SIRGAS: The Geocentric Reference System for the Americas
Report 2018-2019

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SIRGAS was created in 1993

SIRGAS was created in 1993 during the International Conference for the Definition of a South American Geocentric Reference System held in Asuncion, Paraguay. It was promoted and supported by IAG, PAIGH and the former DMA, today National Geospatial-Intelligence Agency (NGA).

26 years ago

Asunción, 1993

SIRGAS acronym

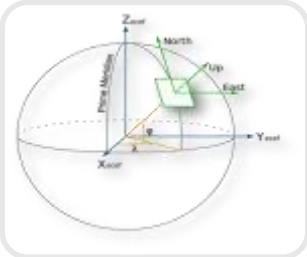
1993: **Geocentric Reference System for South America**

The 2000 GPS campaign was extended to North- and Central America.

2001: **Geocentric Reference System for the Americas**

The United Nations Organization, at its 7th Cartographic Conference for The Americas (New York, January 22 – 27, 2001), **recommend to adopt SIRGAS as official reference system in all the American countries**.

SIRGAS objectives



Define a tridimensional geocentric reference system

SIRGAS adopted the conventions provided by IAG

Realice and maintain a geocentric reference frame.

(the network of stations with high-precise geocentric coordinates [X, Y, Z] and their variation with time [Vx, Vy, Vz]).

WORKING GROUP I

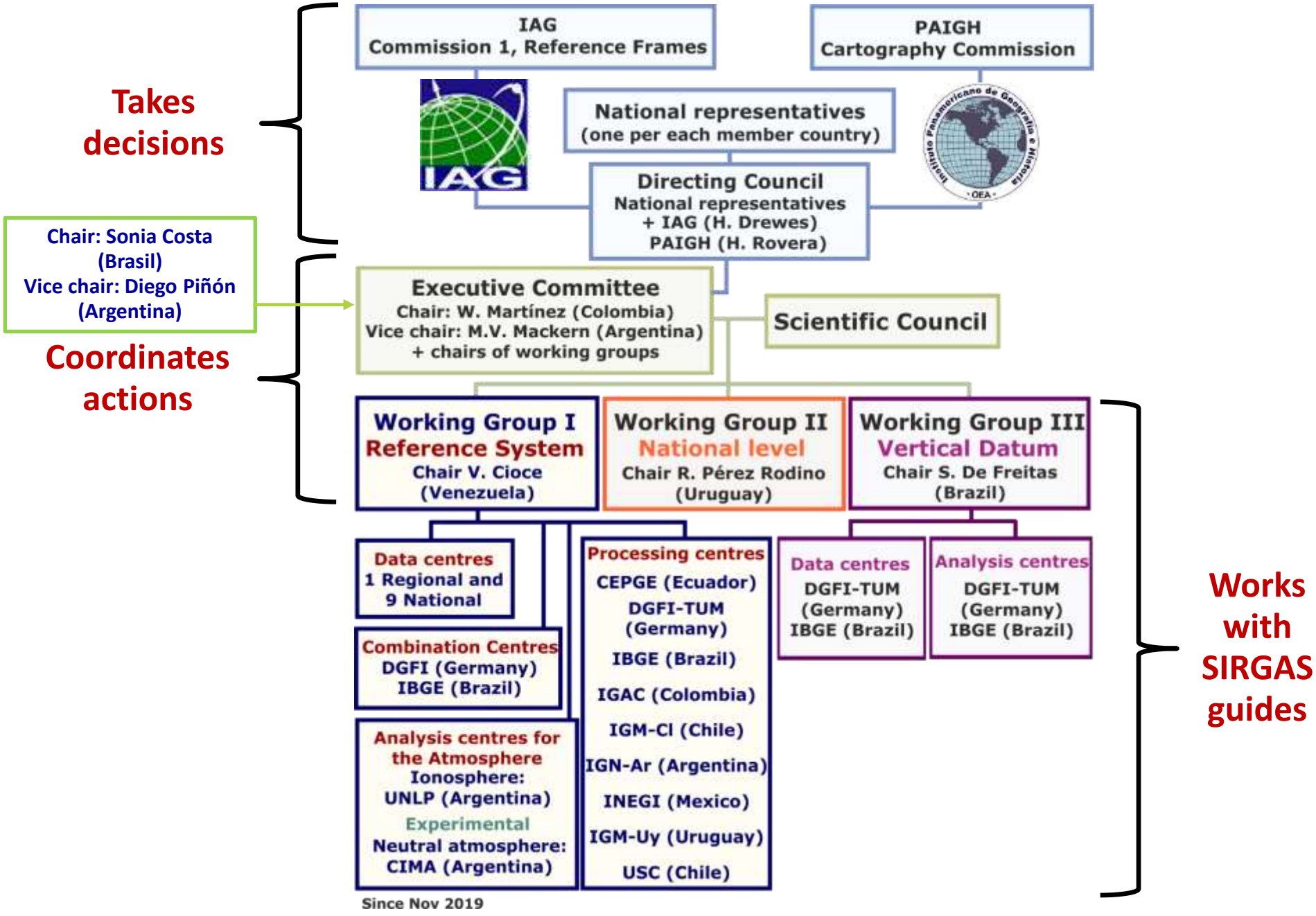
Densificate the continental reference frame in the SIRGAS member countries, as well as promote and supporte of its utilization in practical and scientific applications

WORKING GROUP II

Define and realice the unified vertical reference system based on the consistent combination of physical and geometric heights, include the determination of the reference frame variations with time.

