IAG – Brazilian National Report

National Committee of IUGG

Commité

IAG - Travaux

Period 2003 - 2007

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Introduction

This report intends to cover most of the activities in Brazil related to Geodesy. It is not complete certainly due to the many activities going on by different organizations, universities and research institutes.

The main important centers of Geodesy in Brazil are located in the following cities: Santa Maria, Curitiba, São Paulo, Presidente Prudente, Rio de Janeiro, Viçosa and Recife.

Adjustment of the Leveling Network of the Brazilian Geodetic System

In October 13, 1945 IBGE (Instituto Brasileiro de Geografia e Estatística) initiated the activities for the establishment of the spirit leveling network in Brazil.

In December 1946 it has been completed the first connection of the network with the tide gauge station in Torres, Rio Grande do Sul. In this way the height of the BM was referred to that materialization of the Mean Sea Level.

In 1958, with a total of 30,000 kilometers of leveling lines, the Torres tide gauge was substituted by a new origin, a tide gauge station in Imbituba, Santa Catarina.

In the end of the 70s a remarkable goal was achieved when the leveling network arrived to distant points of the Brazilian territory, as far as the states of Acre and Roraima, in the far north.

After 35 years of successive adjustment carried out with the support of spreadsheets (1948, 1952, 1959, 1962, 1963, 1966, 1970 and 1975), in the 80s IBGE started a new approach with the development of softwares. A preliminary adjustment of the global network was accomplished in 1993.

Since 2005, CGED (*Geodetic Coordination*), as part of the Project of Altimetric Densification DALTI, has been coordinating an effort for more rigorous processing and a global adjustment of the network was accomplished. The Canadian software GHOST (Geodetic adjustament using Helmert blocking of Space and Terrestrial Data) was used.

The last accomplishment was in 2006 with more than 36,000 BM in the adjustment. The old idea of block adjustment due to Helmert was implemented.

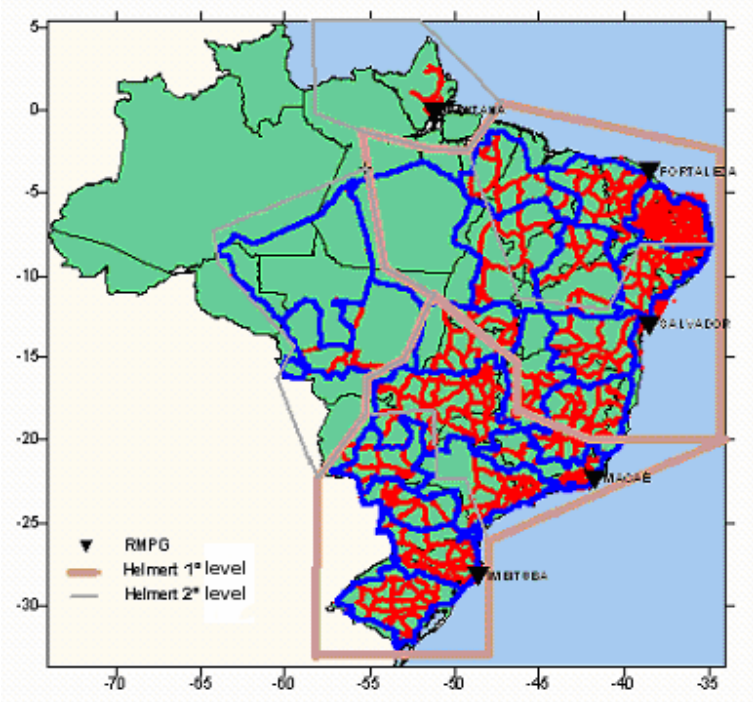

Figure 1 - Leveling adjusted network

At the moment, an effort is under way to provide altimetric information for the Working Group III (GTIII) of SIRGAS.

Gravimetry

Figure 2 presents the actual distribution of gravity data on the leveling network. These are information needed for the computation of scientific heights as a request of GTIII.

