COST-G

Combination Service for Time-variable Gravity Models

Combination Service for Time-variable Gravity Fields (COST-G) – GRACE-FO operational combination

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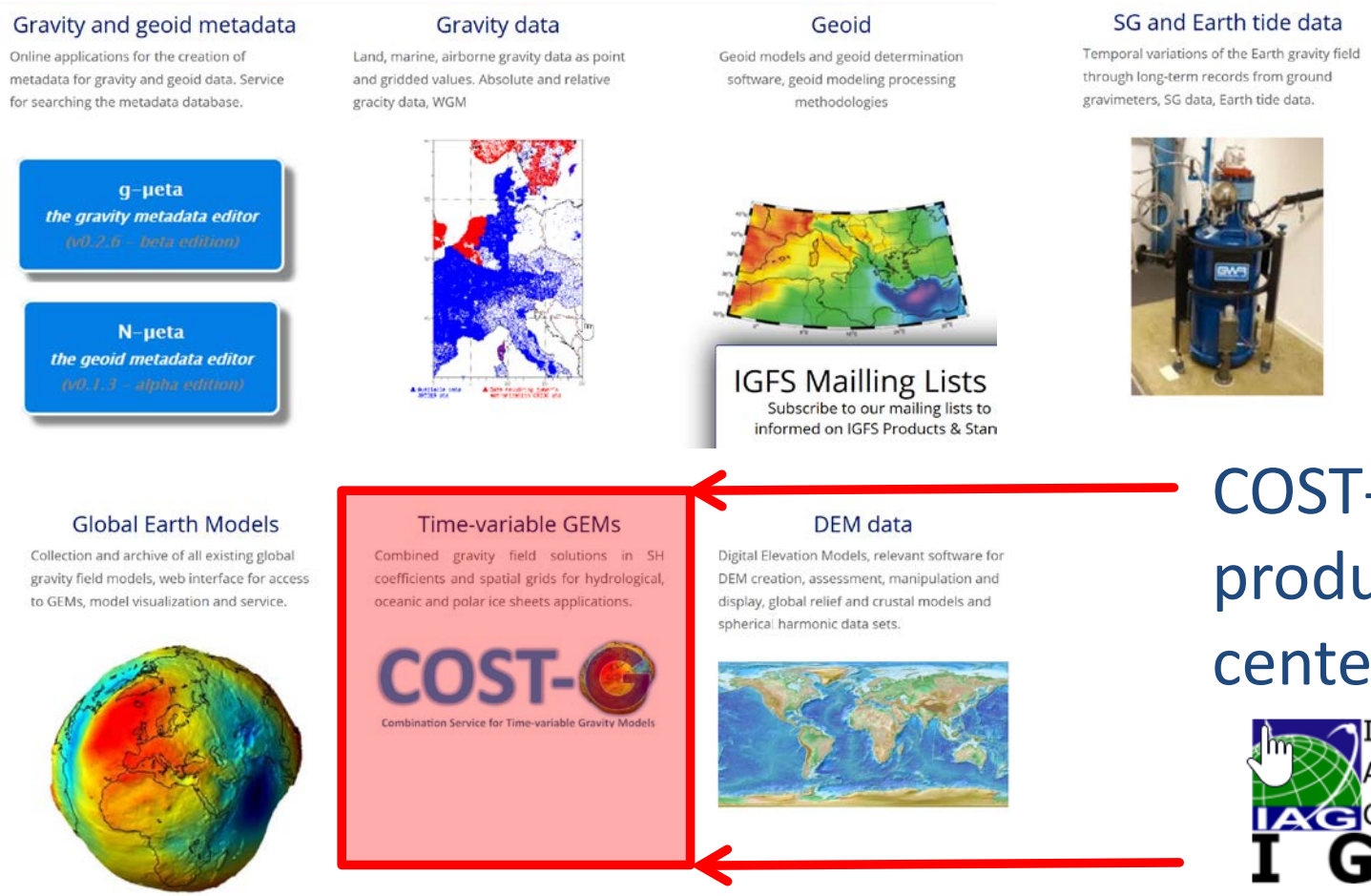
GSTM 2020

A.2 - Analysis Techniques & Inter-comparisons

Contents

- Introduction to COST-G
- Components of COST-G
- COST-G operational GRACE-FO combination:
  - Quality control
  - Combination
  - Validation
- Conclusions and Outlook

Introduction

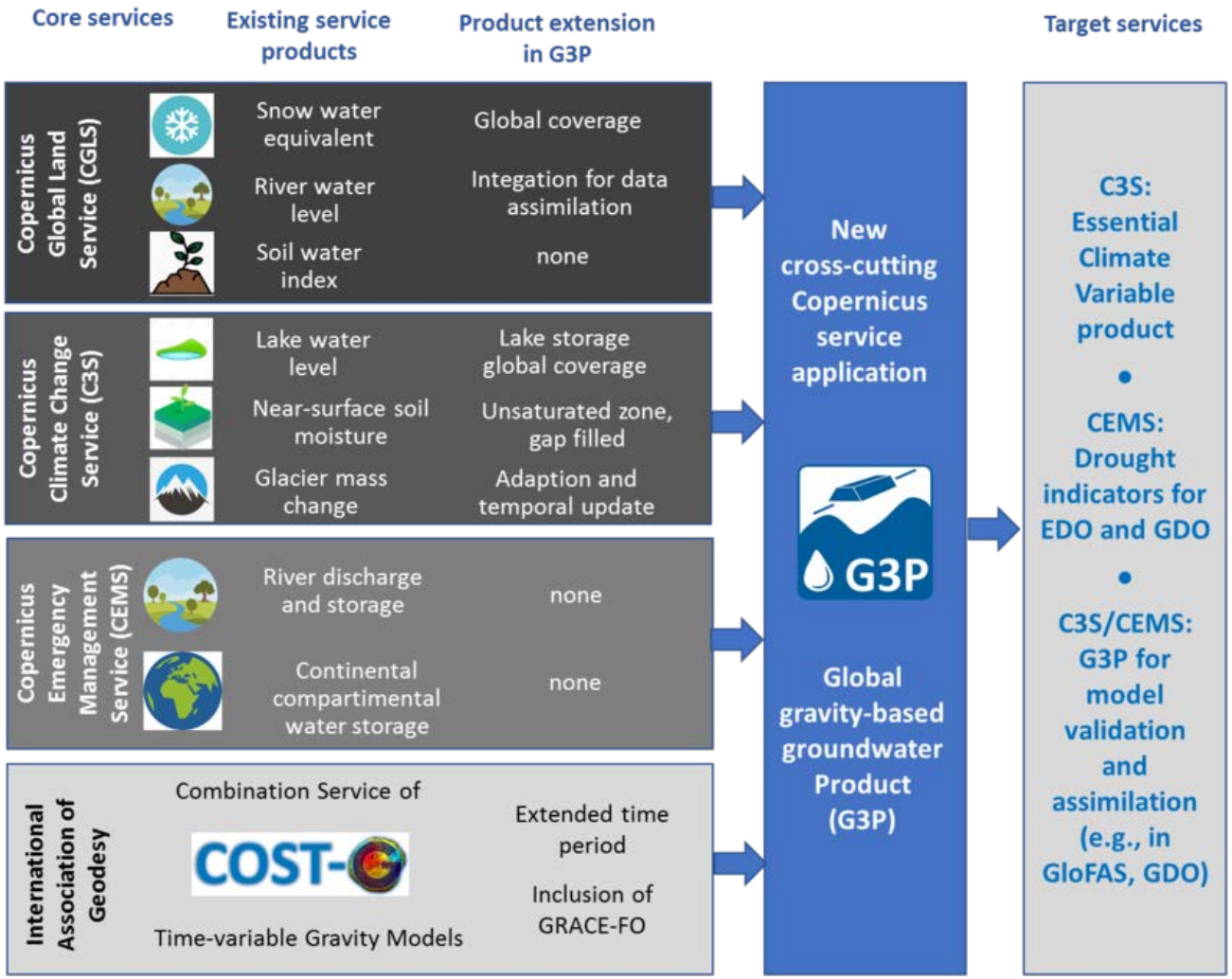


COST-G is a product center of the International Association of Geodesy IAG IGFS

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

COST-G Website

COST-G and the H2020 G3P-project



COST-G is further developed within the frame of the Horizon 2020 project: G3P -Global Gravity - based Groundwater Product

