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

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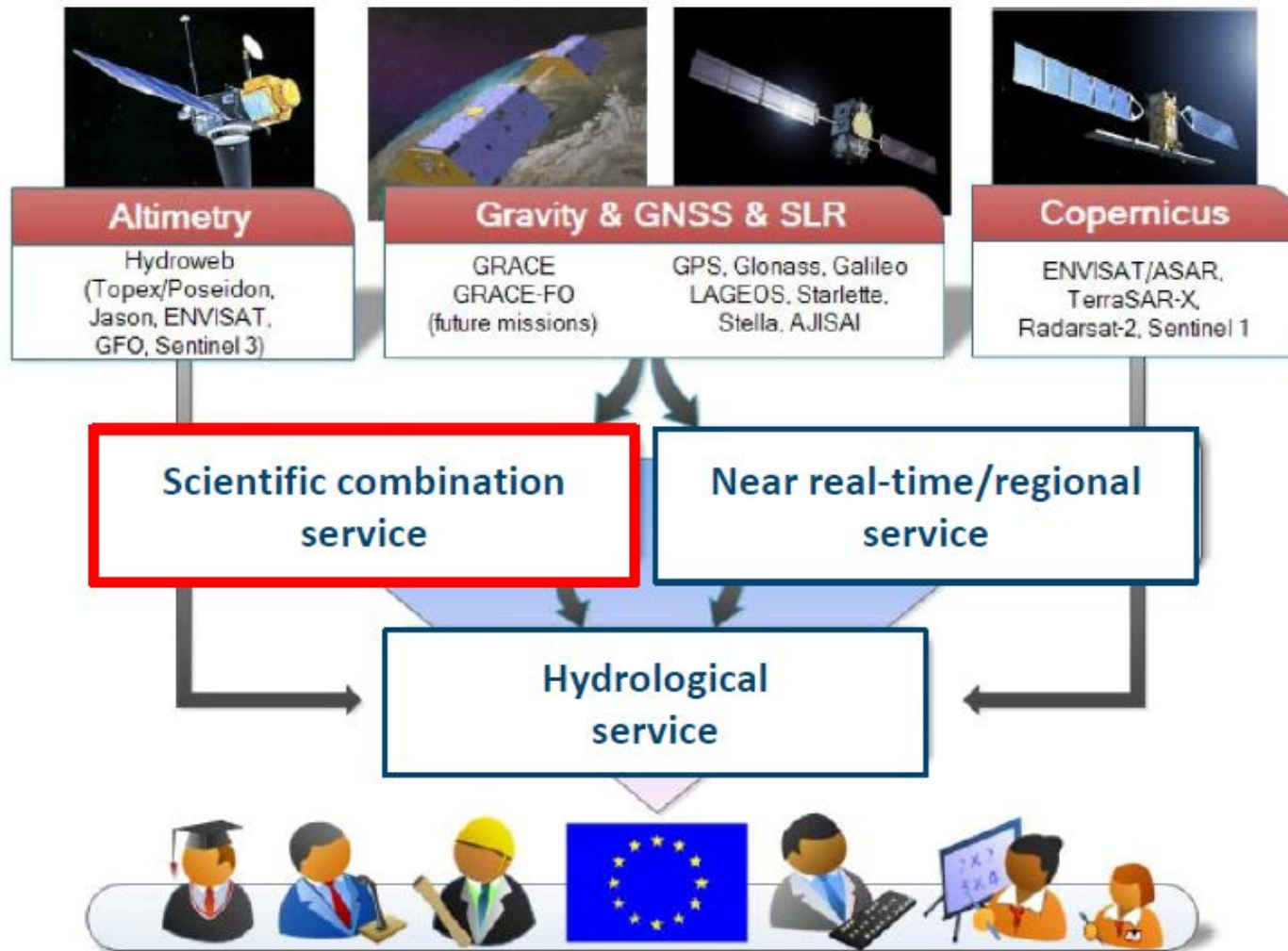
IAG Scientific Assembly 2017

Kobe, Japan
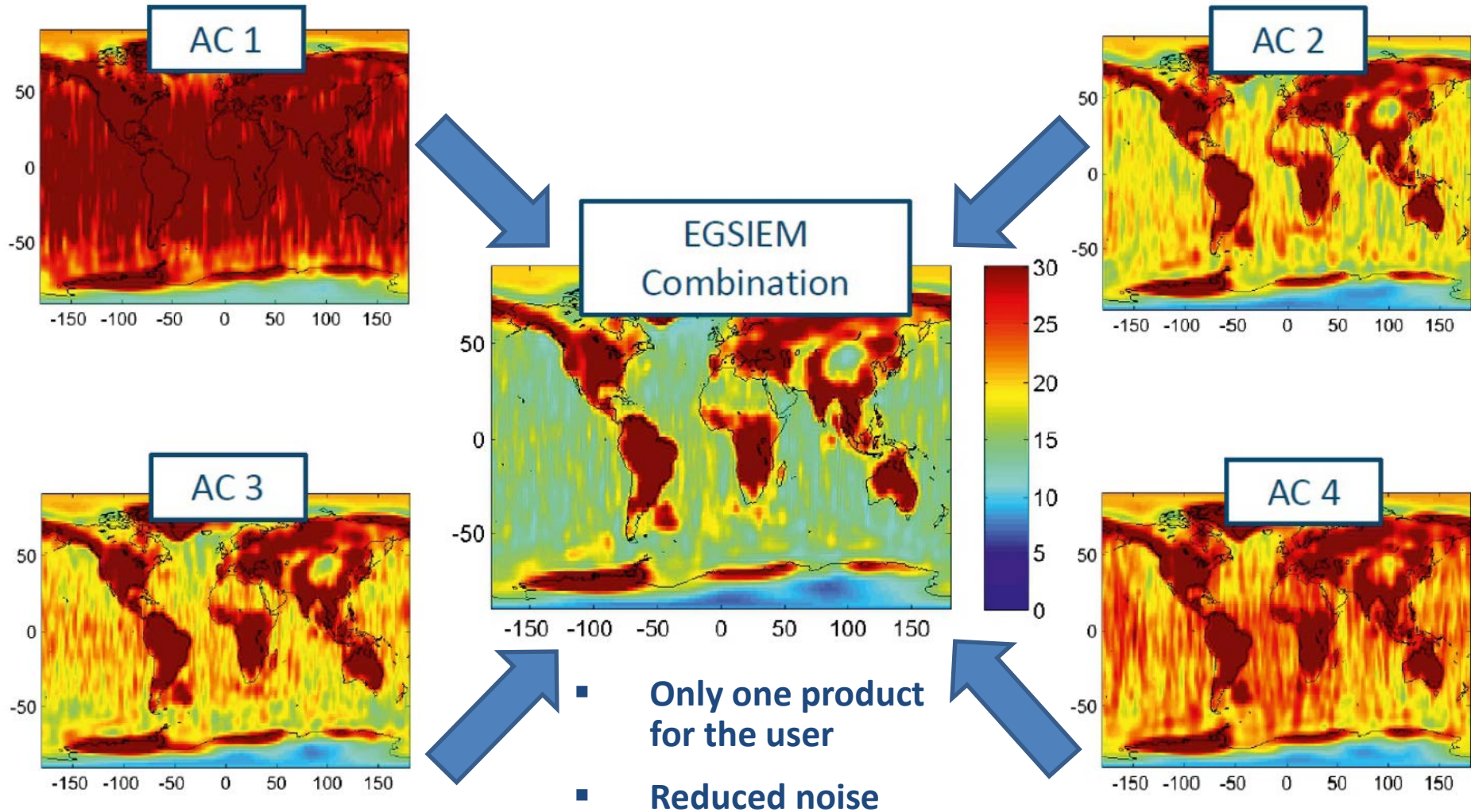**July 31 – August 4, 2017**

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

Altimetry
Hydroweb
(Topex/Poseidon,
Jason, ENVISAT,
GFO, Sentinel 3)

Gravity & GNSS & SLR
GRACE
GRACE-FO
(future missions)
GPS, Glonass, Galileo
LAGEOS, Starlette,
Stella, AJISAI

Copernicus
ENVISAT/ASAR,
TerraSAR-X,
Radarsat-2, Sentinel 1

Scientific combination service

Near real-time/regional service

Hydrological service

Scientific Combination Service

- **Only one product for the user**
- **Reduced noise**

Scientific Combination Service

- The EGSIEM 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.

