

Combination of monthly gravity field solutions – transition from an EGSIEM prototype service into an IAG service

A. Jäggi¹, U. Meyer¹, Y. Jean¹, D. Arnold¹
and the EGSIEM-ACs^{2,3,4}

- ¹ Astronomical Institute, University of Bern
- ² Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences
- ³ Institute for Theoretical and Satellite Geodesy, TU Graz
- ⁴ Groupe de Recherche de Géodésie Spatiale, Toulouse

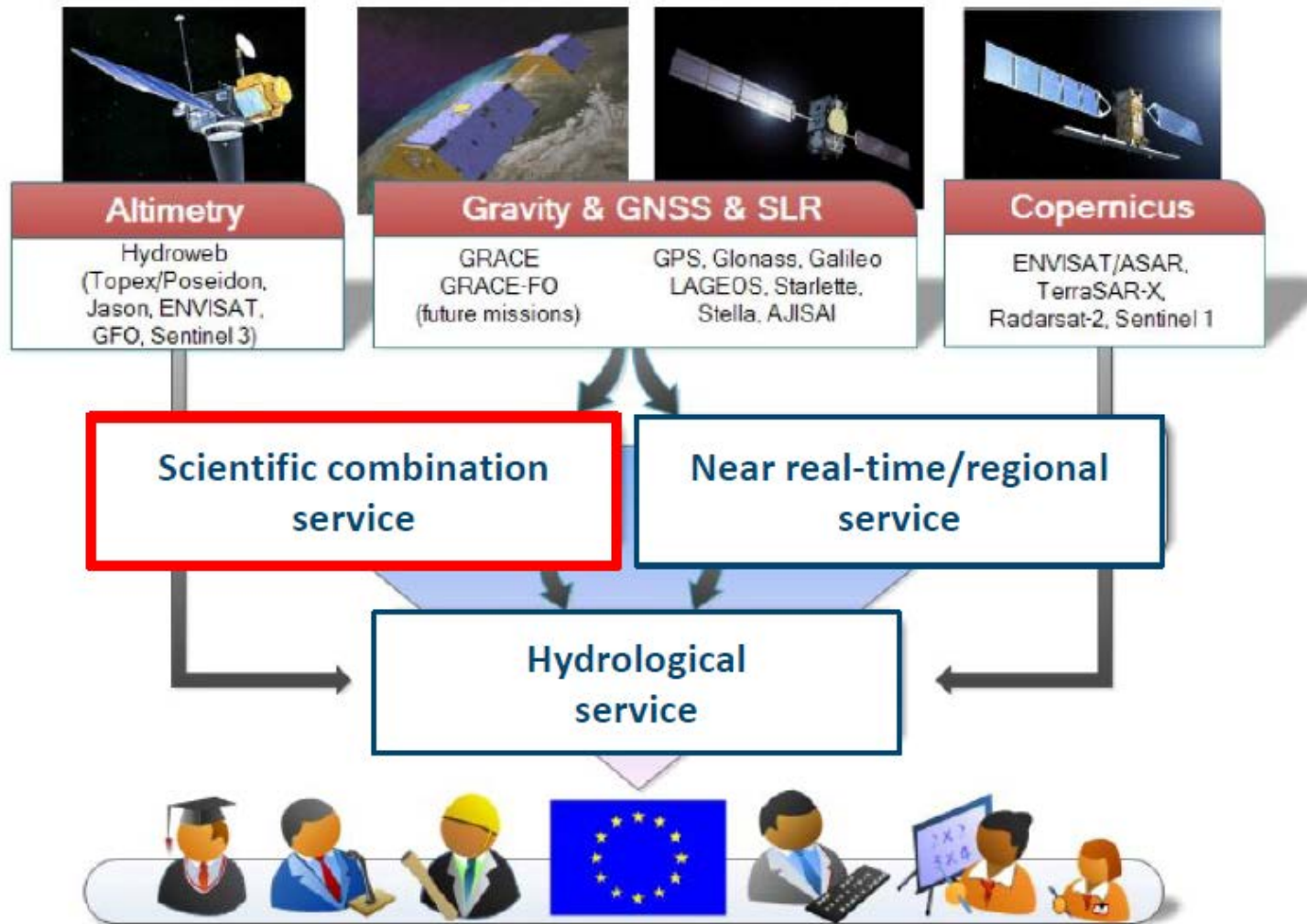
IAG Scientific Assembly 2017

Kobe, Japan
July 31 – August 4, 2017

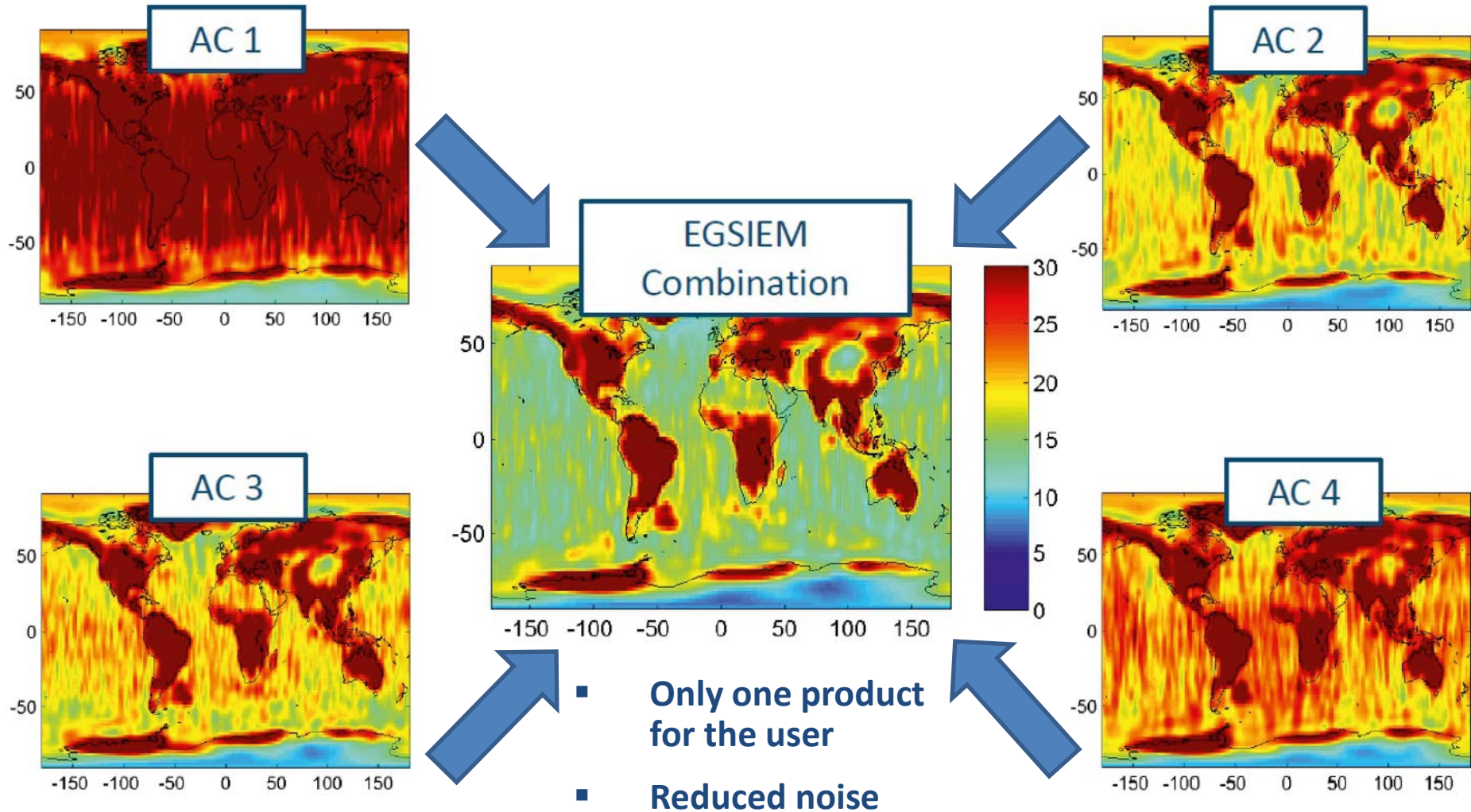
Contents

- EGSIEM Gravity Field Combination Service
- Individual Contributions
- Noise Assessment
- Combination on Normal Equation Level
- Transition to IAG service COST-G

