IUGG

IAG AIG
International Association of Geodesy

Establishment of the International Gravity Reference Frame

Web-Meeting of IAG JWG 2.1.1, 17.03.2021

Chair: Hartmut Wziontek, BKG (Germany)

Vice-chair: Sylvain Bonvalot, BGI (France)

Agenda

1. Publication in Journal of Geodesy
2. Presentation of IGRS/IGRF at the IAG EC meeting, March 26
3. Establishment of the Infrastructure for the IGRF:
   - IAG Res. No. 4 / 2019
   - Activities within SIRGAS (E. Antokoletz)
   - Proposal for a Workshop 2022
   - Site requirements
   - Selection of Reference/Comparison/Core Stations
   - Guide: Best practices in absolute gravimetry
4. CCM comparison 2023 at TMGO/Boulder, CO, USA (V. Pálinkáš)
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6. Correction for the polar motion in IGRS/IGRF (J. Mäkinen)

1) Publication in Journal of Geodesy

Status of the International Gravity Reference System and Frame

- Definition of the International Gravity Reference System (IGRS)
- Concept for its realization (IGRF) based on absolute gravity observations
- IGRS Conventions 2020:
  Update of IAGBN Processing Standards
- Three main stations categories for IGRF:
- Reference, Comparison and Core stations
- Basis to adopt IGRS by IAG

Wziontek, H., Bonvalot, S., Falk, R., Gabalda, G., Mäkinen, J, Pálinkáš, V., Rülke, A., Vitushkin, L.: Status of the International Gravity Reference System and Frame. J Geod 95, 7 (2021).

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ORIGINAL ARTICLE

Check for updates

Status of the International Gravity Reference System and Frame

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Abstract
The increasing importance of terrestrial gravimetry in monitoring global change processes, in providing a reference for satellite measurements and in applications in metrology necessitates a stable reference system reflecting the measurement accuracy achievable by modern gravimeters. Therefore, over the last decade, the International Association of Geodesy (IAG) has developed a system to achieve accurate, homogeneous, long-term global recording of Earth's gravity, while taking advantage of the potential of today's absolute gravity measurements. The current status of the International Gravity Reference System and Frame is presented as worked out by the IAG Joint Working Group 2.1.1 "Establishment of a global absolute gravity reference system" during the period 2015–2019. Here, the system is defined by the instantaneous acceleration of free-fall, expressed in the International System of Units (SI) and a set of conventional corrections for the time-independent components of gravity effects. The frame as the systems realization includes a set of conventional temporal gravity corrections which represent a uniform set of minimum requirements. Measurements with absolute gravimeters, the traceability of which is ensured by comparisons and monitoring at reference stations, provide the basis of the frame. A global set of such stations providing absolute gravity values at the microgal level is the backbone of the frame. Core stations with at least one available space geodetic technique will provide a link to the terrestrial reference frame. Expanded facilities enabling instrumental verification as well as repeated regional and additional comparisons will complement key comparisons at the level of the International Committee for Weights and Measures (CIPM) and ensure a common reference and the traceability to the SI. To make the gravity reference system accessible to any user and to replace the previous IGSN71 network, an infrastructure based on absolute gravity observations needs to be built up. This requires the support of national agencies, which are encouraged to establish compatible first order gravity networks and to provide information about existing absolute gravity observations.

Keywords Gravity reference system and frame · Absolute gravimeter

1 Introduction

As delineated by Wilmes et al. (2016), a new gravity reference system needs to be established to overcome the discrepancy between the high accuracy achieved with current absolute gravimeters and the hitherto valid gravity reference system of the International Association of Geodesy (IAG), the International Gravity Standardization Net 1971 (IGSN71) (Morelli et al. 1974). Although it is widely used, at an uncertainty level of 10^{-6} m s^{-2} it fulfills neither the requirements nor the accuracy for the understanding of the Earth's System and applications in metrology.

Besides several successful prototypes, absolute gravimeters with an uncertainty in the few microgal level (1 μGal = 10^{-8} m s^{-2}) like FG5 (Niebauer et al. 1995) and FG5–X (Niebauer et al. 2011) are commercially available and widely

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BKG

BGI Bureau Gravimétrique International International Gravimetric Bureau

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3) Establishment of the Infrastructure for the IGRF

27th IUGG General Assembly / Assemblée Générale de l'UGGI — IUGG UGGI

July 8 – 18 2019, Montréal, Canada

IAG Resolution No. 4 of 2019

Resolution 4: Establishment of the Infrastructure for the International Gravity Reference Frame

The International Association of Geodesy,

Considering,

- The IAG Resolution No. 2 for the establishment of a global absolute gravity reference system released at the 26th IUGG General Assembly in July 2015;

Acknowledging,

- The achievements of
  - JWG 2.1.1 "Establishment of a global absolute gravity reference system",
  - Sub-Commission 2.1 "Gravimetry and Gravity Networks",
  - International Gravity Field Service (IGFS)
- in realizing this resolution;

Noting,

- That the realization of the International Gravity Reference System (IGRS), the International Gravity Reference Frame (IGRF), is based on measurements with absolute gravimeters (AG) monitored at reference stations and during international comparisons, which needs the support of national and international institutions;

Urges,

- International and national institutions, agencies and governmental bodies in charge of geodetic infrastructure to
  - Establish a set of absolute gravity reference stations on the national level,
  - Perform regular absolute gravity observations at these stations,
  - Participate in comparisons of absolute gravimeters to ensure their compatibility,
  - Make the results available open access.

