SIRGAS Processing Centre at DGFI
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Introduction

According to the SIRGAS 2008 resolutions (Brunini and Sánchez 2008), since the GPS week 1495 (3o August 2008) the SIRGAS Continuously Operating Network (SIRGAS-CON) was divided in four sub-networks: one core network (SIRGAS-CON-C) covering homogeneously Latin America and the Caribbean, and three densification sub-networks (SIRGAS-CON-D) distributed on the northern, the middle, and the southern parts of the region. These four sub-networks are individually processed by four SIRGAS Processing Centres, who generate loosely constrained weekly solutions to be combined in a unified solution for the entire network. The SIRGAS-CON-C core network is processed by DGFI and the other sub-networks by the SIRGAS Local Processing Centres: IGAC (Colombia) processes the northern sub-network, IBGE (Brazil) the middle one, and IGG-CIMA (Argentina) the southern one. The individual solutions are combined by the SIRGAS Combination Centres: DGFI and IBGE. The main products are weekly coordinates aligned to the current ITRF frame and loosely constrained weekly solutions for the whole SIRGAS-CON network. These loosely constrained solutions are delivered in SINEX format to the IGS for the global polyhedron and are the input data for computing multi-annual solutions (coordinates + velocities) for all SIRGAS-CON stations.

The present report summarizes the activities carried out by DGFI as SIRGAS Processing Centre of the SIRGAS-CON-C core network. Activities related to the SIRGAS Combination Centre at DGFI and the determination of the latest multi-year solution (SIR09P01) for the SIRGAS-CON network are described in Sánchez et al. (2009) and Seemüller et al. (2009), respectively.

Processing strategy for the SIRGAS-CON-C core network

The SIRGAS-CON-C core network (Figure 1) is composed by 107 stations homogeneously distributed over Latin America and the Caribbean. The processing strategy follows the IGS and SIRGAS guidelines, main features of which are:

1. Elevation mask and data sampling rate are set to 3° and 30 s, respectively;

2. Absolute calibration values for the antenna phase centre corrections published by the IGS are applied;

3. Satellite orbits, satellite clock offsets, and Earth orientation parameters are fixed to the combined IGS weekly solutions;

4. The quasi ionosphere free (QIF) strategy is applied for solving the L1 and L2 phase ambiguities;

5. Periodic site movements due to ocean tide loading are modelled according to the FES2004 ocean tide model (Letellier 2004). The corresponding values are provided by M.S. Bos and H.-G. Scherneck at http://www.oso.chalmers.se/~loading/;

6. Zenith delay due to the tropospheric refraction (~ wet part) is estimated at a 2 hours interval within the network adjustment. The Niell (1996) dry mapping function is applied to interpolate the a priori zenith delay (~ dry part) modelled using the Saastamoinen model (1973);

