

Combination Service for Time-variable Gravity Fields (COST-G) – one year of operational service

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43rd COSPAR Scientific Assembly

28 January – 4 February 2021, Sydney, Australia



Introduction

Gravity and geoid metadata

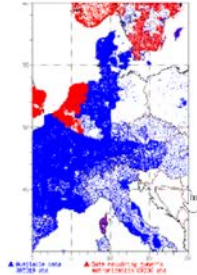
Online applications for the creation of metadata for gravity and geoid data. Service for searching the metadata database.

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

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

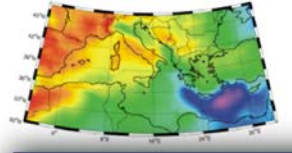
Gravity data

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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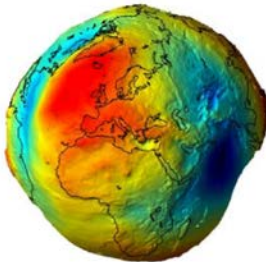
SG and Earth tide data

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.



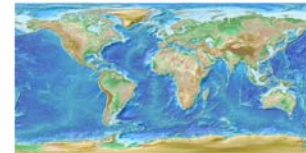
Time-variable GEMs

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.



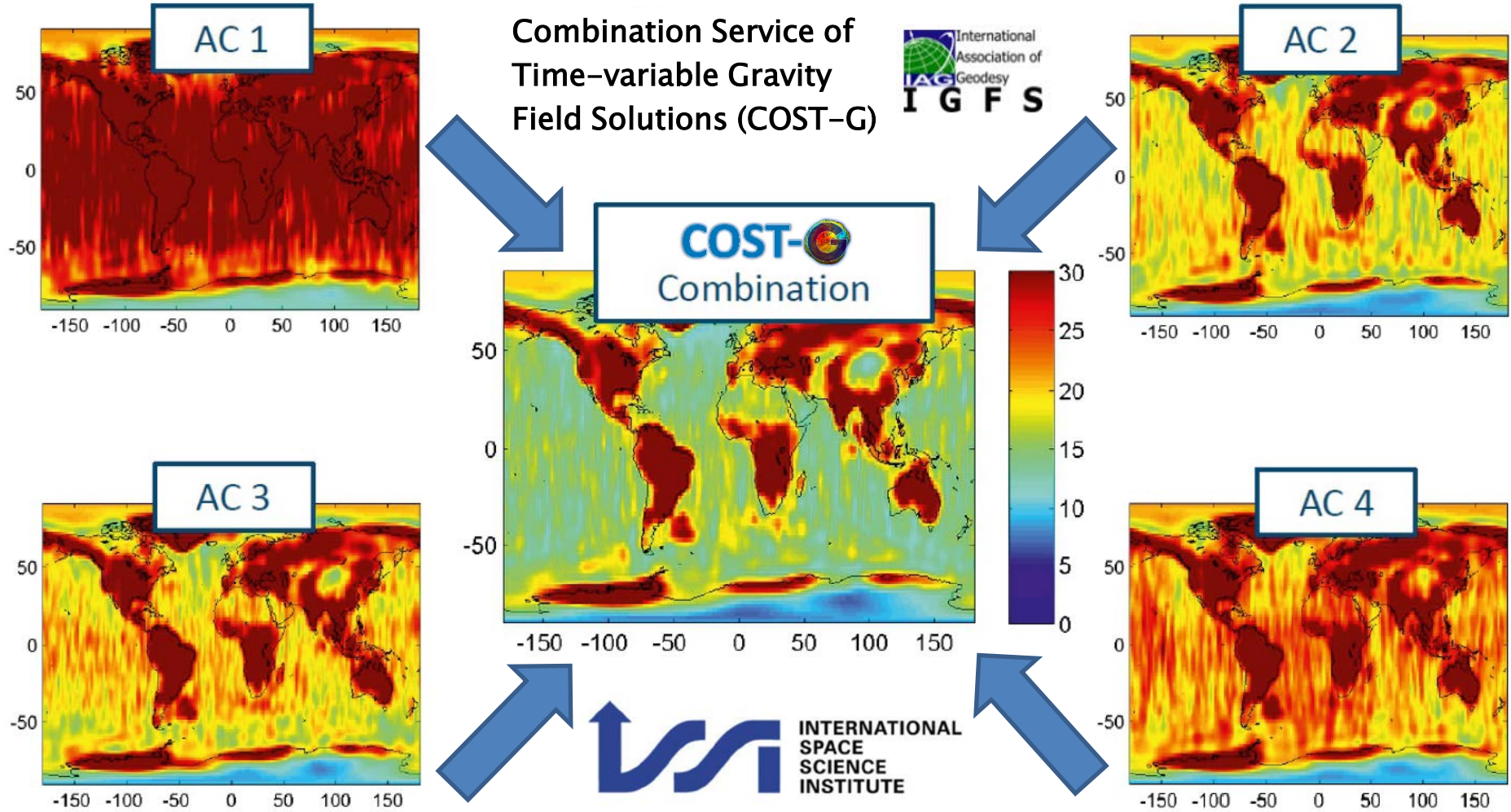
COST-G is a product center of the



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



Introduction



Improved and consolidated product integrating the strengths of all ACs



COST-G Website



Combination Service for Time-variable Gravity Fields

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The COST-G Plotter



Welcome to COST-G

The International Combination Service for Time-variable Gravity 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).

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

The service started its work in 2019 and the website is still under construction. More features will be available soon! We apologize for any inconvenience. For any questions, please contact us.

Best regards,
Your COST-G Team.

<https://cost-g.org/>

Latest News

November 4th 2020

Benchmark data for verifying background model implementations in orbit and gravity field determination software available here (Martin Lasser et al. 2020)

June 16th 2020

COST-G RL01 Level 2B and Level-3 products are available and the GravIS portal has been updated!



COST-G Website



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Latest News

November 23rd 2020

COST-G GRACE-FO monthly models are now available!

November 4th 2020

Benchmark data for verifying background model implementations in orbit and gravity field determination software available here (Martin Lasser et al. 2020)



Permanent Components of COST-G

COST-G accomplishes its objectives through the following permanent components and roles:

- **Central Bureau (CB) & Analysis Center Coordinator (ACC)**
 - AIUB
- **Analysis Centers (ACs)**
 - AIUB, CNES, GFZ, TUG
- **Candidate ACs: LUH, Chinese ACs**
- **Level-3 Center (L3C)**
 - GFZ
- **Validation Centers (VCs)**
 - GRGS, GFZ
- **Product Evaluation Group (PEG)**
 - A. Eicker, A. Groh, B. Meyssignac

GRACE/GRACE-FO
SDS (CSR, JPL)
contribute as partner
ACs to COST-G
combinations.

