The Geocentric Reference System for the Americas SIRGAS: an advancing example of cooperation based on GNSS

William Martínez
President of SIRGAS WG II Geocentric Datum
Instituto Geográfico Agustín Codazzi - Colombia

Laura Sánchez
Vice-President of SIRGAS
Deutsches Geodätisches Forschungsinstitut, Germany

Hermann Drewes
IAG Representative and Scientific Advisor of SIRGAS
Deutsches Geodätisches Forschungsinstitut, Germany

Claudio Brunini
President of SIRGAS
Universidad Nacional de La Plata - Argentina

María Virginia Mackern
President of SIRGAS GT I Reference System
Universidad Nacional del Cuyo - Argentina

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Contents

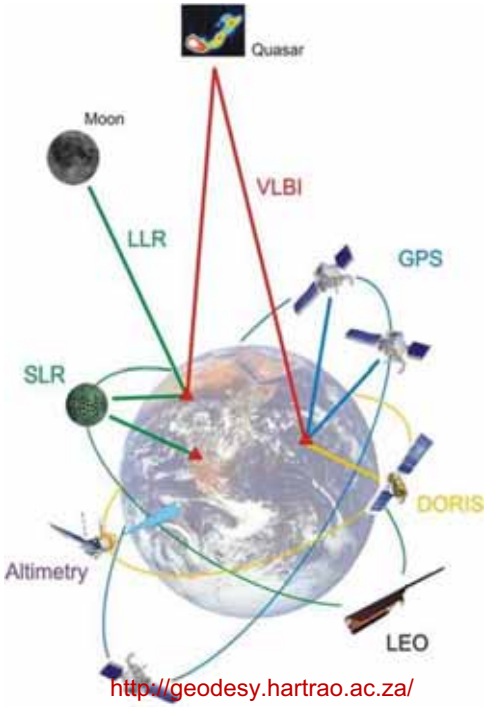
- SIRGAS meanings
- Review
- Structure
- Definition
- Realizations
- Processing
- Velocities
- Time series
- National densifications
- Ionospheric maps for SIRGAS
- Capacity building

SIRGAS means…

Geodesy:

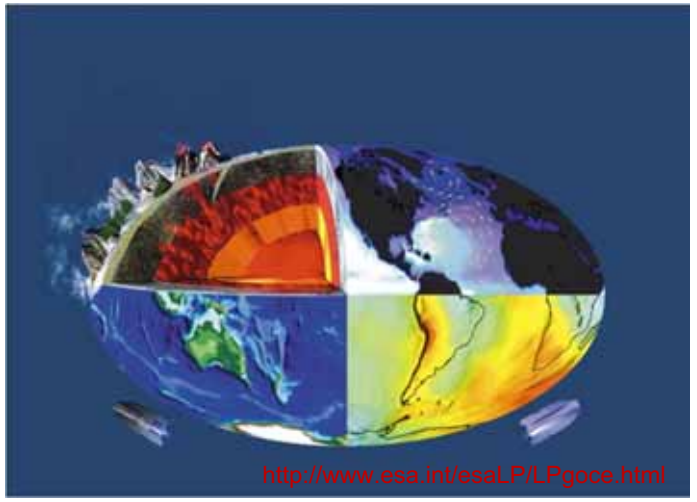
As the science of accurately measure and understand three fundamental properties of Earth: its geometric shape, its orientation in space, and its gravity field; and the changes of these properties with time (Precise Geodetic Infrastructure: National Requirements for a Shared Resource, 2010).

The science for measuring changes in the Earth System.



http://geodesy.hartrao.ac.za/


http://www.igp.ethz.ch/geomeln/


http://www.esa.int/esaLP/LPgoce.html

SIRGAS provides the core data for the Americas Geospatial Data Infrastructure (Mackern, 2010)

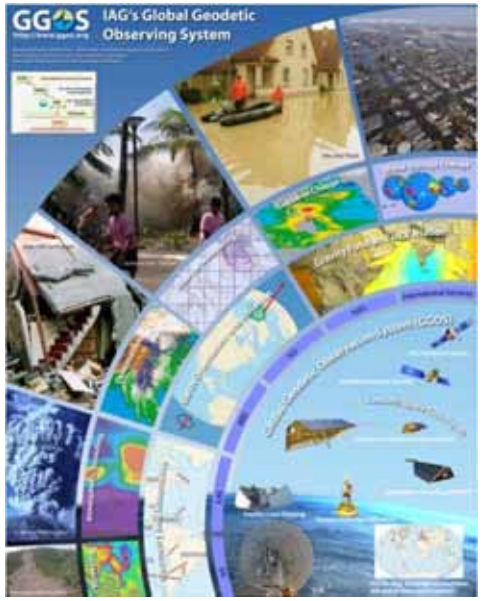
SIRGAS means…

Geodetic infrastructure and observing systems:

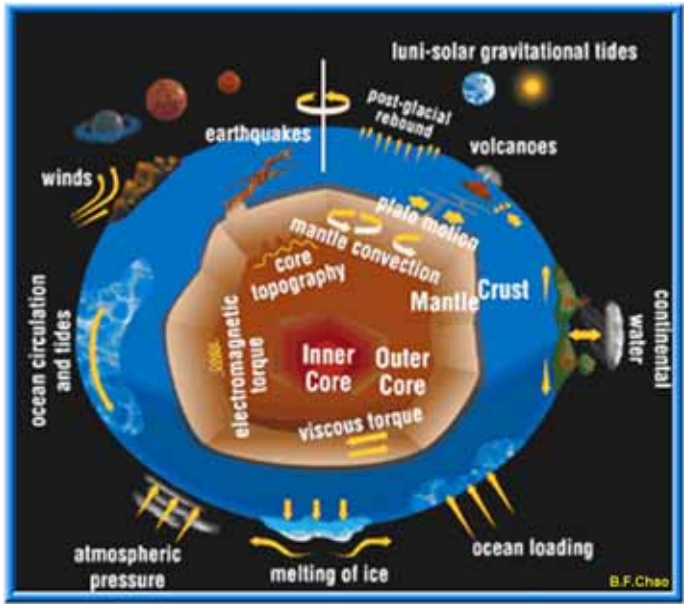
As the set of human and technical resources devoted to the long-term definition, maintenance and modernization of a multipurpose continental network, which is a regional densification (realization) of the global International Terrestrial Reference Frame (ITRF). Systems can be set as components of the 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://ggos.gfz-potsdam.de/



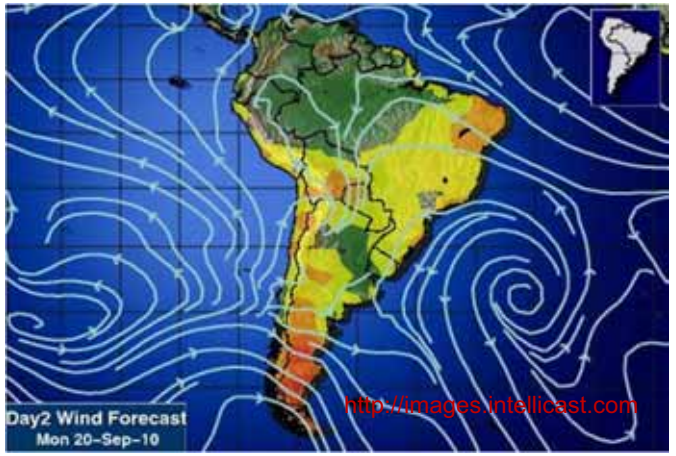
http://www.agu.org/

SIRGAS means…

http://www.radiiosantafe.com

- **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.

•Geodesy is able to measure several effects of geodynamic and global change processes, including the whole cycle of the water.
•A complete understanding of those processes will require very precise and stable time series of data acquired over many years.
•Measurements and satellite orbits must be tied to a Terrestrial Reference Frame (TRF) that supports millimeter-level accuracy and ensures stability over decades.
•Changes must be continuously monitored with mm/year-level accuracy. (Brunini, 2005)



SIRGAS means…

SIRGAS - SISTEMA DE REFERENCIA GEOCÉNTRICO PARA LAS AMÉRICAS

www.sirgas.org

SIRGAS and the earthquake of February 27, 2010 in Chile

L. Sánchez, W. Seemüller, H. Drewes
Deutsches Geodätisches Forschungsinstitut (DGFI)
Munich, March 17th, 2010.

On 27 February 2010, at 06:34 UTC (03:34 local time) an earthquake (magnitude 8,8) shook the western part of Chile. The epicentre was located at 35.846°S and 72.719°W in a depth of about 35 km. In order to estimate the impact of this earthquake in the SIRGAS Reference Frame, daily station positions between February 21 and March 6, 2010 were computed for selected continuously operating SIRGAS stations. This processing includes IGS05 stations located in Europe, North America, Africa, and Antarctica as reference points (Fig. 1).

Fig. 1. IGS05 reference stations applied for the datum realization.

The largest displacements occurred between latitudes 30°S to 40°S from the Pacific to the coast (Fig. 2). Results show that the station CONZ (Concepción, Chile) initially moved (on 27-F 2,9 m in the south west direction. In the week following the first earthquake, additional post movements of more than 10 cm were detected. Strong vertical displacements are also ider Concepción, Santiago, Valparaíso and the Province of Mendoza in Argentina (Fig. 3). Stations lo the west of the Andes moved down, stations located in the east moved up. More details are ava

In summary, 23 SIRGAS-CON reference stations moved more than 1,5 cm (Table 1): ANTC Chile), AZUL (Azul, Argentina), BCAR (Balcarce, Argentina), CFAG (Cavacete, Argentina (Concepción, Chile), CSLO (Complejo Astronómico El Leoncito, Argentina), IGM1 (Buenos Argentina), LHCL (Lihuel Calel, Argentina), LPGS (La Plata, Argentina), MAD1 (Neuquen, Ar MZAS (San Rafael, Argentina), MZAC (Mendoza, Argentina), MZAE (Santa Rosa, Mendoza, Ar RWSN (Rawson, Argentina), SANT (Santiago, Chile), SLO1 (La Punta, Argentina), SRLP (Santa Pampa, Argentina), UCOR (Córdoba, Argentina), UNBO (Rosario, Argentina), UNSJ (S Argentina), UYMO (Montevideo, Uruguay), VALP (Valparaíso, Chile), VBCA (Bahía Blanca, Ar The corresponding time series are enclosed.

