COST-G

Combination Service for Time-variable Gravity Models

COST-G combined gravity field models for POD

Ulrich Meyer[1], Heike Peter[2], Christoph Förste[3], Adrian Jäggi[1]

[1]University of Bern, Astronomical Institute, Switzerland
[2]Positim, Germany
[3]GFZ, Germany

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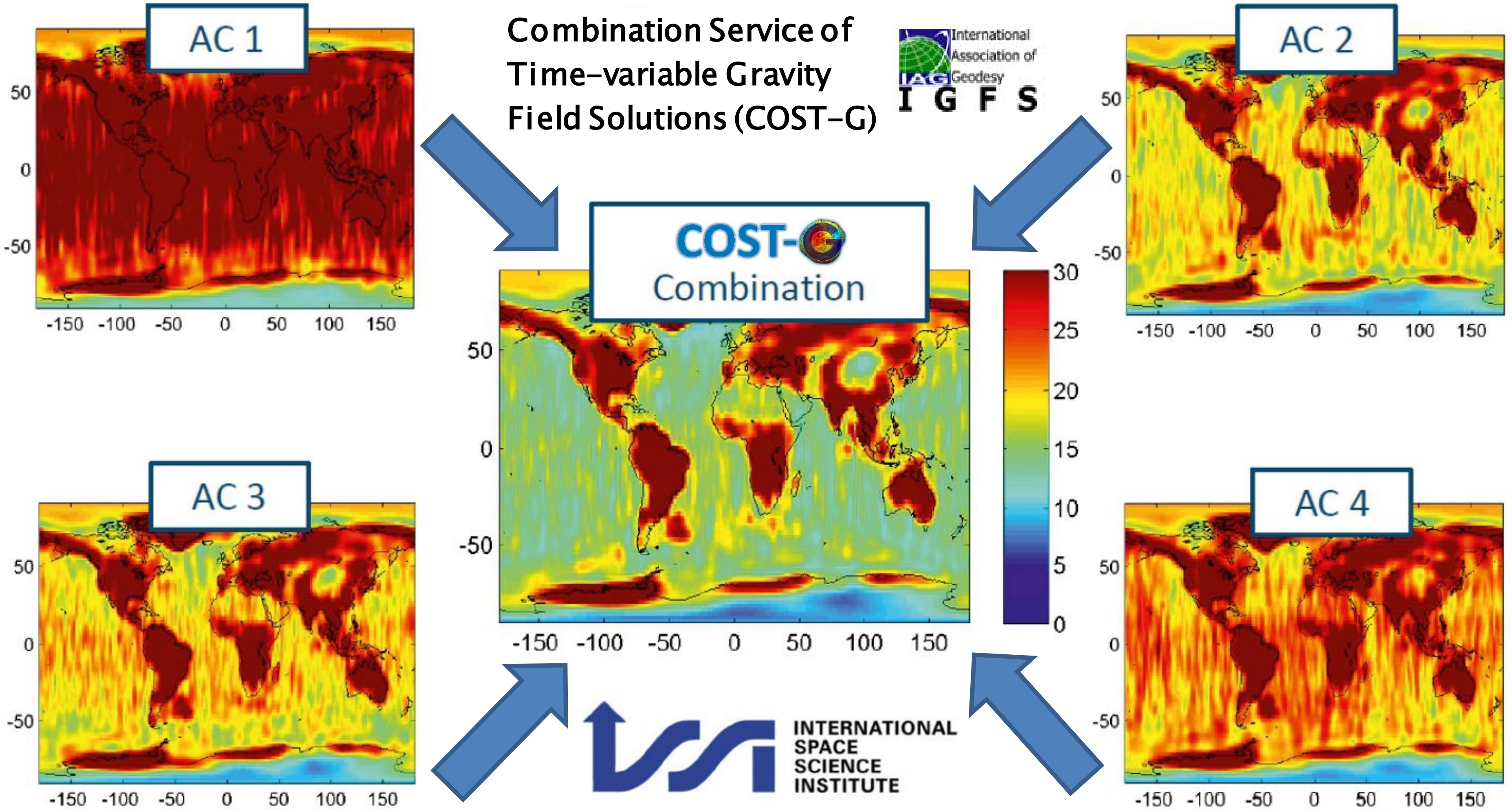
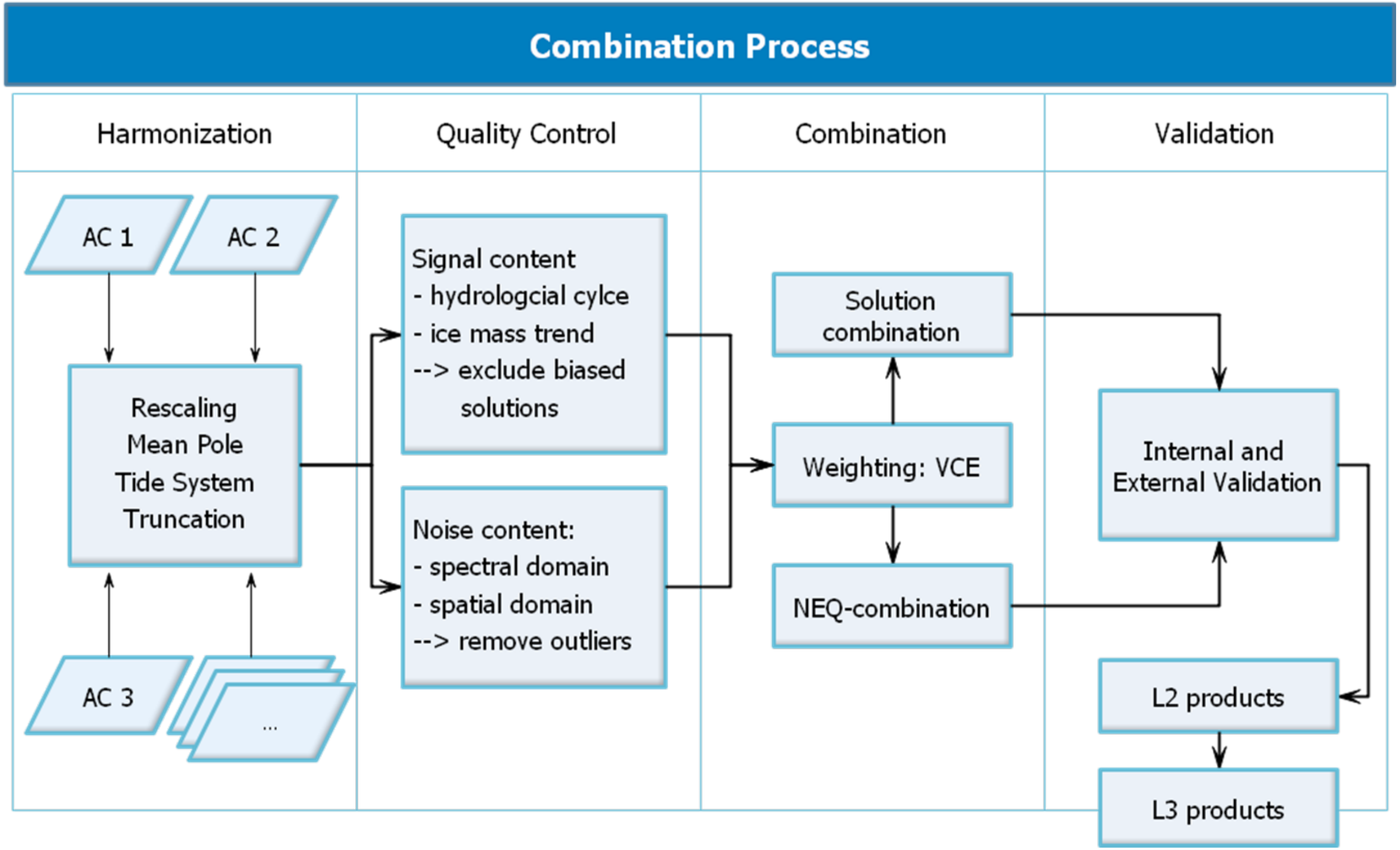
Combination Service for Time-variable Gravity Fields (COST-G)

