

# Time-variable gravity field recovery from GRACE and CHAMP

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***AIUB***

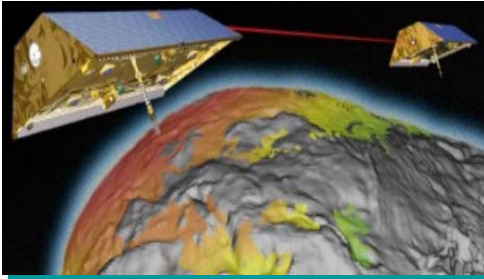
Astronomical Institute  
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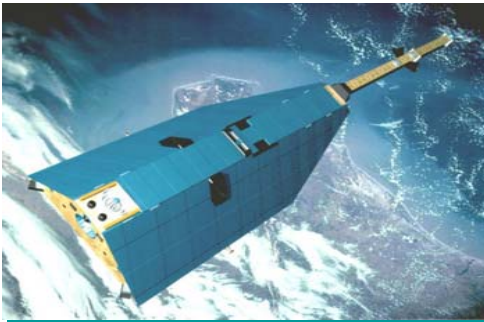
June 28 -  
July 7

# Outline of the talk



## GRACE gravity field recovery (GPS & K-band)

- classical least-squares adjustment
- static field, simultaneously solved for time variations
- monthly solutions



## CHAMP gravity field recovery (GPS-only)

- classical least-squares adjustment
- static field
- time variations

- All solutions are computed without applying any regularizations

# Generation of the static field

## Static field Variations

- SH expansion up to d/o 160
- Periodic signals & trends up to d/o 30

## Data

- GRACE kinematic orbits (2003-09)
- Level 1B K-band range-rates (2003-09)

## Orbits

- Initial conditions every 24h
- Accelerations over 15min

## K-band

- No additional parameters
- Correlations not modeled

## A priori

- EGM96 up to d/o 160

## Accelerometer

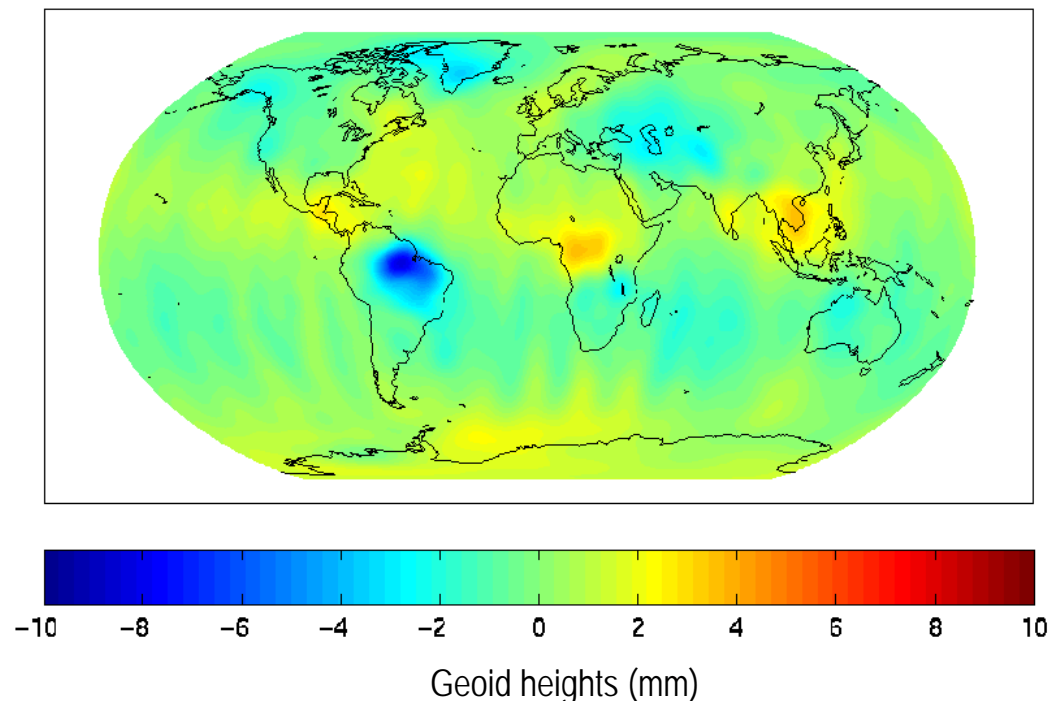
- Level 1B data (2003-09)
- IERS 2003 solid Earth tides
- EOT08a ocean tides
- AOD1B dealiasing

