

New Features and Future Plans of the International Centre for Global Earth Models (ICGEM)

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Abstract

The 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). ICGEM continues its services with its new, modernized and flexible Website created for future developments since May 2017. Static and temporal global gravity field models of the Earth are provided in a standardized format with a possibility to assign DOI number and interactive calculation and visualisation services of gravity field functionals are available. Development and maintenance of such a unique platform is crucial for the scientific community and supported by the German Research Centre for Geosciences, GFZ-Potsdam. This presentation summarizes the old and new features as well as the future plans of ICGEM and aims to make the services of ICGEM visible and increase the interaction with the user.

Gravity Field Models

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 global gravity models (GGMs), and most of the temporal and topographical gravity field models recently from different institutions under one umbrella and make these models freely available to the public. As of April 2019, ICGEM provides access to 169 static GGMs, variety of temporal GGMs and 9 topographic GGMs.

Calculation Service http://icgem.gfz-potsdam.de/calcgird

Figure 1: Calculation Service Interface for Gridded Points. Screenshot of the web interface showing model selection, grid selection, functional selection, and reference system options.

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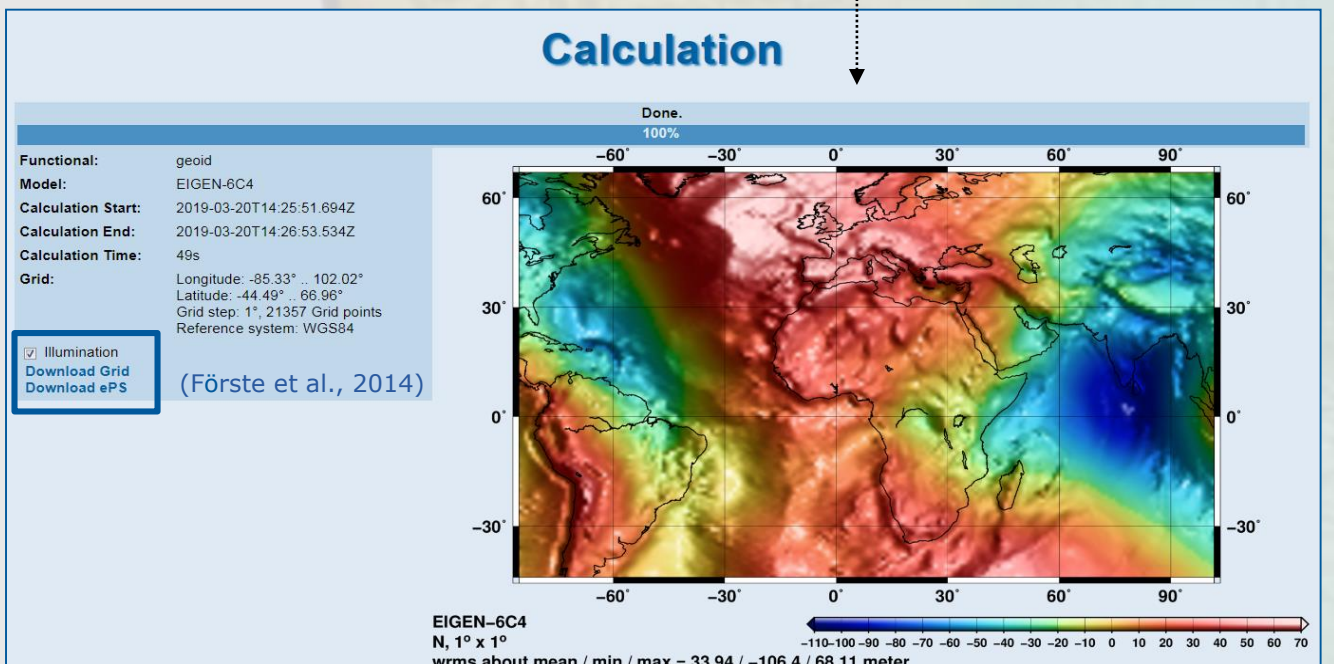


Figure 2: Visualization of the results given by the settings in Fig.1 with download option.

