Report from developing countries Americas and Caribean Region

Sonia Costa
Brazilian Institute of Geography and Statistics- IBGE
Geosicences Directory
Coordination of Geodesy and Cartography

2° Meeting of the IAG EC 2019-2023
San Francisco, December 7, 2019

SIRGAS geo-portal

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

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 in american countries

Argentina
Bolivia
Brasil
Chile
Colombia
Costa Rica
República Dominicana
Ecuador
El Salvador
Estados Unidos
Guatemala
Guyana
Guyana Francesa
Honduras
México
Nicaragua
Panamá
Paraguay
Perú
Uruguay
Venezuela

21 member countries

SIRGAS adopted by 15 countries

SIRGAS in american countries

15 National networks densify SIRGAS

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

SIRGAS Continuously Operating Network

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

More than **400 CORS station (+118 long history)**

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

Other CORS – Caribean Region

Caribean Project - 2014 to 2018(CARICOM)
INEGI-AMEXCID (Mex. Ag. Int. Coop.)

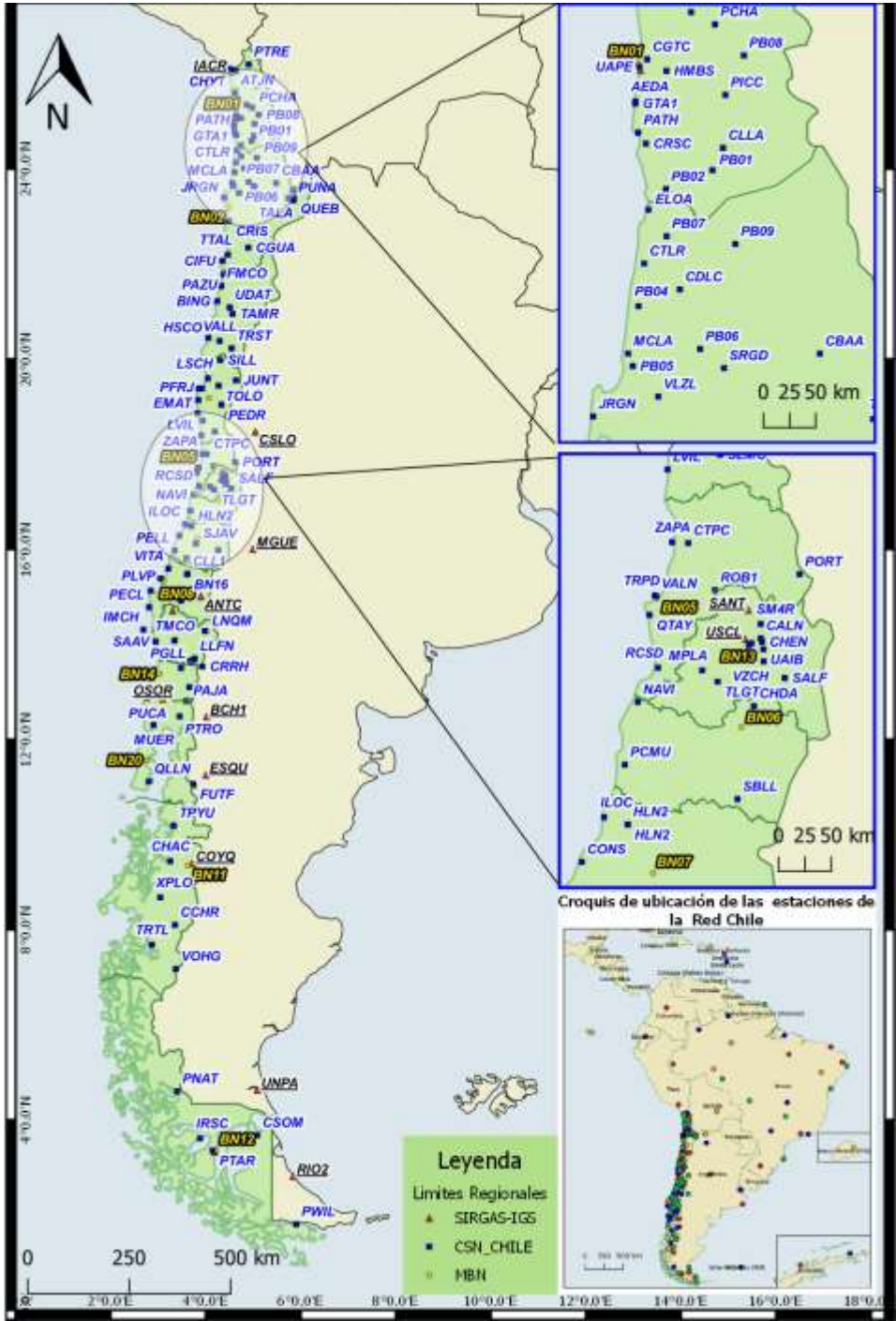
Country (City) – **16 CORS**

- Bahamas 1 (Inagua)
- Bahamas 2 (Exuma)
- Barbados (St. John)
- Cuba 1 (La Habana)
- Cuba 2 (Villa Clara)
- Cuba 3 (Holguín)
- Dominica (Roseau)
- Haití (La Tortue Island)
- Jamaica (Kingston)
- República Dominicana (Sto. Domingo)
- Sint Maarten (Cay Hill)
- St. Vincent and the Grenadines (Argyle)
- St. Kitts y Nevis (Basseterre)
- Trinidad and Tobago (Tobago)
- Suriname (Paramaribo)
- Suriname (Brokopondo)

GAMIT/GLOBK course (2017)
Trinidad y Tobago (West Indies University)
Jamaica (National Land Agency)

