EGSIEM

European Gravity Service for Improved Emergency Management

WP4. Scientific Combination Service

Combination of GRACE Monthly Gravity Field Solutions

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UNIVERSITÄT BERN · UNIVERSITÉ DU LUXEMBOURG · GFZ Helmholtz Centre Potsdam · TU Graz Graz University of Technology · Leibniz Universität Hannover · cnes · DLR · géode&cie · Horizon2020

Introduction

- In WP4 at AIUB
  - Scientific Combination Service :

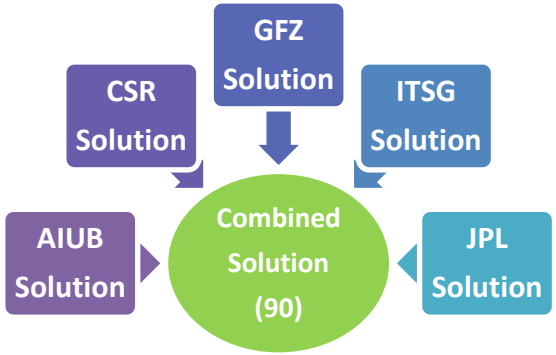
    Combination of GRACE Monthly Gravity Field Solutions

- Contents
  - Review: Combination of GRACE Monthly Solutions
  - Validation of a Combined Solution: Hydrology, Cryology, GIA, GPS Loading
  - Simulation study on the Combination

Review: Combination of GRACE Monthly Solutions

- GRACE Monthly Solutions
  - The solutions available at ICGEM website

- Comparison
  - Signal: MEWH of river basins
  - Variability: wSTD over the oceans
  - Spherical Harmonic Coefficients



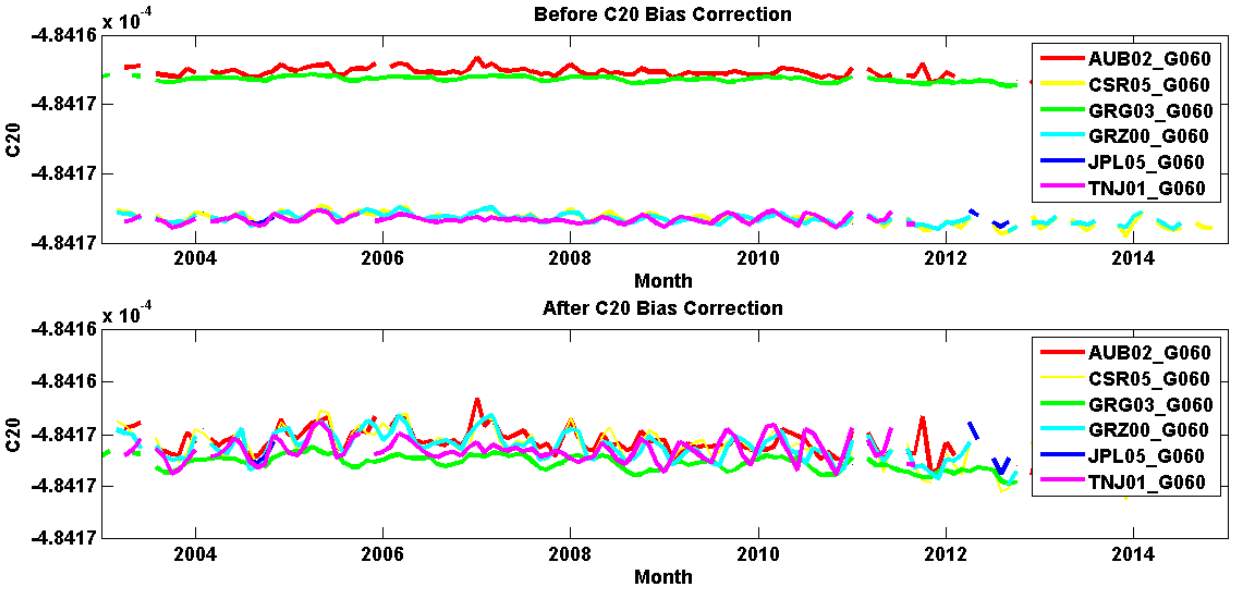
- Combination
  - Weighting schemes: $1/(\text{Solution} - \text{Arithmetic Mean})^2$
  - Weighted combined solutions:

    One weight/month/gravity field

Corrections in Preprocessing Steps

- Correction of ***bias in C20*** coefficient:

  Zero-tide → Tide-free



* MEWH and wSTD over the oceans: C20 was excluded.

