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The International Centre for Global Earth Models (ICGEM)

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Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences

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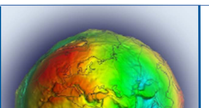

Abstract

The more than 15-year-old ICGEM is one of the five services coordinated by the International Gravity Field Service (IGFS) of the International Association of Geodesy (IAG). It is hosted by GFZ German Research Centre for Geosciences in Potsdam, Germany. The aim of the ICGEM service is to provide the scientific community with a state-of-the-art archive of static and time variable global gravity field models of the Earth in a standardized format with a possibility to assign DOI number. Furthermore, ICGEM contains an interactive calculation and visualization service of gravity field functionals. Development and maintenance of such a unique platform is crucial for the scientific community in geodesy, geophysics, oceanography and climatology and has a positive impact in governmental institutions and industrial practice. This poster covers the maintenance, recently established new features and future plans of the ICGEM Service. New features include the calculation of gravity field functionals at a list of user-defined distributed points and new topographic gravity field models, whereas the future plans aim to meet the needs of the scientific community. As an add-on, ICGEM provides also access to the gravity field models of some other celestial bodies (Mars, Venus, and Earth's moon).

Gravity Field Models

1

The datasets available via the ICGEM Service are the spherical harmonic coefficients, which together with the spherical harmonic functions, approximate the real gravitational potential of the Earth and/or its variations. ICGEM collects all available static and most of the temporal and topographical global gravity field models (GGMs) recently from different institutions under one umbrella and makes these models freely available to the public. ICGEM currently (April 30th, 2020) provides access to 176 static, variety of temporal and 10 topographic GGMs.

New features:

- The temporal models generated by the International Combination Service for Time-variable Gravity Field (COST-G) are available at ICGEM since July 2019.
- Since April 2020, the GAX products associated to the GRACE and Grace-FO solutions from the Science Data System centers CSR, GFZ and JPL are available at ICGEM as well

Calculation Service

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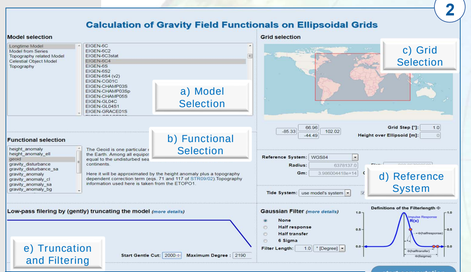

Figure 1: Calculation Service Interface for Gridded Points. http://icgem.gfz-potsdam.de/calcgrid

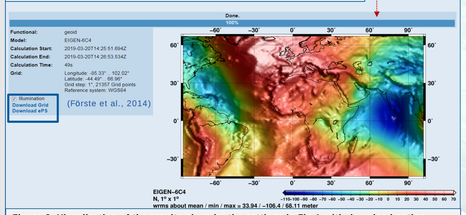

Figure 2: Visualisation of the results given by the settings in Fig.1 with download option.

Availability of topography gravity field models

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

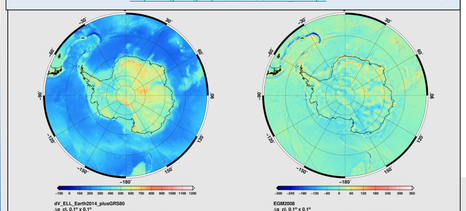

Figure 3: Classical gravity anomalies (free air) computed on the Earth's surface based on a) topographic model dV_ELL_Earth2014_plusGRS80 (Rexer M., 2016) b) EGM2008 (Pavlis et al., 2012) using models_highest d/o available, 2190. Features in Antarctica are better resolved in dV_ELL_Earth2018 due to the availability of high resolution elevation data.

3D Visualisation Service

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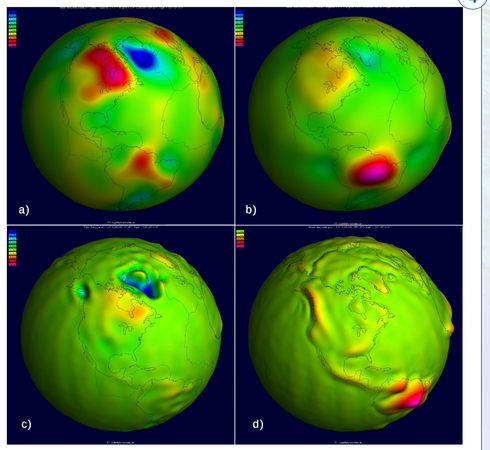

Figure 5: Snapshot of Visualisation Service for temporal gravity field models

a) EWH in January 2009 b) EWH in May 2009, note that the EWH difference between the two months represents the mass change, c) trend, note the strong effect due to the GIA in Hudson Bay area, Canada and ice melting in Greenland and Alaska d) annual amplitude, where the large signal amplitude in the Amazon region is noticeable.
(EWH - Equivalent Water Height)

Calculation Service

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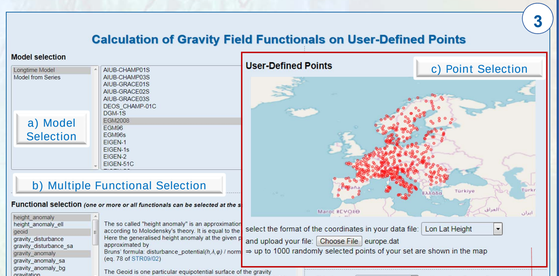
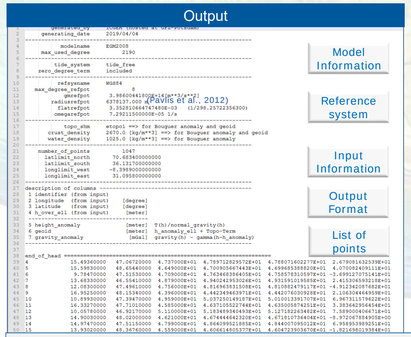