Other CORS – Chile

IGS: 34
Centro Sismológico Nacional (CSN) ≈ 93
Catastro de Bienes Nacionales (MBN): 16
CAP Andes GPS Network, SAGA

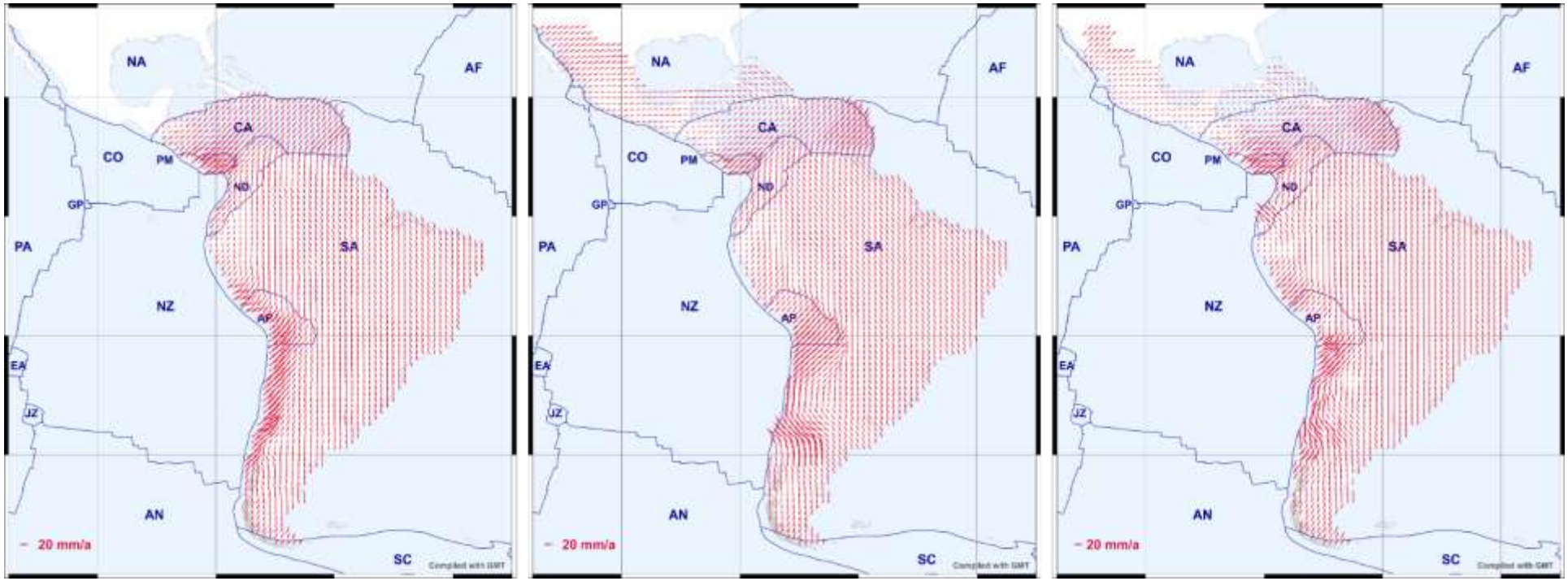


The primary objective of this project is the assessment of the SIRGAS capabilities for the distribution in real time of GNSS corrections and associated data using NTRIP (Networked Transport of RTCM via Internet Protocol) or other similar methods.

Caster	IP:Puerto	Contacto
SIRGAS Experimental	http://200.3.123.65:2101	http://www.fceia.unr.edu.ar/gps/
REGNA-SGM (Uy)	http://201.217.132.178:2101	http://www.sgm.gub.uy/
RAMSAC-NTRIP (Ar)	http://ntrip.ign.gob.ar:2101	http://www.ign.gob.ar/NuestrasActividades/Geodesia/RamsacNtrip/
IBGE - IP (Br)	http://gps-ntrip.ibge.gov.br:2101	http://www.ibge.gov.br/home/geociencias/geodesia/rbmc/ntrip/
IGS-RT	http://www.igs-ip.net:2101	http://register.rtcm-ntrip.org/cgi-bin/registration.cgi

SIRGAS velocity models

Velocity model	Realizations	Region	Stations	Aplications
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 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)

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

- 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:

TUM

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).

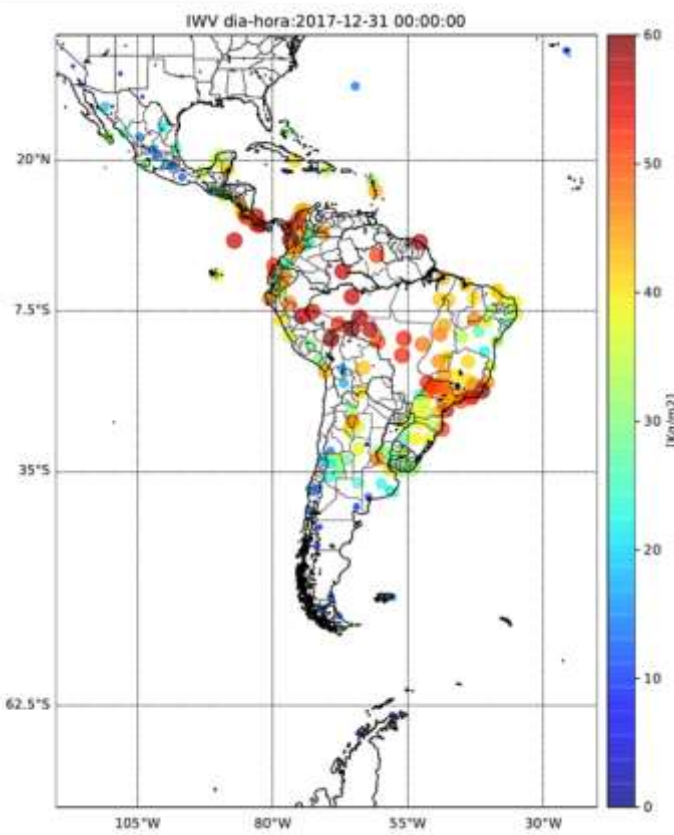
The SIRGAS tropospheric products are weekly generated with a latency of 30 days. They are available with an hourly sampling rate in daily SINEX TRO files since January 2014 and they can be downloaded from