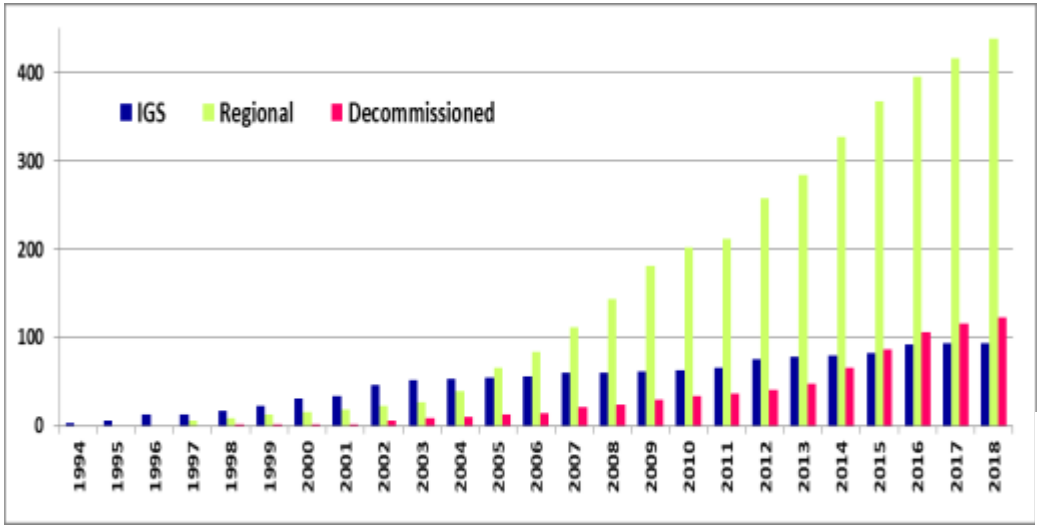
WORKING GROUP III

SIRGAS Structure



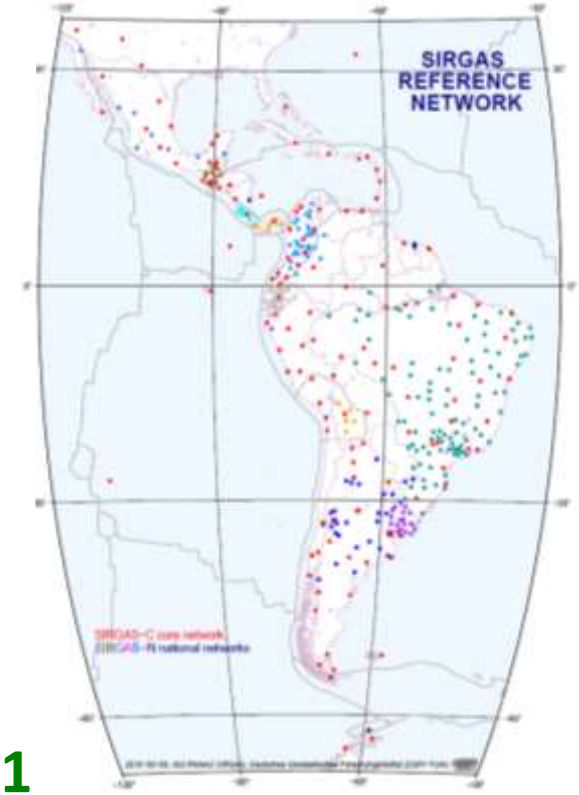
WG I: Reference System

SIRGAS-CON growth



59
IGS stations

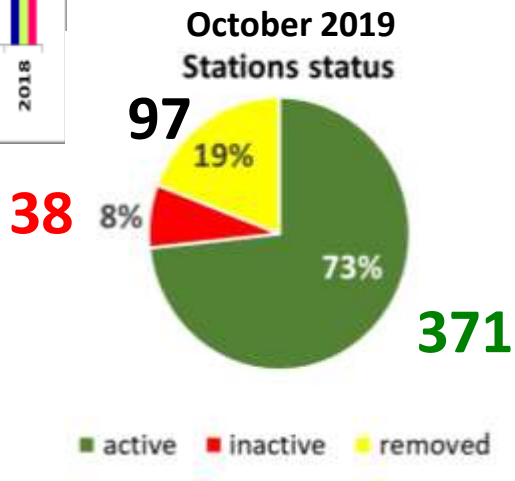
506
SIRGAS-CON



339 GPS + GLONASS

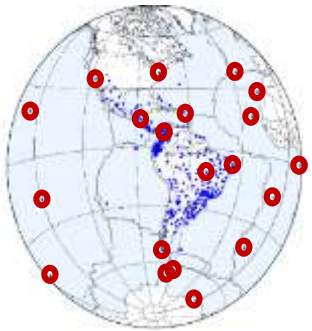
79 GPS + GLONASS + Galileo

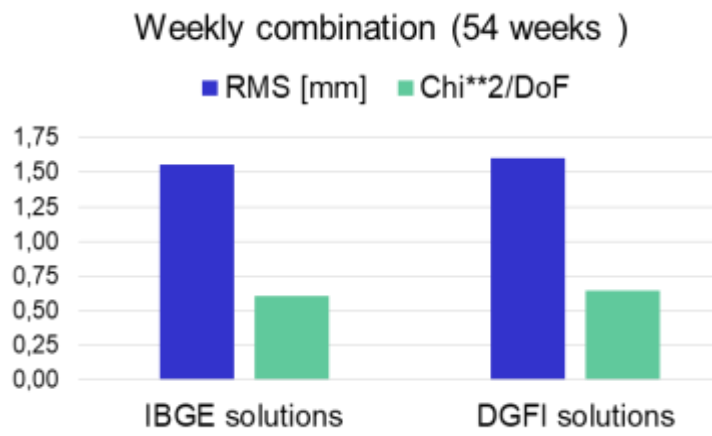
43 GPS + GLONASS + Galileo + BeiDou



- Oriented to ensure the availability of a highly accurate reference frame consistent with the ITRF.
- Materialized by more than 400 GNSS continuous stations.
- It densifies the ITRF in Latin America and the Caribbean being rigorously processed at weekly intervals.

Fiducial stations





SIRGAS WG I Reference System (3)

SIRGAS WG I structure

DGFI-TUM
(Deutsches Geodätisches Forschungsinstitut – TUM)
→ desde **junio-1996** en condición de IGS RNAAC SIR

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

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

LUZ
(Universidad del Zulia)
→ desde **enero-2010**

SGM
(Servicio Geográfico Militar)
→ desde **enero-2010**

IGM
(Instituto Geográfico Militar)
→ desde **enero-2010**

IGN
(Instituto Geográfico Nacional)
→ desde **enero-2011**

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

IGM
(Instituto Geográfico Militar)
→ desde **enero-2013**

UNA
(Universidad Nacional)
From 1-2013 to 1-2019

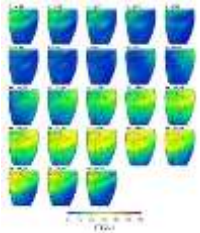
USCH
Universidad de Santiago de Chile
→ from 5-2019

1 European institution

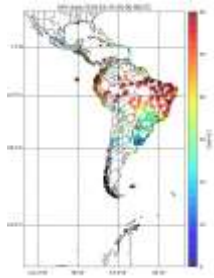
12 Latin American institutions

UNLP-Ar
Ionospheric Analysis Centre

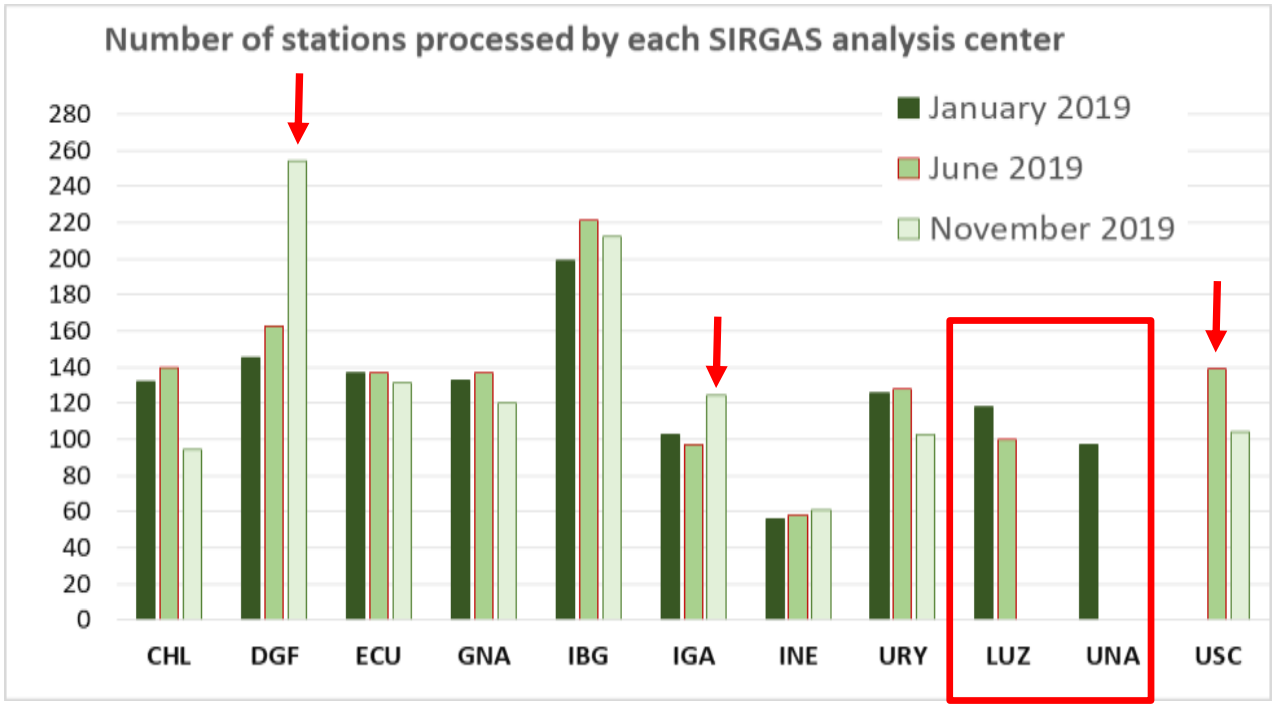
from 2003 to 2015



CIMA-Ar
Neutral Atmosphere Analysis Centre
Facultad de Ingeniería, UNCuyo, Umaza, from 2013
→



Stations distribution for processing



Congratulations USCH !!

In May 2019, Universidad de Santiago de Chile began as SIRGAS Processing Centre

USCH

UNA
(Universidad Nacional)
From 1-2013 to 1-2019

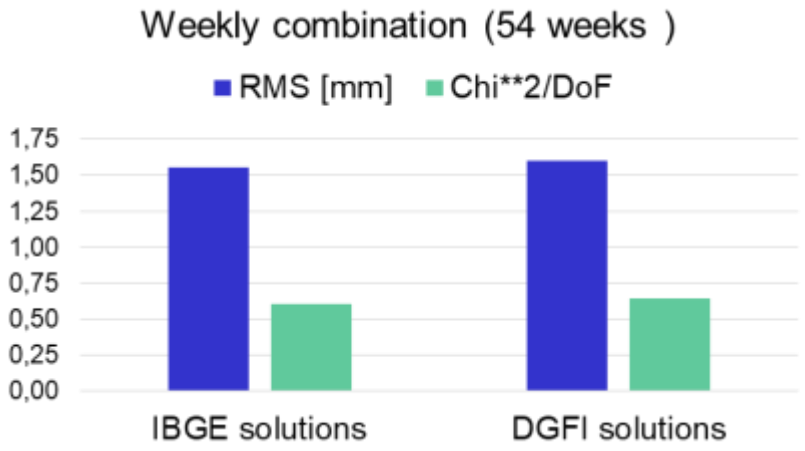
LUZ
(Universidad del Zulia)
From 1-2010 to 6-2019

