An Updated CSR Intermediate Mean Gravity Field Model: GIF63

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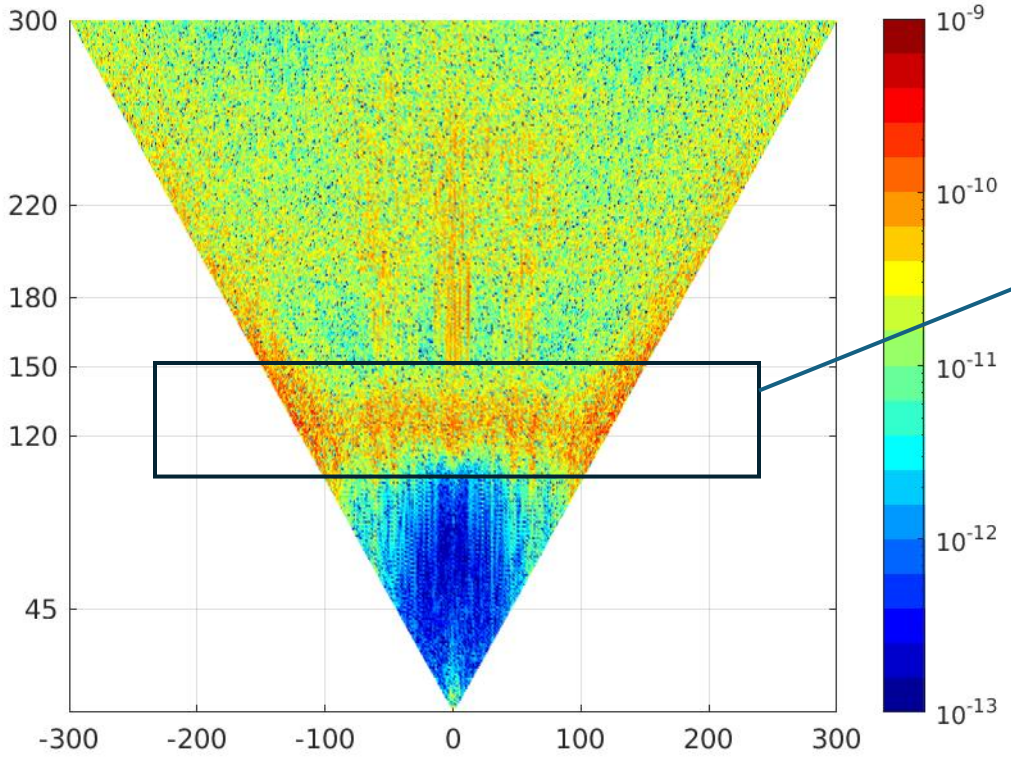
Online

Background

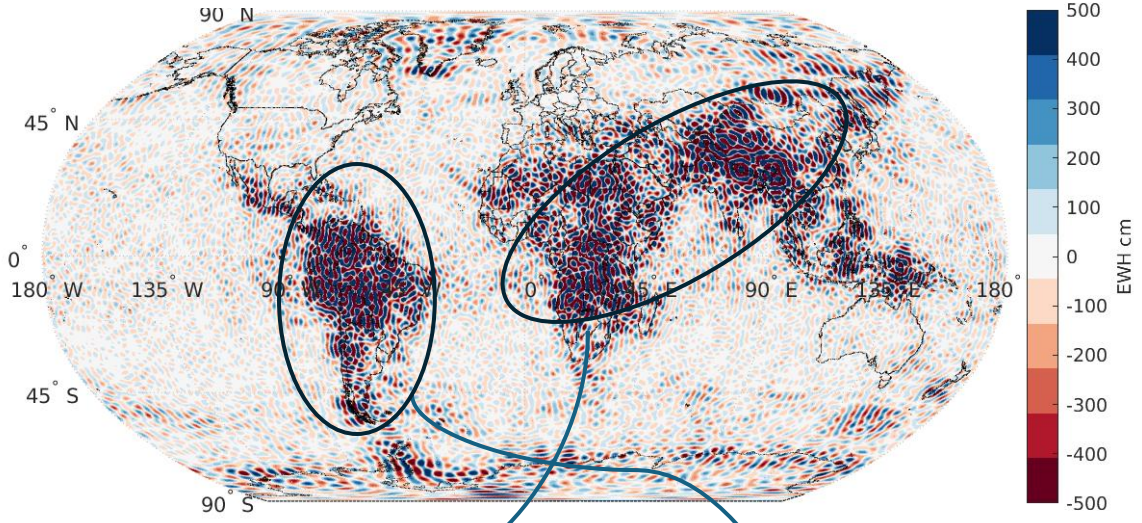
- The CSR RL06 solution for the GRACE data was released in 2017
- Post-release analysis of the RL06 data indicated that improvement in the solution was possible
- Opportunities for improvement have been identified:
  - GGM05C mean reference model
  - Ocean tide model
  - AOD1B model for the high frequency ocean-atmospheric interactions
  - Better error characterization of the K-Band and GPS ranging data
- The CSR RL07 reanalysis of the GRACE and GRACE FO data was initiated in 2020
- This presentation presents our efforts on updating mean reference model - the development and assessment of the intermediate mean gravity field model GIF63.