These computations were carried out by the SIRGAS Analysis Centre at DGFI (Deutscher Geo Forschungsinstitut) and are based on the observation data provided by the IGS (Internatio Service, www.igs.org) and the Latin American Operation Centres and National Data contributing to the continuously operating network SIRGAS-CON (www.sirgas.org). We acknowledge this support.

- **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.

SIRGAS - SISTEMA DE REFERENCIA GEOCÉNTRICO PARA LAS AMÉRICAS

www.sirgas.org

Fig. 2. Horizontal displacements estimated in the week after the earthquake of 2010-02-27 in Chile.

Fig. 3. Vertical displacements estimated in the week after the earthquake of 2010-02-27 in Chile.

SIRGAS - SISTEMA DE REFERENCIA GEOCÉNTRICO PARA LAS AMÉRICAS

www.sirgas.org

SIRGAS and the earthquake of April 4, 2010 in Baja California, Mexico

L. Sánchez, W. Seemüller, H. Drewes
Deutsches Geodätisches Forschungsinstitut (DGFI)
Munich, May 5, 2010.

On April 04th, 2010, at 22:40 UTC (03:40 pm local time) an earthquake (magnitude 7.2) shook the north-western part of Mexico. The epicentre was located at 32.128°N and 115.303°W in a depth of about 10 km. In order to estimate the impact of this earthquake in the SIRGAS Reference Frame, daily station positions between March 31st and April 7th, 2010 were computed for selected continuously operating SIRGAS stations. Since the earthquake occurred in the NW limit of the geographical region covered by SIRGAS, this processing included 13 additional IGS stations located in North America. Results show a displacement of 23 cm in the SE direction of the reference station MEXI (Mexicali).

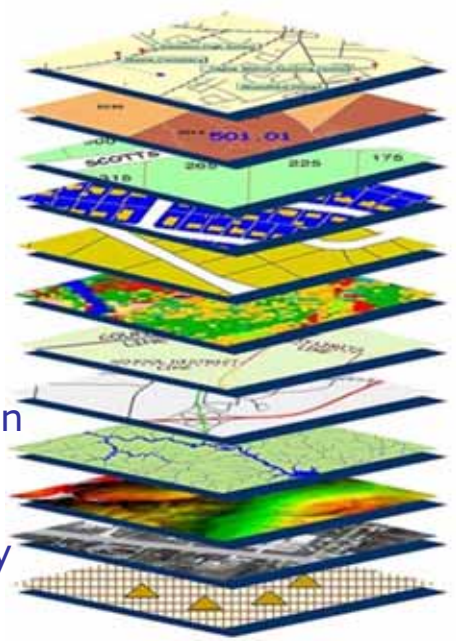
The other SIRGAS stations located in the region present position changes less than 4 mm. Unfortunately, the station CICT (Ensenada), the nearest to the earthquake zone after MEXI, is out of operation and therefore, it has not been possible to estimate, if it is affected by the earthquake.

These computations were carried out by the SIRGAS Analysis Centre at DGFI (Deutscher Geodätischer Forschungsinstitut) and are based on the observation data provided by the IGS (International GNSS Service, www.igs.org) and the Instituto Nacional de Estadística y Geografía - INEGI- of México (www.inegi.gob.mx), which contributes to the continuously operating network SIRGAS-CON (www.sirgas.org) through the Red Geodésica Nacional Activa (RGNA). We deeply acknowledge this support.

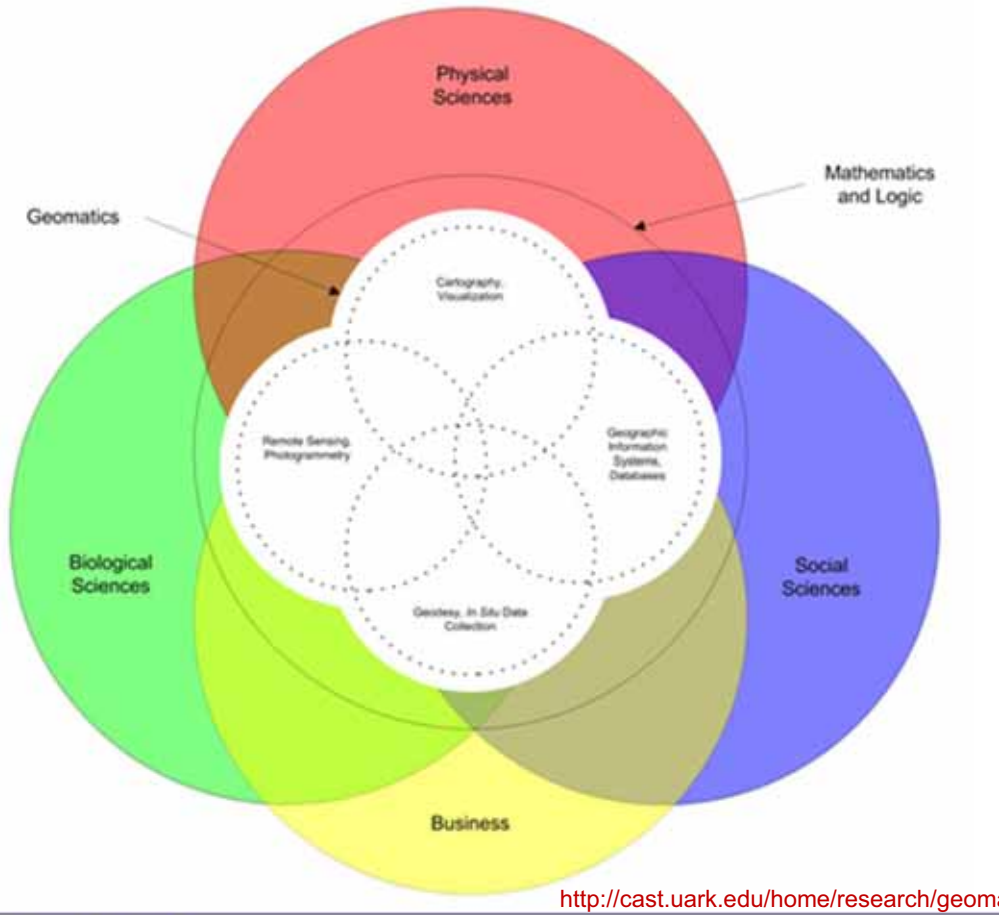
SIRGAS means…

- 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://www.techlines.ky.gov/

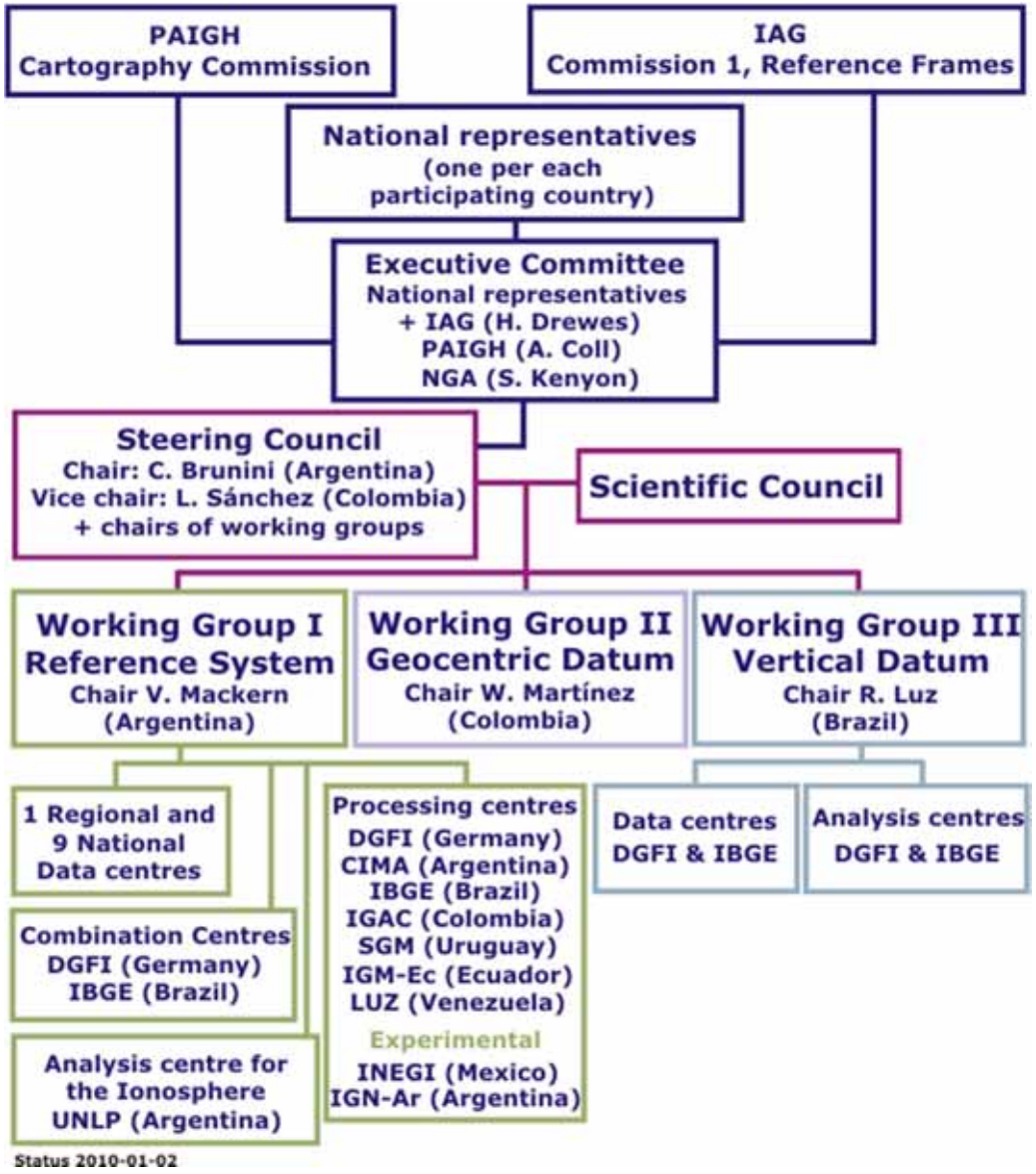


http://cast.uark.edu/home/research/geomatics.html

Review

- Established in1993
- Sponsored by the International Association of Geodesy (IAG), Pan American Institute of Geography and History (PAIGH) and National Geospatial-Intelligenece Agency NGA (former DMA).
- At that time, efforts were made to integrate national reference systems in South America
- GNSS based positioning turned into the primary tool for Geodesy and let the definition of global geodetic networks (ITRF).

