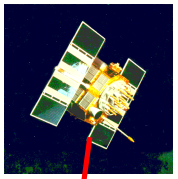
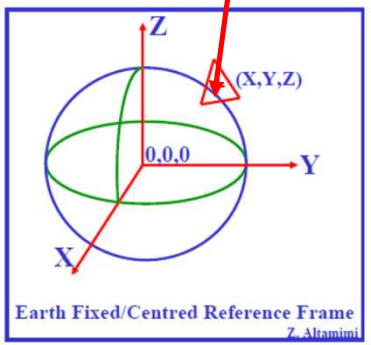


From Global to Regional / National Geodetic Reference Frames: how are they connected and why are they needed?



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Fourth Plenary Meeting of the Subcommittee on Geodesy
18 to 21 March 2024
UN-GGCE, Bonn, Germany

Outline

- Introduction
- Why regional / national reference frames ?

- How to materialize a regional / national reference frame, fully compatible with the ITRF ?

- Access to the ITRF & the IGS role

- AFREF case:
  - First static AFREF solution (2014)

Two main types of reference frame

- **Kinematic reference frame : station positions, velocities & eventually parametric functions describing nonlinear station motions: Post-Seismic deformation, periodic signals, e.g. ITRF2020**

- **Static Reference Frame : station positions valid at a given chosen epoch, with no (or minimized) velocities**

From ITRF to Regional Reference Frames (1/3)

- **Purpose:**
  - Geo-referencing and positioning applications, e.g cadaster, land administration, …
  - Unification of geodetic/mapping applications within a continent or a region, without need for transformation
- **Requirement: no significant change (time variations or velocities) in site coordinates**
  - Imposed by law/decree, but this can be changed/updated
  - Easy to handle by surveyors for centimeter / decimeter precision
- **Not really designed for scientific applications**

From ITRF to Regional Reference Frames (2/3)

- **Three main cases/options to materialize a regional reference frame:**
  - **I) Station positions at a given epoch, eventually updated frequently:**
    - **Many countries, e.g. North & South Americas**
    - **1st AFREF static solution (2014)**
  - **II) Station positions & minimized velocities, e.g. ETRS89 in Europe**
  - **III) Station positions & deformation model, e.g. New Zealand, Greece**

From ITRF to Regional Reference Frames (3/3)