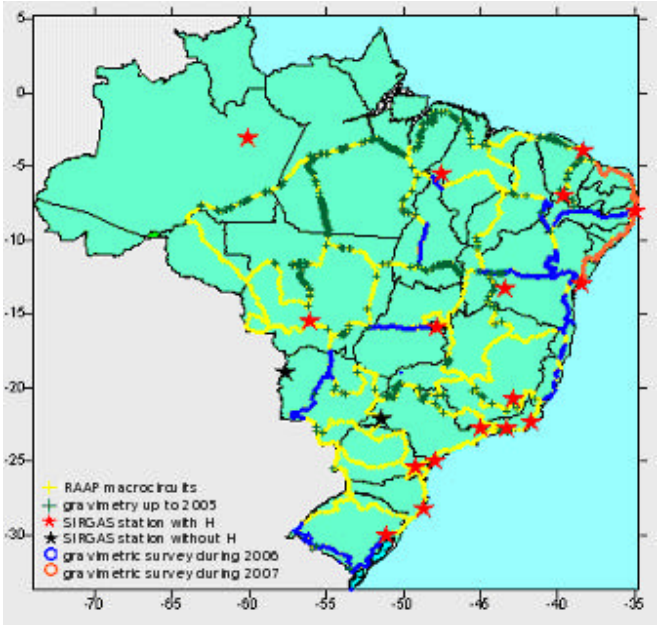

Figure 2- BMs surveyed with gravimetry in 2006 and 2007

Geoid model

IBGE, through the CGED, and Polytechnic School of the University of São Paulo – EPUSP, derived a geoid undulation model with a resolution of 10' and made available a software for interpolation from the grid - MAPGEO2004. The geoid height is available in two reference ellipsoids: SIRGAS2000 and SAD69 (Figures 3 and 4).

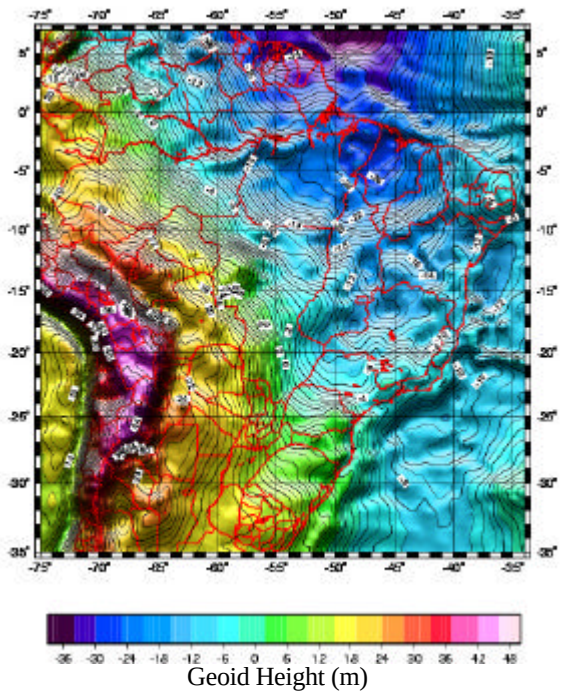

Figure 3 – Geoid model referred to SIRGAS2000

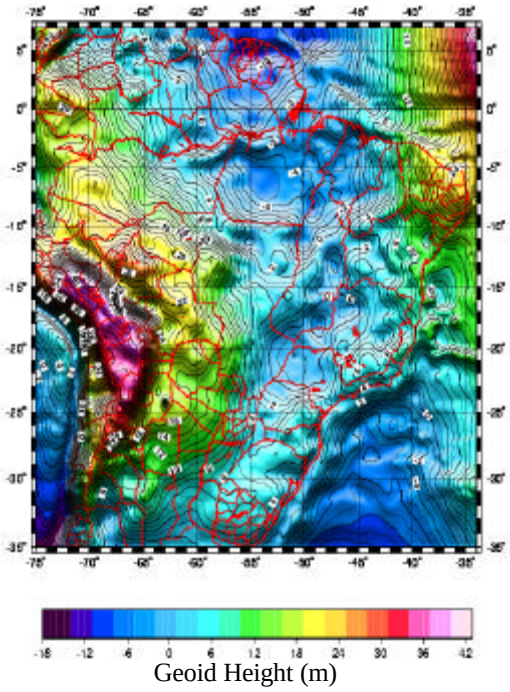

Figure 4 - Geoid model referred to SAD69

A zero order term of -0.5 m was added to the undulations related to SIRGAS2000 in order to compatibilize with GRS80 ellipsoid.

The estimated standard error associated with MAPGEO2004 is +/- 0.5 m. GPS observations on the leveling network were used for the estimation of the error.

