

The Role of the IAG Sub-commissions in Latin America



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Honorary Secretary General of IAG

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Involvement of Latin America in the Present Structure of the IAG Related to the Global Geodetic Reference Frame (GGRF)

- **IAG Commission 1: Reference Frames**
 - Sub-commission 1.3b: South and Central America (including Mexico)
 - Sub-commission 1.3c: North America
- **IAG Commission 2: Gravity Field**
 - Sub-commission 2.4b: Gravity and Geoid in South America
 - Sub-commission 2.4c: Gravity and Geoid in North and Central America
- **IAG Commission 3: Earth Rotation and Geodynamics**
 - Sub-commission 3.2: Crustal Deformation
- **IAG Global Geodetic Observing System (GGOS)**
 - Focus Area Unified Height System
- **International GNSS Service (IGS)**
 - Regional Network Associate Analysis Center for SIRGAS (RNAAC-SIR)

IAG Resolutions Relevant for the GGRF in Latin America

- **IAG Resolutions 2015**

- Definition and Realization of an International Height Reference System (IHRIS)
- Establishment of a global absolute gravity reference system

- **IAG 2016 “Description of the Global Geodetic Reference Frame”**

- *The GGRF includes the **geometry** and **gravity** field of the Earth and the Earth's **orientation** with respect to the celestial reference frame.*

- **IAG Resolutions 2019**

- The International Terrestrial Reference Frame (ITRF)
IAG recommends that the ITRF be the standard terrestrial reference frame for the alignment of national and regional reference frames.
- Establishment of the International Height Reference Frame (IHRF)
- Establishment of the Infrastructure for the Internat. Gravity Reference Frame

Regional Reference Frame for Latin America (1)

- Status before 1990: National triangulation networks, local datum definitions.
- 1989: Convention of IAG and Pan-American Institute for Geography and History (PAIGH) for cooperation in the unification of the South American datum.
- 1993: Conference on a “Unified South American Datum”, Asunción, Paraguay: Geocentric Reference System for South America (SIRGAS)
- 1995: First continental GPS campaign;
- 2000: Extension to all the Americas;
- 2001: UN-RCCA resolution recommends that all countries use SIRGAS, and
- 2005: ... to integrate gravity and levelling.



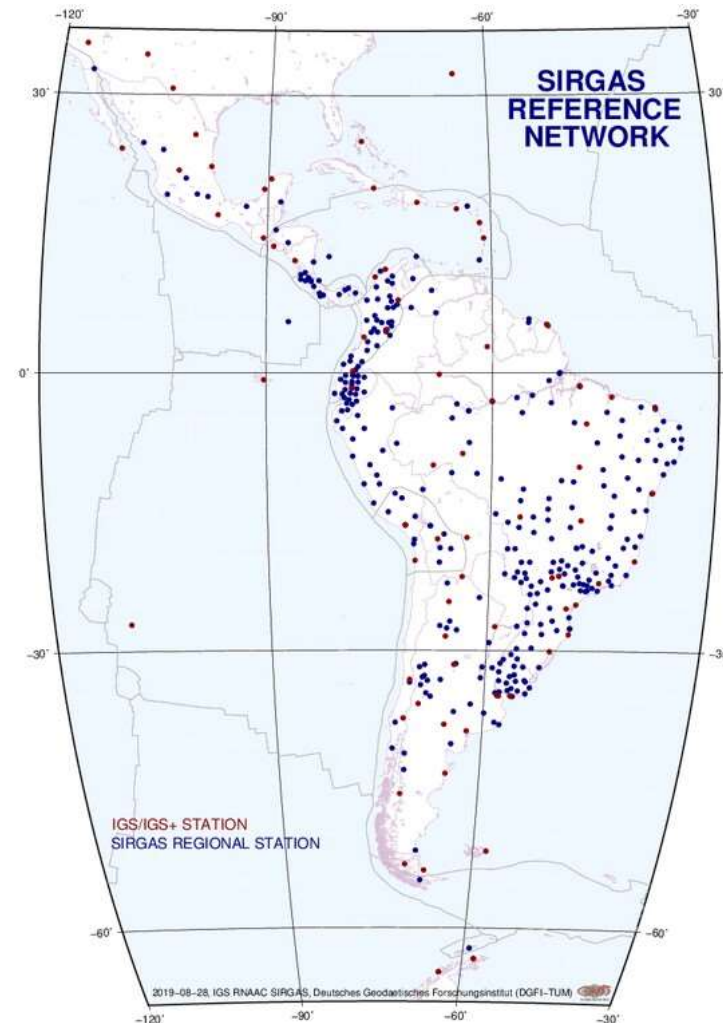
Regional Reference Frame for Latin America (2)

