

International Gravity Field Service (IGFS)

<http://www.gravityfield.org>

Chairman: Renè Forsberg (Denmark, 2011-2013) - Riccardo Barzaghi (Italy, 2013-2015)

Director of the Technical Centre: Steve Kenyon (USA)

Director of the Central Bureau: Iginio Marson (Italy)

Overview

IGFS activities in the period 2011-2015 have been focussed on the main institutional IGFS lines that are: the collection, validation, archiving and testing of gravity field related data; the distribution of software for gravity field estimation; the organization of courses on geoid estimation; the distribution of information materials related to the Earth's gravity field.

These activities were mainly performed by the related Gravity Services in the framework of IGFS that acted in order to harmonize and merge them into a common view.

IGFS has established active links with GGOS. IGFS representatives participated to GGOS meetings (particularly those of the Bureau for Network and Communications) to present some developments on gravity field that are of relevance for GGOS.

Particularly, in this context, the activities carried out in connection with IAG Commission 2 (Gravity Field) were highlighted. Three Joint Study Groups (JWG2.1, JWG2.2, JWG2.3) have been actively operating in assessing the precision of the GOCE global geopotential models, in defining methods for comparing absolute gravimeter observations and in establishing a new global absolute gravity reference system. These researches are of particular relevance for the geodetic community. The realization of the Absolute Gravity Reference System is a key issue in Geodesy. The IGNS71 is the current realization that strictly needs for an update due also to the relevant improvements in absolute gravimeters that occurred in the last decades. The same holds for the assessment of GOCE global geopotential models. As it was done for EGM2008, comparisons with existing ground-based data set are extremely important in order to assess the precision of the different GOCE models, obtained following different approaches. This also in relationship to new planned missions aimed at improving the present day GOCE models precision.

Another action that has been developed in coordination with GGOS is the one on the researches aiming at establishing a global vertical datum. The activities of the Working Group on Vertical datum Standardization are in the framework of GGOS Theme 1 – Global Vertical Datum. Also, IGFS has been involved in the activities of the Group on International Height Reference System (IHRIS) that was established during the IAG Executive Committee in San Francisco with the objective to define a resolution on the definition of an IHRIS to be presented at the IAG/IUGG General Assembly in Prague (June 2015).

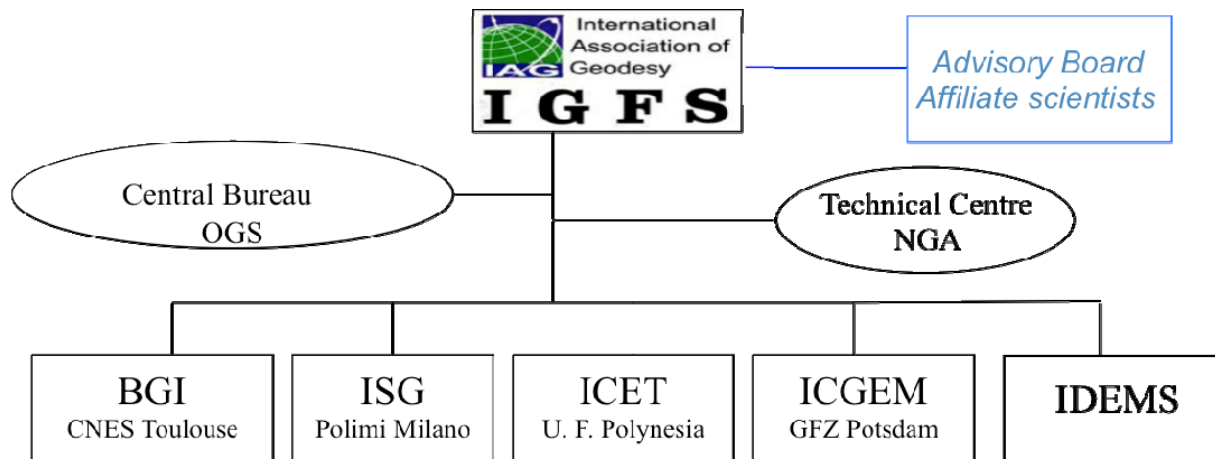
It has also to be mentioned that IGFS has co-organized two scientific meetings on gravity field related topics:

- the International Symposium on Gravity, Geoid and Height System GGHS2012, organized by IAG-Commission 2 and IGFS (via its Central Bureau) in San Servolo, Venice (October 9th-12th, 2012);
- the 3rd IGFS General Assembly, organized by IGFS, the Shanghai Astronomical Observatory and IAG Commission 2 in Shanghai (June 30th - July 6th, 2014).