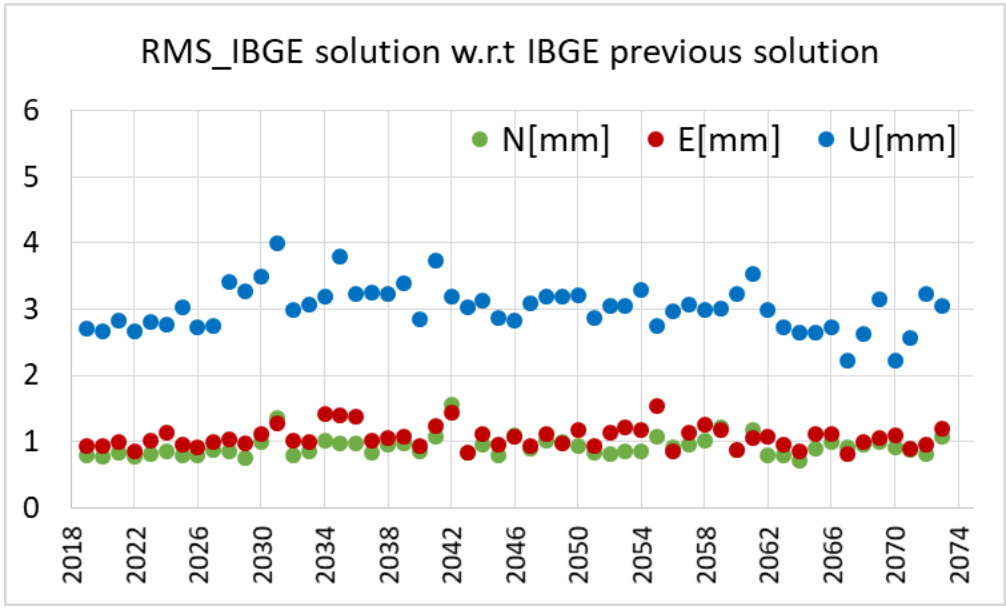
Thanks DGFI !!

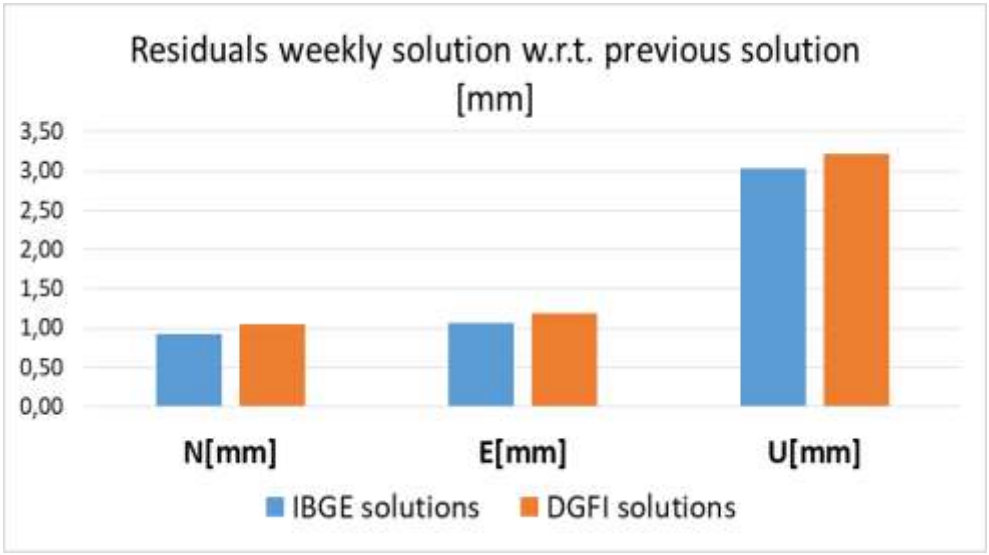
DGFI-TUM
(Deutsches Geodätisches Forschungsinstitut – TUM)
→ desde **junio-1996** en condición de IGS RNAAC SIR

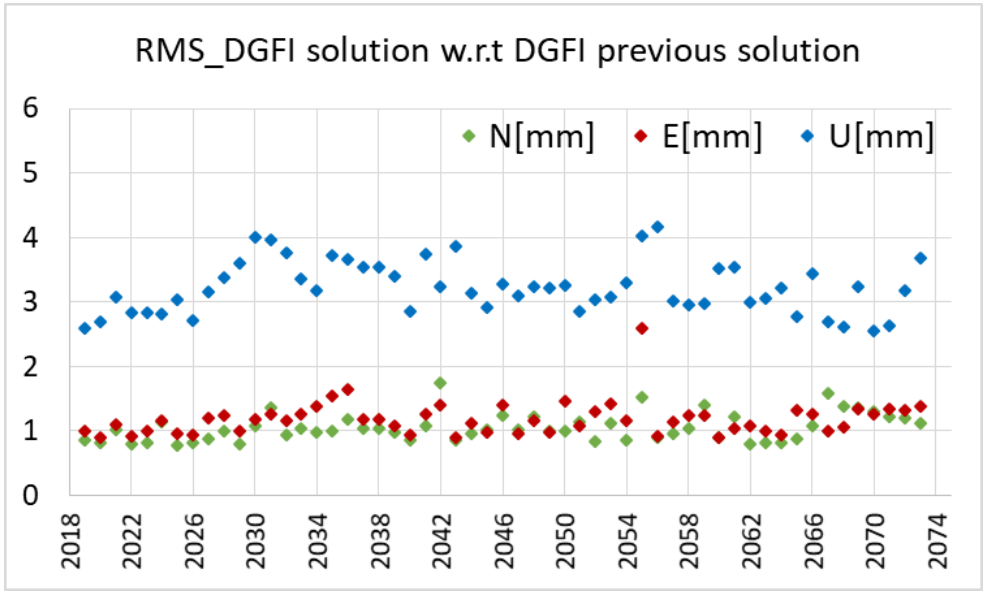
In June 2019, DGFI TUM assumed the stations in charge of LUZ

INTERNAL Accuracy , 54 weeks (sep 2018-sep2019)



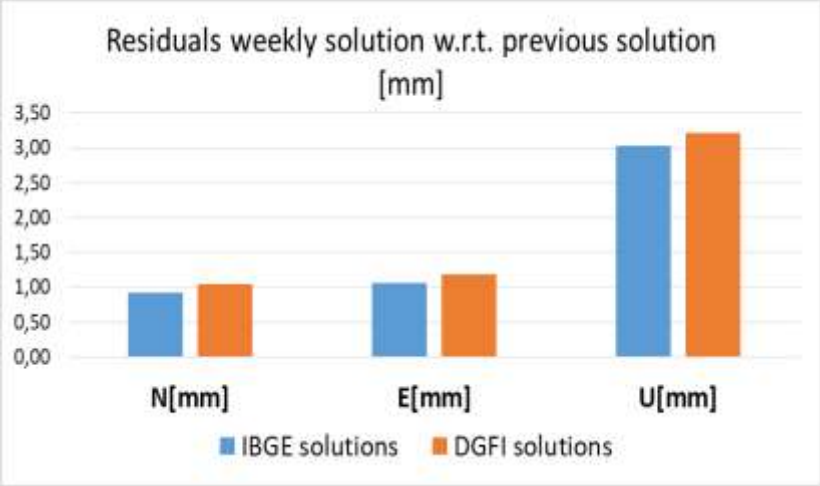




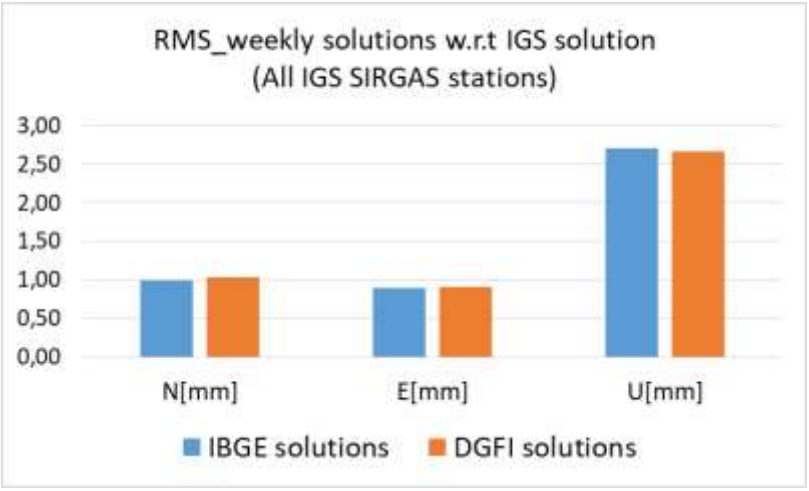


Internal control with the previous weekly solution

EXTERNAL Accuracy , 54 weeks (sep 2018-sep2019)

