

NATIONAL REPORT OF SPAIN

Instituto Geográfico Nacional

Levelling and gravimetry in GNSS Permanent Station Network (ERGNSS) and tide gauges.

In recent years IGN-E has carried out levelling links to ERGNSS stations and tide gauges from the High Precision Levelling Network (REDNAP). This network consists of about 25.000 benchmarks along 20.000 km and currently IGN is facing the replacement of lost benchmarks and the reobservation of some sections as well as a maintenance plan for REDNAP.

- **Absolute gravimetry** close to ERGNSS: since 2001 IGN-E have observed absolute gravity with FG5 and A10 gravimeters in order to establish the Absolute Gravity Network (REGA). About 30% of the ERGNSS stations have a nearby REGA station and the intention is to continue observing ERGNSS stations through regular FG-5 observations (μGal level).
- **ERGNSS levelling:** until now, about 40% of the stations are linked to REDNAP and it is expected in three years all will be levelled.
- **Tide gauge network:** 9 stations and 3 more new tide gauges during this year. All of them have a local control levelling network, connected to REDNAP and with a permanent GNSS station. This infrastructure will contribute to a better control of vertical movements and changes in the mean sea level.

For more details, see posters about this topic.



High Precision Levelling Network (REDNAP).

GNSS National Reference Stations Network (ERGNSS).

ERGNSS is the GNSS Permanent Network of the National Geographic Institute of Spain. The installation of the first station was installed in March 1998 and currently ERGNSS is constituted by 72 stations. Overwhelming majority of them accomplish the requirements of IGS and EPN respecting monumentation, stability and equipment.

Some of the stations of the national network are shared by IGN and Autonomous Regions through agreements in order to not duplicate stations and optimize spatial distribution of them. For the moment, 22 stations are shared and in this year it is planned that about 20 more stations will be re-monumented or adapted, completing the existing network with a total of about 90 stations. All stations belonging to this national network are being connected to the Spanish National High Precision Levelling Network (REDNAP) and most of them also connected with the absolute gravimetric network.

Respecting the participation of the ERGNSS in the international networks, 3 of them (YEBE, MELI and LPAL) are IGS stations and 24 of them are stations of the EPN and the coordinates of 13 of them have been published in ITRF2014.

The Local Data Center of IGN-E provide public access to RINEX files data through a FTP server: <ftp://ftp.geodesia.ign.es>.



National GNSS Reference stations network (ERGNSS).

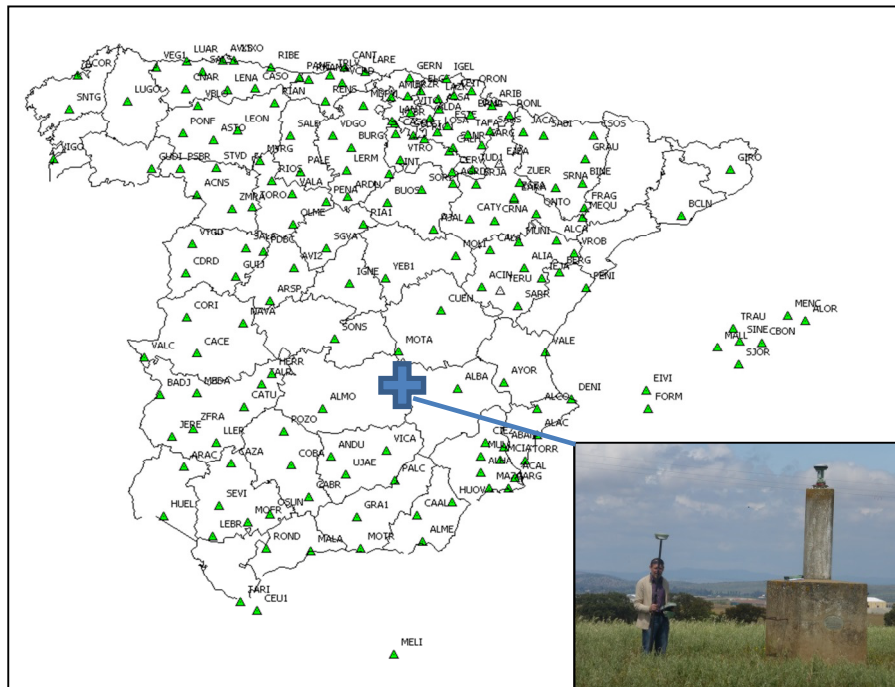
Real-time service (IGN & Autonomous Regions networks).