- EGSIEM 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
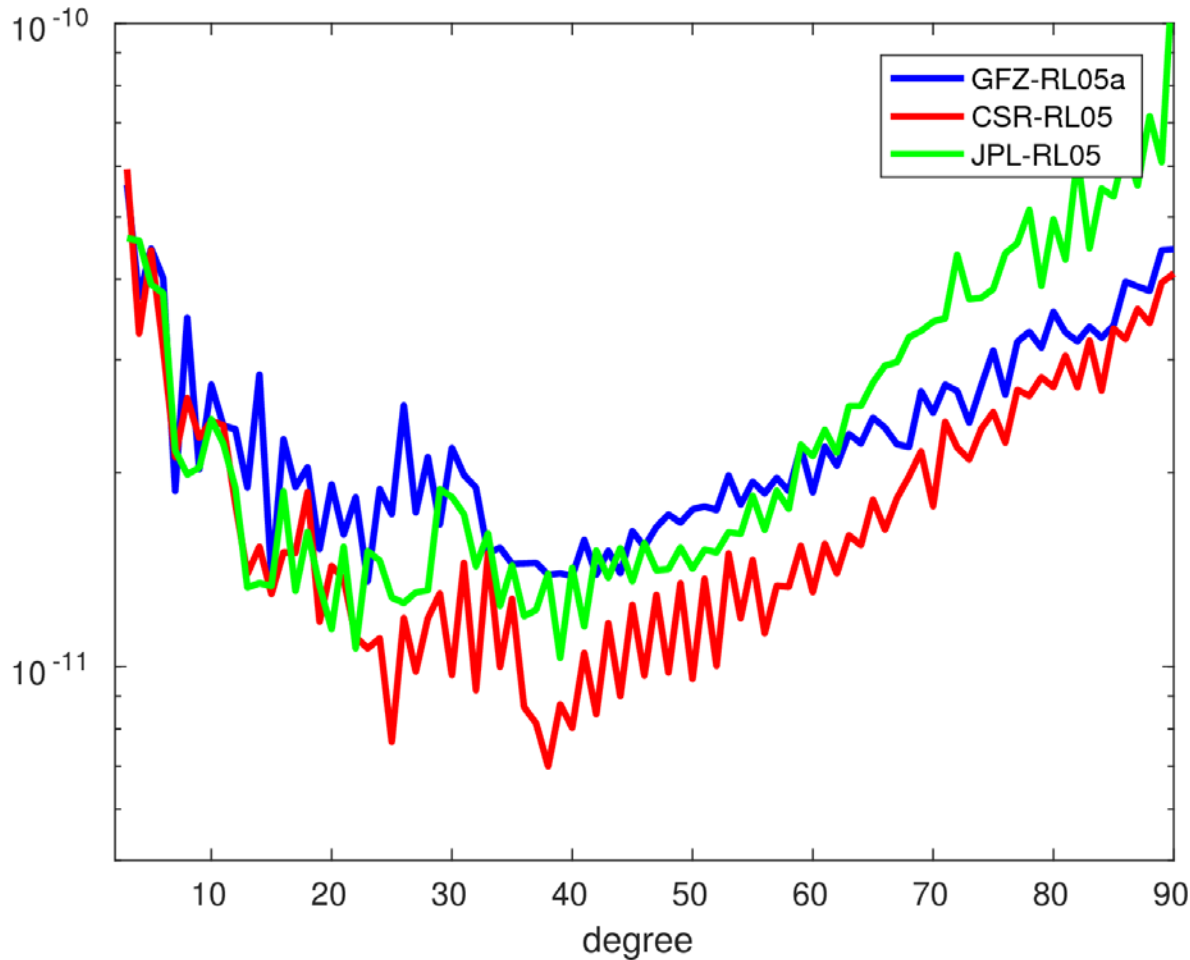**SH coefficients – model fit of secular/seasonal variations**