< C20 Bias >

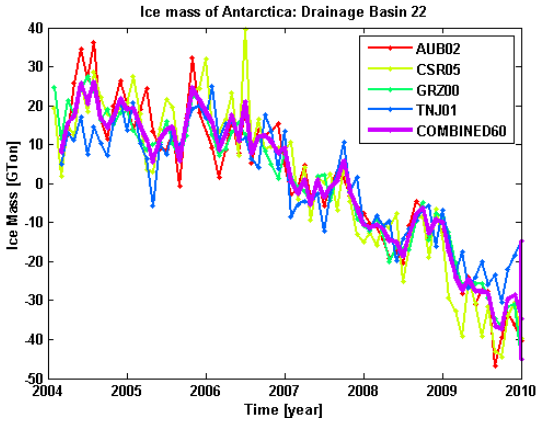
Mean(C20_Sol) — Mean(C20_CSR)

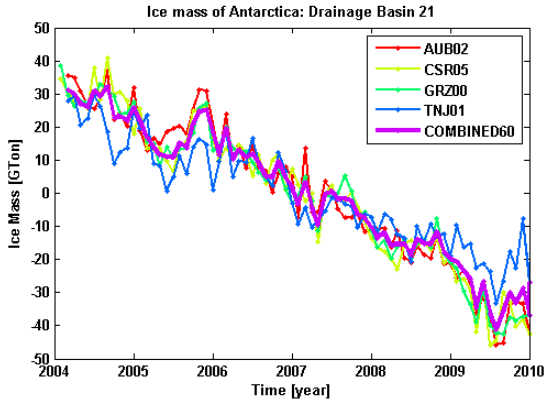
C20 Difference w.r.t. CSR	Degree 60	
	before	after
AIUB-CSR	3.05E-11	-7.58E-11
GRGS-CSR	-1.74E-10	-1.98E-10
ITSG-CSR	-1.77E-11	-1.77E-11
Tongji-CSR	-6.02E-11	-8.45E-11
C20 Difference w.r.t. CSR	**Degree 90**	
	before	**after**
AIUB-CSR	2.99E-11	-7.64E-11
GFZ-CSR	1.57E-10	1.33E-10
ITSG-CSR	-4.41E-12	-4.41E-12
JPL-CSR	2.33E-11	2.33E-11

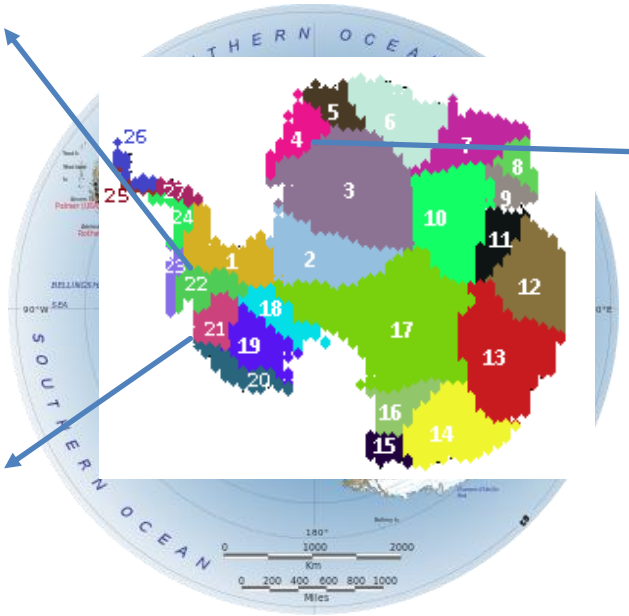
- ***Rescaling*** of spherical harmonic coefficients:
  - Reference value of the radius of Earth: *6,378,136.3* m