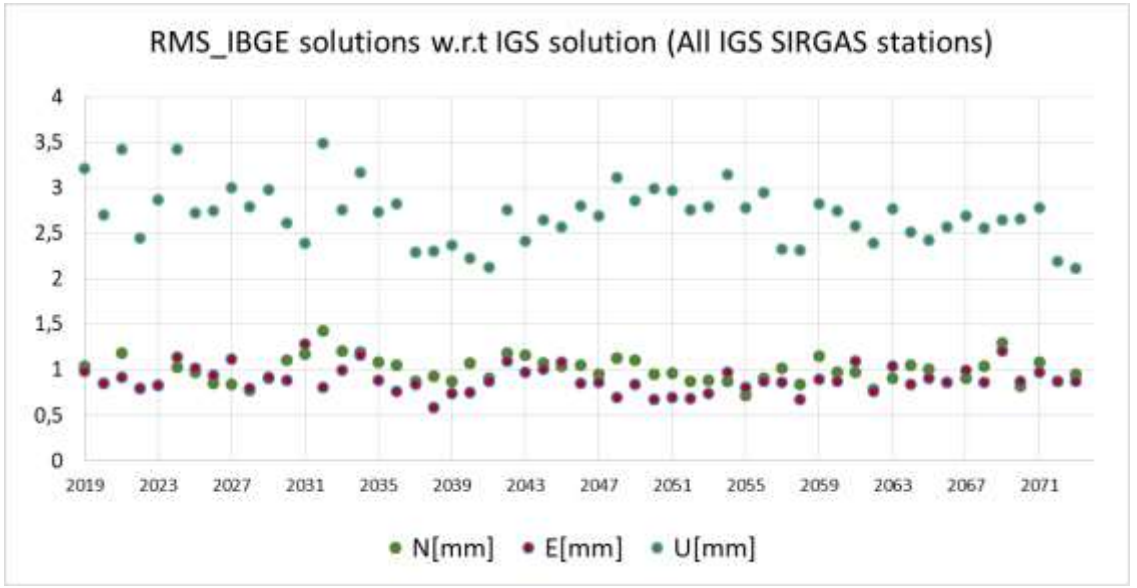


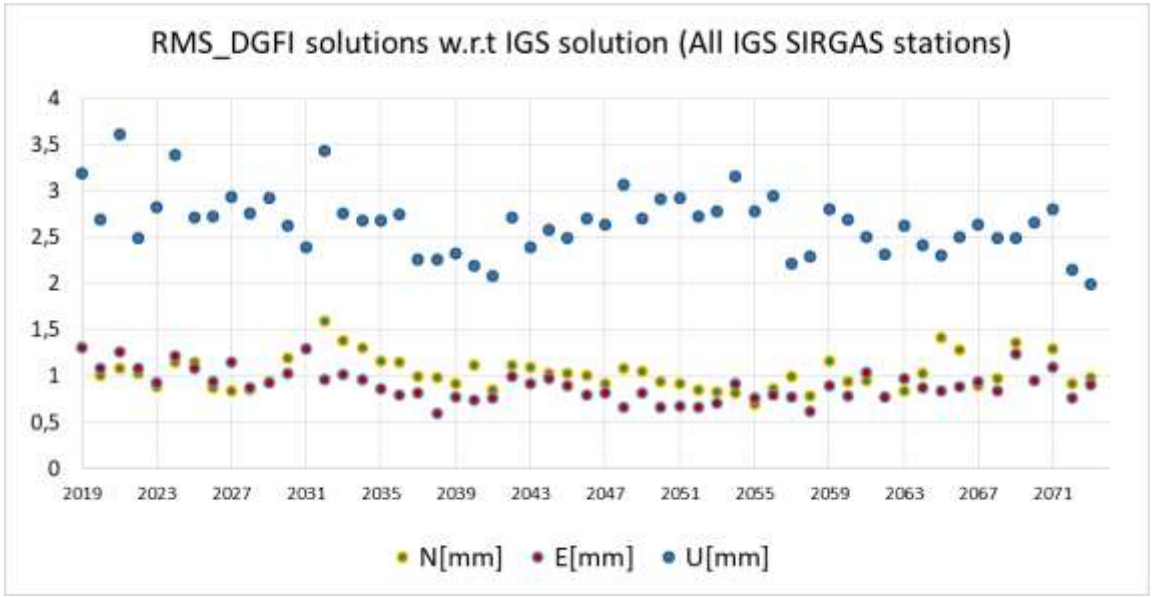
Internal control with the previous weekly solution



External control with respect to IGS solution

(between 68 and 78 IGS stations)





SIRGAS geo-portal

All the information is in the web portal, in spanish, in portugués and in english

Thanks!!,
Muito obrigado !!!!!!

It is maintained by **Laura Sánchez**, IGS RNAAC SIRGAS, DGFI-TUM, Munich, Germany

The translation into the Portuguese language is provided by **Wagner Carrupt Machado e Gabriel do Nascimento Guimarães**, Universidade Federal de Uberlândia - Campus Monte Carmelo

SIRGAS products

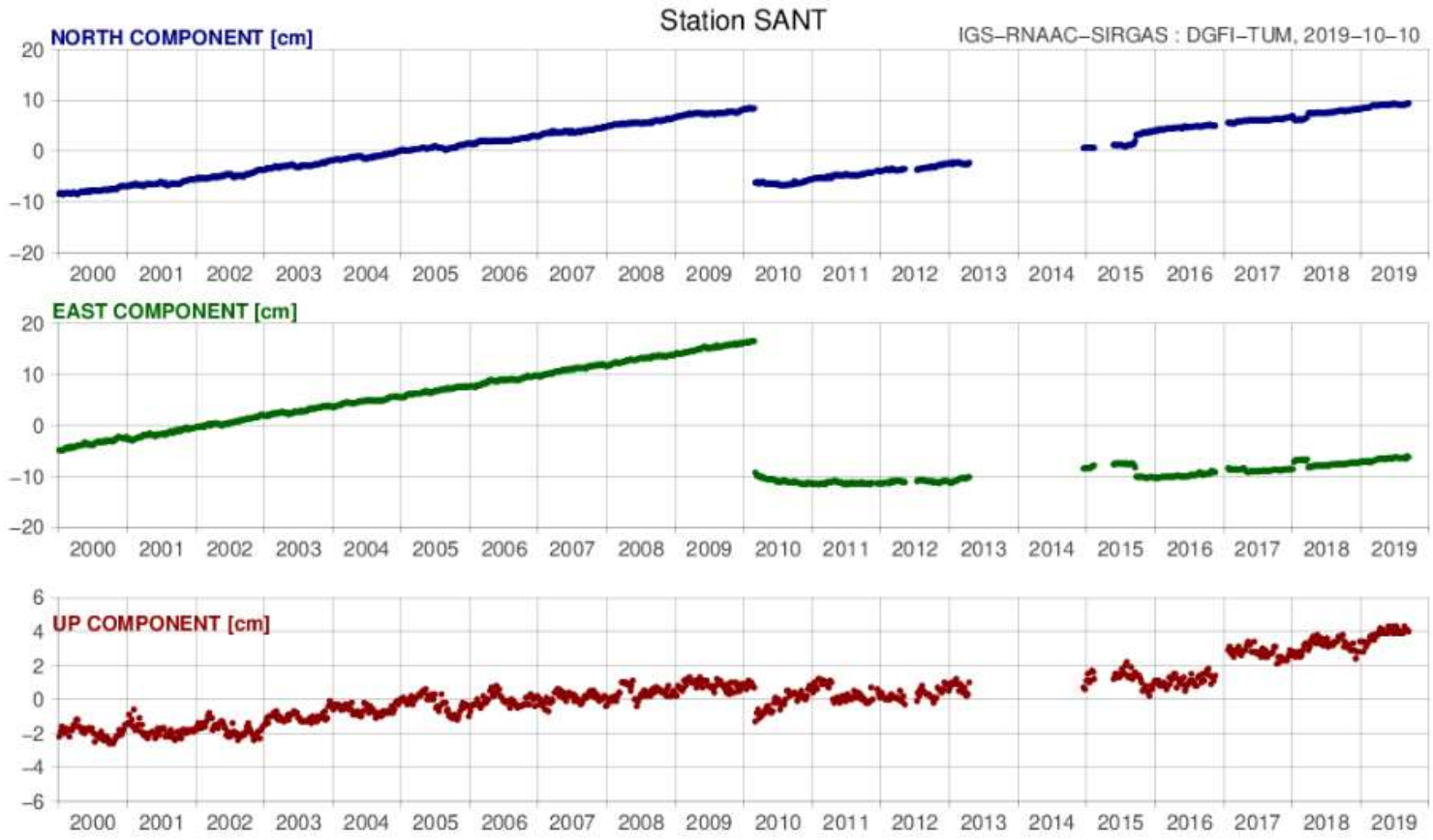
- Home
- Organización
- Sistema de referencia SIRGAS
- Realizaciones SIRGAS
- Red SIRGAS-CON
- Estaciones
- **Coordenadas**
  - Procesamiento
  - Centros de análisis
  - Coordenadas semanales
  - Soluciones multianuales
- Guías
- Modelo de velocidades VEMOS
- Mapas ionosféricos
- SIRGAS-RT

Productos de la red SIRGAS-CON

En el procesamiento rutinario de la red SIRGAS-CON se generan los siguientes productos:

Soluciones semanales semilibres (loosely constrained) en formato SINEX para cálculos posteriores, por ejemplo, combinación con el poliedro global del IGS, determinación de soluciones multianuales, etc.