Introduction: continental anomaly

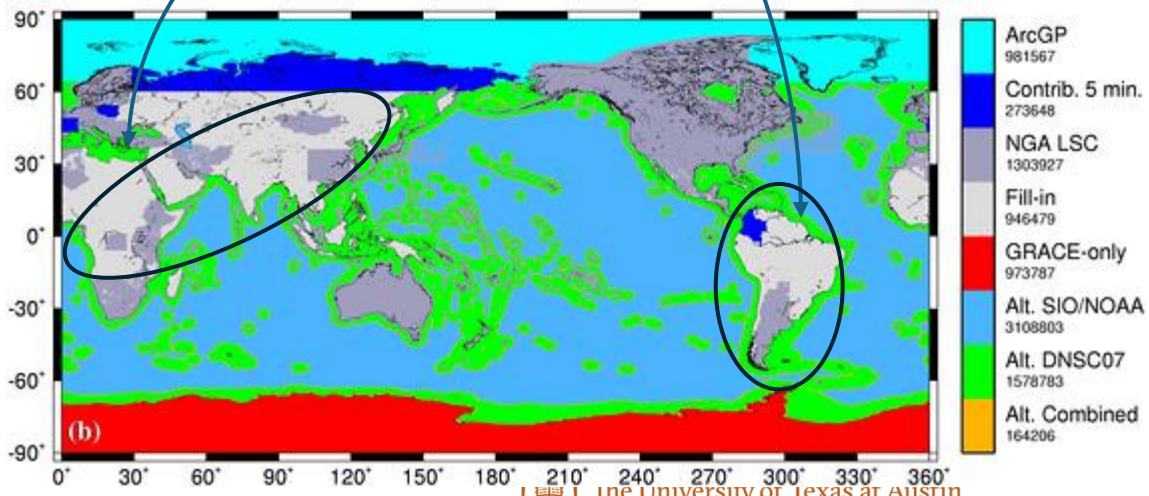
XGM19 – GGM05C



XGM19 – GGM05C D90-150 S120-200km



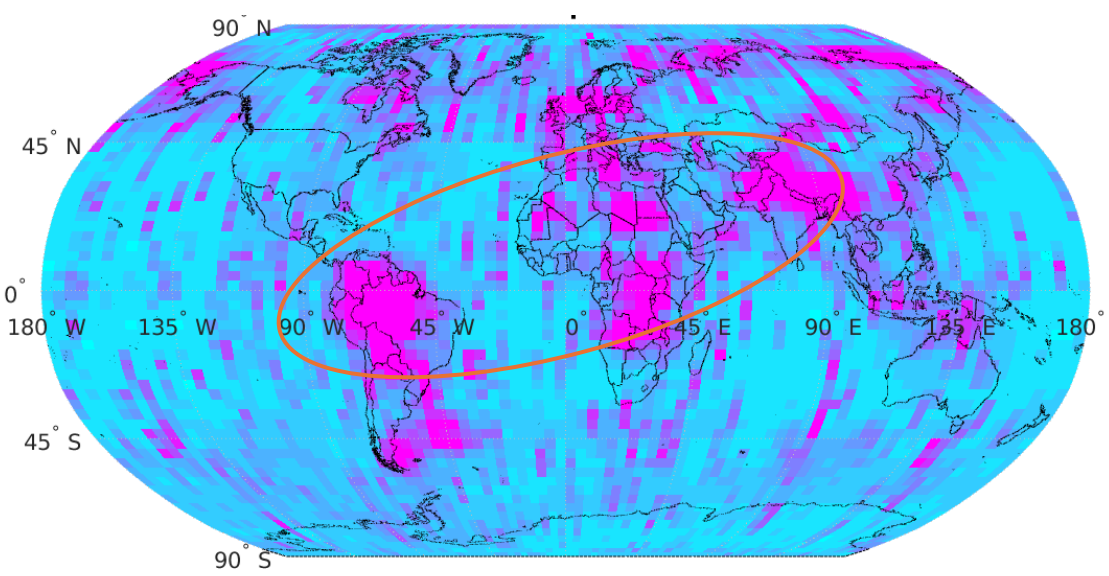
EGM08 data coverage



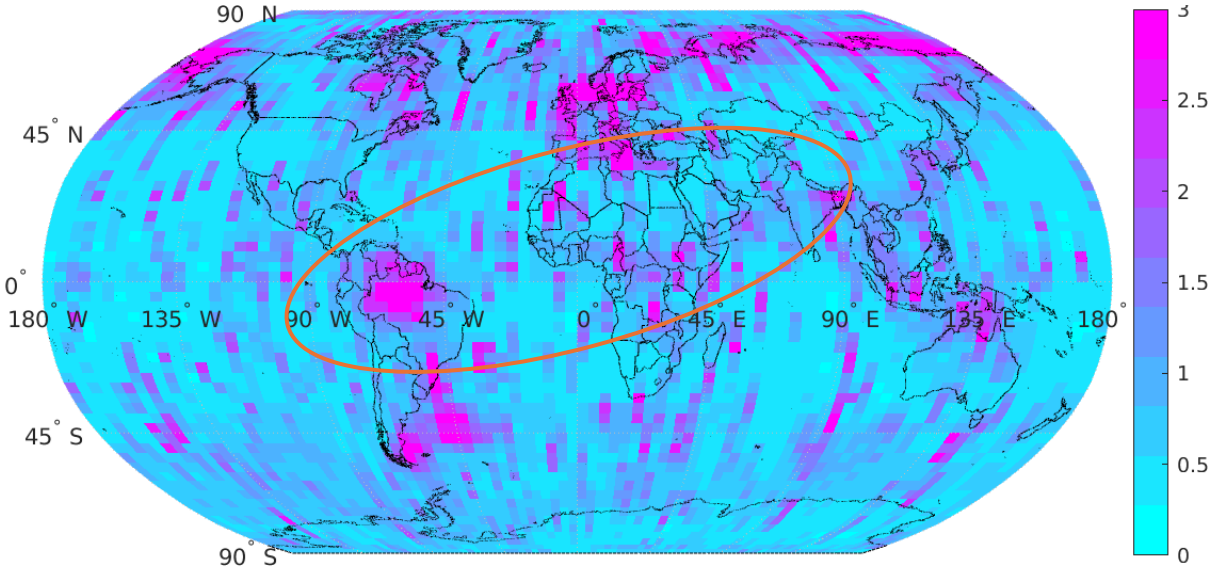
EGM08 data (the best at the time) has been used to produce GGM05C.

Introduction: KBR residual

KBR Postfit residual variance:
GGM05C



KBR Postfit residual variance:
XGM19

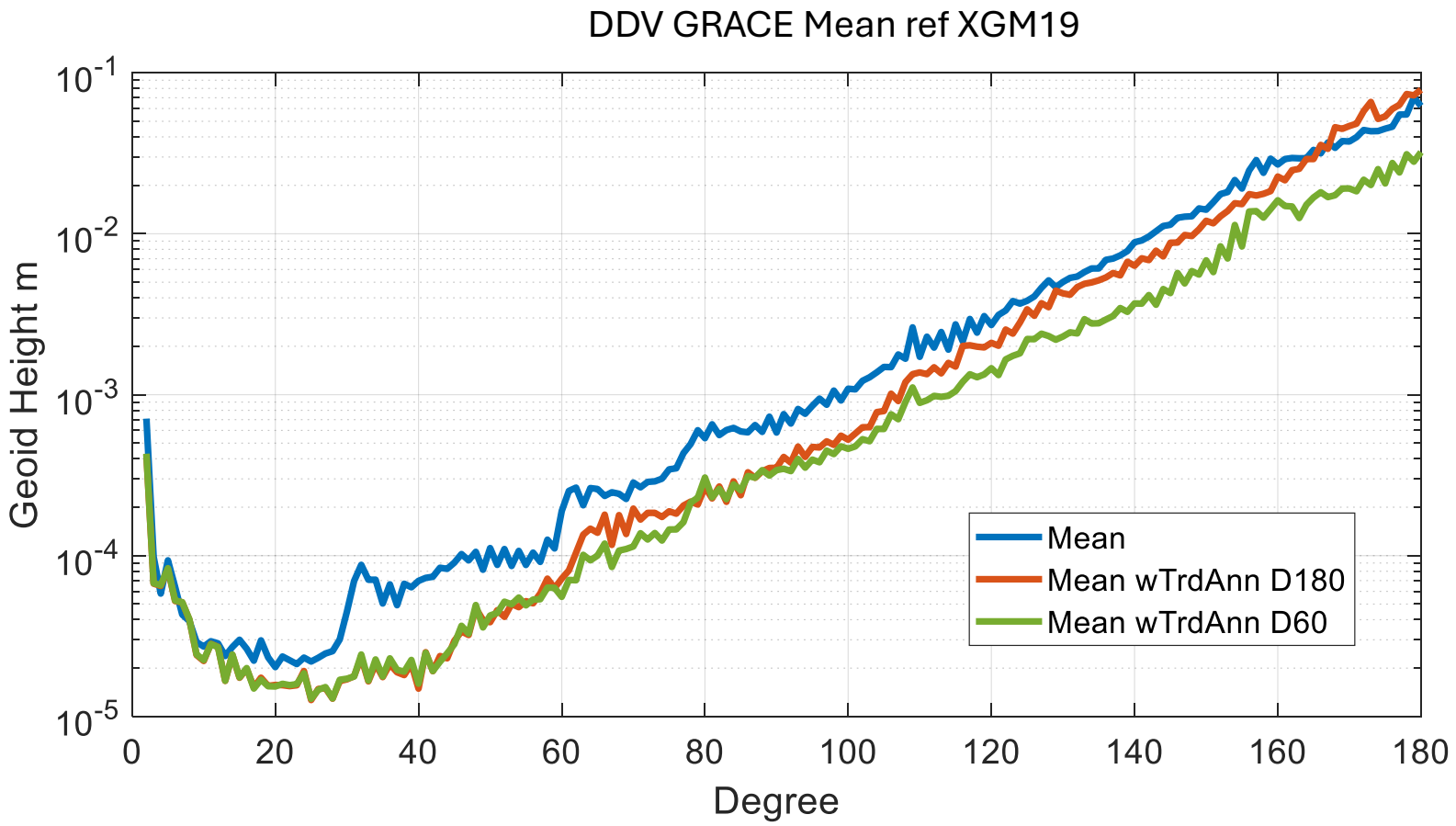


GRACE (2008&2014) KBR data was used to compute monthly solution and postfit residual.

- The continental anomalies are mainly within GGM05C. XGM19 is better in these regions.
- Before RL07 reprocessing, we should update our mean field model.
- More specifically updating the contributions from **GRACE, GOCE and surface data.**

GRACE Mean

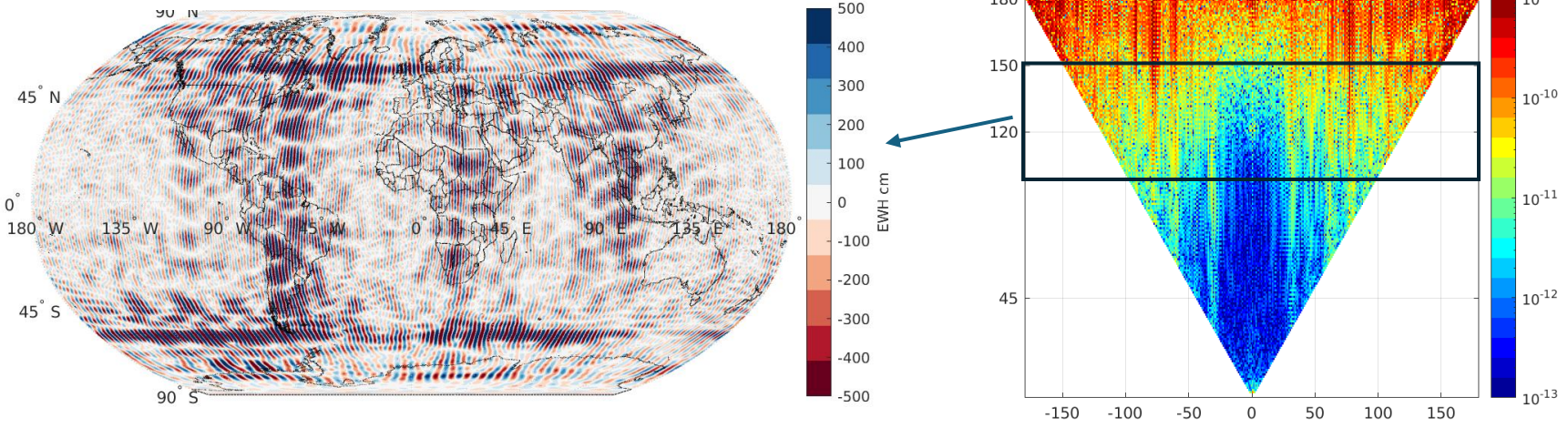
Data: preliminary. V05 L1B (2004-2016)
Parameterization: same as RL06



