COST-G

Combination Service for Time-variable Gravity Models

COST-G: Status and recent developments

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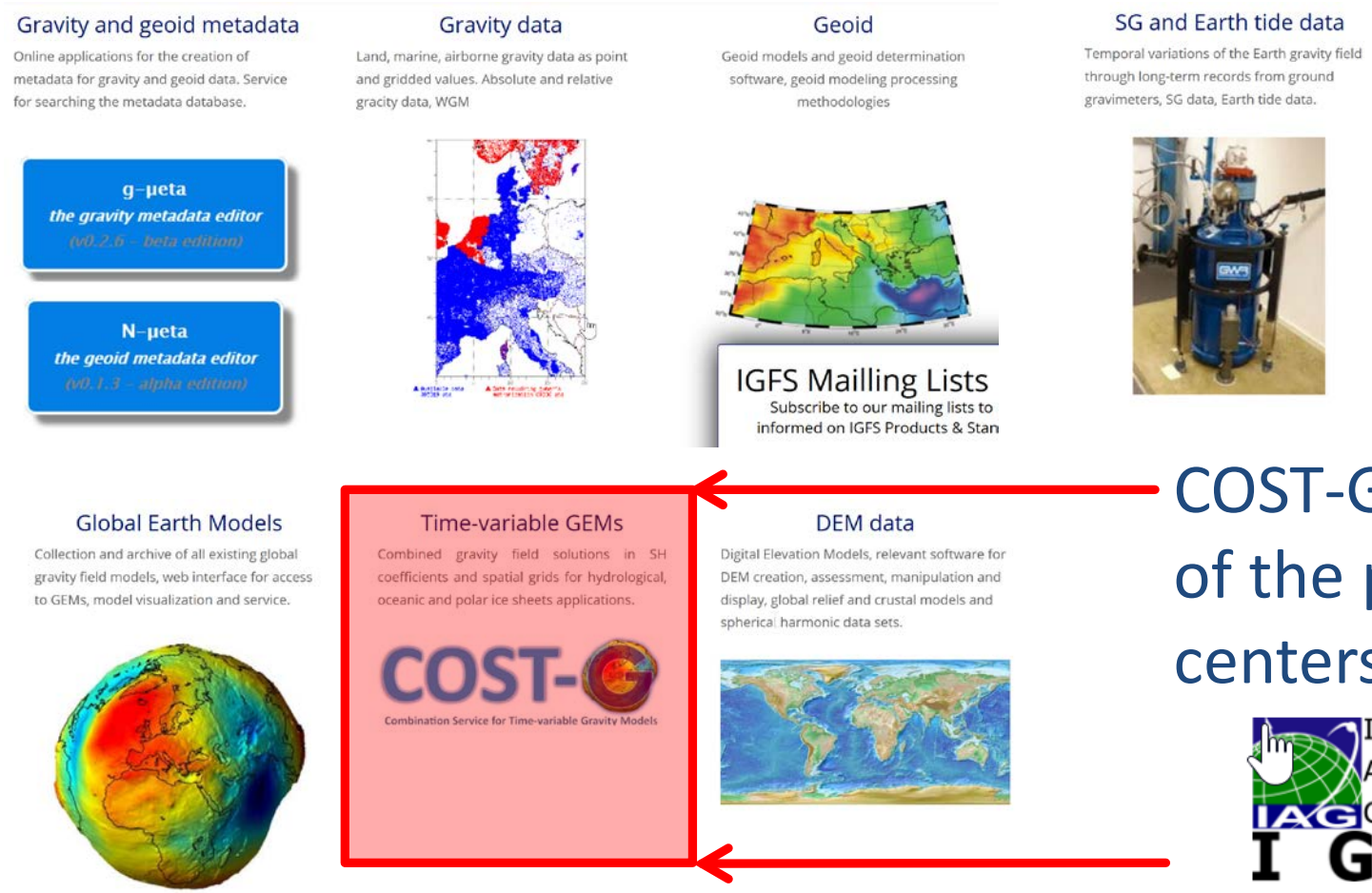
GGHS 2022