SIRGAS Reference Frame 1995



58 stations occupied 10 days in May 1995; adjusted by alignment to 7 ITRF94 fiducial stations.

IGS RNAAC-SIR September 2019



> 400 stations processed in weekly epoch solutions; in alignment to IGS weekly solutions in actual ITRFs.

Regional Reference Frame for Latin America (3)

Characteristics of the SIRGAS Reference Frame (www.sirgas.org)

- The present SIRGAS realization is a network of continuously operating GNSS stations distributed over Latin America, called **SIRGAS-CON** (> 400 stations).
- Regional sub-networks are processed weekly by presently **8 Analysis Centres** (Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Uruguay, Venezuela).
- The IGS Regional Network Associate Analysis Center for SIRGAS (**IGS RNAAC SIRGAS**) computes **weekly** a continental core network in the IGS frame = ITRF, and cumulative **multi-year** solutions with epoch coordinates and velocities.
- The individual solutions are combined by two SIRGAS Combination Centres at IGBE, Brazil and DGFI-TUM, Germany.
- The resulting coordinates and velocities are strictly aligned to the actual ITRF, thereby strictly following the IAG resolutions and IGS conventions.

Gravimetric Reference Networks in Latin America (1)

- Obs.:** Gravity data are particularly important for vertical reference frames.
- Status before 1980: Continental and national gravimetric networks referred in general to the **Potsdam Gravity System** (introduced by IAG 1909).
- 1979: An adjustment of the Latin American Gravity Standardization Network (**LAGSN 77**) referring to the IGSN 71 was published by McConnell.
- ff.: Many stations, in particular situated at airports, got lost.
- 1987: **IAG Resolution No. 5** recommends an International Absolute Gravity Base Station Network (**IAGBN**).
- 1988: Many Latin American countries start absolute gravity measurements in international cooperation.
- 2014: IAG Comm. 1.3b starts in La Paz, Bolivia, a series of workshops on vertical reference frames with training on the processing of gravimetric data.

Absolute Gravity Stations in Latin American Countries (Examples)



Argentina



Brazil



Venezuela

All plots taken from Pacino and Blitzkow, IAG Report 41, 2019
<https://iag.dgfi.tum.de>

Gravity Reference Networks in Latin America



Left:

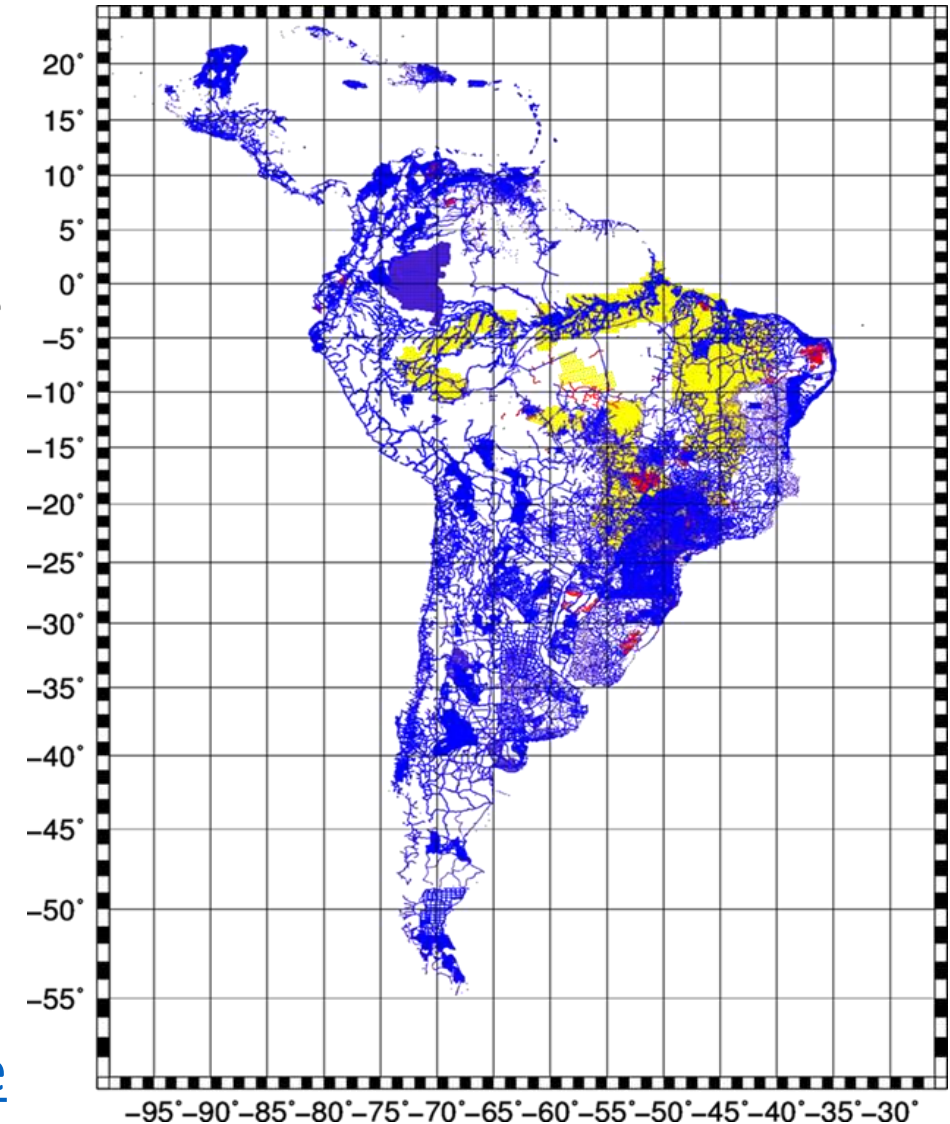
Absolute gravity data in Latin America at Bureau Gravimétrique International (BGI)

<http://bgi.omp.obs-mip.fr/>

Right:

Available gravimetry data in Latin America (Pacino and Blitzkow, IAG Report **41**, 2019)

<https://iag.dgfi.tum.de>



Geoid Determination in Latin America (1)

Obs.: The geoid is the reference surface for physical height reference systems.

1991-1997: Initial steps towards the foundation of a Sub-commission on the geoid for South America were taken by D. Blitzkow.

1997: First IAG Geoid School in Latin America (Rio de Janeiro, Brazil)

1999: Regional gravimetric geoid estimation is available at the International Geoid Service (IGeS).

2000: South America Geoid Workshop, São Paulo, Brazil.

2001: South American Geoid 2000 published.

2011: South American Geoid 2010 released.