Motivation

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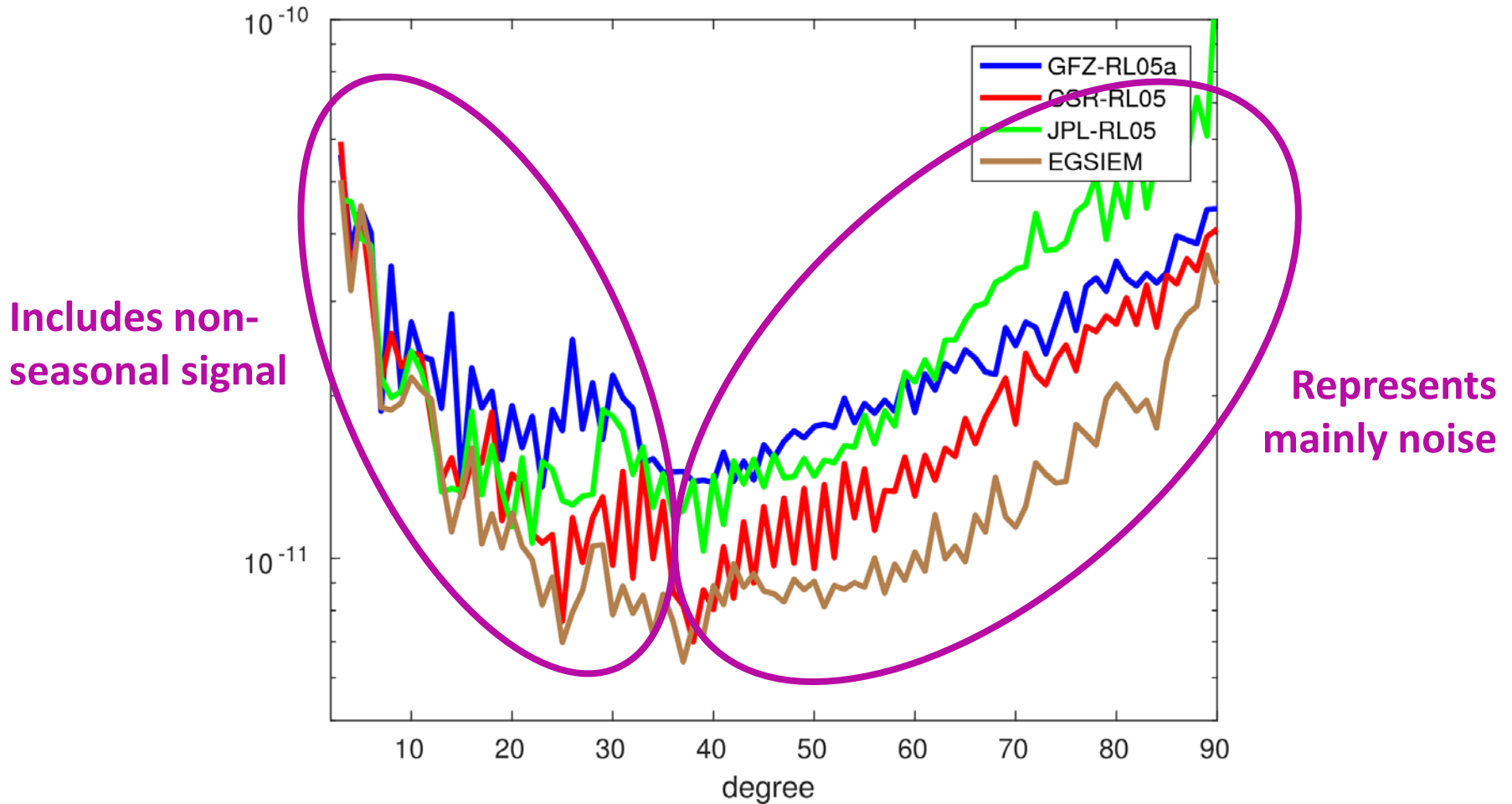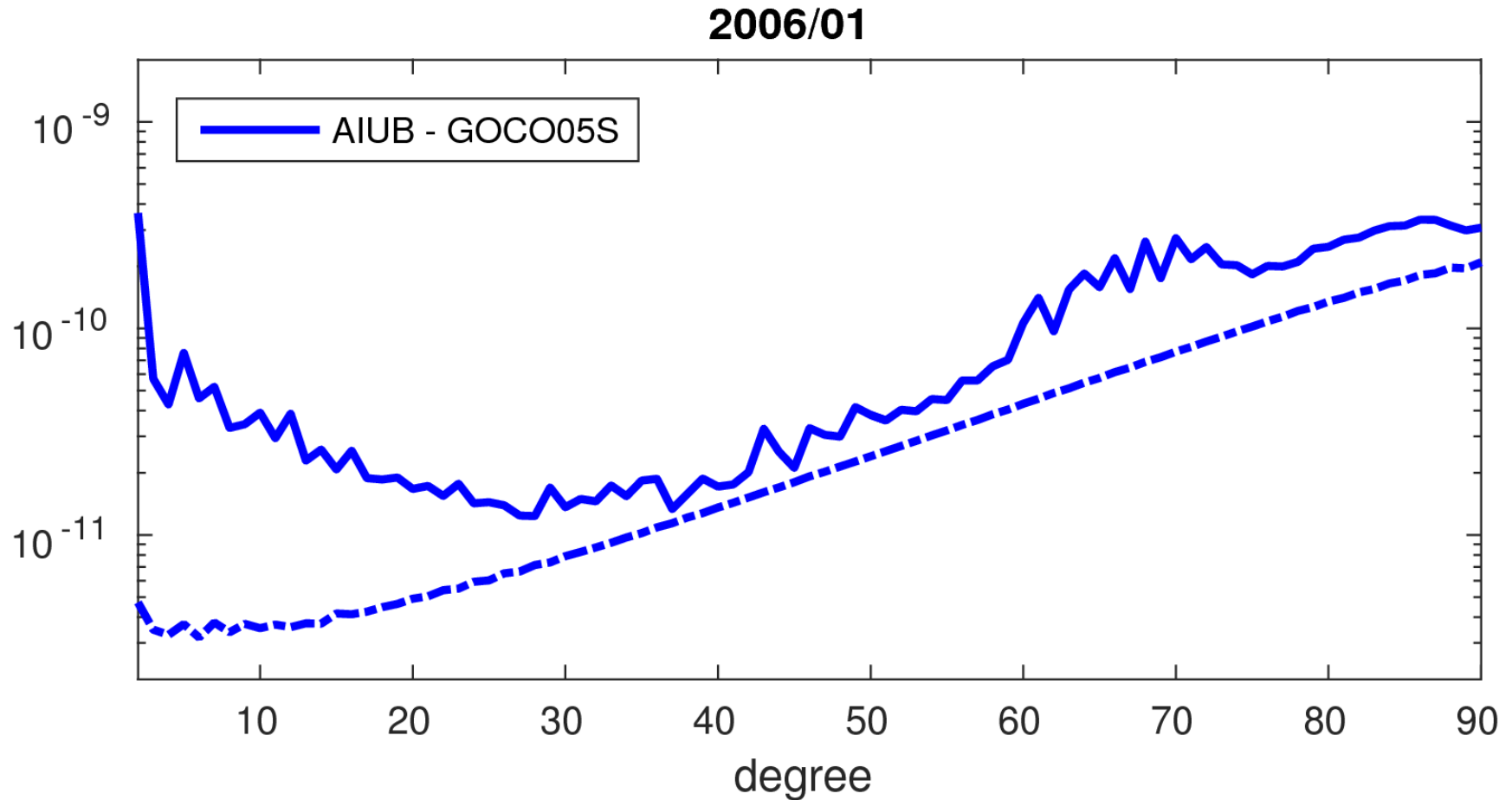