12 – 14 September 2022, Austin, Texas

Introduction



COST-G is one of the product centers of the

International Association of Geodesy

IAG

IGFS

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

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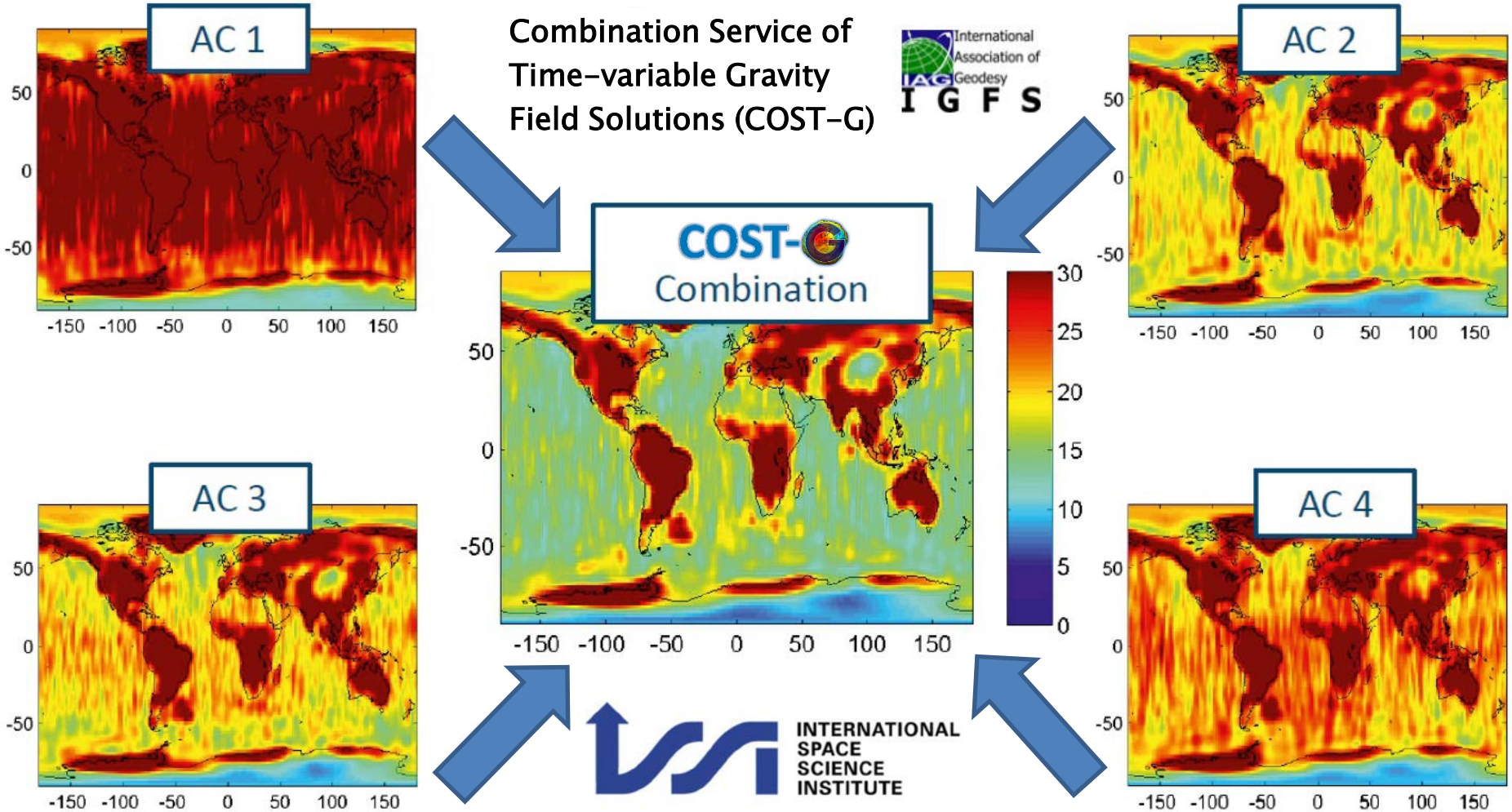
Introduction



Improved and consolidated product integrating the strengths of all ACs

COST-G

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	

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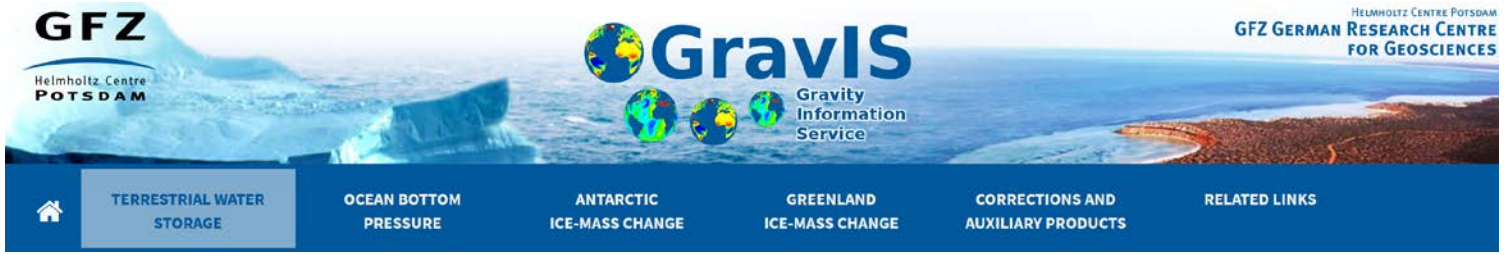
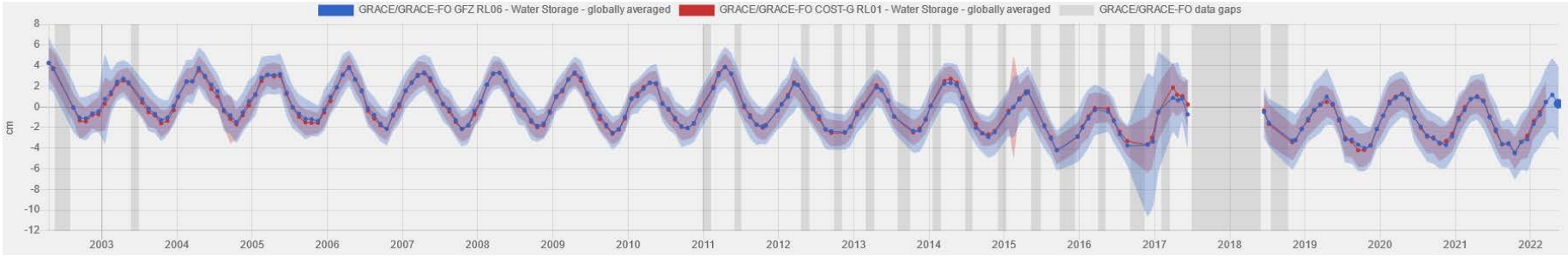
Level-3 Product Availability