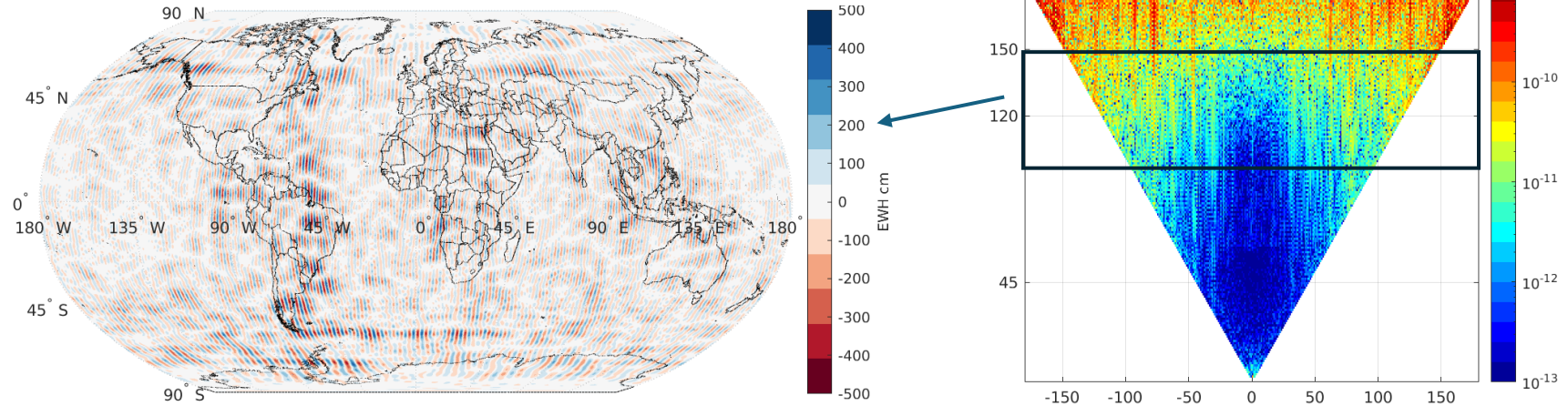
- Co-estimate Trend and Annual reduces the variance.
- Co-estimate Trend and Annual up to Degree 60 (green) is better than Degree 180 (red).

GRACE Mean

GRACE Mean – XGM19 S120-200km

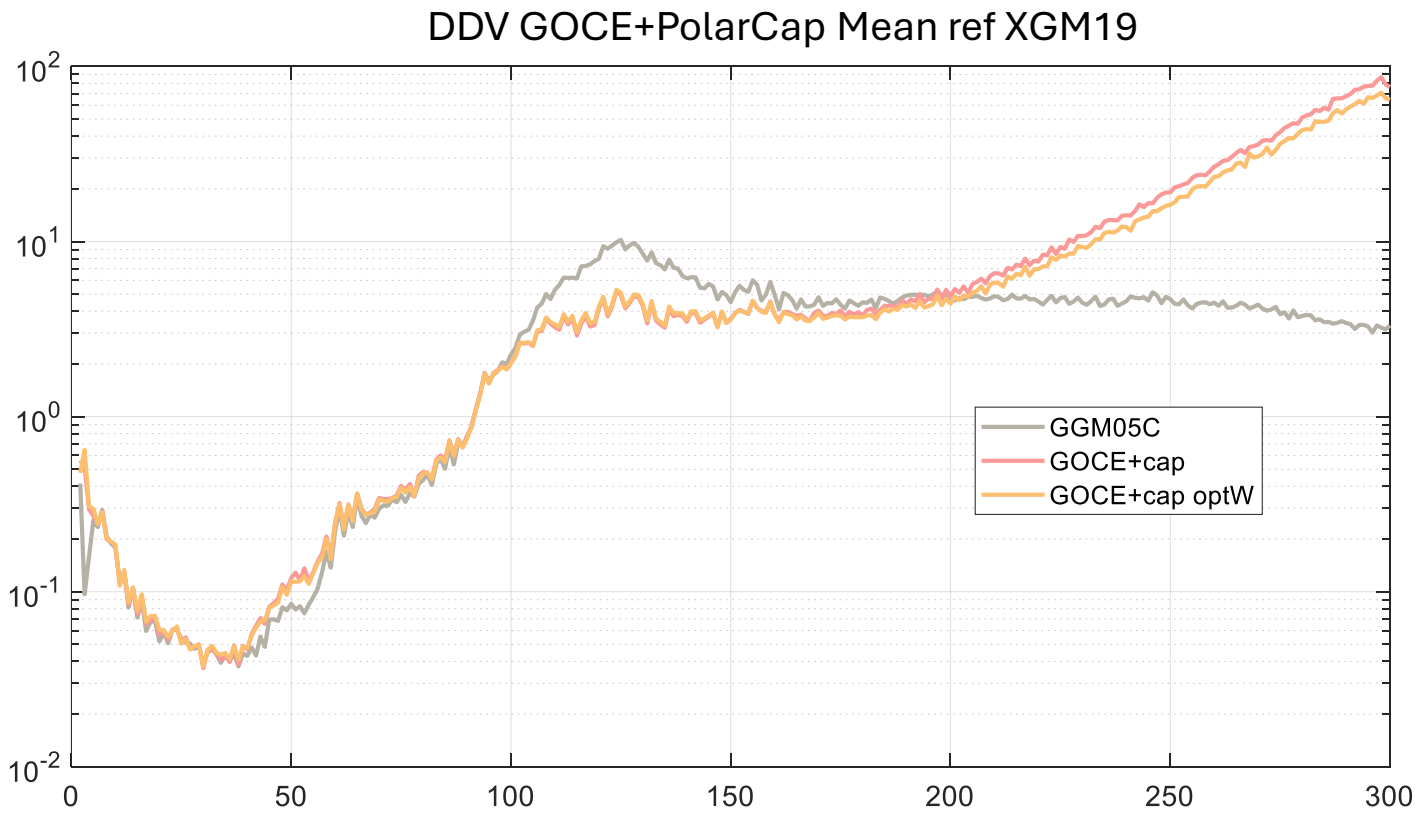


GRACE Mean **wTrdAnnD60** – XGM19 S120-200km



- Co-estimating trend and annual reduce anomalies at resonance order**.**
- The continental anomalies seen in GGM05C is **not introduced by GRACE** Mean field.

GOCE Mean



The new GOCE L1B data derived GOCE mean is better than GGM05C around D120.

The latest GOCE L1B data (version 202) are used. Down sampled from 1s to 5s.

CRN bandpass filter is applied on prefit residual (8-55mHZ) to remove high noise at low frequency and high frequency.

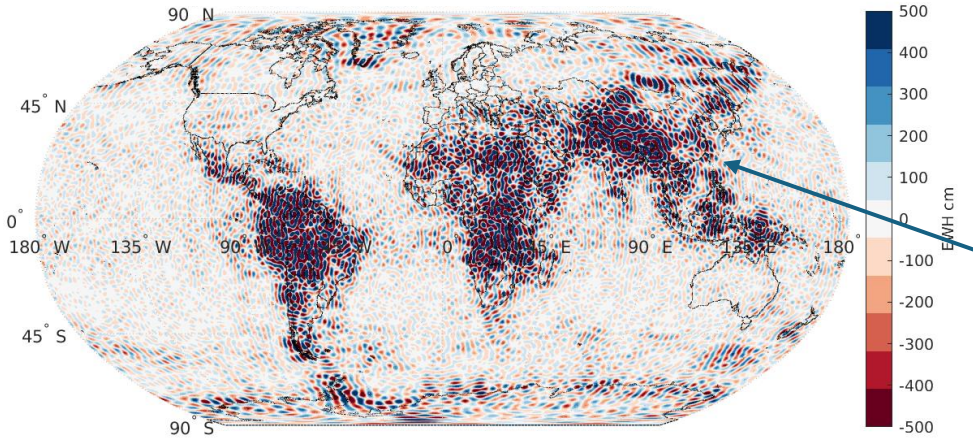
GRACE mean field is used to fill the polar gap.

Only XX, YY, ZZ and XZ components are used.

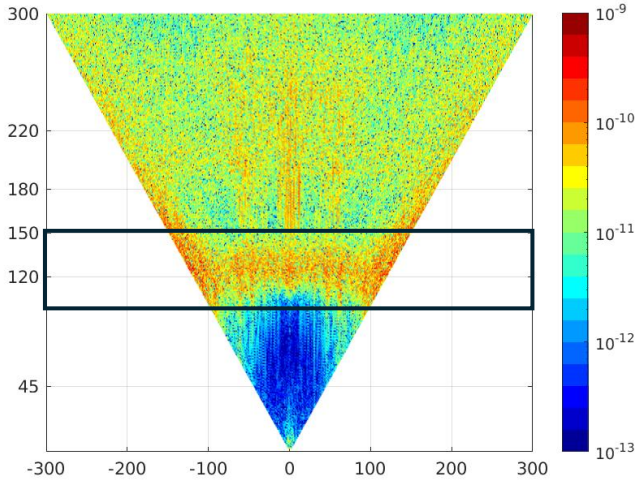
A mean optimal weight factor is used to weigh each component 20, 22, 7 and 4 respectively for XX, YY, ZZ and XZ.

