Sustainability of the SIRGAS Reference Frame

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Introduction

Terrestrial reference frames supporting precise GNSS positioning must be consistent with the reference frame in which the GNSS orbits are determined, in general the ITRF. The reliable accessibility to the ITRF is guaranteed through

1) Regional (continental) densifications of the global network, and

2) National densifications of the continental networks.

According to this hierarchy, SIRGAS is the regional densification of the ITRF in Latin America and the Caribbean, and it is further extended to each country by the national reference networks.

SIRGAS realizations

Initially, SIRGAS was realized by means of two continental GPS campaigns (Fig. 1):

1) **SIRGAS95**: 58 stations in South America observed for ten days, resulting in station positions referring to the ITRF94, epoch 1995.4.

2) **SIRGAS2000**: 184 stations including the SIRGAS95 points and additional stations located in the Caribbean, Central and North America, observed for ten days, resulting in station positions referring to ITRF2000, epoch 2000.4.

At present, SIRGAS is realized by a network of about 230 continuously operating GNSS stations (Fig. 2c). This so-called **SIRGAS-CON** network is processed by the SIRGAS Analysis Centres, who generate weekly solutions for station positions. On a one-year basis, cumulative (multi-year) solutions are computed to estimate the kinematics of the SIRGAS frame, providing epoch positions and constant velocities for the SIRGAS-CON stations (Fig. 2). On this basis, most of the Latin-American countries adopted SIRGAS as the official reference frame with station coordinates associated to a conventional reference epoch to be extrapolated to any other epoch using station velocities.

