IGS 2026 WORKSHOP
SANTIAGO DE CHILE
33°26' S 70°39' O

1-5 June 2026

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IGS and SIRGAS: 30+ Years of GNSS Geodesy in the Americas

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ORGANIZING INSTITUTIONS
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FACULTAD DE INGENIERÍA
DEPARTAMENTO DE INGENIERÍA GEOESPACIAL Y AMBIENTAL
PROCESSING CENTER AND GEODETIC ANALYSIS USC
IGM

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- Conclusions

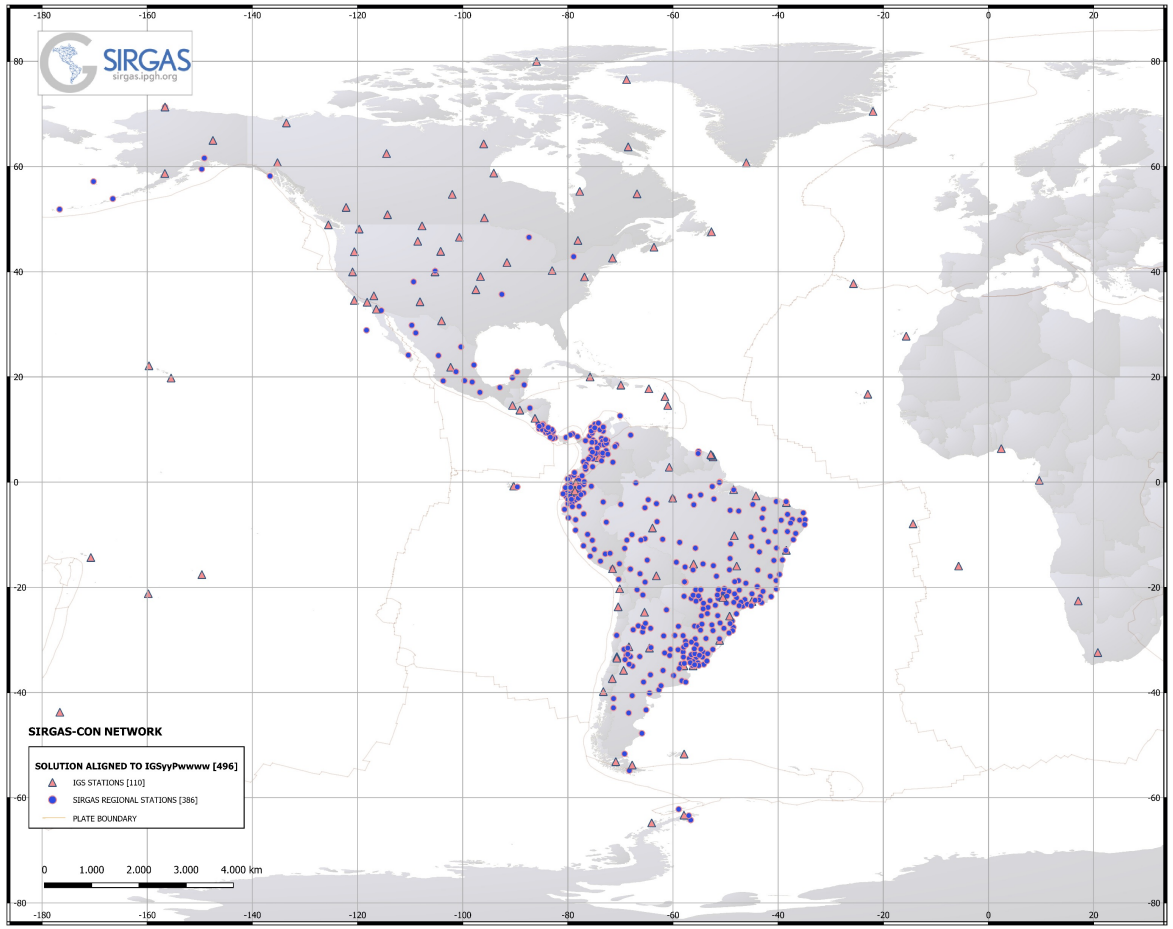
History and Organization of SIRGAS

What is SIRGAS?

SIRGAS (Geodetic Reference System for the Americas) constitutes the regional densification of the ITRF in Latin America and the Caribbean, implementing the ITRS in the Americas through a continental network of GNSS stations and geodetic products compatible with IERS and IGS standards.

It provides:

- Geocentric reference frame
- Unified vertical system
- Continental GNSS infrastructure
- Regional geodetic products

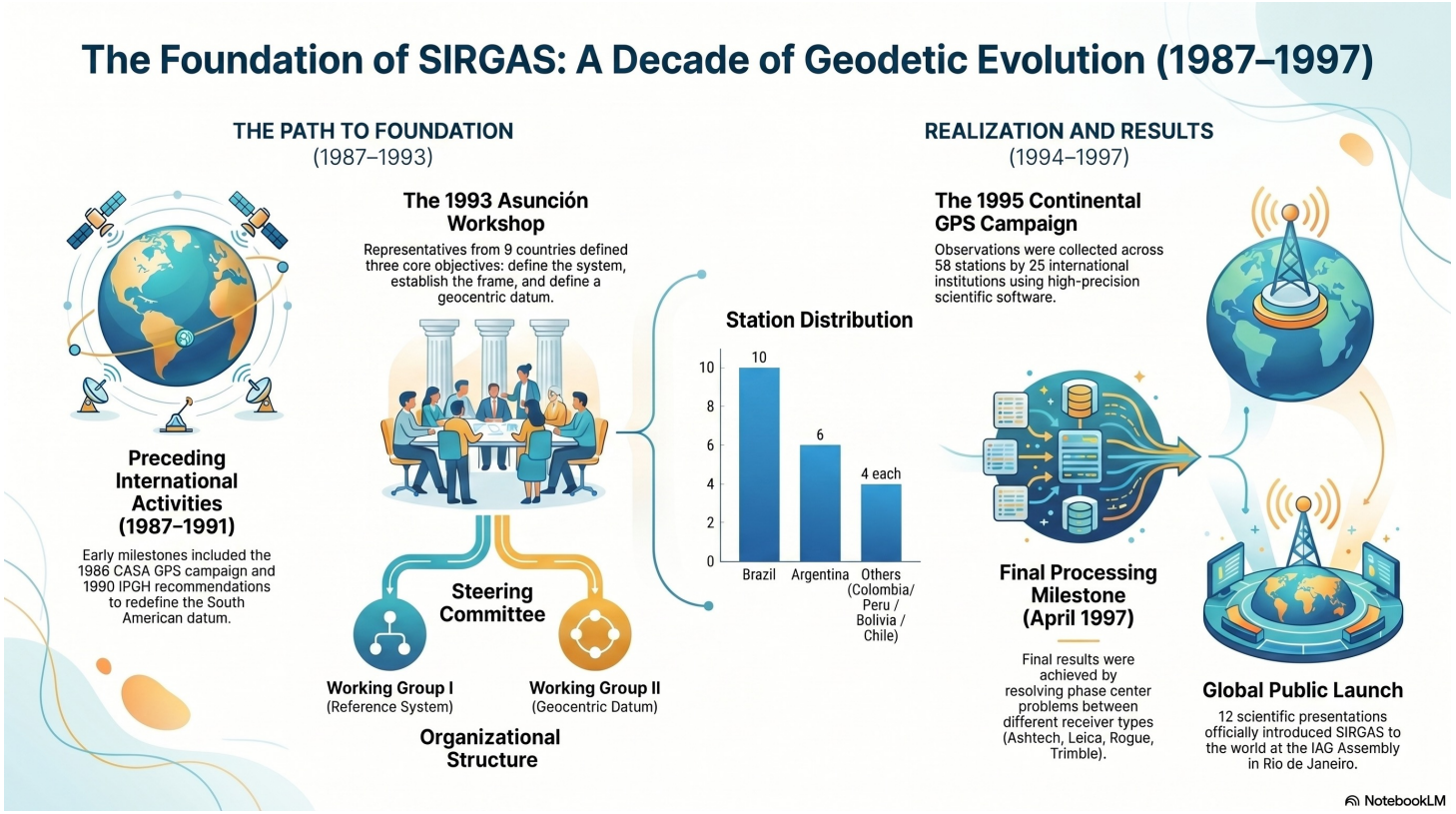


History and Organization of SIRGAS

It was founded in 1993 during the International Conference for the Definition of a South American Geocentric Reference System in Asunción, Paraguay, with the aim of modernizing national geodetic systems or classic South American datums.

The initiative was promoted by:

- International Association of Geodesy
- Pan American Institute of Geography and History
- National Geospatial-Intelligence Agency (NGA).

