EGSIEM

European Gravity Service for Improved Emergency Management

Title: **WP2 Gravity field analysis**

Presenter: TMG and all ACs

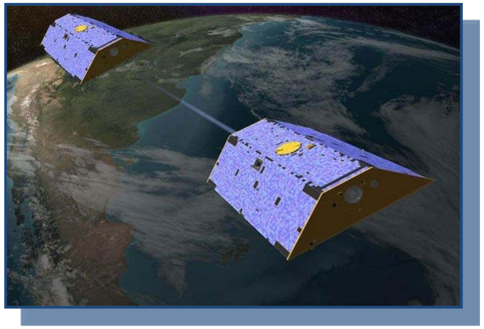
Affiliation: TUG

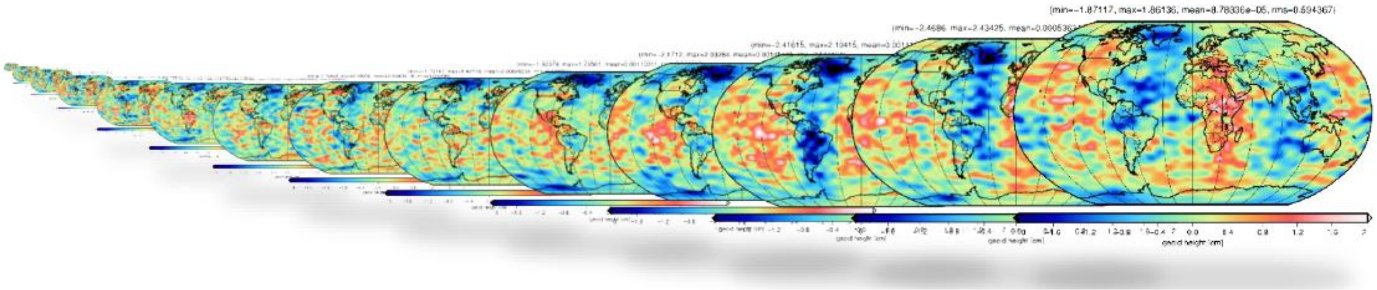
EGSIEM Meeting Bern,
08.02.2018 – 09.02.2018

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

WP2: The basic idea

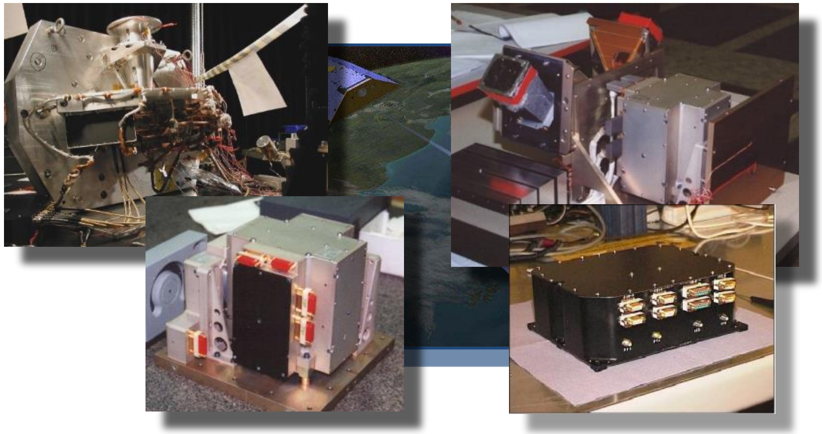
- Process GRACE data to a time series of monthly gravity field solutions
- Processing is challenging

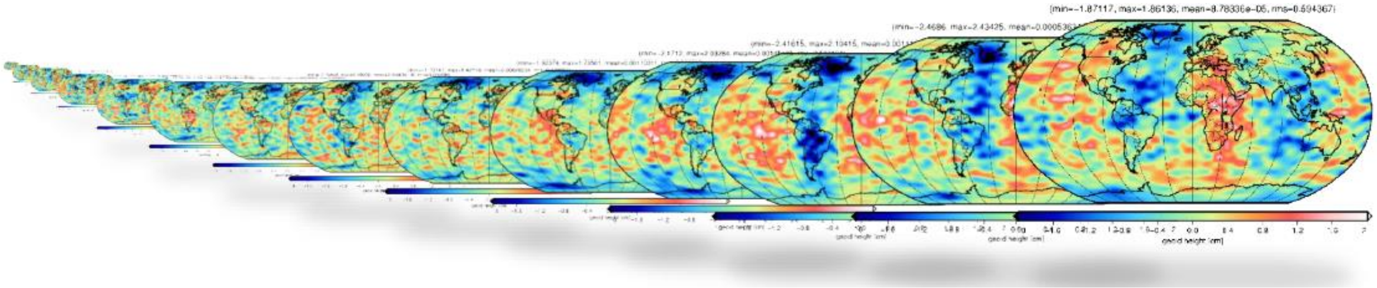




WP2: The basic idea

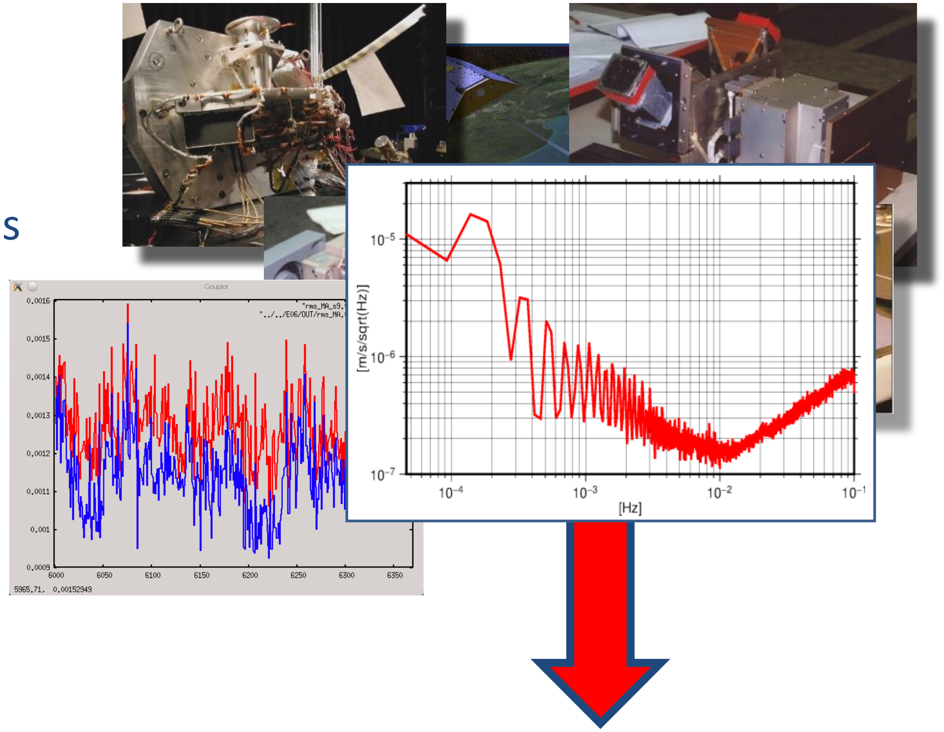
- Process GRACE data to
  a time series of monthly gravity field solutions
- Processing is challenging
  - Interaction of multiple instruments

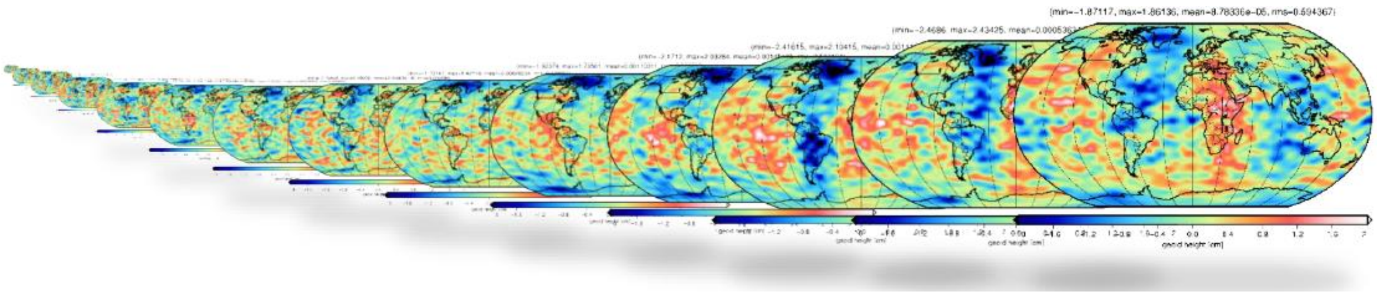




WP2: The basic idea

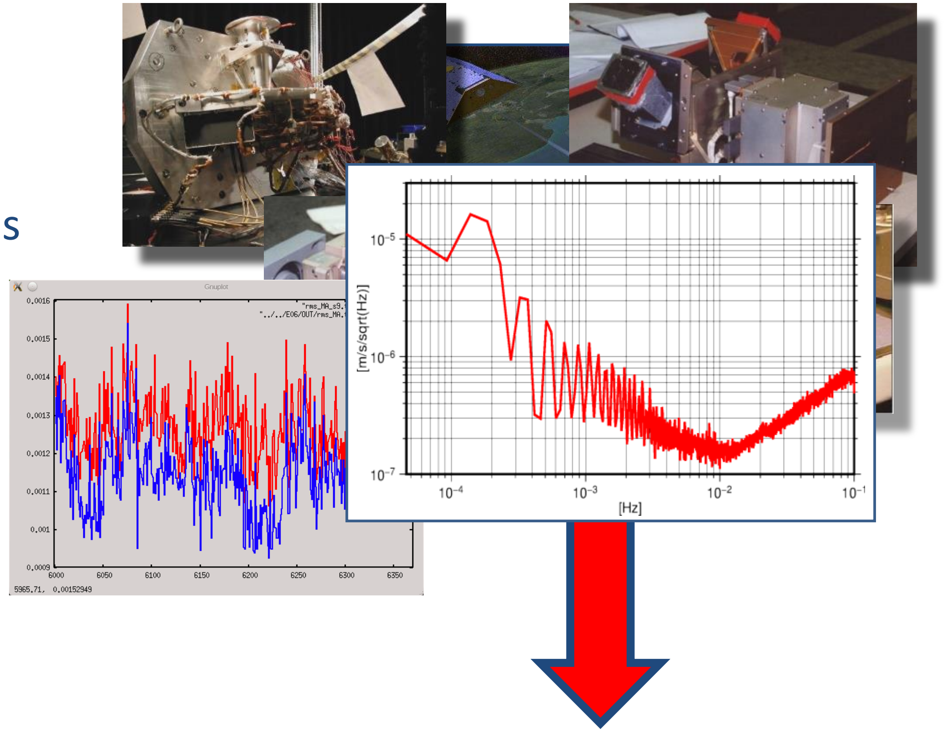
- Process GRACE data to a time series of monthly gravity field solutions
- Processing is challenging
    - Interaction of multiple instruments
    - Different noise characteristics

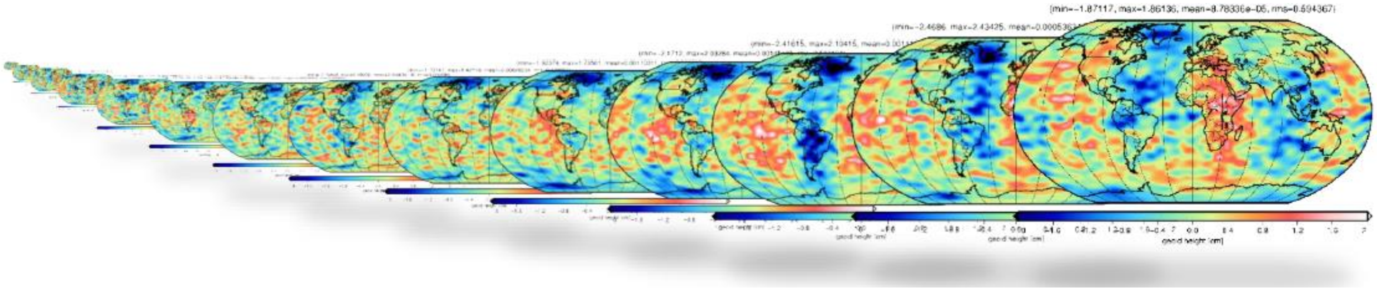




WP2: The basic idea

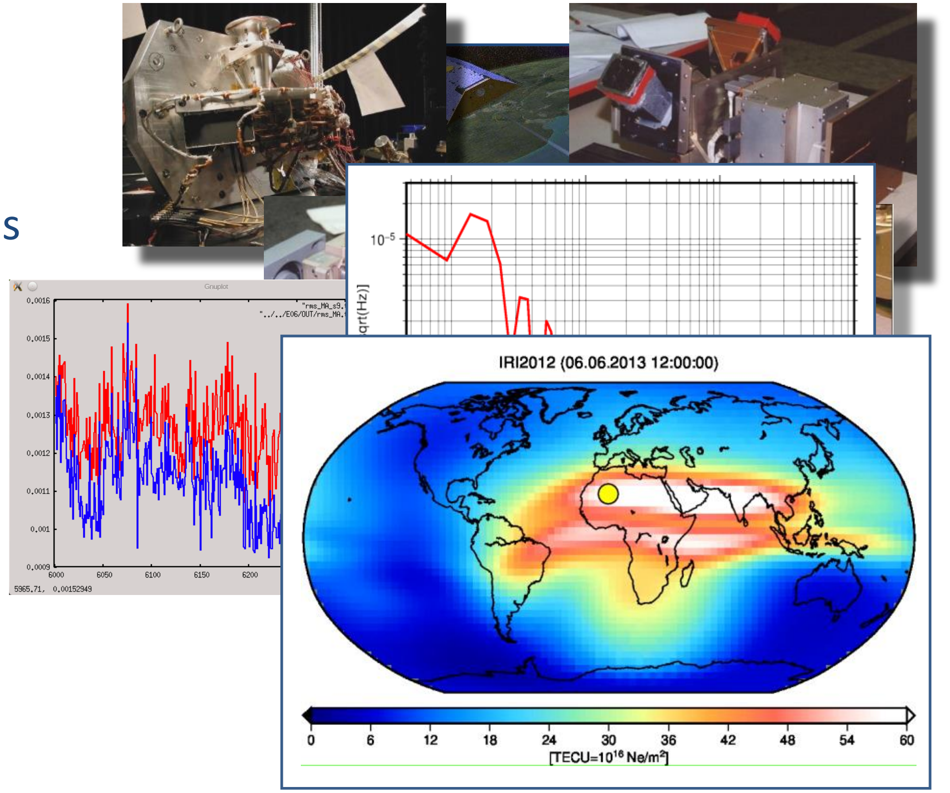
- Process GRACE data to a time series of monthly gravity field solutions
- Processing is challenging
    - Interaction of multiple instruments
    - Different noise characteristics
    - Environmental disturbances

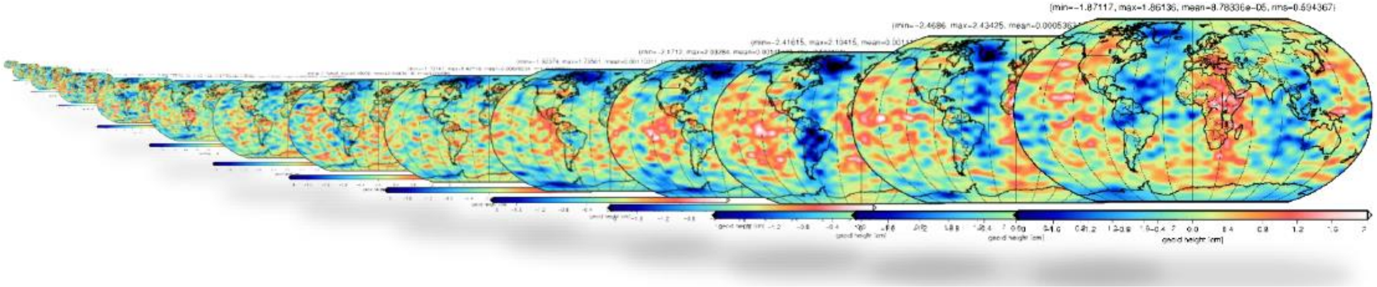




WP2: The basic idea

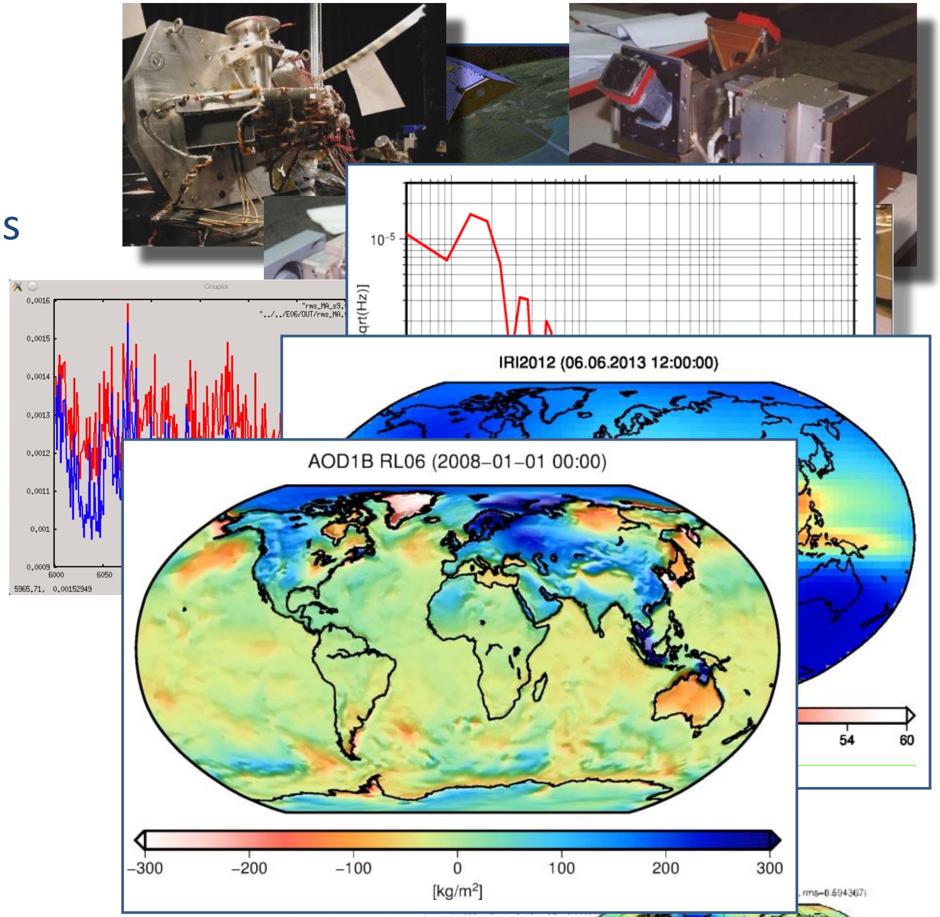
- Process GRACE data to a time series of monthly gravity field solutions
- Processing is challenging
    - Interaction of multiple instruments
    - Different noise characteristics
    - Environmental disturbances
        - Ionosphere

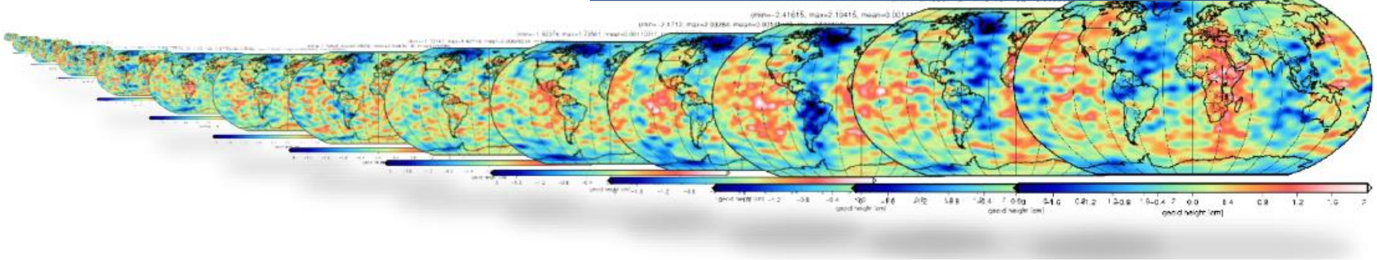




WP2: The basic idea

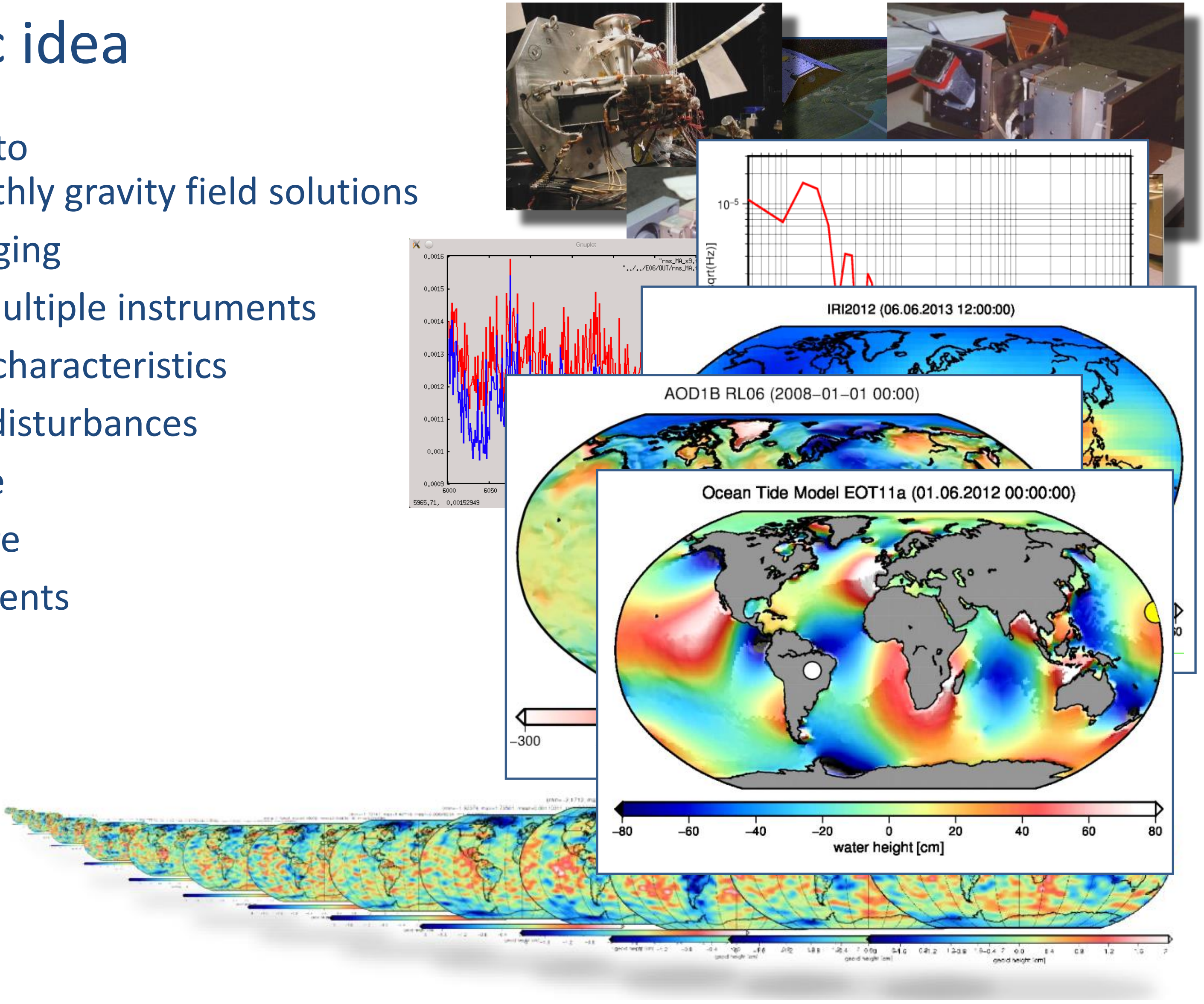
- Process GRACE data to
  a time series of monthly gravity field solutions
- Processing is challenging
  - Interaction of multiple instruments
  - Different noise characteristics
  - Environmental disturbances
    - Ionosphere
    - Atmosphere
    - Ocean currents





