



# Geocentric Reference System for the Americas

## 4th Session UN-GGIM Americas

### April 2017, Santiago, Chile



**María Virginia Mackern**

Vicepresidente SIRGAS

Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina  
Universidad Nacional de Cuyo, Mendoza, Argentina  
Universidad Juan Agustín Maza, Mendoza, Argentina



**William Martínez**

Presidente SIRGAS

Agencia Nacional de Minería, Bogotá, Colombia

Con apoyo de:

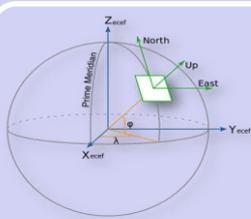


**UN-GGIM: Américas**  
COMITÉ REGIONAL DE LAS  
NACIONES UNIDAS SOBRE  
LA GESTIÓN GLOBAL  
DE INFORMACIÓN GEOESPACIAL  
PARA LAS AMÉRICAS



International  
Association of  
Geodesy

- Definitions and Brief history
- **SIRGAS in numbers today**
  - 1-SIRGAS Reference Frame
  - 2-SIRGAS: National datums
  - 3-SIRGAS: Unified heights
- SIRGAS in the UN-GGIM context
- **Next events 2017 and 2018**

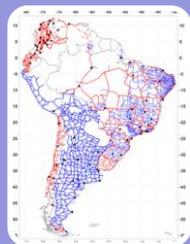


SIRGAS stands for The Geocentric Reference System for the Americas.

It is identical to the International Terrestrial Reference System (ITRS).



It is the definition, realization and maintenance of the 3D geocentric reference system. Its realization is a regional densification of the global International Terrestrial Reference Frame (ITRF).



It defines and maintains the gravity field-related vertical reference system in the Americas region.



The extension of the SIRGAS frame is carried out by national densifications, which serve as local reference frames.



It is a member of the IAG Commission 1 (Reference Frames)



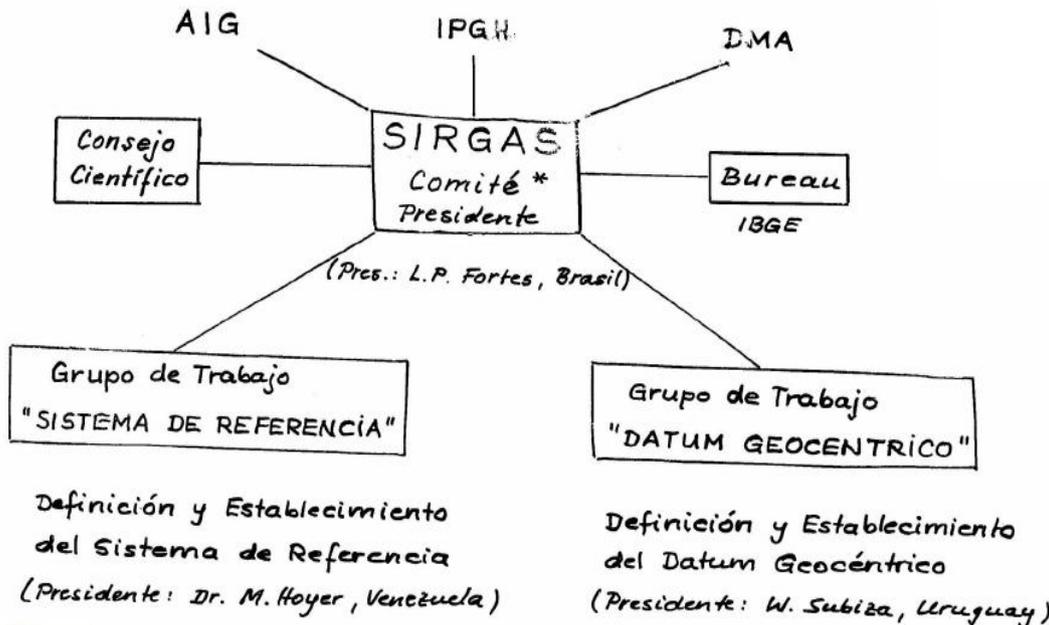
It is a Working Group of the Cartographic Commission of the Pan-American Institute of Geography and History (PAIGH)



**24 years ago**

**Asunción 1993**

**International Conference for definition of the Geocentric Datum for South America**



SIRGAS Grupo de Trabajo "SISTEMA DE REFERENCIA"  
Estaciones pre-existent



Propósito para el número de estaciones GPS por país

País	Número de Estaciones	Área (Mill. km <sup>2</sup> )
Argentina	6	2.78
Brasil	10	8.51
Bolivia	4	1.10
Chile	4	0.76
Colombia	4	1.14
Ecuador	3 (incl. Galapagos)	0.28
Guayana	1	0.21
Guayana Franc.	1	0.09
Paraguay	2	0.41
Peru	4	1.29
Suriname	1	0.16
Uruguay	2	0.18
Venezuela	4	0.91
Países de Islas	2	
<b>en total</b>	<b>48</b>	<b>~ 18 Mill. km<sup>2</sup></b>

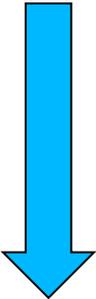
**1993**  
**Definition**  
**WG-I + WG-II**