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





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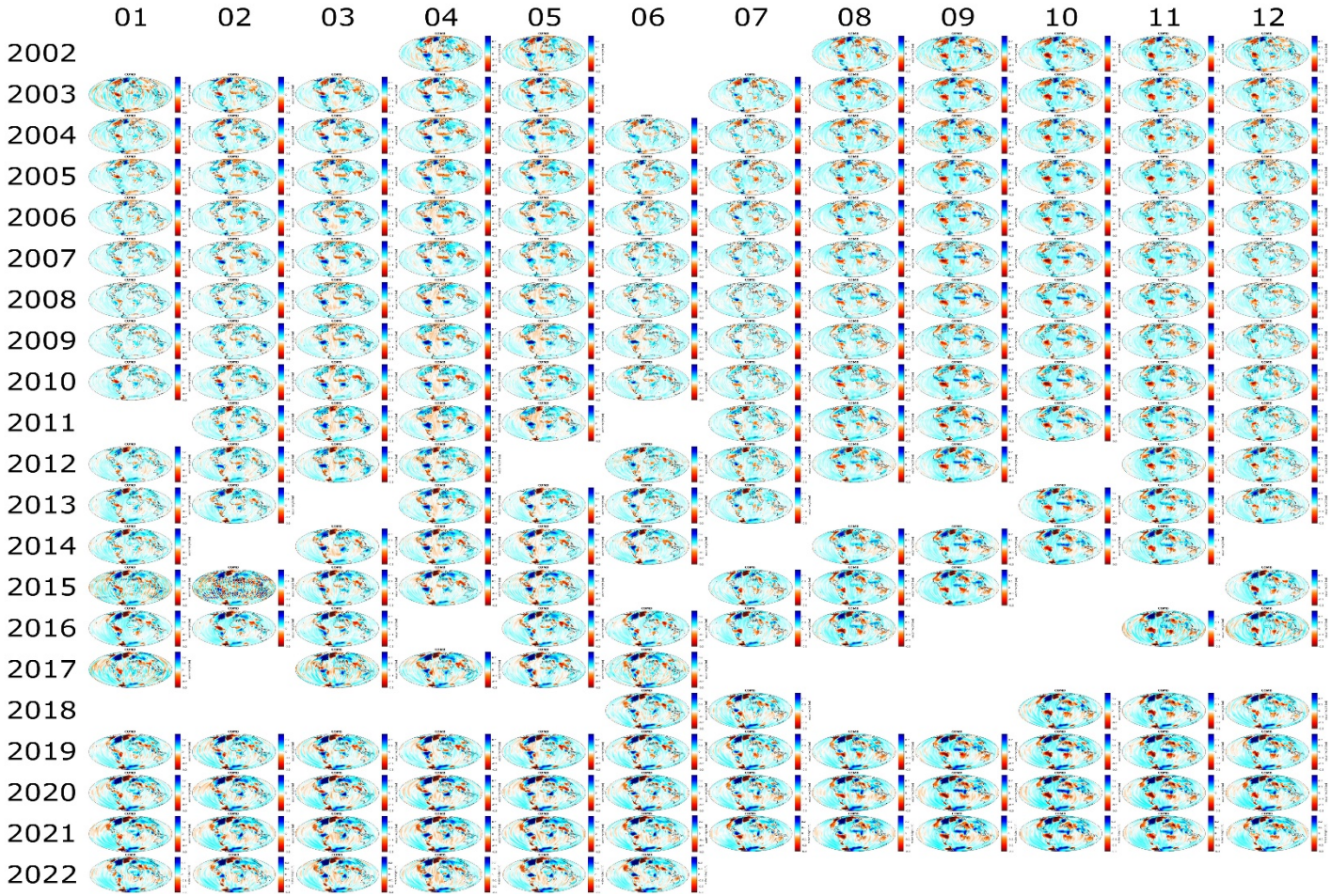
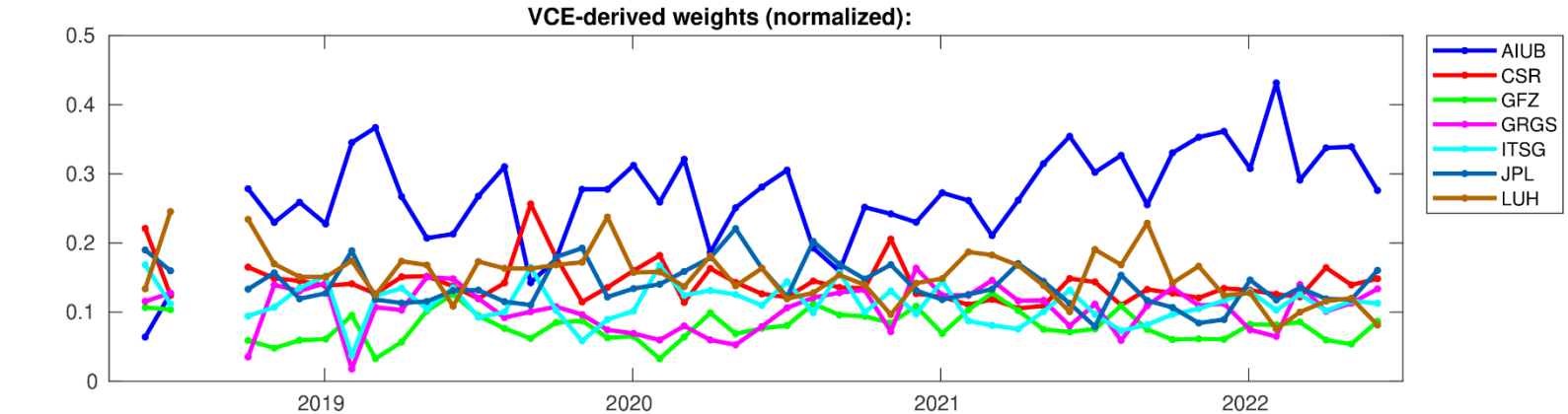
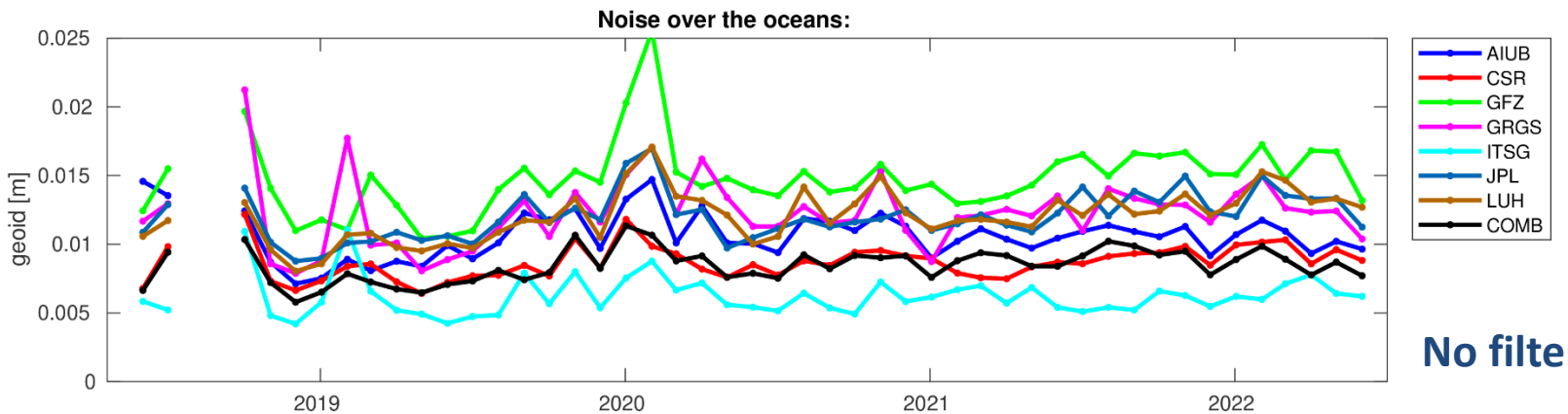
GRACE-FO Operational Combination



