Report on Activities in Latin America and the Caribbean

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Most of the activities developed in the region in fulfilment of the IAG goals have been conducted by the SC 1.3b (Reference Frames for Central and South America) and the SC 2.4b (Geoid and Gravity Field in South America).

This report is possible thanks to many Latin American and Caribbean colleagues and institutions that might not be properly credited; apologies are presented in advance for any involuntary oblivion.

Activities developed in the frame of SC 1.3b

This SC encompasses the "Geocentric Reference System for the Americas" (SIRGAS), a joint endeavour of more than 50 institutions from 19 countries, including the national geographic institutes of the region, universities and research centres in the world.

The SIRGAS reference frame is a regional densification of the ITRF. It is realized by a network of ~400 continuously operating GNSS stations, ~100 of which have been installed during the last four years. The growth of the number of stations has been accompanied by the diversification of the data produced by the stations, and by the improvement of the capabilities to convert the data in useful products to the community.

Presently, 235 stations of the network are capable to track GLONASS, 16 GALILEO, and 2 BEIDOU (in addition to GPS), and almost 100 have real time capabilities. The data are archived by 10 centres, and processed by 11 centres following the IERS and IGS standards. In addition, other two centres, both in Argentina, are processing the GNSS measurements to compute state-of-the-art maps of the electron content distribution in the ionosphere and the integrated water vapour in the neutral atmosphere. Five of these centres have been installed during the last four years.

Processing centres in Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Germany, Mexico, Uruguay and Venezuela, generate redundant loosely constrained weekly solutions of different sub-networks, which are later combined by two redundant combination centres, one in Brazil and another in Germany.

This leads to weekly solutions of the entire network, multi-year solutions with station positions and constant velocities (almost once per year), and frequent updates of the model to interpolate the horizontal velocities measured by the stations. All these results are available at ftp://ftp.sirgas.org/pub/gps/SIRGAS/ or at www.sirgas.org, and constitute the backbone of the national networks of 15 countries that have already adopted SIRGAS as geospatial reference for their national infrastructures.

The accuracy of the weekly positions is estimated to be ±2,0 mm horizontally, and ±4,0 mm vertically. Due to the IGS08/IGb08 discontinuity, the computation of multi-year solutions has been discontinued until three years of weekly normal equations are available. The last released solution (SIR11P01) refers to IGS08 (ITRF2008), epoch 2005.0, includes 230 stations with 269 occupations from January 2000 to April 2011, and its precision is estimated to be ±1,0 mm horizontally and ±2,4 mm vertically for the positions at the reference epoch,

and ±0,7 mm/yr horizontally and ±1,1 mm/yr vertically for the constant velocities. The last update of the horizontal velocity mode has been presented to the community in November 2014; it accounts for the changes in the station velocities caused by the 2010 Maule (Chile) earthquake.

This SC has contributed to the United Nations Global Geospatial Information Management (UN-GGIM) initiative, providing the vision of the region to the Resolution on the Global Geodetic Reference Frame for Sustainable Development that was released by the UN General Assembly in February 2015.

In addition, a close cooperation is being deployed between this SC and other regional organizations, in the framework of the "2013-2015 Joint Action Plan to Expedite the Development of the SDI of the Americas", which specifies four focal points:

- The SC 1.3b provides a unique reference frame of well-marked observation stations with three-dimensional, time-dependent coordinates for ordnance survey, cadastre, geo-information, precise navigation, geodynamic studies etc.;
- The UN-GGIM-Americas promotes and coordinates a variety of actions targeted to a better management of the SDI;
- The GeoSur Program, a specialized program supported by the Development Bank of Latin America, provides www facilities to access and use spatial data;
- The Pan American Institute for Geography and History (PAIGH), a specialized body of the Organization of American States, provides support and coordination.

Major efforts have been dedicated by this SC to the definition and realization of a gravity field-related vertical reference system following the advices of the IAG WG 0.1.1 on Vertical Datum Standardization. On-going tasks include the continental adjustment of the first order vertical networks in terms of geopotential numbers referred to a global W_0; determination of a unified (quasi)geoid model for the region (under the responsibility of the IAG SC 2.4b, 'Gravity and Geoid in South America'); and transformation of the existing height systems into the new one.