Permanent Tide Gauge Network for Geodesy – RMPG

Since 1994, when the operation of the tide gauge station in Macaé was transferred from Petrobrás to IBGE, an effort to establish a Permanent Tide Gauge Network in Brazil was started. Figure 5 shows the distribution of the network presently under operation on the supervision of IBGE with established and scheduled stations.

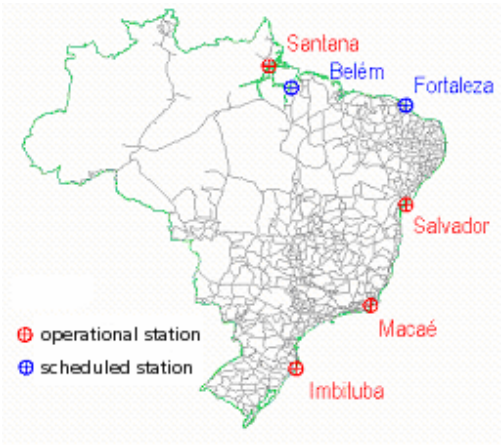

Figure 5 – Permanent Tide Gauge Network

State GPS Networks

Up to December 2006 a total of 13 GPS networks were established in the 18 states of Brazil: São Paulo, Paraná, Minas Gerais, Mato Grosso, Mato Grosso do Sul, Santa Catarina, Rio de Janeiro, Rio Grande do Sul, Bahia, Ceará, Espírito Santo, Acre plus the notheast states.

IBGE Processing Center

IBGE is one of the five processing center in charge of the SIRGAS permanent GPS stations. The others are: Universidad Nacional de La Plata - UNLP (Argentina), Instituto Nacional de Estadística Geografía e Informática - INEGI (México), Instituto Geográfico Agustin Codazzi – IGAC (Colômbia) and Instituto Geográfico Militar (Argentina) (IGM). Figure 6 shows the distribution of the permanent stations.

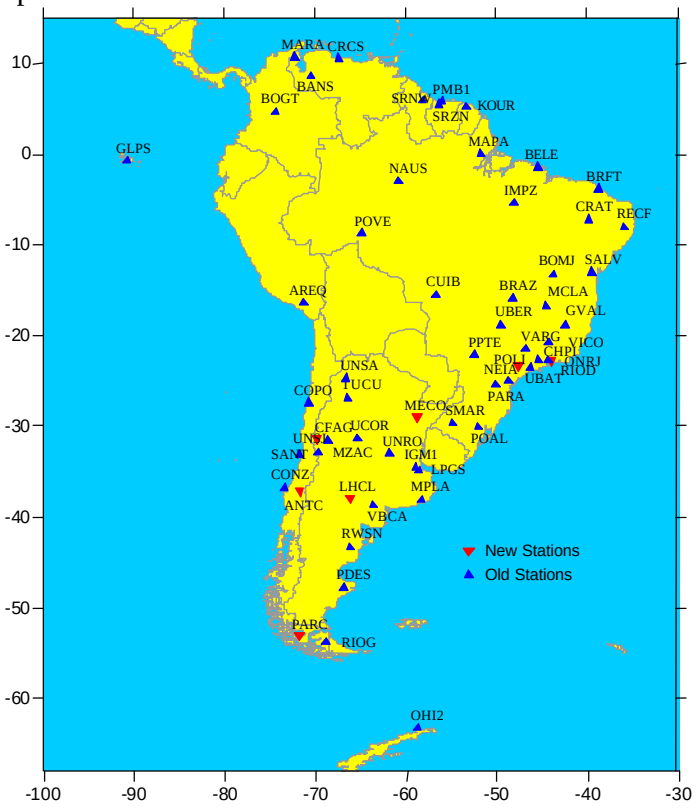

Figure 6 – SIRGAS permanent GPS stations.

