

# IHRF COORDINATION CENTER, A NEWLY ESTABLISHED IAG/IGFS COMPONENT TO ENSURE THE SUSTAINABILITY OF THE IHRS/IHRF

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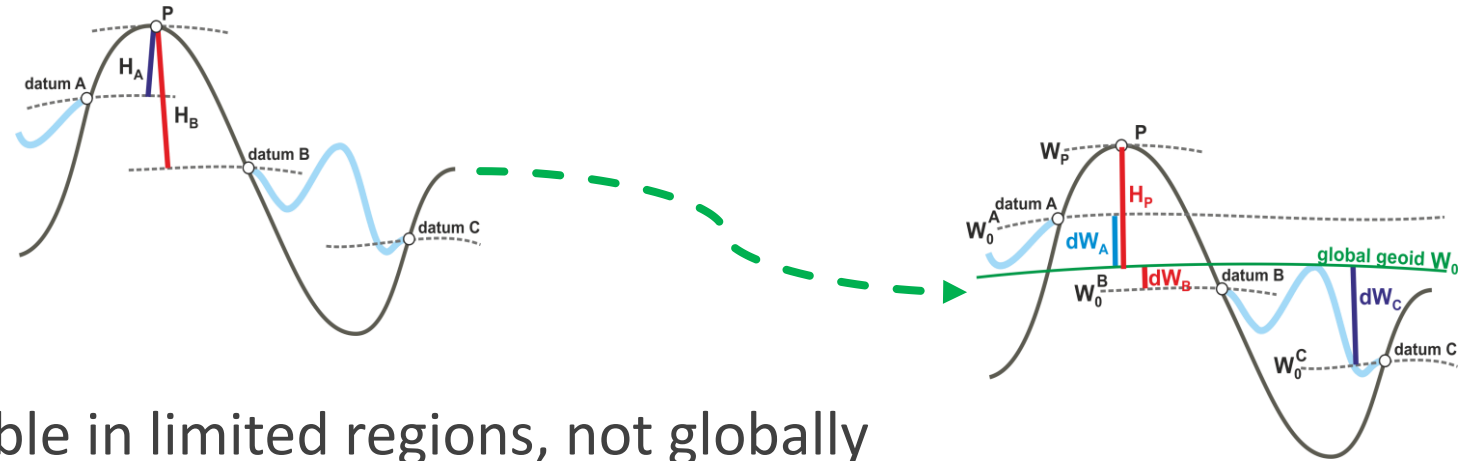
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<sup>3</sup>Politecnico di Milano, Italy

SESSION G2.3, VIENNA, AUSTRIA, APRIL 14-19, 2024



## WHY THE IHRF



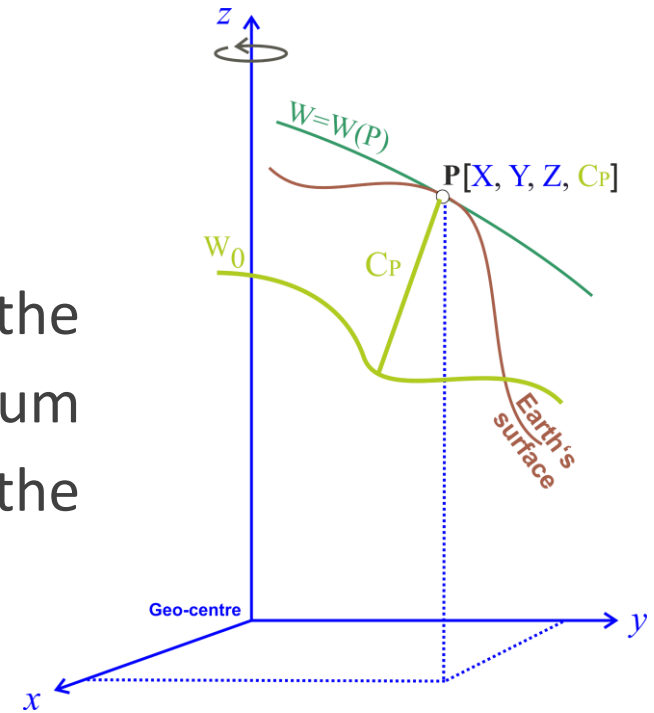
- Existing height systems are usable in limited regions, not globally
- Existing height systems are not connected to each other, hence offsets (at the best-case scenario) exist even in neighboring countries
- Reliable physical heights are needed in a wide spectrum of (geo)scientific and engineering applications
- The vertical datum unification problem (**all physical heights referring to the same equipotential surface**) is a topic with long tradition in the IAG