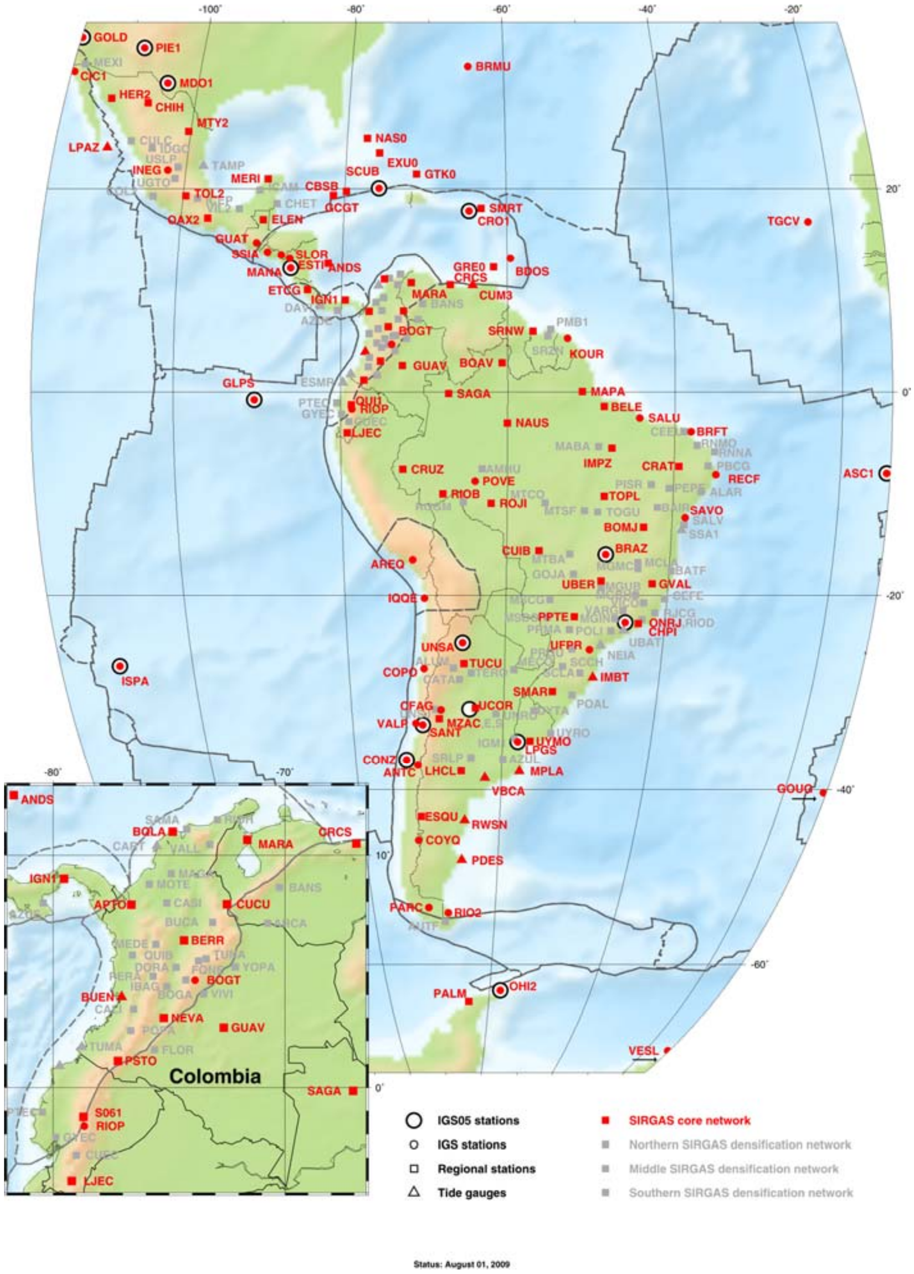

Figure 1. SIRGAS-CON-C core network: *DGFI processes routinely this network and provides loosely constrained weekly solutions to be combined with the SIRGAS-CON-D densification sub-networks.*

7. Daily free normal equations are computed by applying the double differences strategy (Bernese Software 5.0, Dach et al. 2007);

8. Daily free normal equations are combined for computing a loosely constrained weekly solution for station coordinates (all station coordinates are constrained to ±1 m);

9. Stations with large residuals in the weekly combination (more than 20 mm in the N-E component, and more than 30 mm in the Up component) are reduced from the normal equations. Steps (8) and (9) are iterative;

10. These loosely constrained solutions in SINEX format are identified with the name DGF*wwww*7.SNX, DGF stands for DGFI, *wwww* for the GPS week, and 7 for including the seven days of the week. They are available at ftp://ftp.dgfi.badw-muenchen.de/pub/gps/SIRGAS/.

The 107 core stations are not always included in all weeks because the corresponding RINEX are not opportunely available (between the two following weeks after observation). Figure 2 shows the number of weekly solutions in which stations are missing between GPS weeks 1495 (August 31, 2008) and 1538 (July 4, 2009). Stations not included in Figure 2 appear in all weekly solutions (total 44) delivered by DGFI.

