The French GPS Permanent Network

Thierry DUQUESNOY, France

Key words: GPS, Permanent Network.

SUMMARY

In order to provide a modern, cheap and easy access to the French geodetic reference frame (with a completely new legal definition in 2001), the French Institut Geographique National has decided to set up a network of GPS permanent stations. This project began in 1998 and the whole territory (including overseas departments, French West Indies, French Guyana, La Réunion Island) will be covered at the end of 2003.

In addition of its own permanent stations, IGN-F prompts the local authorities to set up permanent GPS stations in urban areas. For these stations, IGN provides a complete technical support and a stability control of the station, keeps and broadcasts free of charge the data records. Most new stations allow for the RTK mode, with a successful pilot experiment that ended in 2002. A figure exceeding 50 stations is expected for the end of 2003.

RESUME

Afin de fournir un accès facile et peu couteux au système de Référence National, dont une nouvelle définition a été publiée en 2001, l'Institut Géographique National français a décidé de mettre en place un réseau de stations GPS permanentes sur l'ensemble du territoire français, départements d'outre-mer compris. L'ensemble du territoire français sera couvert à la fin de 2003.

En supplément de ses propres stations , l'IGN incite les collectivités territoriales à s'équiper de stations permanentes dans les zones urbaines. Pour ces stations , l'IGN fournit une assistance complete pour le choix de l'emplacement de la station, l'installation de cette dernière et contrôle la stabilté de la station au travers de calculs réguliers. L'IGN prend en charge le transfert des données de la station permanente vers les centres opérationnels. La plupart de ces stations permettent le temps réel centimétrique. Une expérience pilote a été menée avec succès en 2002 à Biarritz.

Une cinquantaine de stations devraient constituer le RGP d'ici la fin 2003

The French GPS Permanent Network

Thierry DUQUESNOY, France

1. INTRODUCTION

Many new GPS applications has appeared since a few years. As to get the best accuracy it is necessary to use at least two receivers - one on a known site and another one on the site to determine- it seems interesting to put a permanent station else in place of the fixed station of each user. Data from permanent stations are stored in a file Server and all users may download free of charge the data files. In order to satisfy for all users needs and to limit public spending, The French Institut Geographique National chose to federate the set of French permanent stations and sign an agreement with the different administrator of permanent station.

2. ORGANIZATION

2.1 The Network

Actually forty-one permanent stations make up the French GPS permanent network (RGP) (Fig 1)

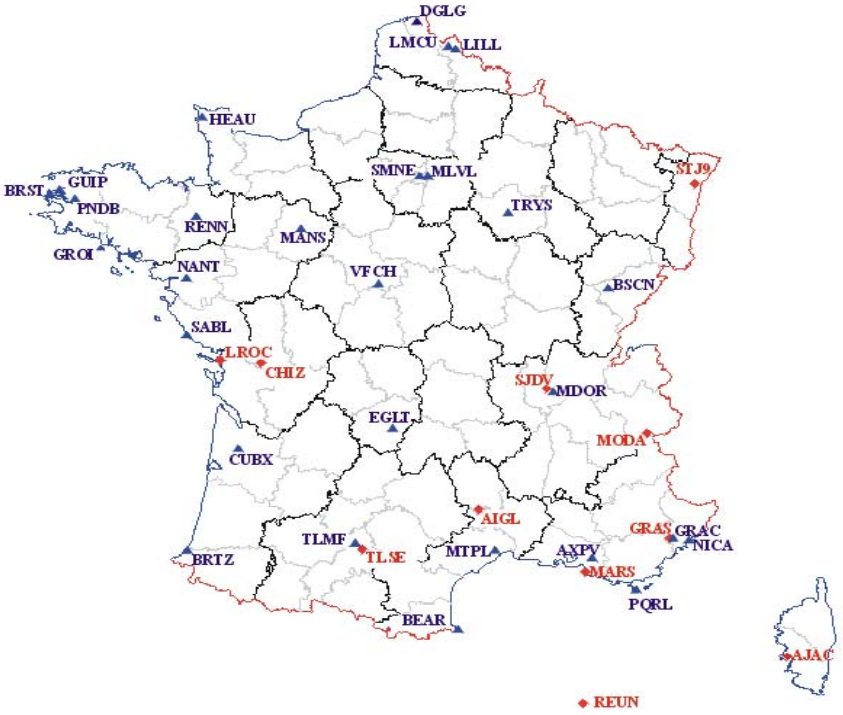

Figure 1 The French permanent network (15 /02/ 2003)

Among these stations sixteen were set up by IGN. At the end of 2003, we hope that IGN will have set up seven or eight new stations.
Historically, the permanent stations provided data by files of 24 hours with a sampling of 30 seconds. In order to fulfill all applications needs, the new stations record data with a sampling of 1 second stored in file of 1 hour duration. Thirty stations are yet in the old configuration.