**1995**  
**First GPS Campaign**

**1997**  
**Definition**  
**WG-III**

**2000**  
**Second GPS Campaign**

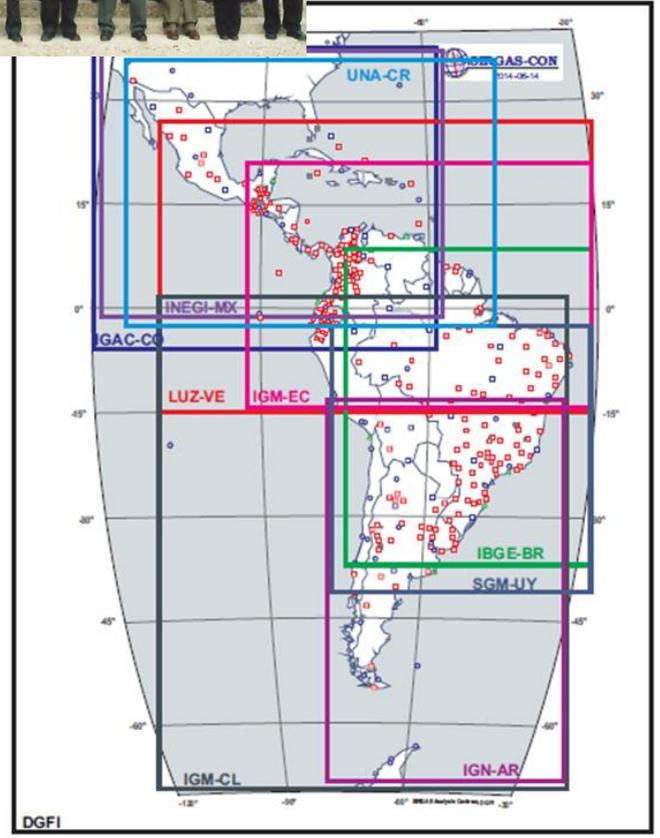
**2001**  
**7th UN Regional Cartographic Conference for the Americas, New York, USA**



- **Recommends** that member countries of the Americas integrate their national geodetic reference systems into a reference system compatible with SIRGAS;
- **Also recommends** that member countries of the Americas provide to SIRGAS gravity data for computation of the geoid as the reference surface of the vertical (height) system;
- **Further recommends** that member countries of the Americas correct their leveling by gravimetric observations in order to compute geopotential numbers and connect the leveling networks with neighboring countries, making all these information available to SIRGAS.

- **Also bearing in mind** that SIRGAS is supporting the participating countries in terms of knowledge transfer and training;
- **Recommends** that member countries of the Americas integrate their national geodetic reference systems into a reference system compatible with SIRGAS;
- **Also recommends** that member countries of the Americas provide to SIRGAS gravity data for computation of the geoid as the reference surface of the vertical (height) system;
- **Further recommends** that member countries of the Americas correct their leveling by gravimetric observations in order to compute geopotential numbers and connect the leveling networks with neighboring countries, making all these information available to SIRGAS.

- 2004**  
+ Central America countries
- 2005**  
SIRGAS-CON
- 2008**  
+ Local Analysis Centers
- 2008**  
+ Open SIRGAS Symposia
- 2009**  
First SIRGAS School  
Build capacities
- 2012**  
First SIRGAS Workshop on Vertical datum



CEPGE-Ec



IGN-Ar



IGM-CI



INEGI-Mx



IGAC-Co



SGM-Uy



**DGFI TUM**



**IBGE-Br**



CNPDG-Cr



CPAGS-Ve



**UNLP-Ar**



**CIMA-Ar**



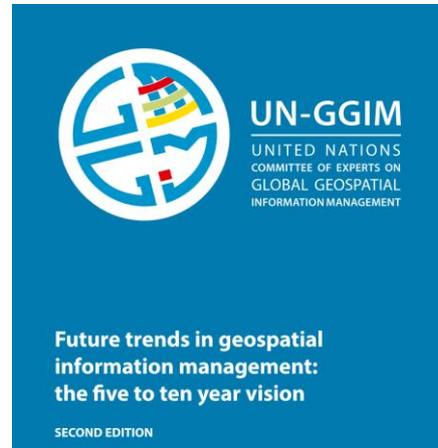
**2012**  
Joint Action Action

**2014**  
Working Group on the Global Geodetic Reference Frame GGRF of the UN-GGIM

**2016**  
Joint Action Plan V. 2

## IPGH + SIRGAS+CP-IDEA + GEOSUR 2013-2015 JOINT ACTION PLAN

to expedite the development of Spatial Data infraestructura of the Americas



## IPGH + SIRGAS+ + UN-GGIM: Americas + GEOSUR 2016-2020 JOINT ACTION PLAN



The Pan American Institute of Geography and History (PAIGH)  
The Geocentric Reference System for the Americas (SIRGAS)  
The Permanent Committee on Spatial Data Infrastructure for the Americas (PC-IDEA)  
The CAF/PAIGH Geospatial Network for Latin America and the Caribbean (GeoSUR)

2013-2015 JOINT ACTION PLAN  
TO EXPEDITE THE DEVELOPMENT  
OF SPATIAL DATA  
INFRASTRUCTURE OF THE AMERICAS

Santiago Borrero, Secretary General, PAIGH  
Claudio Brunini, President, SIRGAS  
Luz Paulo Souto Fortes, President, PC-IDEA  
Eric van Praag, Regional Coordinator, GeoSUR

Instituto Panamericano de Geografía e Historia (IPGH)  
Sistema de Referencia Geocéntrico para las Américas (SIRGAS)  
Comité Permanente para la Infraestructura de Datos Geoespaciales de las Américas (CP-IDEA)  
Red Geoespacial de América Latina y el Caribe (CAF/IPGH-GeoSUR)

PLAN DE ACCIÓN CONJUNTO 2013-2015  
PARA ACELERAR EL DESARROLLO DE LA  
INFRAESTRUCTURA DE DATOS ESPACIALES  
DE LAS AMÉRICAS

Santiago Borrero, Secretario General IPGH  
Claudio Brunini, Presidente SIRGAS  
Luz Paulo Souto Fortes, Presidente CP-IDEA  
Eric van Praag, Coordinador Regional GeoSUR

To represent the Americas  
region in the WG on the  
UN-GGIM GGRF



Instituto Panamericano de Geografía e Historia (IPGH)  
Sistema de Referencia Geocéntrico para las Américas (SIRGAS)  
Comité Regional de las Naciones Unidas sobre la Gestión Global de Información Geoespacial para las Américas (UN-GGIM: Américas)  
Programa CAF/IPGH GeoSUR

