Processing a regional GNSS reference network in the framework of the International GNSS Service

Sonia Costa, SIRGAS

Tour de l'IGS 3rd Stop: **GNSS processing based on IGS products**

February 17, 2022

✓The Geodetic Reference System for the Americas (SIRGAS) is a voluntary country collaborative project focused on obtaining **regional geodetic infrastructure** based on the **International Association of Geodesy (IAG)** standards, recommendations, **products, and services**.

✓**Main objectives:**

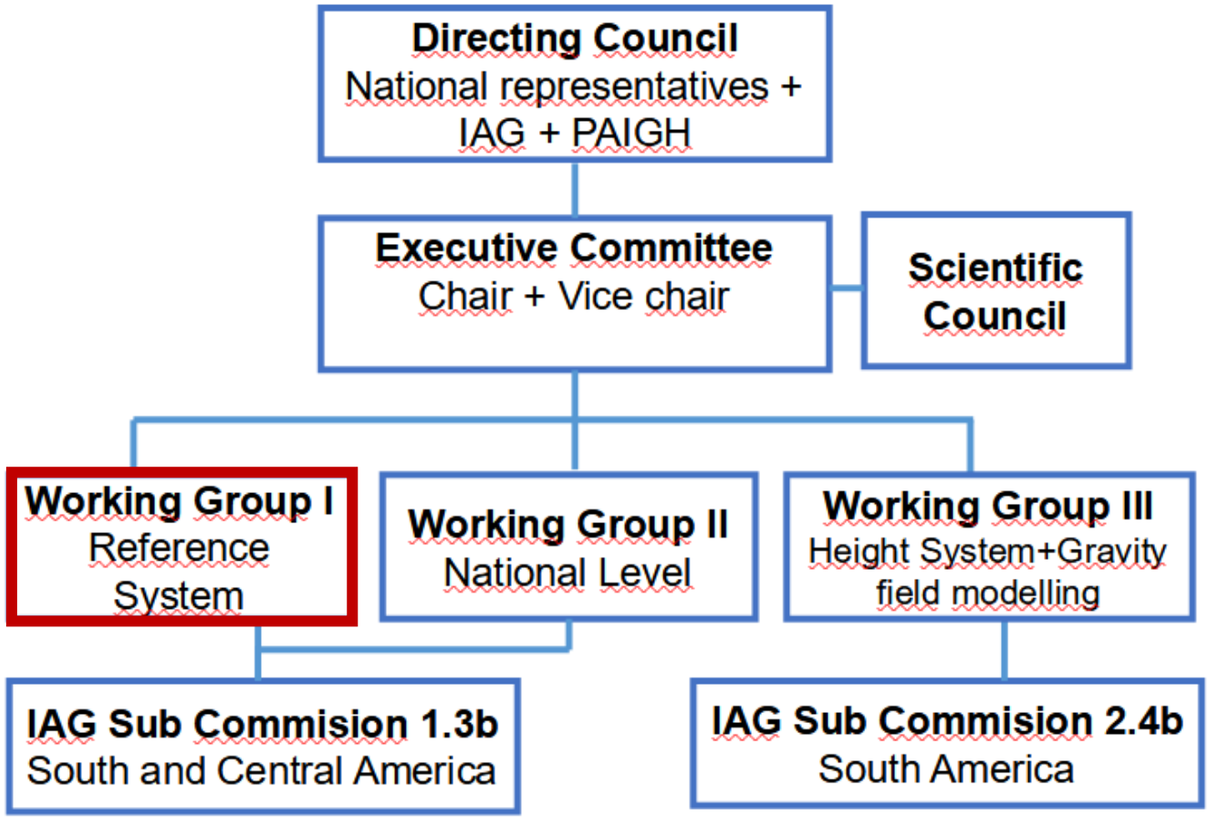
a) **Establish and maintain a continental geocentric reference frame (a network of stations with geocentric coordinates [X, Y, Z] of high precision and their variation over time [Vx, Vy, Vz]);**

b) Define and maintain a unified vertical reference system by means of physical and geometric heights that are consistent at the global level;

c) Develop and update a gravimetric geoid model for continental coverage;

d) Establish and maintain a continental absolute gravity network;