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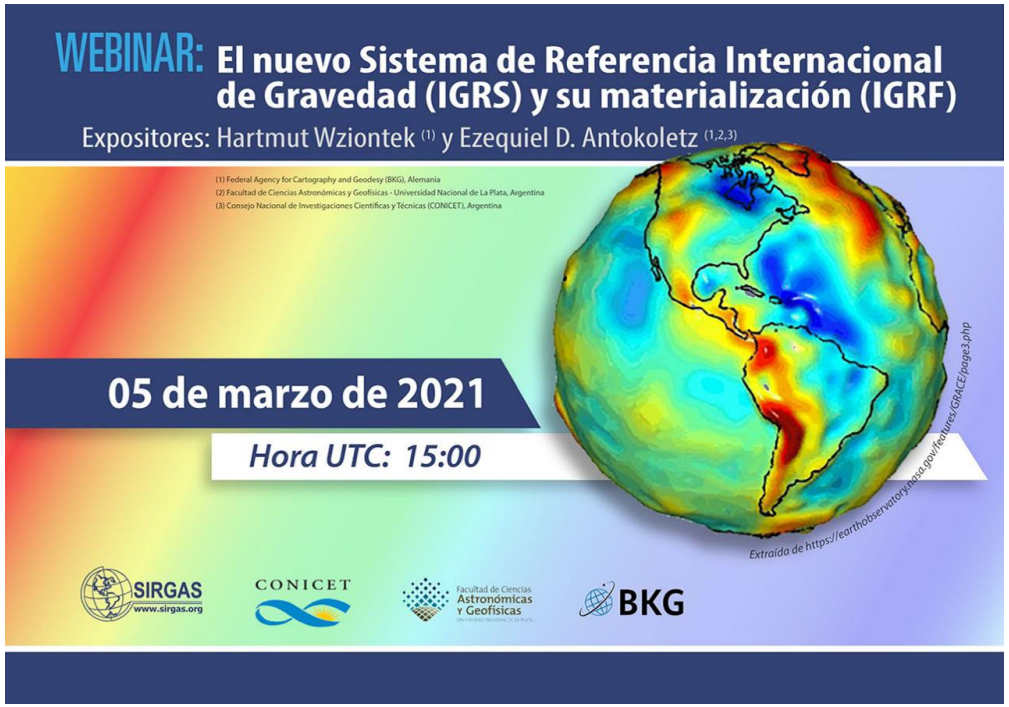
3) Establishment of the Infrastructure for the IGRF

Activities within SIRGAS



http://www.sirgas.org/en/

Working Group III (GTIII): Vertical Datum
Chair: Gabriel Guimarães

- Recent activities in gravimetry:
  E. Antokoletz

3) Establishment of the Infrastructure for the IGRF

Proposal: **Workshop 2022 in Leipzig / Germany**

- Discussion on all details of the implementation of IGRF
- Coordinate activities in establishing first order gravity networks based on absolute gravity observations
- Invite international and national institutions, agencies and governmental bodies in charge of geodetic infrastructure
- Before/after EGU General Assembly 2022, Vienna, Austria, 3–8 April:

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3) Establishment of the Infrastructure for the IGRF

Site requirements

- Update of document CCW-WGG/06-24 of CCM-WGG from 2006
- Requirements to microseismic noise?

→ Proposal: Circulate document in JWG

JWG-Meeting EGU 2019

- Several individual pillars instead of one large monument should be recommended for AG comparisons
- Reinforcement seems not necessary, but would have no negative impact

levels with the recommended range: 1.20m, 0.80 m and close to the marker, defining a linear VGG. Higher order polynomials are possible if required by the local site conditions. No recommendation on the relative gravimeter used for the gradient determination was given.

A final version of the processing standards will be circulated among the participants.

Due to time constraints, an update of the site requirements was only shortly discussed. It was agreed that for comparisons the construction of several individual pillars instead of one large monument should be recommended as well. A reinforcement seems not necessary, but would have no negative impact.

Point 4 and 5 of the agenda were not discussed to the limited time.

3) Establishment of the Infrastructure for the IGRF

Selection/ Identification of

- **Reference stations**: Gravity reference function provides mean absolute level
- **Comparison stations**: reference station with extended facilities to check the compatibility of instruments,
- **Core stations**: Link to space geodetic techniques (GNSS, SLR; VLBI)

- Link to IGETS
- Link to IHRF
- Link to GGOS/ITRF

→ Collection of site proposals!

Start with already announced sites

→ Any volunteers?

3) Establishment of the Infrastructure for the IGRF

Guide:
Best practices in absolute gravimetry

Sharing knowledge about

- Performance
- Processing

absolute gravity observations

Describing

- Concepts, effective measurement height
- Caveats
- Systematic effects

- Any material available?
- Collection / circulation in JWG
- Publication online / dedicated Web page for IGRF

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