

# EGSIEM combination service: combination of GRACE monthly K-band solutions on normal equation level

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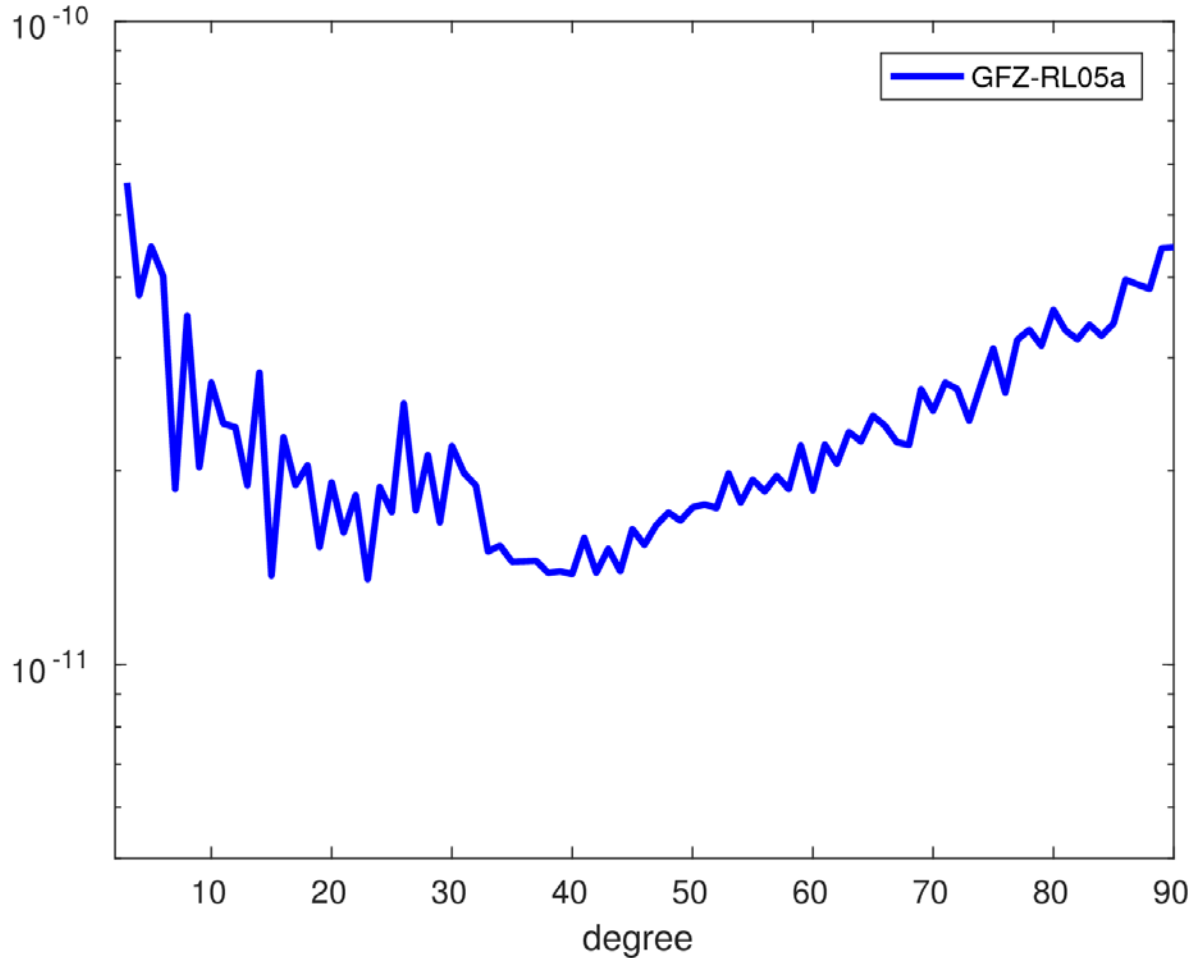
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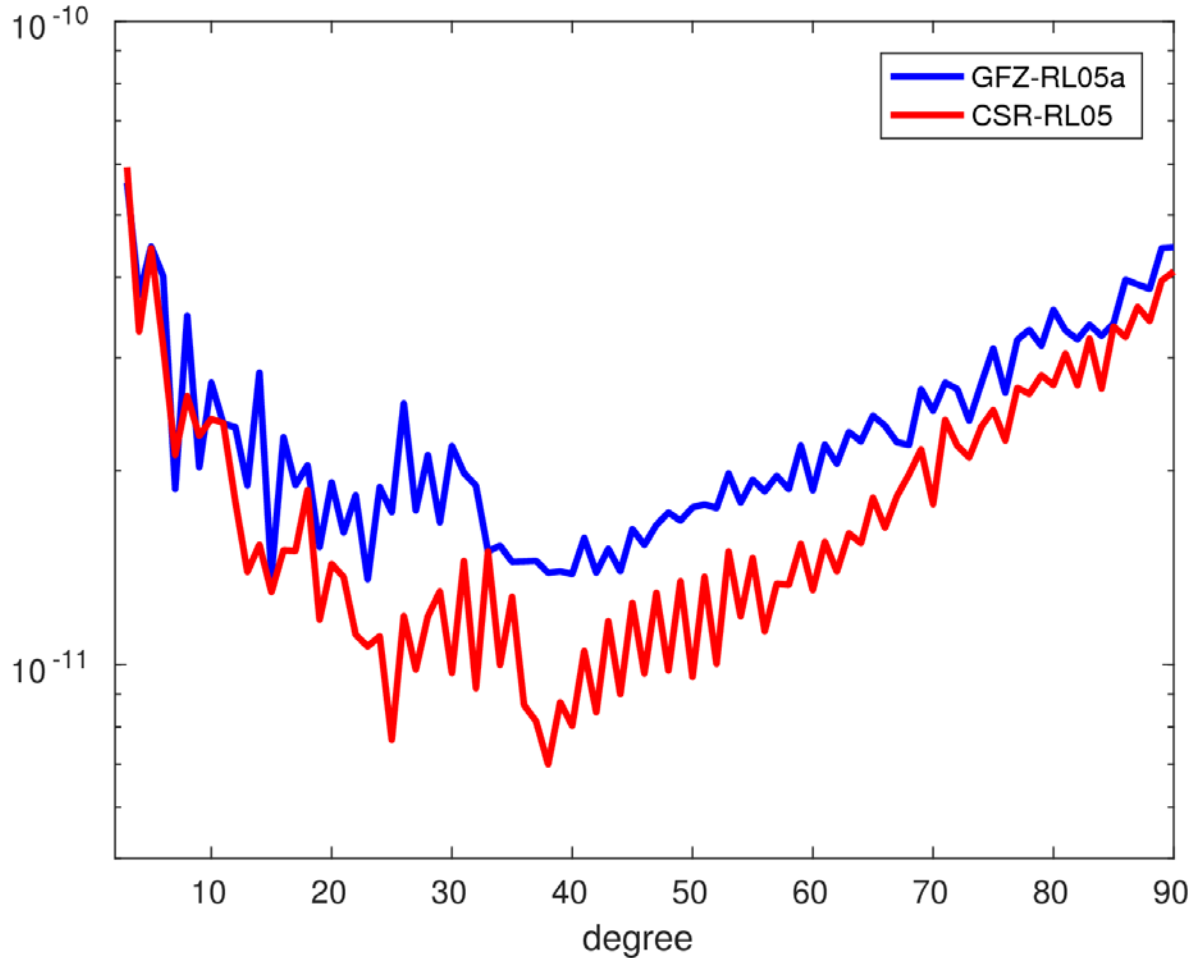
# Motivation