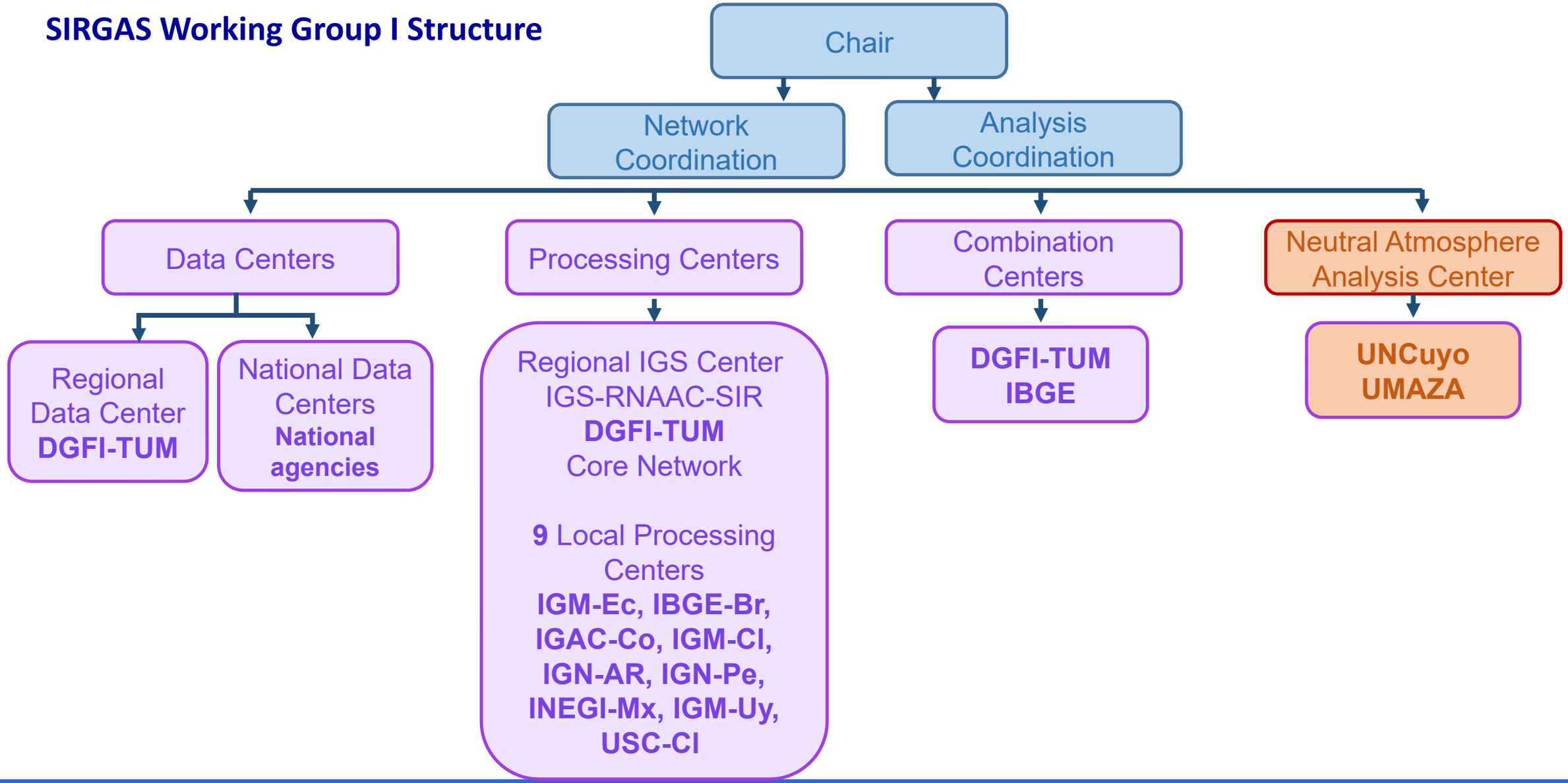
Operational structure of SIRGAS



(Reference Frames for South and Central America)

(Gravity and Geoid in South America)

SIRGAS Working Group I Structure



SIRGAS Reference Frame - SIRGAS WG I (IAG SC 1.3b)

Densify ITRF in the American Continent and Caribbean region

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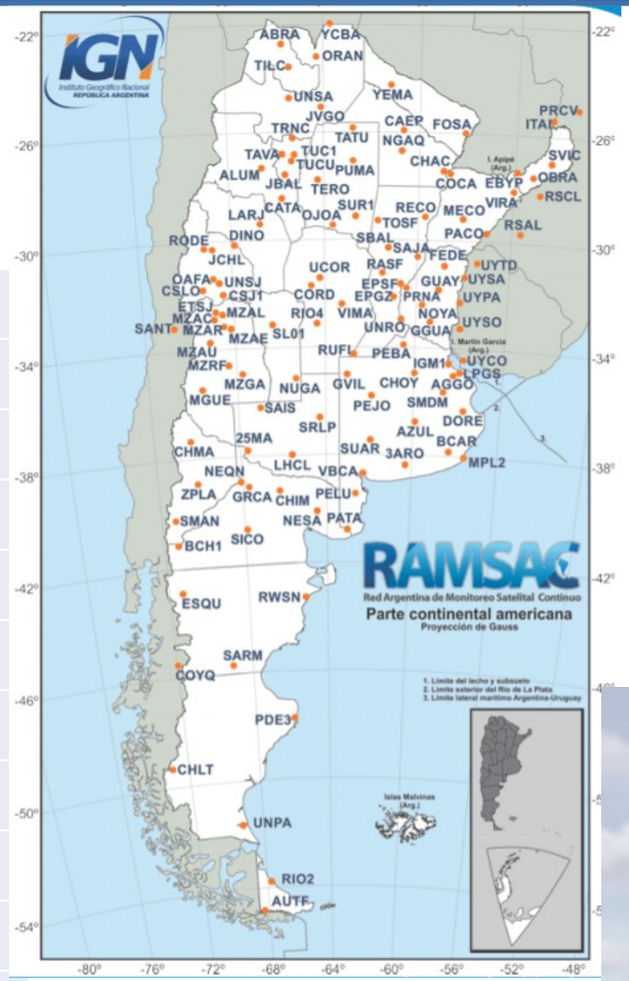
Geodetic Infrastructure

