Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
Technische Universität München

Status of the SIRGAS reference frame: recent developments and new challenges

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REFAG2022: Reference frames for applications in Geosciences
Thessaloniki, Greece, October 17 - 20, 2022

Main objectives

1993
- To establish a geocentric reference frame as ITRF densification in South America
- To support the connection/transformation between the classical local geodetic datums and the geocentric datum

1997 → Geocentric Reference System for **South America**: SIRGAS95 [54 stations, ITRF94, 1995.4]

1998
- To connect the existing height systems to the ITRF
- To establish a unified height system in South America

2000
- To re-measure the 1995 reference network and to extend it to Central and North America

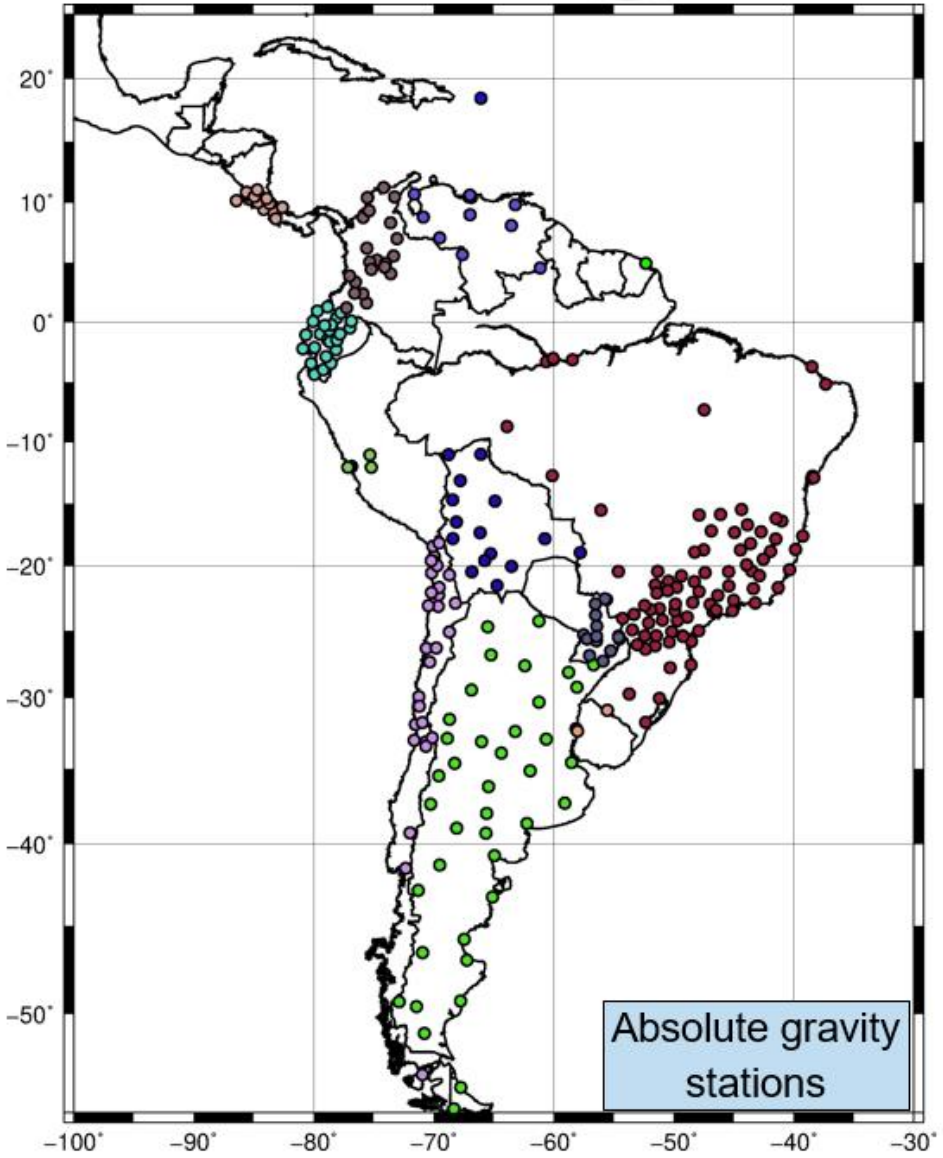
2001 → Geocentric Reference System for **the Americas**: SIRGAS2000 [184 stations, ITRF2000, 2000.4]

2019
- To establish a unified physical reference frame for gravimetry, physical heights, and geoid
- To support the activities of the *Working Group of the Geodetic Reference Framework for the Americas (GRFA)* of UN-GGIM-Americas