GOCE Mean

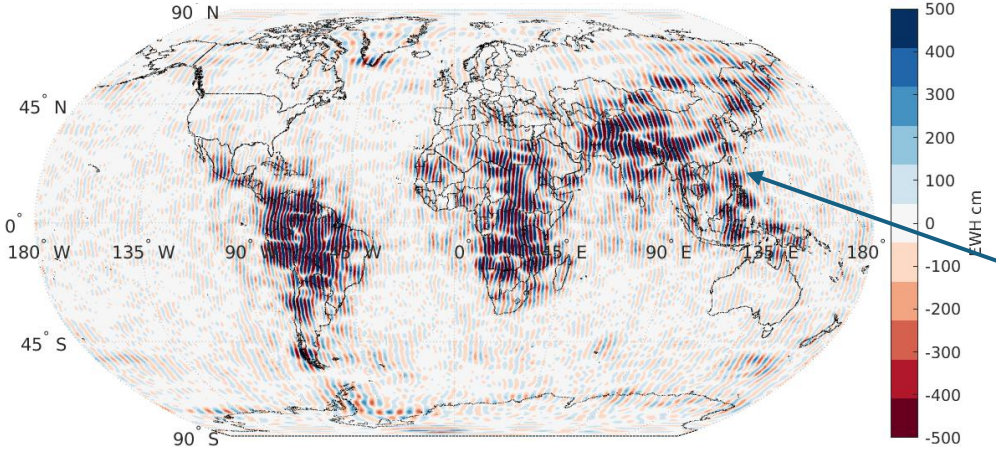
GGM05C – XGM19 S120-200km



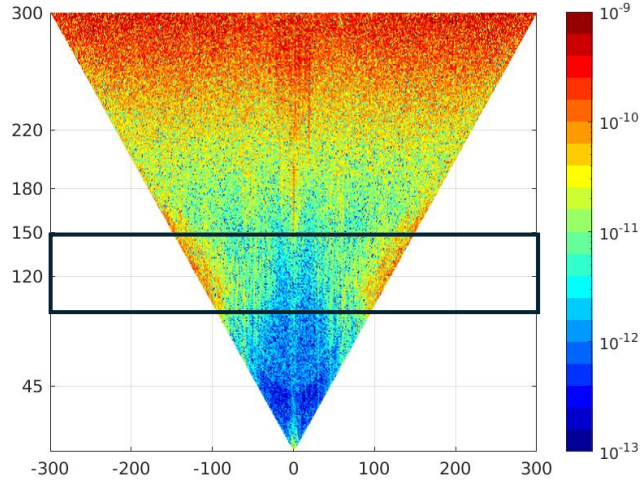
GGM05C – XGM19



GOCE Mean – XGM19 S120-200km



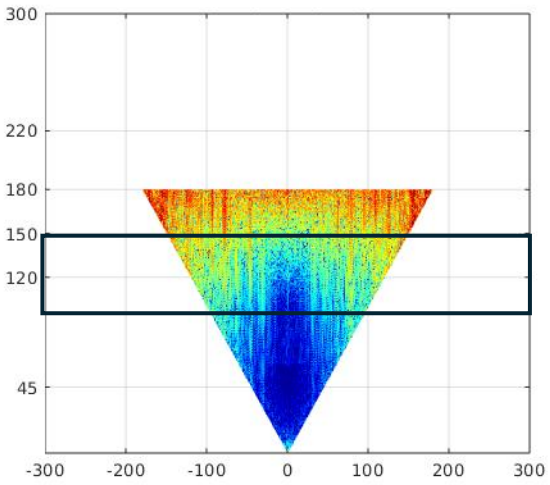
GOCE mean - XGM19



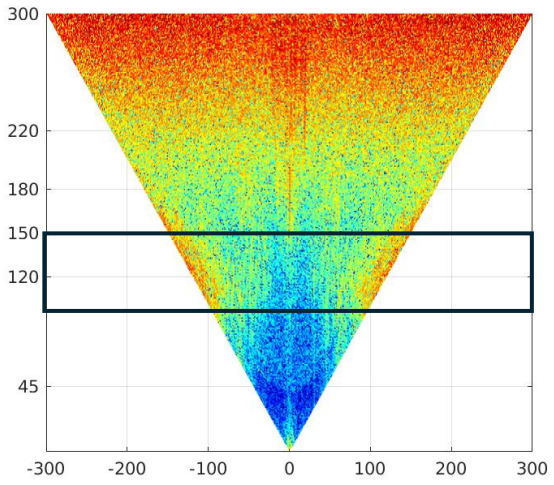
- The continental anomalies partially come “from” GOCE mean field due to the bandpass filter.
- The continental anomalies is reduced from full spectrum to mainly close to sectoral coefficients around degree 120.
- **Optimized GRACE and GOCE combination is needed.**

GRACE+GOCE Mean: Cov. Cal.

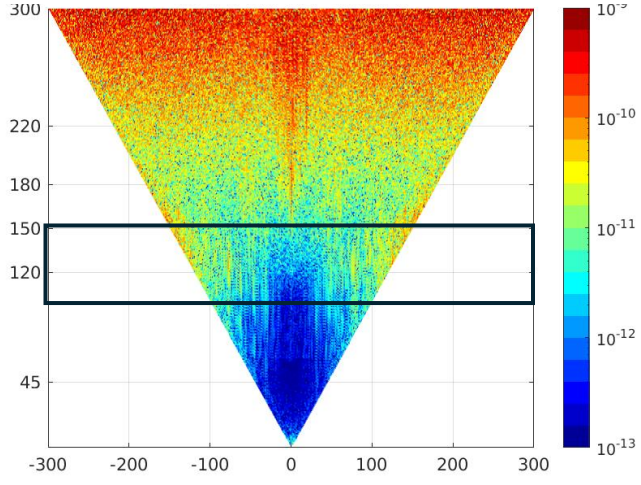
GRACE – XGM19

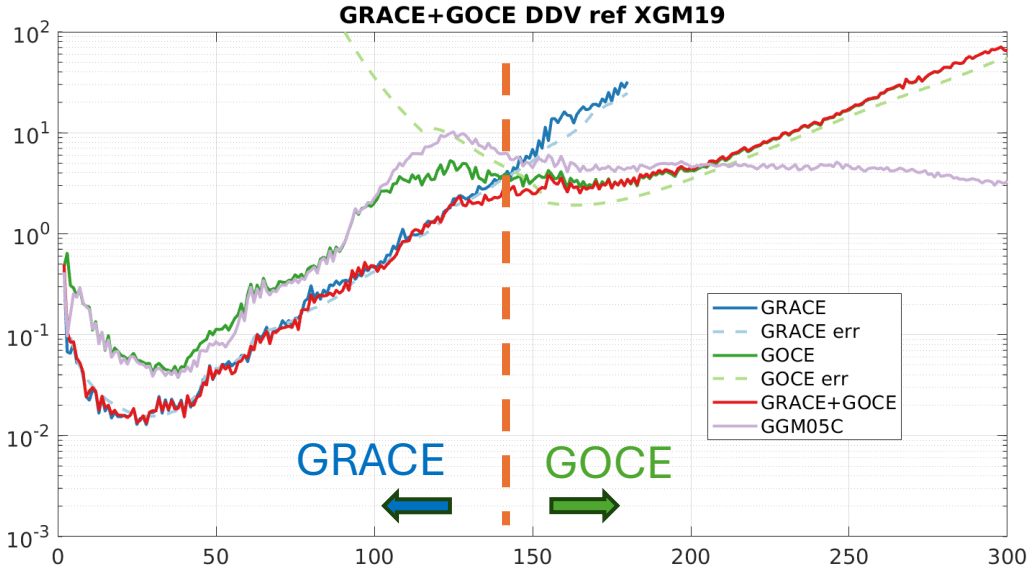


GOCE – XGM19



GRACE+GOCE – XGM19



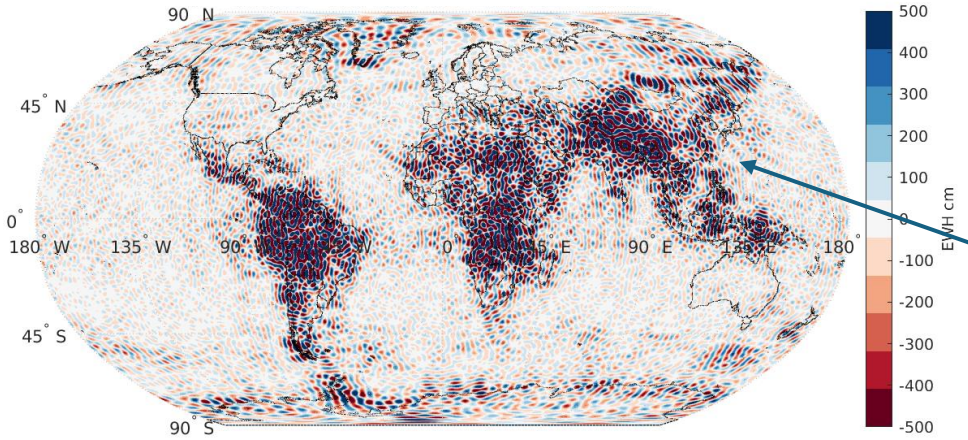


- The continental anomalies are within GOCE only solution.
- Calibrate the covariance matrix **and increase GRACE's contribution** between D90 and D150.