Coordenadas semanales de las estaciones SIRGAS-CON ajustadas al mismo marco de referencia utilizado por el IGS (International GNSS Service) en el cálculo de las órbitas de los satélites GNSS. De este modo, usuarios de estas técnicas en América Latina disponen de coordenadas de referencia para el ajuste de sus levantamientos.



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Multianual solutions

```
File: SIR17P01_XYZ.CRD
Content: SIR17P01: Geocentric Cartesian Positions [m]
Reference frame: IGS14/ITRF2014
Reference epoch: 2015-01-01 00:00:00
```

NUM	STATION NAME	X[m]	sig_X[m]	Y[m]	sig_Y[m]	Z[m]	sig_Z[m]	ID-SNX		START	END
1	AACR 40612M001	644009.00971	0.00059	-6251064.27165	0.00216	1093780.89125	0.00085	A	1	2013-05-26	2017-01-28
2	ABCC 41939M001	1739438.02111	0.00030	-6117252.52449	0.00080	515065.03147	0.00032	A	1	2011-07-24	2017-01-04
3	ABMF 97103M001	2919785.74068	0.00053	-5383744.98817	0.00095	1774604.78156	0.00052	A	1	2011-04-17	2012-01-28
4	ABMF 97103M001	2919785.74639	0.00046	-5383744.99474	0.00079	1774604.78317	0.00045	A	2	2012-01-29	2016-05-21
5	ABPD 41941M001	1742983.24581	0.00032	-6118331.49898	0.00071	494730.68038	0.00032	A	1	2011-04-17	2017-01-28
6	ABPW 41940M001	1753507.20854	0.00042	-6113239.04585	0.00129	518210.54578	0.00034	A	1	2011-04-17	2017-01-28
7	AGCA 41907M001	1782547.06414	0.00050	-6054787.94116	0.00133	916299.50048	0.00048	A	1	2012-06-03	2015-11-28
8	ALAR 41653M001	5043729.69434	0.00053	-3753105.60259	0.00043	-1072966.87291	0.00034	A	1	2011-04-17	2017-01-28
9	ALBE 41943M001	1806735.01398	0.00088	-6056493.31370	0.00234	855562.52177	0.00080	A	1	2012-12-26	2015-07-03
10	ALEC 42029M001	1233231.87220	0.00122	-6255435.58488	0.00426	-243534.52298	0.00112	A	1	2013-09-22	2016-04-09

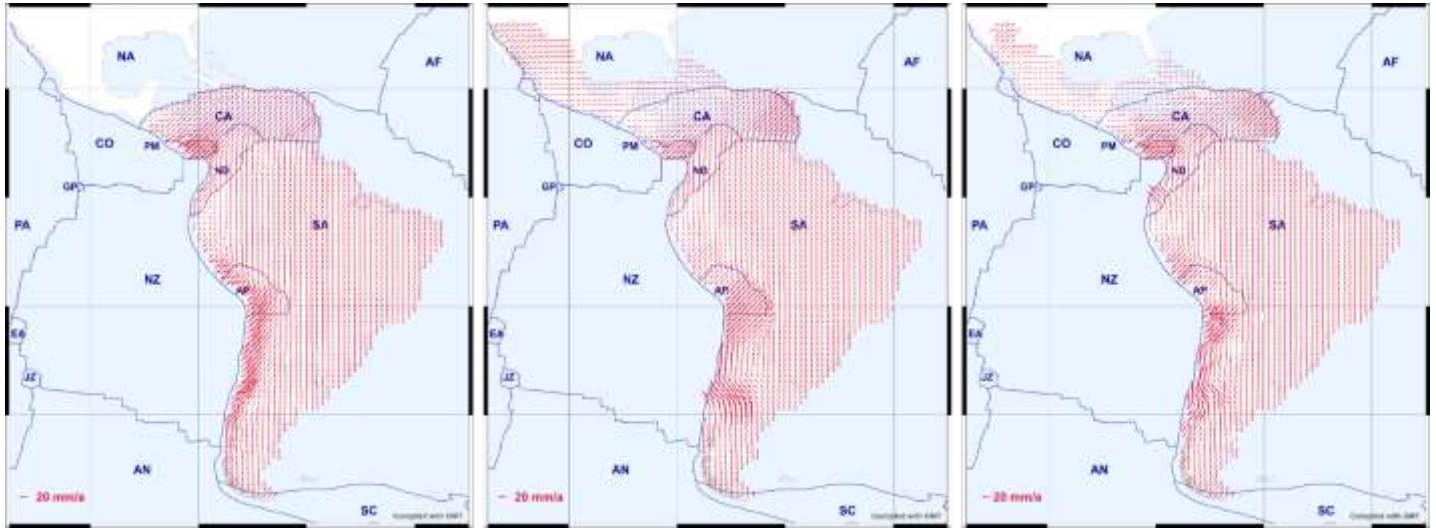
```
File: SIR17P01_XYZ.VEL
Content: SIR17P01: Geocentric Cartesian Velocities [m/a]
Reference frame: IGS14/ITRF2014
```

NUM	STATION NAME	VX[m/a]	sig_VX[m/a]	VY[m/a]	sig_VY[m/a]	VZ[m/a]	sig_VZ[m/a]	ID-SNX		START	END
1	AACR 40612M001	0.00896	0.00027	0.00661	0.00092	0.01507	0.00027	A	1	2013-05-26	2017-01-28
2	ABCC 41939M001	-0.01009	0.00023	0.02553	0.00048	0.01423	0.00020	A	1	2011-07-24	2017-01-04
3	ABMF 97103M001	0.00700	0.00031	0.00878	0.00054	0.01451	0.00023	A	1	2011-04-17	2012-01-28
4	ABMF 97103M001	0.00700	0.00031	0.00878	0.00054	0.01451	0.00023	A	2	2012-01-29	2016-05-21
5	ABPD 41941M001	-0.00079	0.00024	0.00084	0.00046	0.01437	0.00019	A	1	2011-04-17	2017-01-28
6	ABPW 41940M001	-0.00169	0.00036	0.00199	0.00094	0.01447	0.00023	A	1	2011-04-17	2017-01-28
7	AGCA 41907M001	0.00629	0.00037	0.00261	0.00095	0.01326	0.00025	A	1	2012-06-03	2015-11-28
8	ALAR 41653M001	0.00001	0.00038	-0.00458	0.00030	0.01234	0.00021	A	1	2011-04-17	2017-01-28
9	ALBE 41943M001	0.00397	0.00059	0.00485	0.00101	0.01342	0.00038	A	1	2012-12-26	2015-07-03
10	ALEC 42029M001	0.00416	0.00056	0.00132	0.00118	0.00960	0.00037	A	1	2013-09-22	2016-04-09
11	ALUM 41535M001	-0.00030	0.00027	-0.00279	0.00053	0.00829	0.00032	A	1	2011-04-17	2015-09-12

Horizontal (left) and vertical (right) velocities of the multiyear solution SIR17P01. [Sánchez, 2017]

SIRGAS velocity models

Velocity model	Realizations	Region	Stations	Aplications
VEMOS2003	SIRGAS95 y SIRGAS2000 (DGF01P01)	45°S to 12°N	48 stations 231 aditional velocities	April 1995 to april 2000
VEMOS2009	SIR09P01	56°S to 20°N	96 stations 400 aditional velocities	January 2, 2000 to june 30, 2009
VEMOS2015	SIR15P01	55°S, 110°W to 32°N, 35°W	456 stations	March 14, 2010 to abril 11 2015
VEMOS2017	SIR17P01	55°S, 120°W to 32°N, 35°W,	515 stations	January 1, 2014 to January 28, 2017



Left: VEMOS2009 (Drewes H., Heidbach O., 2012); center: VEMOS2015 (Sánchez L., Drewes H., 2016); Right : VEMOS2017 (Drewes H., Sánchez L., 2017)

SIRGAS in the American countries

Which countries have adopted SIRGAS in the national densifications?