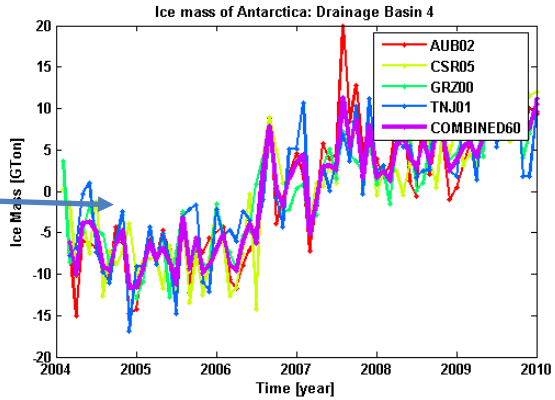
Internal Evaluation (1) : Ice Mass Change

- Ice Mass Change in Drainage Systems in Antarctica
- **Combined solution** (***unfiltered***) and individual solutions

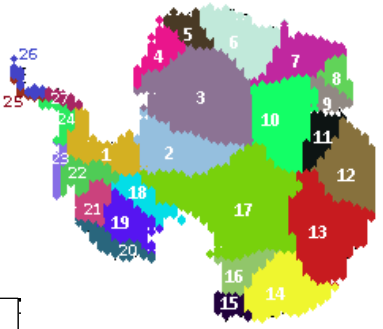