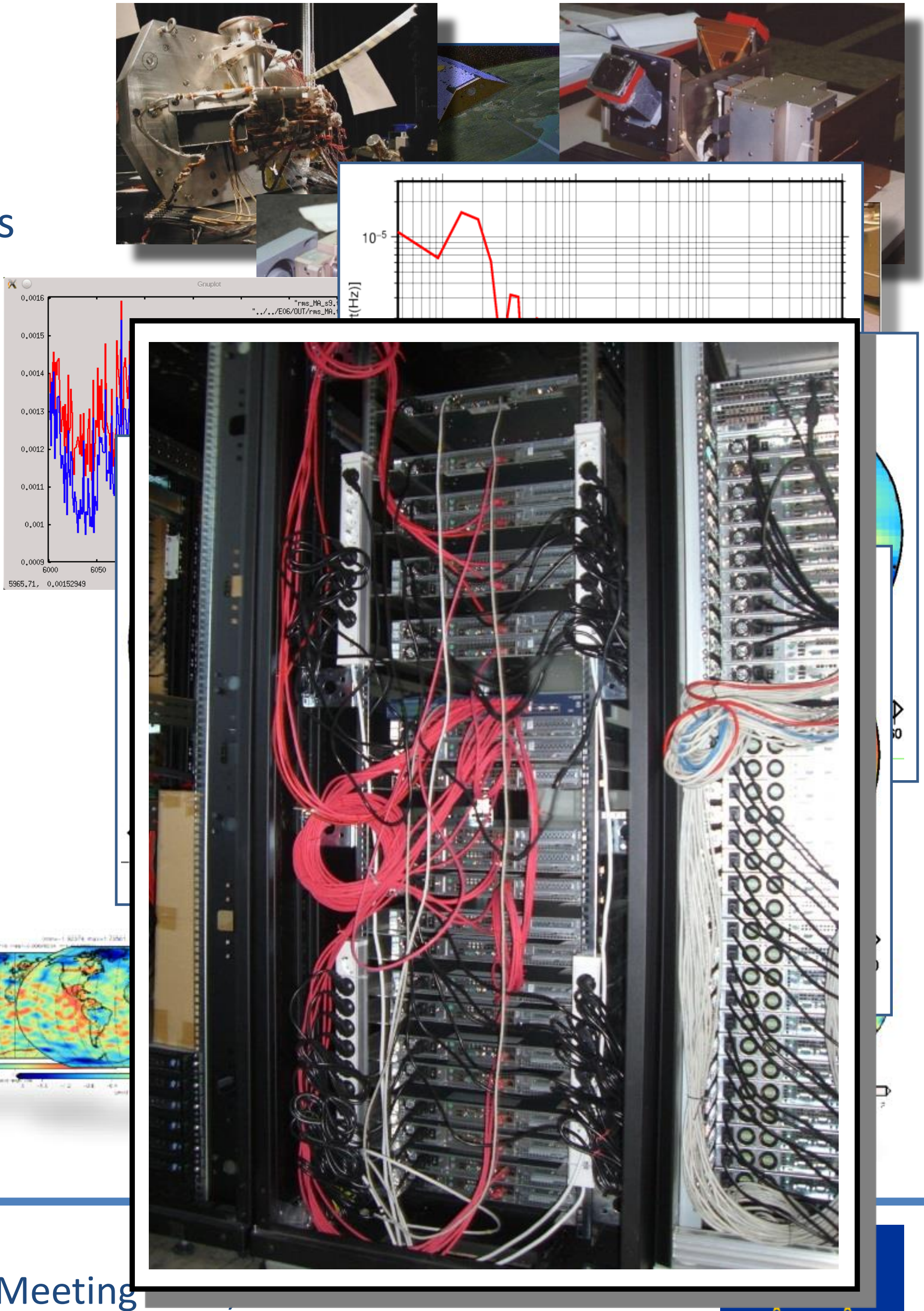
WP2: The basic idea

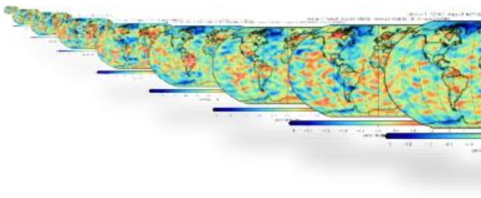
- Process GRACE data to
  a time series of monthly gravity field solutions
- Processing is challenging
  - Interaction of multiple instruments
  - Different noise characteristics
  - Environmental disturbances
    - Ionosphere
    - Atmosphere
    - Ocean currents
    - Tides



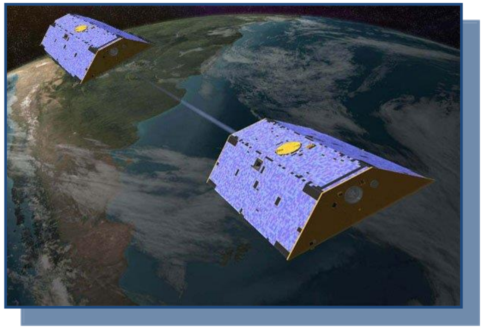
WP2: The basic idea

- Process GRACE data to a time series of monthly gravity field solutions
- Processing is challenging
  - Interaction of multiple instruments
  - Different noise characteristics
  - Environmental disturbances
    - Ionosphere
    - Atmosphere
    - Ocean currents
    - Tides
  - Large system of equations: Computational restrictions

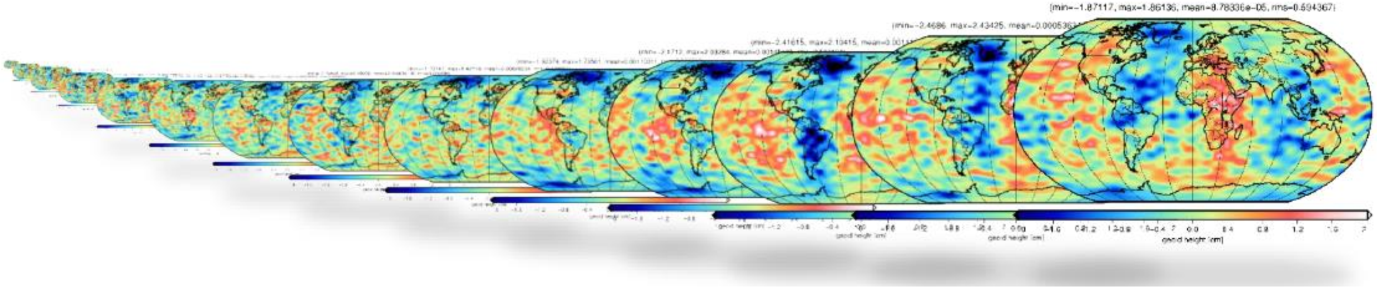




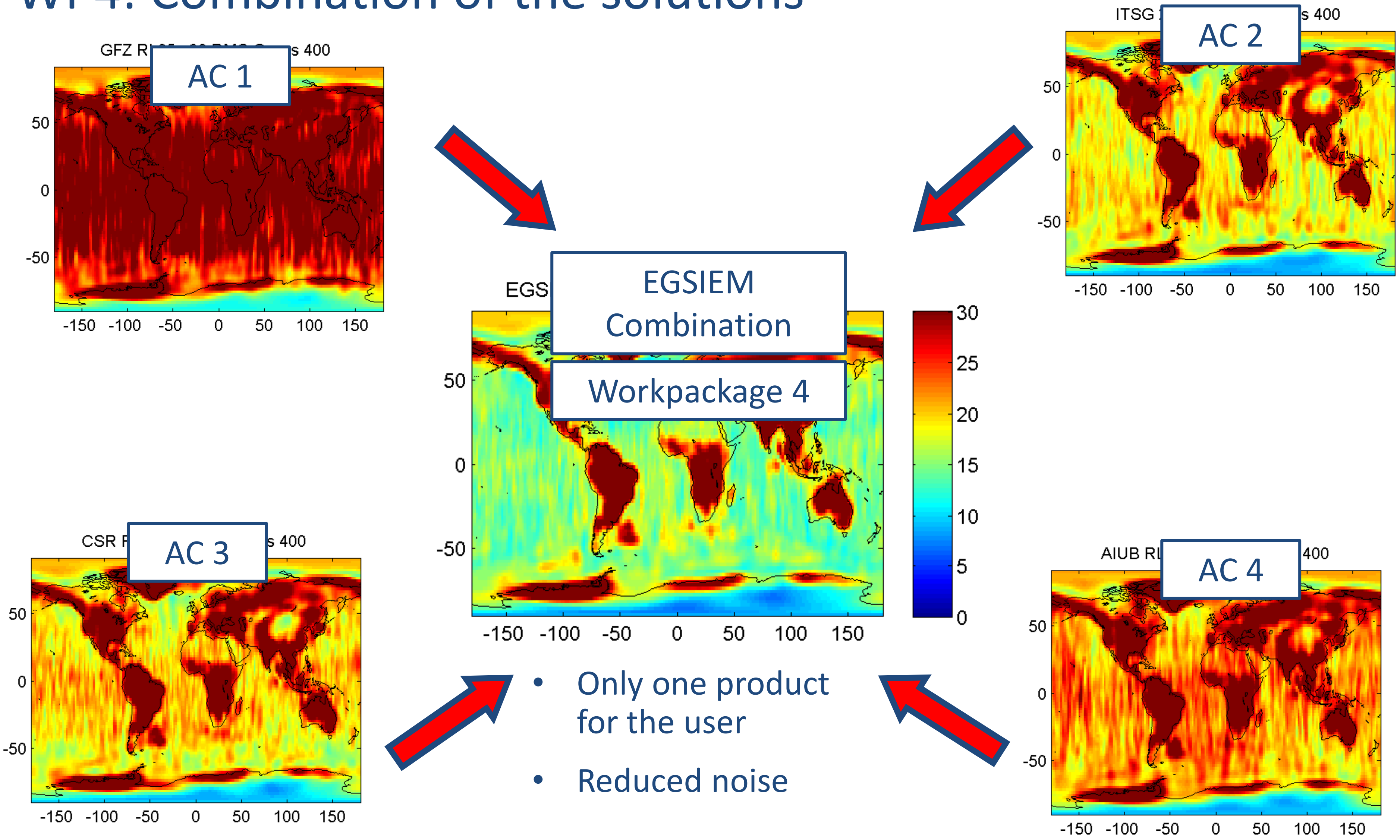
WP2: The basic idea



- Process GRACE data to
  a time series of monthly gravity field solutions
- Processing is challenging
- => There is not only one truth solution
- Computation of different solutions (ensembles) from different Analysis Centers (ACs) with different approaches
- EGSIEM Analysis Centers (ACs):
  - GFZ
  - CNES
  - AIUB
  - TUG - ITSG
  - (ULUX)



WP4: Combination of the solutions



AC 1

AC 2

EGSIEM Combination

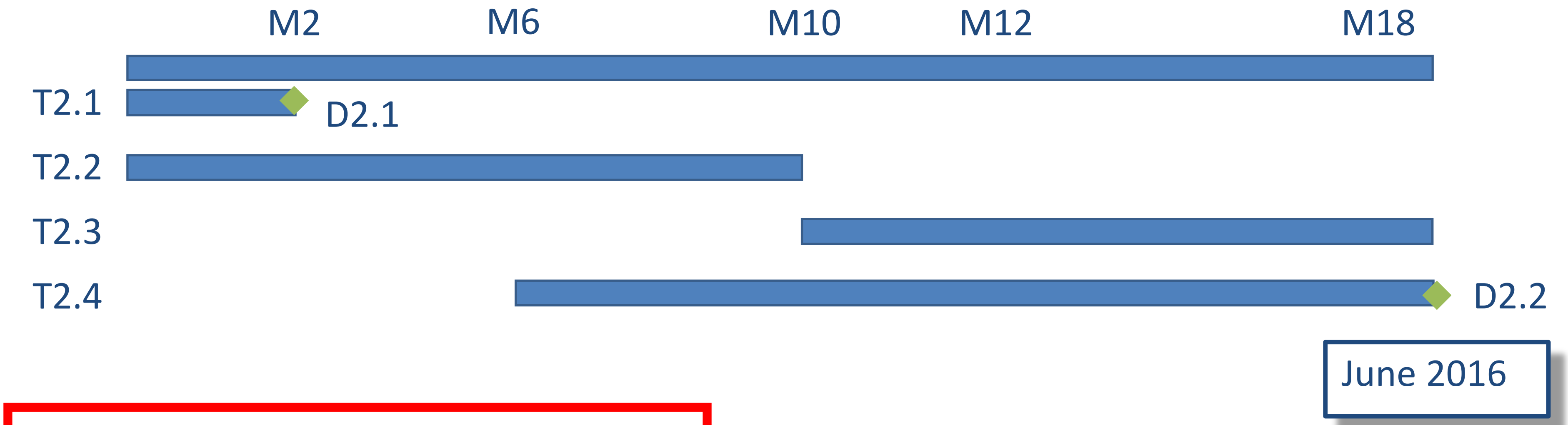
Workpackage 4

AC 3

AC 4

- Only one product for the user
- Reduced noise

WP2 Gravity field analysis – Time Table



T2.1 Processing Standards and Models

T2.2 Improved processing tools

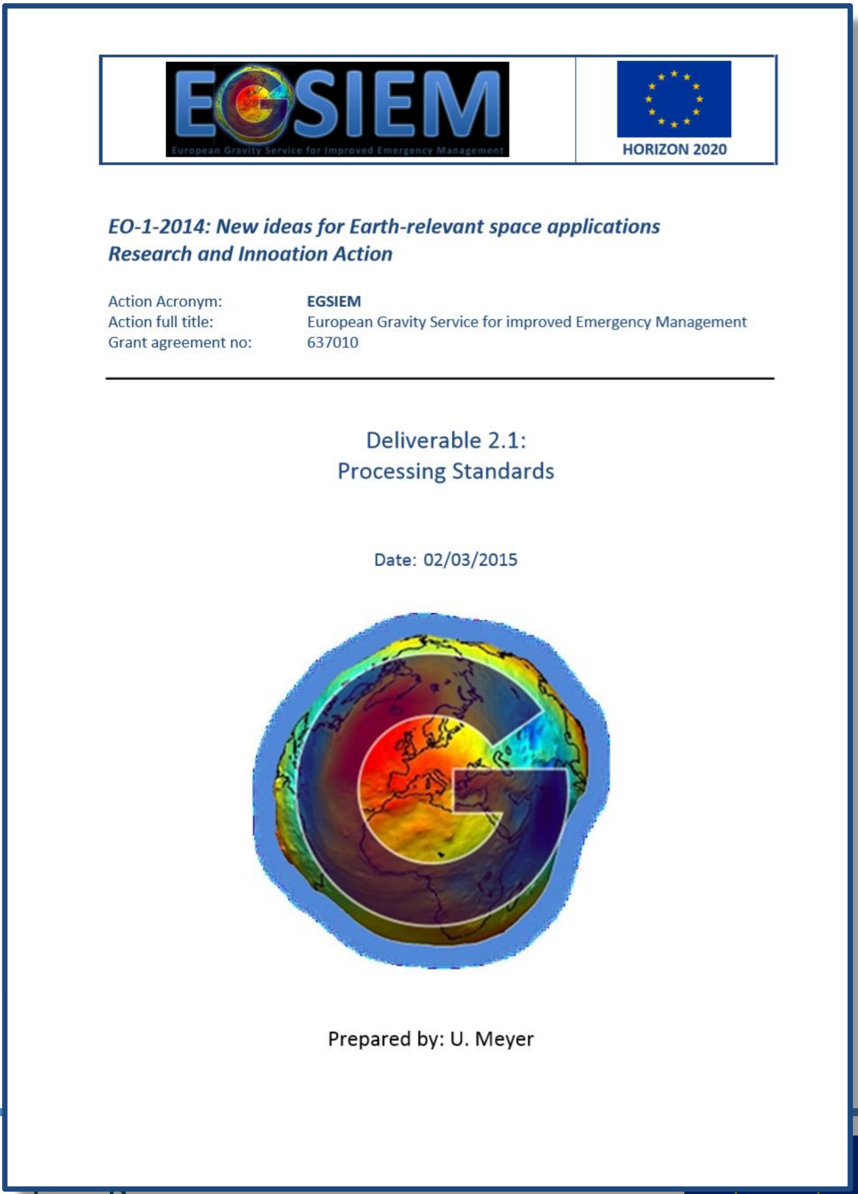
T2.3 Data analysis

T2.4 Instrumental behavior and End-to-end Simulator

T2.1 Harmonization of processing standards

- Common reference frame
  and GPS orbit constellation
- Ensemble of different background models
- Distribution of solutions at normal equation level in standard SINEX format

```
%=SNX 2.02
+FILE/REFERENCE
+FILE/COMMENT
+SOLUTION/STATISTICS
+SOLUTION/NORMAL_EQUATION_VECTOR
+SOLUTION/NORMAL_EQUATION_MATRIX U
+SOLUTION/ESTIMATE
+SOLUTION/APRIORI
%ENDSNX
```



EGSIEM
European Gravity Service for Improved Emergency Management
HORIZON 2020

EO-1-2014: New ideas for Earth-relevant space applications
Research and Innovation Action

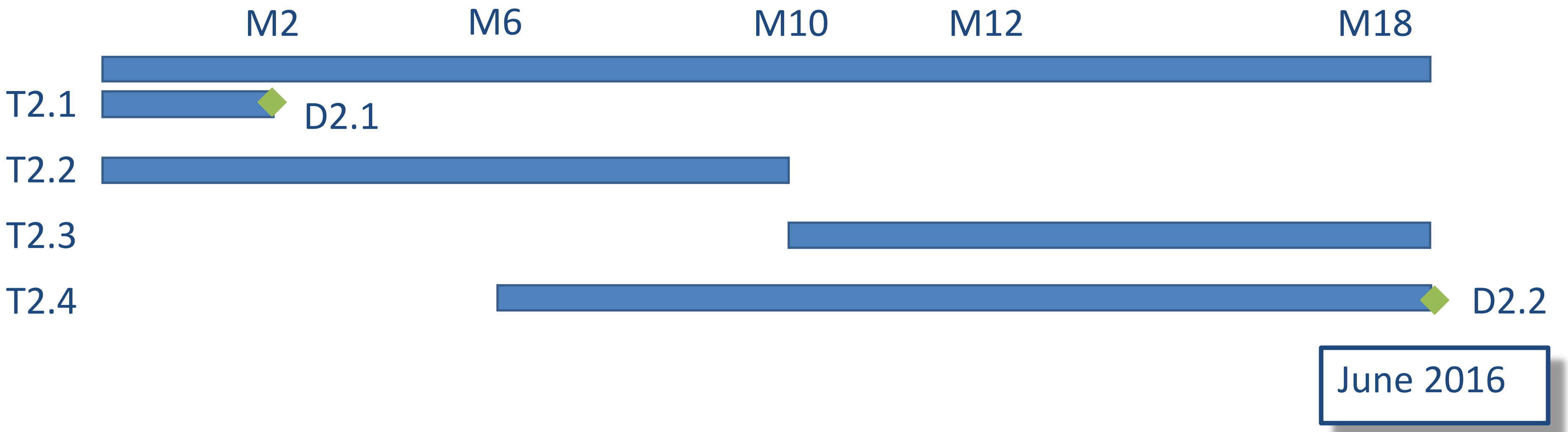
Action Acronym:	**EGSIEM**
Action full title:	European Gravity Service for improved Emergency Management
Grant agreement no:	637010

Deliverable 2.1:
Processing Standards

Date: 02/03/2015

Prepared by: U. Meyer

WP2 Gravity field analysis – Time Table



T2.1 Processing Standards and Models

T2.2 Improved processing tools => Presentations by GFZ, GRGS, AIUB, TUG

T2.3 Data analysis

T2.4 Instrumental behavior and End-to-end Simulator

EGSIEM
European Gravity Service for Improved Emergency Management

Status GFZ Monthly Solutions

Christoph Dahle, Frank Flechtner

EGSIEM Final Meeting, AIUB, Bern, Switzerland

Feb 8-9, 2018

Level 2 Products at GFZ: General

European Gravity Service for Improved Emergency Management

- Operational GRACE release: GFZ RL05a (163 monthly solutions from 04/2002-06/2017)

- Years 2006 & 2007 have been reprocessed for EGSIEM and delivered to WP4 as
  - Monthly Level-2 products (SH coefficients) up to d/o 90x90
  - Monthly NEQs in SINEX format

- These monthly products were based on EGSIEM standards and some initial modifications towards RL06

- WP2 already finished at M18!