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**

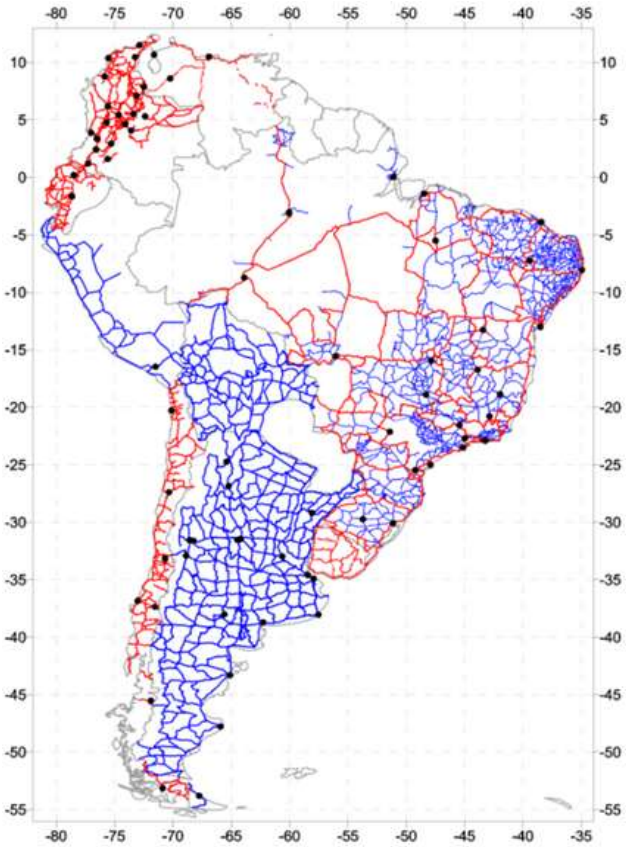
→

UNIVERSIDAD MAZA

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.

Several VDs and big areas without VRN



RVR DE URUGUAY.
CIERCA DE 1 500 PUNTOS DE PRIMERA
ORDEN AHORA REALIZADA
CON NÚMEROS GEOPOTENCIALES

Argentina, Brasil e Uruguai realized VRN C_P y $H^N = f(C_P)$

WG III: Vertical Datum (3)

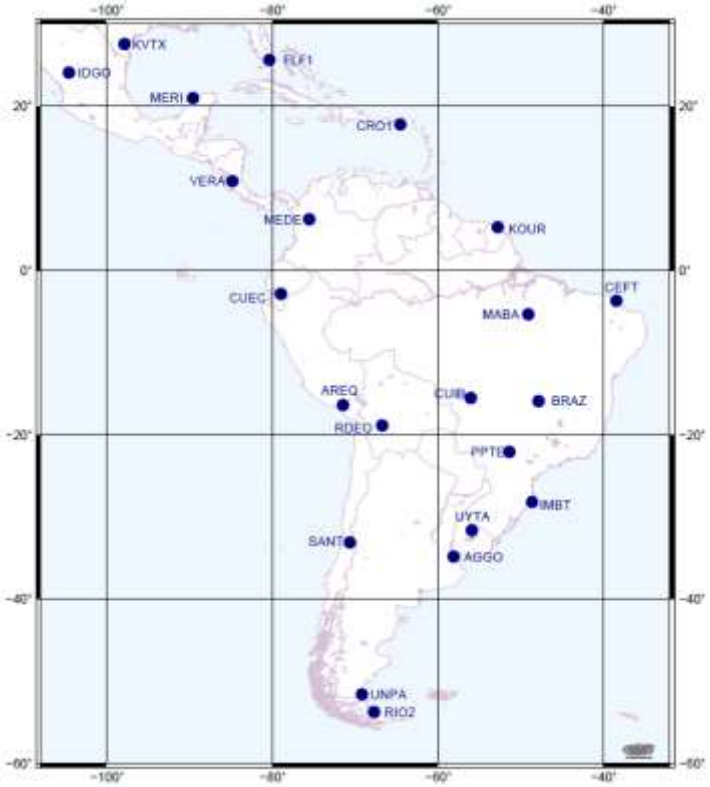
Efforts in the International Height Reference Frame (IHRF)

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.