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



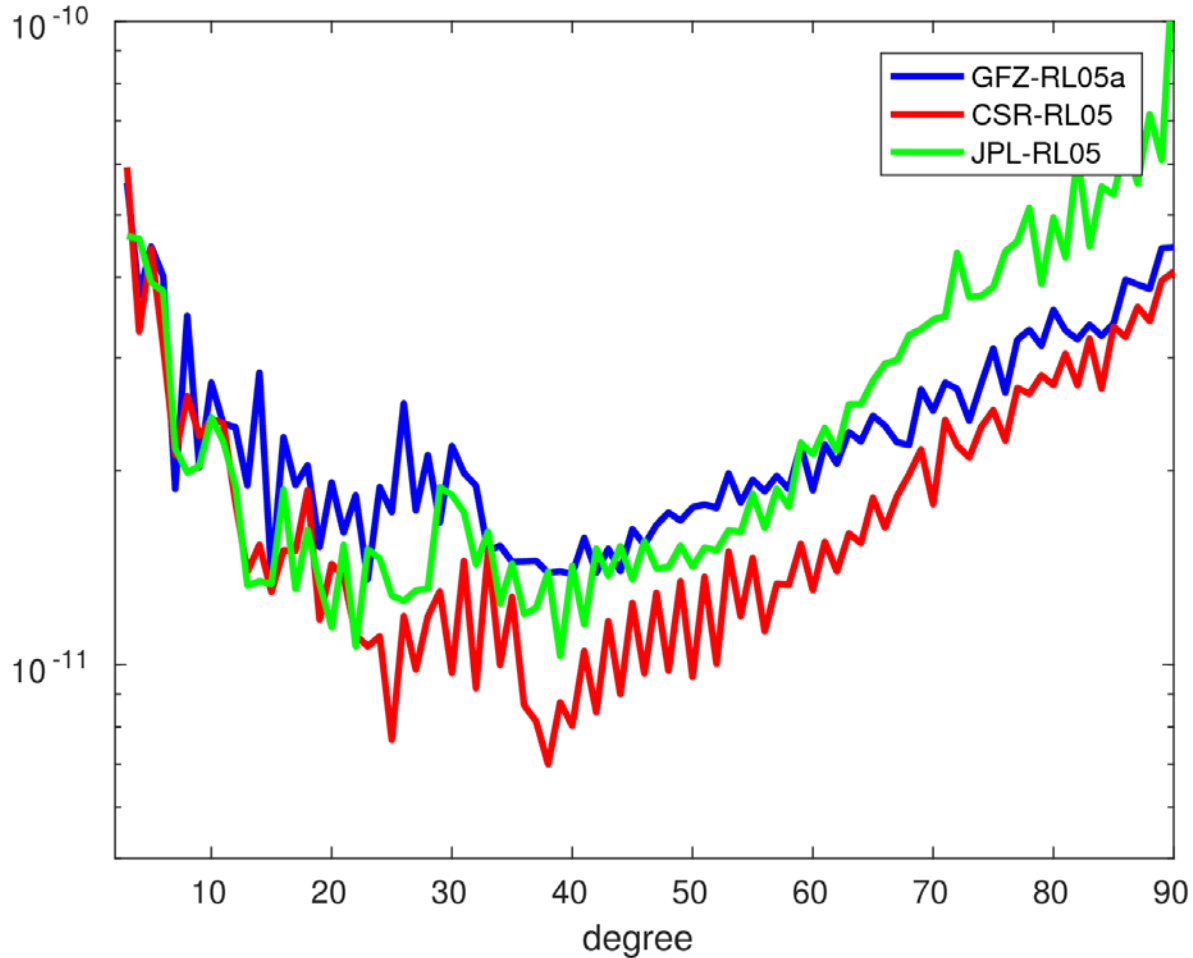
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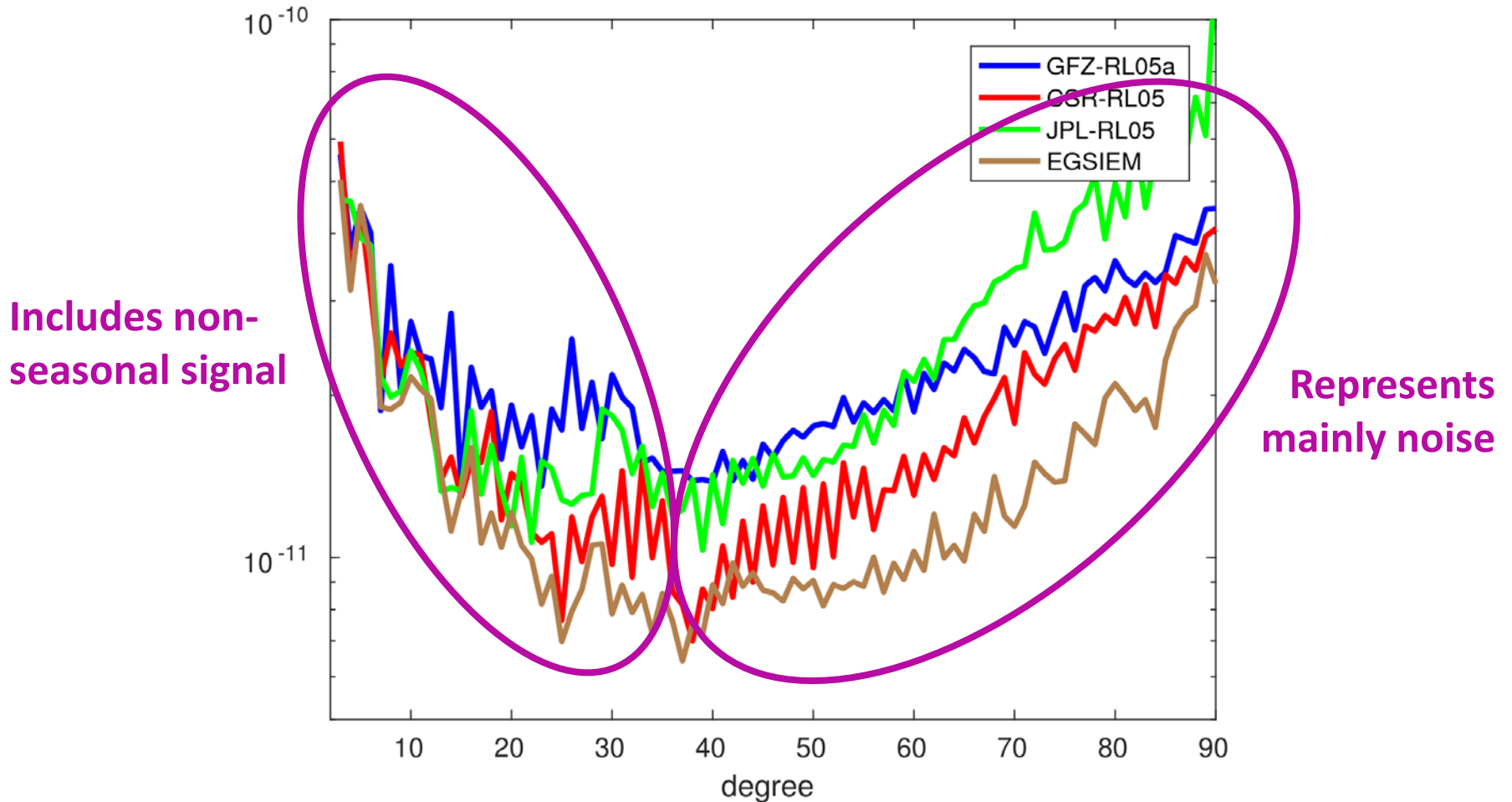
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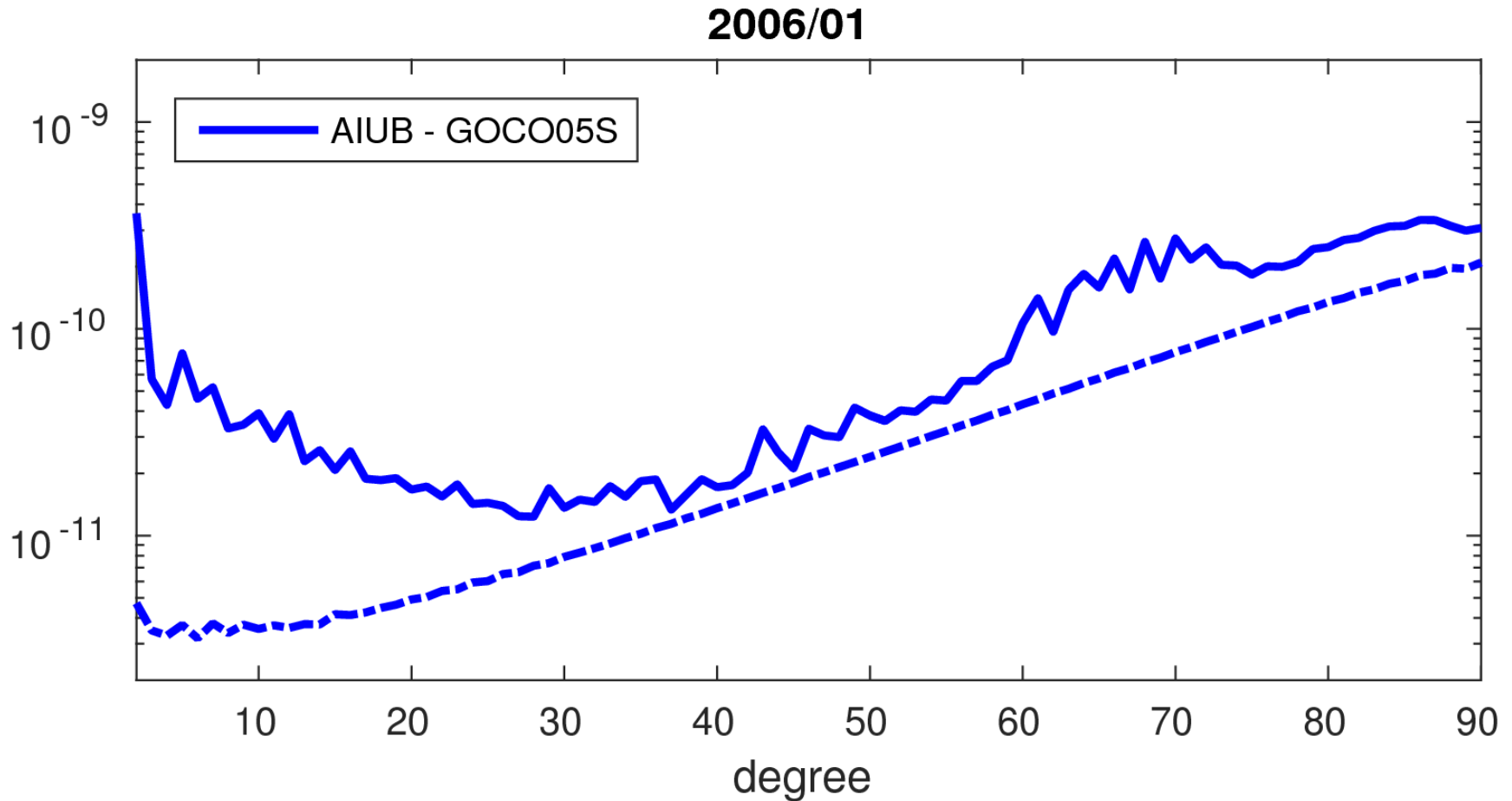