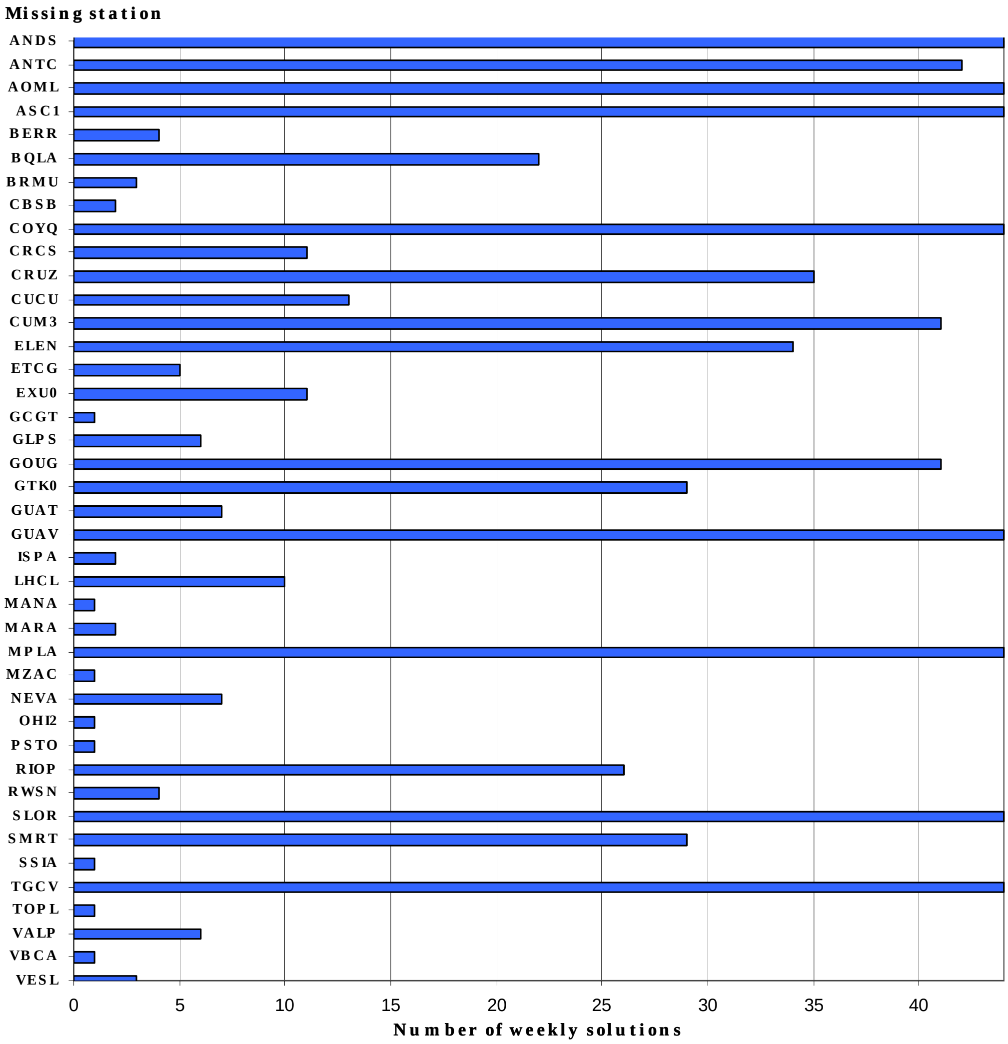

Figure 2. *Number of weekly solutions in which SIRGAS-CON core stations are missing.*

Quality control of the loosely constrained weekly solutions for the SIRGAS-CON-C core network computed by DGFI

Before weekly DGFI solutions for the SIRGAS-CON-C core network are sent for combination, three main steps are carried out for controlling their consistency:

1. **Evaluation of the daily coordinate repeatability**: Loosely constrained weekly solutions delivered by DGFI are a result of combining seven free daily normal equations. The comparison of these seven daily solutions with the combined one allows to determine the repeatability of the station coordinates in the corresponding week. If the daily coordinate repeatability is homogeneous from week to week, one can conclude weekly solutions are consistent amongst themselves. Figure 3 shows mean RMS values for daily repeatability for the GPS weeks between 1495 and 1538. The mean RMS values for the entire period (44 weeks) are N = 1,93 mm, E = 2,04 mm, and Up = 5,56 mm.

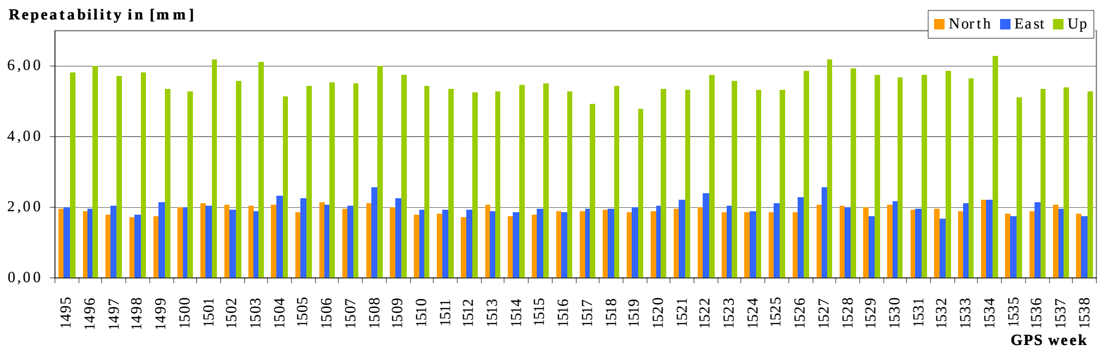

Figure 3. *Mean RMS values for daily coordinate repeatability in the loosely constrained weekly solutions delivered by DGFI for the SIRGAS-CON-C core network (GPS weeks 1495 – 1538).*

2. **Determination of time series for station coordinates and analysis of the weekly RMS values**: The loosely constrained weekly solutions are aligned to the IGS05 positions of the current epoch using a 7-parameter similarity transformation. Then, coordinate time series are generated for each station and mean RMS values are derived from the weekly residuals. This procedure is helpful to identify outliers or jumps of the stations that may cause network deformations within the weekly solutions. The mean RMS values for the entire period (44 weeks) are N = 2,18 mm, E = 2,18 mm, and Up = 5,03 mm. These values are very close to those derived from the daily coordinate repeatability (see previous item). Table 1 summarizes the mean RMS values of the SIRGAS-CON-C core stations processed by DGFI.