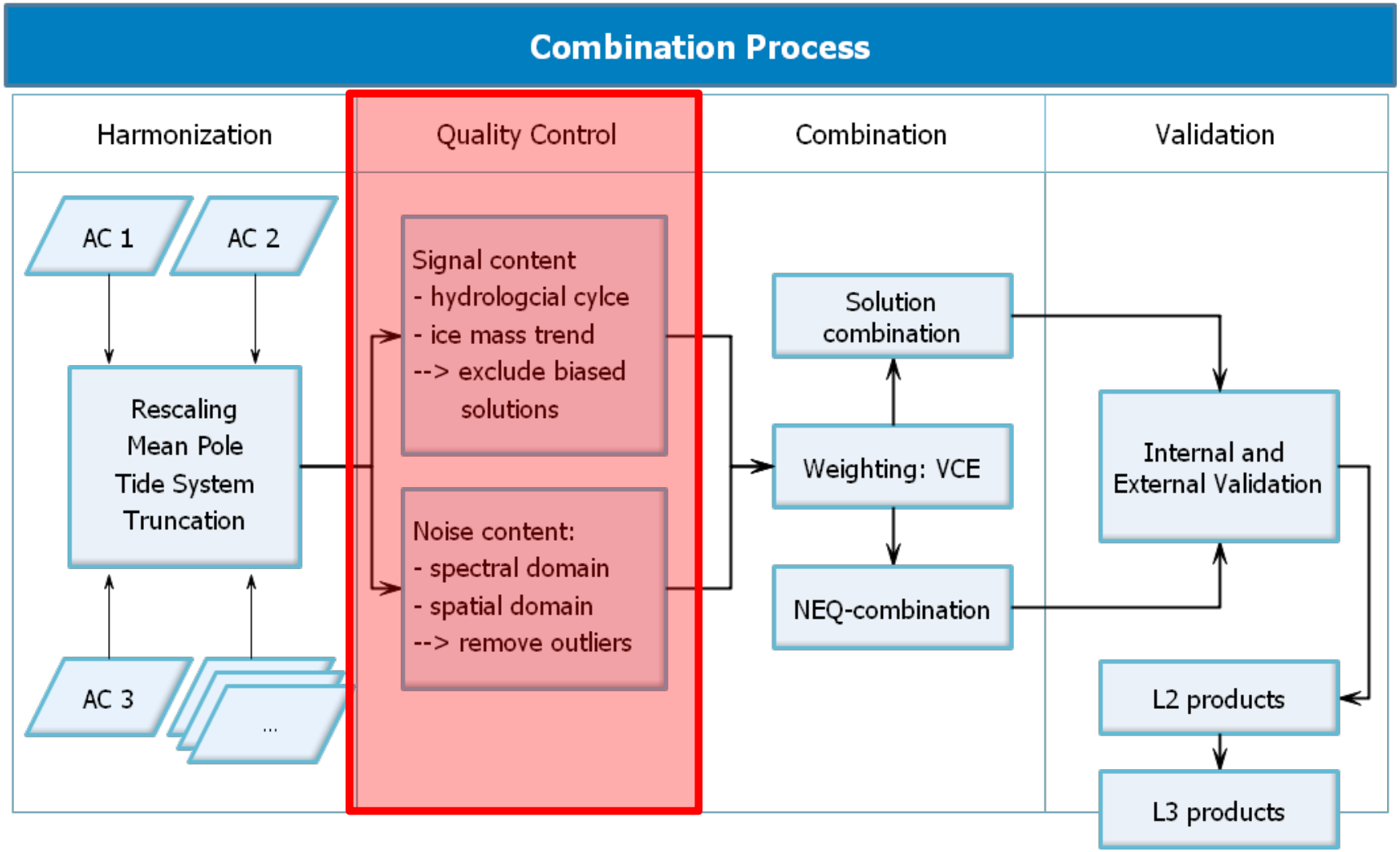
Permanent Components of COST-G

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

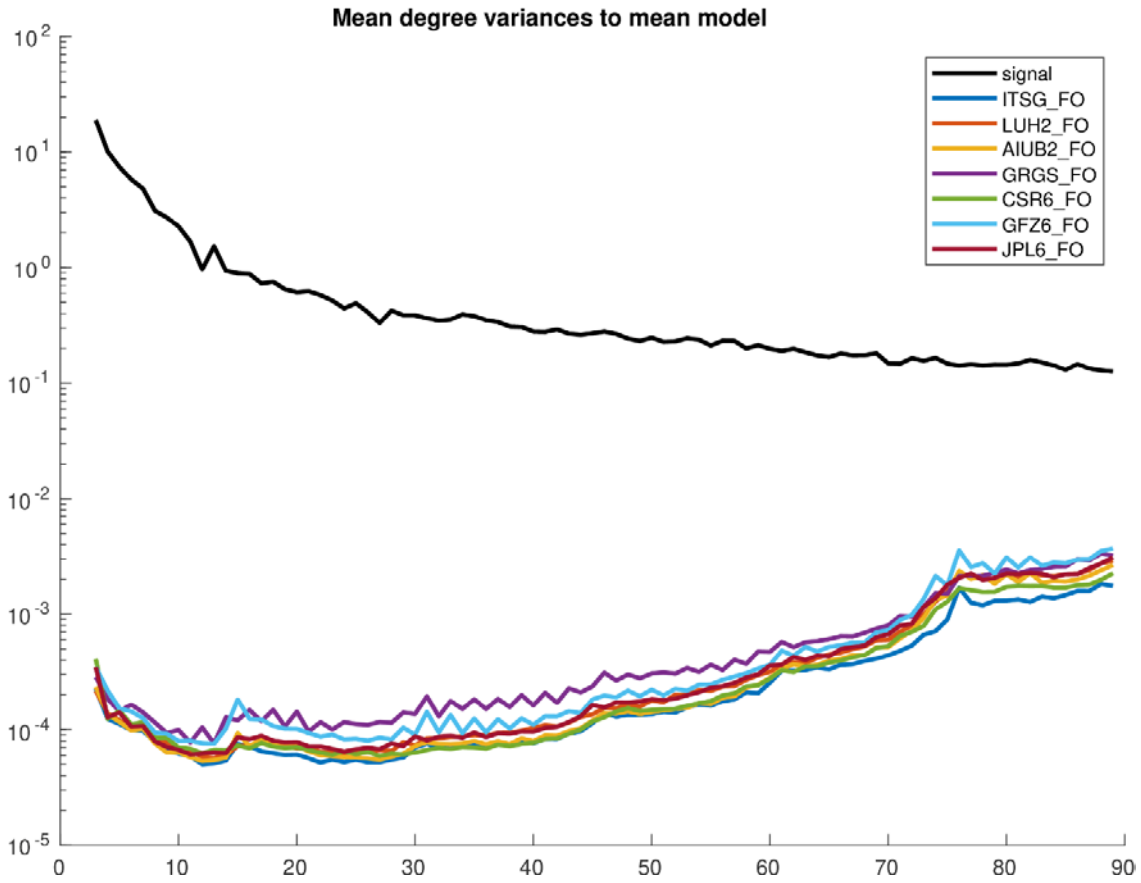
- **Central Bureau (CB) & Analysis Center Coordinator (ACC)**
  - AIUB
- **Analysis Centers (ACs)**
  - AIUB, CNES, GFZ, TUG
- **Level-3 Center (L3C)**
  - GFZ
- **Validation Centers (VCs)**
  - GRGS, GFZ
- **Product Evaluation Group (PEG)**
  - A. Eicker, A. Groh, B. Meyssignac
- **Candidate ACs:**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

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

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:

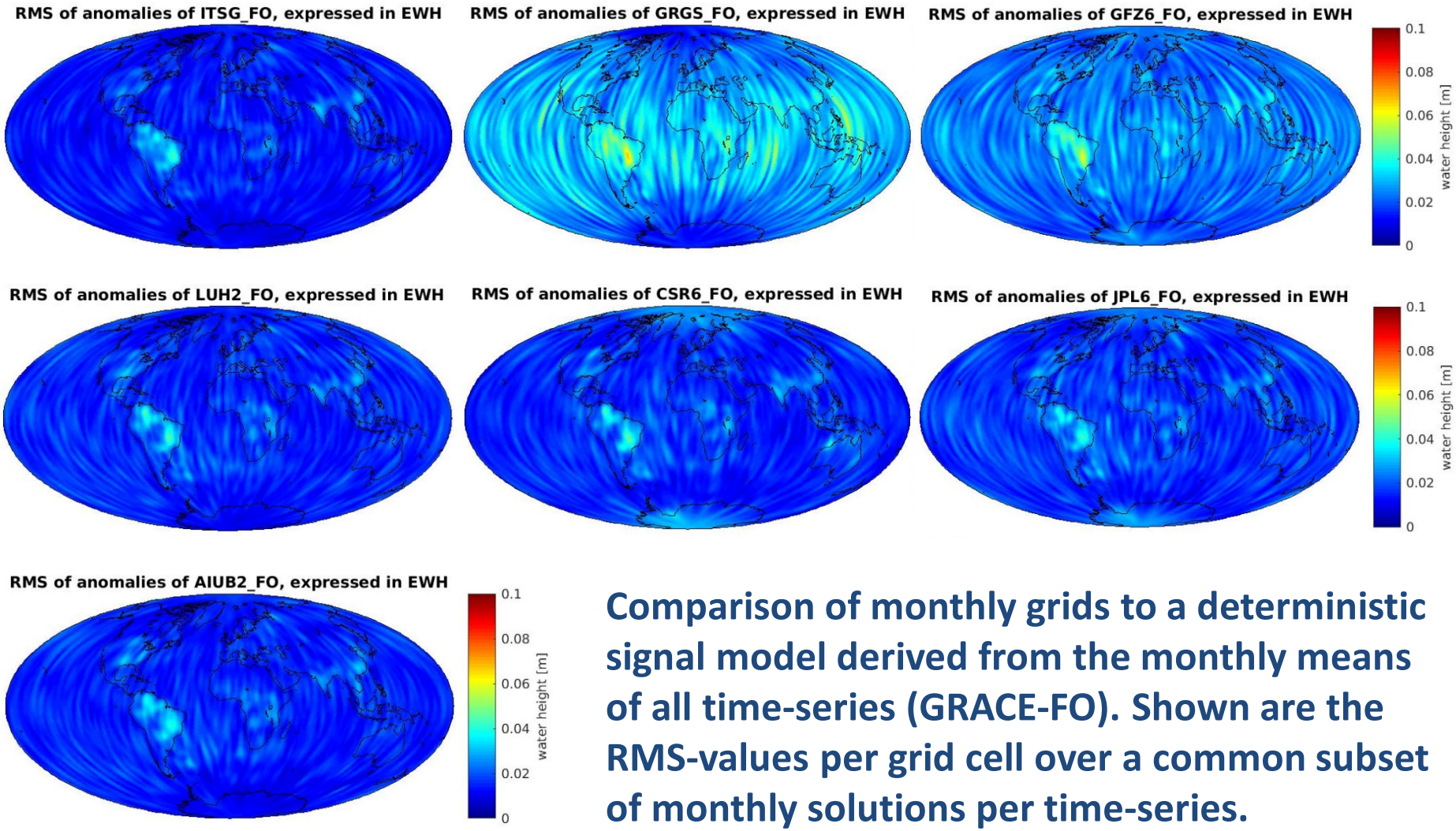
- LUH

COST-G partner ACs:

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

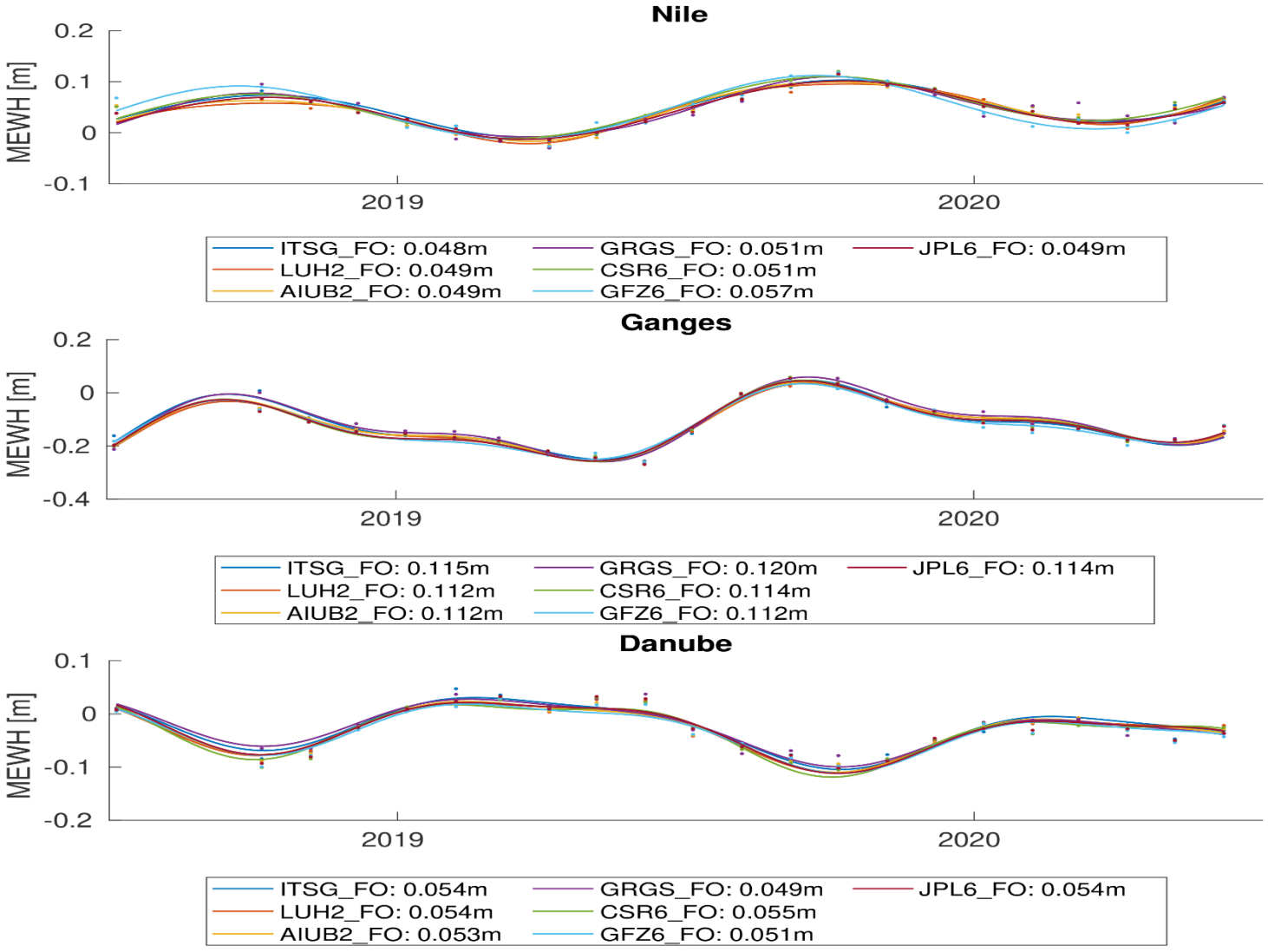
Degree-wise comparison of spherical harmonic coefficients to a deterministic signal model derived from the monthly means of all time-series (GRACE-FO).

Quality Control – Noise Levels (spatial domain)



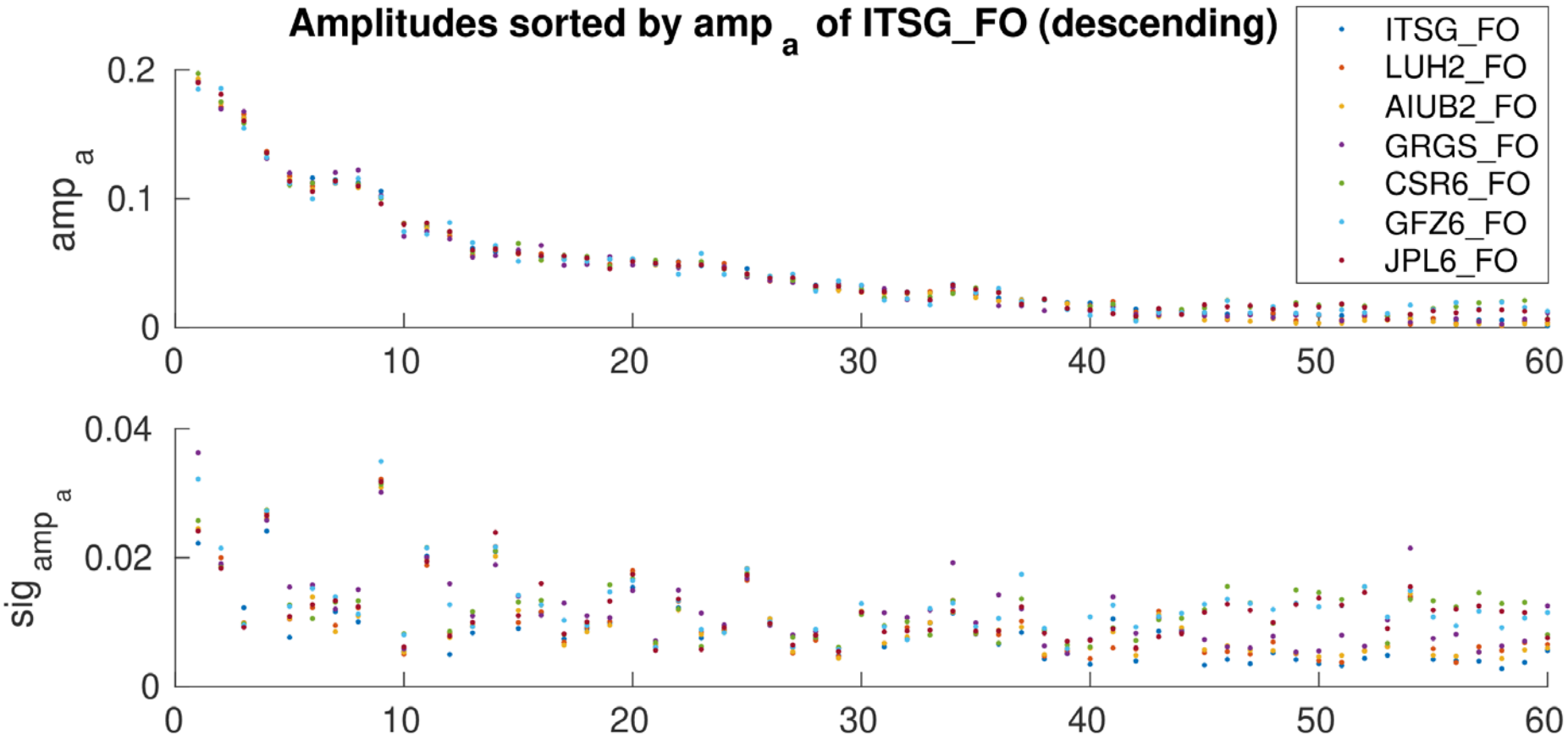
Comparison of monthly grids to a deterministic signal model derived from the monthly means of all time-series (GRACE-FO). Shown are the RMS-values per grid cell over a common subset of monthly solutions per time-series.

