The International Association of Geodesy

Serving Science and Society since 1862

presented by
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FIG Working Week 2025

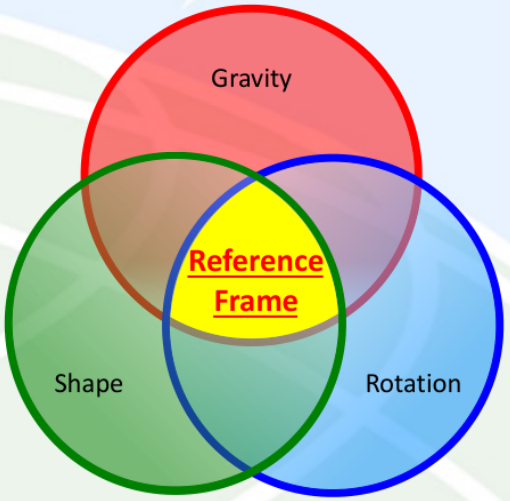
April 6-10, 2025
Brisbane, Australia

Jet Propulsion Laboratory
California Institute of Technology

Geodesy

Geodesy is the science of accurately measuring and understanding three fundamental properties of the Earth and their changes in time

- Geometric shape
- Rotation and orientation in space
- Gravity field



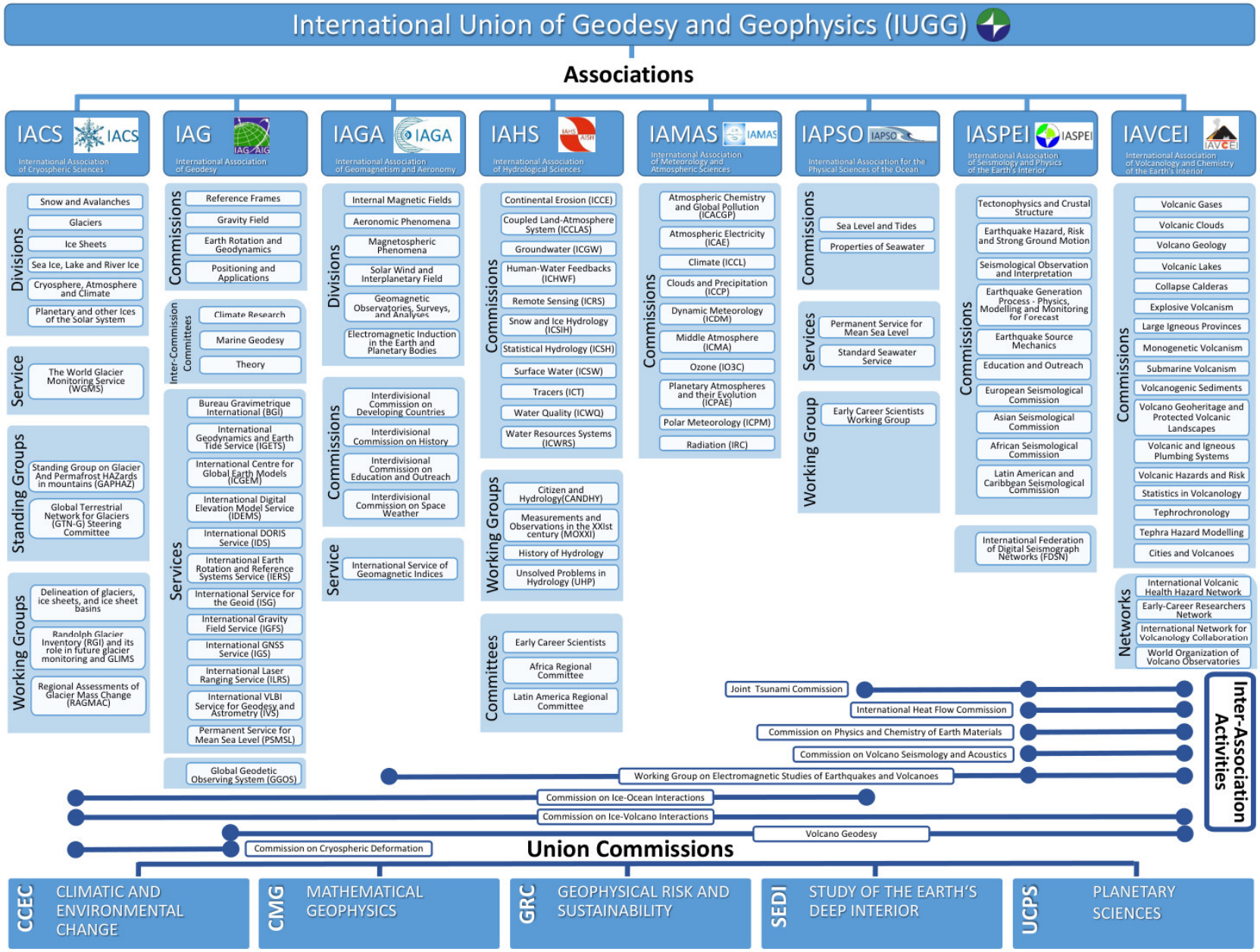
Establishing and disseminating the Terrestrial Reference Frame (TRF) is central to Geodesy