EGSIEM Project – Three services are established



Scientific Combination Service



Scientific Combination Service

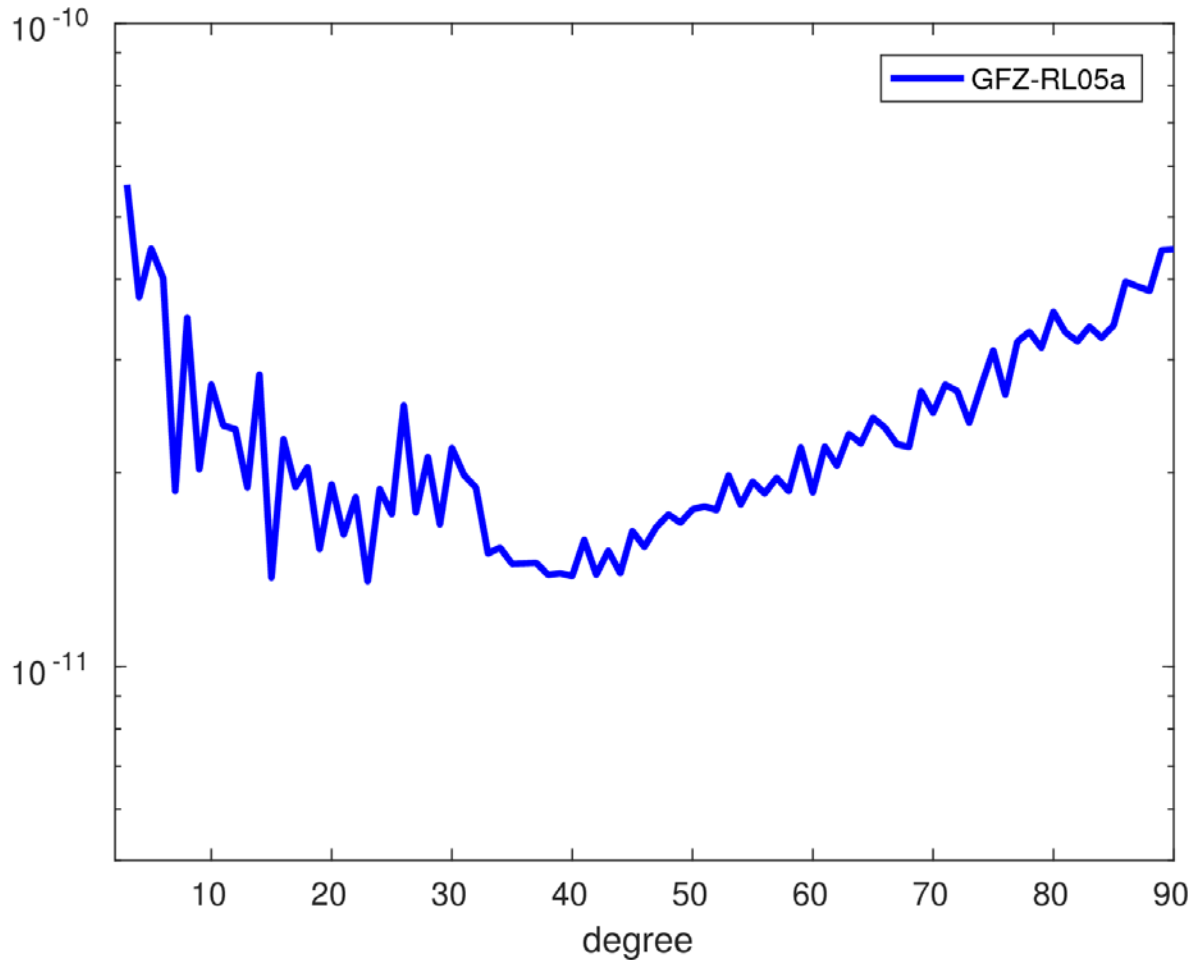
- The EGSIM combination service provides monthly GRACE K-band gravity fields combined on solution / normal equation (NEQ) Level.
- To ensure consistency, a set of common standards for reference frame, Earth rotation, force model and satellite geometry were defined.
- EGSIM lately was extended to also include SLR and GPS-only NEQs.

Why combine results based on the same observations?

Errors in GRACE monthly gravity fields are still dominated by analysis and background model noise, not observation noise => AC-specific errors are reduced by combination!

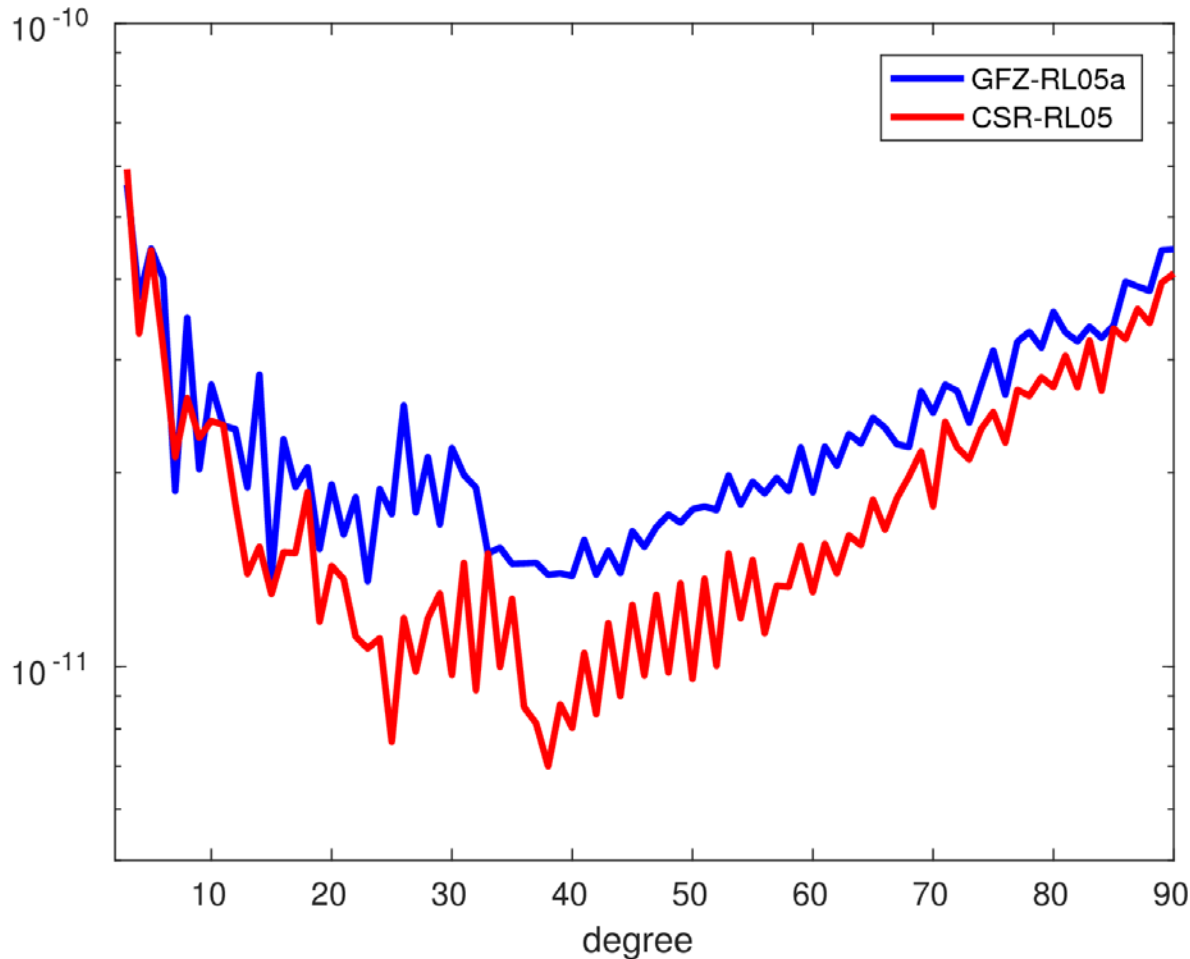
Motivation

Degree Amplitudes of Anomalies 01/2006: orders 0 - 29
SH coefficients – model fit of secular/seasonal variations



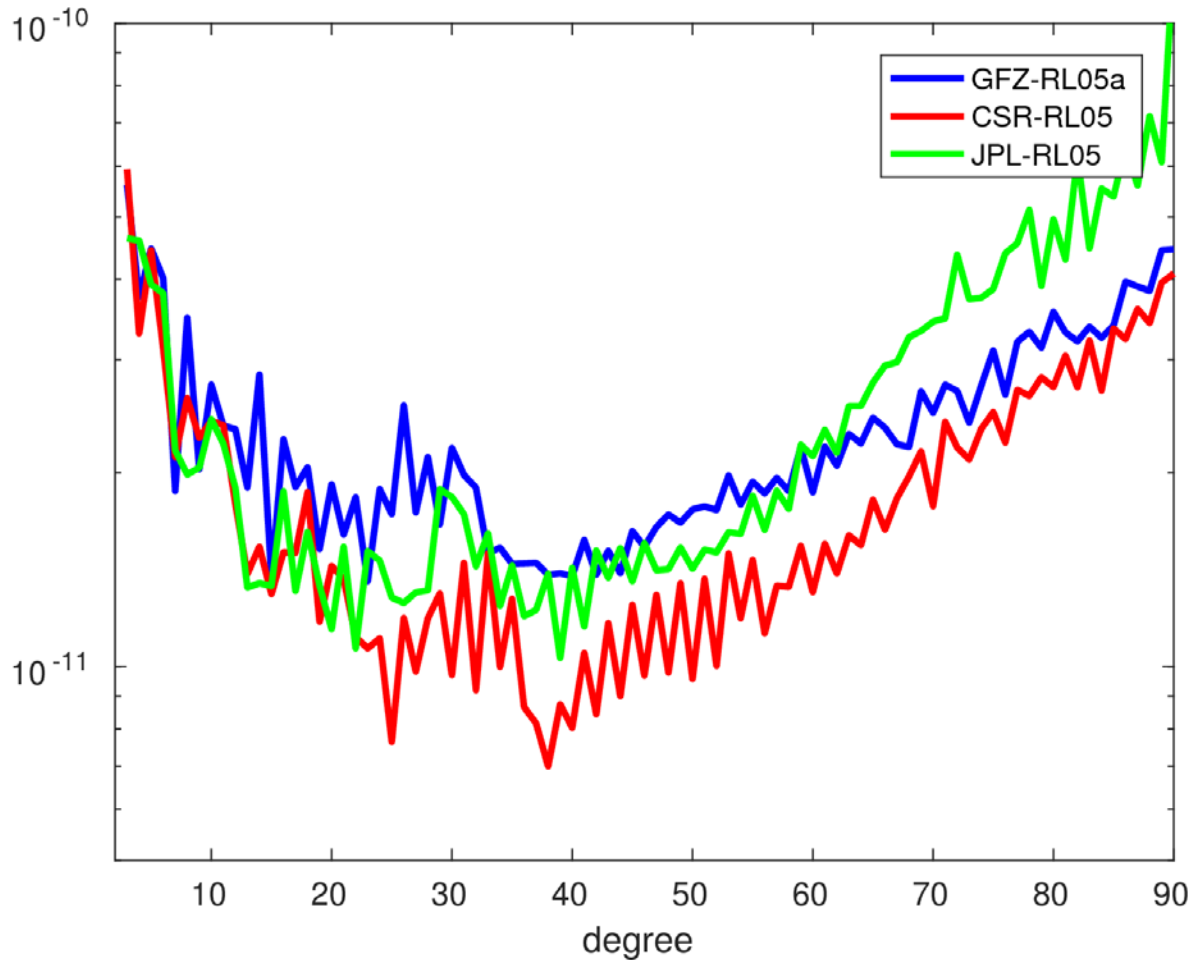
Motivation

Degree Amplitudes of Anomalies 01/2006: orders 0 - 29
SH coefficients – model fit of secular/seasonal variations