New feature Availability of topographic gravity field models

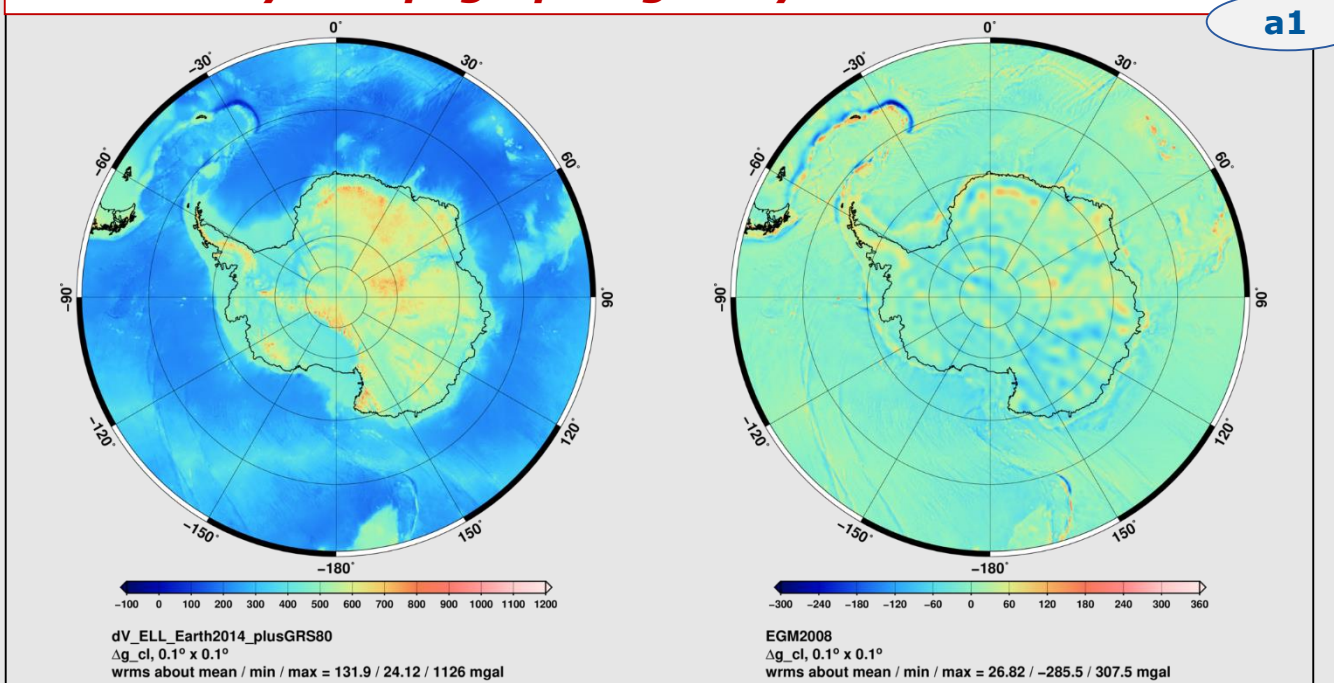


Figure 3: Classical gravity anomalies that are also known as free air gravity anomalies computed on the Earth's surface based on a) topographic model dV\_ELL\_Earth2014\_plusGRS80 (Rexer M., 2016) b) EGM2008 (Pavlis et al., 2012) using models highest degree/order available, 2190. Features in Antarctica are better resolved in due to the availability of high resolution elevation data in the region.

New feature: Availability of User-defined point calculation http://icgem.gfz-potsdam.de/calcpoints

Figure 4: Calculation Service Interface for User-defined Points. Screenshot of the web interface for user-defined points, including model selection, point selection, and functional selection options.

Figure 4: Calculation Service Interface for User-defined Points.

Figure 5: Output table showing columns for generated\_by, generating\_date, modelname, max\_user\_degree, tide\_system, max\_degree, max\_degree\_refpoint, radius\_earth, earth\_gravity\_constant, omega\_earth, topo\_slm, current\_density, water\_density, number\_of\_points, latitude\_north, latitude\_south, longitude\_west, longitude\_east, description\_of\_columns, identifier, longitude, latitude, and s\_over\_all.

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 Service has made available also the calculation of gravity field functionals at user-defined list of points. Input file can be prepared by the user in one of the allowed formats and the calculations are performed directly at those particular 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 from the grid calculation where the height is assumed same for all the grid points and consequently delivers results faster

- 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 GeoForschungszentrum GFZ, http://doi.org/10.2312/GFZ.b103-0902-26, 2013. Ince, E. S., Barthelmes, F., Reibland, 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 Discuss., https://doi.org/10.5194/essd-2019-17, in review, 2019