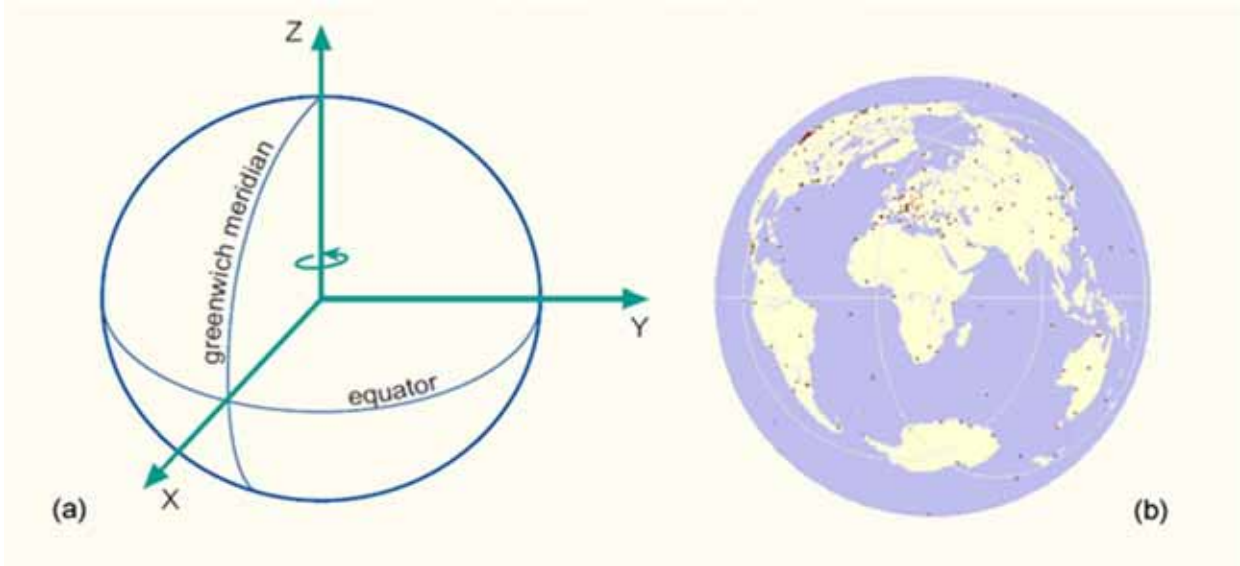
Structure

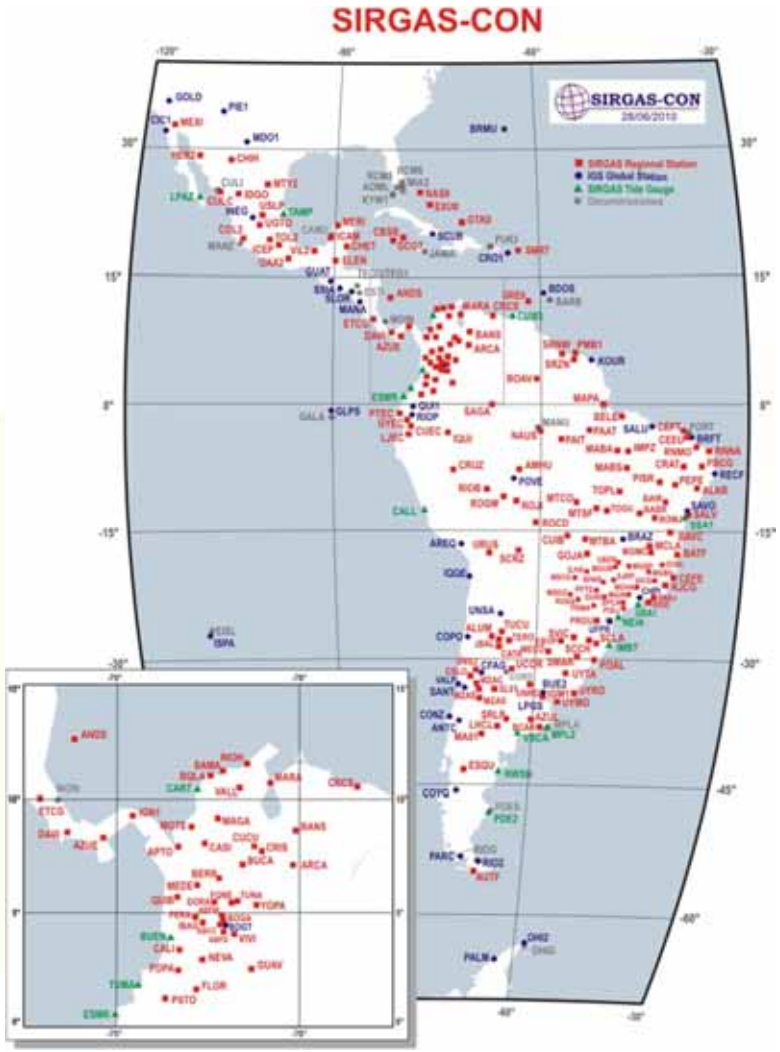

PAIGH
Cartography Commission
IAG
Commission 1, Reference Frames
National representatives
(one per each
participating country)
Executive Committee
National representatives
+ IAG (H. Drewes)
PAIGH (A. Coll)
NGA (S. Kenyon)
Steering Council
Chair: C. Brunini (Argentina)
Vice chair: L. Sánchez (Colombia)
+ chairs of working groups
Scientific Council
Working Group I
Reference System
Chair V. Mackern
(Argentina)
Working Group II
Geocentric Datum
Chair W. Martínez
(Colombia)
Working Group III
Vertical Datum
Chair R. Luz
(Brazil)
1 Regional and
9 National
Data centres
Combination Centres
DGFI (Germany)
IBGE (Brazil)
Analysis centre for
the Ionosphere
UNLP (Argentina)
Processing centres
DGFI (Germany)
CIMA (Argentina)
IBGE (Brazil)
IGAC (Colombia)
SGM (Uruguay)
IGM-Ec (Ecuador)
LUZ (Venezuela)
Experimental
INEGI (Mexico)
IGN-Ar (Argentina)
Data centres
DGFI & IBGE
Analysis centres
DGFI & IBGE
Status 2010-01-02

Definition

- 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)

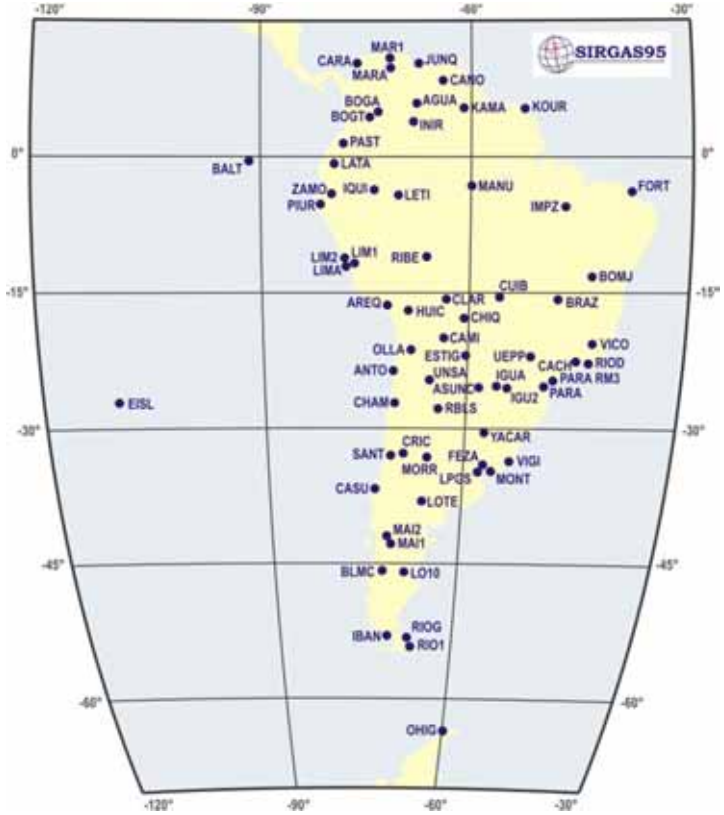




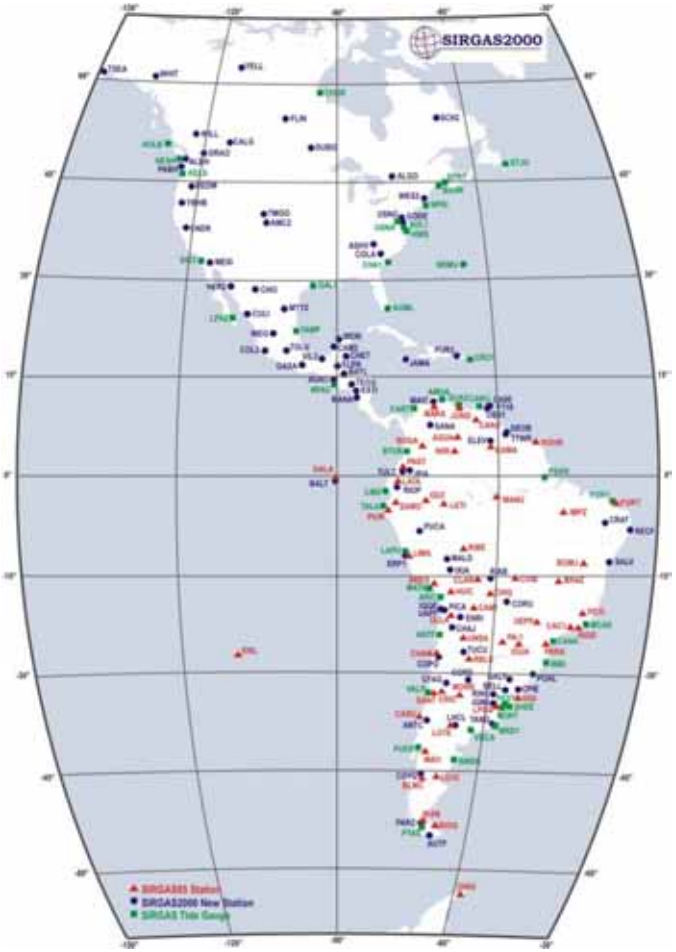
(a) The International Terrestrial Reference System (ITRS)
(b) The International Terrestrial Reference Frame (ITRF) visualized as a distributed set of ground control stations (represented by red points)