2020 → **Geodetic** Reference System for the Americas

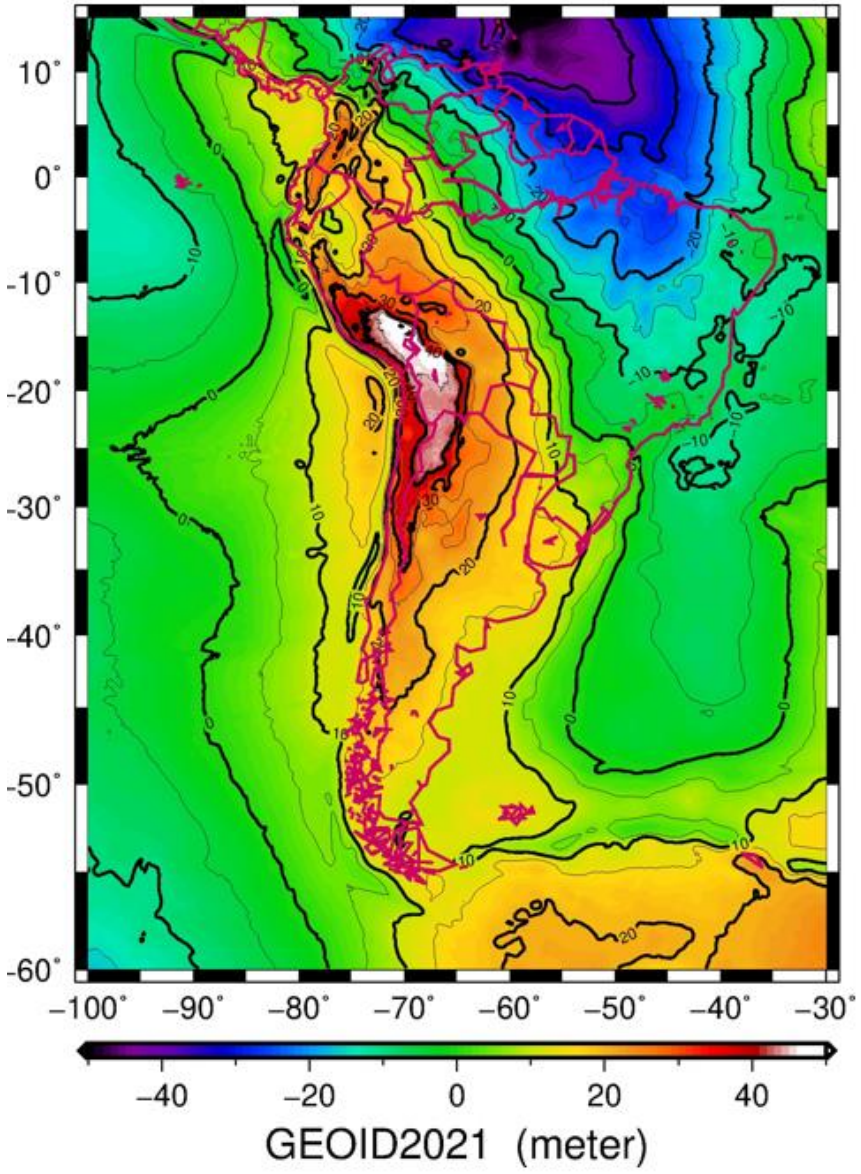
Physical reference frame: Gravimetry

- **Objective:** To provide a modern reference standard for terrestrial gravimetry
- **Goal**: To establish a regional reference network of absolute gravity stations (as a densification of the future *International Terrestrial Gravity Reference Frame – ITGRF*)
- **On-going activities**:
  - Quality evaluation of existing absolute gravity stations
  - Identification of regional gaps and establishment of new stations
- **Challenges**:
  - Deployment of continuous measuring gravimeters (continuous monitoring of reference stations)
  - Comparison/calibration of the different absolute gravimeters used in the region



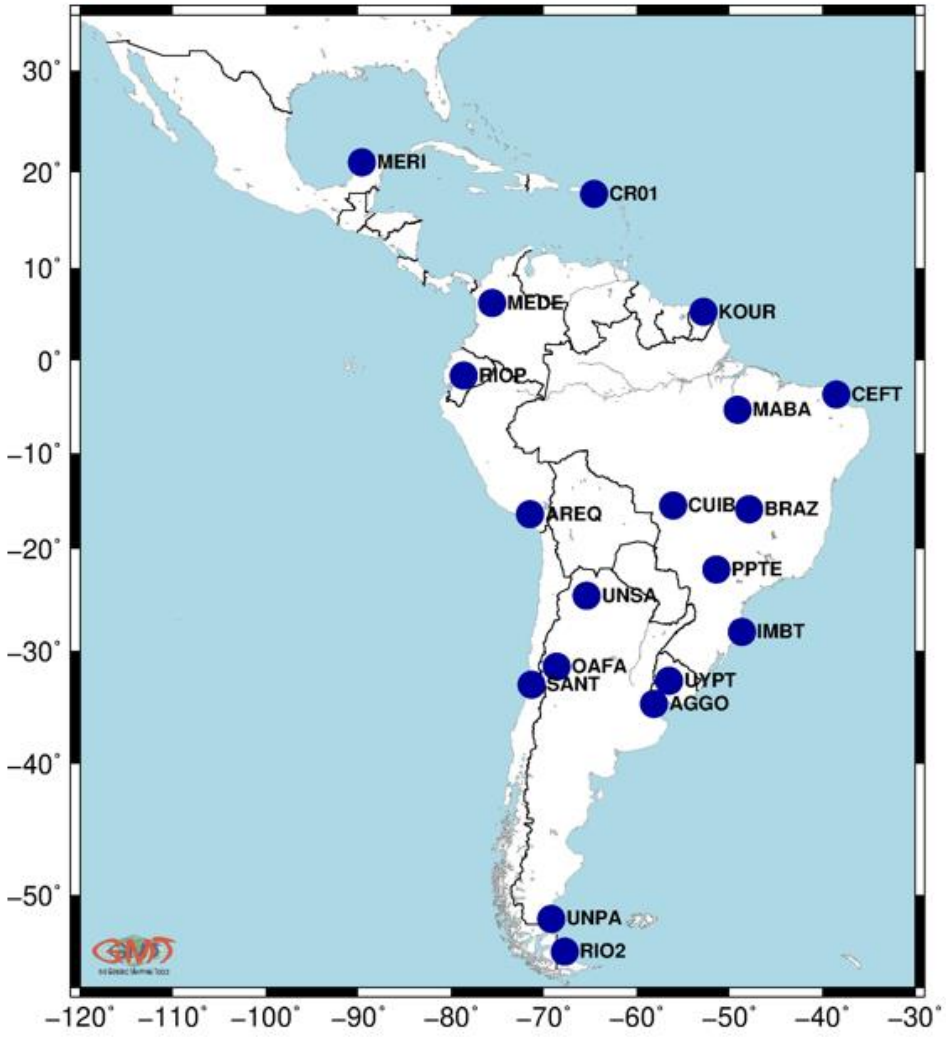
Physical reference frame: Geoid modelling

- **Objective:** To increase the accuracy of existing regional and national models and to promote the determination of national geoid models where they are missing
- **Goal**: To provide precise regional/national geoid models to support GNSS/levelling applications with high reliability
- **On-going activities**:
  - Comparison of existing national geoid models with the regional one
- **Challenges**:
  - To solve regional gravity data gaps
  - To identify sources of discrepancy between different geoid models
  - Quality assessment of geoid models