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

GRACE-FO Operational Combination





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

Highest weight: AIUB **Lowest noise: ITSG**

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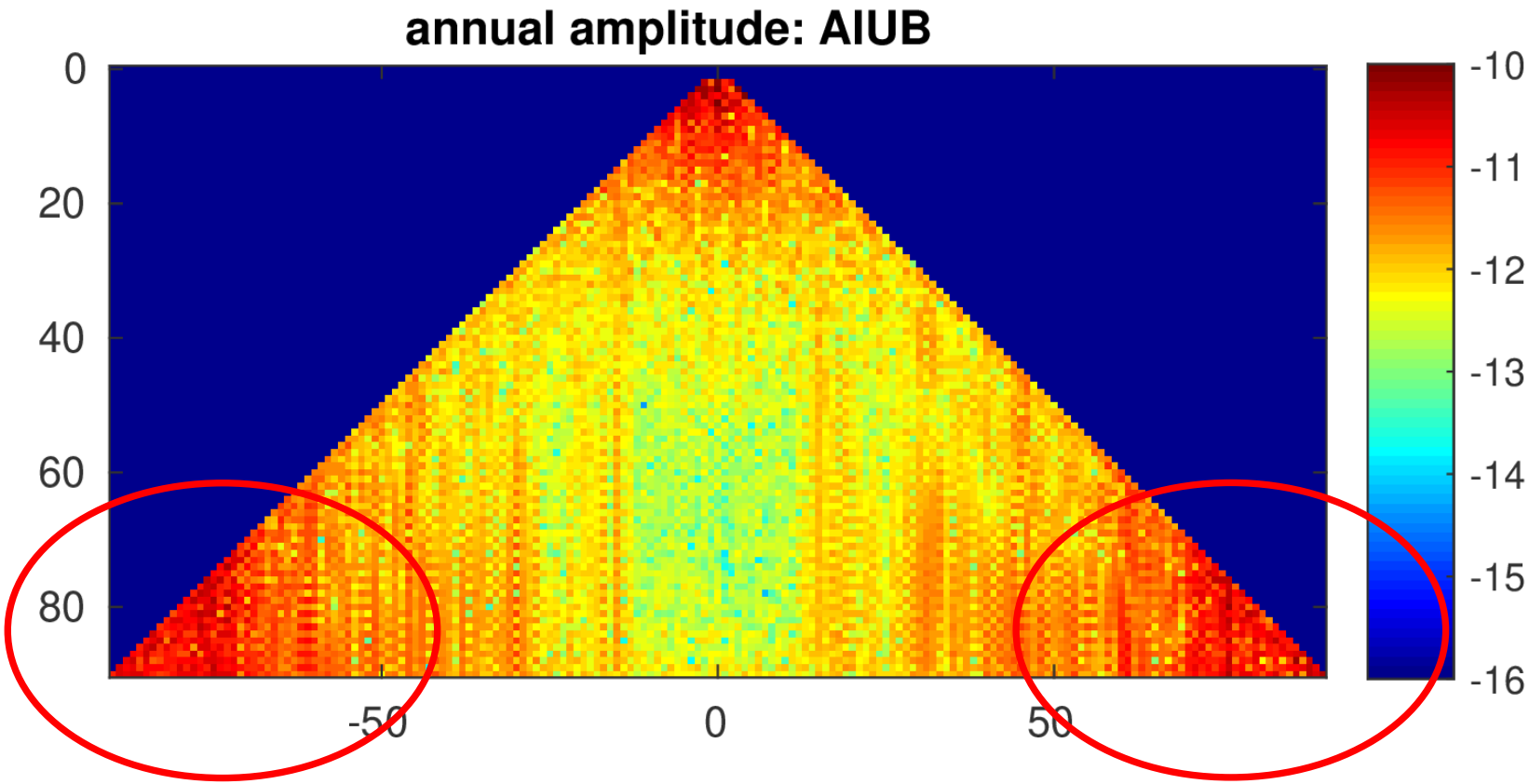
Artefacts in High-Order Coefficients