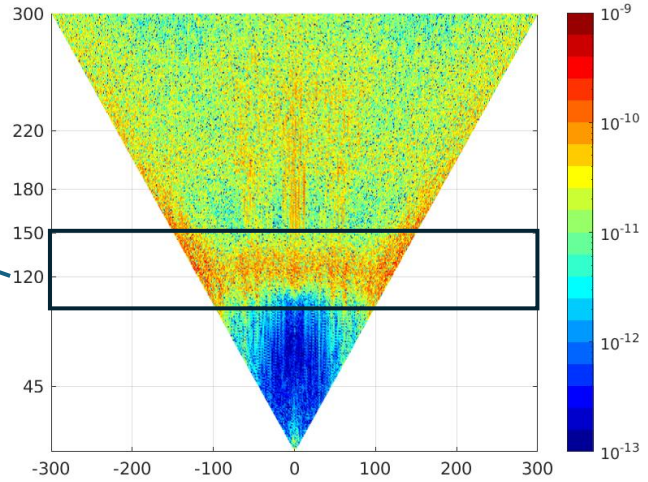
*All combination are in normal equation level.

GRACE+GOCE Mean

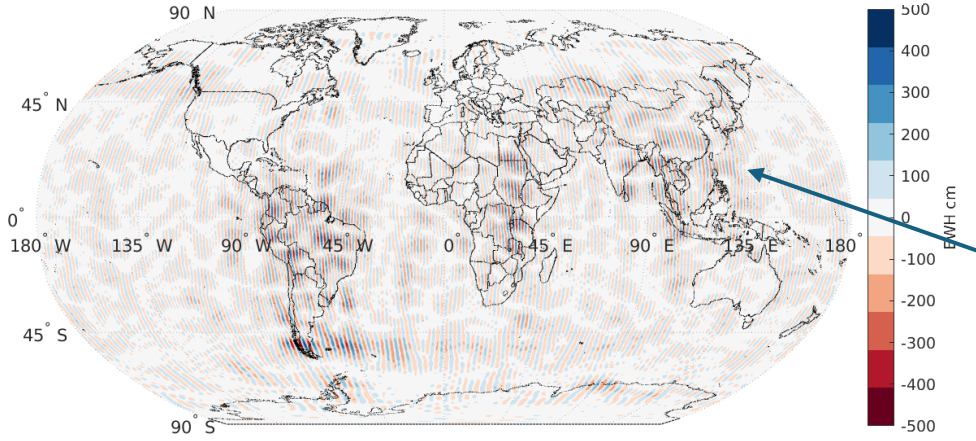
GGM05C – XGM19 S120-200km



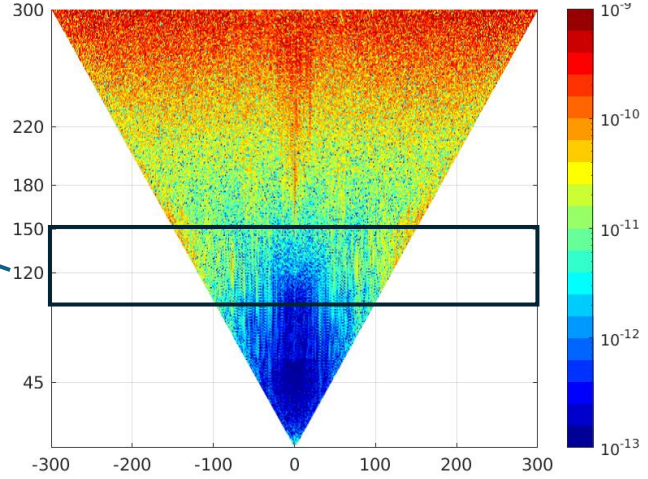
GGM05C – XGM19



GRACE+GOCE Mean – XGM19 S120-200km



GRACE+ GOCE mean - XGM19

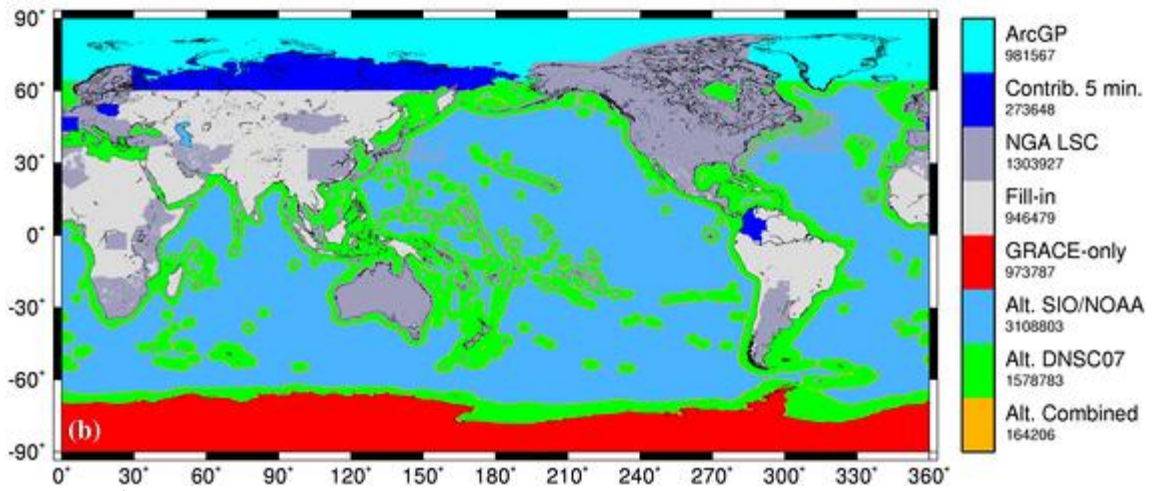


The continental anomalies are largely eliminated in the new GRACE and GOCE combined mean field.

Surface data is still needed to stabilize high degree (above D220) coefficients and GOCE polar gap.