## Background

# Generation of the static field

- Annual and semi-annual periodic terms are **simultaneously** estimated with the static field up to d/o 30

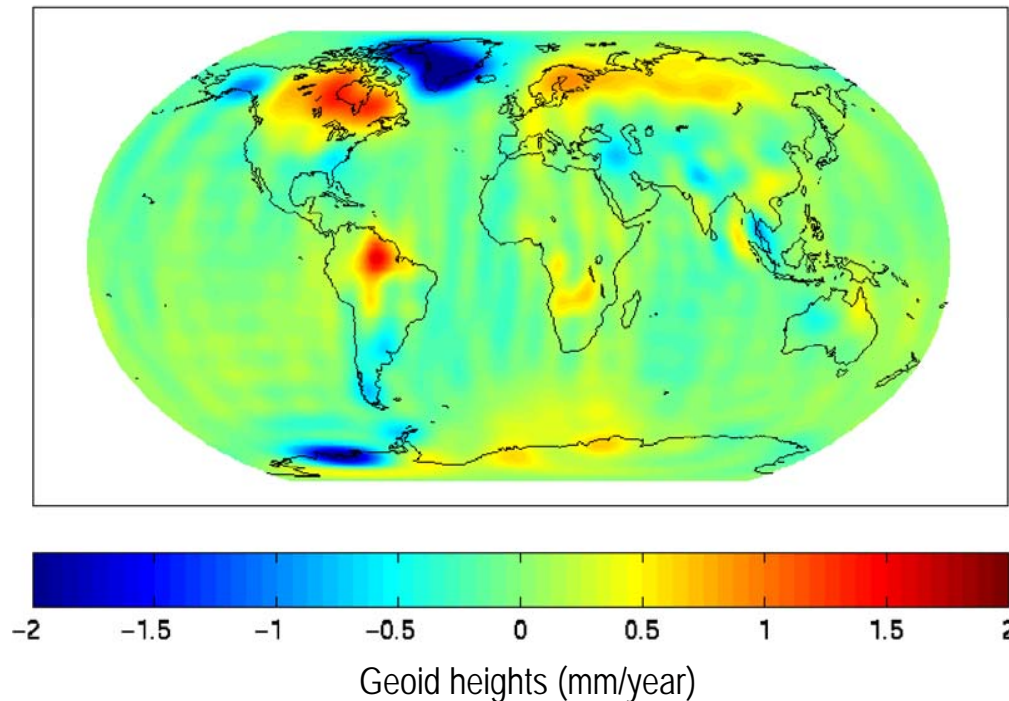
Dec. 07



- The estimates are very smooth by construction, no stabilization or filtering is required
- They are mainly used to improve the coefficients of the static field