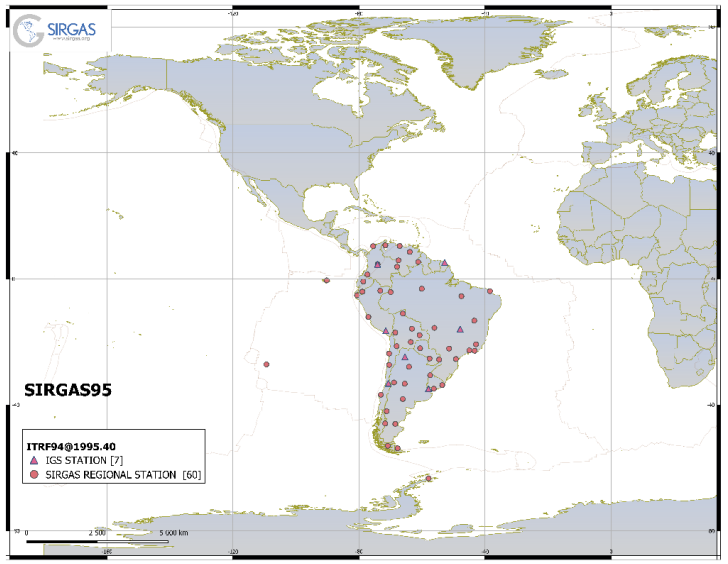


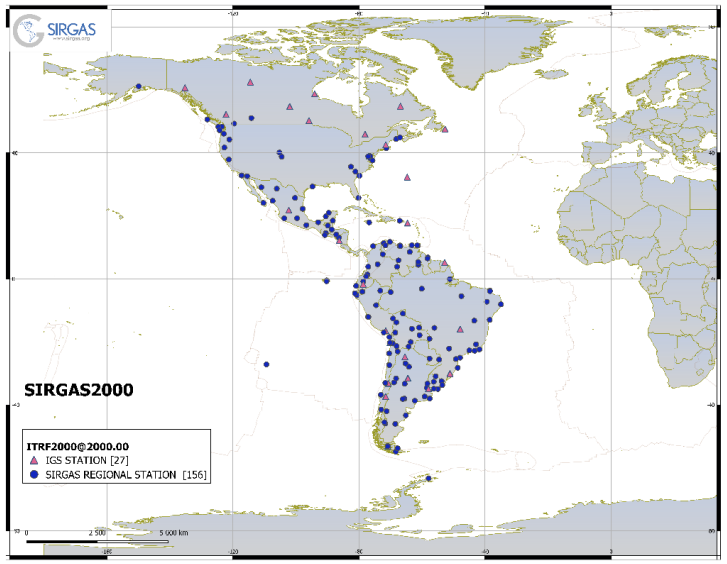
History and Organization of SIRGAS

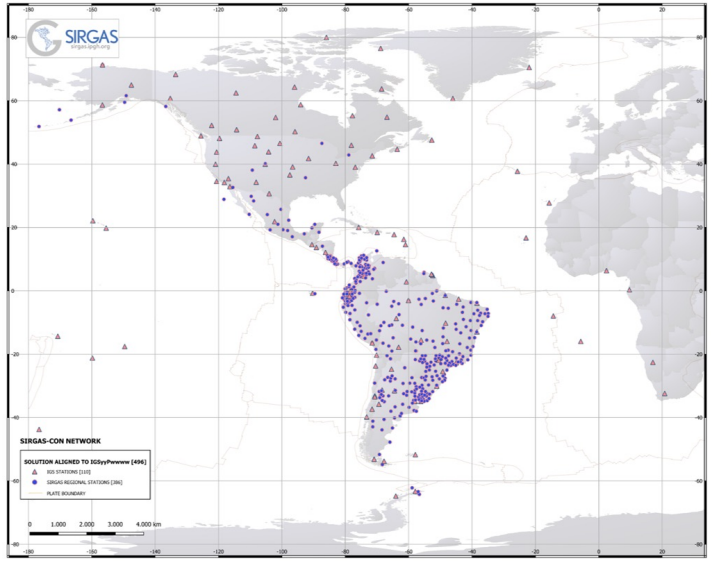
It began as an initiative based on continental GPS campaigns aimed at establishing a geocentric frame compatible with the ITRF.

The first implementation, SIRGAS95, consisted of 58 GPS stations distributed throughout South America and aligned with ITRF94 epoch 1995.4. Subsequently, the SIRGAS2000 realization incorporated 184 GNSS stations referenced to ITRF2000, consolidating the transition to a modern continental frame.

The most significant development occurred with the creation of SIRGAS-CON, an operational infrastructure based on continuous GNSS stations and permanent scientific processing.

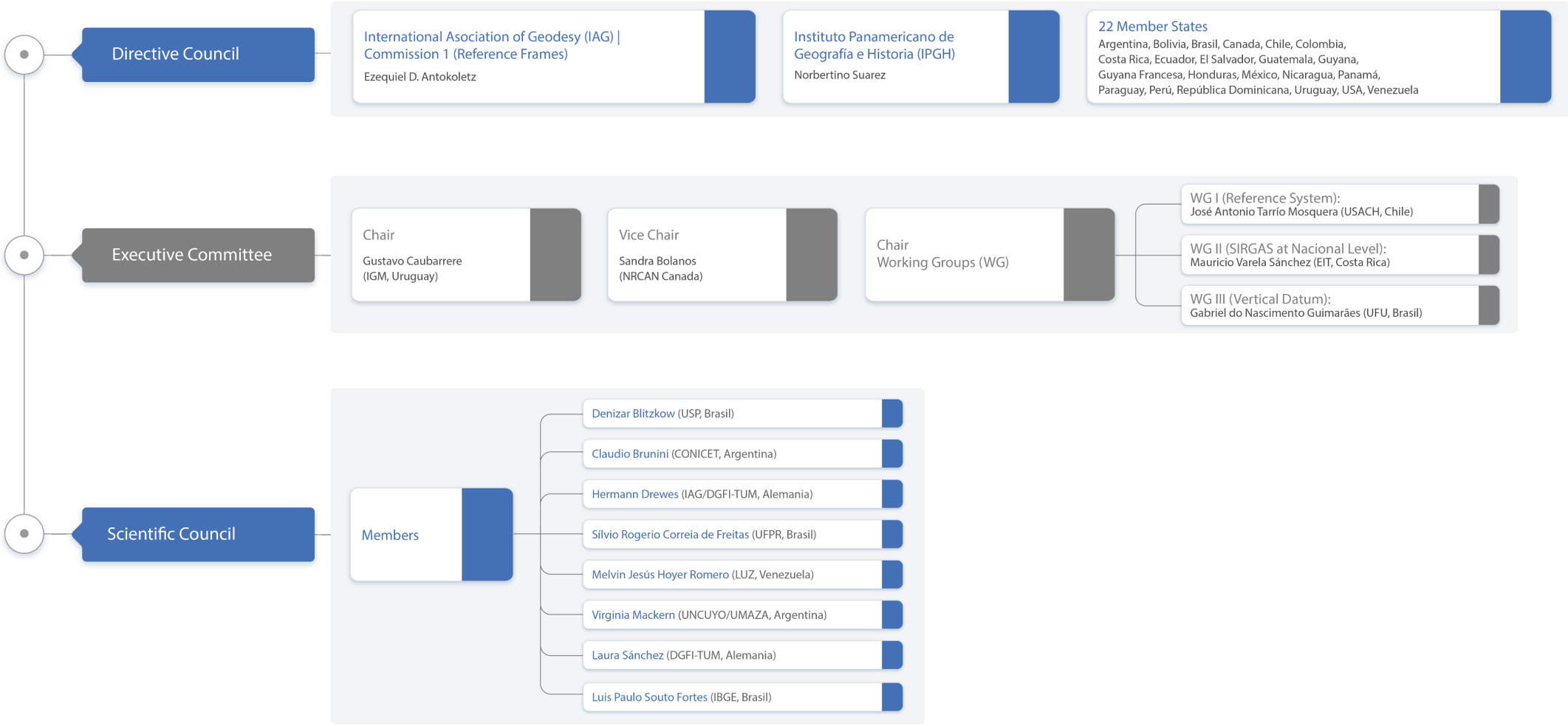






History and Organization of SIRGAS

General Organization:



SIRGAS Working Groups and Its Relationship with IGS

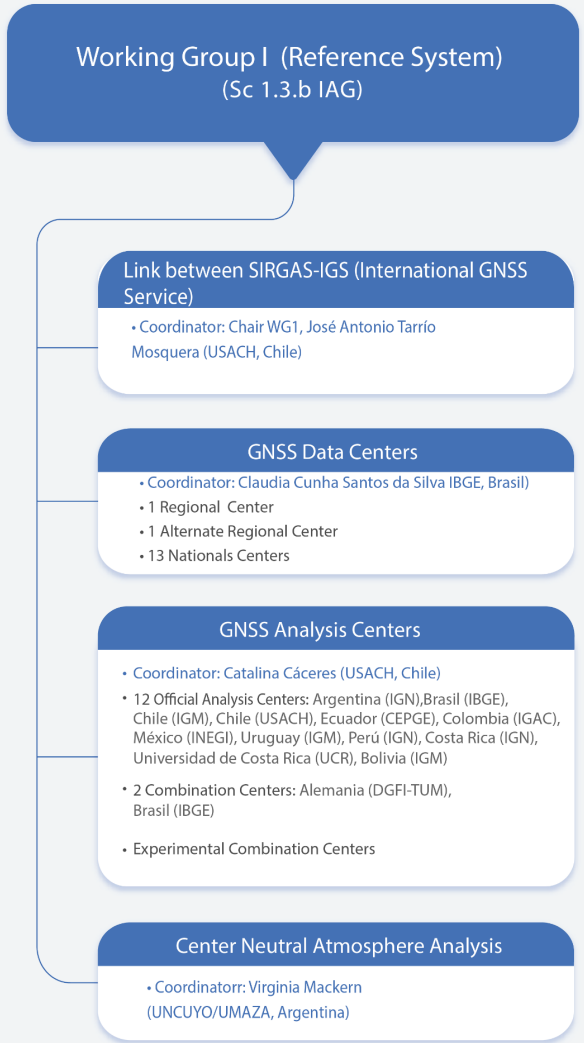
WGI is the Working Group responsible for SIRGAS-CON and is composed of:

- 13 Data Centers
- 12 Processing Centers
- 1 Neutral Atmosphere Analysis Center
- 1 Subgroup Real-Time

The working group is coordinated by:

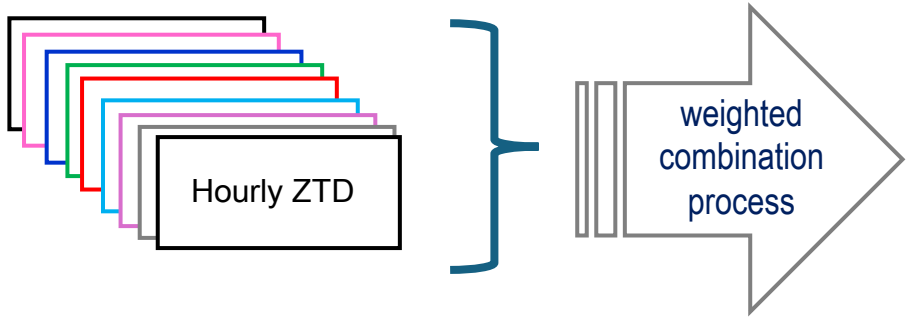
- Chair
- Network Coordinator
- Analysis Coordinator

Working Group I (WGI) is responsible for coordinating the activities required to establish, maintain, and monitor the SIRGAS reference frame through the management of the SIRGAS-CON network. Its main objective is to ensure the long-term stability and homogeneous quality of the network by overseeing station operation and applying standardized high-quality GNSS processing procedures consistent with international conventions.