## IHRF SCOPE

- responsibility to deliver the IHRF coordinates  $(X, Y, Z, C)$  of the IHRF reference stations and a catalogue of the vertical datum parameters, i.e., the transformation parameters between the existing local height systems and the IHRF
- Vertical coordinates are **potential differences** with respect to a **conventionally fixed  $W_0$**  value:

$$C_P = C(P) = W_0 - W(P) = -\Delta W(P) \rightarrow H = \frac{C(P)}{\gamma}$$

$$W_0 = \text{const.} = 62\,636\,853.4 \text{ m}^2\text{s}^{-2}$$

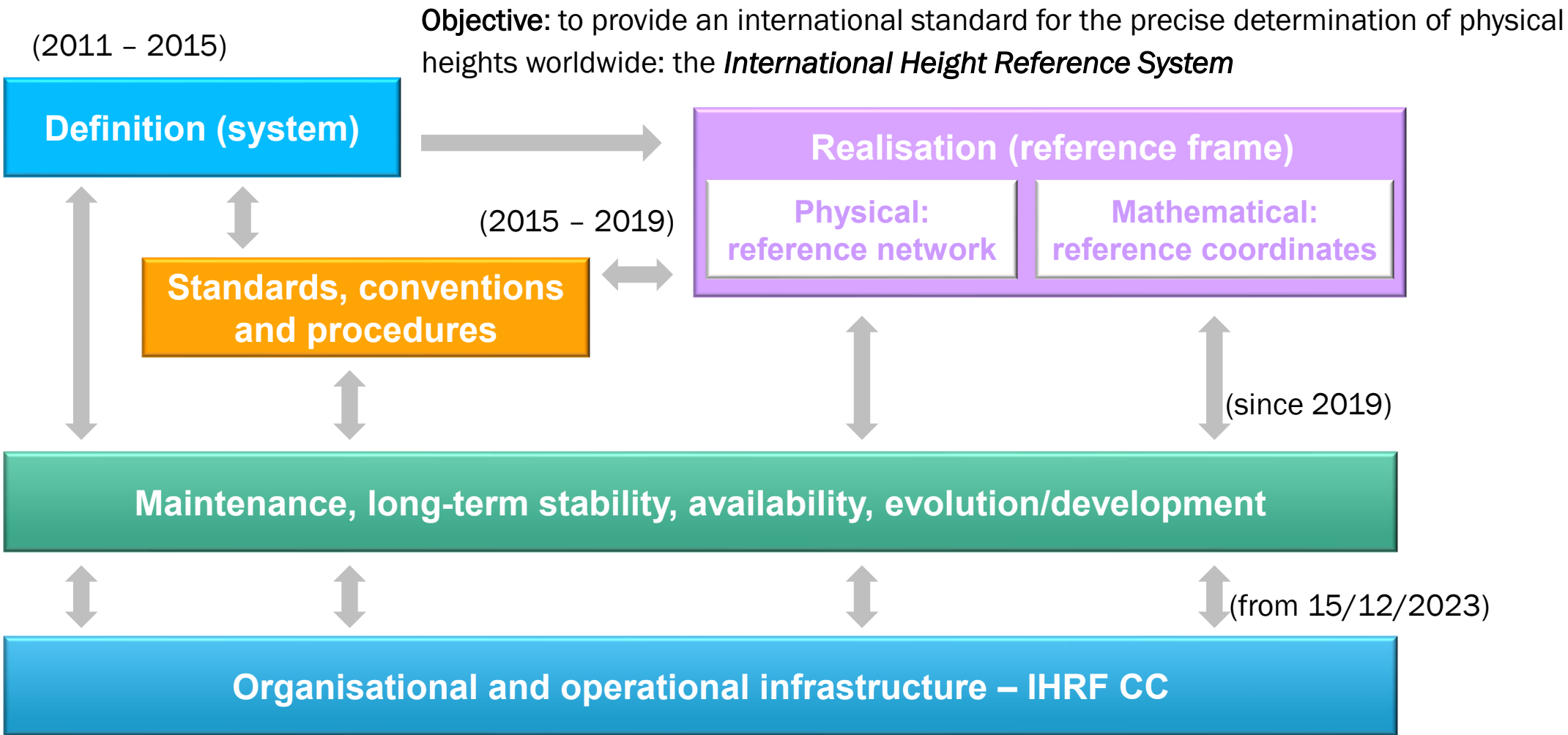


Convention: **geopotential-based** height system

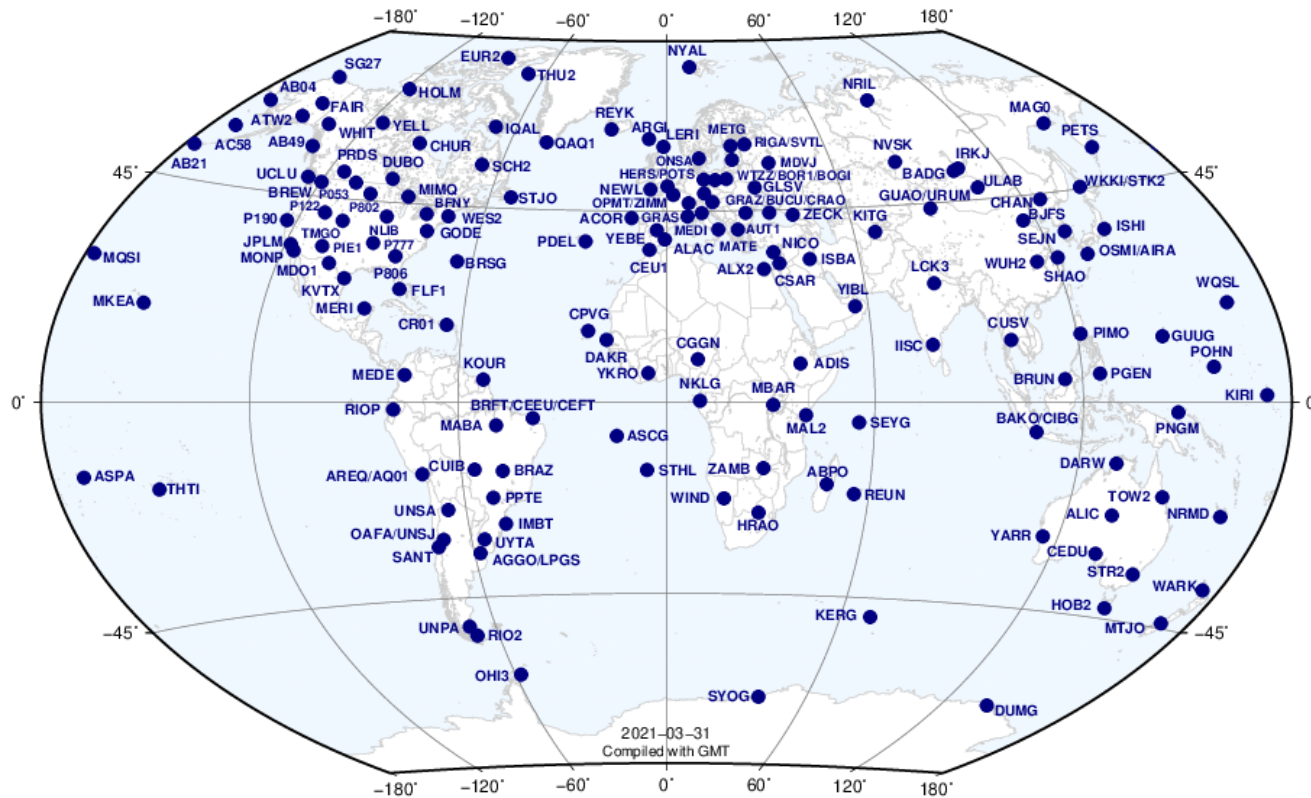
Realisation: the **International Height Reference Frame (IHRF)**