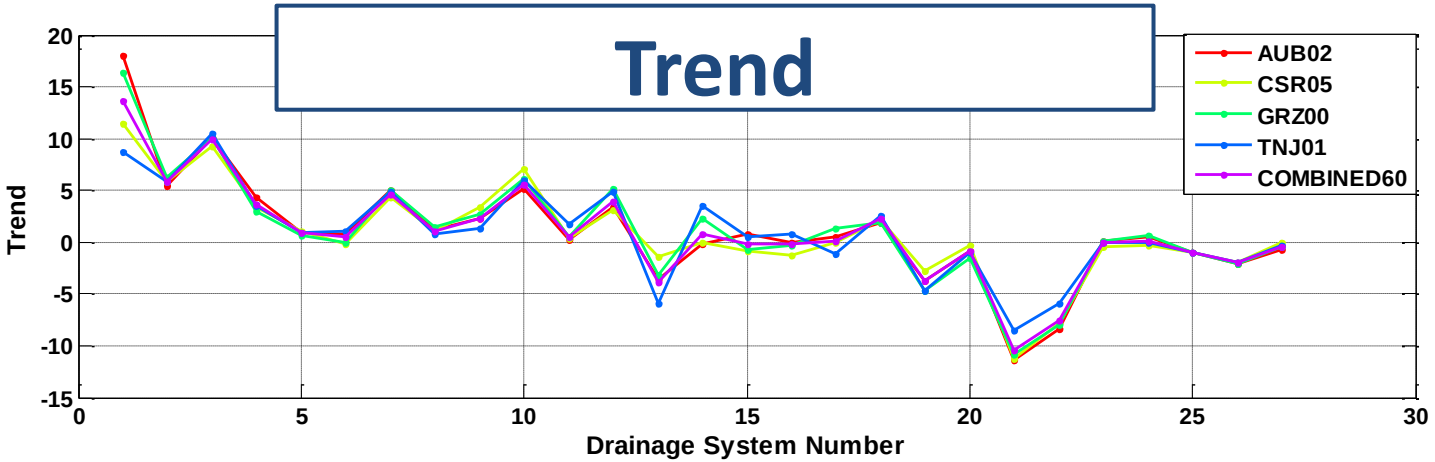


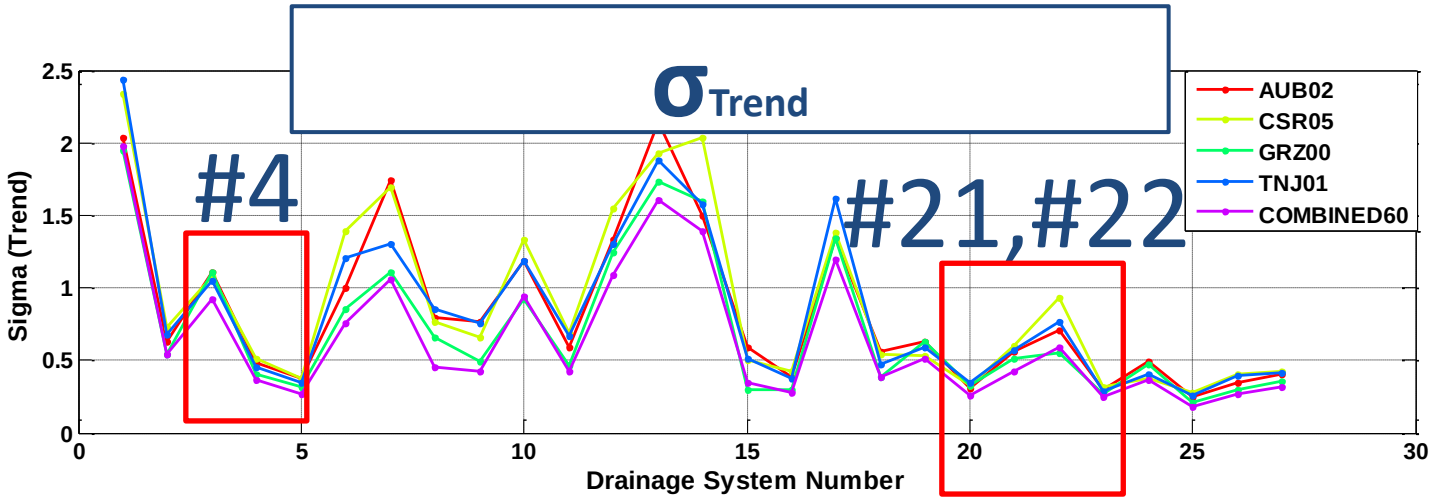


Internal Evaluation (1) : Ice Mass Change



Degree 60, Unfiltered



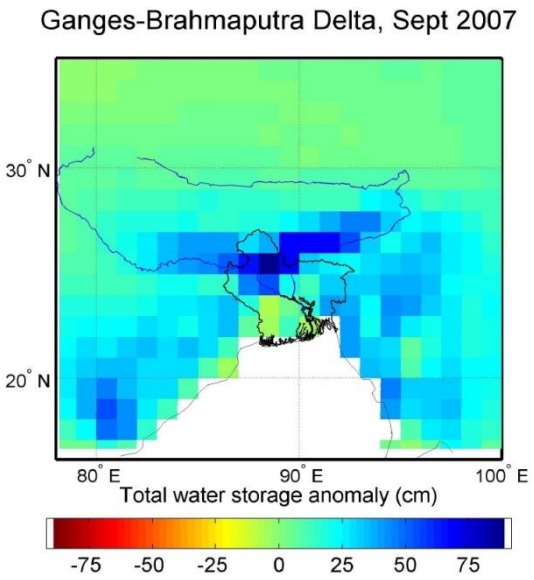


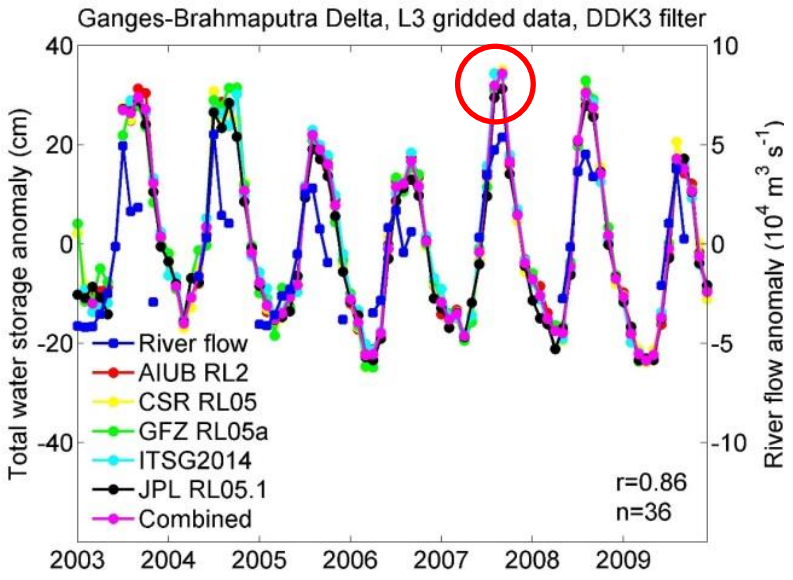
External Evaluation of the Combined Solution