SIRGAS Working Groups and Its Relationship with IGS

CIMA (Mendoza Engineering Center, Argentina) serves as the SIRGAS Neutral Atmosphere Analysis Center and is responsible for generating regional tropospheric products derived from GNSS processing. It has been an official part of the SIRGAS operational structure since November 2019.



Hourly ZTD ; σ_{ZTD}

From 200 stations in 2014 to 420 in 2025

12 years (2014-2025)

Internal precision of SIRGAS final ZTDs 1mm

Mackern M.V et al. (2020). doi: 10.1007/1345_2020_121

Filter applied

until July 2022, σ_{ZTD} < 2 cm **(1st combination)**

since August 2022 σ_{ZTD} < 1 cm

24 ZTDs per day, per station

10 SIRGAS Analysis Centres (9 ACs from 2025)

Filter applied σ_{ZTD} < 1 cm in all American stations available **(2nd combination)**

NEW Re-combination 10 years (2014-2024)

Its objective within SIRGAS is to generate high-quality atmospheric products for:

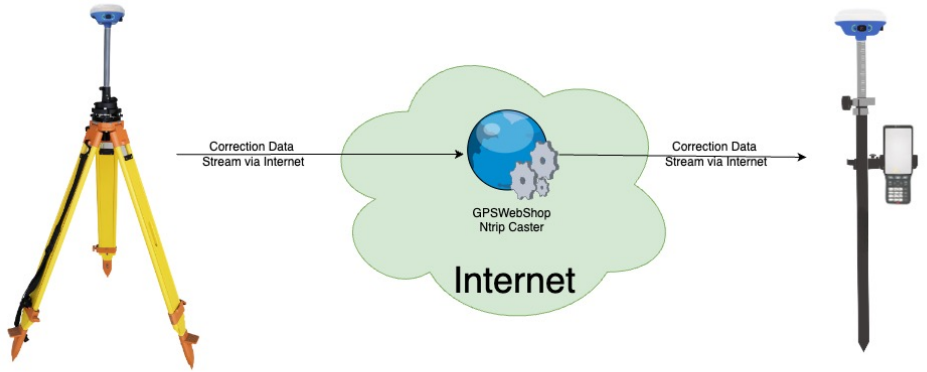
- Monitoring atmospheric water vapor.
- Meteorological and climate studies.
- Improving regional tropospheric models.
- Supporting geodetic and geodynamic research.
- Integrating GNSS observations into atmospheric applications.

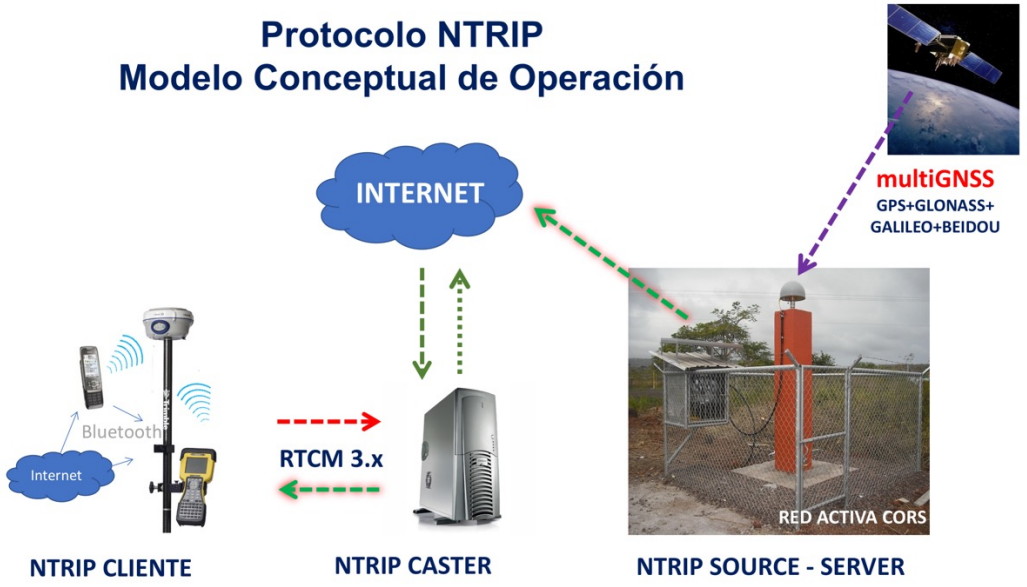
SIRGAS Working Groups and Its Relationship with IGS

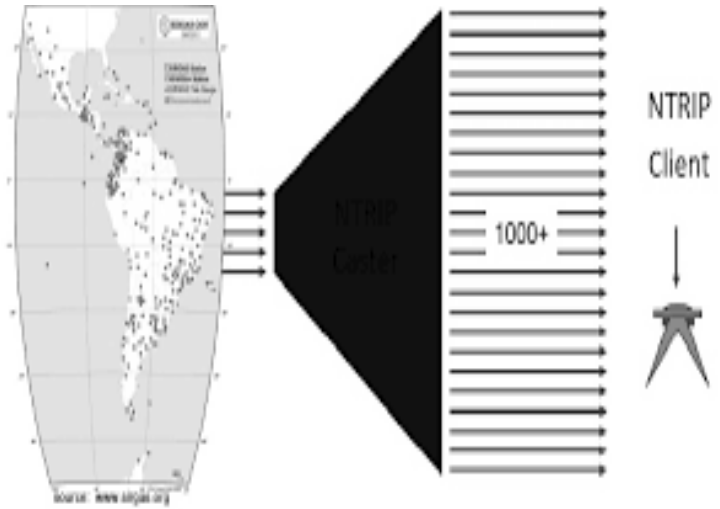
Real Time

Defined in the resolutions of the SIRGAS 2024 symposium as a subgroup within WG1.

Responsible for the SIRGAS Real-Time Experimental Caster.



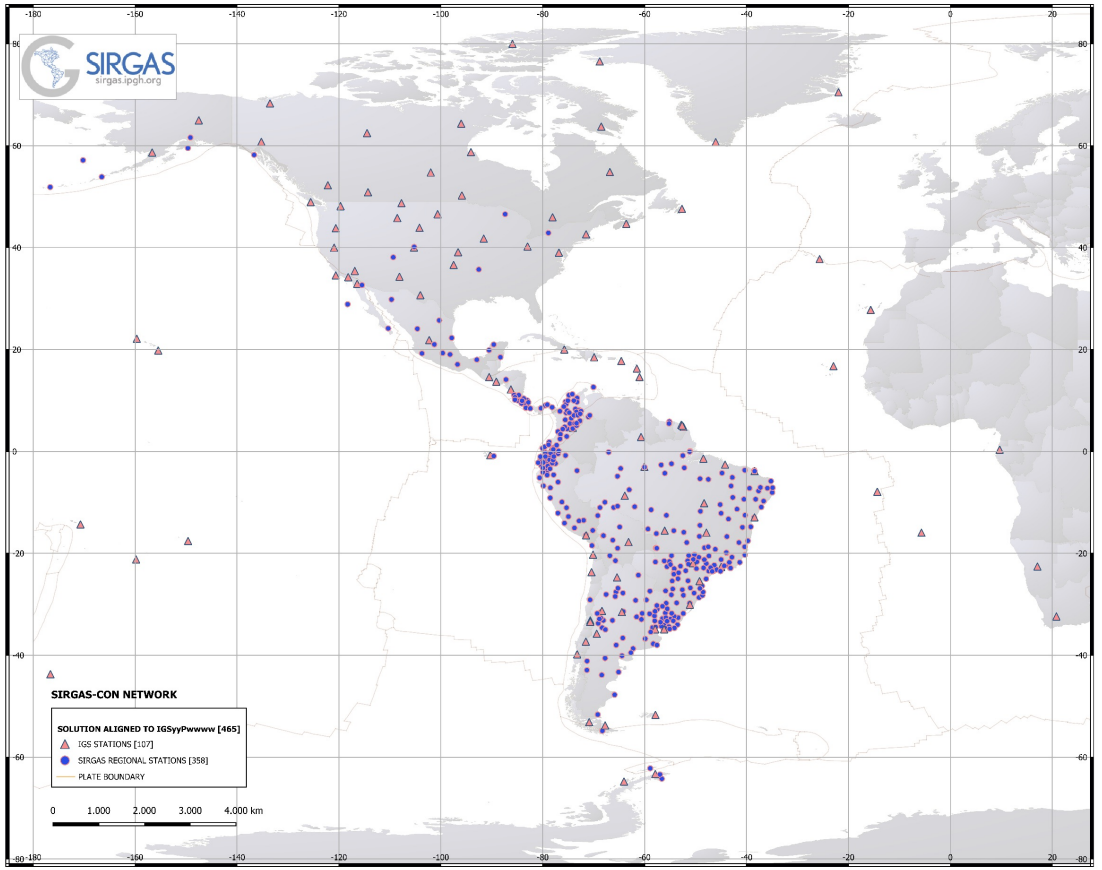




SIRGAS Working Groups and Its Relationship with IGS

SIRGAS-CON

- It is the geodetic network that densifies the **ITRF** (International Terrestrial Reference Frame) in **Latin America and the Caribbean**.
- It is currently (since April) composed of **475** continuously operating GNSS stations but the target is to have ≈500.
- The network is analyzed on a weekly basis, considering **GPS+GLONASS+Galileo** observations.
- Working Group I (Reference System) ensures the proper **operation of the network**, from the acquisition of observations to the generation of products.