Finally, the IGFS Central Bureau has realized the new IGFS web page that will be a tool for better informing the geodetic community on gravity field related topics.

Structure

The IGFS structure is described in Figure 1.



BGI=Bureau Gravimetric International
ISG=International Service for the Geoid (formerly IGeS)
ICET=International Centre for Earth Tides
ICGEM=International Centre for Global Earth Models
IDEMS=International DEM Services
OGS=Istituto Nazionale di Oceanografia e Geofisica Sperimentale
NGA=National Geospatial-Intelligence Agency

Figure 1: The IGFS structure

IGFS coordinates the activities of the related Services via the Advisory Board, its Central Bureau at OGS and the Technical Centre at NGA. This structure allows an effective relationship among the different Services working on gravity field. IGFS also provide a common interface towards other IAG bodies such as GGOS, in order e.g. to come to a standardization of the gravity “products”. Within IGFS, Joint Working Groups are coordinated with Commission 2, namely JWG2.1 (International and Regional Comparison Campaigns of Absolute Gravimeters), JWG2.2 (Absolute Gravimeters and Absolute Gravity Reference System), JWG2.3 (Assessment of GOCE Geopotential Models). Furthermore, a Working Group on Vertical Datum Standardization was established jointly with GGOS Theme 1- Global Vertical Datum. This WG is also involved, through IGFS, in the activities of the Group on IHRS.

It must be mentioned that the IGFS structure has changed in the 2011-2015 period and that there will be further changes in the near future.

Since mid 2013, IDMES is not fully operational. Contacts between Curtin University and ESRI Company have been established by IGFS in order to reactivate this important service for the geodetic community.

At the IAG Executive Committee in Vienna (April 26th, 2014), the International Geoid Service (IGeS) changed its name into International Service for the Geoid (ISG) due to internal organization problems.

On April 1st, 2013, a new chairman, Riccardo Barzaghi from Politecnico di Milano (Italy), started managing IGFS thus substituting Rene Forsberg from the National Space Institute (Denmark).

Finally, there is a proposal for evolving the ICET Service into a new IAG/IGFS Service related to the Global Geodynamic Project (GGP). This proposal will be presented at the General IAG/IUGG Assembly in Prague (June 2015).

Activities

IGFS has directly promoted the GEOMED2 project aiming at estimating a detailed geoid in the Mediterranean area. This project (that will last at the end of 2016) is based on the co-operation of a large number of institutions, namely:

- BGI/ISG
- Politecnico di Milano (Italy)
- University of Thessaloniki (Greece)
- University of Jaén (Spain)
- GET/OCA/Geoazur and SHOM (France)
- DTU Space (Denmark)
- General Command of Mapping (Turkey)
- University of Zagreb (Croatia)

By comparison with existing altimeter data, an accurate estimate of the DOT and of the circulation in the Mediterranean Sea will be also obtained.

Furthermore, as previously mentioned, the Gravity Services have developed many activities that have been coordinated and documented by IGFS.

BGI has developed and finalized the World Gravity Map project. Bouguer, Isostatic and free-air gravity anomalies are available, either as spherical harmonic expansions or 1'× 1' digital grids (see Figure 2).

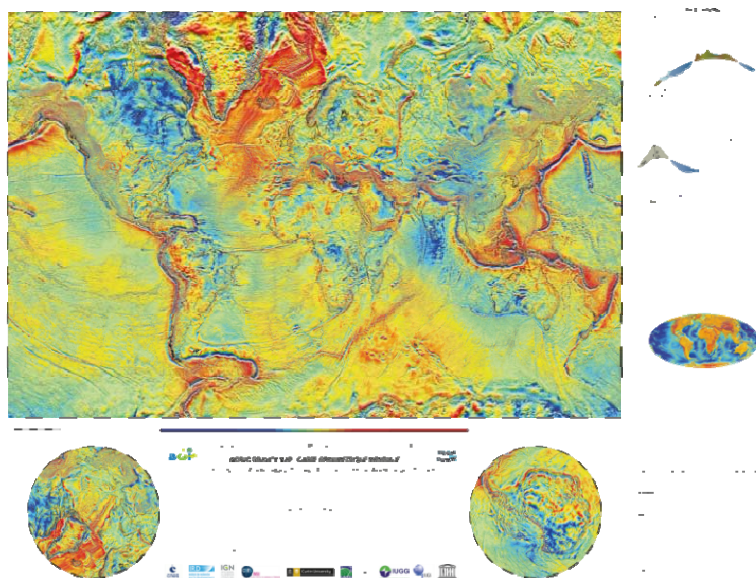


Figure 2: The World Gravity Map by BGI

Furthermore, BGI supports the African Geoid Project (see Figure 3) and, as already mentioned, the GEOMED2 project supplying gravity data and co-operating in processing the gravity data.