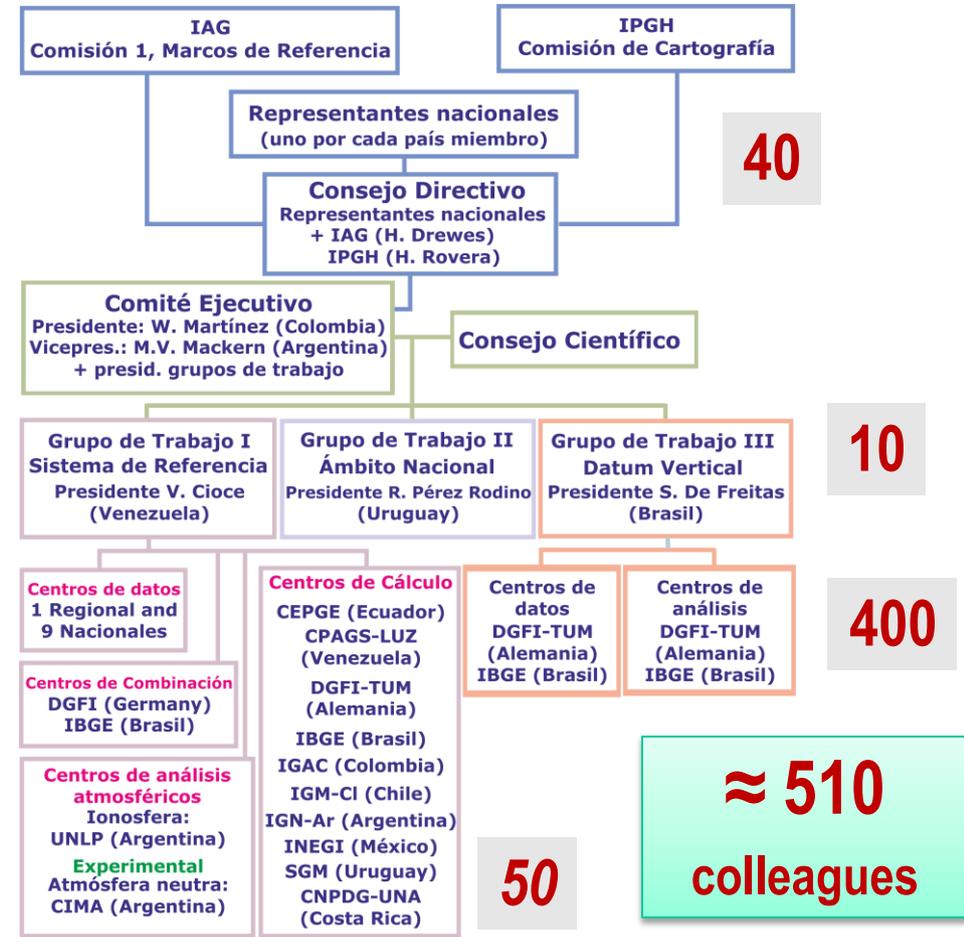
PLAN DE ACCIÓN CONJUNTO 2016-2020  
PARA ACELERAR EL DESARROLLO DE LA  
INFRAESTRUCTURA DE DATOS ESPACIALES  
DE LAS AMÉRICAS

Rodrigo Barriga Vargas, Secretario General IPGH  
William Martínez Díaz, Presidente SIRGAS  
Rolando Ocampo Alcántar, Presidente UN-GGIM: Américas  
Santiago Borrero Mutis, Coordinador Regional GeoSUR



SIRGAS coordinates the largest geodetic infrastructure in Latin America and the Caribbean.

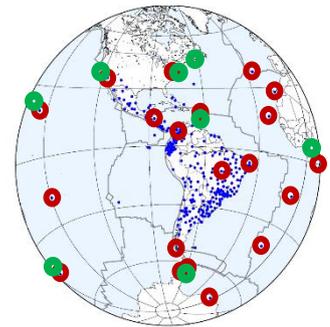
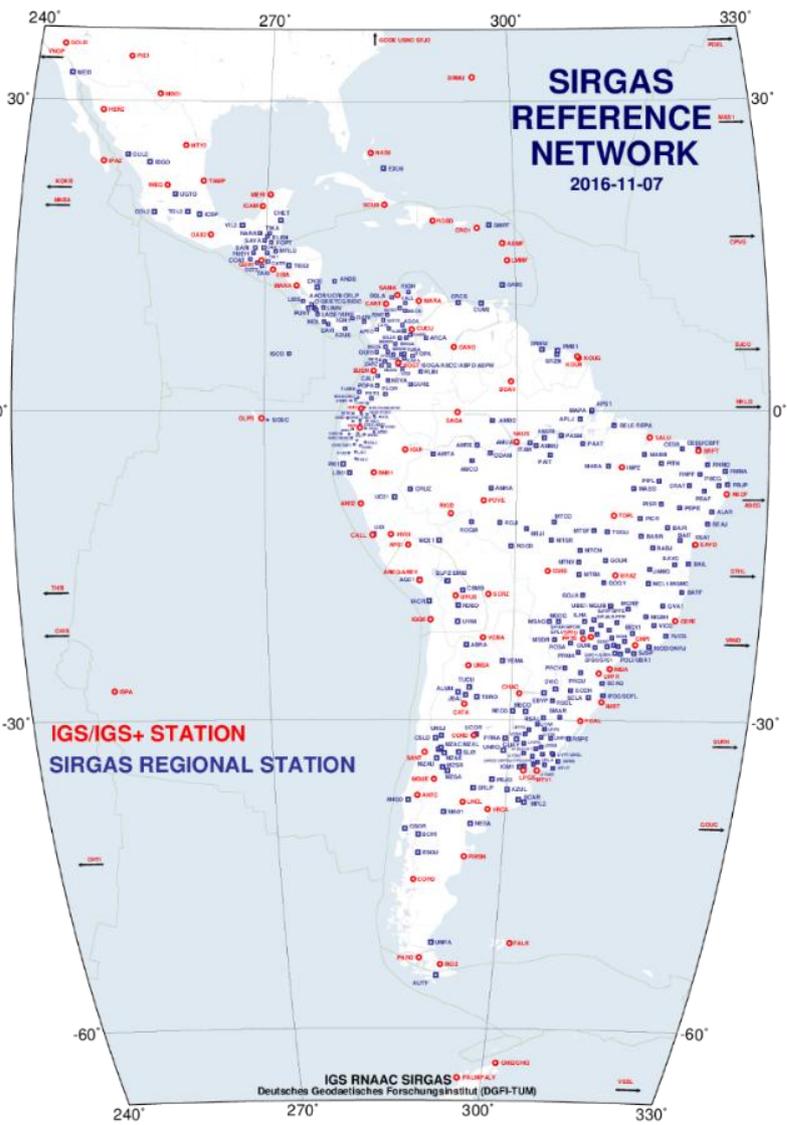
More than 50 institutions from 20 countries



