Modernization and New Services of the Brazilian Active Control Network

Luiz Paulo Souto Fortes, Sônia Maria Alves Costa, Mário Alexandre de Abreu, Alberto Luis da Silva, Newton José de Moura Júnior
Directorate of Geosciences, Brazilian Institute of Geography and Statistics (IBGE), Rio de Janeiro, RJ, Brazil

Katja Barbosa, Edaldo Gomes
Cartographic Coordination, National Institute of Colonization and Land Reform (INCRA), Brasília, DF, Brazil

João Francisco Galera Mônico
Department of Cartographic Engineering, University of the State of São Paulo (UNESP), Presidente Prudente, SP, Brazil

Marcelo Carvalho Santos
Department of Geodesy and Geomatics Engineering, University of New Brunswick (UNB), Fredericton, NB, Canada

Pierre Tétreault
Geodetic Survey Division, National Resources Canada (NRCan), Ottawa, ON, Canada

INTRODUCTION

The Brazilian Network for Continuous Monitoring of GNSS – RBMC, is a national network of continuously operating GNSS reference stations. Since its establishment in December of 1996, it has been playing an essential role for the maintenance and user access of the fundamental geodetic frame in the country. The purpose of RBMC is to provide data, without any cost, for several post-processing applications. It provides users a direct link to the new Brazilian geodetic system, SIRGAS2000, fully compatible with GNSS technology. A law of 2001 requiring that all rural properties be referred to the Brazilian geodetic system intensified the use of RBMC reference data. In order to provide better services for RBMC, the Brazilian Institute of Geography and Statistics – IBGE, and the National Institute of Colonization and Land Reform – INCRA, are both partners involved in the National Geospatial Framework Project - PIGN.

In 2009, a caster was put in operation, providing real-time data of 26 stations. This new service is called RBMC-IP and is accessible for all users in the first semester of 2009 through a login and password. A challenge for the future is to compute WADGPS corrections to be transmitted, in real time, to users in Brazil and surrounding areas. For this purpose some receivers are working already with an external frequency standard. It is estimated that users will be able to achieve a horizontal accuracy between 0.5 to 1m (1s) in static and kinematic positioning and better for dual frequency users. The availability of the WADGPS service will allow users to tie to the new SIRGAS2000 system for positioning and navigation applications in a more rapid and transparent way. It should be emphasized that support to post-mission static positioning will continue to be provided to users interested in higher accuracy levels. In addition to this, a post-mission Precise Point Positioning (PPP) pilot service has been established, based on the current Geodetic Survey Division of NRCan (CSRS-PPP) service. This service is operational since april, 2009. The modernization of the RBMC is under development based on a cooperation signed at the end of 2004 with the University of New Brunswick (UNB), supported by the Canadian International Development Agency and the Brazilian Cooperation Agency (CIDA). The Geodetic Survey Division (GSD) of NRCan is also participating in this modernization effort under the same project.

NETWORK EXPANSION

After three years working on the expansion plan of RBMC/RIBac, the number of stations increased from 24 to 66 in 2009. The goal is provide a larger national coverage with additional capabilities, for example, real time data and an adequate infrastructure for collecting data from GPS and GLONASS, foreseeing the possibility of collecting GALILEO data in the future.

The cooperation between IBGE and INCRA continues with the installation of more 30 stations that will be concentrated in the central and northern part of country. By the end of this year, 10 additional stations will be installed, extending the present network configuration from 66 to 76 stations. The data collected at new stations are released after an initial test period, when the official SIRGAS2000 coordinates are computed. Figure 1 shows the distribution of the station's network.