Although still insufficient, significant progress have been made in collecting and validating the existing databases of levelling, gravity and tide gauges; transcription of old field notebooks to digital format; levelling field works to connect the fundamental points of the vertical networks with the SIRGAS reference stations and with the main national tide gauges; establishing levelling connections between neighbouring countries.

Four symposia were held by this SC during the period 2011 – 2014: Costa Rica, 2011; Chile, 2012; Panama, 2013; and Bolivia, 2014 (170 attendants from 20 countries on average). During the same period, a variety of capacity building activities were developed, including: 2 workshop on "vertical reference systems" (Brazil 2012; and Brazil 2015); 4 schools on "reference systems" (Costa Rica, 2011), "real time GNSS positioning" (Chile 2012), "reference systems, crustal deformation and ionosphere monitoring" (Panama 2013), and "vertical reference systems" (Bolivia, 2014); and 3 courses on precise GNSS data processing at the Instituto Geográfico Militar of Chile (2011), Universidad Nacional of Costa Rica (2012), and Instituto Geográfico Militar of Bolivia (2013). The activities developed by this SC have been presented in 23 international meetings and 32 pear-reviewed papers.

Advertisement in a main street of La Paz, Bolivia (right) and attendants (right) of SC 1.3b 2014 Symposium.

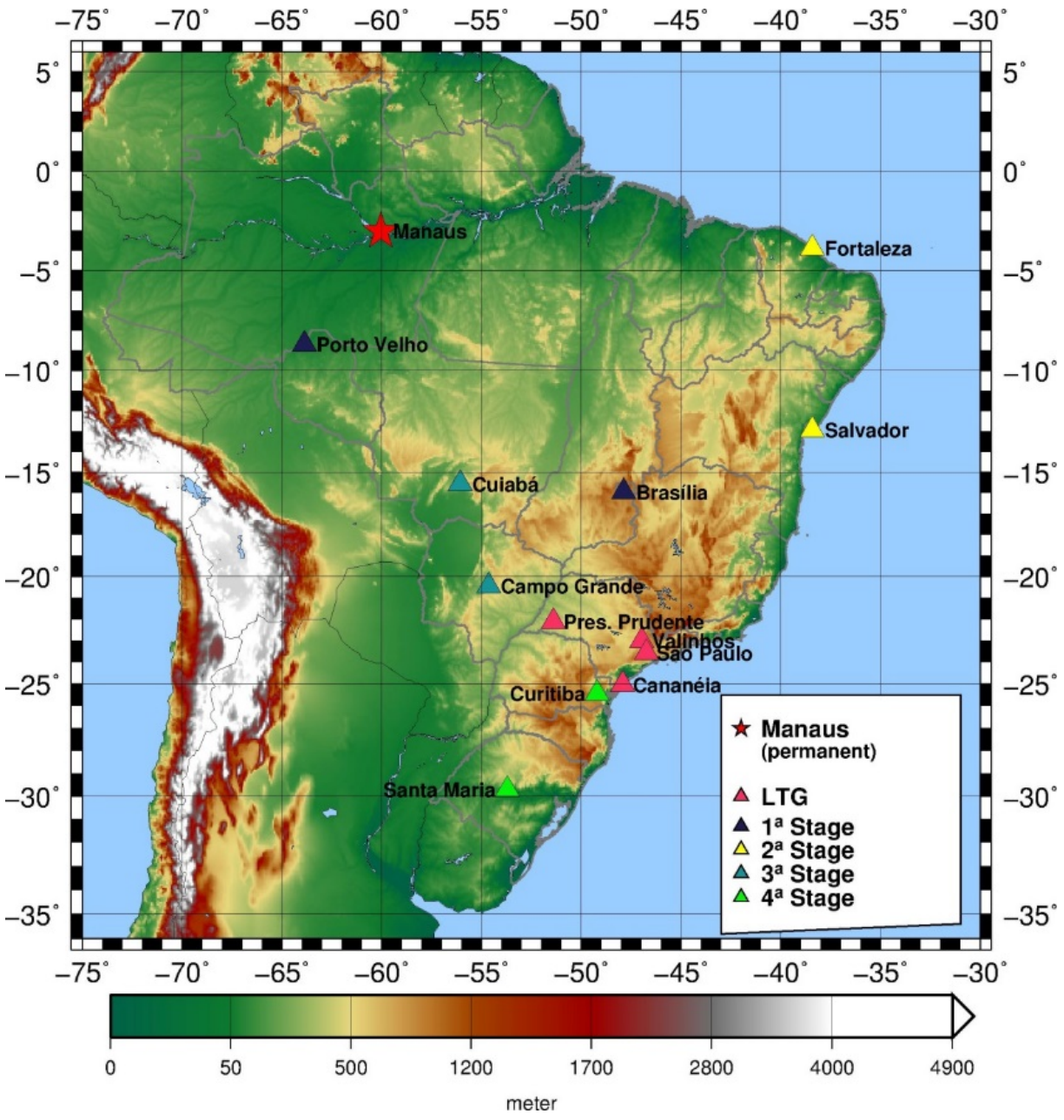
Activities developed in the frame of SC 2.4b