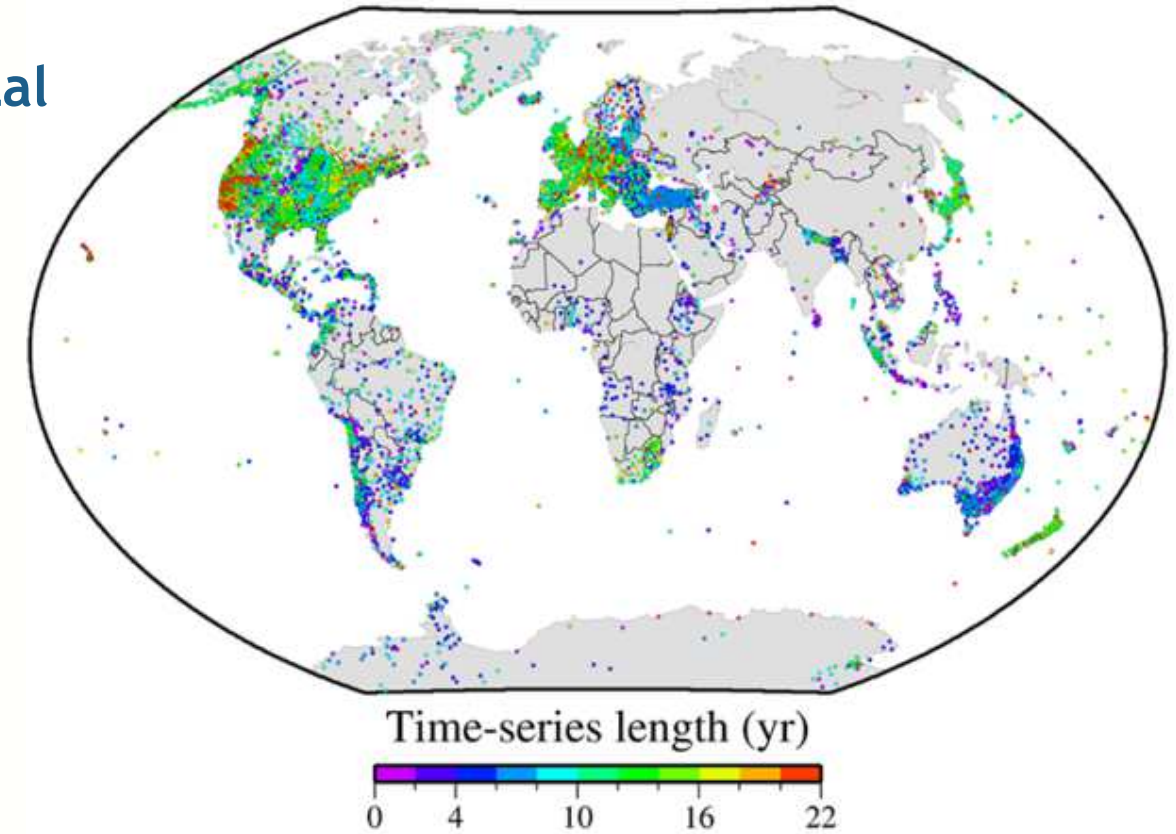
- **Case I is easy to implement**

- **Case II and III are more sophisticated & need application of:**
  - **Transformation formula (ETRS89)**
  - **Deformation model (New Zealand)**

- **ETRS89 does not satisfy certain European countries:**
  - **Greece (tectonic deformation),**
  - **Fennoscandia (significant uplift)**

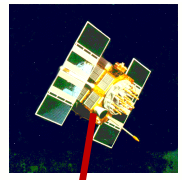
Access to the ITRF via GNSS

- Open Data Sharing is fundamental to enable science applications
- Gaps in some areas, e.g. Africa,
- Some empty areas does not mean no GNSS stations But data is not shared

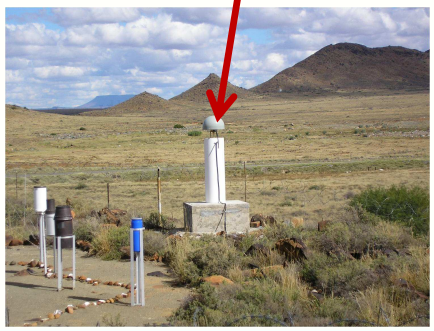


Blewitt, G., W. C. Hammond, and C. Kreemer (2018), Harnessing the GPS data explosion for interdisciplinary science, Eos, 99, https://doi.org/10.1029/2018EO104623

How to connect a National/regional Reference Frame to the ITRF?



- **Build geodetic infrastructure using GNSS continuously operating stations, enabling:**
  - **Modern, more accurate and less costly national reference frame**
  - **Easy to maintain than old classical geodesy**
  - **Easy access to the ITRF**
  - **inter-operability of geospatial data between countries**
  - **==> Economic benefit**
- **Enhance capacity building & international cooperation in Geodesy for knowledge transfer & know how**