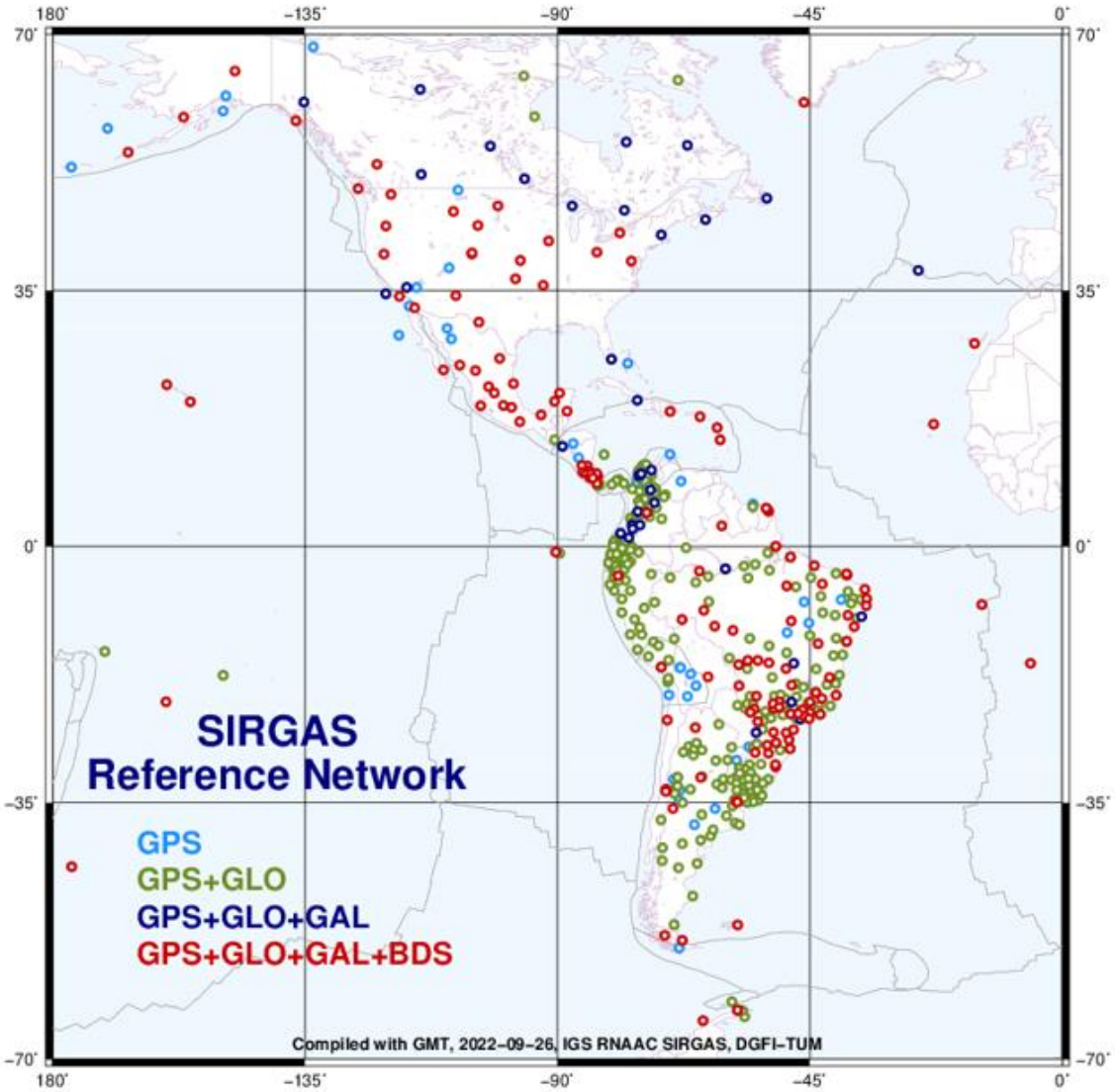
Physical reference frame: Physical heights

- **Objective:** To provide a reference standard for the precise determination of physical heights
- **Goal**: To establish a regional densification of the global *International Height Reference Frame - IHRF*
- **On-going activities**:
  - Determination of potential coordinates at the Latin American IHRF stations
  - Selection of stations for national IHRF densifications
- **Challenges**:
  - Evaluation of discrepancies between different computation methods
  - Quality assessment in the determination of potential values