GNSS CORS Networks

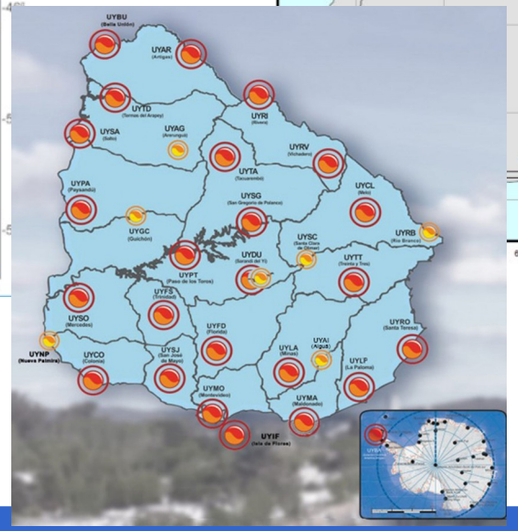
GNSS Data Centers

GNSS Analysis Centers

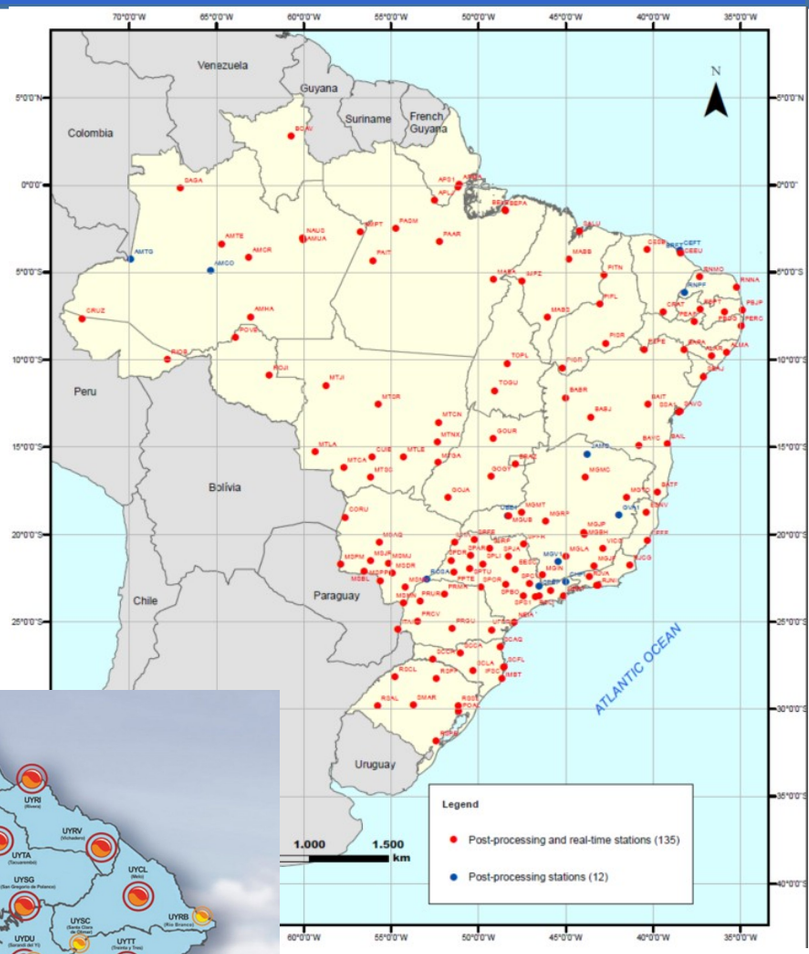
Argentina	RAMSAC
Bolivia	MARGEN
Brasil	RBMC
Canadá	CACS
Chile	IGS, CSN, CAPES
Colombia	MAGNA-ECO
Costa Rica	RGNA-CR
Ecuador	REGME
Estados Unidos	NGS-CORS
México	RGNA
Panamá	Panama-CORS
Perú	REGPMOC
Uruguay	REGNA-ROU



Argentina



Uruguay



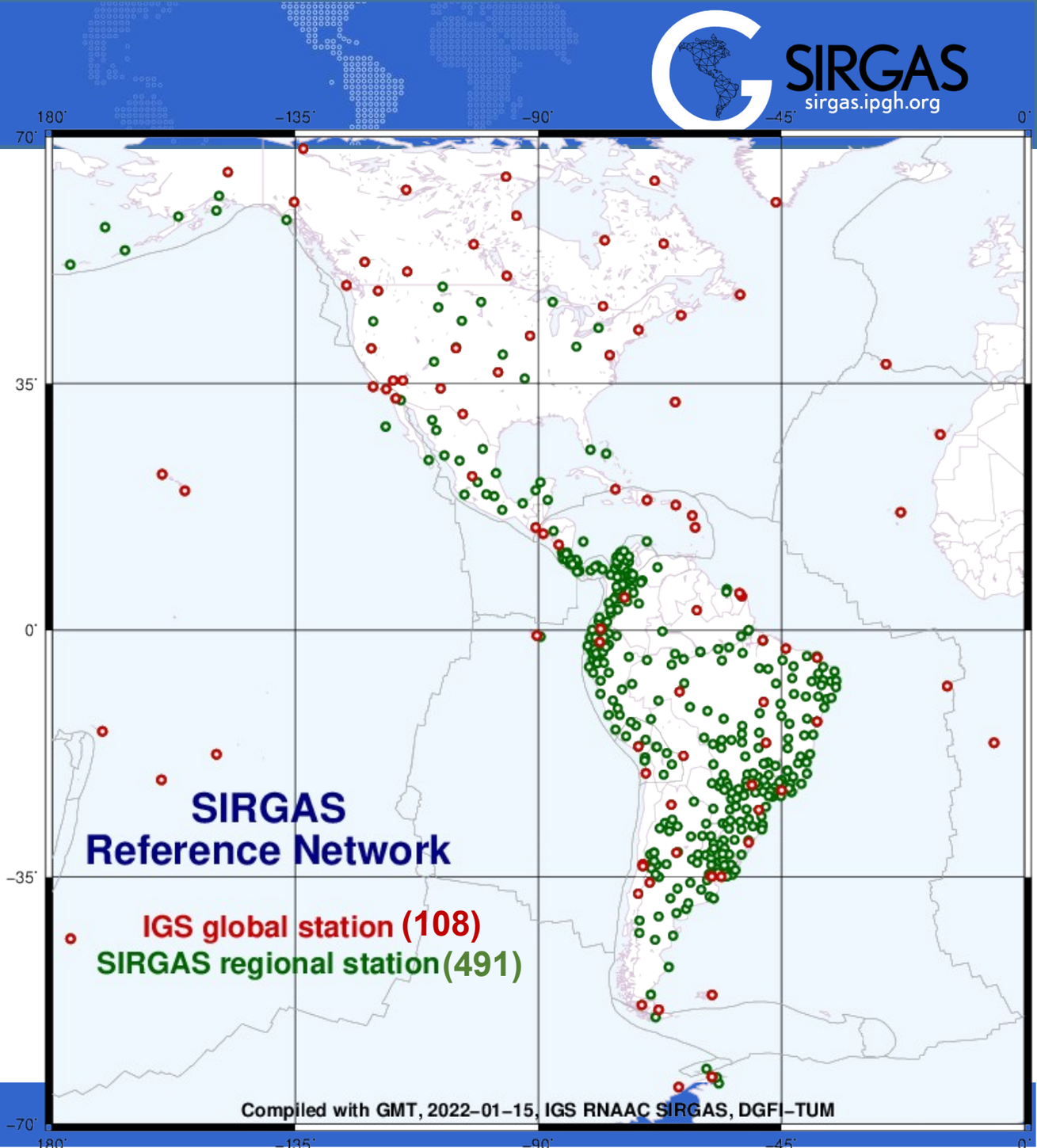
Brazil

Geodetic Infrastructure
SIRGAS Reference Network

- ✓ To maintain and ensure the long-term stability of the SIRGAS reference frame;
- ✓ accessibility to the global reference system at regional, and national level;