- Argentina
- Bolivia
- Brazil
- Chile
- Colombia
- Costa Rica
- Dominican Republic
- Ecuador
- El Salvador
- French Guyana
- Guatemala
- Guyana
- Honduras
- México
- Nicaragua
- Panama
- Paraguay
- Peru
- United States
- Uruguay
- Venezuela

21 member countries

More than 26 years of evolution

More than 50 institutions from 20 countries.

15 National networks densify SIRGAS

Joint Action Plans 2013-2015 & 2016-2020 to Expedite the Development of the Spatial Data Infrastructure of the Americas

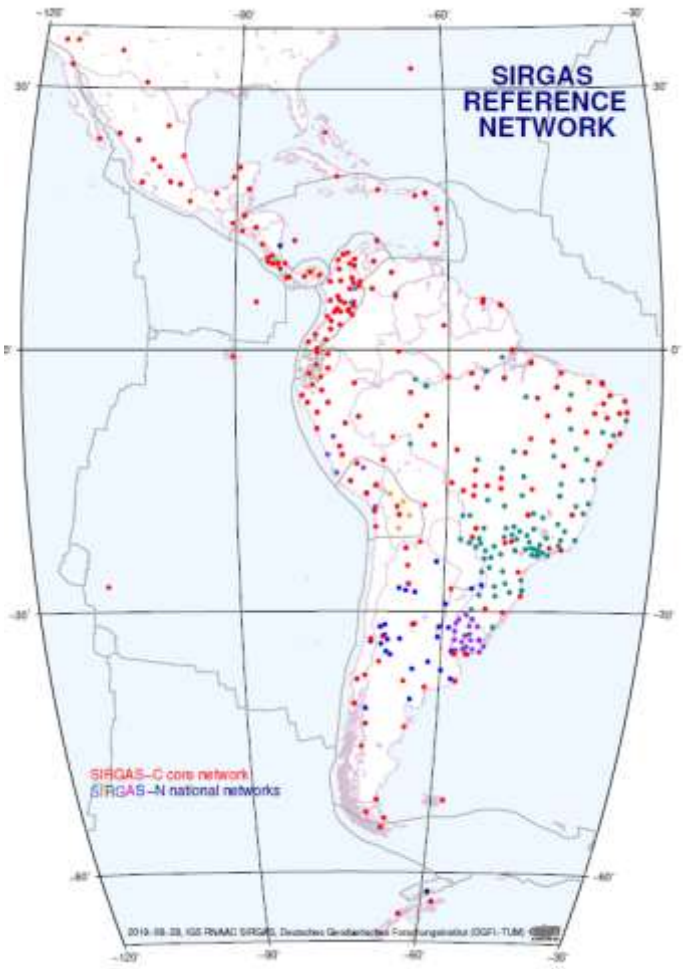
WG II:SIRGAS at the national level (1)

SIRGAS WG II

To integrate the local geodetic datum in SIRGAS is based on:

- Establishment of a first-order national GNSS network.
- Determination of transformation parameters.
- Adoption of SIRGAS as the official reference framework

Passive stations



Active stations,
integrated in SIRGAS-CON

WG II:SIRGAS at the national level (2)

Country	National densification network
Argentina	POSGAR07 ITRF2005 (2006.6); 178 stations / RAMSAC 44 stations
Bolivia	MARGEN SIRGAS95, (1995.4); 125 stations (9 stations in SIRGAS-CON)
Brazil	SIRGAS2000 SIRGAS2000, (2000.4); 1903 stations / RBMC (147 stations in SIRGAS-CON)
Chile	SIRGAS-CHILE SIRGAS2000, (2002.0); 269 stations, updated to ITRF2008 (IGb08), (2016.0) after the Maule earthquake / (10 stations in SIRGAS-CON)
Colombia	MAGNA-SIRGAS SIRGAS95, epoch 1995.4; 70 stations included in SIRGAS, updated to ITRF2008 (IGb08), epoch 2012.0 /MAGNA-ECU 40 stations
Ecuador	RENAGE SIRGAS95, (1995.4); 135 stations included in SIRGAS / REGME 32 stations
French Guyana	RGFG Réseau Géodésique Français de Guyane; ITRF93, (1995.0); 7 stations (1 station in SIRGAS-CON)
Perú	PERU96 SIRGAS95 (1995.4); 47 /REGPMOC Red geodésica peruana de monitoreo continuo; 21 stations
Uruguay	SIRGAS-ROU98 SIRGAS95, (1995.4); 17 / REGNA-ROU Red Geodésica Nacional Activa; 23 stations included in SIRGAS-CON
Venezuela	SIRGAS-REGVEN Red geocéntrica venezolana; SIRGAS95, (1995.4); 156 stations included in SIRGAS; updated to ITRF2014, (2015.5)/ REMOS
Costa Rica	CR05, CR-SIRGAS ITRF2000 (2005.83); changed to CR-SIRGAS ITRF2008 (IGb08), (2014.59) (14 stations in SIRGAS-CON)
El Salvador	SIRGAS-ES2007 SIRGAS, (2007.8); 34 stations included in SIRGAS
Guatemala	CORS SIRGAS
Panama	MGN SIRGAS 2000 (2000.0); 17 stations (6 stations in SIRGAS-CON)
Mexico	REGNO: ITRF1992, epoch 1988.0; updated to ITRF2008, (2010.0)/ REGNA 16

15 National networks densify SIRGAS

Tropospheric products

SIRGAS-CON also provides the geodetic infrastructure in the region for atmospheric studies:
1) Zenith Total delay (ZTD) in each SIRGAS-CON station (2014-2019)

SIRGAS Sistema de Referencia Geocéntrico para las Américas (SIRGAS)

- Home
- Organization
- SIRGAS reference system
- SIRGAS realizations
- SIRGAS-CON network
- SIRGAS velocity model
- SIRGAS ionospheric maps
- **Tropospheric delays**
- SIRGAS-RT
- GGRF Workshop
- National densifications
- SIRGAS symposia
- SIRGAS schools
- Publications
- Presentations
- Web, Links & Contact

hosted by:

Tropospheric delays

Within the weekly processing of the **SIRGAS Continuously Operating Network (SIRGAS-CON)**, the SIRGAS Analysis Centres operationally estimate **tropospheric Zenith Path Delays (ZPD) with an hourly sampling rate**. These ZPD estimates are the input data for the generation of **SIRGAS tropospheric products**, which provide weekly combined troposphere estimates of high-reliability for each SIRGAS station. The station positions, as a necessary part of this analysis, are taken from the SIRGAS weekly combined solutions. Consequently, stations without estimated positions in the weekly combination are not included in the combined tropospheric solution.

The SIRGAS tropospheric products are computed by the **SIRGAS Analysis Centre for the Neutral Atmosphere (CIMA)**, which is operated by the **Facultad de Ingenieria of the Universidad Nacional de Cuyo** (UNCuyo, Mendoza, Argentina) in cooperation with the **Facultad de Ingenieria of the Universidad Juan Agustin Maza** (Mendoza, Argentina) and with support of the **Argentinean Consejo Nacional de Investigaciones Cientificas y Técnicas** (CONICET).

The SIRGAS tropospheric products are weekly generated with a latency of 30 days. They are available with an hourly sampling rate in daily SINEX TRO files since January 2014 and they can be downloaded from

ftp://ftp.sirgas.org/pub/gps/SIRGAS-ZPD/

More details about the processing strategy can be found at

Mackern M.V., Mateo M.L., Camisay M.F., Morichetti P.V.: Tropospheric products from high-level GNSS processing in Latin America. In: 27th IUGG General Assembly. Montreal, Canada. July 8 - 18, 2019.

Whenever you use the SIRGAS tropospheric products, please include this publication as a citation.