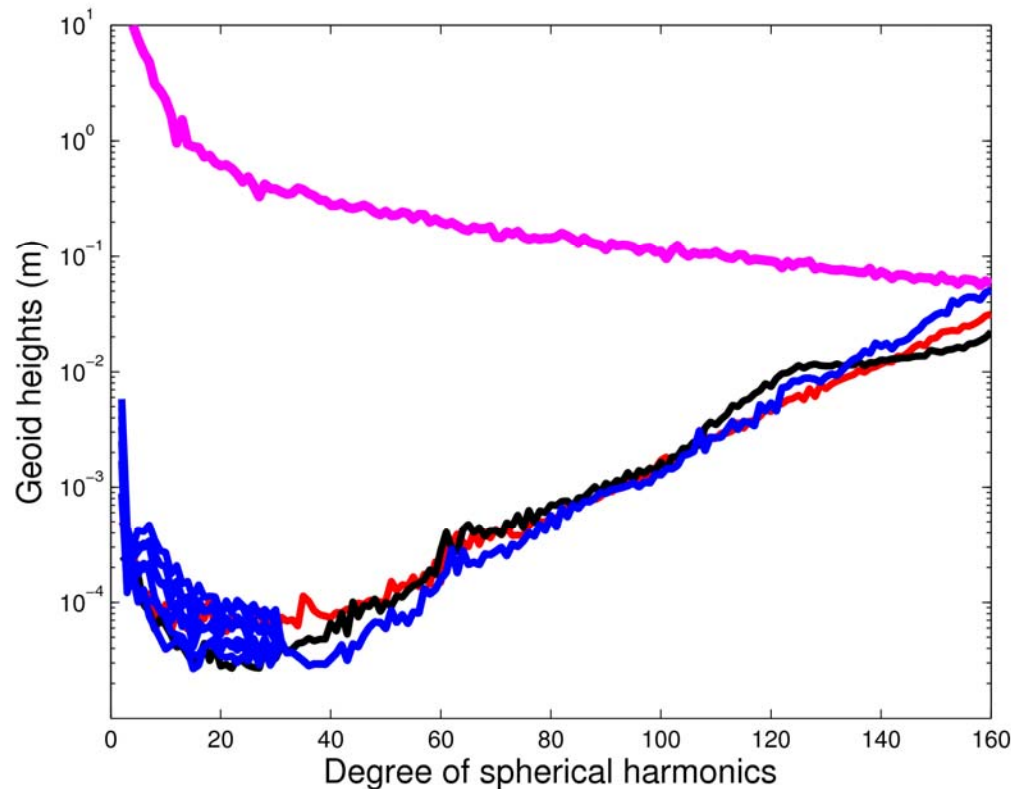
# Generation of the static field

- Trends are **simultaneously** solved with the static field up to d/o 30 as well



- The estimates are mainly used to refer the „static“ field to any given epoch in time
- They are rather smooth as well

# Comparison of the static field



Reference field:

ITG-GRACE2010

Differences:

ITG-GRACE03S

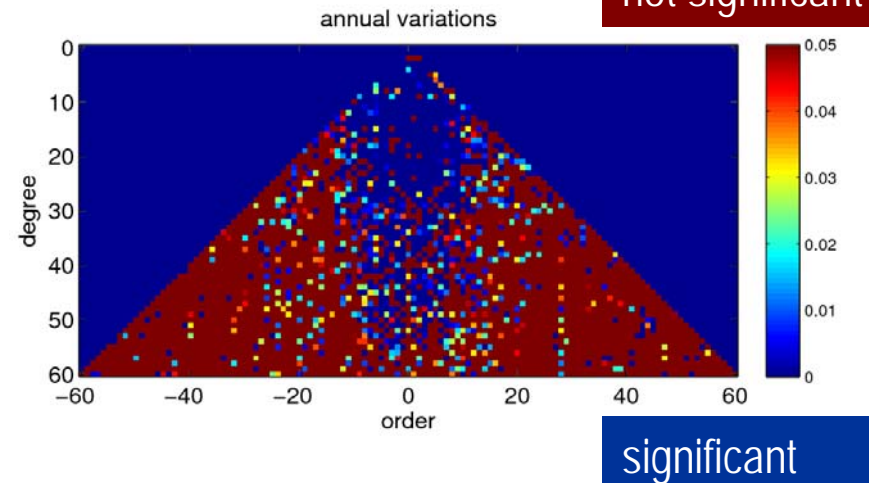
EIGEN-51C

AIUB-GRACE03S

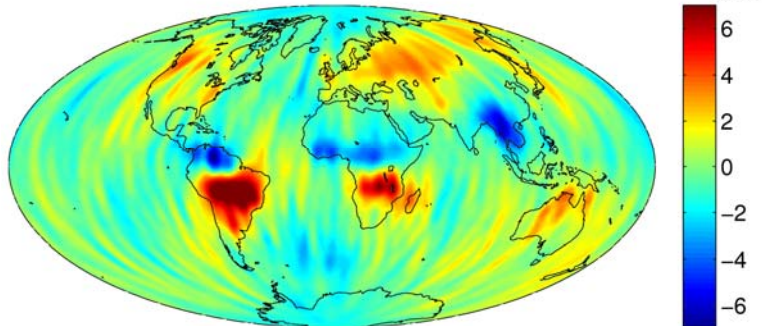
- AIUB-GRACE03S may be downloaded from the ICGEM website (static field with trends)
- It is used to generate the series of AIUB monthly gravity field solutions

# Sensitivity to periodic signals

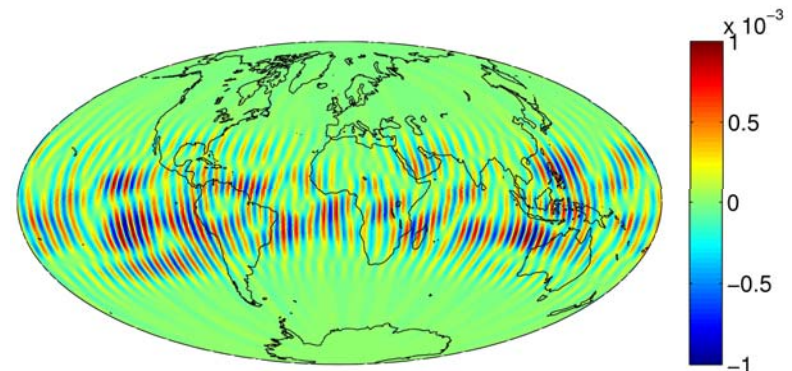
- Monthly solutions up to degree 60, background model AIUB-GRACE03S (static part only)
- Secular and seasonal variations may be fitted a posteriori to the monthly solutions for analysis
- Significance tests for seasonal parameters show sensitivity up to degree 60, but only to a reduced order
- Coefficients above order 45 are not estimated, resulting in a reduction of high-frequency stripe patterns