Current/Planned Combinations

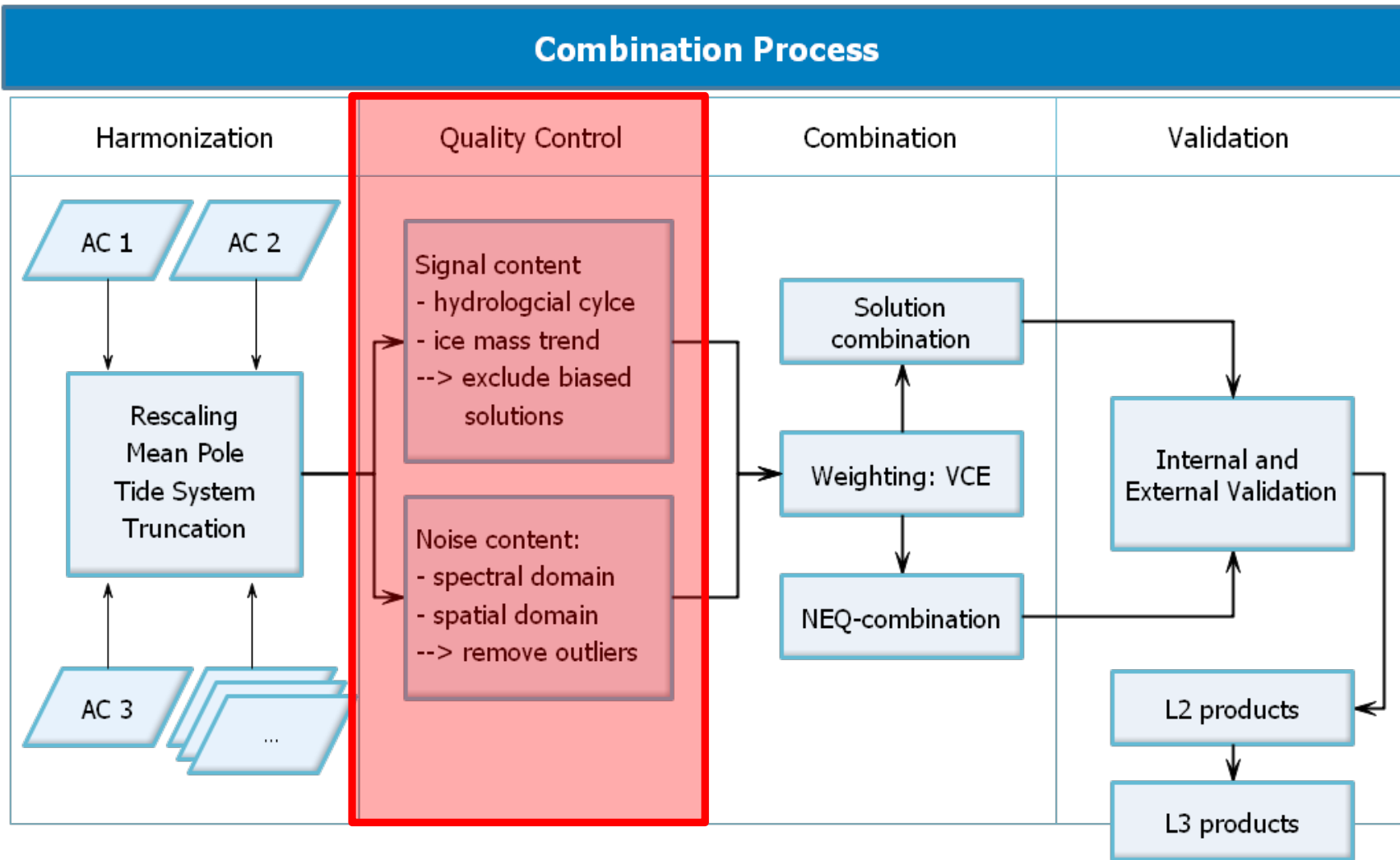
The COST-G ACs adopt different analysis methods but apply agreed-upon consistent processing standards to deliver time-variable gravity fields currently from:

- **GRACE/GRACE-FO low-low satellite-to-satellite tracking (ll-SST)**
- **Swarm high-low satellite-to-satellite tracking (hl-SST)**

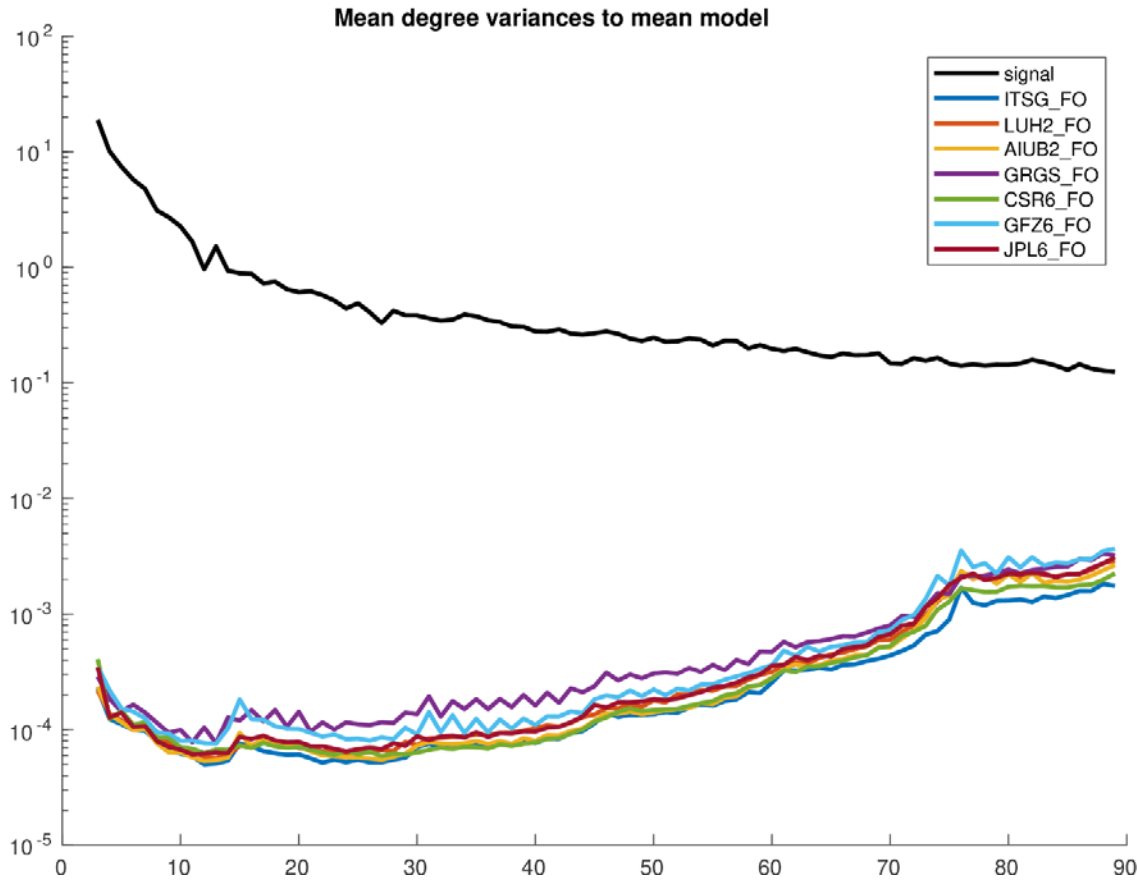
Extensions are discussed for:

- **Satellite Laser Ranging (SLR) to cannonball satellites**

COST-G Quality Control



Quality Control – Noise Levels (spectral domain)



GRACE-FO time-series:

COST-G ACs:

- AIUB-GRACE-FO_op
- GFZ-RL06 (GFO)
- GRGS-RL05: free solution
- ITSG-Grace_op

COST-G candidate AC:

- LUH

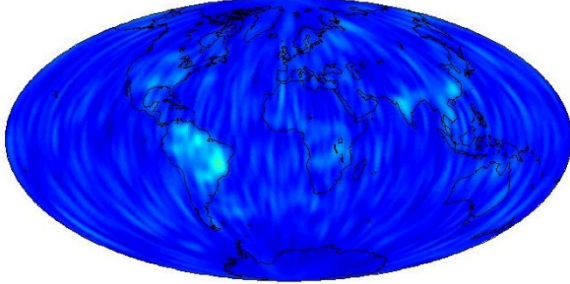
COST-G partner ACs:

- CSR-RL06 (GFO)
- JPL-RL06 (GFO)

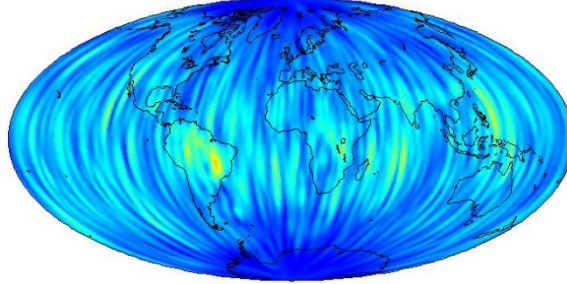
Degree-wise comparison of spherical harmonic coefficients to a deterministic signal model derived from the monthly means of all time-series (GRACE-FO).