Origins of the IAG

- Central European Arc Measurement
  - Established in 1862
    - By General Johann Jacob Baeyer of Prussia
  - Objective
    - Determine anomalies in Earth's curvature in Central Europe
      - Deflection of vertical; Relative structure of geoid
    - Interpret observed anomalies
      - Structure and composition of Earth
- First Conference of Representatives
  - Held in 1864 in Berlin
  - Created
    - Permanent Commission; Central Bureau; Triennial meetings of General Conferences
  - Considered forerunner of IAG and IUGG General Assemblies
- International Geodetic Association
  - Established at General Conference of 1886 in Berlin
  - First President: General Carlos Ibáñez de Ibero
    - First Director General of Instituto Geográfico Nacional (IGN) Spain
  - Incorporated into International Union of Geodesy and Geophysics
    - Established in 1919 by International Research Council

General Johann Jacob Baeyer

General Carlos Ibáñez de Ibero



Source: iugg.org

International Association of Geodesy Organizational Structure

- 4 Commissions
- 3 Inter-Commission Committees
- 1 Project
- GGOS Global Geodetic Observing System
- 12 Services
- Communication and Outreach Branch

- Council
- Executive Committee
- Bureau
- Office

The Mission of IAG

is the advancement of geodesy, an Earth science that studies the size, shape, orientation and gravity field of the Earth, planets and their satellites including the temporal variations of these features.

The IAG accomplishes its mission

- by furthering geodetic theory through research and teaching;
- by collecting, analysing, modelling and interpreting observational data;
- by stimulating technological development; and
- by providing a consistent representation of the figure, rotation and gravity field of the Earth and planets, and their temporal variations.

IAG's objectives

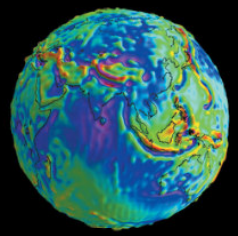
- To study, at the highest possible level of accuracy, all geodetic problems related to Earth observation and global change, including:
  - Definition, establishment and maintenance of global and regional reference systems,
  - Rotation of the Earth and planets,
  - Positioning and deformation studies,
  - Gravity field determination,
  - Ocean, ice and sea level variations,
  - Time transfer,
  - Signal propagation through the planets' atmospheres.
- To support and maintain geodetic reference systems for continuous, long-term observations.
- To provide observational and processed data, standards, methodologies and models.
- To stimulate development of space techniques to increase the resolution of geodetic data.
- To initiate, coordinate and promote international cooperations and knowledge exchange.
- To cooperate with national and international agencies in establishing research goals, missions and projects.
- To collaborate with the international science and engineering community in supporting the application of geodetic theory and the interpretation of the results.
- To foster the development of geodetic activities and infrastructure in the world, especially in developing countries.

