National Report of France

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The GPS Permanent Network: RGP

The French GPS Permanent Network (RGP) is intended to provide full access to high precision positioning all over the national territory in the geodetic reference frame RGF93. In order to achieve this goal, near real time post-processing capabilities are required for both static and mobile users. Thus, the main features of the RGP rely on:

– a high rate recording of GPS code and phase data

– an efficient delivery process.

The RGP is designed to fulfil the following requirements:

a) Regular distribution of stations: the mean range between stations is about 200 km, in order that any point within the coverage area is less than 150 km from a RGP station. This requirement gives a minimum number of 20 stations in France.

b) GPS receivers / antennas: 2-frequency receivers (L1/L2) code and phase measurements at a 1-second sampling rate for satellites above 5/ elevation. Antennas are designed to minimize multipath effects (DM "Choke ring").

c) Station I/O & storage device: GPS data are locally managed and stored (PC).

d) Data flow: the unit of data set is one hour (GPS time) i.e. 3600 epochs of measurement (and related parameters as broadcast orbits) are downloaded each hour to operational centers. A transfer is made under FTP protocol, except for some stations without Internet link, which are downloaded via phone/modem procedure.

e) Data format: according to IGS specifications, data are stored under RINEX format and follow a twofold compression scheme (so-called Hatanaka compression + Zip).

f) Operational Centres: Two OC work independently to recover, quality-check and deliver data. Both are also used to compute hourly, daily and weekly solutions for the entire network as well as by-products, e.g. ionospheric / tropospheric propagation models.

g) Data availability: Data is available online via FTP for one week. It is kept and available on specific request for four more weeks. Then, it is saved on CD-ROM and archived, but is no longer monitored

h) Data is free of charge

The RGP network has been established with essentially public (and a few private) partnerships, such as scientific organisation and local communities. From this point of view, an effort has been made to encourage all interested operators to join the RGP. So, it is expected that up to 100 stations could be integrated within the next few years.

A total of 27 stations are already set up, 14 of them have the full capability (1-second measurements).

6 new stations located in Besançon (BSCN), Egletons (EGLT), La Rochelle (LROC), Rennes (RENN), Troyes (TRYS) and Villefrance-sur-Cher (VFCH) were established since year 2001 (see location map nearby).

The "La Rochelle" RGP station is also a EUREF one since the GPS week 1166. It is co-located with tide gauge.

Data are freely available for any purposes at the following ftp addresses:

Data availability	Sampling rate	Internet address
Daily	30s	*ftp://lareg.ensg.ign.fr/pub/rgp*
Hourly	30s	*ftp://lareg.ensg.ign.fr/pub/rgp2/nrt/data_30*
	1s	*ftp://lareg.ensg.ign.fr/pub/rgp2/nrt/data_1*