This SC reports a significant improvement in the coverage of the gravity data over South America (~10^6 gravity stations are presently available for computing the geoid). Orthometric heights for recent surveys have been derived from geodetic height using EGM2008 restricted to degree and order 150. LaCoste&Romberg and/or CG5 gravity meters and dual-frequency GNSS receivers have been used for establishing 504 new stations in Argentina, 11,941 in Brazil, 543 in Ecuador, and 771 in Paraguay.

Since 2014, the National Geographic Institute (IGN) of Argentina is developing a project devoted to install an absolute gravity network with 10 μGal accuracy covering the entire country. The activities are being developed through a joint effort supported by the IGN, the Brazilian University of Sao Paulo, the Argentinean universities of La Plata, Rosario and San Juan, and the French Institute of Research for the Development.

The Brazilian Institute of Geography and Statistics (IBGE) have dedicated large efforts to improve the Brazilian gravity network and, further, the geoid model in Brazil. A total of 34,000 gravity points were reprocessed with attention to the height values derived from the new adjustment of the leveling network. A big effort was addressed to gravimetric surveys in São Paulo, Minas Gerais, Santa Catarina, Rio Grande do Norte, Ceará, Mato Grosso do Sul, Goiás, Paraiba and Sergipe states, with a total of 5,017 new gravity stations. A geoid model will be released in October 2015, in substitution to MAPGEO1010. It will include airborne gravity data in the Amazonas and the Paraiba basins.

In cooperation with other institutions, the Brazilian University of São Paulo has been working to improve the Earth tide model in Brazil. Thirteen stations around the country are being occupied for one year using 2 gPhone gravitymeters. Measurements are already completed in Cananeia, Valinhos, São Paulo and Presidente Prudente; are being conducted in Porto Velho and Manaus; and are planned in Brasília, Fortaleza, Salvador, Cuiabá, Campo Grande, Curitiba and Santa Maria.



The Institute of Geography and Cartography of São and the São Paulo University are cooperating for the establishment of absolute gravity points in Brazil, Argentina, Venezuela, Ecuador and Peru, using an A-10 gravitymeter.

Other activities

During the period 2011-2013 the Fundamental Geodetic Observatory TIGO operated in Concepción, Chile, in partnership between the Chilean Universidad de Concepción and the German Bundesamt für Kartographie und Geodäsie (BKG). In this frame, TIGO provided high quality data to the IVS, ILRS, IGS, IGFS, IERS, and Time Section of BIPM. In 2013, the partners decided to stop the cooperation and BKG decided to move the Observatory to Argentina, in the frame of a new agreement with the Argentinean National Council of Science and Technology (CONICET). The now called Argentina – German Geodetic Observatory (AGGO) is almost ready to enter in operation in the vicinity of La Plata, where its official opening is schedule for July 2015.