Quality Control – Signal Content (Hydrology)



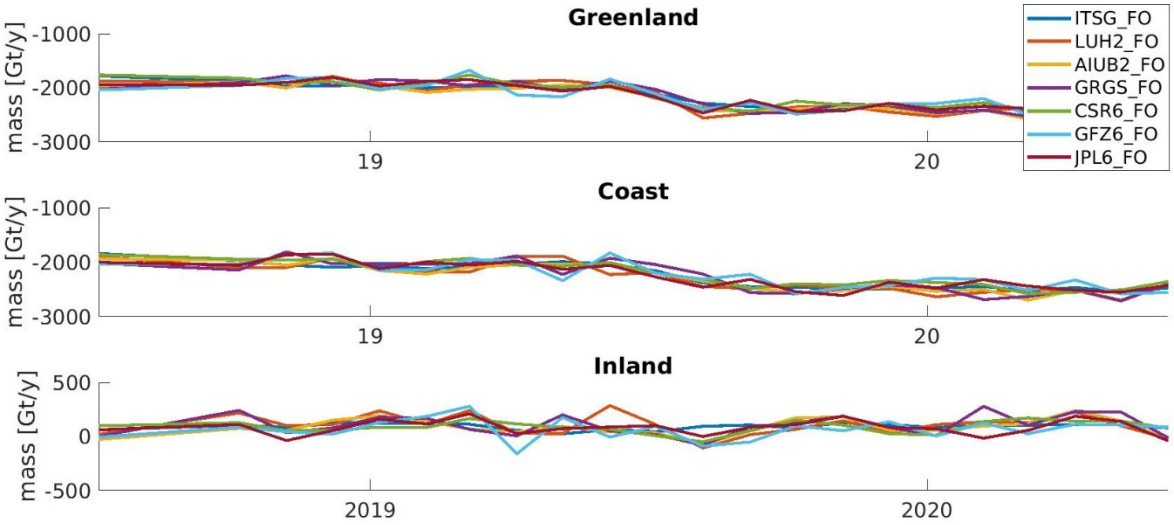
Example: fit of seasonal variations in selected river basins (GFO).

Quality Control – Signal Content (Hydrology)

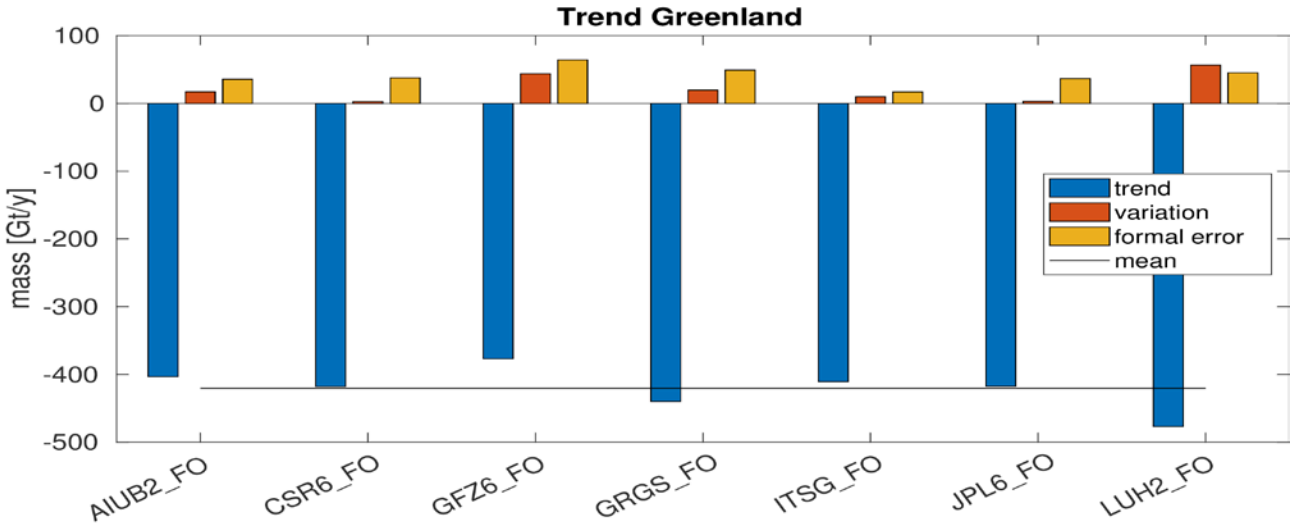


Comparison of amplitudes **amp$_a$** of seasonal mass variations and their formal errors **sig$_{amp}$** in 60 major river basins.

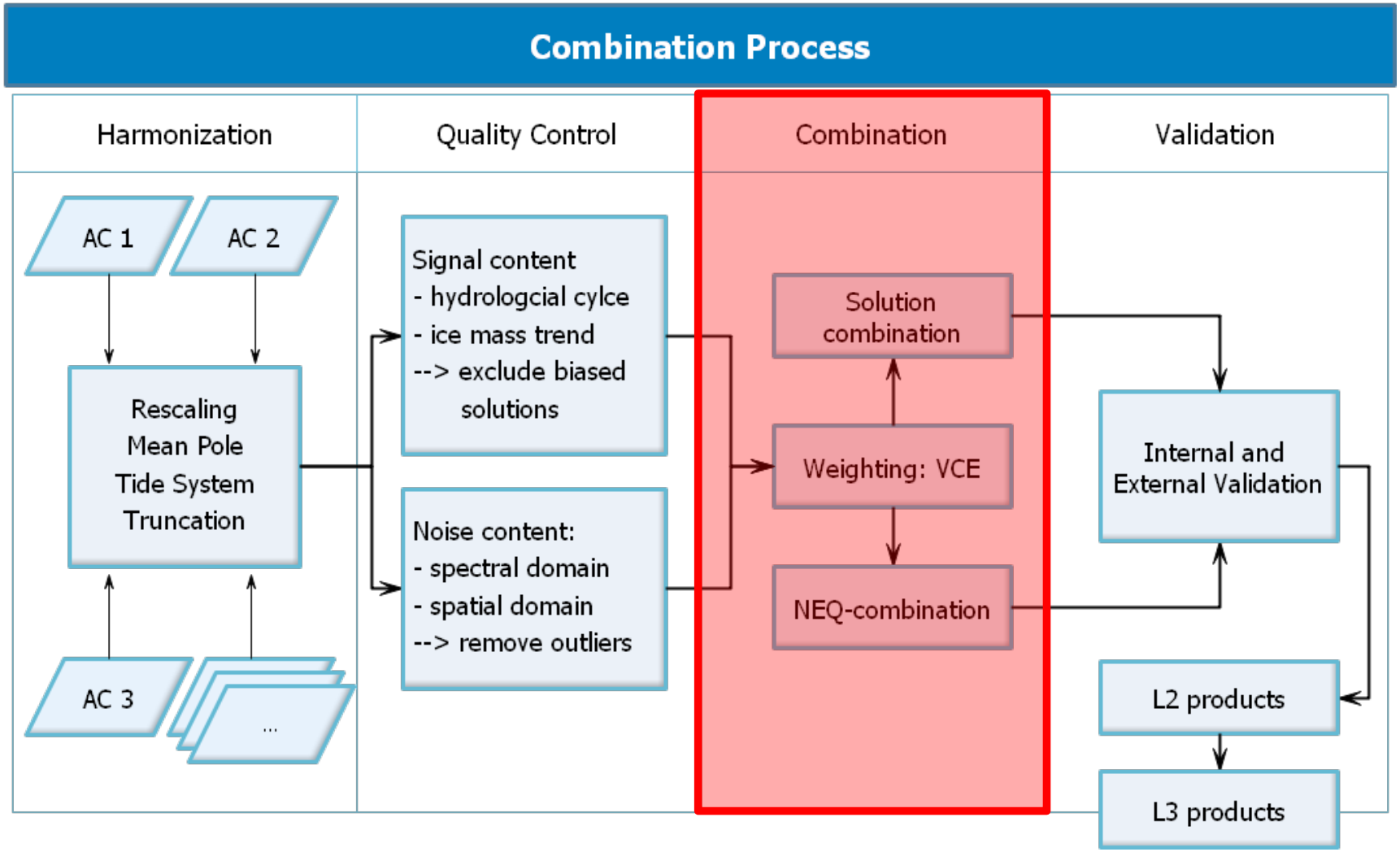
Quality Control – Signal Content (Ice Mass Loss)



