Focus Area: Unified Height System
Terms of reference 2019 – 2023 (Geodesist's Handbook 2020, in press)

Chair: Laura Sánchez (Germany)

The present objective of Focus Area Unified Height System is the implementation of the IAG resolution for the definition and realization of an *International Height Reference System* (IHRS) issued during the 2015 IUGG General Assembly. This resolution outlines the conventions for the definition of the IHRS in terms of potential parameters: The definition is given in terms of potential parameters: the vertical coordinates are geopotential numbers ($-\Delta W_P = C_P = W_0 - W_P$) referring to an equipotential surface of the Earth's gravity field realized by the conventional value $W_0 = 62\ 636\ 853.4\ m^2s^{-2}$. The spatial reference of the position P for the potential $W_P = W(\mathbf{X})$ is given by coordinates **X** of the International Terrestrial Reference Frame (ITRF). This Resolution also states that the IHRS coordinates should be related to the mean-tide system/mean crust.

At present, a main challenge is the realization of the IHRS; i.e., the establishment of the International Height Reference Frame (IHRF). It is expected that the IHRF follows the same structure as the ITRF: a global network with regional and national densifications, whose geopotential numbers referring to the global IHRS are known. According to the GGOS objectives, the desired accuracy of these global geopotential numbers is $1 \times 10^{-2}\ m^2s^{-2}$. In practice, the precise realization of the IHRS is limited by different aspects; for instance, there are no unified standards for the determination of the potential values W_P, the gravity field modelling and the estimation of the position vectors **X** follow different conventions, the geodetic infrastructure is not homogeneously distributed globally, etc. Therefore, the achievable accuracy may be restricted to $10 \times 10^{-2}\ m^2s^{-2}$ … $100 \times 10^{-2}\ m^2s^{-2}$, which is one or two orders of magnitude lower than the desired accuracy.

During the term 2015 – 2019, important advances were achieved: a global core reference network for the IHRF was defined and, within the Colorado experiment, it was possible to compare different methodologies for the determination of the reference coordinates W_P. The results are very promising and these activities will be continued in term 2019 – 2023 by the Joint Working Group (JWG) 0.1.3 "Implementation of the International Reference Frame – IHRF". This working group is a joint initiative of Joint Working Group (JWG) of the GGOS Focus Area Unified Height System, the International Gravity Field Service (IGFS), the IAG Inter-commission Committee on Theory (ICCT) and the IAG Commissions 2 (Gravity field) and 1 (Reference Frames). The corresponding terms of reference are describe in the following.

Joint Working Group 0.1.3: Implementation of the International Height Reference Frame (IHRF)

Chair: Laura Sánchez (Germany), Lead of the GGOS Focus Area Unified Height System
Vice-chair: Riccardo Barzaghi (Italy), Chair of the International Gravity Field Service

Major objectives of the JWG 0.1.3 are:

- Based on the Colorado experiment outcomes, to elaborate a document with detailed standards and conventions for the realization and maintenance of the IHRS.

- To compute a first static solution for the IHRF core network, to evaluate the achievable accuracy under the present conditions (data availability, computation methods, etc.) and to identify key actions to improve the determination of the IHRS/IHRF coordinates.
- With the support of the IAG Commission 2, the IGFS and the ICCT to promote the study of
    - quality assessment in the determination of potential values,
    - determination of potential changes with time $\dot{W}$,
    - realization of the IHRS in marine areas.
- In agreement with the IGFS and the IAG Commission 2, to design a strategy to install an operational infrastructure within the IGFS to ensure the maintenance and availability of the IHRF in a long-term basis. Aspects to be considered are
    - Updates of the IHRS definition and realization according to future improvements in geodetic theory and observations.
    - Regular updates of the IHRF (e.g. IHRFyyyy) according to new stations, coordinate changes with time, improvements in the estimation of reference coordinates and modelling of the Earth's gravity field, etc.
    - Support in the realisation and utilisation of the IHRS/IHRF at regional and national level.
    - To guarantee an organizational and operational infrastructure to ensure the sustainability of the IHRF.

A strong joint work is planned with

- International Gravity Field Service – IGFS, chair: R, Barzaghi (Italy), vice-chair: G. Vergos (Greece).
- ICCT JSG: Geoid/quasi-geoid modelling for realization of the geopotential height datum, chairs: J Huang (Canada), YM Wang (USA).
- IAG SC 2.2: Methodology for geoid and physical height systems, chair: G. Vergos (Greece).
- IAG Commission 2.2 WG: Error assessment of the 1 cm geoid experiment, chairs: M Willberg (Germany), T Jiang (China).
- IAG Commission 2 JWG: On the realization of the International Gravity Reference Frame, chairs: H. Wziontek (Germany), S. Bonvalot (France)
- GGOS-BPS WG: Towards a consistent set of parameters for a new GRS, chair U Martí (Switzerland).

Members: H.A. Abd-Elmotaal (Egypt), J. Ågren (Sweden), H. Denker (Germany), W. Featherstone (Australia), R. Forsberg (Denmark), V.N. Grigoriadis (Greece), T. Gruber (Germany), G. Guimarães (Brazil), J. Huang (Canada), T. Jiang (China), Q. Liu (Germany), J. Mäkinnen (Finland), U. Marti (Switzerland), K. Matsuo (Japan), P. Novák (Czech Republic), I. Oshchepkov (Russia), M. Sideris (Canada), D. Smith (USA), M. Varga (Croatia), G. Vergos (Greece), M. Véronneau (Canada), Y. Wang (USA), M. Willberg (Germany), M. Amos (New Zealand), D. Avalos (Mexico), M. Bilker-Koivula (Finnland), D. Blitzkow (Brazil), S. Claessens (Australia), X. Collilieux (France), M. Filmer (Australia), A.C.O.C. Matos (Brazil), J. McCubbine (Australia), R. Pail (Germany), D. Roman (USA), C. Tocho (Argentina), H. Wziontek (Germany).