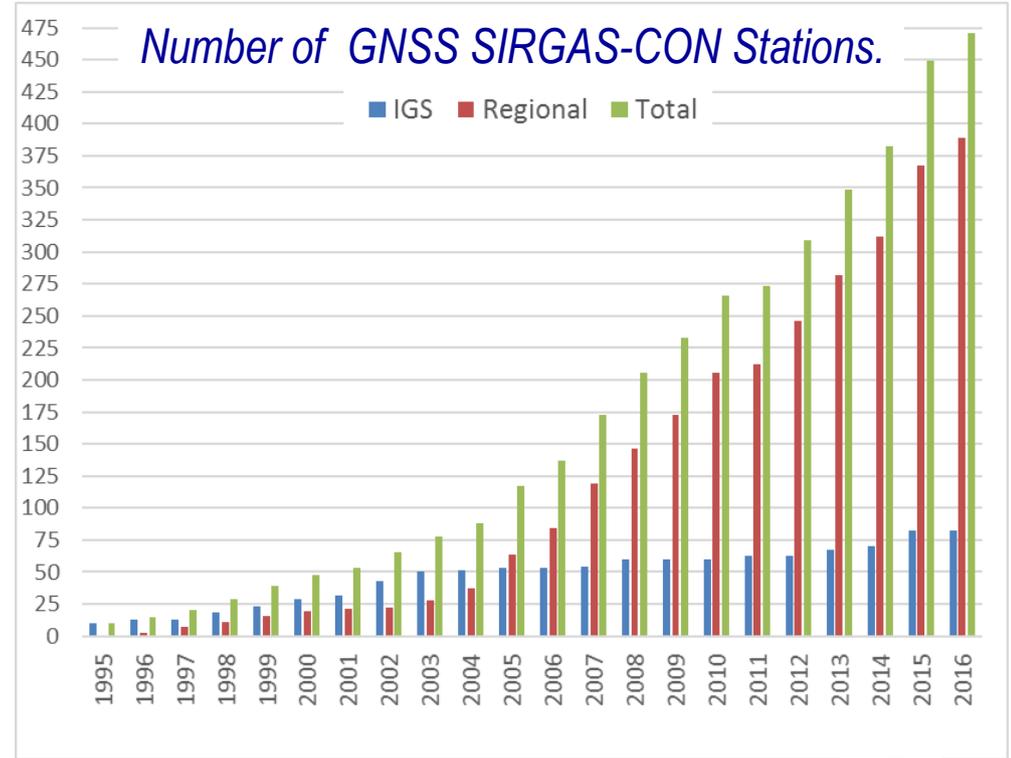
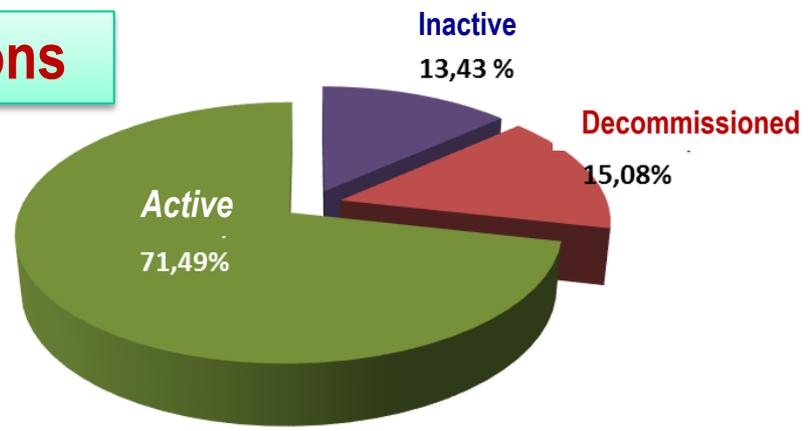
Status 2015-11-21