Introduction to COST-G

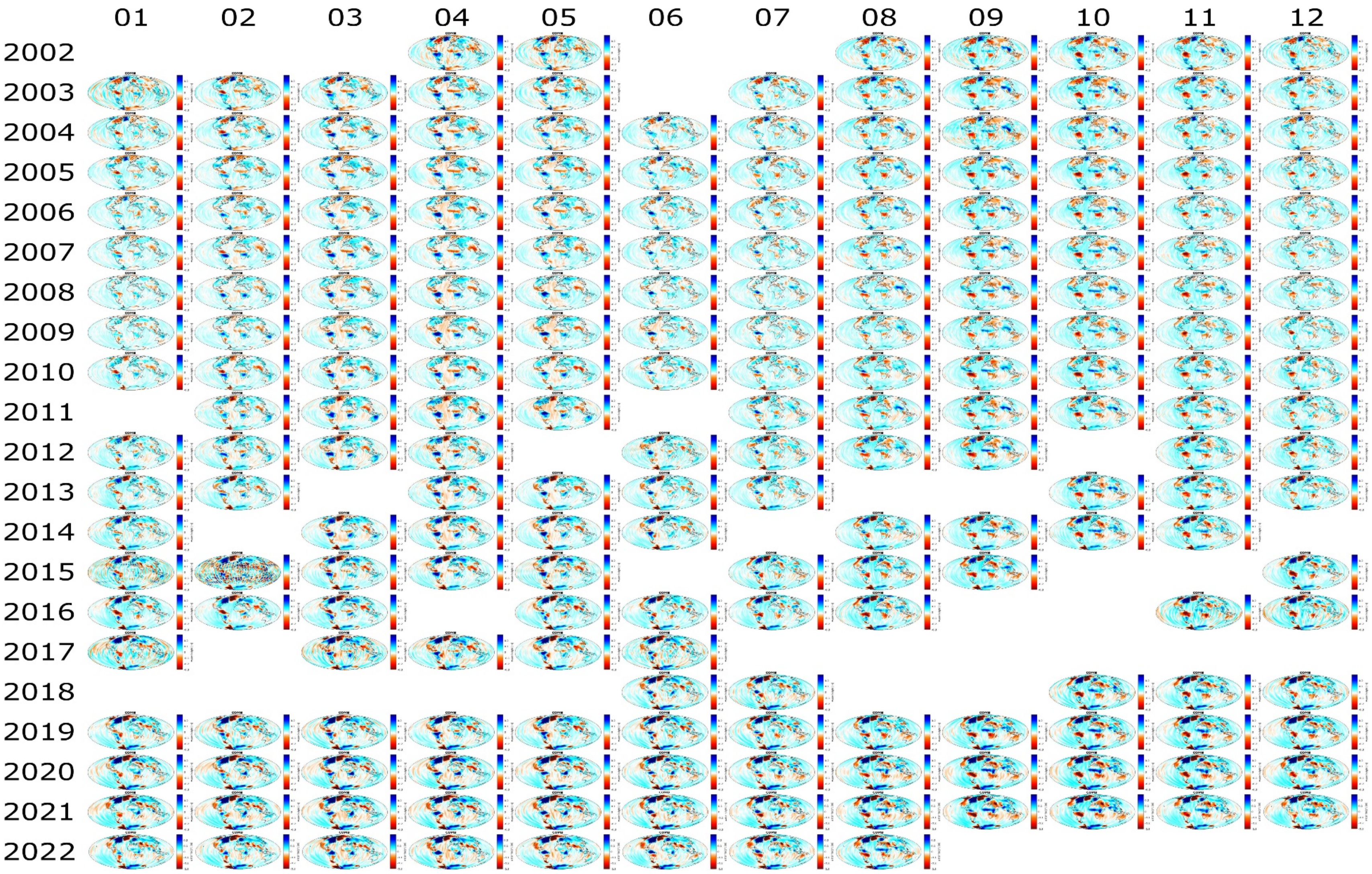


Improved and consolidated product integrating the strengths of all ACs

Workflow of COST-G

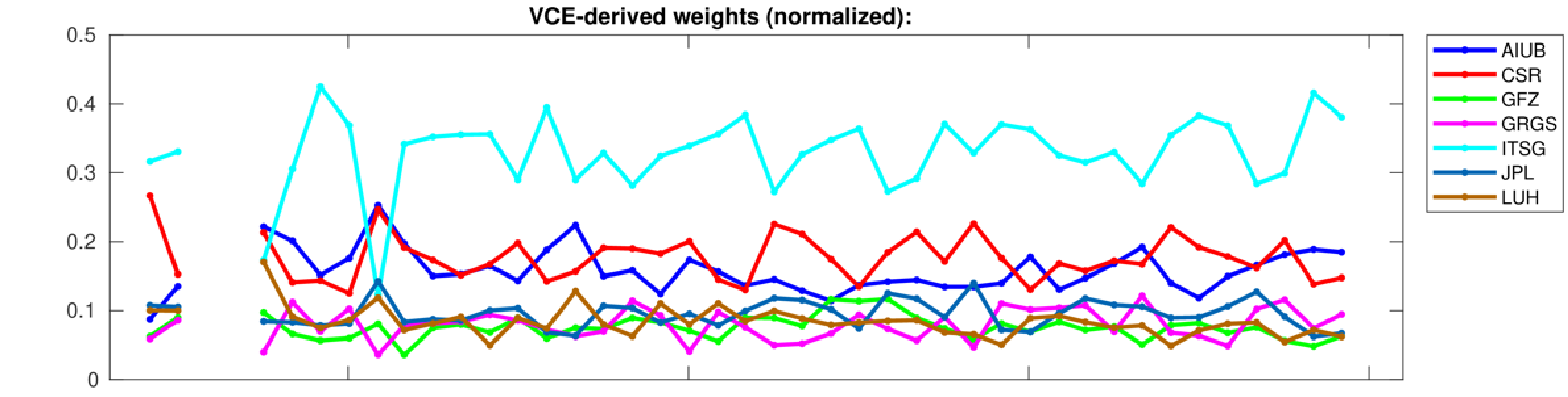


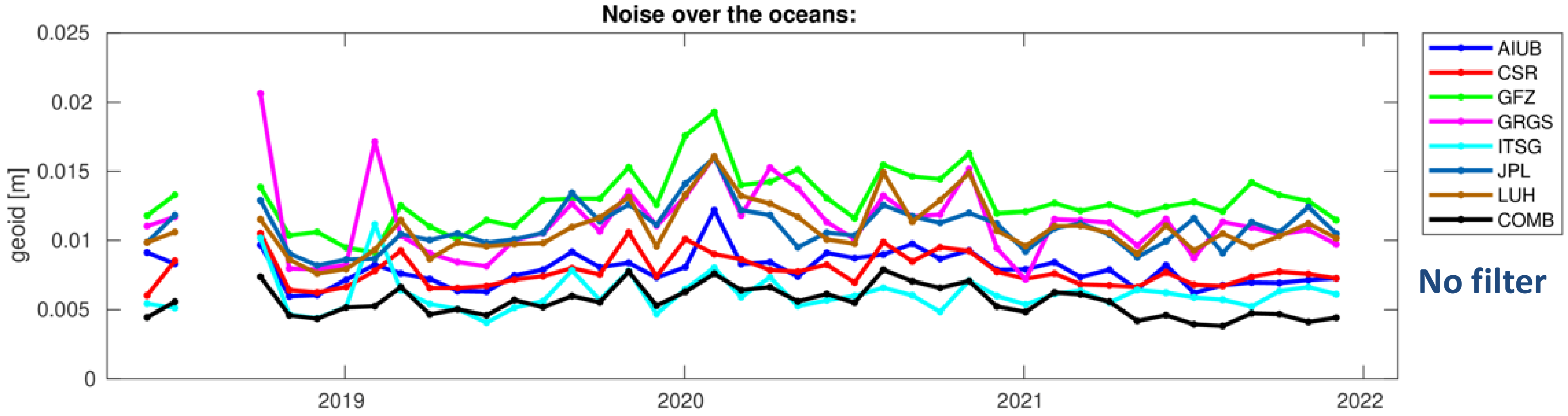
GRACE-FO operational combined monthly gravity fields



Flawless and uninterrupted operational combination with a latency < 2-3 months.

Weighted combination and validation of the Combined Solution

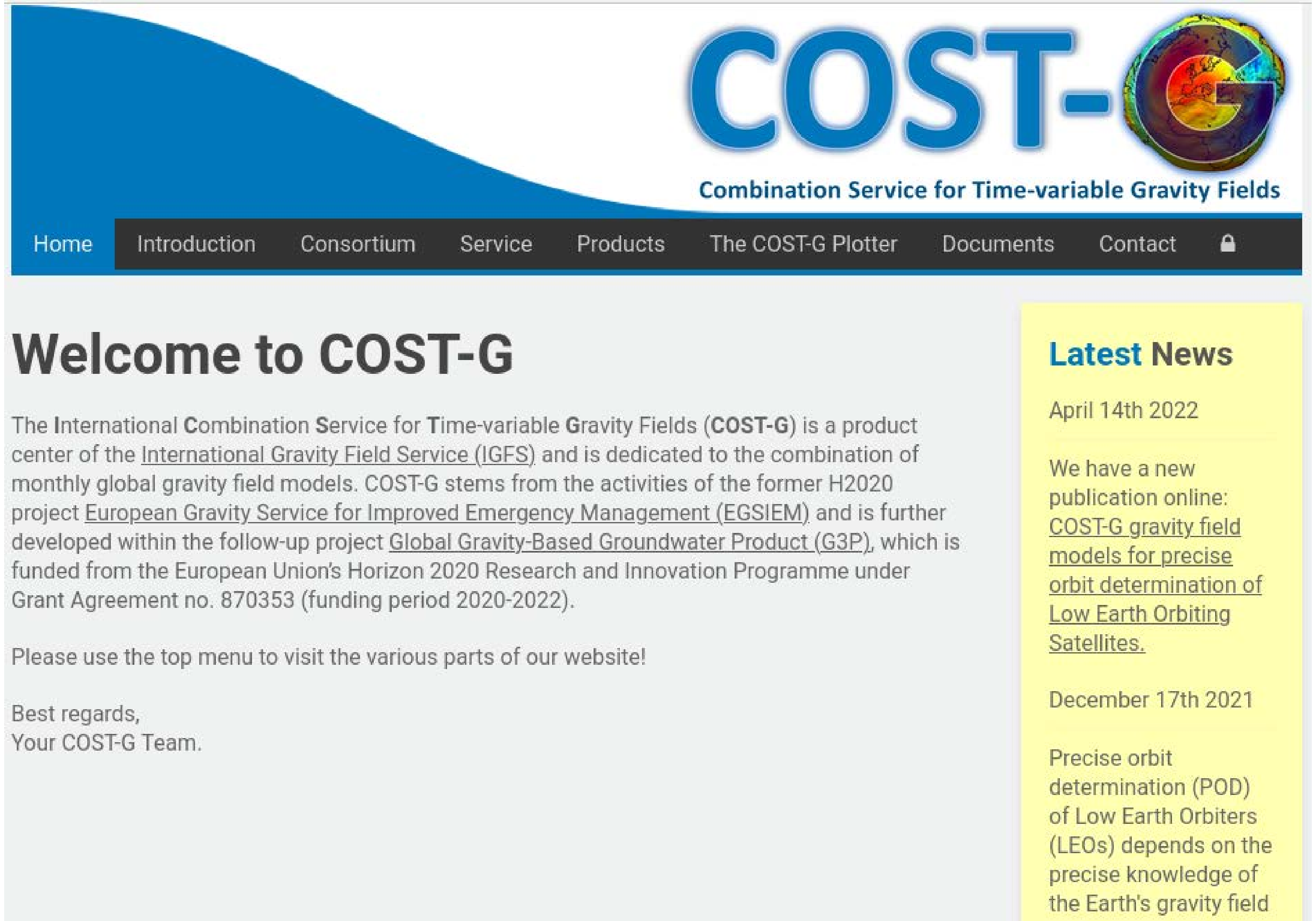




No filter

Combination outperforms all individual solutions in 2021

https://cost-g.org/


COST-G
Combination Service for Time-variable Gravity Fields

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Welcome to COST-G

The **I**nternational **C**ombination **S**ervice for **T**ime-variable **G**ravity Fields (**COST-G**) is a product center of the International Gravity Field Service (IGFS) and is dedicated to the combination of monthly global gravity field models. COST-G stems from the activities of the former H2020 project European Gravity Service for Improved Emergency Management (EGSIEM) and is further developed within the follow-up project Global Gravity-Based Groundwater Product (G3P), which is funded from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement no. 870353 (funding period 2020-2022).