Realizations

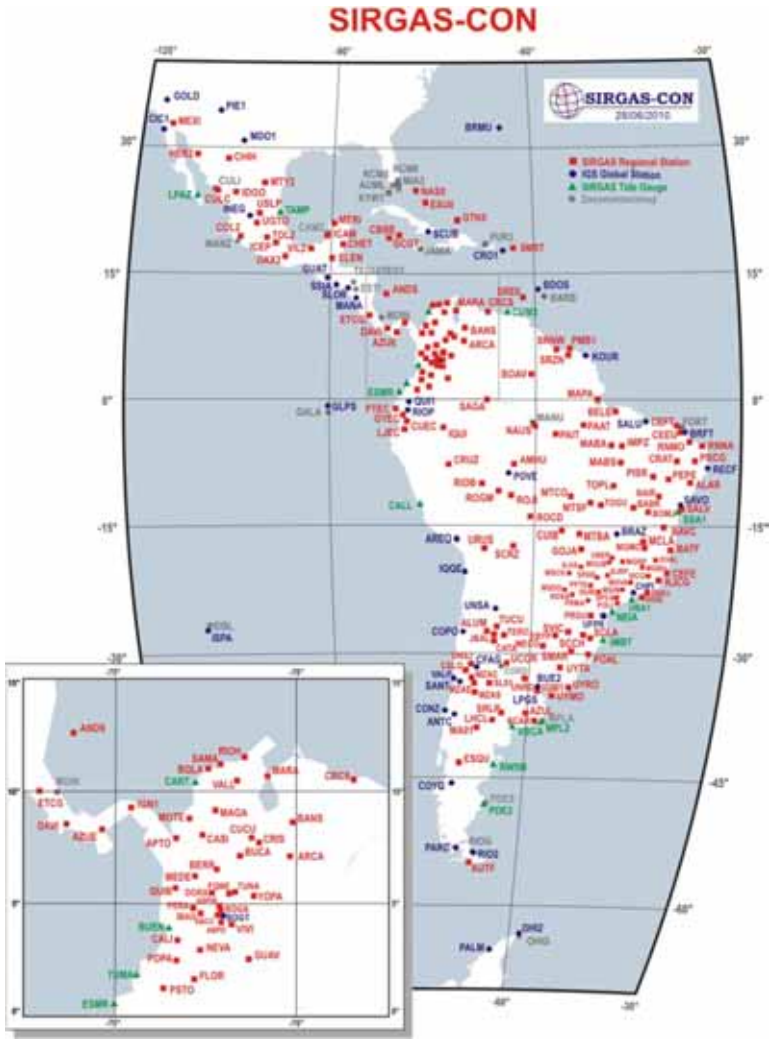
- SIRGAS 1995: Refers to ITRF94, epoch 1995.4.High-precision GPS network of 58 points distributed over South America.



- SIRGAS 2000: The second realization. Includes 184 GPS stations and refers to ITRF 2000, epoch 2000.4



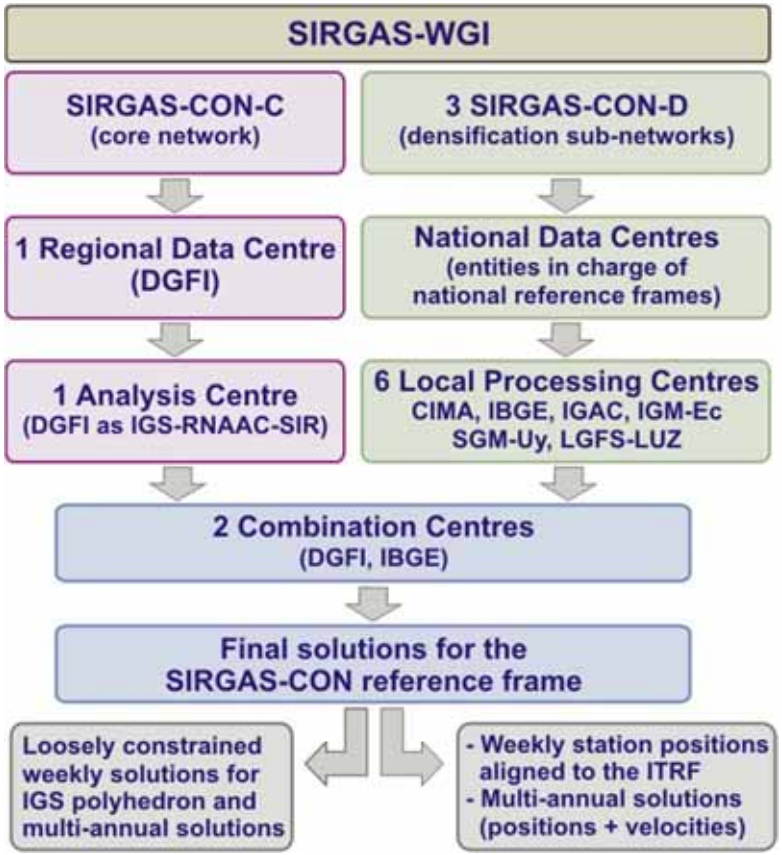
Realizations

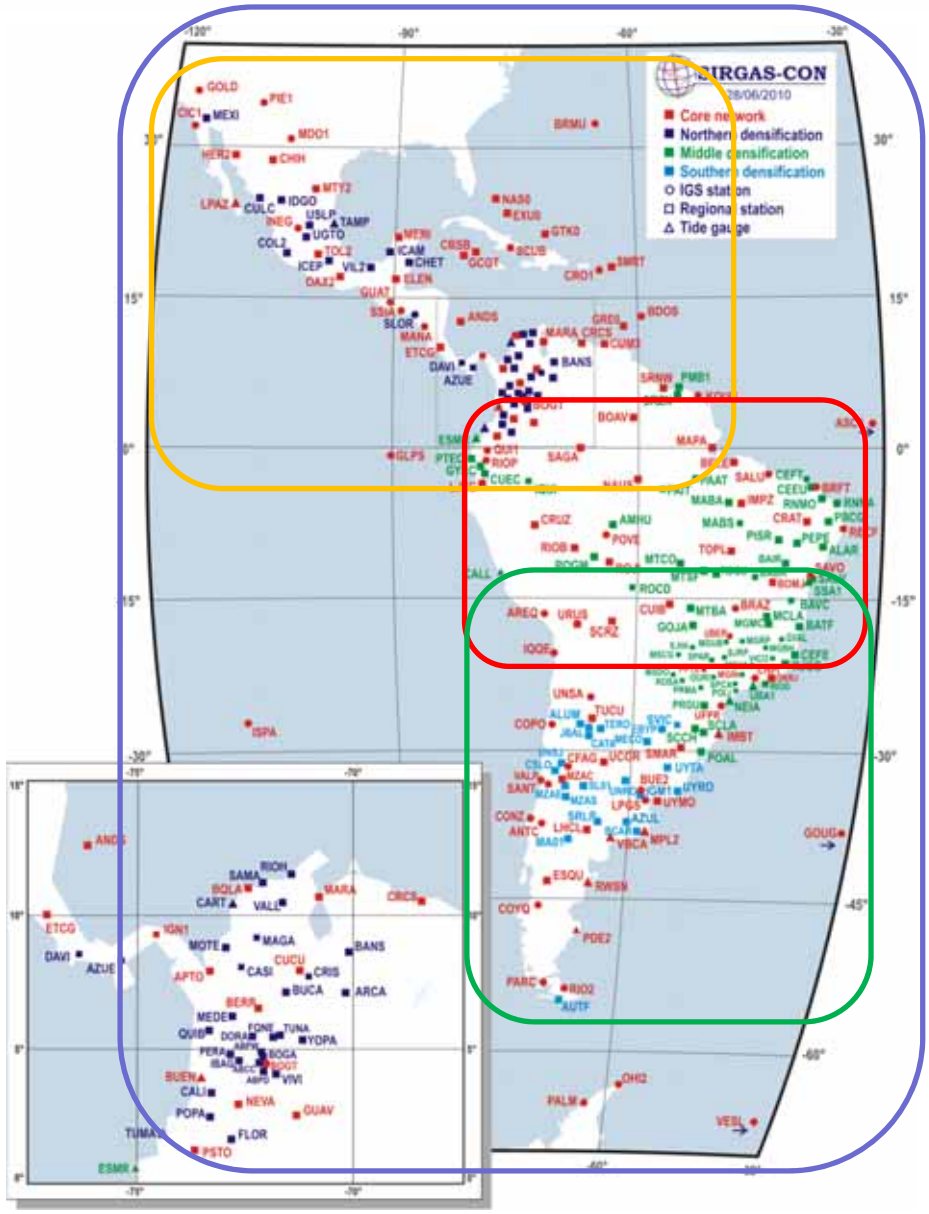


SIRGAS-CON: SIRGAS CONTINUOUSLY OPERATING NETWORK.