Quality Control – Noise Levels (spatial domain)

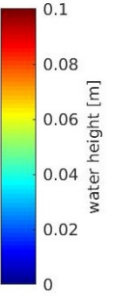
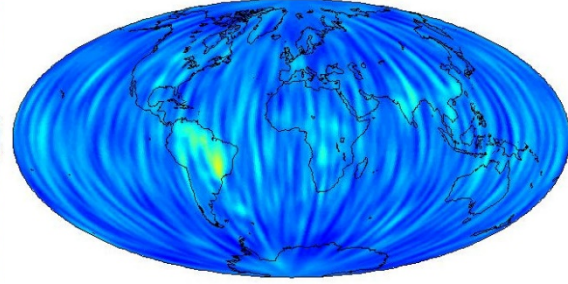
RMS of anomalies of ITSG_FO, expressed in EWH



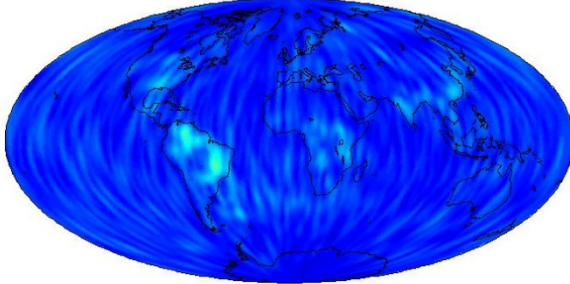
RMS of anomalies of GRGS_FO, expressed in EWH



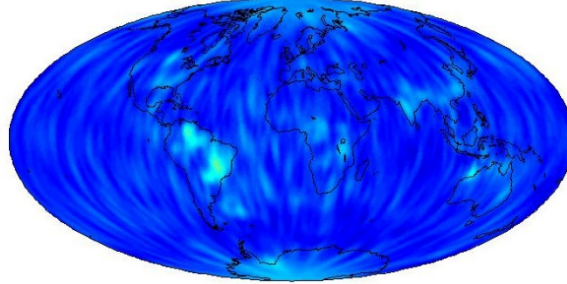
RMS of anomalies of GFZ6_FO, expressed in EWH



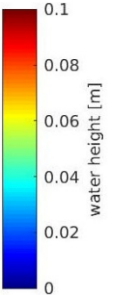
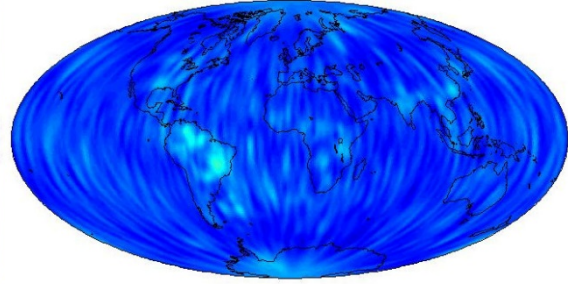
RMS of anomalies of LUH2_FO, expressed in EWH



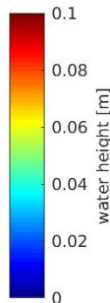
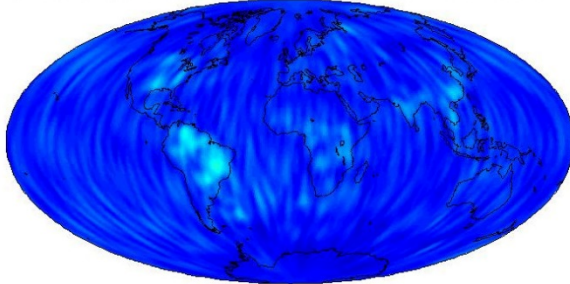
RMS of anomalies of CSR6_FO, expressed in EWH