3. **Analysis of weekly mean standard deviations** based on minimum datum conditions (No Net Rotation -NNR- and No Net Translation -NNT-) with respect to the IGS05 stations included in the SIRGAS-CON-C core network. Figure 4 presents the mean standard deviations obtained after fitting the loosely constrained weekly solutions to the IGS05 coordinates contained in the IGS weekly combinations (files igsP*wwww*.snx). The worst value (1,81 mm) appears in the first week (1495); afterwards, standard deviations are around 1,55 mm. These values shall be

understood as the formal errors of the station coordinates within the weekly solutions.

Table 1. *Mean RMS values derived from time series for the SIRGAS-CON-C core stations (Period: GPS weeks 1495 – 1538).*

Station	RMS N [mm]	RMS E [mm]	RMS Up [mm]	Station	RMS N [mm]	RMS E [mm]	RMS Up [mm]
ANTC	1,79	0,77	6,52	**LPGS**	1,12	1,33	4,32
APTO	1,48	3,89	4,06	**MANA**	2,54	1,40	4,90
ARCA	1,48	1,27	4,43	**MAPA**	3,39	2,65	6,51
AREQ	0,97	1,94	4,50	**MARA**	1,75	1,78	6,39
BANS	1,48	1,27	4,43	**MDO1**	1,83	3,04	3,85
BDOS	3,87	3,13	5,53	**MERI**	1,80	2,62	5,19
BELE	3,80	2,83	6,52	**MTY2**	1,45	2,23	3,16
BERR	1,74	4,52	7,06	**MZAC**	1,27	1,43	2,49
BOAV	1,18	2,06	5,15	**NAS0**	2,17	1,34	4,36
BOGA	1,48	1,48	4,43	**NAUS**	4,88	2,24	25,36
BOGT	2,51	0,94	4,83	**NEVA**	2,48	1,19	3,76
BOMJ	1,99	3,31	5,19	**OAX2**	3,43	1,44	3,09
BRAZ	1,36	2,64	5,61	**OHI2**	3,08	2,67	10,97
BRFT	2,22	3,36	4,43	**ONRJ**	2,20	1,66	3,58
BRMU	5,45	3,31	7,97	**PALM**	2,73	3,17	7,60
BUCA	1,48	1,48	2,62	**PARC**	1,85	2,72	4,74
BUEN	1,89	1,50	2,97	**PIE1**	2,21	2,98	3,08
CALI	1,27	1,48	4,43	**POPA**	1,27	1,48	4,43
CBSB	2,39	3,56	4,63	**POVE**	1,26	1,69	14,15
CFAG	0,96	1,26	2,08	**PPTE**	1,84	1,37	3,21
CHIH	1,87	2,35	2,62	**PSTO**	2,10	1,21	2,96
CHPI	2,05	1,80	3,48	**RECF**	1,34	3,19	4,80
CIC1	2,69	3,29	5,22	**RIO2**	1,81	2,16	2,98
CONZ	1,53	1,17	4,06	**RIOB**	2,18	1,20	9,49
COPO	0,81	0,83	4,32	**RIOP**	1,45	2,09	5,20
CRAT	1,37	2,27	8,59	**ROJI**	2,73	1,55	8,12
CRCS	1,81	1,55	4,32	**RWSN**	1,31	1,67	3,14
CRO1	3,53	1,86	6,77	**S061**	1,09	3,23	3,77
CRUZ	2,06	1,27	4,48	**SAGA**	1,28	0,86	7,85
CUCU	1,95	1,34	4,08	**SALU**	1,55	4,45	3,93
CUIB	1,60	1,15	7,52	**SAMA**	1,55	1,48	4,43
ESQU	1,78	2,27	3,45	**SANT**	1,06	2,04	4,08
ETCG	7,74	3,17	5,53	**SAVO**	3,19	4,33	6,27
EXU0	1,34	1,39	2,51	**SCUB**	3,35	1,84	4,13
FLOR	1,48	1,48	4,43	**SMAR**	1,56	1,06	4,10
GCGT	2,40	1,25	6,57	**SMRT**	0,84	3,68	4,83
GLPS	1,34	2,42	3,28	**SRNW**	1,41	1,62	6,24
GOLD	3,09	3,32	5,68	**SSIA**	3,03	2,44	6,13
GRE0	2,29	2,34	3,57	**TOL2**	1,50	2,39	3,40
GTK0	1,27	0,92	2,43	**TOPL**	2,58	3,47	9,55
GUAT	1,58	3,21	5,04	**TUCU**	0,78	1,42	4,51
GVAL	1,57	2,74	5,55	**TUNA**	1,48	1,48	4,43
HER2	1,94	2,69	3,37	**UBER**	1,73	1,82	6,69
IGN1	1,63	5,39	3,72	**UCOR**	6,72	3,44	3,68
IMBT	4,15	1,45	3,42	**UFPR**	4,45	1,41	3,08
IMPZ	2,06	2,84	9,01	**UNSA**	1,59	2,41	3,25
INEG	1,55	2,47	3,62	**UYMO**	6,97	2,88	5,10
IQQE	1,10	1,11	3,02	**VALL**	1,27	1,27	4,43
ISPA	2,08	2,57	4,67	**VALP**	5,85	5,16	3,01
KOUR	2,83	2,08	4,67	**VBCA**	1,70	0,84	3,00
LHCL	1,20	1,04	2,87	**VESL**	4,74	4,47	4,78
LJEC	0,79	1,77	5,44	**VIVI**	0,78	0,78	4,43
LPAZ	2,19	2,77	2,73	**Mean**	**2,18**	**2,18**	**5,03**