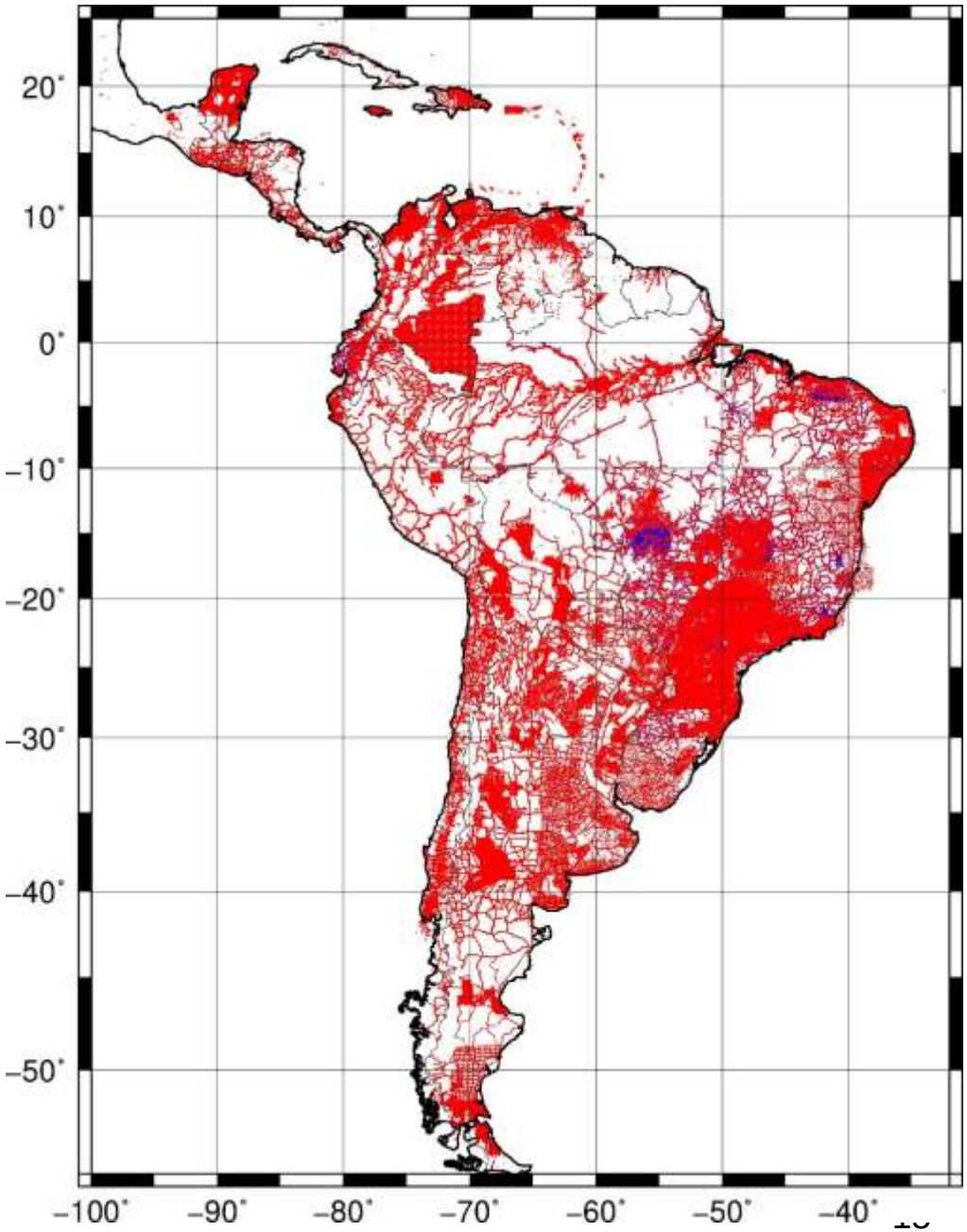
SIRGAS proposed a set of 22 **IHRF** stations in South America, Central America and Caribbean regions.