RMS of anomalies of JPL6_FO, expressed in EWH

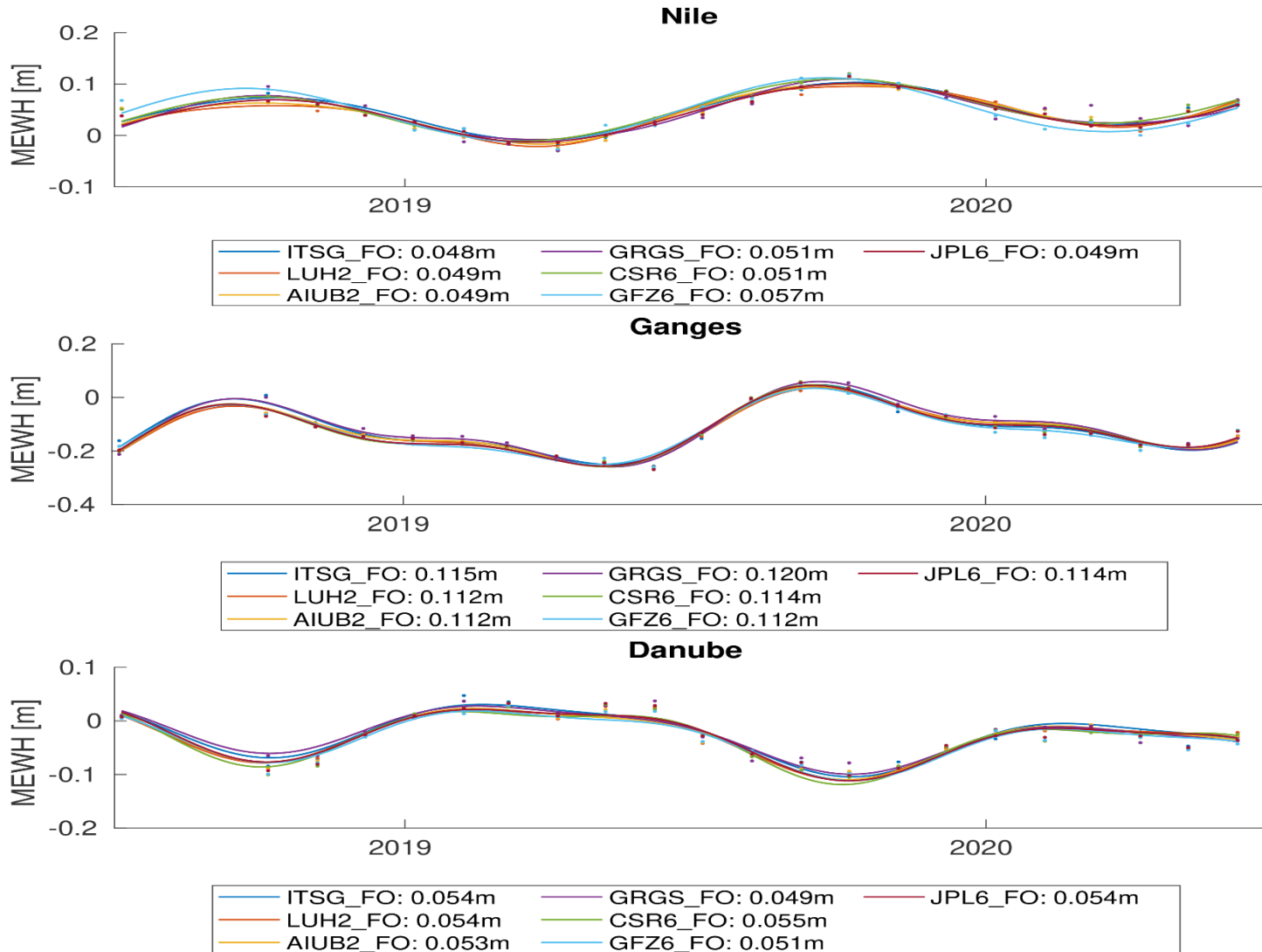


RMS of anomalies of AIUB2_FO, expressed in EWH



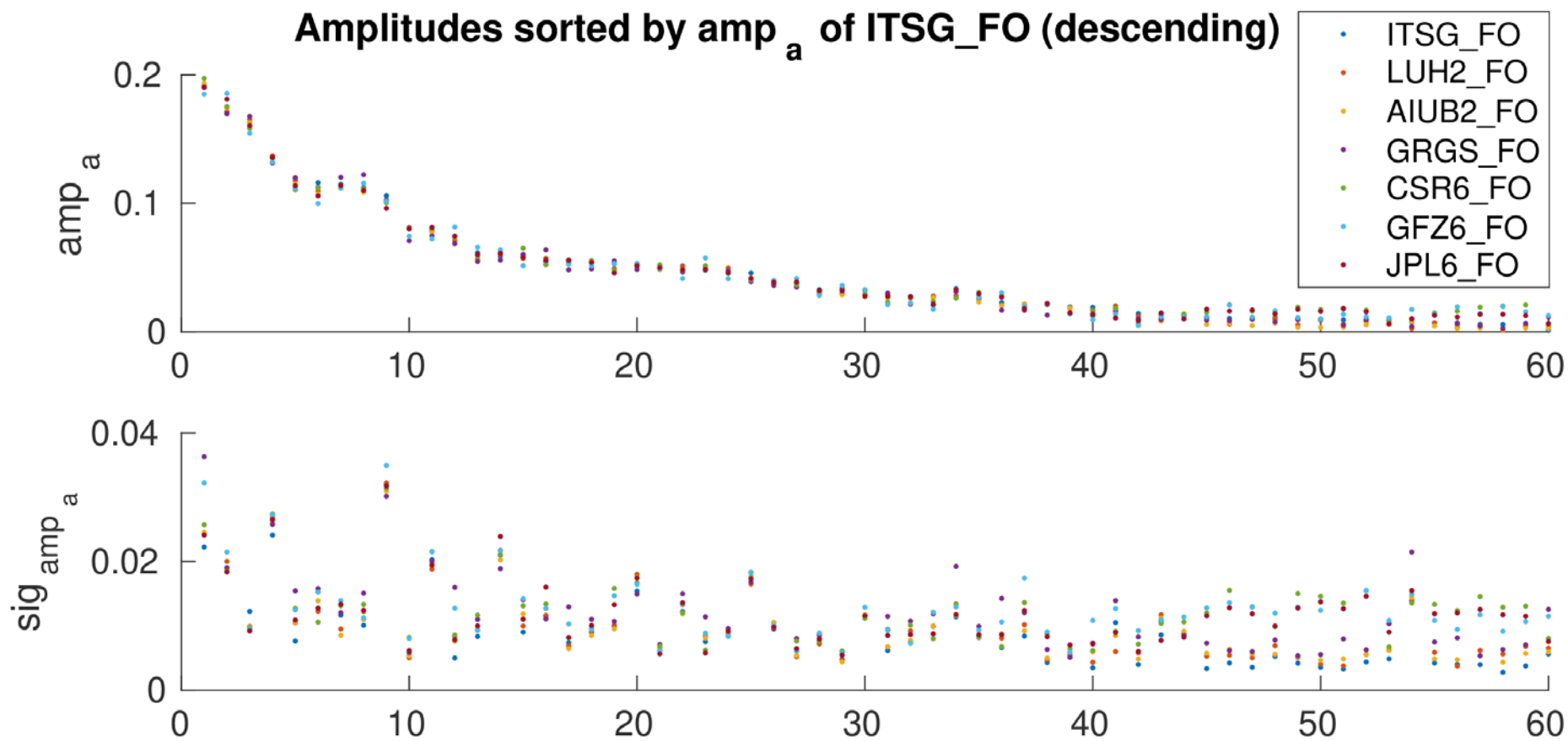
Comparison of monthly grids to a deterministic signal model derived from the monthly means of all time-series (GRACE-FO). Shown are the RMS-values per grid cell over a common subset of monthly solutions per time-series.

Quality Control – Signal Content (Hydrology)



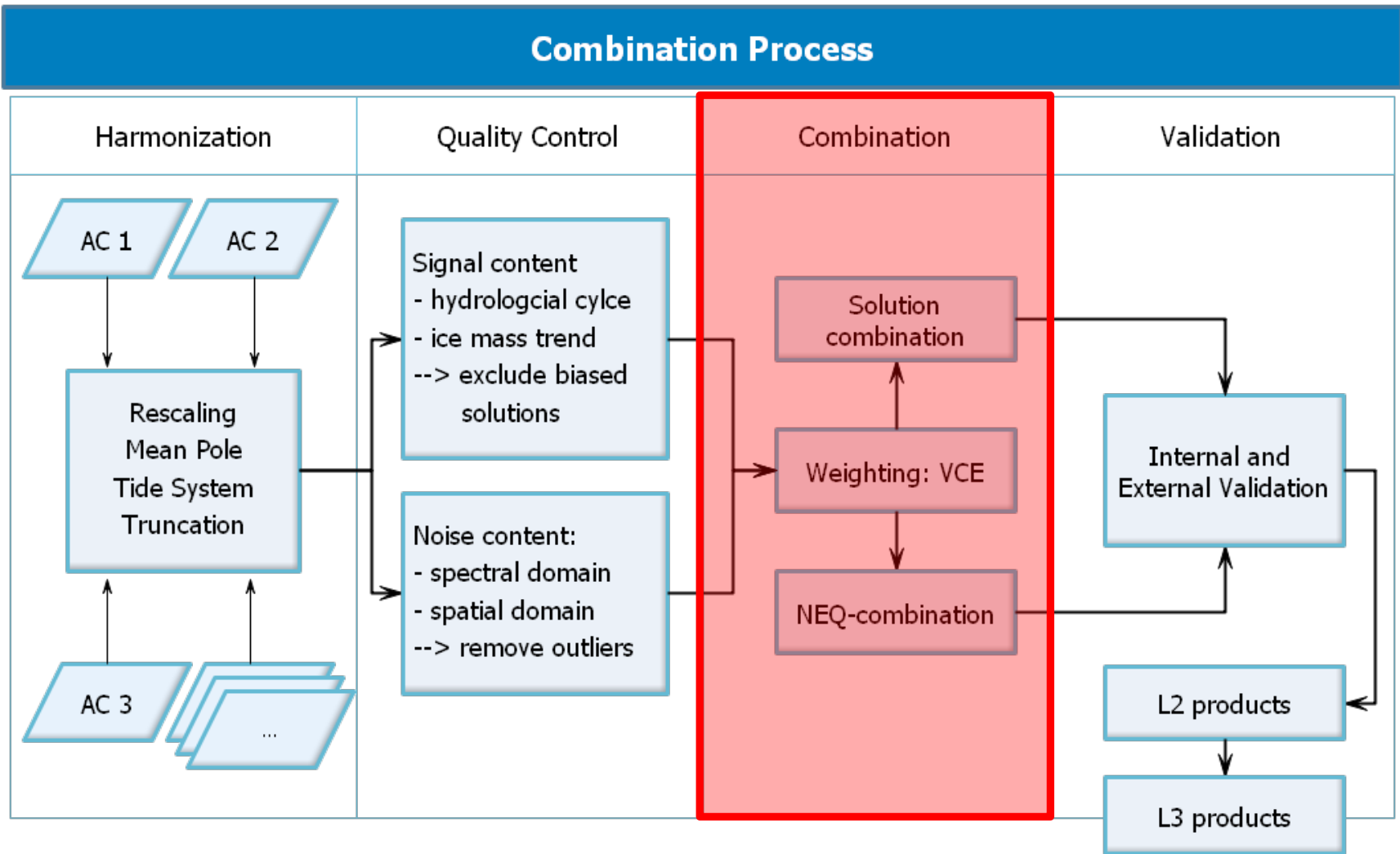
Example: fit of seasonal variations in selected river basins (GFO).