The structure of IAG

Commission 1: Reference Frames

- Establishment, maintenance, improvement of the geodetic reference frames.
- Advanced terrestrial and space observation techniques development.
- International collaboration for the definition and deployment of networks of terrestrially based space geodetic observatories.
- Theory and coordination of astrometric observations.
- Collaboration with space geodesy/ref. frame related international services, agencies and organizations.

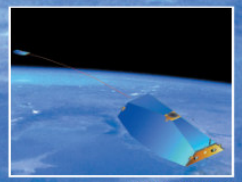
The EPN Network



Gravity anomalies from EIGEN-GRACE01S model (GFZ Potsdam)

Commission 2: Gravity field

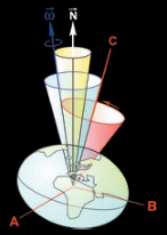
- Terrestrial, marine, and airborne gravimetry.
- Satellite gravity field observations.
- Gravity field modelling.
- Time variable gravity field.
- Geoid determination.
- Satellite orbit modelling and determination.



GRACE Satellites (Illustration)

Commission 3: Earth Rotation and Geodynamics

- Earth orientation (Earth rotation, polar motion, nutation and precession).
- Earth tides.
- Tectonics and Crustal Deformation.
- Sea surface topography and sea level changes.
- Planetary and lunar dynamics.
- Effects of the Earth's fluid layers (e.g. post-glacial rebound, loading).



Earth's precession and nutation

Commission 4: Positioning and Applications

- Terrestrial and satellite based positioning system development, including sensor and information fusion.
- Navigation and guidance of platforms.
- Interferometric laser and radar applications (e.g. InSAR).
- Application of geodetic positioning using three dimensional geodetic networks including monitoring of deformations.
- Applications of geodesy to engineering.
- Atmospheric investigations using space geodetic techniques.

EnviSat (Photo: ESA

Individual Membership Benefits

IAG provides many benefits for its individual members, such as:

- Substantial reduction on the individual subscription rate to the Journal of Geodesy
- Becoming a member of an IAG Commission of choice
- Reduction of registration fee for IAG meetings
- Right to participate in the IAG election process as nominator and/or nominee

source: iag-aig.org

Geometric & General Services

IERS

IGS INTERNATIONAL GNSS SERVICE

International Laser Ranging Service

IVS

IDS

PSMSL

source: ggos.org

Gravity Services

International Association of Geodesy
IAG
I G F S

ICGEM

iDEMS

IGETS

ISG

BGI
Bureau Gravimétrique International
International Gravimetric Bureau

Global Geodetic Observing System

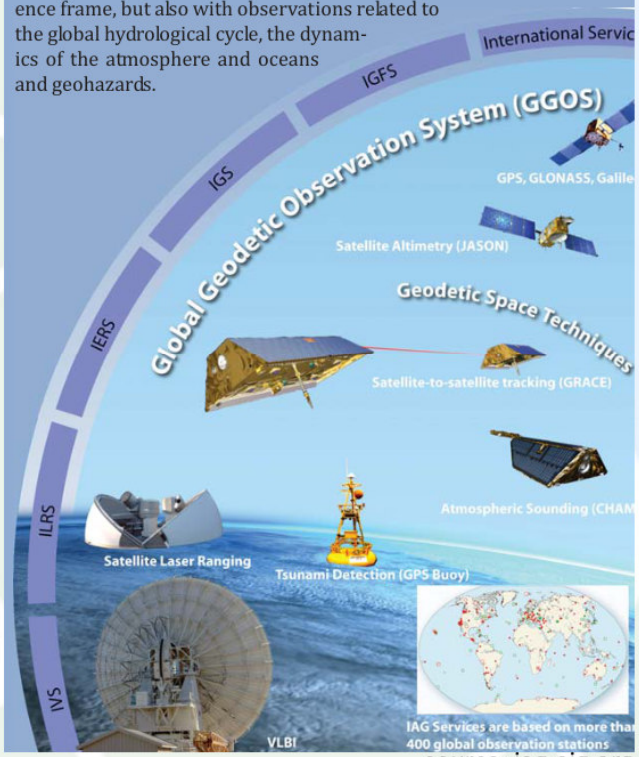
The Global Geodetic Observing System (GGOS)