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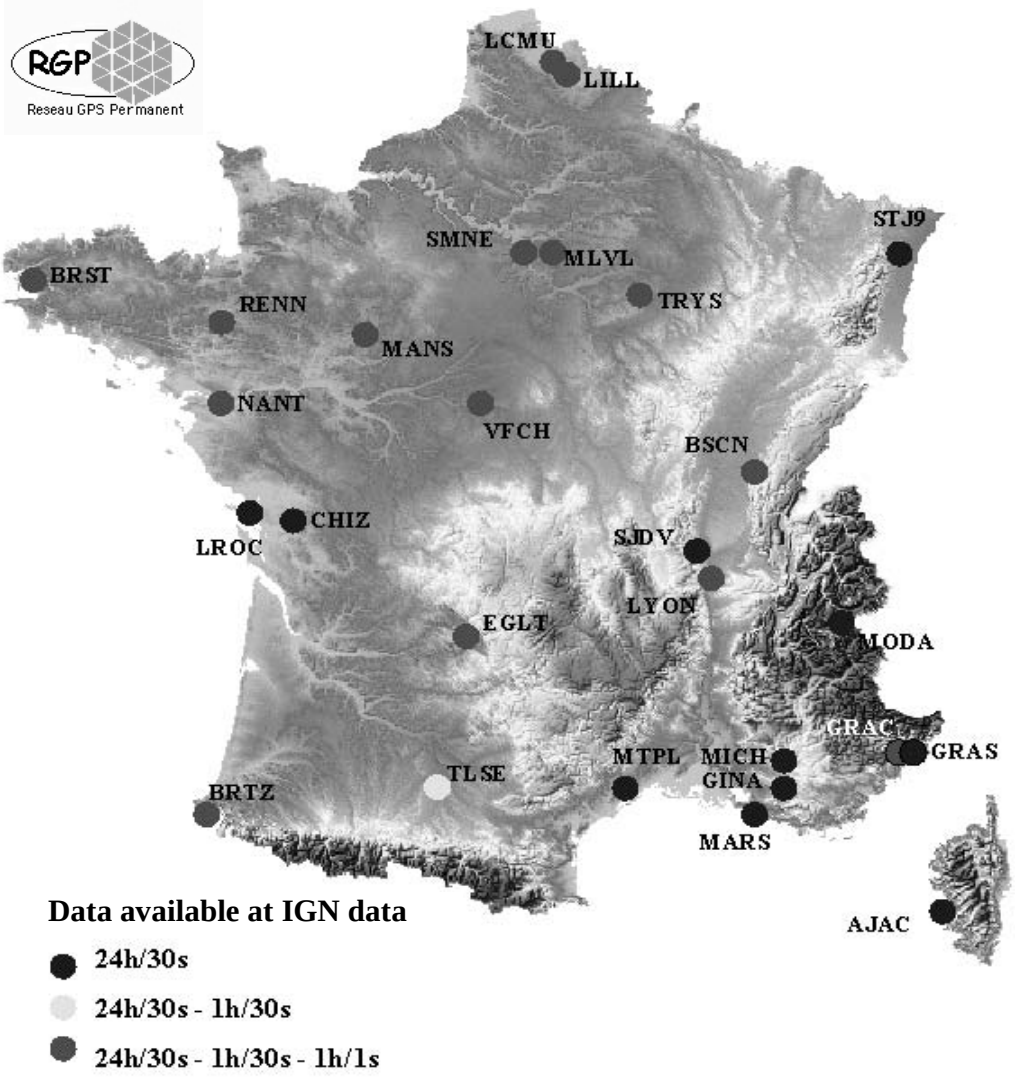


Operational Centres

During this year the main effort is concentrated onto the development of the 2 operational centres for data storage and deliver, and computation.

Data of the 27 stations is concentrated, mostly via internet, to the two IGN centres. At this time only one server is available at Marne-la-Vallee (*ftp://lareg.ensg.ign.fr* for data and *http://lareg.ensg.ign.fr/RGP* for general information), the second one (Saint-Mandé) is still under development. They are planed to operate as a backup of each others, based on mirroring procedures and leased line connection.

The two centres are also concerned with computation, made with the Bernese 4.2 version software, using IGS products.

One is operating as EUREF analysis centre in Marne-La-Vallée including some non EUREF GPS stations from the RGP to provide weekly positions of the stations.

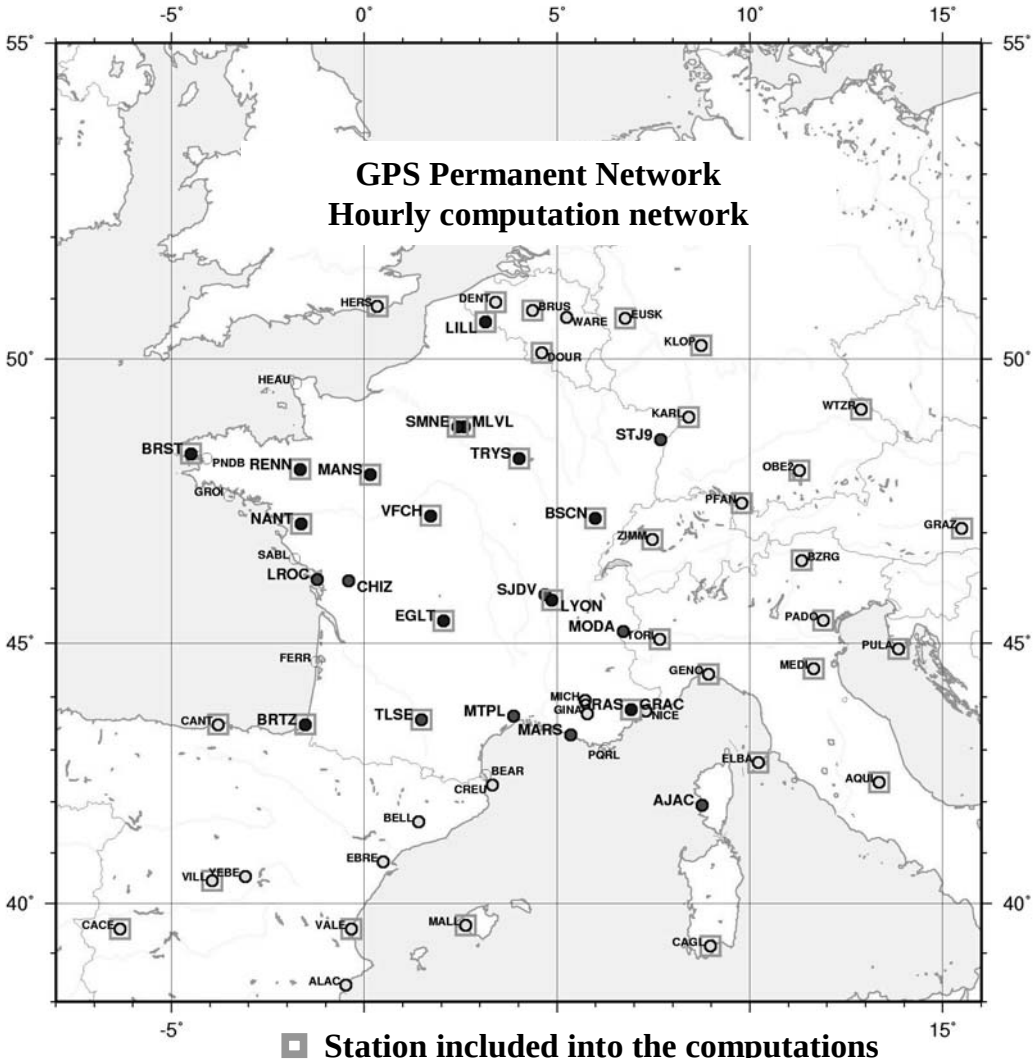
The other one, located in Saint-Mandé is dedicated to daily and hourly data processing, as a data-quality and monitoring procedures of the RGP network. All the RGP stations delivering hourly data are included in this process with 20 other European stations situated in the vicinity.

