International Gravimetric Bureau
Bureau Gravimétrique International (BGI)

Director: **S. Bonvalot** (France)

http://bgi.obs-mip.fr

Terms of Reference

Introduction

The Bureau Gravimétrique International (BGI) has been created in 1951 as a service of IAG during the IUGG (International Union in Geophysics and Geodesy) General Assembly. The initial task of BGI was to collect, on a world-wide basis, all gravity measurements to generate a global digital database of gravity data for any public or private user. The technological and scientific evolutions which occurred over the last 50 years in the area of gravimetry (improvements in field, airborne and seaborne gravity meters, development of absolute gravity meters, space gravity missions, etc.) provided significant increases of the number, diversity and accuracy of the gravity field observables. Following these evolutions, the BGI has contributed to provide original databases and services for a wide international community concerned by the studies of the Earth gravity field.

The BGI is an official service of the International Association of Geodesy (IAG) and is coordinated since 2003, with others IAG services (IGeS, ICET, ICGEM, IDEMS) by the International Gravity Field Service (IGFS). It also directly contributes to the activities of the IAG Commission 2 "Gravity Field" and of the IAG Global Geodetic Observing System (GGOS). It is recognized by the International Council for Science (ICSU) successively as one of the services of the Federation of Astronomical and Geophysical Services (FAGS) and of the World Data System (WDS) created in 2008.

Missions and objectives

The main task of BGI is to collect, on a world-wide basis, all gravity measurements (relative or absolute) and pertinent information about the gravity field of the Earth, to compile and validate them and store them in a computerized data base in order to redistribute them on request to a large variety of users for scientific applications. With this aim, BGI has the responsibility of 4 global scientific gravity databases:

- Relative gravity measurements (land surveys)
- Relative gravity measurements (marine surveys)
- Absolute gravity measurements (free fall techniques)
- Reference gravity stations (International gravity network).

Product and services

Database of relative gravity data

The database of relative measurements contains over 12 million of observations compiled and computerized mostly from land and marine gravity surveys. It has been extensively used for the definition of Earth gravity field *models and for many applications in geodesy, satellite orbi*t computation, oceanography, geophysics, etc. It provides today the most precise information available on the Earth gravity field at short wavelengths and is highly complementary to airborne and satellite gravity measurements. Database access to land and marine gravity data:

- *http://bgi.obs-mip.fr/data-products/Gravity-Databases/Land-Gravity-data*
- *http://bgi.obs-mip.fr/data-products/Gravity-Databases/Marine-Gravity-data*

Database of absolute gravity data

The database for absolute gravity measurements was set up in 2008 in cooperation between BGI and BKG (Bundesamt für Kartographie und Geodäsie, Germany). This database (AGrav) has the ability to store information about gravity observations (raw or processed data), stations, instruments, involved institutions, contacts, etc. It has been designed with two main objectives : (i) at providing information to the scientific community on existing absolute gravity stations and measurements and (ii) at ensuring storage and long term availability of gravity data and processing details. The database can be accessed by a web based interface which provides publicly available meta-data as well as complete datasets for community of users contributing to the archive. A simple exchange format was selected which includes all relevant information and is known by the majority of users avoiding additional effort. In this way the upload of absolute gravity data to the database can be done by the owner institutions, using a web based upload form. Database access to absolute gravity data:

- *http://bgi.obs-mip.fr/data-products/Gravity-Databases/Absolute-Gravity-data*
- *http://agrav.bkg.bund.de/agrav-meta/*

Database of gravity reference stations

Reference gravity stations established and connected to the previous IGSN71 and Potsdam reference systems have been previously collected and archived at BGI. For several decades, these stations have provided the only information available on gravity value for tying local or regional relative gravity surveys in a global reference frame. Even if a significant number of reference stations should have disappeared with time, the database is still accessible at the following link:

- *http://bgi.obs-mip.fr/data-products/Gravity-Databases/Reference-Gravity-Stations*

In a next future, this gravity reference network should be advantageously replaced by the increasing network of actual absolute gravity measurements as provided by the Absolute gravity database (AGrav).