# THE ROAD TO IHRF

## IHRF EVOLUTION



## IHRF – FIRST PROPOSAL

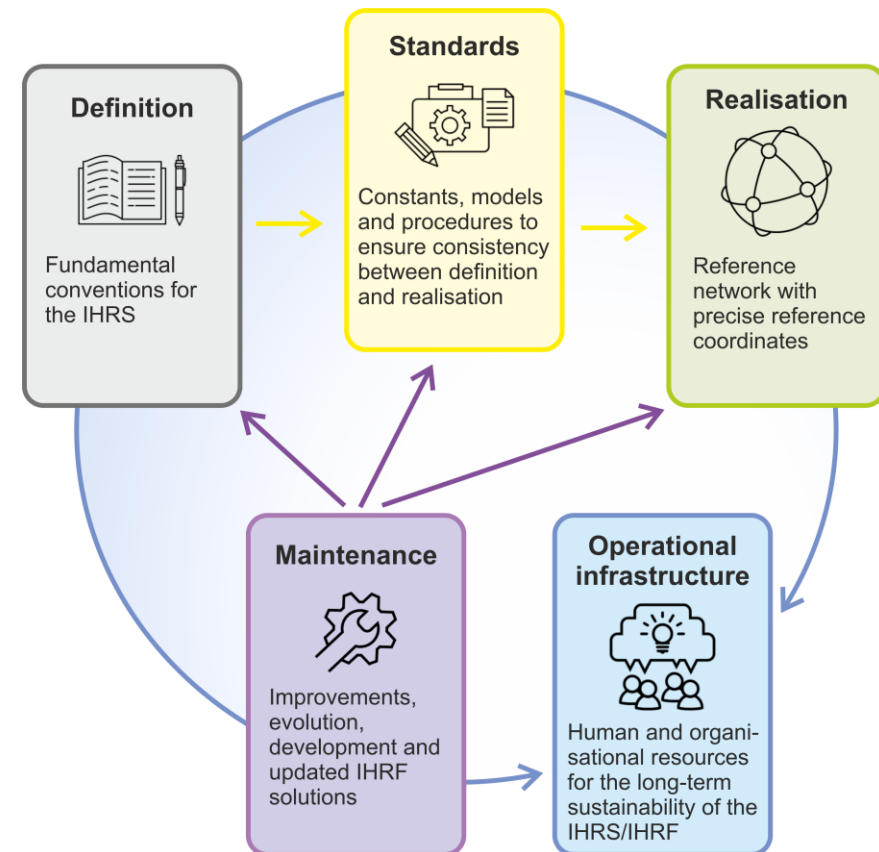
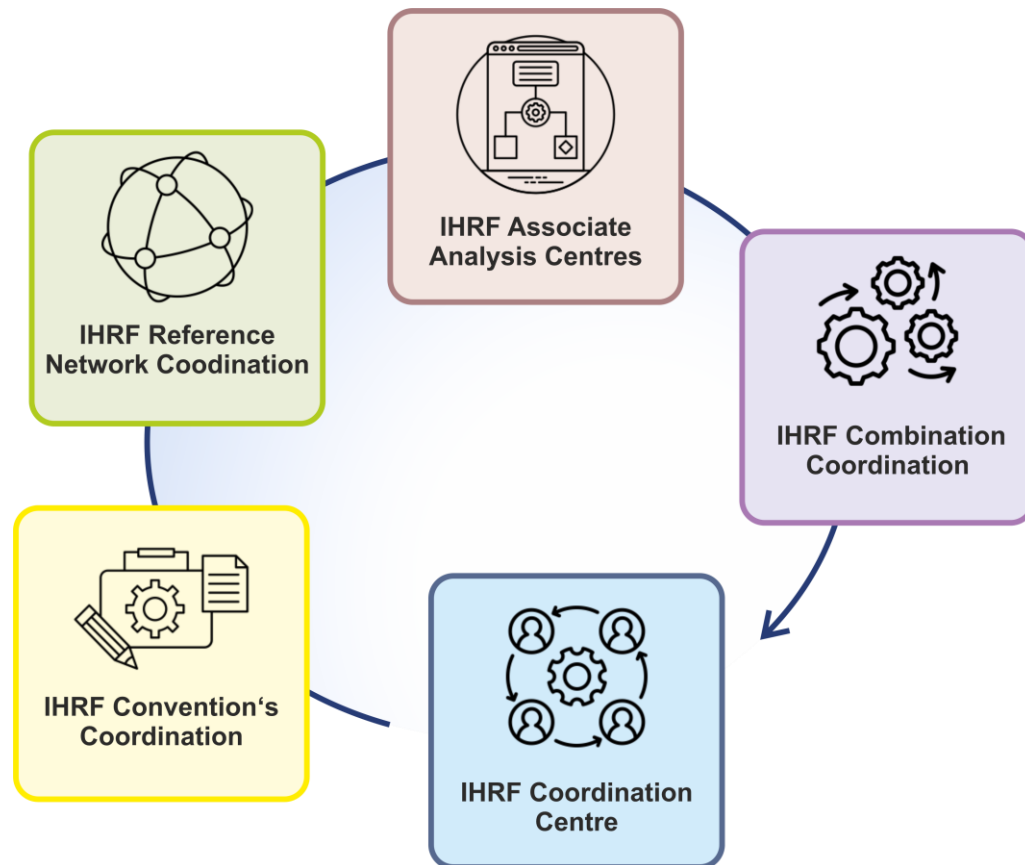