- It is composed by more than 200 permanently operating GNSS sites, 48 of them from the global IGS network.
- SIRGAS-CON coordinates are weekly computed by the SIRGAS processing and combinations centers.
- The final coordinates and velocities are provided by the IGS Regional Network Associate Analysis Centre for SIRGAS (IGS-RNAAC-SIR) at DGFI Deutsches Geodätisches Forschungsinstitut,Munich, Germany).
- Multi annual solutions give the kinematics of the network with accuracies better than 1 mm in position and 1 mm/yr in velocities.
- The coordinates of the multi annual solutions refer to a specified epoch, e.g. the solution SIR09P01 refers to IGS05, epoch 2005.0.

Processing

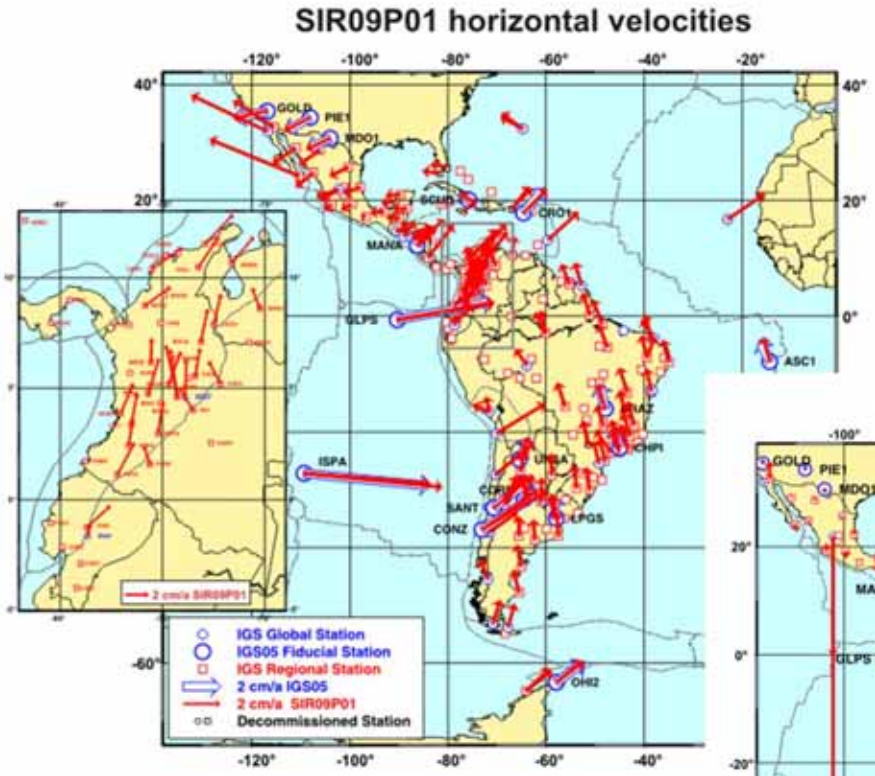


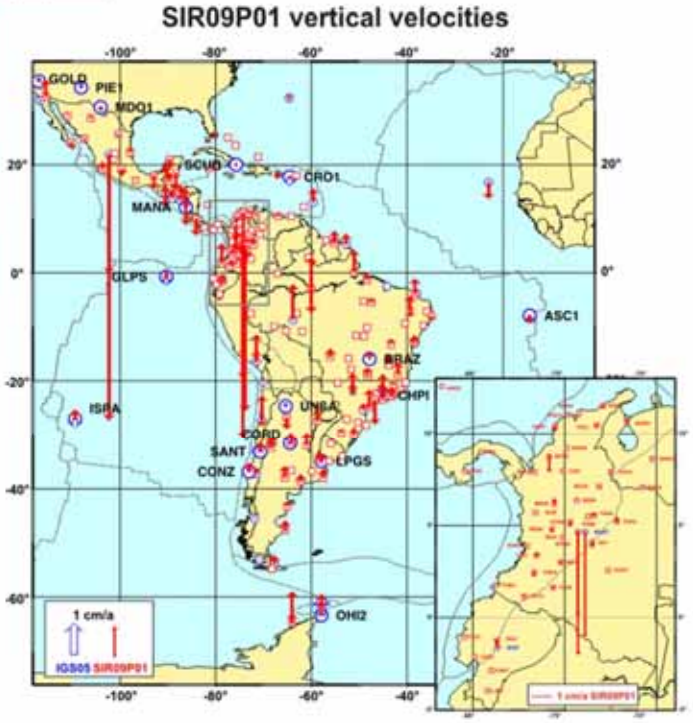


The goal is that each country processes its own stations following the SIRGAS processing guidelines, which are defined in accordance with the IERS and IGS standards and conventions (Sánchez, 2009)

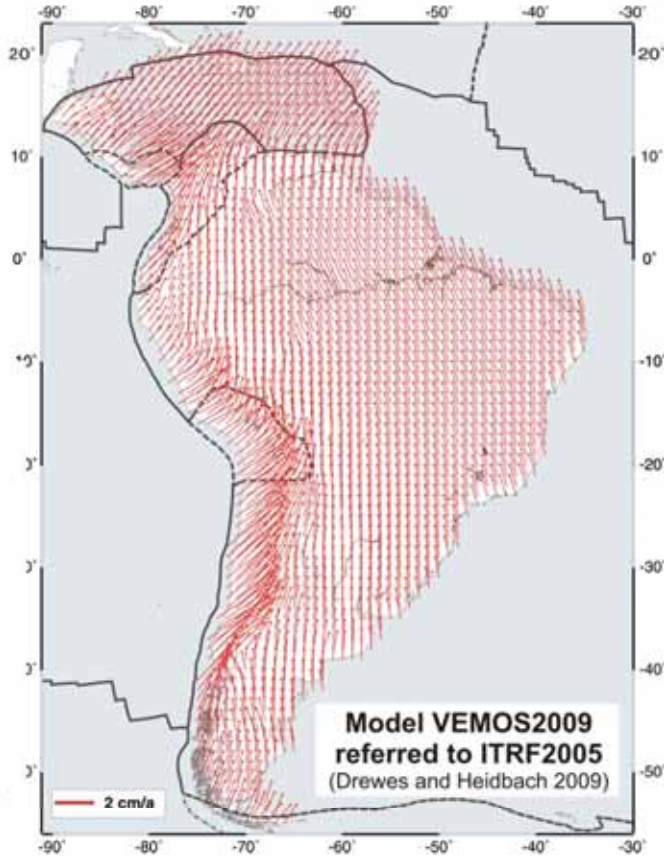
SIRGAS Processing / combination centres

Velocities



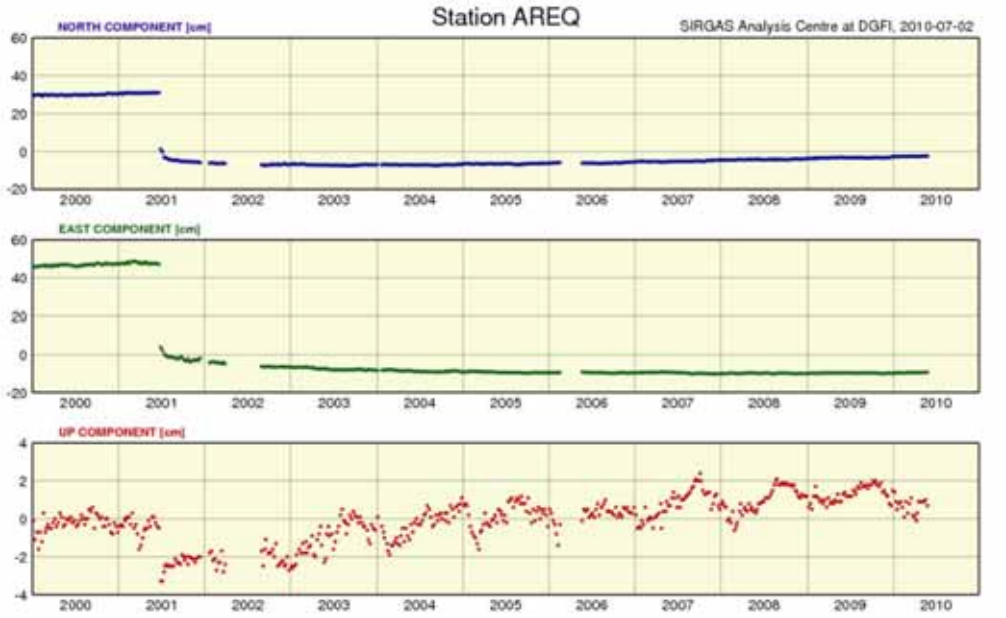


Velocity Model for South America and the Caribbean (VEMOS2009) referred to the ITRF2005 (Drewes and Heidbach 2009).



The Position and Velocity Solution SIR09P01 of the IGS Regional Network Associate Analysis Centre for SIRGAS (IGS RNAAC SIR) Seemüller et al.