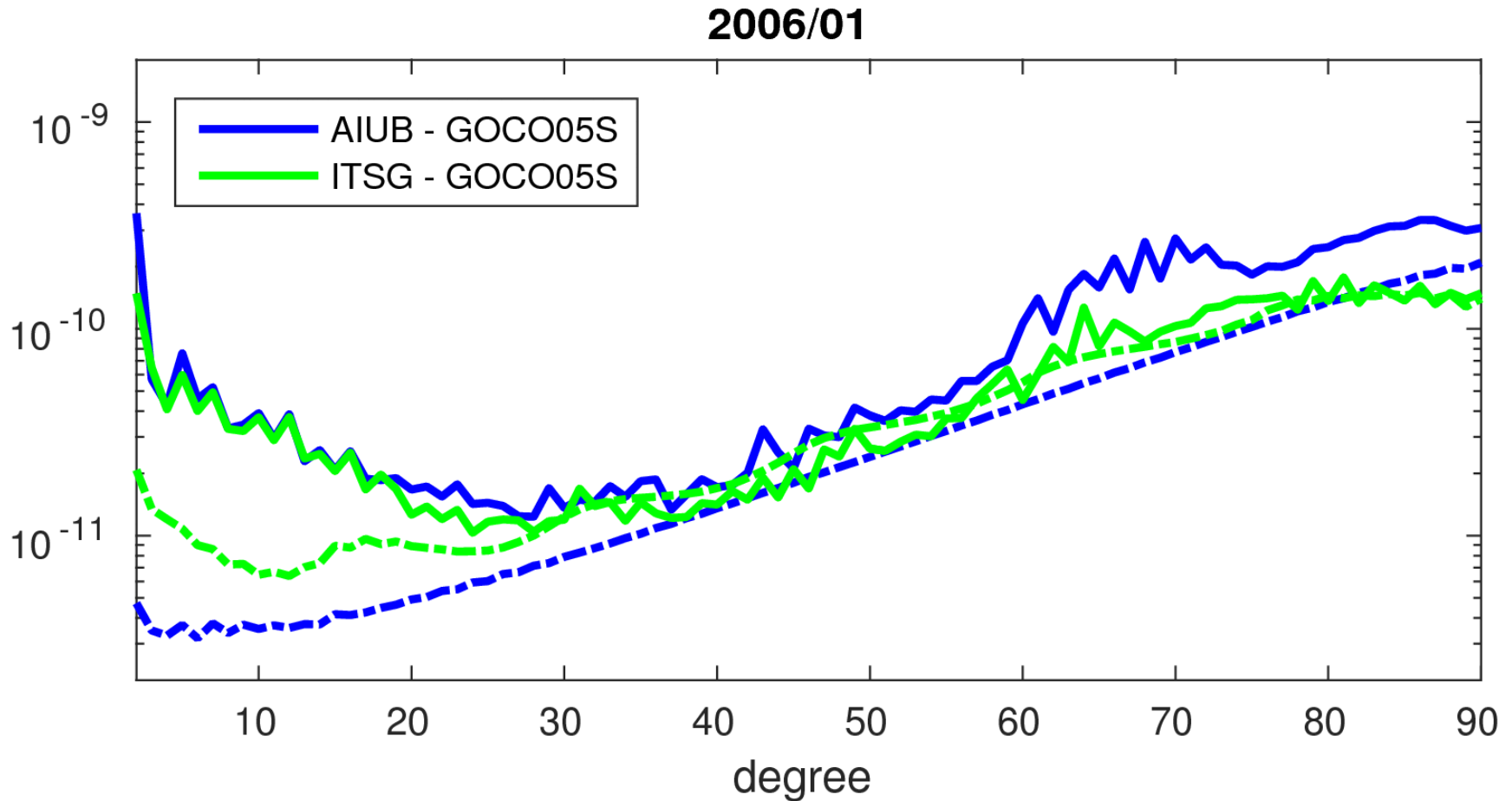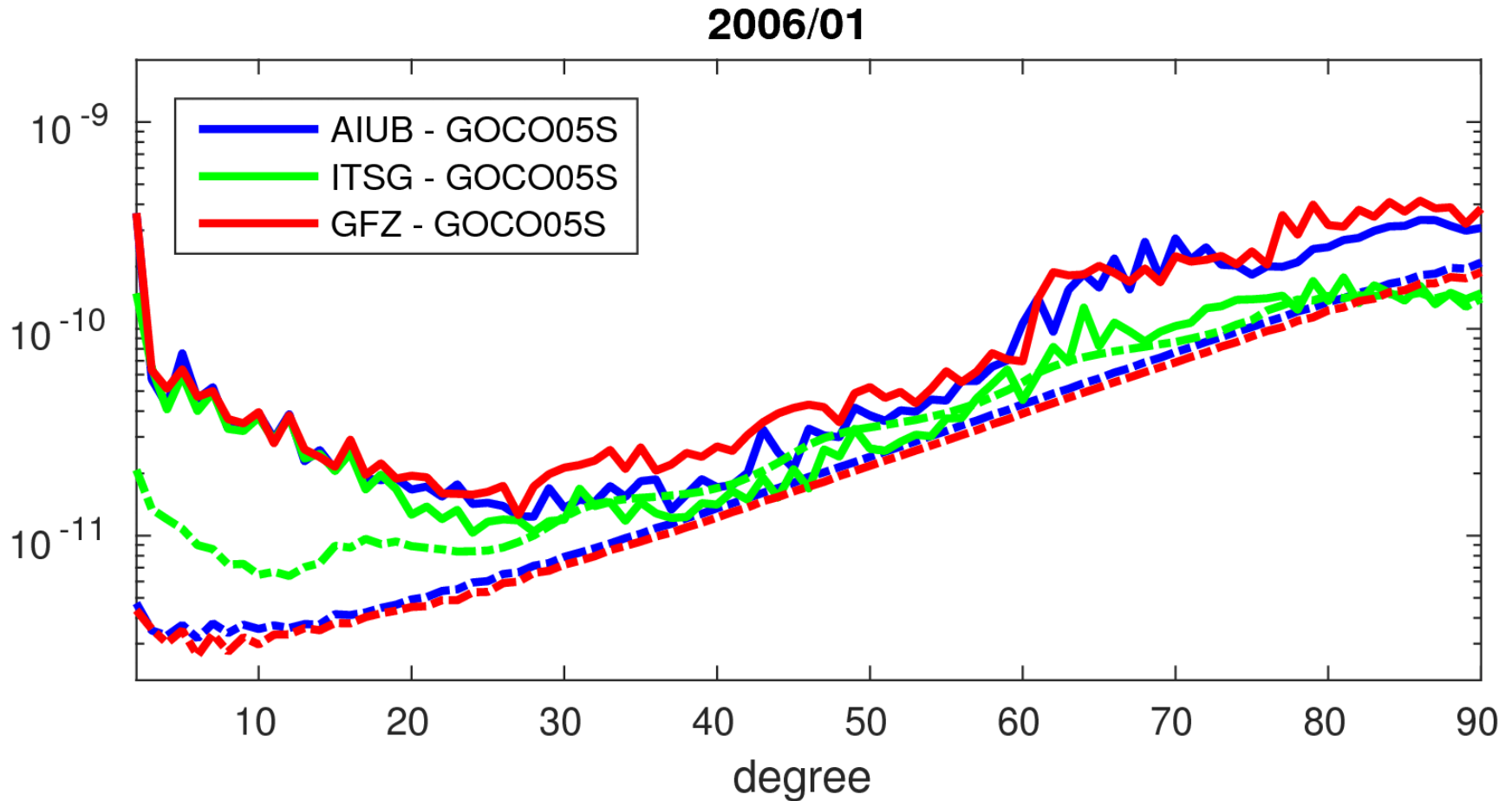**SH coefficients – model fit of secular/seasonal variations**