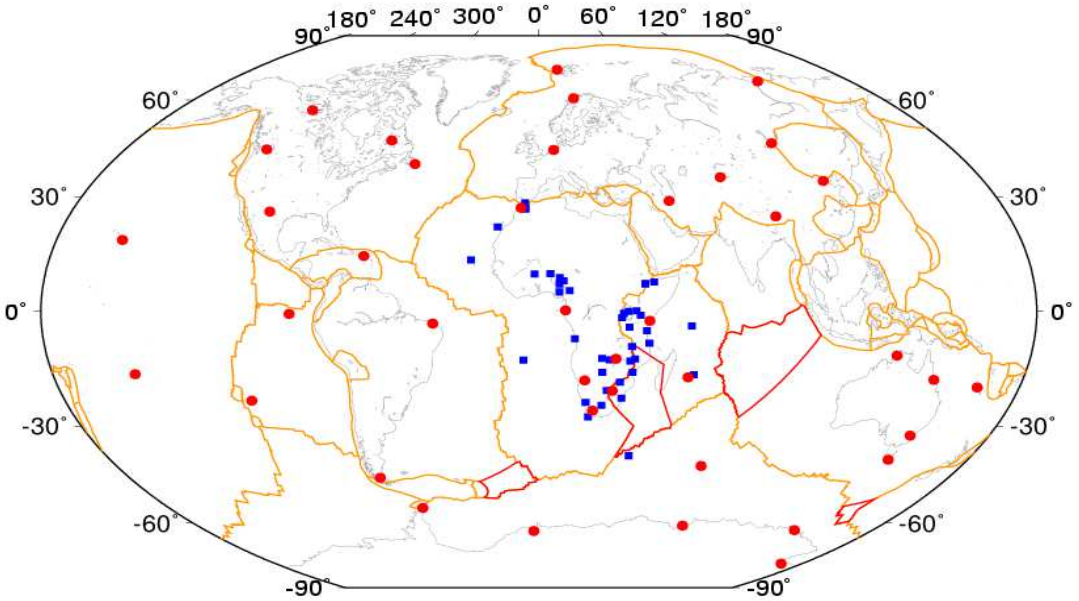


Benefits of a regional reference frame?

- A unified Geodetic Reference Frame for all countries of a given region
- Interoperability of geospatial data exchanges and of multi-lateral geodetic / geospatial projects.
- Learning /working together on how to (1) accurately analyze GNSS data, (2) determine geodetic parameters, (3) use GNSS data for scientific and societal applications
  - Need cooperation: data, analysis & combination centers
  - Need data sharing between countries
- Fully connected and consistent with the International Terrestrial Reference Frame (ITRF) ==> Interoperability
- Densification of and access to the ITRF using IGS products
- IGS products ==> universal access to the ITRF

How to connect a Regional / National Reference Frame to the ITRF?