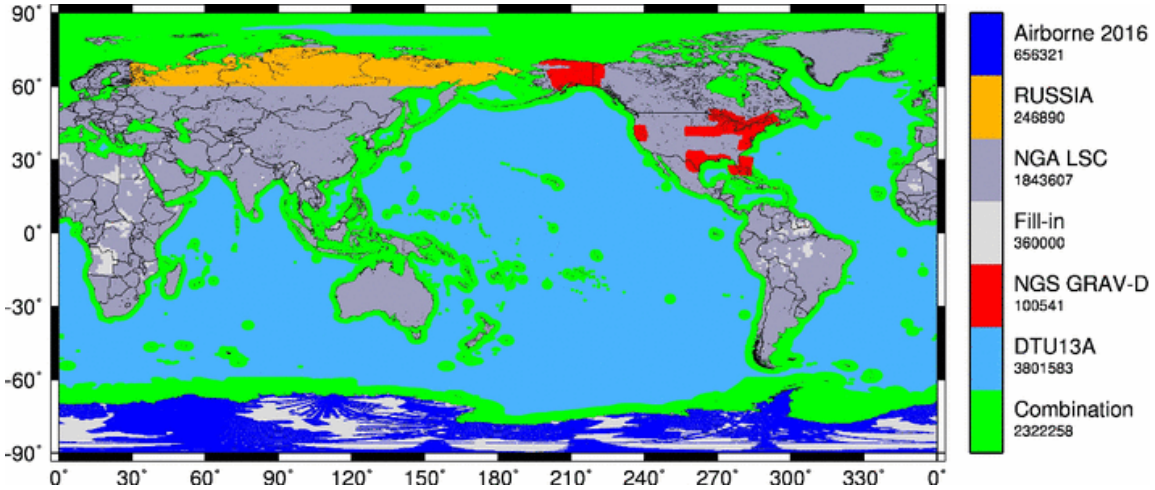
GIF63: (pseudo) surface data

EGM08 gravity data



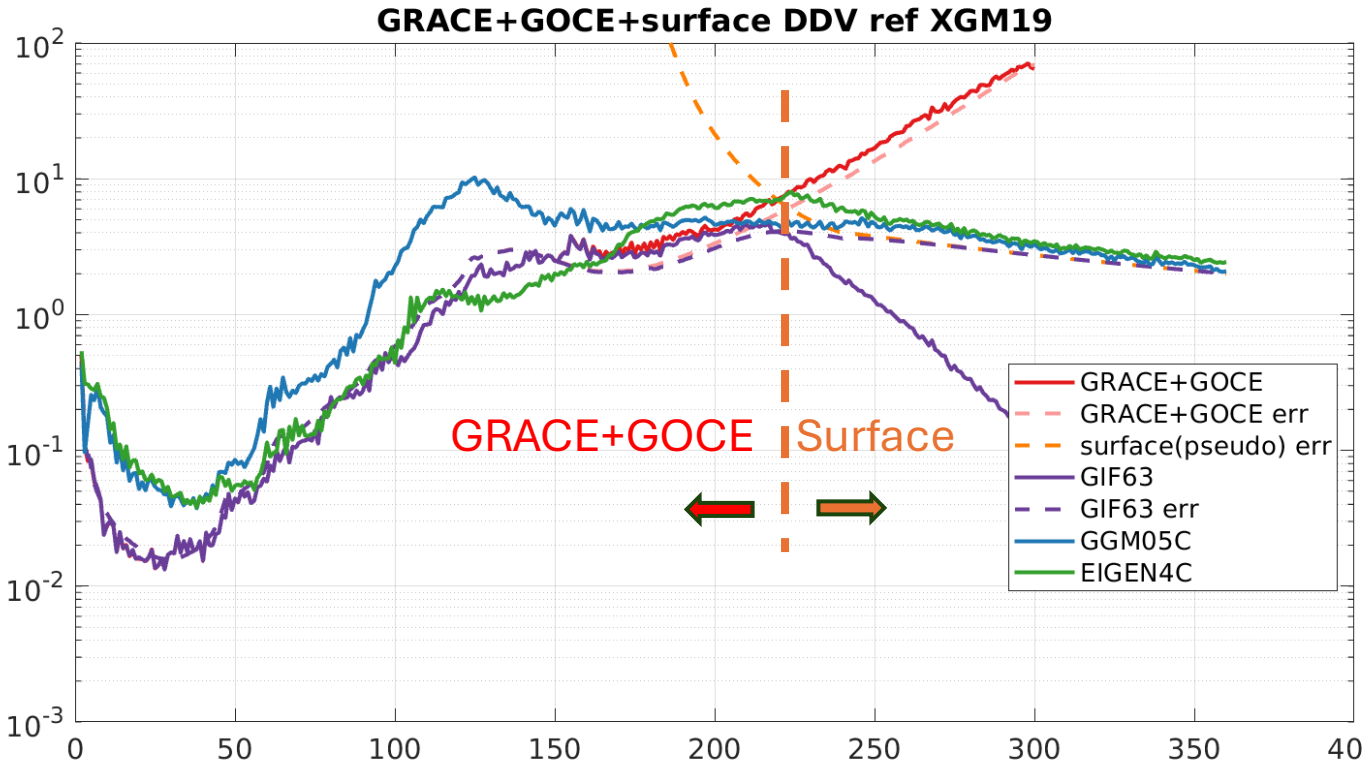
Pavlis et al. 2012

XGM19(16) gravity data



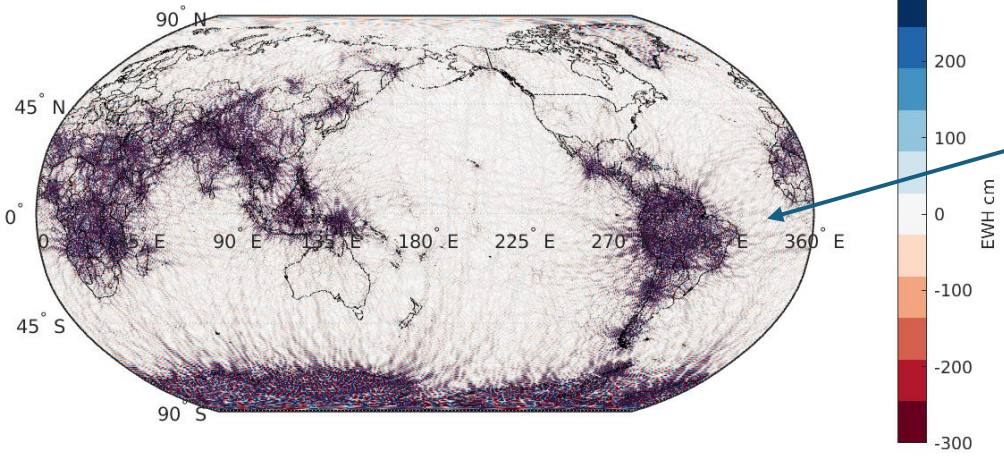
Pail et al. 2017

XGM19 used updated NGA compilation, which has better land coverage. But it is not publicly available.
GIF63 uses XGM19 as **(pseudo) surface gravity** input to stabilize the high degree coefficients and polar cap.

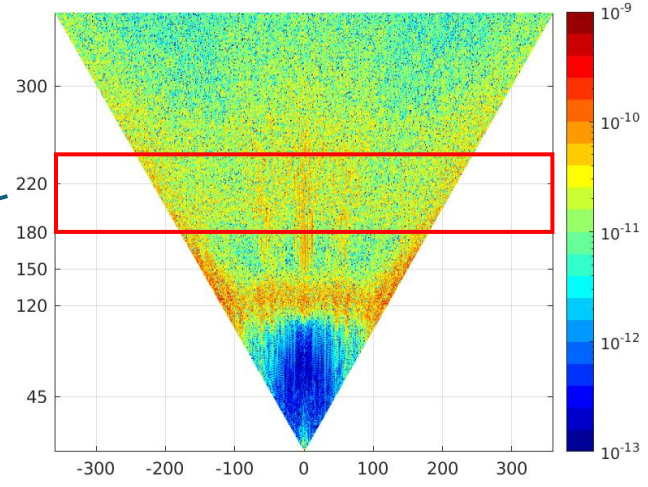


GIF63: high degree (180~240)

GGM05C – XGM19 S75-100km

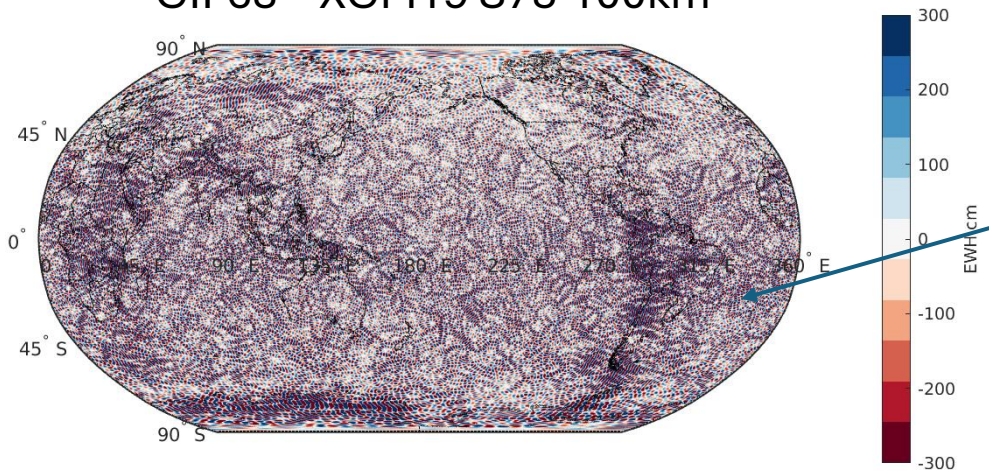


GGM05C – XGM19

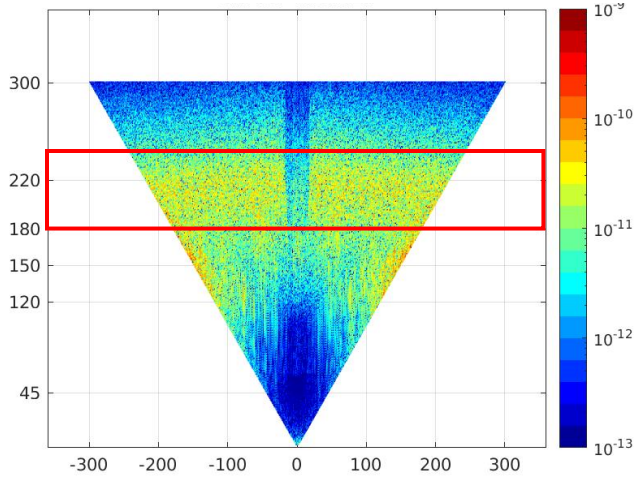


GGM05C is heavily constrained towards the surface data from EGM08 in this band (75km to 100km)

GIF63 – XGM19 S75-100km



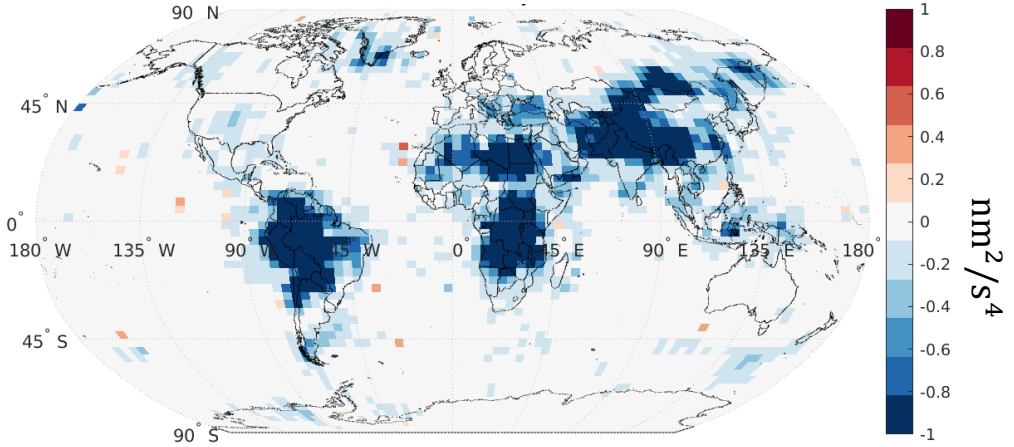
GIF63 - XGM19



The satellite only part of GIF63 (GOCE+GRACE) **preserved the GOCE contribution** but also eliminated the continental anomalies at higher degree.