March 2007 ( $l=60, m=45$ ); 250 km Gauss

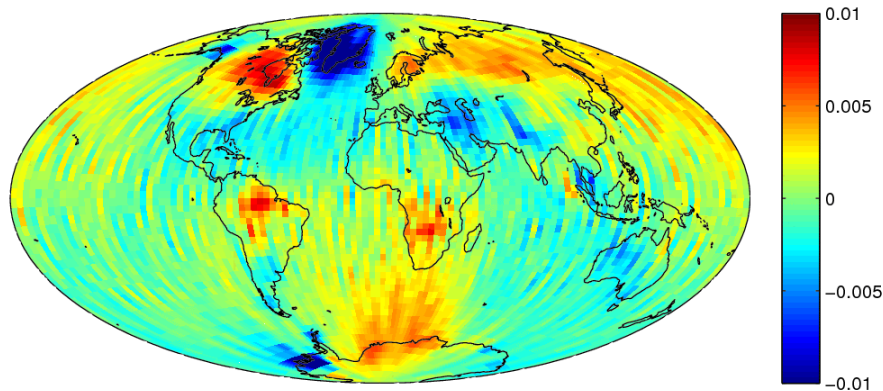


Effect of orders > 45



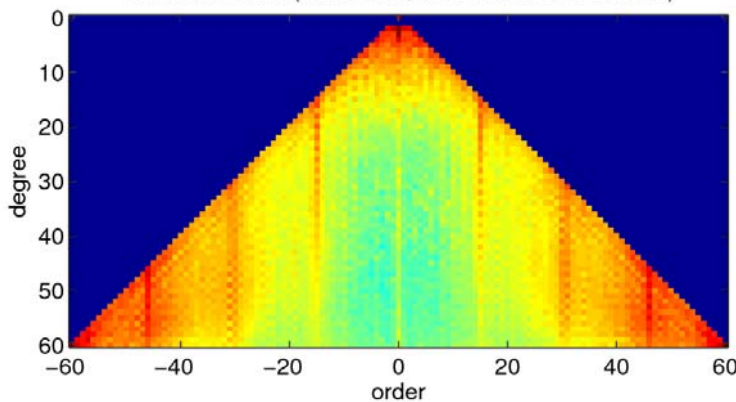
# Sensitivity to trends

gravity trend (7 years) from GRACE

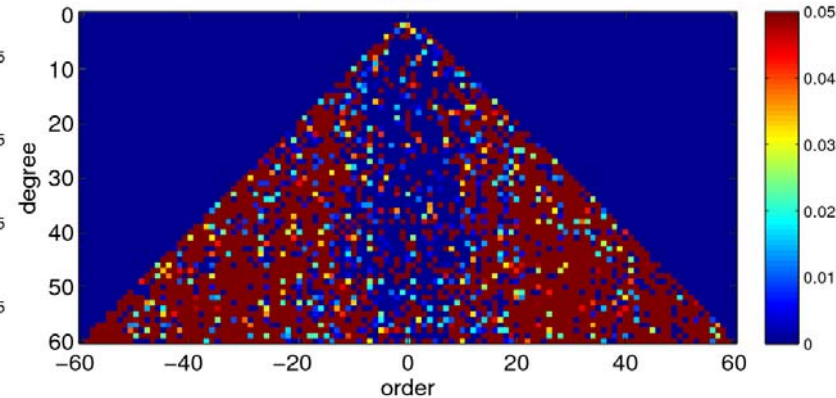


- Trends fitted a posteriori to 7 years of monthly solutions
- Significance tests show sensitivity at least to degree 60
- Orders above 45 do not contain much signal

