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

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 - Quality control (Noise/Signal content)
 - Combination applying variance component estimation
- External validation (COST-G GRACE RL01)

Introduction

Gravity and geoid metadata

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

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

N-meta
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

IGFS Mailing Lists

Subscribe to our mailing lists to be informed on IGFS Products & Stan

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.

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/>

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COST-G Website

Combination Service for Time-variable Gravity Fields

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Welcome to COST-G

The International **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 steems 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

March 18th 2020

COST-G standards and RL01 release notes are now available [here](#)!

January 19th 2020

COST-G had its second ISSI team meeting in Bern, January 13-17. The Terms of References are [available here](#).

July 14th 2019

COST-G is officially launching at the occasion of the IUGG 2019 in Montreal!

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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

Products: Combined GRACE/GRACE-FO Gravity Fields

Improved and consolidated product integrating the strengths of all ACs

Products: Combined Swarm Gravity Fields

GSWARM_GF_SABC_AIUB_2015-03_01_AIUB

Combination Service of
Time-variable Gravity
Field Solutions (COST-G)

GSWARM_GF_SABC_ASU_2015-03_01_TUD

GSWARM_GF_SABC_IFG_2015-03_03_IFG

For Swarm

- Operational continuation is already running
- Will be funded by Swarm/DISC for two more years

funded by contract SD-ITT-1.1,
part of contract 000109587/13/I-NB

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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.

COST-G Workflow

Quality Control – Noise Levels (spectral domain)

GRACE-FO time-series:

COST-G ACs:

- AIUB
 - continuation of RL02
 - G3P project
- GFZ
- GRGS (delayed)
- ITSG

COST-G candidate AC:

- LUH

COST-G partner ACs:

- CSR-RL06
- JPL-RL06

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 (spectral domain)

GRACE-FO time-series:

COST-G ACs:

- AIUB
 - continuation of RL02
 - G3P project

GFZ

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If not labeled differently, the AIUB time-series derived from alternative ACC transplant products in the frame of the G3P project is shown.

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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)

Amazon

Example: amplitude of seasonal variations in Amazon river basin (GRACE).

Quality Control – Signal Content (Hydrology)

Example: amplitude of seasonal variations in Amazon river basin (GRACE-FO).

Quality Control – Signal Content (Hydrology)

Amplitudes sorted by amp_a of ITSG_FO (descending)

Comparison of amplitudes amp_a of seasonal mass variations and their formal errors sig_{amp} in 100 major river basins.

Quality Control – Signal Content (Ice Mass Loss)

**Example: ice mass loss in Greenland (GRACE),
compared to static reference field GOCO05S.**

Quality Control – Signal Content (Ice Mass Loss)

Example: ice mass loss in Greenland (GRACE-FO) with respect to GOCO05S.

Despite the short time span of the GRACE-FO time-series the mass loss trends in Greenland agree well, no signal attenuation in any of the time-series could be detected.

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

Internal Validation: spectral domain

Median degree amplitudes of anomalies wrt a linear and seasonal model (no filtering applied)

For the COST-G GRACE-FO combination no external validation is yet available, in the following slides we therefore provide examples on the validation of the COST-G GRACE combination released in July 2019.

The main gain of the combination is in the range of degrees 15-45.

Internal Validation: spatial domain

RMS of anomalies of CSR6 (geoid heights)

RMS of anomalies of GFZ6 (geoid heights)

RMS of anomalies of COMB (geoid heights)

RMS of anomalies of COMB (geoid heights)

RMS of anomalies of COMB (geoid heights)

Basin-Averaged GIS Mass Changes

Basin-integrated AIS/GIS mass changes based on the sensitivity kernel approach by TU Dresden

Trends agree fairly well for the Greenland Ice Sheet

Basin-Averaged AIS Mass Changes

**Larger trend
differences for
Antarctic Ice Sheet**

Basin-Averaged AIS Mass Changes

Trends from GFZ seem to be different for East Antarctica. A slight influence on COST-G products may be seen (under investigation).

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

Comparison to Altimetry

SIGNAL ASSESSMENT → Comparison to Altimetry. Presently, two test areas for the signal assessment have been selected: **the Caspian sea and the Black sea**. Correlation coefficient with altimetry over the Caspian Sea: the COST-G solution presents a slight improvement over the TUGRAZ and CSR solutions.