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

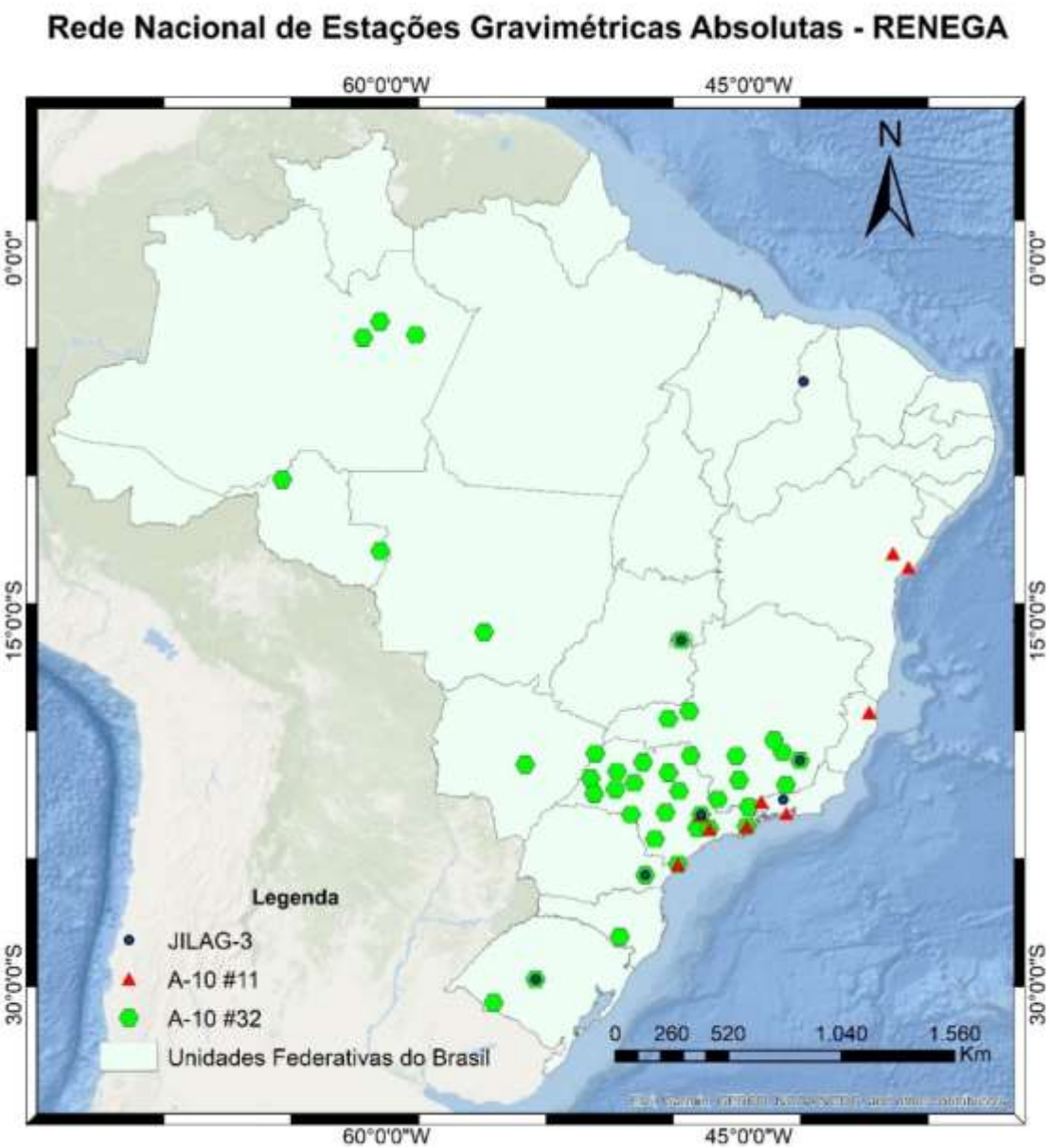


Densification – Gravity Surveys

Gravity points : 977,821



Gravity Reference System – Absolute measurements