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

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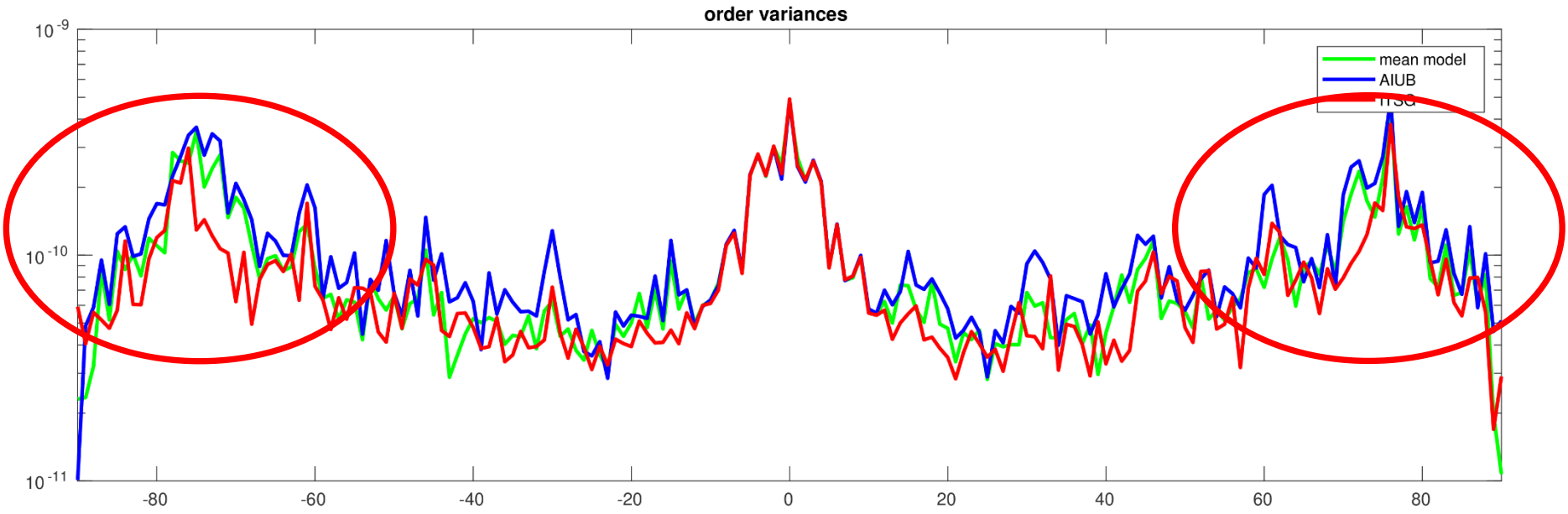
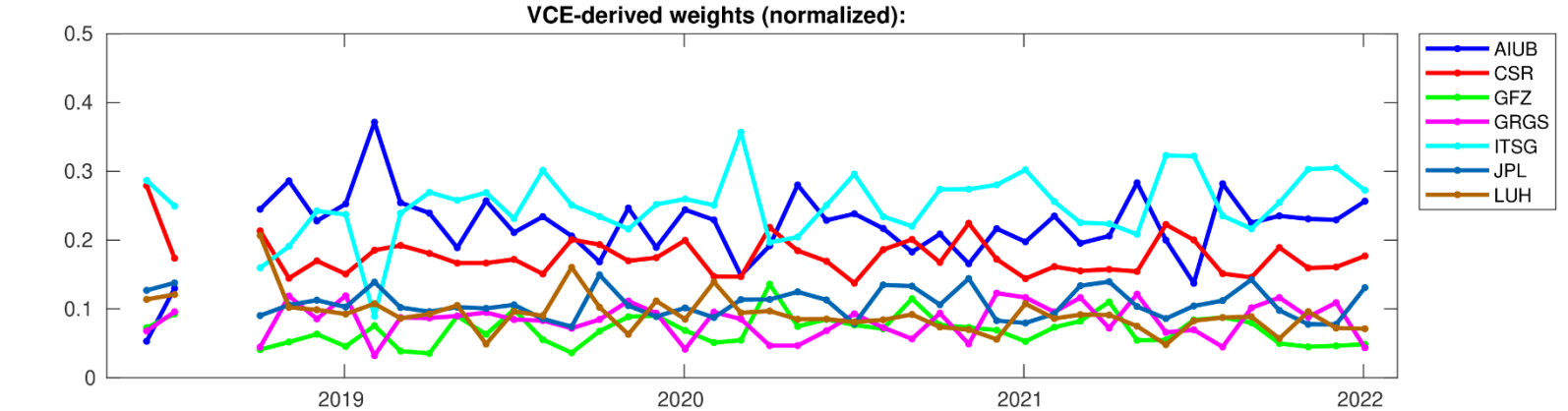
Artefacts in High-Order Coefficients

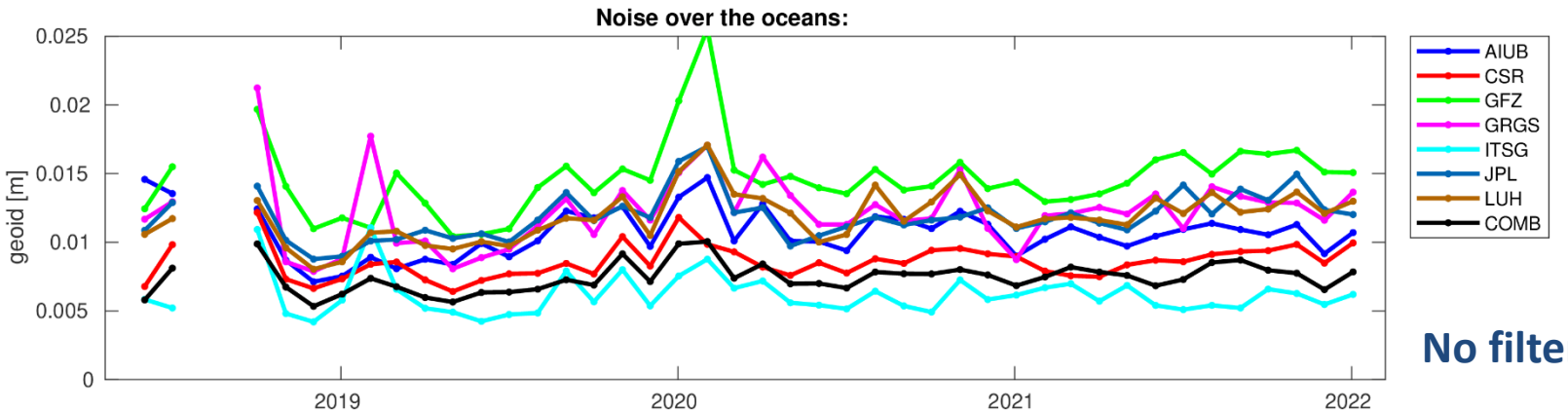


Systematic artefacts in high orders are significantly reduced in the ITSG time-series. Consequently ITSG is down-weighted by VCE if high orders are taken into account for the derivation of weights.

