

The New GFZ RL05 GRACE Gravity Field Model Time Series

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General Remarks

- Processing status:
 - 72 monthly solutions from 01/2005 till 12/2010 are currently available
 - 01-12/2004 will be delivered next
- Maximum d/o: 90x90
- Level-2 products: GSM, GAA, GAB, GAC, GAD
- RL05 solutions contain same geophysical information as RL04
- Difference wrt RL04: solutions do not contain drift rates for C_{20} , C_{30} , C_{40} , C_{21} , S_{21}
 - users do not have to apply any rates when analyzing RL05**

Modifications from RL04 to RL05

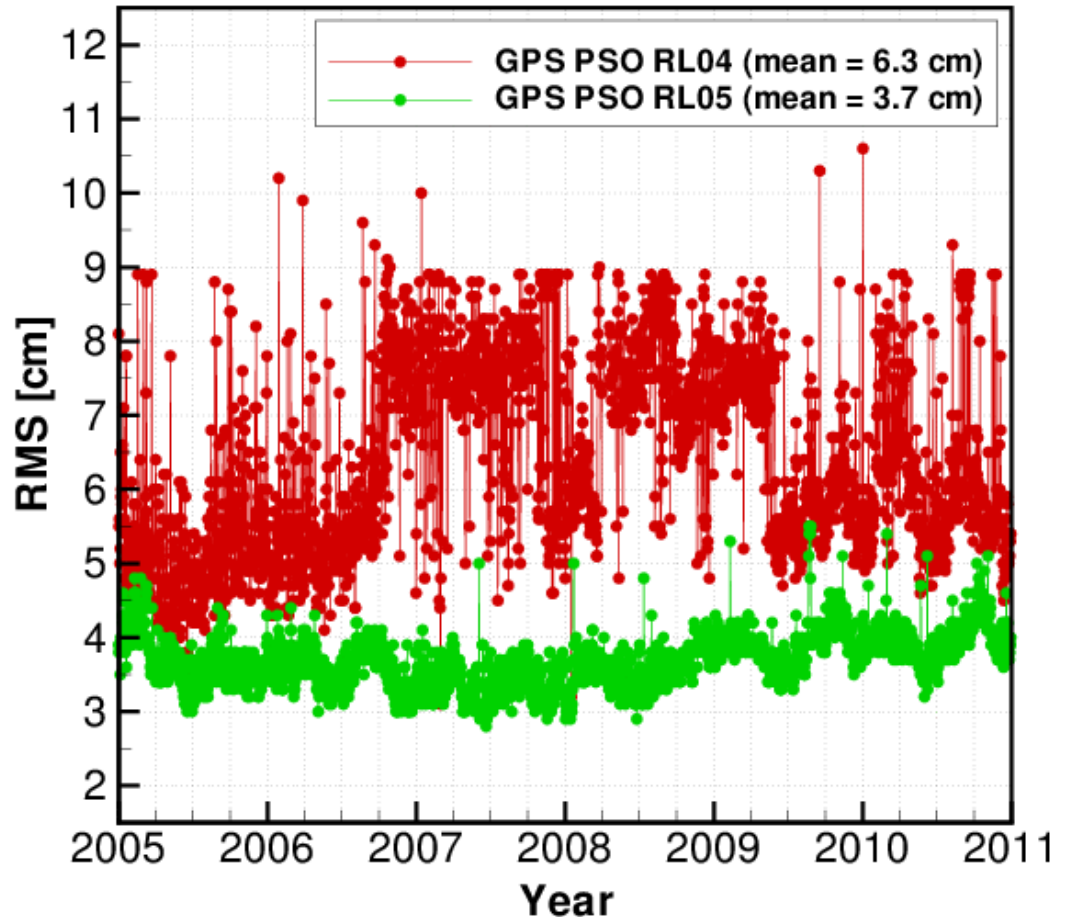
- Reprocessed Level-1B data
- Changes in the force models:
 - EIGEN-6C incl. time-variable part till d/o 50x50
 - AOD1B RL05 (new OMCT model: **Dobslaw et al., Session G5.2**)
 - EOT11a
- Changes in the reference frame:
 - reprocessed GPS constellation (orbits & clocks) based on IGS08 realization of ITRF2008
 - frame transformation according to IERS2010
- Changes in the observation model:
 - 1-hourly ACC biases in all 3 directions, no more scale factors
 - GFZ derived phase center corrections for GRACE GPS-SST obs.
 - modified relative weighting of KRR and GPS-SST

GPS Constellation

Updated GPS orbits and clocks for RL05:

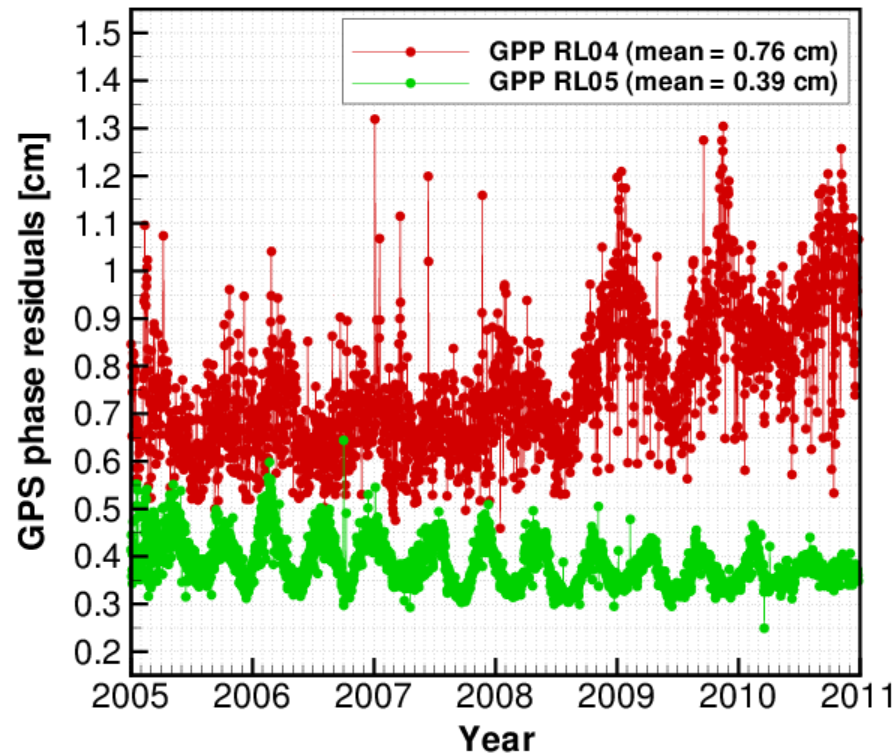
- absolute PCVs
- phase windup corr.
- GPS attitude model