Figure 2: A permanent GPS Station

2.2 Data Transfer

Several mode of transfer are used for the data collection. We privilege transfer using file transfer protocol (FTP) but for few stations we collect data by phone. When it is possible the global data center pick up the files at the permanent station. But due to network security device (firewall) many of stations send their data to the global data center.
Before transferring, data are converted in the international exchange format RINEX and compressed both logical and physical to limit the transfer time.

2.3 The global data centers

We are planning to have two global data centers at the end of 2003. These two centers will be independent but with a file Server mirroring of the other one in each data Center.

2.3.1 Quality Check

IGN wants to give the maximum information concerning the site of permanent station and quality of data.
To qualify the site, we use the software developed for EUREF permanent station by B Tacaks (Fig 3).

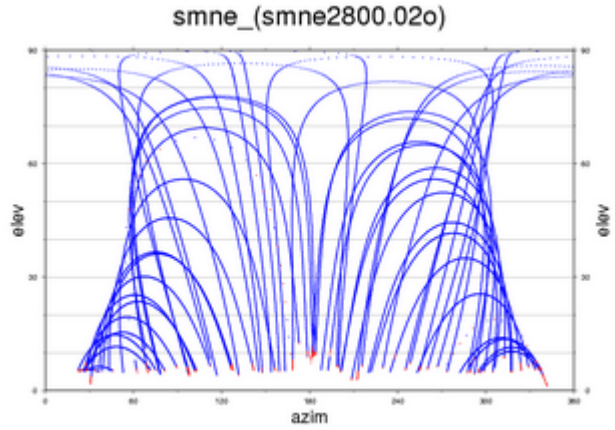

Figure 3: Information about the data observed at each station. Azimuth/elevation of observed satellites Dual frequency L1/L2 data are displayed in blue. Periods with missing L2 data are given in red.

To inform the users on the quality of the data, we process the "teqc" software developed at UNAVCO. We present each hour the ratio between the number of observations expected and the number of observations recorded at the station. (Fig 4) This information will be available on the future web site with a frequent update

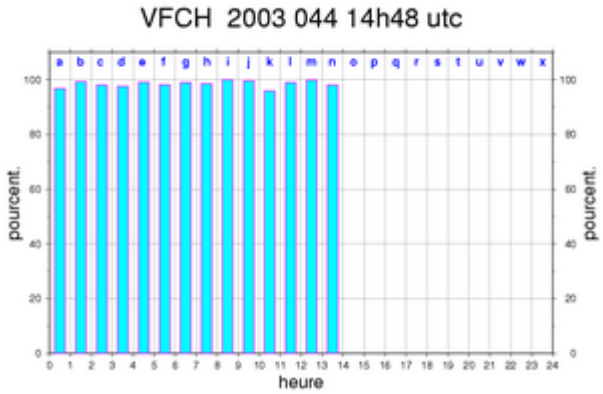

Figure 4: Graph of ratio between expected and observed data for each station. One blue bar for one hour data.

But the first activity in the data center is to check the presence of data files on the server. For that we develop software in order to look after the incoming of the files from all permanent stations (Fig 5)