- RL06 testing currently in its final stage. First years shall be published in April 2018 (EGU). EGSIEM L2 can be seen as “precursor”

Level 2 Products at GFZ: General

European Gravity Service for Improved Emergency Management

- Improvements from RL05 to RL06 will comprise (red: already applied for EGSIEM), e.g.
  - Reprocessed RL03 L1B data:
    - KBR1B and SCA1B only, made available within SDS
  - New (improved) background models
    - Ocean tide model: FES2014, AOD1B: RL06
  - GPS constellation
    - AIUB GPS constellation , GFZ reprocessed constellation based on ITRF2014/IGS2014
  - Modifications in processing strategy, e.g.
    - Relative weighting KBR vs GPS
      - GPS slightly down-weighted (a priori sigma for GPS phase 0.7 cm -> 1 cm)
      - use of arc-wise KBR and GPS weights
    - Parameterization
      - ACC biases and scales every 3h in all directions (RTN)
      - review of empirical orbit & K-band parameter setup

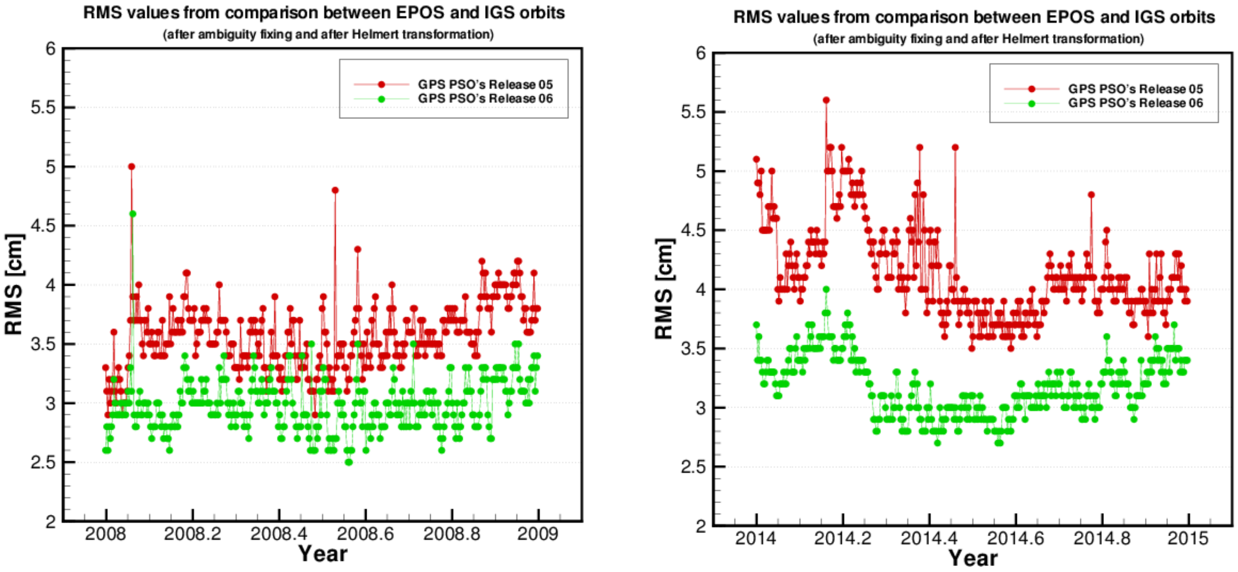
HORIZON 2020

Level 2 RL06 Products at GFZ: GPS Constellation

European Gravity Service for Improved Emergency Management

Main differences compared to previous RL05 constellation:

- New reference frame ITRF2014/IGS2014 (instead of ITRF2008/IGS08)
- Increased number of ground stations (approx. 120 instead of 70)
- Improved solar radiation pressure parameterization
- Background models according to GRACE RL06 standards



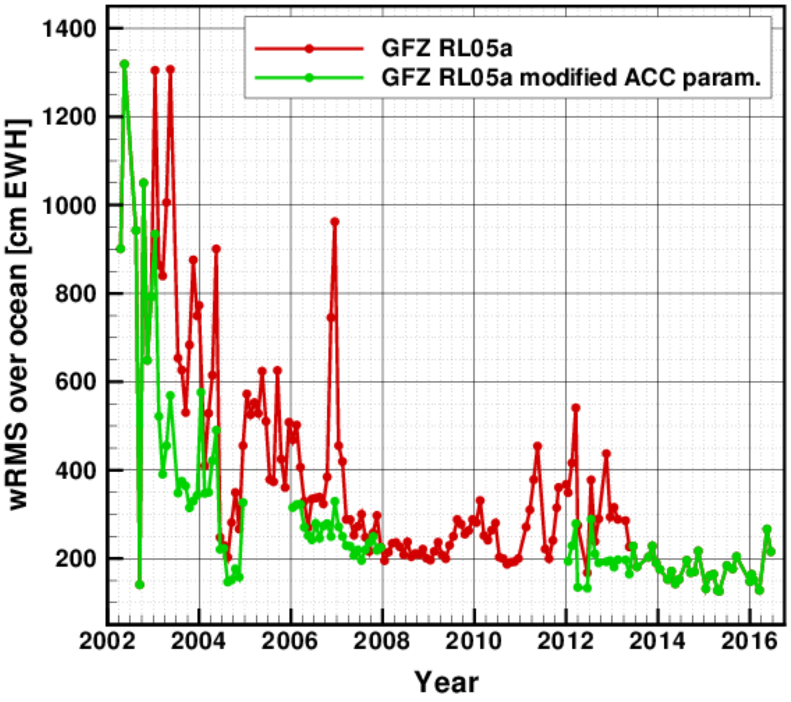
3D RMS of RL05 & RL06 GPS precise orbits w.r.t. IGS final orbit products for 2008 (left) and 2014 (right)

Level 2 RL06 Products at GFZ: ACC Parametrization

European Gravity Service for Improved Emergency Management

- During some periods, monthly solutions of the GFZ RL05a time series are significantly worse than for most other months
- Internally available RL05a solutions with modified ACC parameterization clearly improves the quality of the time series
- Modified parameterization shown in figure: 3-hourly biases and scales instead of 1-hourly biases and fixed scales
- Further refinement of ACC parameterization for RL06 ongoing

➢ Quality of RL06 time series will be much more consistent



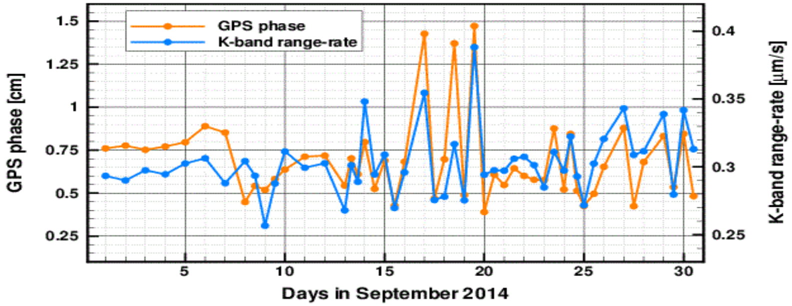
wRMS over ocean [cm EWH] of unfiltered monthly solutions

Level 2 RL06 Products at GFZ: Arc-wise Weighting

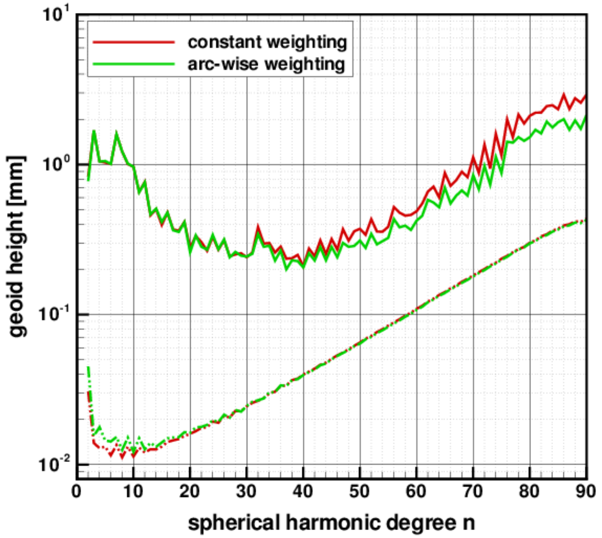
EGSIEM

European Gravity Service for Improved Emergency Management

- For RL05, constant weights for K-band range-rate and GPS code and phase observations have been used
- For RL06 arc-wise weights will be used that are based on RMS values of the corresponding pre-fit residuals



Arc-wise RMS values of pre-fit GPS phase and K-band range-rate observations for 2014/09.



Degree amplitude differences w.r.t. the static gravity field model EIGEN-6C (solid lines) and formal errors (dash-dotted lines) for the month 2014/09.

- No influence on gravity field solutions is expected for (many) months with homogeneous quality of individual arcs within the month, but solutions of particular months will significantly benefit
- Due to arc-wise weights for both K-band and GPS, the relative weighting between these two measurement types is not constant either
- However, mean relative weights over one month are close to the relative weighting applied for RL05 with a tendency to down-weight GPS slightly more

EGSIEM

HORIZON 2020

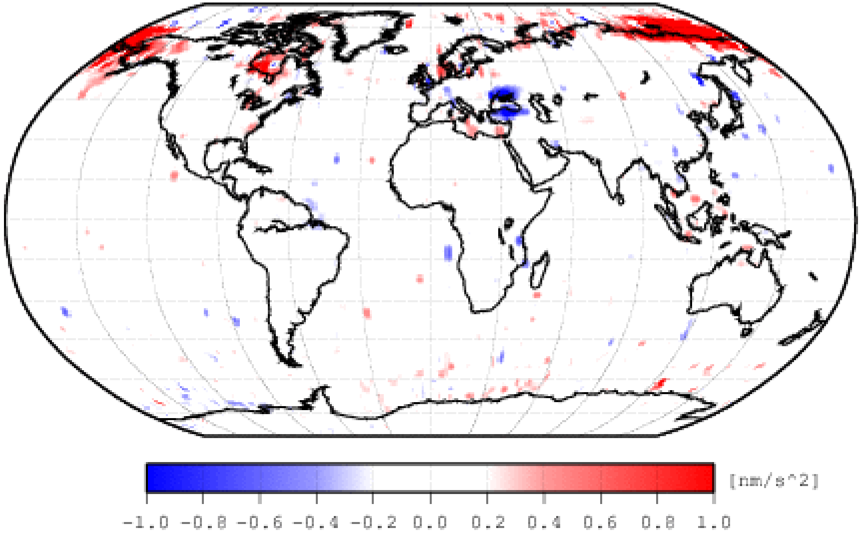
Level 2 Products at GFZ:
AOD1B RL06

European Gravity Service for Improved Emergency Management

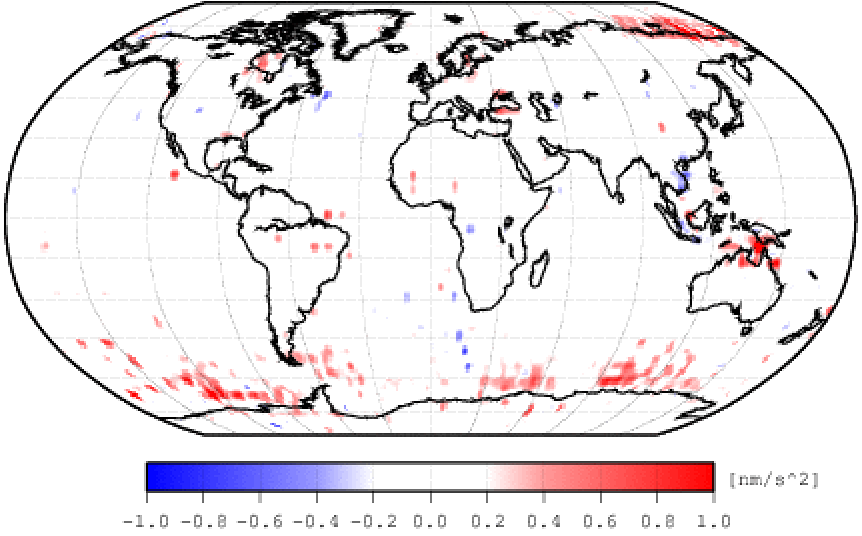
Variance reduction of K-band range-acceleration residuals

Differences between GFZ GRACE solutions using (1) AOD1B RL05 and (2) AOD1B RL06 (red indicates AOD1B RL06 is better, blue AOD1B RL05 is better)

2008/03



2008/08



- Generally improvements by AOD1B RL06
- Years investigated so far: 2008 & 2014 (similar conclusions can be drawn from all months)

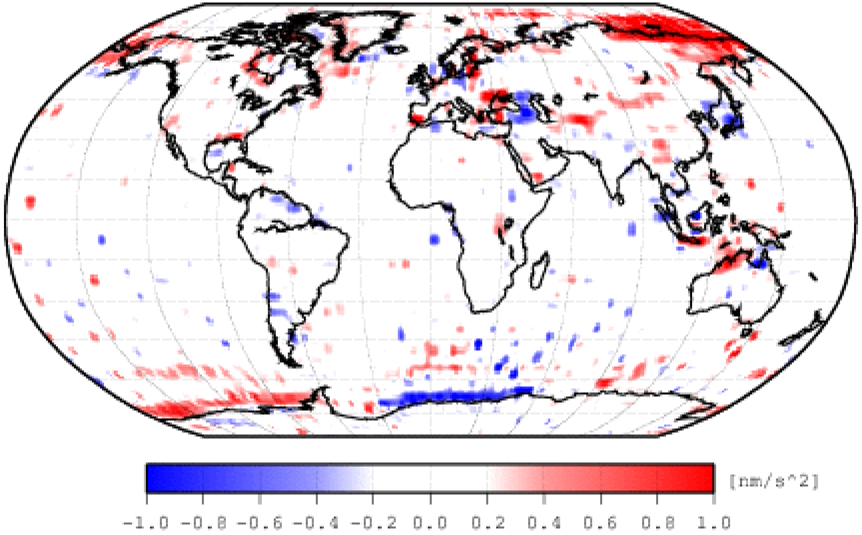
Level 2 Products at GFZ: AOD1B RL06

European Gravity Service for Improved Emergency Management

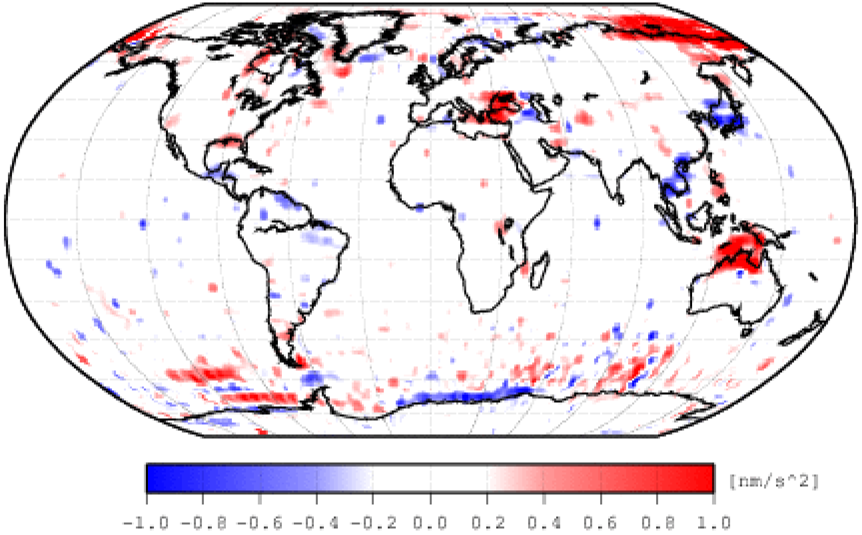
Variance reduction of K-band range-acceleration residuals

Differences between GFZ GRACE solutions using (1) AOD1B RL05 and (2) AOD1B RL06 (red indicates AOD1B RL06 is better, blue AOD1B RL05 is better)

2014/03



2014/08



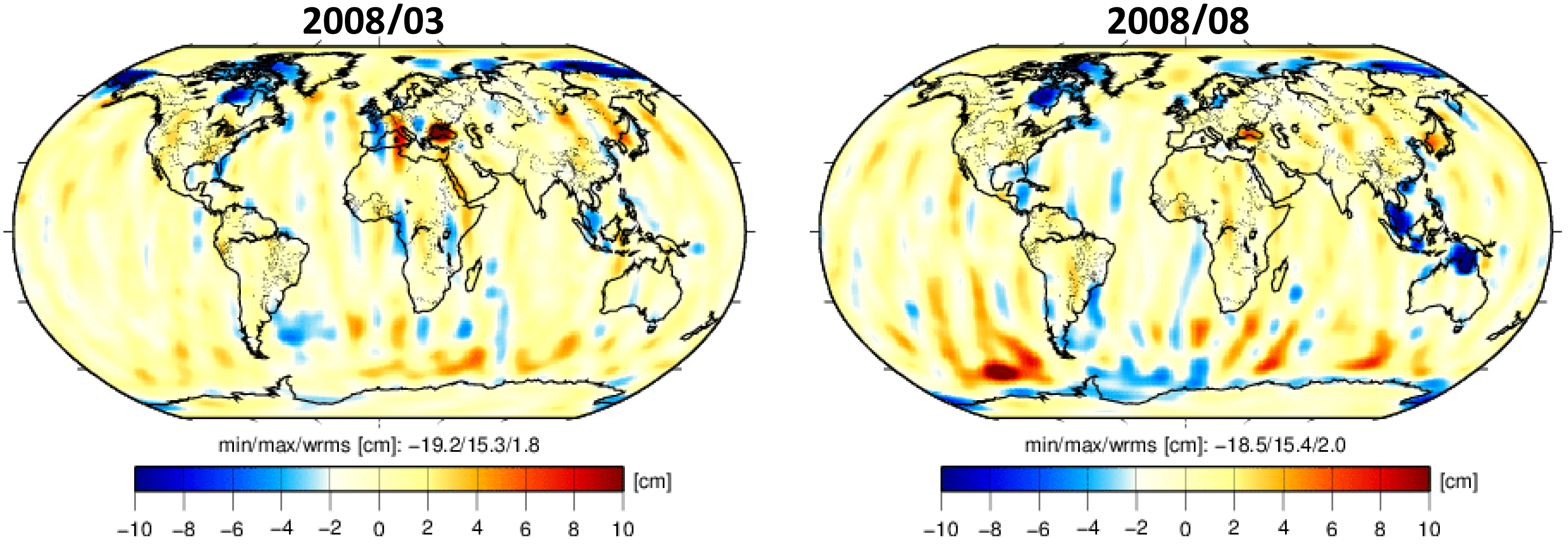
- Generally improvements by AOD1B RL06
- Years investigated so far: 2008 & 2014 (similar conclusions can be drawn from all months)

Level 2 Products at GFZ: AOD1B RL06

European Gravity Service for Improved Emergency Management

Impact on monthly gravity field solutions

EWH differences [cm] (DDK3 filtered) between GFZ GRACE solutions using (1) AOD1B RL05 and (2) AOD1B RL06 (red indicates AOD1B RL06 has smaller values, blue AOD1B RL05 has smaller values)



- RMS differences of ~2cm, but also up to ~20 cm in certain regions!