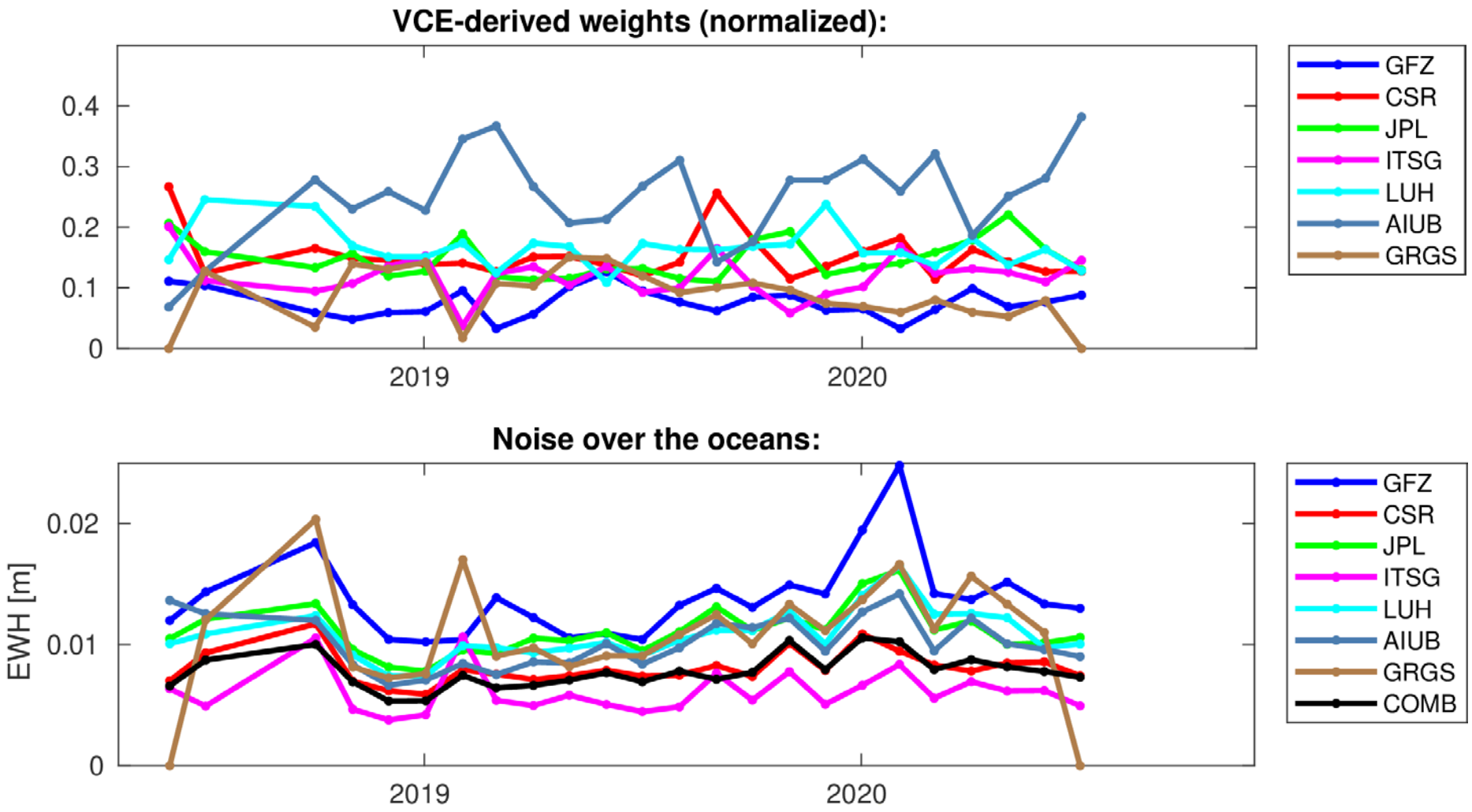
Example: ice mass loss in Greenland (GFO) with respect to GOCO05S.