- 1) Global network with regional/national densifications
- 2) Core network materialised by GNSS continuously operating stations and co-located with the ITRF (and its regional densifications), ITGRF, reference clocks, national vertical frames
- 3) First proposal for the **IHRF reference network** (~170 stations) in coordination with the **GGOS-BNO**, **IERS**, **BGI/IGFS** and the **IAG regional sub-commissions for reference frames and gravity field modelling**.
- 4) A **living network**: new stations and decommission of stations.

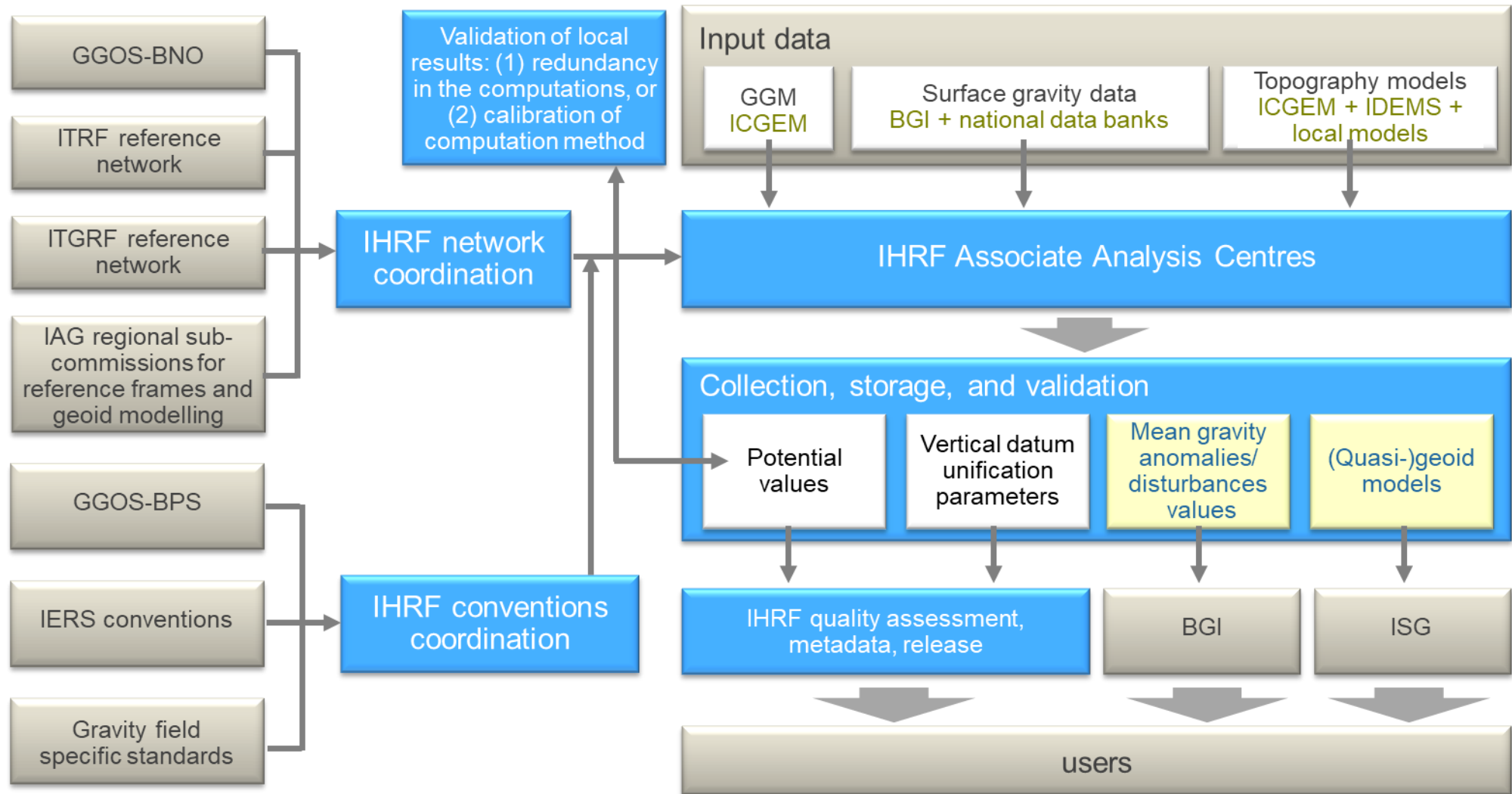
## IHRF COORDINATES

- 1) The IHRS/IHRF is
  - a combination of a geometric component given by the **coordinate vector  $\mathbf{X}$**  in the ITRS/IHRF and
  - a physical component given by the determination of **potential values  $W$**  at  $\mathbf{X}$
- 2) The determination of  $\mathbf{X}$  follows the **IERS Conventions** and it is well established in practice (IERS and associated data, analysis, combination and product centres)
- 3) The determination of  $W$  is only possible by means of **gravity field modelling** (so far without standard procedures, see next slide)
- 4) To be in agreement with the ITRF, the **expected accuracy** of  $W$  is
  - Positions:  $\approx \pm 3 \times 10^{-2} \text{ m}^2\text{s}^{-2}$  (about **3 mm**)
  - Velocities:  $\approx \pm 3 \times 10^{-3} \text{ m}^2\text{s}^{-2}/\text{a}$  (about **0.3 mm/a**)
- 5) For the moment, our goal is  $\pm 1 \times 10^{-1} \text{ m}^2\text{s}^{-2}$  (about **1 cm**)