Calibrated error (all months, time variations removed)



trend

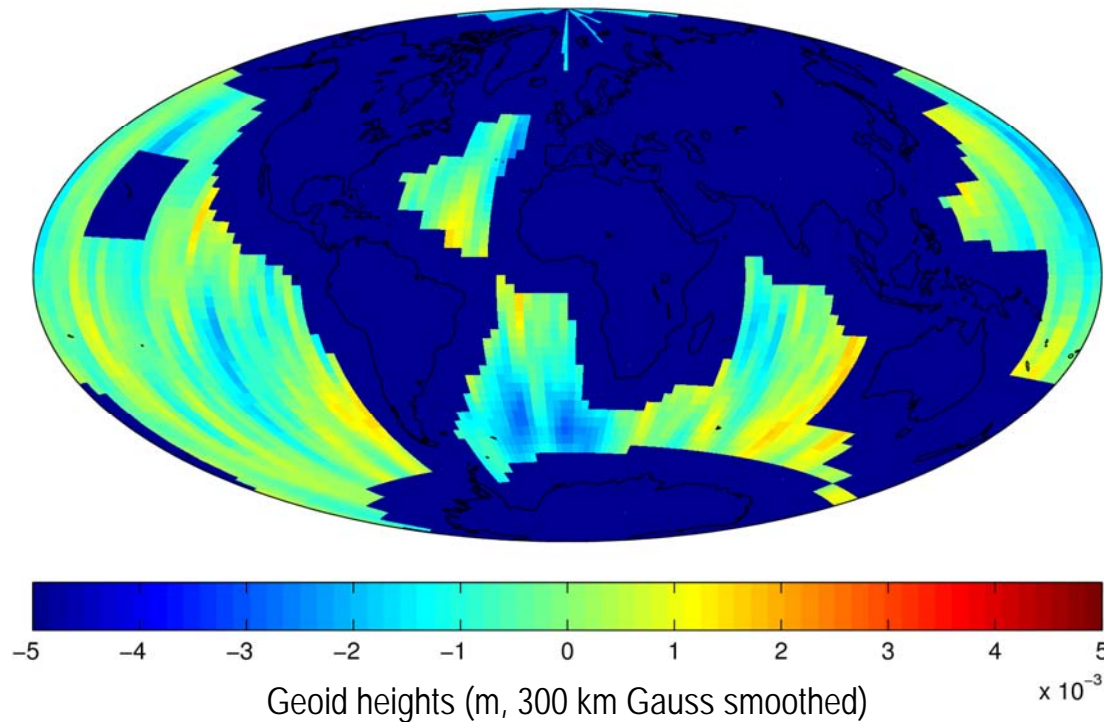


not significant

significant

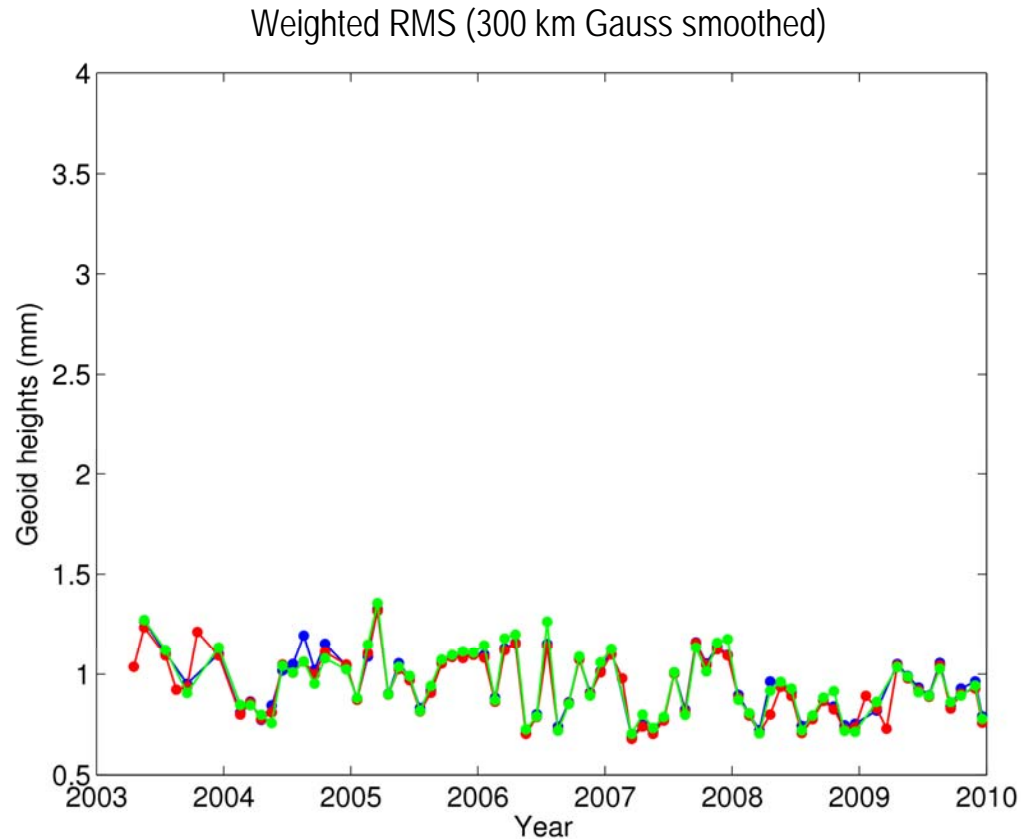
# Variability over oceans

- weighted RMS of the variability over the oceans may be used to compare the quality of the monthly solutions in a simple way