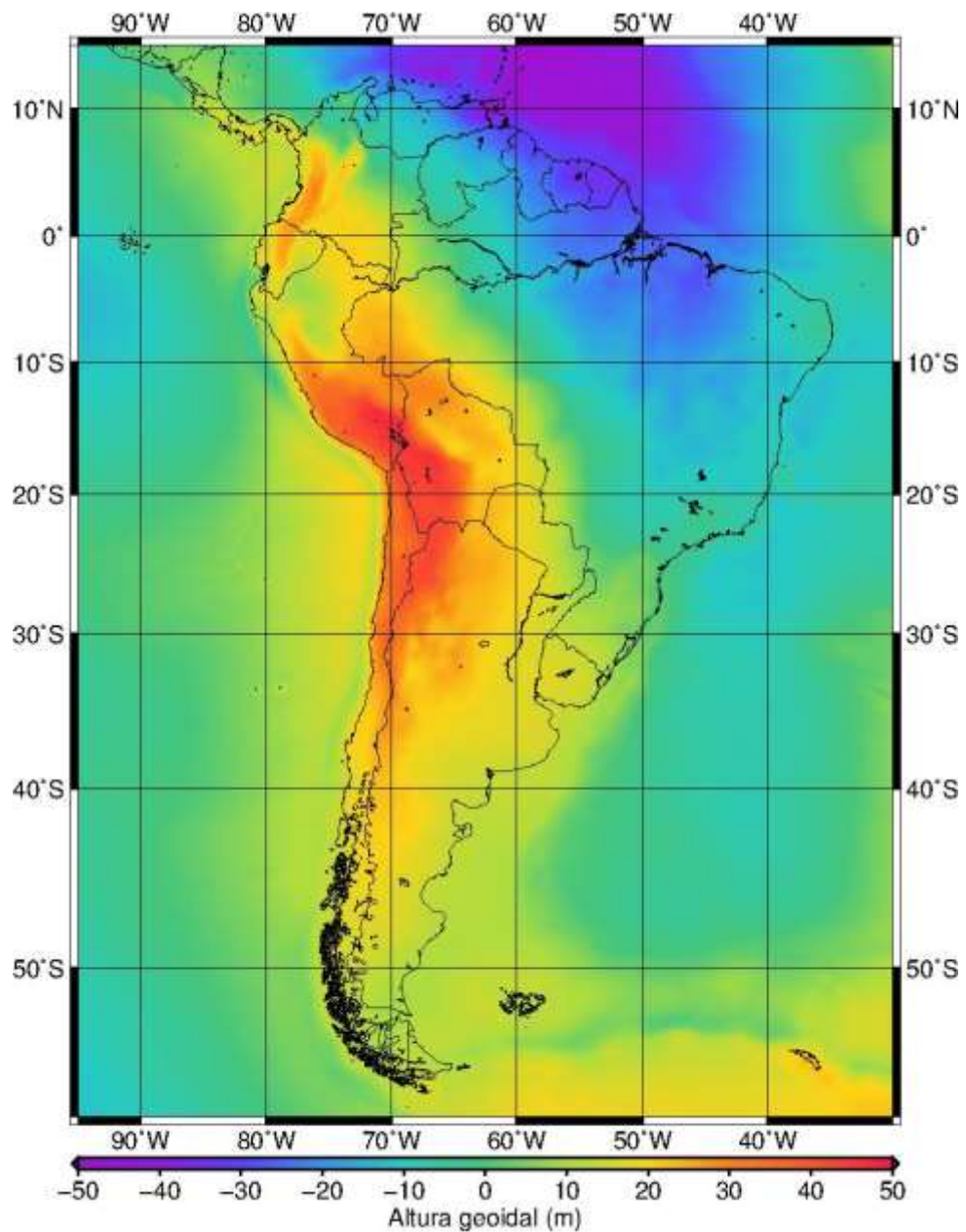
2015: South American Geoid 2014 released.

2019: South American Geoid 2015 released.

Geoid Determination in Latin America (2)

The South American Geoid 2015

(Pacino and Blitzkow, IAG Report **41**, 2019)



Crustal Deformation Models in Latin America (1)

Obs: Deformation models are necessary to consider station coordinate changes

Repeated GPS Campaigns

1988 – 2003: First GPS campaign for monitoring crustal deformation in Central America and South America (**CASA UNO**): Costa Rica, Panama, Colombia, Ecuador (Drewes et al. 1995, Kaniuth et al. 2002, Trenkamp et al. 2002/04);

1993 – 2001: South America – Nazca Plate Motion Project (**SNAPP**): Peru and Bolivia (Norabuena et al. 1998, Kendrick et al. 2001, 2003);