Global SIRGAS-CON Stations

→110 (part of the IGS network)

Regional SIRGAS-CON Stations

→Correspond to national reference frames

SIRGAS Working Groups and Its Relationship with IGS

- SIRGAS-CON stations are operated by a wide range of academic, research, and governmental institutions, which are organized into:

Operating Centers

→ currently, about 274 operators

National Data Centers

Regional Data Center

→DGFI-TUM[1]

Alternate Regional Data Center

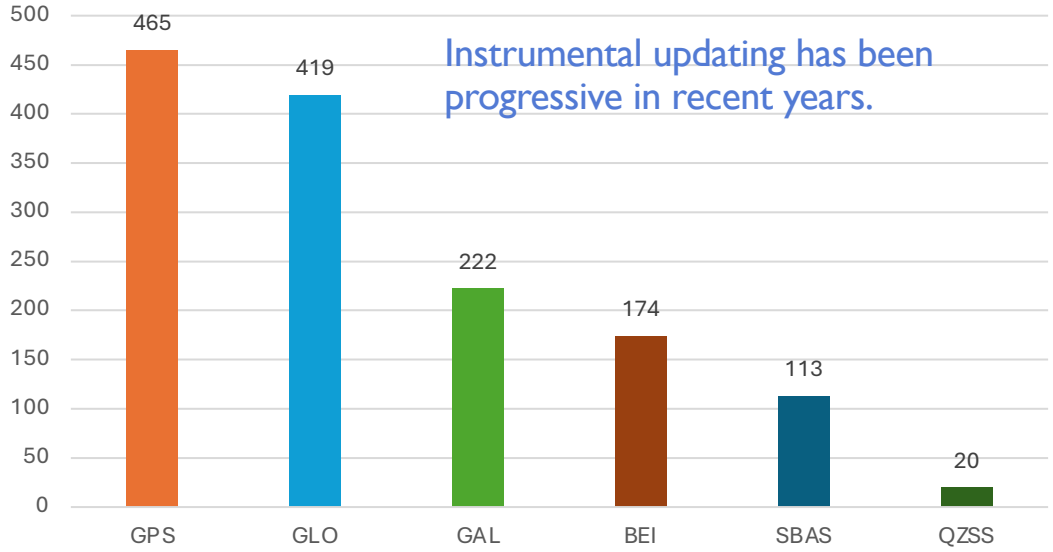
→ USC Center (USACH[2])

[1]Deutsches Geodätisches Forschungsinstitut der Technischen Universität München

[2]Universidad de Santiago de Chile

SIRGAS Working Groups and Its Relationship with IGS

- SIRGAS-CON stations are operated by a wide range of academic, research, and governmental institutions, which are organized into:



- The incorporation of continuous stations into SIRGAS-CON is of great importance for:
  - Establishing and maintaining a modern reference frame in the countries of the region
  - Contributing to the IHRF[1] and GGRF[2]
- WGI is available to provide guidance to any interested institution, especially in countries that do not yet have this infrastructure.

[1]International Height Reference Frame
[2]Global Geodetic Reference Frame

SIRGAS Working Groups and Its Relationship with IGS

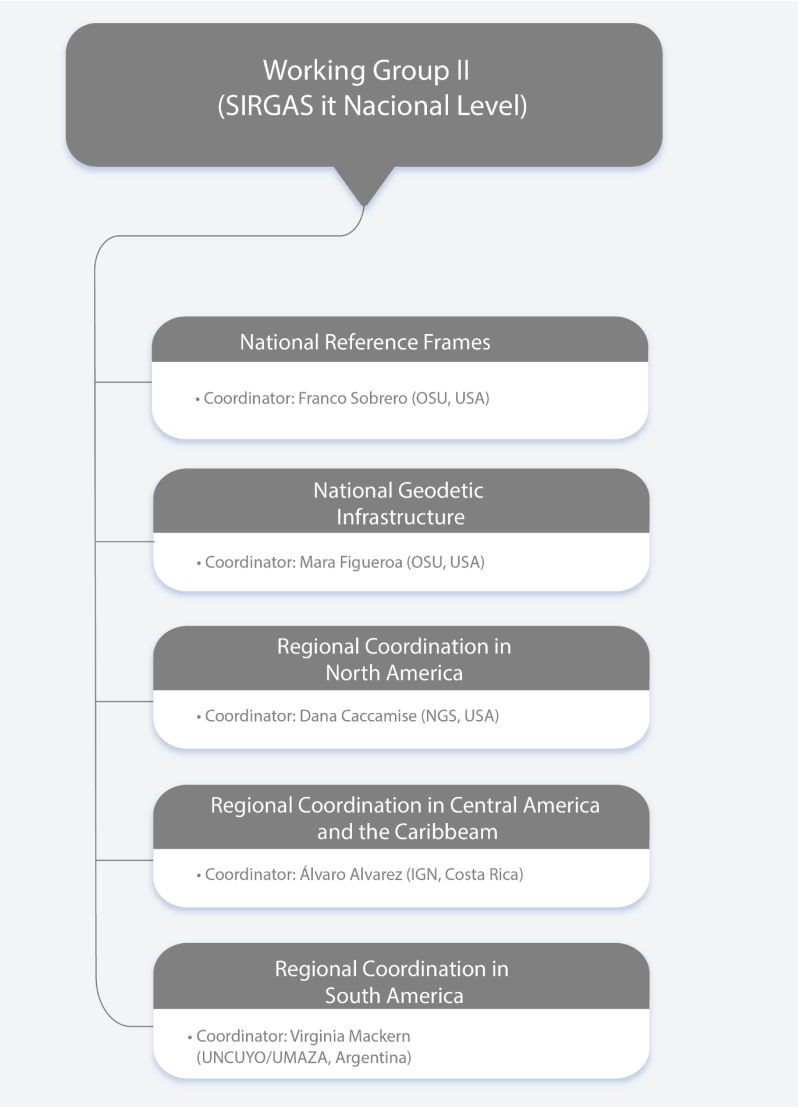
WGII are responsible to carry out the scientific and technical activities (approved by the Directive Council) necessary to fulfill the articles 1 and 2 of the SIRGAS bylaws.

The working group is coordinated by:

- Chair
- National Reference Frame Coordinator
- National Infrastructure Coordinator
- Regional Coordination in North America
- Regional Coordination in Central America and the Caribbean
- Regional Coordination in South America

The responsibilities for WG II are:

- Promote the integration to ITRF of the national geodetic networks of the SIRGAS member countries.
- Develop tools, applications, technical guidelines, and training programs to implement the ITRF / SIRGAS reference frames (geocentric and vertical) at the national level.



SIRGAS Working Groups and Its Relationship with IGS

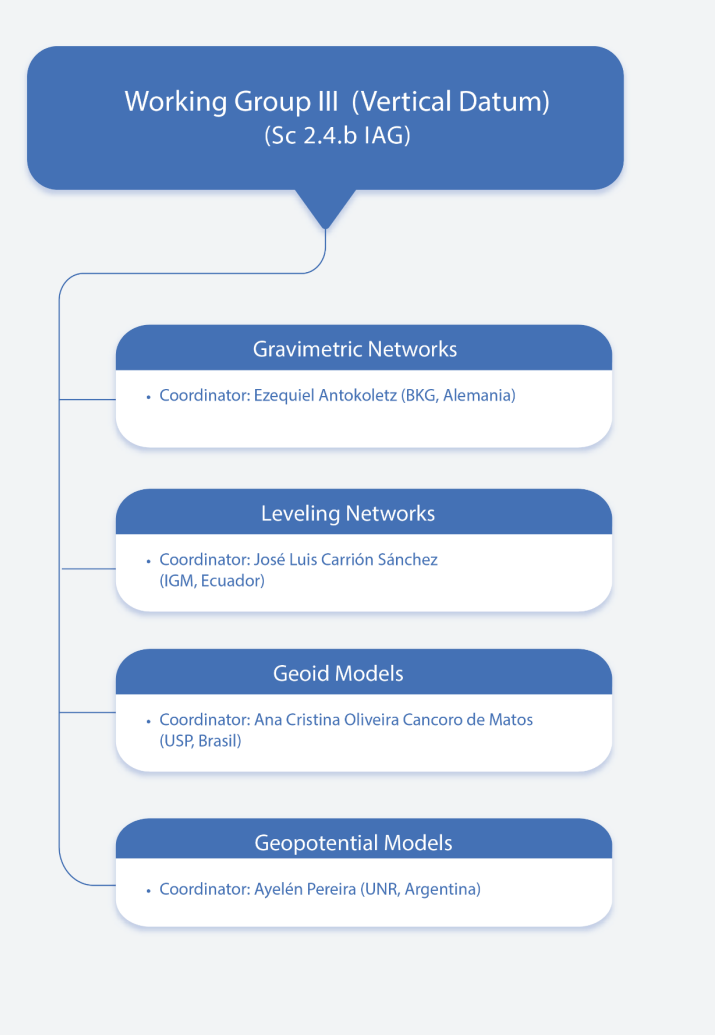
WGIII are responsible to definition, establishment and maintenance of the Vertical Datum for the Americas and the Caribbean.