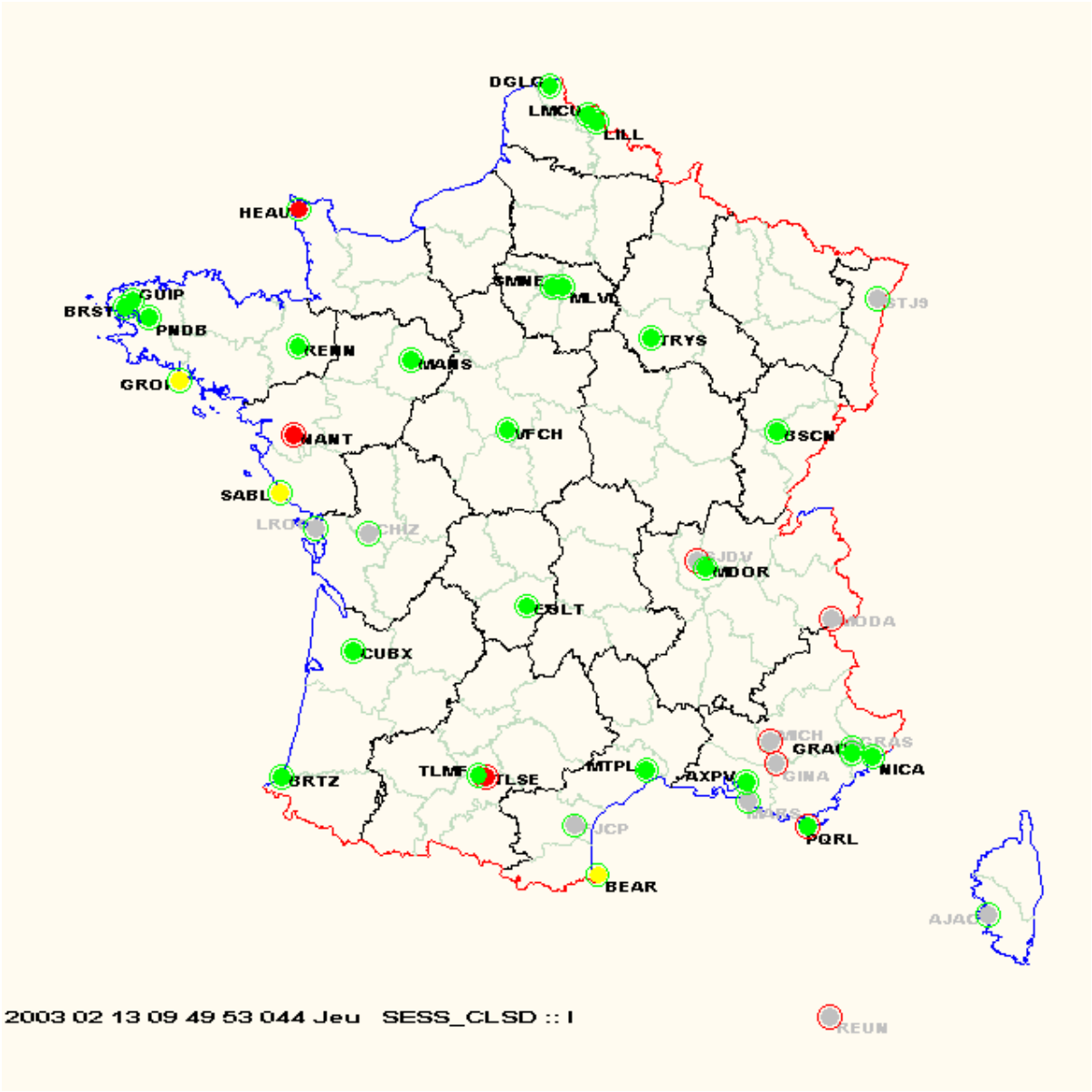

Figure 5: Instantaneous image of available files

2.3.2 Computations

Using the Bernese GPS processing software 4.2 we calculate hourly, daily and weekly solutions of the RGP network including some stations from the European Permanent Network (EPN).
For these computations we use this strategy:

Preprocessing:

- Phase preprocessing in a baseline by baseline mode using triple-differences. The Basic Observable are: Carrier phase, The code are only used for receiver clock synchronization.

- Elevation angle cutoff: 10 degrees
  - Data sampling: 30 s
  - Double-differences, ionosphere-free linear combination for ambiguity resolution strategy
  - Ground antenna elevation-dependent phase center corrections are phase center applied to model the differences between different calibrations antenna types
  - Troposphere: No a priori model estimating zenith delays in 1 hour interval for each station mapping function: Dry Niell.
  - Ionosphere: Ionosphere model estimated from L2 - L1 double-difference observations.

The daily solution normal equations are combined to achieve the weekly solution. All the coordinates solutions are get in ITRF2000. An Helmert transformation is used to get RGF93 coordinates.
The hourly computation is done with Ultra rapid IGS ephemerides. The last weekly solution is get using precis IGS ephemerides .
Hourly solutions are computed in the hour following the last record. Weekly solution are computed only when precise ephemerides are available

3. RGP PRODUCTS

On the RGP file Server, we supply the different kind of ephemerides: broadcast and IGS ephemerides.
We supply also ionosphere model calculated using the Bernese GPS processing software 4.2 IONEST module.
We supply results of weekly solution in the exchange format SINEX
We supply also the estimating troposphere zenith delays in two file formats: Bernese file format and Sinex file format. This product is used by Meteo France in order to compute the Integrated Water Vapor Content
The offset between a standard model value and the calculated value is extrapoled and plotted on the whole french territory (Figure 6).

