SIRGAS stands for Geocentric Reference System for the Americas
IAG Sub Commission 1.3b
Working Group of the PAIGH Cartography Commission

- SIRGAS as a reference system is defined identical with the International Terrestrial Reference System (ITRS)

- SIRGAS as a reference frame is a regional densification of the International Terrestrial reference Frame (ITRF)

(a) The International Terrestrial Reference System (ITRS)
(b) The International Terrestrial Reference Frame (ITRF) visualized as a distributed set of ground control stations (represented by red points)

http://www.kartografie.nl
• SIRGAS was created during the International Conference for the Definition of a South American Geocentric Datum, held from October 4 to 7, **1993**, in **Asunción**, Paraguay.

• The Conference was attended by delegations from the most of the countries.

• The development of SIRGAS “Project” comprised the activities needed to the adoption on the continent of a reference network of accuracy compatible with the techniques of satellite positioning, especially those associated with the Global Positioning System (GPS).
• Measurements from 00:00 (UT), May 26 to 24:00 (UT) June 04.

• 57 stations

• 30 institutions

• 11 countries

• 3 processing centres

“An extremely well executed project”, Wolfgang Torge, XXI IUGG General Assembly, Boulder.
• Measurements from 00:00 (UT), May 10 to 24:00 (UT), May 19.

• 184 stations

• 25 countries

• The 2005 campaign stations were re-occupied as well as national tide gauges and international connecting points

Table 1. Distribution and types of stations in the countries

<table>
<thead>
<tr>
<th>Country (Island)</th>
<th>SIRGAS 1995</th>
<th>New Site</th>
<th>Tide Gauge</th>
<th>Total No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Bermuda</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Bolivia</td>
<td>6</td>
<td>3</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>Brazil</td>
<td>11</td>
<td>5</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>Canada</td>
<td>-</td>
<td>10</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Chile</td>
<td>7</td>
<td>8</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Colombia</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Ecuador</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Ft. Gournia</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Guatemala</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Guyana</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Honduras</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Jamaica</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Mexico</td>
<td>-</td>
<td>13</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Paraguay</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Saint Croix</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Peru</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Trinidad&amp; Tobago</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Uruguay</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>USA</td>
<td>-</td>
<td>12</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Venezuela</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Antartica</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Sum</td>
<td>56</td>
<td>85</td>
<td>45</td>
<td>184</td>
</tr>
</tbody>
</table>
After 2000, SIRGAS begun its realization by a network of continuously operating GNSS stations with precisely known positions (referred to an specific reference epoch) and their changes with time (station velocities). This SIRGAS Continuously Operating Network (SIRGAS-CON) is currently composed by about 250 permanently operating GNSS sites, 48 of them belonging to the global IGS network.
• National reference frames in Latin America are part of SIRGAS CON.

• The core network (SIRGAS-CON-C) is the primary densification of ITRF in Latin America.

• Densification sub-networks (SIRGAS-CON-D) provide accessibility to the reference frame at local levels.

• Today, there are three SIRGAS-CON-D sub-networks, but in the future, there shall be given so many SIRGAS-CON-D sub-networks as countries in the region.
**CHANGES IN DATA ANALYSIS**

**SIRGAS-WGI**

**SIRGAS-CON-C** (core network)

3 SIRGAS-CON-D (densification sub-networks)

1 Regional Data Centre (DGFI)

National Data Centres (entities in charge of national reference frames)

1 Analysis Centre (DGFI as IGS-RNAAC-SIR)

8 Local Processing Centres
CEPGE, CIMA, CPAGS-LUZ, IBGE, IGAC, IGN-Ar, INEGI, SGM-Uy

2 Combination Centres (DGFI, IBGE)

Final solutions for the SIRGAS-CON reference frame

- Weekly station positions aligned to the ITRF
- Multi-year solutions (positions + velocities)

**Weekly loosely constrained solutions for combination (IGS multiannual solutions)**

**Weekly coordinates adjusted to ITRF Multiannual solutions (positions + velocities)**

2007

2011

**SIRGAS-CON NETWORK**

**1 DATA CENTRE** (DGFI as IGS-RNAAC-SIR)

**1 ANALYSIS CENTRE** (DGFI as IGS-RNAAC-SIR)
STRUCTURAL EVOLUTION

1993 – 1997

1997 -2011

2011...
9 processing centres

CEPGE-Ec  CIMA-Ar  CPAGS-Ve

IBGE-Br  IGAC-Co  SGM-Uy

DGFI-De  IGN-Ar  INEGI-Mx

2 combination centres

IBGE-Br  DGFI-De

- Each station is processed by 3 centres
- 2 independent combinations
- Weekly coordinates:
  \( \sigma = \pm 1.7 \text{ mm in N-E} \)
  \( \sigma = \pm 3.7 \text{ mm in h} \)

Officially since 2011-01-01
SIRGAS MEMBERS: 2011

International Association of Geodesy (IAG)
Pan American Institute of Geography and History (PAIGH)

Argentina
Bolivia
Brazil
Canada
Chile
Colombia
Costa Rica
Ecuador
El Salvador
Guatemala
Guyana
Honduras
Mexico
Nicaragua
Panama
Paraguay
Peru
Uruguay
Venezuela
The new SIRGAS vertical reference system is based on a geometrical component that corresponds to ellipsoidal heights referred to the SIRGAS datum, and a physical component that is given in terms of geopotential quantities ($W_0$ as a reference level and geopotential numbers as primary coordinates). Its realization should:

i) Refer to a unified global reference level $W_0$,

ii) Be given by proper physical heights (derived from spirit levelling in combination with gravity reductions), and

iii) Be associated to a specific reference epoch, i.e. it should consider the coordinate and referential changes with time.