Please use the top menu to visit the various parts of our website!

Best regards,
Your COST-G Team.

Latest News

April 14th 2022

We have a new publication online: COST-G gravity field models for precise orbit determination of Low Earth Orbiting Satellites.

December 17th 2021

Precise orbit determination (POD) of Low Earth Orbiters (LEOs) depends on the precise knowledge of the Earth's gravity field

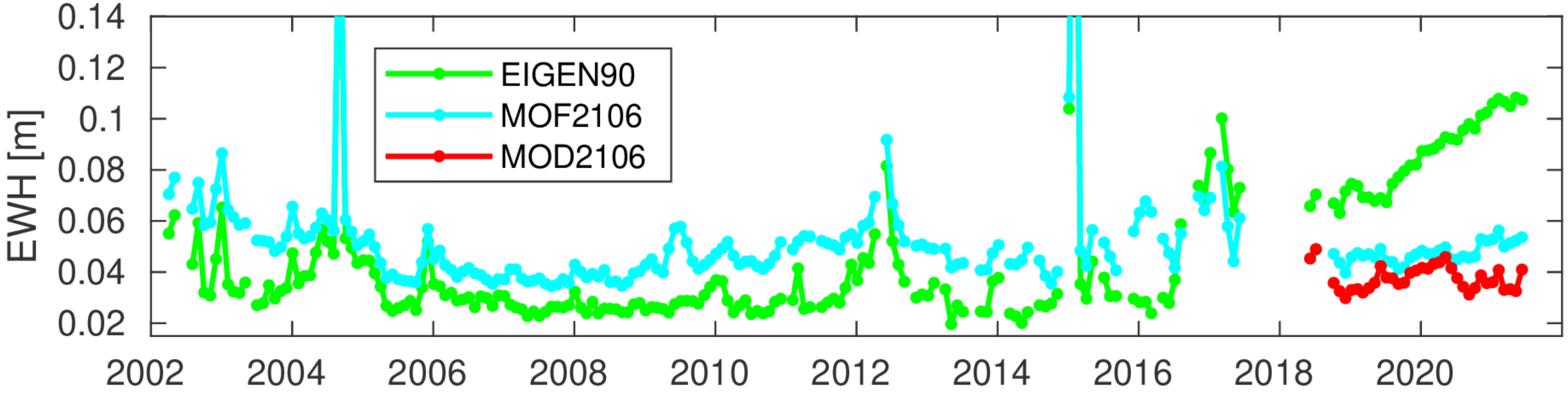
For background information on COST–G and links to products take a look at: https://cost-g.org/

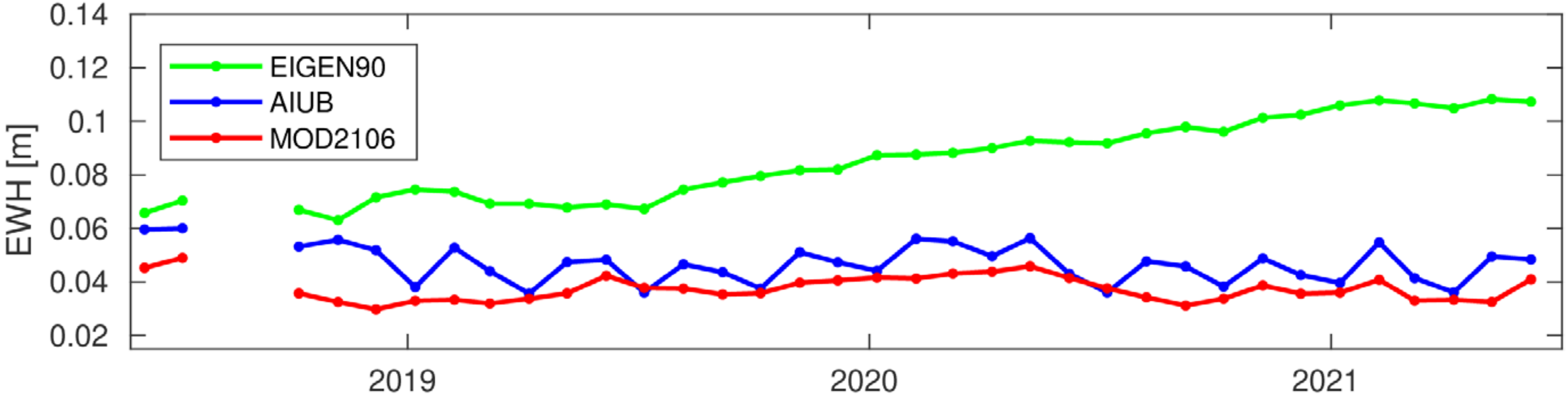
Peter H, Meyer U, Lasser M, Jäggi A (2022): COST-G gravity field models for precise orbit determination of Low Earth Orbiting Satellites. Advances in Space Research (69), **12**, 4155-4168.
doi: 10.1016/j.asr.2022.04.005