Time series


Station AREQ
SIRGAS Analysis Centre at DGFI, 2010-07-02
NORTH COMPONENT [cm]
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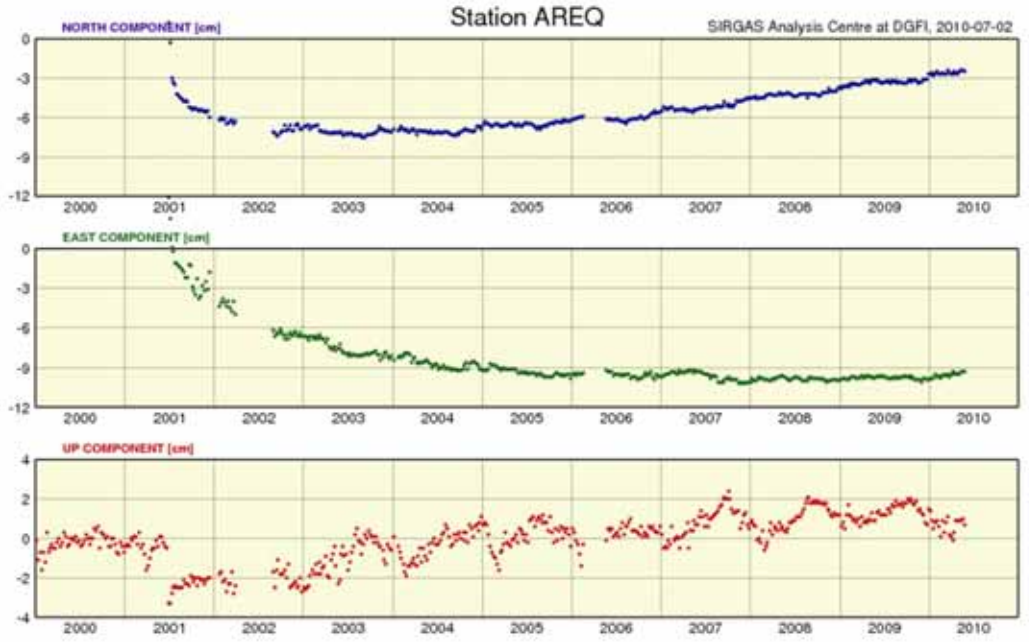
Station AREQ
SIRGAS Analysis Centre at DGFI, 2010-07-02
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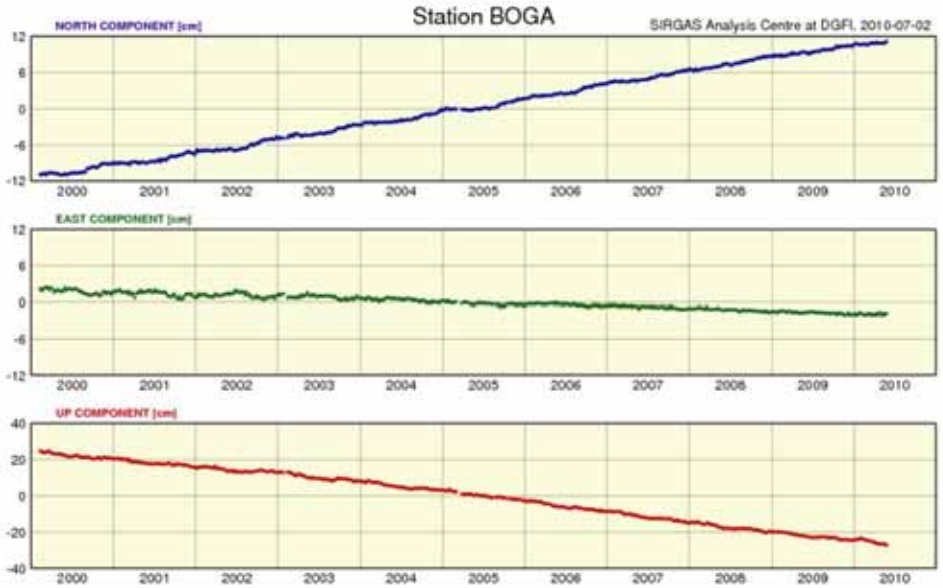
Time series


Station BOGA
SIRGAS Analysis Centre at DGFI, 2010-07-02
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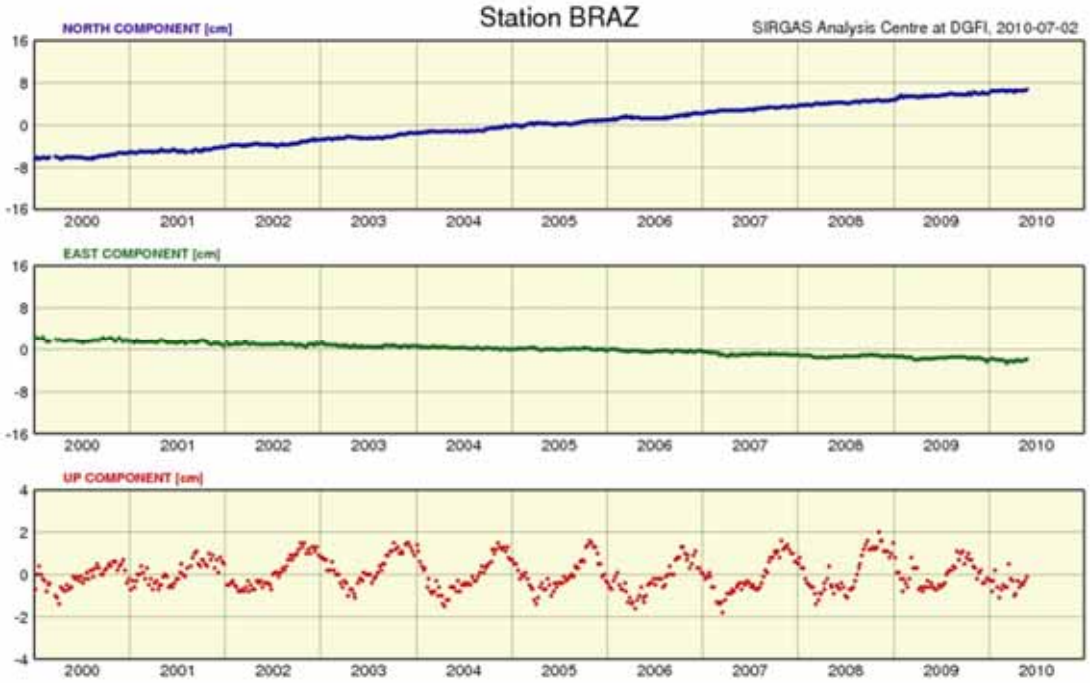
Station BRAZ
SIRGAS Analysis Centre at DGFI, 2010-07-02
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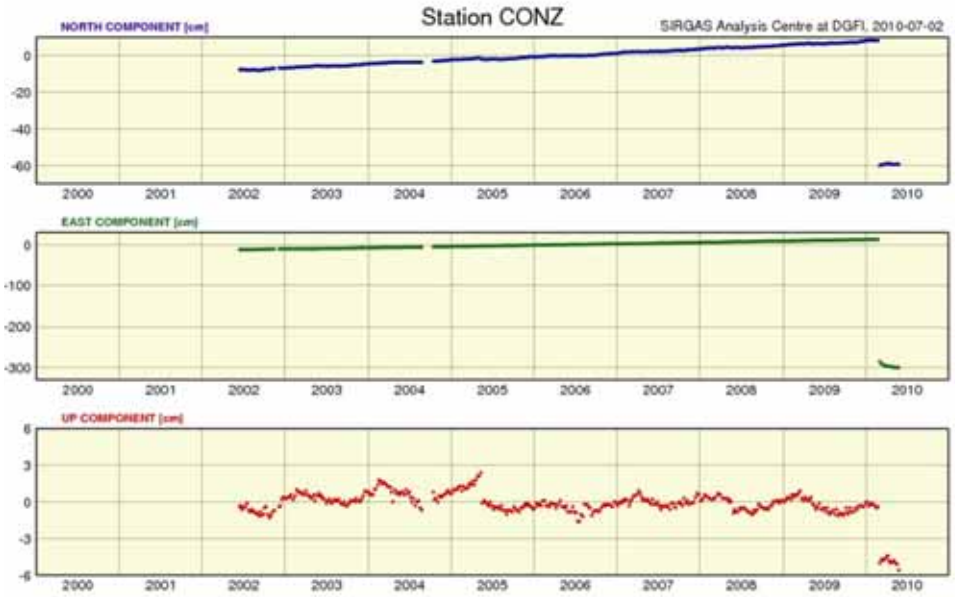
Time series


Station CONZ
SIRGAS Analysis Centre at DGFI, 2010-07-02
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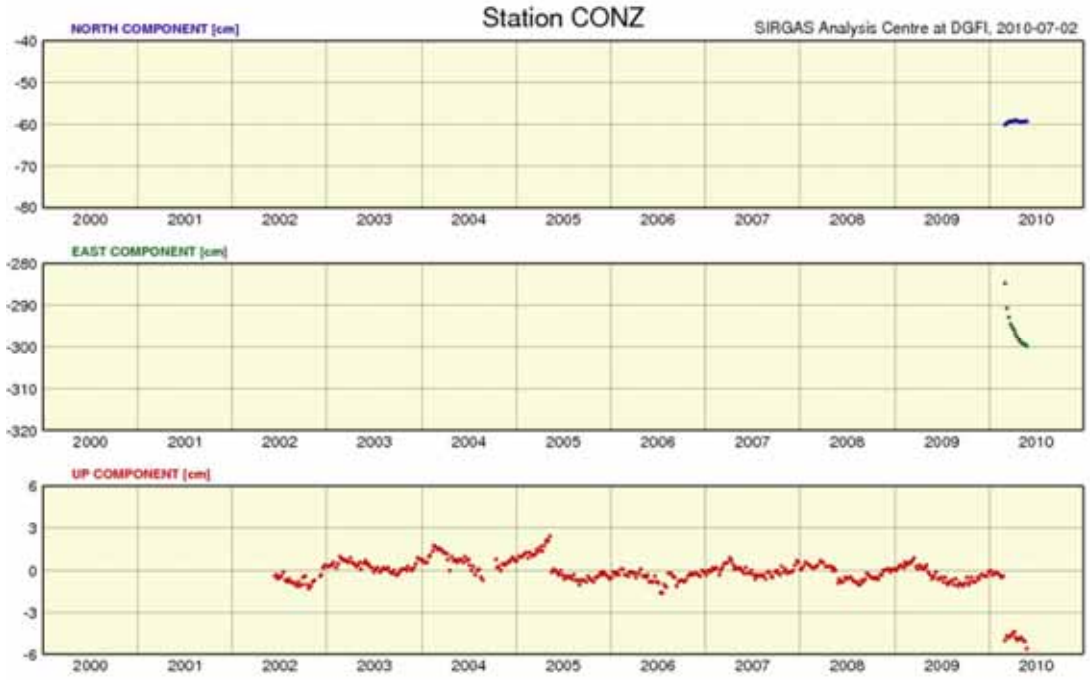
Station CONZ
SIRGAS Analysis Centre at DGFI, 2010-07-02
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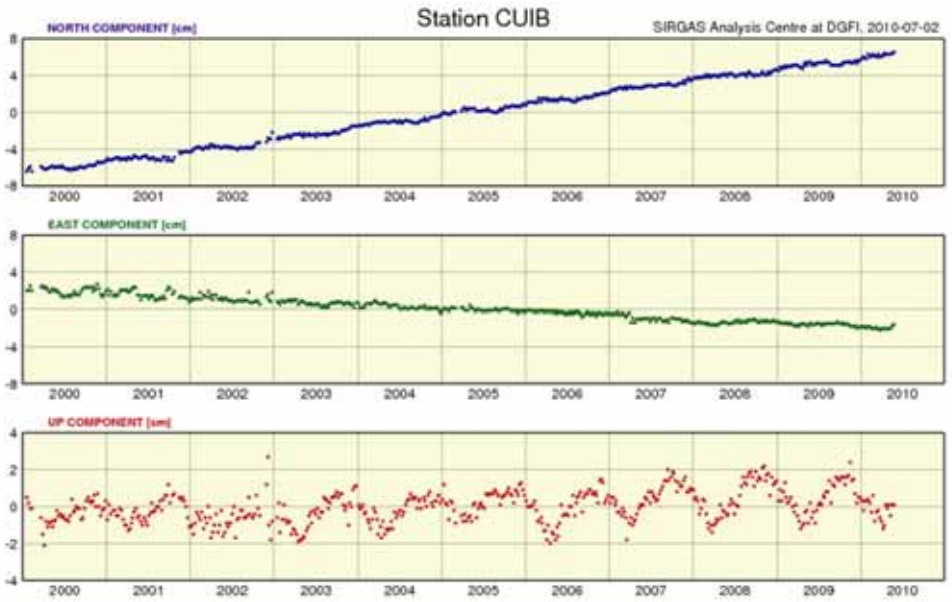
Time series