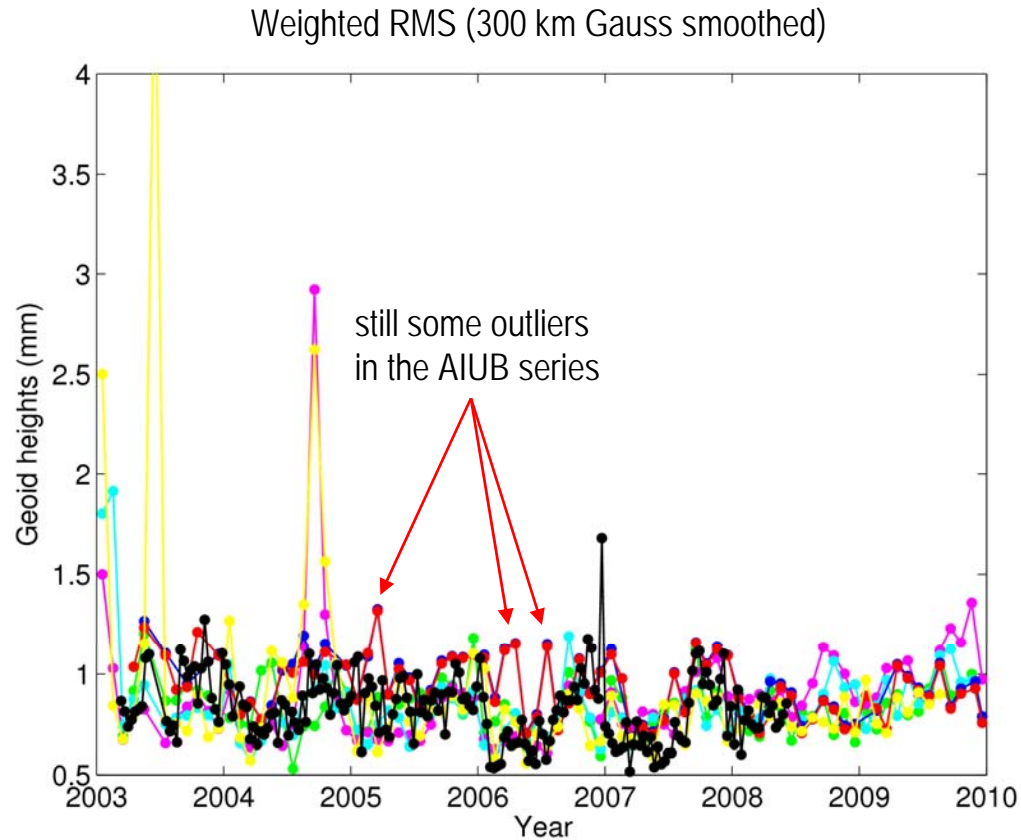
- an enlarged landmask is applied to compute the weighted RMS in order to avoid leakage from continental regions with strong hydrology

# Variability over oceans



- Only solutions which are based on comparable parametrizations should be rated against each other
- Filtered solutions show a similar performance

# Variability over oceans



60 x 60:

GFZ

JPL

CSR

AIUB

ITG

60 x 45:

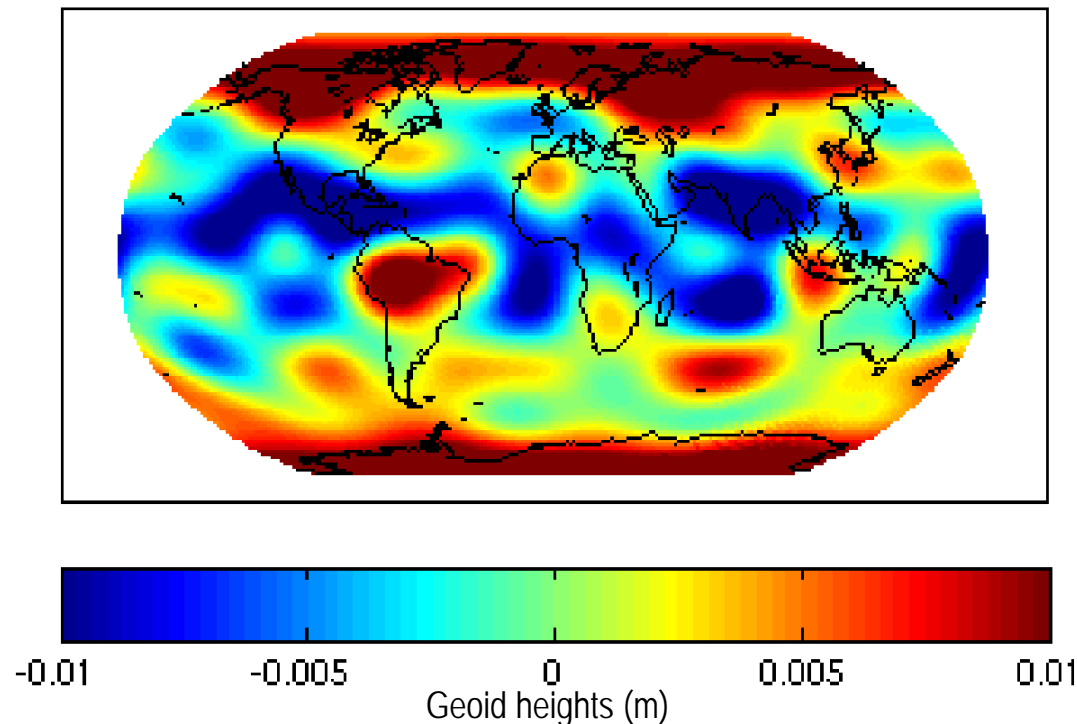
AIUB

50 x 50:

GRGS

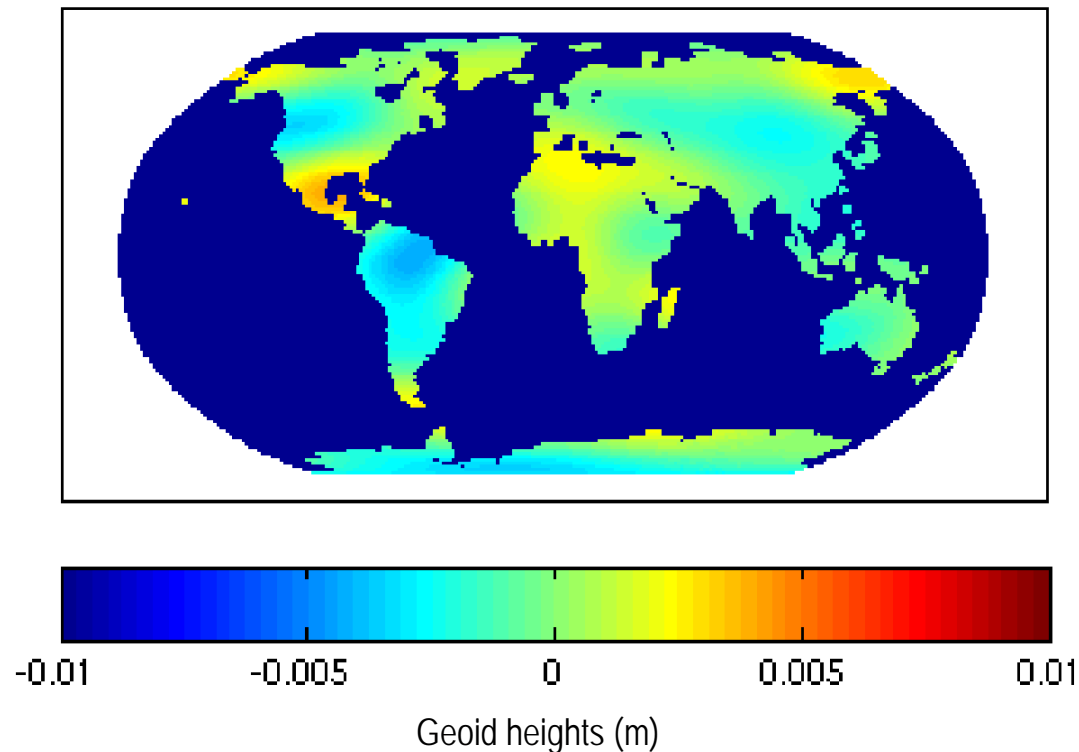
# Time variability from CHAMP

- a single monthly CHAMP solution does not really look very promising ...