The working group is coordinated by:

- Chair
- Gravimetric Networks Coordinator
- Leveling Networks Coordinator
- Geoid Models Coordinator
- Geopotential Models Coordinator

The responsibilities for WG III are:

- Define, maintain and update a unified system of physical heights.
- Coordinate the implementation of a network of stations linked to the international system for heights.
- Develop and update a model of a gravimetric, high-resolution geoid.
- Establish and maintain an absolute gravity network.
- Develop tools, applications, technical guidelines and training linked to the activities performed by this Working Group.



SIRGAS Working Groups and Its Relationship with IGS

Institutional Cooperation Between SIRGAS and IGS:

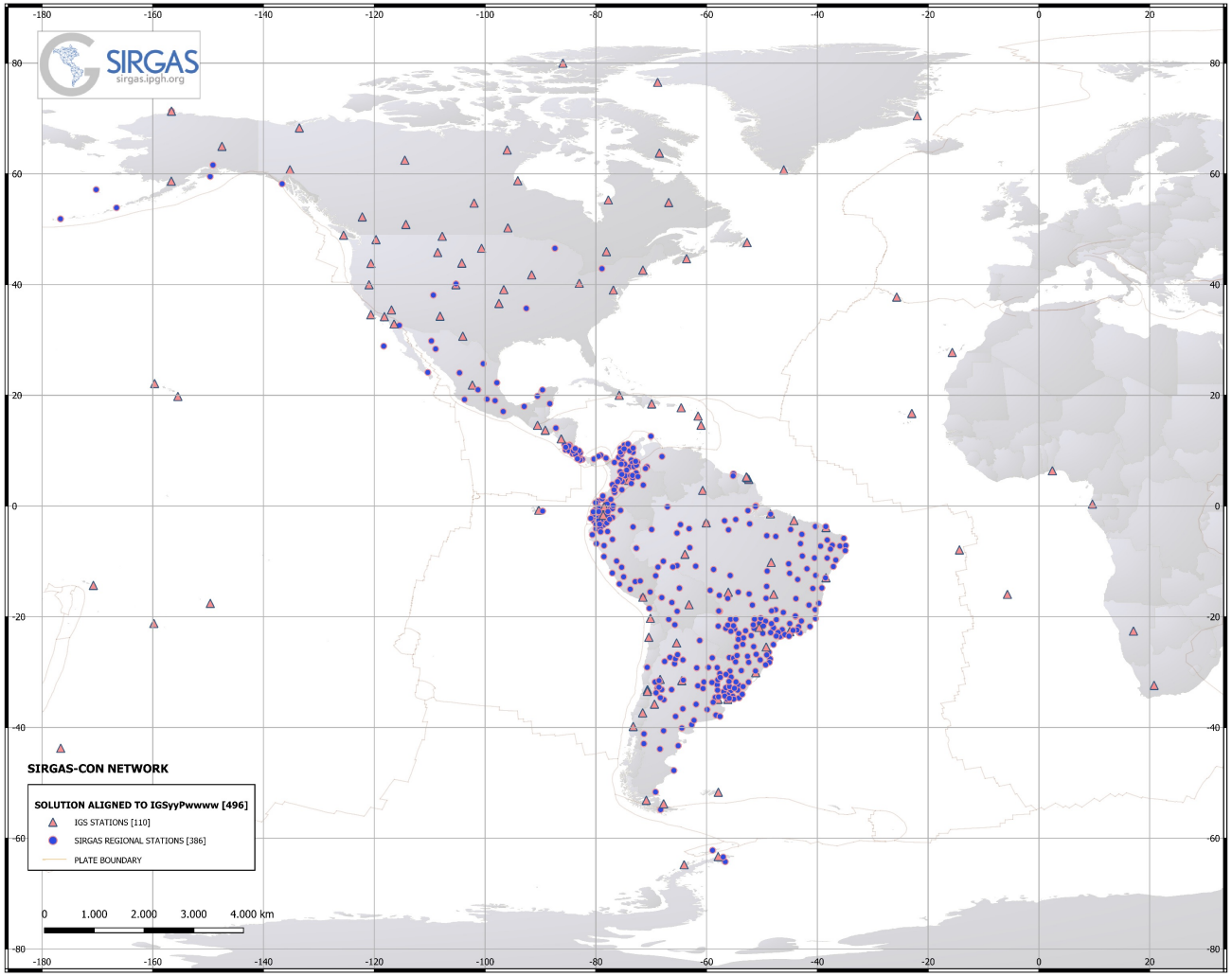
SIRGAS operates within the scientific frame of the IAG and the IGS, as well as the continental geodetic infrastructure for the Americas aligned with the ITRF.

Both organizations maintain continuous cooperation in the following areas:

- Geodetic standards
- Reference frames
- GNSS infrastructure
- Scientific products

Common objective:

To ensure global consistency and regional densification of the terrestrial reference frame.



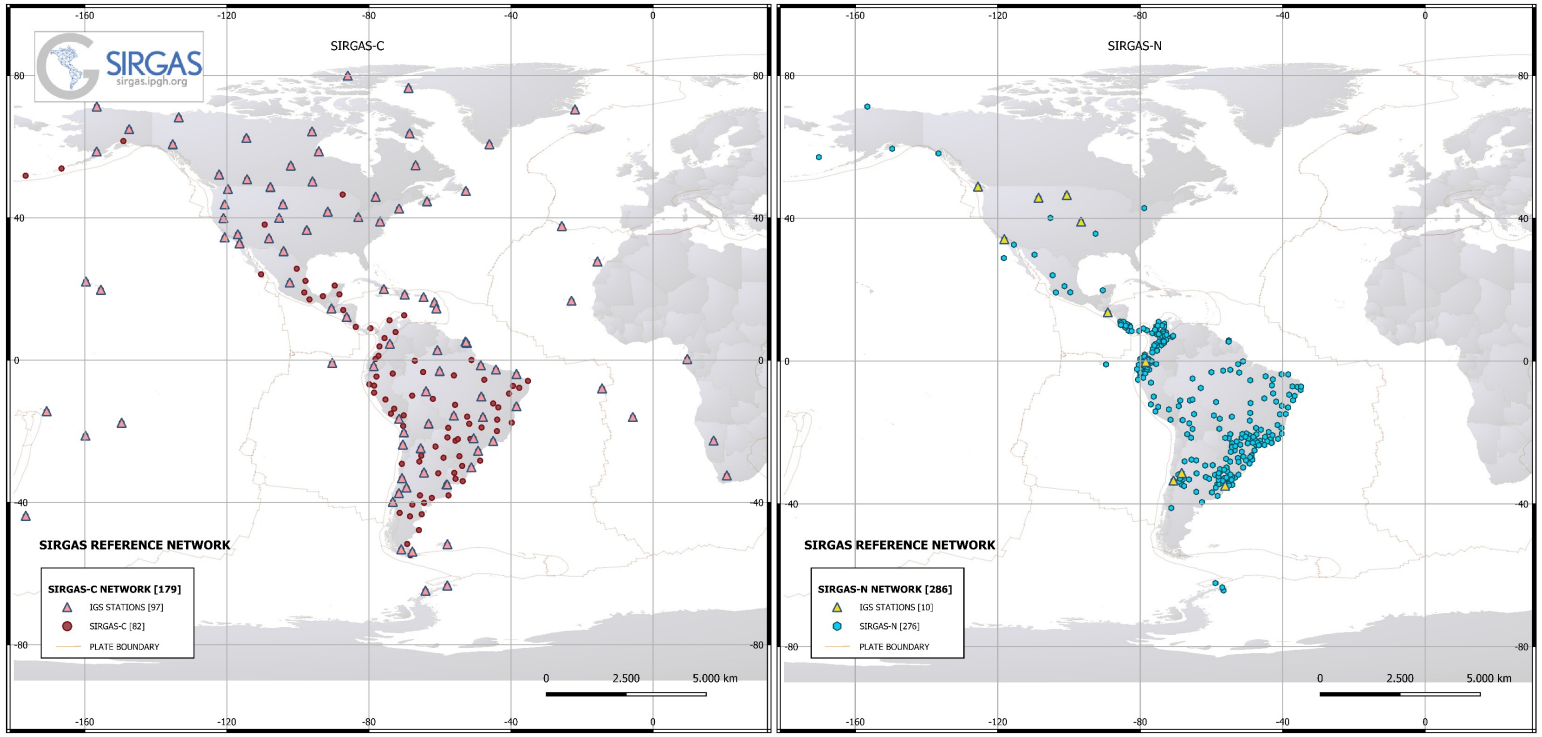
SIRGAS Working Groups and Its Relationship with IGS

IGS provides:

- Precise orbits and clock products
- Global standards
- Consistency with the ITRF and ITRF-aligned solutions

SIRGAS uses:

- IGS final orbits and clock products
- IERS models and conventions
- GNSS calibrations
- International processing standards
- IGS station coordinates