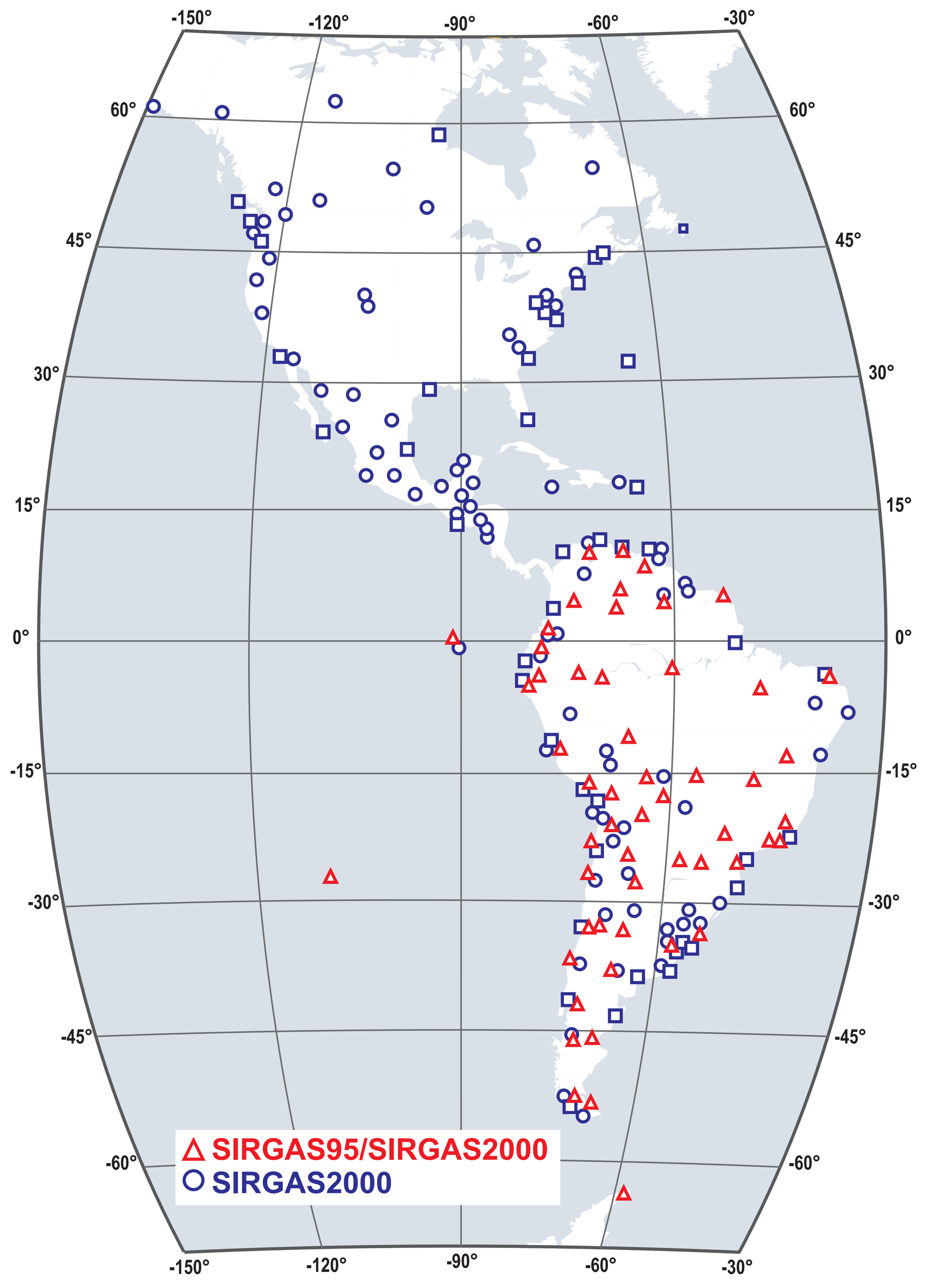

Fig.1. Realizations SIRGAS95 and SIRGAS2000

Evaluation of the SIRGAS reference frame sustainability

The former SIRGAS realizations (SIRGAS95 and SIRGAS2000) as well as the different multi-year solutions of the SIRGAS-CON network include those models, standards, and strategies widely applied at the time in which they were computed; e.g. relative corrections for the phase centre variations (PCV) until 2006 and absolute PCV afterwards. In order to evaluate the sustainability of the SIRGAS realizations, the following steps are carried out:

1) The SIRGAS95 and SIRGAS2000 realizations are compared with the latest SIRGAS-CON multi-year solution SIR10P01 (Table 1). This comparison is done in the ITRF2008 reference frame transformed to the reference epochs of the former realizations, i.e. 1995.4 and 2000.4

2) The different SIRGAS multi-year solutions are compared with the ITRF2008 (Table 2). For this purpose, the multi-year solutions are transformed to ITRF2008 and the comparison is done for epoch 2000.0.

In all cases, stations affected by earthquakes are excluded.