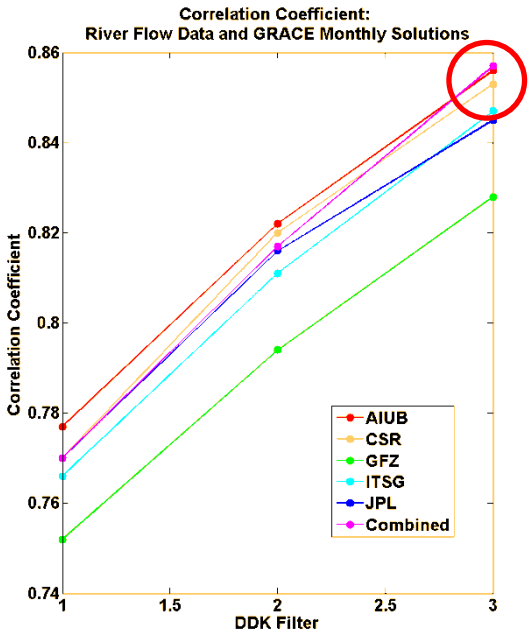
- Combined solution: one weight/month/gravity field, degree 90
  - gfc file format
  - L3 grids (Thanks to *TU Graz*'s prompt conversion assistance)

External Evaluation (1): Hydrology

- Hydrological events
- Tested by Dr. ***Ben Gouweleeuw*** and Prof. ***Andreas Güntner*** (GFZ)
- Individual solutions, Combined solutions, and River flow data
- River basin: Ganges-Brahmaputra (2007)
- Possible loss of benefits during conversion process (e.g. Filtering) into L3 grids

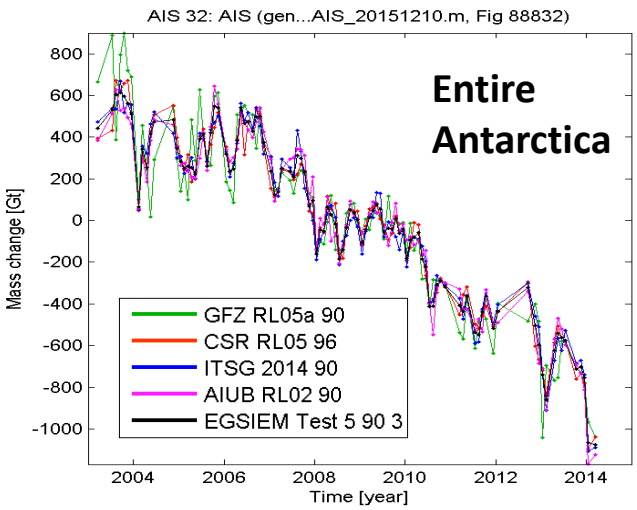




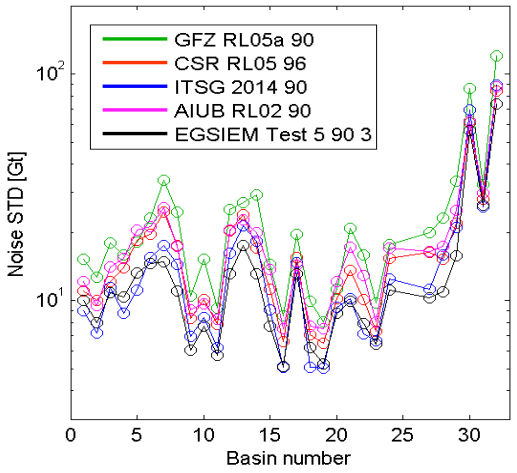


External Evaluation (2): Cryology

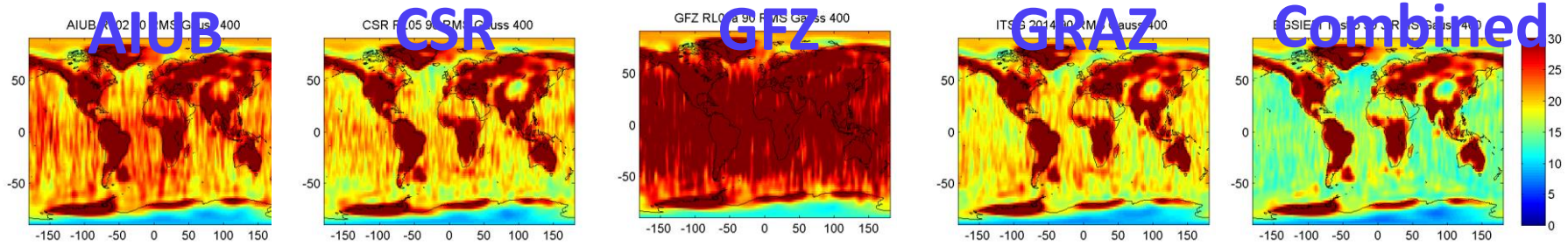
- Ice mass change in Antarctica and Greenland
- Tested by Prof. ***Martin Horwath*** (TU Dresden)



