SIRGAS: ITRF densification in Latin America and the Caribbean

SIRGAS-WGI: Reference System

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Sistema de Referencia Geocéntrico para Las Américas

(Geocentric Reference System for the Americas)

Objectives

1. Definition, realization, and maintenance of a geocentric reference system:

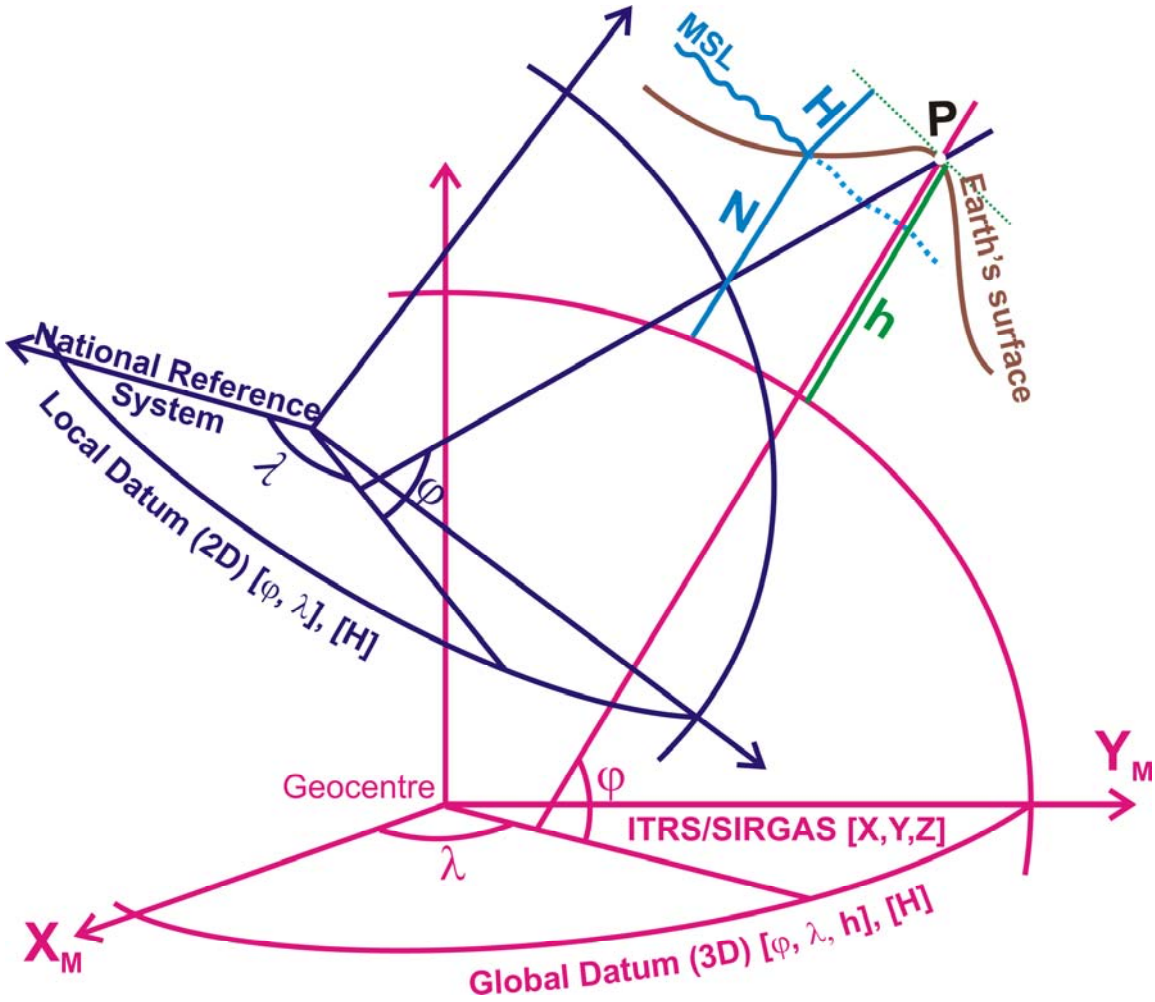
   $[X, Y, Z], [V_X, V_Y, V_Z]$

2. Densification (adoption and use) of the continental reference frame in the Latin American and Caribbean Countries:

   $[\varphi, \lambda]_{Local} \rightarrow [X, Y, Z]_{SIRGAS}$

3. Definition and realization of a unified vertical reference system, supporting physical and geometrical heights:

   $h = H + N; (V_h, V_H, V_N)$



Geometric reference system and reference frame

SIRGAS as a **reference system** is defined identical with **ITRS**

SIRGAS as a **reference frame** is a regional densification of the **ITRF**

Realizations:

- by means of GPS campaigns:

  1) SIRGAS95 (ITRF94, epoch 1995.4)
  (58 stations over South America)

  2) SIRGAS2000 (ITRF2000, epoch 2000.4)
  (184 stations over North, Central, and South America)

- by means of continuously operating stations:

  3) SIRGAS-CON

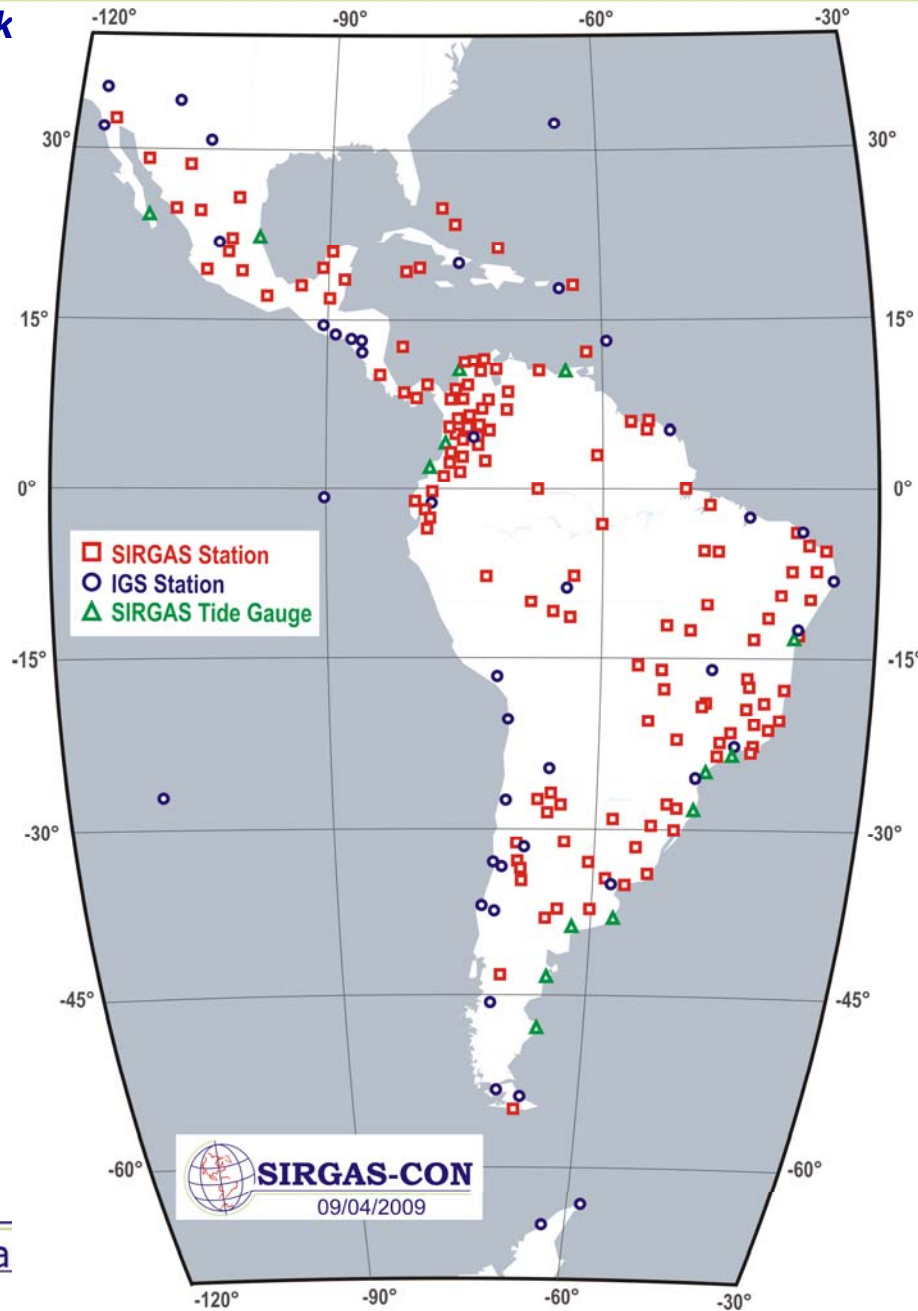
SIRGAS-CON

(SIRGAS Continuously Operating Network

Realization of SIRGAS by means of continuously operating GNSS stations

Number of continuously operating GNSS stations since SIRGAS95

Year	IGS	Regional	Total
1995	10	0	10
1996	13	2	15
1997	13	7	20
1998	18	11	29
1999	23	16	39
2000	29	19	48
2001	32	21	53
2002	43	22	65
2003	50	28	78
2004	51	37	88
2005	53	64	117
2006	53	84	137
2007	54	119	173
2008	59	147	206
April 2009	59	161	220
Decommiss.	12	12	24
April 2009	**47**	**149**	**196**



SIRGAS-CON products

Loosely constrained weekly solutions

Satellite orbits, satellite clock offsets, and Earth orientation parameters are fixed to the final weekly IGS solutions, and coordinates for all sites are constrained to ±1 m

→ **SINEX files**

Constrained weekly solutions

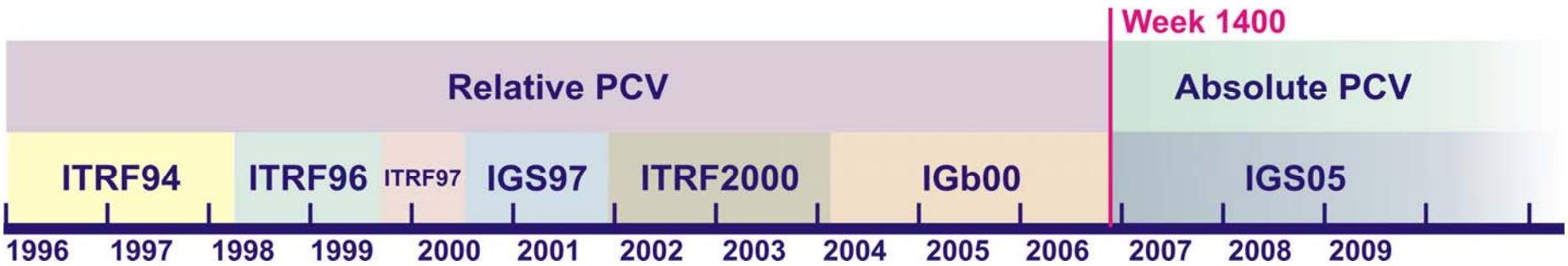
Datum realization through reference coordinates for IGS reference frame stations (ITRFyy, IGb00, IGS05, ...)

