

COST-G: Status and recent developments

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GGHS 2022

12 – 14 September 2022, Austin, Texas



Introduction

Gravity and geoid metadata

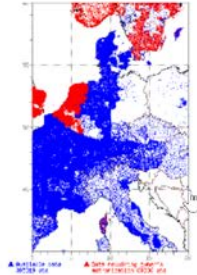
Online applications for the creation of metadata for gravity and geoid data. Service for searching the metadata database.

g- μ eta
the gravity metadata editor
(v0.2.6 - beta edition)

N- μ eta
the geoid metadata editor
(v0.1.3 - alpha edition)

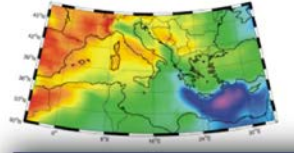
Gravity data

Land, marine, airborne gravity data as point and gridded values. Absolute and relative gravity data, WGM



Geoid

Geoid models and geoid determination software, geoid modeling processing methodologies



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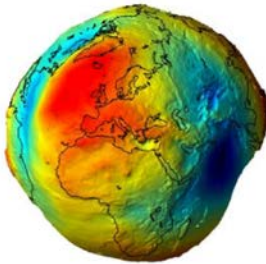
SG and Earth tide data

Temporal variations of the Earth gravity field through long-term records from ground gravimeters, SG data, Earth tide data.



Global Earth Models

Collection and archive of all existing global gravity field models, web interface for access to GEMs, model visualization and service.



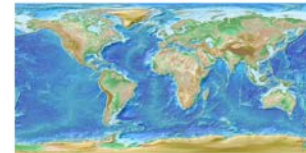
Time-variable GEMs

Combined gravity field solutions in SH coefficients and spatial grids for hydrological, oceanic and polar ice sheets applications.

COST-G
Combination Service for Time-variable Gravity Models

DEM data

Digital Elevation Models, relevant software for DEM creation, assessment, manipulation and display, global relief and crustal models and spherical harmonic data sets.



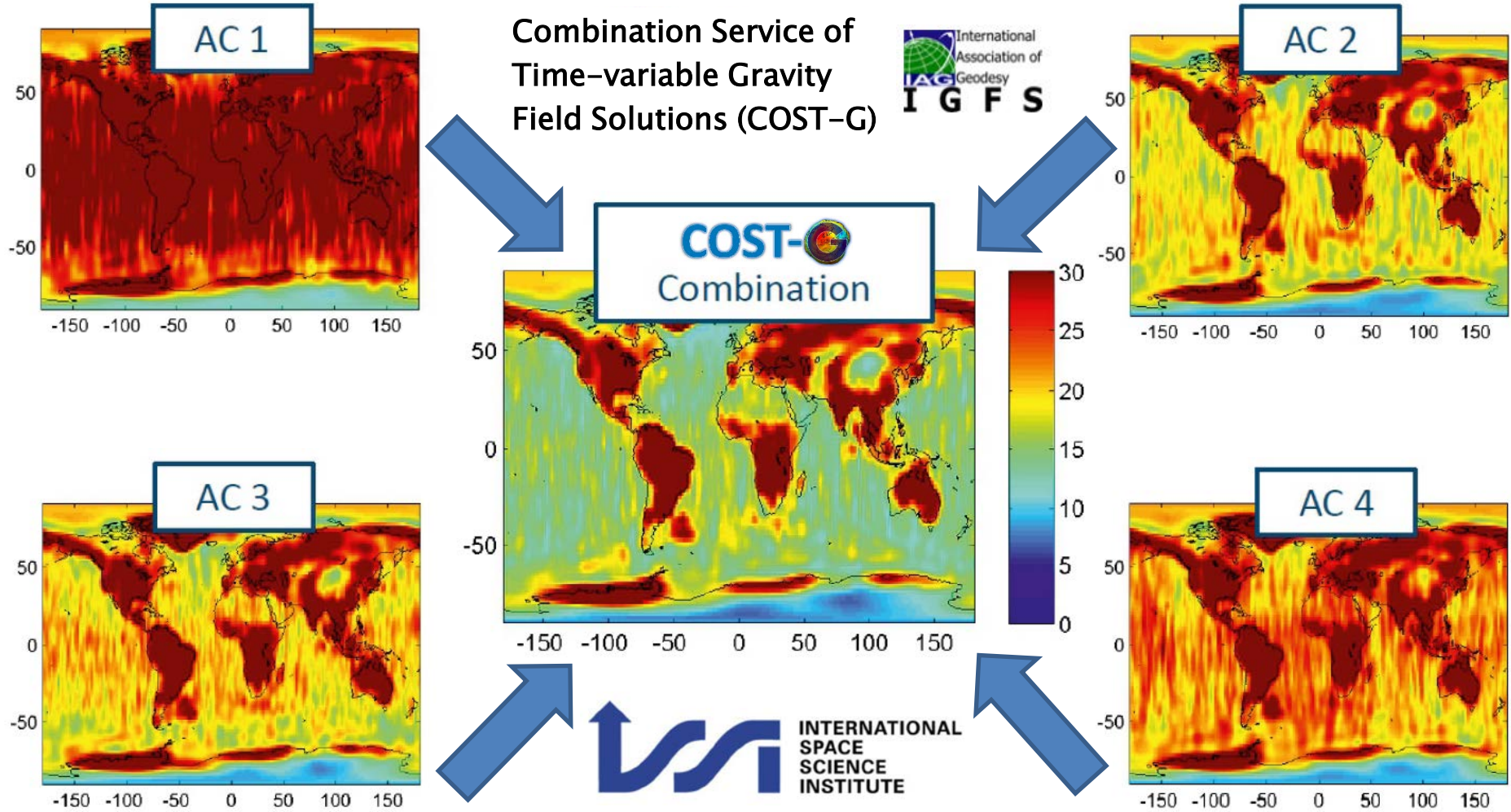
COST-G is one of the product centers of the



<http://igfs.topo.auth.gr/>



Introduction



Improved and consolidated product integrating the strengths of all ACs

Level-2 Product Availability



ICGEM

Gravity Field Solutions for dedicated Time Periods

The following gravity field time series are presently available:

GRACE and Grace-FO solutions from the Science Data System centers CSR, GFZ and JPL			collapse all
- CSR			Center for Space Research at University of Texas, Austin
CSR Release 05		monthly	UTCSR Level-2 Processing Standards Document, Rev 4.0 May 29, 2012
CSR Release 06	DOI	monthly	UTCSR Level-2 Processing Standards Document, Rev 5.0 April 18, 2018
CSR Release 06 (GFO)	DOI	monthly	UTCSR Level-2 Processing Standards Document, V 1.1 June 6, 2019
- GFZ			Helmholtz Centre Potsdam German Research Centre for Geosciences
GFZ Release 05		monthly weekly	GFZ GRACE Level-2 Processing, Revised Edition, January 2013
GFZ Release 06	DOI	monthly	GFZ GRACE Level-2 Processing Standards Document for Level-2 Products, Rev. 1.0, October 26, 2018
GFZ Release 06 (GFO)	DOI	monthly	GFZ GRACE Level-2 Processing Standards Document for Level-2 Products, Rev. 1.0, June 3, 2019
- JPL			Jet Propulsion Laboratory
JPL Release 05		monthly	JPL Level-2 Processing Standards Document, Release 05.1 November 3, 2014
JPL Release 06	DOI	monthly	JPL Level-2 Processing Standards Document, Release 06.0 June 1, 2018
JPL Release 06 (GFO)	DOI	monthly	JPL Level-2 Processing Standards Document, v 1.0 May 28, 2019

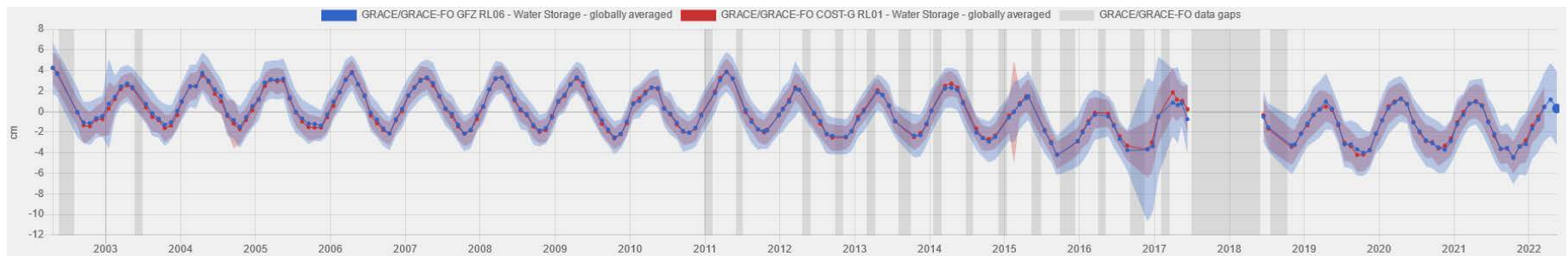
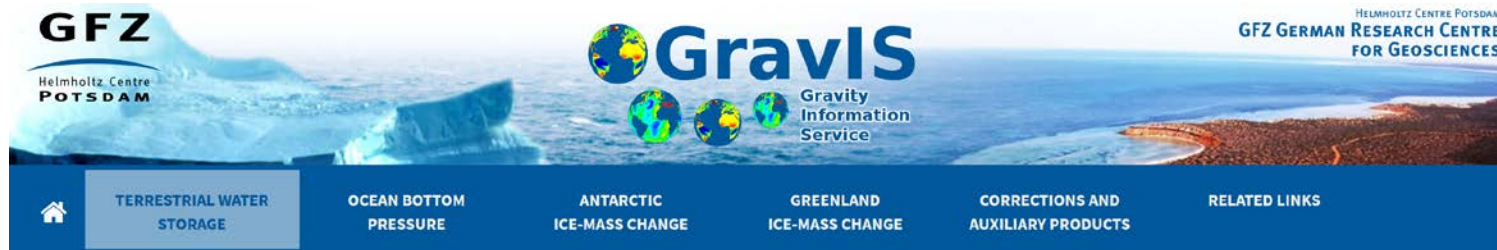
The processing standards to generate the GRACE Level-2 products of CSR, GFZ and JPL are also available in the Document Section of the GRACE archives at [GFZ ISDC](#) or [JPL PO.DAAC](#)

COST-G (International Combination Service for Time-variable Gravity Field)			collapse all
DSM		quarterly	Deterministic Signal Model
Grace	DOI	monthly	
Grace-FO	DOI	monthly	
Swarm	DOI	monthly	