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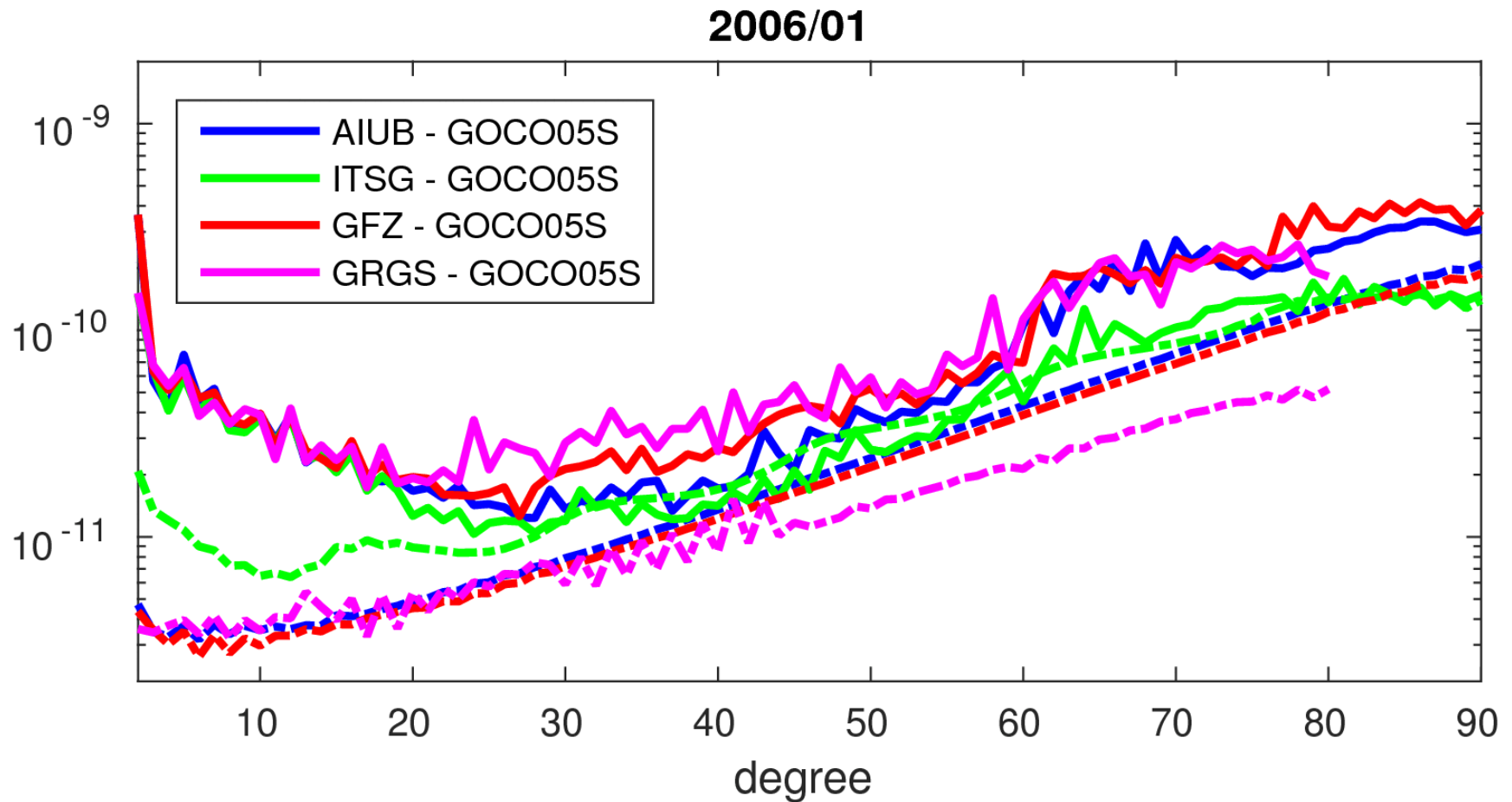
Degree Amplitudes of Anomalies 01/2006: orders 0 - 29
SH coefficients – model fit of secular/seasonal variations

