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Report of the GGOS Focus Area Unified Height System

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GGOS Focus Area Unified Height System

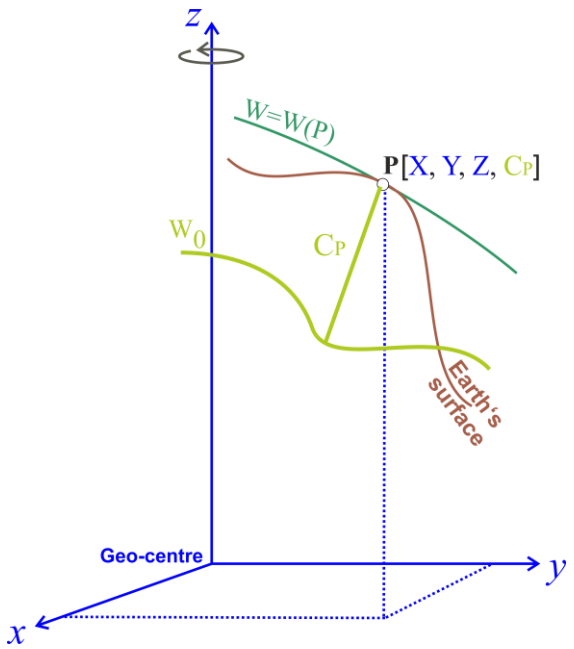
The GGOS Focus Area Unified Height System (formerly Theme 1) was established in 2010 with the objective to *unify the existing height systems* through the *definition and realisation of a world height system*, including the following goals:

- Short-term goals:
  - To establish a *global vertical reference level* and its potential value W_0.
  - Refinement of standards and conventions for the *definition and realisation of a world height system*.
- Mid-term goals:
  - To develop *GGOS products* for the *realisation of a world height system*: reference frame, global height system unification, registry and metadata of existing height systems.
- Long-term goals:
  - To *maintain and use in practice* the world height system: temporal changes, update of definition and realisation according to new geodetic developments, servicing the vertical datum needs to other geosciences.

GGOS Focus Area Unified Height System

- Short-term goals (2011 – 2015):
  - Conventional global reference level (W_0)
  - Standards and conventions for the definition and realisation of a world height system.

  → *Main result: IAG Resolution for the Definition and Realisation of an International Height Reference System (IHRS) released in July 2015.*



1) Vertical coordinates are *potential differences* with respect to a *conventionally fixed* W_0 value:

$$C_P = C(P) = W_0 - W(P) = -\Delta W(P),\ W_0 = const. = 62\ 636\ 853.4\ \mathrm{m^2 s^{-2}}$$

2) The position P is given in the ITRF

   $\mathbf{X}_P\ (X_P, Y_P, Z_P)$; i.e., $W(P) = W(\mathbf{X}_P)$

3) The estimation of $\mathbf{X}(P)$, $W(P)$ (or $C(P)$) includes their variation with time; i.e., $\dot{\mathbf{X}}(P)$, $\dot{W}(P)$ (or $\dot{C}(P)$).

4) Coordinates are given in *mean-tide system / mean (zero) crust*.

5) The unit of length is the *meter* and the unit of time is the *second* (SI).

See: Ihde J. et al.: *Definition and proposed realisation of the International Height Reference System (IHRS)*. Surv Geophy 38(3), 549-570, 10.1007/s10712-017-9409-3, 2017