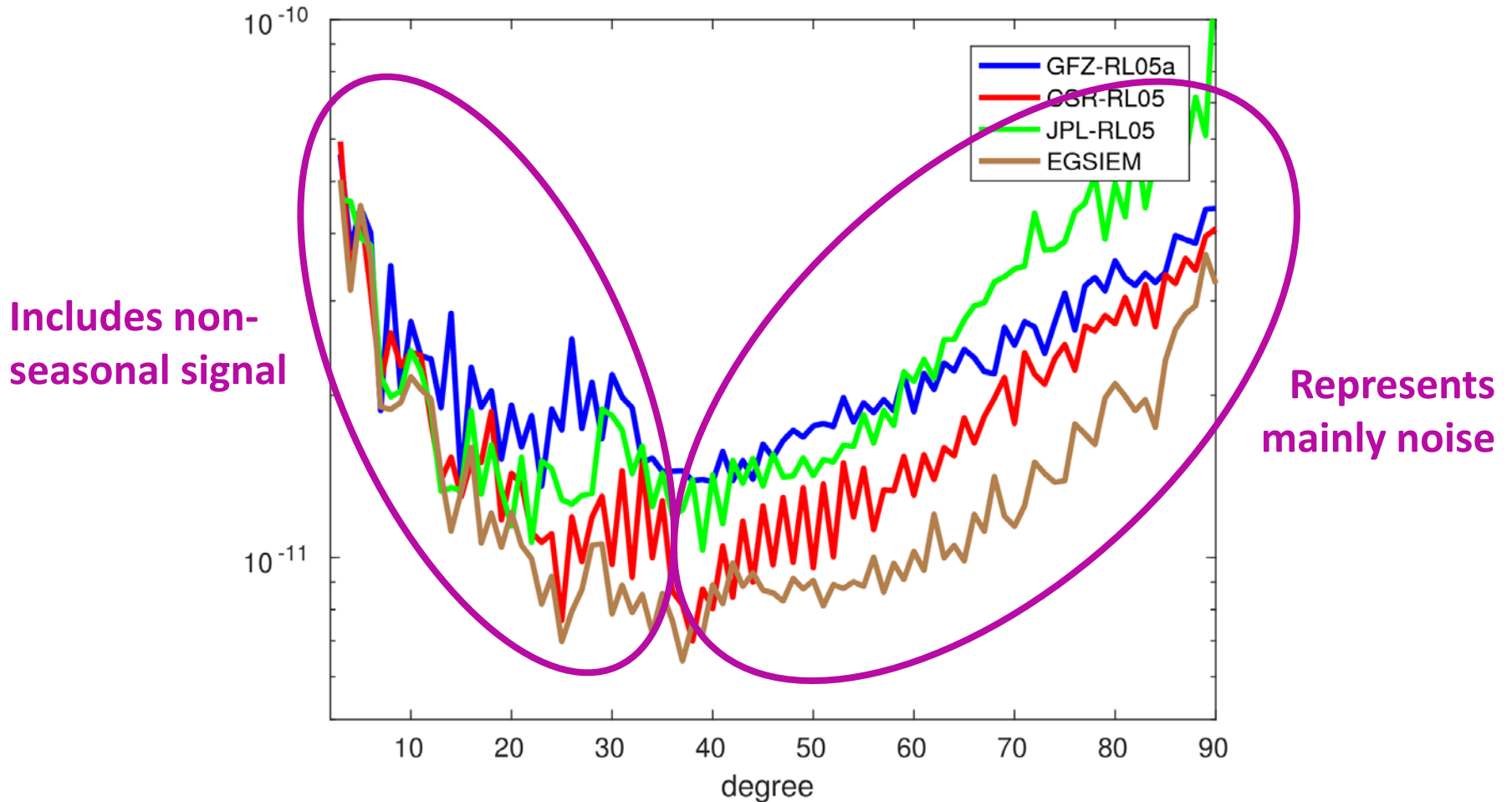
Motivation

Degree Amplitudes of Anomalies 01/2006: orders 0 - 29
SH coefficients – model fit of secular/seasonal variations