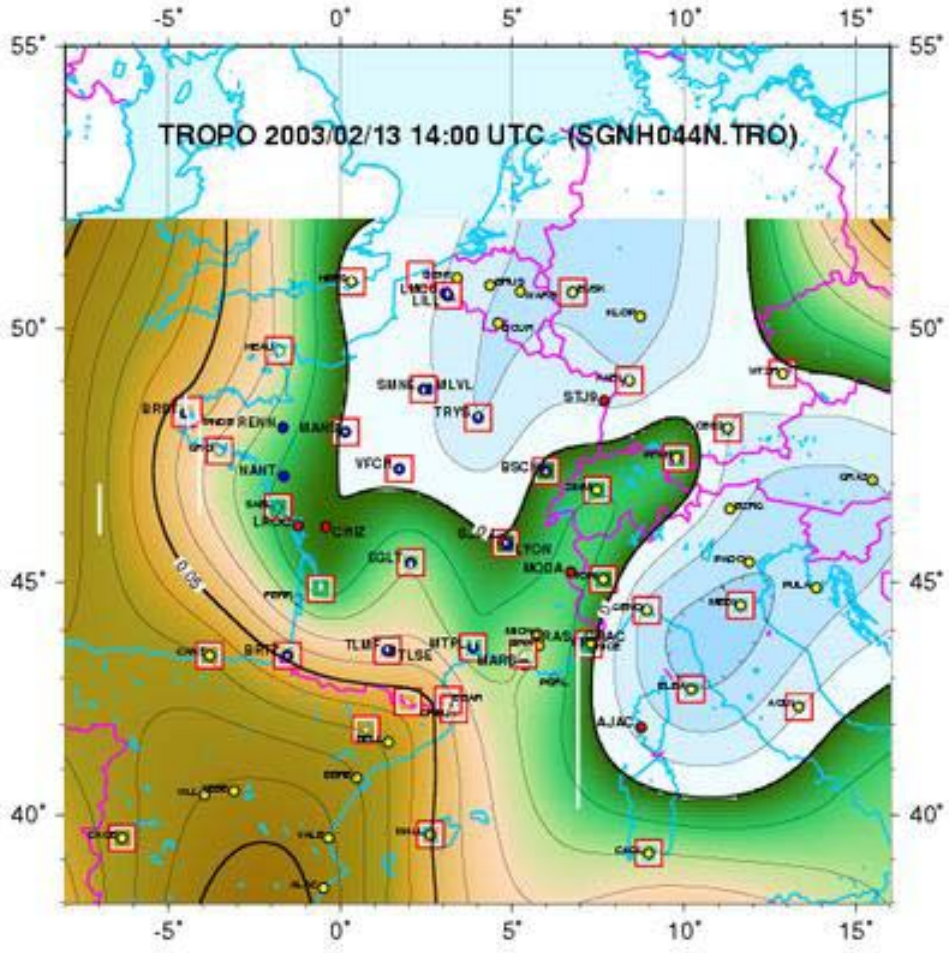

Figure 6: Map of extrapoled meteorological standard model offsets

4. RGP AND REAL TIME

4.1 DGPS

The French Institut Geographique National wants to develop a real time positioning service with a few decimeter accuracy level. This level of precision is typically used in GIS.
A large part of the lack of precision for natural GPS is due to the atmospheric biases. So, in order to correct data, some permanent stations – probably five or six stations – will send data with a continuous flow by leasing liaison to global data center to compute predicted ionospheric and troposheric models. Several others stations will send their data with a continuous flow by IP to prove the model valid.
Corrections for each satellite will be produced in RTCM104 format and valid on territory large as a French department.
This service will be available in 2005. The medium to broadcast the data is not yet chosen.

4.2 RTK

The RTK positioning is performed using a rover thirty kilometers maximum far-away the fixed station. Beyond this limit the rover receiver is not yet able to fix ambiguities. So French Institut Geographique National consider that RTK applications are only local applications. This is the reason for what, the French Institut Geographique National urge the local authorities to set up permanent GPS stations in urban areas. These permanent stations produce data in the standard RTCM 104 format for RTK applications purposes and these stations are included inside RGP in order to be sure that the survey are in the French legal reference system (RGF93). For these stations, IGN provides a complete technical support and a stability control of the station, keeps and broadcasts free of charge the data records

5. CONCLUSIONS

France had leeway to make up with regard of some others countries for the setting up of the GPS permanent network. But now the delay is fill up. The choice of is to pool all the permanent stations – only dual frequency receivers and choke-ring antennas– France chose to have a permanent network with France to set up its permanent network. This choice allow to provide data from reference stations free of charge and therefore to give a cheap and easy access to the French geodetic reference frame.

CONTACTS

Thierry Duquesnoy
Institut Géographique National
2, 4 Avenue Pasteur
F94165 Saint-Mandé
FRANCE
Tel. + 01 43 98 83 27
Fax + 01 43 98 84 50
Email: Thierry.Duquesnoy@ign.fr
Web site: www.ign.fr