Minutes of the Meeting of IAG JWG 2.1.1
Establishment of a global absolute gravity reference system

International Symposium Gravity, Geoid and Height Systems 2
in Copenhagen, Denmark
Thursday, 20 Sep. 2018, 14:00–15:20, Holberg Room

Chair: Hartmut Wziontek (Germany)
Vice-chair: Sylvain Bonvalot (France)

Agenda

1. Finalizing the definition of system and frame
2. Selection of reference stations
3. Update and define a set of common processing standards
4. Data storage and Processing
5. Documentation: DOI
6. Deadlines, Report to IAG (IUGG 2019), Publication

1. Definition of System and Frame

At the last meeting at the EGU in Vienna (Apr. 11th 2018), the definition of system and frame was agreed on. The definition of the system reflects the fundamental principles and must be stable over time. It is based on the momentary acceleration of free fall and on the traceability to the International System of Units (SI). It is completed by set of conventional corrections for the time independent components of gravity effects: the tide system (zero tide), the standard atmosphere and the IERS reference pole. It was discussed whether the vertical gravity gradient should be included in the definition, but it was agreed to include it as be part of the systems realization.

The frame as the realization of the system then contains the observations with absolute gravimeters (AG) and their comparison to ensure a long term stable and common reference level and the compatibility of the observations, including the assessment of systematic effects. A set of conventional models for the correction of temporal gravity changes needs to be selected, covering the Earth tides, ocean tide loading, atmospheric variations and polar motion. It should follow the technical protocols established for the AG comparisons to ensure compatibility of all measurements. The question on the treatment of magnetic field variations was raised, but not discussed in detail and should be subject of future investigation.

The selection of an ocean model was discussed. Due to significant deviations in specific regions it seems not to be possible to choose only one best fitting model. Especially in polar regions, deviations of up to 10 µGal (peak to peak) may appear. For such regions, an alternative model should be recommended.

It was further discussed, whether long term gravity changes should be estimated and included in the frame definition. There was an agreement that this is not needed to be considered at the moment, as each AG observation has an epoch assigned and the modeling of such gravity changes is still challenging. However, information about known height changes of gravity stations needs to be documented. The requirement to assign an epoch to each AG observation should be part of the systems definition. Applied corrections for systematic effects, like self-attraction and diffraction correction need to be documented to be able to discriminate gravity changes from instrumental effects in case of resurveying station, e.g. for maintaining the reference frame. A regular re-observation for the reference frame seems not to be necessary, but the stations need to be maintained and kept accessible. Further, a consistent reprocessing of existing observations was discussed. However, this would require to collect the results of the individual free fall experiments (drop files) in a standard format. Also, a comparison of individual software packages was considered to be useful. The latest version of the AGrav database will be capable to store set and drop files. It is recommended but not required to provide also raw data. The documentation of clock calibrations seems not to be necessary, as the final processing is usually carried out based on actual frequency estimates.

2. Selection of Reference Stations

To establish an infrastructure, site requirements (minimum criteria) for different station categories have been discussed regarding the monitoring of gravity changes. Reference stations are essential to ensure a long term stable reference level by monitoring AGs. At such stations, a continuous gravity reference function should be provided by a superconducting (SG) and/or quantum gravimeter or repeated AG observations. The repetition rate for AG observations is recommended to be less than two months if continuous monitoring is not possible. Where continuous monitoring with a SG is possible, AG observations should be performed at least once every two years for the determination of the instrumental drift.

Site requirements have already been described in a document of the CCM-WGG in 2006. This document should serve as a basis for further discussion and updates. A connection to the national levelling network is recommended and GNNS should be collocated to monitor vertical displacements.

Comparison sites are reference sites which allow for a simultaneous measurement of at least two AGs. The main purpose is to check the compatibility of instruments. Calibration of an AG serves as a tool to document significant systematic deviations in order to improve or restore the compatibility.

Core stations are reference stations where at least one space geodetic technique is established. In particular, all GGOS core sites should be included and it is recommended to perform at all these stations at least repeated AG observations if gravity changes are not monitored continuously. The currently available list of GGOS core sites needs be updated and checked whether gravity observations are already performed on a regular basis.

Potential reference stations are stations of the International Geodynamics and Earth Tide Service (IGETS). Some stations are already established, others are not appropriate. A new station close to St. Petersburg (RU) was recently equipped with a SG and will join. Station Larzac (FR) is another potential candidate. The continuous operation of the SG installed at station Table Mountain (US) needs to be checked. Station Cantley (CA) is proposed as a reference site where the operation of the SG will be continued in the future. In South America, only AGGO / La Plata (AR) is currently established.

In China, two new stations became recently available through IGETS and may be candidates besides the comparison site at Changping Campus close to Beijing, and the station in Wuhan. In Japan, currently at 2-3 stations SG are continuously operated.

In Africa, only station Sutherland (ZA) is operational, station Djougou (DJ) can hardly be recommended. The establishment of a new gravity site in the Pacific at Tahiti is currently under discussion, but also the already established gravity sites need to be evaluated.

All Canadian sites are available online by the database of NRCan. A meta data exchange with the AGrav database will be discussed and prepared.

The IGRF should be linked to the International Height Reference Frame (IHRF). Based on a list of the proposed IHRF sites and AG sites currently included in the AGrav database, 51 common stations have been identified within a distance of 75 km, most of which are only a few 100 m apart. Where possible, common sites for both frames should be established to ensure a close link between gravity and height.

3. Processing standards

The processing standards of the International Absolute Gravimeter Base Network (IAGBN) proposed by Boedecker (1988) are widely used today. The zero tide system is used and atmospheric corrections are based on DIN5450 (ISO 2533:1975) standard atmosphere and a single admittance of with 0.3 µGal/hPa with the local air pressure record. The effect of polar motion will be reduced based on the IERS reference pole in spherical approximation with an elastic gravimetric factor 1.164. Updates are necessary for the tidal potential catalogue and the treatment of ocean tide loading. A document will be prepared and circulated among the members of the JWG.

4. Data storage and processing

The storage of raw data (times of zero-crossings) is recommended and allows the reprocessing with alternative processing software, e.g. by V. Palinkas (GOPE), or Jacques Liard (NRCan). Further proposals have already made by I. Oshchepkov at the EGU meeting (Apr. 2018). A common standard exchange format should be developed, based on the text data exported by the g-software as a minimum requirement.

5. Digital object identifiers (DOI)

A DOI prefix was already reserved by BGI which allows to reference datasets of the AGrav database. Suffixes can be derived based on the primary keys of the database. A DOI will be assigned to data providers (identified by their institution), network of stations and AG comparison epochs. In cooperation with BGI a proposal will be prepared and circulated, referring to the new AGrav web application.

6. Deadlines, Report to IAG, Publication

A first station list should be presented in Dec 2018 at the AGU FM and included in AGrav. A proposal about the processing standards will be started and circulated preferably before AGU. The next meeting will be at the EGU 2019 (Vienna, Austria, 7–12 April 2019), where also the session G4.3 on “High accuracy terrestrial gravity observations in the time varying gravity field” was accepted (conveners: H. Wziontek, V. Pálinkáš, D. van Westrum). The meeting at EGU will be dedicated to the preparation of the report to IAG (IUGG 2019). Together with JWG 0.1.2. (IHRS / IHRF), a Special Issue in JoG to document the progress is currently under discussion.

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