URL: http://www.ggos.org

GGOS is an official component of IAG as well as a participating organization of the Group on Earth Observations (GEO).

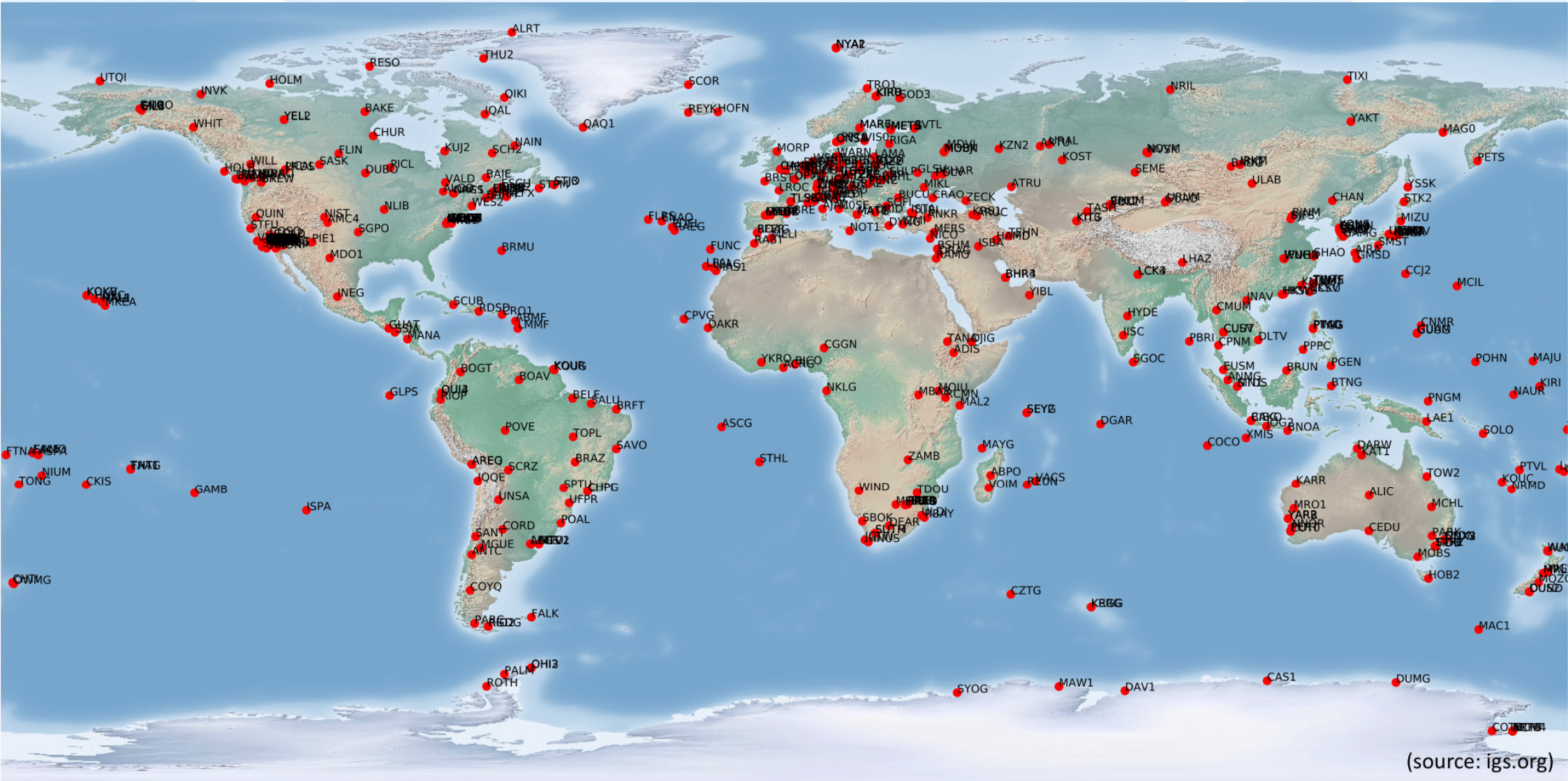
GGOS provides observations of the three fundamental geodetic observables and their variations, that is the Earth's shape, the Earth's gravity field, and the Earth's rotational motion. Thus GGOS ensures the basis to maintain a stable, accurate and global reference frame, which is crucial for all Earth observation.