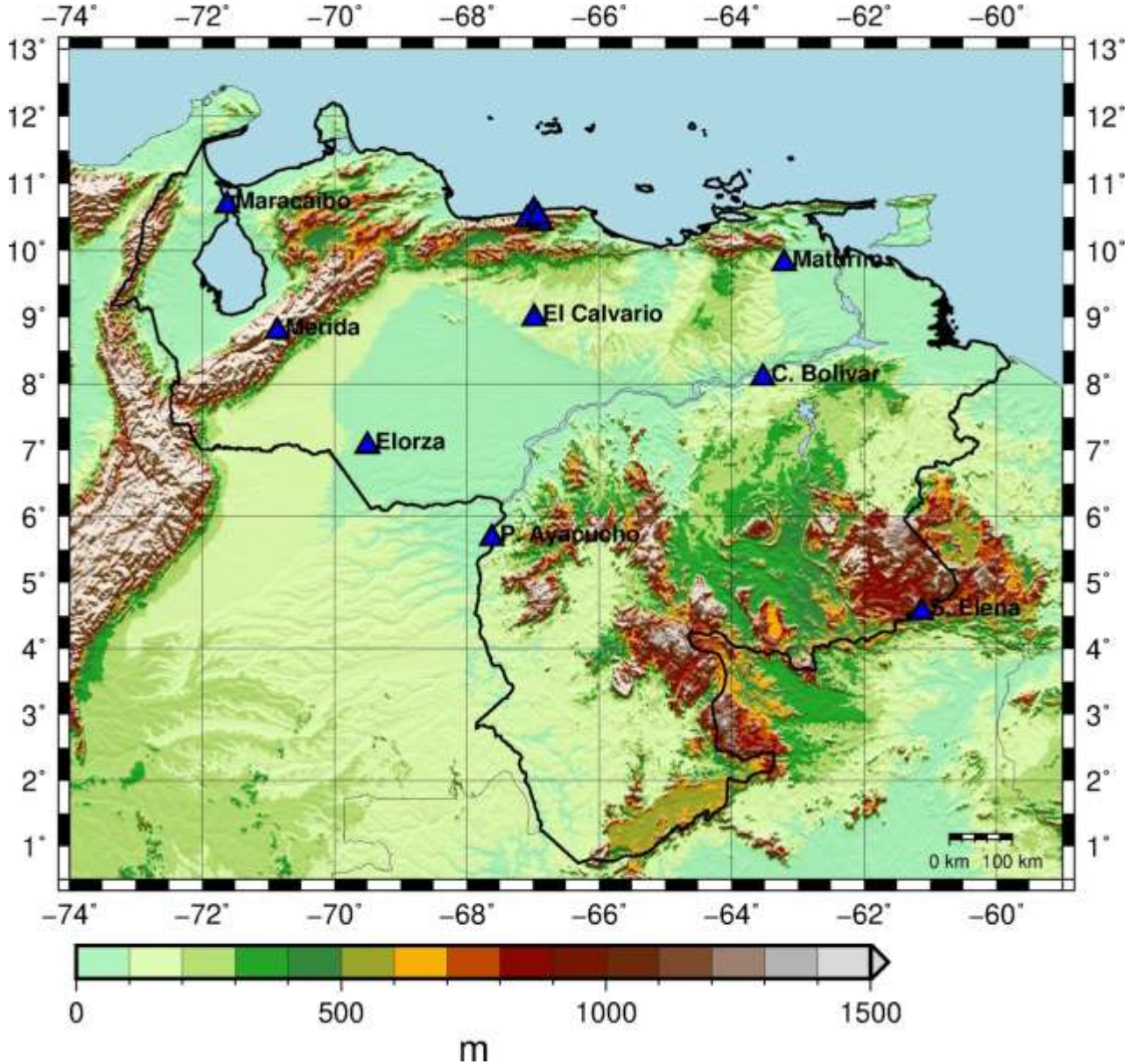


Brazil, **43 stations**

Gravity Reference System – Absolute measurements

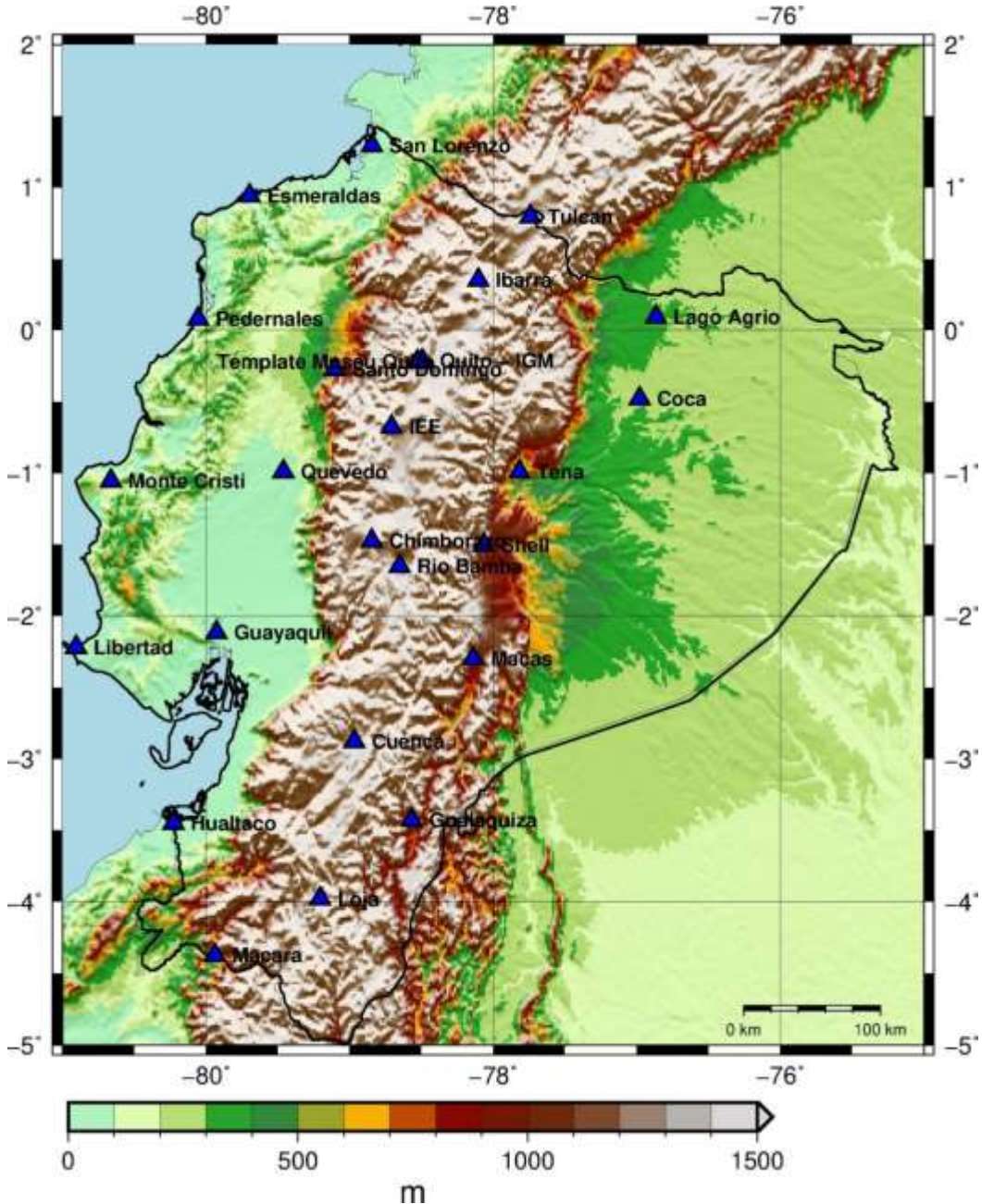
Argentina, **35 stations**
(2014-2016)