- 6) The IHRS/IHRF coordinates include the determination of time variations. For the moment, we consider **static coordinates only**

# IHRF PERMANENT COMPONENTS – DUTIES - PRODUCTS



# THE IHRF & IGFS SERVICES





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## IHRF PERMANENT COMPONENTS - DUTIES

- IHRF Coordination Centre (IHRF CC)

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- IHRF Conventions Coordination (IHRF CVC)

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- IHRF Conventions Coordination (IHRF CVC)
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- IHRF Combination Coordination (IHRF CombC)

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## IHRF PERMANENT COMPONENTS - DUTIES

- IHRF Associate Analysis Centers (IHRF ASCs)
  - The main driving force of the IHRF, based on a voluntary effort
  - The IHRF ASCs are national/regional agencies/bodies that **contribute to the realization of the IHRF** by providing the potential values at the IHRF stations located in their countries/regions and the vertical datum parameters.
  - These ASCs will **strictly follow the conventions outlined by the IHRF CVC**, use the ITRF input coordinates provided by the IHRF RNC, and provide detailed descriptions about their calculations.

## IHRF WEBSITE, COMMUNICATION & VISIBILITY



- Website already developed (<https://ihrfcc.topo.auth.gr/>)
- Main IHRF e-mail alias is ready and working ([ihrf@topo.auth.gr](mailto:ihrf@topo.auth.gr))
- IHRF documents repository to the website (minutes, material, presentations, notes, etc.)