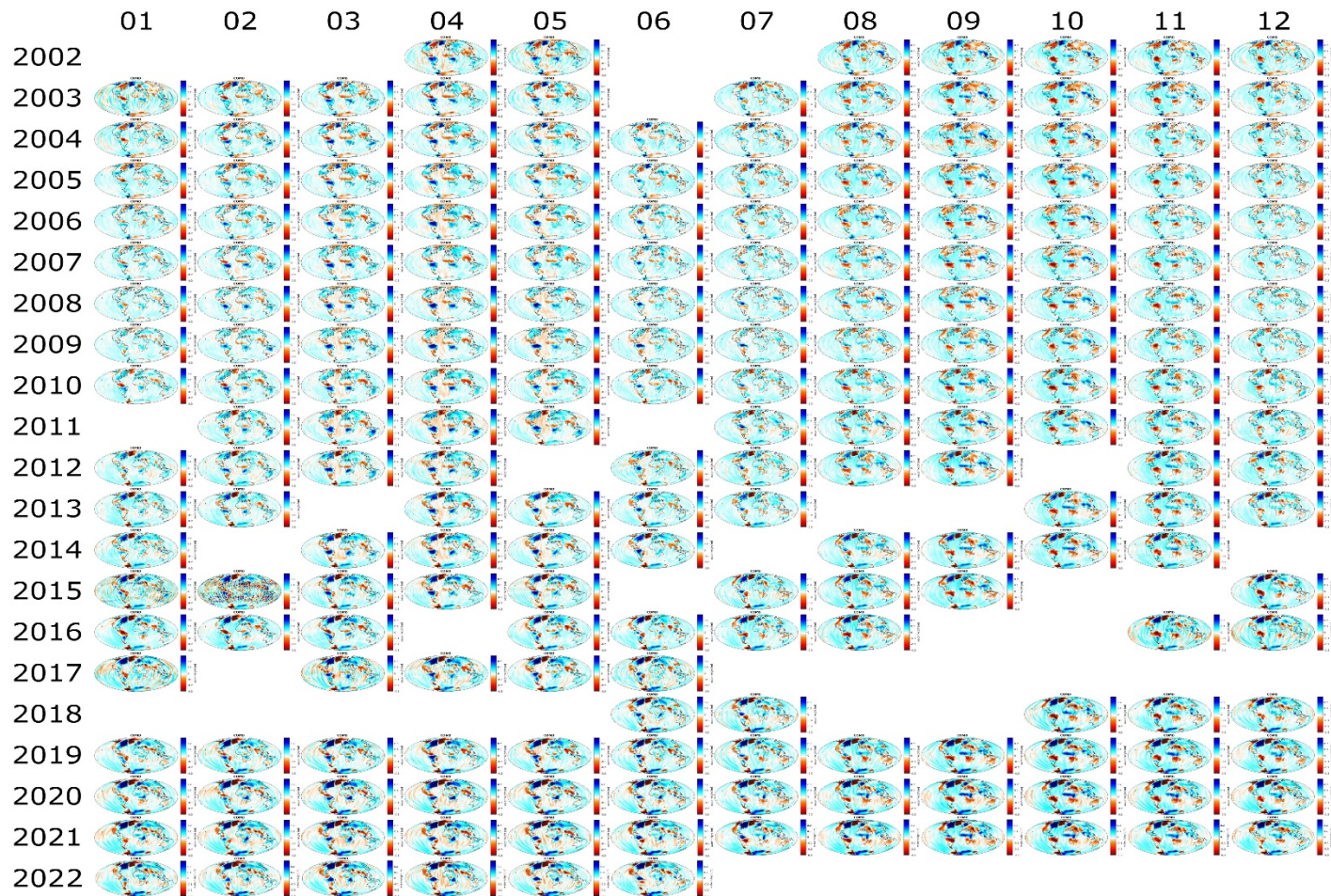


Level-3 Product Availability

- Monthly combined GRACE/GRACE-FO gravity models:
 - available at ISDC, GravIS
 - <ftp://isdctftp.gfz-potsdam.de/grace/GravIS/COST-G/Level-3>

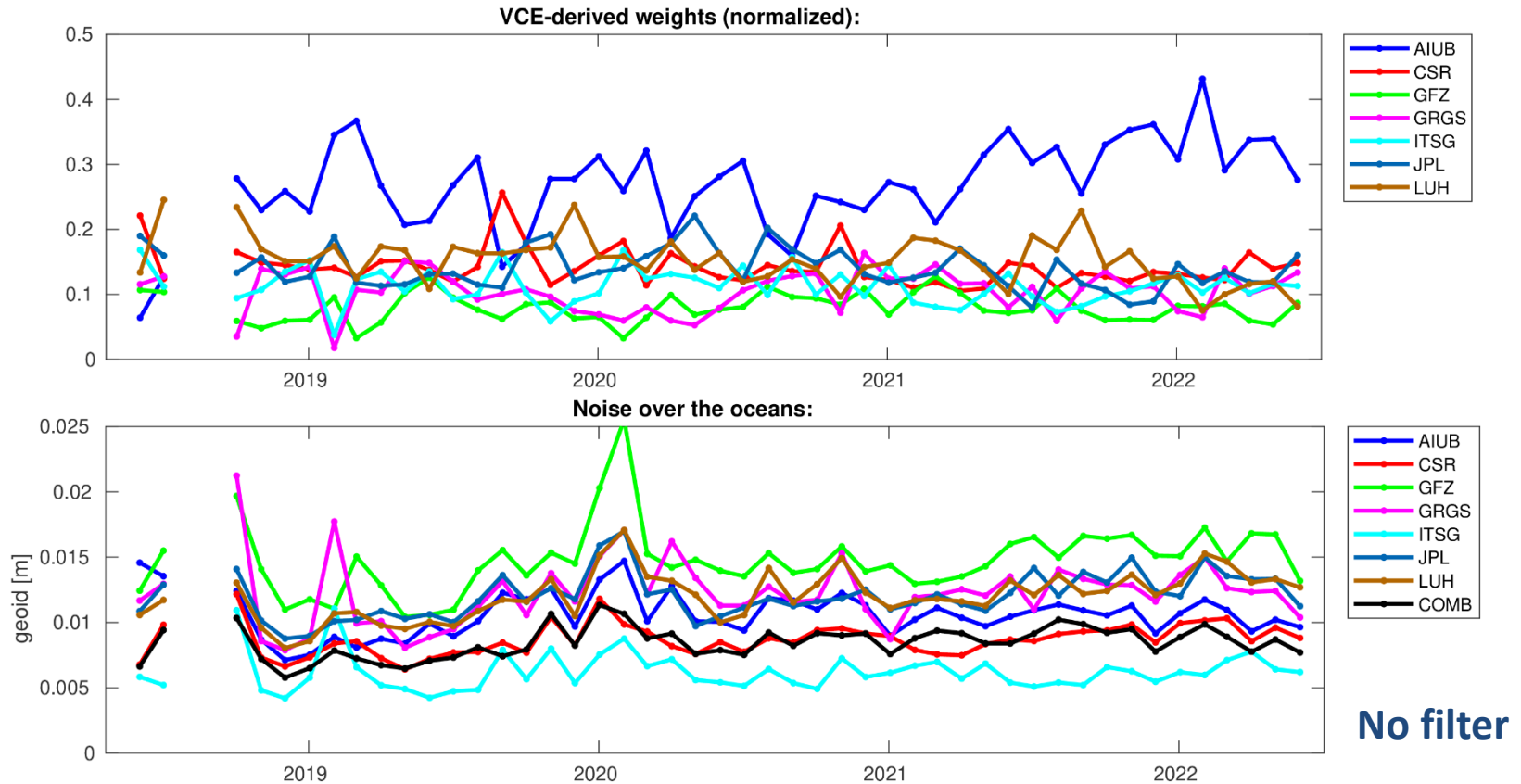


GRACE-FO Operational Combination



Flawless and uninterrupted operational combination with a latency < 3 months.