Facing the increasing interest of meteorologists for ZTD, this parameter is also computed in a final step of the hourly data processing, provided in near real time conditions with a 1 hour time step over the last three hours, and according to the following main specifications:

- fixed coordinates
- no troposphere a priori model
- use of the Dry-Niell mapping function
- use of Ultra rapid ephemeris provided by IGS

This product as well as parameters of an ionosphere propagation model, are freely available within about 1 hour after the last observation at th following address:

- *ftp://arethuse.ign.fr/pub/troposphere*: for ZTD parameters in special SINEX format
- *ftp://arethuse.ign.fr/pub/ionosphe*re: for ionosphere local models with a 1 to 2 TECU accuracy



In the next weeks, the ZTD parameters data will be converted into the BUFR format and placed on the THORN server, in order to make them available to the COST 716 participants.

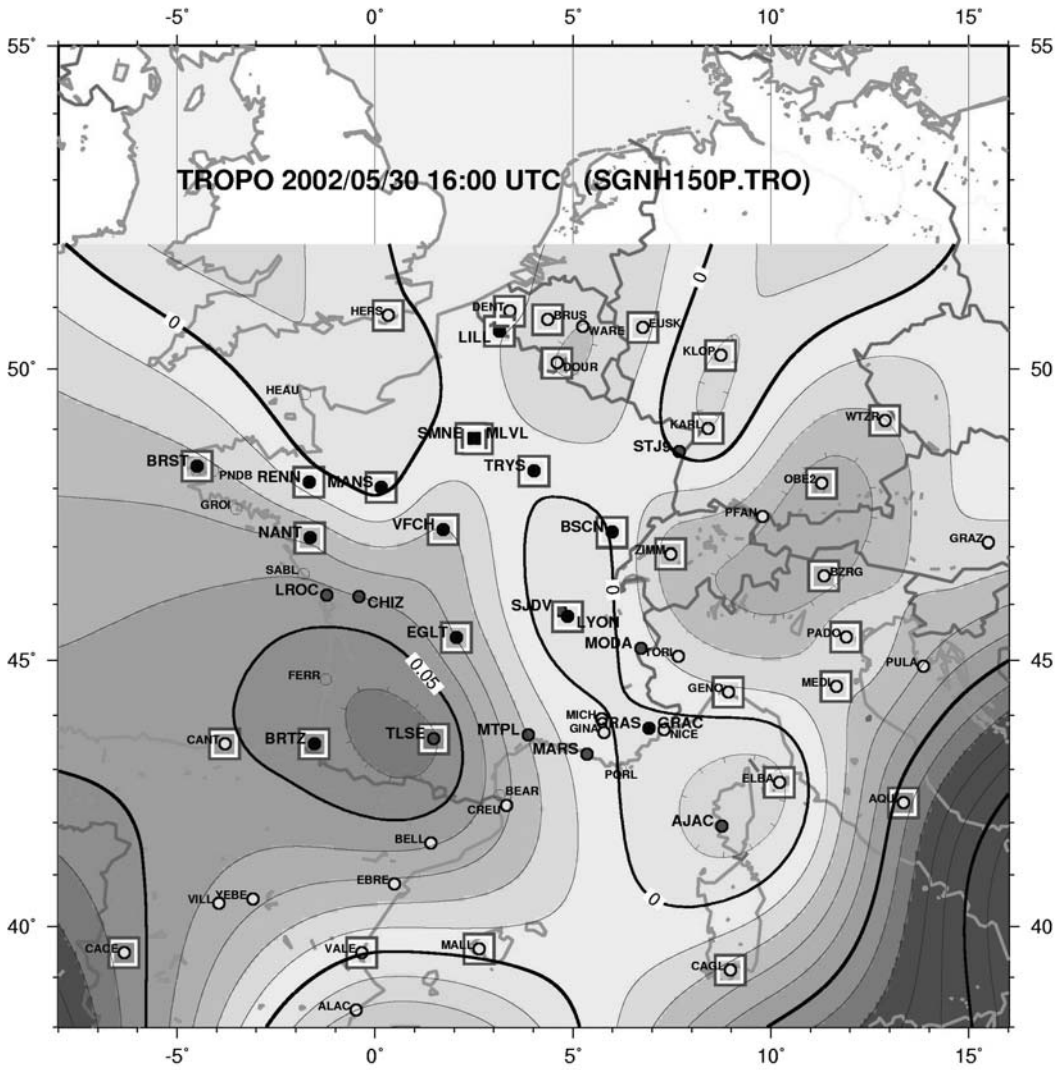
As an illustration, the computed ZTD individual parameters have been mapped as a grid of differences with the values coming from the "Saastamoinen" troposphere model.

