
William Martínez
SIRGAS Chair
Agencia Nacional de Minería, Bogotá, Colombia

M. Virginia Mackern
SIRGAS Vice Chair
Fac. de Ingeniería, UNCuyo, CONICET, UMaza. Mendoza, Argentina

Victor Cioce
WG I Chair
Universidad del Zulia (LUZ), Maracaibo, Venezuela

Roberto Pérez Rodino
WG II Chair
Facultad de Ingeniería - Universidad de la República (UDELAR) Uruguay

Silvio R.C. de Freitas
WG III Chair
Universidade Federal do Paraná, Curitiba, PR, Brazil.

Simposio SIRGAS2019, Noviembre 11-14, 2019, Rio de Janeiro, Brasil
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

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

**SIRGAS adopted the conventions provided by IAG**

Define a tridimensional geocentric reference system

Realice and maintain a geocentric reference frame.
(the network of stations with high-precise geocentric coordinates \([X, Y, Z]\) and their variation with time \([V_x, V_y, V_z]\)).

**WORKING GROUP I**

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

**WORKING GROUP II**

Define and realize 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

- **Takes decisions**
  - Chair: Sonia Costa (Brasil)
  - Vice chair: Diego Piñón (Argentina)

- **Coordinates actions**
  - Executive Committee
    - Chair: W. Martínez (Colombia)
    - Vice chair: M.V. Mackern (Argentina)
    + chairs of working groups

- **Works with SIRGAS guides**
  - **Working Group I Reference System**
    - Chair V. Cioce (Venezuela)
    - Data centres
      - 1 Regional and 9 National
      - Combination Centres
        - DGFI (Germany)
        - IBGE (Brazil)
    - Analysis centres for the Atmosphere Ionosphere:
      - UNLP (Argentina)
      - Experimental Neutral atmosphere:
        - CIMA (Argentina)
  - **Working Group II National level**
    - Chair R. Pérez Rodino (Uruguay)
    - Processing centres
      - CEPGE (Ecuador)
      - DGFI-TUM (Germany)
      - IBGE (Brazil)
      - IGAC (Colombia)
      - IGM-Cl (Chile)
      - IGN-Ar (Argentina)
      - INEGI (Mexico)
      - IGM-Uy (Uruguay)
      - USC (Chile)
  - **Working Group III Vertical Datum**
    - Chair S. De Freitas (Brazil)
    - Data centres
      - DGFI-TUM (Germany)
      - IBGE (Brazil)
    - Analysis centres
      - DGFI-TUM (Germany)
      - IBGE (Brazil)

Since Nov 2019
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.
SIRGAS WG I structure

1 European institution
12 Latin American institutions
In May 2019, Universidad de Santiago de Chile began as SIRGAS Processing Centre

Congratulations USCH !!

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

Thanks DGFI !!

From 1-2013 to 1-2019

UNA (Universidad Nacional)

From 1-2010 to 6-2019

LUZ (Universidad del Zulia)

DGFI-TUM (Deutsches Geodätisches Forschungsinstitut – TUM)

→ desde junio-1996 en condición de IGS RNAAC SIR
INTERNAL Accuracy , 54 weeks (sep 2018-sep2019)

Weekly combination (54 weeks )
- RMS [mm]
- Chi**2/DoF

IBGE solutions
DGFI solutions

Residuals weekly solution w.r.t. previous solution [mm]
- N[mm]
- E[mm]
- U[mm]

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

Sistema de Referencia Geocéntrico para las Américas (SIRGAS)

Main menu

News

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
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.
## Horizontal and vertical velocities of the multiyear solution SIR17P01. [Sánchez, 2017]