Global or regional gravity grids and models

BGI also contributes to the realization of derived gravity products with the aim to provide relevant information on the Earth gravity field at global or regional scales. The products mostly used by scientific users are the World Gravity Maps and Grids (WGM) which represent the first gravity anomalies computed in spherical geometry taking into account a realistic Earth model.

The World Gravity Map (Fig. 1) is a set of 3 global anomaly maps of the Earth's gravity field realized for the Commission for the Geological Map of the World (CGMW), UNESCO, International Union of Geodesy and Geophysics (IUGG) and International Union of Geological Sciences (IUGS). Maps available at: *http://ccgm.org/en/16-catalogue*

The WGM is also available as digital high resolution global grids of Bouguer, isostatic and surface free-air anomalies. These grids derived from available Earth gravity models (i.e. EGM2008) include high resolution terrain corrections including the contribution of most surface masses (atmosphere, land, oceans, inland seas, lakes, ice caps and ice shelves). Such gravity anomalies, which point out the density heterogeneities in the Earth's interior (crust, mantle…), are used in a large variety of applications. Global or regional gravity grids available at:

- *http://bgi.obs-mip.fr/data-products/Grids-and-models/wgm2012*

Other services

- Delivery of DOI (Digital Object Identifier) for gravity data set or products
- Online tools for prediction gravity at a given site
- Tools and software for data acquisition or validation

Key activities

The current activities at BGI are mostly dedicated (i) to consolidate and validate the terrestrial gravity databases (relative and absolute measurements) and (ii) to ease the consultation and retrieval of gravity data and products by end-users. BGI also contributes with its supporting organizations to research and educational activities (summer schools on gravity data acquisition and processing, provision of tutorials and educational materials in gravimetry).

- Gravity databases: The main achievements consist in maintaining and developing the BGI databases (relative and absolute gravity database, reference gravity stations). The collection / compilation of new dataset (from field, marine or airborne surveys) is encouraged in order to improve the global data coverage and accuracy. Incoming datasets are evaluated and validated using protocols and software developed at BGI. Global data and products derived from satellite altimetry and gravity missions are to be more and more frequently used to validate land and sea measurements.
- Gravity products: As done for the digital World Gravity Map, new products are currently under development for updating global or regional gravity products (maps and grids) for educational and research purposes.

- Contribution to Newton's Bulletin: BGI contributes jointly with the International Service for Geoid (ISG) to the edition of this Bulletin which publish technical papers on gravity data acquisition and processing.
- Contribution to the Establishment of a Global Absolute Gravity Reference System: BGI contributes within the IAG commission 2 "Gravity Field" and Joint Working Group JWG2.1 to the definition of this new absolute gravity network that will replace the obsolete IGSN71.
- Contribution to International summer schools on gravity or geoid in collaboration with ISG and IGFS.