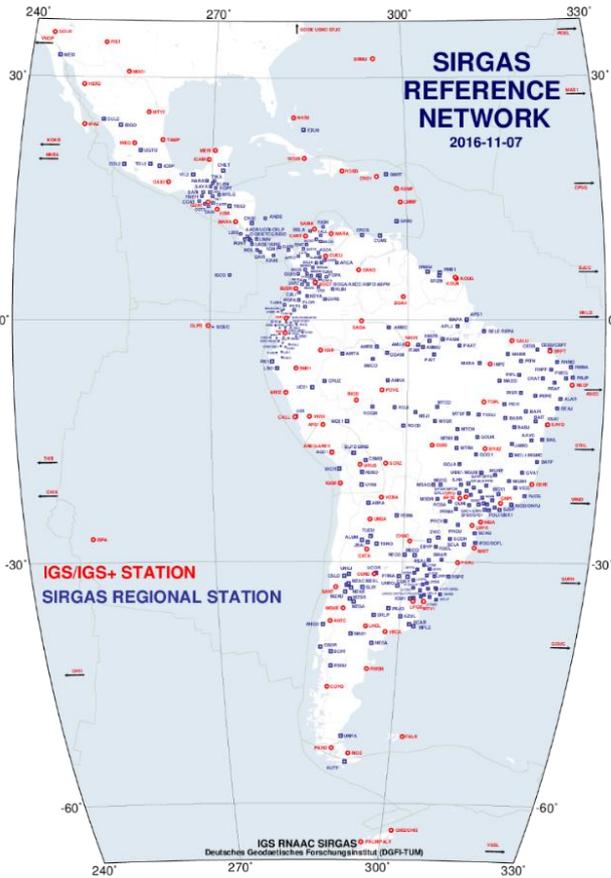


**≈350 GNSS stations**



- Fiducial stations
- New Fiducial stations

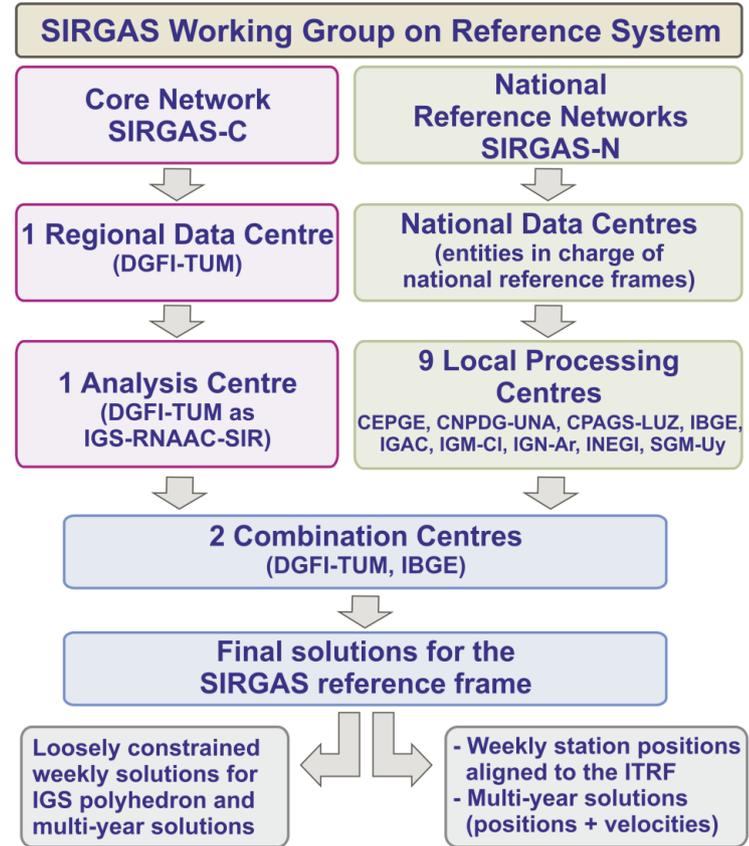




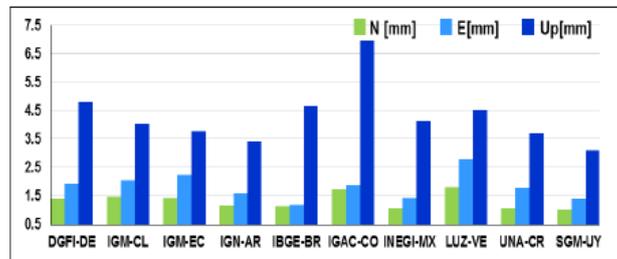
Extremely accurate

The highest level of **theory, technology and data analysis** has to be used to achieve positions with mm-accuracy and velocities with 0.1 mm/a. **Stability** over decades has to be guaranteed.

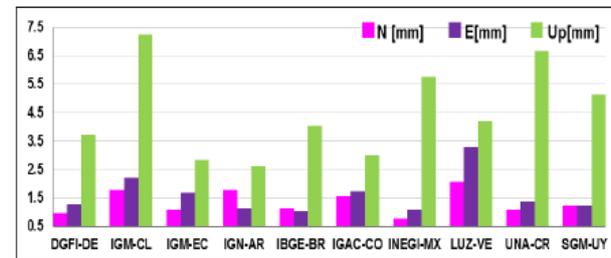
## SIRGAS-CON

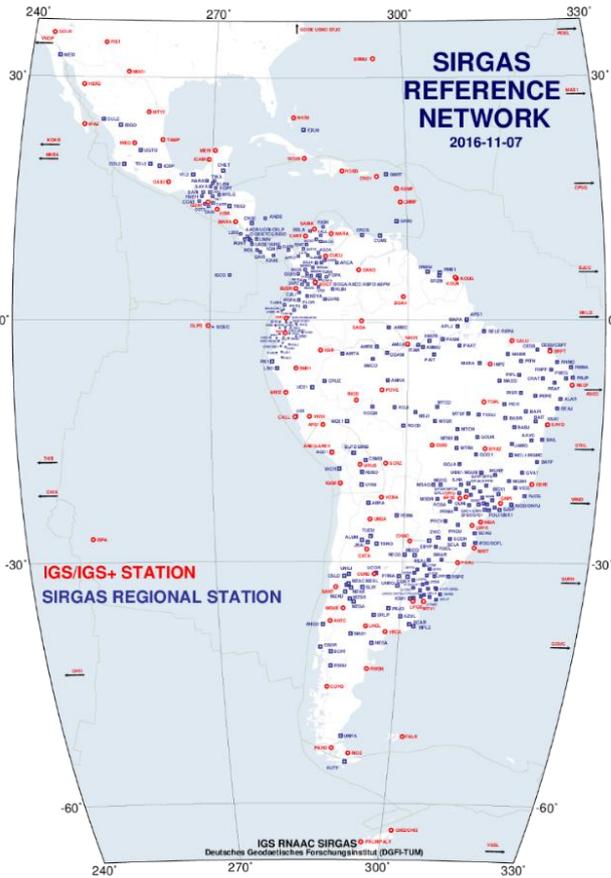


**Consistency of the weekly coordinate in the individual solutions**



**Reliability of the individual solutions (comparison with IGS)**



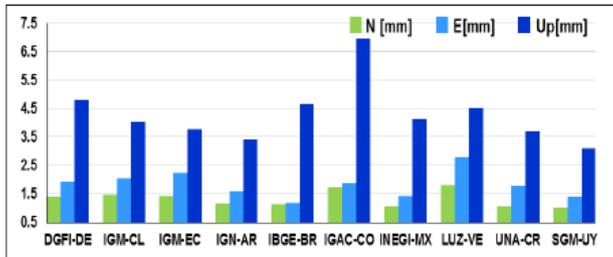


Extremely accurate

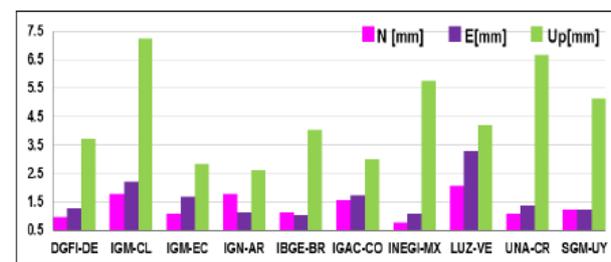
The highest level of **theory, technology and data analysis** has to be used to achieve positions with mm-accuracy and velocities with 0.1 mm/a. **Stability** over decades has to be guaranteed.