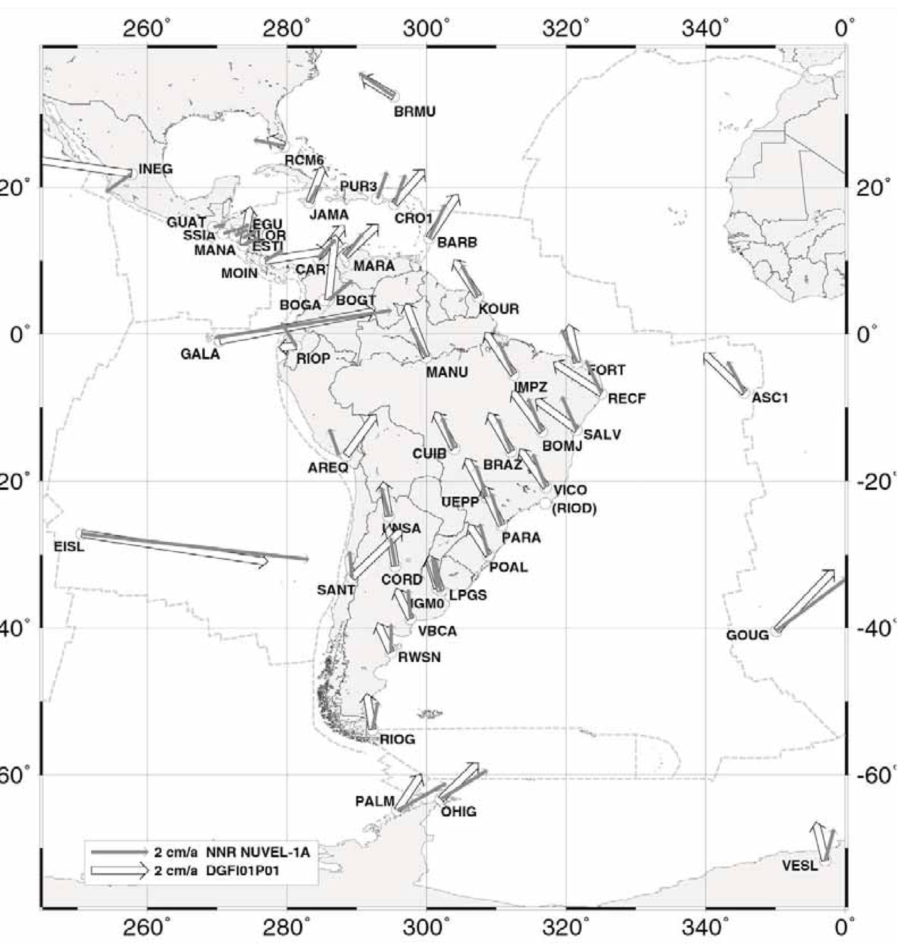

Fig. 2a. Horizontal velocities of the multi-year solution DGF01P01 (released in June 2001)

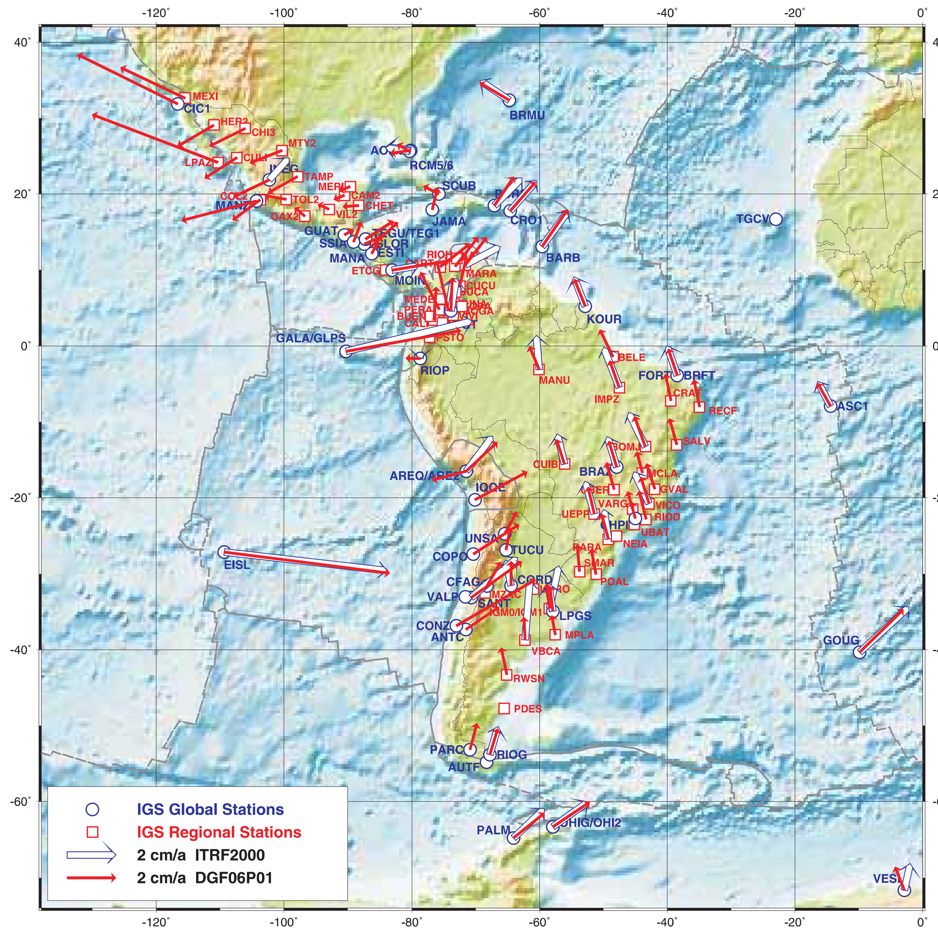

Fig. 2b. Horizontal velocities of the multi-year solution DGF06P01 (released in July 2006)