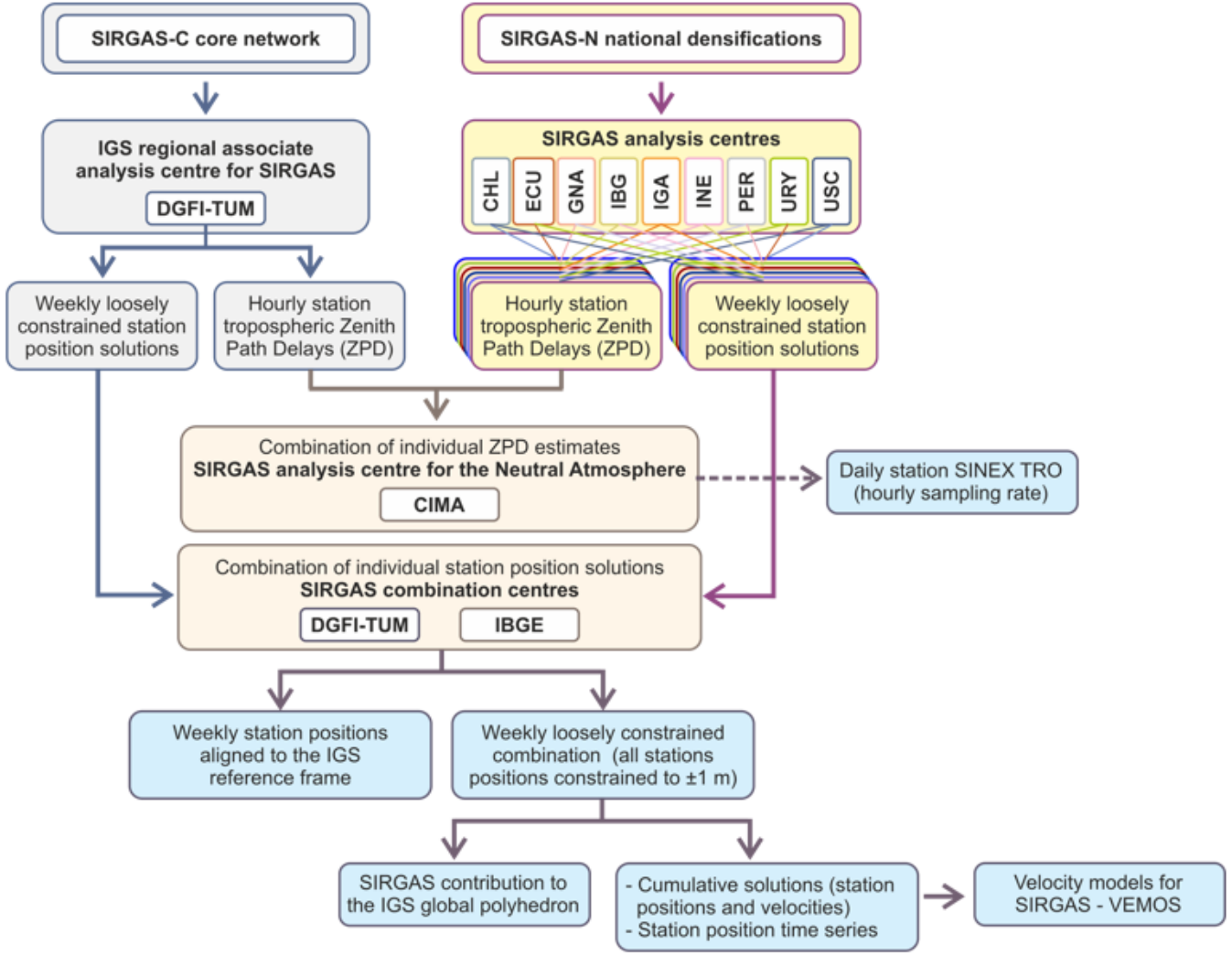


Geocentric Reference Frame: Reference Network

- 493 stations (169 decommissioned)
  - 109 IGS stations
  - 384 regional stations
  - All tracking GPS
  - 440 tracking GLO
  - 194 tracking GAL
  - 151 tracking BDS

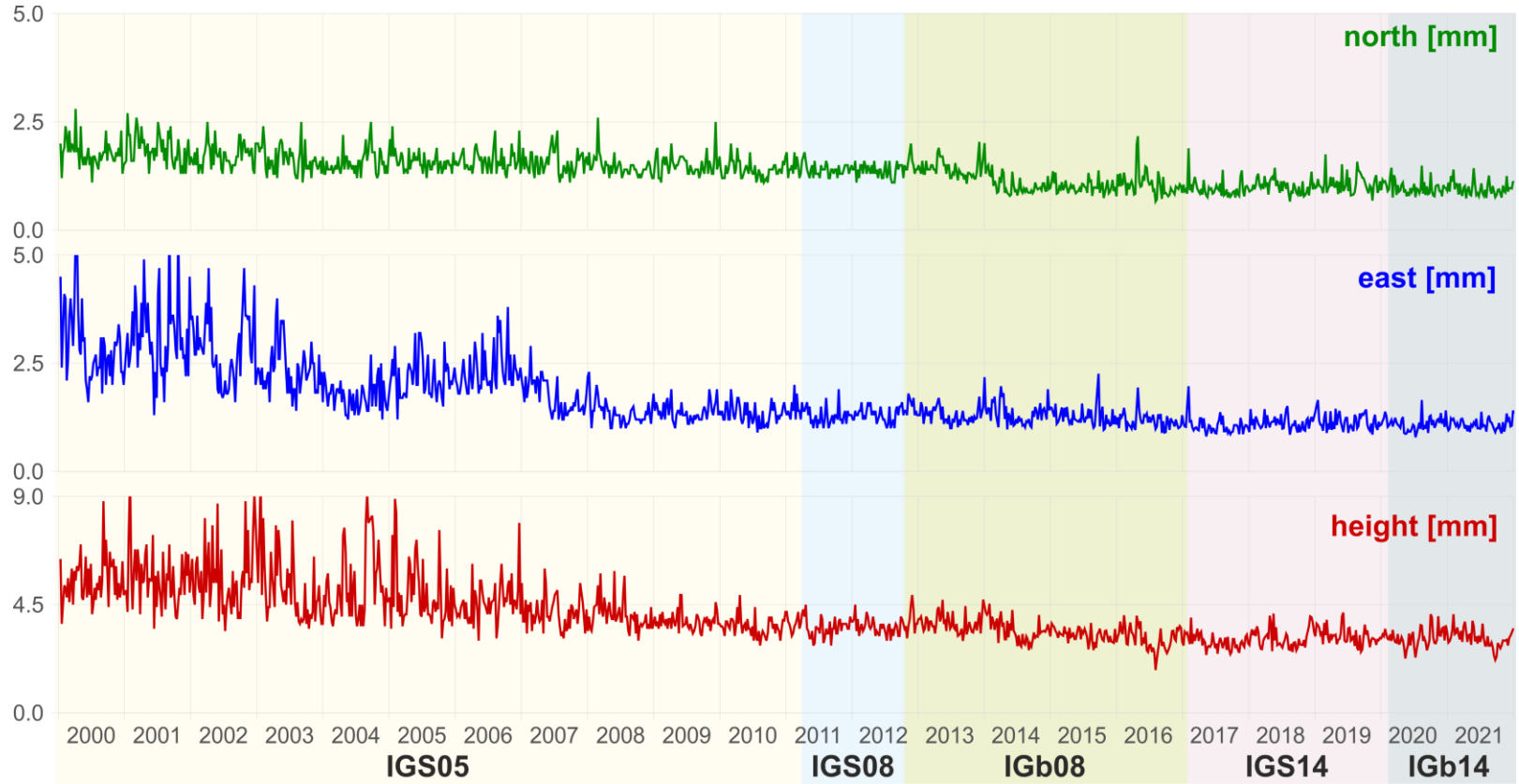


Geocentric Reference Frame: Analysis and products



- Analysis
  - Ten GNSS analysis centres
  - Two GNSS combination centres
  - One analysis centre for the Neutral Atmosphere
- Products
  - Combined tropospheric Zenith Path Delays (hourly sampling rate)
  - Weekly station positions aligned to the IGS reference frame
  - Cumulative solutions (station velocities, time series, post-seismic functions)
  - Velocity models VEMOS

Geocentric Reference Frame: Analysis and products



- Weekly station position repeatability in operational SIRGAS analysis
  - IGS05:

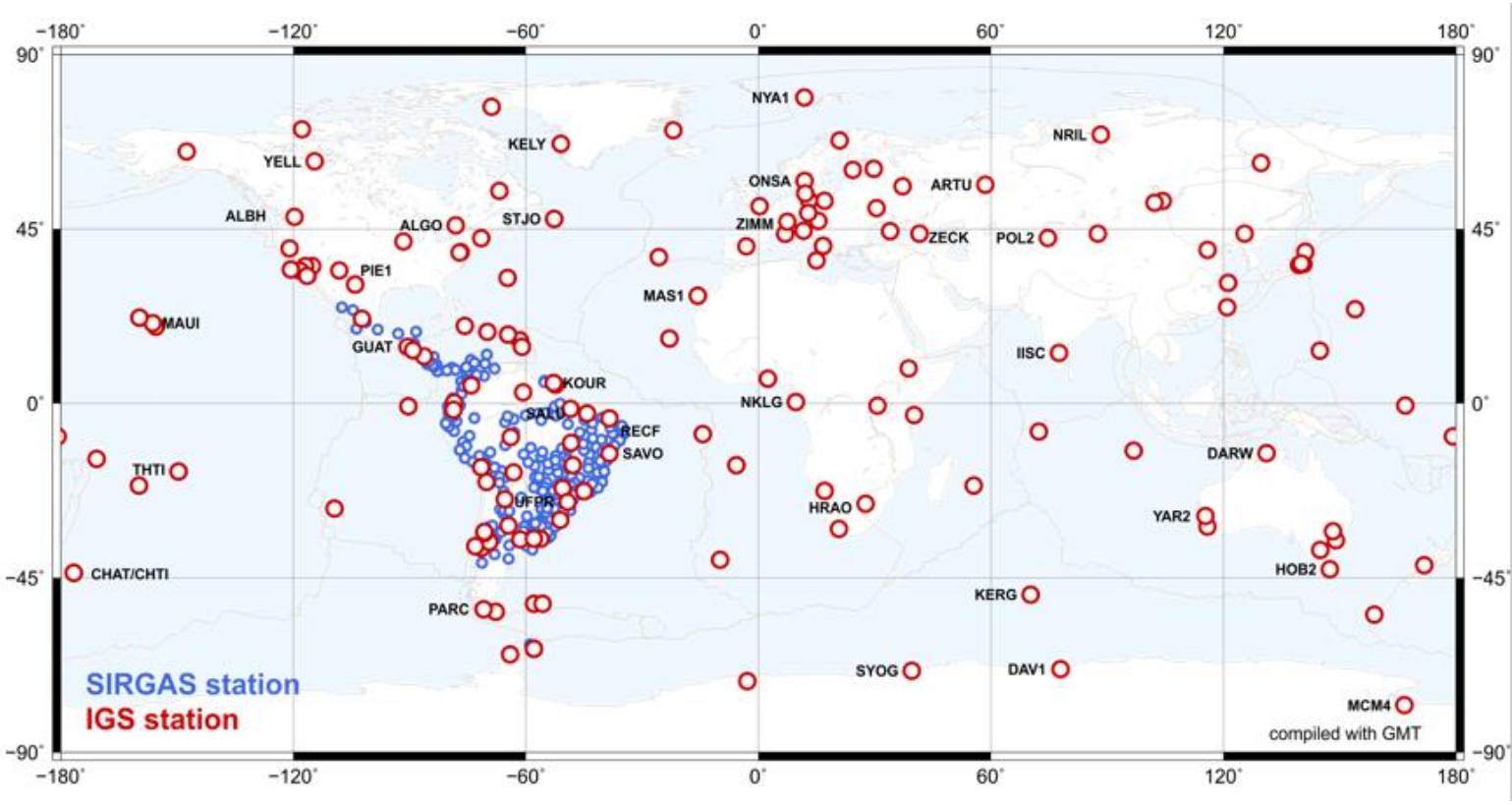
    N/E: ±2.8 mm, h: ±6.0 mm
  - IGS08/IGb08:

    N/E: ±1.8 mm, h : 3.5 mm
  - IGS14/IGb14:

    N/E: ±0.8 mm, h: ±2.6 mm

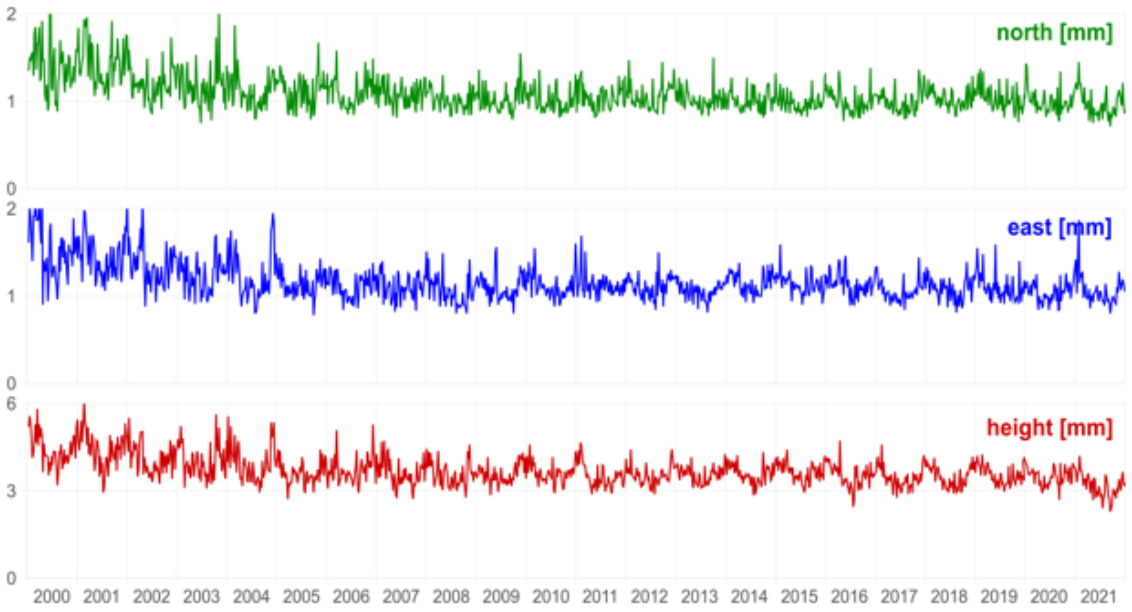
Geocentric Reference Frame: Second SIRGAS reprocessing

- Reanalysis of the historical SIRGAS GNSS data using a unified set of newest standards and conventions over the complete time span
- Reprocessing of SIRGAS data from January 2000 to December 2021
- 537 SIRGAS regional stations plus 128 IGS global stations (88 of them belonging to the IGS14/IGb14 reference frame)
- 2.6 million daily RINEX files processed
- IGS14/IGb14 reference frame: IGS and IG2 products (satellite orbits and clocks, EOPs) and phase centre variation model