## SIRGAS-CON

**Consistency of the weekly coordinate in the individual solutions**



**Reliability of the individual solutions (comparison with IGS)**

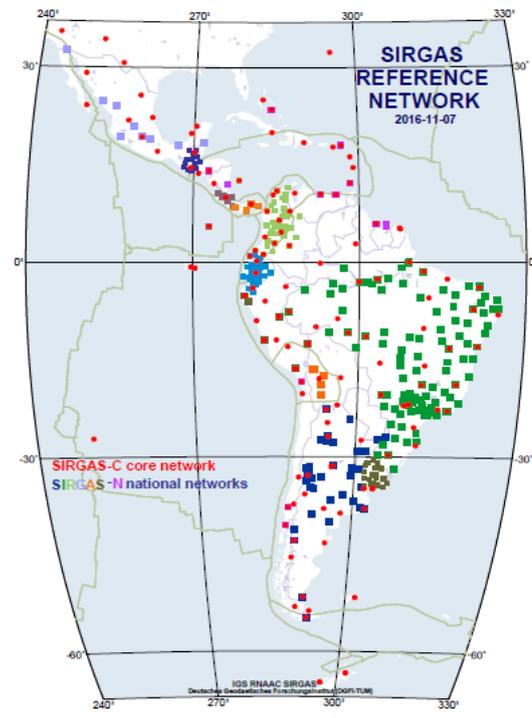


## SIR15P01 – VEMOS2015 Model

Period: 2010.2 (2012.2) - 2015.2;  
471 stations;  
Frame: IGb08 epoch 2013.0;  
Precision: N - E =  $\pm 1.0$  mm/y,  
h =  $\pm 1.2$  mm/y

Country	Nacional Network / CON	Number of stations
Argentina	POSGAR/ RAMSAC	178/ 45
Bolivia	MARGEN / CON	125/ 7
Brasil	SIRGAS2000 /RBMC	1903/128
Chile	SIRGAS-CHILE /CON	269/9
Colombia	MAGNA-SIRGAS /MAGNA-ECO	70/47
Costa Rica	CR05 / CON	15
Ecuador	Red básica GPS /REGME	135/ 37
El Salvador	SIRGAS-ES2007 / CON	34/1
Guyana Francesa	RGFG /CON	7 / 1
Guatemala	CORS	15
México	RGNO /REGNA	17
Panamá	MGN /CON	17/7
Perú	PERU96 / REGPMOC	47 / 14
Uruguay	SIRGAS-ROU98 / REGNA-ROU	17 / 23
Venezuela	SIRGAS-REGVEN / REMOS	156 / 3

National datums  
Extremely reliable  
National datums are basic for **legal** affairs (borders), **geo-information**, and constructions. Required precision is not as high, but it has easily to be handled & results have to be reliable.

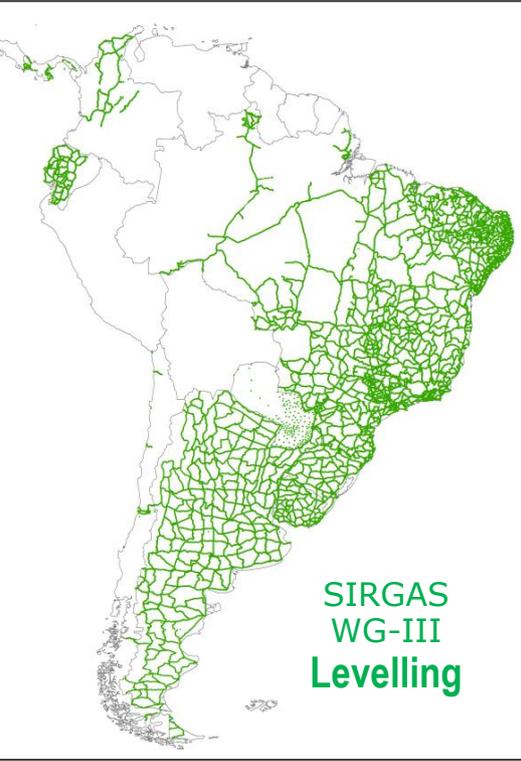


**Central America :**  
**5 countries**

**South America: 10**  
**countries**

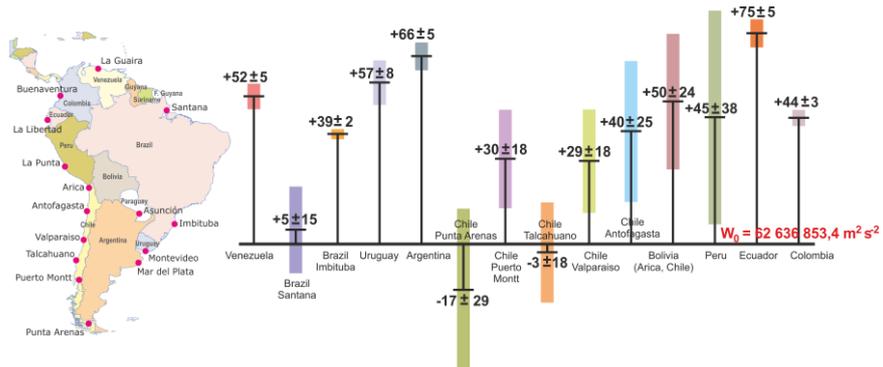


**SIRGAS-RT**  
The RT Station number and RT casters number are increasing



Unified heights  
Highly consistent  
Heights for use in practice are in general physically defined, referring to the gravity field. Therefore position & gravity related parameters must be completely consistent.