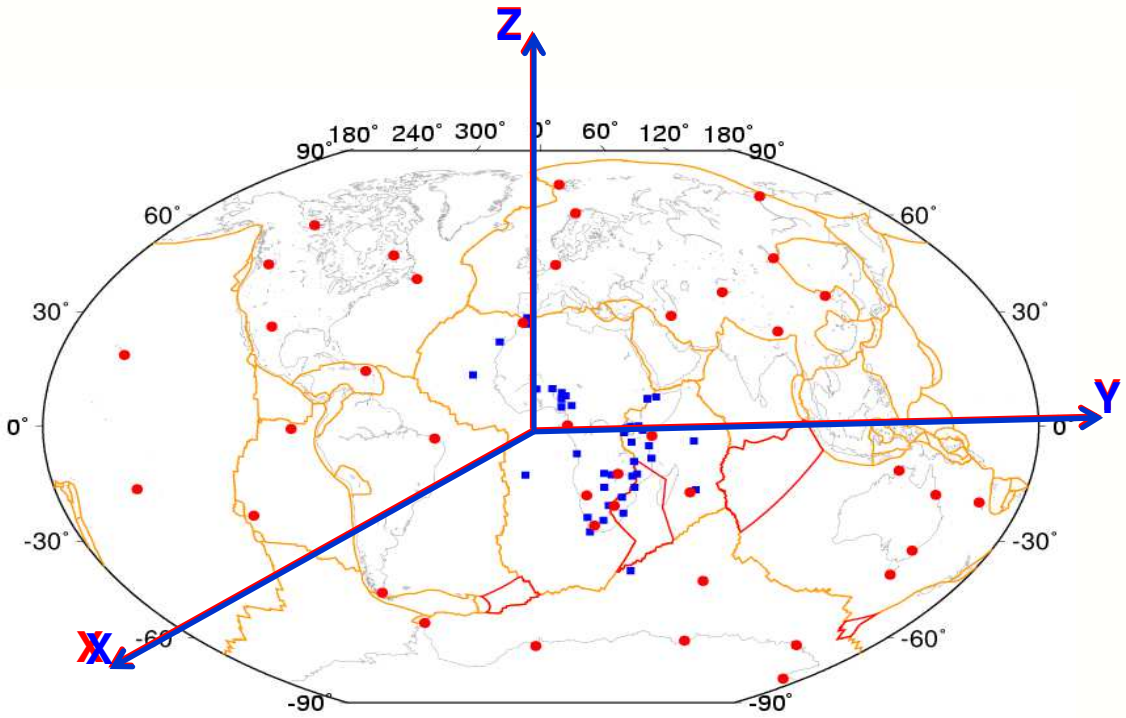
AFREF Example 2014



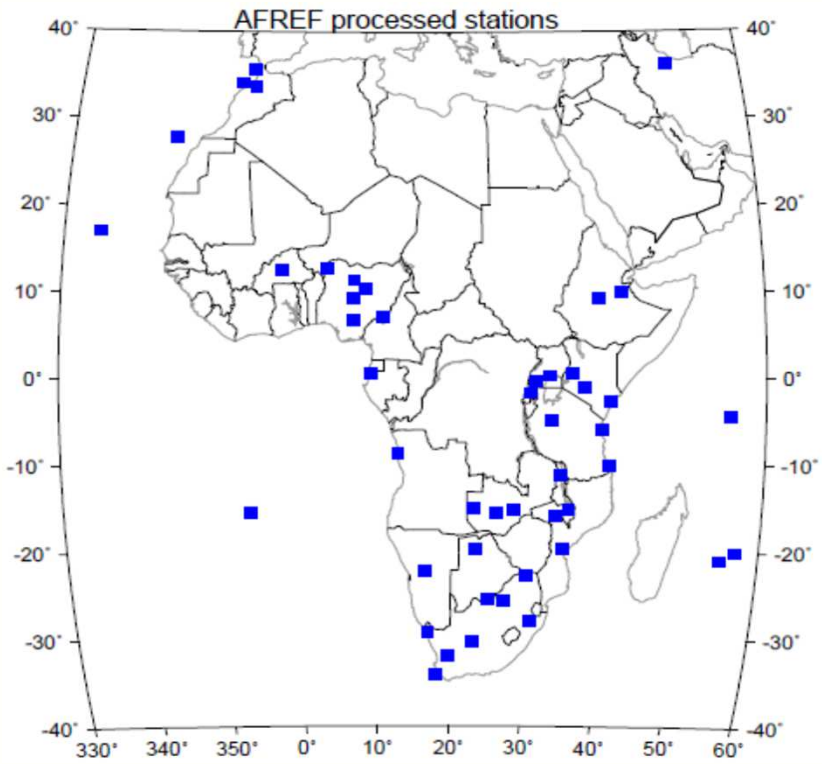
Distribution of processed sites:

- **Red : ITRF/IGS sites used in the alignment to ITRF**
- **Blue : African sites**