GRACE-FO Operational Combination

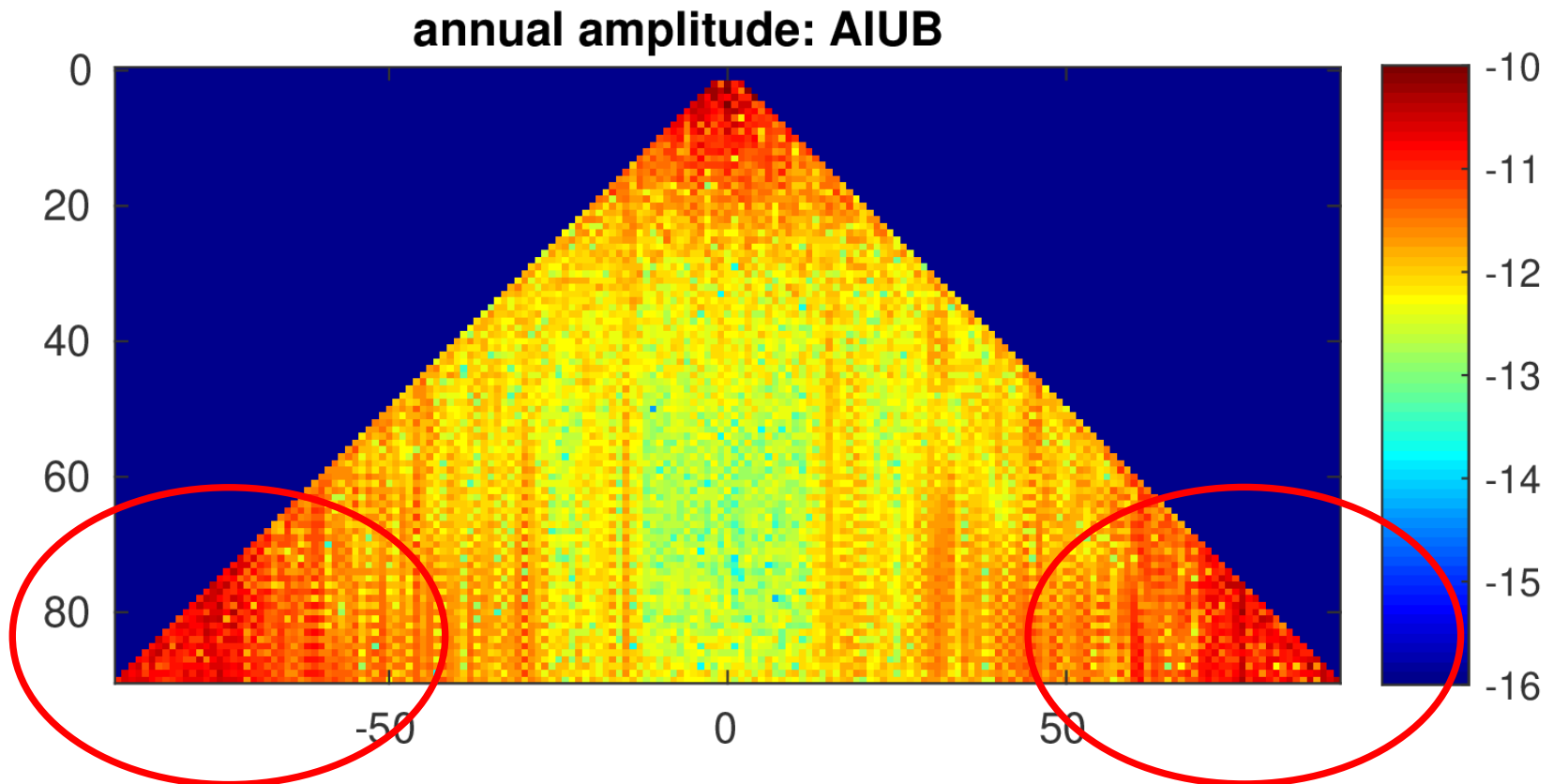


Weights do not reflect the noise over the oceans of AC solutions:

Highest weight: **AIUB**

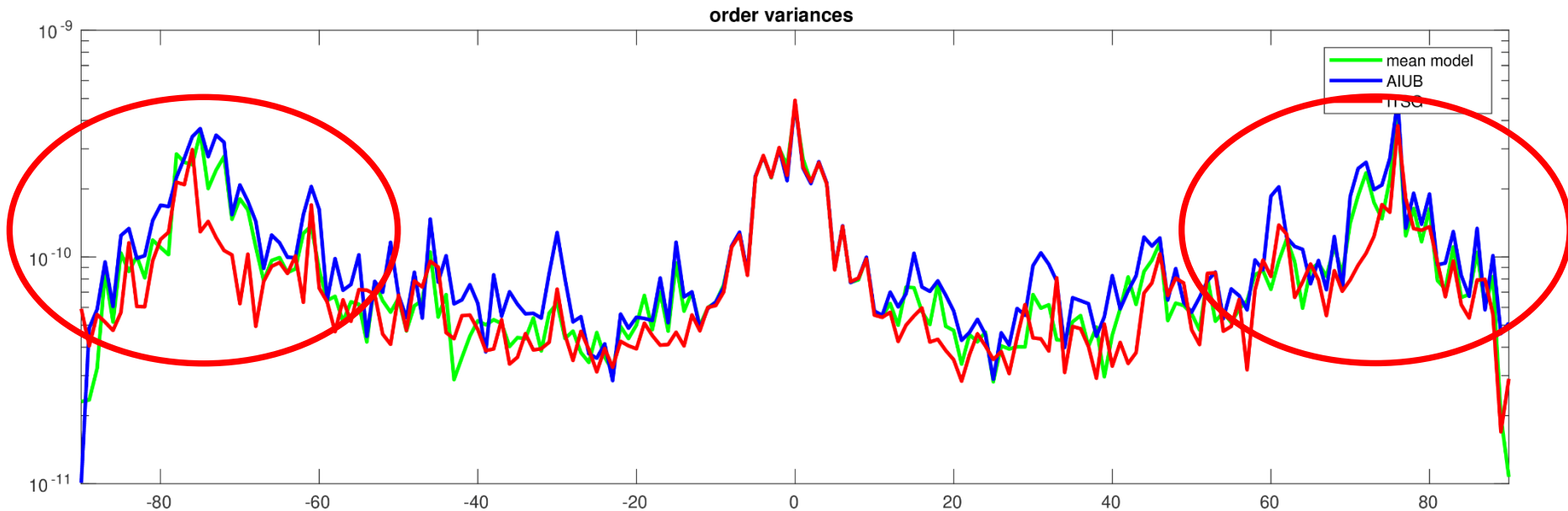
Lowest noise: **ITSG**

Artefacts in High-Order Coefficients



Fitted signal models to AC solutions generally show apparently increased signal amplitudes for high-order coefficients.

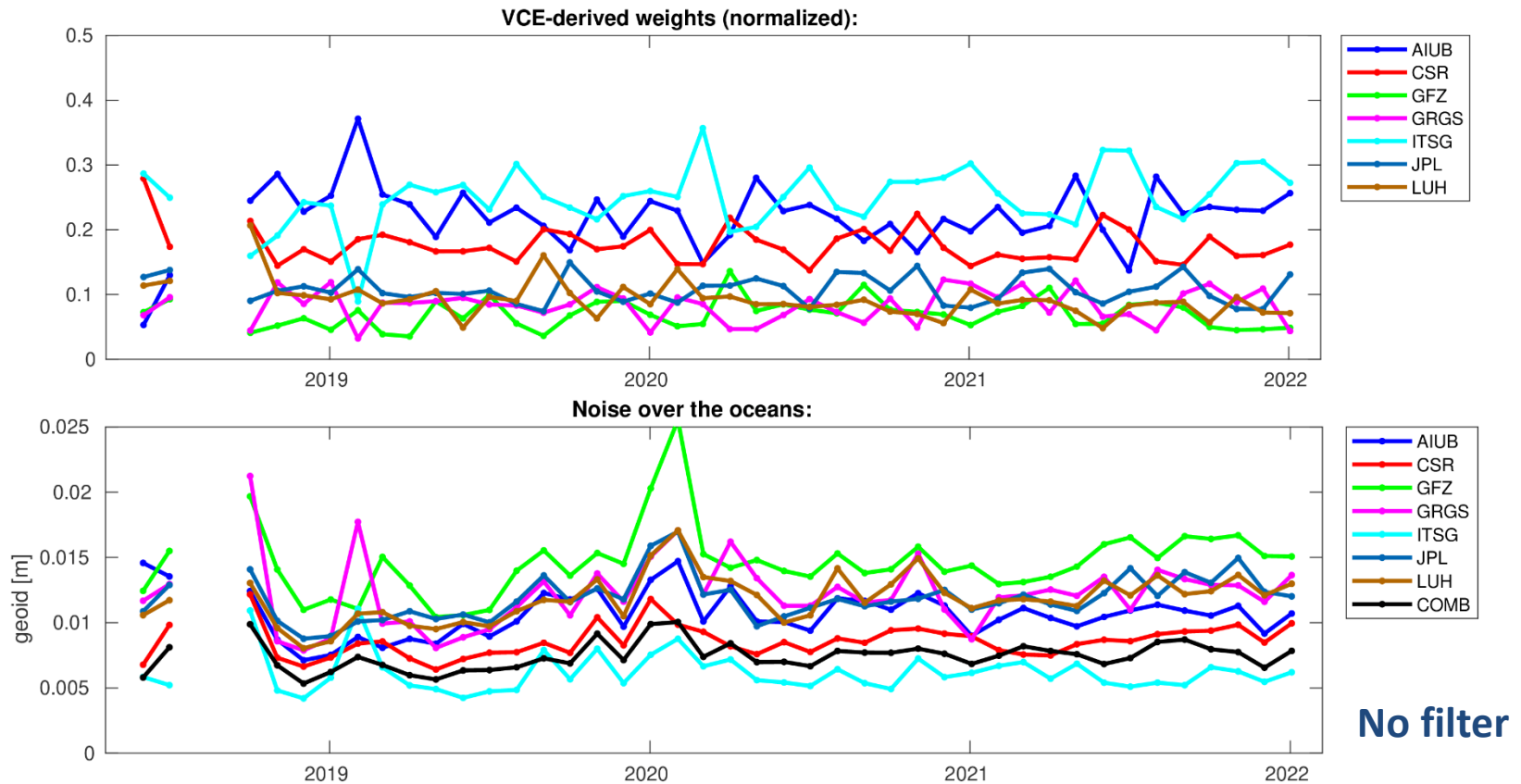
Artefacts in High-Order Coefficients



Systematic artefacts in high orders are significantly reduced in the ITSG time-series. Consequently ITSG is down-weighted by VCE if high orders are taken into account for the derivation of weights.

