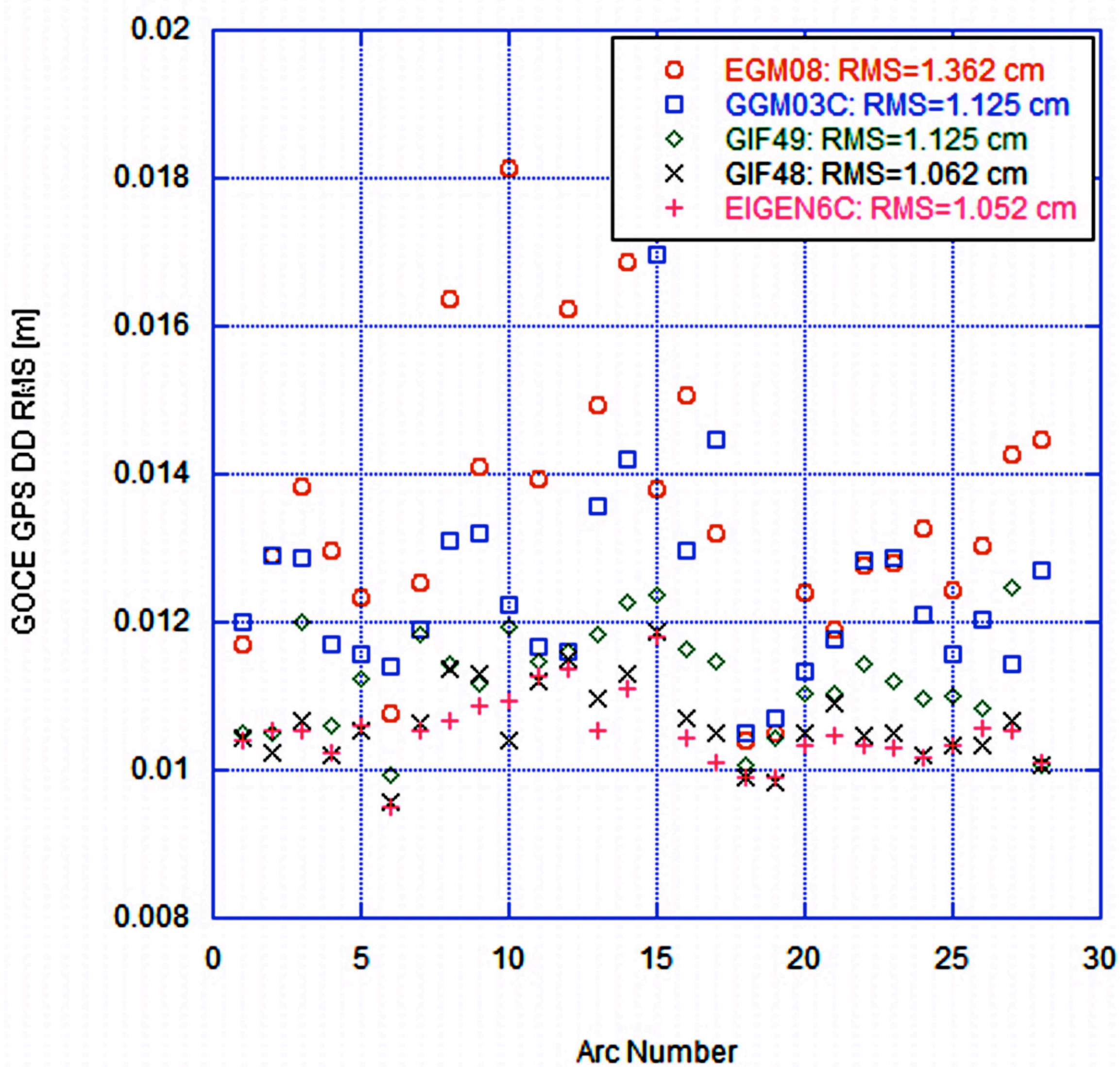


Short Wavelength Geoid Residuals GGM03C

‘Orange peel’ artifacts similar to EIGEN-6C but larger in GGM03C



GOCE Orbit Tests Provide an Independent Test of the Effect of the Relative Weighting



As GRACE information is downweighted, GOCE orbit fits degrade.

GPS DD RMS:

EGM2008: 1.362 cm

GGM03C: 1.125 cm

GIF49: 1.125 cm

GIF48: 1.062 cm

EIGEN6C: 1.052 cm

(EIGEN6C includes GOCE gravity information)

Summary

- While calibration of GRACE-only models at lower degrees has little effect on the mean field combination, a reliable error estimate for all degrees is essential for users to judge the impact of mean field errors in their applications.

- Incompatible information can lead to artifacts in the combination of GRACE and terrestrial gravity information
  - Downweighting GRACE leads to ‘smoother’ marine geoid but less accurate orbits for GOCE

- GRACE coefficient errors are generally under-estimated for sectorials and near-sectorials
  - These terms are most susceptible to long-wavelength dynamical modeling errors
  - Using shorter arcs is one approach that may reduce this but the effect on monthly estimates not yet evaluated in our processing