Alignment



AFREF sites processed

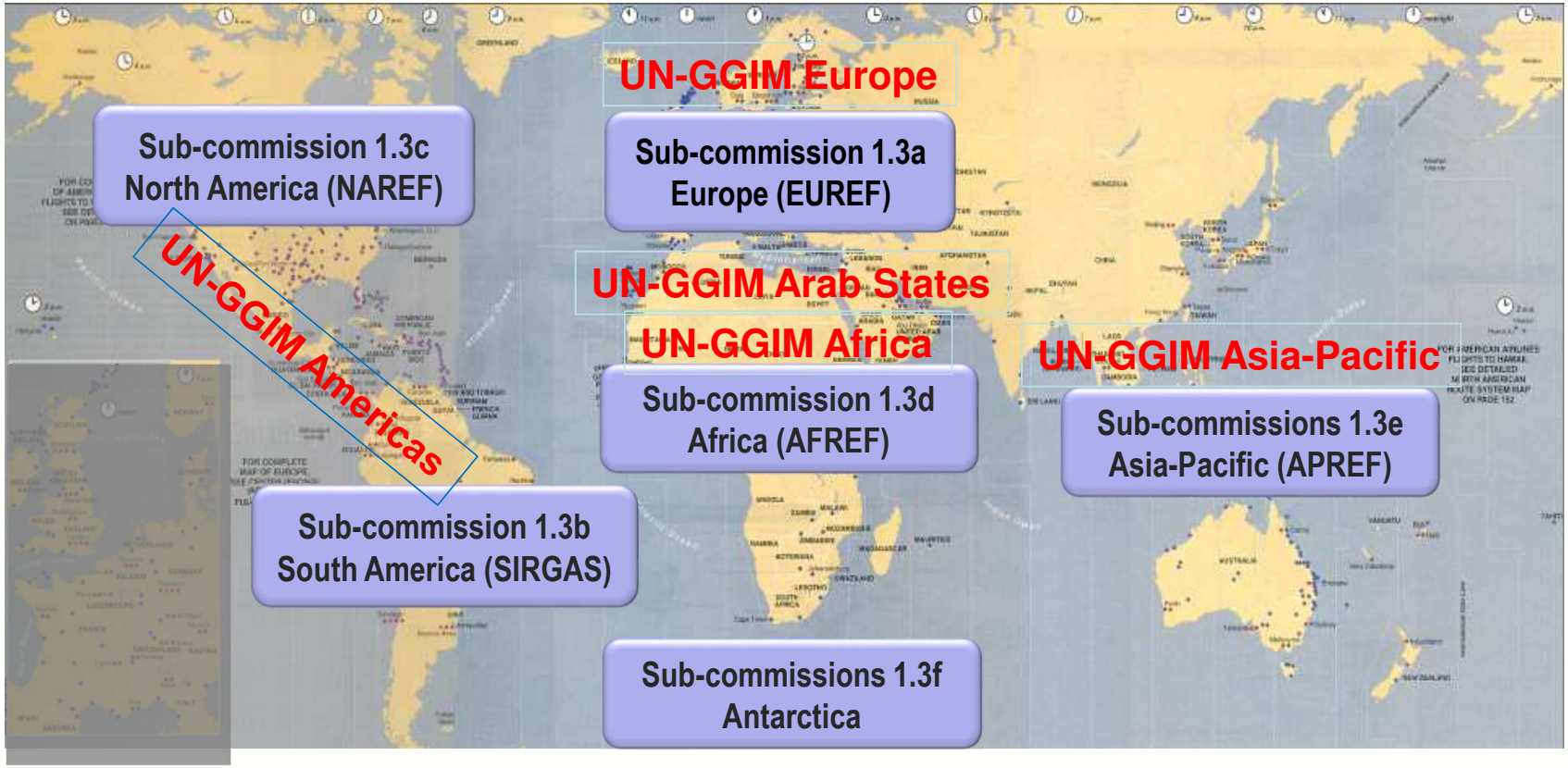


Distribution of AFREF sites processed. Note gap from Angola through Congo, Sudan and across North Africa.