Quality Control – Signal Content (Hydrology)



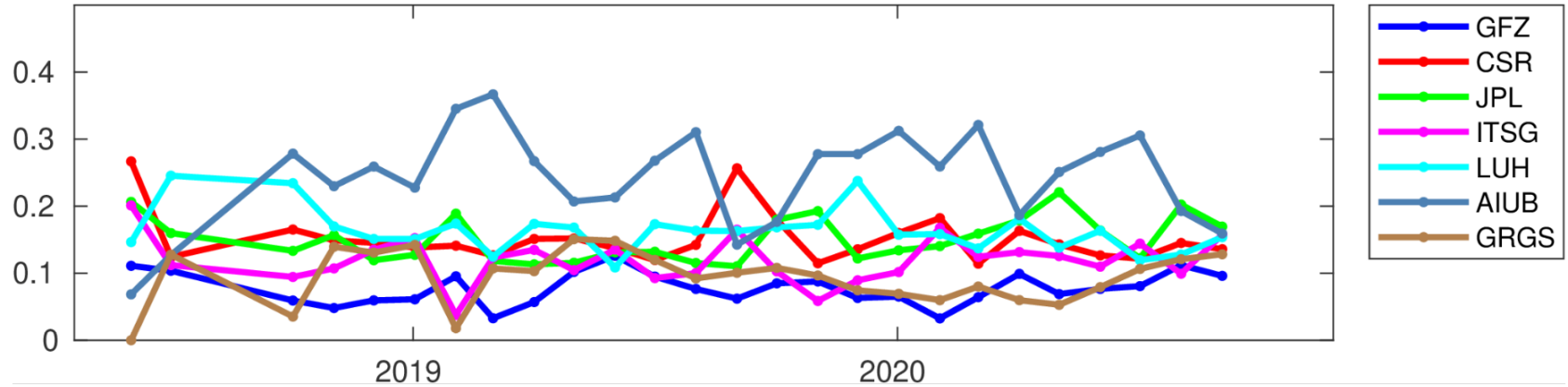
Comparison of amplitudes amp_a of seasonal mass variations and their formal errors sig_{amp} in 60 major river basins.

COST-G – Combination

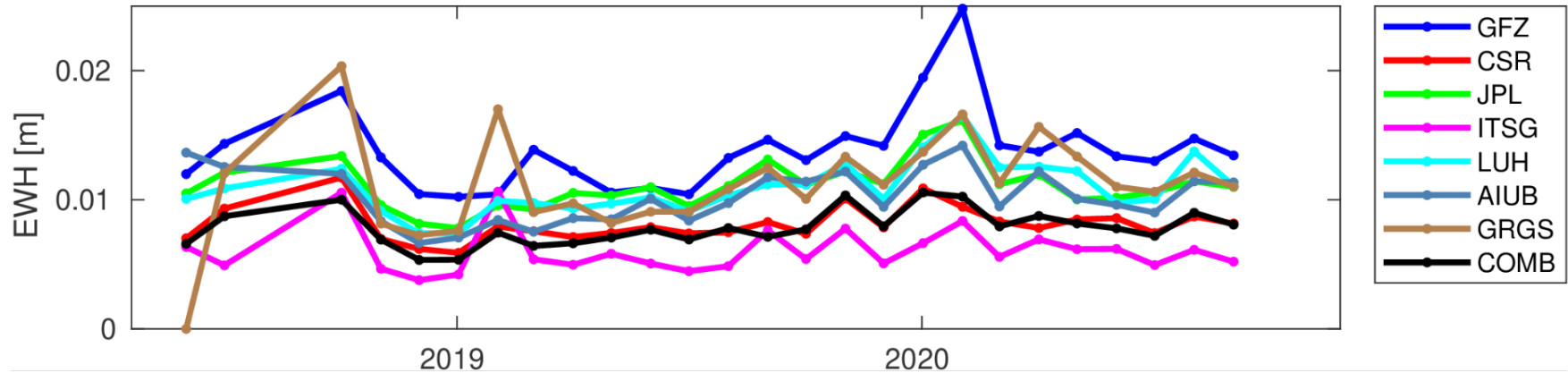


Combination applying Variance Component Estimation

VCE-derived weights (normalized):