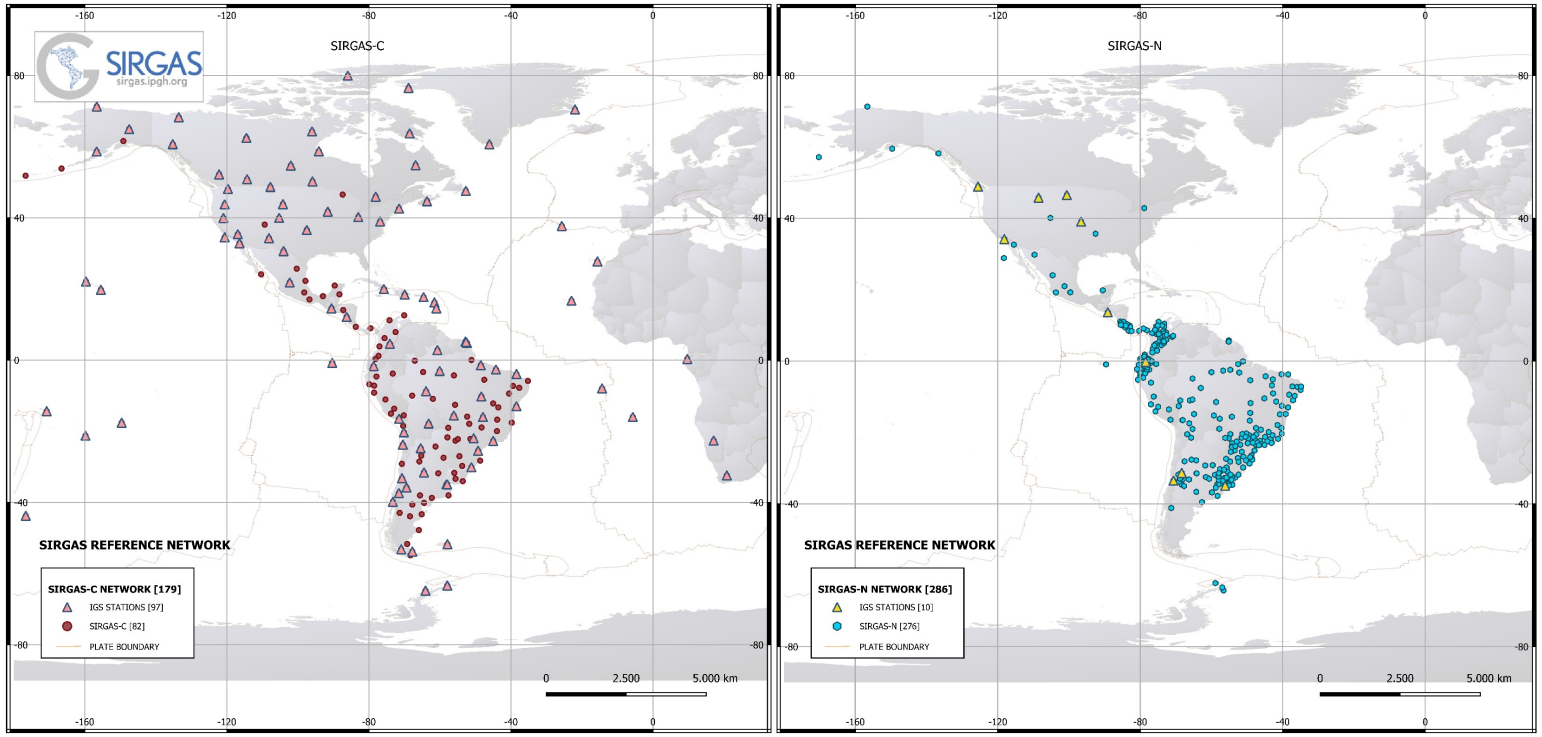


SIRGAS Working Groups and Its Relationship with IGS

A mutually beneficial scientific partnership.

SIRGAS provides IGS with:

- Continental geodetic infrastructure (CORS)
- Weekly continental reference frame solutions (SNX[1] and CRD[2] files) using IGS nomenclature.
- Tropospheric products[3]



1 SIR0OPSFIN_20260670000_07D_07D_SOL.SNX.gz
2 SIR0OPSFIN_20260670000_07D_07D_CRD.SNX.gz
3 SIR0OPSFIN_20261000000_01D_01H_SANT00CHL_TRO.TRO.gz

Scientific Processing and Analysis

SIRGAS operates 12 processing centers that process observations from the GNSS stations in the SIRGAS-CON, generating weekly solutions aligned with the ITRF.

This is only achievable by applying:

- Rigorous estimation criteria
- International standards and conventions (IERS[1] and IGS[2])

In addition, there are two combination centers that combine the solutions provided by the processing centers, generating the official weekly continental solution aligned with the current IGS reference frame.

Recently incorporated Processing Centers

IGM, Bolivia
(Instituto Geográfico Militar)
→desde julio 2025

UCR, Costa Rica
(Universidad de Costa Rica)
→desde julio 2025

Bernese GNSS Software v5.4

DGFI-TUM, Alemania
(Deutsches Geodätisches Forschungsinstitut – TUM)
→ desde junio-1996

IBGE, Brasil
(Instituto Brasileiro de Geografia e Estatística)
→ desde agosto-2008

IGAC, Colombia
(Instituto Geográfico Agustín Codazzi)
→ desde agosto-2008

IGM, Ecuador
(Instituto Geográfico Militar)
→ desde enero-2010

IGM, Uruguay
(Instituto Geográfico Militar)
→ desde enero-2010

IGM, Chile
(Instituto Geográfico Militar)
→ desde enero-2013

USACH, Chile
(Universidad de Santiago de Chile)
→ desde septiembre-2019

IGN, Costa Rica
(Instituto Geográfico Nacional)
→desde enero 2023

GAMIT/GLOBK v10.71

IGN, Argentina
(Instituto Geográfico Nacional)
→ desde enero-2011

INEGI
(Instituto Nacional de Estadística y Geografía)
→ desde enero-2011

IGN, Perú
(Instituto Geográfico Nacional)
→desde enero 2022

[1]International Earth Rotation and Reference Systems Service
[2]International GNSS Service

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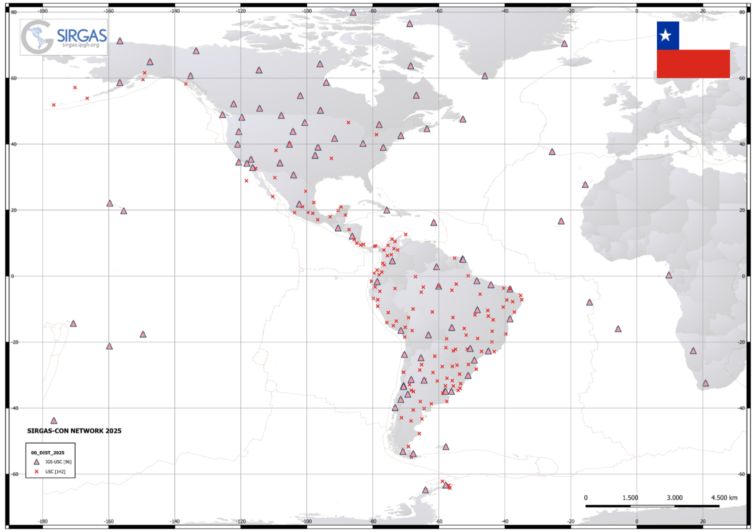
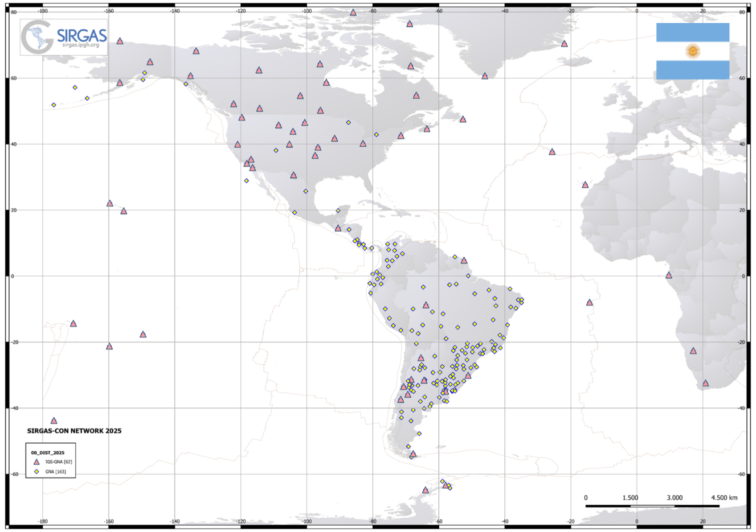
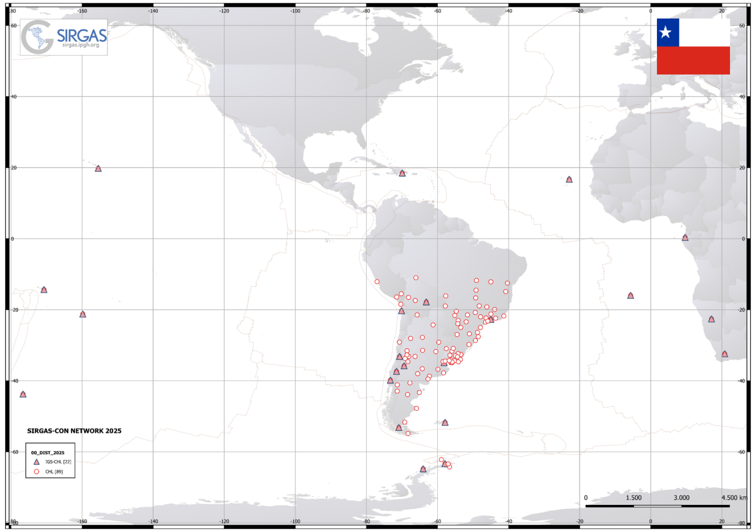
Scientific Processing and Analysis

Local Processing Centers

- Generate **loosely constrained solutions** based on the distribution of SIRGAS-CON stations.
- Each station is processed by three different centers.