These troposphere and ionosphere by-products are studied to be used for a real-time positioning model at the decimetre level.

Reference activities

An effort is supported to ensure the consistency of the RGF93 national reference frame with ITRS/ETRS89 as recommended in last Dubrovnik EUREF Symposium. Noted discrepancies are in the 2 to 3 centimetres level. A re-alignment to ETRS89 is to be carried out through the exploitation of 4 years GPS measurements on the RGP and EPN.

The aim is to provide users with an accurate access to the national reference frame better than 5 mm.



References

BOUCHER C, ALTAMIMI Z.: *Memo: Specifications for reference frame fixing in the analysis of a EUREF GPS campaign,, version 12-04-2001*, http://lareg.ensg.ign.fr/EUREF/memo.pdf)

BOUCHER C, ALTAMIMI Z.: *The ITRS and ETRS89 Relationship: New Results from ITRF2000*, Proceedings of the EUREF Symposium, Dubrovnik, 16-18 May 2001.)

J.-M. NOCQUET, E. CALAIS, P. NICOLON: *Combination of national (RGP) and regional (REGAL) permanent networks solutions with EUREF-EPN and the ITRF2000*. This paper is presented at EUREF 2002 symposium in Ponta Delgada and it is a part of another one submitted as "Crustal velocity field of western Europe from permanent GPS array solutions, 1996-2001" by J.M. Nocquet and E. Calais.

Vertical References

The improvement of the Zero-reference surface (RAF98) of the NGF (IGN69) levelling system is based on the three main components:

- a strengthening of a very high precise levelling network
- a set of one thousand points with high accurate ellipsoid and levelling heights
- the observations of a gravimetric network including the Geodetic basic network (RBF) and some levelling nodal points

Scientific levelling program

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The 2000-2001 observations equivalent of about 2166 km of the East-West line going from Strasbourg to Brest along first order levelling sections were computed and the first results show a 23.5 mm misclosure.

This work comes within the strengthening of a high precise levelling network. It will be completed during the next years by the observations of lines going east to west from Marseille to Hendaye, and north to south from Cherbourg to Hendaye.

The levelling network

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The maintenance of the French National Levelling Network (NGF) using GPS, started this year following the specifications and field procedures established and validated after the last year experimentation (see the national report for the last EUREF symposium in Dubrovnik, 16-18 may 2001).