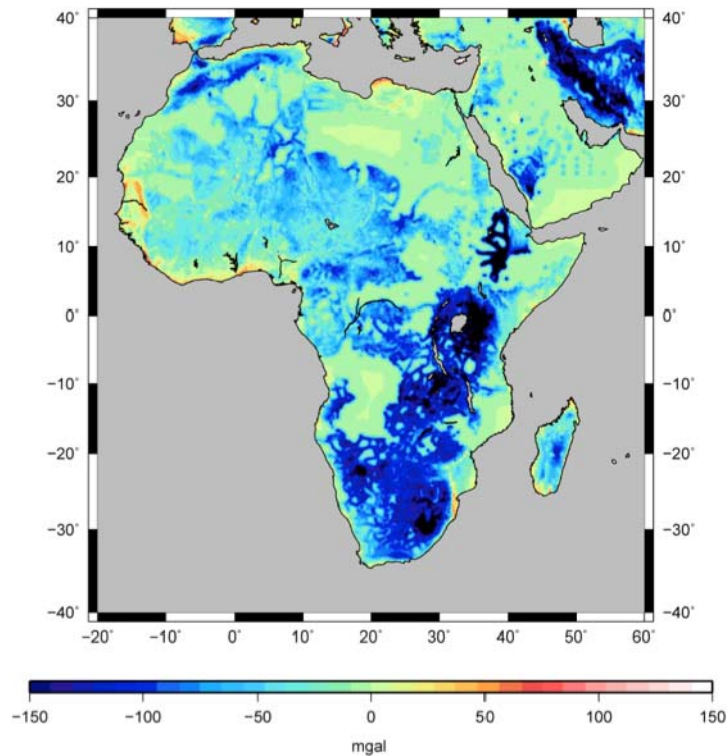


Figure 3: The Bouguer Anomaly Map in Africa

GOCE data were also processed at BGI (DIR-5 is the last computed solution) and global GOCE gradients have been estimated in a Local North-Oriented Frame (LNOF) and in the Instrument Frame (GRF frame).

Furthermore BGI is developing in co-operation with BKG an absolute gravity database that contains data from 1121 stations, from 44 different institutions (at June 2015). The information contained in these data is of strong interest in many geodetic/geophysical investigations and could contribute to the project aiming at establishing the new global gravity reference system.

ICGEM and ISG have collected both global geopotential models and local geoid solutions which are available through their web pages that are linked to the IGFS web page.

ICGEM collected and documented 150 global geopotential models that can be downloaded via the ICGEM web page. Validation of global models is provided both in the spectral domain and by direct comparison with GPS/levelling data.

On line interactive visualization tools can be used and evaluation of global model effects can be obtained via web interface. Particularly, the new G3-Browser has been developed for visualizing gravity field variations based on GRACE observations (see Figure 4).