- ✓ For the high precision of daily and weekly network solutions it is necessary apply **IGS standards, guidelines and products**:
- ✓ Satellite orbits, satellite and station clock offsets, and Earth orientation parameters;
- ✓ Absolute IGS Antenna (satellite and receiver) Phase Center Correction Model - igs14.atx;
- ✓ IGSyy weekly station geocentric coordinates;

- ✓ **SIRGAS Products**: weekly station positions, multi-year solutions, surface deformation models, and tropospheric parameters in hourly intervals.

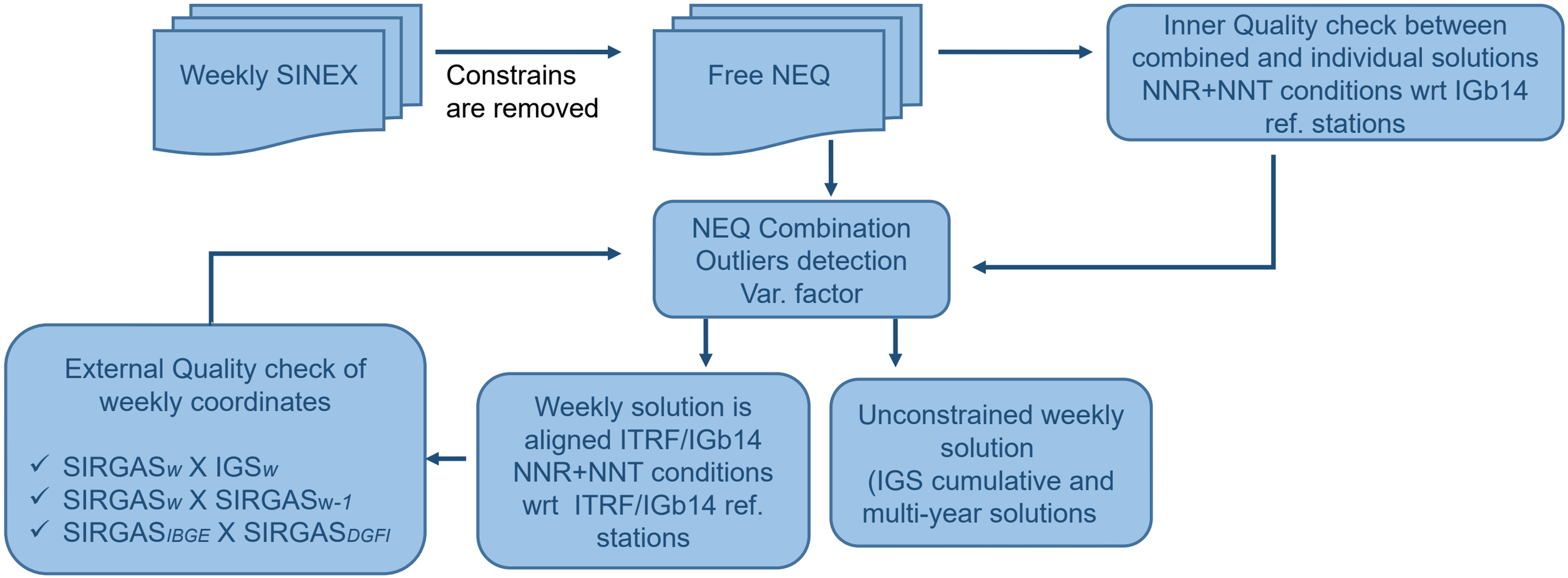


Geodetic Infrastructure
SIRGAS Reference Network

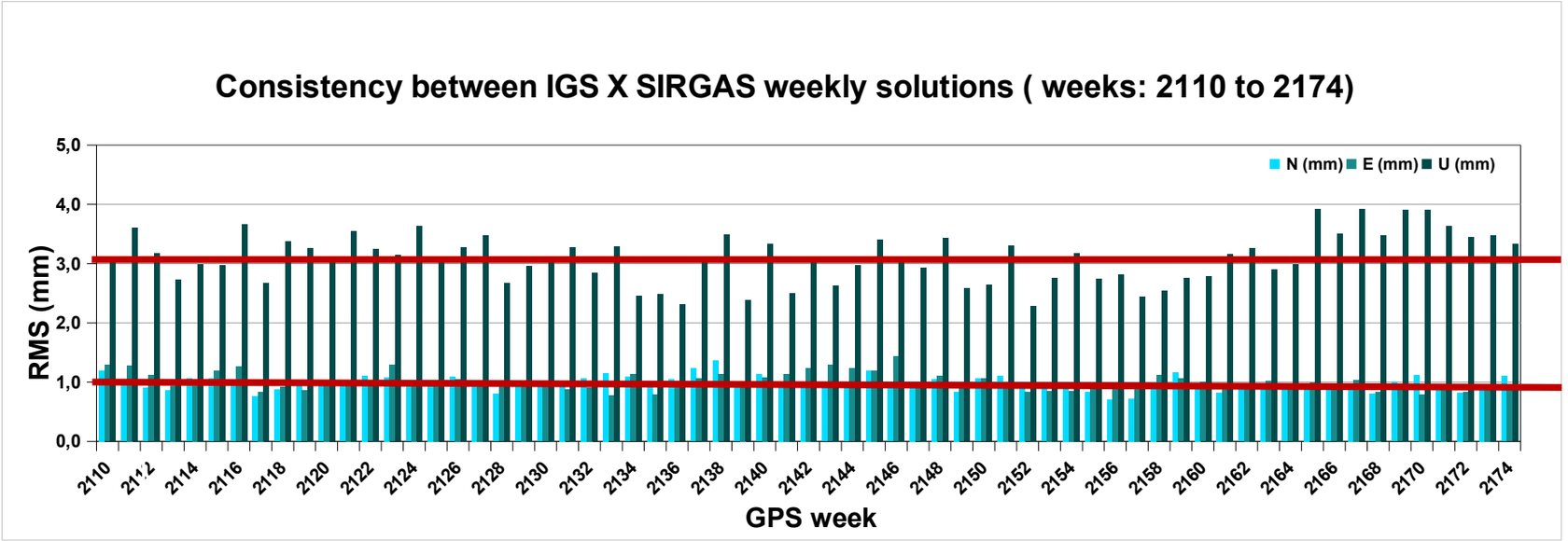
GNSS data processing strategy and caracteristics