Station CUIB
SIRGAS Analysis Centre at DGFI, 2010-07-02
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UP COMPONENT [cm]
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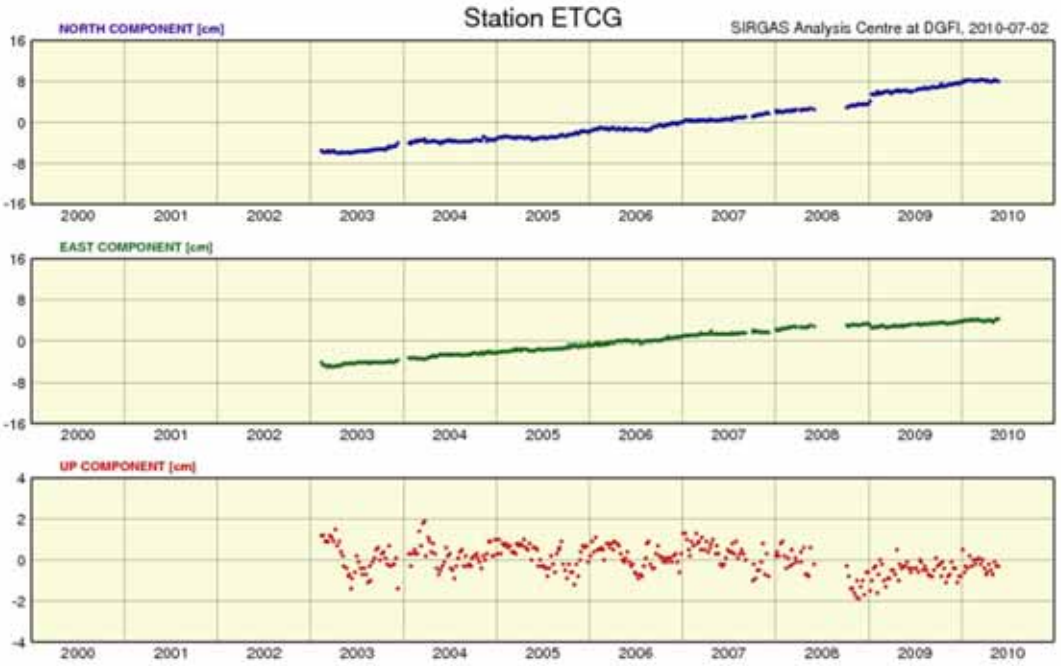
Station ETCG
SIRGAS Analysis Centre at DGFI, 2010-07-02
NORTH COMPONENT [cm]
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UP COMPONENT [cm]
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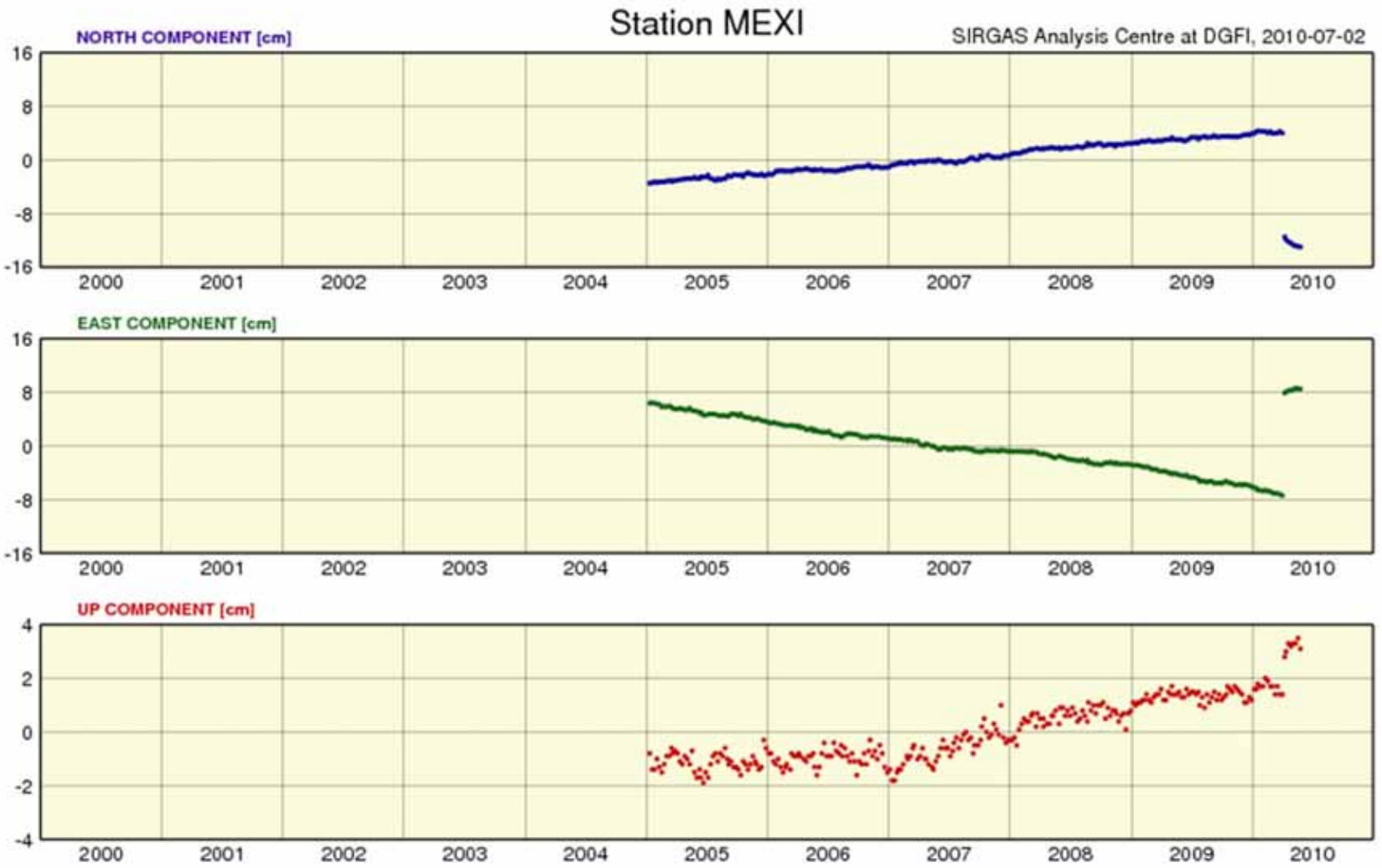
Time series


Station MEXI
SIRGAS Analysis Centre at DGFI, 2010-07-02
NORTH COMPONENT [cm]
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-8
-16
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2006
2007
2008
2009
2010
EAST COMPONENT [cm]
16
8
0
-8
-16
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2004
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2008
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2010
UP COMPONENT [cm]
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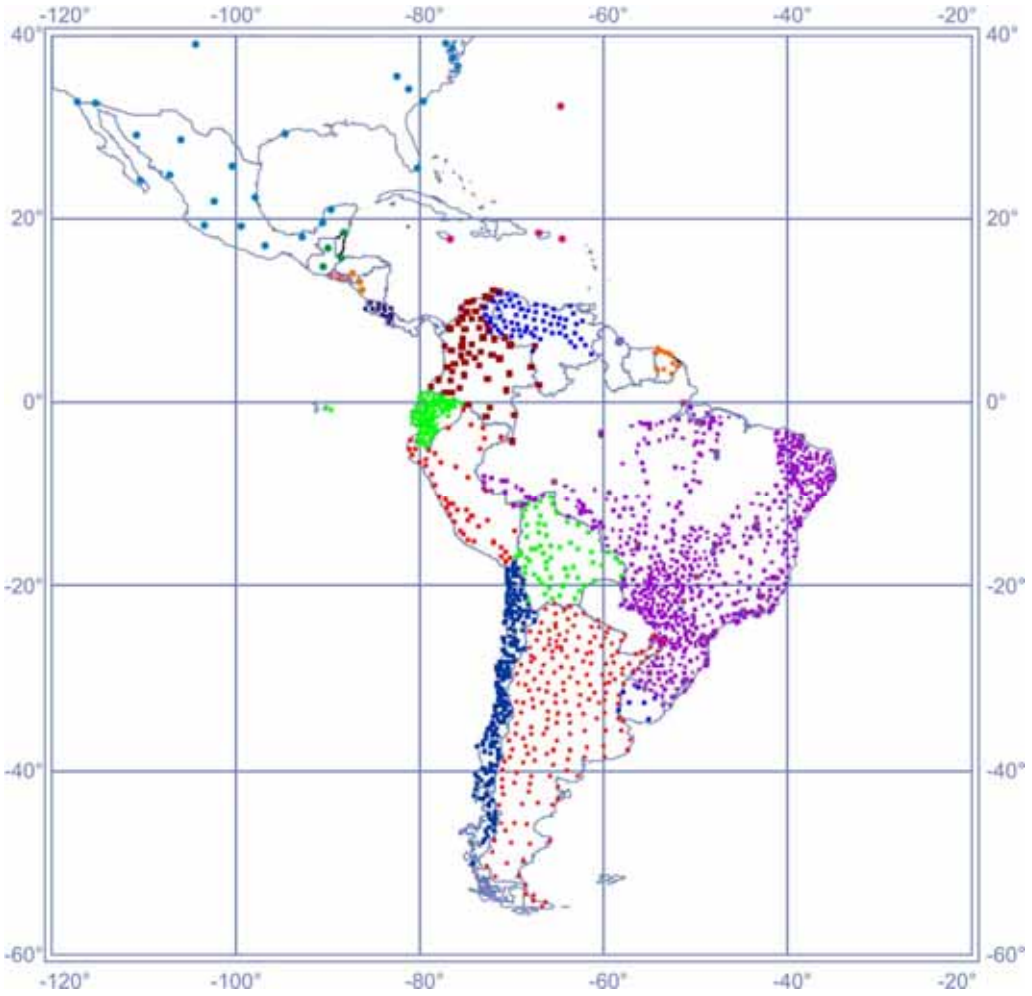
National densifications