IAG Sub-commission 1.3
Regional Reference Frames

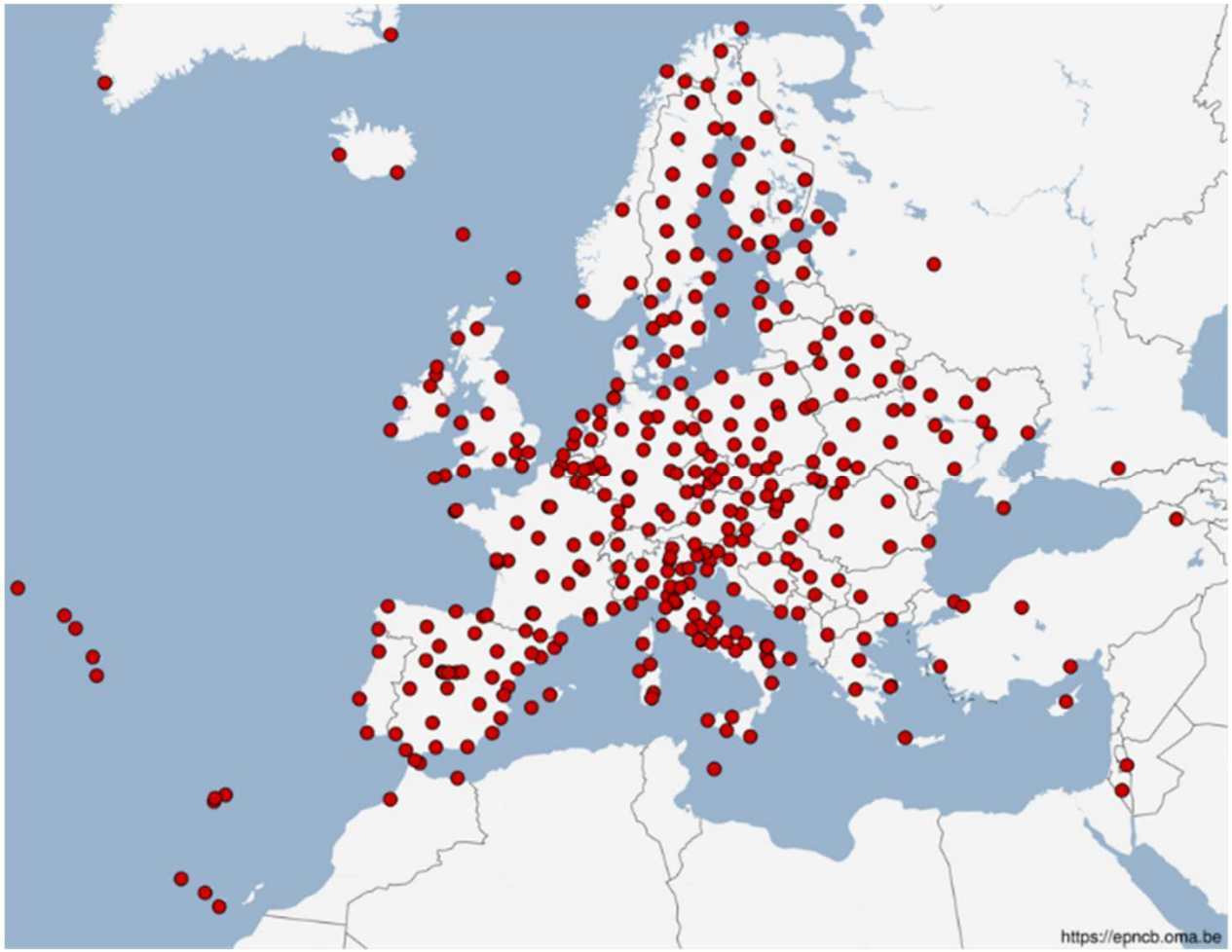
&