- ✓ Basic observable ionosphere-free linear combination;
- ✓ Sampling rate 30 sec;
- ✓ Elevation cut-off angle 3°;
- ✓ Elevation-dependent observation weighting cos(z)**2;
- ✓ **Satellite orbits, satellite clock offsets, and Earth orientation parameters** are fixed to the combined IGS weekly solutions;
- ✓ **Phase centre variations and offsets, absolute model for receiver and satellite antennae, model igs14.atx;**
- ✓ Apply antenna excentricities according to the site logs;
- ✓ Troposphere modelling: the a-priori zenith delay is modelled using the Vienna Mapping Function;
- ✓ Phase ambiguities are solved;
- ✓ Tidal corrections for solid and permanent Earth tide IERS Conventions 2010;
- ✓ Ocean tide loading reduced with the FES2014b;
- ✓ Atmospheric tide loading for S1 and S2 reduced with the model of Van Dam and Ray 2010;
- ✓ Daily normal equations are computed by applying the double difference strategy and are combined to produce loosely constrained weekly solutions for station positions in SINEX format.

Combination Strategy



Combination Results

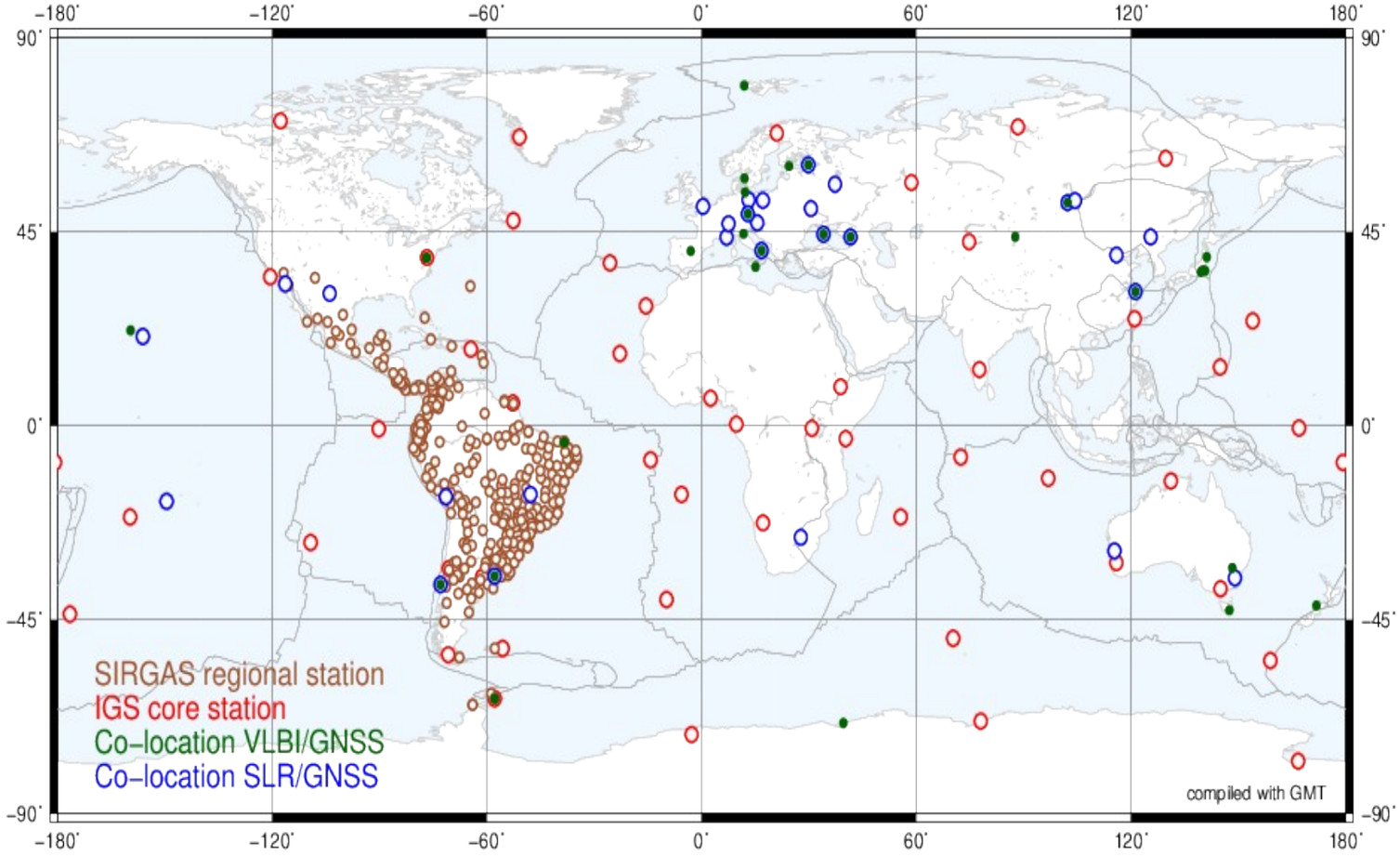


Geodetic Infrastructure
SIRGAS Reference Network

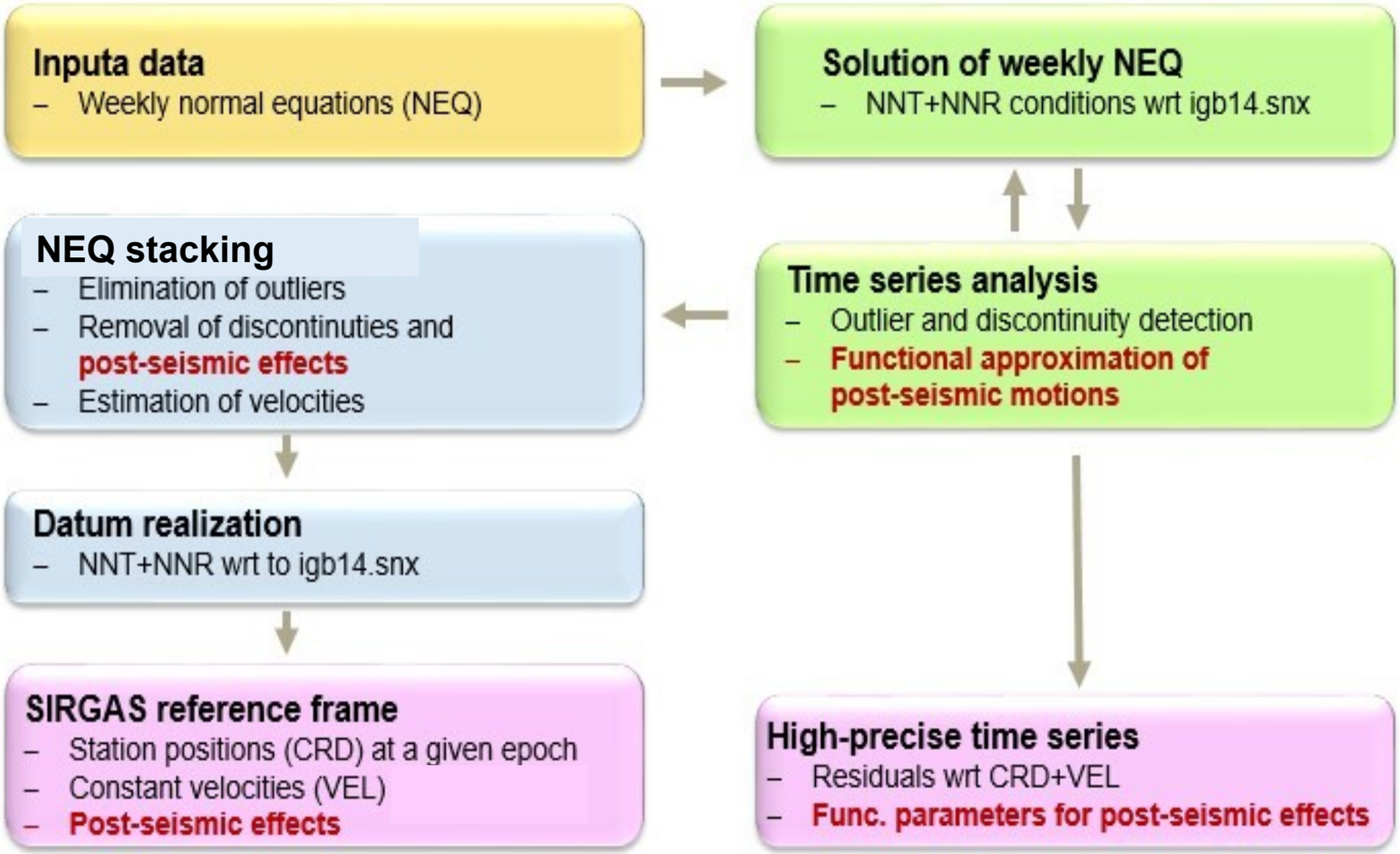
Multi-year solutions
to ensure the long-term stability of the SIRGAS reference frame
Results: coordinates and **velocities**
DGFI-TUM, IGS RNAAC SIR

SIR17P01
Aligned to IGS14, epoch 2015.0
Time span: 2011 - 2017
345 stations

SIR2020
Aligned to IGS14/IGb14, epoch 2010.0
Time span: 2000 - 2020
723 stations
Post-seismic effects
Included global IGS stations co-located with VLBI and SLR



Multi-year solution strategy



- ✓ For GNSS data reprocessing it was applied IGS products (Satellite orbits, satellite clock offsets, and Earth orientation) from **REPRO1 and REPRO2** campaigns;
- ✓ Absolute phase centre corrections model from IGS realization;
- ✓ Weekly combination is aligned to ITRF/IGSyy coordinates and velocities;
- ✓ Weekly unconstrained solutions **(to be considered for national realizations);**

