Inter-Commission Working Group 2.1: Absolute Gravimetry

Chair: Herbert Wilmes (Germany)

Overview

The Working Group on Absolute Gravimetry "WGAG" has been set up under the umbrella of the International Gravity Field Service[1] and the IAG Sub-Commission 2.1 Gravimetry and Gravity Networks. This working group cooperates with the Study Group 2.1 "Comparisons of Absolute Gravimeters" and the "Consultative Committee on Mass and Related Quantities[2], Working Group on Gravimetry", which organize the four-yearly international absolute gravimeter comparisons. The International Gravity Field Service IGFS coordinates the servicing of the geodetic and geophysical community with gravity field-related data, software and information.

Motivation

Absolute gravity measurements have increased in significance because new questions and fields of application have arisen about time-varying geophysical processes. This is underlined by the continuously growing number of absolute gravimeters and observations worldwide. New applications are to monitor, for example, global change, mass transports and regional changes of the gravity field. Hence IAG's Global Geodetic Observing System[3] has asked for absolute gravity observations to be carried out in a global network in conjunction with selected reference stations using other geodetic observation techniques: GNSS[4], SLR[5], VLBI[6] or DORIS[7]. It is obvious that a combination of the different observation techniques requires agreed common standards for observations and data processing.

The WGAG strives to strengthen the importance of the gravity observations and to provide the means for a better presentation and coordination of activities together with a standardisation of procedures and outcomes. It works, in particular, on the following tasks discussed and agreed with IGFS and the Bureau Gravimétrique International (BGI):

- Implementation and promotion of a freely accessible common database for absolute gravity observations aiming at a better visibility of AG measurements and an improved cooperation with other disciplines,
- Encouragement of combined absolute gravity and superconducting gravity (SG) measurements for the determination of precise gravity time series. This is carried out in close cooperation with the Global Geodynamics Project, GGP[8],
- Establishment of a global network of absolute gravity sites in conjunction with other geodetic observation techniques. The absolute gravity observations need to be repeated at regular intervals. A first realisation has been achieved in the European Geodetic Network, ECGN[9],
- Standardisation of AG observation and evaluation to make the results compatible and to enable the combination with geometric observations or complementary information.

The absolute gravity database AGrav

[1] cf. IGFS – http://www.igfs.net/
[2] cf. CCM – http://www.bipm.org/en/committees/cc/ccm/
[3] cf. GGOS – http://www.ggos.org/
[4] cf. IGS – International GNSS Service http://igscb.jpl.nasa.gov/
[5] cf. ILRS – International Laser Ranging Service http://ilrs.gsfc.nasa.gov/
[6] cf. IVS – International VLBI Service for Geodesy and Astronomy http://ivscc.gsfc.nasa.gov/
[7] cf. IDS – International DORIS Service http://ids.cls.fr/
[8] cf. GGP – http://www.eas.slu.edu/GGP/ggphome.html
[9] cf. ECGN – http://gibs.bkg.bund.de/ecgn/

The growing number of AG instruments together with the understanding that the absolute gravity measurements have a high importance in their timely and geographical distribution encourage the development of an international database for absolute gravity observations. This database initiated by the International Gravity Field Service (IGFS) (Forsberg et al. 2005) was developed at the Bundesamt für Kartographie und Geodäsie (BKG) and put into operation together with the Bureau Gravimétrique International (BGI). This new database improves the propagation and notice of the AG observations. Further, it enhances the use of gravity data, encourages cooperation in regional and global gravity projects, allows for synergy effects and improves the value of the existing networks.

The system was set into operation at two mirrored servers with web-based frontend located at BGI: http://bgi.dtp.obs-mip.fr/agrav-meta/ acting now as the official BGI AG database and at BKG: http://agrav.bkg.bund.de/agrav-meta/. Fig. 1 shows the AGrav database graphical web interface.

