Unification of Heights and Vertical Reference Surfaces

Canberra, Australia
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International Height Reference System/Frame (IHRS/IHRF)

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IHRS/IHRF

- Unified Height System / Frame
- Realized following internationally coordinated Standards and Conventions
- Reference Surface: global mean sea surface (W0)

IHRS : Definition of height reference system unified around the world

IHRF : Realization of IHRS using actual geodetic data

Objectives

1. supports geometrical (ellipsoidal) and physical (normal, orthometric, geoidal) heights world-wide with centimetre precision in a global frame.
2. enables the unification of all existing physical height systems
   (i.e., all physical heights shall be referred to the same reference surface with potential W0)
3. provides high-accuracy and long-term stability of the vertical coordinates.

IAG resolutions driving IHRS/IHRF

- IAG Resolution 2015 (Resolution1):
  Definition and Realization of an International Height Reference System (IHRS)
- IAG Resolution 2019 (Resolution3):
  Establishment of the International Height Reference Frame (IHRF)

IAG Resolution 2015
https://iag.dgfi.tum.de/fileadmin/IAG-docs/IAG_Resolutions_2015.pdf
IAG Resolution 2019
https://iag.dgfi.tum.de/fileadmin/IAG-docs/IAG_Resolutions_2019.pdf

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Activities and current status

- A resolution for **the definition and realization of IHRS** has been released in July 2015 from the International Association of Geodesy (IAG)
- Principal organizer is **Prof. Laura Sanchez** at Technical University of Munich
- 37 researchers participate in **the Working Group for the realization of IHRS**
- **First proposal for the IHRF reference network** was approved at GGHS2018 conference (Copenhagen, Denmark)
- **First IHRF** will be released in 2019 following IAG resolution issued at IUGG2019 conference (Montreal, Canada)

Details of IHRS/IHRF

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Standards and Conventions of IHRS

1. Geopotential value of the reference surface（W0）is **62 636 853.4 m^2/s^2** (at the geoid)
2. The position (**X, Y, Z**) is given by the International Terrestrial Reference Frame (**ITRF**)
3. IHRF includes **physical heights, geopotential values, and their variation with time**
4. Mean-tide or Mean(zero) crust
5. SI Units（meter and second)

The IHRF includes:

- **Physical height (H, dH/dt)**
- **Potential value of the Earth's gravity field (W, dW/dt)**

W0 value is defined as **62 636 853.4 m^2s^{-2}.**
(Geopotential number on the global mean sea surface, i.e. reference surface)

Details of IHRS/IHRF

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Primary requirement of IHRF reference network

1. GNSS **CORS**
2. Hold a physical height tied up with **reference tide gauges and local leveling networks**
3. Hold **an absolute gravity value**
4. 100 or more **land gravity data** are available around an IHRF site within 210 km distance
5. Collocated with other space geodetic observatories (VLBI or SLR or DORIS) (recommended)

First proposal for the IHRF reference network

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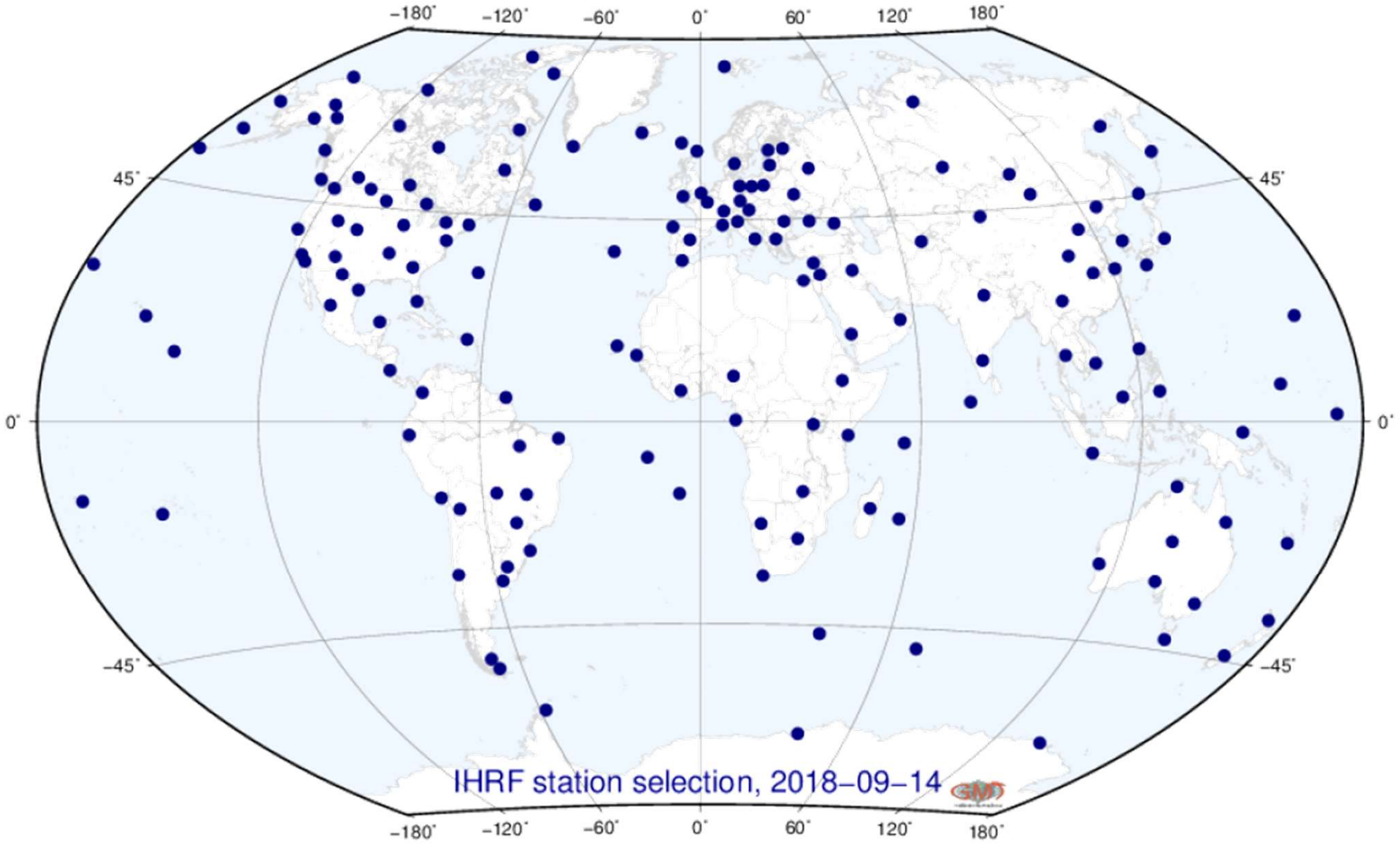
165 sites have been selected as of Sep. 2018