COST-G

Fitted Signal Model (FSM) for operational LEO-POD

RMS of differences (over land, 300 km Gauss): FSM - monthly gravity fields



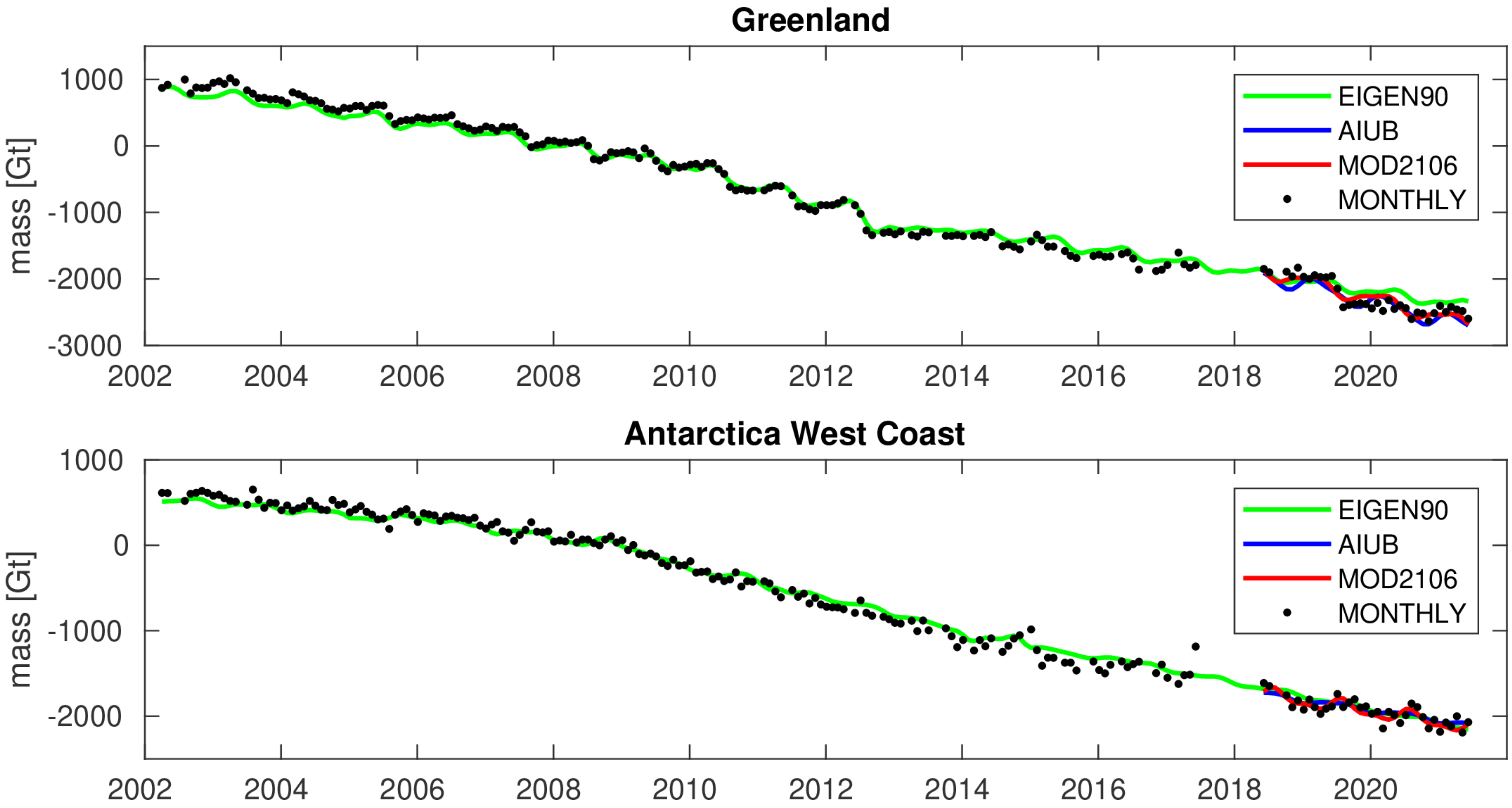


Operational precise orbit determination (POD) of low Earth orbiters (LEO) relies on a Earth gravity model including time-variable gravity (TVG).

The EIGEN-GRGS-RL04 model (green) has been the standard for LEO-POD of altimeter satellites, but the extrapolation to the GRACE-FO period reveals large prediction errors.

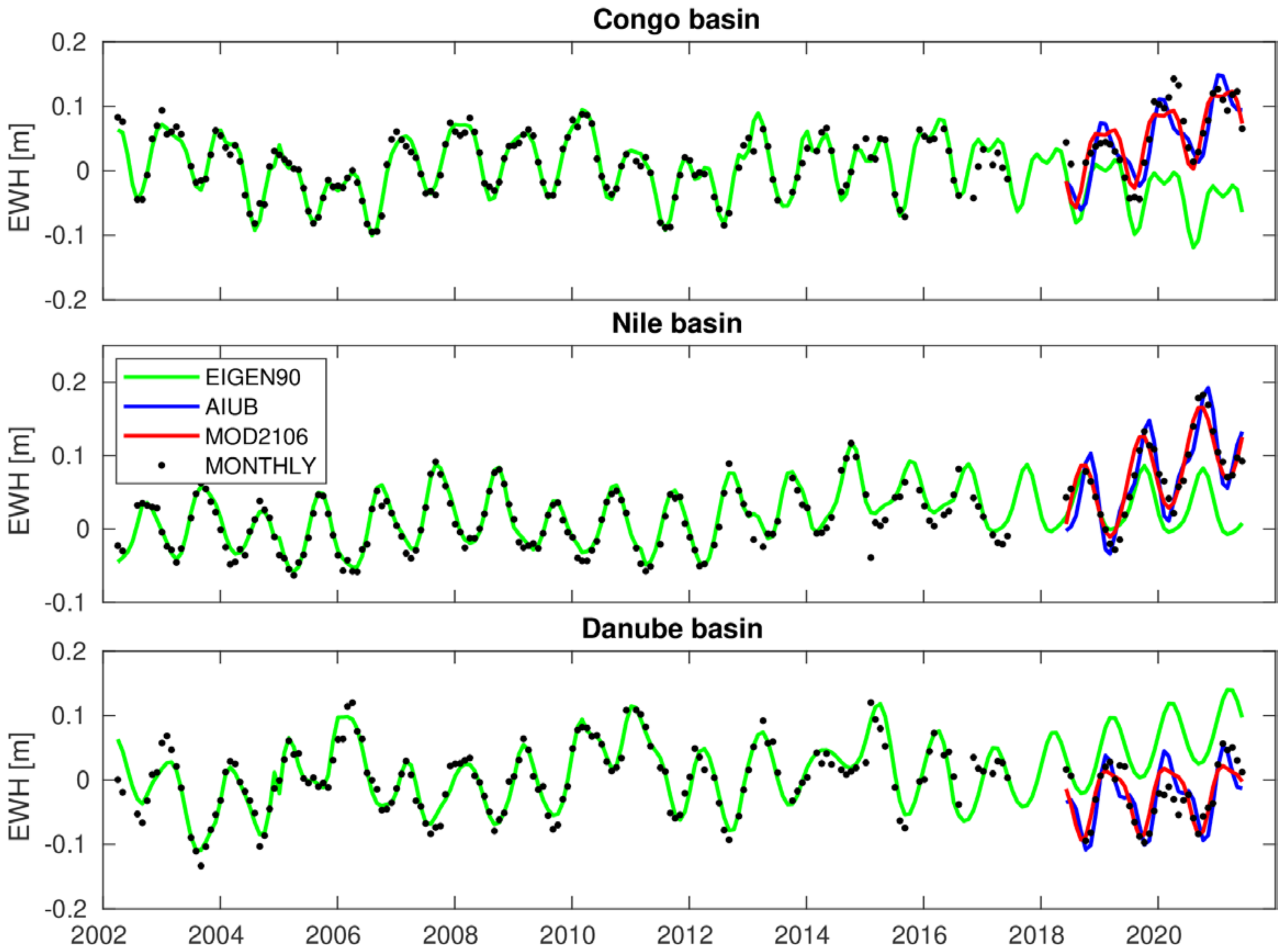
For comparison, a model fitted to COST-G GRACE-FO gravity fields is shown (red).

Polar mass trend (no filter)



Surprisingly, the reason for the prediction error in the EIGEN-GRGS-RL04 model (green) seems not to be in regions with strong mass trends.