Figure 4: Calculation Service Interface for User-defined Points. http://icgem.gfz-potsdam.de/calcpoints



d) Input Format

Index Lat Lon Height
Index Lon Lat Height
Index Lat Lon
Index Lon Lat
Lat Lon Height
Lon Lat Height
Lat Lon
Lon Lat

The details of the calculation procedure applied in the Calculation and Visualisation Services can be found in Barthelmes, 2014, Technical Report.

http://icgem.gfz-potsdam.de/str-0902-revised.pdf

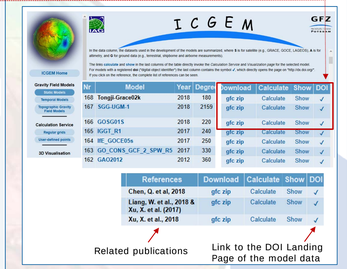
Since December 2018, ICGEM makes available also the calculation of gravity field functionals at user-defined list of points that are given in one of the input formats and the calculations are performed directly at those given points using model coefficients (not an interpolation to grid values). Different heights for different points can be introduced in the point calculation which is different than the grid calculation where the height is assumed same for all the grid points.

DOI Service

DOI Service was developed as a request by the user community in cooperation with GFZ Data Services.

To reduce the heterogeneity in data documentation for static global gravity field models, standardised metadata templates for describing the models were developed. At the moment, all models with assigned DOIs are published under the Creative Commons Attribution 4.0 International Licence (CC BY 4.0).

Since its implementation in late 2015, we have assigned DOIs to 23 static and 8 temporal global gravity field models, mostly timely related to their first publication via ICGEM.

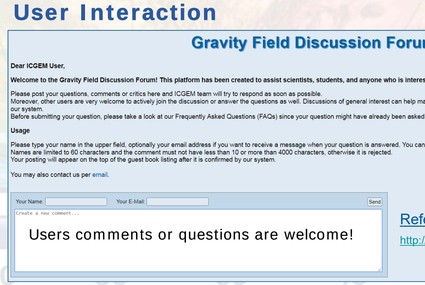


DOI request for gravity field models:
http://pmd.gfz-potsdam.de/panmetaworks/metaedit/

An online interactive 3D Visualisation Service of the static models (geoid undulations and gravity anomalies), temporal models (geoid undulation and equivalent water column or height), trend and annual amplitude of GRACE gravity time variations, and spherical harmonics as illuminated projection on a freely rotatable sphere are available on the ICGEM Service. Static model visualisation enables also the demonstration of differences between two models with a selected grid interval and spherical harmonic degree expansion. Users of this service can select the functional, the model, the grid interval and the spherical harmonic degree expansion of the model to demonstrate the results on the 3D visualization. 3D Visualisation of temporal gravity field models displays computation of geoid undulation and equivalent water height from different daily and monthly series with an option of using filtered or unfiltered model coefficients. The visualisation tool can also be used for animation purposes for different monthly series.

ICGEM provides a gravity field discussion forum (http://icgem.gfz-potsdam.de/guestbook) which provides users with a platform to communicate with the ICGEM team and other scientists working on similar topics. Apart from fulfilling the requirements of the service, this platform has also been used as a tool for educational purposes in which undergraduate or graduate students communicate with the ICGEM team directly. The updated version of the forum in 2016 should give the users the opportunity to discuss any topic related to gravity field among themselves or answer each other's question and probably share data in the future.

User Interaction



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Refer also to FAQs:
http://icgem.gfz-potsdam.de/icgem_faq.pdf

Future Plans

- In the near future, the **G3 Browser,** which showed the time variation of gravity field at any desired point or pre-defined basin, will be available again with improved features developed for both advanced researchers and educational purposes. **A specific web interface** will be made available for the user to calculate and visualise time series of mass variations.
- New services, such as the provision of **time series** of the changes of the gravity field of the Earth due to the flattening retrieved from SLR measurements from different institutions and agencies and the offer of the calculation of horizontal gravity gradients in the ICGEM Calculation Service are among our future plans.
- In the following years, we propose to establish sub-sections for different topics and **expand the discussion forum** to be unique in this field. Anyone without any registration requirement should still be able to write comments in the forum which will be publicly available after approval of the ICGEM team.
- If requested by the users, **data sharing** such as terrestrial gravity measurements and GNSS/levelling derived geoid undulations for GGM evaluation purposes can also be developed under the ICGEM web service safely.
- An **e-mail subscription list** for the delivery of important updates to the interested users has been completed and will be activated soon.

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

References

- Barthelmes, F.: Definition of Functionals of the Geopotential and Their Calculation from Spherical Harmonic Models: Theory and formulas used by the calculation service of the International Centre for Global Earth Models (ICGEM). Scientific Technical Report STR09/02, Revised Edition, January 2013. Deutsches GeoForschungZentrum GFZ, http://doi.org/10.2312/GFZ.b103-0902-26, 2013
- Ince, E. S., Barthelmes, F., Reißland, S., Elger, K., Förste, C., Flechtner, F., and Schuh, H.: ICGEM – 15 years of successful collection and distribution of global gravitational models, associated services, and future plans, Earth Syst. Sci. Data, 11, 647-674, https://doi.org/10.5194/essd-11-647-2019, 2019.

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