→ clear reduction of 3D RMS wrt. IGS orbits

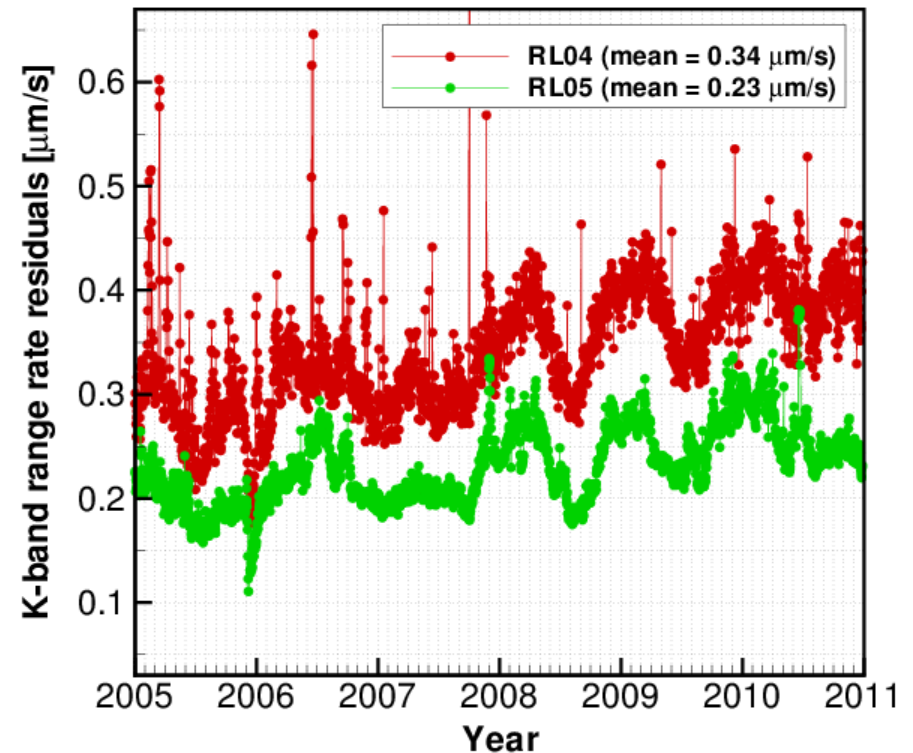


Pre-fit Residuals

GPS phase (49%)



K-band range rate (32%)

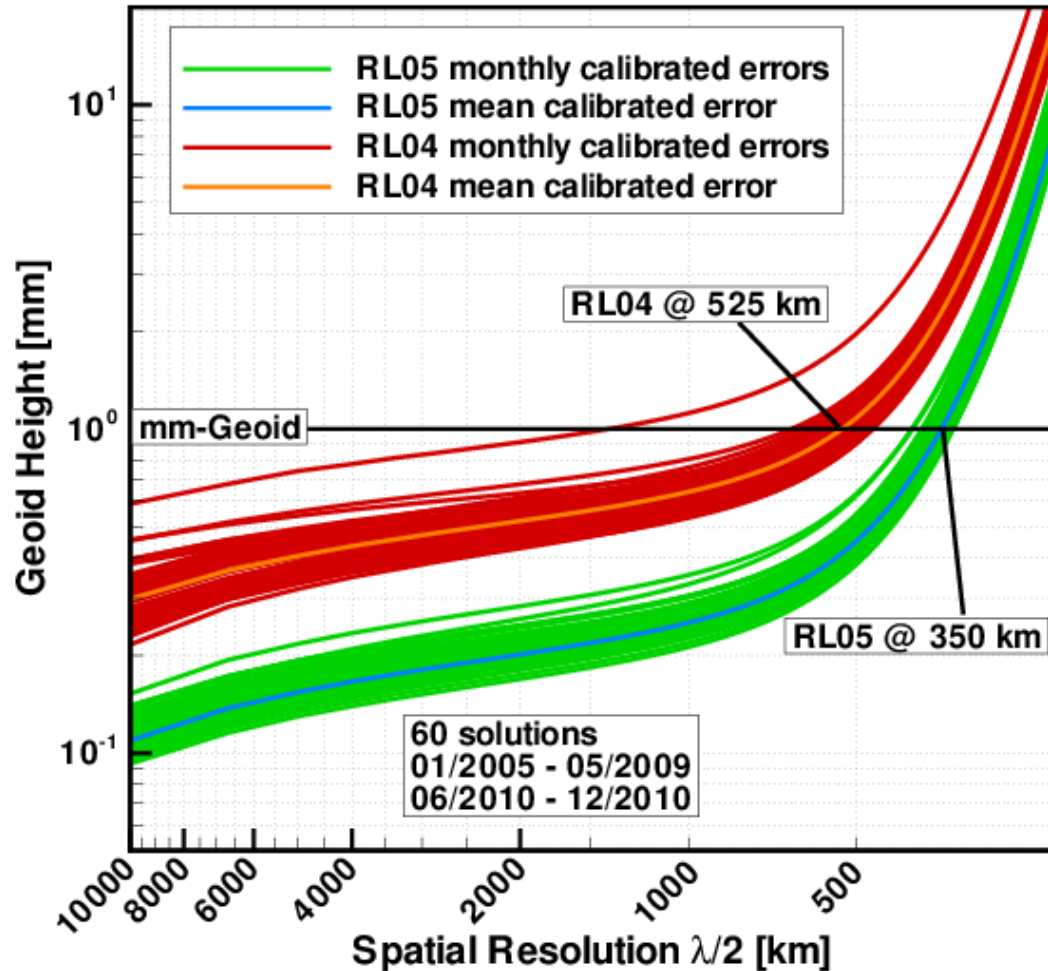


- RL05 residuals significantly decreased & less scattered
- RL05 revealed some systematic structure in GPS residuals
- structure of KRR residuals correlated with inter-satellite distance

Cumulated Errors

RL05 features

- increased spatial resolution
- less difference in accuracy from month to month
- no more extremely large errors