=> Exclude high orders for VCE

Adopting the Revised Weighting Scheme

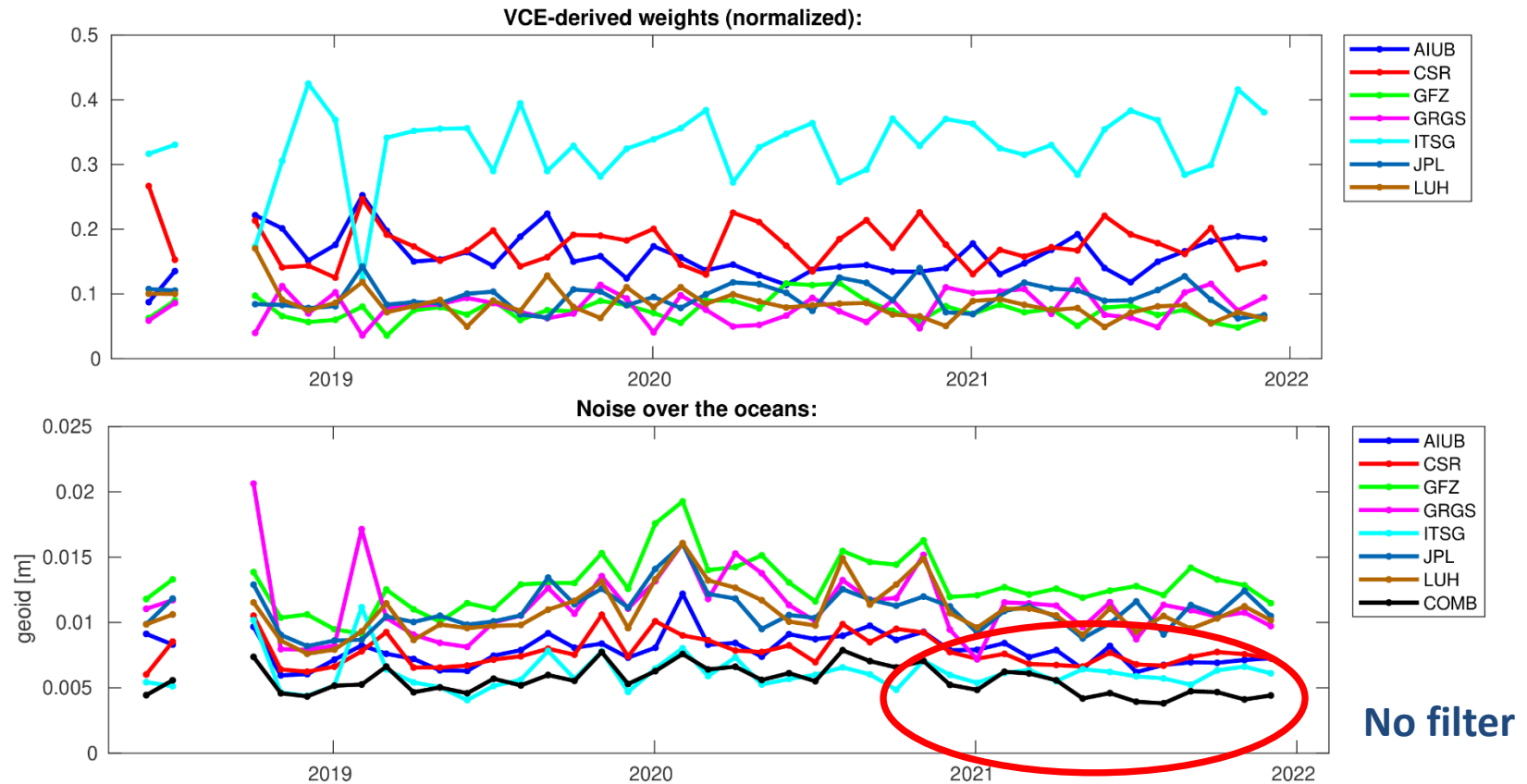


Weights better reflect the noise over the oceans of AC solutions:

Highest weight: **ITSG**

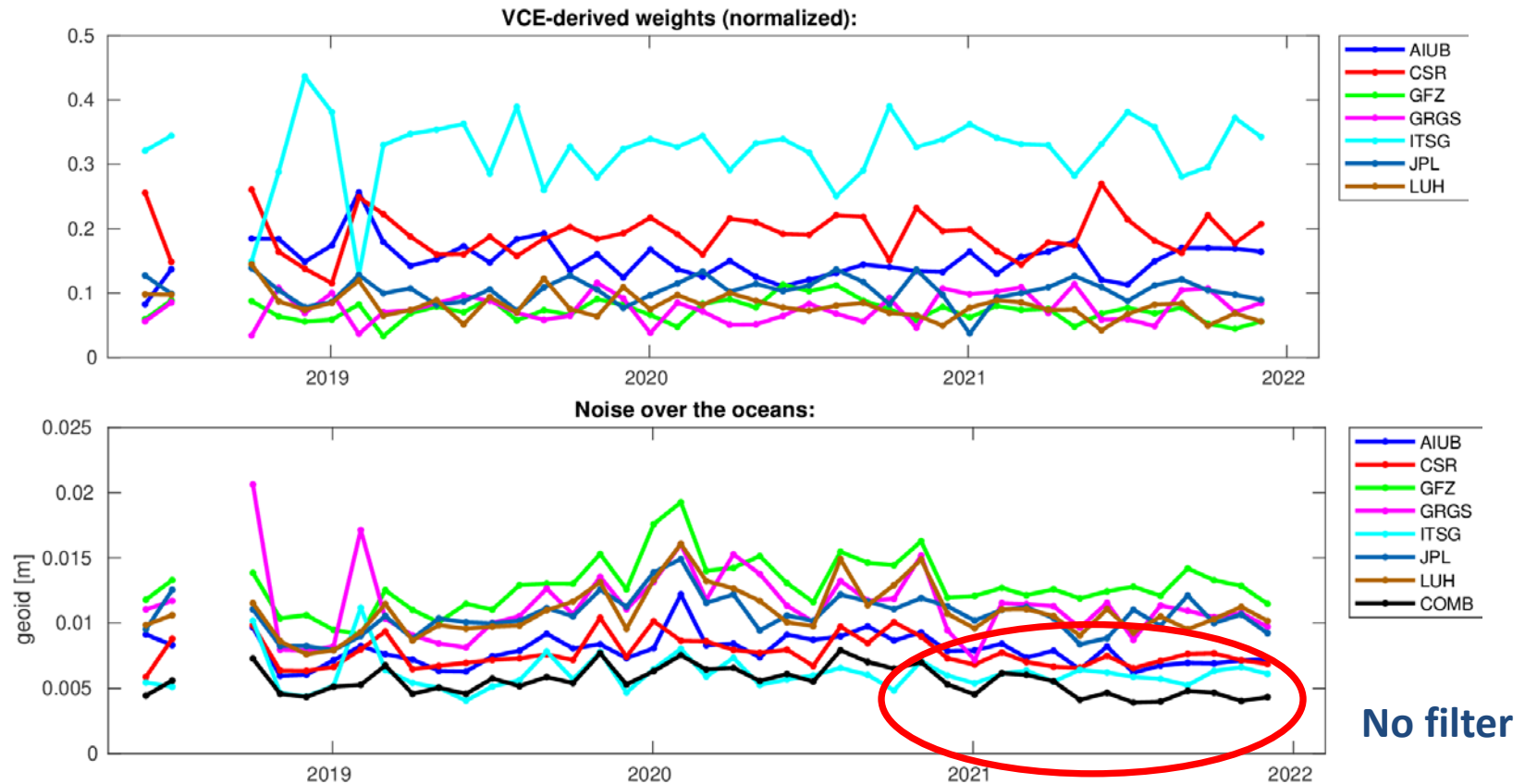
Lowest noise: **ITSG**

Further Improvements of the Combined Solution



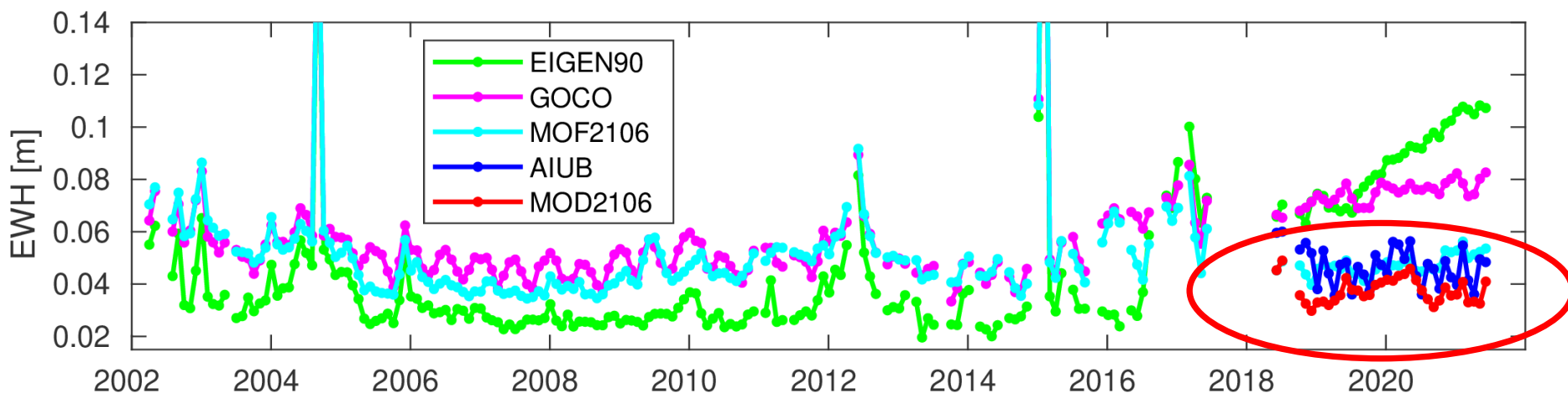
- Empirical Noise Modeling of **AIUB** AC solution (Ph.D. work of M. Lasser)
 - **GFZ** time-series based on ACT product from G3P (as AIUB, GRGS, ITSG, LUH)
- => **Combination outperforms all solutions in 2021**

Further Improvements of the Combined Solution



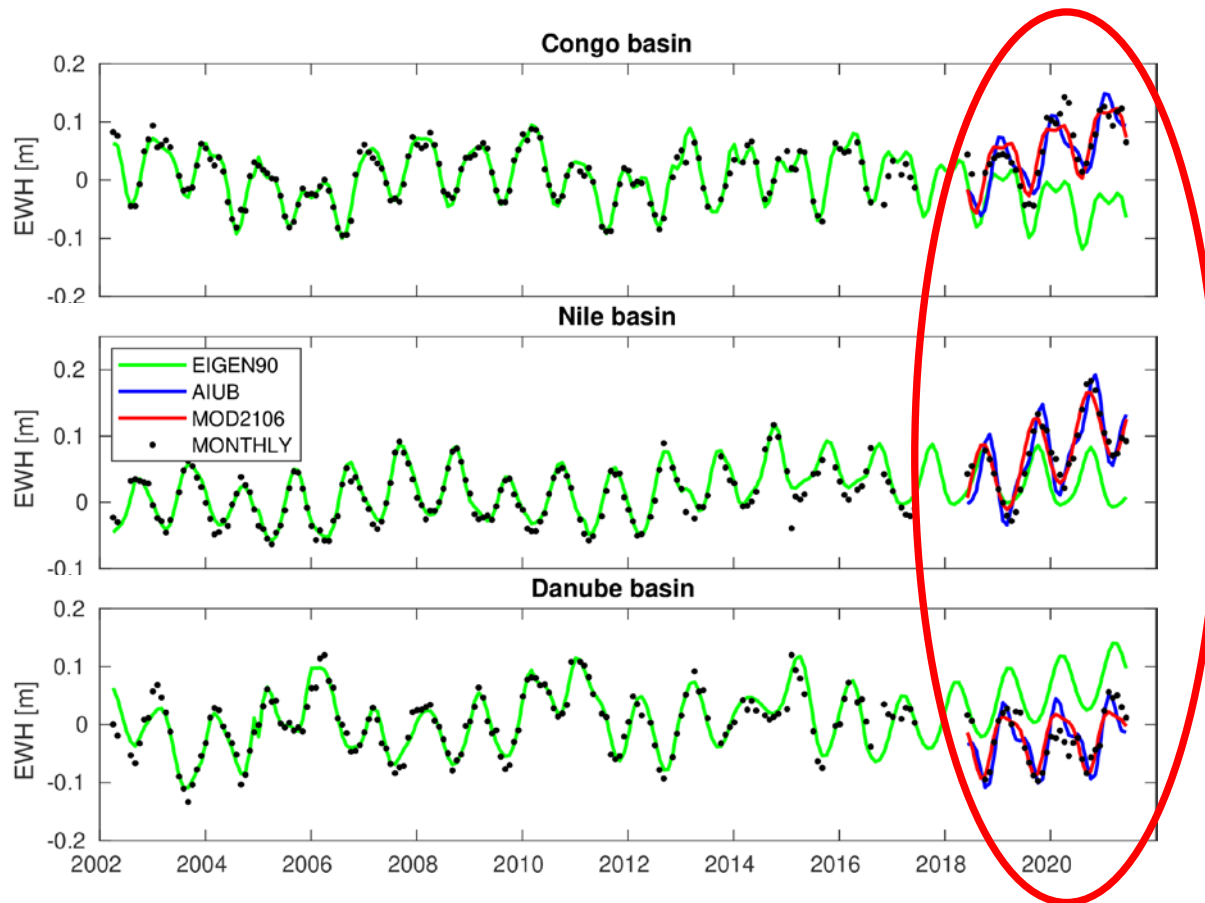
- **CSR** and JPL RL06.1 time-series are based on the new JPL-ACT product; the main effect is on C_{30} , which in case of using either the G3P-ACT or the new JPL ACT does not need to be replaced by SLR-derived values.

