International Centre for Global Earth Models (ICGEM)

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

Director: **F. Barthelmes** (Germany)

Terms of Reference

The determination of the Earth's global gravity field is one of the main tasks of Geodesy: it serves as a reference for geodesy itself, and it provides important information about the Earth, its interior and its fluid envelope for all geosciences. Thus, it is important to make the models of the global gravity field available to the public as products of geodesy. This becomes increasingly important as time variations of the global gravity field can be measured with better and better spatial and temporal resolution.

The calculation of the different functionals of the geopotential (e.g.: geoid, gravity anomaly, gravity disturbance, equivalent water height) from a defined global model, on a specified grid and with respect to a defined reference system, is far from being trivial and a responsibility of geodesy too.

Additionally, it is important to make the spatial structure and temporal variability of the global gravity field available to the general public in a graphic vivid manner.
In particular for temporal gravity models, aspects of consistency in processing, reference frame, and parameterization are becoming more and more important.

ICGEM has been established in 2003 as a new service under the umbrella of the new International Gravity Field Service (IGFS) as one of six centres.

Objectives

- collecting and long-term archiving of existing global gravity field models
- making them available on the web
- use of standardised format (self-explanatory)
- interactive visualisation of the models
- solutions from dedicated time periods (e.g. monthly GRACE models) included
- web-interface to calculate gravity functionals from the spherical harmonic models on freely selectable grids (filtering)
- evaluation of the models

Services

The Models

Currently, 122 models are listed with their references and, apart from 17 older models, all are available in form of spherical harmonic coefficients. If available, the link to the original model web site has been added. Models from dedicated time periods (e.g. monthly solutions from GRACE) of CSR, JPL, CNES/GRGS and GFZ are also available.

The Format

The spherical harmonic coefficients are available in a standardised self-explanatory format which has been accepted by ESA as the official format for the GOCE project.

The Visualisation

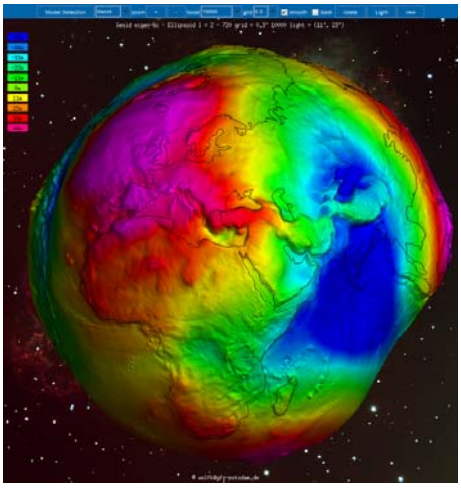

Fig. 1: Visualisation (geoid) of a global gravity field model

An online interactive visualisation of the models (height anomalies and gravity anomalies) as illuminated projection on a freely rotatable sphere is available (see fig. 1). Differences of two models, arbitrary degree windows, zooming in and out, are possible. Additionally, an animation over time of the monthly solutions from GRACE is also included. The visualisation of single spherical harmonics is possible for tutorial purposes.

The Calculation Service

A web-interface to calculate gravity functionals from the spherical harmonic models on freely selectable grids, with respect to a reference system of the user's choice, is provided (see figs. 2 and 3). The following functionals are available:

- pseudo height anomaly on the ellipsoid (or at arbitrary height over the ellipsoid)
- height anomaly (on the Earth's surface as defined)
- geoid height (height anomaly plus spherical shell approximation of the topography)
- gravity disturbance
- gravity disturbance in spherical approximation (at arbitrary height over the ellipsoid)
- gravity anomaly (classical and modern definition)
- gravity anomaly (in spherical approximation, at arbitrary height over the ellipsoid)
- simple Bouguer gravity anomaly
- gravity on the Earth's surface (including the centrifugal acceleration)
- gravity on the ellipsoid (or at arbitrary height over the ellipsoid, including the centrifugal acceleration)
- gravitation on the ellipsoid (or at arbitrary height over the ellipsoid, without centrifugal acceleration)
- second derivative in spherical radius direction (at arbitrary height over the ellipsoid)
- equivalent water height (water column)

Fig. 2: Input mask of the calculation service

Filtering is possible by selecting the range of used coefficients or the filter length of a Gaussian averaging filter. The calculated grids (self-explanatory format) and corresponding plots (postscript) are available for download after some seconds.