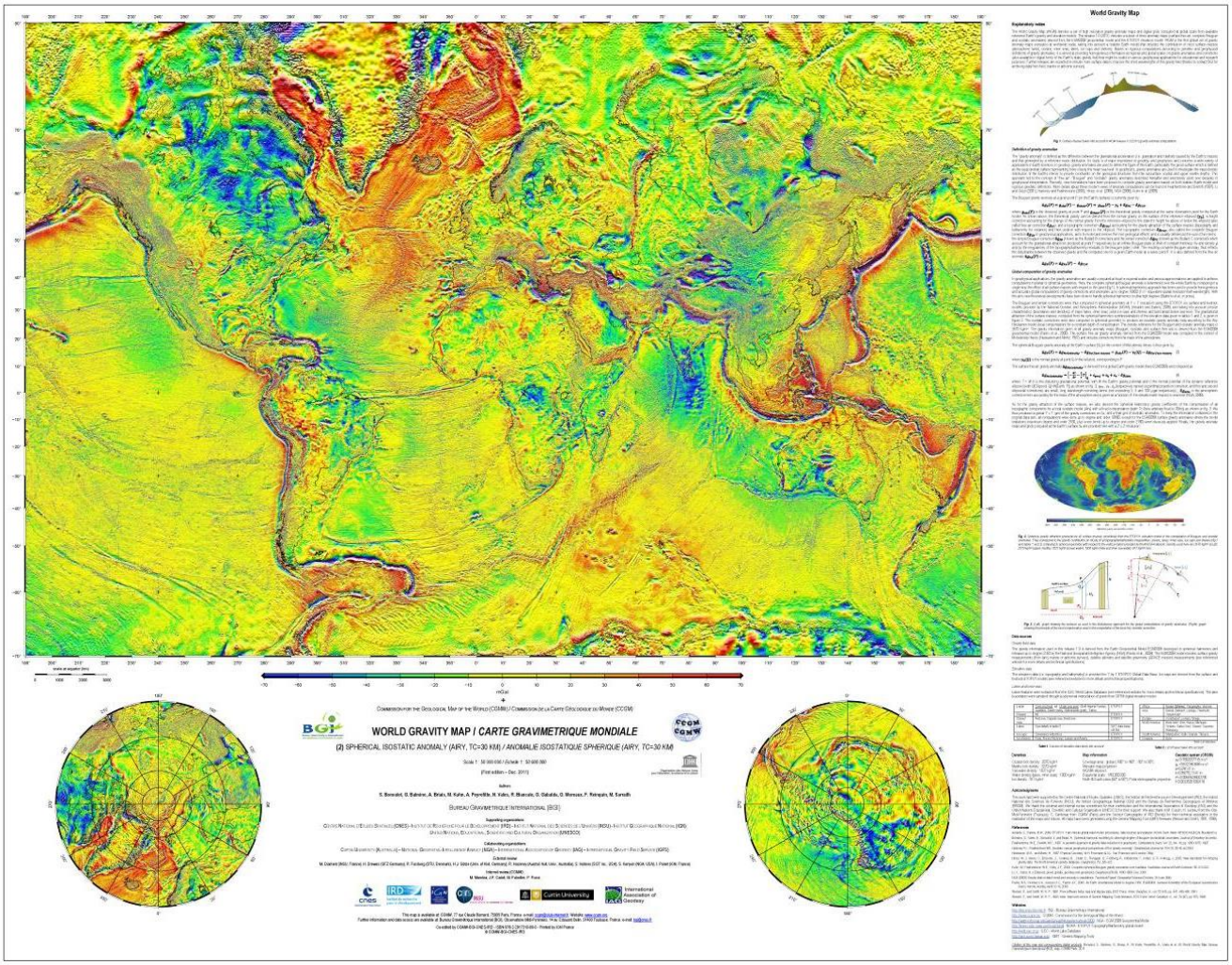

Fig. 1 World Gravity Map

Data policy / DOI (Digital Object Identifier)

Data, products or software available at BGI are mostly dedicated to support scientific and academic activities. Digital gravity data or products are distributed free of charge to research or academic institutions or to data contributors according to the conditions given below. Other users, individual or private companies, are invited to specify in their request the expected use of the data and products. See BGI website for diffusion and charging policies.

- Access to non-confidential or non-proprietary relative gravity measurements is provided free of charge to public institutions or data contributors over geographic areas limited to 20°x20° or on the base of a maximum number of 10000 data points (land data) and/or 100000 data points (marine data). Retrieval of full data coverage for a whole country is not included in that case. All other requests (for larger datasets, for extended geographic area or for a whole country) as well as massive data retrieval will be subject to an evaluation by BGI who might require a specific protocol of use of the data or ask

authorization of the proprietary Institutions. Charges might be applied
- Access to the Absolute gravity database is provided free of charge without any restriction. Data retrieval is done through the Web interfaces at BGI and BKG mirror sites. Confidential data or proprietary data may appear with restricted information (metadata only).
- Access to the Reference gravity stations database is provided free of charge without any restriction. Please note that reference gravity stations (especially those determined and described decades ago) may have been destroyed or modified.
- Access to other services is also provided free of charge: global or regional gravity anomaly grids; Prediction of gravity value on Earth ; Software ; Documentation, etc.