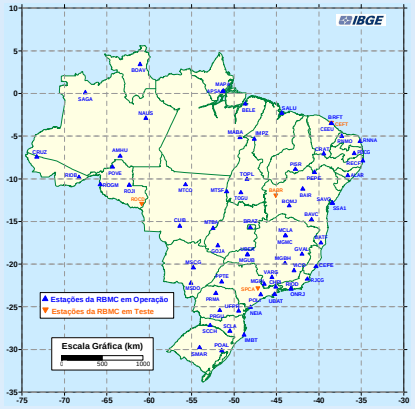


Fig. 1 – The Expansion of RBMC

REAL TIME DIFFERENTIAL GPS CORRECTIONS SERVICE

In may of 2009 the IBGE NTRIP caster was officially opened to Brazilian users, with 26 mountpoints (stations) installed in the main cities of the country where wireless internet is available. Users have access to the caster after a registration that allows to stream data from 3 mountpoints in a maximum period of 3 months. This new service is called RBMC-IP and more information can be found at: http://www.ibge.gov.br/home/geociencias/geodesia/rbmc /ntrip/

At present, Brazil contributed with 5 new IGS stations (POVE, SALU, SAVO, RECF and UFPR) and 8 RTIGS stations (POVE, SALU, SAVO, RECF, UFPR, CEEU, BRAZ and ONRJ) with GNSS receivers belonging to a subset of RBMC-IP network. Other 9 stations (POVE, SALU, SAVO, RECF, UFPR, ONRJ, CEEU, NAUS and BRAZ,) contribute to the IGS-IP network providing data in real time as well.

In a second step he real-time Wide Area Corrections service of the RBMC is under implementation. The Geodetic Survey Division of NRCan is also participating in this modernization effort under the same project, transferring their *know how* from the CDGPS – Canadian Differential GPS service. The availability of the WADGPS service will allow users to tie to the new SIRGAS2000 system in a more rapid and transparent way.

Parts of the system's implementation is already concluded: (1) Connect a subset of receivers connected to atomic clock. At least 2 stations can satisfy this requirement, CEEU (located in Fortaleza) is connected to a Hydrogen Maser and ONRJ (located in Rio de Janeiro) is connected to a Cesium clock that belongs to the Brazilian Time Service at the National Observatory; (2) Operate a group of stations streaming data on real-time; (3) Installation of servers responsible for the computation of corrections; (4) Installation and configuration of software for data format conversion, data scan and data base management, and computation of corrections; (5) Installation and configuration of a NTP time server (to slave the server's CPU to GPS time); (6) Near real time orbit computations.

The resulting configuration for this system is shown in Figure 2.

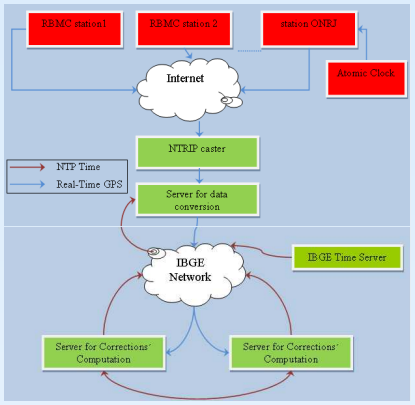


Fig. 2 – Config. of real-time Wide Area Corrections of the RBMC

IBGE-PPP SERVICE

The IBGE-PPP (IBGE Precise Point Positioning) is an on-line service for GPS data -processing. It allows the GPS users to get coordinates of good precision in the Geocentric Reference System for the Americas (SIRGAS2000) and the International Terrestrial Reference Frame (ITRF).
In GPS positioning, the term Precise Point Positioning usually refers to the computation of a single station using carrier phase observation, obtained from dual-frequency receivers, together with IGS products.

The IBGE-PPP service processes data collected in either static or kinematic modes, from single or dual frequency receivers. Only data collected after february 25, 2005, are accepted, this being the time of official adoption of the SIRGAS2000 frame in Brazil.
The following information is required by the service: GPS data in RINEX or Hatanaka format, preferably compressed using Winzip, Gzip or Tar-Gzip; Antenna type used to collect the data, following the IGS identification scheme, and the value of the antenna height in meters referred to the antenna reference plane (ARP) .