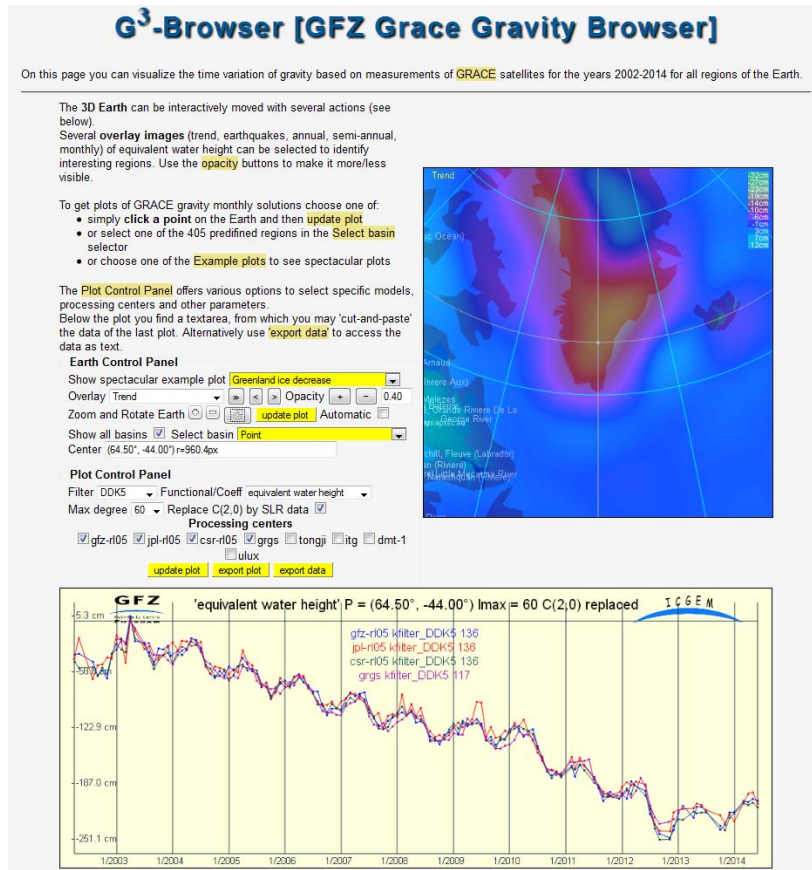


Figure 4: The gravity data variation in the area of Greenland

The ISG web page has been totally renewed in order to provide a better service to the users. At present (June 2015), 41 estimated geoids are stored in ISG database and can be downloaded, either freely or on demand, through the web page (see Figure 5). They are frequently requested by users that are interested in detailed geoid solutions, basically for mapping and GIS applications.

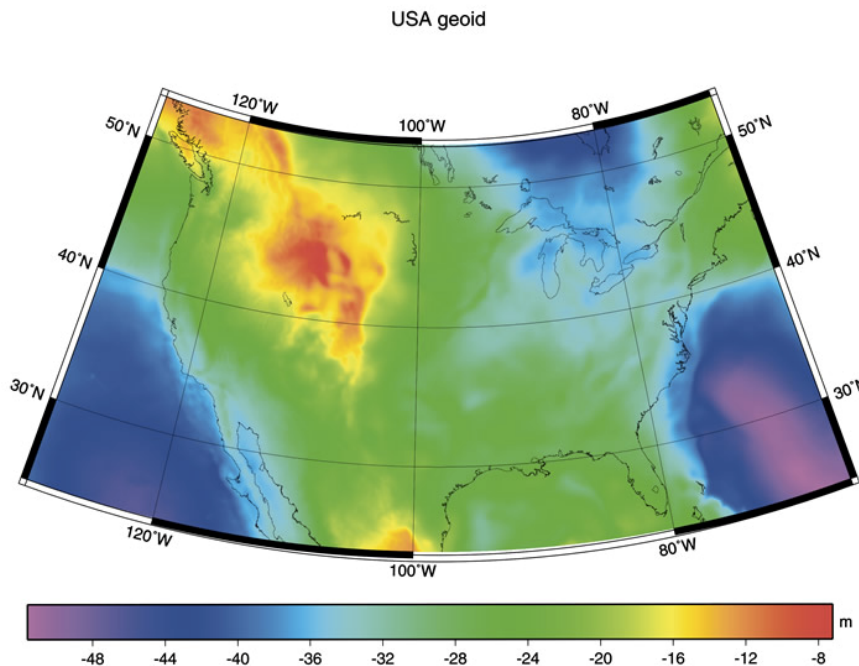


Figure 5: The USA gravimetric geoid available at ISG

Furthermore, ISG contributed to the estimation of a GOCE global geopotential model based on the space-wise approach.

ICET participated to the Global Geodynamics Project (GGP) by processing the gravity data uploaded to the ICET and GFZ database for earth tides.

As an example, in Figure 6, the gravity variation in time in one of the station is displayed.

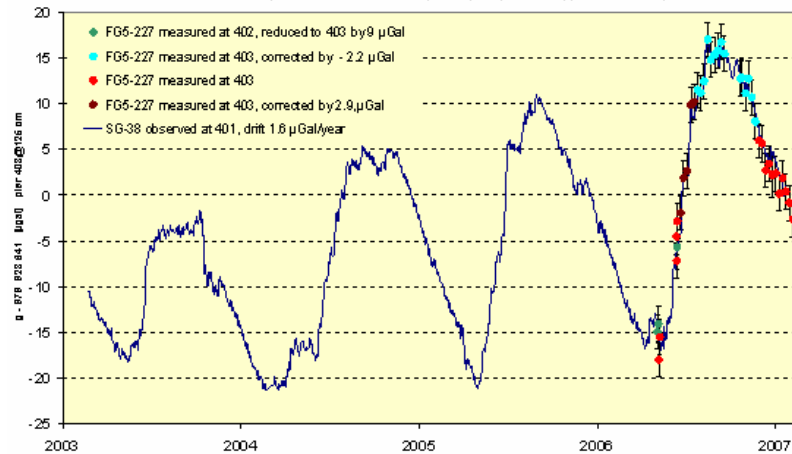


Figure 6: The gravity field variations at Conception

As mentioned previously, a proposal for merging the ICET Service into a new IAG/IGFS Service related to the GGP will be presented at the General IAG/IUGG Assembly in Prague (June 2015).