Level 2 Products at GFZ: AOD1B RL06

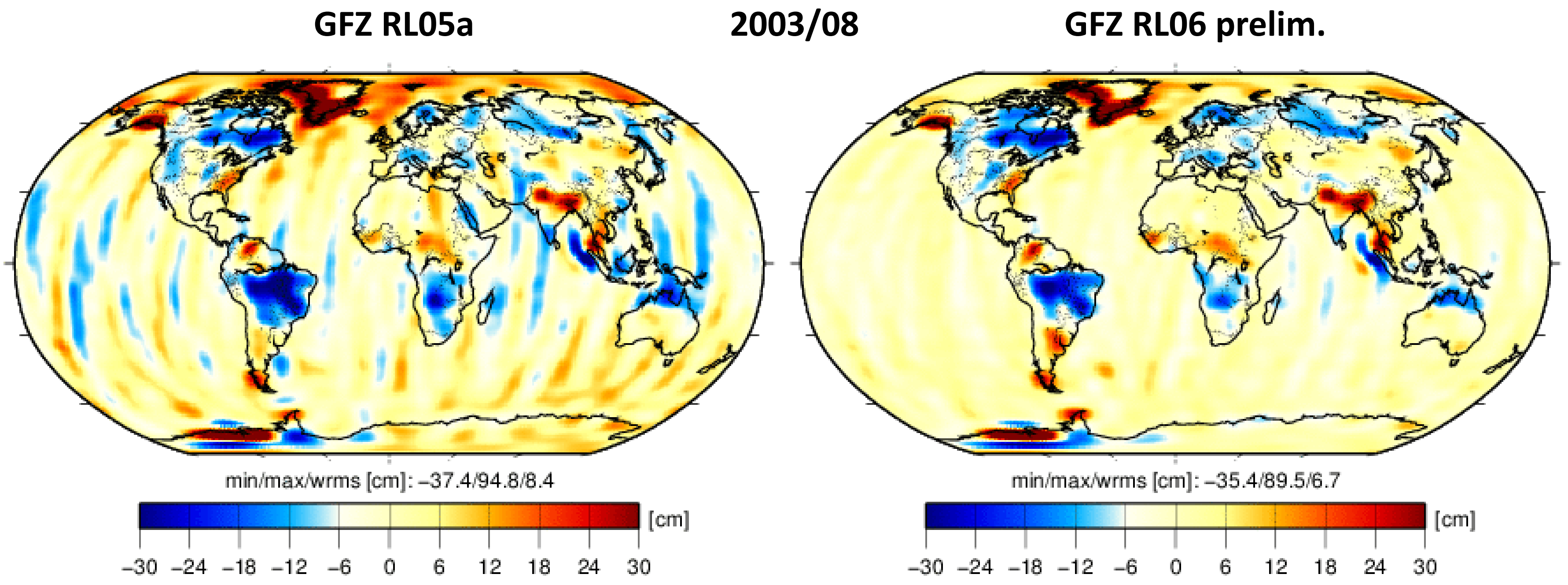
European Gravity Service for Improved Emergency Management

Impact on monthly gravity field solutions: wRMS over ocean (EWH [cm], unfiltered):

	AOD1B RL05	AOD1B RL06
2008/01	**186.7**	**177.5 (-5%)**
2008/02	**200.8**	**192.4 (-4%)**
2008/03	**198.2**	**191.7 (-3%)**
2008/04	**200.8**	**197.5 (-2%)**
2008/05	**189.5**	**186.7 (-1%)**
2008/06	**213.5**	**211.7 (-1%)**
2008/07	**208.1**	**199.7 (-4%)**
2008/08	**215.1**	**210.8 (-2%)**
2008/09	**213.2**	**214.2 (+0%)**
2008/10	**190.3**	**186.2 (-2%)**
2008/11	**195.0**	**188.9 (-3%)**
2008/12	**195.5**	**187.6 (-4%)**

Level 2 Products at GFZ:
RL06 preview

EWH maps wrt. EIGEN-6C4, **DDK3** filtered, C_{20} **NOT** replaced



GFZ RL05a

2003/08

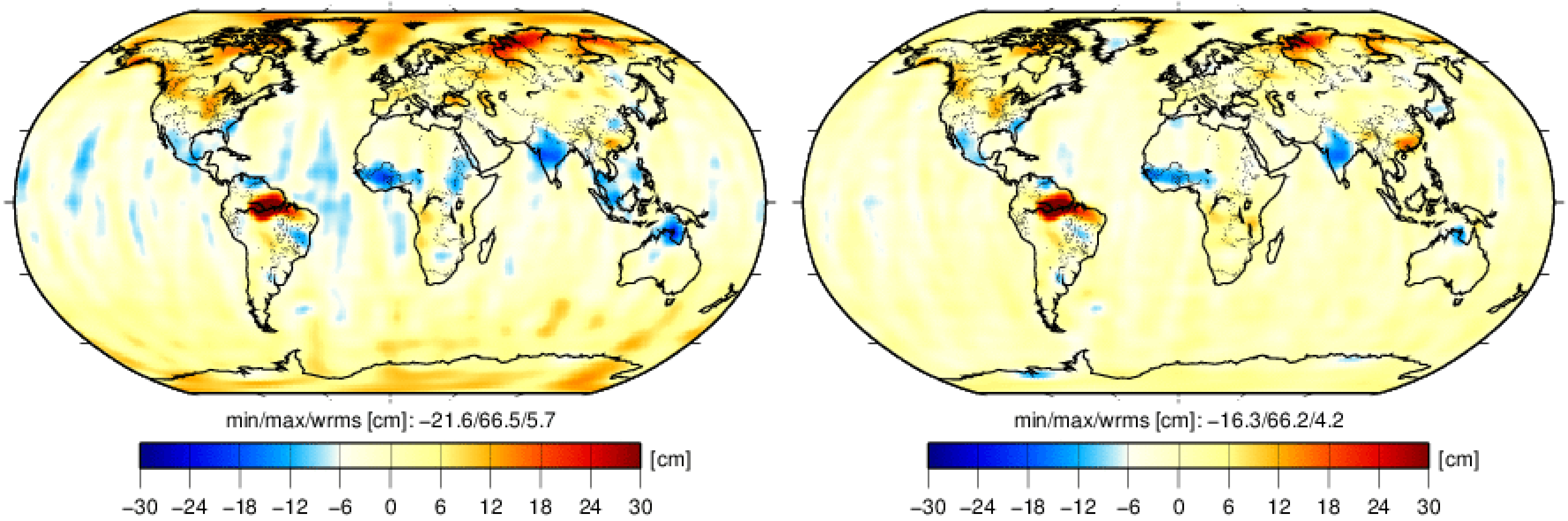
GFZ RL06 prelim.

Level 2 Products at GFZ: RL06 preview

European Gravity Service for Improved Emergency Management

EWH maps wrt. EIGEN-6C4, **DDK3** filtered, C_{20} **NOT** replaced

GFZ RL05a **2008/06** **GFZ RL06 prelim.**



CNES/GRGS gravity field solutions: From RL03-v3 to RL04

Richard Biancale (CNES/GRGS)

OUTLINE:

- Difference between CNES/GRGS RL03-v3 and RL04
- Improvement on the determination of the sectorial coefficients
- Validation of solutions with respect to independent data

From RL03-v3 to RL04

All level 1B (v2) data have been reprocessed from August 2002 to June 2017 with:

- ☐ **Improvement of a priori models**
  - starting from RL03-v2 mean field + annual/semi-annual + drift terms
  - using ITRF-2014 for SLR processing (Lageos1/2, Starlette, Stella)
- ☐ **Revisiting the parameterization**
  - ACC parameter behavior
- ☐ **Modelling**
  - Spherical harmonics extended to degree/order 90
  - Alternative surface mass modelling per 2° square
  - Hybridizing spherical harmonic representation (degree/order <= 25) and surface masses over continents
- ☐ **Stabilization**
  - Constraints on parameters (relative vs. absolute)
  - SVD “soft” truncation

From RL03-v3 to RL04

❑ Accelerometer and empirical parameters

	RL03	RL04
1/rev and 2/rev empirical accelerations along X_{sat} and Y_{sat}	16 sets / day / axis (= 1 set / rev / axis)	0
Accelerometer biases along $(X,Y,Z)_{sat}$	1 bias + 1 drift / day / axis	1 bias / half-rev / axis (= 32 / day / axis)
Accelerometer scale factors along $(X,Y,Z)_{sat}$	1 scale / day / axis	1 scale / day / axis

❑ Geophysical models

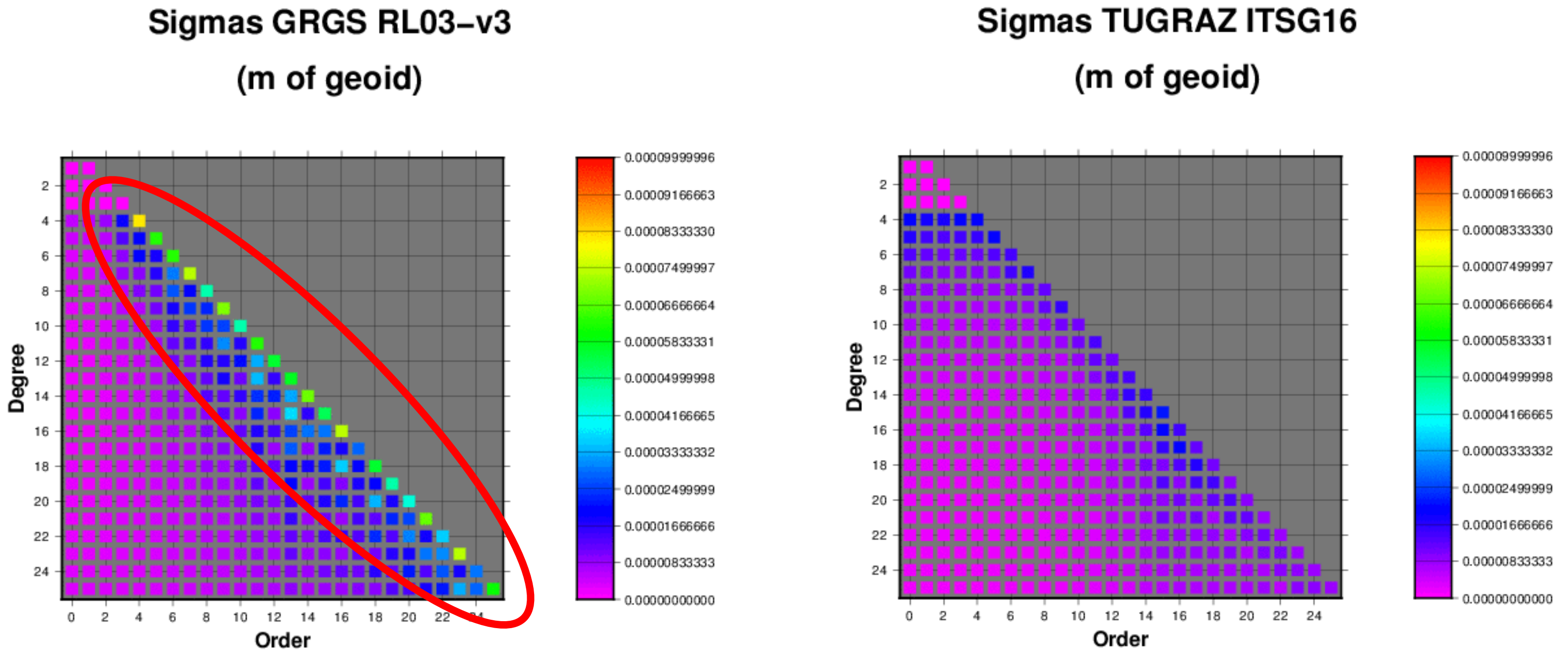
	RL03	RL04
A priori gravity field	Mean model from RL02	Mean model from RL03
Ocean tides	FES2012	FES2014

RL04 standards

GRACE / 1 d-arc	samp-ling (s)	nb of meas./d	bias per	scale per	nb of bias/d	absolute constraint	relative constraint	a priori σ	mean residuals
ACC (m/s^2)	5	~34500	½ rev.	day	192	- 10^{-2}X,10^{-3}YZ	10^{-9}XZ,5.10^{-9}Y	-	-
KBRR (m/s)	5	~17000	½ rev.		64	Bias: 10^{-7} Drift:10^{-11}	10^{-9}	10^{-7}	.16 10^{-6}
GPS (m) range phase	30 30	~43000 ~43000	pass & meas.		ambig. ~700 clock ~6000	10 1000		1 .002	~.5 ~.005
SLR (m) / 5 d-arc	passes / 5 d	meas. / 5 d			nb of range bias / 5 d				
Lageos Lageos2 Starlette Stella	112 93 121 68	~1025 ~935 ~1175 ~550	station “ “ “		~20 (10-30) ~19 (10-30) ~18 (10-25) ~17 (10-25)	~.02	-	~.02	8.4 10^{-3} 8.0 10^{-3} 10.5 10^{-3} 10.4 10^{-3}
GRACE (for validation)	15	~300			~10				2.5 10^{-2}

Improvement on the determination of the sectorial coefficients

- One weakness of the CNES/GRGS unconstrained solutions revealed by EGSIEM was a loose determination of the sectorial coefficients:



(Unconstrained uncertainties of the SH coefficients in November 2007)

Improvement on the determination of the sectorial coefficients

- The information on the sectorial coefficients contained in GRGS normal equations was not wrong, it was weak.

- This didn't pose a problem in EGSIEM
  - For the combination at the normal equations level,
  - Nor for the official RL03 solution, because of the truncated SVD inversion

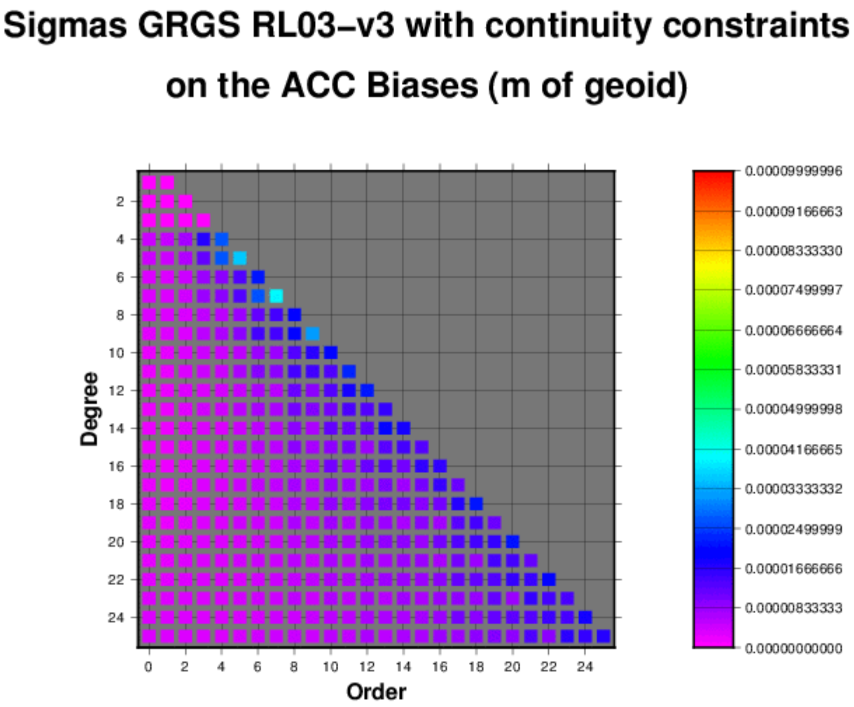
  … but, it was a problem for the combination of the unconstrained solutions.

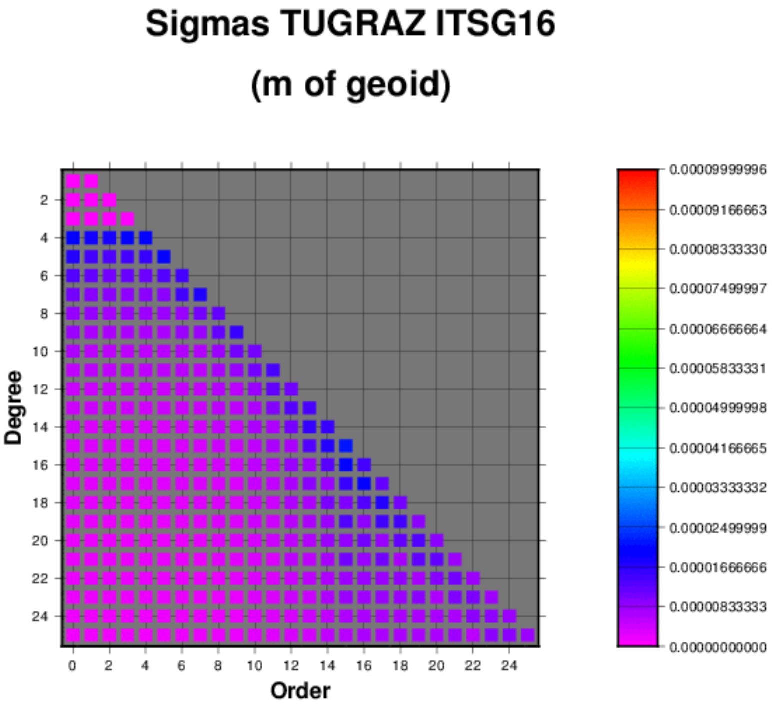
- The origin of this weakness of information comes from a very dense parameterization of the accelerometer biases: one parameter every half-revolution on each axis.

- The problem will be solved by applying a continuity constraint on the accelerometer biases (comparable in some ways to the cubic splines with a node interval of six hours applied by TU Graz).

Improvement on the determination of the sectorial coefficients

- By applying a continuity constraint on the accelerometer biases the uncertainty of the sectorial coefficients is strongly reduced:


Sigmas GRGS RL03–v3 with continuity constraints on the ACC Biases (m of geoid)


Sigmas TUGRAZ ITSG16 (m of geoid)

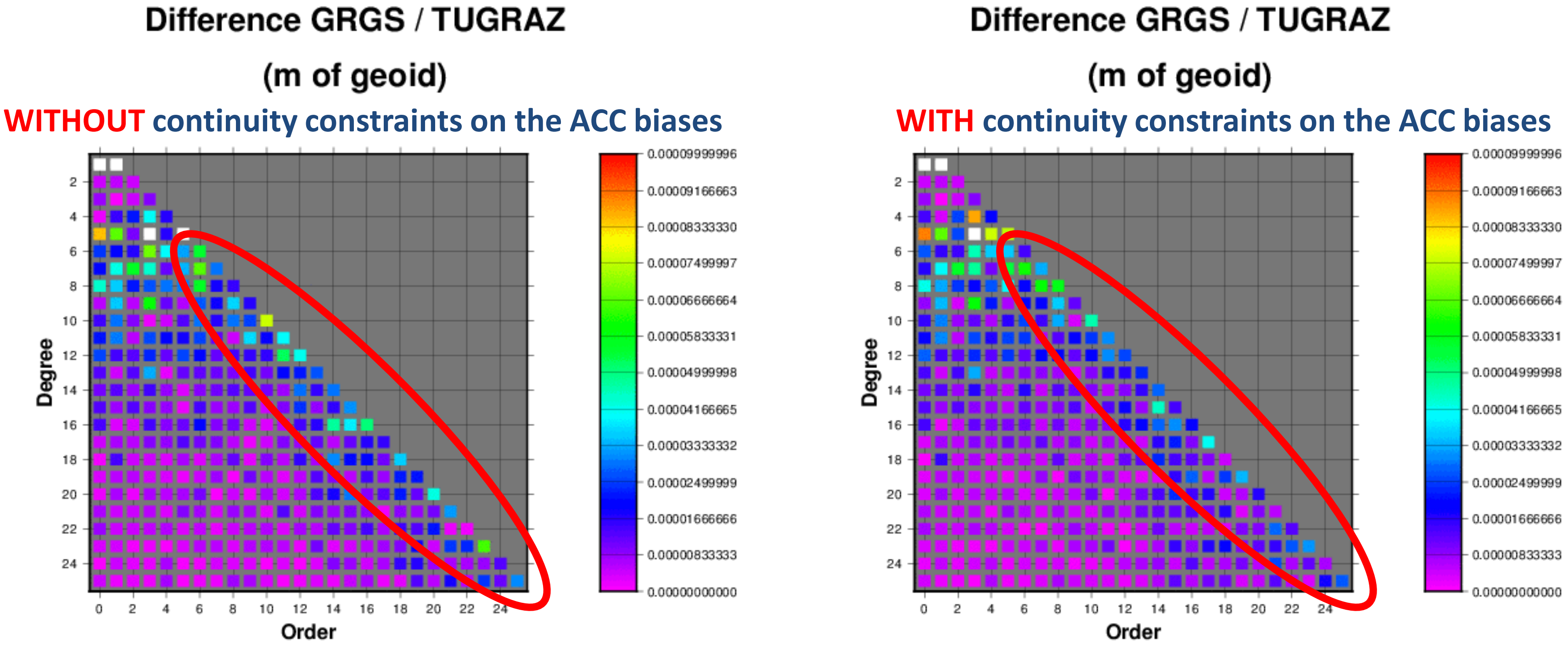
(Unconstrained uncertainties of the SH coefficients in November 2007)

EGSIEM
European Gravity Service for Improved Emergency Management

Horizon2020

Improvement on the determination of the sectorial coefficients

- …and the comparison with TU Graz is improved: the difference GRGS / TU Graz for SH degrees 10-25 is down from 2.3 to 1.9 cm EWH



WITHOUT continuity constraints on the ACC biases

WITH continuity constraints on the ACC biases

(Differences of the SH coefficients in November 2007)

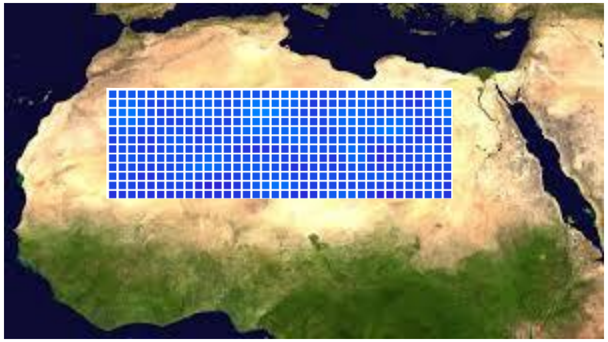
Validation of solutions with respect to independent data

- The assessment of the quality of the GRACE solutions should not only be made on unfiltered solutions, but also on filtered ones.

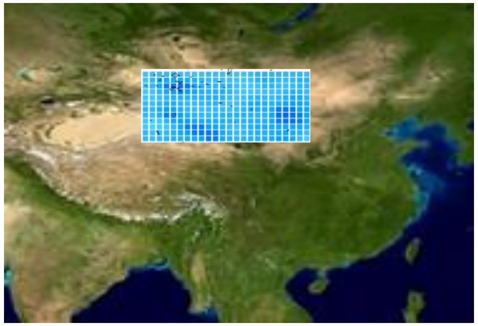
- Two main types of quality control can be made:
  - The assessment of noise, through the measurement of the RMS of the solutions over very quiet areas (deserts, some oceanic domains, Antarctica)
  - The assessment of signal, through comparison with independent data, in particular satellite altimetry.

