Guidelines for IHRF station selection

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This document has been structured on the basis of the bibliographic references cited in the "References" section. The guidelines have been drawn up by the SIRGAS Working Group III: Vertical Datum. SIRGAS appreciates the collaboration of its members who have contributed their comments and suggestions.

In order to keep this document up-to-date, you are cordially invited to send your comments, questions or suggestions to the president of SIRGAS Working Group III (GT-III).

In 2015, the International Association of Geodesy (IAG) published Resolution No. 1 covering the definition and implementation of an International Height Reference System (IHRS). The establishment of the International Height Reference Frame (IHRF) will be carried out on the basis of the materialization and realization of a set of previously selected stations.

This document describes the requirements and recommendations for selecting an IHRF station. The following instructions are aimed at institutions that already have a station planned in the calculation of their first IHRF implementation as well as at those wishing to propose new stations to make up the IHRF. The recommendations and guidelines are based on work published by the “Unified Height System" focus area of the Global Geodetic Observing System (GGOS) and Working Group 0.1.2: "Strategy for the realisation of the IHRS” (Ihde et al., 2017; Sánchez 2019; Sánchez; Barzaghi 2020, Sánchez et al., 2021).

1. Strategy for the selection of IHRF station

The implementation of the IHRS must be based on a set of reference stations distributed throughout the world, in the most uniform way possible; it must also include a central reference network to allow national or regional densifications to be realized. The

central reference network must be well materialized and maintained over time to ensure long-term sustainability and stability. Regional and national densifications should provide local accessibility relative to the global reference. The following aspects should be considered when selecting an IHRF station:

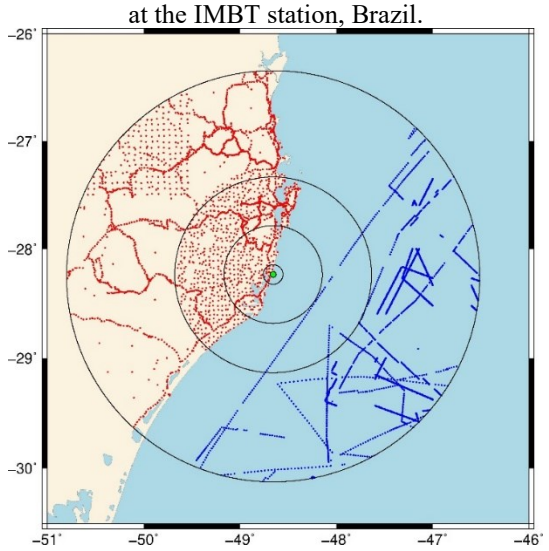
a) It should be materialized by a Global Navigation Satellite System (GNSS) continuous monitoring station, so that it is possible to monitor and detect any deformations in the core site. The station should be integrated into the SIRGAS-CON network.
b) The IHRF station should be co-located with other geodetic techniques (VLBI, DORIS and/or SLR), if the country has these techniques. In this sense, fundamental geodetic observatories offer great potential to integrate the IHRF (Appleby et al., 2015). In addition, the station should have gravity measurements and should preferably be linked to the International Gravity Reference Frame (IGRF) (Wziontek et al., 2021) (Figure 1). In this way, it will be possible to make the connection between the geometric reference frame (Cartesian geocentric X coordinates) and the physical reference frame (potential values (W and C) and gravity g).
c) The station should be linked to the local Vertical Datum to facilitate unification with the IHRF (Figure 1). Otherwise, the connection must be made by leveling operation.

Figure 1 - Example of a co-located IHRF station (UNSA station, Argentina) and an IHRF station with absolute gravity measurement and connection to the local Vertical Datum - GNSS / leveling (BRAZ station, Brazil).

d) If the station selected is located in the country's coastal region and is close to the tide gauge linked to the local Vertical Datum, then a link should be made by leveling.

e) It is essential for the selected station to have ground gravimetric measurements around it. The gravimetric points must be uniformly distributed and measurements should be made in a radius of 210 km (~2º) around the IHRF station. More details on this topic are given in the "Guide for performing gravimetric measurements around IHRF stations". If part of the area intended for gravimetric measurements lies in the ocean (Figure 2), then the availability of marine gravimetric measurements should be verified. The *Bureau Gravimetrique International* (BGI) and local institutions should be consulted where possible. In the absence of such information, airborne gravity or gravimetric surveys on board ships should be carried out along the coastal region, within the 210 km radius. As both activities are known to be expensive, a third option is to use information from models acquired by satellite missions.

Figure 2 - Distribution of land (in red) and marine (in blue) gravimetric measurements at the IMBT station, Brazil.

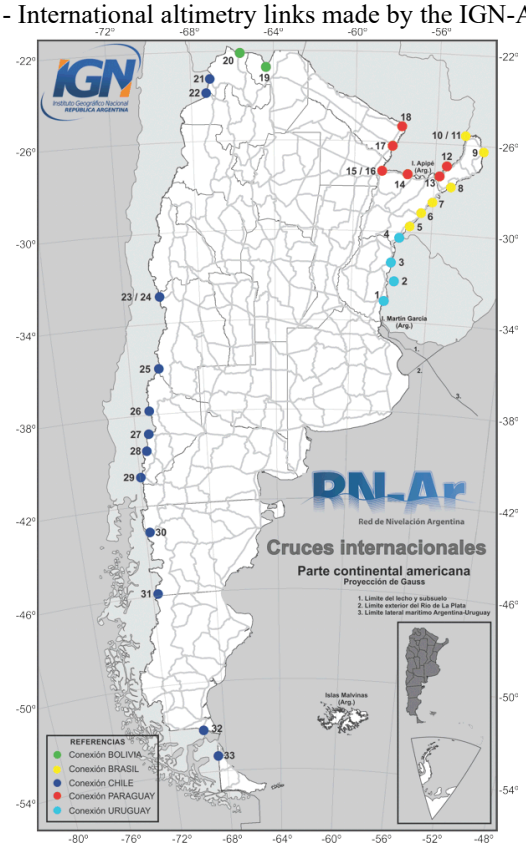


2. General recommendations

Other observations should be taken into account with a view to achieving the materialization and maintenance of the unified vertical reference system on the continent, using physical and geometric heights which are globally consistent in accordance with IAG recommendations. Three aspects are thus recommended:

a) International altimetry links are encouraged, as they foster the regional integration of leveling networks, which is a fundamental process for the development of any binational civil, hydraulic or cartographic engineering infrastructure activity. In addition, international connections make it possible to obtain differences in the heights making up the leveling networks of the countries in question, allowing them to analyze consistency. In addition to leveling measurements, gravimetric and GNSS observations should also be made. Figure 3 illustrates an example of international altimetry links made by the National Geographic Institute of Argentina (IGN-Argentina) at international bridges and border crossings.

Figure 3 - International altimetry links made by the IGN-Argentina.



Source: https://www.ign.gob.ar/NuestrasActividades/Geodesia/Nivelacion/Vinculaciones

b) It is essential to ensure that the national altimetric network is adjusted according to geopotential unevenness. The geopotential number is a physical quantity that, associated with a certain gravity value (observed or calculated), allows physical heights to be obtained (either orthometric, normal or dynamic). In addition, the calculation of the IHRF station coordinates will be based on the geopotential number. Therefore, the importance of this magnitude is emphasized in the context of the IHRF. Some countries have already completed this task; more details may be found in IGN (2017) and IBGE (2019), for example.

c) It is recommended that the geodetic data repositories of the SIRGAS Member States be opened for this purpose, as their objective is to improve and develop the geodetic framework in the Americas using geodetic data and metadata.

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