Motivation

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

Includes non-seasonal signal

Represents mainly noise

Individual Contributions

2006/01

Individual Contributions

2006/01

Individual Contributions

2006/01

Legend:
- AIUB - GOCO05S (blue)
- ITSG - GOCO05S (green)
- GFZ - GOCO05S (red)

x-axis: degree

Individual Contributions

2006/01

Legend:
- AIUB - GOCO05S (blue)
- ITSG - GOCO05S (green)
- GFZ - GOCO05S (red)
- GRGS - GOCO05S (magenta)

x-axis: degree
y-axis: 10^{-9}, 10^{-10}, 10^{-11}

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

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

Optimistic

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

Realistic (empirical)
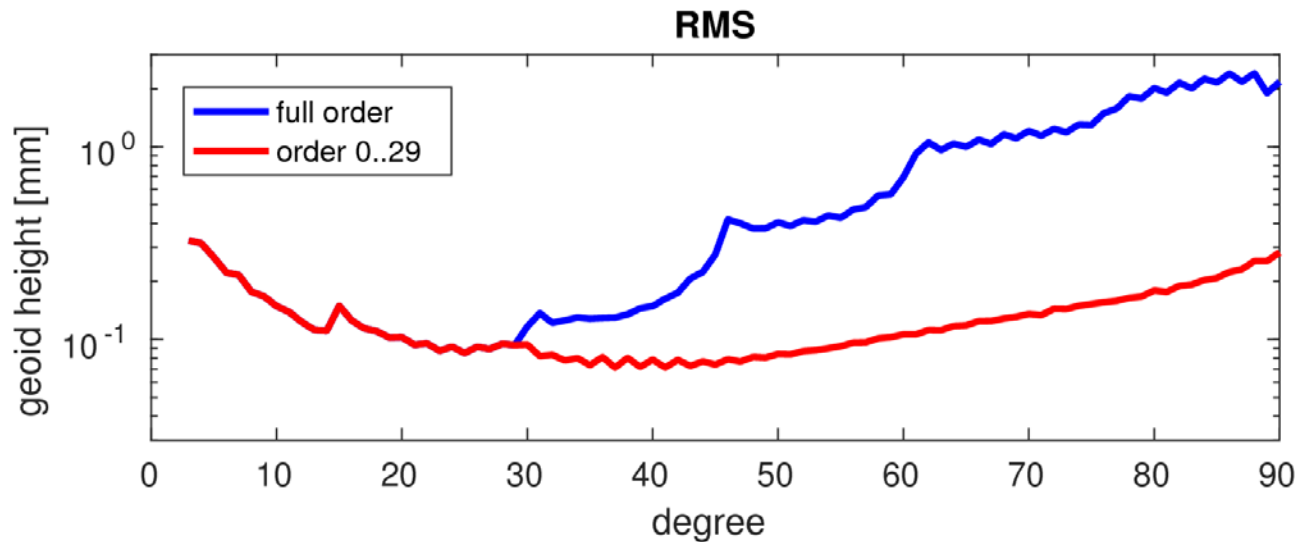
Noise Assessment

Anomalies:
differences to model

Noise Assessment
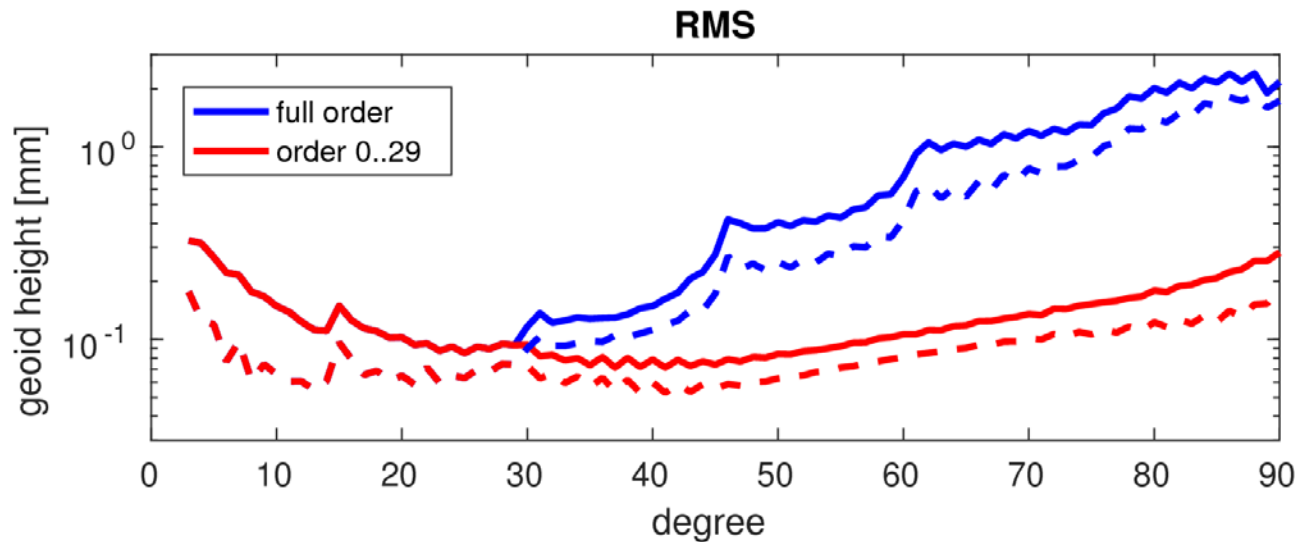

RMS
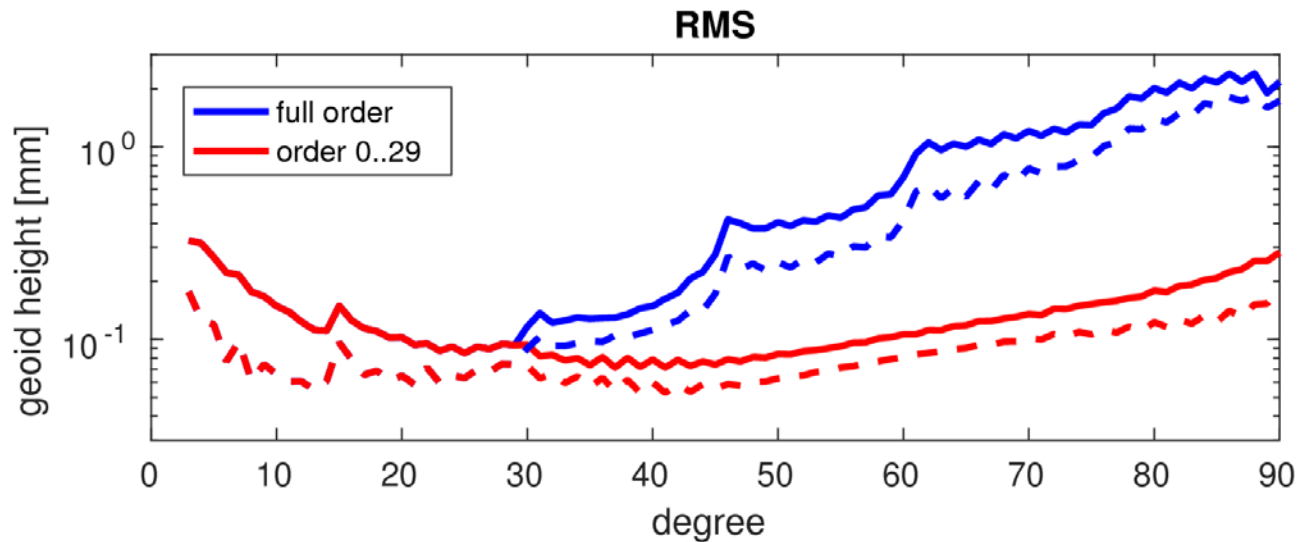
Anomalies: ———
differences to model

Differences: — — —
differences to mean

RMS of anomalies
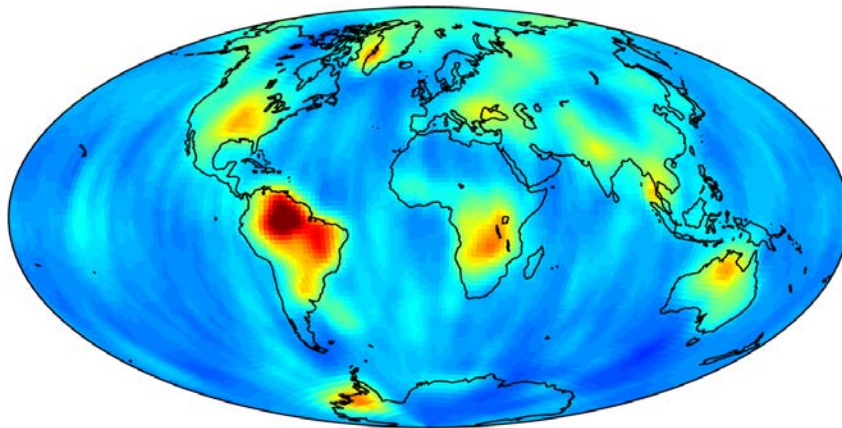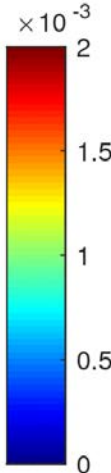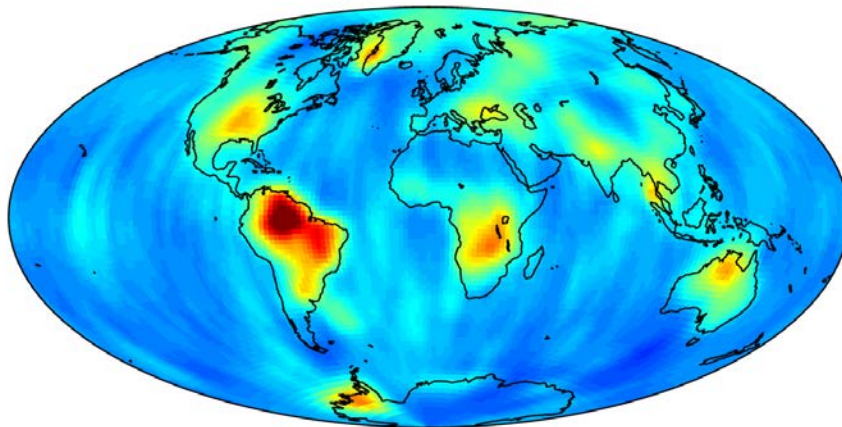
RMS of differences to mean
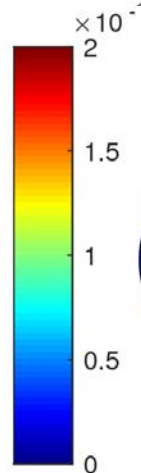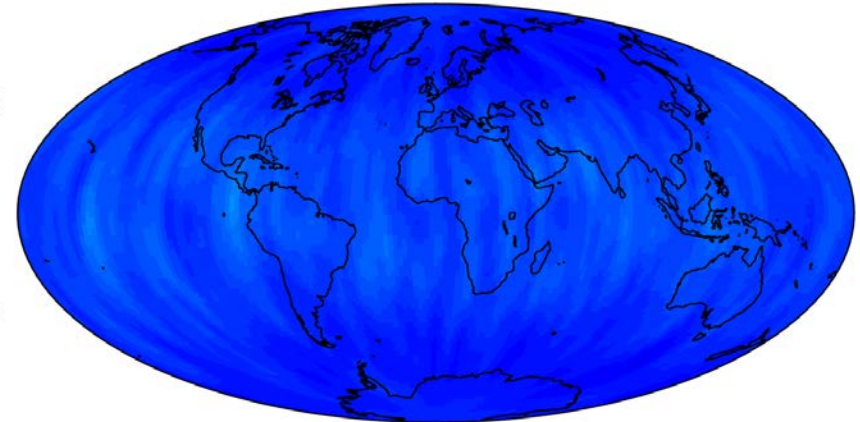
Noise Assessment

Differences to mean to derive relative weights.

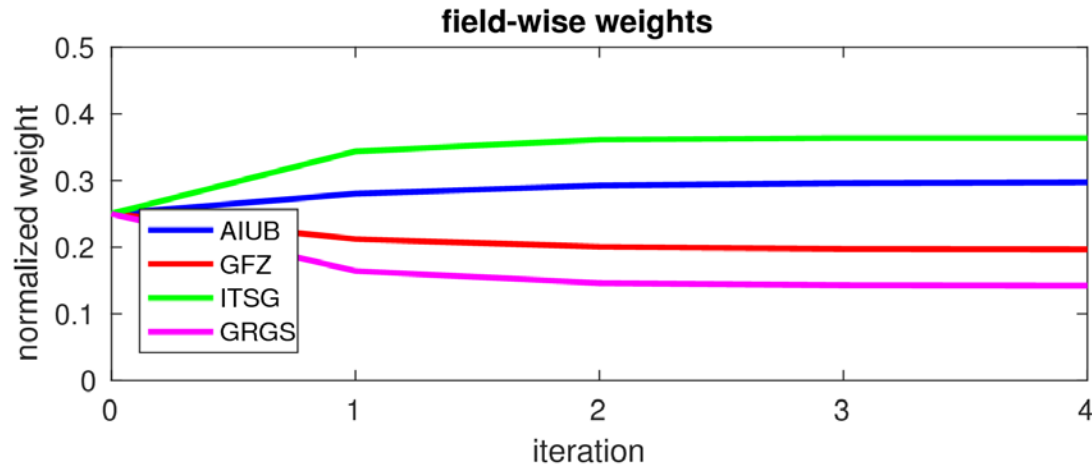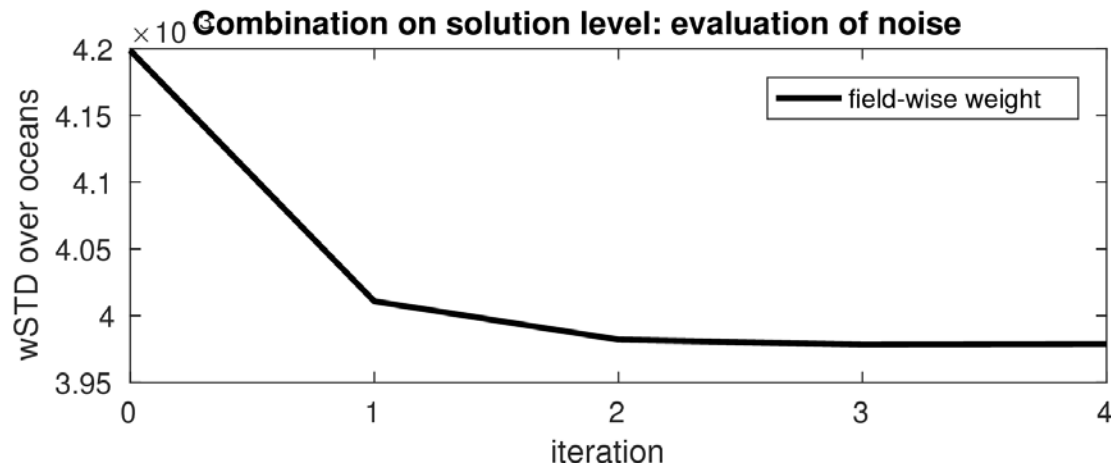**Anomalies over quite regions to indepently assess quality.**