Noise levels per basin



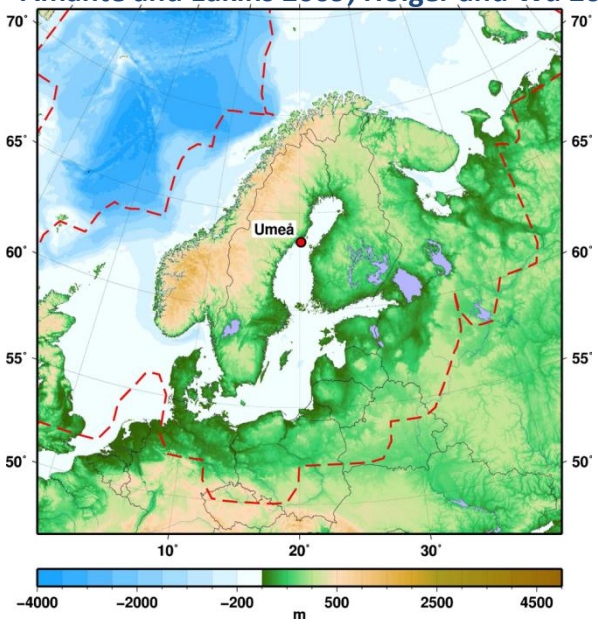
RMS of EWH variability (400km Gaussian filtering)



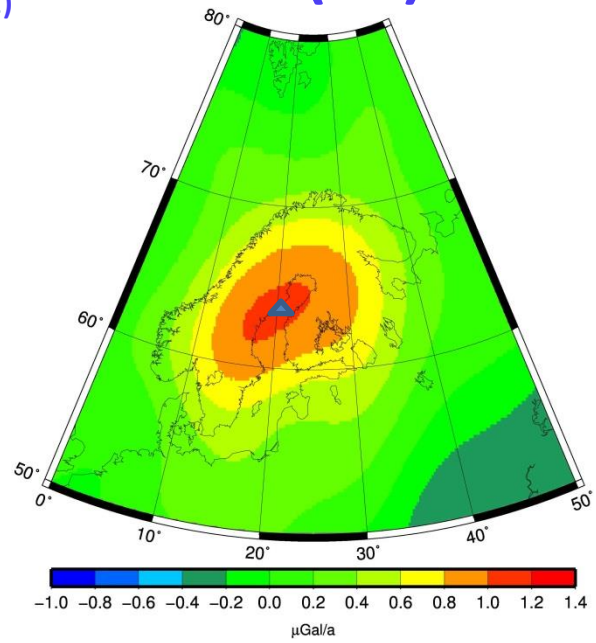
External Evaluation (3): GIA

- Post-glacial rebound
- Tested by Dr. ***Holger Steffen*** (Lantmäteriet)
- CSR and Combined solutions
- Fennoscandia (Northern Europe) and Canada (North America)

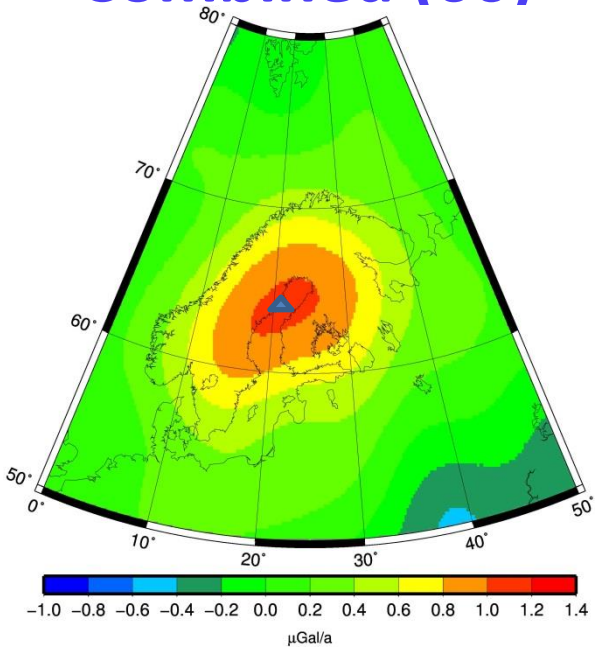
From Topography (ETOPO1; Amante and Eakins 2009; Holger and Wu 2011)