UN-GGIM regional committees



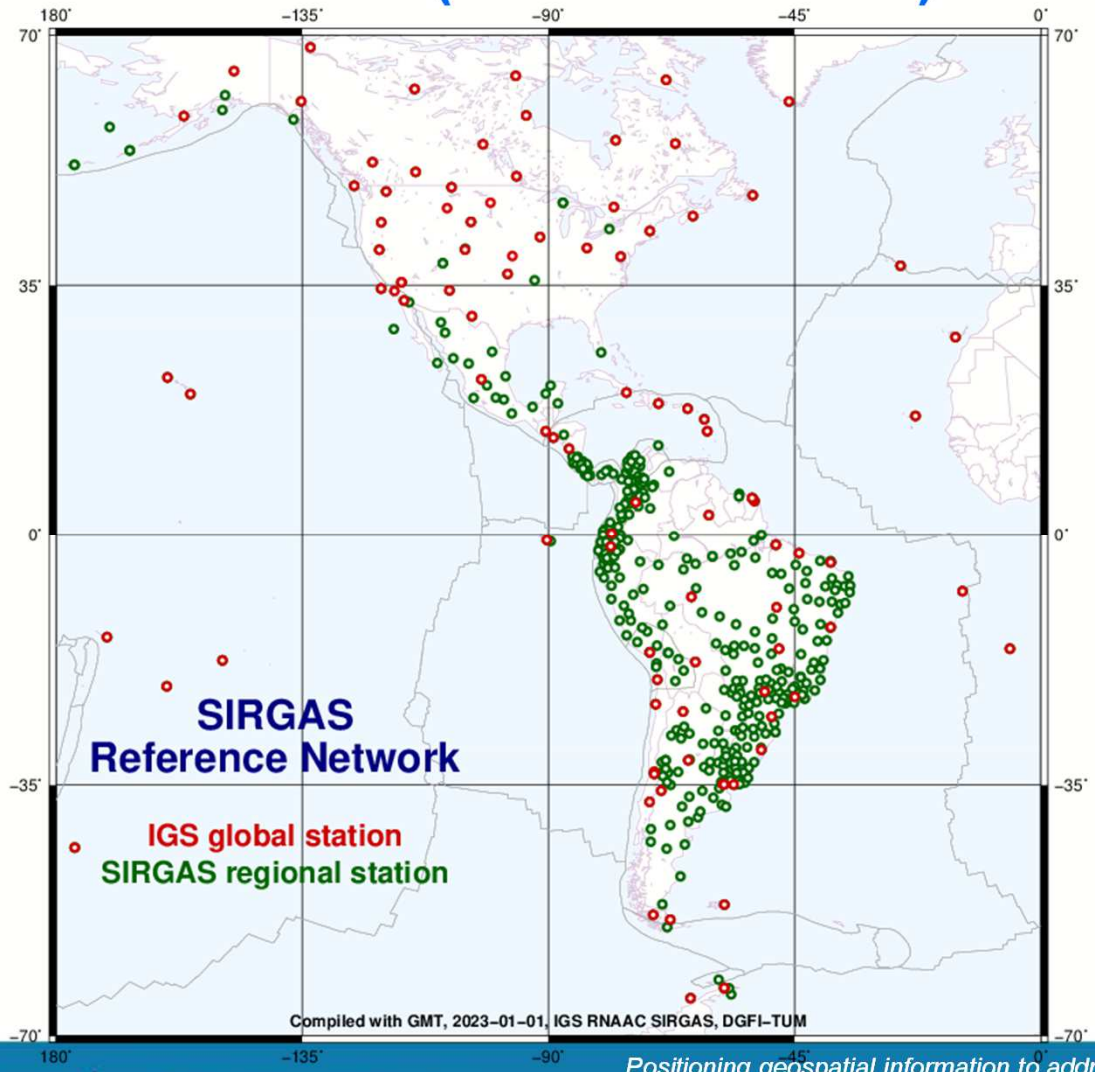
EUREF (European reference Frame)