→ **SINEX files and coordinates**

Multiyear solutions

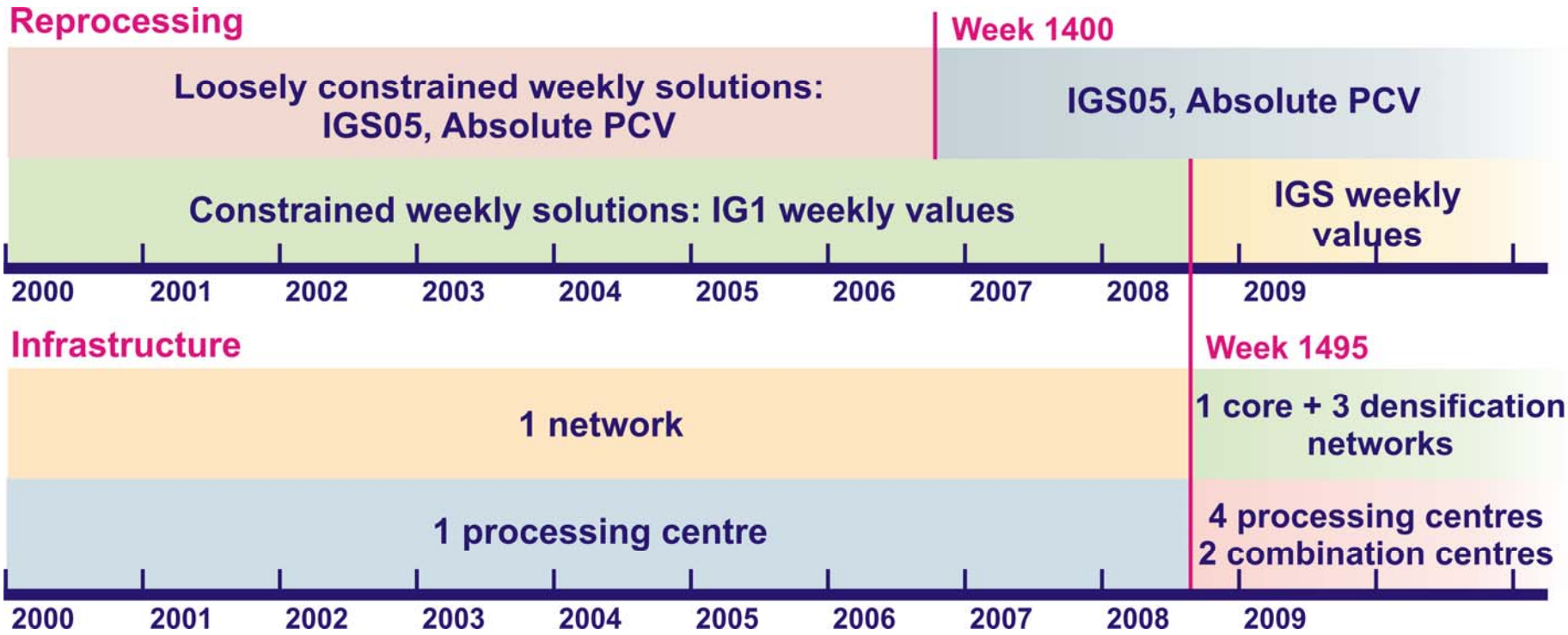
Combination of the loosely constrained weekly solutions

→ **SINEX files for loosely constrained and constrained cumulative solutions, coordinates, and velocities**



SIRGAS-CON Reprocessing

The **SIRGAS-CON weekly solutions** from **January 2000 to November 2006** computed with relative phase centre corrections and referred to former ITRF solutions have been **reprocessed** including **absolute phase centre** corrections and **IGS05** as reference frame. This provides consistent precise point positions and velocities for all SIRGAS-CON stations.