CSR (60)

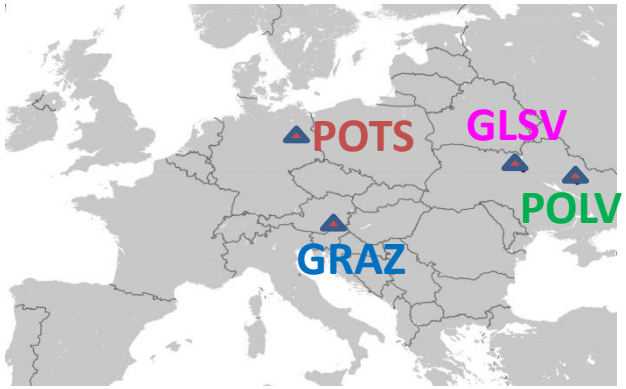


Combined (60)



External Evaluation (4): GPS Loading

- GPS station loading
- Tested by Prof. ***Tonie van Dam*** (U Luxembourg)
- Comparison: GPS and GRACE solutions
- GPS stations: POTS, POLV, GRAZ, GLSV

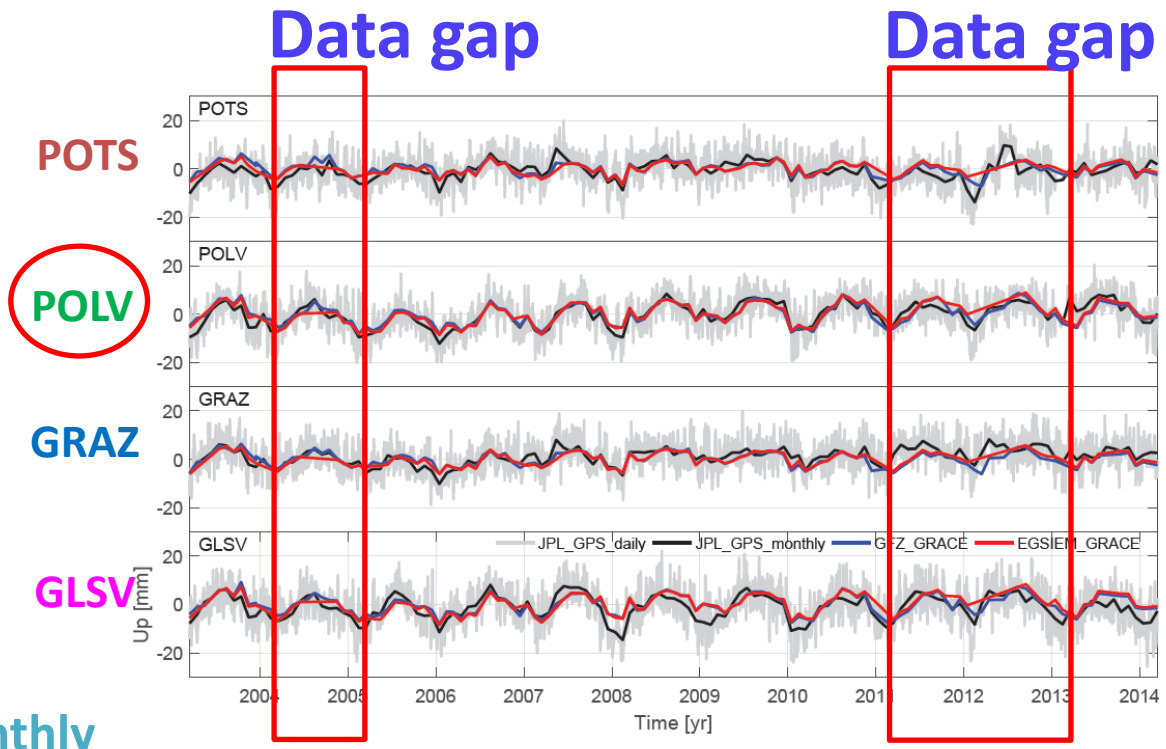


– GPS: JPL daily

JPL monthly

– GRACE: GFZ monthly

EGSIEM$_{combined}$ monthly



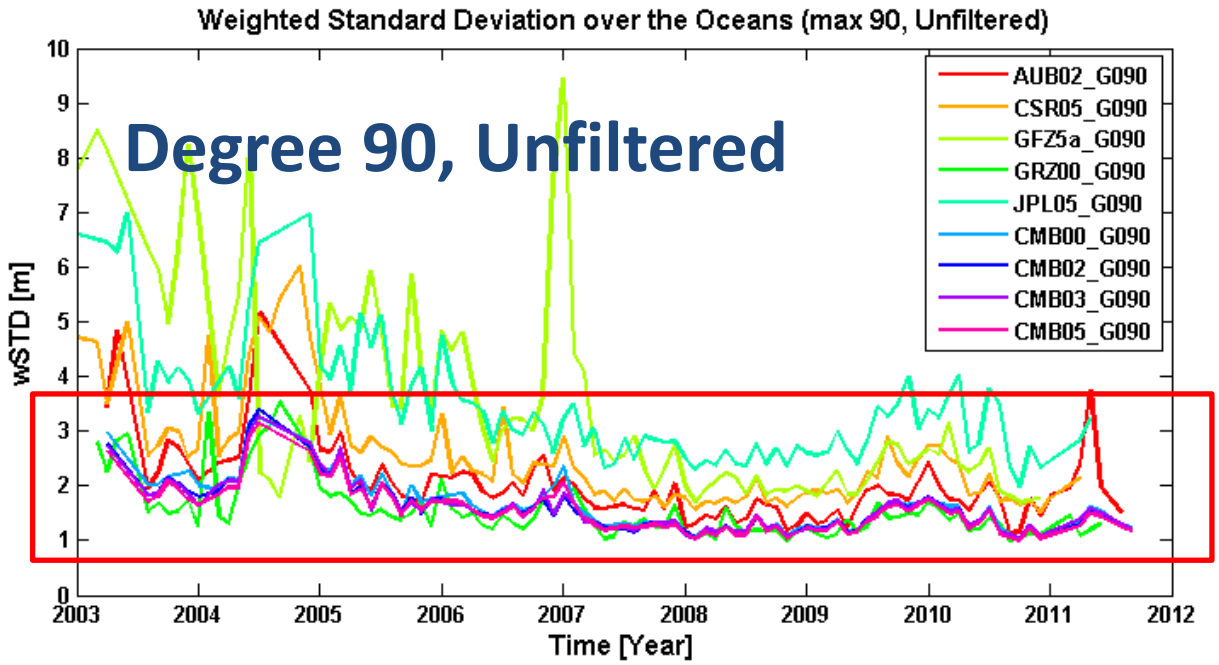
Simulation Study: Motivation

- Motivation:
  - Combined solution vs. a low-noise individual solution
  - Impact of a deviated individual solution
  - Investigation & Validation of the weighting scheme

Combined solution

vs.

Graz solution



Simulation Study

- Weighting scheme
  - Assumption: the arithmetic mean is close to the truth.
  - However, the reality may not be like that.
  - How to improve the weighting scheme?
  - Limits of the weighting scheme

- Simulated gravity fields:
  - Reference gravtiy field: extracted from a model
  - Added bias and noise

→ presentation in *EGU 2016*

Presentations / Publications

- **Presentation in the EGU 2015 (Apr. 2015)**
  - Comparison and combination of GRACE monthly gravity field solutions

- **Presentation in the Geodätische Woche 2015 (Sep. 2015)**
  - Combination of GRACE monthly gravity field solutions with different weighting schemes

- **Contribution to presentation by Prof. Adrian Jäggi in the AGU meeting 2015 (Dec. 2015)**
  - Combination service of GRACE monthly solutions
  - Contribution to validation of the weighted combined solution

- **Plans**
  - **Presentation in EGU 2016**
  - **Manuscript for a journal article (to be submitted in the first half of 2016)**