Assessment of noise

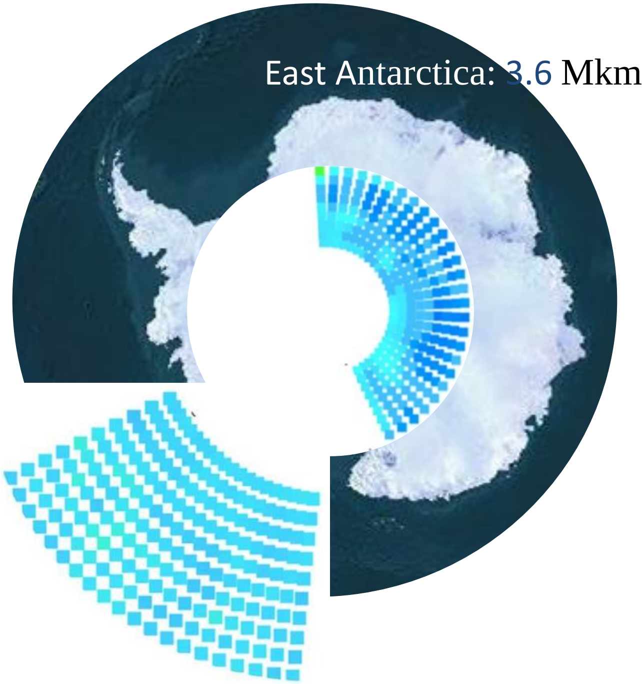
Study areas: Sahara and Gobi deserts, East Antarctica, South Pacific…



Sahara desert: 2.2 Mkm^2



Gobi desert: 1.6 Mkm^2



East Antarctica: 3.6 Mkm^2

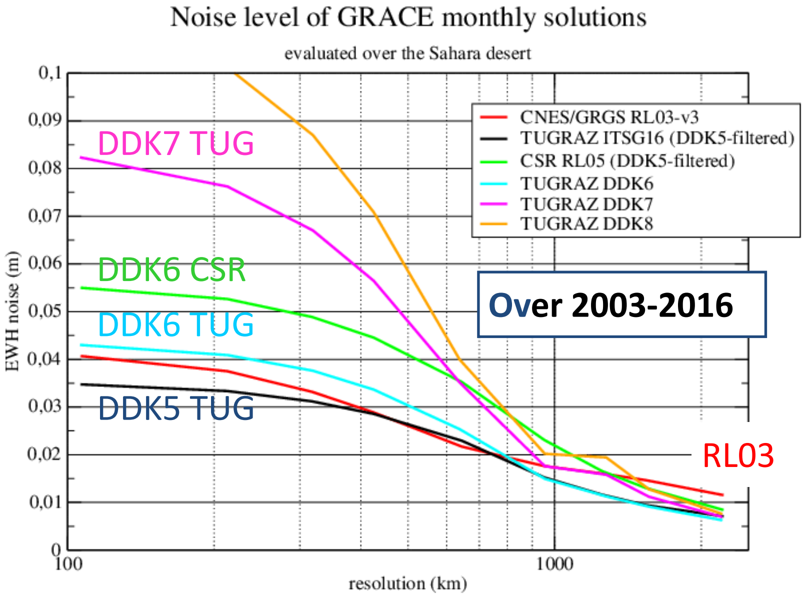
South Pacific 6.7 Mkm^2

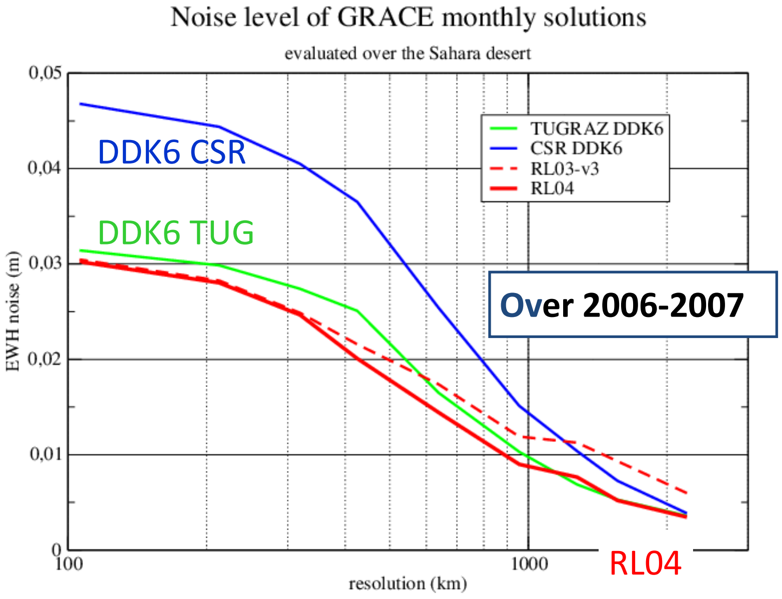
Assessment of noise

Example over the Sahara desert:

By dividing the surface in 2*2 deg. blocs (⬄ degree/order 90), then averaging in blocs of larger size up to 20 deg.*20 deg., an estimate of the noise as a function of the wavelength can be obtained.

Different time-varying gravity models are compared spectrally in this way from 100 km to 2200 km.





Summary

- GRGS-RL04 series improves compared to the previous RL03-v3 series, mainly at the poles and at very long wavelengths
- The origin of the weakness in the determination of the sectorial coefficients has been understood and will be corrected in RL04
- Validation sets of 2 types:
    - over areas with very few gravity signal
    - in comparison with altimetry

  … show a good quality of GRGS solutions
- The new series up to degree/order 90 will be available on grgs.obs-mip.fr as usual

EGSIEM
European Gravity Service for Improved Emergency Management

WP 2: Gravity field reprocessing at AIUB

Uli Meyer

EGSIEM Final Review Meeting

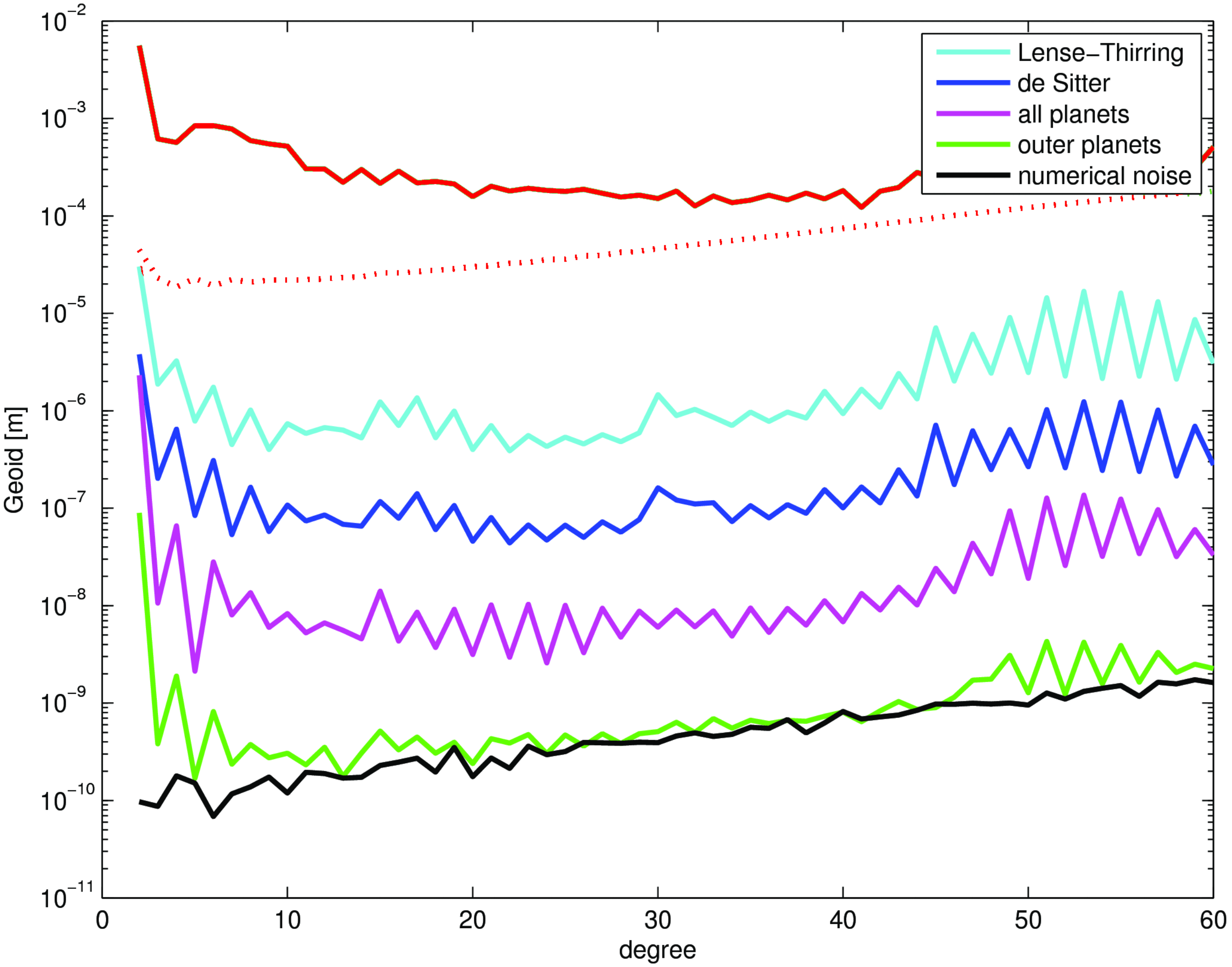
Bern
February 8 / 9th, 2018

Horizon2020

Contents

- Implementation of common EGSIEM standards.
- Use of EGSIEM-REPRO products (=> AS in WP3).
- Impact of screening strategy on monthly gravity solutions.
- Whole mission noise study for
  - GPS phase observations / kinematic orbits,
  - KRR-observations.
- Test of sensor fusion data.

Adaption of standards: relativity and third bodies

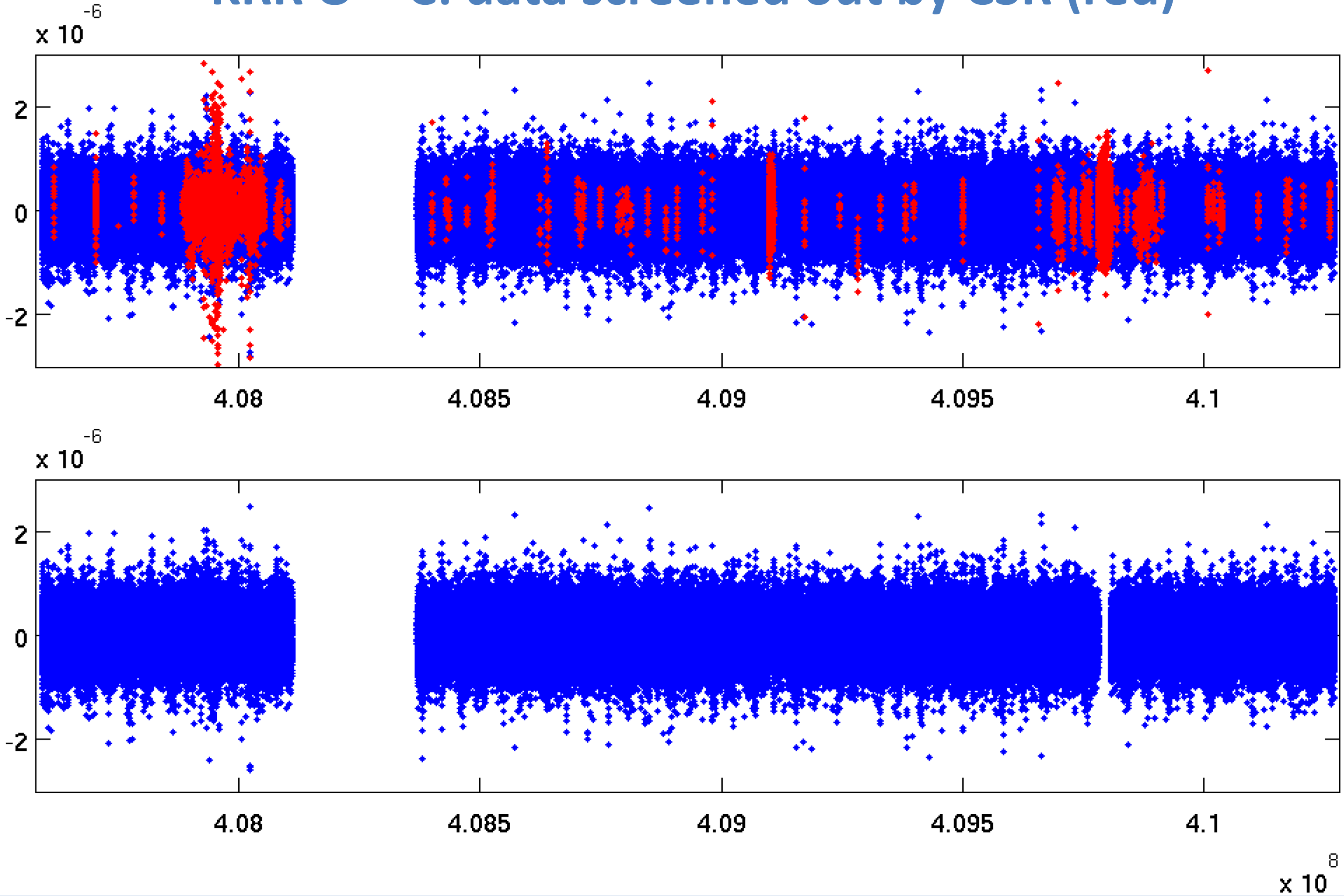


All effects well below level of formal errors.

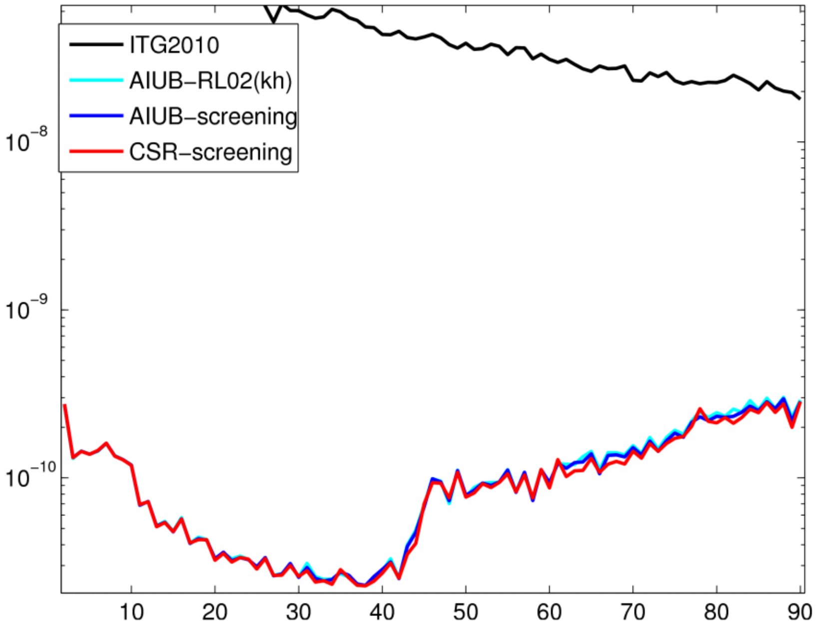
Largest effect: Lense-Thirring (may be visible in degree 2).

Data screening

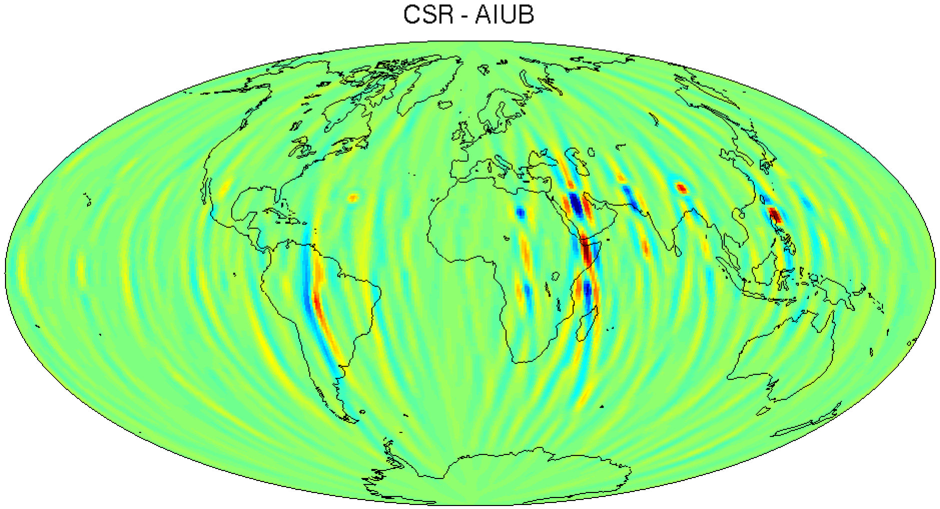
KRR O – C: data screened out by CSR (red)



Effect on gravity field



Differences in degree variances (with respect to ITG-GRACE2010) are small and limited to high orders (> 60).



Differences in equivalent water heights reach 20 cm but are very localized.

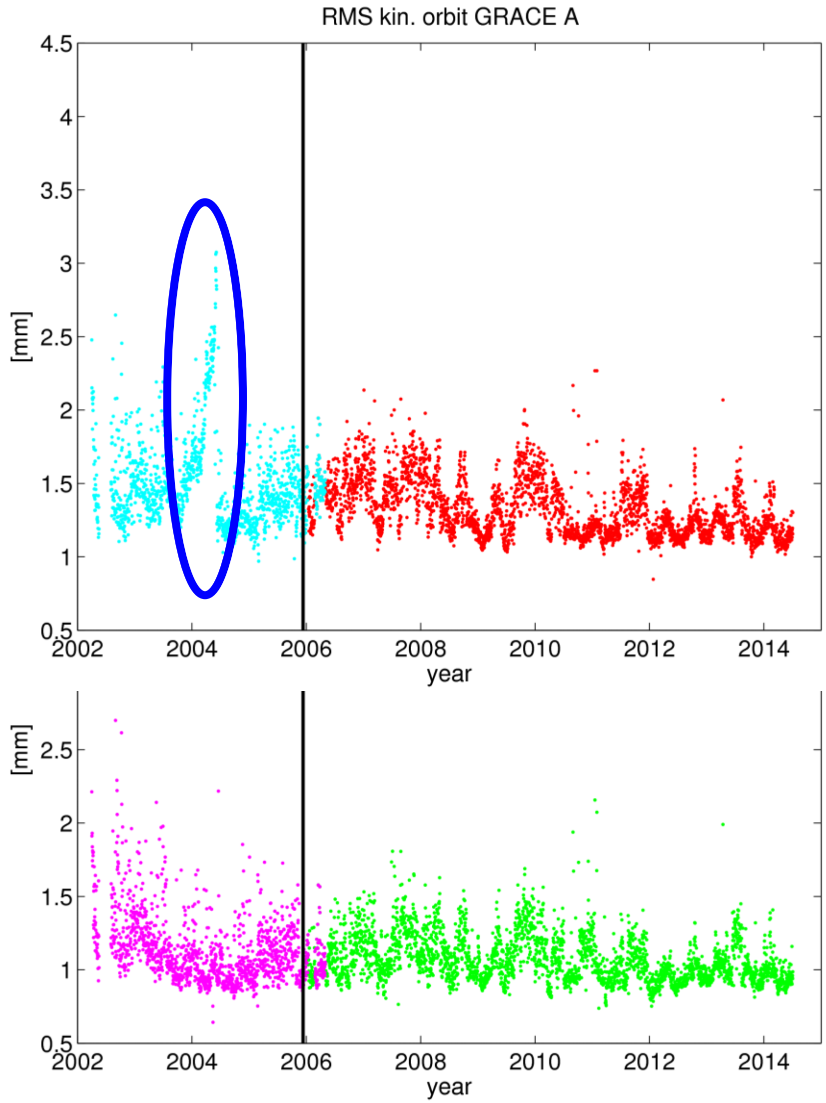
Conclusions: data screening

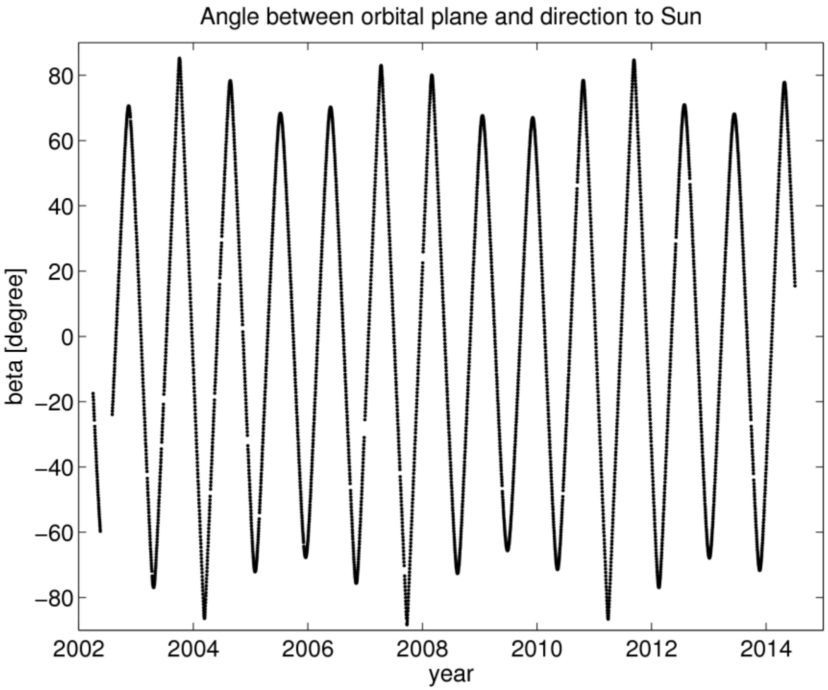
- quite massive (6120 obs / 975810 obs = 0.6%) screening of KRR observations does not hurt the solution ...

- ... neither does it help significantly.