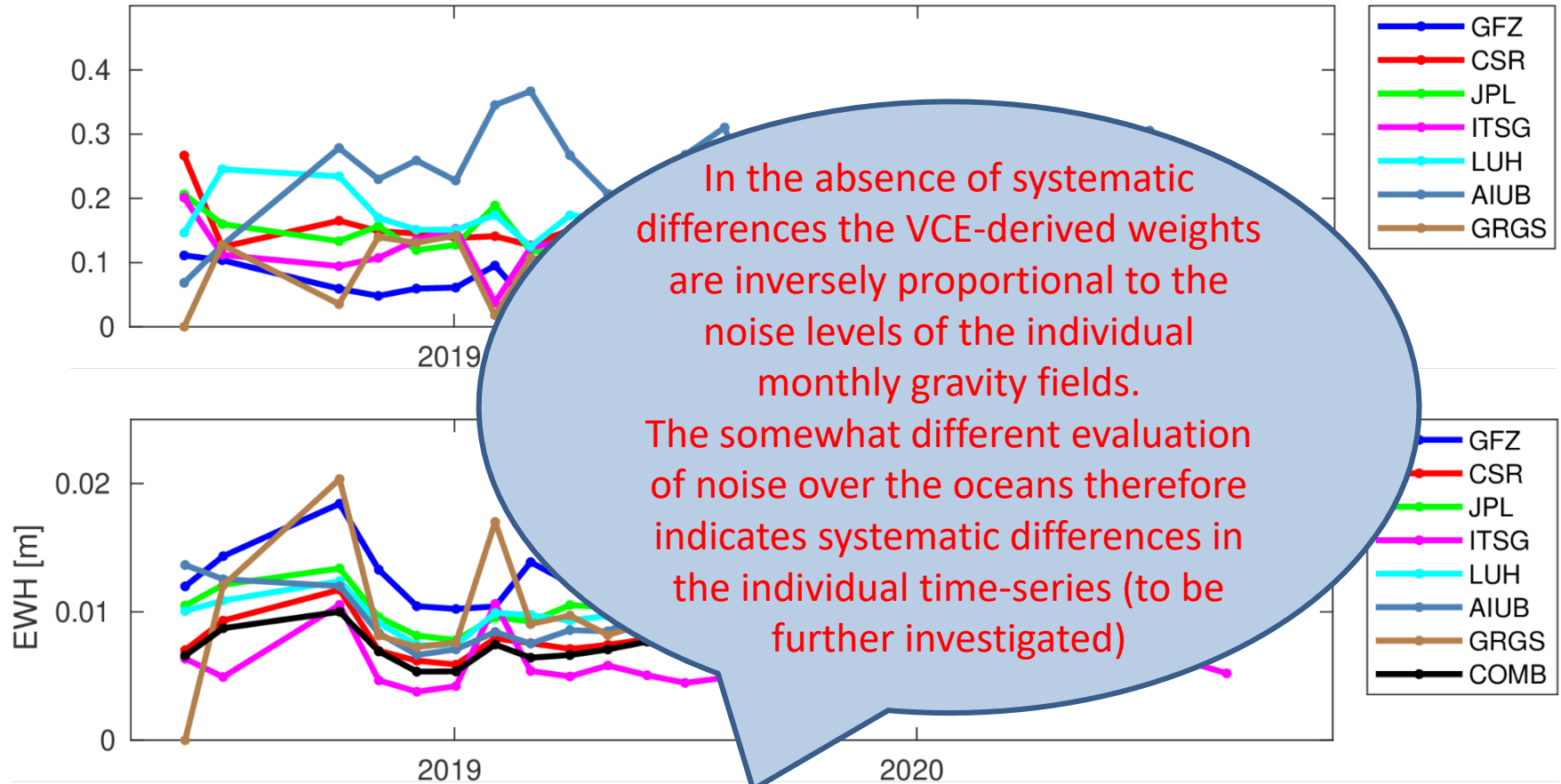


Noise over the oceans:

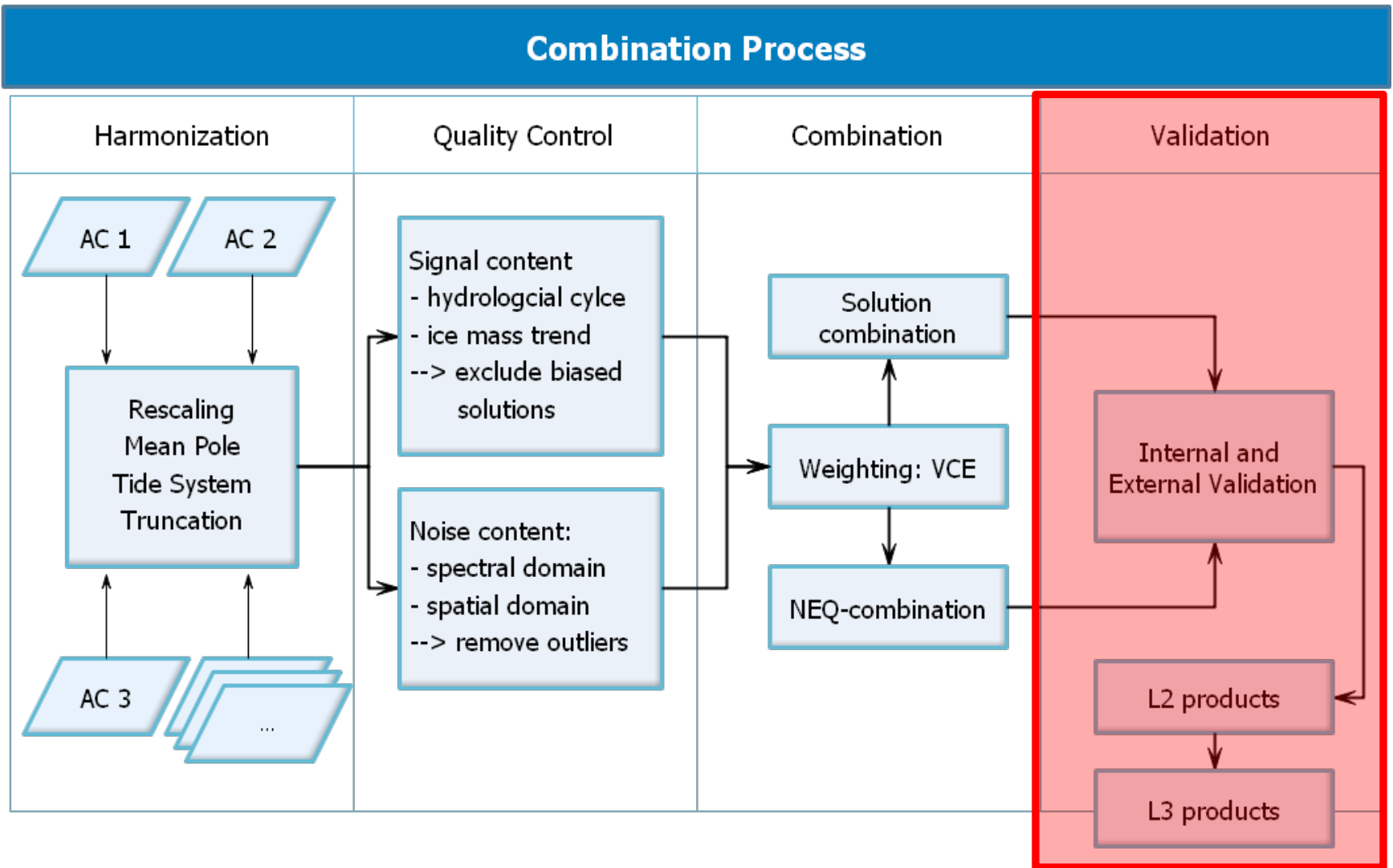


Combination applying Variance Component Estimation

VCE-derived weights (normalized):

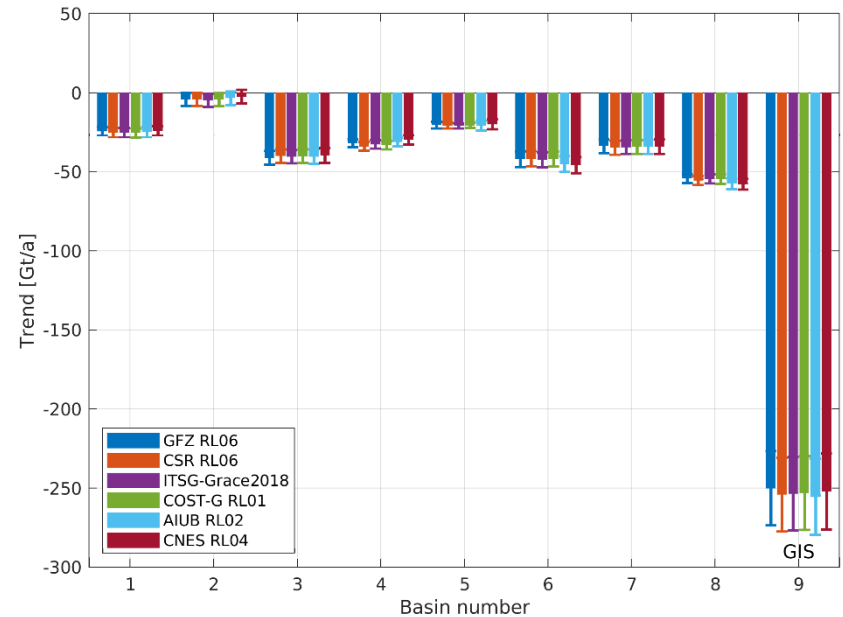
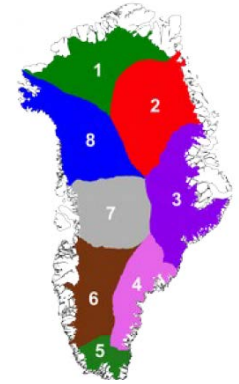