Hydrological cycle in large river basins (300 km Gauss)

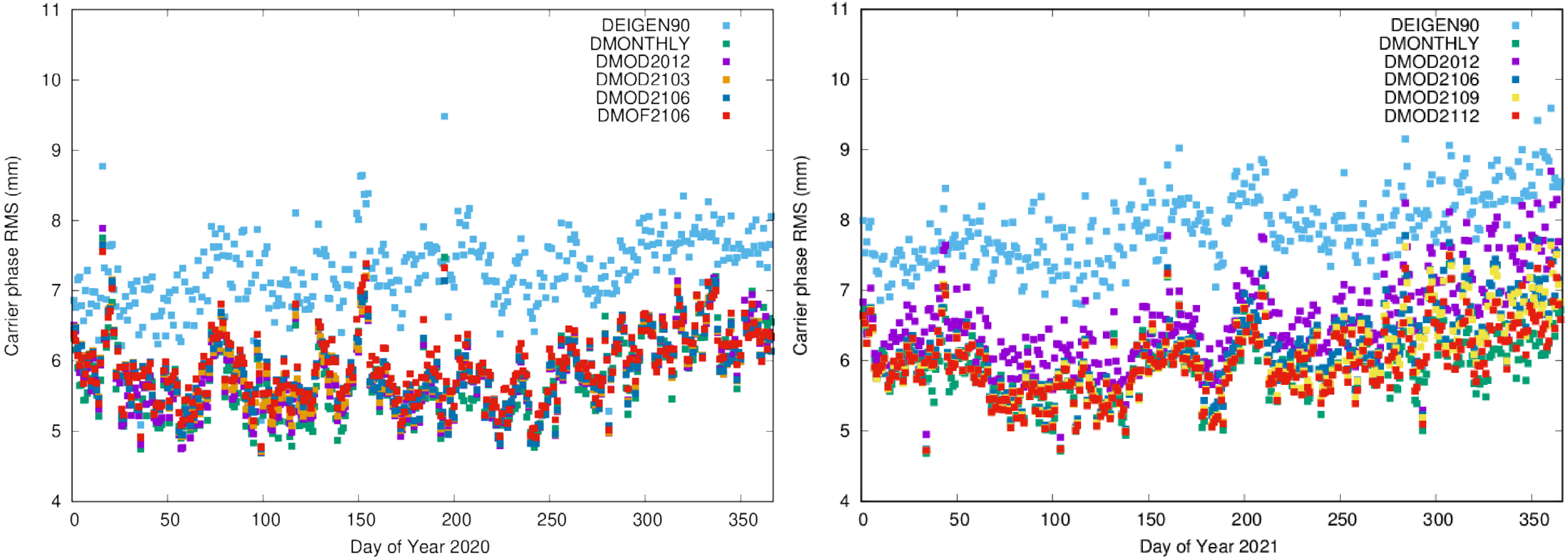


The time-series of monthly GRACE gravity field solutions was fitted in yearly batches for the EIGEN-GRGS-RL04 model.

While the fit in the GRACE period is very good, the extrapolation of the last of these batches leads to large errors in river basins with strong non-seasonal variations.

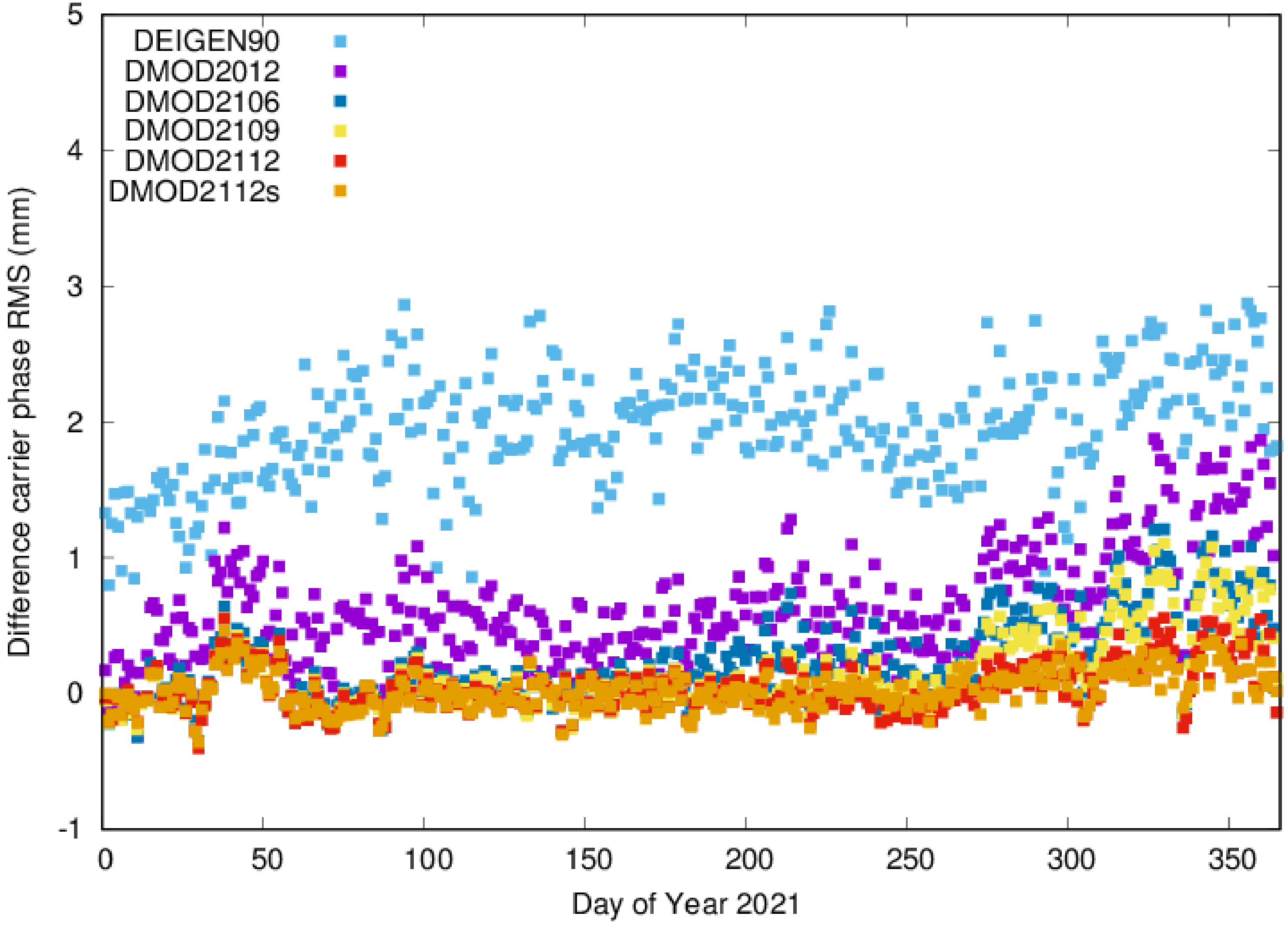
Application to Sentinel orbit POD

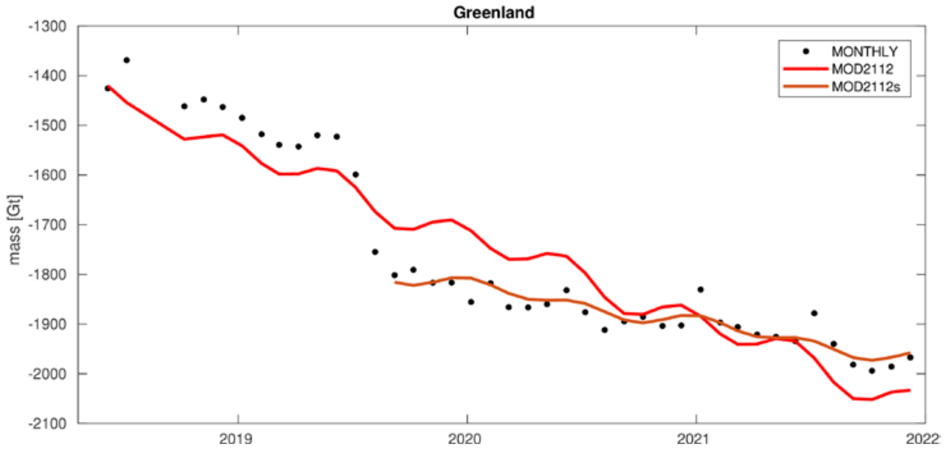
Sentinel - 3B (altitude 811 km) orbit determination