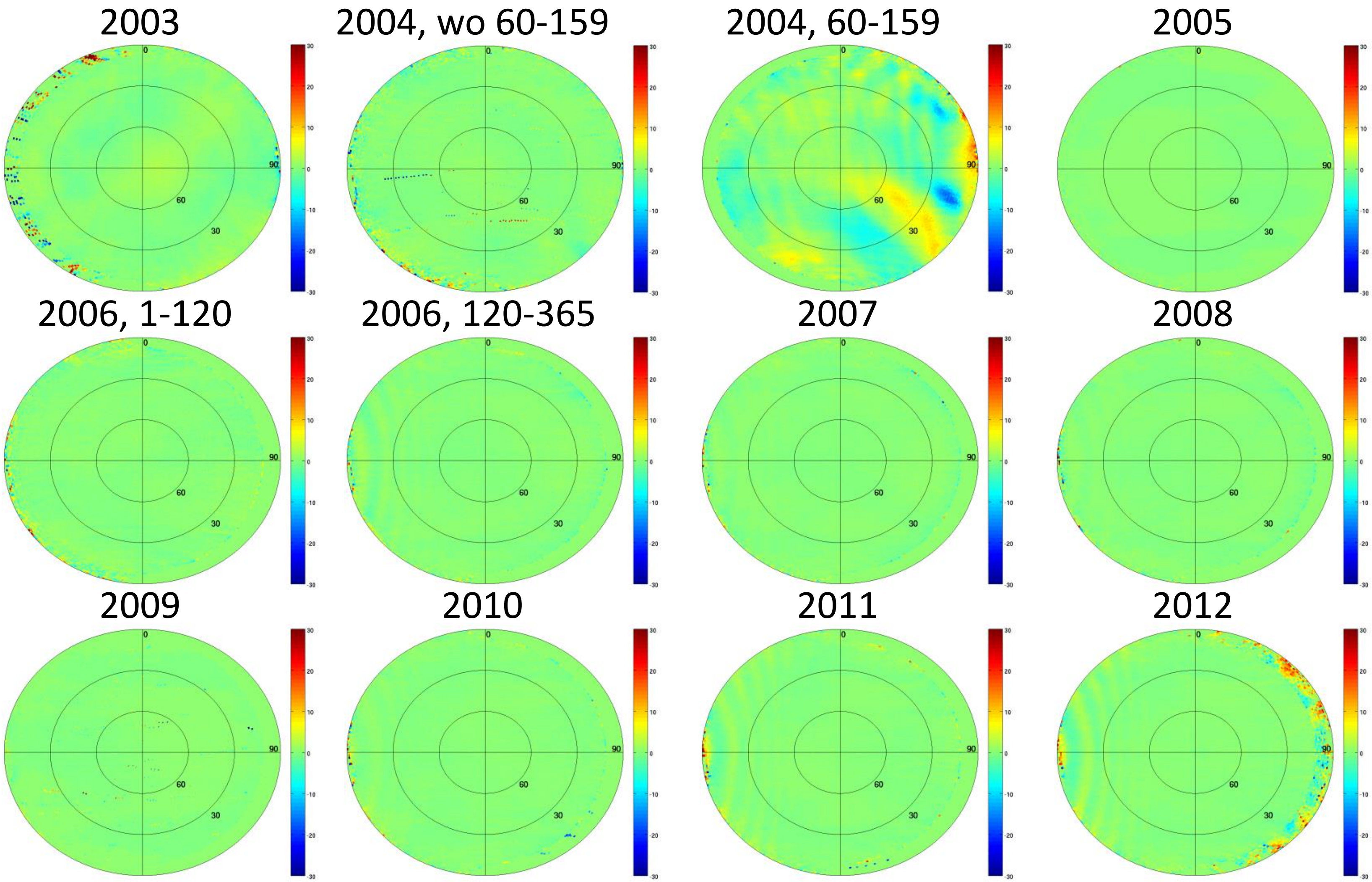
- Largest KRR-residuals remain at
  - summer magnetic pole
  - Micronesia (problem area of ocean tide models)

Noise study: daily RMS of kin. orbits (geometry)





Phase residuals mapped to antenna fixed system



2003

2004, wo 60-159

2004, 60-159

2005

2006, 1-120

2006, 120-365

2007

2008

2009

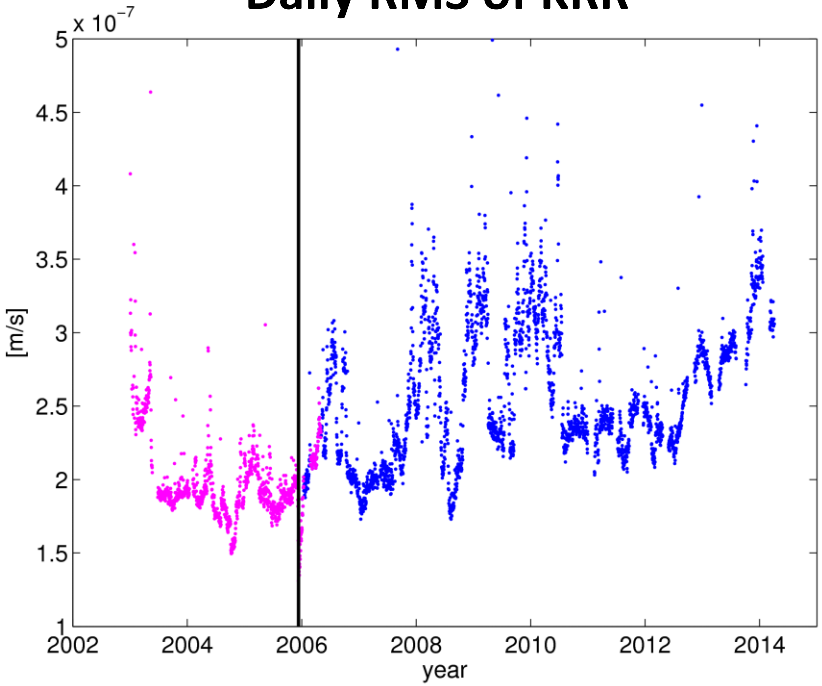
2010

2011

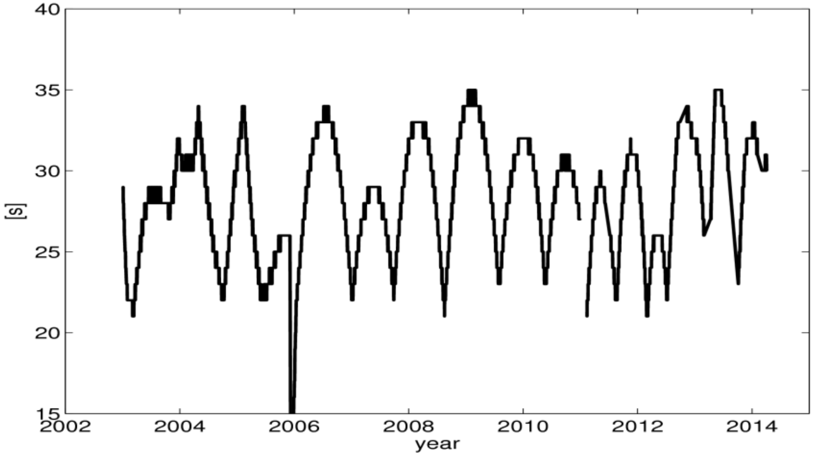
2012

Noise study: KRR-residuals (geometry + background model)

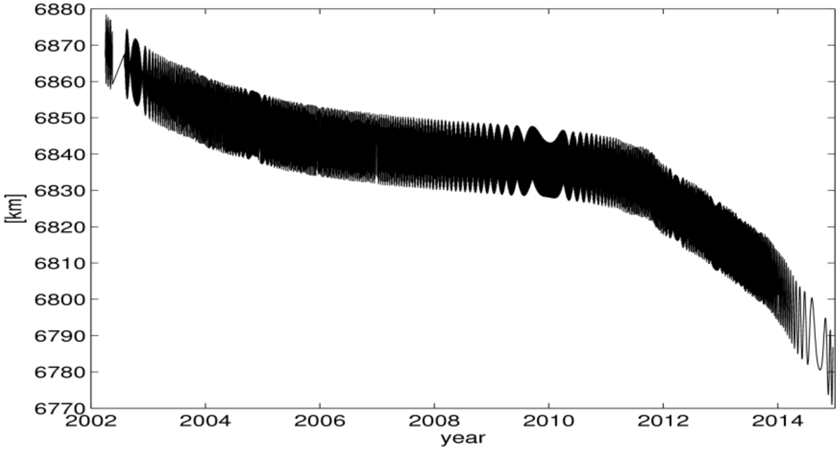
Daily RMS of KRR



Inter-satellite distance



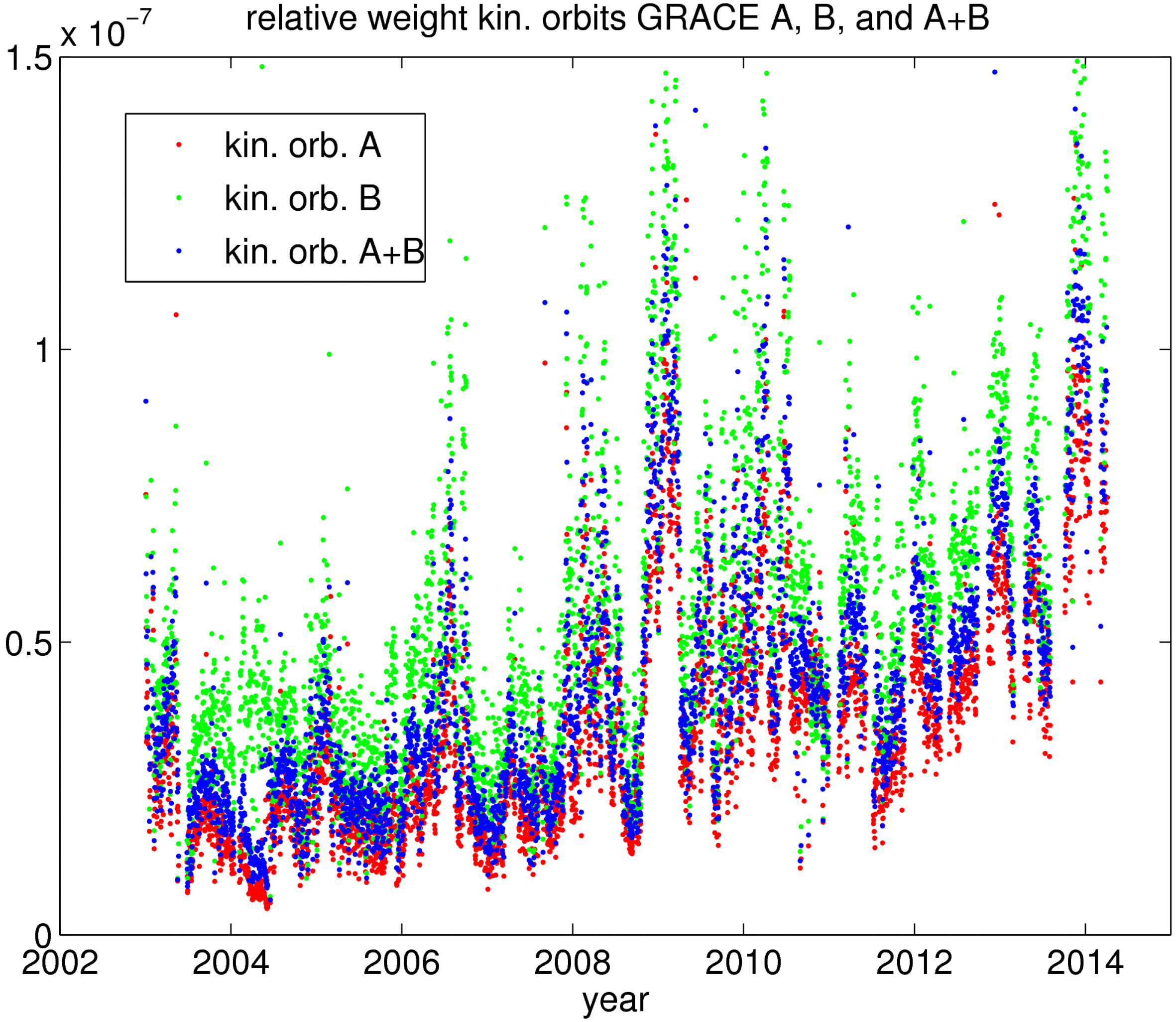
Semimajor axis (GRACE A)



Theoretical relative weights kin. orbits / KRR

$$W = \sigma^2_{krr} / \sigma^2_{kin.\ orb.}$$

Empirical: 1e-10


relative weight kin. orbits GRACE A, B, and A+B

Conclusions: noise study

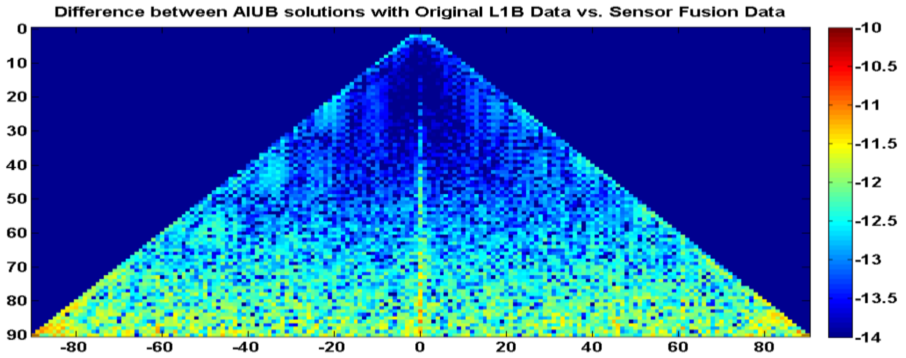
- RMS kin. orbit GRACE A: 1.5 – 1.2 mm,
  GRACE B: 1.3 – 1.0 mm
    - correlation with beta-angle (Sun)
- RMS of KRR residuals: 0.2 – 0.3 µm/s
    - correlation with inter-satellite distance
    - correlation with satellite elevation

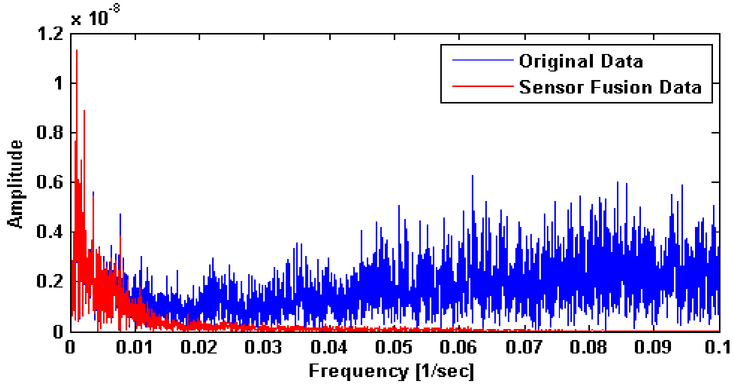
⇒ constant relative weight not appropriate

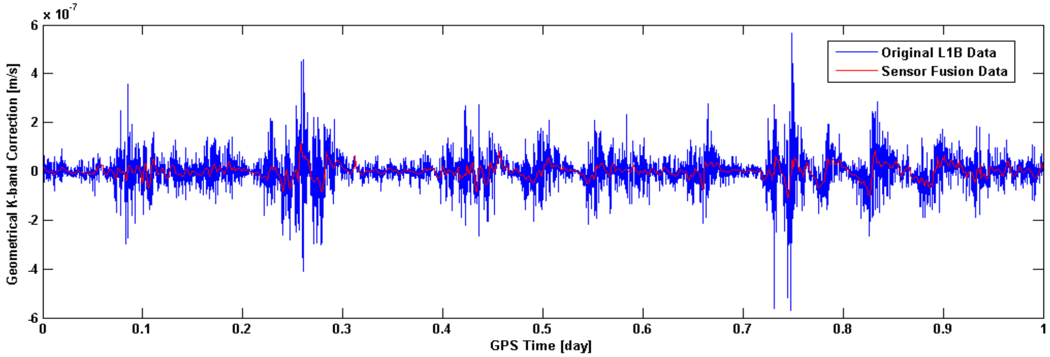
But: empirically derived optimal weight is signifficantly different from theoretical weights.

Sensor Fusion Data (1/2)

- Test period: January 2007
- processing method: CMA (AIUB)
  - Case 1: original L1B
  - Case 2: ITSG sensor fusion



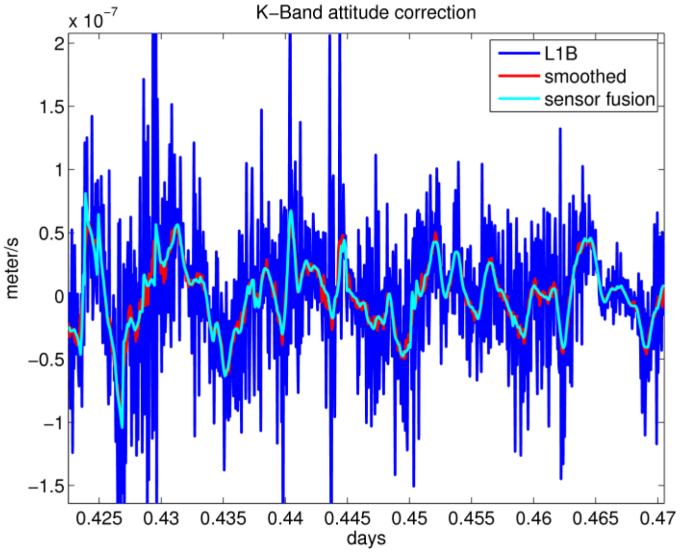


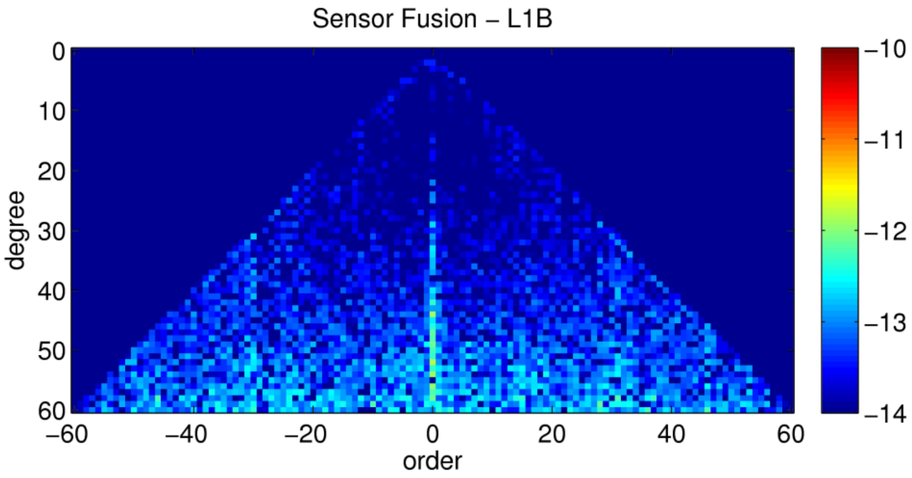


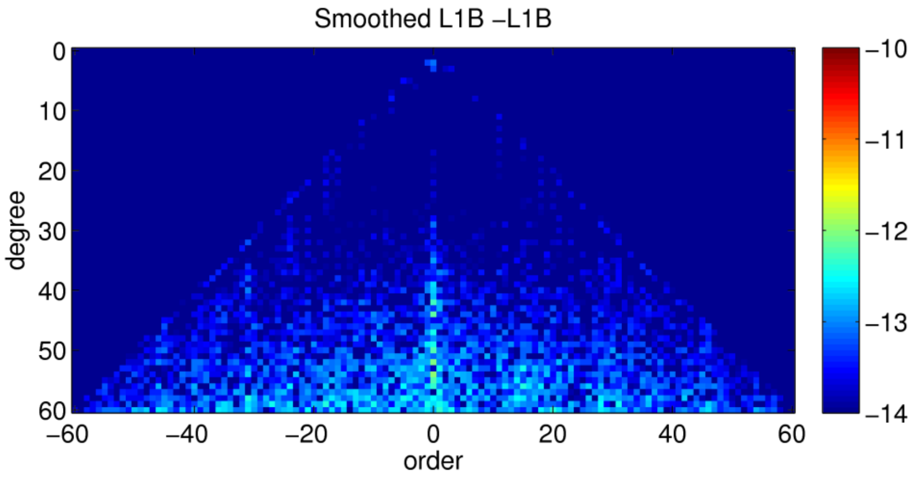
Sensor Fusion Data (2/2)

Main effect of sensor fusion data: smoothing of geometric K-Band correction.

Conclusion: May be replaced by low-pass filtered L1B geometric K-Band correction.