3D Visualisation Service

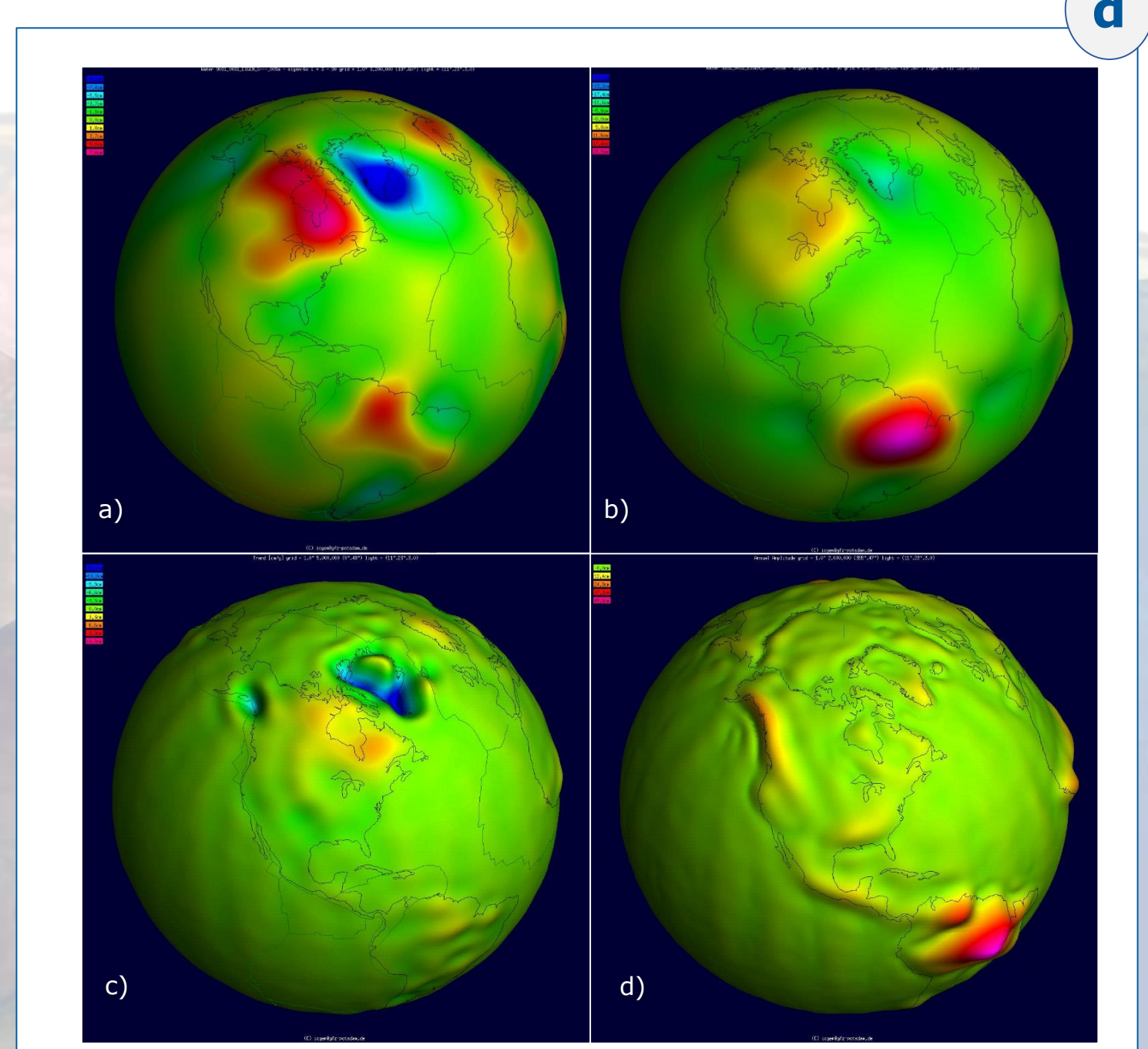


Figure 5: Snapshot of Visualisation Service for temporal gravity field models (EWH - Equivalent Water Height)

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 Alaska and ice melting in Greenland d) annual amplitude, where the large signal amplitude in the Amazon region is noticeable. See also GRAVIS Poster EGU2019-10455-1, Fri, 12 Apr, 10:45-12:30 Hall X3.

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

Gravity Field Discussion Forum. Welcome to the Gravity Field Discussion Forum! This platform has been created to assist scientists, students, and anyone who is interested in using ICGEM service and its products. Please post your questions, comments or critics here and ICGEM team will try to respond as soon as possible. Before submitting your question, please take a look at our Frequently Asked Questions (FAQs) since your question might have already been asked and answered by our team.

Form for user interaction with the Gravity Field Discussion Forum, including fields for Name, E-mail, and a text area for the message.

DOI Service

ICGEM DOI Service interface showing dataset information for EIGEN-6S4, citation information, data download options, model parameters, and related publications.

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 17 static and 3 temporal series, mostly timely related to their first publication via ICGEM.

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Future Plans

- ICGEM will continue its services with the support of GFZ and IAG. 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 settings safely. Creation of an e-mail subscription list for the delivery of important updates to the interested users is under discussion. These are possible options and opportunities to share the science and its products.

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

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ICGEM website navigation and related publications section, including links to Gravity Field Models, Calculation Service, 3D Visualization, and a list of related publications with download and calculation options.

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

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