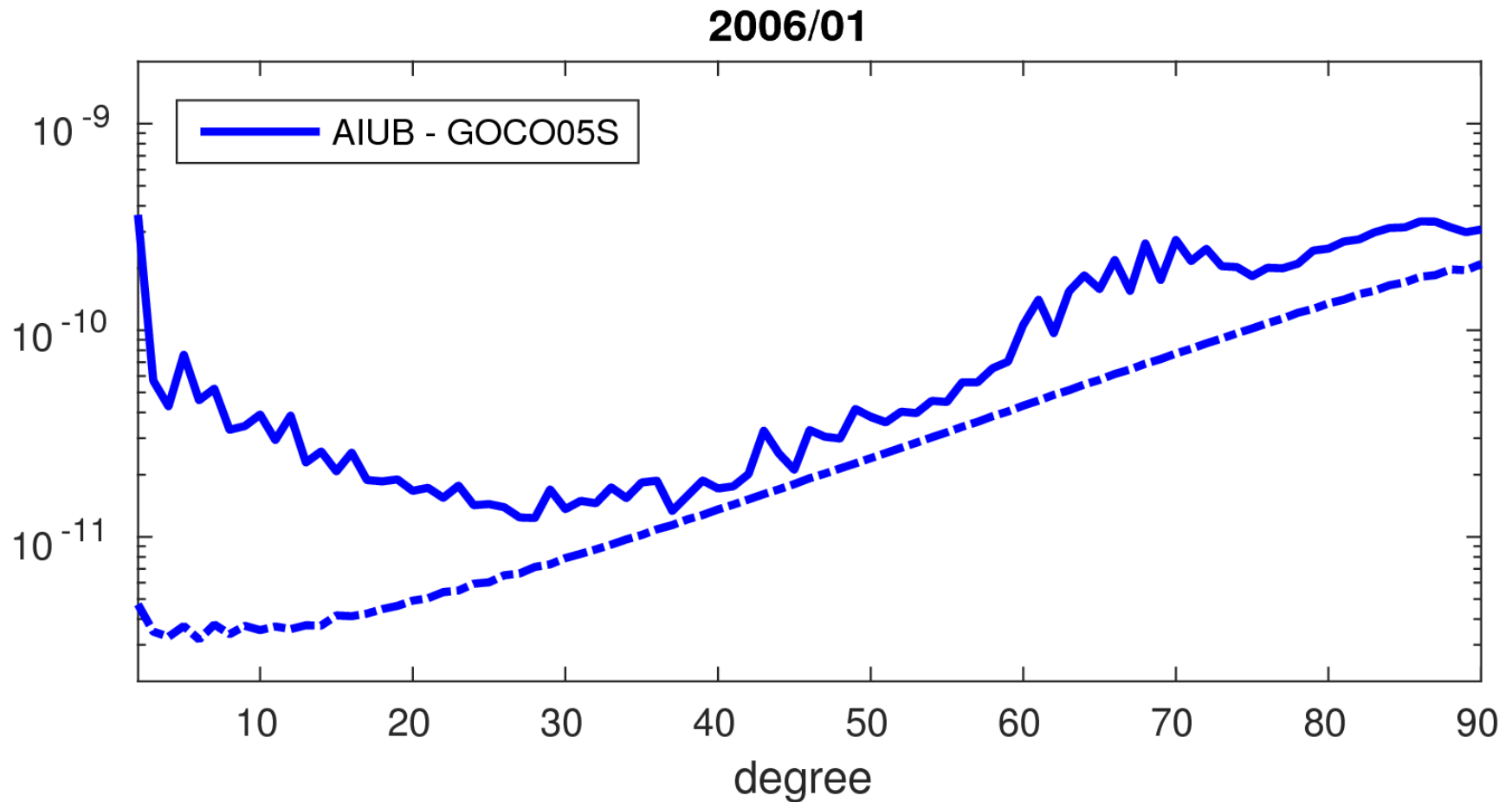


Motivation

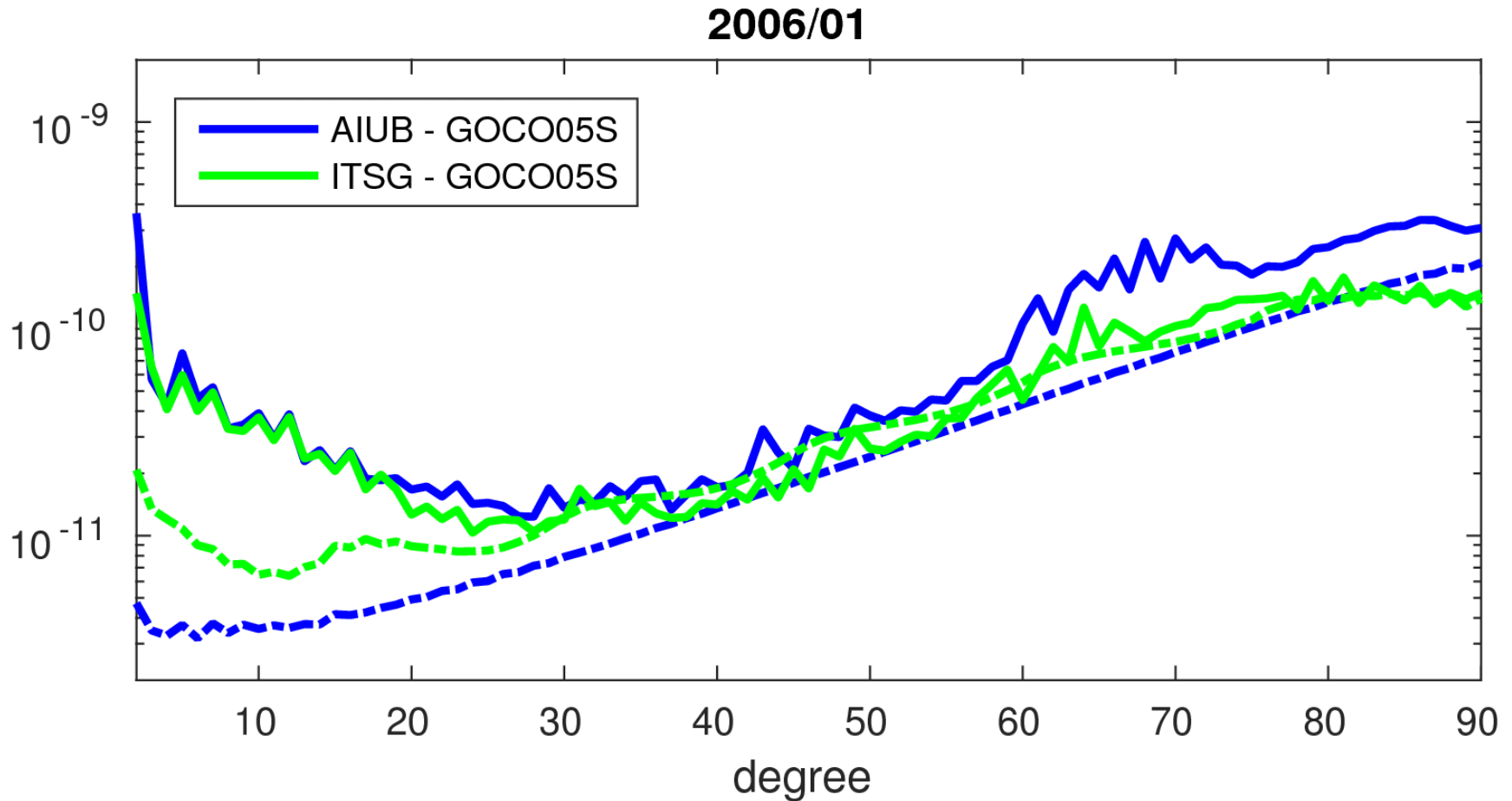
Degree Amplitudes of Anomalies 01/2006: orders 0 - 29
SH coefficients – model fit of secular/seasonal variations



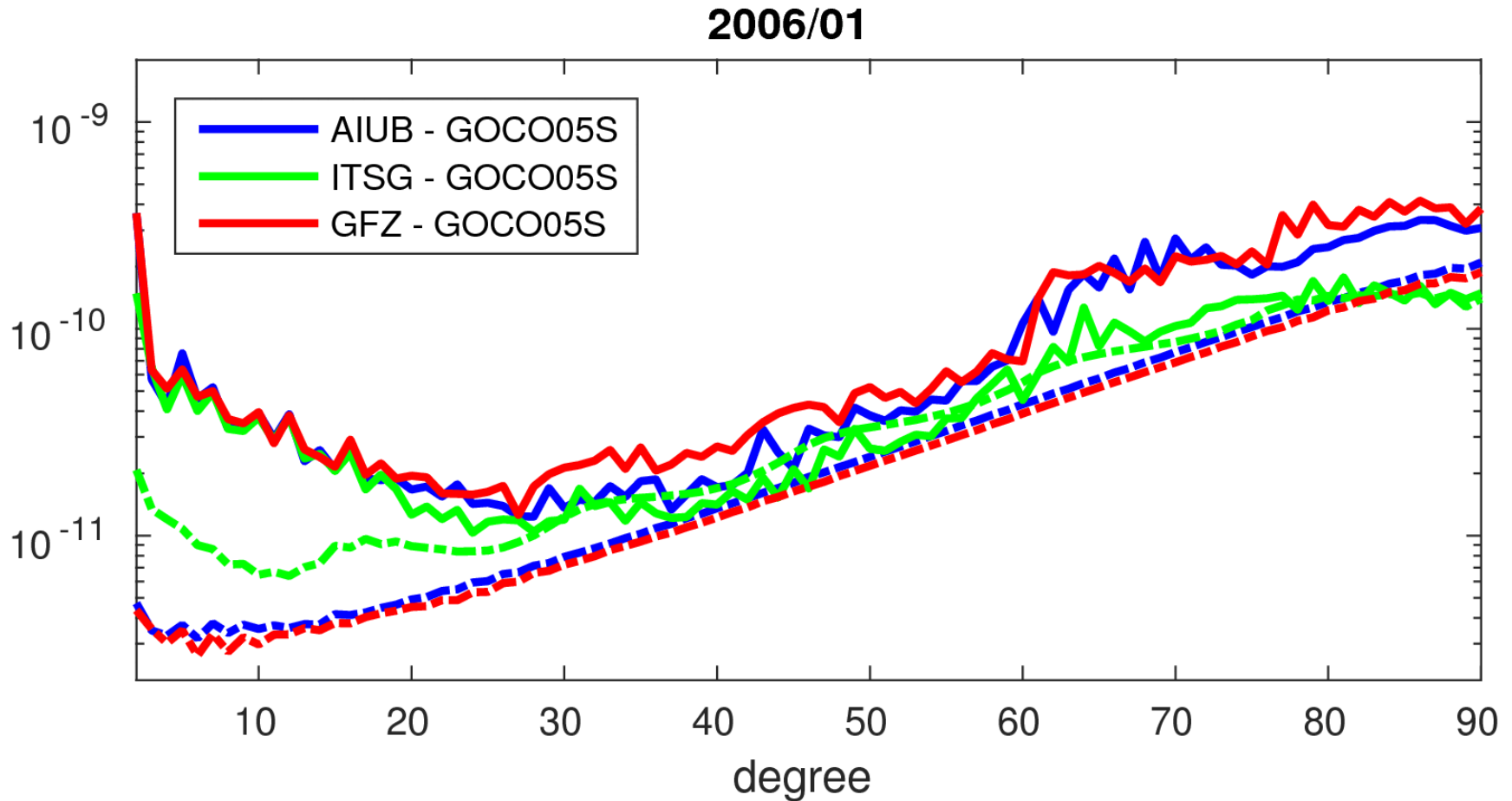
Individual Contributions



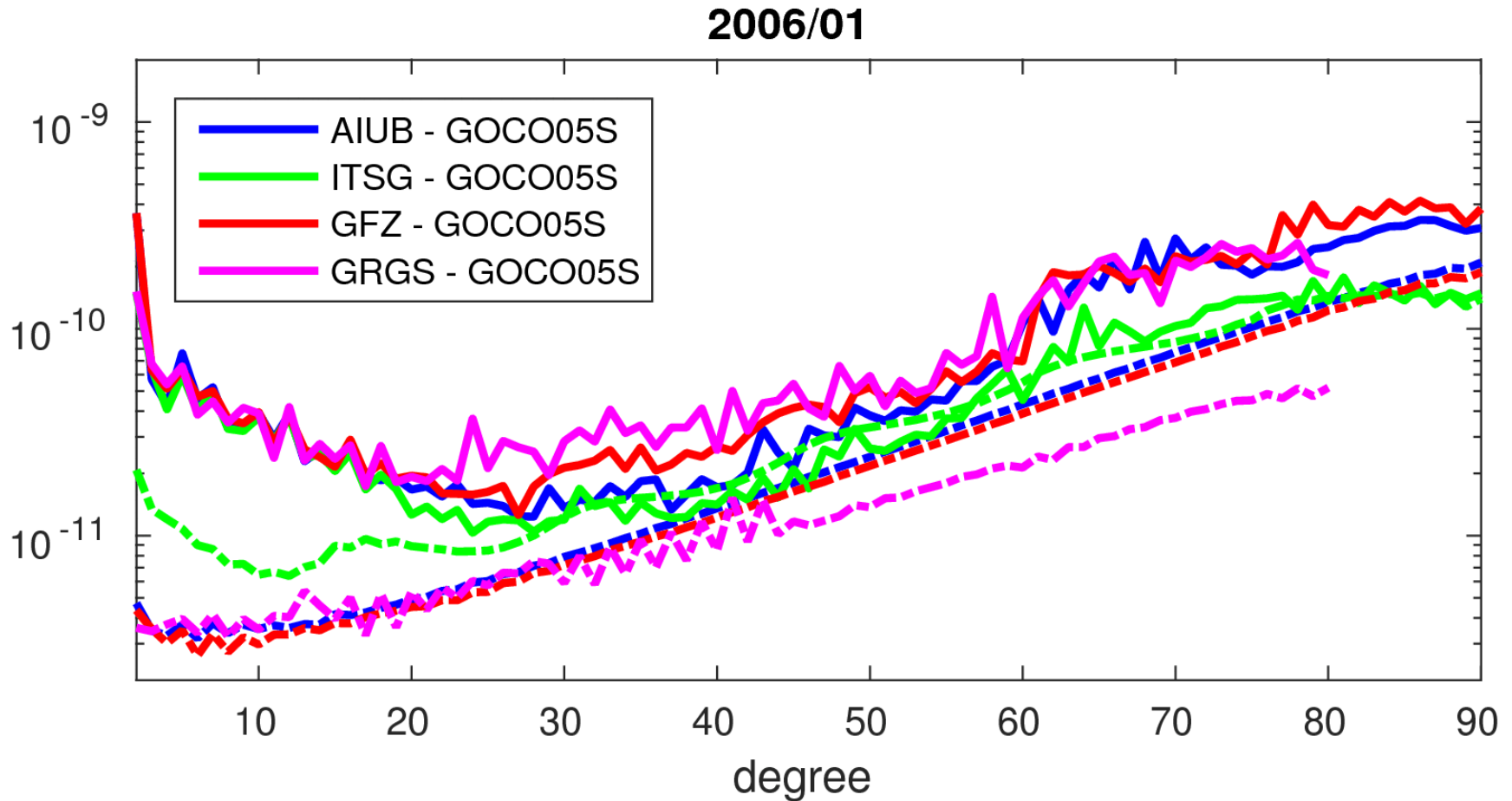
Individual Contributions



Individual Contributions



Individual Contributions



Individual Contributions

Why are formal errors so different?

Formal errors depend on the noise model applied!