# Motivation

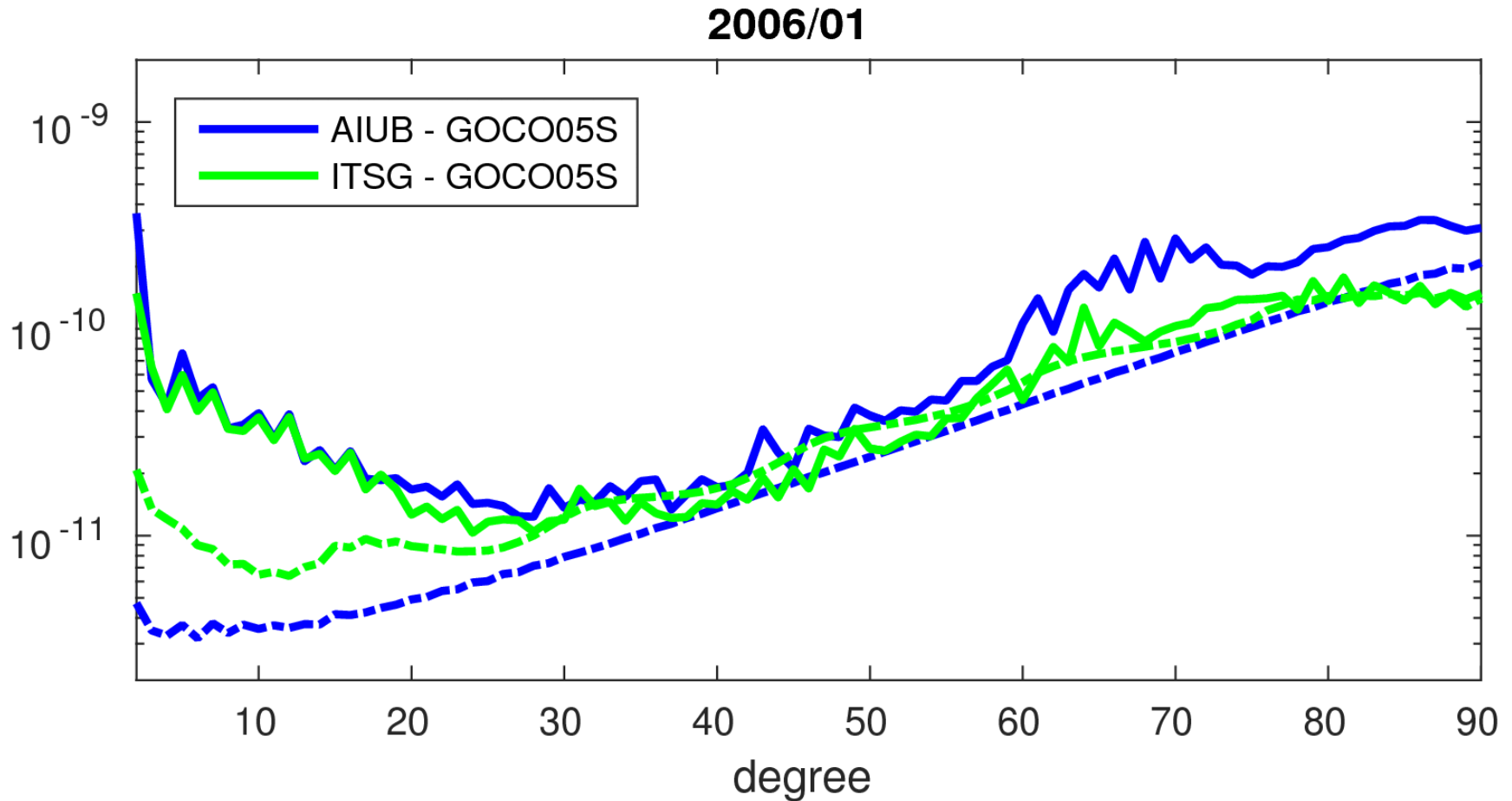
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# Individual Contributions

