National Report of France

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GEODETIC REFERENCES

The RGF93 (French realization of ETRS89) which was presented in a previous report was adopted on December 26th, 2000 as the new legal geodetic reference system for surveying and mapping activities in metropolitan France, made by or for governmental identities or local communities, starting from February 1st, 2001. A new map projection Lambert93 was also defined.

Within the same decree, geodetic and mapping references were also specified for overseas regions of France.

The GPS Permanent Network : RGP

The RGP is being developed under the control of IGN to become fully operational in the next year. Final technical specifications to implement operational policies are under way so as to achieve the following main objectives :

- Permanent realization of the geodetic reference system RGF93.
- Access to the national reference frame

To achieve these purposes, the RGP is based on a set of GPS permanent stations coordinated by IGN, and established with essentially public but possibly private partnerships, such as scientific organisations and local communities.

The reference monitoring system will be based on a “fiducial” network of about 20 stations operated by IGN, which could be integrated into the EUREF Permanent Network.

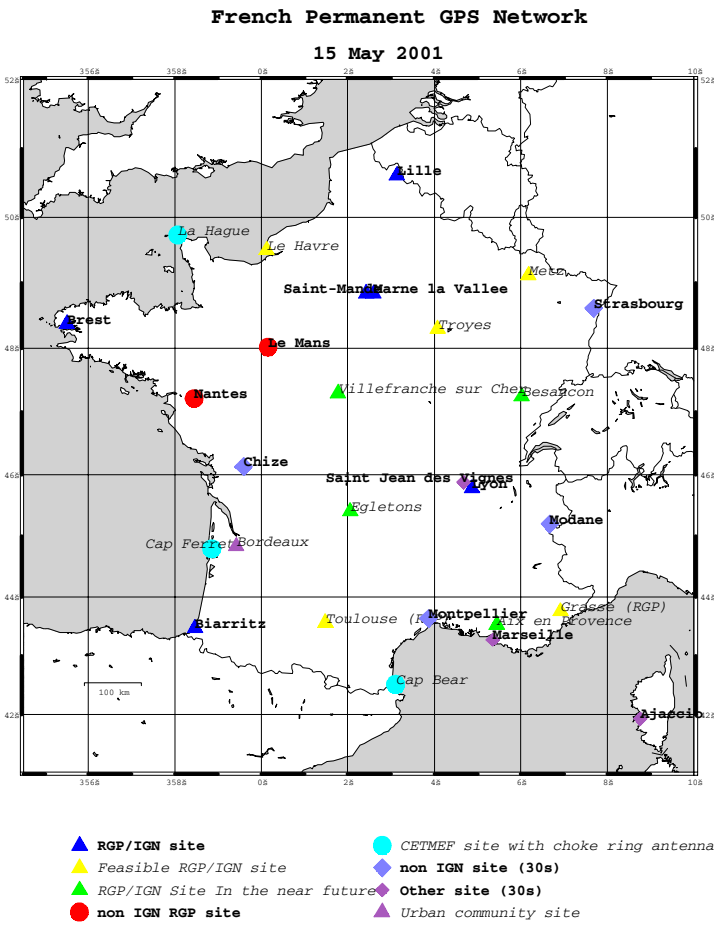
Daily solutions are computed using the Bernese GPS software, version 4.2 and constrained to the ITRF97 coordinates (it will be replaced by ITRF2000 in the next months when the ephemeris is available) of the IGS stations included into the solution, then compared to the RGF93 coordinates using Helmert transformations. This processing strategy shows the consistency of RGF93 with the ETRS89 realization derived from ITRF97 and provides quality check of the data.

Many local communities are planning to get GPS permanent stations for GIS and local surveying activities. IGN will propose to provide them with technical support to install the stations, ensuring them a position monitoring and a short and long-term data storage period.

All the data collected at the stations are transferred to the data and analysis operational centre located in IGN, using Internet, leased lines or telephone if necessary, to become freely available for all users through the Internet web site.

Present status of the RGP, the French GPS permanent network :

Station	Data availability	Sampling rate	Station	Data availability	Sampling rate
AJAC	Hourly	1s / 30s	**MARS**	Daily	30s
BRST	Hourly	1s / 30s	**MLVL**	Hourly	1s / 30s
BRTZ	Hourly	1s / 30s	**MODA**	Daily	30s
CHIZ	Daily	30s	**NANT**	Hourly	1s / 30s
GRAS	Daily	30s	**SJDV**	Daily	30s
LILL	Hourly	1s / 30s	**SMNE**	Hourly	1s / 30s
LYON	Hourly	1s / 30s	**STJ9**	Daily	30s
MANS	Hourly	1s / 30s	**TLSE**	Daily	30s



Data are available 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

9 stations are planned to be set up by IGN by the end of this year in order to complete the fiducial network.

The GPS / GLONASS receiver Ashtech Z-18 will be soon set up in Grasse in its previous location (GRAC identification) for the IGEX experiment.

So far, the data of the following RGP stations are included in the weekly EUREF solutions performed by the IGN Geodesy Research Laboratory in Marne-La-Vallée (LAREG) as a EUREF local data and analysis centre.

AJAC	Ajaccio
BRST	Brest
CHIZ	Chizé
GRAS	Grasse
MANS	Le Mans
MARS	Marseille
MLVL	Marne-La-Vallée
SJDV	St-Jean-des-Vignes
TLSE	Toulouse

The IGN Geodetic and levelling department (SGN) in Saint-Mandé is now operating as a data and analysis centre for all the RGP GPS permanent stations.