### Horizontal Velocities

<table>
<thead>
<tr>
<th>NUM</th>
<th>STATION NAME</th>
<th>VX[m/a]</th>
<th>sig_VX[m/a]</th>
<th>VY[m/a]</th>
<th>sig_VY[m/a]</th>
<th>VZ[m/a]</th>
<th>sig_VZ[m/a]</th>
<th>ID-SNX</th>
<th>START</th>
<th>END</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AACR</td>
<td>0.00996</td>
<td>0.00027</td>
<td>0.00661</td>
<td>0.00092</td>
<td>0.01507</td>
<td>0.00027</td>
<td>A</td>
<td>2013-05-26</td>
<td>2017-01-28</td>
</tr>
<tr>
<td>2</td>
<td>ABCC</td>
<td>-0.01009</td>
<td>0.00023</td>
<td>0.02553</td>
<td>0.00049</td>
<td>0.01423</td>
<td>0.00020</td>
<td>A</td>
<td>2014-07-24</td>
<td>2017-01-28</td>
</tr>
<tr>
<td>3</td>
<td>ABMF</td>
<td>0.00700</td>
<td>0.00031</td>
<td>0.00878</td>
<td>0.00054</td>
<td>0.01451</td>
<td>0.00023</td>
<td>A</td>
<td>2011-04-17</td>
<td>2012-01-28</td>
</tr>
<tr>
<td>4</td>
<td>ABMF</td>
<td>0.00700</td>
<td>0.00031</td>
<td>0.00878</td>
<td>0.00054</td>
<td>0.01451</td>
<td>0.00023</td>
<td>A</td>
<td>2012-01-29</td>
<td>2016-05-21</td>
</tr>
<tr>
<td>5</td>
<td>ABFD</td>
<td>-0.00079</td>
<td>0.00024</td>
<td>0.00804</td>
<td>0.00046</td>
<td>0.01437</td>
<td>0.00019</td>
<td>A</td>
<td>2011-04-17</td>
<td>2017-01-28</td>
</tr>
<tr>
<td>6</td>
<td>ABFR</td>
<td>-0.00839</td>
<td>0.00036</td>
<td>0.00159</td>
<td>0.00094</td>
<td>0.01447</td>
<td>0.00023</td>
<td>A</td>
<td>2011-04-17</td>
<td>2017-01-28</td>
</tr>
<tr>
<td>7</td>
<td>AJCA</td>
<td>0.00629</td>
<td>0.00037</td>
<td>0.00261</td>
<td>0.00095</td>
<td>0.01326</td>
<td>0.00025</td>
<td>A</td>
<td>2012-06-03</td>
<td>2015-11-28</td>
</tr>
<tr>
<td>8</td>
<td>ALAR</td>
<td>-0.00001</td>
<td>0.00038</td>
<td>-0.00458</td>
<td>0.00030</td>
<td>0.01234</td>
<td>0.00021</td>
<td>A</td>
<td>2011-04-17</td>
<td>2017-01-28</td>
</tr>
<tr>
<td>9</td>
<td>ALRE</td>
<td>-0.00997</td>
<td>0.00059</td>
<td>0.00485</td>
<td>0.00101</td>
<td>0.01342</td>
<td>0.00039</td>
<td>A</td>
<td>2012-12-26</td>
<td>2015-07-03</td>
</tr>
<tr>
<td>10</td>
<td>ALEC</td>
<td>0.00101</td>
<td>0.00056</td>
<td>0.00132</td>
<td>0.00118</td>
<td>0.00960</td>
<td>0.00057</td>
<td>A</td>
<td>2013-09-22</td>
<td>2016-04-09</td>
</tr>
<tr>
<td>11</td>
<td>ALUM</td>
<td>-0.00030</td>
<td>0.00027</td>
<td>-0.00275</td>
<td>0.00053</td>
<td>0.00829</td>
<td>0.00032</td>
<td>A</td>
<td>2011-04-17</td>
<td>2015-09-12</td>
</tr>
<tr>
<td>Velocity model</td>
<td>Realizations</td>
<td>Region</td>
<td>Stations</td>
<td>Aplications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>---------------</td>
<td>-------------------------</td>
<td>-----------------------------------</td>
<td>------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEMOS2003</td>
<td>SIRGAS95 y</td>
<td>45°S to 12°N</td>
<td>48 stations 231 additional velocities</td>
<td>April 1995 to April 2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SIRGAS2000 (DGF01P01)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEMOS2009</td>
<td>SIR09P01</td>
<td>56°S to 20°N</td>
<td>96 stations 400 additional velocities</td>
<td>January 2, 2000 to June 30, 2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEMOS2015</td>
<td>SIR15P01</td>
<td>55°S, 110°W to 32°N, 35°W</td>
<td>456 stations</td>
<td>March 14, 2010 to April 11, 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEMOS2017</td>
<td>SIR17P01</td>
<td>55°S, 120°W to 32°N, 35°W</td>
<td>515 stations</td>
<td>January 1, 2014 to January 28, 2017</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which countries have adopted SIRGAS in the national densifications?

21 member countries

More than 26 years of evolution

More than 50 institutions from 20 countries.

15 National networks densify SIRGAS

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

15 National networks densify SIRGAS
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)

Sistema de Referencia Geocéntrico para las Américas (SIRGAS)

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 Ingeniería of the Universidad Nacional de Cuyo (UNCuyo, Mendoza, Argentina) in cooperation with the Facultad de Ingeniería of the Universidad Juan Agustín Maza (Mendoza, Argentina) and with support of the Argentinean Consejo Nacional de Investigaciones Científicas 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:


More details about the processing strategy can be found at:


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

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

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

16 attendees received financial aid
5 student grant

Thank you, very much