Neutral Atmosphere Analysis Centre

Facultad de Ingeniería, UNCuyo, Umaza, **from 2013**

→

/pub/gps/SIRGAS-ZPD/2014/001/

[directorio principal]

Nombre
AACR0010.14zpd.gz
ABPD0010.14zpd.gz
ABPW0010.14zpd.gz
AGCA0010.14zpd.gz
ALAR0010.14zpd.gz
ALEC0010.14zpd.gz
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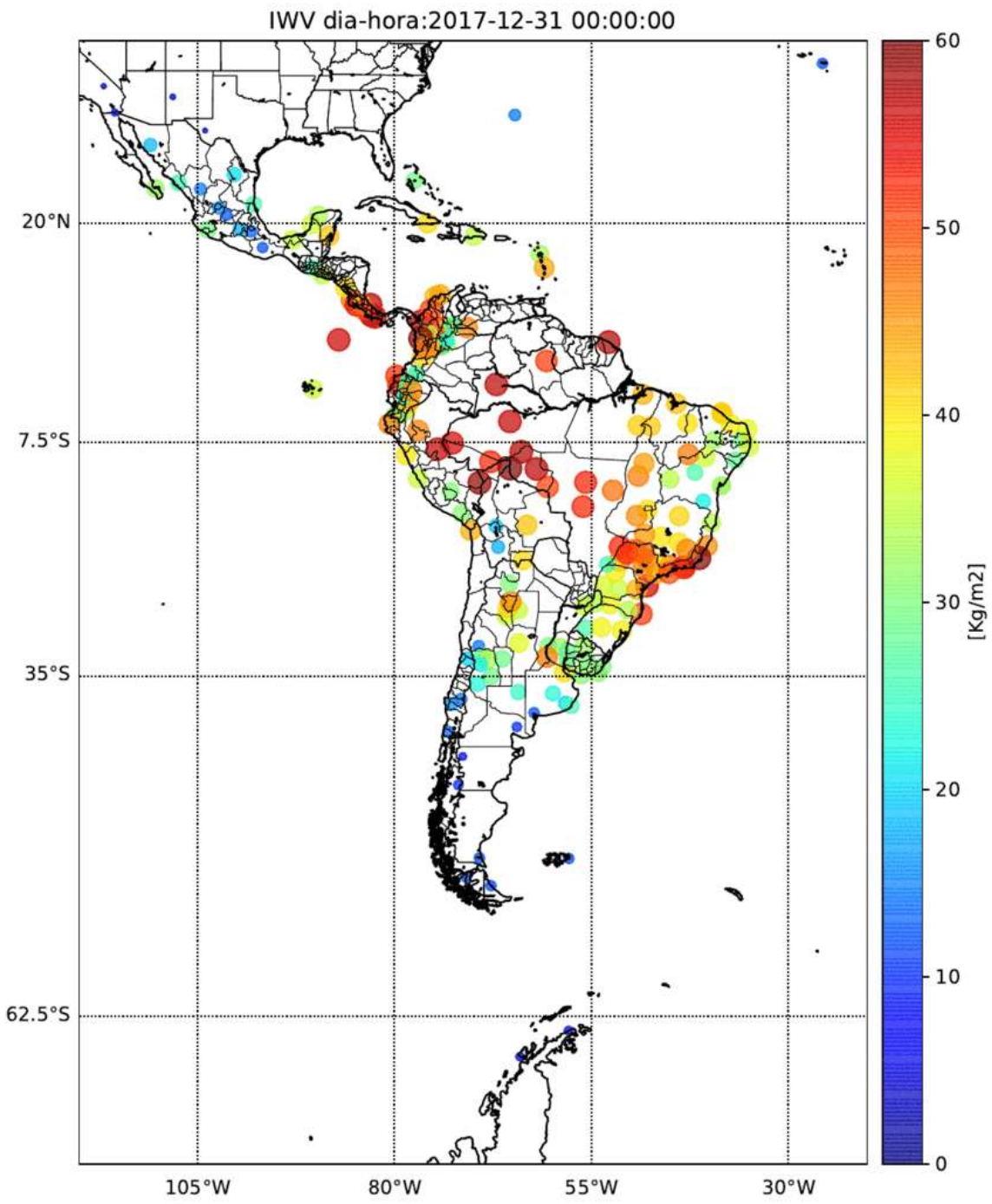
APTO0010.14zpd.gz
ARCA0010.14zpd.gz
BABR0010.14zpd.gz
BAIR0010.14zpd.gz
BNGA0010.14zpd.gz
BOAV0010.14zpd.gz
BOGA0010.14zpd.gz
BRFT0010.14zpd.gz
BRMU0010.14zpd.gz
BUEN0010.14zpd.gz
CALL0010.14zpd.gz
CART0010.14zpd.gz
CBSB0010.14zpd.gz
CEFT0010.14zpd.gz
CHET0010.14zpd.gz

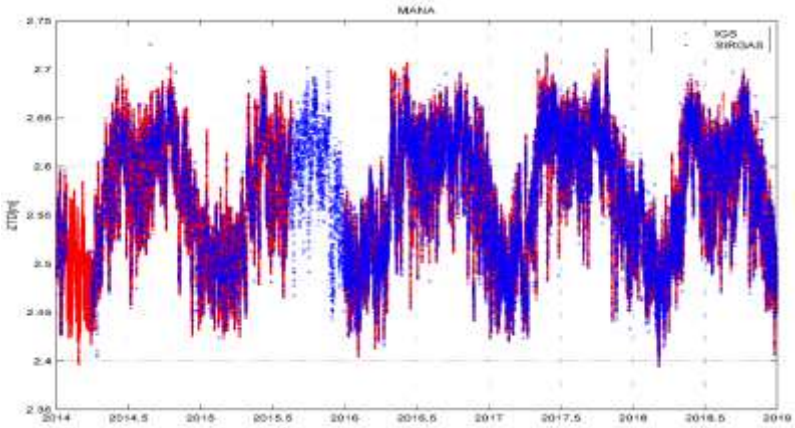
Water vapour

IWV_{SIRGAS} values (31-12-2017 to 6-1-2018), 6 hourly rate

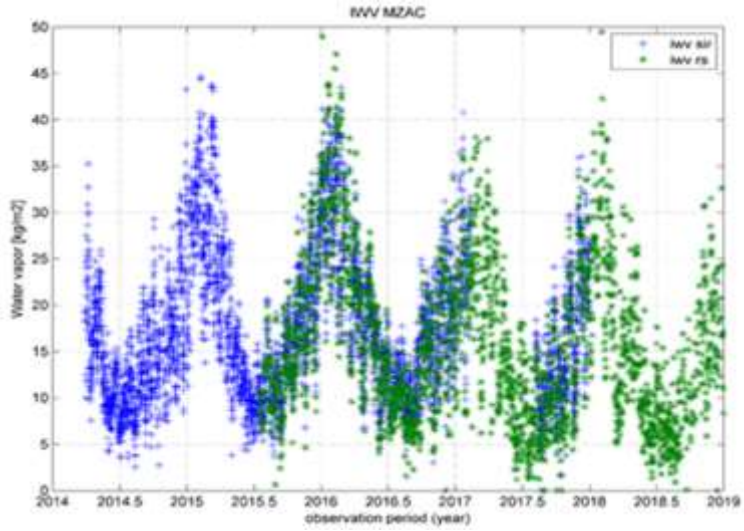


ZTD_{SIRGAS} values were validated w.r.t :

- ZTD_{IGS}
- $ZTD_{radiosounding}$



ZTD_{SIR} validation w.r.t. ZTD_{IGS}

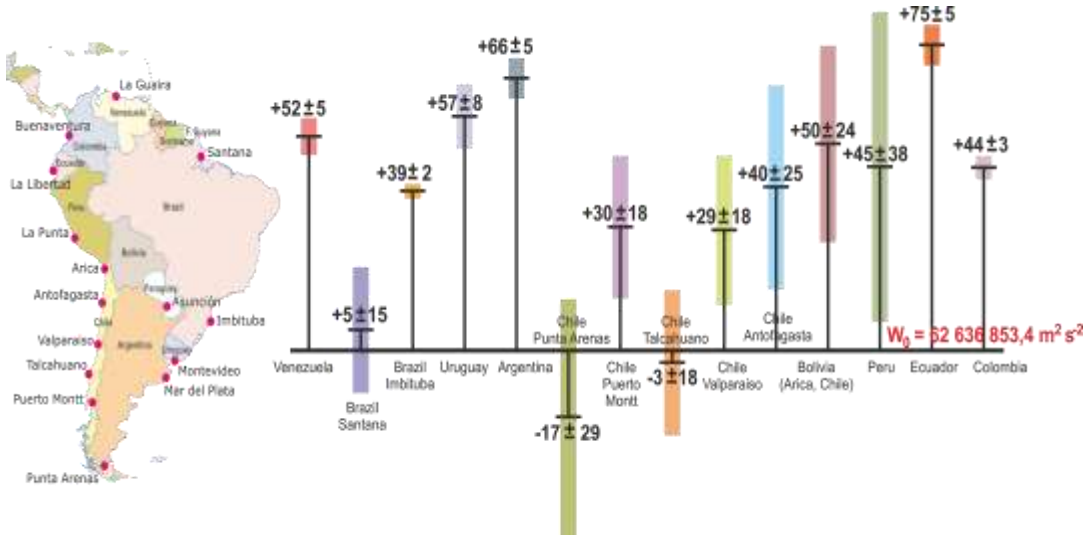


- IWV_{SIRGAS} values were validated w.r.t IWV radiosounding

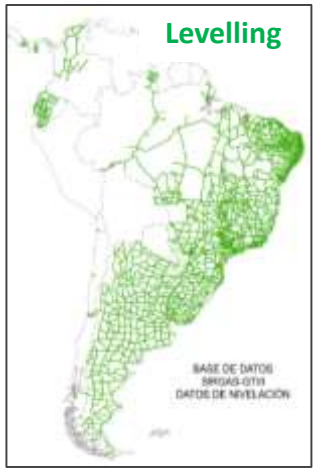
WG III: Vertical Datum (1)

Since 1997, SIRGAS Working Group III:

- Has been compiled information on heights (physical and geometric) and gravity from the member countries.
- Have identified and work on problems as missing connection, errors, etc.
- Have coordinated campaigns in neighboring areas.
- Provides technical accompaniment: Countries such as Argentina, Brazil, Costa Rica, Uruguay and Ecuador, have remarkable advances; Chile, Colombia, El Salvador have begun with their organization and calculation tasks.