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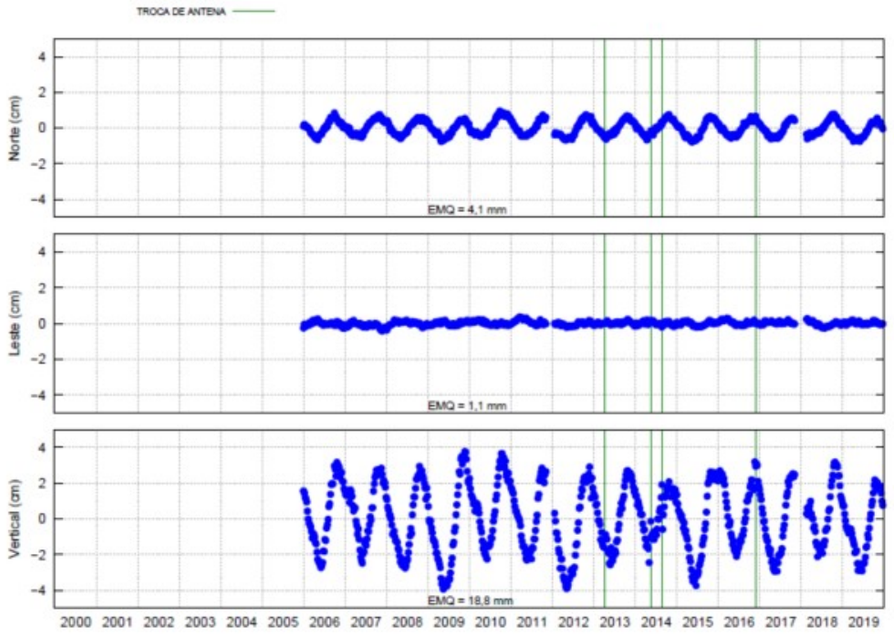
Multi-year solution applied to a national realization - RBMC14 – IGb14, epoch 2010.0 Weekly solutions from 2000 to 2019

Solução Multianual das Estações da RBMC no Período de 2000 a 2019

Estação: NAUS — Domes Number: 41614M002

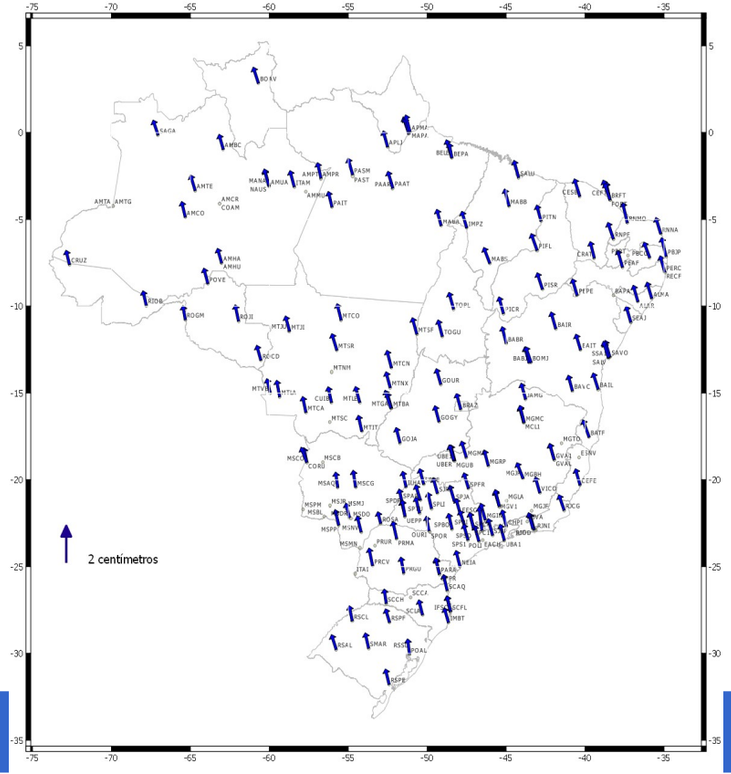
1 - Série residual das coordenadas

Resíduos gerados a partir da comparação entre a solução combinada e a solução semanal ajustada ao referencial IGb14, época 2010.0. As linhas verticais indicam as descontinuidades identificadas e as novas soluções geradas para a estação. A estimativa de precisão considera a variação dos resíduos ao longo da série e é representada por 1 sigma.



3 - Informações sobre as soluções

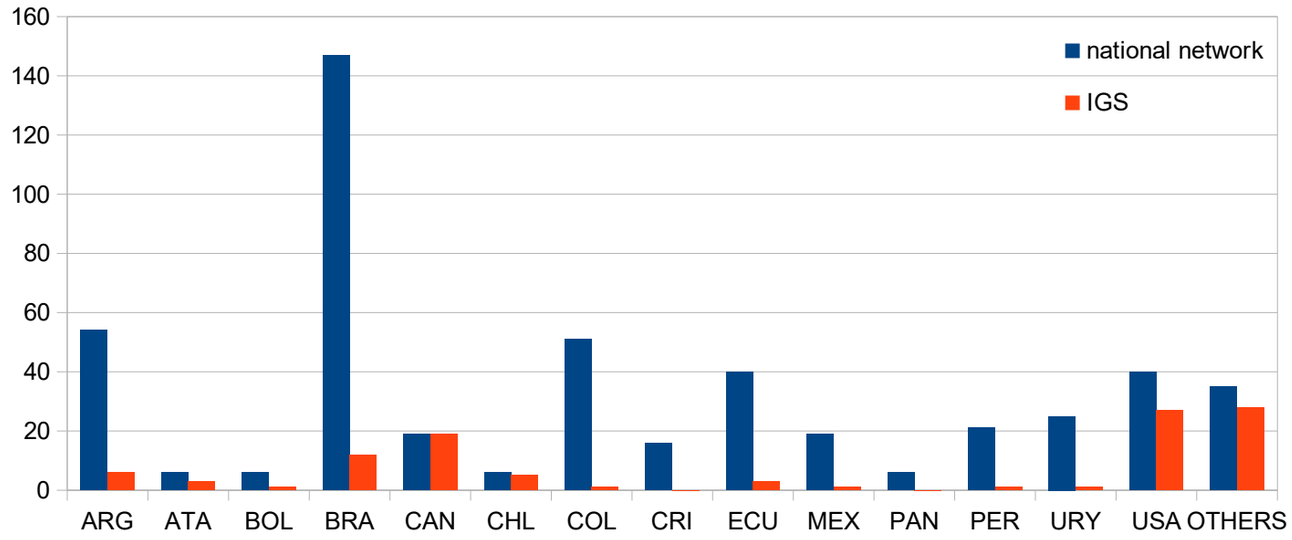
Causa da descontinuidade			Diferenças entre as coordenadas				
Nº. da Solução	Motivo	Data	Sol. 1	Sol. 2	Norte (m)	Leste (m)	Vertical (m)
1	Troca de antena	09-04-2013	1	2	0,026	0,007	0,003
2	Troca de antena	24-05-2014	2	3	-0,017	-0,008	0,022
3	Troca de antena	28-08-2014	3	4	0,005	0,004	0,008
4	Troca de antena	25-11-2016	4	5	0,009	-0,012	-0,034