Besides the user supplied RINEX files, the IBGE-PPP service uses other information for the processing, such as: orbit and clock (satellite) information from IGS (final and rapid), IGS antenna phase centre corrections for satellite and receiver antennas, transformation parameters between ITRF/SIRGAS2000 frames, FES04 ocean loading model parameters, velocity model VEMOS and the geoidal ondulation model -MAPGEO2004.

The results are informed through a compressed archive containing 5 files, as following: readme, summary report, coordinate series for kinematic mode, kml format and complete report. This positioning service makes use of CSRS-PPP developed by the Geodetic Survey Division of Natural Resources of Canada (NRCan) and can be access through webpage: http://www.ibge.gov.br/home/geociencias/geodesia/ppp/. The Accuracy of IBGE-PPP is show in Figures 3 and 4.

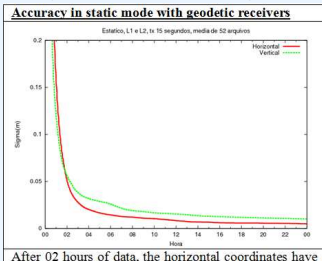
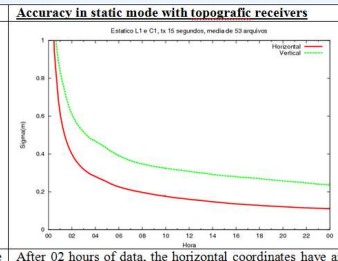
Accuracy in static mode with geodetic receivers	Accuracy in static mode with topografic receivers
	
After 02 hours of data, the horizontal coordinates have an accuracy better than 4 cm and height better than 6 cm. After 6 hours of data the accuracy stabilizes on the 2 cm and 4 cm level, respectively. These results confirm the good quality of service.	After 02 hours of data, the horizontal coordinates have an accuracy better than 30 cm and height better than 70 cm. After 6 hours of data the accuracy stabilizes on the 15 cm and 40 cm level, respectively.

Fig. 3 – IBGE-PPP accuracy in static mode

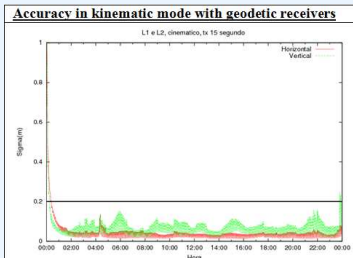
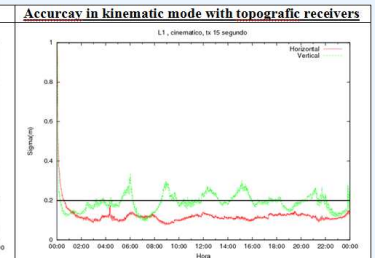
Accuracy in kinematic mode with geodetic receivers	Accuracy in kinematic mode with topografic receivers
	
After 2 hours of data, the horizontal coordinates reach an accuracy better than 10 cm, the height better than 20cm. After this period, this level of accuracy is maintained.	After 2 hours of data, the horizontal coordinates reach an accuracy better than 20 cm, the height better than 40cm. After this period, this level of accuracy is maintained.

Fig. – IBGE-PPP accuracy in kinematic mode

FINAL CONSIDERATIONS:

The new structure, after full implementation, will have as main characteristics:
– Make use of remote and automatic Active Control Points (ACP) / Transfer 1-Hz real time data from ACPs to the Network Control Centre, located in Rio de Janeiro;
– Generate real-time WADGPS corrections (orbit,clocks and ionospherie) / Make corrections available to users in Brazil (and surrounding areas) through Internet;
– Offer a Precise Point Positioning (PPP) service (IBGE-PPP) to users;
– Offer a horizontal accuracy around 0.5 m (1-sigma) in static and kinematic positioning and better for dual frequency users;
– Collaborate with international GNNS networks such as IGS and RTIGS.

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