Based on some GPS permanent stations of the fiducial network, a project to provide necessary data for a real-time positioning at the decimetre level in a standardised, producer-independent format RTCM SC104 was launched last year. Mobile telephone and low frequencies radio transmitters used by the lighthouse agency are studied so as to be eventually used to broadcast the data in the whole country.

Additional information can be found on the following web page :
http://schubert.ensg.ign.fr/RGP/index.html

VERTICAL REFERENCES

The NGF, the French national vertical reference frame, is entering in a new stage of complete maintenance. A project of revision of the levelling network is starting this year. Its main purpose is to provide a more reliable and effective access to the height reference for local surveys.

After a long phase of experimentation, the fieldwork has been defined and an experimental production is beginning, using classical levelling and GPS methodologies. At the end of the next 5-6 years, the NGF is expected to have been completely visited and refurbished, and to enter in a phase of successive general 2-years long cyclic maintenance.

At the end of the year 2000 the various researches performed at IGN and in many other institutes, as well as the results of the systematic visit of the levelling and geodetic networks enabled us to define the policies that will be followed concerning the maintenance of the NGF. The initial structure of a national levelling network has always been heavily dimensioned according to (1) the technique of spirit levelling and (2) to the former difficulties experienced to perform least square adjustments before the availability of computers. Due to the technical reasons of (1) the levelling benchmarks are traditionally put along roads, with a linear density more or less constant. Due to (2) it was formerly necessary to adopt a hierarchical structure (1^{st}, 2^{nd}, 3^{rd}, … orders).

Today, the availability of GPS allows us to re-evaluate these matters in a completely different way, and it was decided to analyse first without any technological considerations what are the needs of the customers regarding high precision altimetry.

Most of the needs for a precise levelling system are related to the gravity water flows, such as sewage, drainage, irrigation, etc… Many new environmental laws have recently been voted regarding water, pushing ahead for considerable new sewage works. In large cities, the NGF levelling network is also more and more necessary as a base for 3D definitions of property subdivisions.

Altimetric surveys are now performed largely using the GPS techniques. In order to perform such works, the national altimetric geoid correction grid should be as precise as possible, and its error should ideally be lower than the common vertical GPS errors. In France, the RAF98 grid shows an error around 1-2 cm (excepted in mountains), and its errors are mainly due to the bias in the gravity data and the errors on the vertical component of GPS determination on the RBF (sessions of only 2 hours). The correction grid should ideally be provided with a 5 mm uncertainty in any flat areas (in mountains a lower requested accuracy may be accepted), and thus an improvement of the **RAF98** is highly advisable.

Considering these and the fact that levelling benchmarks are all the more useful since they are in high density population areas, we decided to maintain for any village with more than 200 inhabitants and more than 5 km distant from another one, at least three benchmarks less than one kilometre distant from each others, with a relative accuracy of one or two millimetres and an absolute one of about 1 centimetre. This triplet is necessary to provide stability control for all the future levelling works.

This can be achieved with the following specifications :

- the triplet is observed by digital levelling
- the control or the determination of an absolute value in the NGF normal height reference system is performed by the simultaneous use of :
  - GPS observations on fixed points with regard to the GPS permanent network (more than 48 hours session duration).
  - the very accurate height reference surface model **RAF98**
  - high precision levelling techniques to locally connect the NGF levelling network to the GPS reference station

Equipment used to make levelling with GPS

All the GPS computations are made using the Bernese GPS software version 4.2, compiled with the Microsoft Fortran Power Station in order to be run under the Windows NT or Windows 2000 operating systems.

At the end of the project, these processing and observation strategies, completed with very precise levelling measurements of the fixed points will provide very precise ellipsoid height of the geodetic network and a reliable link between ellipsoidal and normal heights that will be used, jointly with new gravimetric data on the points of the Geodetic Base Network, to compute a still better precise quasi-geoid and a new height reference surface model.

Scientific levelling program

The west part of an East-West line going from Strasbourg to Brest along first order levelling sections has been observed using high precision levelling techniques.

One of the objectives of this work is to analyse and find eventual systematic errors which could confirm the computation of an East-West tilt of the QGF98 quasi-geoid of about 1m to fit the Zero-reference surface of the NGF (IGN69) levelling system.

Gravimetry

In august and September 2000, a campaign of relative gravimetric measurements was carried out in south-east of France over a hundred geodetic points from the Base Geodetic Network (RBF), 10 nodal points from the levelling network (NGF), and six gravity points from the French Gravity Network (RGF 83). Using two differential Scintrex CG3-M gravimeters, the existing "zero order network" (absolute gravity values determined at Montpellier, Mont Aigoual, Marseille and Grasse) was densified into a first and second order network consisting of the aforementioned points. The instruments were calibrated over the baseline between Montpellier and Mont Aigoual (310 milliGals change). The network encompassed the Côte d'Azur region as well as the southern Alps. Another survey of similar scale is planned for august and September 2001, which will embrace the remainder of the French Alps and of the Rhône valley.

Calculations with the CG3TOOL and GEOLAB softwares were completed in April 2001, providing the g gravity values with standard deviations of 8 μGals to 60 μGals. Discrepancies with respect to RGF83 values and absolute values varied from 1 to 71 μGals. Further analysis will allow us to compute a better height conversion surface over the surveyed area as a further step towards precise levelling with GPS.

The quasi-geoid will be checked and improved by incorporation of this gravity data.

DORIS ACTIVITIES

The DORIS antenna at Metsahovi has been changed and moved in order to improve its stability. The Finish Geodetic Institute made local surveys and computation to tie the antenna to its formal location.

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/