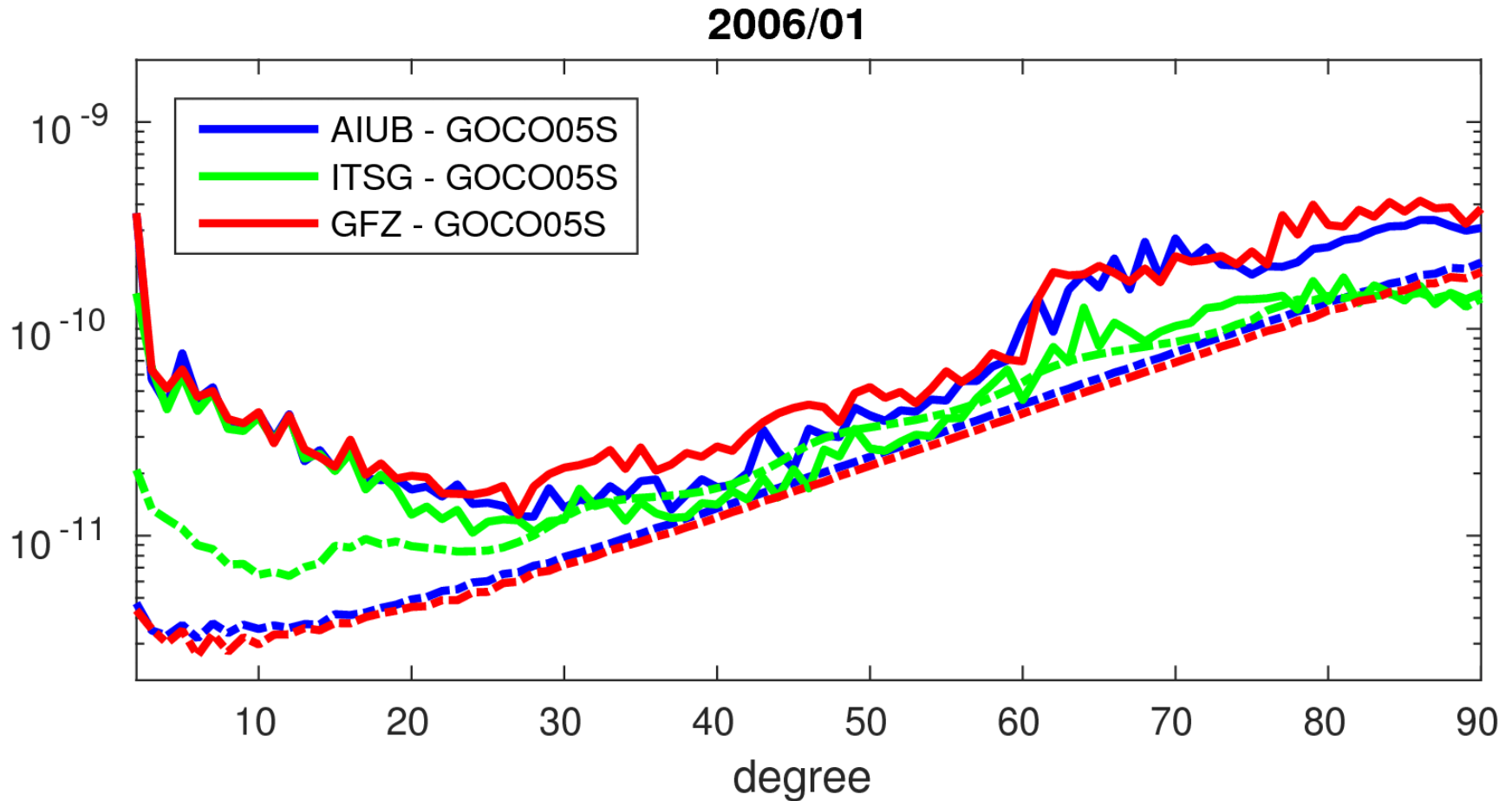


# Individual Contributions

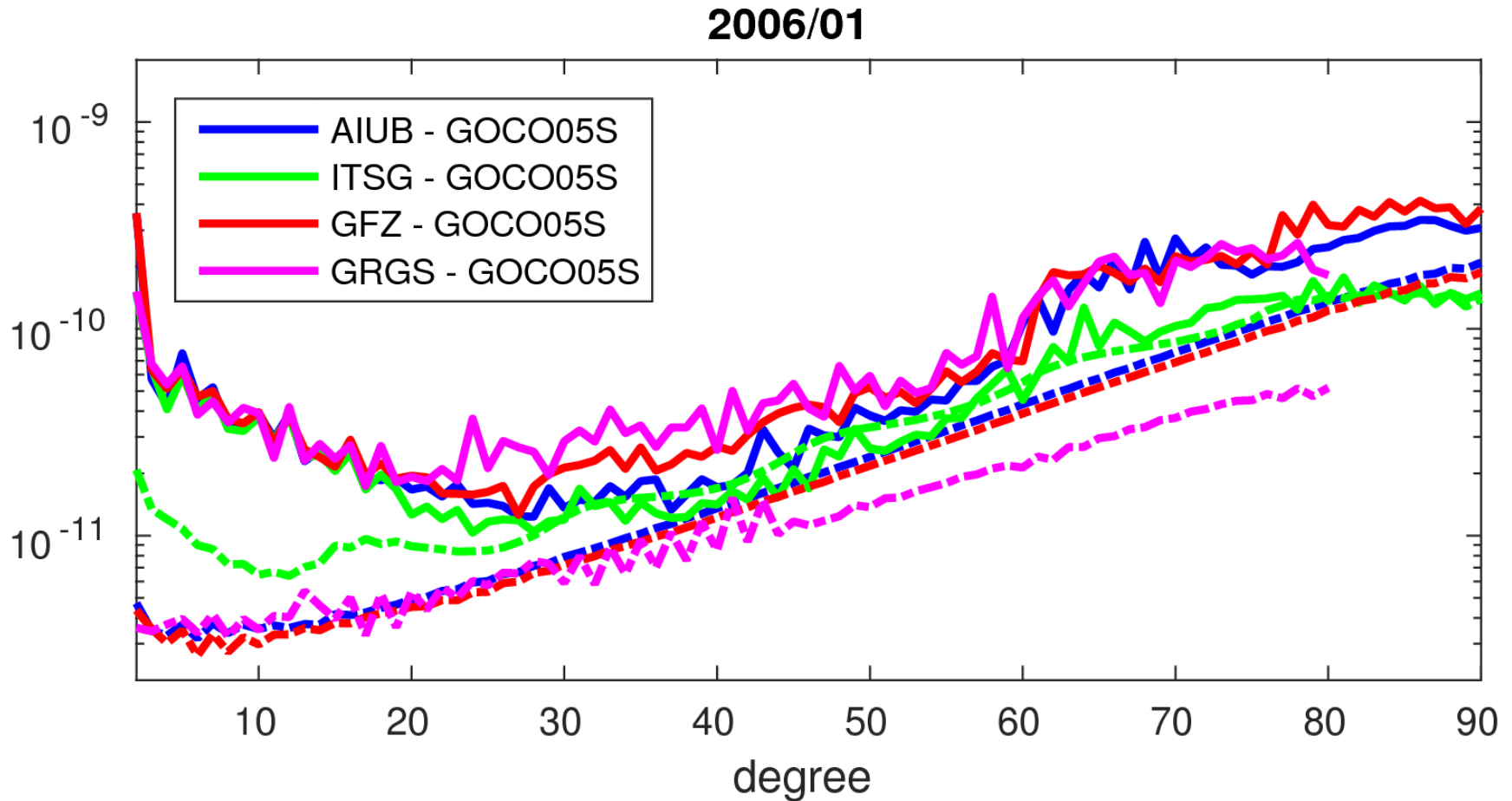




# Individual Contributions



# 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**



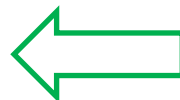
**Optimistic**

**Realistic (empirical)**

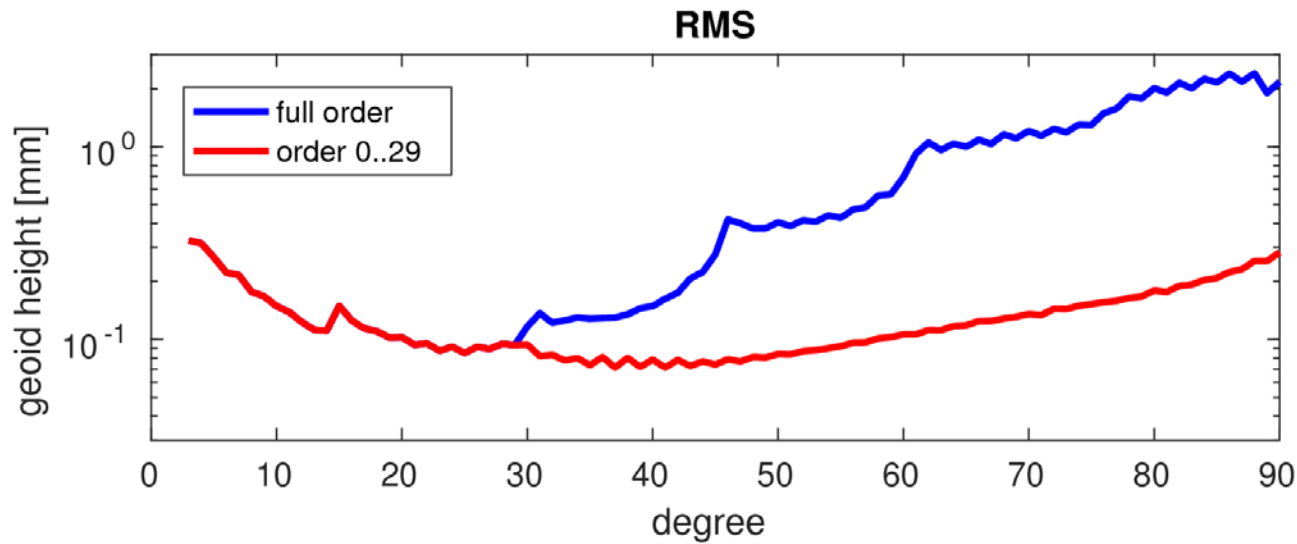
**Errors of observations: GPS, K-band, accelerometers, star cameras**