Finally, despite some recent inefficiencies in its activity, it must be considered the important role of IDEMS that distributes and validates global DEM models. They are extremely important for removing/restoring the terrain effect in e.g. geoid estimation. IGFS is currently having contacts with Curtin University and ESRI Company in order to set a new proposal aiming at renewing and improving this important service.

Other important activities that have been documented by IGFS during the GGOS Bureau for Network and Communications meetings in San Francisco (end of 2014) and Vienna (Spring 2015) were related to the European geoid computation, the Arctic Gravity Project and the project aiming at coordinating the activities of the Consultative Committee for Mass and Related Quantities-Working Group on Gravity (CCM-WGG) and IAG Commission 2. As for this last point, it must be mentioned that a common strategy document of IAG and CCM for metrology in absolute gravimetry have been prepared by the cooperation of IAG JWGs (2.1 and 2.2) and CCM-WGG. The IAG Executive Committee accepted the current document "CCM-IAG Strategy for Metrology in Absolute Gravity" as relevant and important for IAG in the establishment of a global gravity reference system and a contribution to the Global Geodetic Observing System (GGOS).

The publication of technical papers is also one of the activities that are coordinated and sponsored by IGFS.

ISG and BGI are issuing via their web pages the Newton's Bulletin which contains technical papers on geoid computation, gravity data handling and gravity campaigns. Within mid June 2015, a Special Issue of the Newton's Bulletin will be published. This issue contains reports on the validation of the GOCE global geopotential models carried out in the framework of the JWG2.3 activities.

Another publication related to the gravity field services is issued by ICET which regularly publishes the Bulletin International des Marées Terrestres (BIM) in electronic form through its web page.

All these activities are documented in the IGFS web page at the address: <http://www.gravityfield.org/>.

Another important activity that is performed by IGFS in cooperation with IAG Commission 2 is to organize Symposia and Schools on geoid computation.

On October 9th-12th 2012, the International Symposium on Gravity, Geoid and Height System GGHS2012 has been organized in Venice (San Servolo island) with the following session scheme:

- Session 1: Gravimetry and gravity networks
- Session 2: Global gravity field modelling, assessments and applications
- Session 3: Future gravity field missions
- Session 4: Advances in precise local and regional high-resolution geoid modeling
- Session 5: Establishment and unification of vertical reference systems
- Session 6: Gravity field and mass transport modelling
- Session 7: Modelling and inversion of gravity-solid earth coupling
- Session 8: Gravity field of planetary bodies

As it can be seen, the most relevant topics related to the gravity field analysis and estimation have been discussed. Most of the presented papers have been submitted for publication (after peer review) on IAG Symposia Series published by Springer.

Furthermore, IGFS has organized in Shanghai the 3rd IGFS General Assembly, together with the Shanghai Astronomical Observatory and IAG Commission 2 (June 30th - July 6th, 2014).

The focus of this Assembly was on methods for observing, estimating and interpreting the Earth gravity field as well as on applications. The scientific sessions were:

- Session 1: Gravimetry (aerograv, absolute/relative gravity observations, gravity network)
- Session 2: Global geopotential models and vertical datum unification
- Session 3: Local geoid/gravity modelling
- Session 4: Satellite gravity
- Session 5: Mass movements in the Earth system
- Session 6: Solid Earth Investigations

Also in this case, paper will be published on a dedicated volume of the IAG Symposia Series. Finally, a new school was organized in 2013. It was held at the Universidad Tecnica Particular de Loja, Loja (Ecuador) in October 7th-11th, 2013. It was the eleventh Geoid School that continued the ISG schools tradition. Besides geoid estimation, a new important topic has been added, namely the one related to the definition of a global height datum. The program of this school and the teachers were the following:

- Heights, height datum and Boundary Value Problems (Sansò)
- Global geopotential models and their use (Pavlis)
- Modelling the topographic effect (Blitzkow)
- Local improvements of the geoid (Barzaghi)
- Vertical Datum Standardization (Sanchez)

15 participants attended this school: they were coming from Brazil, Colombia, Dominican Republic, Ecuador, Egypt, Greece, Mexico, USA and Venezuela. As usual, software and lecture notes were distributed them.

In the end, it has to be mentioned that IGFS meetings were held during the IAG Scientific assembly in Potsdam (September, 2013) and the 3rd IGFS General Assembly in Shanghai (June, 2014). In these meetings, IGFS structure, projects and perspectives were discussed among the participants.