- About 450 stations
- 16 Analysis centers



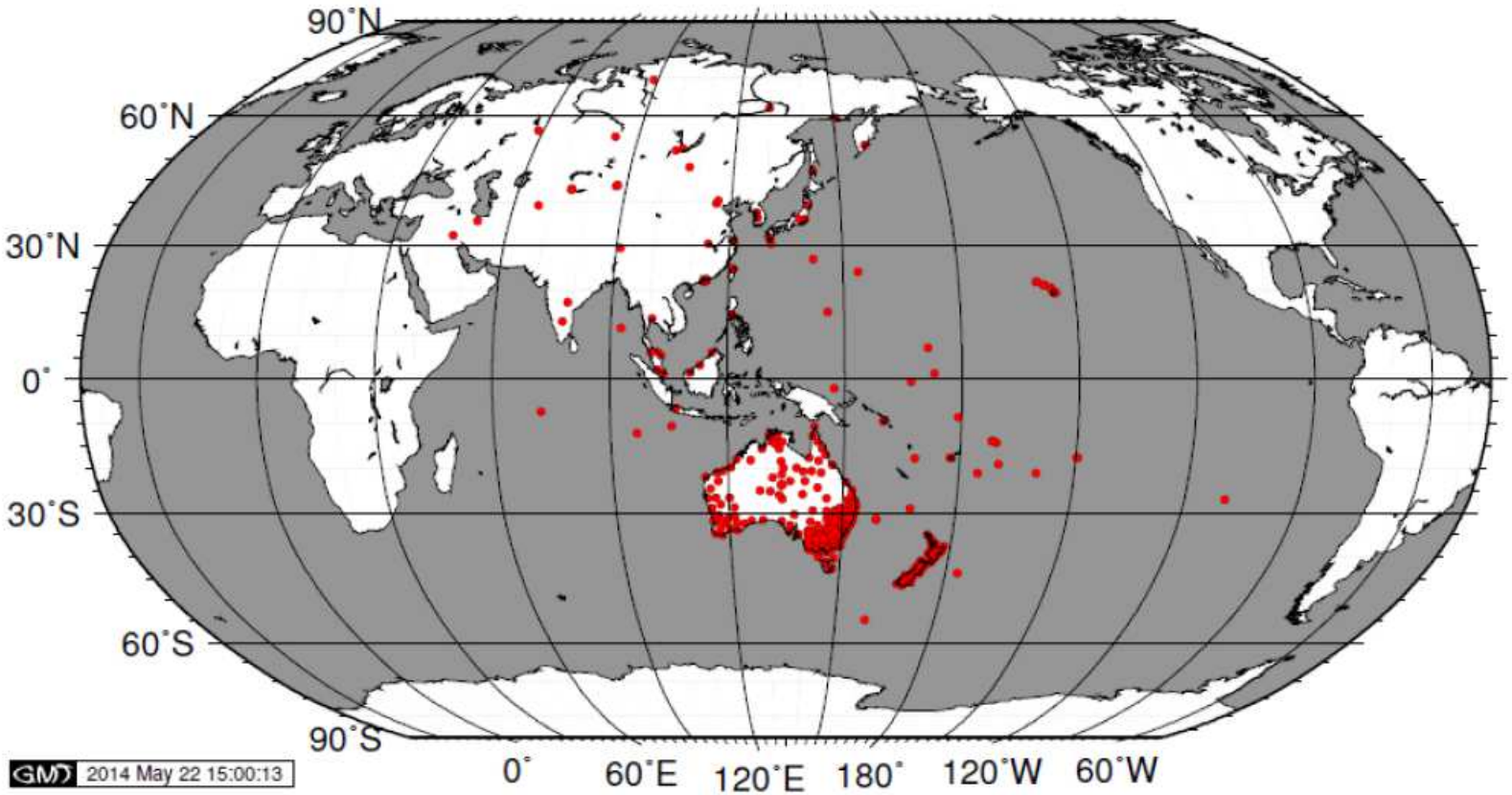
SIRGAS (South America)

- About 500 stations
- 8 Analysis centers



APREF (Asia Pacific Reference Frame)

- About 450 stations
- 3 Analysis centers



Summary

- The UN GA resolution on the GGRF calls for commitments by Member States to improving national geodetic infrastructure as a means to enhance the GGRF

- There are benefits for regional reference frames:
  - Densification & access to the ITRF
  - EUREF, NAREF, APREF, SIRGAS, Antarctica are working
  - AFREF & Arab States need to make progress

- National Reference Frames are needed for land administration and mapping applications: imposed by law / decree

- GNSS technology is the tool today for regional / nation RF implementation, but:
  - Need for IGS products
  - Need to ensure interoperability: fully connected /aligned to the ITRF
- There are still gaps in GNSS network to provide effective access to the ITRF