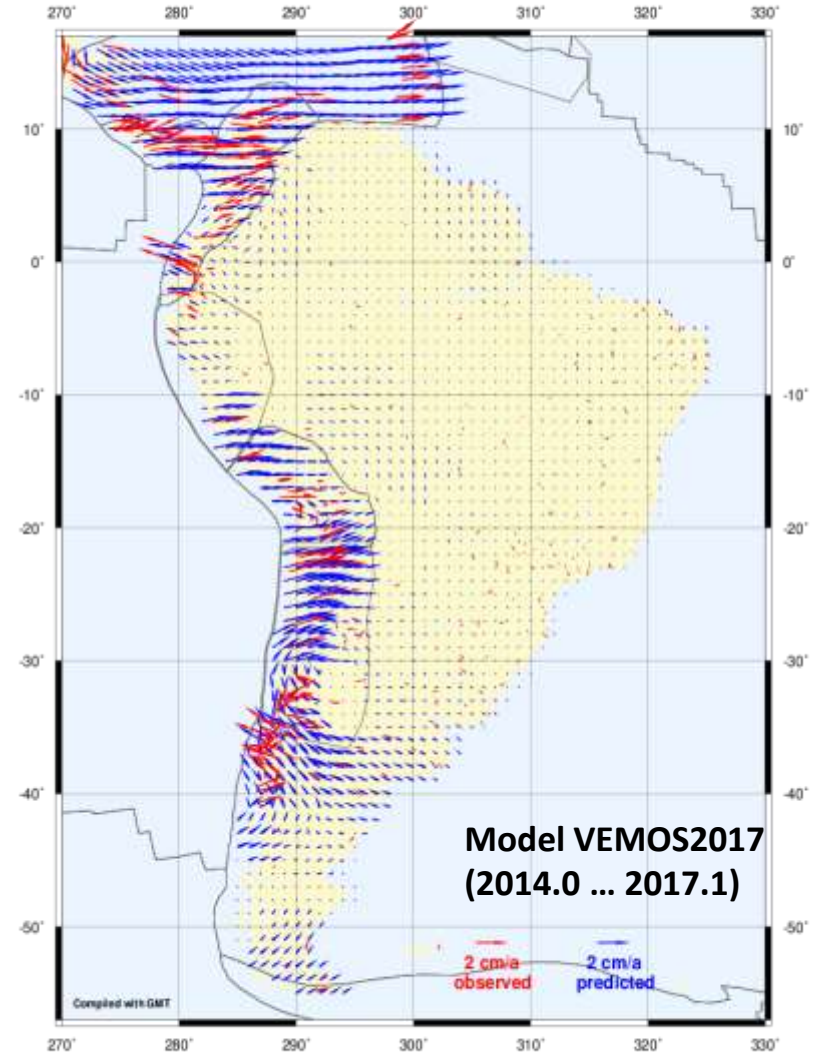
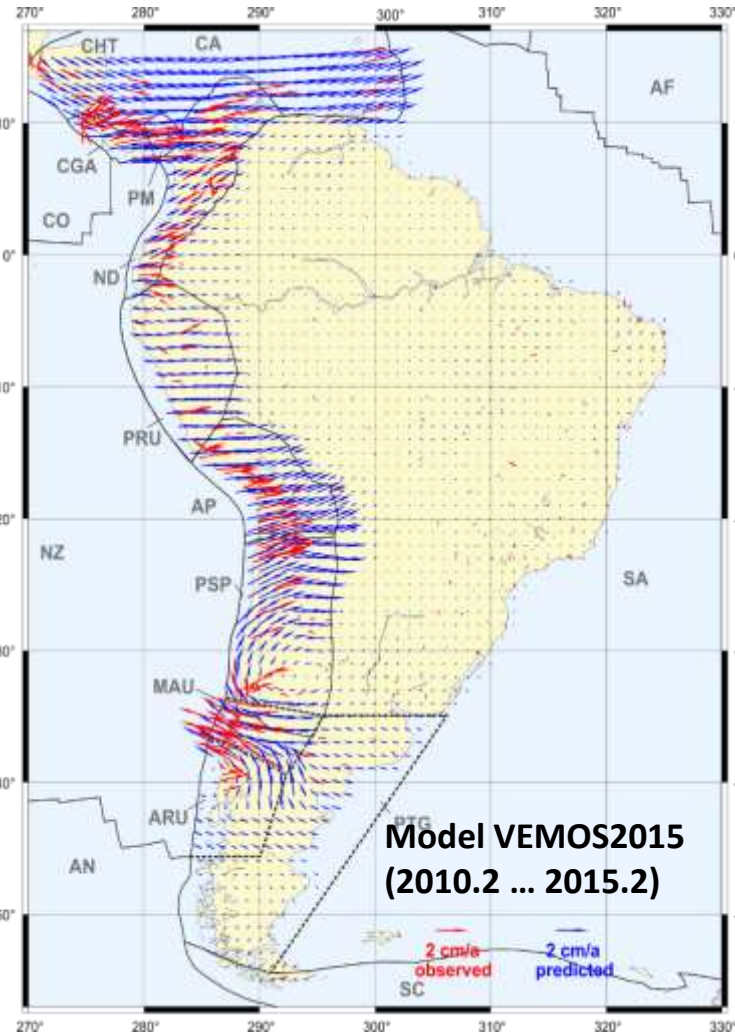
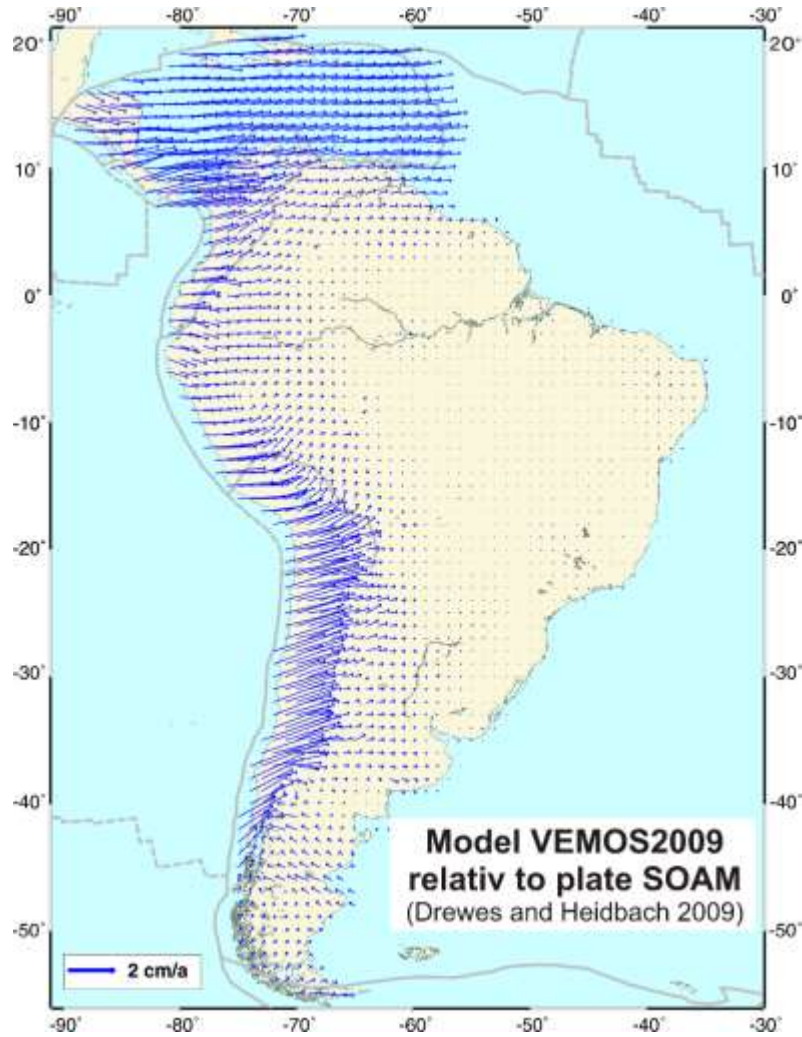
1993 – 2001: Central Andes Project (**CAP**): Chile, Argentina (Kendrick et al. 1999)

