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


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


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


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

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

**IUGG**
SC 1.3b: Reference frames, South and Central America
SC 2.4b: Gravity and Geoid in South America

**Working group of the Cartography Commission**

**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. Tarrio, 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

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More details at

https://sirgas.ipgh.org/

Social Media : @SirgasAmericas

SIRGAS 2022 Symposium
Santiago de Chile, November 7 to 9, 2022