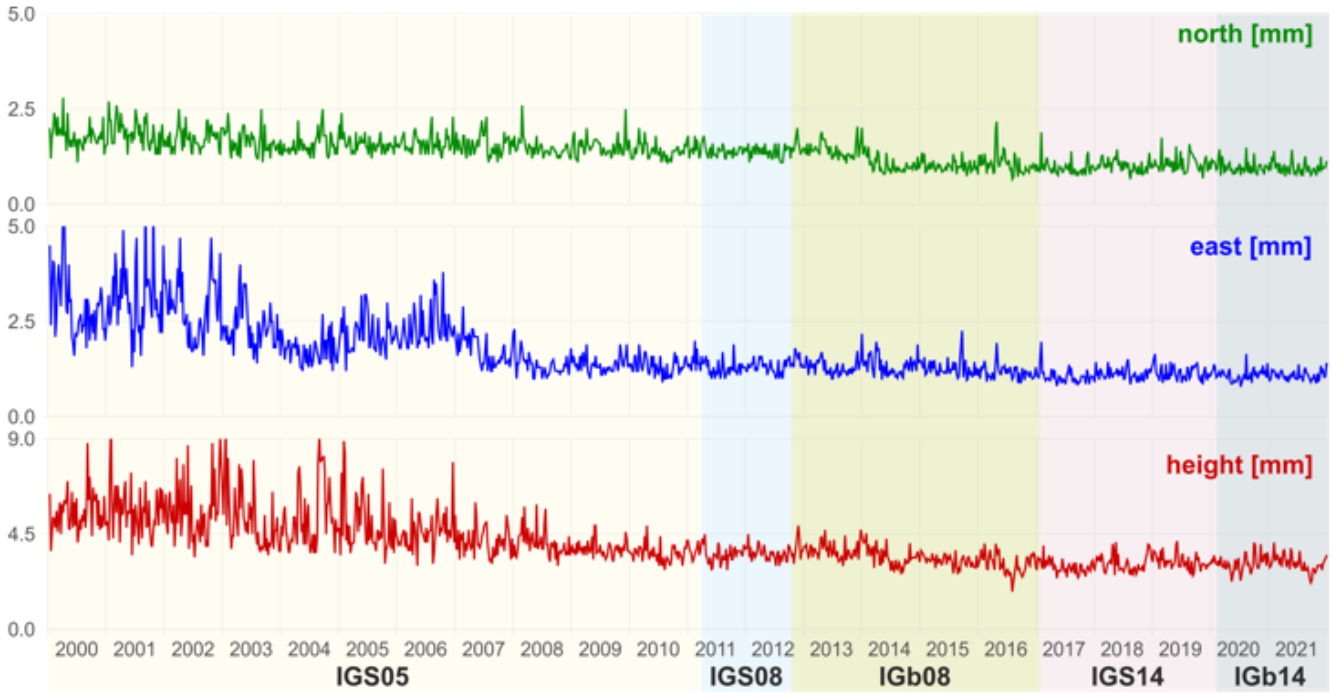


Geocentric Reference Frame: Second SIRGAS reprocessing

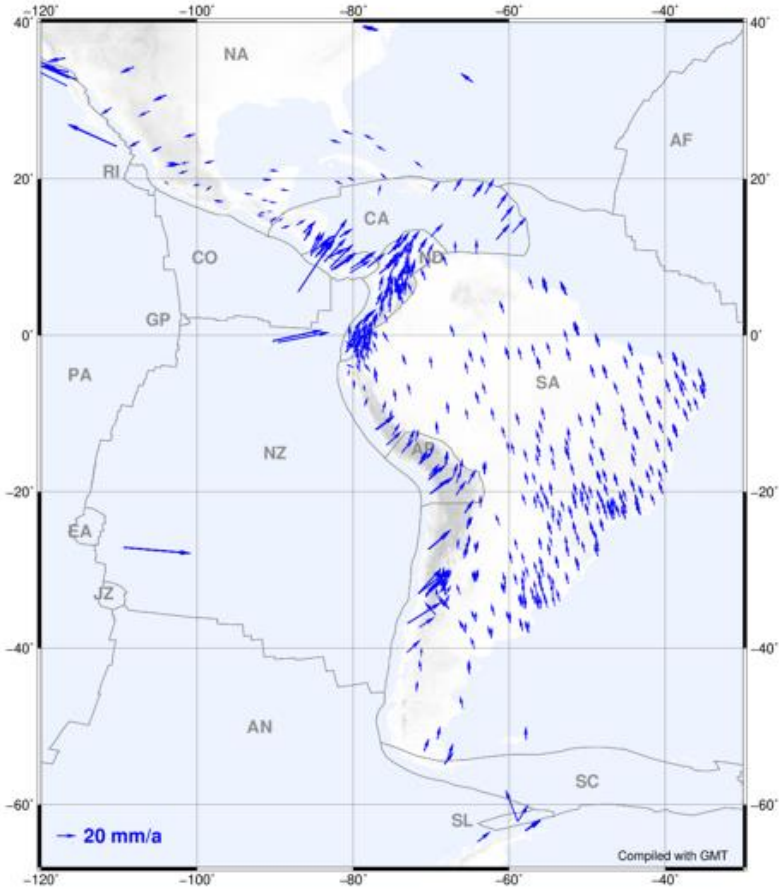
Weekly station position repeatability in SIRGAS-Repro2