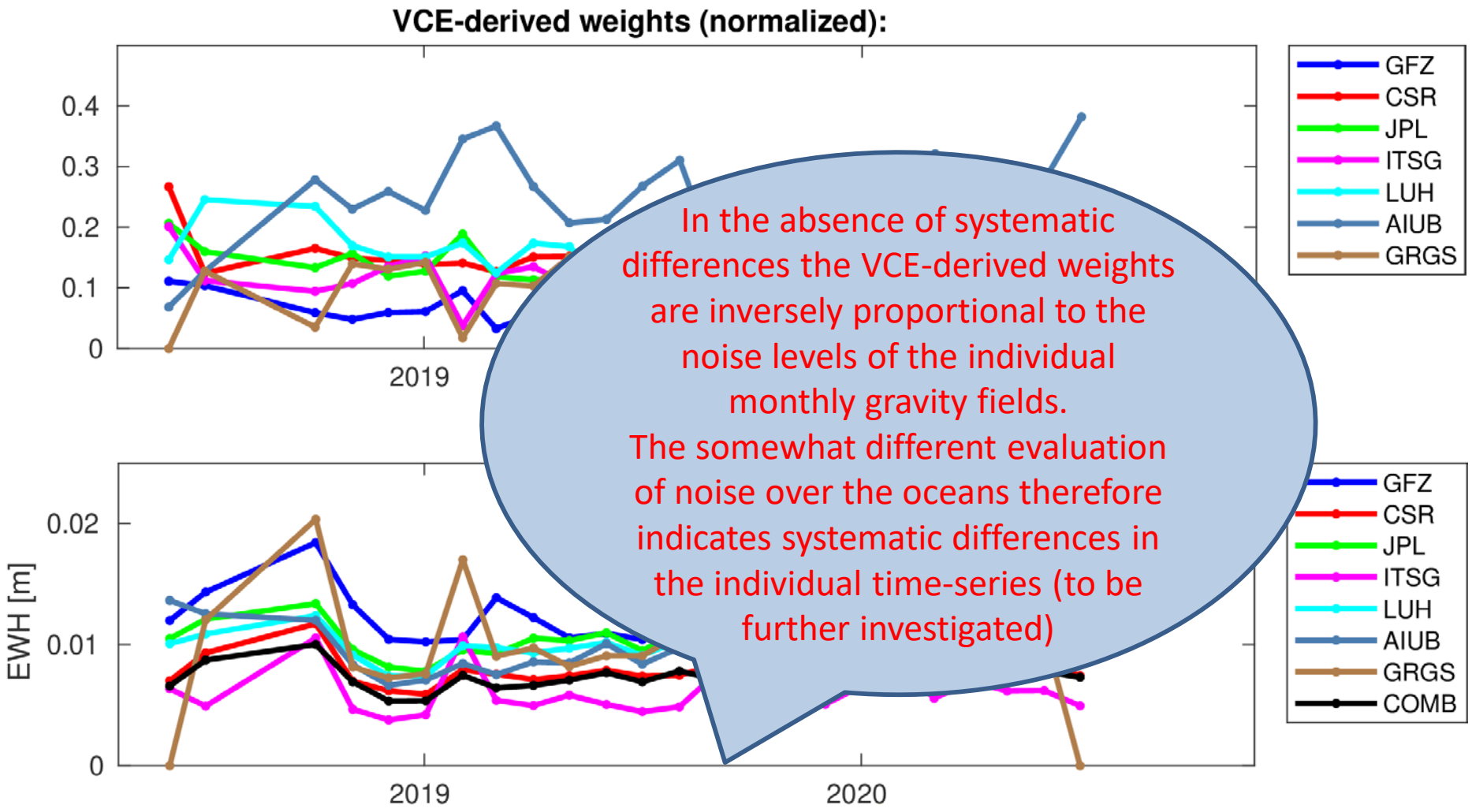
COST-G – Combination



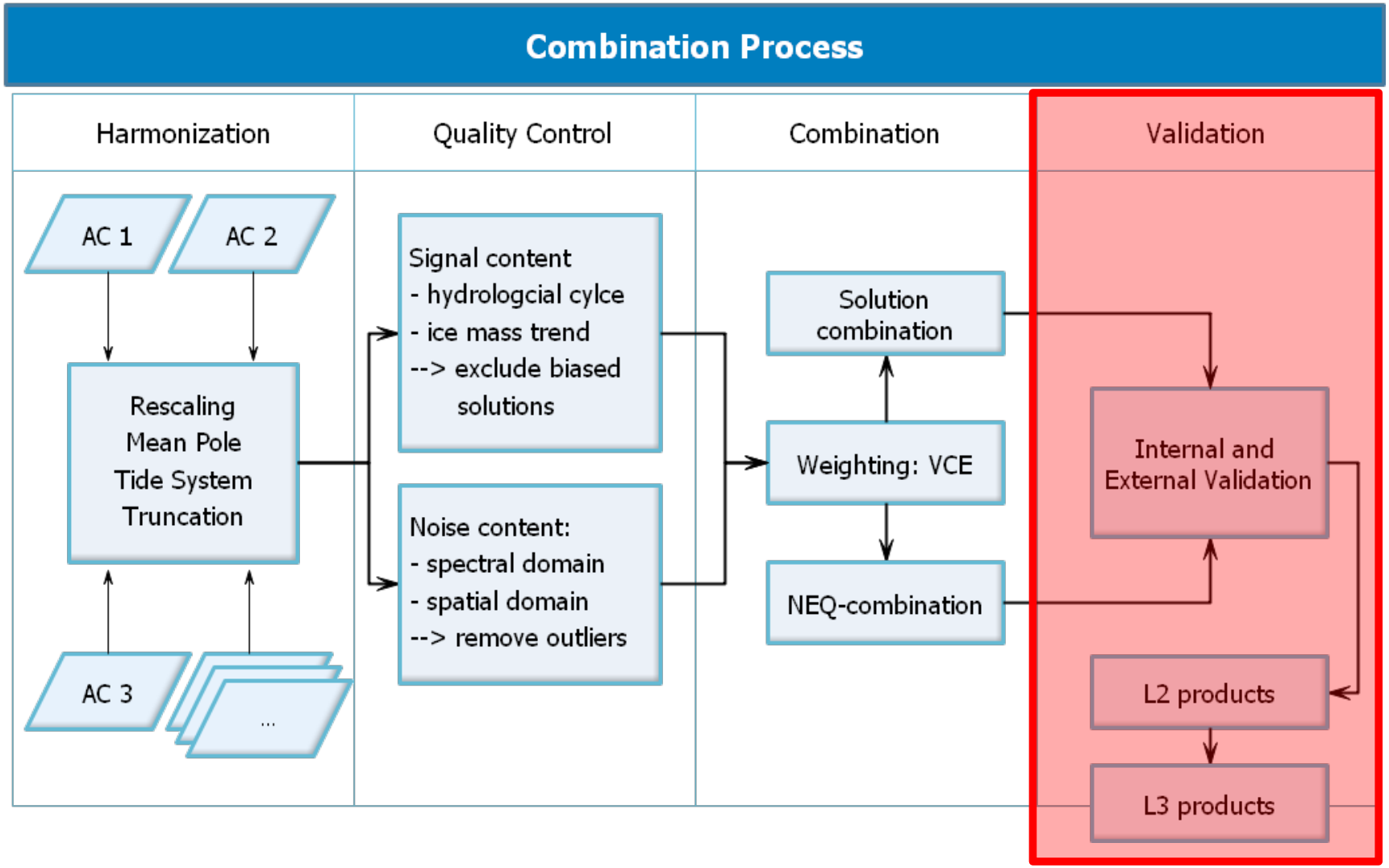
Combination applying Variance Component Estimation



Combination applying Variance Component Estimation

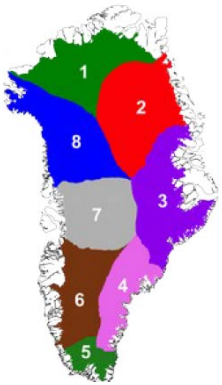


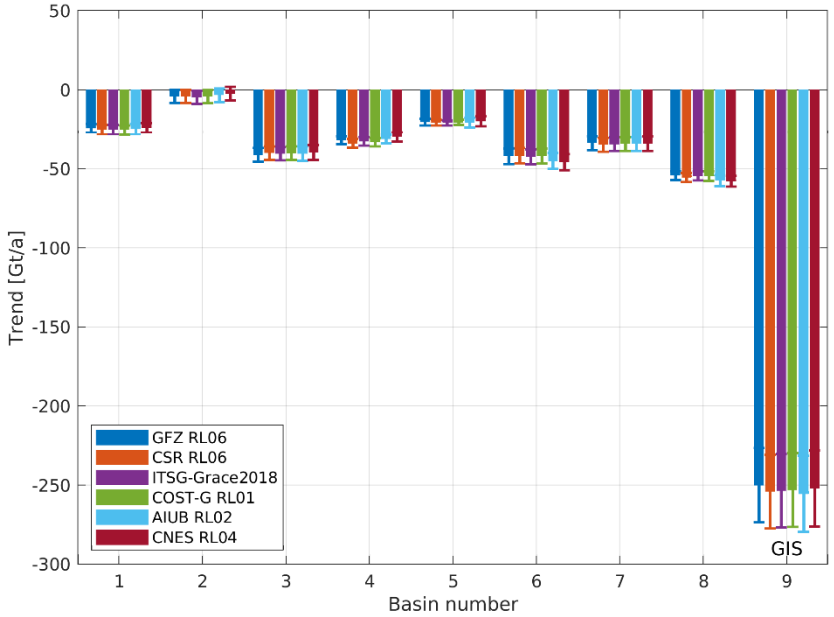
COST-G – Validation



Basin-Averaged Greenland Ice Mass Changes

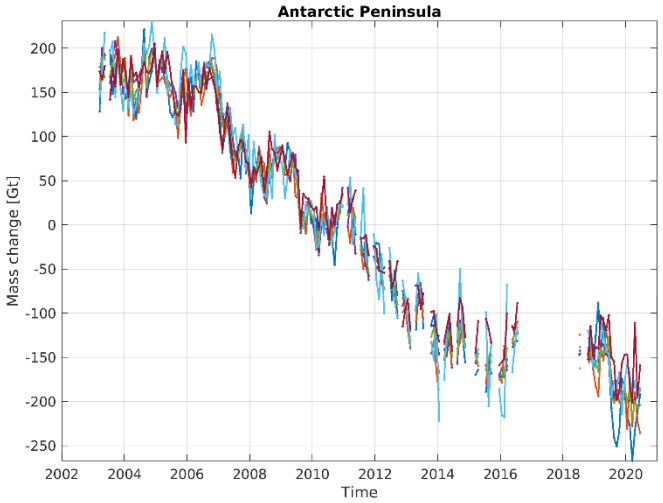
Basin-integrated Greenland/Antarctic Ice Sheet (GIS/AIS) mass changes based on the sensitivity kernel approach by TU Dresden

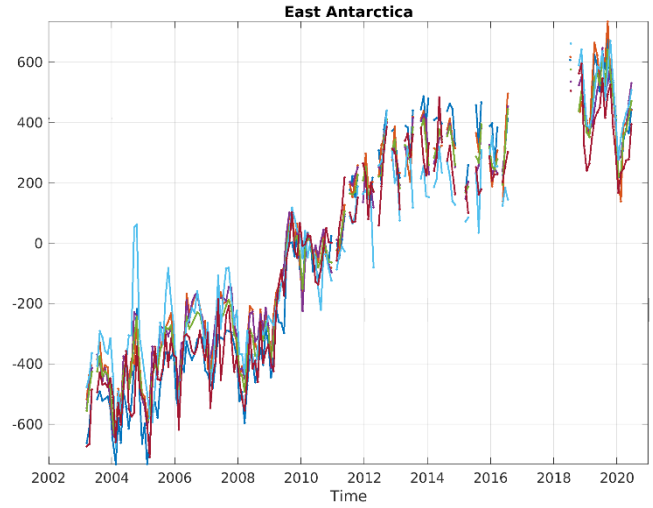


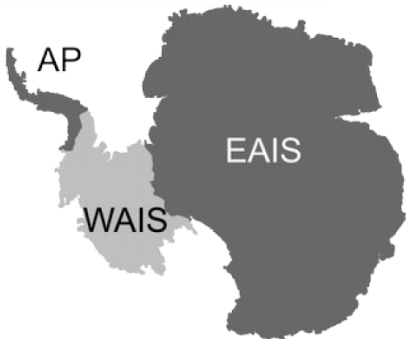


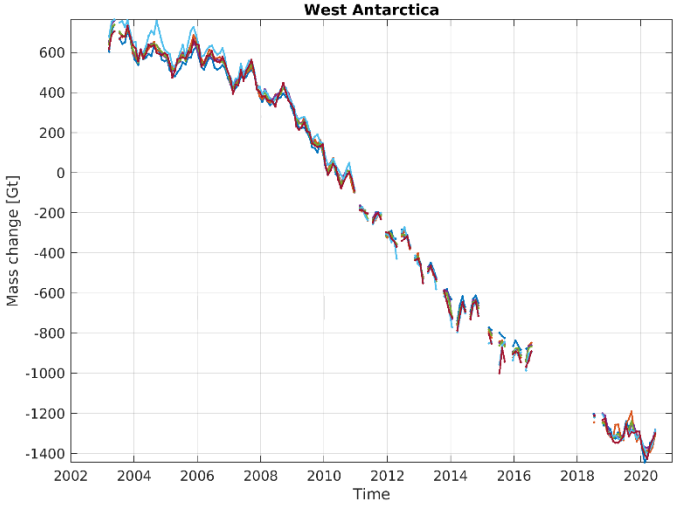
Trends are calculated from GRACE and GRACE-FO results.