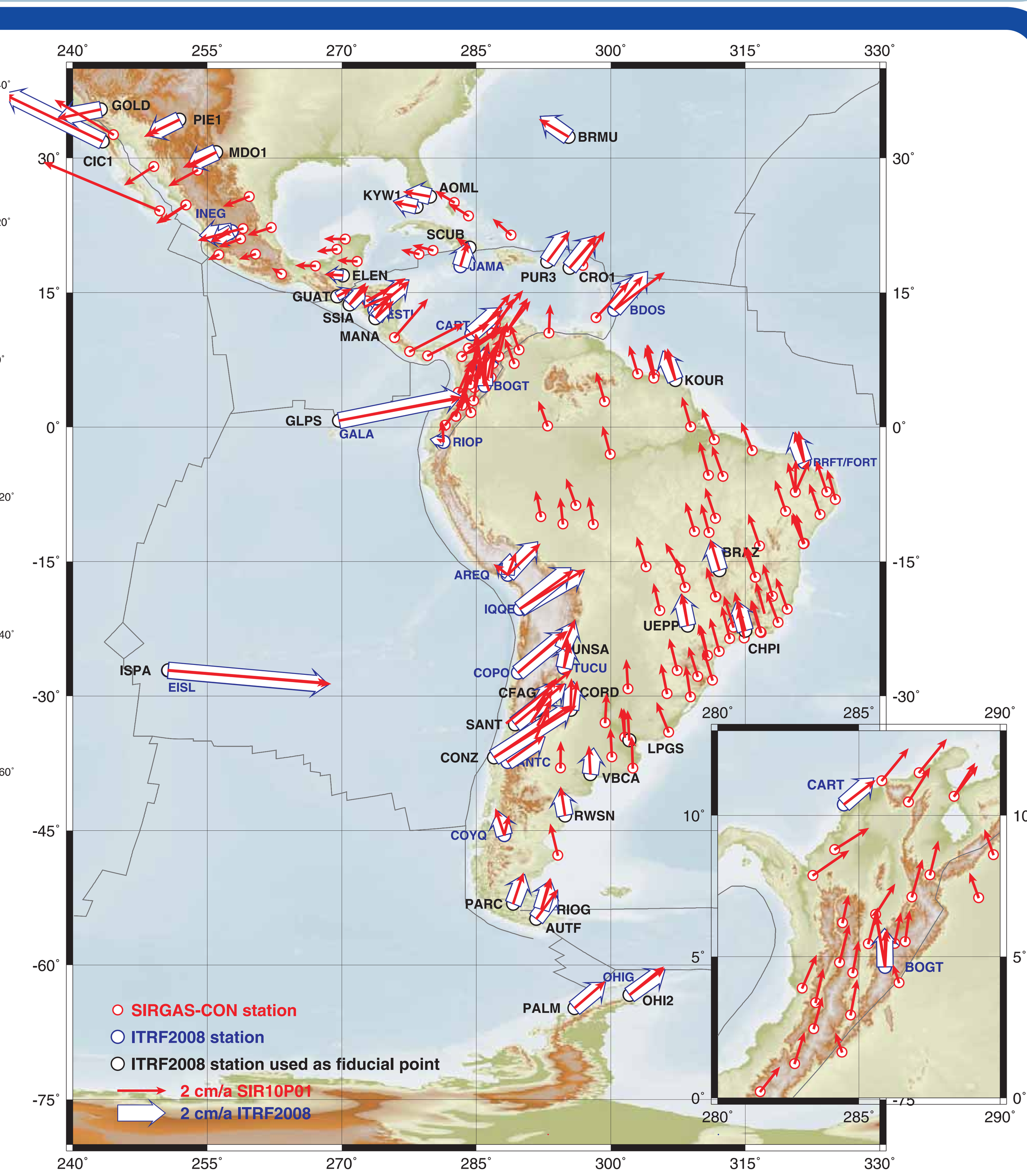

Fig. 2c. Horizontal velocities of the multi-year solution SIR10P01 (released in June 2010)

Table 1. Comparison of SIRGAS95 and SIRGAS2000 with the latest multi-year solution of the SIRGAS-CON network (SIR10P01)