Brazilian Geodetic Network Adjustment to SIRGAS2000

Due to the extensive use of the GPS technology by the user community for positioning, IBGE created the Project for the Change of the Reference System (PMRG). In the context of this project an adjustment of the geodetic network, using not only the present technology but also the old triangulation data available, has been carried out. A total of 6,265 stations are part of the adjustment, between them 1600 GPS stations. The epoch of reference is 2000.4. Figure 7 shows the schedule of the network.
http://www.ibge.gov.br/home/geografia/geodesico/srg/Documentos/ResolucaoSP.pdf

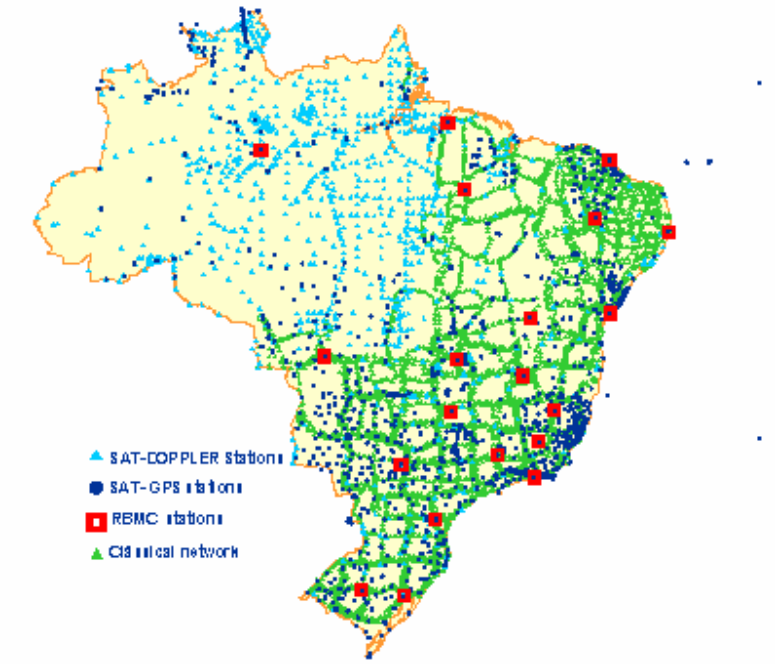

Figure 7 - Geodetic Network adjusted in 2006

Expansion and Modernization of the Brazilian Network for Continuous GPS Monitoring (RBMC)

IBGE, in a cooperation with INCRA (Instituto Nacional de Colonização e Reforma Agrária), is carrying out an effort for the expansion and modernization of RBMC. For this purpose in 2006 a total of 83 modern GPS receivers have been purchased. In 2007 the substitution of the existing receivers was started and the definition of the sites for the new stations accomplished. The receivers are prepared for GPS as well as for GLONASS satellites tracking system (Figure 8).

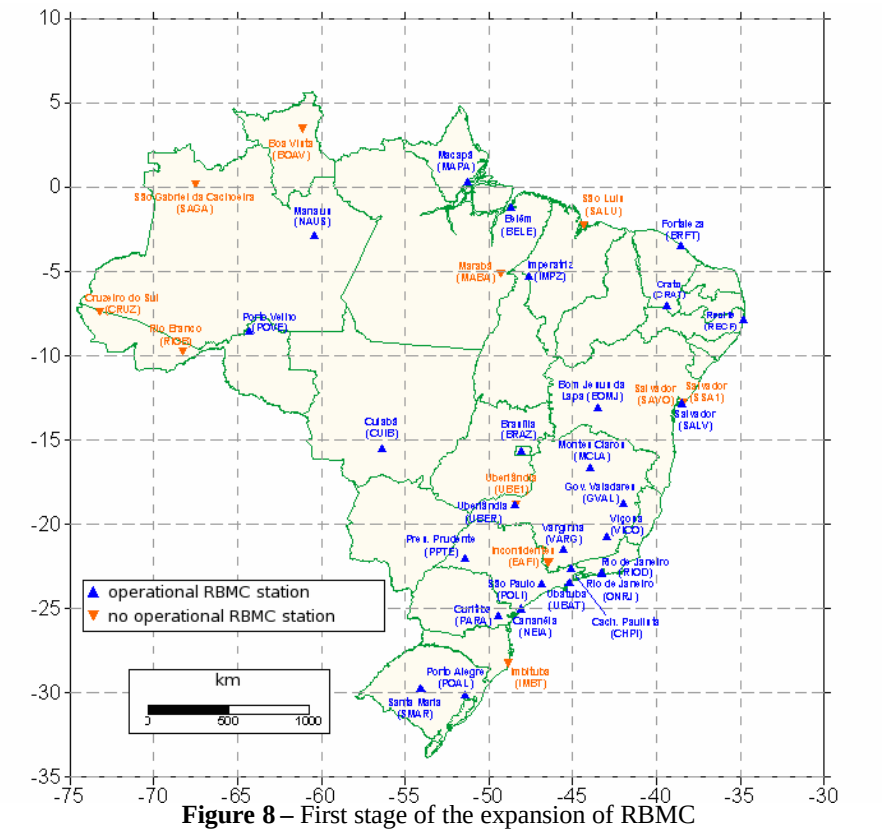

Figure 8 – First stage of the expansion of RBMC

Gravity network

A big effort was carried out by many different organizations in the last few years to improve the gravity data coverage all over the country. As a result a total of 472,535 station (gravity data) is available for geoid determination (Figure 9).