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## IHRF DEVELOPMENTS

- A (short) white paper will be prepared on why the IHRF is needed + why the geoid and gravity are needed
- What are the benefits of having it and the pitfalls of not having it (similar to the GGOS Strategic Plan and Implementation Strategy)
- IHRF cookbook as a short guide for ASCs and interested entities that want to be involved
- Simulated and GGM+topo based data on the IHRF web-repository to test approaches, methods & algorithms
- First realization on-line as potential values, offsets to national VRFs and metadata until GGHS2024 (Sep. 4-6, 2024 – Thessaloniki, Greece)

# ACKNOWLEDGEMENTS



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UNIVERSITY  
OF THESSALONIKI



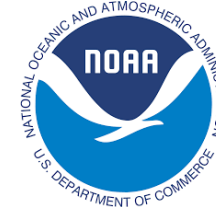
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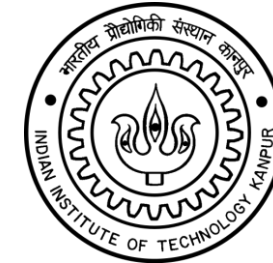
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DE LA PLATA



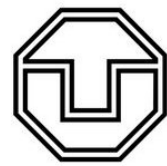
Natural  
Resources  
Canada



GEOSA  
الهيئة العامة للمساحة  
والمعلومات الجيومكانية  
General Authority for Survey  
and Geospatial Information



TECHNISCHE  
UNIVERSITÄT  
DRESDEN





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# BACK-UP SLIDES

## IHRF WITHIN IAG

- .....the development of theory and methods for the continuous improvement of the IHRF should be **promoted** by the IAG Commissions and the Inter-Commission Committee on Theory (ICCT), while the operational performance should be ensured by the IAG Services.
- In that respect, the IHRF Coordination Centre (IHRF CC) has been **proposed and accepted** by the IAG EC as a central coordinating body under the responsibility of the International Gravity Field Service (IGFS) with direct adherence to the IGFS Central Bureau (IGFS CB), composed of individual modules taking care of the main components of the IHRF.

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# IHRF PERMANENT COMPONENTS

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## IHRF PERMANENT COMPONENTS - PEOPLE

- IHRF Coordination Centre (IHRF CC - GS Vergos & EM Mamagiannou, AUTH, Greece)
- IHRF Reference Network Coordination (IHRF RNC - C Tocho & GS Vergos)
- IHRF Conventions' Coordination (IHRF CVC - J Huang & J Ågren)
- IHRF Combination Coordination (IHRF CombC - L Sánchez & R Barzaghi)
- IHRF Associate Analysis Centers (IHRF ASC)

# IHRF PERMANENT COMPONENTS – IHRF ASC PEOPLE

- Africa **Hussein Abd-Elmotaal**
- America North **Yan Ming Wang, Jianliang Huang**
- America South **Ana Cristina Oliveira Cancoro de Matos, Claudia Tocho, Gabriel do Nascimento Guimarães**
- Oceania **McCubbine Jack**
- Europe **Joachim Schwabe, Heiner Denker**
- India **Ropesh Goyal**
- Japan **Koji Matsuo**
- China **Tao Jiang**
- KSA/Arabia **Rossen Grebenitcharksy, Abdullah Theeb Hassan Al-Qahtani**
- Iran **tbd**
- Turkey **Bihter Erol**
- Greenland **Rene Forsberg, Hergeir Teitsson**
- Antarctica **tbd**

# IHRF DIRECTING BOARD (PERMANENT COMPONENTS & APPOINTED)

## ■ Permanent IHRS/IHRF components

- Chairman of IHRF Coordination Center (George Vergos)
- Chairs of IHRF Conventions' Coordination (Jialiang Huang and Jonas Ågren)
- Chairs IHRF Reference Network Coordination (Claudia Tocho)
- Chairs of IHRF Combination Coordination (Laura Sánchez and Riccardo Barzaghi)

## ■ Elected Members:

- Associate Analysis Center representative (Bihter Erol)

## ■ Appointed Members:

- Sinem Ince, ICGEM representative, GFZ - Germany;
- Mirko Reguzzoni, Polimi – Italy;
- Lucia Seoane, BGI representative, GET - France;
- Christian Hirt, IDEMS representative, Germany;
- Ezequiel Antokoletz, IGETS representative, BKG – Germany;
- Laura Sanchez, GGOS representative, DGFI/TUM - Germany;
- ITRF representative;
- Hartmut Wziontek, ITGRF representative, BKG – Germany;
- Jürgen Müller, QuGe IAG project representative, IFE – Germany