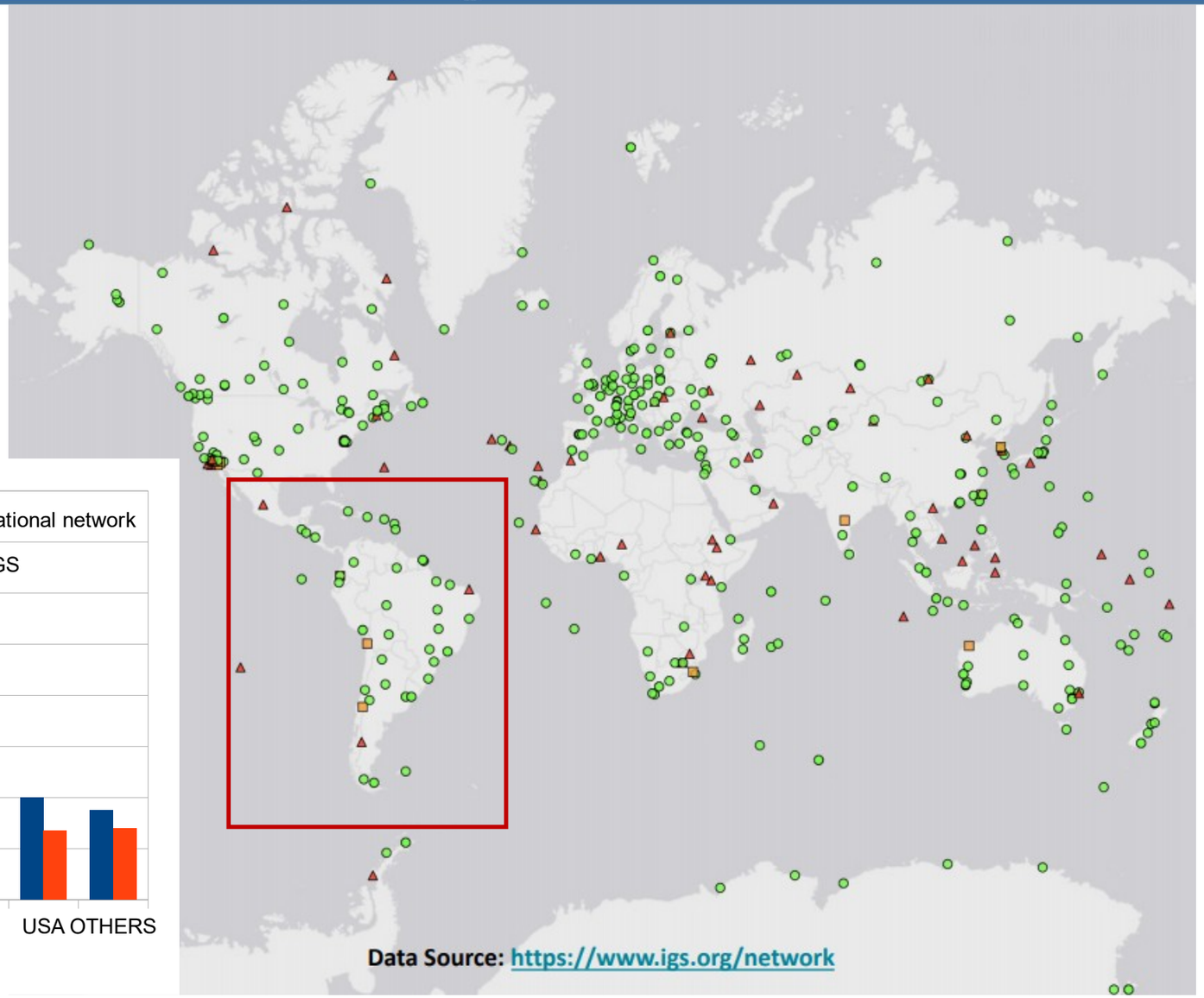


2 - Coordenadas geodésicas referenciadas ao IGb14, época 2010.0

Nº. da Solução	Coordenadas Geodésicas		Altitude Geom.(m)	Velocidades			Período de dados	
	Latitude	Longitude		VN (m/ano)	VE (m/ano)	VU (m/ano)	Início	Fim
1	-03° 01' 22,50702"	-60° 03' 18,06064"	93,875	0,0124	-0,0038	-0,0006	01-01-2006	06-04-2013
2	-03° 01' 22,50785"	-60° 03' 18,06085"	93,872	0,0130	-0,0032	0,0003	14-04-2013	04-05-2014
3	-03° 01' 22,50729"	-60° 03' 18,06058"	93,851	0,0126	-0,0038	-0,0005	24-05-2014	30-08-2014
4	-03° 01' 22,50744"	-60° 03' 18,06071"	93,843	0,0132	-0,0042	0,0082	31-08-2014	18-11-2016
5	-03° 01' 22,50773"	-60° 03' 18,06034"	93,877	0,0147	-0,0050	-0,0001	25-11-2016	28-12-2019

How to collaborate with IGS products improvement





Final Remarks

- ✓ IGS products are essential for the high precision GNSS solutions, provide the direct link to the ITRF through the IGS reference frame and assure the consistency between different reference frames (regional and national) ;

- ✓ IGS products must be applied to maintain and to ensure the long-term stability of a reference frame (regional and national) for daily processing, weekly combination and multi-year solutions;

- ✓ I would like to call attention to the importance of open GNSS data-sharing for the benefit of realizing and improving the access to the Global Geodetic Reference Frame at the national, regional, and global levels; mainly multi-constellation data, for the IGS products improvement and geodetic research.

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Thank you!

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