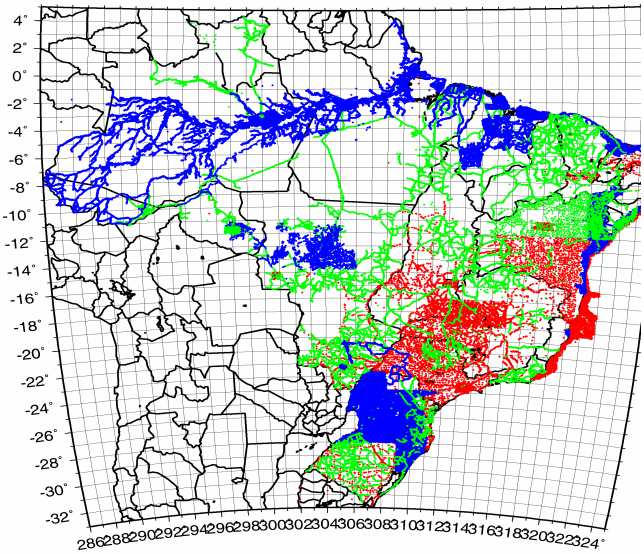

Figure 9 – Gravity data distribution in Brazil.

Digital Terrain Model - South America Model

EPUSP-LTG created three Digital Terrain Models for South America:

• SAM_30s: this model consists of SRTM3 information in the 30” grid. For the continental and the oceanic areas, where no information was available, DTM2002 has been added. SAM_30s has the original height of the point, not mean value of the grid cell.
• SAM_1mv1: this model was generated in the same way as the previous model, except the spacing of the grid that was changed to 1’.
• SAM_1mv2: this model uses the maps digitized in the continental and oceanic areas of South America (Figure 10). In the gaps without maps, the model is exactly the same as the previous one. Topographic maps of Brazil were digitized by GETECH in the Northern region, by IBGE at the center-west and northeast and by Petrobras (Petróleo Brasileiro) in the southeast and south parts. *Servicio Geográfico Militar* (SGM) of Uruguay carried out an effort to obtain a DTM for the country using topographical maps. Argentina area used information derived from topographic maps in the scale 1:250,000 as an effort of Military Geographic Institute (IGM).

The models are available in the web page: http://www.ptr.poli.usp.br/ltg/proj/proj21.htm.

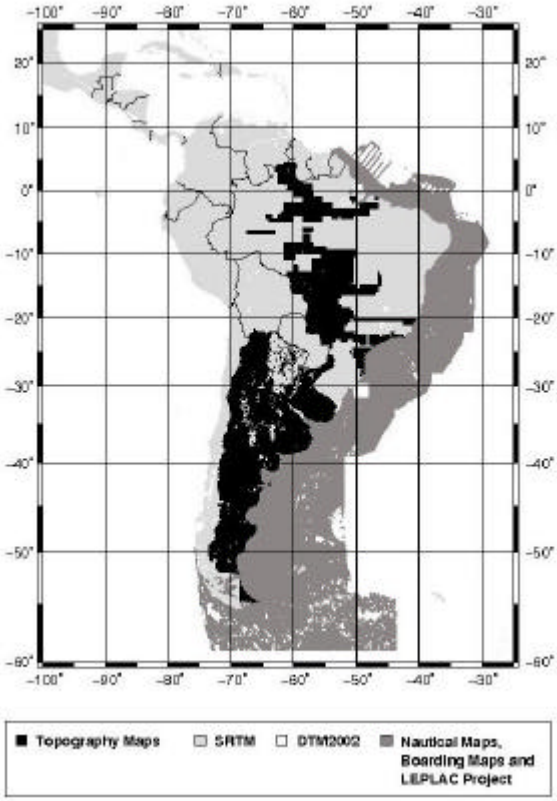

Figure 10 – Distribution of informations of the SAM_1mv2.