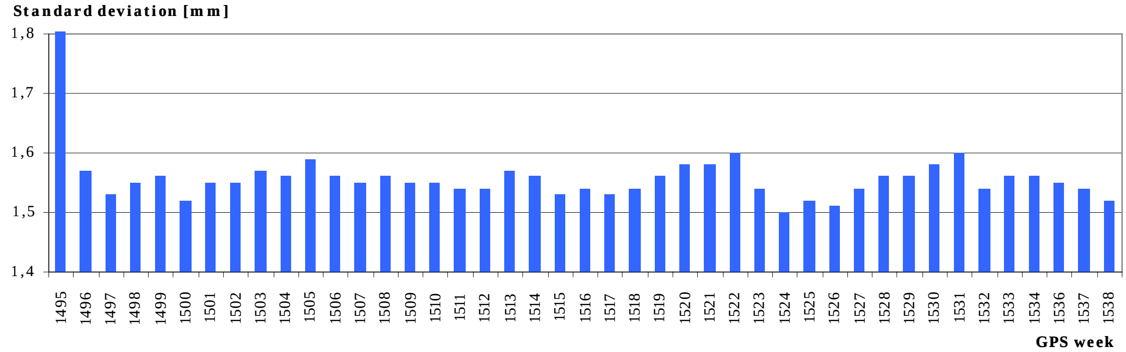

Figure 4. *Mean standard deviations obtained after fitting the loosely constrained weekly solutions for the SIRGAS-CON core network to the IGS05 reference frame.*

References

Brunini, C.; L. Sánchez, Eds. (2008). *Reporte SIRGAS 2007-2008*. Boletín Informativo No. 13. Pp. 40. Available at http://www.sirgas.org/index.php?id=97

Dach, R., U. Hugentobler, P. Fridez, M. Meindl, Eds. (2007). *Bernese GPS Software Version 5.0* - Documentation. Astronomical Institute, University of Berne, January, 640 Pp.

Letellier, T. (2004). *Etude des ondes de marée sur les plateux continentaux*. Thèse doctorale, Université de Toulouse III, Ecole Doctorale des Sciences de l'Univers, de l'Environnement et de l'Espace, 237pp.

Neill, A.E. (1996). *Global mapping functions for the atmosphere delay at radio wavelength*. J. Geophys. Res. (101) 3227-3246.

Saastamoinen, J. (1973). *Contribution to the theory of atmospheric refraction*. Part II: Refraction corrections in satellite geodesy. Bull. Géod. (107) 13-34.

Sánchez, L., W. Seemüller, M. Seitz (2009). *Report of the SIRGAS Combination Centre at DGFI*. Presented at the SIRGAS 2009 General Meeting. Buenos Aires, Argentina. Septiembre.

Seemüller, W., M. Seitz, L. Sánchez, H. Drewes. (2009). *The position and velocity solution SIR09P01 of the IGS Regional Network Associate Analysis Centre for SIRGAS (IGS-RNAAC-SIR)*. DGFI Report No. 85, June 2009, Pp. 90.