Error propagation of kinematic orbits and K-band observations



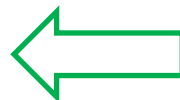
Optimistic

Realistic (empirical)

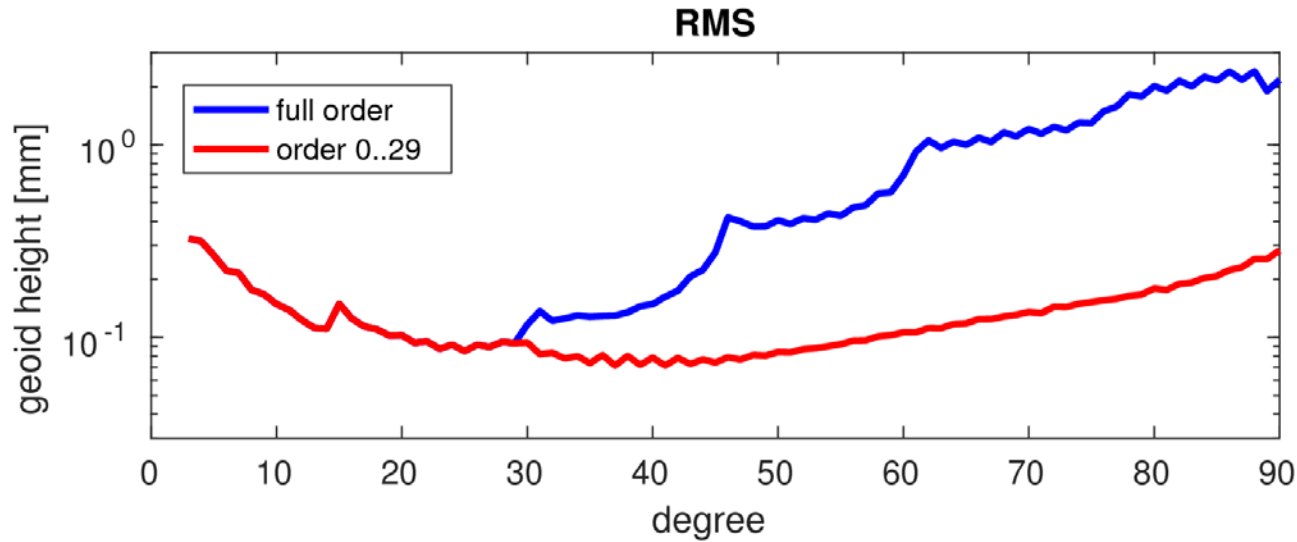
Errors of observations: GPS, K-band, accelerometers, star cameras



Errors of background models and de-aliasing: ocean tides, short periodic atmosphere and ocean variations (AOD)

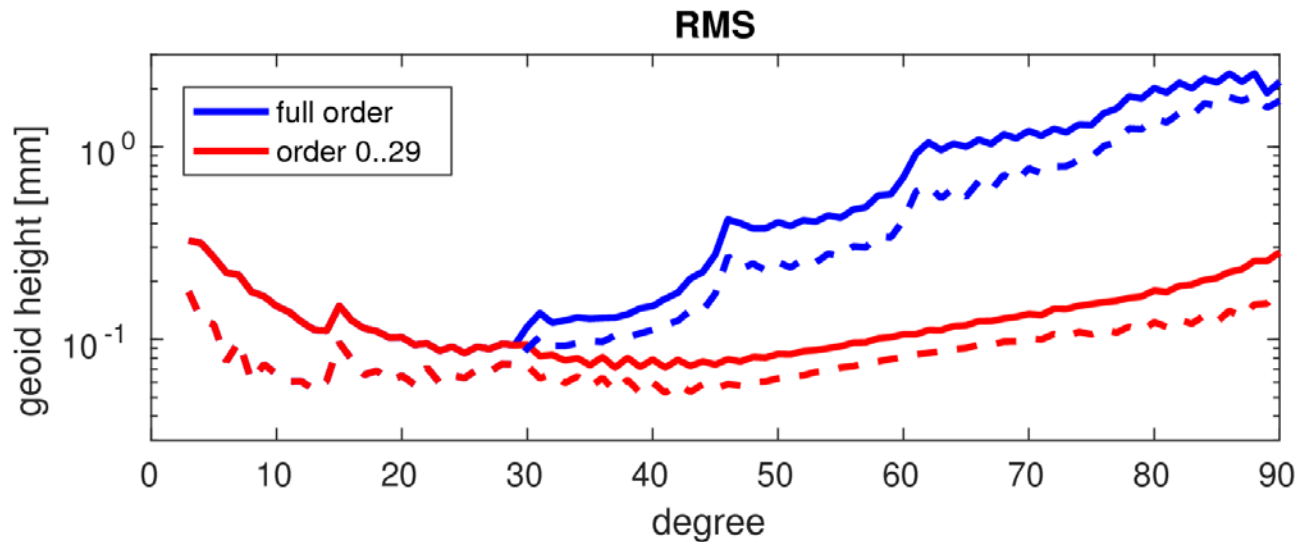


Noise Assessment



Anomalies:  
differences to model

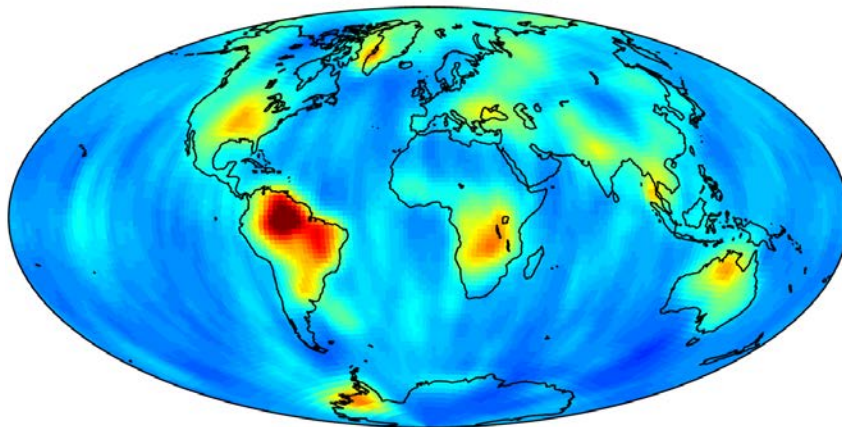
Noise Assessment



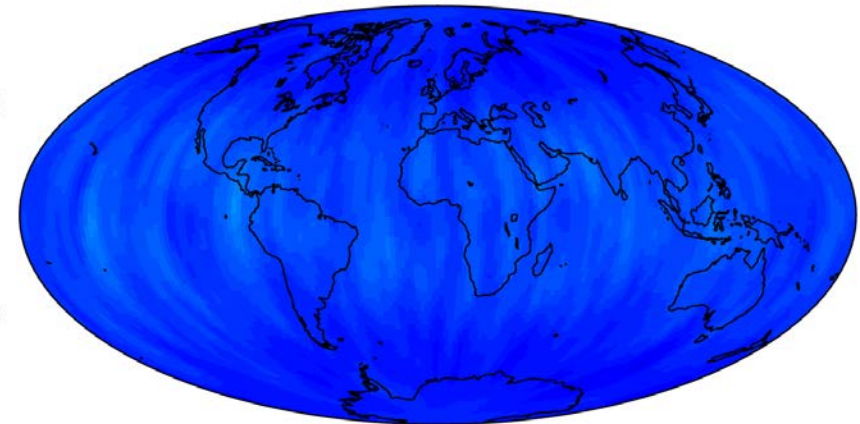
Anomalies:  
differences to model

Differences:  
differences to mean

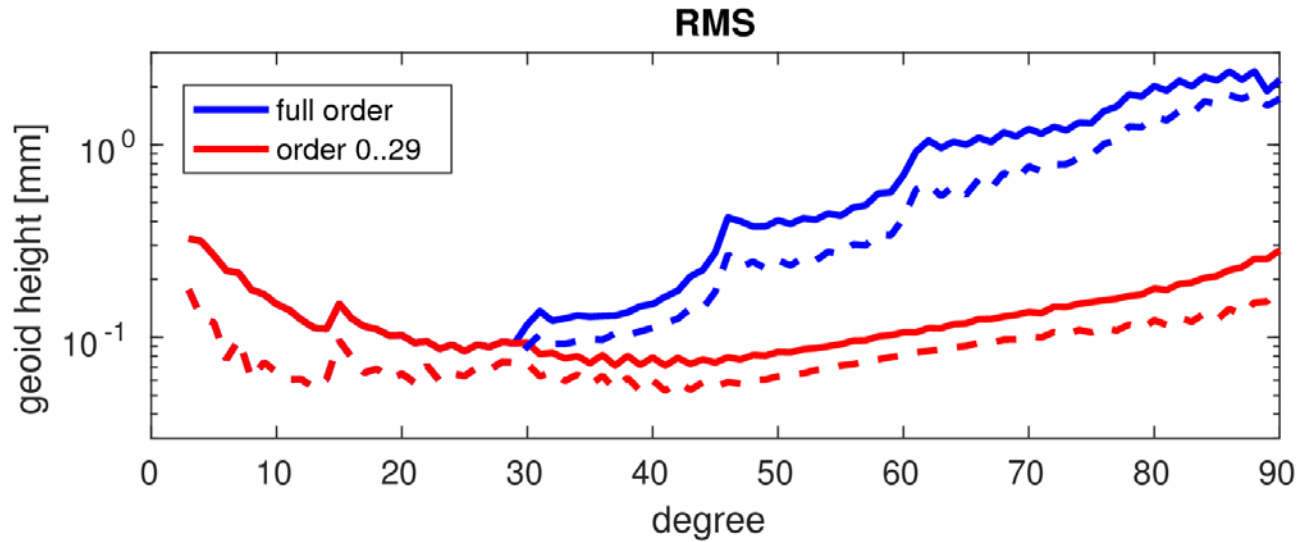
RMS of anomalies





RMS of differences to mean



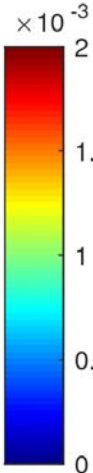
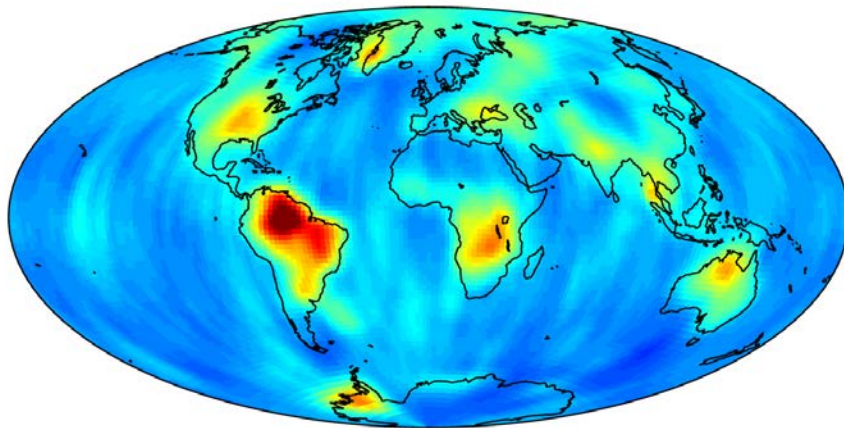
Noise Assessment