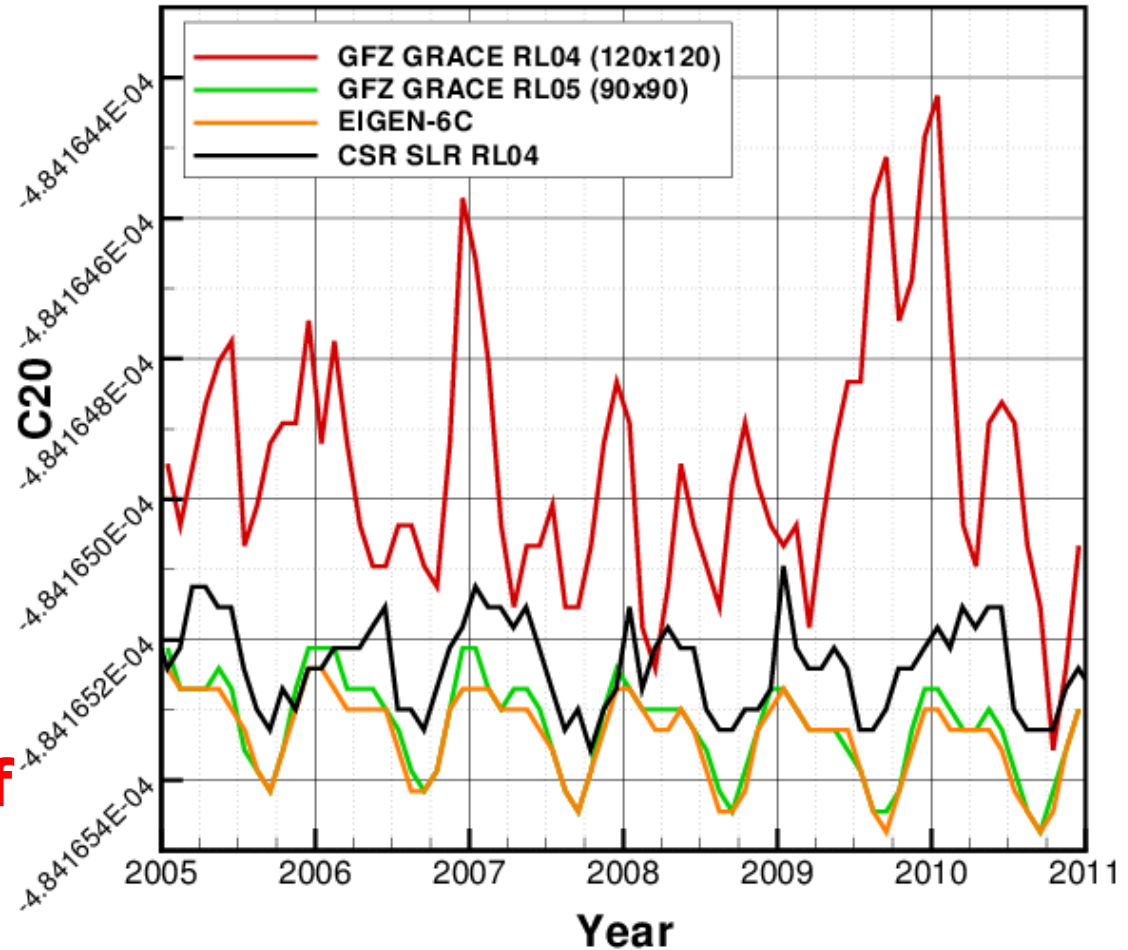


RL05 C_{20} is

- very close to a-priori values
- and also quite close to CSR's RL04 SLR time series

Remark:

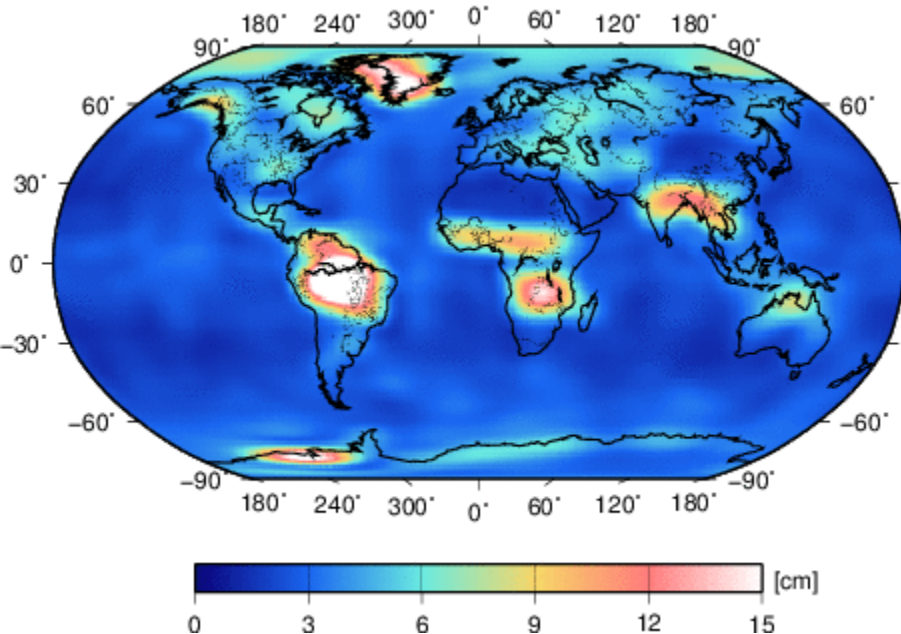
No substitution of C_{20} necessary for GFZ RL05!



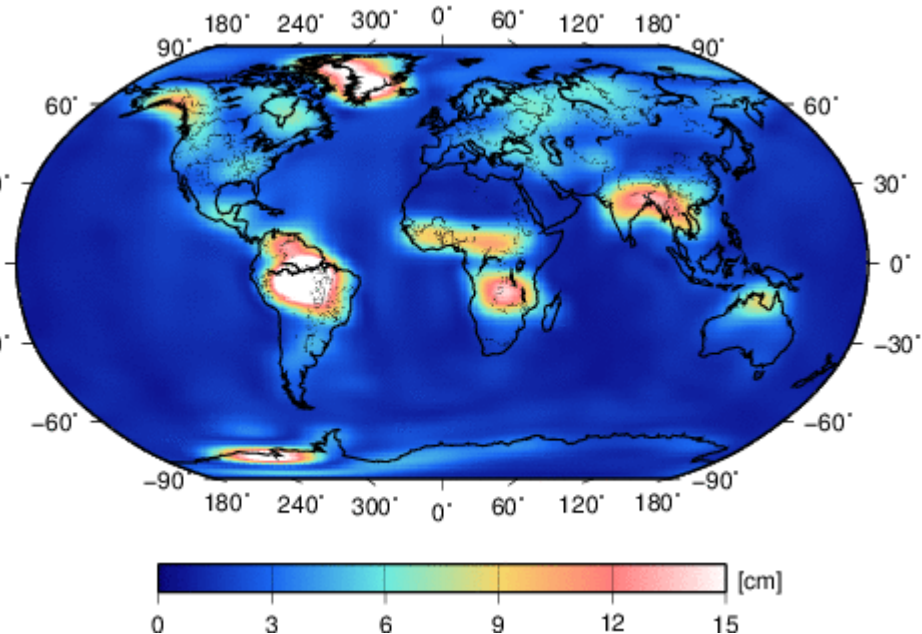
RMS Variability

RMS variability of EWH grids over 6 years:

DDK1 filter ($\sim 530\text{km}$)



RL04

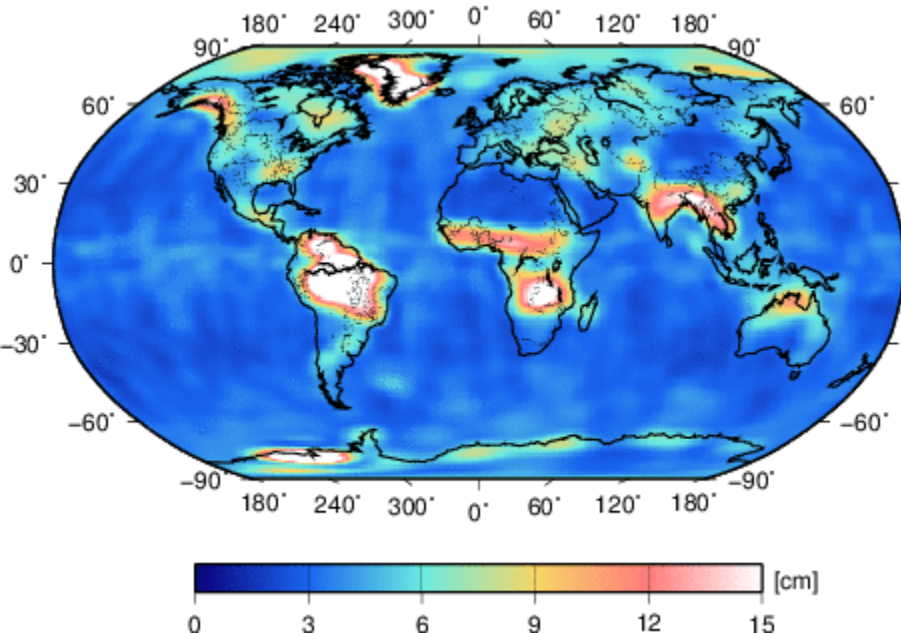


RL05

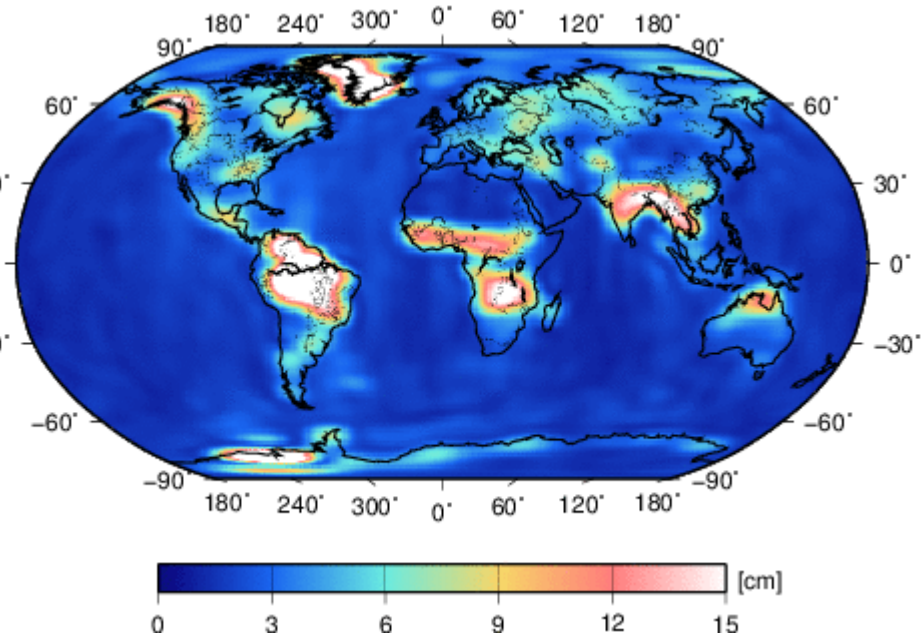
RMS Variability

RMS variability of EWH grids over 6 years:

DDK2 filter ($\sim 340\text{km}$)