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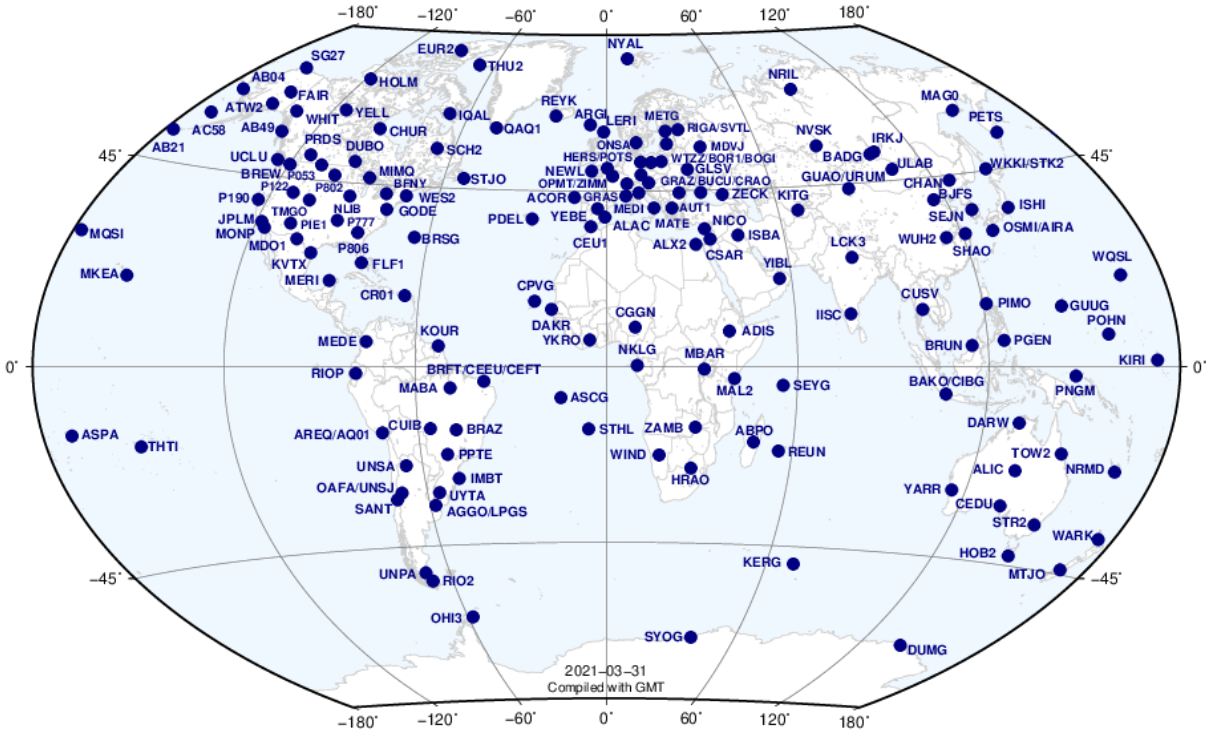
- Mid-term goals (2015 – 2019):
  - Station selection for the International Height Reference Frame (IHRF)
  - Evaluation/calibration of different methodologies for the computation of IHRF coordinates
  - Refinement of standards and conventions

→ *Main result: An extensive guideline for the realisation of the IHRS, including*

- *Strategy for the determination/evaluation of IHRF coordinates depending on the data availability and quality*
- *Strategy to improve the input data required for the determination of IHRF coordinates*
- *Strategy for the IHRF station selection in regional and national densifications*
- *Strategy to ensure the usability and long-term sustainability of the IHRF*



See: Sánchez et al. (2021). *Strategy for the realisation of the International Height Reference System (IHRS)*. J Geod, 95(3), 10.1007/s00190-021-01481-0
Wang et al. (2021). *Colorado geoid computation experiment: overview and summary*. J Geod, 95(12), 10.1007/s00190-021-01567-9
Sánchez and Sideris (2017). *Vertical datum unification for the International Height Reference System (IHRS)*. Geop J Int, 209(2), 570-586, 10.1093/gji/ggx025

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- On-going activities (since 2020):
  - Preparation of a first solution for the IHRF considering
  - Research/developing activities:
    - Evaluation of discrepancies between different (quasi-)geoid computation methods
    - Quality assessment in the determination of potential values
    - Methods to determine potential changes with time.
  - Computation activities:
    - Based on existing resources
    - Determination of a first preliminary IHRF solution based on existing regional and global gravity field (geoid/quasi-geoid) models
    - Guideline/standard for recovering potential values from precise geoid and quasi-geoid models
- With the support of
  - About *40 colleagues* responsible for the geoid/quasi-geoid modelling in different countries/regions worldwide
  - GGOS-FA-UHS WG: *Implementation of the International Height Reference Frame*, chairs: L Sánchez (Germany), R. Barzaghi (Italy)
  - *International Gravity Field Service* (IGFS), chair: R Barzaghi (Italy), IGRF-CB G Vergos (Greece)
  - IAG Sub-Comm. 2.2: *Methodology for geoid and physical height systems*, chair: G Vergos (Greece), RS Grebenitcharsky (Saudi Arabia)
  - IAG Comm. 2 WG: *Error assessment of the 1 cm geoid experiment*, chairs: T Jiang (China), VN Grigoriadis (Greece), M Varga (Hungary)
  - ICCT SG: *Geoid/quasi-geoid modelling for realisation of the geopotential height datum*, chairs: J Huang (Canada), YM Wang (USA)

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- On-going activities (since 2020):
  - Preparation of terms of reference for an IHRF Product Centre under the responsibility of IGFS (L Sánchez, R Barzaghi, G Vergos)
  - It should ensure the maintenance and availability of the IHRF in a long-term basis.
- Once this infrastructure is established, the objectives of the GGOS-FA-UHS can be understood as accomplished and the maintenance of the IHRF will be a continuous task of IGFS with the support of the other IAG components: IAG Commissions, ICC, study and working groups.
- Deadline: IUGG General Assembly 2023.