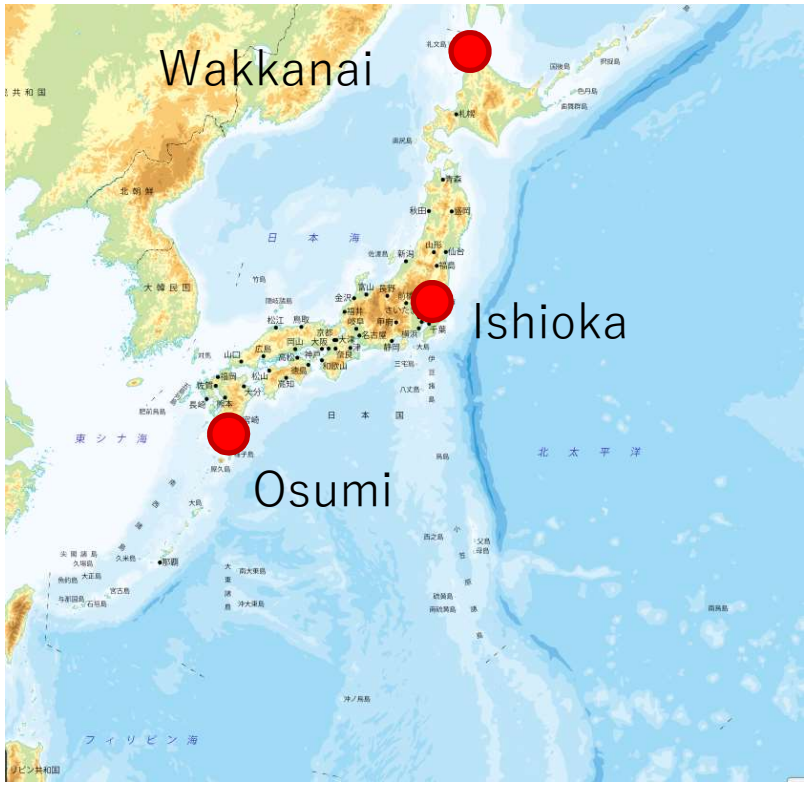
Sanchez (2018): GGOS Focus Area Unified Height System: Status report, ongoing activities, outlook

IHRF stations in Japan

GSI (Dr. Koji Matsuo) proposed 3 sites in japan to IHRF.

1. **CORS**
2. **Reference tide gauges and local leveling networks**
3. A**n absolute gravity value**
4. 100 or more **land gravity data** around an IHRF
5. Collocated with VLBI or SLR or DORIS (recommended)
6. Globally even spatial distribution

	Wakkanai	Ishioka	Osumi
1	○	○	○
2	○	○	○
3	○	○	○
4	○	○	○
5	×	△ (VLBI)	×
6		○	



Calculation of Geopotential Values

GSI calculated geopotential values (height) of 3 IHRF stations.

$$W_p = W_0 - (H_p - N)(g_p + 0.0424(H_p - N) \times 10^{-5})$$

W_p : Geopotential value at ground surface

W_0 : Geopotential value at the Geoid (62 636 853.4 m^2s^{-2})

H_p : Ellipsoidal height at ground surface (ITRF)

N : Geoid height of JGEOID2018（Matsuo et al., 2018）

g_p : Absolute gravity value of JGSN2016（Yahagi et al., 2018）

	Lon. (度)	Lat. (度)	Ellipsoidal height (m)	W_p value (m^2s^{-2})
Wakknai	141.75043	45.40299	74.620	62 636 387.699
Ishioka	140.21895	36.20883	155.800	62 635 723.789
Osumi	130.99830	31.56461	126.860	62 635 911.818

Summary

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- IHRS/IHRF is a unified height system/frame realized following internationally coordinated Standards and Conventions (Reference Surface: global mean sea surface (W0))
- Working Group for the realization of IHRS (Principal organizer : Prof. Laura Sanchez, TUM) is working for the first IHRF, which will be released in 2019.
- GSI of Japan (Dr. Koji Matsuo) is participating in the first IHRF reference network with 3 GNSS CORS in Japan.
- GSI of Japan calculated geopotential values of the CORS from ITRF ellipsoidal heights, geoid height (geoid model of Japan) and absolute gravity values.