Gravity Reference System – Absolute measurements



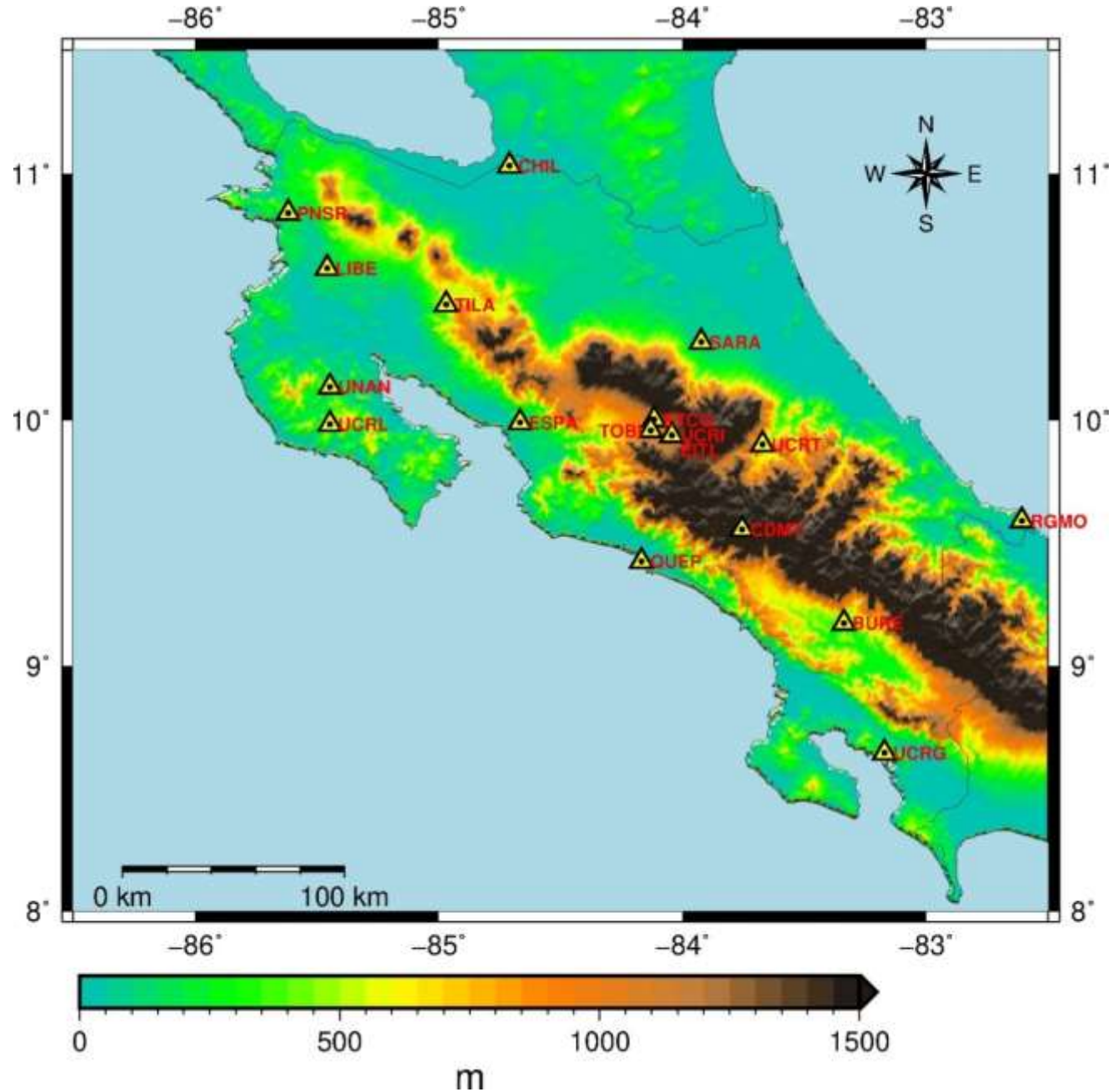
Venezuela, **13 stations (2016)**

Gravity Reference System – Absolute measurements



Ecuador, **25 stations**
(2017)

Gravity Reference System – Absolute measurements



Costa Rica, **18 stations (2019)**

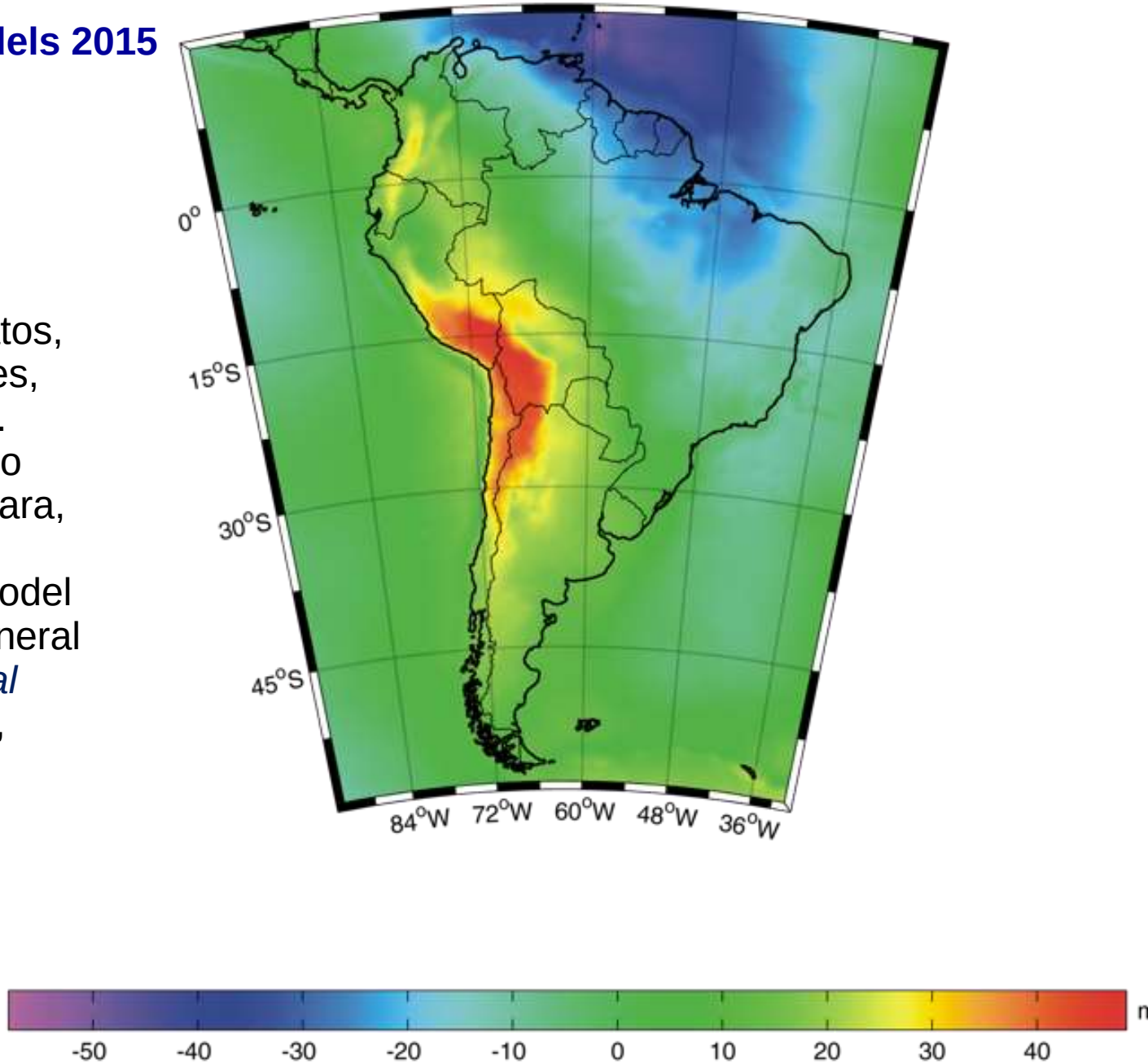
Geoid modelling in South America

Most of geoidal models have their grids available on the International Service for the Geoid (ISG) website.