During last year a new service of real time positioning with network-based solution has been implemented using ERGNSS and almost all stations of Autonomous Regions networks. Currently the service is available in Peninsula and Balearic Islands with about 210 stations participating in this service. In the near future the system will be implemented in Canary Islands.

Running over GNSMART (Geo++) the stations are divided geographically in 17 clusters with overlapping and 7 servers are processing in parallel.

The service provides VRS, MAC, FKP and single point solutions to the users, all with GPS or GPS+GLONASS. The precision tests carried out in several areas along the country fulfill the expected accuracy of RTK service (better than 2 cm in planimetric and better than 3-4 cm in altimetry).

This service is free available in <http://ergnss-tr.ign.es>, port 2101 (user: "ign-test" password: "ign").



Stations currently used for real-time positioning service.

GNSS processing at IGN.

There are several projects where IGN is involved with a continuous GNSS processing. Main projects are:

- **As EUREF Analysis Centre.**

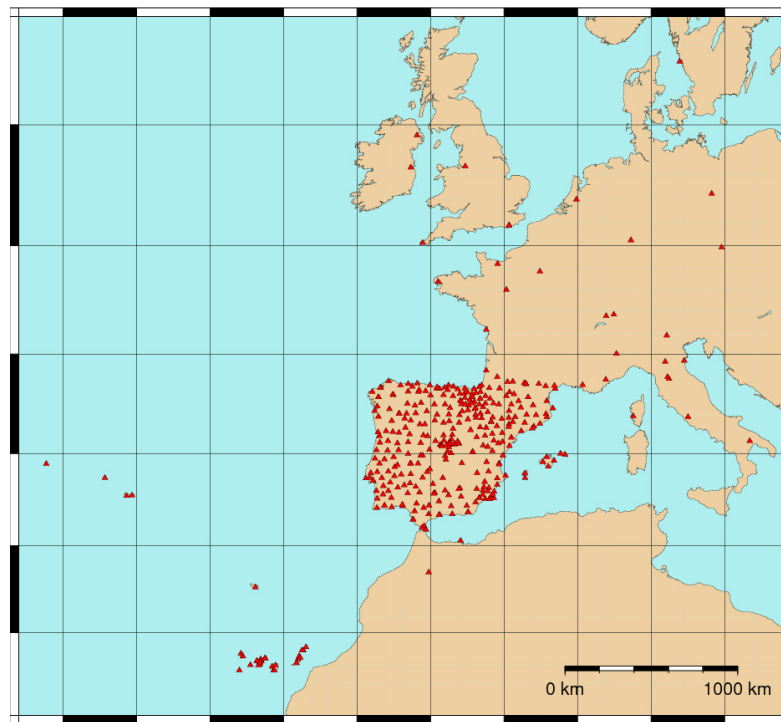
- **Local Analysis Center.**

The IGN geodetic department became a EUREF Analysis Centre since September, 2001 (GPS WEEK 1130) under the acronym of IGE.

Currently, the processing is being carried out with Bernese Processing Engine, BPE of Bernese 5.2 under LINUX platforms in an automatic procedure. Weekly (final orbits) and daily (rapid orbit) solutions are reported in SINEX format (Solution Independent Exchange format) together with a weekly SUMMARY of results and troposphere parameter files (zenith path delays).

The current number of EPN stations that are being processed is around 75, most of them with GPS + GLONASS observations and 14 with individual calibration stations.

Currently IGE is processing about 350 stations in this project, collaborating at the same time with the “Regional Dense Velocity Field” Project managed by the same called IAG Working Group. Until the moment this processing has been carried out with BSW5.0, but at the same time IGN is making the reprocessing of the data with BSW5.2 following almost the same configuration that in EUREF LAC processes.