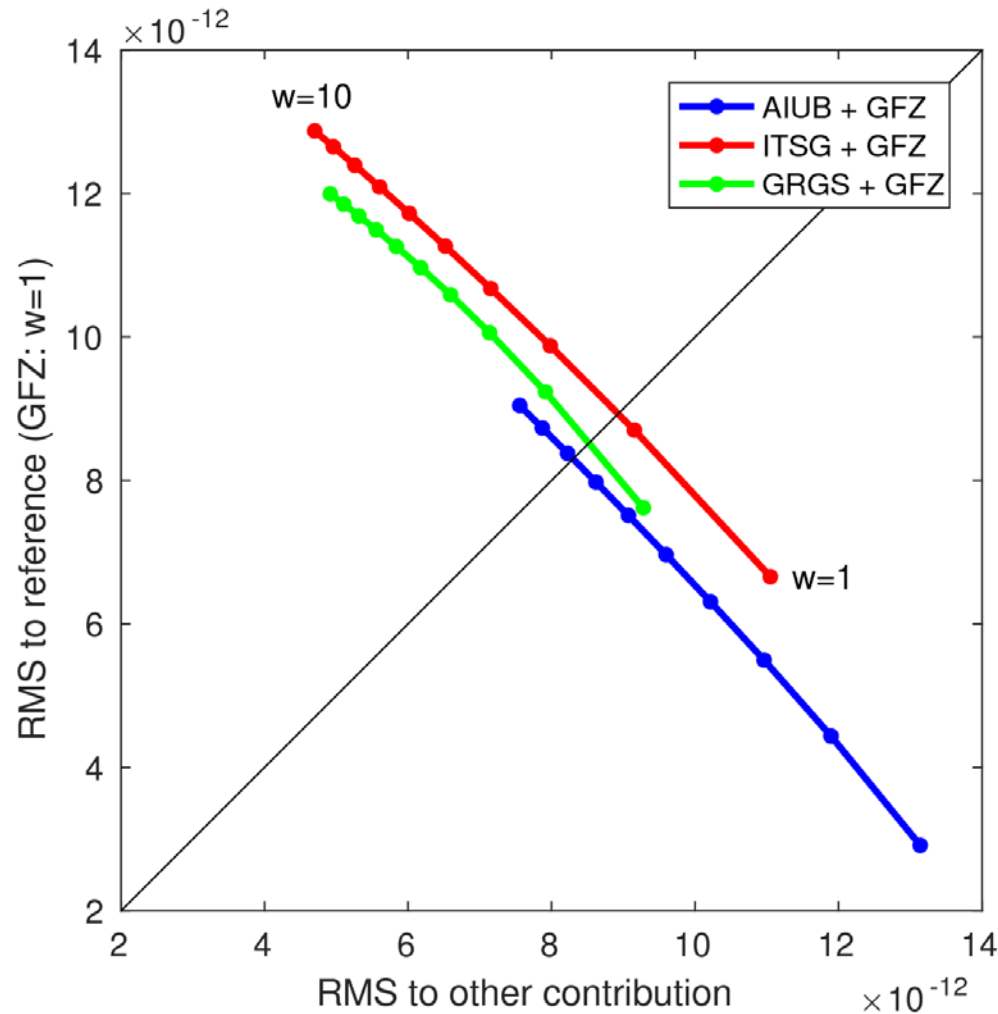# Variance component estimation on solution level

field-wise weights

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

Combination on solution level: evaluation of noise

RMS of anomalies restricted to ocean areas as quality criterion.

Combination on Normal Equation Level

Combination: 2006/01
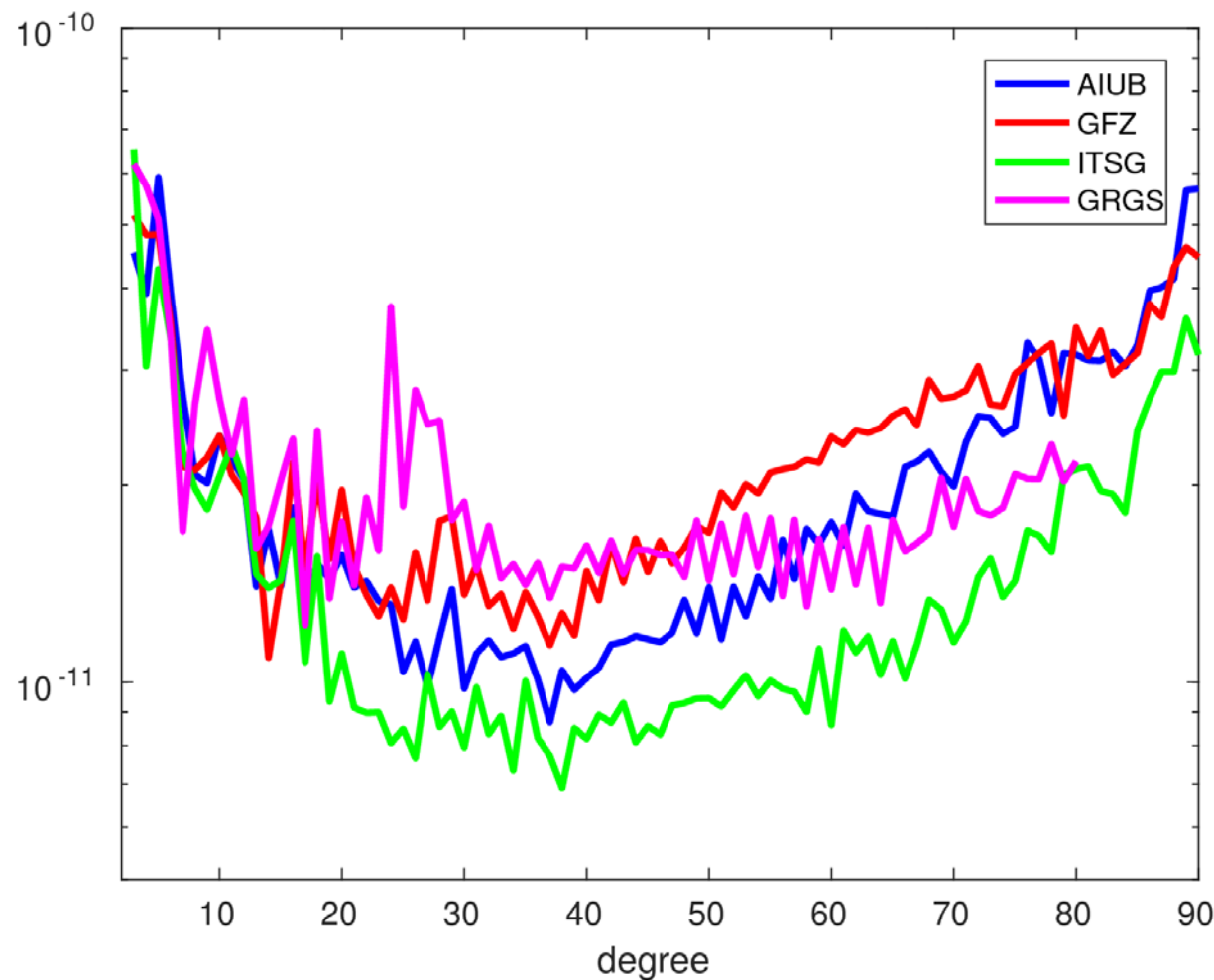
Combination: 2006/01