The carrier phase RMS of dynamic Sentinel-3B satellite orbits (orbit altitude 811 km) based on monthly GRACE-FO gravity fields (green) or different fitted signal models reveals the benefit of up-to-date models. All models were truncated at max. degree/order 90.

Impact of fit period on LEO-POD (Sentinel-3B, altitude 811 km)





Carrier phase residuals of Sentinel-3B orbits (811 km orbit altitude) confirm the sensitivity on the data period that entered the model.

Independent orbit validation

SLR-validation Sentinel-3B

Data: Year 2020, Sentinel-3B, SLR validation, 12 stations (cm)

Gravity field model	Mean (cm)	RMS (cm)	Standard deviation (cm)
DEIGEN120	0.29	1.01	0.97
DEIGEN90	0.29	1.01	0.97
D90MONTHLY	0.28	0.91	0.87
D90MODEL2012	0.28	0.92	0.88
RDEIGEN120	0.31	0.91	0.85
RDEIGEN90	0.31	0.91	0.85
RD90MONTHLY	0.31	0.88	0.82

The limited max. degree does not negatively affect LEO POD (S3B)

LEO POD profits from monthly gravity fields

The fitted signal models perform close to the monthly gravity fields

Reduced dynamic LEO POD is less sensitive to model deficiencies.

GOCE orbit fit

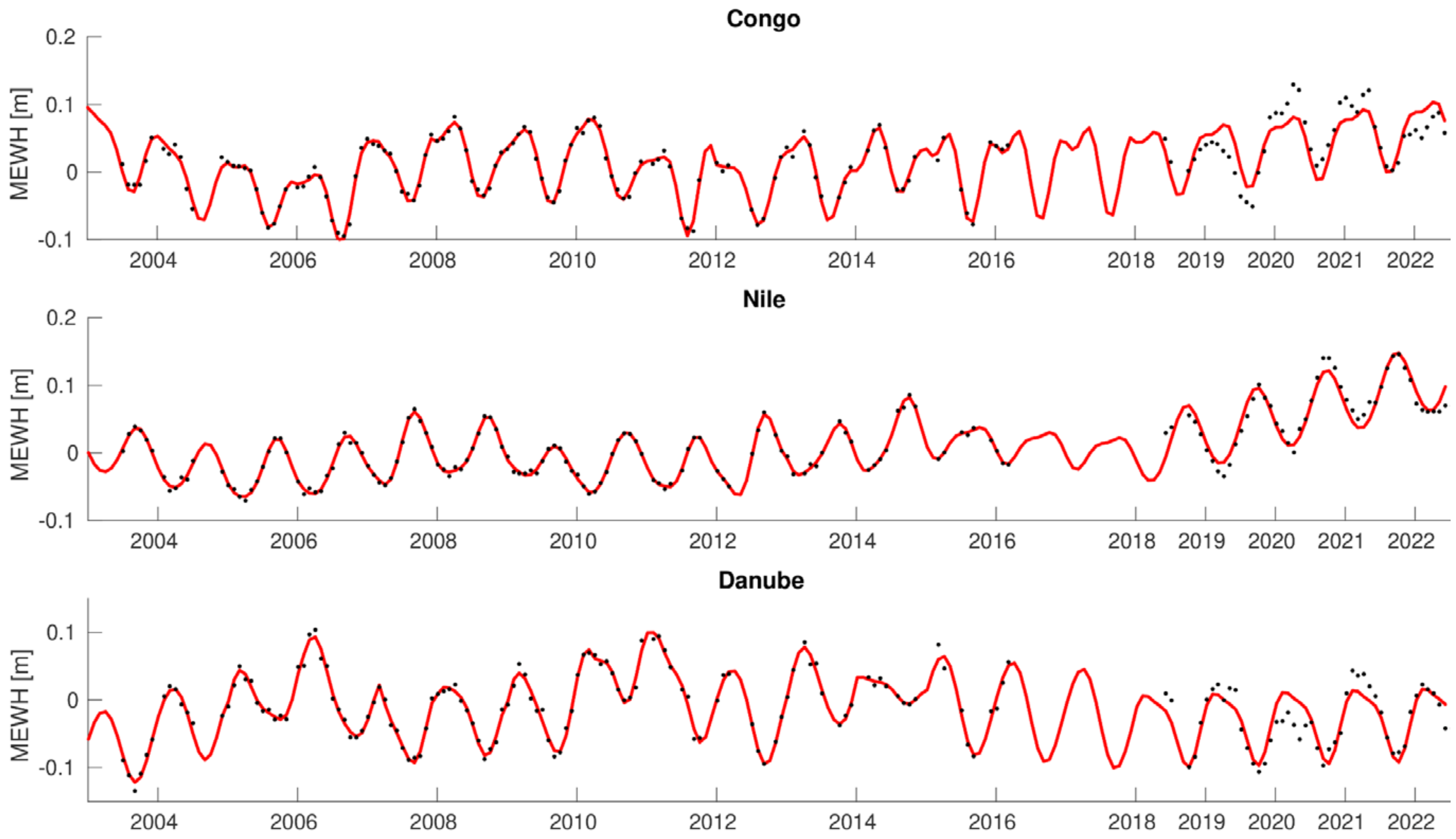
3D-RMS values **[cm]** of the orbit fit residuals (mean values from the involved arcs)
Parametrization: 6 orbital elements, accelerometer biases 1/arc (3 directions)

	March			April			June			December		
Model/Month	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
COST-G FSM	5,53	5,77	6,30	5,37	5,72	6,39	5,39	5,86	6,63	5,48	6,05	7,78
COST-G monthly	6,42	7,10	7,27	6,36	7,06	7,84	6,40	7,36	7,62	6,94	7,51	7,57
COST-G (G3P)	5,92	6,76	6,79	5,99	6,55	7,30	5,85	6,68	6,86	6,38	6,77	7,21
ITSG-Grace_operational_n96	5,94	6,95	7,11	5,93	6,69	7,08	5,68	6,33	6,77	6,17	6,95	7,36

– COST-G fitted signal models (FSM), augmented by high-degree coefficients from a static field (GOCO06S), show signifcant improvement w.r.t. the monthly models of ITSG and COST-G in almost all cases!