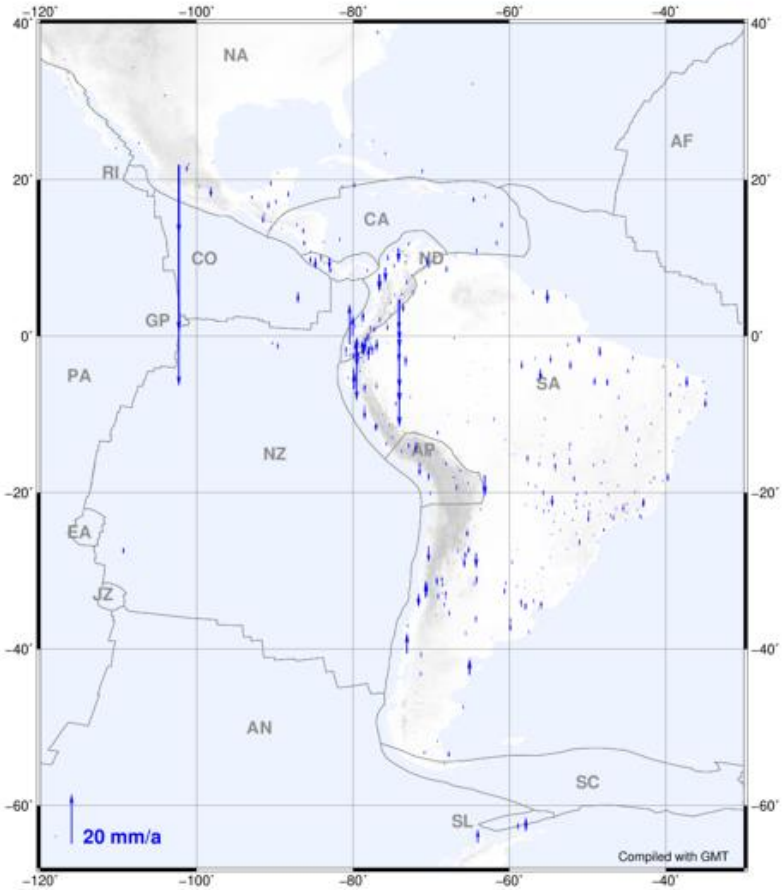


Weekly station position repeatability in SIRGAS operational



Geocentric Reference Frame: SIRGAS2022

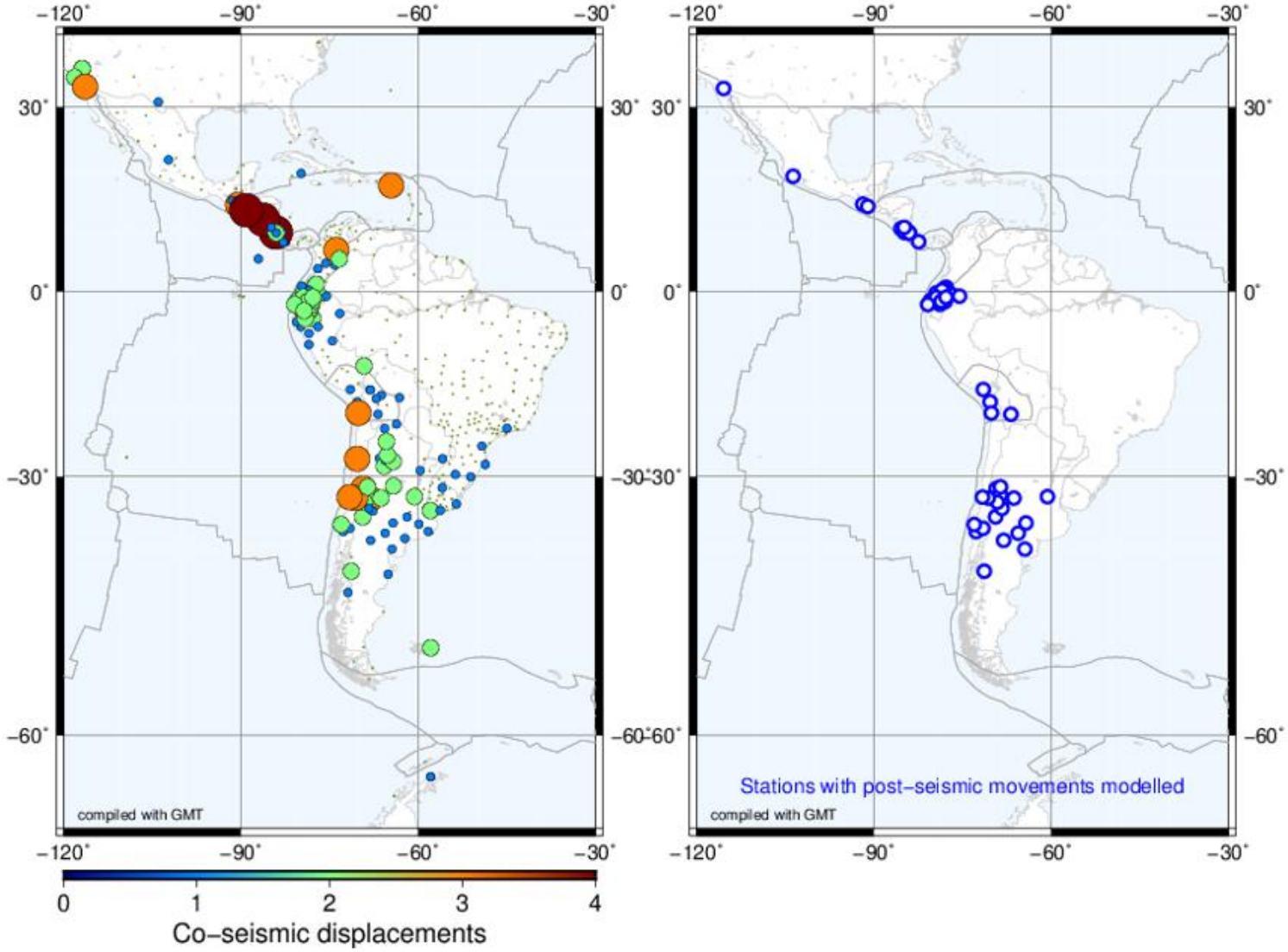




- Newest reference frame solution
- From Jan 2000 to April 2022 (update every 6 months)
- SIRGAS-Repro2 in IGb14 (Jan 2000 – Dec 2021) + operational SIRGAS solutions in IGb14 (since Jan 2022)
- 587 stations with 1389 occupations
- IGb14, 2015.0