COST-G Fitted Signal Model (FSM)



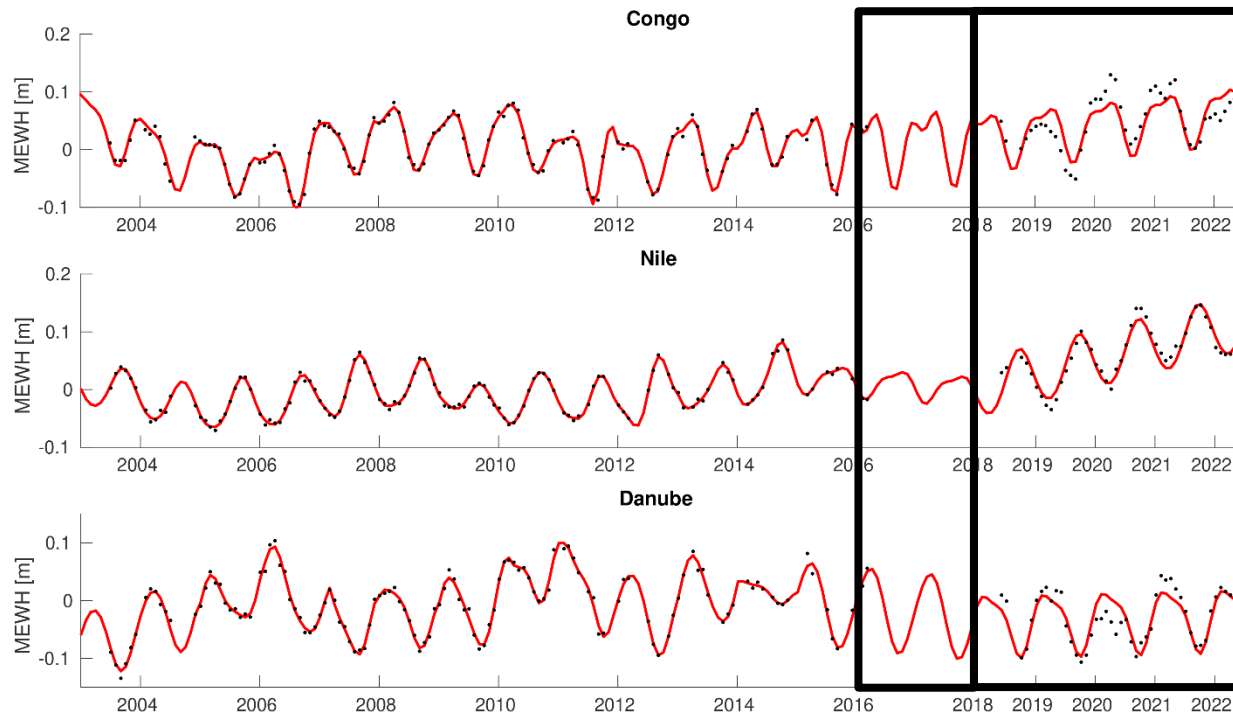
- Differences (RMS over continental areas) to the monthly GRACE/GRACE-FO gravity fields indicate rather poor prediction quality of **EIGEN-GRGS-RL04** (standard model for, e.g., POD of altimetry satellites).
- High-resolution models based on GRACE-data only (e.g., **GOCO06S**) are clearly out-performed by fitted signal models including GRACE-FO data (**MOF2106: GRACE + GRACE-FO; MOD2106: GRACE-FO only**).
- A high-resolution static GRACE-FO model with co-estimated time-variations (**AIUB**) seems to suffer from over-estimation of semi-annual variations.

COST-G FSM: performance in river basins



Quarterly updated fitted signal models are provided as a COST-G product to support operational LEO POD activities.

COST-G FSM: extension to GRACE period



- **GRACE period is fitted in yearly batches (small adaptations due to Earthquakes) with continuity conditions at boundaries**
- **GRACE data of 2016/2017 is used for prediction till 12/2017**
- **GRACE-FO data is fitted in one batch to ensure good prediction quality**
=> Might be interesting for post-processing LEO POD analyses

Summary: GRACE-FO combination

- **COST-G GRACE-FO combined Level-2 products are made available with a latency of approx. 3 months at ICGEM.**
- **COST-G Level-3 products for GRACE and GRACE-FO are available via GFZ's GravIS portal.**
- **A revised weighting scheme has been tested that is in better accordance with the noise assessment of the individual AC solutions.**
- **Further improvements of the combined solution are achieved by improving individual AC solutions, e.g., by using stochastic noise modeling not only for the ITSG but also for the AIUB solution.**
- **The combined solution is shown to outperform individual AC solutions in terms of the noise assessment over the oceans.**

Summary: COST-G FSM

- **New COST-G product for operational LEO-POD**
- **Fit to GRACE-FO monthly combined solutions**
- **Updated quarterly**
- **Outlook: extension of FSM to GRACE period for e.g., altimetry/SLR reprocessing campaigns.**