Outlook

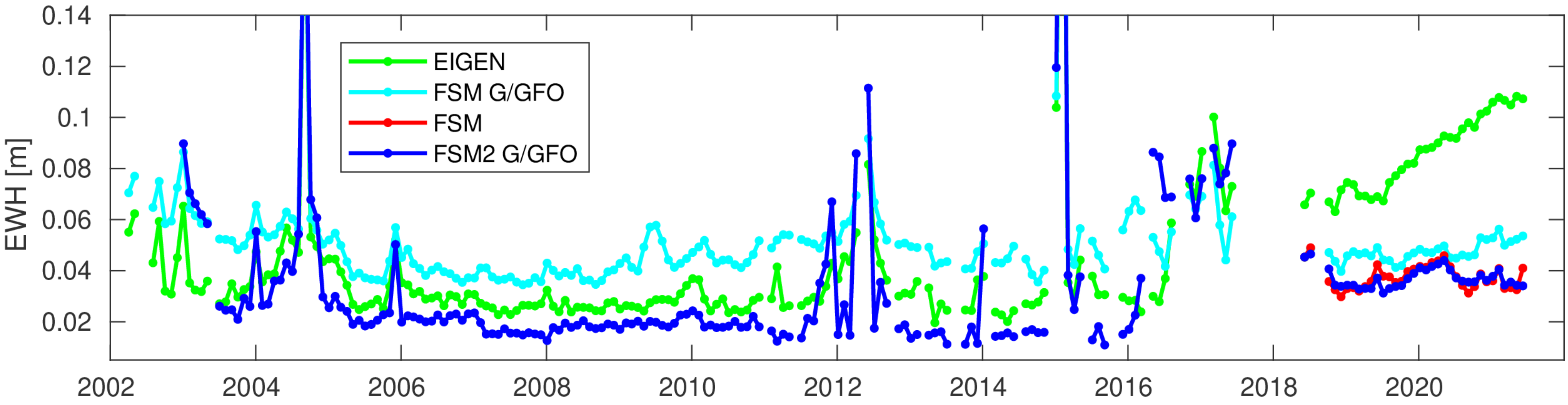
Extension of COST-G FSM for REPRO purposes



Extension of the COST-G FSM to cover the whole GRACE/GRACE-FO period:

- Fit of GRACE monthly models in yearly batches
- Continuity conditions between individual batches
- Fit of GRACE-FO monthly models in one batch to allow for prediction.

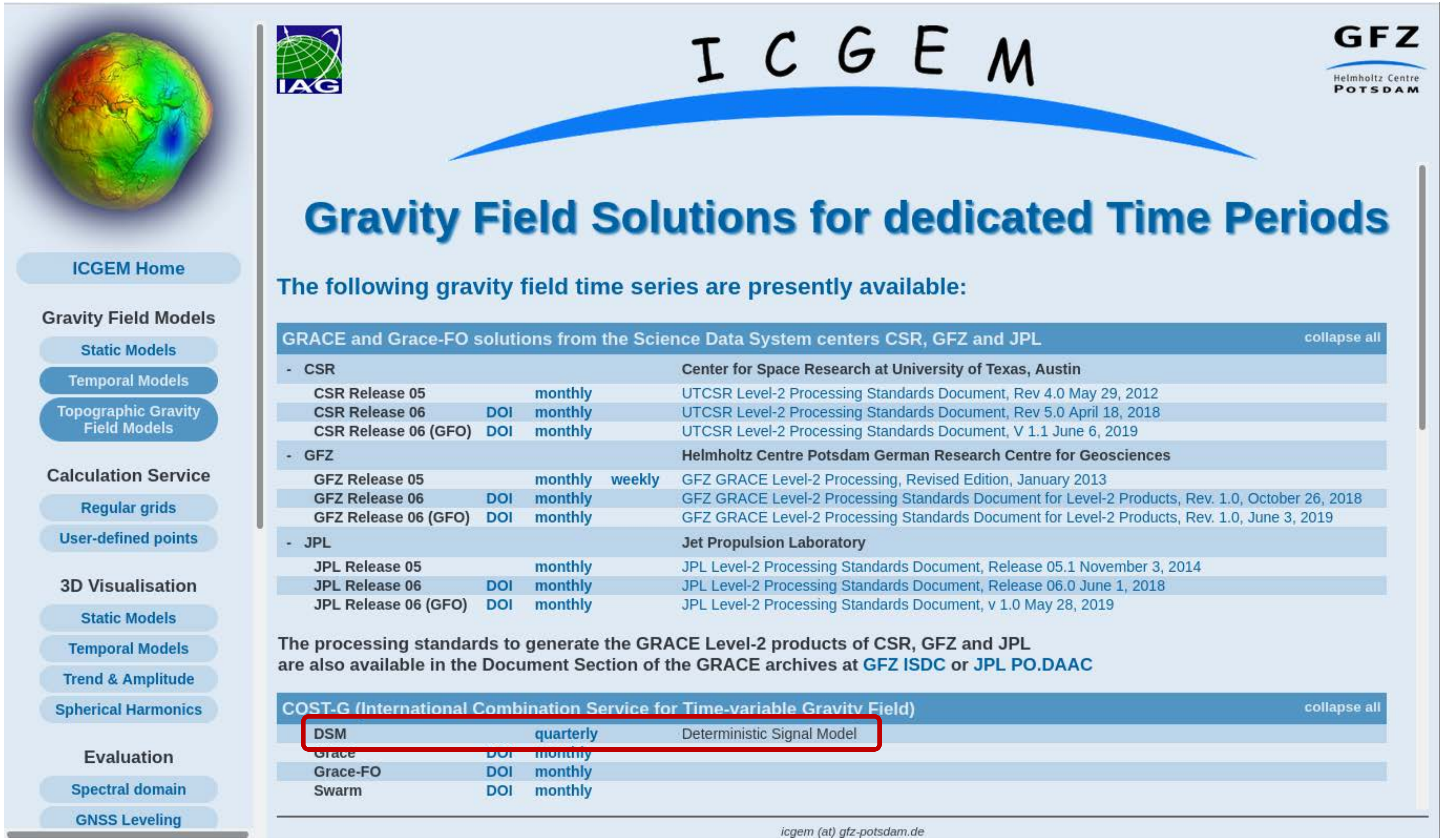
Consistency with monthly models



The monthly GRACE gravity fields were screened prior to the fit of the extended COST-G FSM => outliers indicate monthly solutions of inferior quality.

Where to get the COST-G fitted signal models?

http://icgem.gfz-potsdam.de/series



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Gravity Field Models
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- Temporal Models
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Calculation Service
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- Spectral domain
- GNSS Leveling

IAG

I C G E M

GFZ Helmholtz Centre Potsdam

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	

icgem (at) gfz-potsdam.de

The COST-G fitted signal model is available in the ICGEM.2-format from the International Center for Global Earth Models (ICGEM).

The COST-G FSM is updated quarterly with the newest combined monthly GRACE-FO gravity fields.