Absolute gravity

As a result of the fact that National Observatory of Brazil has two absolute gravitymeters, FG-5 and A-10, it is planned to re-observe existing absolute gravity stations in Brazil and in South America in the new future as well as the establishment of new absolute stations. Measurements with A-10 have been made at the Agulhas Negras calibration baseline, with 5 stations distributed from sea level to 2,500 meters. Two tide gauge stations in the state of São Paulo, Cananéia and Ubatuba, were measured as well as a geodynamic station in the University of São Paulo (Figure 11). These are efforts coordinated by the Institute of Oceanography (IOUSP), by Polytechnic School (EPUSP) and Institute of Astronomy, Geophysics and Atmospheric Sciences (IAGUSP), University of São Paulo (USP).

Figure 11 – Tide gauge Cananéia station

GEGE – Spatial Geodesy Study Group
FCT/UNESP Presidente Prudente, SP, Brazil
http://gege.prudente.unesp.br

Introduction

The Spatial Geodesy Study Group (GEGE) started its activities in 1997. This group is established within the context of an undergraduate course of Cartographic Engineering and a graduate program in Cartographic Science, both at FCT/UNESP, Presidente Prudente, Brazil.

The goal of GEGE is to investigate and to discuss topics related to the researches developed at the Faculty of Sciences and Technology – FCT/UNESP in Spatial Geodesy and correlated fields.

Fortnight meetings of the group occur during the year with approximately 1 and half hour of duration each. And normally, at the end of year, in December, there is the Annual Seminar of GEGE. During 2006 we organized the VI GEGE Annual Seminar. Details of the fortnight meetings and Annual seminar can be found in the home page of GEGE.

The main investigations carried out by our group are related to realization of reference system, development of algorithms for high precision positioning, GNSS error mitigation, estimation of IWV (Integrated Water Vapor) from GPS measurements, Ionosphere models, among other. Some general ideas of the projects are given below.

Projects under development

Geodetic Positioning in the GNSS Context

The aim of this project is to investigate improvements in terms of accuracy and reliability that may be reached in the positioning considering the GNSS (GPS, GLONASS and Galileo), besides to continue studies concerning the integration of these systems and to effective the synergy with other sciences. The main topics are implemented in the in-house software under development at FCT/UNESP, so called GPSeq.

The Wavelet Analysis for Detection and Reduction of Multipath

The aim of this research is to develop an innovative and viable methodology, considering cost benefit, which has to be able to identify, reduce and even to eliminate the multipath effects in the GNSS carrier phase and pseudo-range measurements, for static and kinematic applications. Besides post processing, real time applications will be also considered. The main mathematical

tool to be used will be the Wavelet transform (WT), which will be used to decompose the temporal series of the GNSS residuals in high and low frequencies ones.

GPS Active Network of São Paulo State: support to geodetic positioning and atmosphere studies

The central theme of this project is to set up an active GPS network at São Paulo state to establish the necessary infra-structure for the development of researches and applications within the geodetic positioning context. It will allow carrying out researches related to RTK positioning having a network of base stations (network RTK), Virtual Reference Station (VRS) concept besides provides several kinds of services. Therefore, assessment of accuracy and reliability using GPS (as well as GNSS) can be carried out. The quality of the zenithal tropospheric model (ZTD) available at CPTEC, whose prediction comes from numerical weather model, can also be evaluated from this network, which can produce the same quantity (ZTD). The stations of this network have been make part of the real time network managed by BKG (Federal Agency for Cartography and Geodesy of Germany) using the NTRIP protocol. They also make part of the project to evaluate the quality of the L2C data. Therefore, its data are making available in real time. See details at http://gege.prudente.unesp.br/english/index.php?p=50. This project involves the development of in-house software for the development of Network RTK, using the concept of VRS. The network solution (ambiguities mainly) has been carried out using the Bernese V5.0 software. Besides using phase only, a version has been developed for using code within the context of VRS. Concerning the Meteorology, zenithal tropospheric delays (ZTD) have been produced to investigate aspects of now-casting as well as to be used as input data for climatic studies.

GPS RTK Technology to support Cartographic Sciences

This project aim is to use the RKT GPS technology to provide support to the activities of the Department of Cartography related to Mapping and Geodesy.