1994 – 1996: South America Geodynamics Activities (**SAGA**): Chile, Argentina (Klotz et al. 2001).

The GPS Campaigns were replaced by Continuously Observing Networks (CON). Continental deformation models were derived from GNSS reference frames like SIRGAS and the IGS RNAAC.

Crustal Deformation Models in Latin America (2)

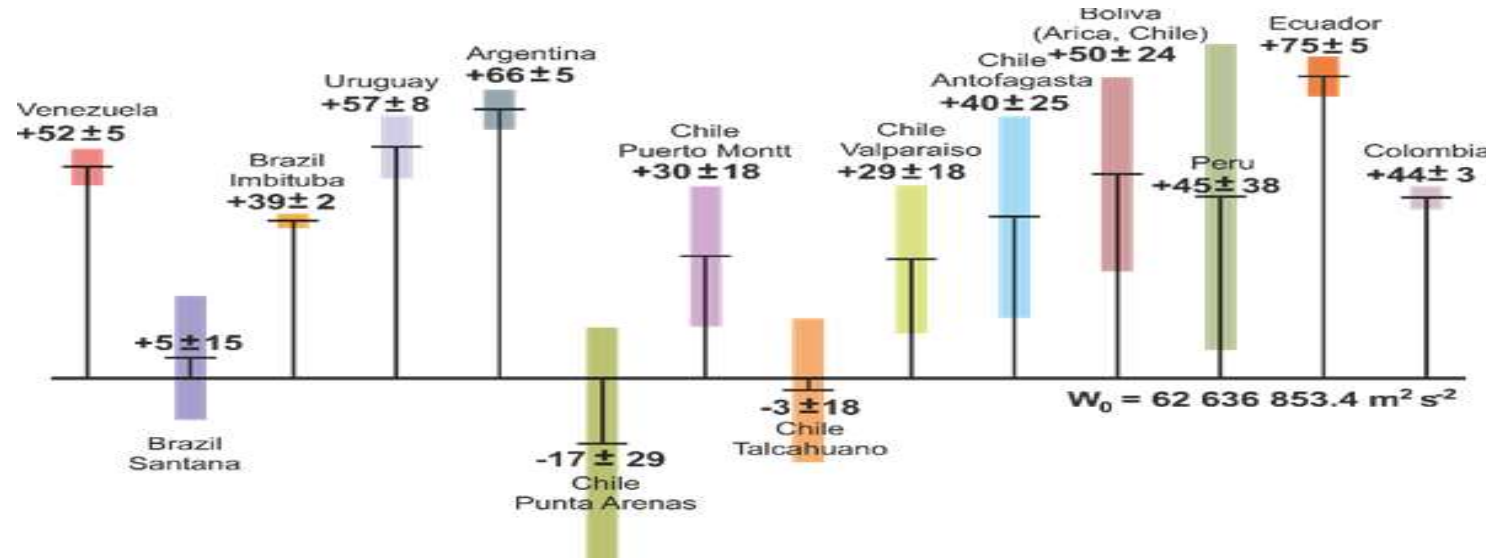
Velocity models for SIRGAS (reduced to the South America Plate)



Unified Height Systems in Latin America (1)

Obs.: Vertical Reference Systems are the basis for physical heights (classically from spirit levelling) referring to the Earth's gravity field.

Status: National height systems refer presently to different regional tide gauges.



Offset of national South American height systems [cm] (Sánchez 2018)