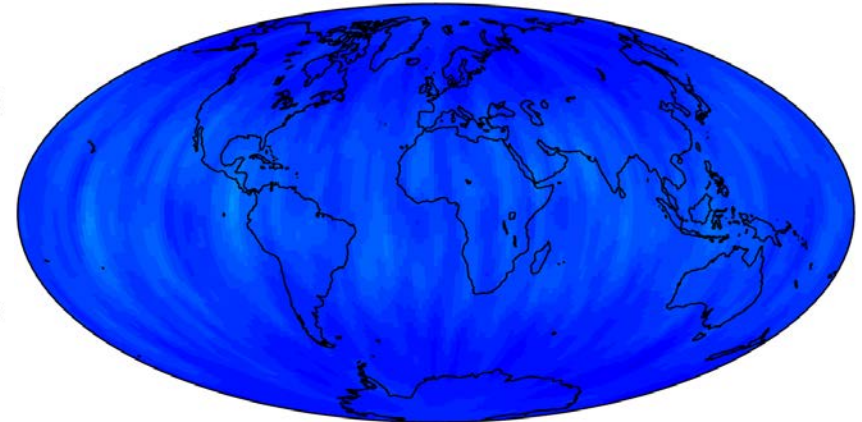
Differences to mean
to derive relative
weights.  

Anomalies over quite
regions to independtly
assess quality.  

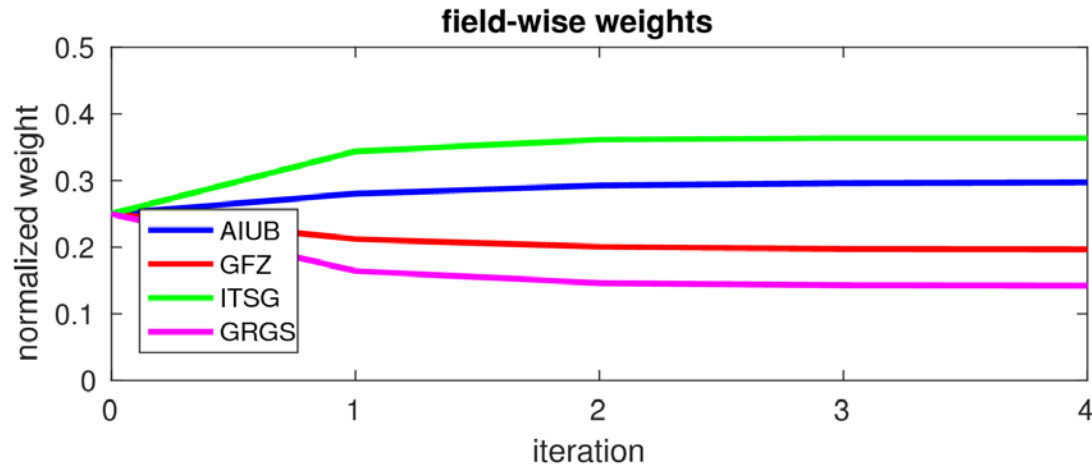
RMS of anomalies



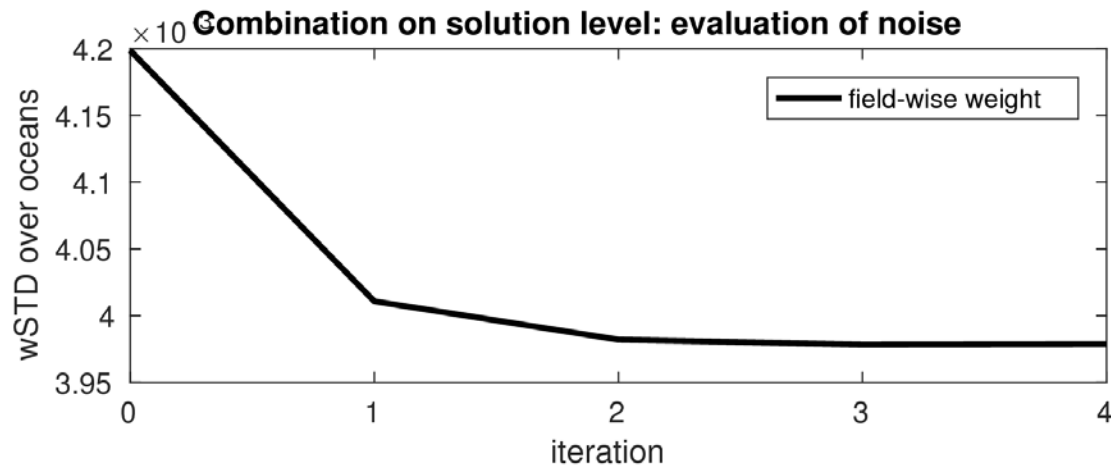
RMS of differences to mean



Variance component estimation on solution level

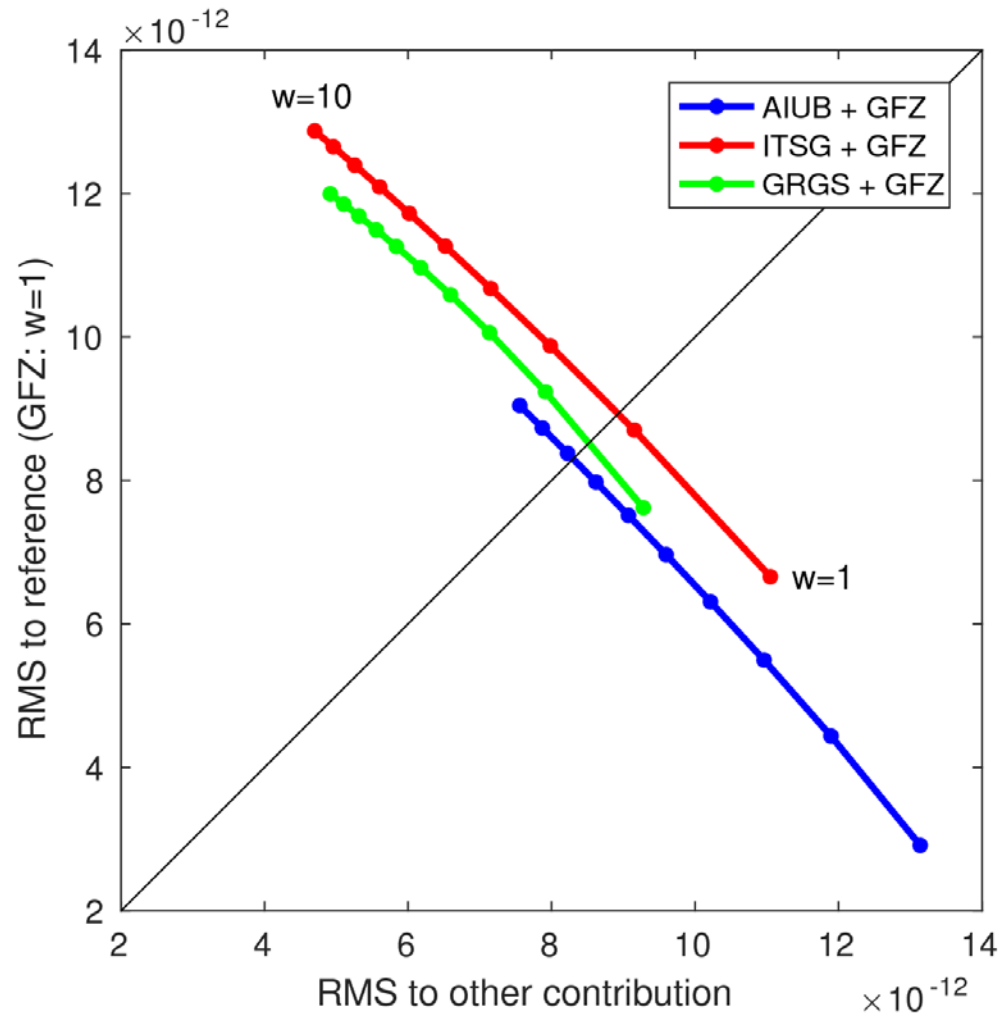


Variance component estimation on solution level taking into account all SH coefficients up to degree and order 80 with equal weight.