Solution:	weight
GRGS	0.14
GFZ	0.19
AIUB	0.29
ITSG	0.38

Horizon2020

Combination: 2006/01

equalizing weight	
GRGS	1.60
GFZ	1.00
AIUB	7.81
ITSG	2.21

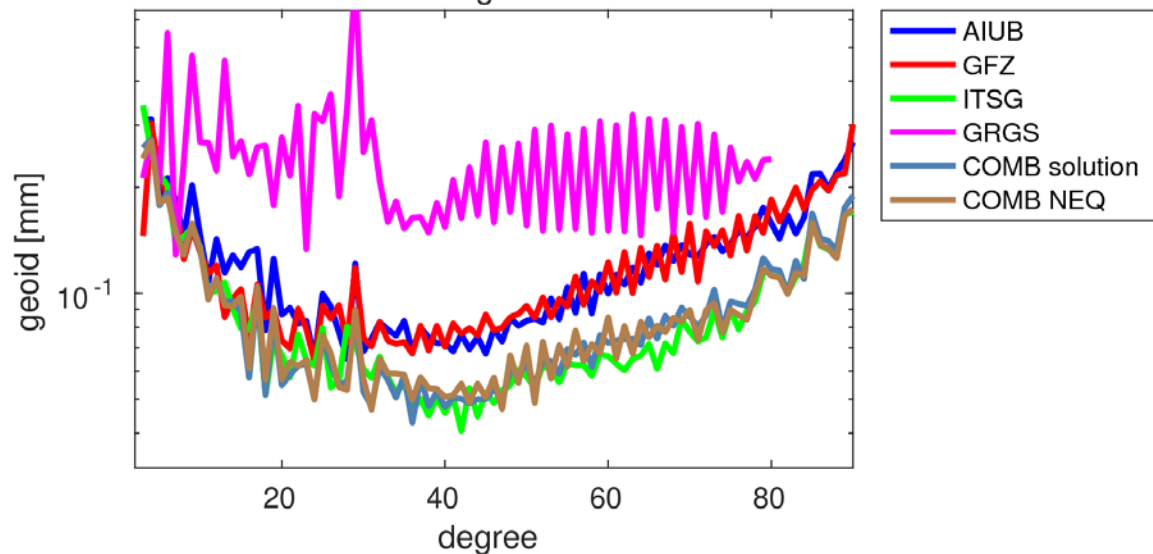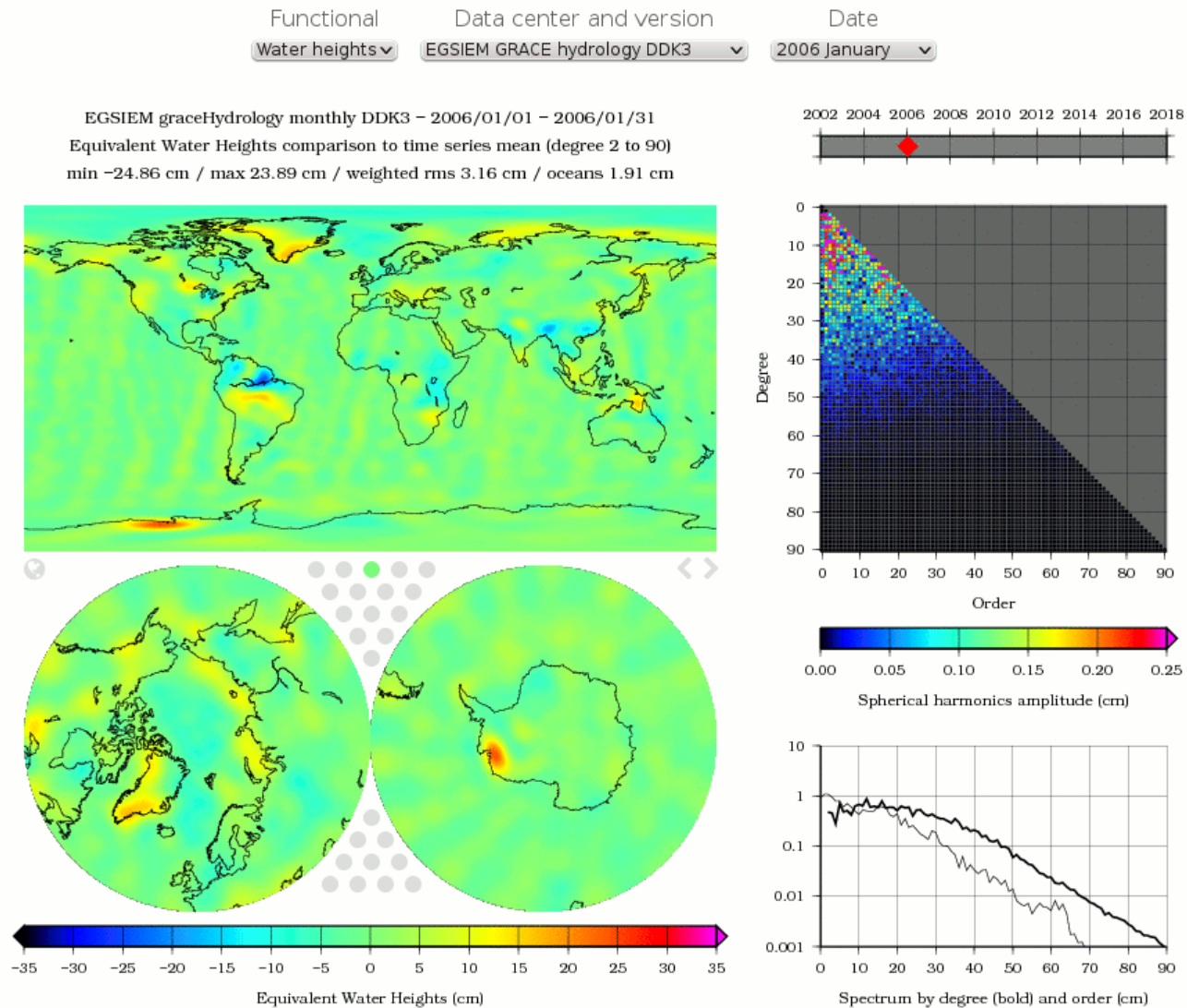| Solution:	weight
GRGS	0.14
GFZ	0.19
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ITSG	0.38

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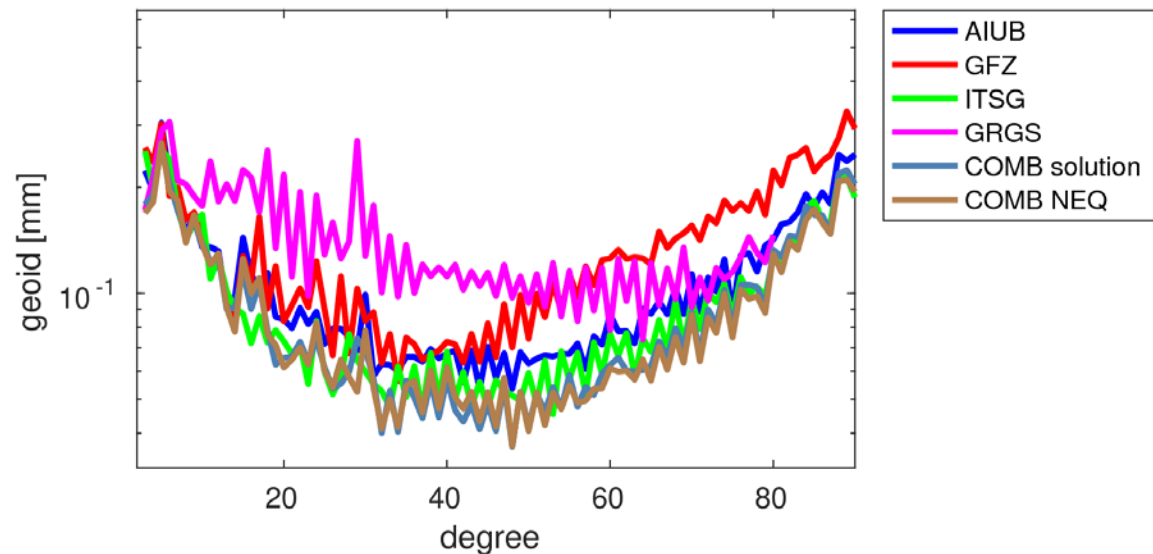
June 2006: in case of more homogeneous quality among ACs the combination clearly outperforms the best individual contribution.

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

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

Transition to IAG service COST-G

- EGSIEM Scientific Combinatin Service is ready for transition into IAG service COST-G.

- Noise assessment by variance component estimation on solution level.

- Relative weigths 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