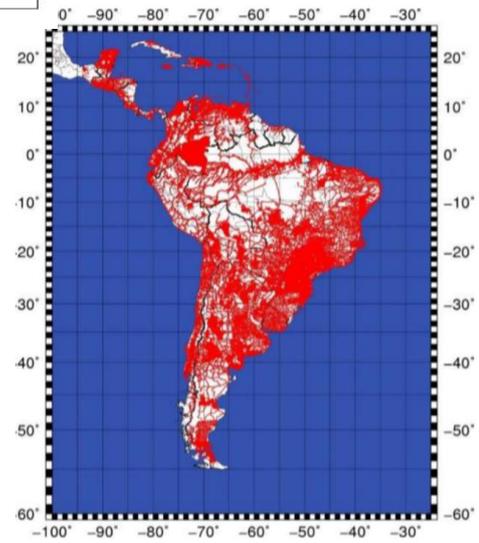
## 15 Vertical Datums in South America. (L.Sanchez)



Large gaps in leveling lines and gravity

Gravity Densification Network in South/Central America  
951.928 points

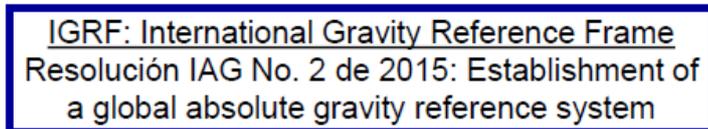
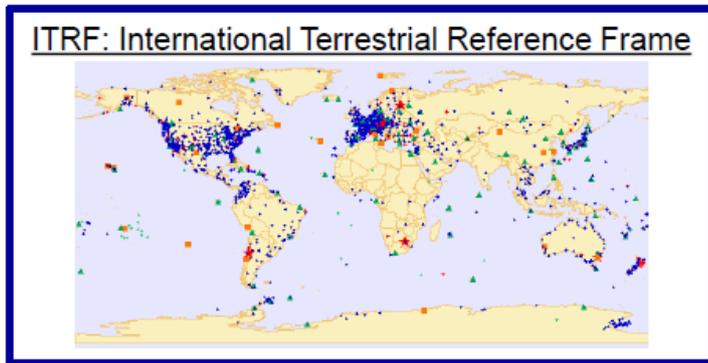
(Blitzkow et al. 2016)



- 1) **The 2015 United Nations General Assembly** adopted the Resolution A/RES/69/266 to promote the Establishment of a Global Geodetic Reference Framework (GGRF) for sustainable development.
- 2) **The International Association of Geodesy (IAG)**, as the responsible organization for the advance of Geodesy at the World, drew up a paper describing the scientific bases for the GGRF implementation in order to achieve the UN objectives.
- 3) **The UN** (through the Resolution and the new **permanent and regional committees for the GGRF**) provides the necessary governmental framework for the promotion and **establishment of GGRF**.
- 4) **The IAG** provides the scientific and theoretical foundations, infrastructure observational and analytical methods, and a broad human network composed by hundreds of experts working together in favor of the GGRF.

The establishment of the GGRF (Global Geodetic Reference Framework ) is one of the main goals of GGOS (Global Geodetic Monitoring System) and IAG (International Association of Geodesy).

## Terrestrial Componente



## The concept of the IAG on GGRF

Common reference frame for identifying and describe the geometry and Gravity field of the Earth at any time.

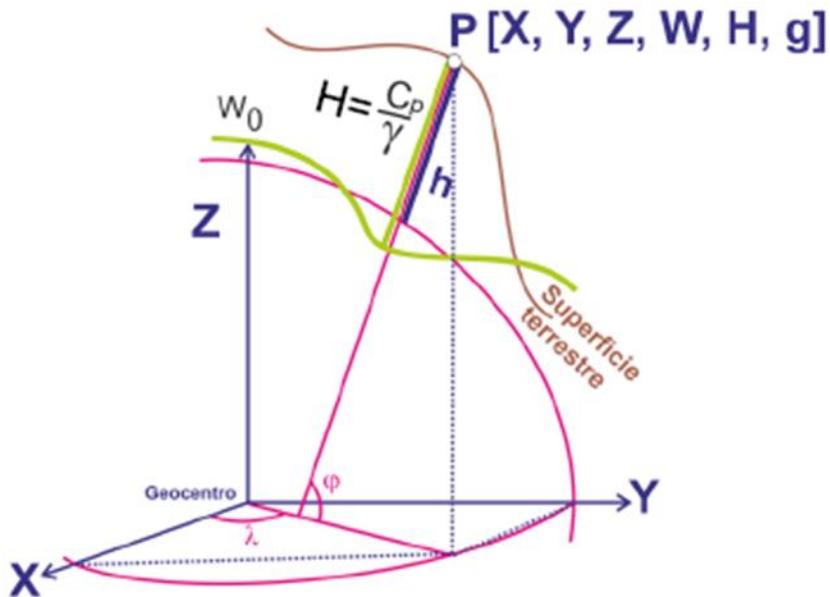
The accurate realization of the GGRF (GGRF) is indispensable to generate reliable geospatial information required in:

- \* The determination of the changes that take place within the Earth System.
- \* The generation of policies for sustainable development

**SIRGAS has been working, in this, since 24 years in the American region.**

The establishment of the IHRF (International Height Reference Frame) is one of the main goals of GGOS (Global Geodetic Observing System) and the IAG.

## Terrestrial Component



## The concept of IAG on GGRF:

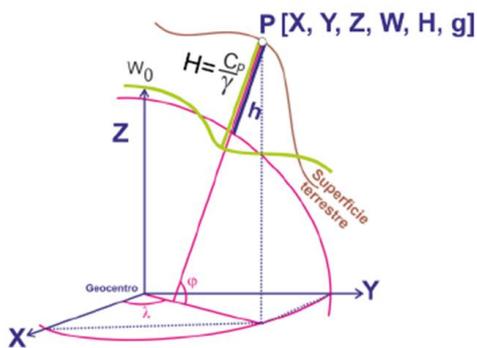
A common reference frame to identify and describe the geometry and gravity field of the Earth at any time.