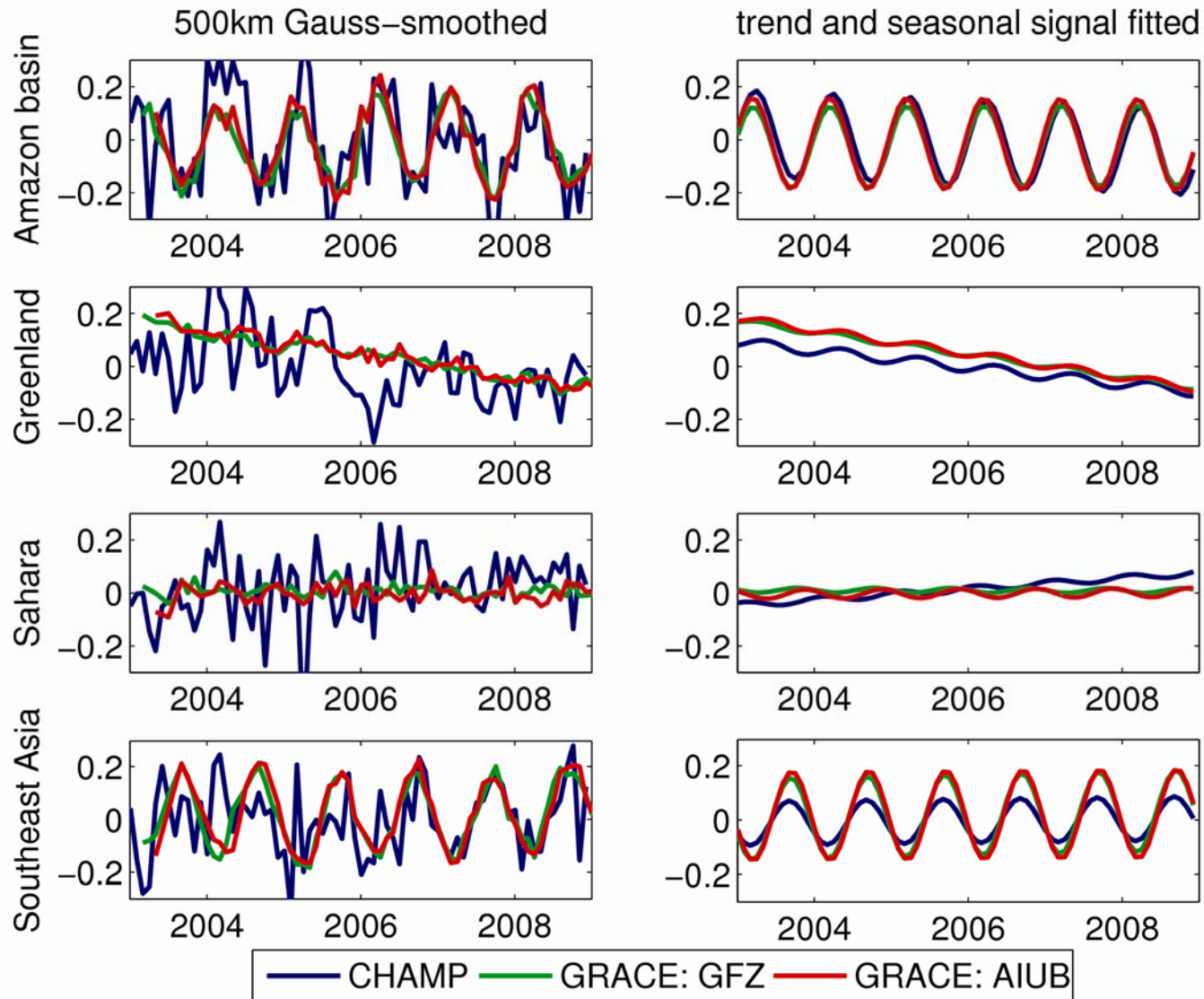
- ... but a long time series of data allows it to either
  - solve for periodic and trend functions, or to
  - „stack“ monthly solutions (each January, each February, etc.), and to apply significance tests (up to d/o 10)

# Time variability from CHAMP



- CHAMP allows to recover the most pronounced time variable signals due to the long data series available

# Comparison of time variability



GFZ and AIUB show a very good agreement in amplitude and phase of the variations

CHAMP shows a remarkable sensitivity to seasonal and secular mass variations.

# Conclusions

- The AIUB-GRACE03S static field with simultaneously solved for trends is available at the ICGEM website
  - Trends are helpful to properly compare static fields which are referring to different reference epochs
- A first release of the AIUB series of monthly solutions is available at the ICGEM website
  - Based on sensitivity analyses the monthly fields are determined up to degree 60 and order 45
- High-quality static fields may be computed with CHAMP GPS data
  - CHAMP also allows it to recover the most pronounced time variable signals due to a long data series