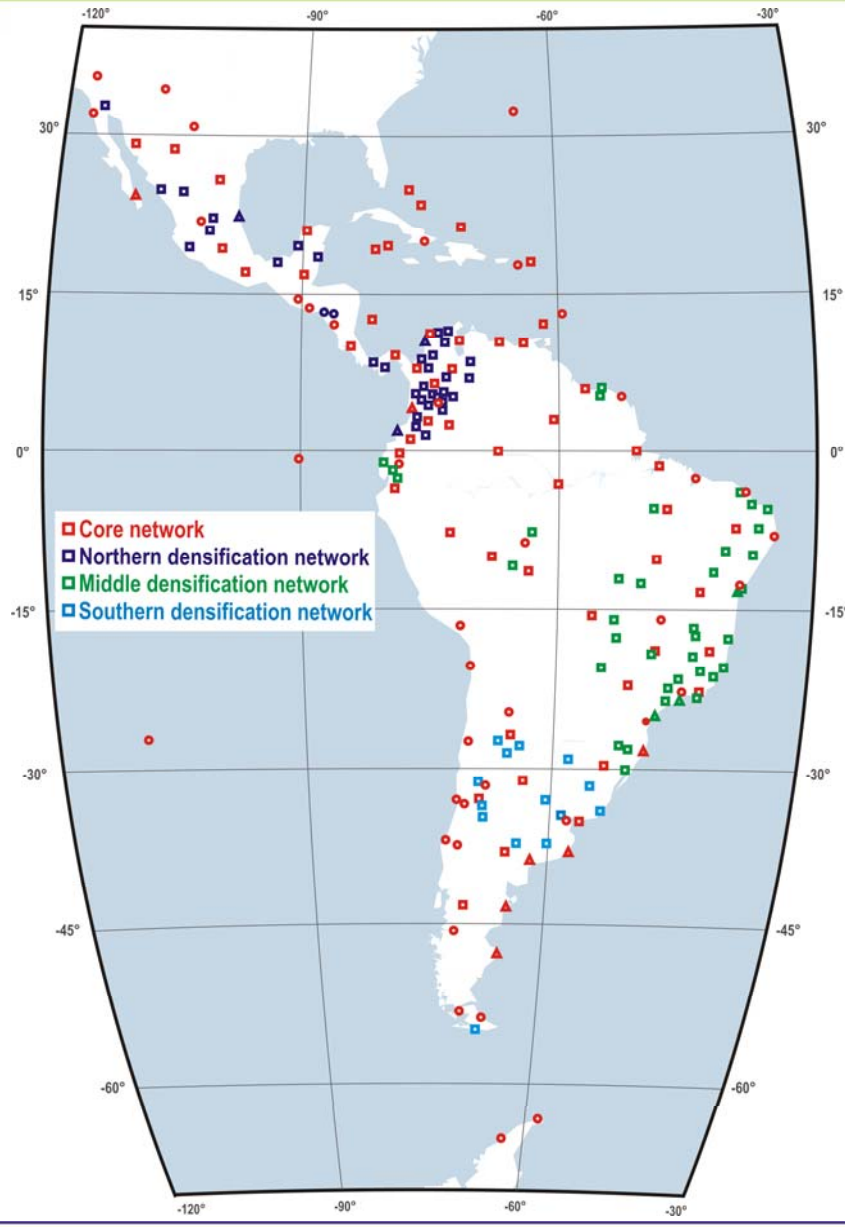


SIRGAS-CON sub-networks

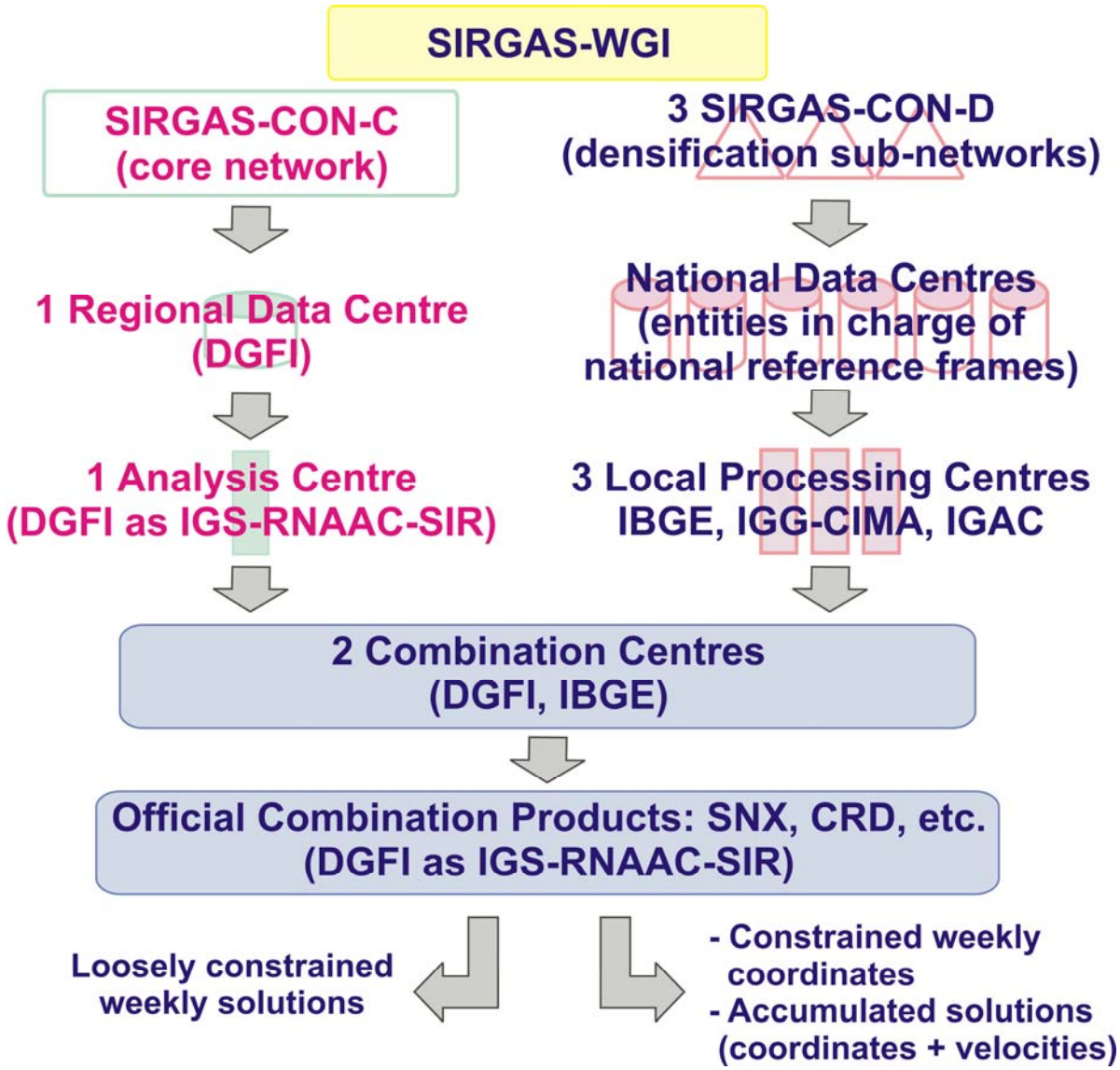
Since GPS week **1495** (2008-08-31) the SIRGAS-CON network comprises two hierarchies:

1. A core network (**SIRGAS-CON-C**) with homogeneous continental coverage and stabile site locations ensures the long-term stability of the reference frame and provides the primary link to the ITRS.
2. Several densification sub-networks (**SIRGAS-CON-D**) improve the accessibility to the reference frame. At present, there are three densification networks (a Northern, a middle, and a Southern one).

Stations included in the core network, as well as in the densification sub-networks match the requirements, characteristics, and processing performance of the ITRF.



SIRGAS-CON infrastructure

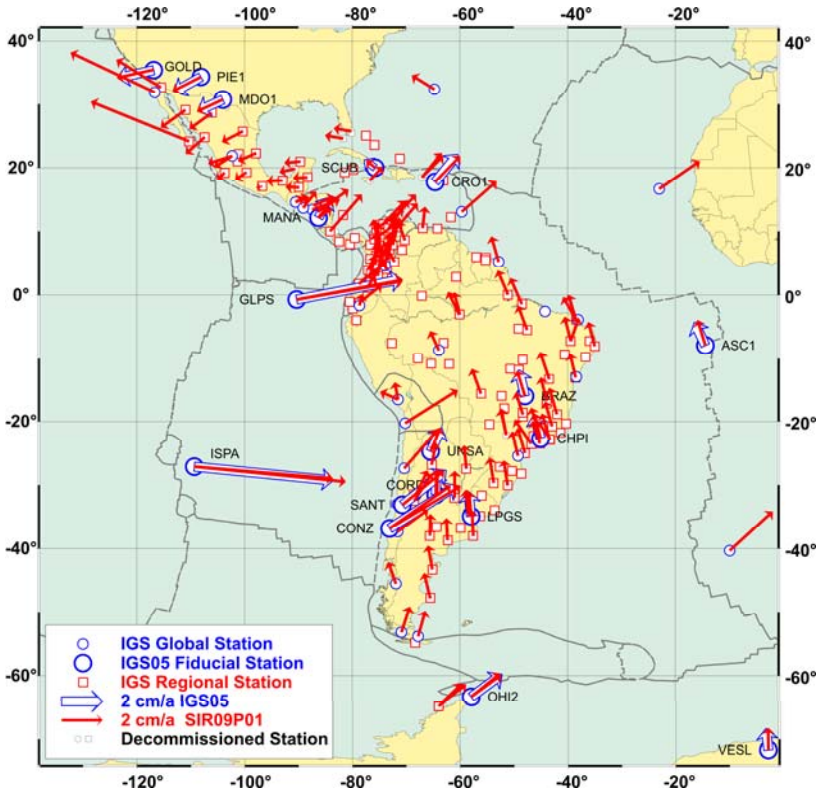


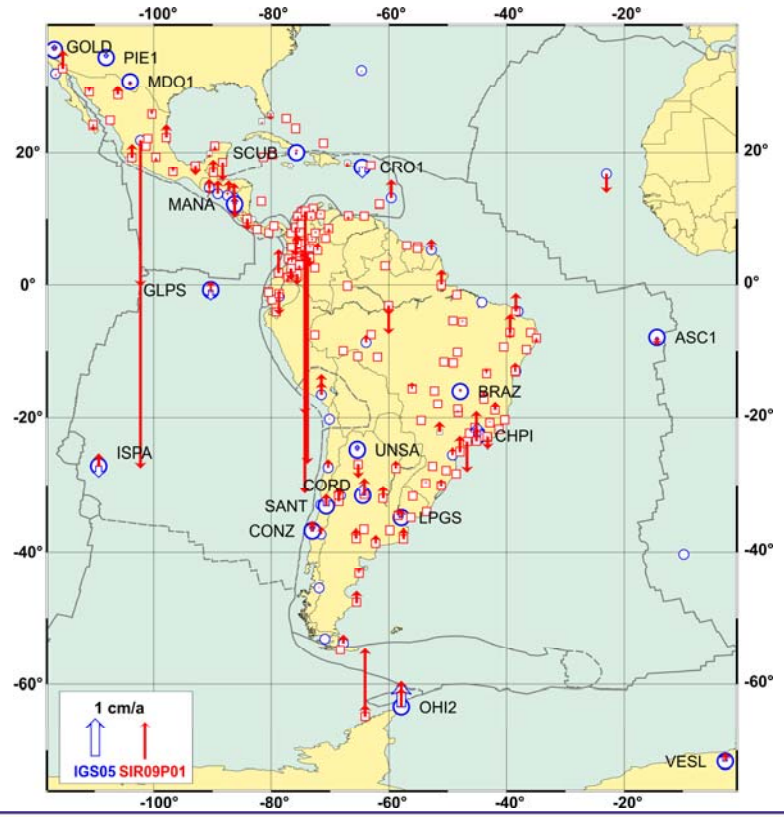
SIRGAS-CON weekly processing

1. Each SIRGAS Processing Centre delivers loosely constrained solutions for the assigned sub-network (1 core + 3 densifications);
2. Sub-networks are individually aligned to the IGS05 reference frame by applying NNR+NNT conditions, and compared to IGS weekly values and to each other in order to identify possible outliers;
3. Stations with large residuals (> ±10 mm in N and E, > ±20 mm in Up) in individual solutions are reduced from the normal equations;
4. Individual normal equations are accumulated and solved for computing a loosely constrained weekly solution for station coordinates (i.e., coordinates for all stations are constrained to ±1 m). This solution in SINEX format is submitted to IGS for the global polyhedron and applied for SIRGAS multiyear solutions.
5. Computation of a constrained weekly solution for station coordinates. Datum realization through IGS weekly coordinates (igs*yy*P*wwww*.snx) of the IGS05 stations (applied constraint in Bernese Soft.: ±1E-04 m).