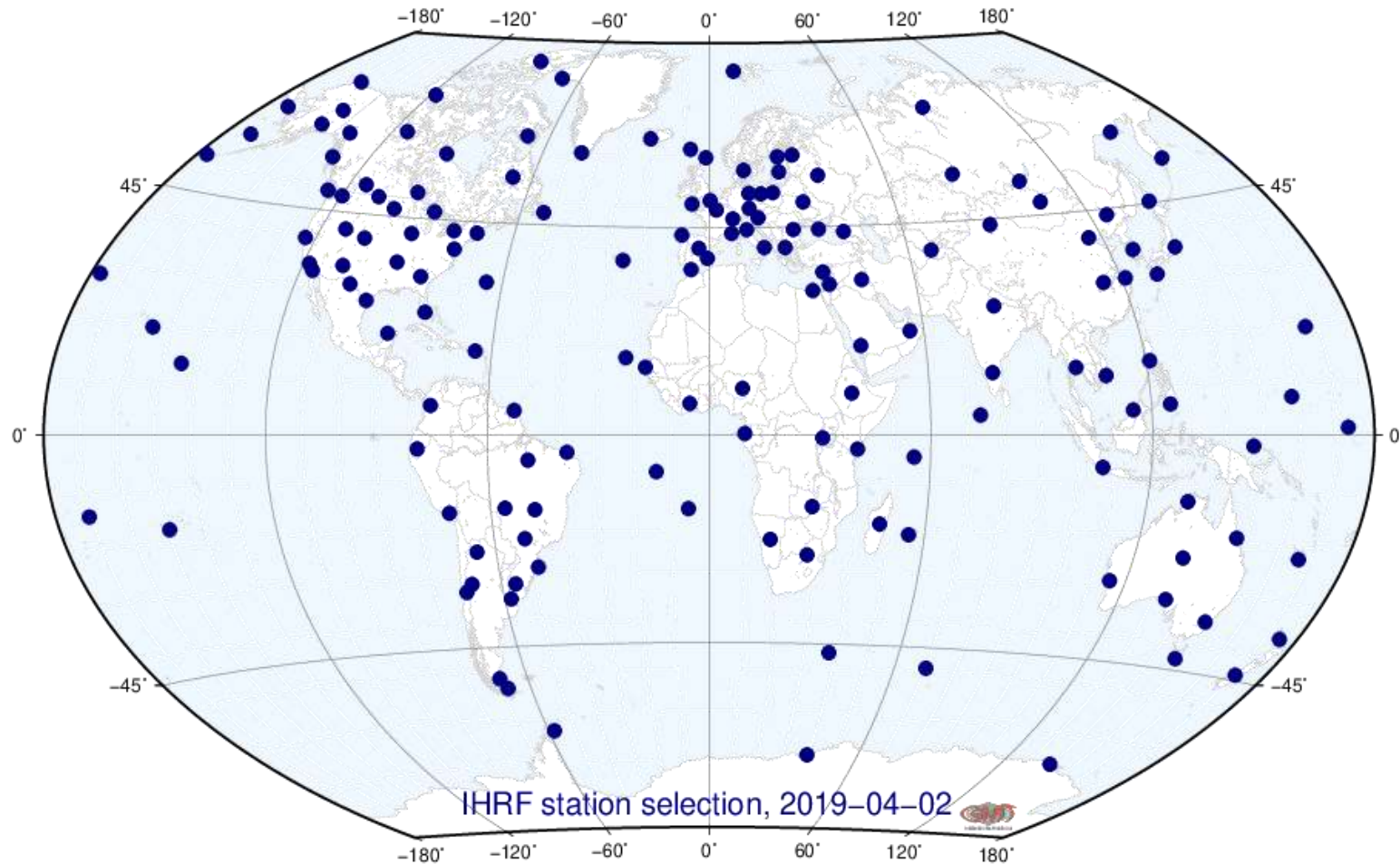
2003: IAG Inter-commission project Vertical Reference Frames.

2011: GGOS Focus Area “Unified Height Systems”;

Working Group “International Height Reference System”.

Unified Height Systems in Latin America (2)

Status of the realisation of the International Height Reference System (IHR)



L. Sánchez et al.,
IAG Report **41**, 2019)

Summary

The Statutes of the IAG define the objectives:

“Study, at the highest possible level of accuracy, all geodetic problems related to **Earth observation and global change**”.

Latin America plays the most important role in global change research. There is no comprehensive study without mention of the **Amazonas** region in climate research, and the **East Pacific** orogen in earthquake research.

Geoscientists of Latin America are active in the IAG Commissions, Inter-Commission Committees, Global Geodetic Observing System (GGOS), and IAG Scientific Services, which is gratefully acknowledged.

Thank you for your attention!