RL04

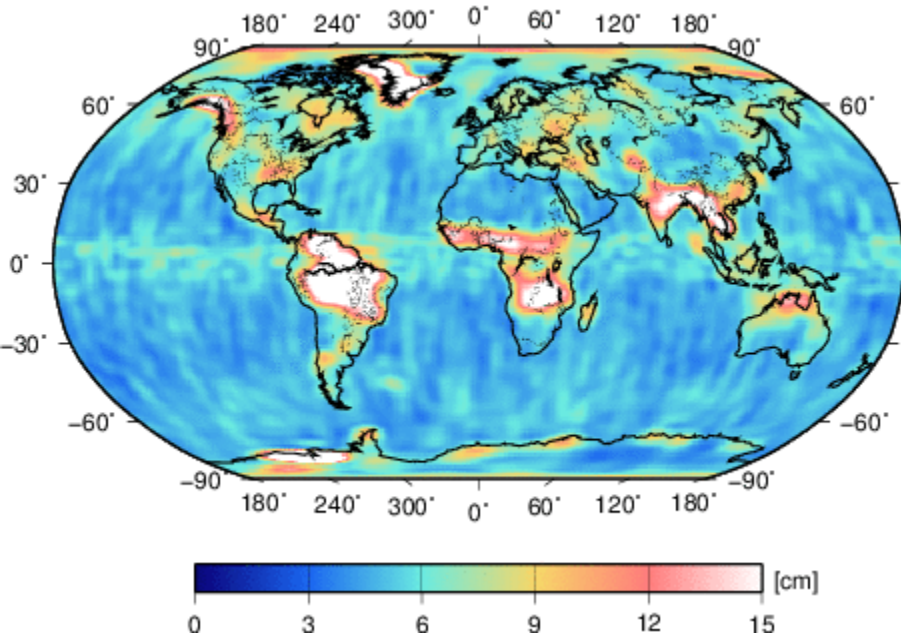


RL05

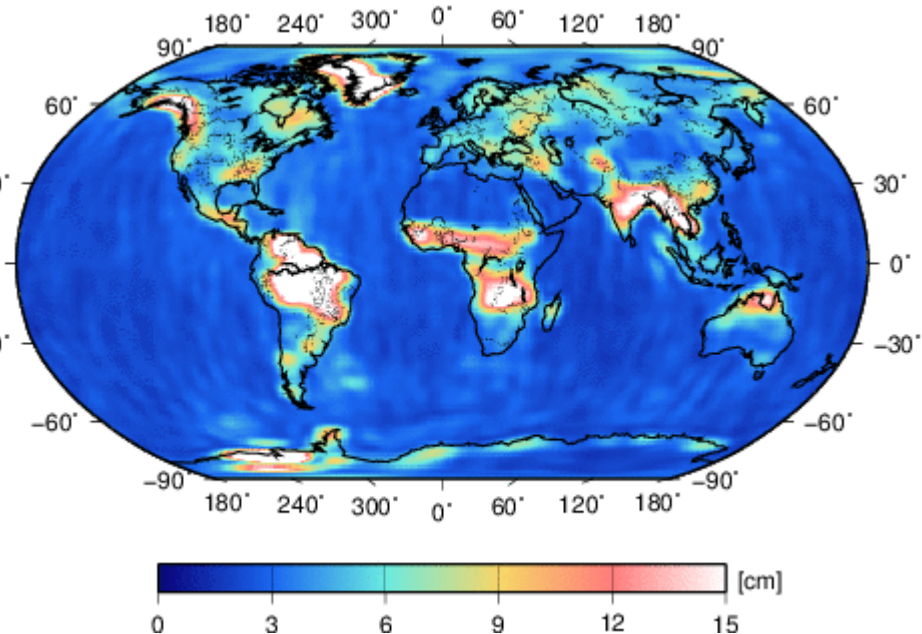
RMS Variability

RMS variability of EWH grids over 6 years:

DDK3 filter ($\sim 240\text{km}$)



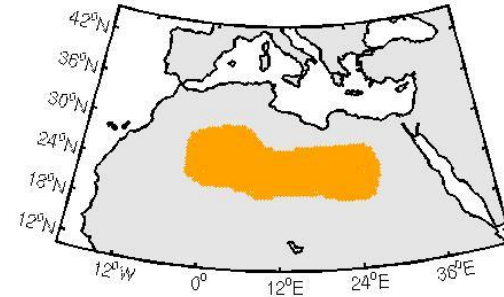
RL04



RL05

RMS Variability

Statistics for Sahara basin:



Sahara	DDK1		DDK2		DDK3	
	wMean	wRMS	wMean	wRMS	wMean	wRMS
RL04	1.58	0.20	2.45	0.29	4.71	0.54
RL05	1.13	0.15	1.53	0.21	2.49	0.35

RL05

accuracy ~1.0cm@530km ~1.5cm@340km ~2.5cm@240km
in EWH

RL05@340km as good as RL04@530km!

Comparison of Derived Mass Trends

Example: Antarctica

- time-series of monthly GRACE mass estimates much smoother for RL05
- uncertainty of RL05 decreased by $\sim 50\%$

a-posteriori
error

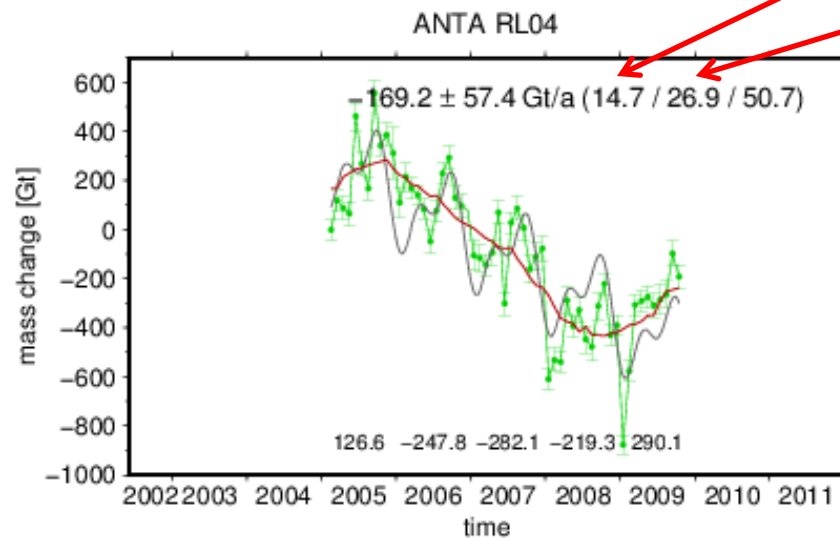
total error
(without GIA)