	Comparison with SIR10P01			
	Common	Position deviations: Offsets ± RMS		
Realization	stations	N[mm]	E[mm]	h[mm]
SIRGAS95	19	-21,3 ± 4,9	-18,7 ± 4,2	5,8 ± 18,3
SIRGAS2000	53	-0,3 ± 8,6	0,1 ± 7,5	-6,2 ± 10,3

Table 2. Comparison of the different SIRGAS-CON multi-year solutions with the ITRF2008

Characteristics of the multi-year solutions						Comparison with the ITRF2008						
						Common stations	Position deviations: Offsets ± RMS			Velocity deviations: Offsets ± RMS		
Identifier	Stations	Reference	PCV	Data start	Data end	with ITRF2008	N[mm]	E[mm]	h[mm]	VN[mm/a]	VE[mm/a]	Vh[mm/a]
DGF01P01	48	ITRF97, 2000.0	Rel	1996-06-30	2001-04-14	27	-16,3 ± 8,0	7,2 ± 19,5	27,9 ± 16,2	-0,4 ± 2,6	3,1 ± 4,7	1,3 ± 4,5
DGF02P01	53	ITRF2000, 2000.0	Rel	1996-06-30	2002-07-31	24	-2,4 ± 3,7	-2,5 ± 5,8	4,0 ± 13,9	1,1 ± 1,6	1,4 ± 2,1	-3,7 ± 6,7
DGF04P01	69	ITRF2000, 2003.0	Rel	1996-06-30	2004-07-31	35	-0,4 ± 4,3	-3,4 ± 5,0	1,3 ± 14,9	1,9 ± 2,3	1,3 ± 2,1	0,1 ± 3,6
DGF05P01	95	ITRF2000, 2004.0	Rel	1996-06-30	2005-09-17	34	0,2 ± 3,8	-2,0 ± 5,0	0,1 ± 13,1	1,8 ± 2,1	1,1 ± 2,1	1,2 ± 3,6
DGF06P01	96	ITRF2000, 2004.0	Rel	1996-06-30	2006-06-17	32	0,0 ± 3,9	-1,7 ± 4,9	1,1 ± 12,3	2,0 ± 2,2	1,0 ± 1,9	0,8 ± 3,0
DGF07P03	106	IGS05, 2004.5	Abs	2002, 01/05-2005, 2006, 01/08-2007		22	-1,3 ± 5,1	0,9 ± 6,2	-4,4 ± 19,5	0,5 ± 1,3	-0,4 ± 1,3	0,5 ± 2,7
DGF08P01	126	IGS05, 2004.5	Abs	2002-01-02	2008-03-31	28	-3,2 ± 5,1	1,1 ± 8,9	-8,0 ± 10,0	0,5 ± 1,3	-0,5 ± 1,6	1,0 ± 2,3
SIR09P01	128	IGS05, 2005.0	Abs	2000-01-02	2009-01-03	34	0,3 ± 4,0	-0,6 ± 6,7	-5,1 ± 12,0	0,3 ± 1,0	0,0 ± 1,1	-0,2 ± 1,9
SIR10P01	183	ITRF2008, 2005.0	Abs	2000-01-02	2010-06-05	74	0,8 ± 5,0	0,3 ± 3,6	-4,9 ± 8,6	-0,1 ± 1,1	-0,1 ± 1,1	0,0 ± 2,2

Results

The comparisons show a very good consistency between the different SIRGAS realizations. The largest discrepancies (~±2 cm) were detected in the SIRGAS realizations referring to ITRF94 and ITRF97. Realizations referring to ITRF2000 and IGS05 have an agreement better than ±5 mm. This reflects the expected improvement of the SIRGAS reference frame as consequence of its time evolution and the better new models, standards, and analysis strategies presently applied. Although the reliability of the estimated positions and velocities of the SIRGAS reference stations as well as its compatibility through time are demonstrated, it is necessary to give special care to the reference frame deformations caused by seismic events. This implies the permanent monitoring of the (continental and national) reference networks by means of continuously operation GNSS stations and the consequent modelling of the deformations (see poster "*Long-term stability of the SIRGAS Reference Frame and episodic station movements caused by the seismic activity in the SIRGAS region*", Sánchez et al. 2010).