GGOS

GLOBAL GEODETIC OBSERVING SYSTEM

IUGG

IAG GGOS Global Geodetic Observing System

GGOS activities related to the implementation of the International Height Reference System (IHRS)

Motivation

GGOS requires unified geodetic reference frames with

- an order of accuracy higher than the magnitude of the effects to be observed (e.g. global change);
- homogeneous consistency and reliability worldwide (the same accuracy everywhere);
- long-term stability (the same accuracy at any time).

Therefore, GGOS and the IAG promote the implementation of an integrated geodetic reference frame that supports the consistent determination and monitoring of the Earth's geometry, rotation and gravity field with high accuracy. This is in agreement with the UN Resolution on the Global Geodetic Reference Frame (GGRF) for Sustainable Development released in Feb. 2015.

The establishment of such a GGRF demands the implementation of a worldwide-unified (standardised) physical reference system. An important step oriented to this purpose was the release of two IAG resolutions during the IUGG2015 General Assembly in July 2015:

- one for the definition and realisation of an International Height Reference System (IHRS);
- the second one for the establishment of a Global Absolute Gravity Reference System (GAGRS).

Advances in the IHRS/IHRF implementation

The implementation of the IHRS/IHRF is coordinated by the *GGOS Focus Area Unified Height System* (FA-UHS) through its working group *Strategy for the Realisation of the IHRS*. It is supported by the *International Gravity Field Service* (IGFS), the *IAG Commissions 1 and 2* (Reference Frames and Gravity field), the *Inter-commission Committee on Theory* (ICCT), the *regional sub-commissions for reference frames and geoid modelling*, and both *GGOS Bureaus* (Networks and Observations and Products and Standards). Main activities are:

- Sep. 2016 (GGHS2016, Thessaloniki): first meeting of the WG; brainstorming and definition of action items; criteria for selection of IHRF stations.
- Oct. 2016 (GGOS Days 2016, Cambridge, MA): Preliminary station selection for the IHRF.
- Nov. 2016 – Mar. 2017: Interaction with regional and national experts about the preliminary station selection and proposal for further geodetic sites.
- Apr. 2017 (EGU2017, Vienna): First proposal for the IHRF reference network.
- Since May 2017: Numerical experiments for the computation of potential values at the IHRF stations.
- Since Aug. 2017 (IAG-IASPEI Assembly, Kobe): Discussion on standards and conventions for the IHRS/IHRF.

The IHRF experiment

Goal is to assess the repeatability of potential values as IHRS coordinates using different computation approaches. The input data for the experiment comprise terrestrial and airborne gravity data, a digital terrain model, and GNSS/levelling data for an area of 700 km^2 in Colorado, USA. With these data, different groups working on the determination of IHRF coordinates compute potential values at some virtual geodetic stations. The comparison of the results should highlight the differences caused by disparities in the computation methodologies. Based on this, a set of standards should be identified to get as similar and compatible results as possible.

The first results of this experiment should be discussed during the Gravity, Geoid and Height Systems (GGHS2018) Symposium (in Sep. 2018, Copenhagen).

This experiment is supported by:

- GGOS JWG: Strategy for the Realisation of the IHRS (chair: L. Sánchez)
- IAG JWG 2.2.2: The 1 cm geoid experiment (chair: Y.M. Wang)
- IAG SC 2.2: Methodology for geoid and physical height systems (chair: J. Ågren)
- ICCT JSG 0.15: Regional geoid/quasi-geoid modelling - Theoretical framework for the sub-centimetre accuracy (chair: J. Huang)
- IGFS: International Gravity Field Service (chair: R. Barzaghi, director Central Bureau: G. Vergos)
- GGOS JWG: Establishment of the GGRF (chair: U. Martí)

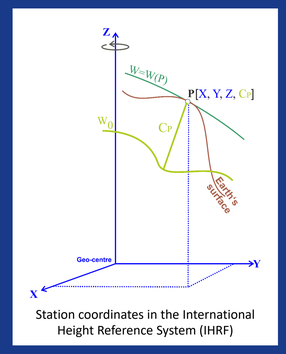
The International Height Reference System (IHRS)

The main characteristics of the IHRS are:

- Vertical coordinates are potential differences $-W_P = C_P = W_0 - W_P$ with respect to the conventional value $W_0 = 62\,636\,853.4\ \mathrm{m^2 s^{-2}}$
- The position P is given by the coordinate vector $\mathbf{X}_P$ (X_P, Y_P, Z_P) in the ITRF; i.e., $W_P = W(\mathbf{X}_P)$
- The determination of $\mathbf{X}_P$, W_P (or C_P) includes their variation with time; i.e., $\dot{\mathbf{X}}_P$, $\dot{W}_P$ (or $\dot{C}_P$).

The immediate objective is the establishment of an International Height Reference Frame (IHRF) as realisation of the IHRS. This includes:

- Station selection for a global network (worldwide distribution) with regional and national densifications (local accessibility).
- Determination of high-precise primary coordinates $\mathbf{X}_P$, $\dot{\mathbf{X}}_P$, W_P, $\dot{W}_P$ at the IHRF stations.
- Identification and compilation of standards, conventions and procedures to ensure consistency between definition (IHRS) and realisation (IHRF).



Station coordinates in the International Height Reference System (IHRF)

The IHRF reference network

A global network (worldwide distribution) comprising a core network (to ensure sustainability and long term stability) and regional/national densifications (for local accessibility).

Main requirement: terrestrial gravity data around the reference stations for high-resolution gravity field modelling (precise estimation of W). The IHRF network is collocated with:

- fundamental geodetic observatories → connection between $\mathbf{X}$, W, $\mathbf{g}$ and reference clocks to support the GGRF;
- continuously operating reference stations → to detect deformations of the reference frame;
- reference tide gauges and national vertical networks → for the vertical datum unification;
- Absolute gravity reference stations (IAG Resolution 2, 2015).

Contact

Laura Sánchez (lm.sanchez@tum.de), Deutsches Geodätisches Forschungsinstitut, Technische Universität München (DGFI-TUM), Germany

Matthias Madzak (matthias.madzak@bev.gv.at), Federal Office of Metrology and Surveying (BEV), Austria

More information: http://ihrs.dgfi.tum.de, www.ggos.org

Image courtesy of the Earth Sciences and Remote Sensing Unit, NASA Johnson Space Center