The respective reference surface (geoid or quasigeoid) shall be determined in a common analysis over the whole continent.
Determination of:

\[ \delta W_i = W_0 - W_i \]
\[ \delta W_{ij} = W_j - W_i \]

At:
- Reference tide gauges
- Areas around the tide gauges
- SIRGAS reference stations
- International connection points

Combined analysis of tidal records, satellite altimetry and GNSS positioning in order to unify the local vertical reference systems.
Evolution of the ionospheric model:
- 3-D representation of TEC and 4D of EC.

Applications for the projects:
- Augmentation Solution for the Caribbean, Central and South America (SACCSA) for ICAO.
- Low Ionosphere Sensor network;
- International Reference Ionosphere.

“Contribution to the Study of the Global Climatic Change and the Meteorological Prediction and the Space Weather: Argentina, Brazil, Colombia, Ecuador, Mexico, Venezuela and Uruguay under the guidance of Virginia Mackern (approved PAIGH in 2010);
• Increasing number of stations that generate observations and corrections in real Time: installation of new casters and sharing of experiences that demonstrate the potential of the method, specially in Brazil, Uruguay, Argentina and Venezuela.

• At the beginning of 2011, the project “Evaluation of potential applications of NTRIP in SIRGAS” was presented to PAIGH with the participation of Uruguay, Argentina and Venezuela.
SIRGAS Resolution 03, August 10, 2011:

• To establish the project SIRGAS-GLONASS ascribed to the WGI.

• To study the appropriate processing strategies for obtaining the best possible accuracies based on GLONASS positioning as a tool for the realization of the SIRGAS reference frame and to define the feasibility of its routine analysis in the same way as GPS.

SIRGAS Resolution 04, August 10, 2011:

• To establish the project SIRGAS-MoNoLin ascribed to the WGI and WGIi.

• To define the most appropriate strategy to include the non linear movements of the reference stations in the determination of their coordinates and, in consequence, to improve the kinematic representation of the reference frames that they integrate.
• Specialized courses for the establishment of the SIRGAS analysis centres
  - Instituto Geográfico Militar de Ecuador, December 2008 and February 2011. CEPGE-IGM
  - Servicio Geográfico Militar del Uruguay, March 2009

• SIRGAS Schools on Reference Systems
  - First: Bogotá, July 2009, IGAC, 120 participants, 12 countries.
  - Second: Lima, November 2010, IGN, 122 participants, 13 countries.
  - Third: Heredia, August 2011, ETCG, 116 participants, 18 countries

• SIRGAS Chapter in Advanced Course of Satellite Positioning: AECID
  - Universidad Politécnica de Madrid, November 2009
  - Montevideo, May 2010
  - Universidad Politécnica de Madrid, November 2010
As the science of accurately measure and understand three fundamental properties of Earth: its geometric shape, its orientation in space, and its gravity field; and the changes of these properties with time (Precise Geodetic Infrastructure: National Requirements for a Shared Resource).

The science for measuring changes in the Earth System.

SIRGAS provides the core data for the Americas Geospatial Data Infrastructure (Mackern, 2010)
Geodetic infrastructure and observing systems:

As the set of human and technical resources devoted to the long-term definition, maintenance and modernization of a multipurpose continental network, which is a regional densification (realization) of the global International Terrestrial Reference Frame (ITRF). Systems can be set as components of the Infrastructure, oriented to the monitoring and study of different phenomena occurring in Earth System.

- “Global patterns of tectonic deformation
- Global patterns of all types of height changes
- Deformation due to the mass transfer between solid Earth, atmosphere, and hydrosphere including ice;
- Quantification of angular momentum exchange and mass transfer”

(Drewes, 2005)

http://www.agu.org/

http://ggos.gfz-potsdam.de/
• **Earth sciences.** As the contribution of geodetic science and techniques to the family of Earth sciences by sharing data, providing services and generating information that combined with those provided by different sources lead to a better comprehension of Earth.
• **Social benefits.** As a practical application focused on solving problems derived from natural hazards, global change and the social evolution itself. It is related to all the elements, variables and processes that can be located by geopositioning. This covers, by far, the most of the human activities and their relation with the environment.

**Geographic Names**  
Census  
Addresses  
Structures  
Parcels  
Land Cover  
Boundaries  
Transportation  
Hydrography  
Elevation  
Orthoimagery  
Geodesy


[http://cast.uark.edu/home/research/geomatics.html](http://cast.uark.edu/home/research/geomatics.html)
Thank you very much.