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

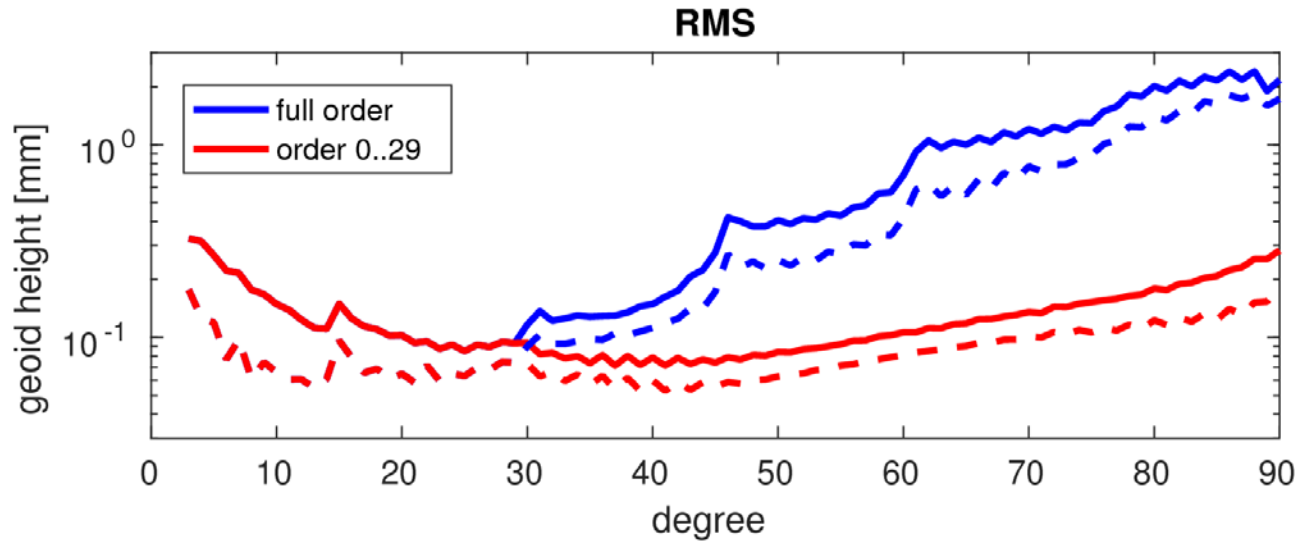


# Noise Assessment



Anomalies:    
differences to model

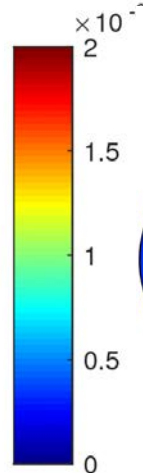
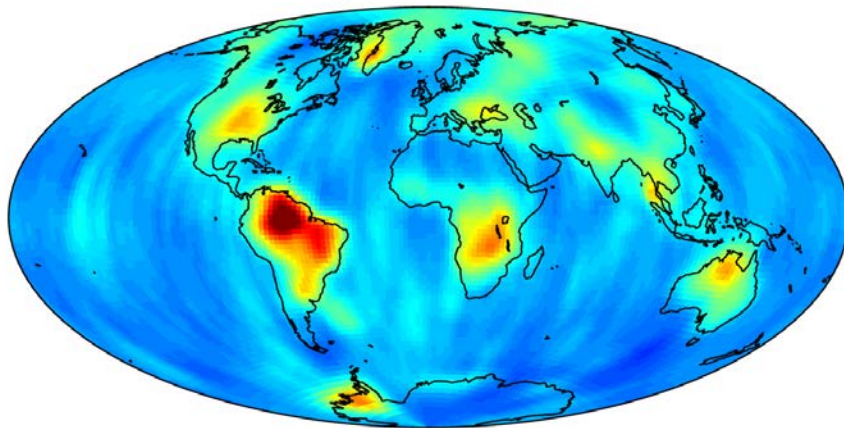
# Noise Assessment



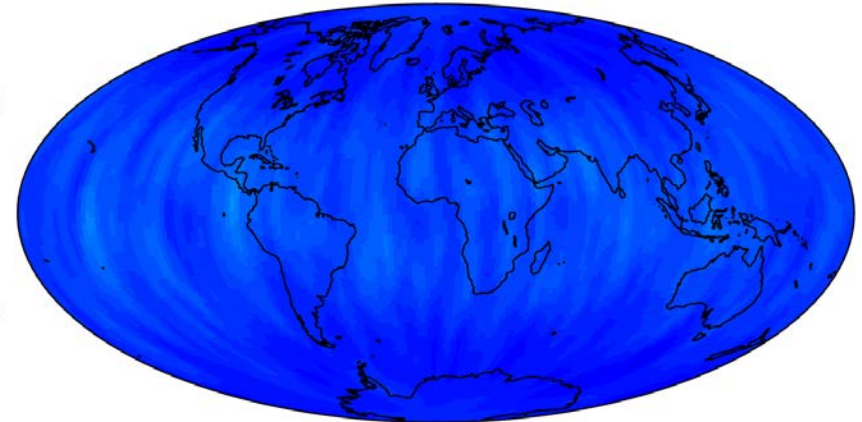
Anomalies:   
 differences to model

Differences:   
 differences to mean

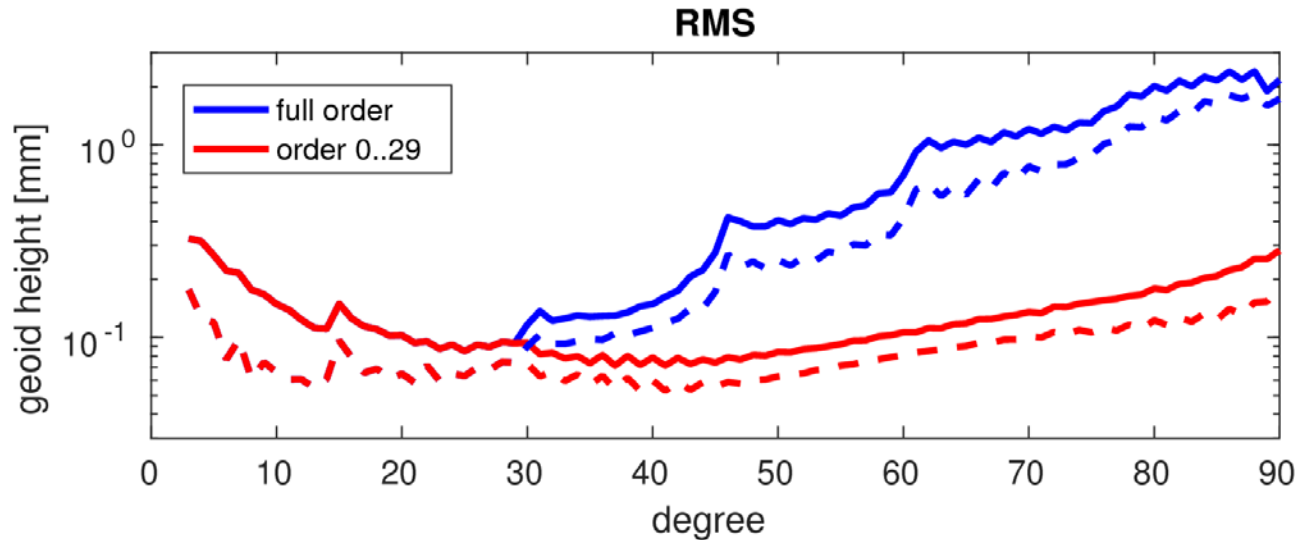
**RMS of anomalies**



**RMS of differences to mean**



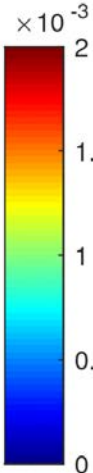
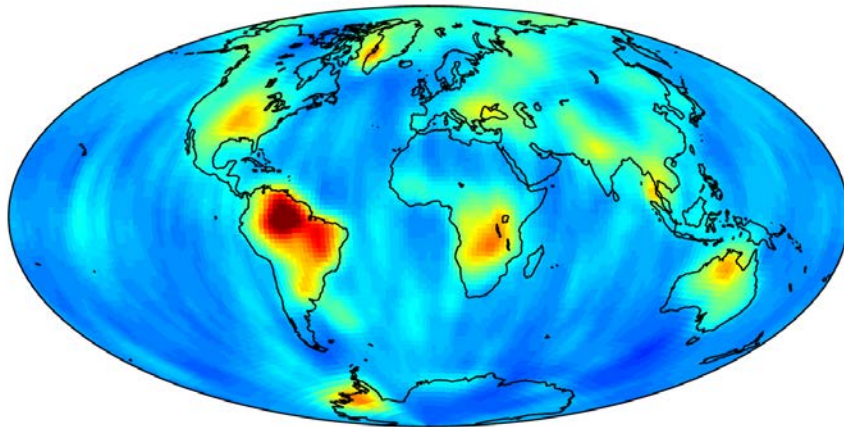
# Noise Assessment



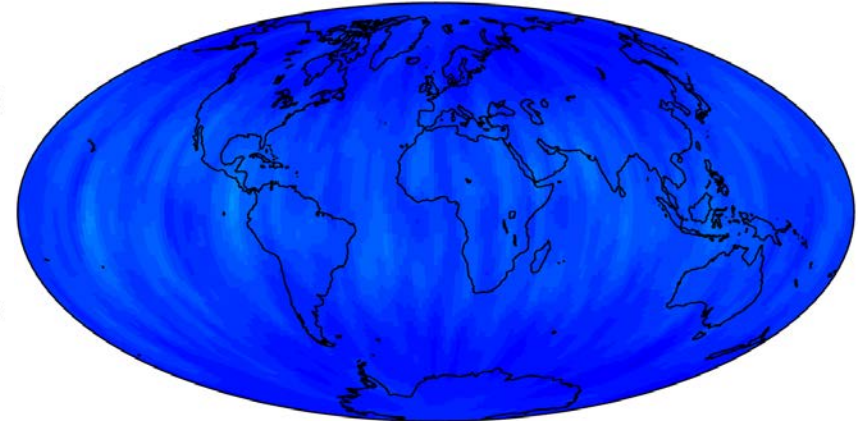
Differences to mean to derive relative weights. — — —