=> Exclude high orders for VCE

Adopting the Revised Weighting Scheme





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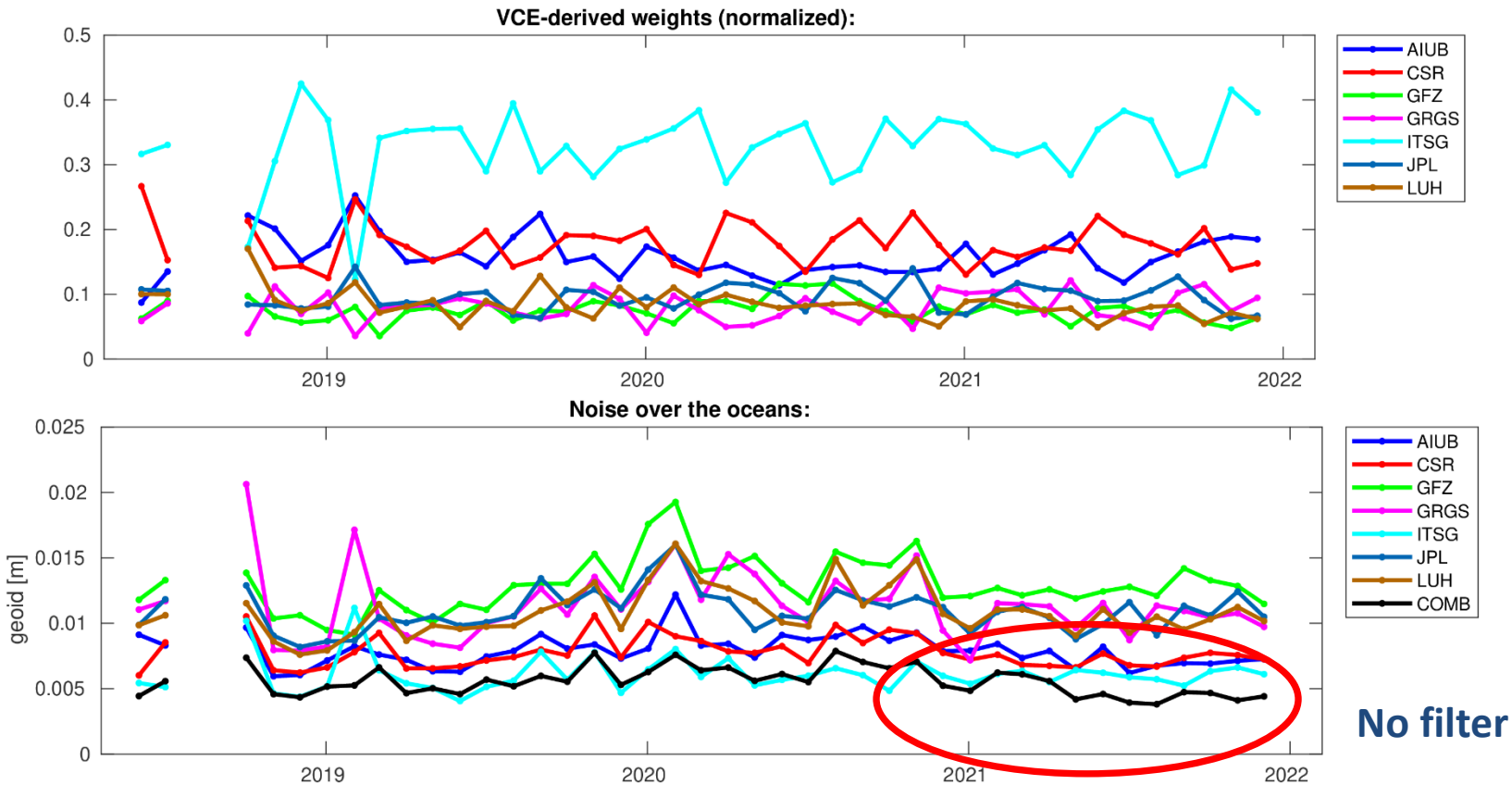
Weights better reflect the noise over the oceans of AC solutions:

Highest weight: ITSG **Lowest noise: ITSG**

Further Improvements of the Combined Solution



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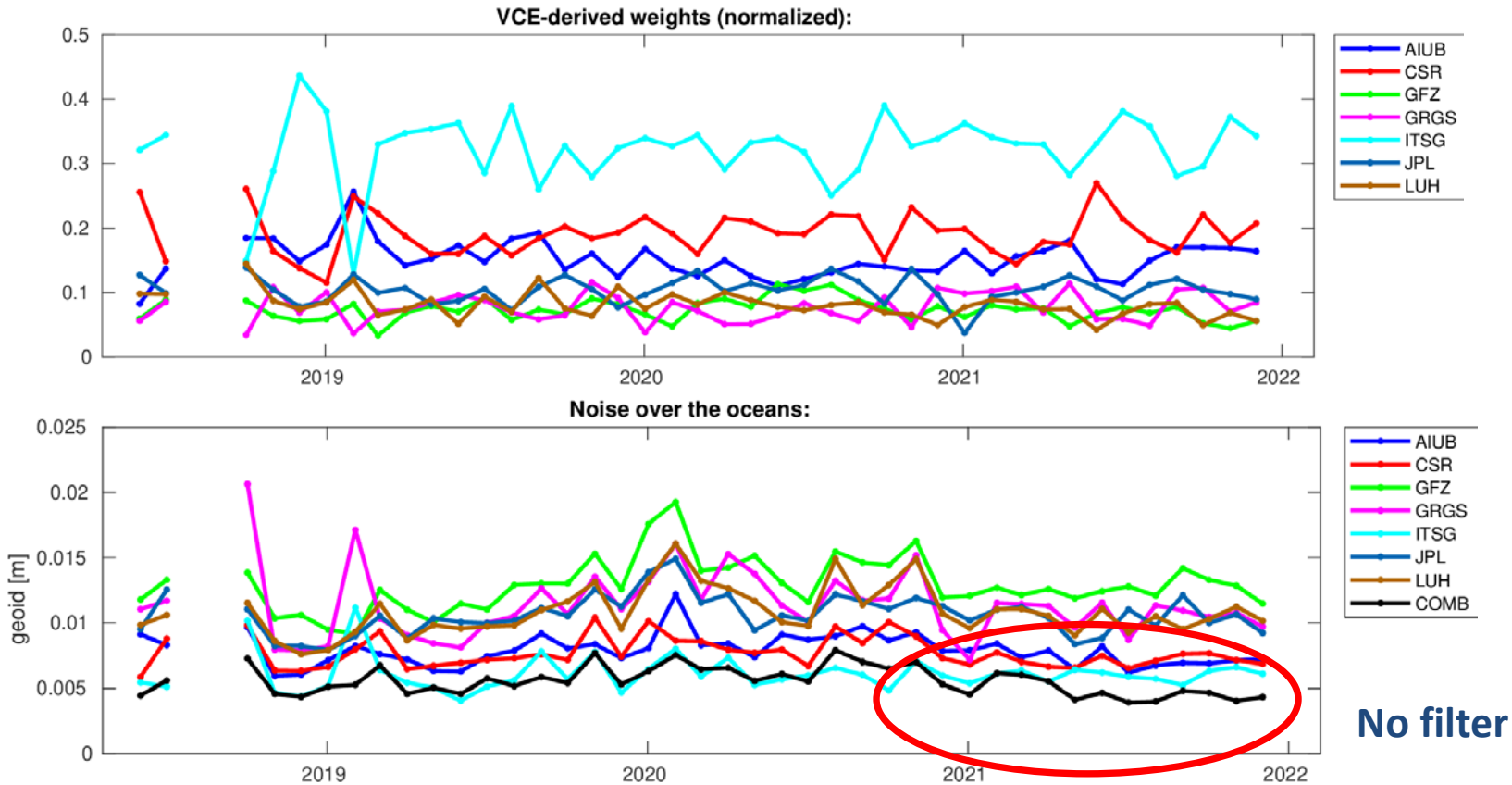
- Empirical Noise Modeling of AIUB AC solution (Ph.D. work of M. Lasser)
- GFZ time-series based on ACT product from G3P (as AIUB, GRGS, ITSG, LUH)

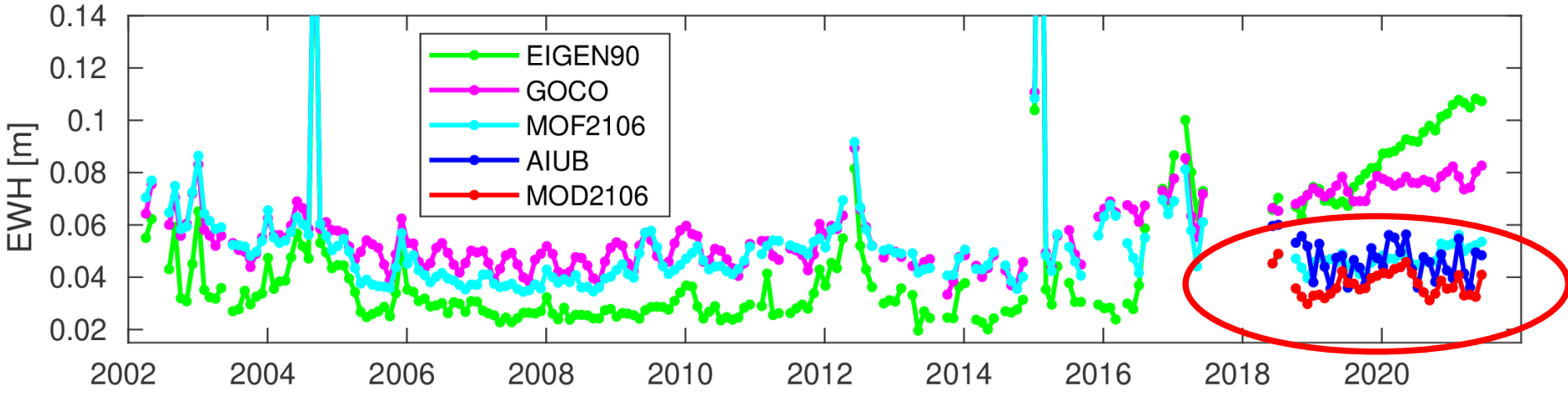
=> **Combination** outperforms all solutions in 2021

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.