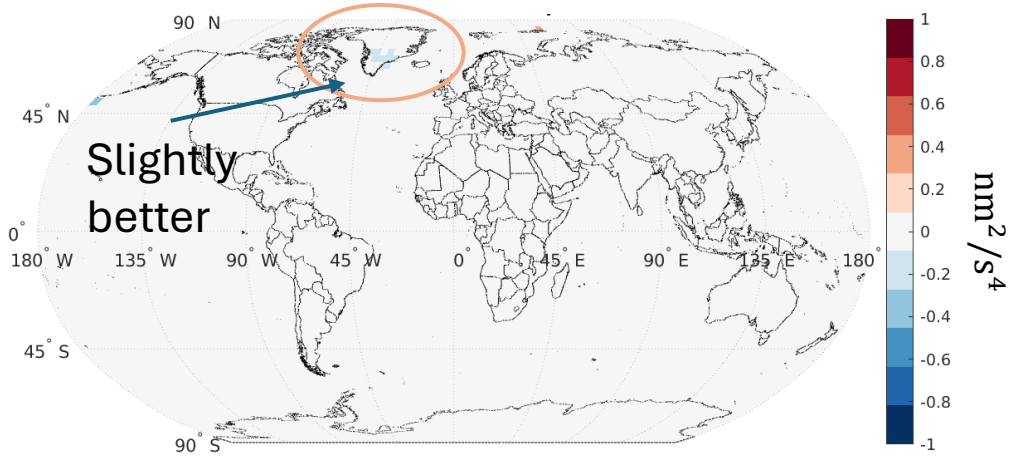
Evaluation: KBR postfit variance

Postfit Var.: GIF63 - GGM05C



Blue: GIF63 is better; Red: GGM05C is better

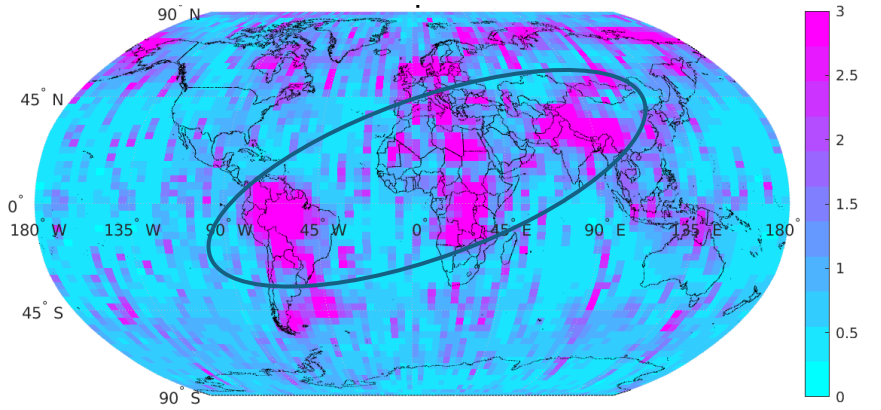
Postfit Var.: GIF63 - XGM19



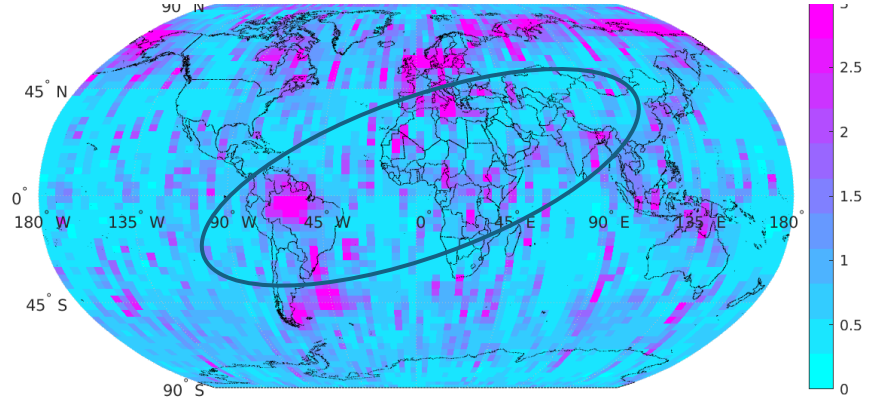
Blue: GIF63 is better; Red: XGM19 is better

KBR Postfit variance:

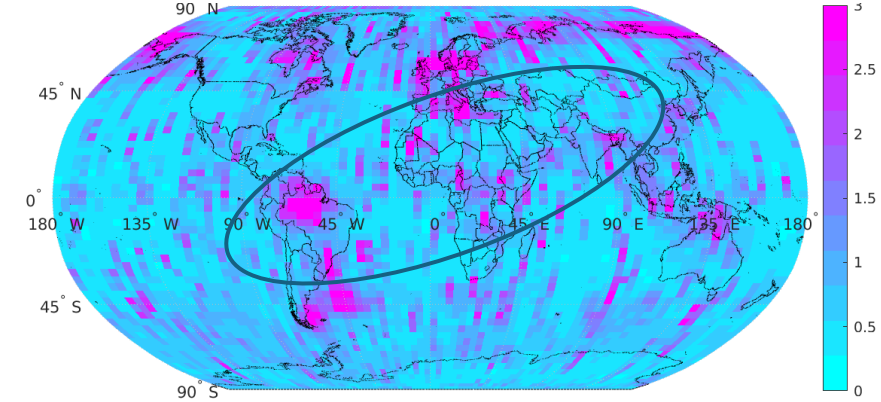
GGM05C



XGM19

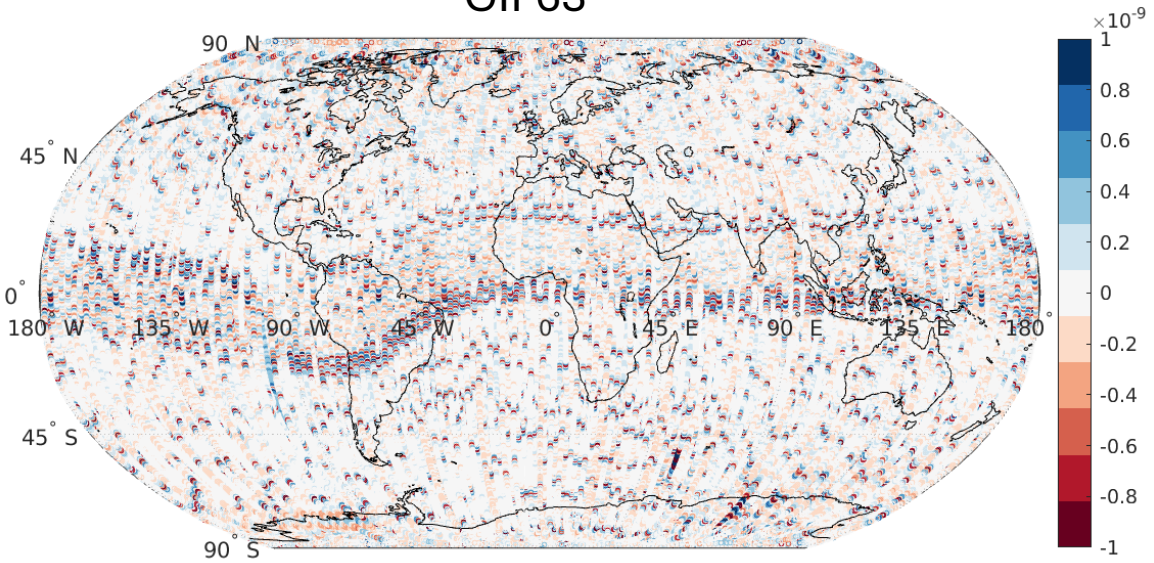


GIF63

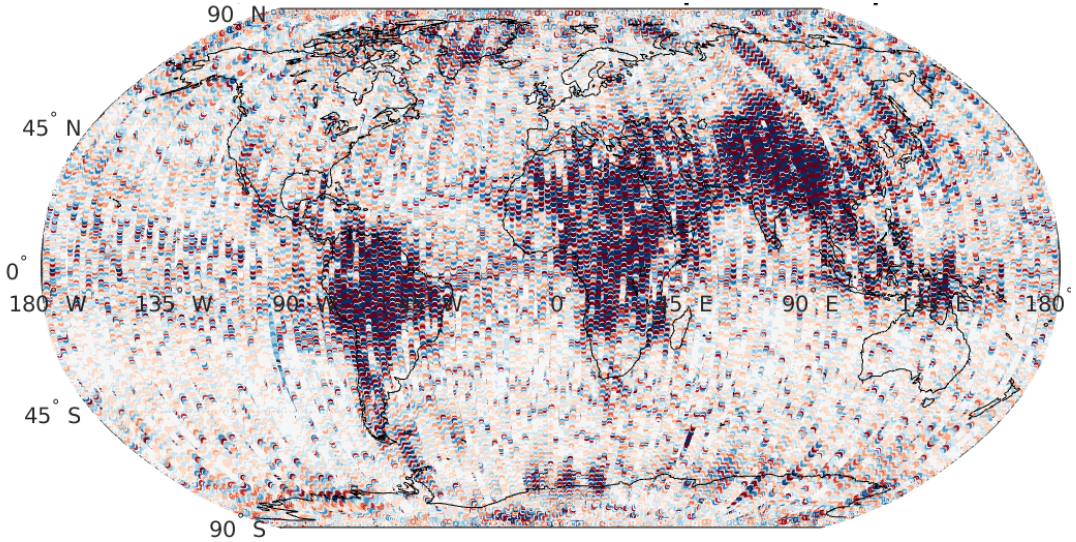


Evaluation: LRI Prefit

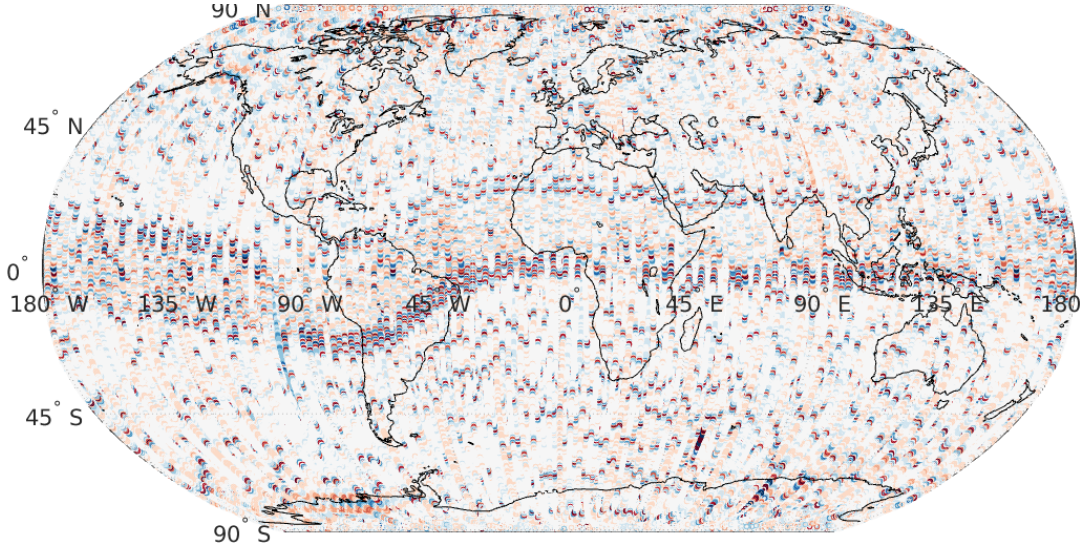
GIF63



GGM05C



XGM19

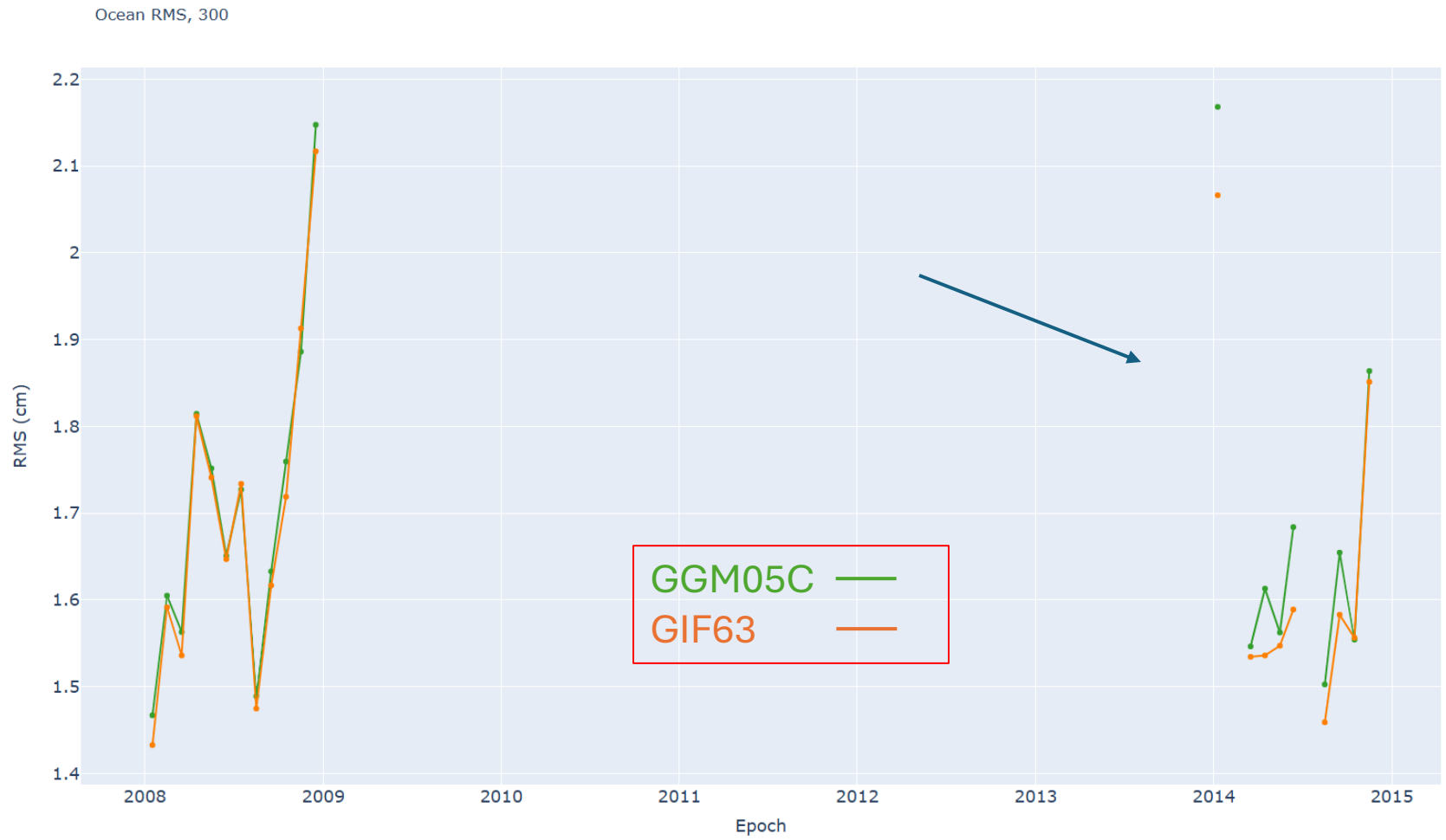


GRACE-FO LRI range acceleration prefit residual (90-300CPR).

- The updated mean field **GIF63** eliminates all the continental wide LRI residual.

RL6.2 5s LRI range acc 90-300CPR
between 2020-10-15 and 2020-11-15

Evaluation: Residual Ocean RMS



- GIF63 yields smaller residual ocean rms for several months in 2014.

L1B 05p: 2008 and 2014

Summary

- We developed an updated CSR intermediate mean gravity field GIF63 (ref. epoch 2010.0) for RL07 re-process.
- GIF63 eliminated continental anomalies in GGM05C by updating the combination of reprocessed GRACE and GOCE data and (pseudo) surface data.
- GIF63 performs on par with recent model.

- Covariance calibration is applied for optimal combination.
  GRACE contributed mostly between degree 2-150;
  GOCE contributed mostly between degree 120-220;
  and surface data (XGM2019) contributed mostly above degree 220.

- GRACE data: V05p L1B data 2004-2016 (preliminary RL07). GPS: phase/range 30s; KBR: range rate 5s. Up to d/o 180 co-estimated trend and annual up to d/o 60.
- GOCE data: Version 202 L1B data 2009-2013. Down- sampled to 5s, bandpass filtered (8-55mHZ) and used XX,YY , ZZ and XZ components. Up to d/o 300.
- (Pseudo) Surface data: XGM19. Up to d/o 360.

Acknowledgement:
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