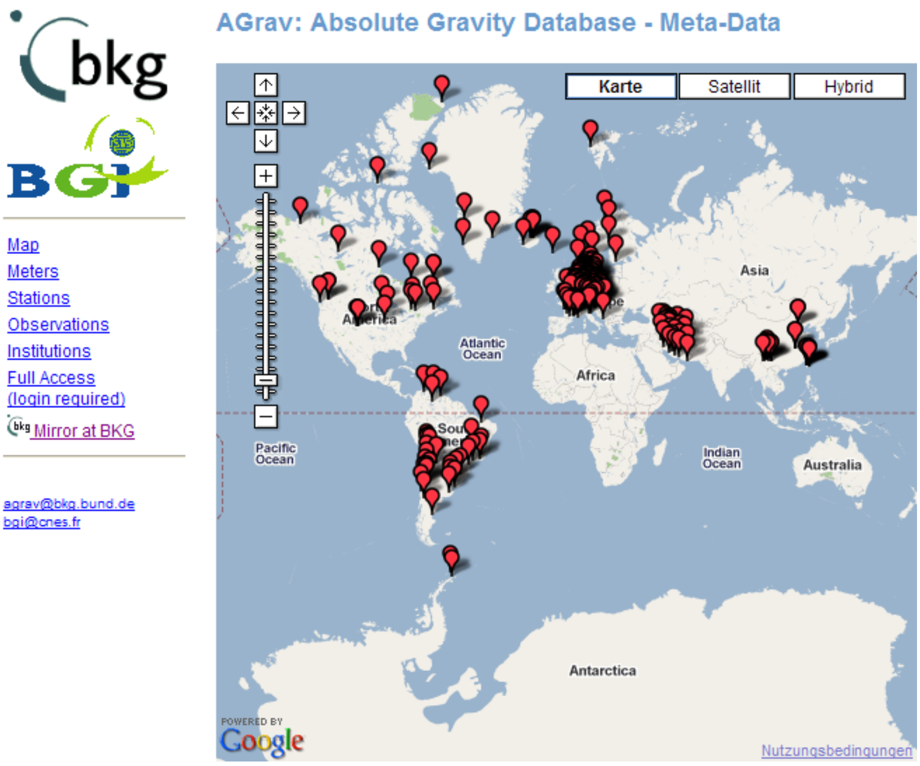

Figure 1: Layout of the AGrav database web interface (status 2009)

The AGrav database informs about station location, observation epoch, instrument type and serial number, instrument owner or user respectively and measurement results. Accordingly, the basic structure of the relational database is composed by four tables to store information about the stations, instruments, measurement epochs, and involved institutions, which are linked to each other. Other details can be stored in supplemental tables. In this way, storage of redundant information is avoided and a flexible adaption to future needs is possible. Concerning observation epochs for instance, it is possible just to store time and date of the observation up to complete processing results, including single drop observations.

The database concept distinguishes two basic features:

- It can inform with meta-data about measurements and, where the details are available, about results, but with limited accuracy. This service is freely available without access restrictions.

- It can store the measurement results including all corrections and processing details. Here, restrictions are applied, access is granted only to users, who have contributed own data.

By this design, meta-data and detailed data share the same database. Dependent on task and authentication, meta-information only or complete datasets are provided. In this way it is possible just to inform other interested groups about the existence of the stations and observations or to store the data for projects, publications and cooperation. The latter case with the complete observation results would be very helpful for cooperation between groups or if the database is used as permanent repository. In any case, the user retains control over the data, which means, later editing of submitted data is possible at any time

The international community of absolute gravimeter users has been asked to contribute to this database. This process has started with contributions of e.g. Belgium, Canada, Czech Republic, France, Germany and Taiwan. The work with the database has shown that continuous support was necessary in the form of smaller database modifications and adaptations related to new requirements. Maintenance work was provided to support the international users with the upload of data. Contact with the groups to encourage cooperation and data upload will be continued. This service will be continued and the owners of absolute gravimeters will be requested for their support.

A working group meeting was held during the International Symposium on Gravity, Geoid and Earth Observation GGEO2008 in Chania, Crete, June 24, 2008.

Continuation of the work

As mentioned above, the standardisation of AG observation and evaluation are an important condition to make the results compatible and to enable the combination of absolute gravity data e.g. with geometric observations. The IABGN data processing features of 1992 still form an agreed basis for the observation and evaluation of absolute gravity data. Work has begun and will be continued to improve and complement these settings for AG measurements using consistent parameters and models.

The absolute gravity database and a standardisation of the data evaluation would make it much easier to create a new gravity reference system which could replace the IGSN71, the International Standardization Net 1971 after Morelli (1974). Its accuracy is estimated with ±1 $\mu m/s^2$ (±100 µGal!). This value shows the strong discrepancy between the realization of the gravity reference system and the much improved absolute gravimeters. The gap between gravity reference system and present-day instrument reaches almost two orders of magnitude.

References:

Morelli, C. et al. : The International Gravity Standardization Net 1971 (IGSN71), International Association of Geodesy, Special Publication No. 4, 1974.

Wilmes, H., H. Wziontek, R. Falk, S. Bonvalot: AGrav – the New International Absolute Gravity Database of BGI and BKG and its Benefit for the Global Geodynamics Project (GGP), ETS2008 Symposium, New Challenges of the world, submitted to Journal of Geodynamics, 2009.