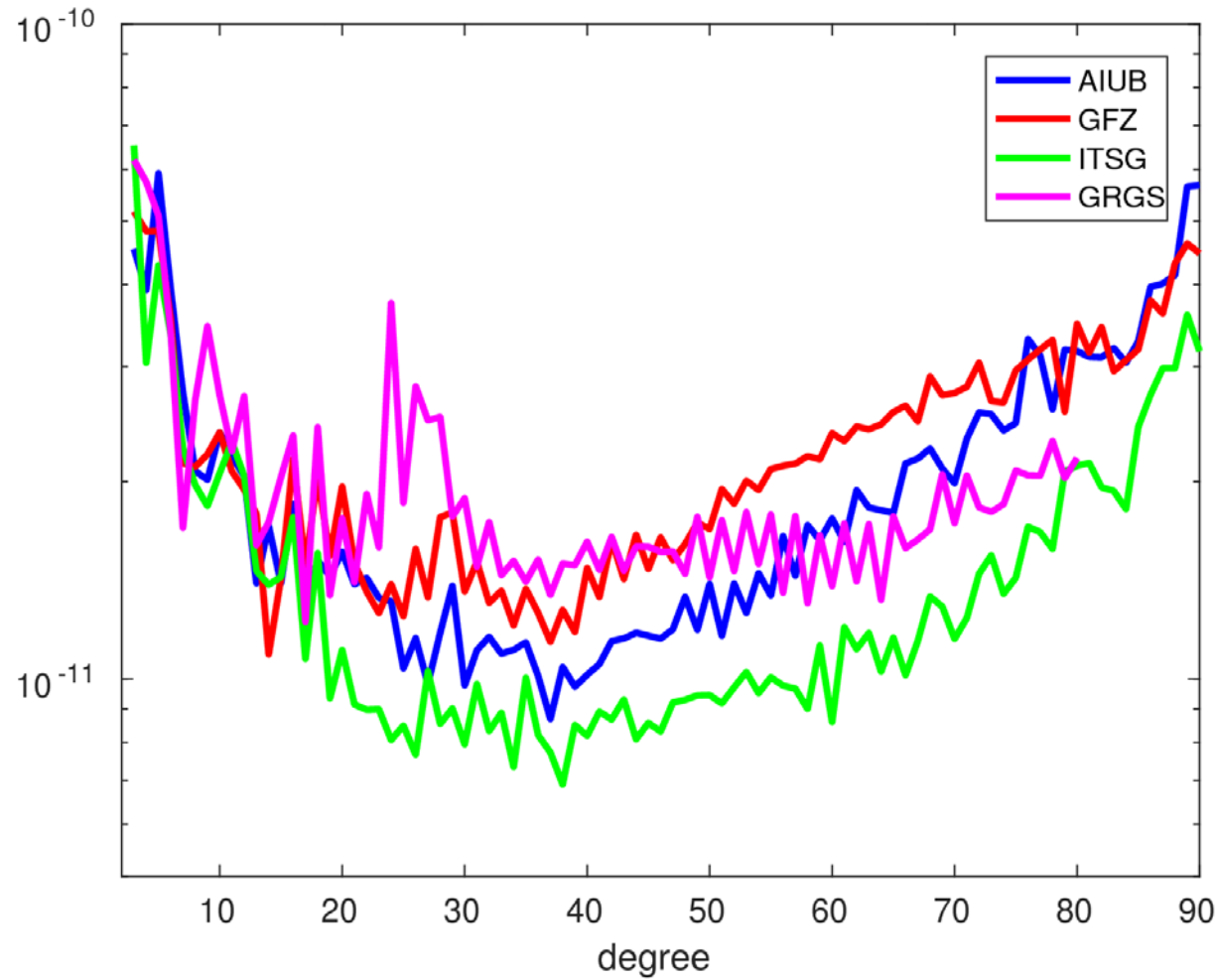
RMS of anomalies restricted to ocean areas as quality criterion.