K–Band attitude correction

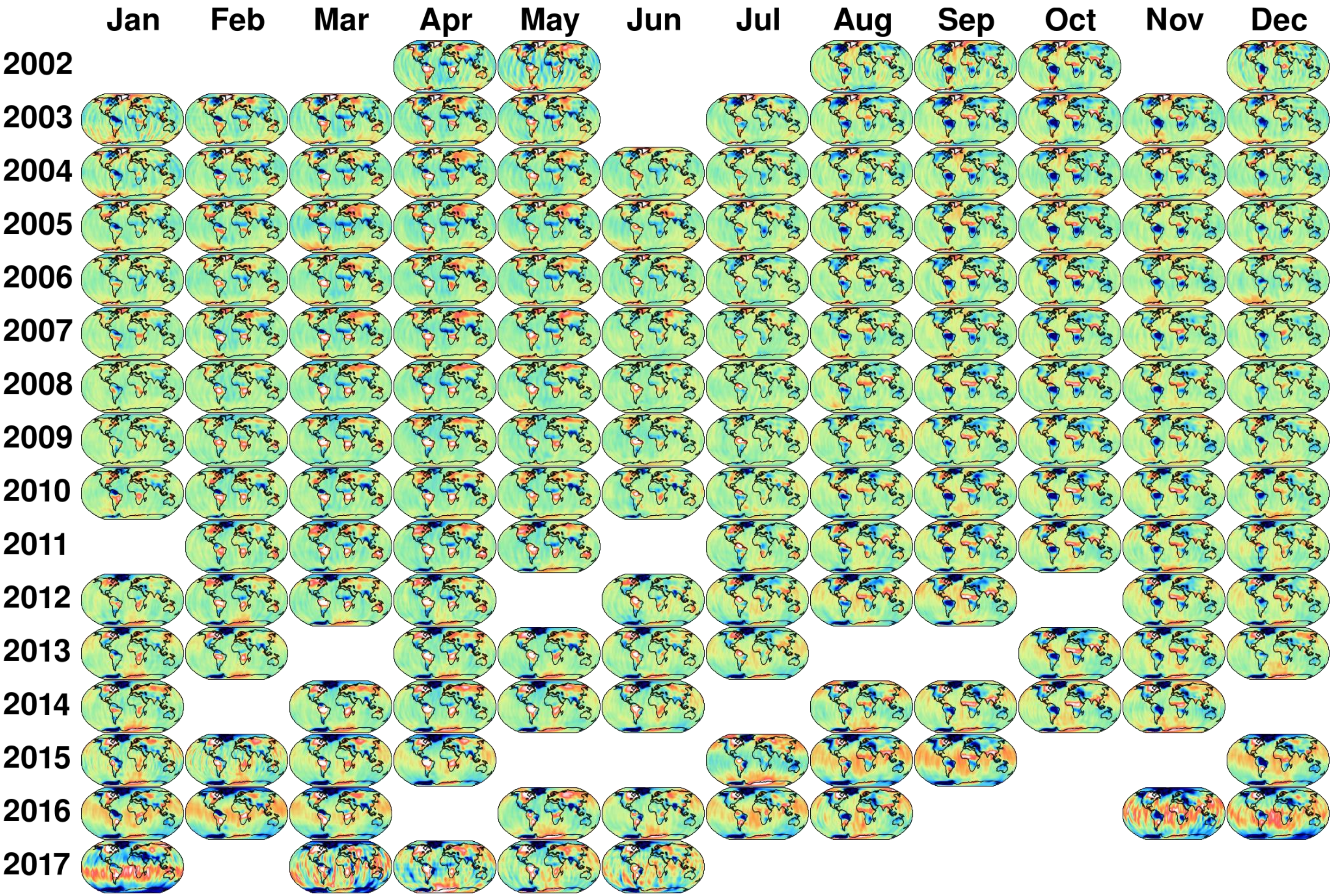

Sensor Fusion – L1B


Smoothed L1B –L1B

ITSG-GRACE processing at TUG

Beate Klinger (TUG)

ITSG-Grace2016



ITSG-Grace2016

- **161 monthly solutions**: covering the whole GRACE period from 2002-04 to 2017-06

Input:

- GRACE Level-1B data (2002-04 to 2017-06)
- ITSG orbit product (Zehentner et al., 2015)
- Improved satellite attitude (Klinger et al., 2014)

Output - Unconstrained monthly solutions:

- Degree 60, 90, 120
- Full normal equations in SINEX format

⇒ **EGSIEM:** 2006 & 2007 of ITSG-Grace2016 used as input for WP4

Future release – ITSG-Grace 2018:

- In progress. First results will be published in April 2018 (EGU).

ITSG-Grace2016: Processing details

Improvements within the processing chain since ITSG-Grace2014:

- Updated background models
- Fully-automated instrument data screening
- Improved accelerometer data calibration*
- Improved numerical orbit integration**
- Improved covariance function estimation
- Co-estimation of constrained daily variations: constraints based on improved error estimates for the dealiasing models

[*] Klinger, B. and Mayer-Gürr, T. (2016). The role of accelerometer data calibration within GRACE gravity field recovery: Results from ITSG-Grace2016. Advances in Space Research 58, 1597–1609. DOI: 10.1016/j.asr.2016.08.007.

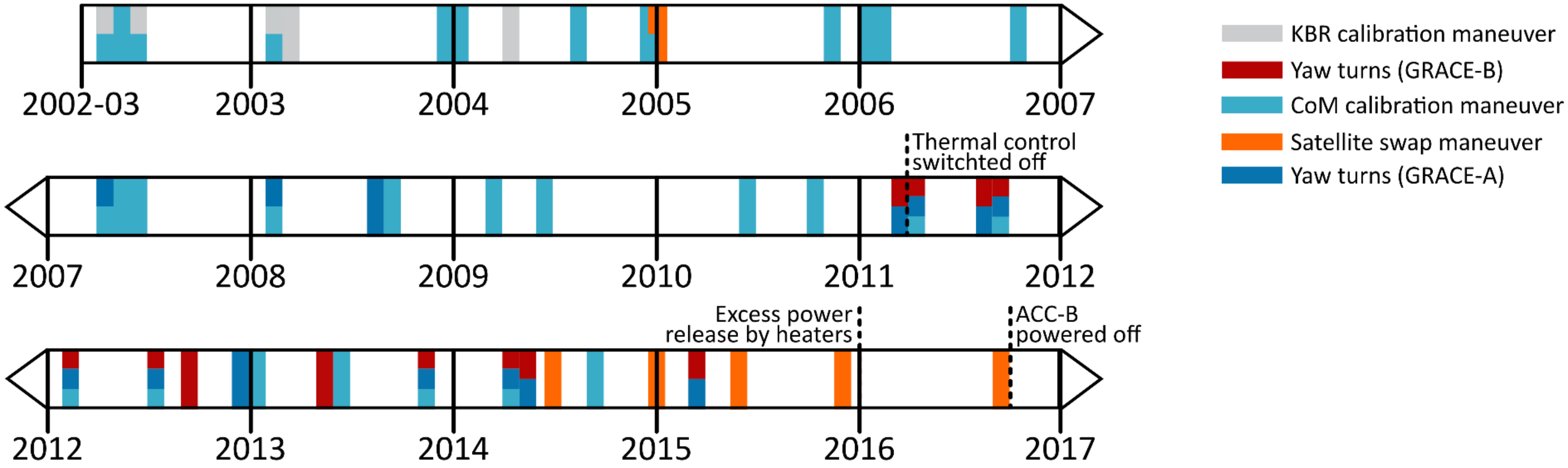
[**] Ellmer, M. and Mayer-Gürr, T. (2017). High precision dynamic orbit integration for spaceborne gravimetry in view of GRACE Follow-on. Advances in Space Research 60 (1), 1 –13. DOI: 10.1016/j.asr.2017.04.015.

Data screening

- Detect outliers within Level-1B data products
- Identify periods of possibly anomalous data quality

Outlier detection:

1) Threshold-based outlier detection
2) Exclusion of CoM and KBR calibration maneuvers (SoE file)
3) Detection of periods around yaw turns with non-nominal attitude characteristics



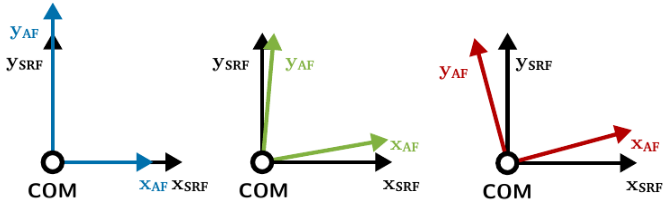
Accelerometer data calibration

Estimation of accelerometer bias & scale factors:

- Two-step approach: a-priori calibration for data screening
- Calibration equation: $\mathbf{a}_{\mathrm{cal}} = \underline{\mathbf{S}}\,\mathbf{a}_{\mathrm{obs}} + \underline{\mathbf{b}}$

$$\text{with } \mathbf{S} = \begin{bmatrix} s_x & \alpha + \zeta & \beta - \epsilon \\ \alpha - \zeta & s_y & \gamma + \delta \\ \beta + \epsilon & \gamma - \delta & s_z \end{bmatrix}$$

- **Main-diagonal elements**
- **Shear parameter (cross-talk)**
- **Rotation parameter (misalignment)**



(1) Bias:

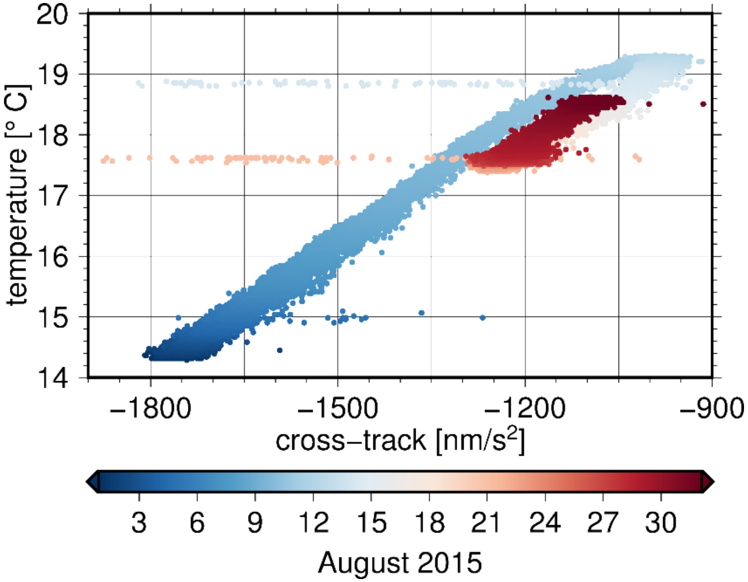
- Estimation: once per day
- Parameterization: uniform cubic basis splines (UCBS), with a 6h knot interval

(2) Scale factors:

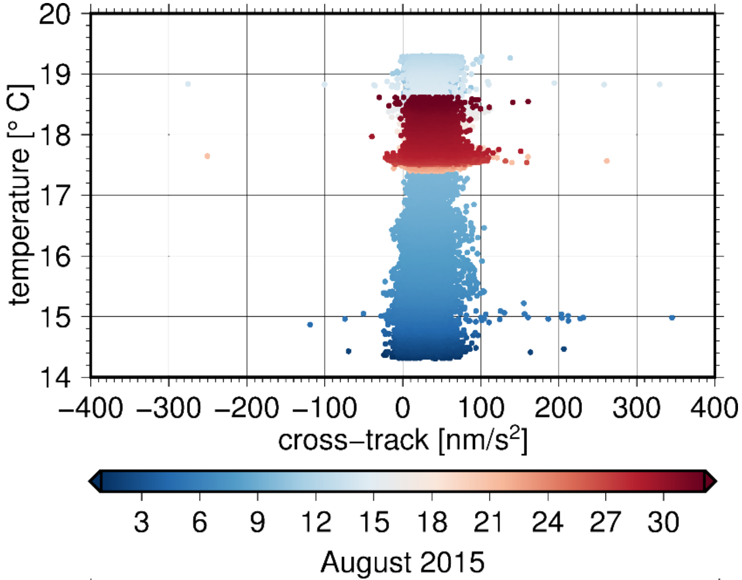
- Estimation: once per day
- Parametrization: fully-populated scale factor matrix

Accelerometer data – Temperature dependency

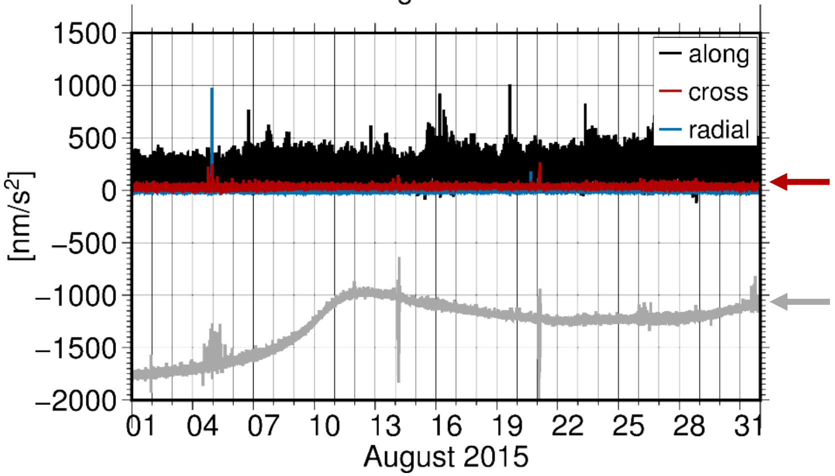
Before - Uncalibrated



After - Calibrated



- Accelerometer data calibration approach successfully reduces temperature-related bias drifts!
- Since April 2011 active thermal control switched off, i.e. periodically reoccurring temperature variations.



After

Before

EGSIEM

European Gravity Service for Improved Emergency Management

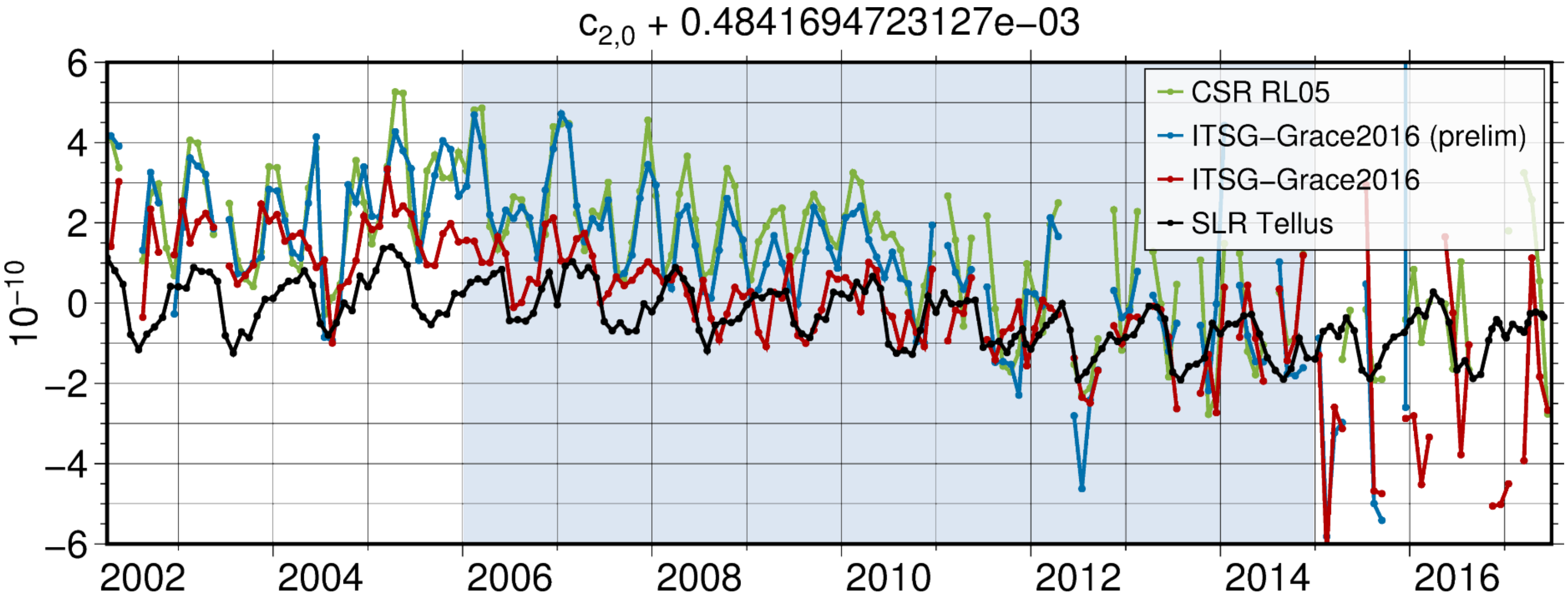
EGSIEM Meeting Bern,
08.02.2018 – 09.02.2018

Horizon2020

Accelerometer scale factor matrix - C20 estimates

- Parameterization using a fully-populated scale factor matrix significantly reduces the offset w.r.t Satellite Laser Ranging (SLR) ⇒ C20 does not necesserily need to be replaced!

- **ITSG-Grace2016 (prelim): main-diagonal elements only**
- **ITSG-Grace2016: fully-populated scale factor matrix**



European Gravity Service for Improved Emergency Management

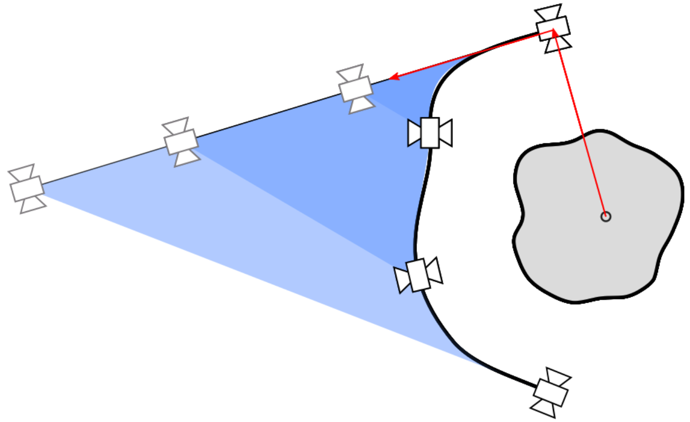
Horizon2020

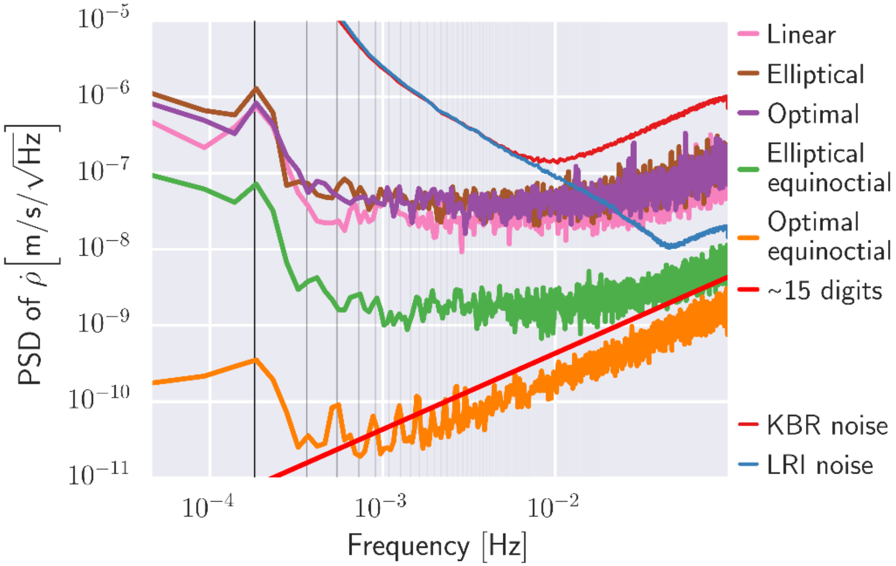
Numerical orbit integration

Modified Encke's method:

- Improved force model integration for dynamic orbit computation using equinoctial elements
- Improved stability of numeric orbit integration
- Reduced processing artifacts in adjusted SST observations and residuals

⇒ Important for GRACE-FO!!

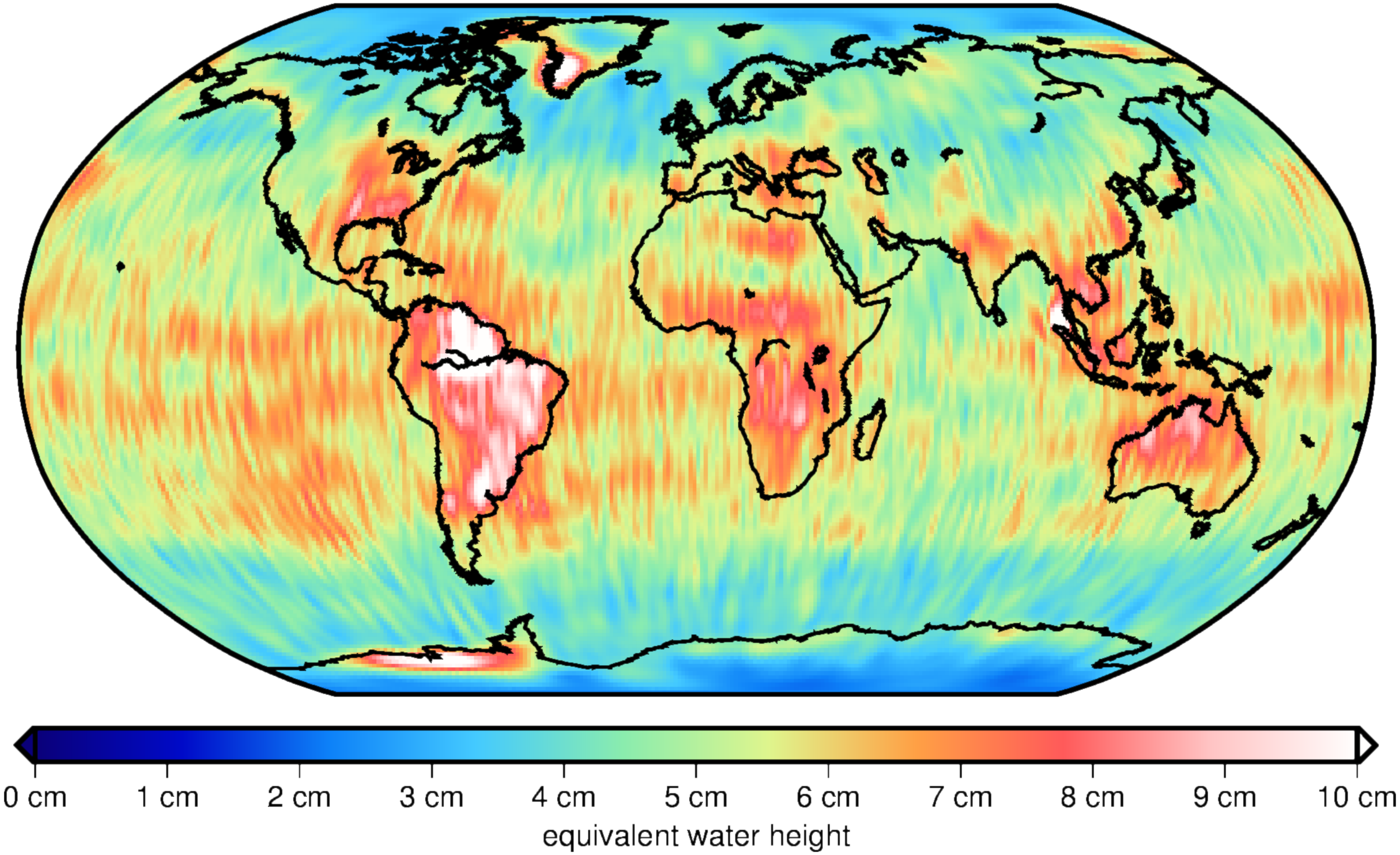




Temporal RMS

CSR RL05 - trend/SA/SSA (Gauß 300km)