The coordinates of any point must be given by the geocentric position X,Y,Z, the gravity potential W, its physical height H, and the gravity value g.

**SIRGAS has been working on these topics since 1993 in the American region.**

The establishment of the IHRF is one of the main goals of GGOS and the IAG.

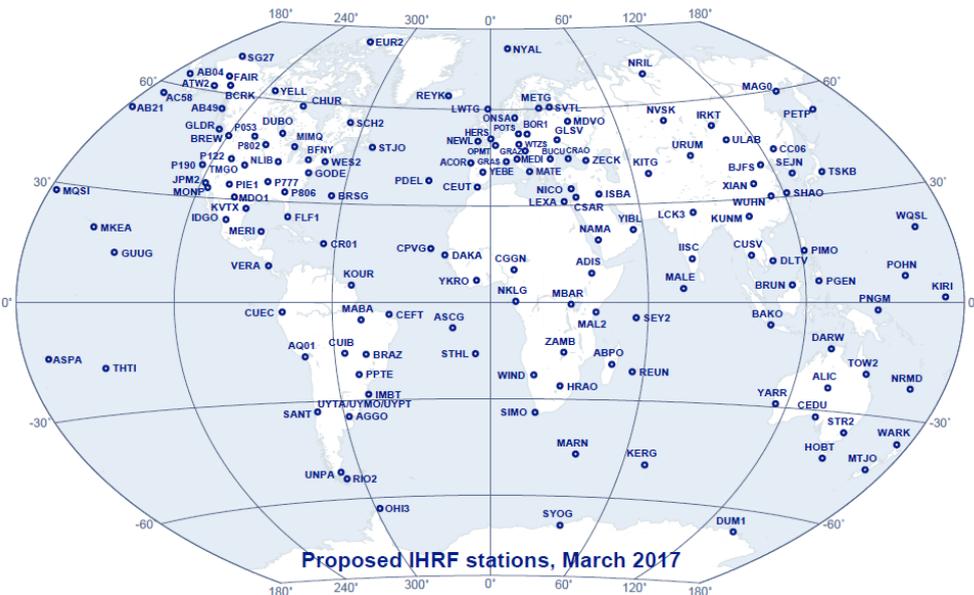
## The main current SIRGAS precepts related to SVRS :



- Referred to the IHRF global reference level  $W_0$ ;
- Performed by physical altitudes [ $HP = f(CP)$ ];
- Connected to the geometric component of SIRGAS;
- Associated with an specific reference epoch; It should consider the temporal variations.
- Linked to a GGRF station profile.

## Implementation of the IHRF in SIRGAS

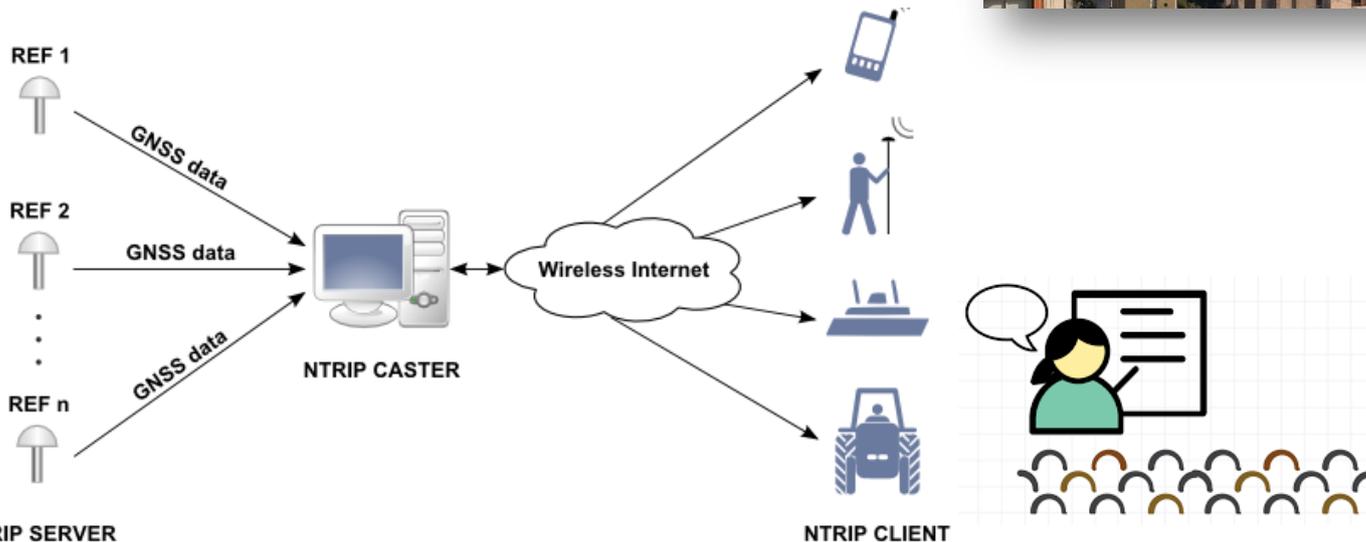
SIRGAS has selected stations that will be part of the IHRF and the countries have undertaken to carry out complementary measurements of  $\varphi$ ,  $\lambda$ ,  $h$  (GNSS),  $H$  (leveling) and  $g$  (gravity) in the sites and their surroundings according to the guidelines of GGOS



November 22 - 24: Workshop on Real-Time infrastructure, products and applications.

November 27 - 29: Symposium

November 30: Workshop on Satellite Laser Ranging (SLR) instrumentation in Latin America



November maybe.



Symposium  
Workshop on : SLR, VRS or RT



We hope you too....

The collaborative effort continues.

SIRGAS faces new challenges according to social and scientific needs.

More data, more accuracy, a better distribution...

**¡¡ Thank you very much!!**

To those who generate data and maintain the stations.

To the data, processing and combination centers.

To those that collaborate with the Working Groups.

To PAIGH and IAG.

To UN-GGIM: Americas

**¡See you in Mendoza 2017!**