COST-G – Validation



Basin-Averaged Greenland Ice Mass Changes

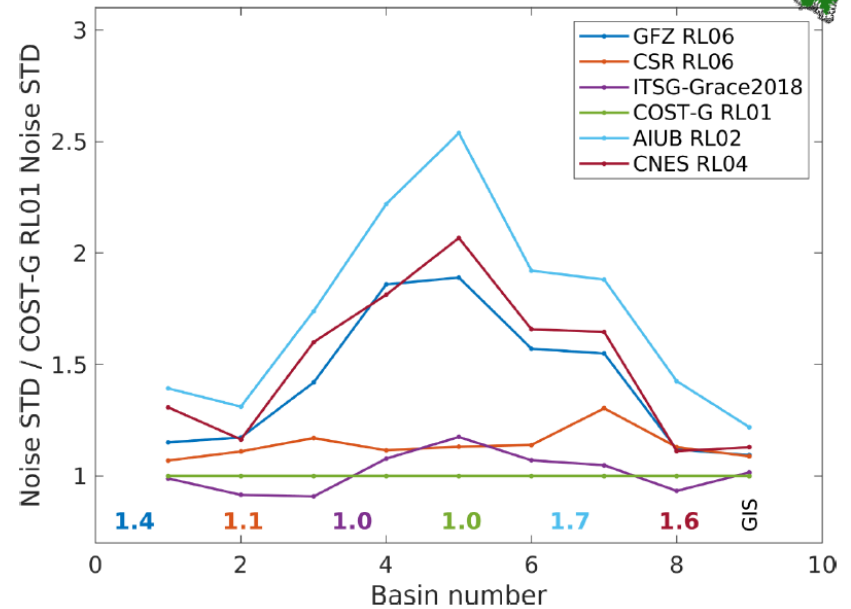
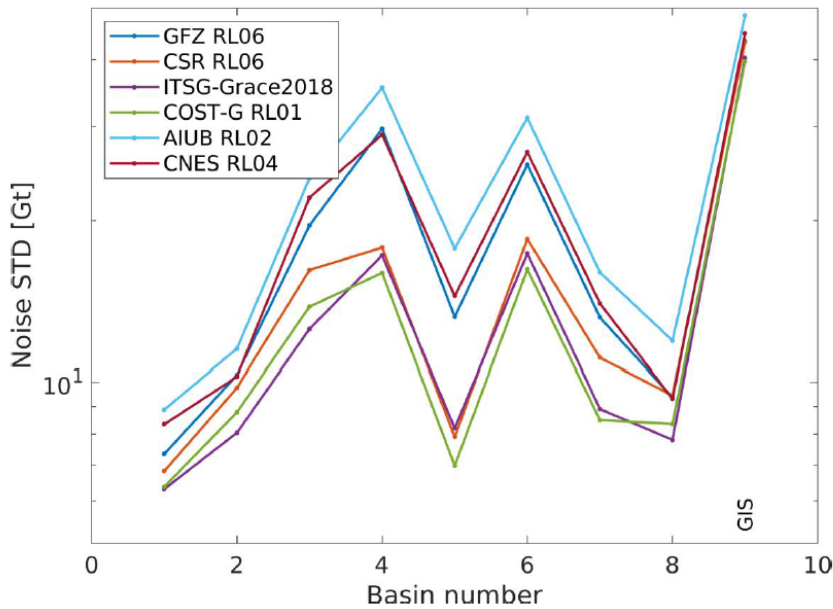
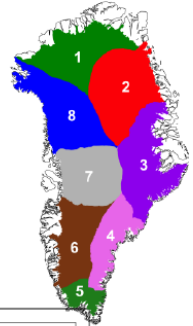
Basin-integrated Greenland/Antarctic Ice Sheet (GIS/AIS) mass changes based on the sensitivity kernel approach by TU Dresden



Trends are calculated from GRACE and GRACE-FO results (from a fitted linear, quadratic and seasonal model).

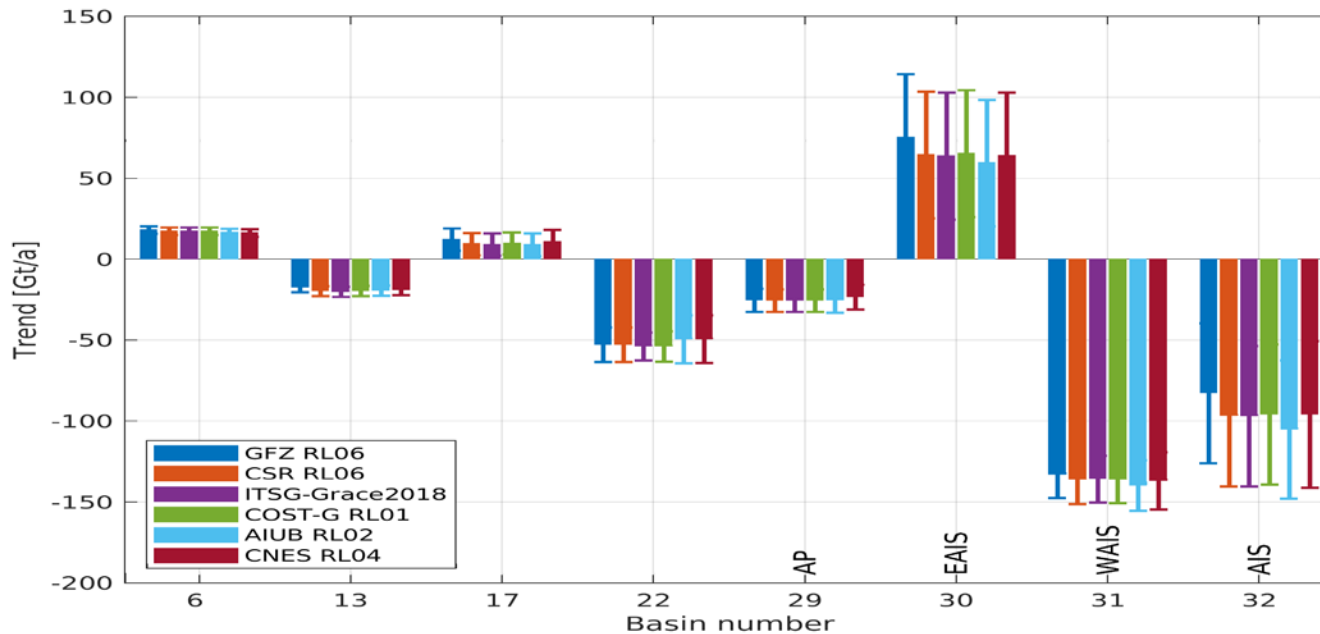
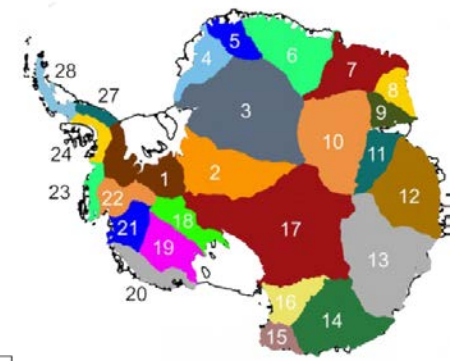
Basin-Averaged Greenland Ice Mass Changes

- Noise measure for each basin time series and ratio to the noise measure of the COST-G time series (numbers indicate the median of all basin ratios). Basin 9 denotes the entire GIS.