Total stations	
USC	238
GNA	225
IBG	179
CHL	111
URY	103
PER	102
ECU	83
UCR	81
CRI	76
IGA	74
BOL	72
INE	51

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Scientific Processing and Analysis

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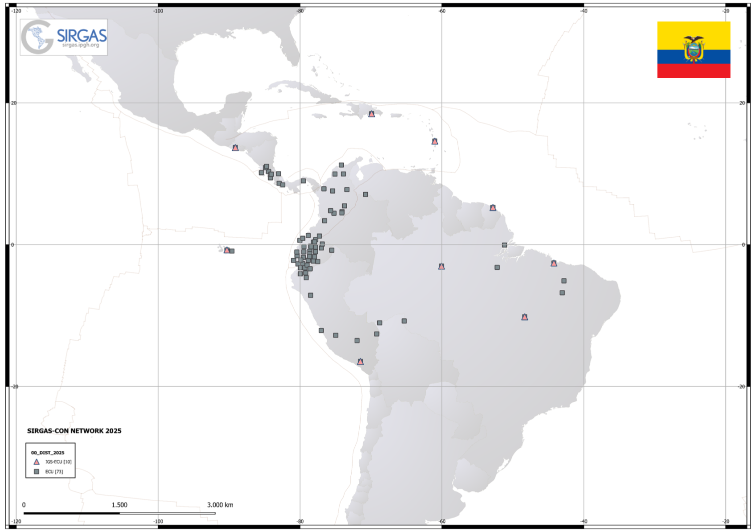

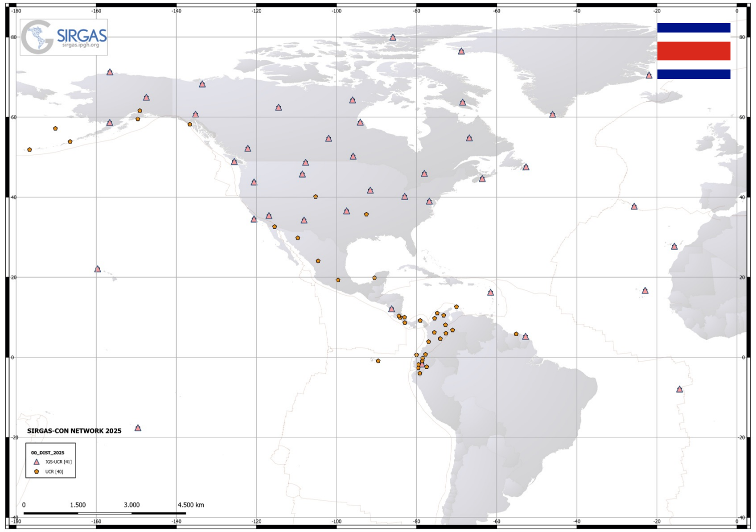

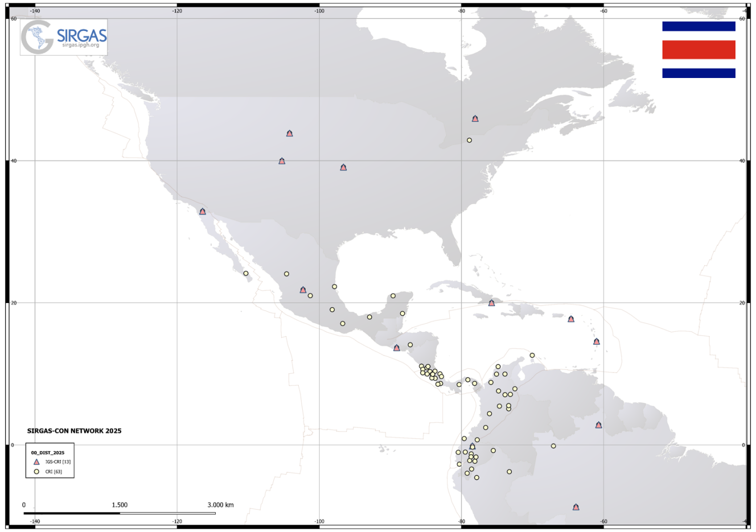

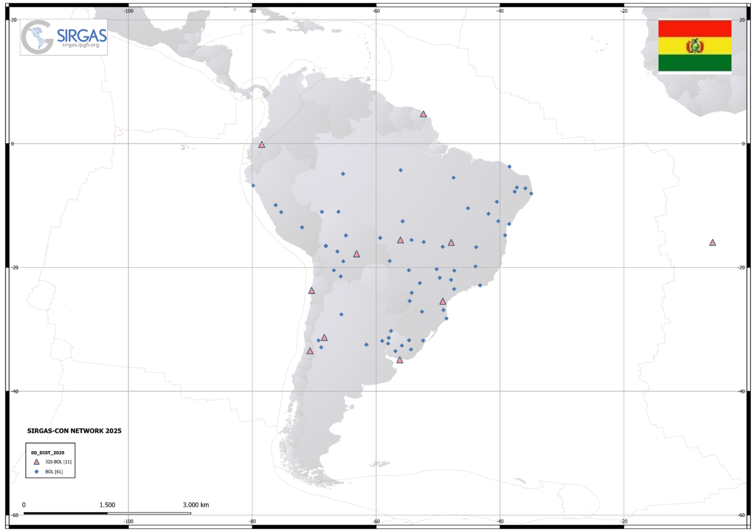

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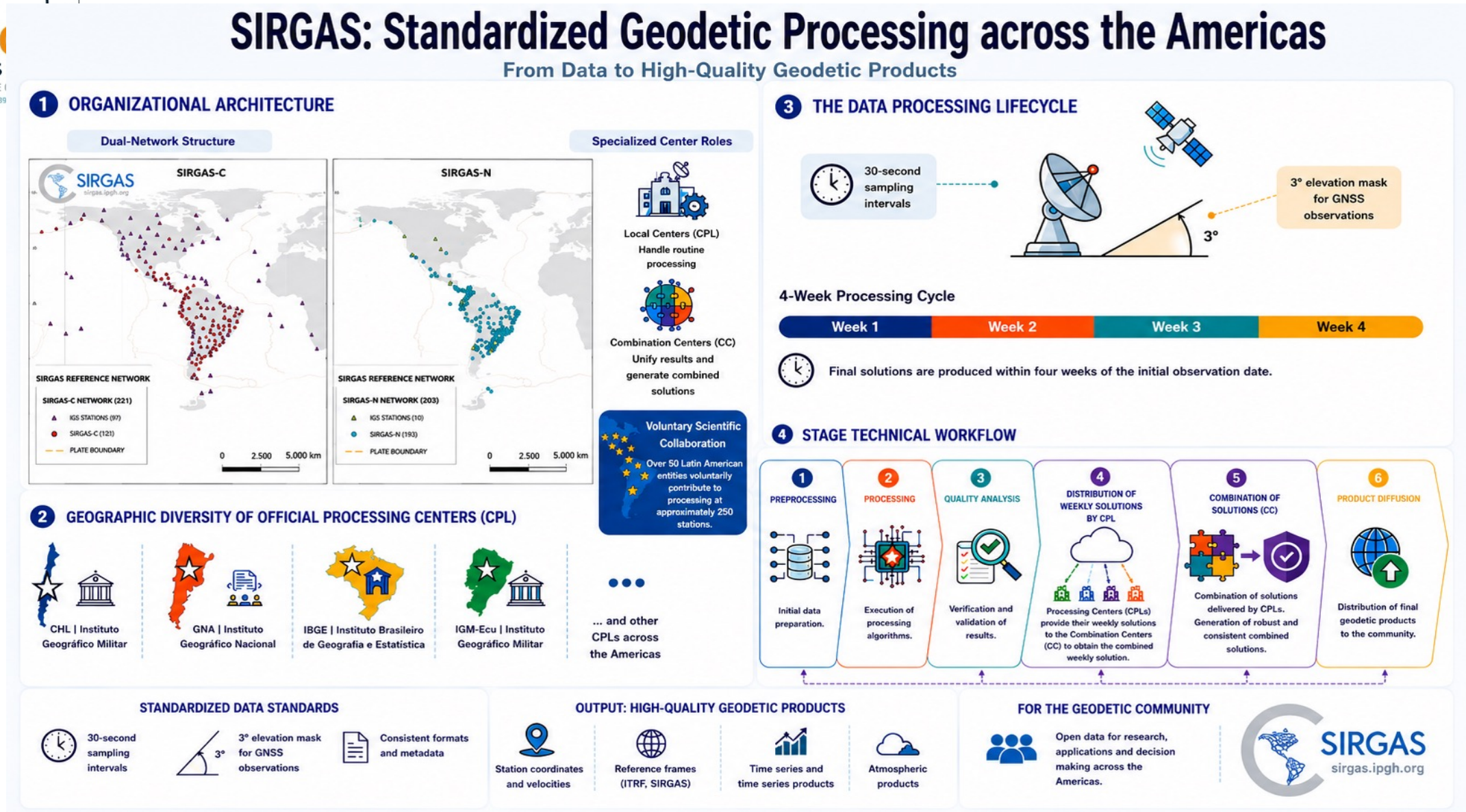
Scientific Processing and Analysis



Scientific Processing and Analysis

For data processing, the following general guidelines are applied:

SOFTWARE	BSW 5.4	GG 10.71
PARAMETER	SETTINGS	
MEASUREMENT MODELS		
Pre-processing	Phase pre-processing in a baseline-by-baseline mode using triple-differences. In most cases, cycle slips are fixed, looking simultaneously at different linear combinations of L1 and L2. If a cycle slip cannot be fixed reliably, bad data points are removed, or new ambiguities are set up.	Phase pre-processing in a baseline-by-baseline mode using triple-differences. In most cases, cycle slips are fixed, looking simultaneously at different linear combinations of L1 and L2. If a cycle slip cannot be fixed reliably, bad data points are removed, or new ambiguities are set up.
Basic Observable	Carrier phase, the code is only used for receiver clock sync. Use of elevation dependant weighting (cos (z)) Elevation angle cut off: 3 degrees	GNSS carrier phase. Code-only for receiver clock sync and ambiguity resolution. Melbourne-Wübbena wide lane combination
	Data sampling: 30 s	

Additionally, the following files are used:

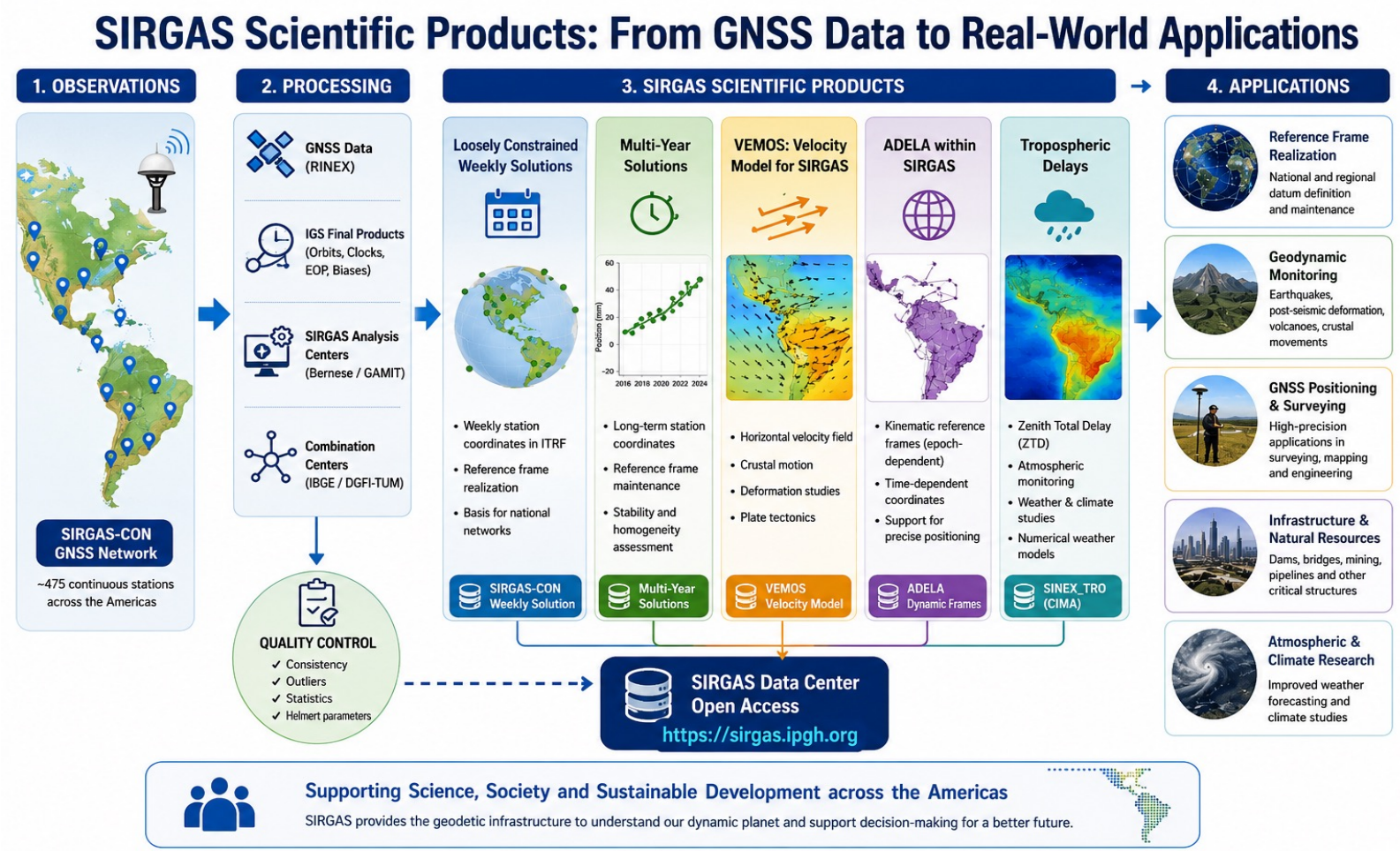
Metadata			Observations
Generals	**Others**	**ORB**	**RINEX**
.PCV/.ATX	.SNX	.SP3	.CRX
.STA/station.info	.GRD	.BIA	.RNX
.BLQ	.ION	.ERP	.O
.ATL			.D
.CRD			
.ABB			

Scientific Processing and Analysis

SIRGAS Products

SIRGAS offers the following products:

- Loosely constrained weekly solutions
- Multi-year solutions
- VEMOS: Velocity model for SIRGAS
- ADELA within SIRGAS
- Tropospheric delays



Capacity Building: Universidad SIRGAS

SIRGAS supports:

- Human resources development
- Technical training
- Knowledge transfer
- Regional scientific cooperation

Through:

- Schools
- Workshops
- Courses
- Technical meetings

Advanced Processing of Space Geodesy Data with Bernese 5.4: GNSS Techniques and Nonlinear Models, 2025.

8th SIRGAS School on Reference System

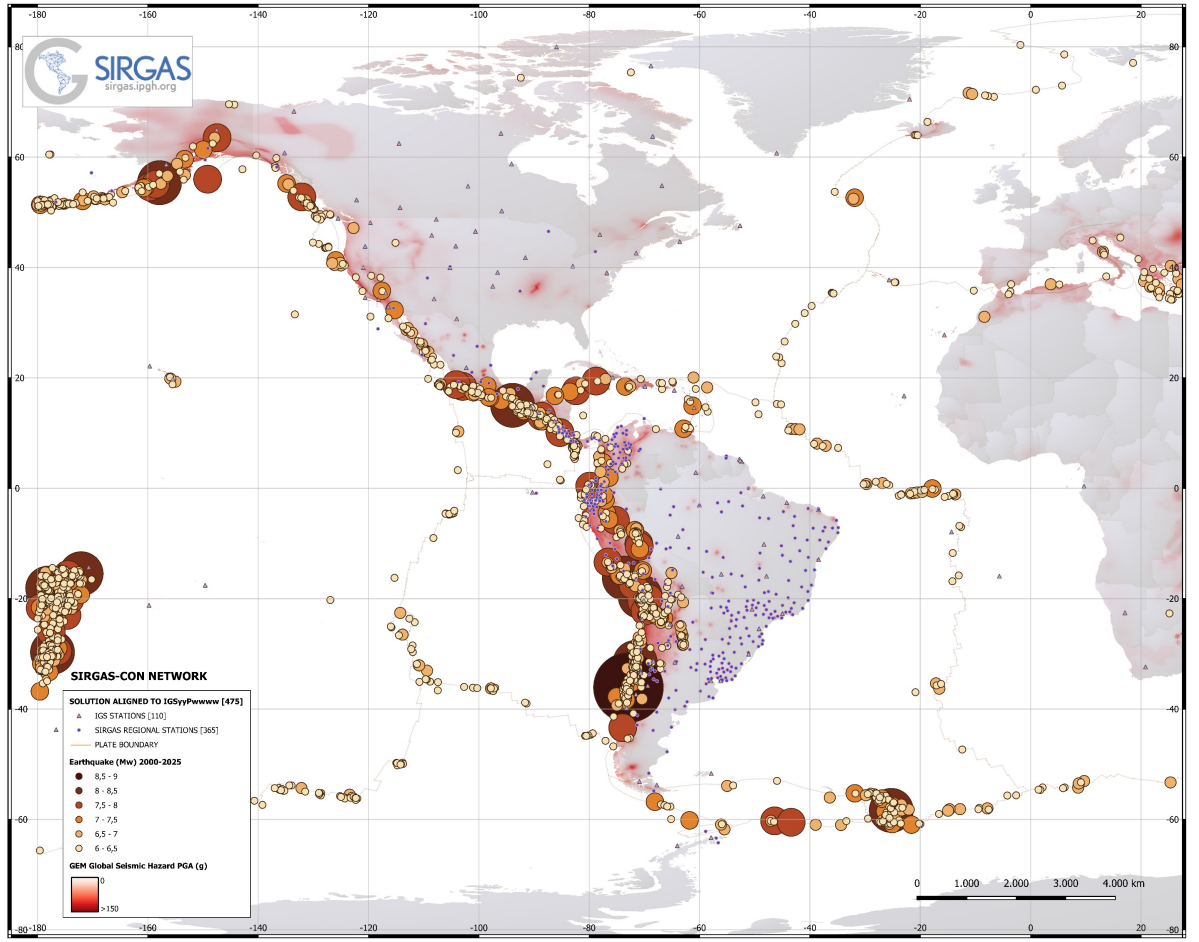
Capacity Building: Universidad SIRGAS

Year	Event
2021	SIRGAS Symposium 2021
2022	Workshop on Vertical Reference Systems (IHRS/IHRF)
2022	SIRGAS Symposium 2022
2022	SIRGAS Workshop on Height Systems and Gravity
2022	SIRGAS Workshop on Installation and Operation of Continuous GNSS Stations
2023	8th SIRGAS School on Reference Systems
2023	14th International School on the Determination and Use of the Geoid (co-organized by SIRGAS)
2024	SIRGAS School on Real-Time GNSS Applications
2024	SIRGAS Symposium 2024
2024	Course on Processing Continental GNSS Networks with Scientific Software BSW 5.4
2025	Virtual School on Terrestrial Reference Frames, Geodynamic and Atmospheric Monitoring
2025	16th SIRGAS School on VLBI and SLR Data Processing
2025	SIRGAS Course at the University of Costa Rica

Future Challenges and Opportunities

There are two main challenges in SIRGAS:

1. Promoting the transition from static reference frames to dynamic reference frames in SIRGAS member countries, as the region is affected by:
    - Tectonic deformation
    - Nonlinear displacements
    - Seismicity and post-seismic displacements
2. Implementation of the IHRF in the SIRGAS region, due to:
    - Unification of national vertical datums
    - Regional densification of the IHRF



Conclusions

SIRGAS has established itself as a robust continental reference frame for the Americas.

Collaboration with the IGS includes scientific, technical, and operational areas.

SIRGAS has evolved over time, moving from GPS campaigns in its early days to a continuous geodetic infrastructure today.

The future requires dynamic reference frames for member countries as well as a unified vertical datum, in line with IAG recommendations.

The sustained regional cooperation promoted by SIRGAS in its statutes enables significant advances to be made on the continent in the field of geodesy.

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Thank you for your attention