GGOS contributes to the Global Earth Observing System of Systems (GEOSS) not only with the global reference frame, but also with observations related to the global hydrological cycle, the dynamics of the atmosphere and oceans and geohazards.

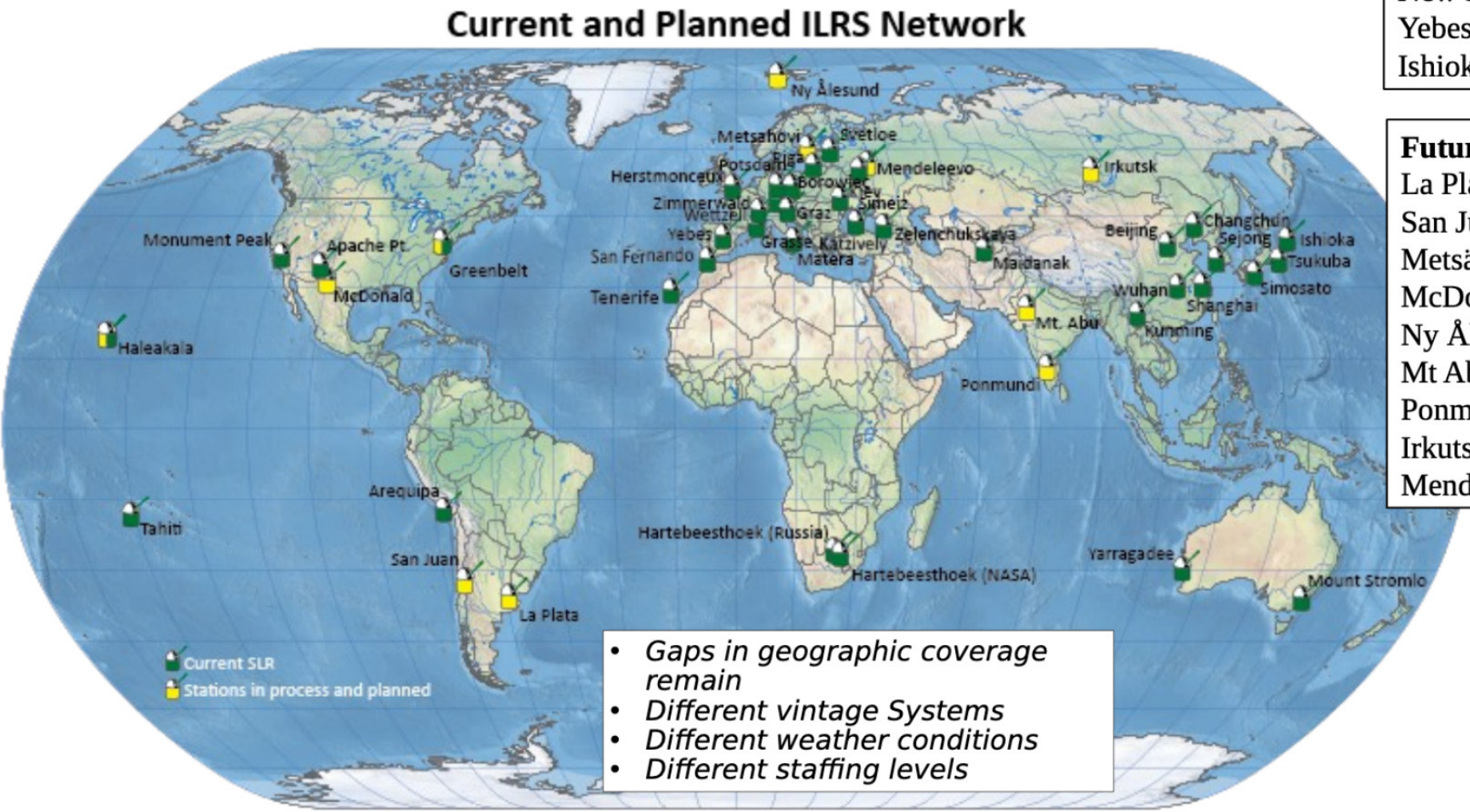


source: iag-aig.org

International GNSS Service



International Laser Ranging Service

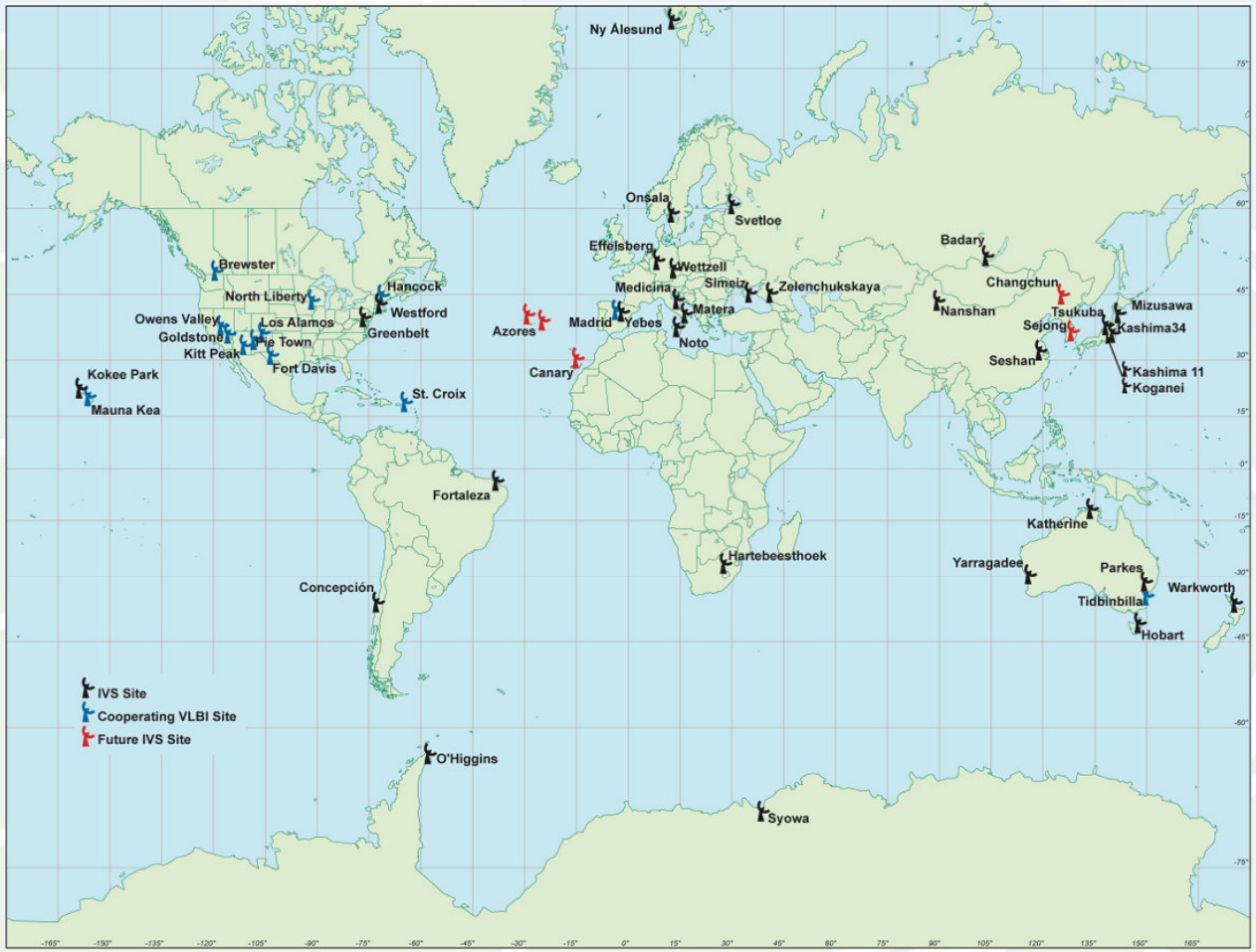


New Stations (2023-2024)
Yebes, Spain
Ishioka, Japan

Future Stations (2024-2027)
La Plata, Argentina
San Juan, Argentina
Metsähovi, Finland
McDonald, TX, USA
Ny Ålesund, Norway
Mt Abu, India
Ponmundi, India
Irkutsk (Tochka), Russia
Mendeleevo (Tochka), Russia

source: ilrs.gsfc.nasa.gov

International VLBI Service