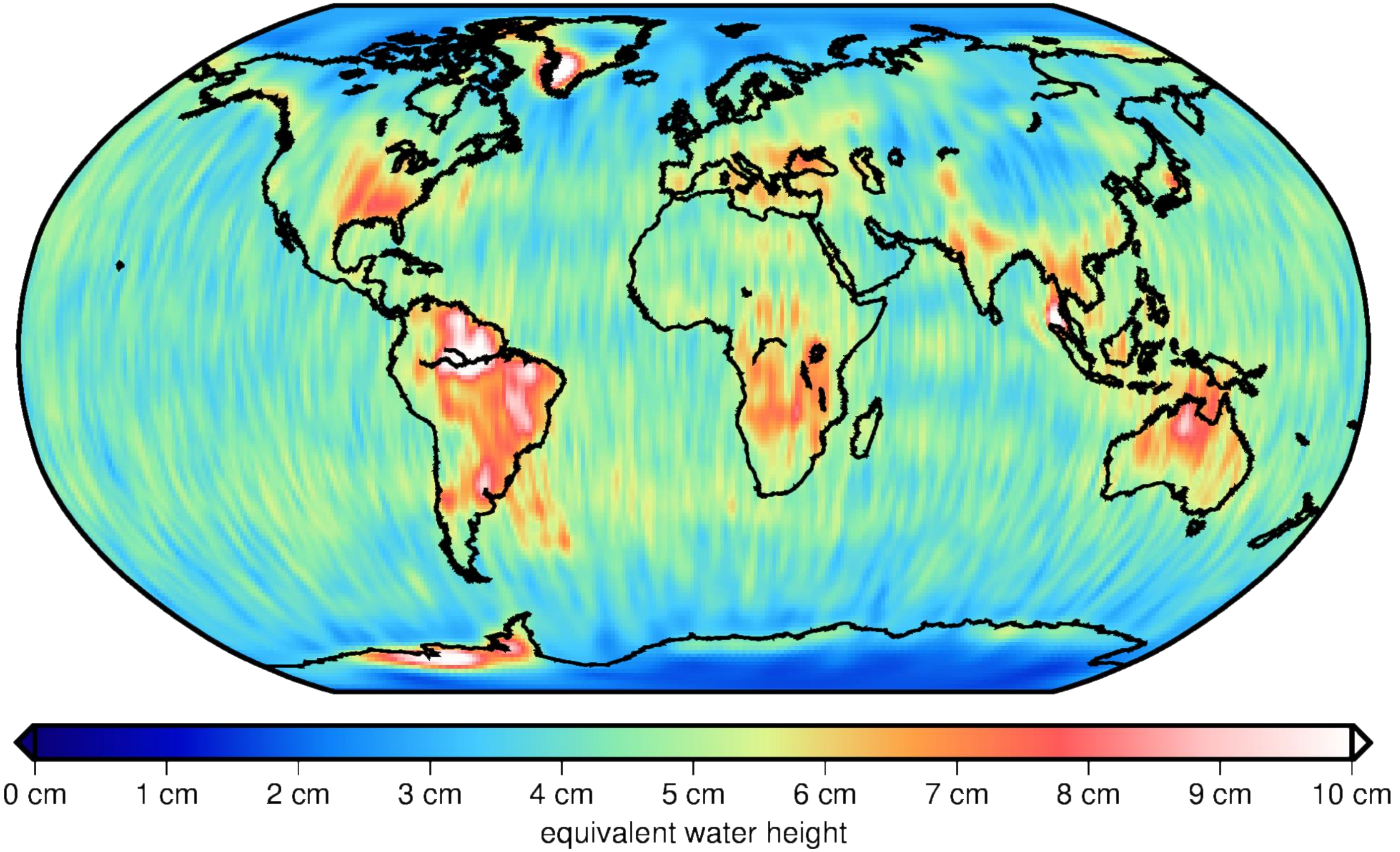
RMS = 5.5901



Temporal RMS

ITSG-Grace2014 - trend/SA/SSA (Gauß 300km)

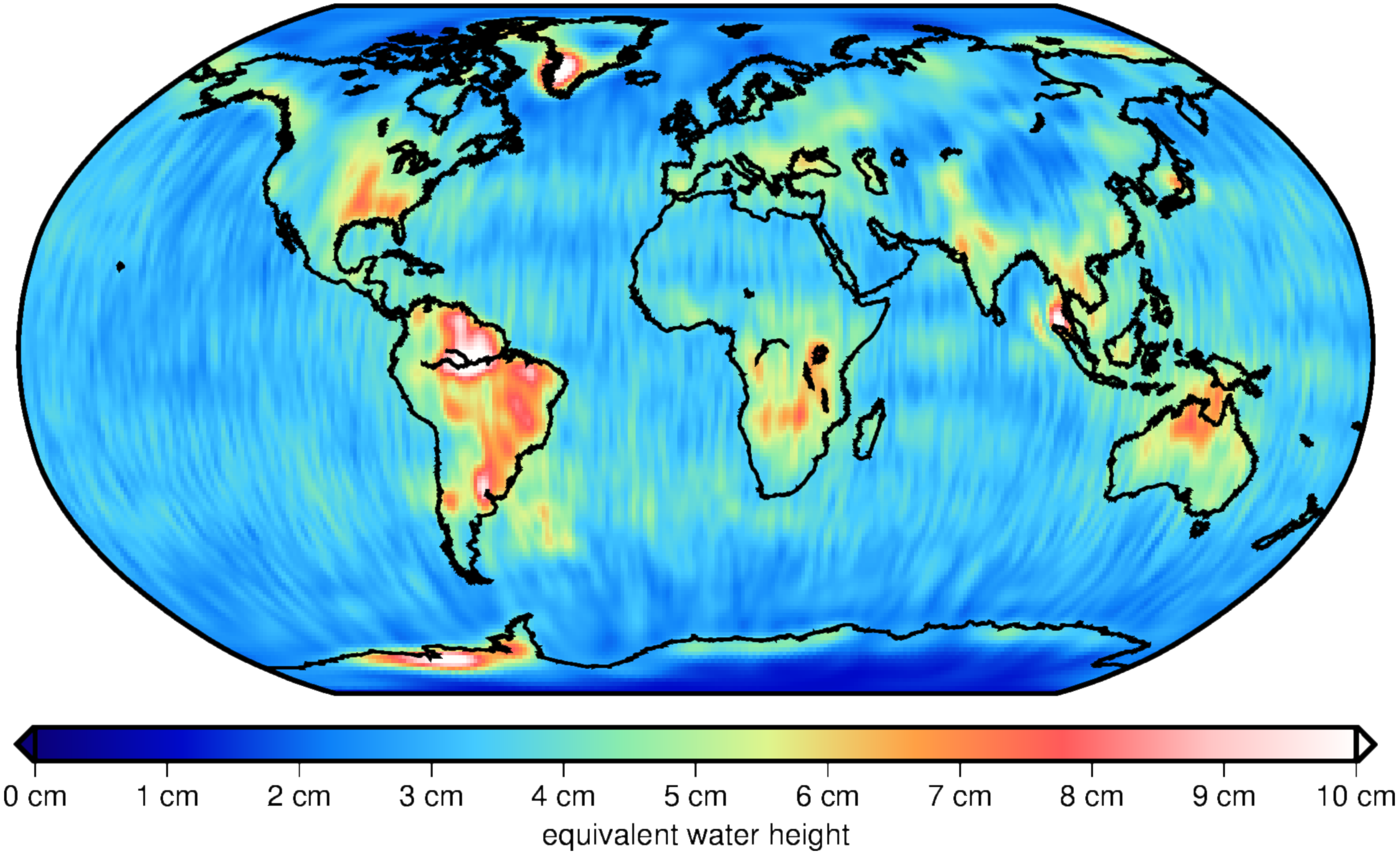
RMS = 4.6011



Temporal RMS

ITSG-Grace2016 - trend/SA/SSA (Gauß 300km)

RMS = 3.7209



ITSG-Grace2016: Summary

- Improved processing contributes to overall accuracy of monthly gravity field solutions
- Noise reduction w.r.t ITSG-Grace2014 (predecessor) in the order of
    - 20% for n = 15-25
    - 40% for n = 25-40
    - 25% for n = 40-90 (Horwath et al., 2016)
- Fully-populated scale factor matrix significantly improves C20 coefficients

ITSG-Grace2016 Release publicly available at:

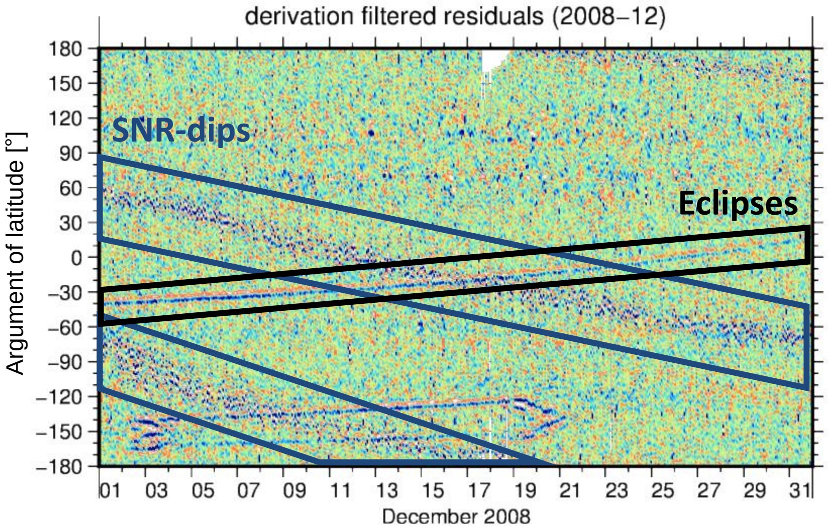
- ifg.tugraz.at/ITSG-Grace2016

ITSG-Grace2018: Preview

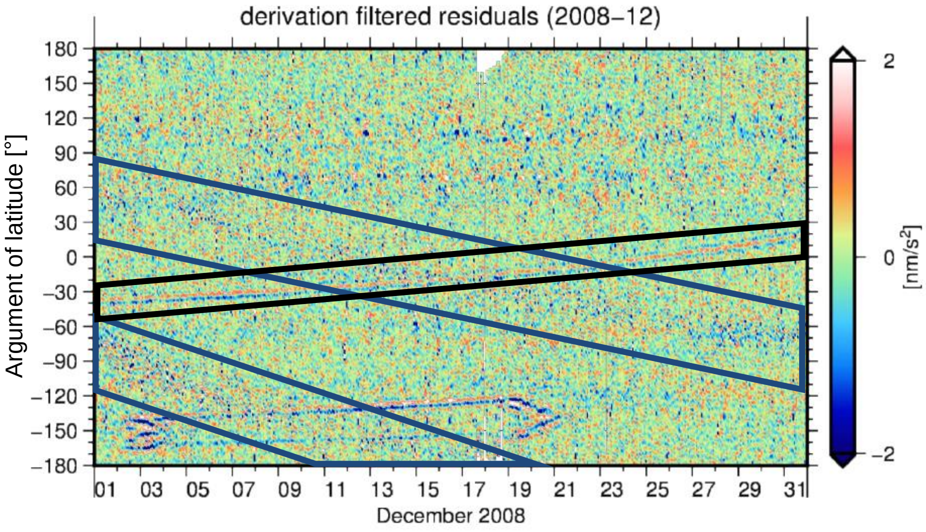
Improvements within the processing chain since ITSG-Grace2016:

- Updated background models: AOD1B RL06, FES2014
- Co-estimation of tides
- Stochastic modeling of satellite orientation measurements
- Co-estimation of KBR bias parameters

Before – No bias parameter

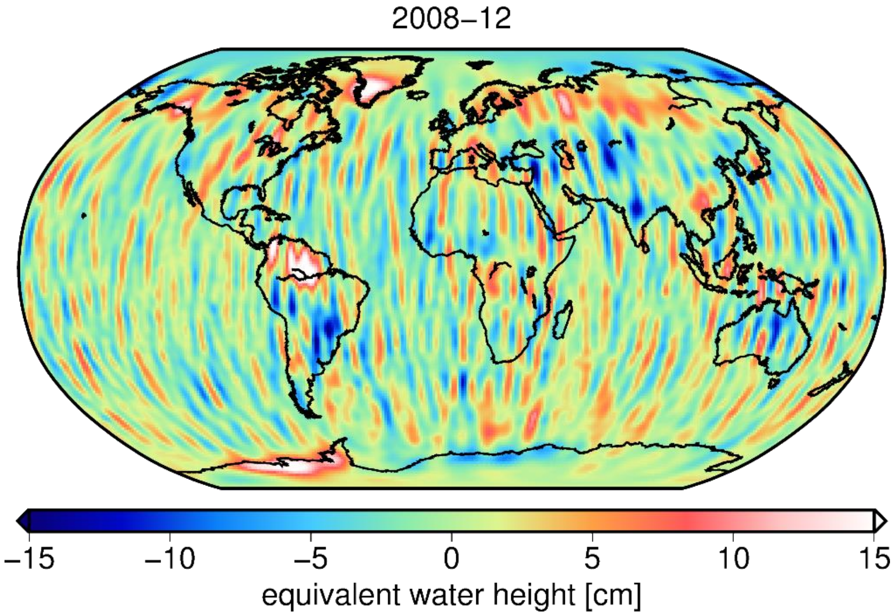


After – EF & SNR bias parameters

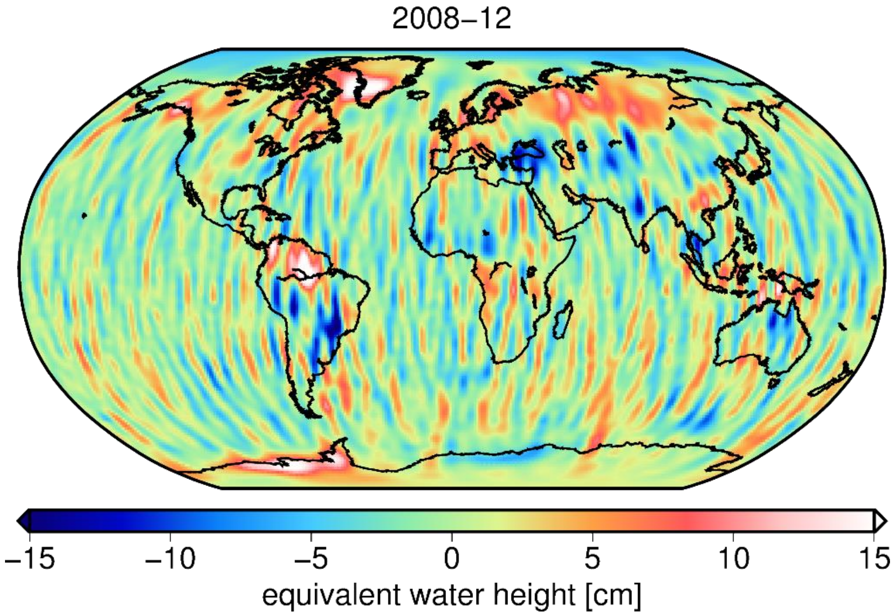


ITSG-Grace2018: Preview

ITSG-Grace2016
EWH w.r.t GOCO05s (Gauß 300 km)

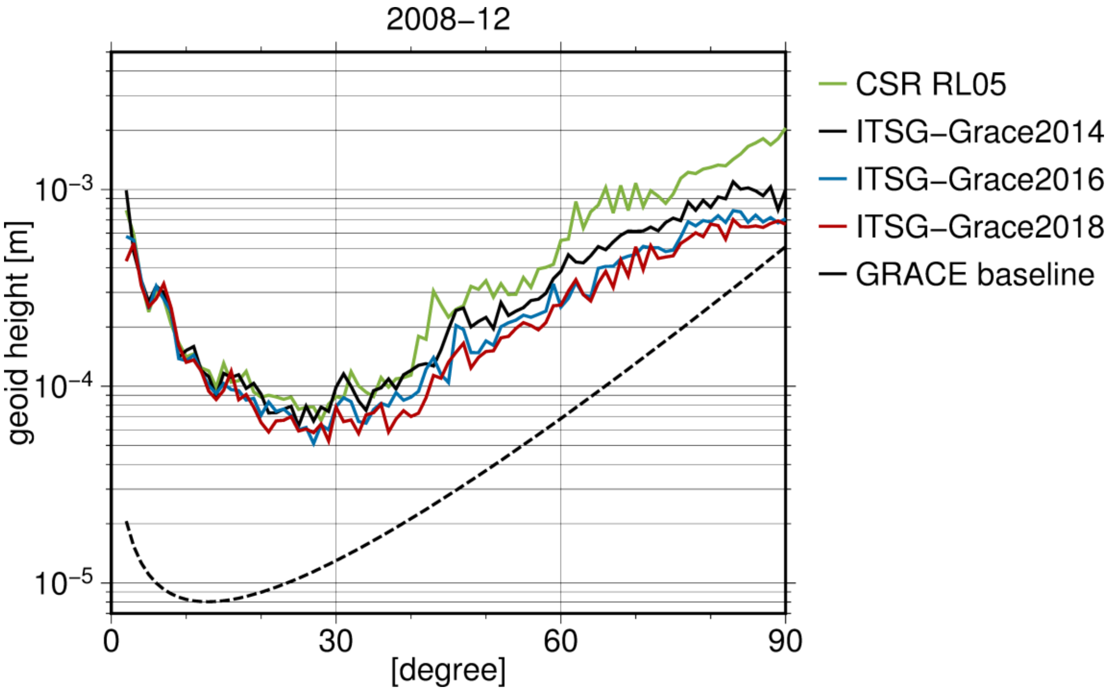


ITSG-Grace2018
EWH w.r.t GOCO05s (Gauß 300 km)



ITSG-Grace2018: Preview

Degree amplitudes w.r.t GOCO05s



⇒ Preliminary ITSG-Grace2018 Release will be presented in April 2018 at the EGU General Assembly!!

EGSIEM

European Gravity Service for Improved Emergency Management

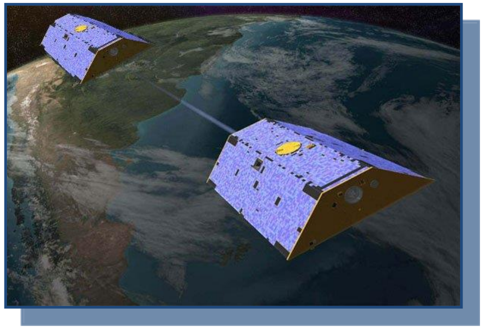
WP2: Gravity field analysis

Torsten Mayer-Gürr and all Analysis Centers

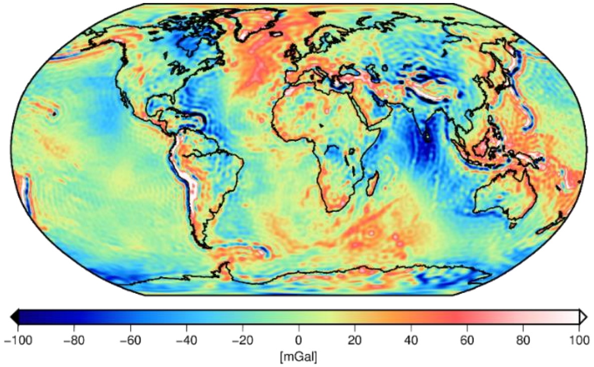
EGSIEM Final Meeting, AIUB, Bern, Switzerland

Feb 8-9, 2018

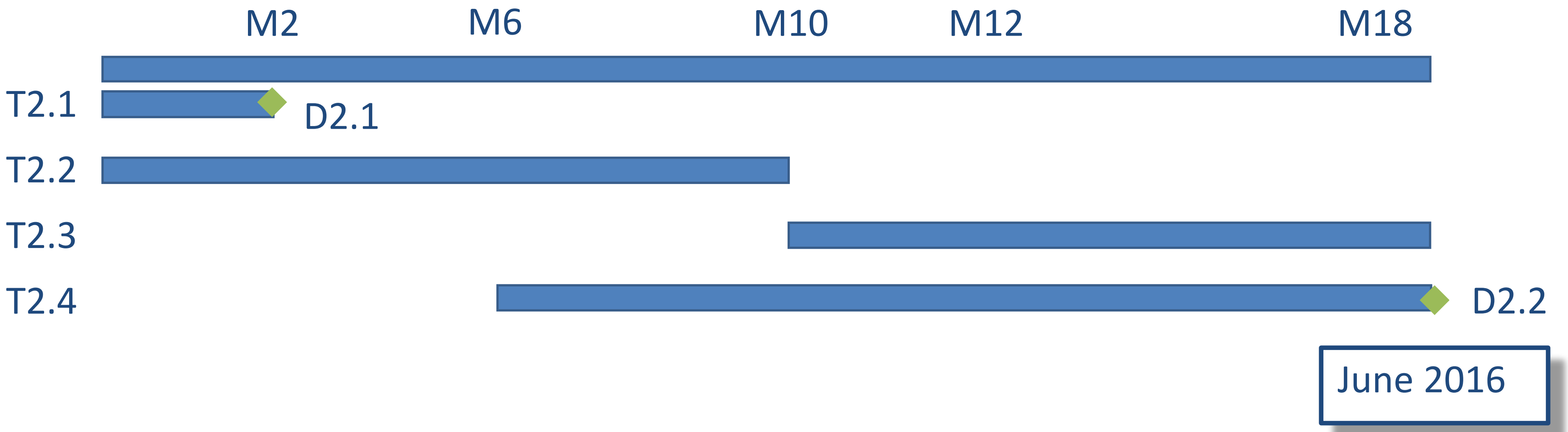
Summary



- Common processing standards harmonize the results
- The regularly exchange of ideas and data in EGSIEM has helped all centers to improve the solutions (The discussions in WP2 during each meeting breaks the time table every time)
- All processing centers delivered at least two years of reprocessed monthly solutions and additionally the normal equations in SINEX format
- Although the WP was closed in June 2016 the efforts in improving the solutions are still ongoing and will in future
- Waiting for GRACE-FO …



WP2 Gravity field analysis – Time Table



T2.1 Processing Standards and Models

T2.2 Improved processing tools

T2.3 Data analysis

T2.4 Instrumental behavior and End-to-end Simulator