RL04
14.7

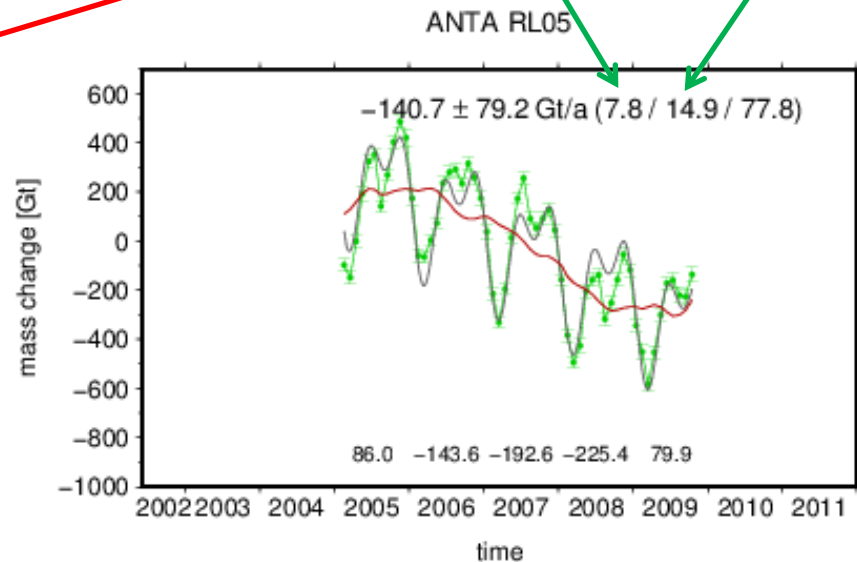
RL05
7.8

RL04
26.9

RL05
14.9



RL04



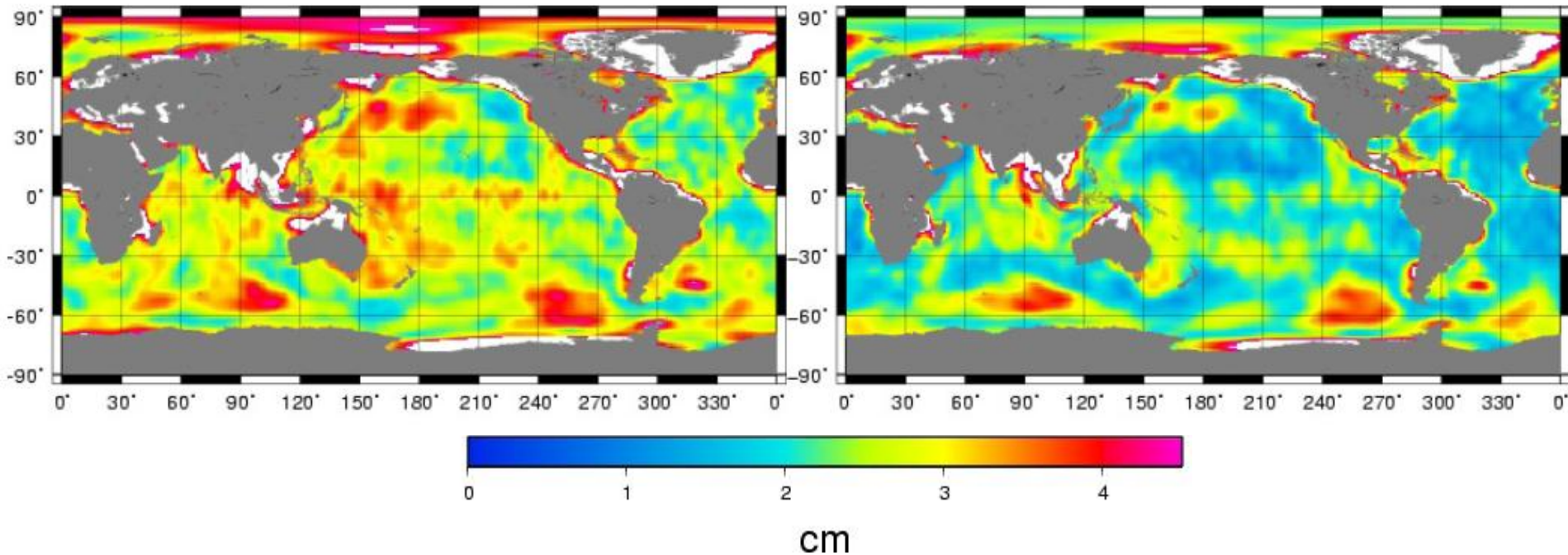
RL05

Courtesy: Andreas Groh et al. (TU Dresden)

Standard Deviation of Derived OBP

RL04

RL05



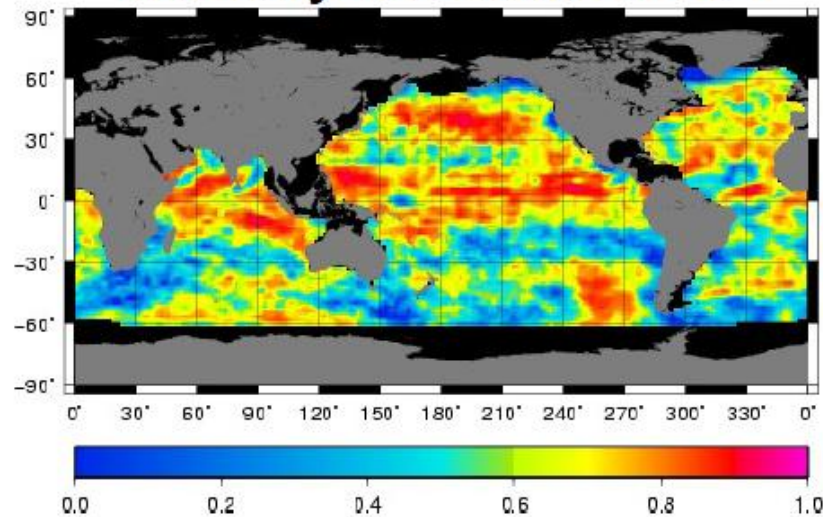
Preliminary Findings (GSM+GAD):

- RL05 clearly less noisy than RL04 at 300km smoothing & de-stripping
- Obvious in tropics and “quiet” ocean areas, where standard deviation has dropped from 2-4 cm to 1-2 cm.

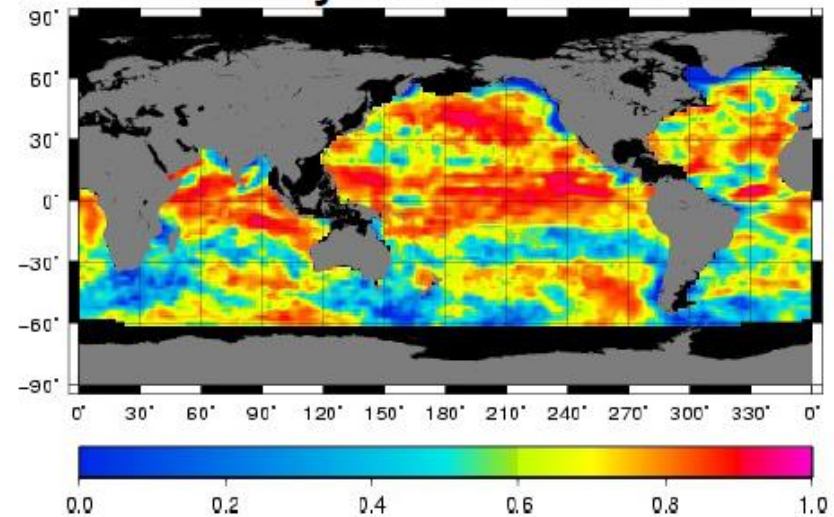
Courtesy: Don Chambers (Univ. of South Florida)

Correlation of Altimetry vs. GRACE + Steric Correction

Altimetry vs. Steric+GFZ04



Altimetry vs. Steric+GFZ05



Preliminary Findings (GSM+GAD):

- Correlation increases significantly throughout the tropics for RL05 solutions, indicating a reduction in noise.