Basin-Averaged Antarctic Ice Mass Changes

Trends are calculated from GRACE and GRACE-FO results (from a fitted linear, quadratic and seasonal model).



Basin numbers:
29: Ant. Peninsula (AP)
30: East Ant. (EAIS)
31: West Ant. (WAIS)
32: AIS

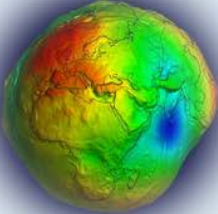


Comparison to Altimetry

QUALITY CRITERIA:

- Correlation: aim for 100%
- Scale factor: aim for 1

	Correlation (Black Sea)	Scale factor (Black Sea)	Correlation (Caspian S.)	Scale factor (Caspian S.)
CSR-RL06	71.8 %	1.23	98.2 %	1.64
GFZ-RL06	71.5 %	1.25	97.8 %	1.66
JPL-RL06	69.2 %	1.27	97.6 %	1.61
ITSG	72.3 %	1.21	98.3 %	1.62
COST-G	79.6 %	1.07	98.3 %	1.63

Level-2 Product Availability



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	
- 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	

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
GRACE	DOI	monthly		
Swarm	DOI	monthly		

GRACE / CHAMP solutions from other groups				expand all
+ AIUB			Astronomical Institute University Bern	
AIUB-GRACE-FO_op	DOI	monthly	Operational GRACE Follow-On monthly gravity field solutions from AIUB	
AIUB-RL02		monthly	GRACE monthly solutions Release 2 from AIUB, more information can be found here	
+ CNES			Centre national d'études spatiales	

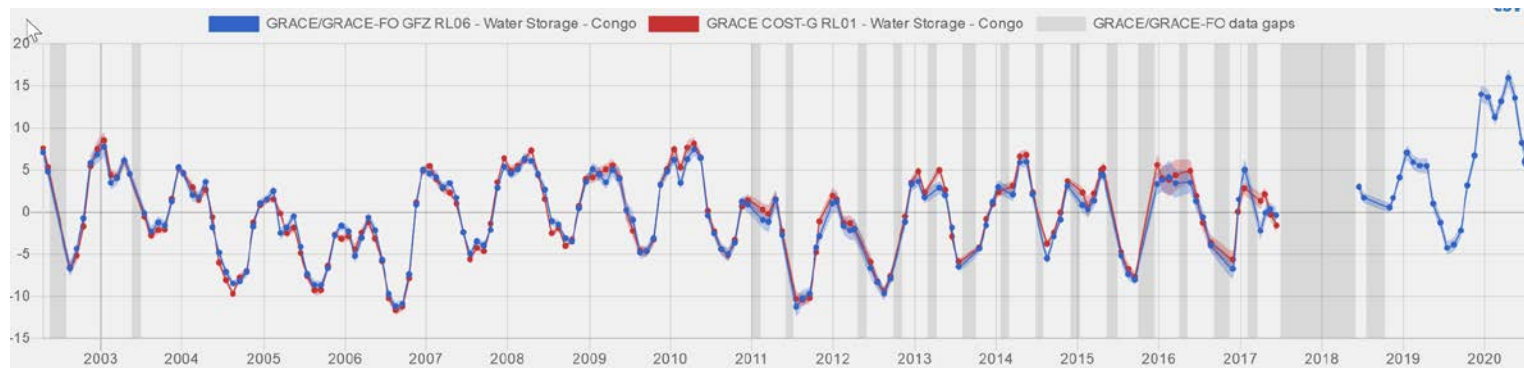
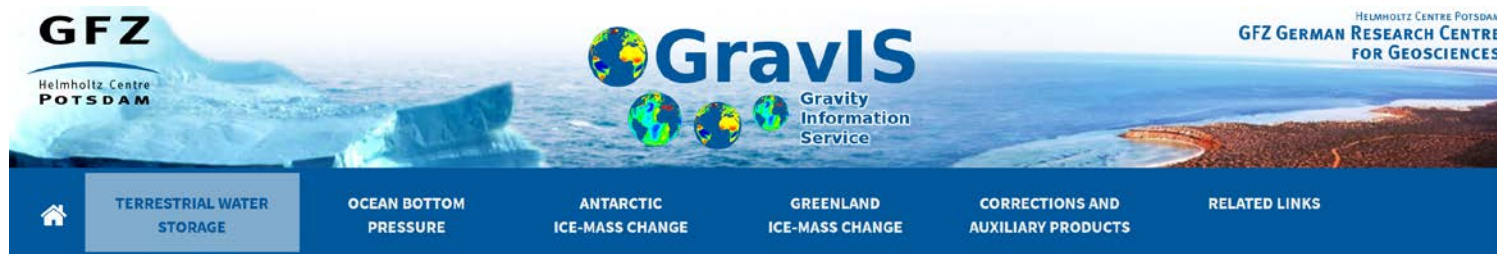
- ICGEM Home
- Gravity Field Models
 - Static Models
 - Temporal Models
 - Topographic Gravity Field Models
- Calculation Service
 - Regular grids
 - User-defined points
- 3D Visualisation
 - Static Models
 - Temporal Models
 - Trend & Amplitude
 - Spherical Harmonics
- Evaluation
 - Spectral domain
 - GNSS Leveling
- Documentation
 - FAQ

Level-2 Product Availability

- **Monthly combined GRACE gravity field models:**
 - from Apr. 2002 to Jun. 2017 available at ICGEM
 - http://icgem.gfz-potsdam.de/series/02_COST-G/GRACE
- **Monthly combined Swarm gravity field models:**
 - from Dec. 2013 to “present” available at ICGEM
 - http://icgem.gfz-potsdam.de/series/02_COST-G/Swarm
- **Monthly combined GRACE-FO gravity field models:**
 - from May 2018 to “present” available at ICGEM
 - http://icgem.gfz-potsdam.de/series/02_COST-G/Grace-FO

Level-3 Product Availability

- Monthly combined GRACE/GRACE-FO gravity field models:
 - from Apr. 2002 to to “present” available at ISDC, GravIS
 - <ftp://isdctftp.gfz-potsdam.de/grace/GravIS/COST-G/Level-3>



Summary and Outlook

- **COST-G combined Level-2 products for GRACE (repro), Swarm (operational), and GRACE-FO (operational) are available from ICGEM.**
- **COST-G Level-3 products for GRACE and GRACE-FO are available via GFZ's GravIS portal (<http://gravis.gfz-potsdam.de/>).**
- **Inclusion of further candidate Analysis Centers (Chinese ACs) is planned for 2021 (benchmark testing and quality control are currently being performed).**