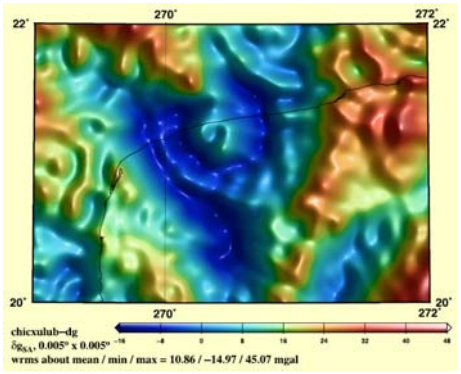

Fig. 3: Example of grid and plot generation by the calculation service: gravity disturbances of the Chicxulub crater region from the model EGM2008

Evaluation

For a concise evaluation of the models, comparisons with GPS-levelling data (see fig. 4) and with the most recent combination model in the spectral domain (see figs. 5 and 6) are provided.

Model	Nmax	USA 6169 points	Canada 1930 points	Europe 1235 points	Australia 201 points
EIGEN-6C	1420	0.247 m	0.136 m	0.214 m	0.219 m
EIGEN-6S	240	0.446 m	0.373 m	0.449 m	0.397 m
GOCO02S	250	0.435 m	0.352 m	0.434 m	0.372 m
AIUB-GRACE03S	160	0.650 m	0.514 m	0.713 m	0.486 m
GO_CONS_GCF_2_DIR_R2	240	0.443 m	0.374 m	0.449 m	0.391 m
GO_CONS_GCF_2_TIM_R2	250	0.436 m	0.355 m	0.434 m	0.376 m
GO_CONS_GCF_2_SPW_R2	240	0.457 m	0.376 m	0.473 m	0.376 m
GO_CONS_GCF_2_DIR_R1	240	0.407 m	0.319 m	0.402 m	0.319 m
GO_CONS_GCF_2_TIM_R1	224	0.455 m	0.378 m	0.474 m	0.371 m
GO_CONS_GCF_2_SPW_R1	210	0.471 m	0.399 m	0.498 m	0.384 m
GOCO01S	224	0.451 m	0.374 m	0.473 m	0.370 m
EIGEN-51C	359	0.335 m	0.245 m	0.289 m	0.234 m
EIGEN-5C	360	0.341 m	0.251 m	0.303 m	0.244 m
AIUB-CHAMP03S	100	0.755 m	0.743 m	1.148 m	1.148 m
EIGEN-CHAMP05S	150	0.784 m	0.763 m	1.216 m	0.661 m
ITG-GRACE2010S	180	0.548 m	0.459 m	0.595 m	0.523 m
AIUB-GRACE02S	150	0.630 m	0.571 m	0.701 m	0.495 m
GGM03C	360	0.346 m	0.279 m	0.334 m	0.259 m
GGM03S-UPTO150	150	0.641 m	0.521 m	0.710 m	0.494 m
AIUB-GRACE01S	120	0.724 m	0.628 m	0.930 m	0.563 m
EGM2008	2190	0.248 m	0.126 m	0.208 m	0.217 m
EIGEN-5S	150	0.630 m	0.547 m	0.737 m	0.475 m
ITG-GRACE03	180	0.633 m	0.557 m	0.658 m	0.603 m
AIUB-CHAMP01S	70	0.843 m	0.906 m	1.513 m	0.893 m
ITG-GRACE02S	170	0.623 m	0.511 m	0.639 m	0.489 m
EIGEN-GL04C	360	0.339 m	0.253 m	0.336 m	0.244 m
EIGEN-GL04S1	150	0.630 m	0.576 m	0.748 m	0.464 m
EIGEN-CG03C	360	0.346 m	0.306 m	0.355 m	0.260 m
GGM02C	200	0.473 m	0.378 m	0.515 m	0.376 m
GGM02S	160	0.977 m	1.116 m	1.416 m	1.356 m
EIGEN-CG01C	360	0.351 m	0.270 m	0.370 m	0.263 m
EIGEN-CHAMP03S	140	0.816 m	0.842 m	1.451 m	0.849 m
EIGEN-GRACE02S	150	0.739 m	0.643 m	0.828 m	0.538 m
TUM2S	60	0.864 m	0.963 m	1.630 m	1.101 m

Fig. 4: Table (truncated) of comparison of the models with GPS-levelling: Root mean square (rms) about mean of GPS / levelling minus gravity field model derived geoid heights [m]