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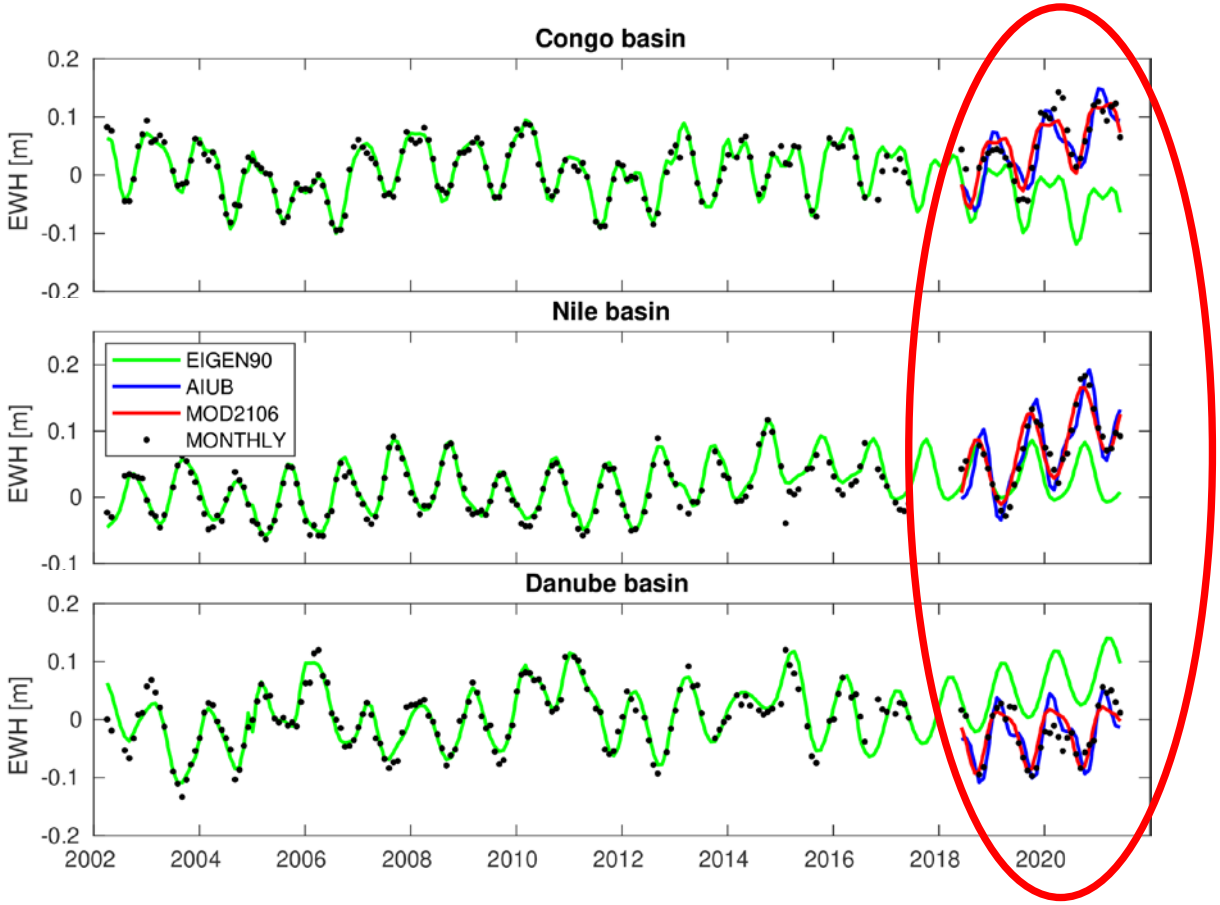
COST-G FSM: performance in river basins



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

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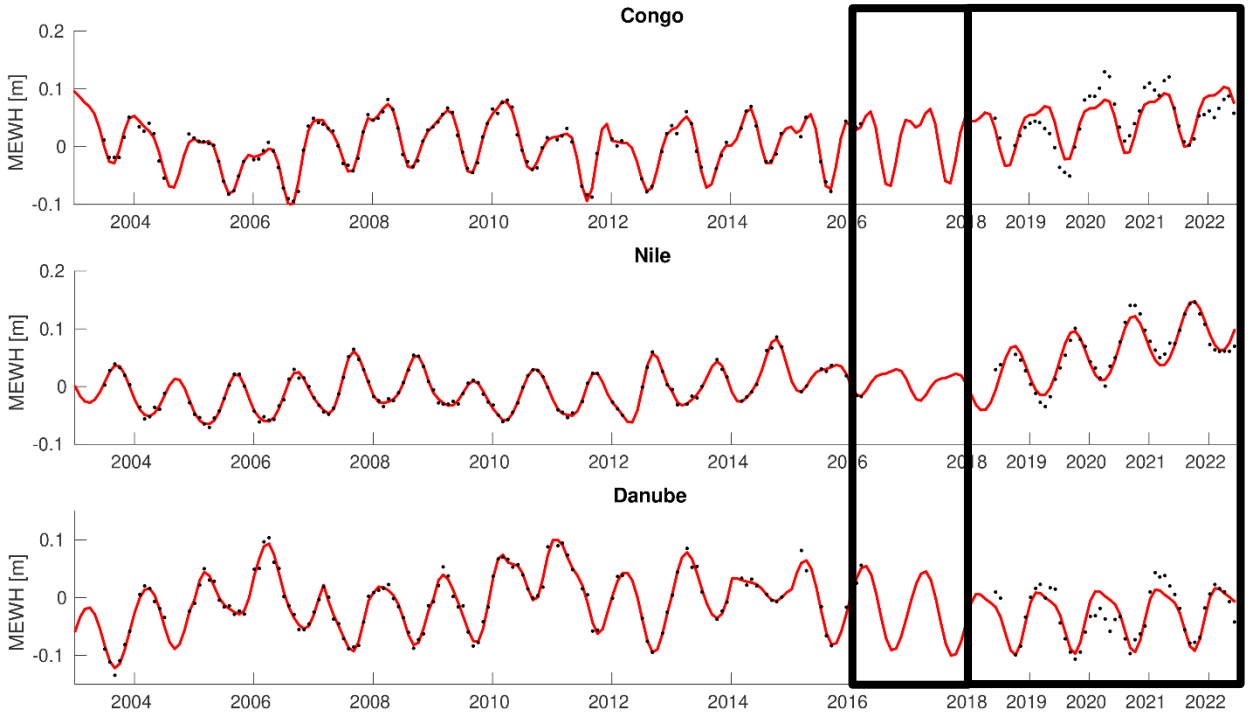
COST-G FSM: extension to GRACE period



- GRACE period is fitted in yearly batches (small adaptions 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

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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.