At present, SIRGAS is the reference fame in 16 countries that have implemented national networks with a growing number of 230 GNSS continuous stations and 2800 passive stations.



Strategy:

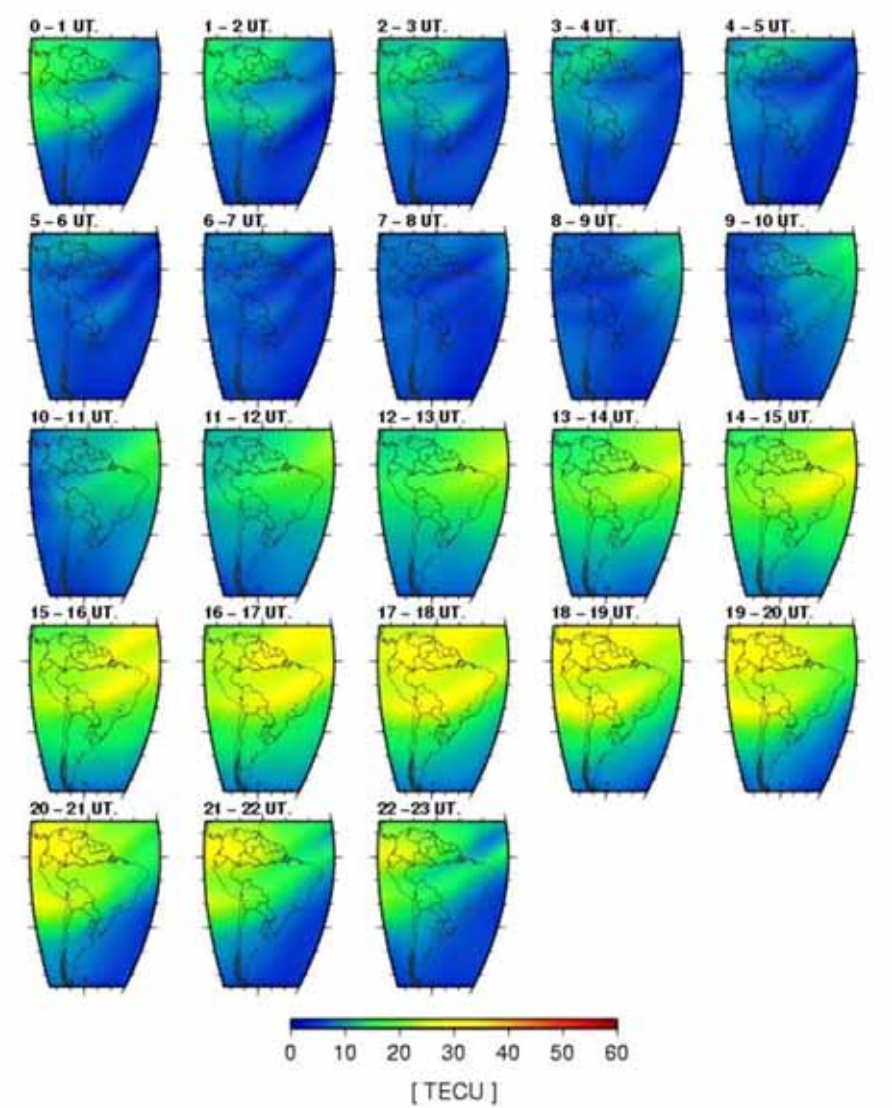
i) establishment of a first order GNSS national network (with passive or continuously observing stations),

ii) determination of transformation parameters between the old geodetic datums and SIRGAS, and

iii) adoption of SIRGAS as official frame in each country.

Ionospheric Maps for SIRGAS

- Ionosphere over Central and South America presents challenging problems for aeronomers.
- Since July 2006, SIRGAS operates an Ionospheric Analysis Center under the responsibility of La Plata National University, Argentina.
- Hourly regional maps of vTEC are computed and delivered to the community.
- They have been used for:
  - validation of the International Reference Ionosphere (IRI);
  - improvement positioning with single-frequency GNSS receivers;
  - feasibility studies for a SBAS in the region (supported by the International Civil Aviation Organization - ICAO).



Capacity building

- SIRGAS is driving a powerful capacity building process in the Americas:
- Eight Analysis Centres were installed during the last four years in Latin American institutions.
- The “SIRGAS Schools in Reference Systems”, intended to provide the theoretical background; and the “Training Courses for Analysis Centers”, intended to provide the practical skills.
- The next SIRGAS School will be held from November 8 – 10 2010, in Lima (Perú).

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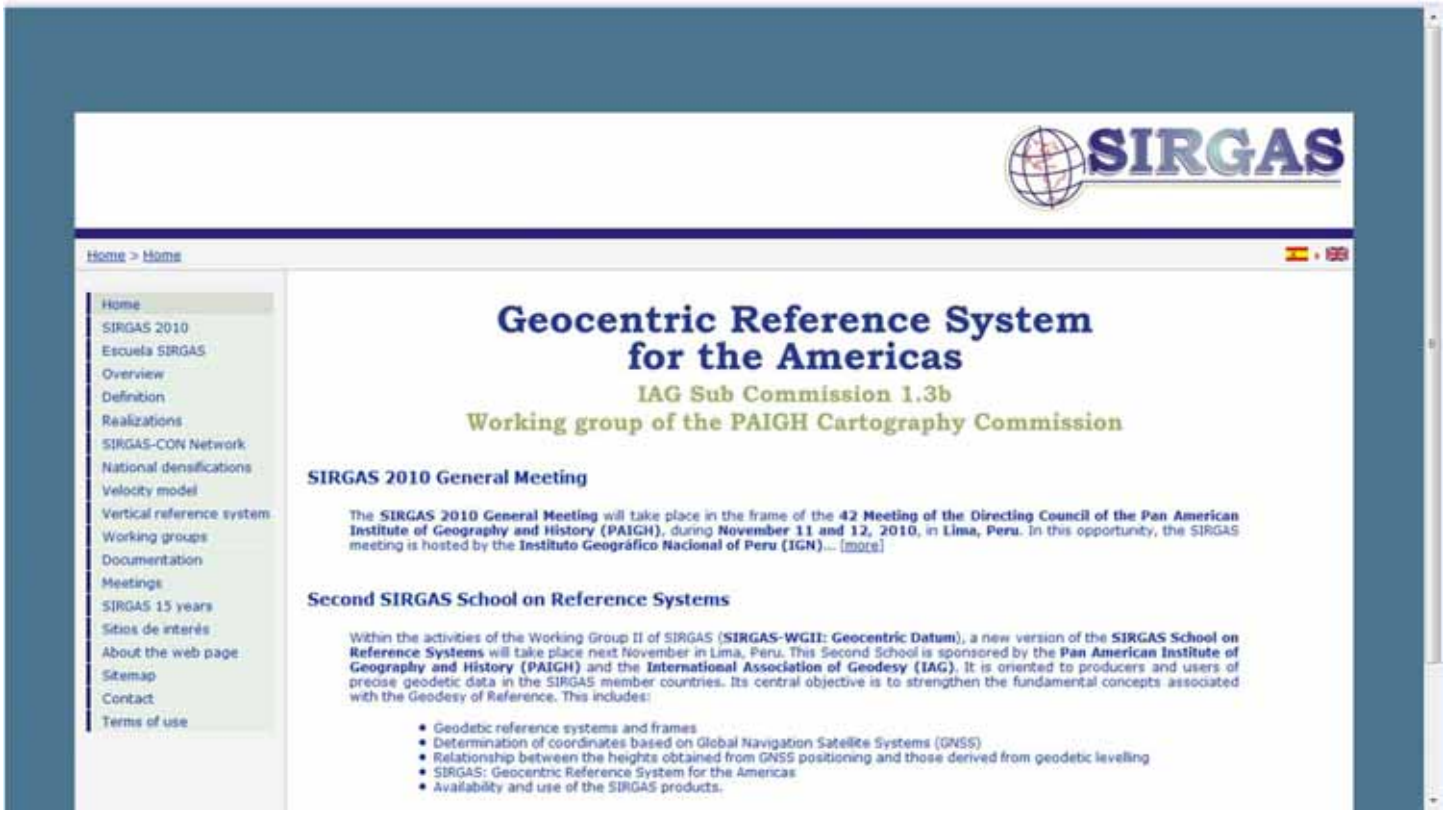

Thank you, very much.