Anomalies over quite regions to independently assess quality. — — —

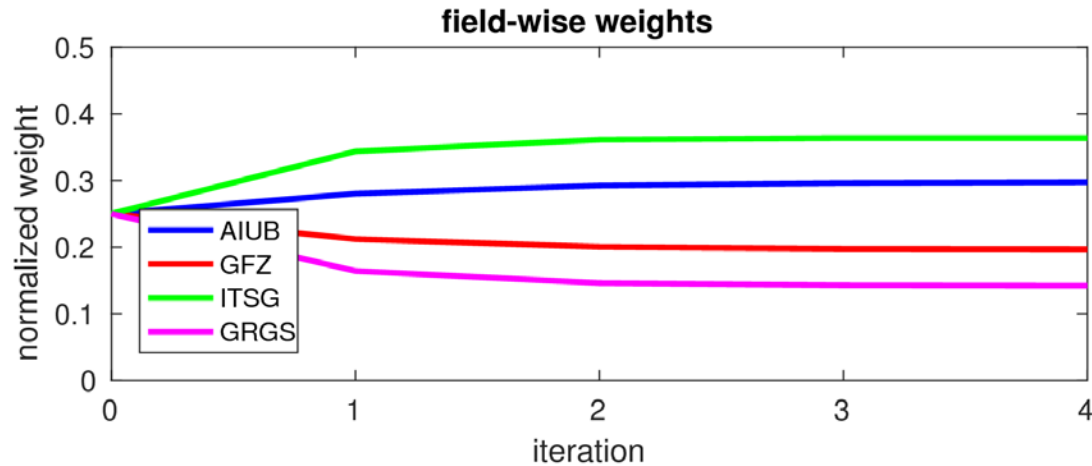
**RMS of anomalies**



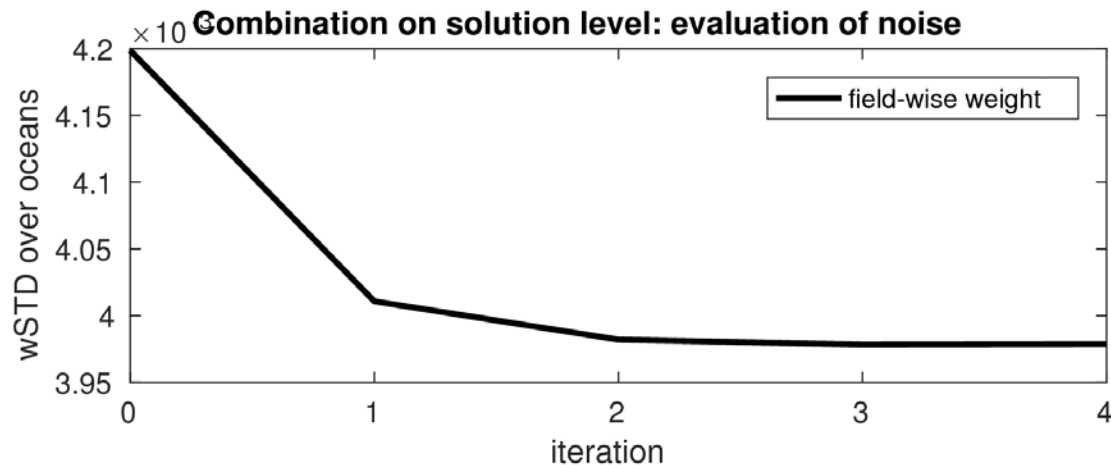
**RMS of differences to mean**



# 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

Achieve equal impact of individual contributions on pairwise combinations:

$$(\mathbf{N}_{\text{ref}} + w_i \mathbf{N}_i) d\mathbf{x} = \mathbf{b}_{\text{ref}} + w_i \mathbf{b}_i$$

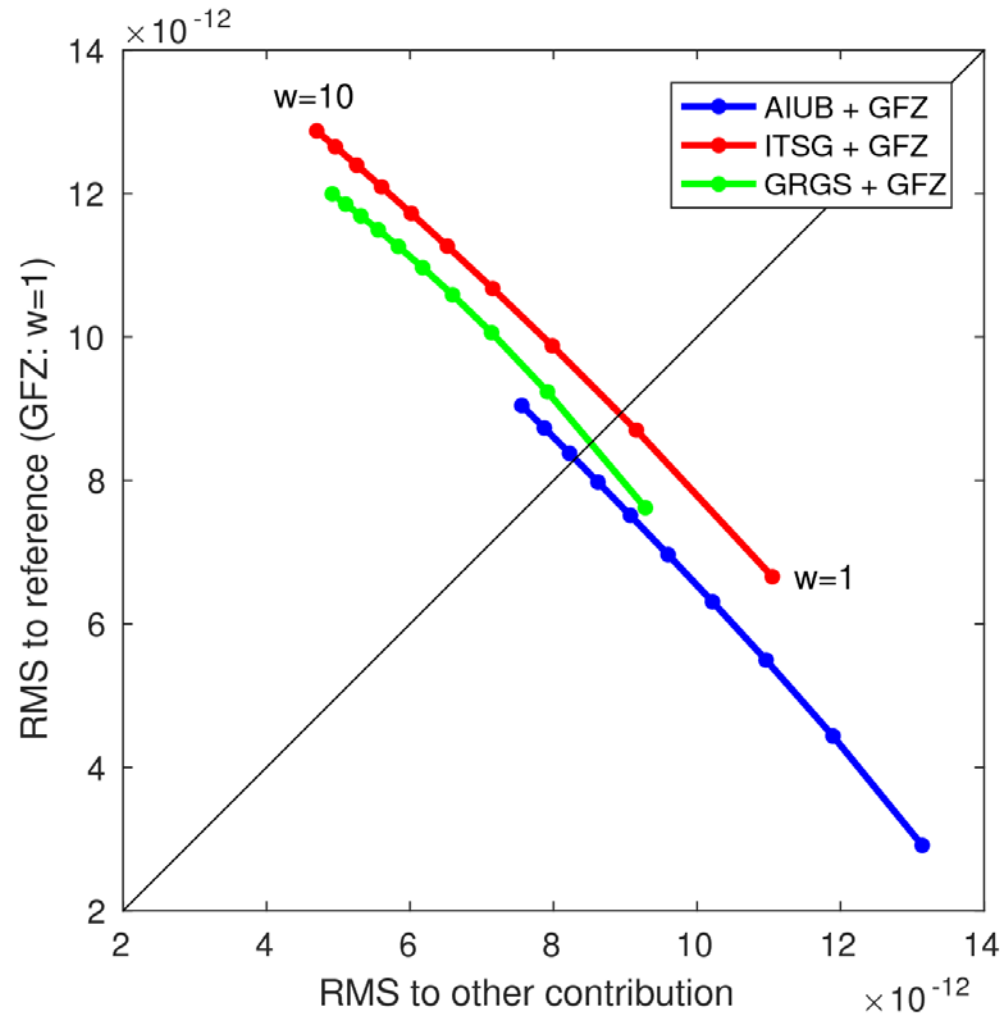
The impact is measured by:

$$\text{RMS}_i = \sqrt{\frac{\sum_{l,m} (K_{l,m}^{\text{comb}} - K_{l,m}^i)^2}{n_{\text{coef}}}}$$

Equal impact is achieved for:  $\frac{\text{RMS}_i}{\text{RMS}_{\text{ref}}} = 1$