In addition to the production of height reference system altitudes for levelling benchmarks according to a specified density, these operations will produce a new set of very high accurate geoid heights by the combination of:

- GPS observations on semi-permanent stations (“pivot”) linked to the GPS permanent network (RGP) with at least 48 hours session duration, and 2 hours GPS observations to the nearest point of the Geodetic Base network (RBF).
- high precision levelling techniques to locally connect the NGF levelling network to the GPS semi-permanent station

Gravimetry

TH. GATTACCECA[4]

In July, august and September 2001, another campaign of relative gravimetric measurements was carried out in the south and south-east of France, over seventy seven geodetic points from the Base Geodetic Network (RBF), fourteen nodal and border points from the levelling network (NGF), and three gravity points from the French Gravity Network (RGF 83).

The network observed in 2001 using two differential Scintrex CG3-M gravimeters was an extension of the previous network to the eastern Pyrenean and the northern Alps mountainous regions, including the Mont Blanc area. The instruments were calibrated twice over the baseline between Montpellier and Mont Aigoual (310 milliGals change).

Another survey of similar scale is planned for august and september 2002, which will embrace the remainder of the French Alps and of the French Pyrenees.

Calculations with the CG3TOOL and GEOLAB softwares were completed in February 2002, providing the g gravity values for the combined networks of 2000 and 2001, with standard deviations of 7 mGals to 82 mGals.

Discrepancies with respect to available RGF83 values and absolute values varied from 5 to 130 mGals.

DORIS Activities

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The maintenance of the DORIS antenna at Ponta Delgada has been made in order to improve its stability. Additional information about the DORIS activities in general can be found on the following web page: *http://www.ign.fr/fr/PI/activites/geodesie/DORIS/*

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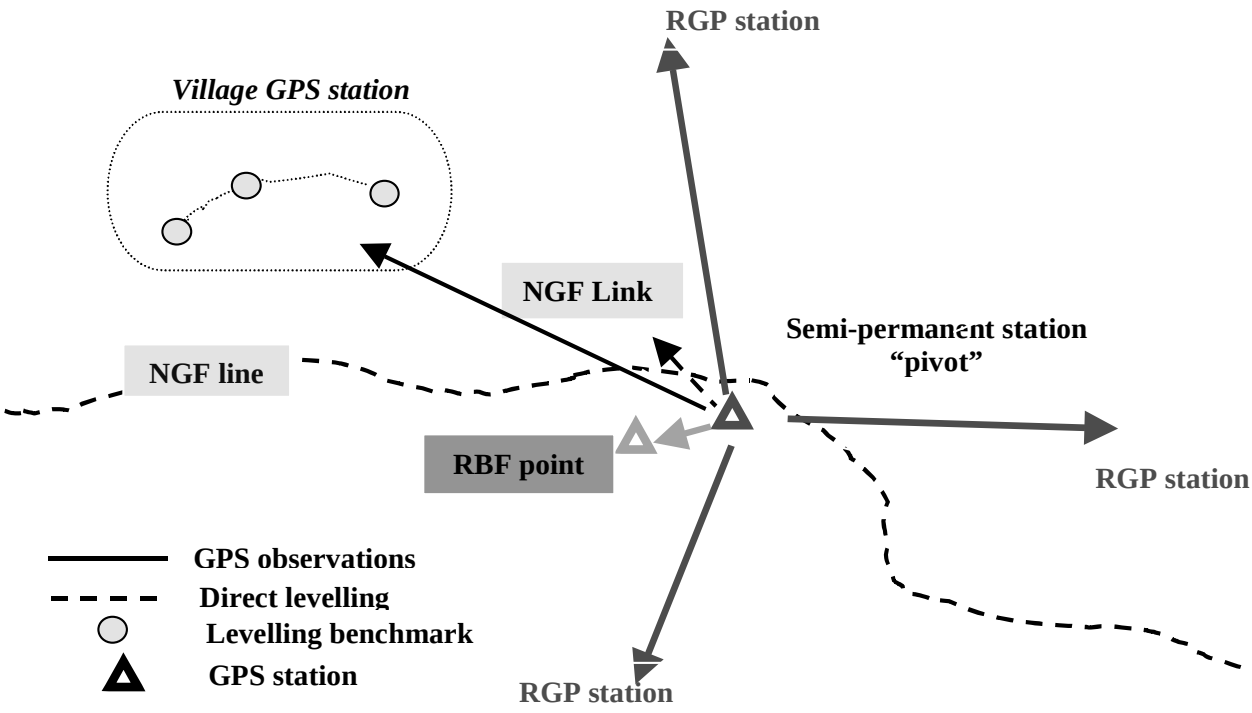
RGP station
Village GPS station
NGF Link
Semi-permanent station
"pivot"
NGF line
RBF point
RGP station
GPS observations
Direct levelling
Levelling benchmark
GPS station
RGP station