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SIRGAS: ITRF densification in Latin America and the Caribbean

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The continental reference frame of SIRGAS (Sistema de Referencia Geocéntrico para las Américas) is at present realized by the SIRGAS Continuously Operating Network (SIRGAS-CON) composed by about 200 stations distributed over all Latin America and the Caribbean. SIRGAS member countries are qualifying their national reference frames by installing continuously operating GNSS stations, which have to be consistently integrated into the continental network. As the number of these stations is rapidly increasing, the processing strategy of the SIRGAS-CON network was redefined during the SIRGAS 2008 General Meeting in May 2008. The new strategy relies upon the definition of two hierarchy levels:

a) 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. Stations belonging to this network have been selected so that each country contributes with a number of stations defined according to its surface and guarantying that the selected stations are the best in operability, continuity, reliability, and geographical coverage.

b) Several densification sub-networks (SIRGAS-CON-D) improve the accessibility to the reference frame. 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. The goal is that each country processes its own continuously stations following the SIRGAS processing guidelines, which are defined in accordance with the IERS and IGS standards and conventions. Since at present not all of the countries are operating a processing centre, the existing stations are classified in three densification networks (a Northern, a middle, and a Southern one), which are processed by three local processing centres until new ones are installed.

As SIRGAS is defined as a densification of the ITRS, stations included in the core network, as well as in the densification sub-networks match the requirements, characteristics, and processing performance of the ITRF.

The SIRGAS-CON-C network is processed by DGFI (Deutsches Geodätisches Forschungsinstitut, Germany) as the IGS-RNAAC-SIR. The Local Processing Centres are for the Northern sub-network IGAC (Instituto Geográfico Augustín Codazzi, Colombia), for the middle sub-network IBGE (Instituto Brasileiro de Geografia e Estátistica, Brazil), and for the Southern sub-network IGG-CIMA (Instituto de Geodesia y Geodinámica, Universidad Nacional de Cuyo, Argentina). These four Processing Centres deliver loosely constrained weekly solutions for station coordinates (i.e., 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 [U+F0B1]1 m). The individual contributions are integrated in a unified solution by the SIRGAS Combination Centres (DGFI and IBGE) according to the following strategy:

1) Individual solutions are reviewed/corrected for possible format problems, data inconsistencies, etc.
2) Constraints imposed in the delivered normal equations are removed.
3) Sub-networks are individually aligned to the IGS05 reference frame by applying the No Net Rotation (NNR)

and No Net Translation (NNT) conditions.
4) Coordinates obtained in (3) for each sub-network are compared to IGS05 values and to each other in order to identify possible outliers.
5) Stations with large residuals (more than 10 mm in the N-E component, and more than 20 mm in the Up component) are reduced from the normal equations.
Steps (3), (4), and (5) are done iteratively.
6) Since at present the four Analysis Centres are processing GPS observations only and all of them use the Bernese Software for computing weekly solutions, relative weighting factors are not applied in the combination.
7) 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.
8) Combination obtained in (7) is constrained by applying NNR+NNT conditions with respect to the IGS05 stations included the SIRGAS region to provide constrained coordinates for all SIRGAS-CON (core + densification) stations. The applied IGS05 reference coordinates correspond to the weekly IGS solution for the global network, i.e., coordinates included in the igsYYPwwww.snx files. This constrained solution provides the final weekly SIRGAS-CON coordinates for practical applications.

The DGFI (i.e. IGS RNAAC SIR) weekly combinations are delivered to the IGS Data Centres for combination in the global polyhedron, and made available for users as official SIRGAS products, respectively. The IBGE weekly combinations provide control and back-up.

The above described analysis strategy is applied since GPS week 1495. Before (since June 1996 to August 2008), the SIRGAS-CON network was totally processed by DGFI. Until now, results show a very good agreement with previous computations; however, the present sub-networks distribution has two main disadvantages: 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, and 2) since there are not enough Local Processing Centres, the required redundancy (each station processed by at least three processing centres) is not fulfilled. Therefore, efforts are being made to install additional Local Processing Centres in Latin American countries as Argentina, Ecuador, Mexico, Peru, Uruguay, and Venezuela.