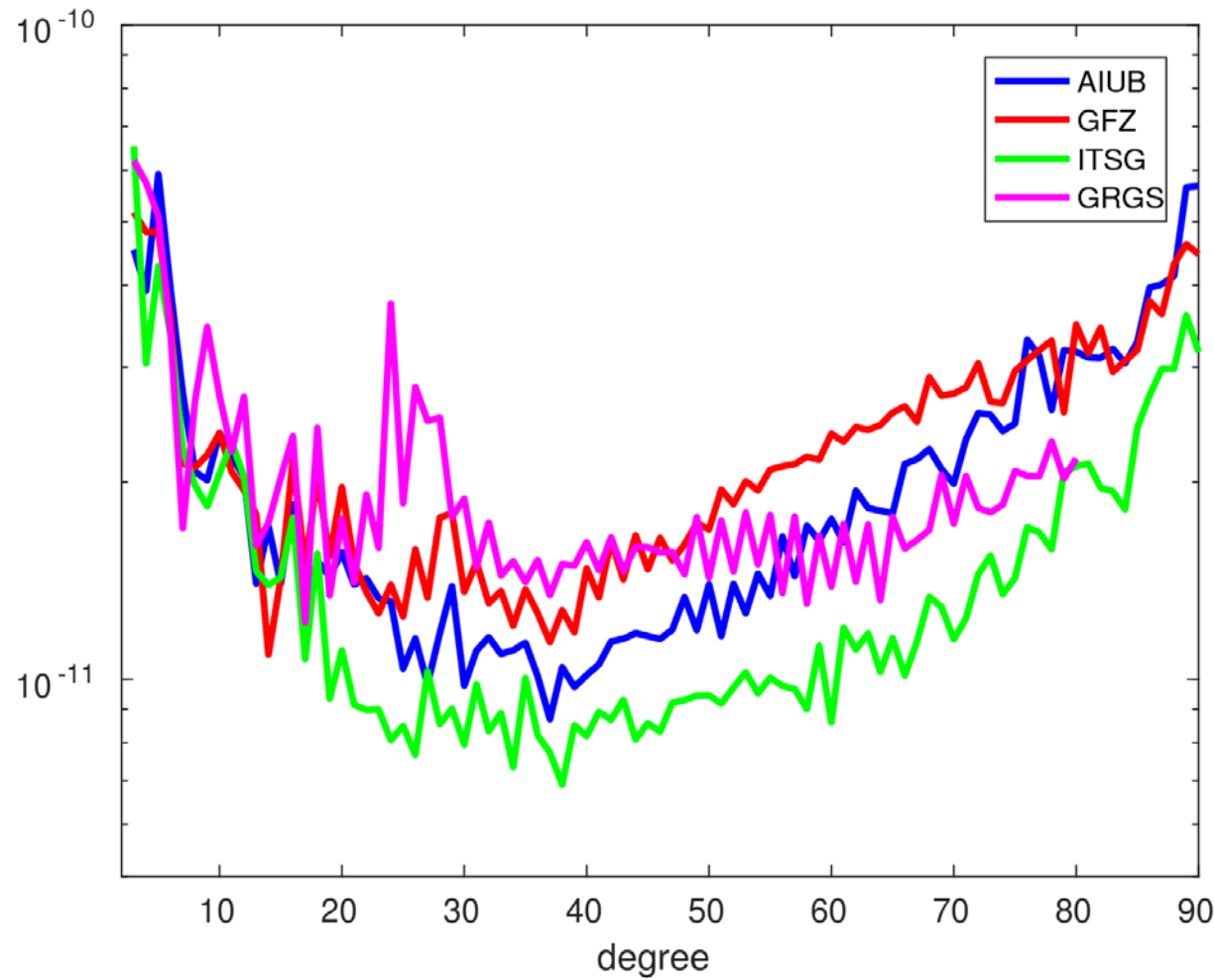


# Combination on Normal Equation Level

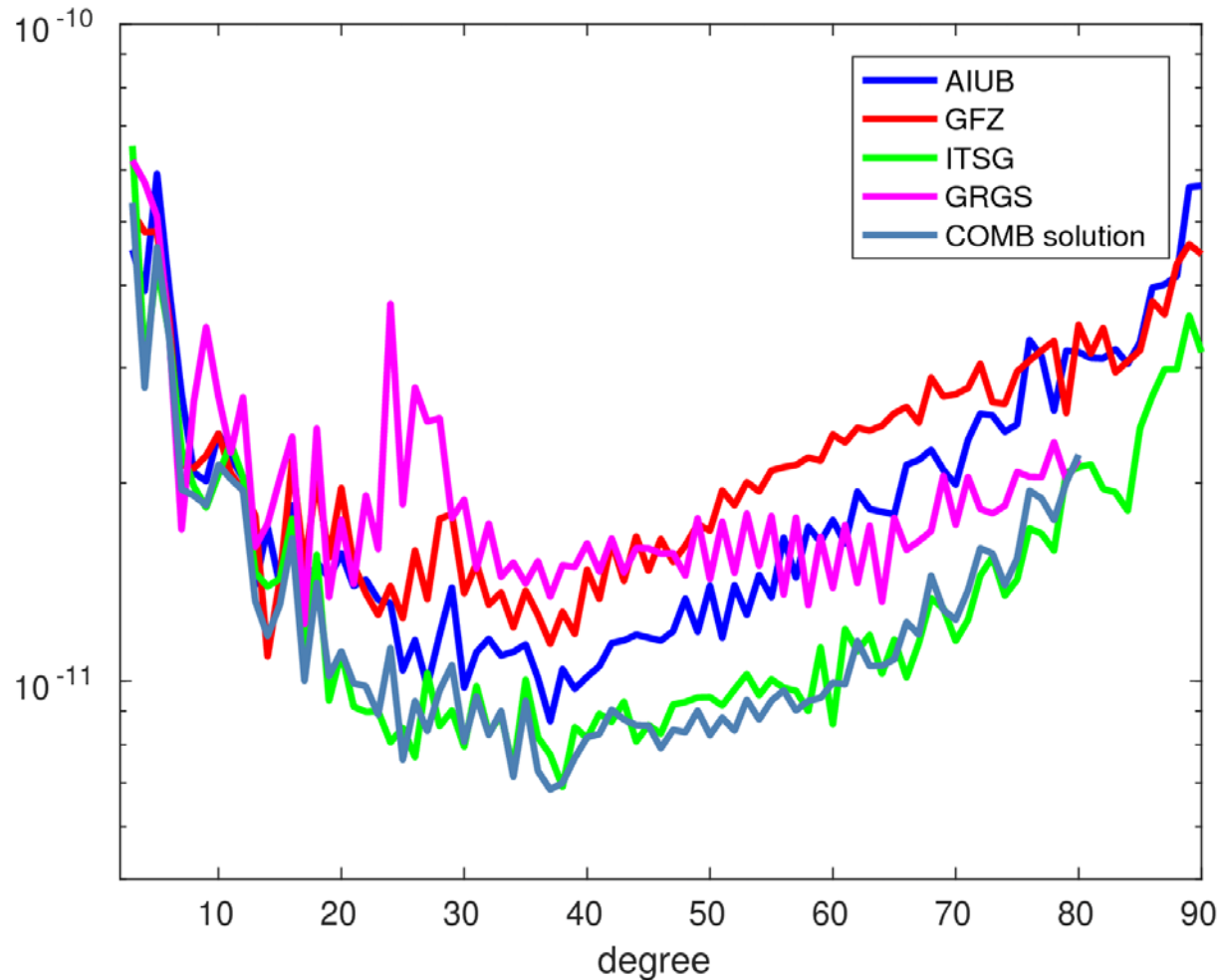


equalizing weight	
GRGS	1.60
GFZ	1.00
AIUB	7.81
ITSG	2.21

# Combination: 2006/01

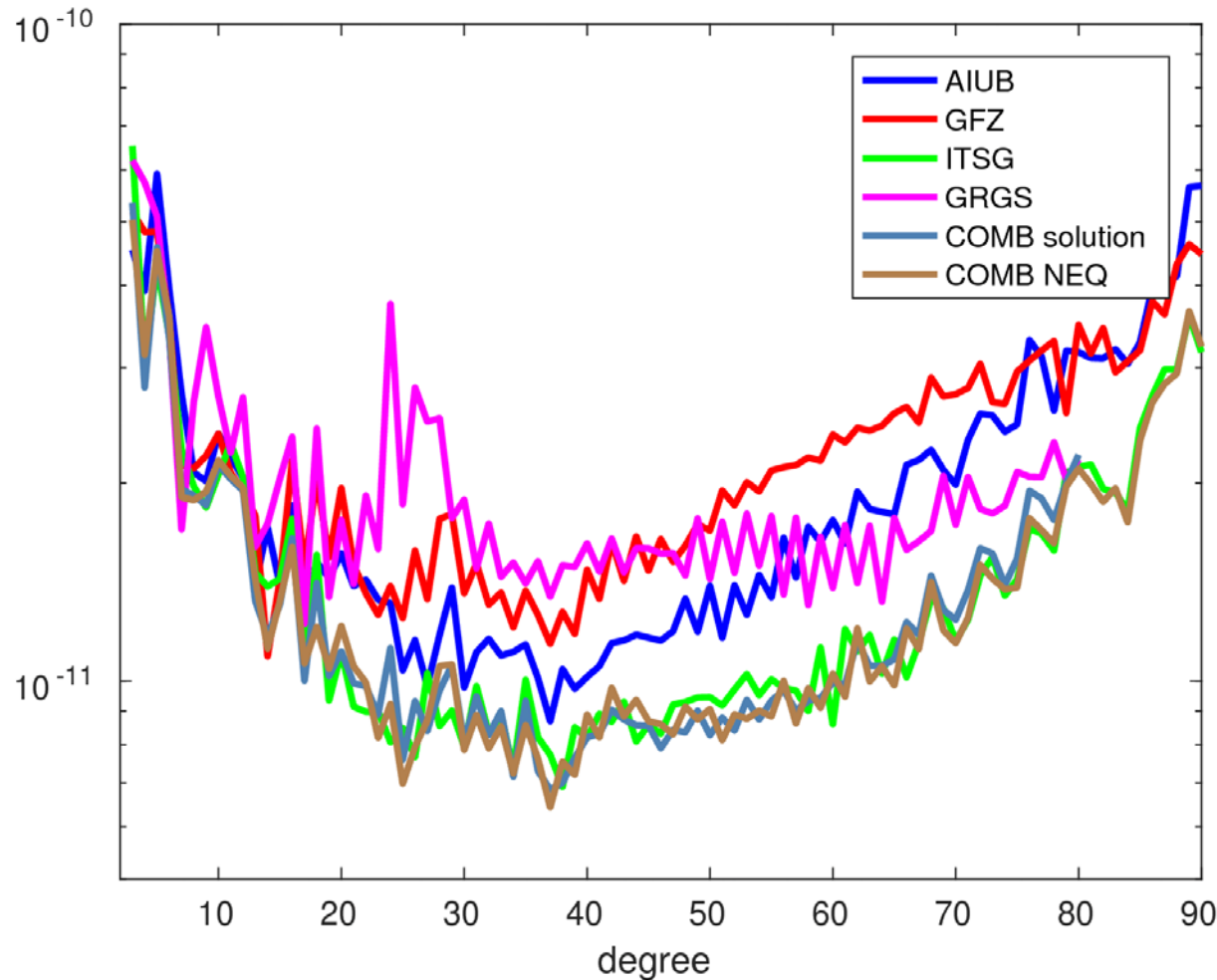


# Combination: 2006/01



Solution:	weight
GRGS	0.14
GFZ	0.19
AIUB	0.29
ITSG	0.38

# Combination: 2006/01



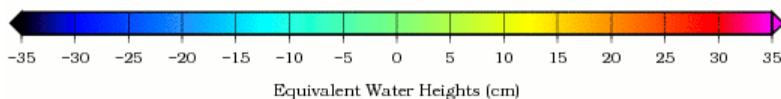
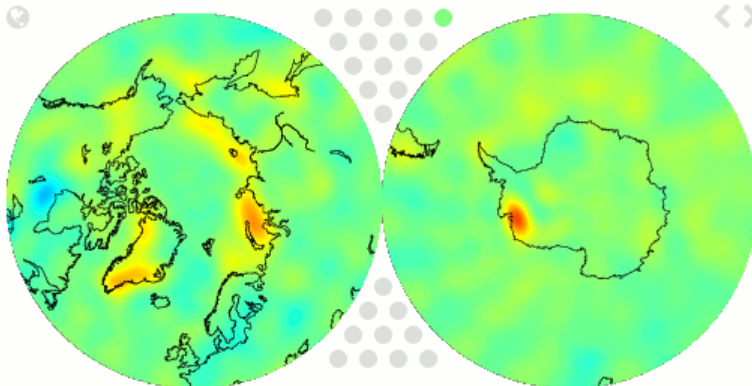
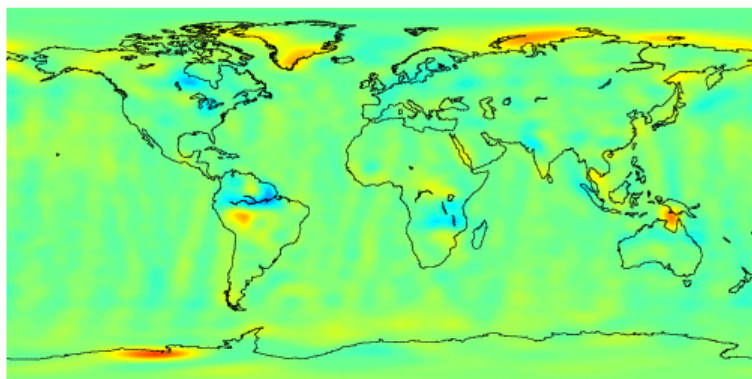
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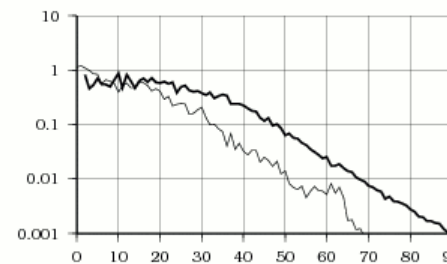
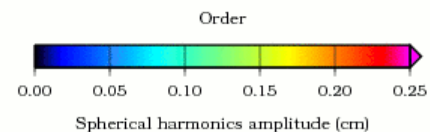
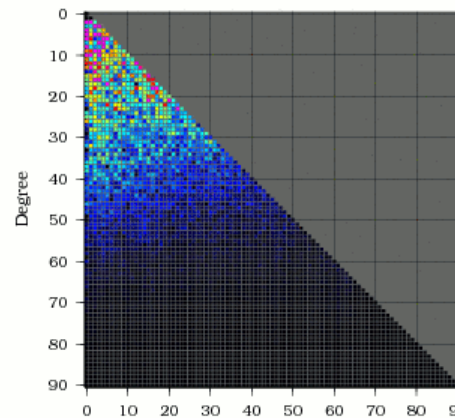
# L3-Products: [www.egsiem.eu](http://www.egsiem.eu) -> Data -> EGSIEM-Plotter

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

EGSIEM graceOceanography monthly DDK3 - 2006/01/01 - 2006/01/31  