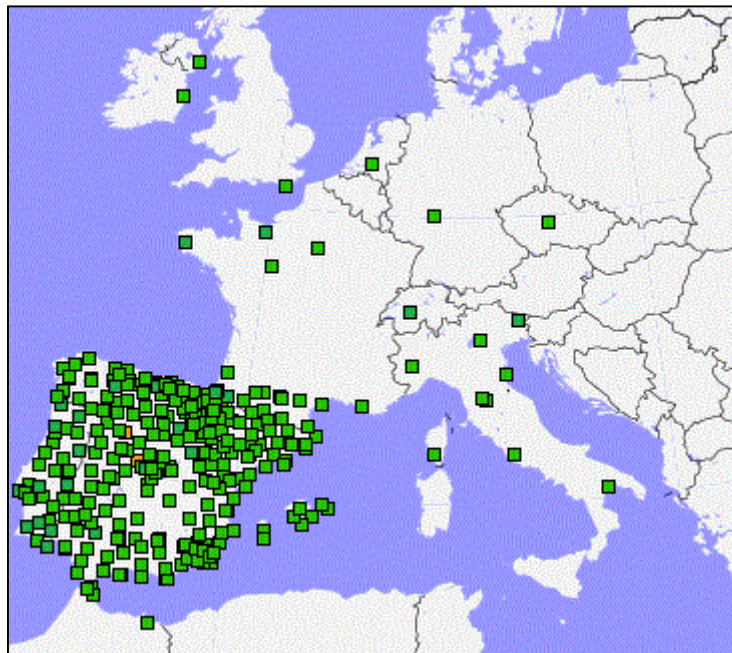
IBERRED network. Stations submitted for the Dense Velocity field project.

- **E-GVAP Analysis Centre.**

IGE Analysis Centre began the collaboration with AEMET, the Spanish Meteorological Institution, in the frame of E-GVAP since March 2009. In this project Zenith Troposphere Delay (ZTD) is estimated in “near real time” each hour in a set of stations covering all the Iberian Peninsula and adjacent archipelagos (Azores, Canary and Balearic Islands) in order to be used in Numerical Weather Prediction by meteorological agencies integrated in the EUMETNET organization.

For this purpose hourly data are collected by IGN immediately after every hour from 15 different networks. In the minute 20 of each hour the process starts with BSW 5.2 and ZTD data in COST file format are sent to Met-Office (GB) around minute 30, which disseminates the information.

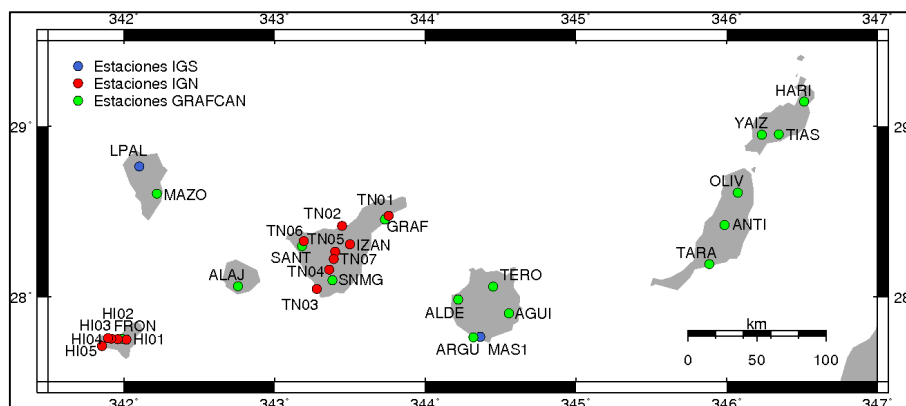
During this time the number of stations have grown up and the strategy have been re-adapted. Currently processing of IGE consists of about 350 stations, the same that in IBERRED project. The hourly process is done using the precise coordinates from the first process, with double differences strategy and using ultra rapid CODE products. Finally, the 6 last hours of normal equations are combined to get the hourly ZTD.



E-GVAP network processed by IGE.

- **Other regional/national projects.**

- **Volcanic monitoring system:** continuous processing of a dedicated GNSS network in Canary Islands, mainly in two of them (Tenerife and El Hierro) with recent volcanic and seismic activity. Hourly and daily coordinates are obtained in order to detect surface deformation. Detected deformations in volcanic areas can be precursors of a volcanic activity and contribute with useful information to study the evolution of unrest, eruption or any volcanic process. It has been used to measure the surface deformation associated with the precursory unrest since summer 2011, submarine eruption (October 2011-March 2012) and the following unrest periods (2012-2013).



GNSS volcanic monitoring network (Canary Islands).

- **National coordinates:** in collaboration with Autonomous Regions with GNSS active networks, this project will provide homogeneous ETRF00 coordinates to all networks and continuity in the processing of these stations. Three regional institutions together with IGN are currently participating in the reprocessing of data from 2011 to 2015 in order to establish a consistent reference frame agreed by all regional networks and IGN, following the recommendations for EUREF densifications.

For more details about the ERGNSS network and related projects, see poster.

Acknowledges

Our thanks to all institutions that provide data to some projects with their GNSS networks:

- EUREF Permanent Network (EPN).
- International GNSS Service (IGS) network.
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