website:
http://www.isgeoid.polimi.it/index.html

Geoid modelling in South America

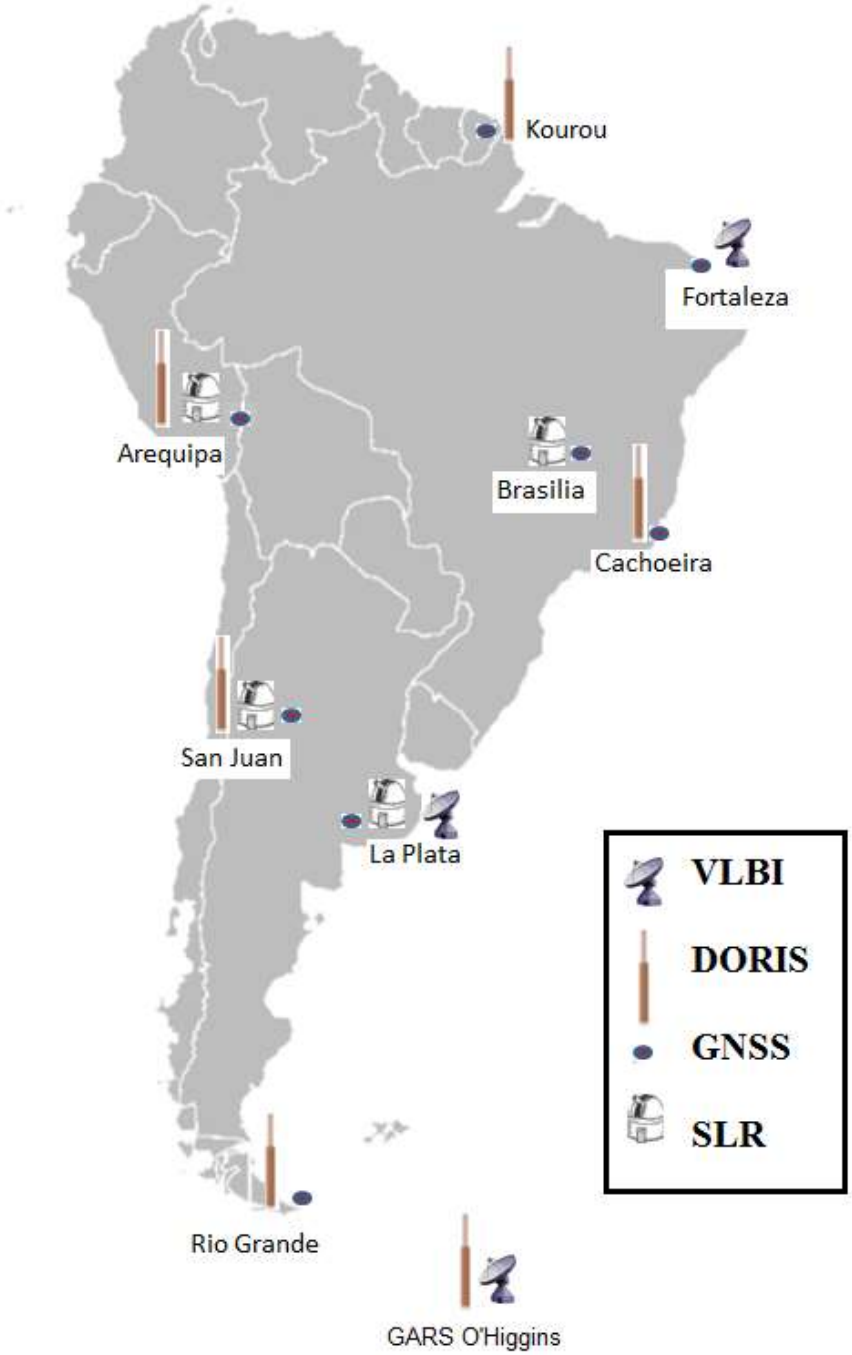
South America Geoid models 2015 (GEOID2015)



GEOID2015

D. Blitzkow, A.C.O.C. de Matos, G. do Nascimento Guimaraes, M.C. Pacino, E.A. Lauria, M. Nunes, C.A. Correia e Castro Junior; F. Flores, N.O. Guevara, R. Alvarez, J.N. Hernandez (2016). Gravity and geoid model for South America. EGU General Assembly 2016, *Geophysical Research Abstracts*, Vol. 18, EGU2016-1626.

Geodetic Observatories in Latin America



AGGO with SLR/VLBI/GNSS

Fortaleza with VLBI/GNSS (new VLBI in 2022)

Brasília with SLR

Arequipa with SLR/DORIS/GNSS

OAFA with SLR/DORIS/GNSS/VLBI **(in 2020)**

Kourou, Cachoeira Paulista and Rio Grande with DORIS/GNSS

SIRGAS training

SIRGAS Workshops: 14 (436 students - 10 countries on average)

SIRGAS schools: 6 Total (603 students - 17 countries on average)

Symposia SIRGAS – every year
More than 1850 attendees
from 15 countries on average

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

https://www.newlinkstraining.com/courses/#prettyPhoto[gallery4941]/0/

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

Workshop SLR in SIRGAS2019 ,

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

25 attendees from 9 countries

6 from latinamerican SLR observatories

Important Issues

(1) There are large differences in terms of technical knowledge
(2) Make investments in other possibilities of capacity building and training - VIDEOS

Thank you very much!