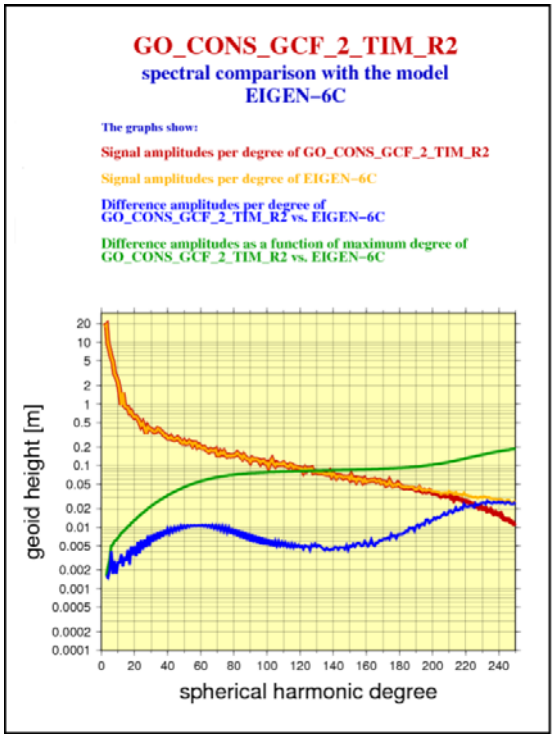

Fig. 5: Comparison of the models in the spectral domain (e.g.: GO_CONS_GCF_2_TIM_R2) with one of the most recent combination models (e.g. EIGEN-6C)

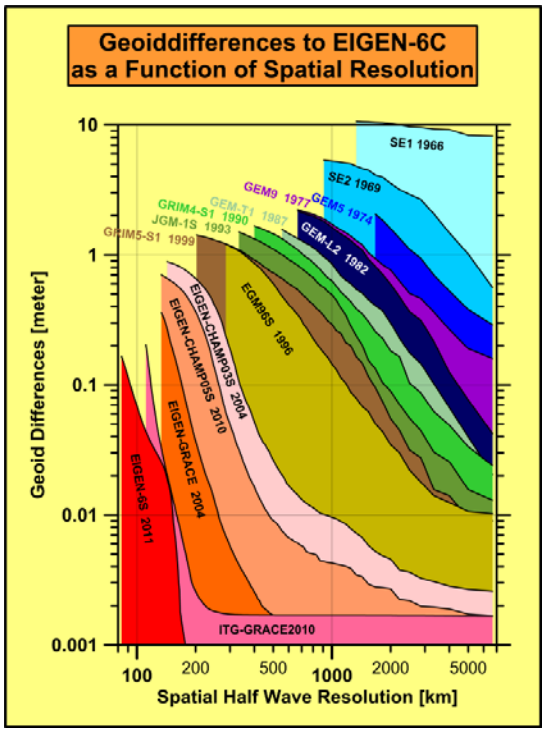

Fig. 6: Visualisation of the improvement of satellite-only models over the past decades: Geoiddifferences to the model EIGEN-6C as a function of spatial resolution

Models of other Celestial Bodies

Although it is not the main purpose of ICGEM, the calculation and visualisation service for some gravity field models of the celestial bodies Moon, Mars and Venus are also offered (see fig. 7).

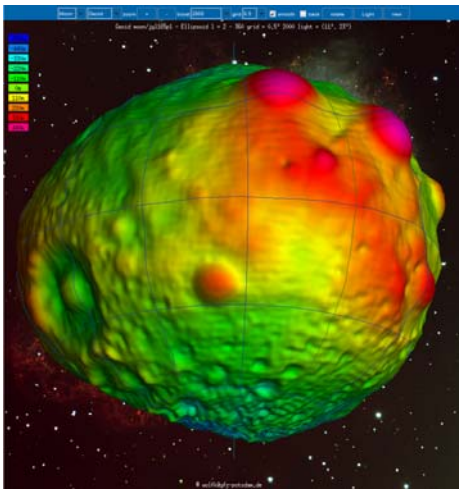

Fig. 7: Visualisation of the "Geoid" of the Moon

Data Policy

Access to global gravity models, derived products and tutorials, once offered by the centre, shall be unrestricted for any external user.

Staff

ICGEM is hosted by GFZ Potsdam. Its staff consists of
- Franz Barthelmes
- Wolfgang Köhler

Point of Contact

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