Combination on Normal Equation Level

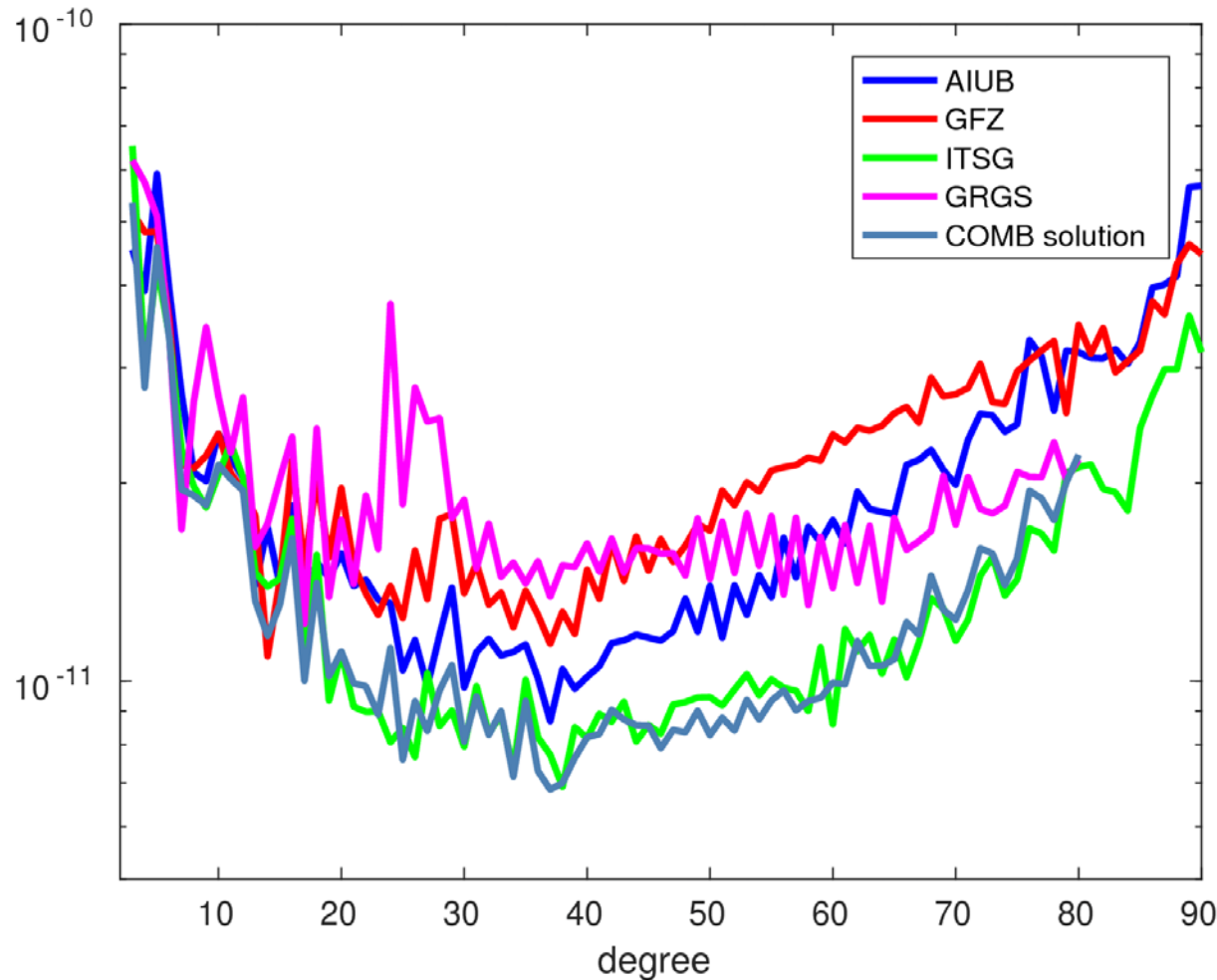


equalizing weight	
GRGS	1.60
GFZ	1.00
AIUB	7.81
ITSG	2.21

Combination: 2006/01

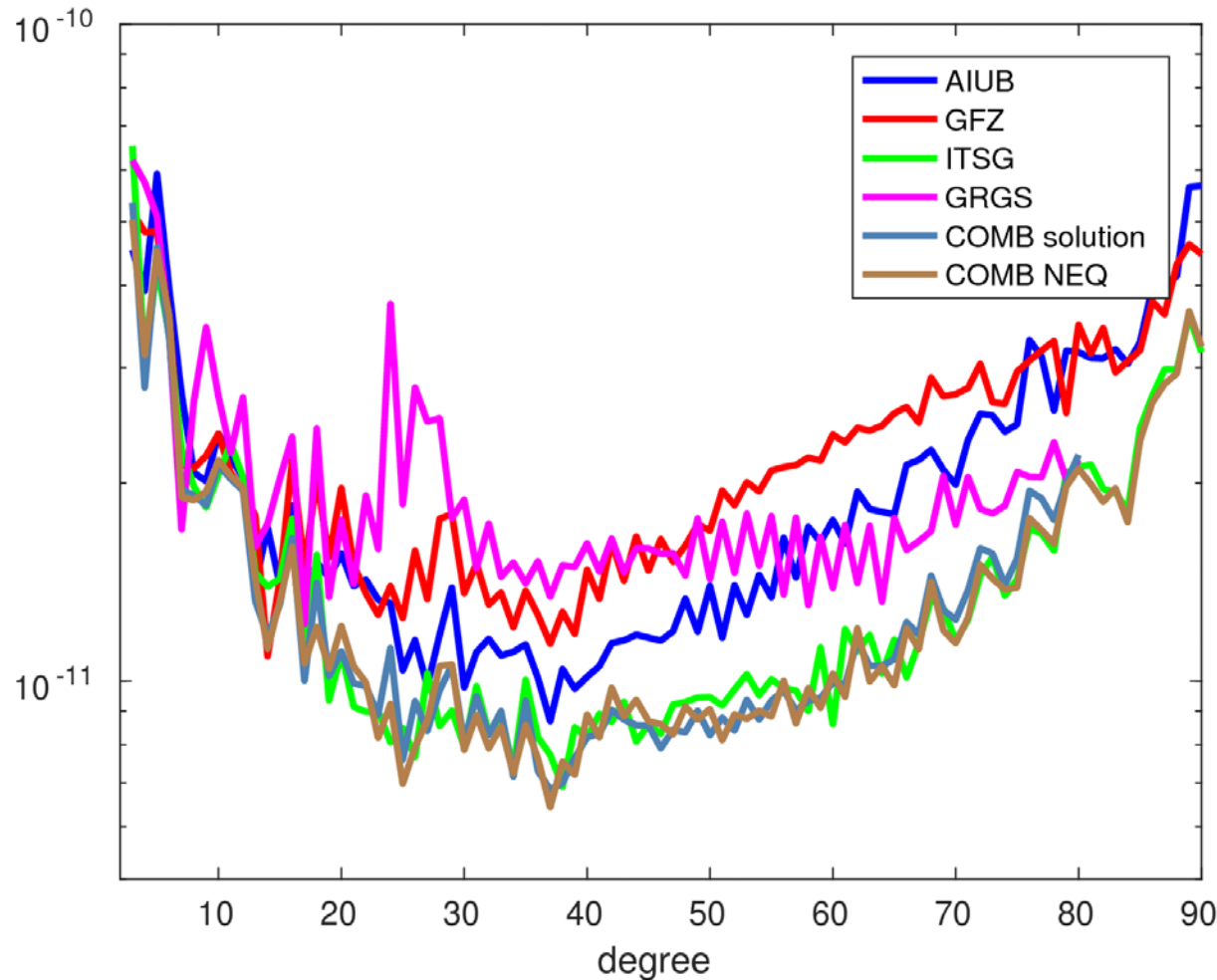


Combination: 2006/01



Solution:	weight
GRGS	0.14
GFZ	0.19
AIUB	0.29
ITSG	0.38

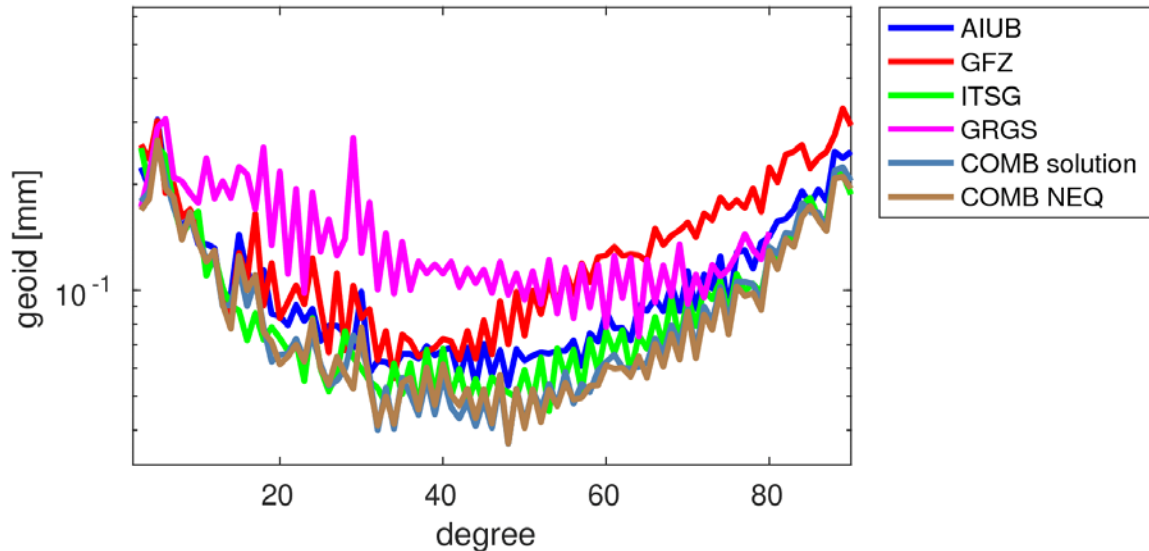
Combination: 2006/01



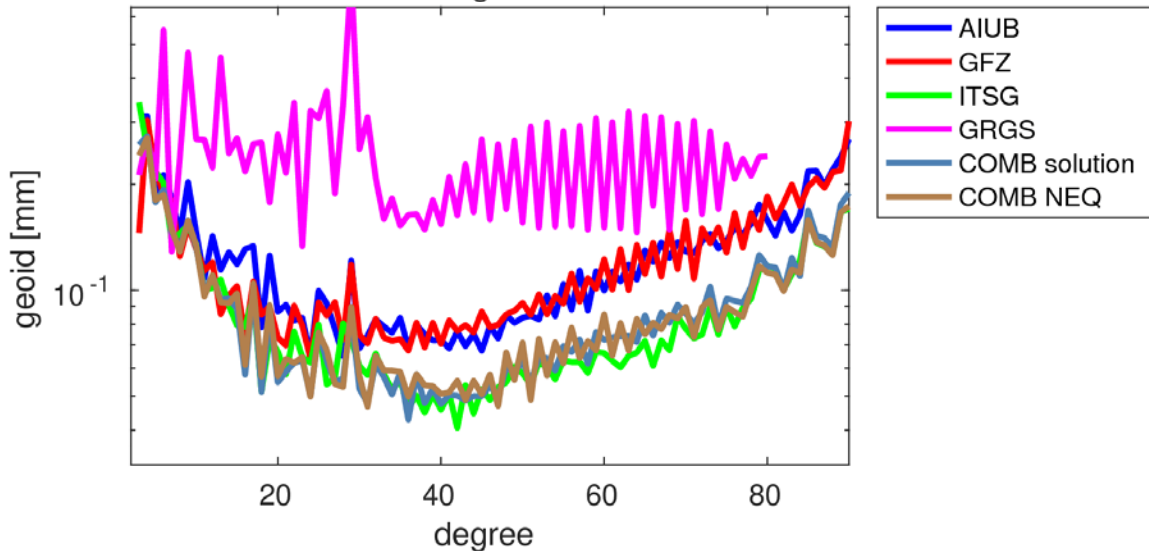
equalizing weight	
GRGS	1.60
GFZ	1.00
AIUB	7.81
ITSG	2.21

Solution:	weight
GRGS	0.14
GFZ	0.19
AIUB	0.29
ITSG	0.38

Combination results



June 2006: in case of more homogeneous quality among ACs the combination clearly outperforms the best individual contribution.

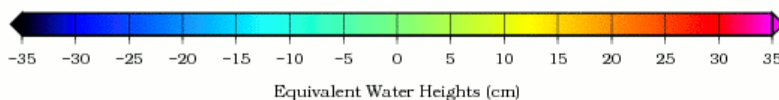
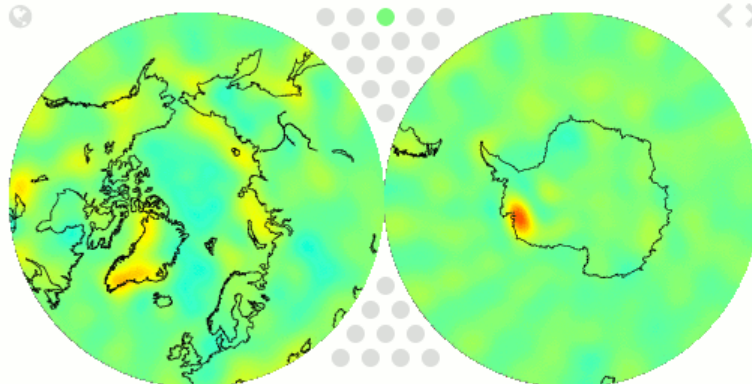
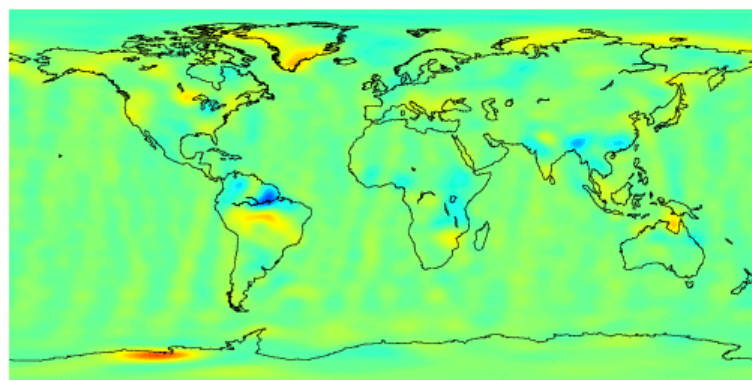


Oct. 2006: in case of cross outliers screening is necessary, otherwise the combination is degraded.

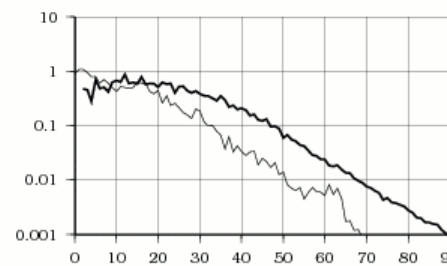
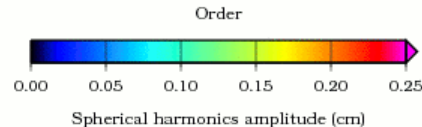
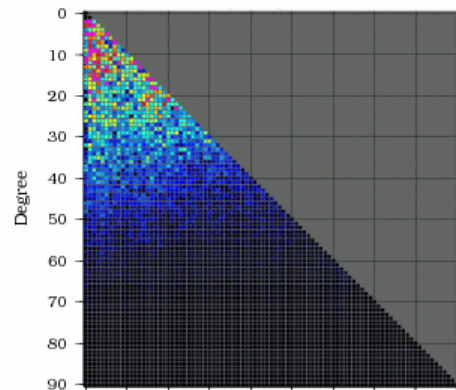
L3-Products: www.egsiem.eu -> Data -> EGSIEM-Plotter

Functional: Water heights ▾
Data center and version: EGSIEM GRACE hydrology DDK3 ▾
Date: 2006 January ▾

EGSIEM graceHydrology monthly DDK3 - 2006/01/01 - 2006/01/31
Equivalent Water Heights comparison to time series mean (degree 2 to 90)
min -24.86 cm / max 23.89 cm / weighted rms 3.16 cm / oceans 1.91 cm



2002 2004 2006 2008 2010 2012 2014 2016 2018



Transition to IAG service COST-G

- EGSIEM Scientific Combination Service is ready for transition into IAG service COST-G.
- Noise assessment by variance component estimation on solution level.
- Relative weights based on noise levels.
- The EGSIEM combination service provides two test years (2006 + 2007):
 - SH-coefficients (Level-2): www.icgem.de
 - grids and de-aliasing (Level-3): www.egsiem.eu