Since 2016, users are invited to make reference to the generic DOI (Digital Object Identifier): **10.18168** for acknowledging BGI services. As an IAG Service, BGI has also the ability to deliver a **DOI** to any institution or author for archiving their own dataset resulting from gravity survey or gravity data compilation. This new service will ensure proper reference to authors and institutions who have acquired or compiled gravity data and a better traceability of improvements in the global gravity data coverage from local or regional surveys.

Structure and membership

Since 2003, the BGI is one of the services of the International Gravity Field Service (IGFS) which coordinates within the IAG, the servicing of the geodetic and geophysical community with gravity field-related data, software and information.

The BGI central office (management, secretariat and technical staff) is located in Toulouse, France, in the premises of the Observatoire Midi-Pyrénées. Since 1998, BGI is supported by French Institutions, Universities and Laboratories (see below) whose contributions to BGI over four year renewable periods are defined by a covenant. The supporting French organizations are:
- Centre National d'Etudes Spatiales (CNES)
- Bureau de Recherches Géologiques et Minières (BRGM)
- Centre National de la Recherche Scientifique (CNRS)
- Institut National des Sciences de l'Univers (INSU)
- Institut National de l'Information Géographique et Forestière (IGN)
- Institut de Recherche pour le Développement (IRD)
- Service Hydrographique et Océanographique de la Marine (SHOM)
- Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER)
- Groupe de Recherches en Géodésie Spatiale (GRGS)
- Institut de Physique du Globe de Paris (IPGP)
- Ecole et Observatoire des Sciences de la Terre (EOST)
- Ecole Supérieure des Géomètres et Topographes (ESGT)
- Université de Toulouse (GET/OMP)
- Université de Montpellier (Géosciences Montpellier)

Each supporting organization has a representative member in the BGI Advisory Board. The Advisory Board (who also includes a representative member of IAG) contributes once a year to the orientation and evaluation of the BGI activities. The program of BGI activities is also evaluated and discussed by the IGFS Advisory Board at each IGFS meetings and IUGG General Assemblies. A new partnership has been also established in 2008 between BGI and the Bundesamt für Kartographie und Geodäsie (BKG), Germany, for the realization and the maintenance of the global database of absolute gravity measurements (AGRAV).

Providing and referencing data to BGI

As a service of IAG/IGFS, the final task of BGI is to give access to the largest scientific community to relative and absolute measurements of the Earth gravity field and related information. The permanent archiving of new incoming gravity data sets is crucial to improve the coverage and accuracy of the global gravity database and to improve our knowledge of the Earth gravity field. It also enables BGI to validate the gravity observations in a global reference frame and restore them in standard and unified formats useful for various users.

BGI currently collect & provides information on:
- Relative gravity measurements from land, marine & airborne surveys
- Absolute gravity measurements
- Reference gravity base stations
- Software for gravimetric applications (data processing, modeling, etc.)
- Other gravimetry-related information (printed or digital maps, bibliography, etc.)

The contribution of scientists, agencies or institutions involved in these fields is welcome to ensure the best service to the community. Contributors interested in archiving their gravity observations as non-confidential or as proprietary data (to be defined by the contributors themselves) are invited to contact BGI. For relative gravity observations, all kind of data from land, marine or airborne surveys can be sent to BGI. ASCII data files containing all necessary information and quantities are preferred (station coordinates, gravity measurements and accuracies; gravity corrections; reference geographic, height and gravity systems, etc.). For absolute gravity observations, the data-

base is maintained on two mirror sites located in Toulouse (France), at BGI and in Frankfurt/Main (Germany), at the Federal Agency for Cartography and Geodesy (BKG). Scientists interested to upload their observations or meta-data only (site positions and approximated values for instance) in the international Absolute Gravity database AGRAV are invited to contact either BGI (http://bgi.obs-mip.fr) or BKG (http://agrav.bkg.bund.de/agrav-meta/). For any contribution (relative or absolute gravity data), it is reminded that BGI will keep the status of diffusion (with or without restrictions of redistribution) as specified by the proprietary institution.

Notice

- For making reference to BGI service, use doi: 10.18168
- For asking attribution of a DOI for a given dataset: sent request to bgi@cnes.fr.

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