for Geodesy and Astrometry



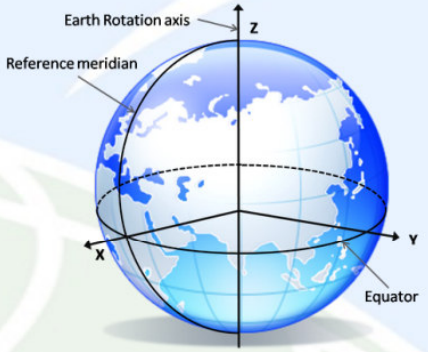
(source: ivscc.gsfc.nasa.gov)

International DORIS Service

(source: ids-doris.org)

Terrestrial Reference Frame (TRF)

- **Definition**
  - The TRF is an accurate, stable set of positions and velocities of reference points on Earth's surface
  - The TRF provides the stable coordinate system that allows us to link measurements over space and time for numerous scientific and societal applications including critical climate and sea level change studies



Terrestrial Reference Frame

- **Determination**
  - The GNSS, VLBI, SLR, & DORIS geodetic networks, along with ground surveys of stations at co-located sites to tie the networks together, provide the data for determining the TRF as well as for direct science investigations
- **Improvement**
  - An improved TRF is needed for numerous scientific and societal applications including critical climate and sea level change studies

GGOS Goal: TRF accurate to better than 1 mm, stable to better than 0.1 mm/yr over a decade


GNSS


SLR


VLBI


DORIS

Different Approaches to Determining TRFs

- The traditional approach to the International Terrestrial Reference Frame (ITRF)
  - The frame is the **model** fit to observed station positions
  - Station positions at times beyond the date of the frame creation are based on model predictions alone
    - IGN plans to provide annual updates to ITRF2020