Equivalent Water Heights comparison to time series mean (degree 2 to 90)  
min -20.25 cm / max 24.79 cm / weighted rms 3.31 cm / oceans 2.34 cm



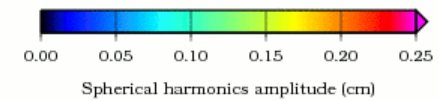
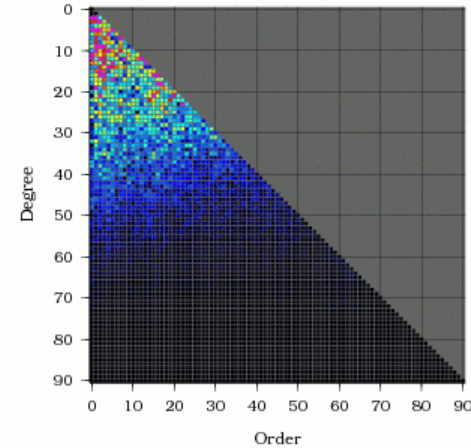
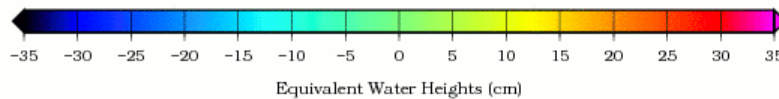
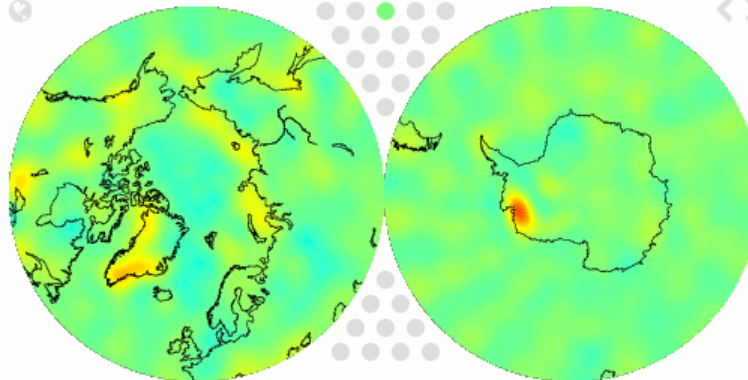
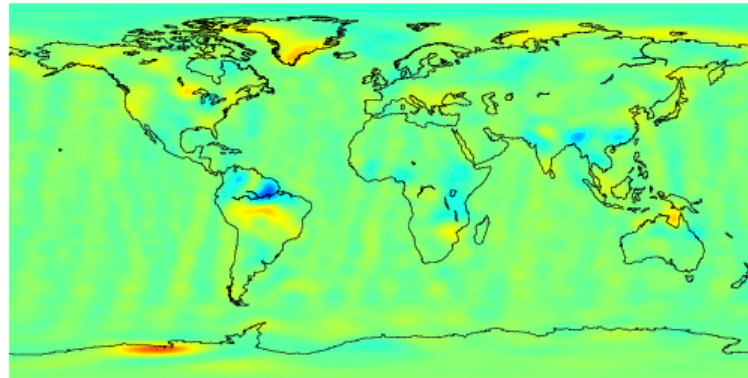
2002 2004 2006 2008 2010 2012 2014 2016 2018



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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



# Conclusions

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- EGSIEM monthly gravity field combination on NEQ-level is operational.
- 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](http://www.icgem.de)
  - grids and de-aliasing (Level-3): [www.egsiem.eu](http://www.egsiem.eu)