Correlation w. ALT	COST-G	TUGRAZ ITSG18	CSR RL06
DDK5 filter	97.2 %	97.0 %	96.9 %
DDK6 filter	96.6 %	96.5 %	96.3 %

Method: *The 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 bias (irrelevant) and one scale factor are adjusted. The criteria are the **scale factor** and **correlation coefficients**. Both should be as close as possible to 1.*

Orbit Tests with GOCE

- GRACE solutions up to d/o 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 the 30 individual arcs in question)

Gravity model	Month			
	2009/11	2009/12	2010/10	2010/11
GFZ_RL06	7,38	6,84	6,23	6,18
AIUB_RL02	8,69	8,56	7,39	7,21
CSR_RL06	6,88	9,09	6,65	6,20
GRGS_RL04f	5,88	7,30	5,47	5,83
ITSG_2018_tide_free	5,51	5,12	4,19	4,54
COSTG_RL01	5,03	5,54	4,52	4,72

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 Dec. 2019 available at ICGEM
 - http://icgem.gfz-potsdam.de/series/02_COST-G/Swarm

Level-2 Product Availability

ICGEM

GRACE and Grace-FO solutions from the Science Data System centers CSR, GFZ and JPL

expand all

- + CSR Center for Space Research at University of Texas, Austin
- + GFZ Helmholtz Centre Potsdam German Research Centre for Geosciences
- + 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 monthly
Swarm DOI monthly

GRACE / CHAMP solutions from other groups

expand all

- + AIUB Astronomical Institute University Bern
- + CNES Centre national d'études spatiales
- + DMT Delft University of Technology
- + EGSIM European Gravity Service for Improved Emergency Project

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Level-2 Product Availability: GRACE

Gravity Field Solutions for dedicated Time Periods

GRACE

You can download all the models in this set as [zip](#) (22.4 MiB) or you can find subsets and single model files below. It can take a moment to generate the zip file for you.

You can also find these files at ftp://icgem.gfz-potsdam.de/02_COST-G/GRACE.

GAX_products	zip
unfiltered	zip

GAX_products	zip
GAC-2_2002095-2002120_GRAC_COSTG_BF01_0100.gfc	gfc (213.2 KiB)
GAC-2_2002122-2002137_GRAC_COSTG_BF01_0100.gfc	gfc (213.2 KiB)
GAC-2_2002213-2002243_GRAC_COSTG_BF01_0100.afc	afc (213.2 KiB)

unfiltered	zip
GSM-2_2002095-2002120_GRAC_COSTG_BF01_0100.gfc	gfc (368.8 KiB)
GSM-2_2002122-2002137_GRAC_COSTG_BF01_0100.gfc	gfc (368.8 KiB)
GSM-2_2002213-2002243_GRAC_COSTG_BF01_0100.gfc	gfc (369.0 KiB)

Level-2 Product Availability: Swarm

ICGEM

Gravity Field Solutions for dedicated Time Periods

Swarm

Citation: Encarnacao, J, Visser, P, Jaeggi, A, Bezdek, A, Mayer-Gürr, T, Shum, C K, Arnold, D, Doornbos, E, Elmer, M, Guo, J, van den IJssel, J, Iorfida, E, Klokocnik, J, Krauss, S, Mao, X, Meyer, U, Sebera, J, Zhang, C, Zhang, Y, and Dahle, C 2019 Multi-approach Gravity Field Models from Swarm GPS data. DOI: <https://doi.org/10.5880/ICGEM.2019.006>

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You can download all the models in this set as [zip](#) (1.1 MiB) or you can find subsets and single model files below. It can take a moment to generate the zip file for you.

You can also find these files at ftp://icgem.gfz-potsdam.de/02_COST-G/Swarm.

Summary and Outlook

- COST-G RL01 Level-2 products for GRACE and Swarm are available from ICGEM
- COST-G RL01 Level-3 products for GRACE are currently being processed and will be made available via GFZ's GravIS portal (<http://gravis.gfz-potsdam.de/>)
- Operational GRACE-FO combination will start shortly after EGU
- CSR and JPL are listed as Partner Analysis Centers in the COST-G ToR
- Inclusion of candidate Analysis Centers (LUH, Chinese ACs) is envisaged in the near future.