Report on the analysis of the SIRGAS reference frame at the IGS RNAAC SIRGAS

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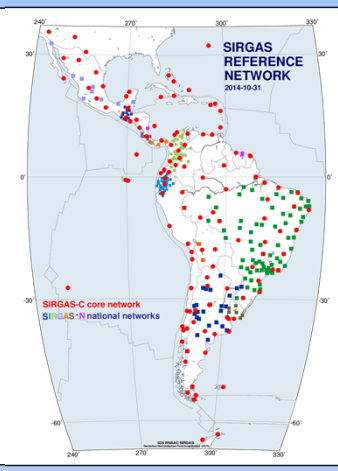
The SIRGAS Reference Frame

The SIRGAS Reference Frame comprises ca. **350 continuously operating GNSS stations**, distributed in one core network (**SIRGAS-C**), primary densification of ITRF in Latin America, with a good continental coverage and stabile site locations to ensure high long-term stability of the reference frame; and national reference networks (**SIRGAS-N**) improving the densification of the core network and providing accessibility to the reference frame at national and local levels. Both, the **core network and the national networks satisfy the same characteristics and quality**; and **each station is processed by three analysis centres**.



IGS Regional Network Associate Analysis Centre for SIRGAS (IGS RNAAC SIRGAS)

DGFI acts as the IGS RNAAC SIRGAS since June 1996. It is responsible for

- **processing** the **SIRGAS-C** core network;
- **combining** the **SIRGAS-C** core network with the national densifications **SIRGAS-N**; and
- **making available the SIRGAS products**, i.e.: loosely constrained weekly solutions, weekly station positions aligned to the ITRF, and multi-year solutions describing the kinematics of the reference frame.

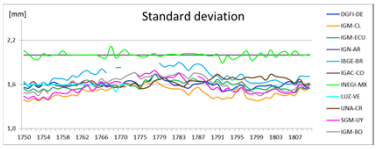
These products are published at the **FTP server ftp.sirgas.org**, which is maintained by the DGFI. The loosely constrained weekly solutions are weekly delivered to the IGS to be combined together with those generated by the other IGS Global and Regional Analysis Centres.

Routine analysis of the SIRGAS Reference Frame

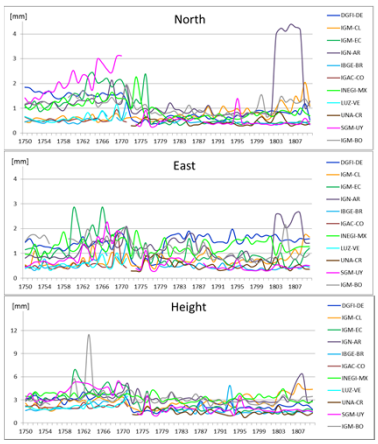
The **SIRGAS-C** core network is processed by **DGFI** as **IGS RNAAC SIRGAS**. The **SIRGAS-N** national densifications are processed by the **SIRGAS Local Analysis Centres**: **CEPGE-IGM** (Ecuador), **CNPDG-UNA** (Costa Rica), **CPAGS-LUZ** (Venezuela), **IBGE** (Brazil), **IGAC** (Colombia), **IGM-Cl** (Chile), **IGN-Ar** (Argentina), **INEGI** (Mexico), and **SGM-Uy** (Uruguay). The individual solutions are combined by the **SIRGAS Combination Centres: IBGE** and **DGFI**. The different SIRGAS Analysis Centres follow the same standards for the computation of loosely constrained weekly solutions. INEGI and IGN-Ar work with GAMIT/GLOBK (Herring et al. 2010); all the other 8 Processing Centres use the Bernese GNSS Software V. 5.2 (Dach et al. 2007). Apart from LUZ and IGAC, since January 2014 the SIRGAS Analysis Centres apply the new processing standards outlined by the IGS for the second reprocessing (http://acc.igs.org/reprocess2.html). LUZ and IGAC stopped the delivery of weekly solutions until they are able to update the processing software.

Since October 2013, **the Instituto Geográfico Militar of Bolivia (IGM-Bo)** acts as a **SIRGAS Experimental Analysis Centre**. It delivers weekly solutions for a set of SIRGAS stations, to demonstrate its capacity for timely and continuously delivery of weekly solutions according to the SIRGAS standards. The results of the corresponding evaluation are presented together with the results of the official processing centres. The performance of IGM-Bo is in accordance with the other SIRGAS Analysis Centres and therefore, it is recommended **to install it as an official SIRGAS Processing Centre**.

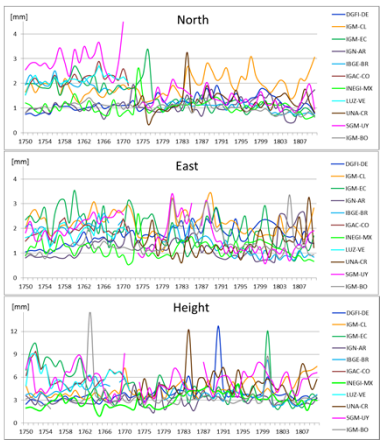
Quality control of the individual solutions delivered by the SIRGAS Analysis Centres (time span GPS weeks 1750 – 1810)



Standard deviation of station positions after solving the individual solutions with respect to the IGS Reference Frame. These values represent the formal errors of the individual solutions. Processing Centres applying the Bernese GNSS Software present values about ±1,6 mm, while Processing Centres using GAMIT/GLOBK have values of about 2,0 mm.



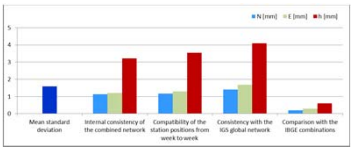
Time series of the RMS of the station position residuals for each analysis centre with respect to the SIRGAS weekly solutions. The individual contributions are much more consistent to each other (especially in the vertical component) since the new processing standards are applied (week 1773). Outliers in the IGN-Ar series are caused by tracking problems at station RWSN (Rawson, Argentina).



Time series of the RMS of the station position residuals for each analysis centre with respect to the IGS weekly solutions. This comparison allows to assess the accuracy of the individual solutions; i.e. about ±2 mm in the North and the East, and ±5 mm in the height .

Quality evaluation of combined (final) SIRGAS solutions

(time span GPS weeks 1750 – 1810)



The mean standard deviation of the combined solutions agrees quite well with those computed for the individual contributions, i.e. the quality of the individual solutions is maintained and their combination does not deform or damage the internal accuracy of the entire SIRGAS network. The coordinates repeatability in the weekly combinations provides an estimate of the accuracy (internal consistency) of the weekly combinations of about ±1,2 mm in the horizontal component and about ±3,2 mm in the vertical one. The RMS values derived from the time series for station positions and with respect to the IGS weekly coordinates indicate that the reliability of the network (external precision) is about ±1,5 mm in the horizontal position and ±4,0 mm in the height. The differences respect to the IBGE weekly combinations are within the expected level (less than 0,5 mm).

Sustainability of the SIRGAS Reference Frame

The accuracy of the weekly solutions for the SIRGAS Reference Frame is in accordance with the quality of other regional densifications of the ITRF. One can say that the SIRGAS weekly station positions are the best possible under the present conditions (standards, conventions, models, software, etc.). However, the sustainability of the SIRGAS Frame is being affected by failures in the functional integrity of the reference stations. Data gaps due to Internet connection failures, tracking problems due un-updated receiver firmware, antenna changes and other administrative problems reduce the operability of the frame in such a way that at present only 80% of the references stations are functioning as expected. The following figures show the geographical distribution of the decommissioned stations until October 31, 2014, as well as the non-operating stations for selected weeks.