15 vertical datums in South America
(Sanchez, 2002)



WG III: Vertical Datum (3)

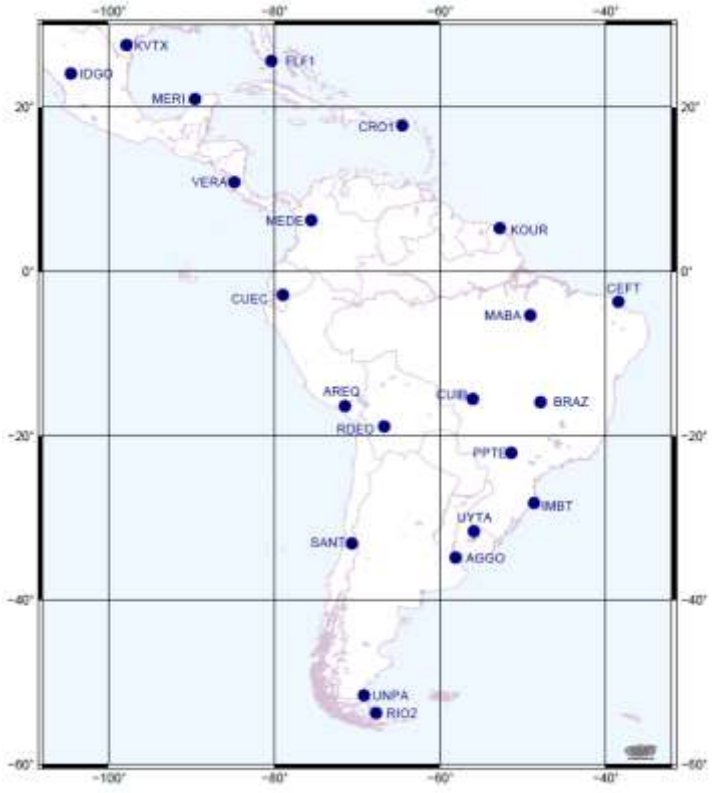
Vertical Reference System SIRGAS (SVRS) Protocols are:

- It is performed by appropriate physical heights (involving gravity by geopotential numbers) ;
- Connected to the geometric component of SIRGAS;
- Integrates the vertical networks of member countries;
- Referred to a global reference level W0 of the **IHRS / IAG**;
- Associated with a specific reference period; i.e., you should consider the temporal variations of the coordinates and the network.
- Linked with a profile of GGRF stations consistent with the ITRF.

SIRGAS proposed a set of 22 **IHRF** stations in South America, Central America and Caribbean regions.

SIRGAS WG III is involved in the testing of approaches for facing the realization of such stations.

The progress of these objectives, in the countries, will be presented in the contributions of Thursday 14/11



SIRGAS training

SIRGAS Workshops:

- **14** workshops: Total 436 students.
- 10 countries on average

SIRGAS Schools:

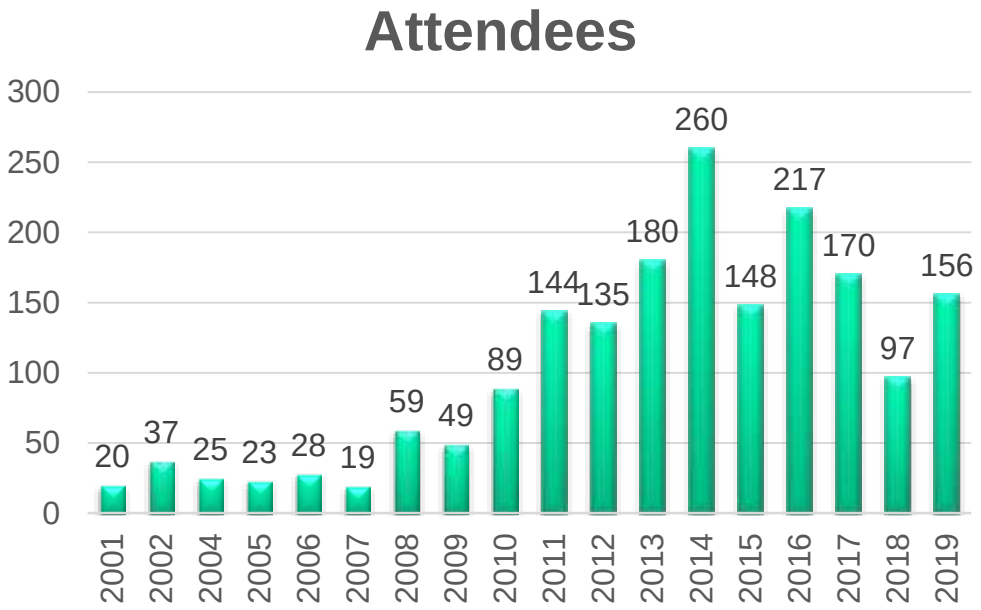
- **6** schools: Total **603** students.
- 17 countries on average

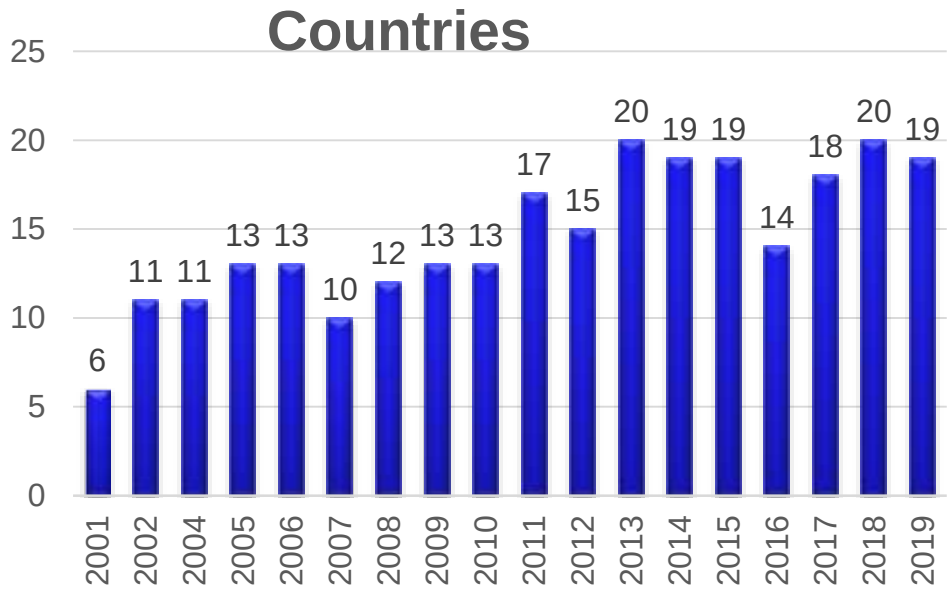
Symposia SIRGAS

More than 1850 attendees from 15 countries on average

We include SIRGAS2019 events, Rio de Janeiro, Brasil

SIRGAS 2019
Sistema de Referencia Geocéntrico para las Américas
Rio de Janeiro, Brasil





SIRGAS training in 2019

The International Workshop for the Implementation of the Global Geodetic Reference Frame in Latin America , *IGN, Buenos Aires, Argentina, from Sep 16 to 20, 2019*

130 participants from 20 countries

Thanks Laura Sanchez, Claudio Brunini, Hermann Drewes !!

Thanks IUGG, IAG, IASPEI, IGNA, AGGO, ICG and IPGH

Workshop SLR in SIRGAS2019 ,

IBGE, Rio de Janeiro, Brasil, 6 to 8 November, 2019

25 attendees from 9 countries
6 from latinamerican SLR observatories

Thanks Daniela Thaller!!
Thanks BKG, IBGE,UERJ, IAG and IPGH

IBGE, Rio de Janeiro, Brasil, 6 to 8 November, 2019

To the data centres, to the processing centres, to the combination centres, to the teachers inside the SIRGAS comunity

Thank you, very much. Please continue working, SIRGAS needs you

16 attendees received financial aid

5 student grant

Thank you, very much