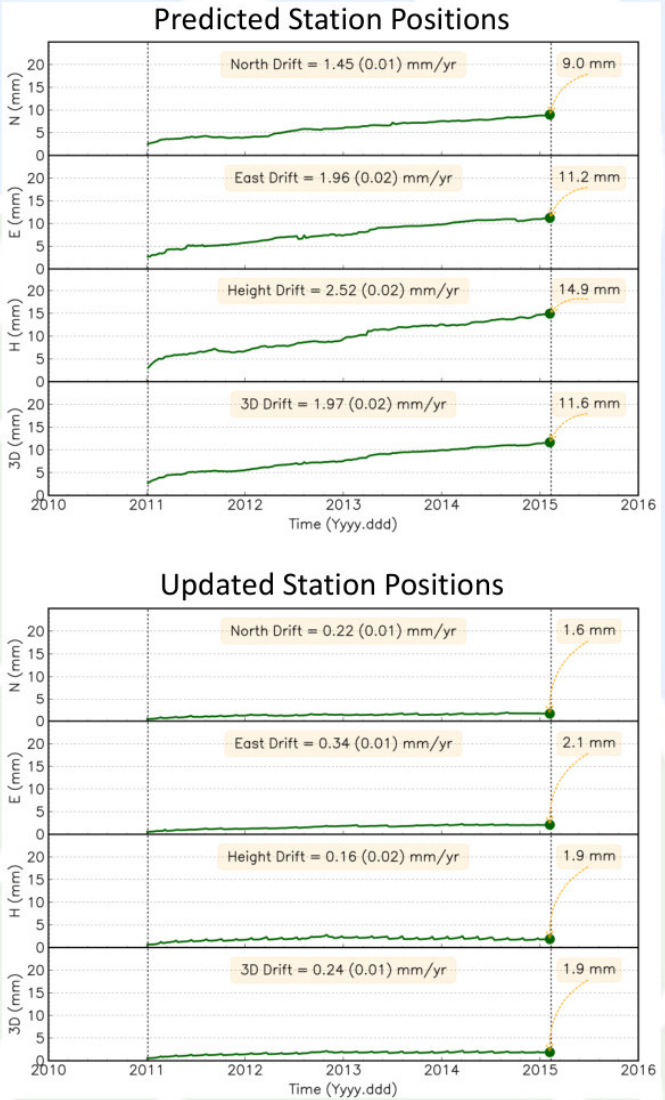
- The JPL Terrestrial Reference Frame (JTRF) approach is different
  - Rather than a model, the JPL Frame is a **set of time series of smoothed, actually observed station positions**
  - Station positions at times beyond the date of the frame creation are based on model predictions alone
    - JPL plans to provide annual updates to JTRF2020

JPL Terrestrial Reference Frame

Need to Update TRFs

- TRFs degrade with time
  - Predictions of station positions
    - Rely on model fit to data
    - Model accurate during data interval, degrades after that
  - ITRFs must be re-determined
    - Every 3-5 years to maintain accuracy
- Update TRF
  - By updating predictions of station positions
    - Using new observations as they become available
  - Reduces frame degradation
    - Maintains accuracy of TRF (station positions, geocenter)
    - Maintains consistency of EOPs with TRF
    - May extend interval between frame re-determinations
      - Frame still needs to be re-determined to include new stations, new/improved background models, etc.

Growth in Station Position Uncertainty
(wrms over 495 stations)



Plans to Update TRFs

- ITRF2020 updates
  - Annual updates being planned
  - First update released December 2024
    - Using data through 2023 from special submissions of Services
  - Entire history of observations processed
    - Station positions will change
    - But frame parameters constrained to be consistent with ITRF2020
- JTRF2020 updates
  - Annual updates being planned
  - First update released January 2025
    - Using data through 11/26/2022 from special submissions of Services
      - IGS Repro3 SINEX combination extended to 11/26/2022
  - Only new data processed
    - Station positions during 1979-2020 did not change
    - Post-2020 frame parameters are consistent with JTRF2020


thank you
danke
謝謝
ngiyabonga
شكراً جزيلاً
рахмат
teşekkür ederim
спасибо
gracias
dank je
tapadh leat
Баярлалаа
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terima kasih
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diolch
তোমাকে ধন্যবাদ
감사합니다
xiexie
merci
ευχαριστώ