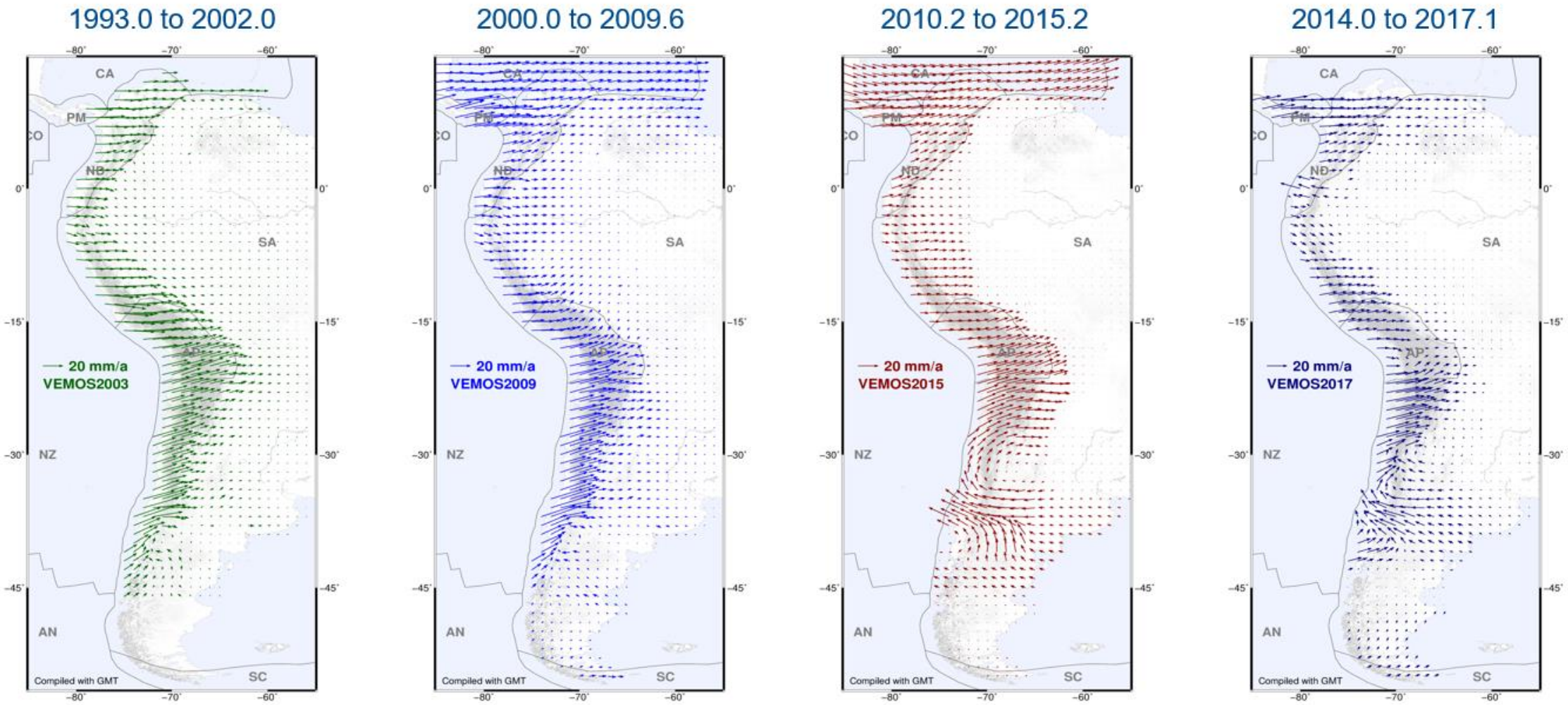
- Accuracy
  - Positions at reference epoch: N/E: ±0.8 mm, h : ±1.4 mm
  - Velocities: N/E: ±0.6 mm/year, h: ±1.0 mm/year

Present challenge: handling of co- and post-seismic effects



- SIRGAS2022
  - 21% of the discontinuities correspond to co-seismic displacements
  - 62 post-seismic functions

Velocity model for SIRGAS: VEMOS (relative to South American plate)



Organisational infrastructure

SIRGAS
sirgas.ipgh.org

Extern

UN-GGIM:Américas
Geodetic Reference Framework for the Americas (GRFA) Working Group

IUGG
IAG/AIG International Association of Geodesy
SC 1.3b: Reference frames, South and Central America
SC 2.4b: Gravity and Geoid in South America

Instituto Panamericano de Geografia e Historia - OEA -
Working group of the Cartography Commission

SIRGAS
sirgas.ipgh.org

Intern

Directing Council
- IAG
- PAIGH
- 22 member countries
- Observers

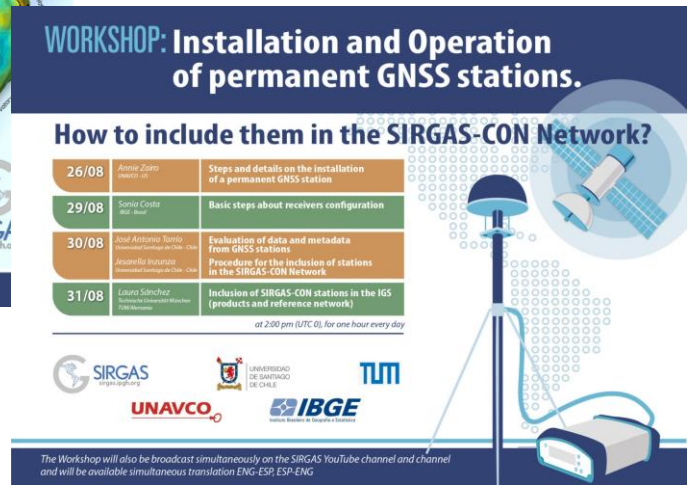
Scientific council

Executive Committee
- President (S. Costa, Brazil)
- Vice-president (F. Arpe, Argentina)
- Three working groups
  - ***Geometric reference frame*** (J. Tarrío, Chile)
  - ***Physical reference frame*** (G. Guaimarães, Brazil)
  - ***National duties*** (D. Gómez, USA)

Recent training and capacity building

Frequent *on-line* workshops, webinars

- 6 in 2020
- 4 in 2021
- 10 in 2022



Back to face-to-face…

Determination of precise geodetic reference frames using the scientific software for GNSS processing GAMIT-GLOBK, Costa Rica, July 2022

Acknowledgements

The SIRGAS activities are possible thanks to the active support of more than two hundred colleagues contributing to the working groups, to capacity building activities, operating GNSS stations, operating SIRGAS Analysis Centres, … This support and that provided by the International Association of Geodesy (IAG) and the Pan-American Institute for Geography and History (PAIGH) to the geodetic reference activities in the SIRGAS region are highly appreciated.

More details at

https://sirgas.ipgh.org/

Social Media : *@SirgasAmericas*

SIRGAS 2022 Symposium
https://sirgas.ipgh.org/simposio/en/home-2/
Santiago de Chile, November 7 to 9, 2022