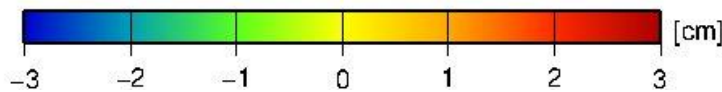
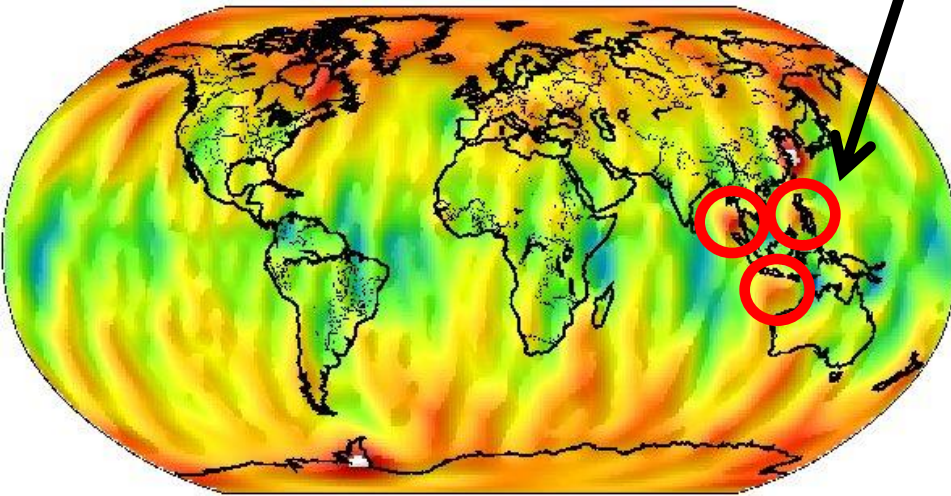
Courtesy: Don Chambers (Univ. of South Florida)

Effect of EOT11a

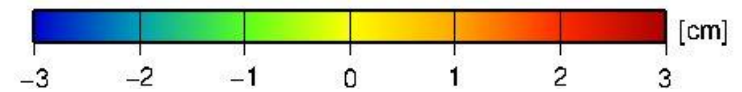
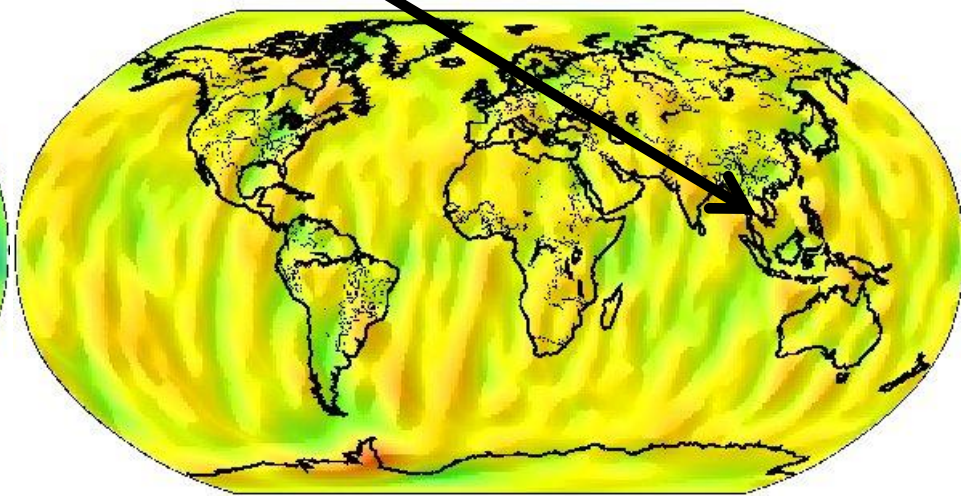
Cosine part of 161d fit (S2 tidal alias period)

deficiencies in FES2004, vanished in EOT11a

RL04 (FES2004)



RL05 (EOT11a)



GRACE monthly time-series currently has gaps when accelerometers are switched-off due to battery problems – how to handle this for RL05?

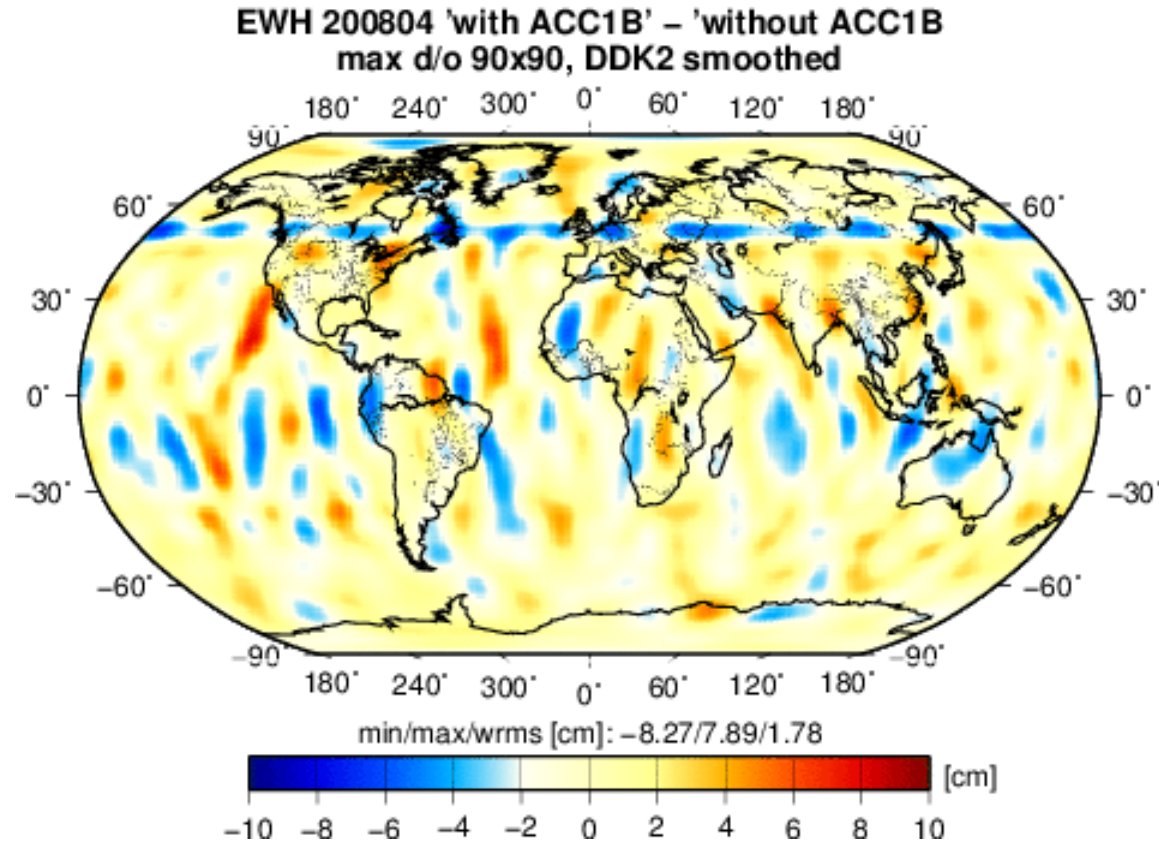
Test:

Generation of alternative GSM product without ACC1B data and models instead

- empirical 1/rev parameters
- additionally use of solar radiation and atmosphere density models

ACC1B vs Models

EWH Differences [cm]:



RL05

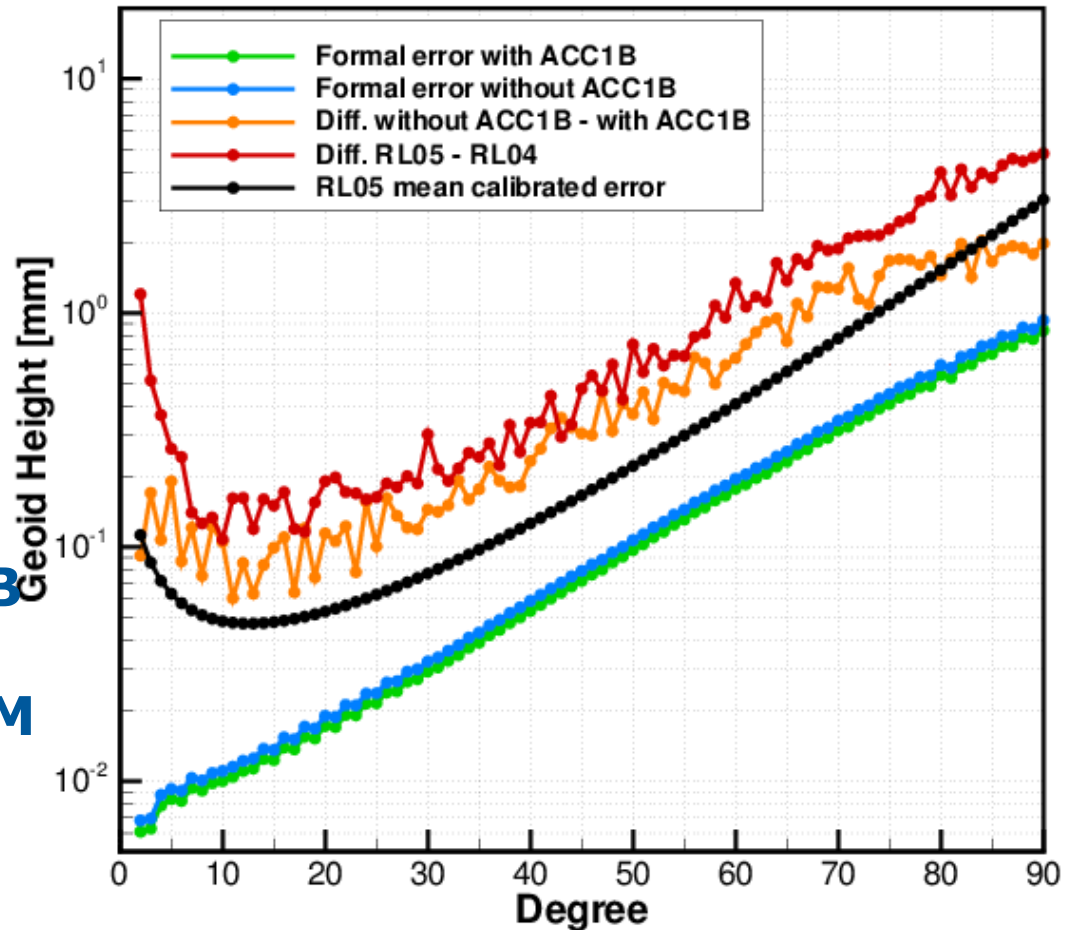
with ACC1B – without ACC1B

ACC1B vs Models

Difference between model-based and standard solution is

- larger than RL05 error level
- but less than RL05-RL04 difference

→ Periods where ACC1B data is missing can be filled by alternative GSM products of sufficiently good quality



Summary & Outlook

- GFZ RL05 monthly solutions are significantly better than RL04 (\sim by a factor of 2)
- Users do not have to replace C_{20} !
- Users do not have to apply any drift rates!
- Alternative solutions using models instead of ACC1B data will be provided to fill gaps in time-series due to switched-off GRACE accelerometers
- For periods with pronounced repeat orbits (4d-repeat in 2004, 3d-repeat in 2012), stabilized 90x90 solutions will be provided
- Beside standard monthly 90x90 solutions, GFZ plans to publish RL05 based
 - weekly solutions up to 30x30
 - static solution up to 180x180

About GFZ RL05

- All RL05 products are available at the following archives:
 - ISDC: <http://isdc.gfz-potsdam.de/grace>
 - PO.DAAC: <ftp://podaac.jpl.nasa.gov/allData/grace/L2/GFZ/RL05/>
 - ICGEM: <http://icgem.gfz-potsdam.de/ICGEM/>
- GFZ RL05 reference and documentation:
 - [Level-2 Processing Standards Document](#)

Dahle, Christoph; Flechtner, Frank; Gruber, Christian; König, Daniel; König, Rolf; Michalak, Grzegorz; Neumayer, Karl-Hans (2012): *GFZ GRACE Level-2 Processing Standards Document for Level-2 Product Release 0005, (Scientific Technical Report - Data, 12/02), Potsdam, 20 p.*
DOI: 10.2312/GFZ.b103-12020

- [Release Notes for GFZ GRACE Level-2 Products – version RL05 \(available at archives mentioned above\)](#)