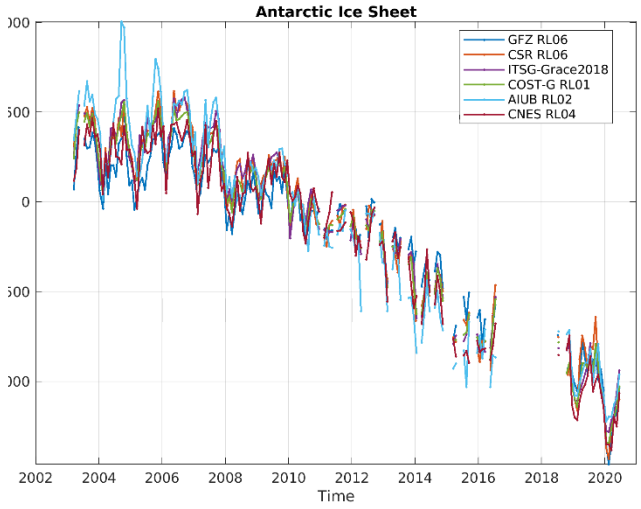
Basin-Averaged Antarctic Ice Mass Changes



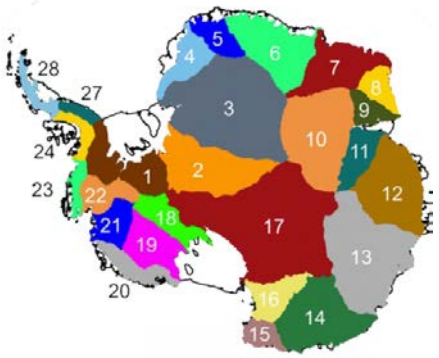


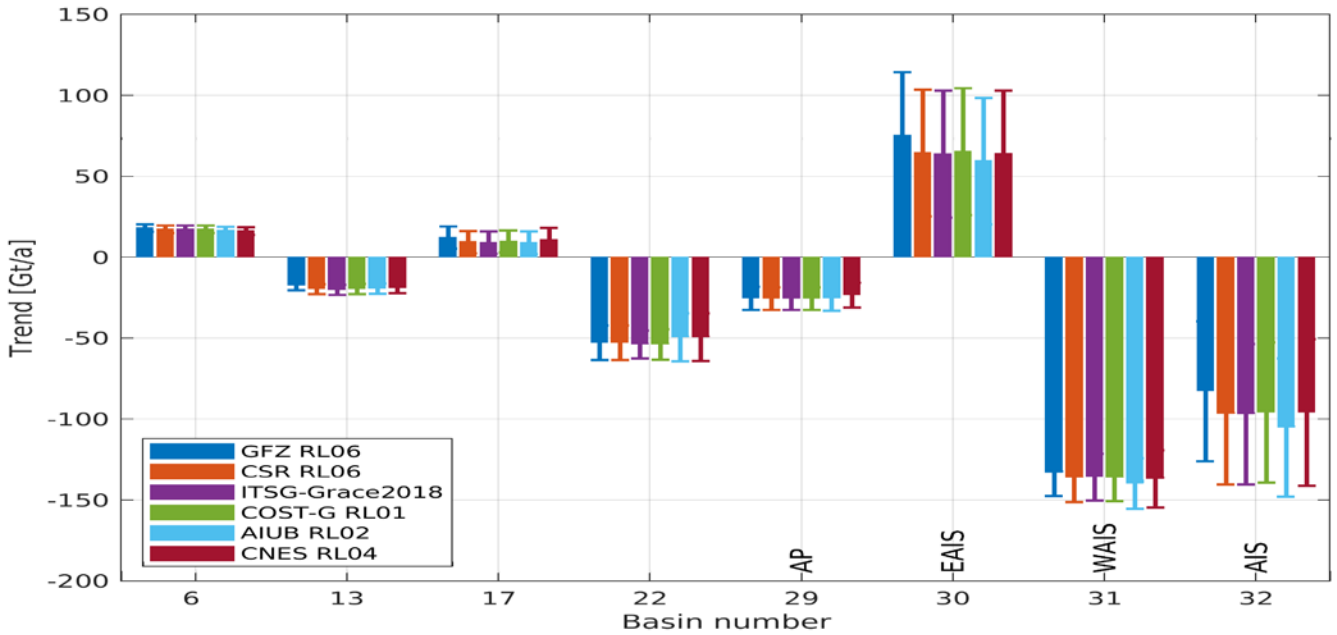






Basin-Averaged Antarctic Ice Mass Changes





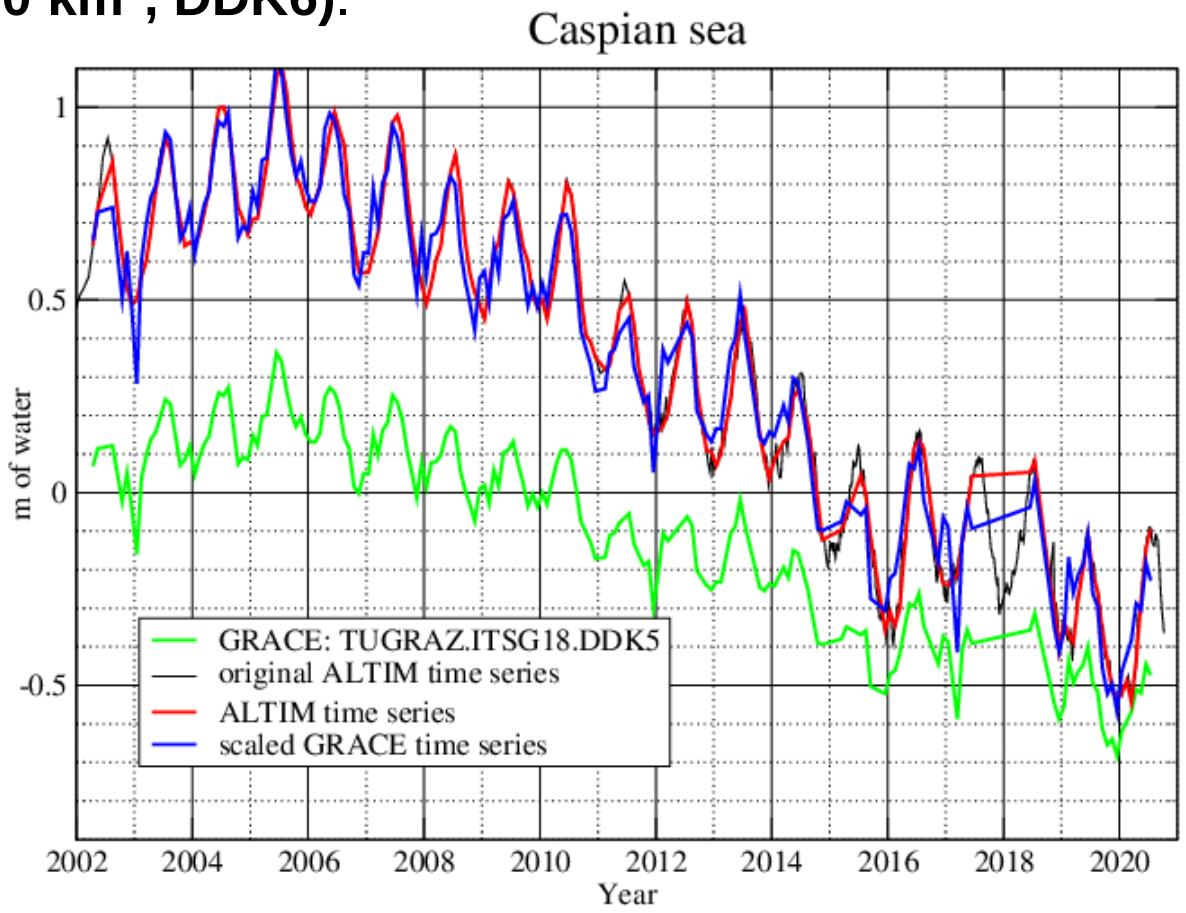
Basin numbers:
29: Ant. Peninsula (AP)
30: East Ant. (EAIS)
31: West Ant. (WAIS)
32: AIS

Comparison to Altimetry

SIGNAL ASSESSMENT:

- **Caspian sea (386.400 km^2, DDK5),**
- **Black sea (181.000 km^2, DDK6).**

Method: *Filtered time series of the TVG solutions are compared with the time series of altimetric heights (from Hydroweb for the Caspian Sea or AVISO+ for the Black Sea). One scale factor and one bias (irrelevant) are adjusted.*



Comparison to Altimetry

QUALITY CRITERIA:

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

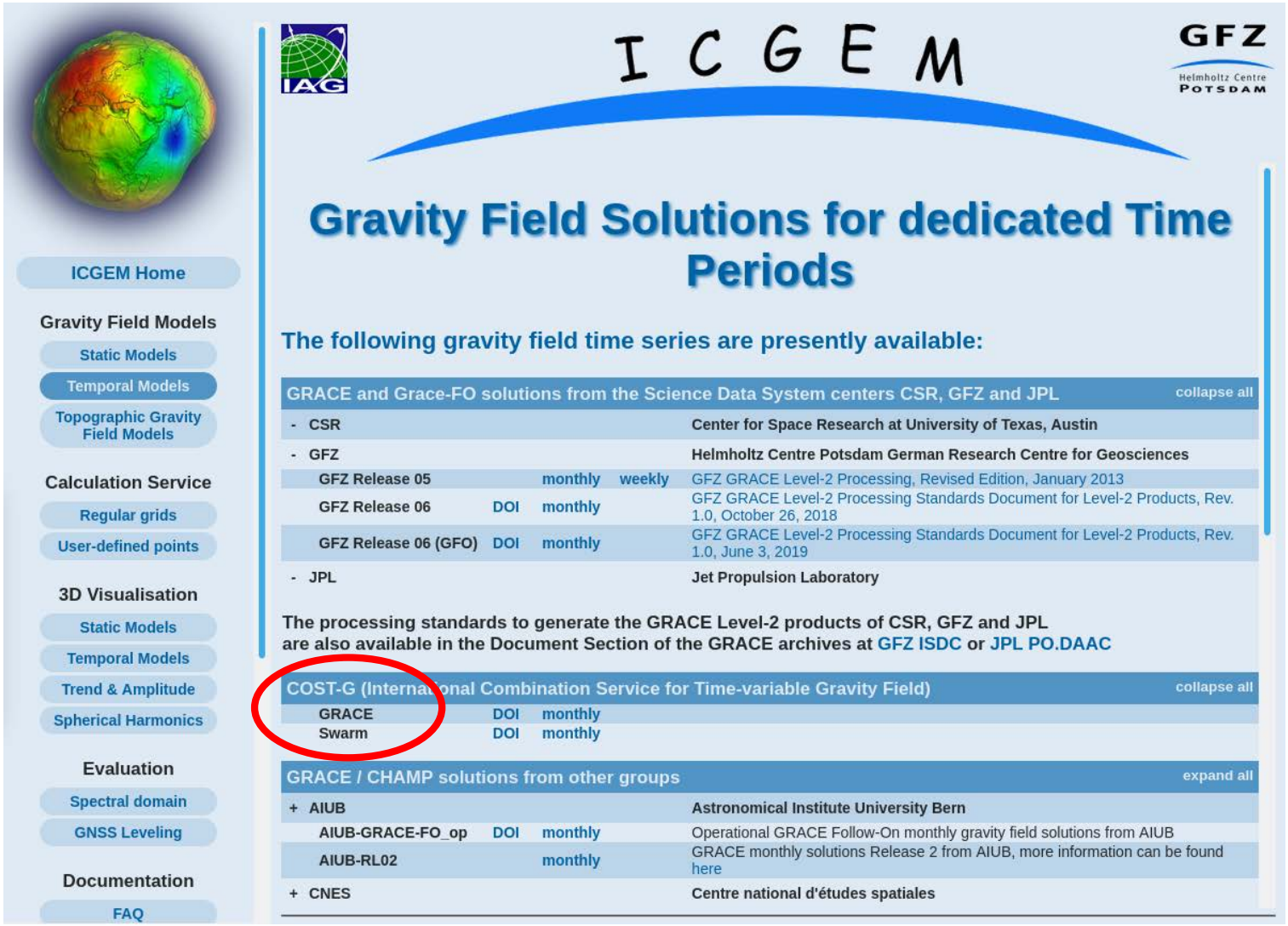
	Correlation (Black Sea)	Scale factor (Black Sea)	Correlation (Caspian S.)	Scale factor (Caspian S.)
CSR-RL06	71.8 %	1.23	98.2 %	1.64
GFZ-RL06	71.5 %	1.25	97.8 %	1.66
JPL-RL06	69.2 %	1.27	97.6 %	1.61
ITSG	72.3 %	1.21	98.3 %	1.62
COST-G	79.6 %	1.07	98.3 %	1.63

Orbit Tests with GOCE

- GRACE solutions up to d/o 60 and 90 filled up with DIR-6 up to d/o 240:
  - Table shows RMS of orbit fits (cm) for the different test cases (3D-residuals, mean values from 60 individual arcs)

Gravity model	Month					
	2019/11		2019/06		2018/11	
	90	60	90	60	90	60
GFZ_RL06	**8.93**	**7.08**	**8.08**	**6.73**	**9.00**	**7.11**
JPL_RL06	**9.22**	**7.06**	**8.33**	**6.86**	**8.17**	**6.86**
CSR_RL06	**9.01**	**6.86**	**7.84**	**6.62**	**7.97**	**6.88**
GRGS (unconstr. Sol.)	**9.01**	**6.77**	**7.74**	**6.59**	**7.52**	**6.50**
LUH	**9.78**	**7.19**	**9.27**	**6.92**	**7.78**	**6.56**
AIUB operational	**9.42**	**7.33**	**7.97**	**6.95**	**7.53**	**6.81**
ITSG operational	**9.27**	**6.86**	**6.92**	**6.47**	**6.70**	**6.32**
COST-G	**8.58**	**6.97**	**7.36**	**6.57**	**7.34**	**6.60**

Level-2 Product Availability



Level-3 Product Availability

GFZ Helmholtz Centre Potsdam

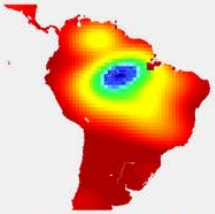
GravIS Gravity Information Service

Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences

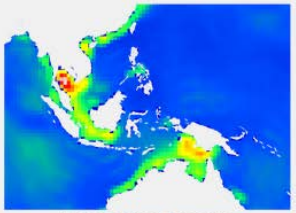
TERRESTRIAL WATER STORAGE | OCEAN BOTTOM PRESSURE | ANTARCTIC ICE-MASS CHANGE | GREENLAND ICE-MASS CHANGE | CORRECTIONS AND AUXILIARY PRODUCTS | RELATED LINKS

Welcome to GravIS, the Gravity Information Service of the German Research Centre for Geosciences (GFZ), in collaboration with the Alfred-Wegener-Institut (AWI) and Technische Universität Dresden. Data products derived from the gravimetric Earth observation satellite missions GRACE and GRACE-FO are widely used by scientists and other interested users to study mass variations in the Earth system. However, processing of GRACE/GRACE-FO data into user-friendly products for dedicated geophysical applications is nontrivial, neither when starting from original satellite observations nor from the level of gravity field products. In order to enable the usage of satellite gravimetry data for a broader community, user-friendly ('Level-3') products are generated by various institutions.

GravIS visualizes and describes Level-3 products based on the most recent GRACE and GRACE-FO data release from GFZ. In addition, Level-3 products based on the most recent release of combined GRACE models from COST-G are offered as well. The products presented at GravIS are available for download at GFZ's Information System and Data Center (ISDC).



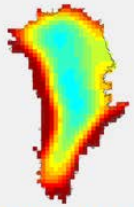
Terrestrial Water Storage



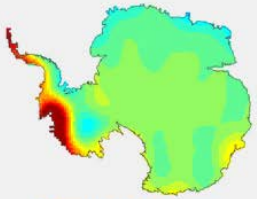
Ocean Bottom Pressure

The Gravity Recovery and Climate Experiment (GRACE; 2002 - 2017) and its Follow-On mission (GRACE-FO; launched in May 2018) typically provide monthly independent estimates of the Earth's global gravity field. Differences between consecutive months are caused by mass redistribution and mass transport in the Earth system, particularly in the geophysical fluid layers of the atmosphere, oceans, and continental hydrosphere.

GRACE/GRACE-FO data processing is structured into sensor data analysis (Level-0 to Level-1), global gravity field estimation (Level-1 to Level-2), and geophysical mass anomaly inversion (Level-2 to Level-3). Level-3 products at GravIS comprise gridded mass anomalies as well as basin average time series and are available for terrestrial water storage over non-glaciated regions, bottom pressure variations in the oceans, and ice-mass changes in both Antarctica and Greenland. In order to achieve the highest possible accuracy of the mass anomalies, several post-processing steps have been applied to the Level-2 spherical harmonic coefficients before inversion.



Greenland Ice-Mass Change



Antarctic Ice-Mass Change

Summary and Outlook

- COST-G combined Level-2 products for GRACE (repro) and Swarm (operational) are available from ICGEM, operational GRACE-FO combinations are in the process of publication (matter of days).
- COST-G Level-3 products for GRACE are available via GFZ's GravIS portal (http://gravis.gfz-potsdam.de/), GRACE-FO will follow within 2-3 weeks.
- Inclusion of further candidate Analysis Centers (Chinese ACs) is planned for 2021 (benchmark testing and quality control are being performed).