Multiyear solution SIR09P01

- Comprises from January 2000 to December 2008;
- Stations operating less than two years are excluded;
- Constrained solution by NNR+NNT to IGS05 stations: IGS05, epoch 2005.0;
- Precision of coordinates at reference epoch: ± 0,5 mm (hor), ± 0,9 mm (up);
- Precision of velocities: ± 0,8 mm/a.
- Loosely constrained solution: SIRGAS contribution to the *IAG Working Group on Dense Regional Velocity Fields*.





Present weaknesses

1. Not all SIRGAS-CON stations are included in the same number of individual solutions, i.e., they are unequally weighted in the weekly combinations;
2. Since there are not enough Local Processing Centres, the required redundancy (each station processed by at least three processing centres) is not fulfilled;
3. All the four operative Processing Centres apply the Bernese Software, it is desirable to use other software for control.

Short-term objectives related with SIRGAS-CON

1. The SIRGAS-CON-D sub-networks shall correspond to the national reference frames, i.e., as an optimum there shall be as many sub-networks as countries in the region;
2. 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;
3. It is necessary to have more operative processing centres. At present, there are five experimental centres, which after satisfying a training period of one year will be become official SIRGAS processing centres. They are: IGM (Argentina), INEGI (Mexico), IGM (Ecuador), LUZ (Venezuela), and SGM (Uruguay);
4. The density of the SIRGAS-CON stations shall be improved, specially in Central America, Peru, and Bolivia.