COST-G combination of Swarm gravity fields of different analysis centers

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Content

• IAG Services
• COST-G
  • Products
  • Work Flow
• Combination of Swarm gravity fields
• Validation
• Product dissemination
• Application of Swarm gravity fields

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International Association of Geodesy

Int. Gravity Field Service

Int. Gravimetric Bureau

Int. Geoid Service

Int. Gedoymamics and Earth Tide Service

Int. Center for Global Earth Models

Int. DEM Service

PSMSL - Permanent Service for Mean Sea Level

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

Product Center of the IGFS

Int. Earth Rotation Service

Int. Laser Ranging Service

Int. VLBI Service
**Products**

COST-G provides a number of products via different platforms and channels:

**GRACE**

**Level 2** – Products are sets of spherical harmonic coefficients which stem from the combination on solution or normal equation level. The coefficients need to be processed by a spherical harmonic synthesis in order to derive gridded data. They are available at the International Center for Global Gravity Earth Models (ICGEM): [http://icgem.gfz-potsdam.de/series/03_COST-G/GRACE](http://icgem.gfz-potsdam.de/series/03_COST-G/GRACE)

**Level 2b** – Products will be available soon.

**Level 3** – Products will be available soon.

**GRACE Follow-On**

**Level 2** – Products will be available soon.

**Level 2b** – Products will be available soon.

**Level 3** – Products will be available soon.

**Swarm**

**Level 2** – Products are a combination of different kinematic orbit products and various gravity field recovery approaches. Data is available at the International Center for Global Gravity Earth Model (ICGEM): [http://icgem.gfz-potsdam.de/series/03_COST-G/Swasham](http://icgem.gfz-potsdam.de/series/03_COST-G/Swasham)
COST-G: Harmonization

Combination Process

Harmonization

- AC 1
- AC 2
- Rescaling
- Mean Pole
- Tide System
- Truncation
- AC 3
- ...

Quality Control

- Signal content
  - hydrological cycle
  - ice mass trend
  --> exclude biased solutions
- Noise content:
  - spectral domain
  - spatial domain
  --> remove outliers

Combination

- Solution combination
- Weighting: VCE
- NEQ-combination

Validation

- Internal and External Validation
  - L2 products
  - L3 products
Combination Process

<table>
<thead>
<tr>
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<tbody>
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Signal content:
- hydrological cycle
- ice mass trend
--> exclude biased solutions

Noise content:
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--> remove outliers
# COST-G: Combination

## Combination Process

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Variance Component Estimation

monthly weights, normalized

- AIUB
- IFG
- ASU
- OSU

# COST-G: Validation

## Combination Process

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Noise Levels of Swarm Gravity Fields

RMS of non-seasonal, non-secular variations over oceans

Unfiltered

Smoothed by 400 km Gauss filter
Product Dissemination

ICGEM

Tongji-Grace2018
ULux
WHU RL01 DOI
XISM&STC-GRACE01

COST-G (International Combination Service for Time-variable Gravity Field)
GRACE
Swarm

GRACE weekly solutions
GFZ Release 05

GRACE daily solutions
ITSG-Grace2014
ITSG-Grace2016
ITSG-Grace2018

SLR monthly
SLR-only monthly solutions from AIUB

Non-isotropic smoothing
AIUB Release 02
CSR Release 05
GFZ Release 05
HUST-Grace2016 DOI
ITSG-Grace2014
ITSG-Grace2016 DOI
JPL Release 05
Tongji Release 01
Tongji Release 02 new version
Tongji Release 02 old version

(GRACE monthly solutions from the Tongji University, Shanghai, PR China)
(CHAMP monthly solutions from the University of Luxembourg)
(GRACE monthly solutions from the GNSS Research Center of Wuhan University, PR China)
(GRACE monthly solutions from Xi’an Research Institute of Surveying and Mapping (XISM) and Space Star Technology co., LTD. (SSTC))

(GRACE monthly solutions from the International Combination Service for Time-variable Gravity Field (COST-G), see also here here)
(Monthly Swarm solutions, more information can be found here here)

(GFZ GRACE Level-2 Processing, Revised Edition, January 2013)

(more information can be found here)

(more information can be found here)

(more information can be found here)

(more information can be found here)

(more information can be found here)

(more information can be found here)
Application of Swarm Gravity Fields

Amazon

Greenland

COST-G
Swarm Data Quality Workshop
Prague, 16 – 20 September, 2019
Swarm / SLR Combination
Conclusions:

- Swarm monthly gravity fields are determined by several analysis centers (AIUB, ASU, IfG, OSU)
- Swarm gravity fields are combined by COST-G, the new product center of the IGFS (IAG)
- L2 products (spherical harmonic representation) are available at ICGEM
- Swarm gravity fields are useful, e.g., to bridge the gap between GRACE and GRACE-FO