EUREF Symposium 2012 NATIONAL REPORT OF BELGIUM

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1. Contribution to the EPN

1.1 EPN Central Bureau

ROB hosts the EPN Central Bureau (http://www.epncb.oma.be/). In 2011, the site received about 1.7 million hits. New web pages that have been recently added to the EPN CB include an on-line site picture submission (http://epncb.oma.be/_trackingnetwork/sitepicturesubmission/)

1.2 EPN Tracking Stations

ROB operates four permanent GNSS tracking stations: BRUS/BRUX, DENT, DOUR and WARE; all are streaming real-time data.
On, Feb. 14, 2012, after more than almost 19 years, ROB stopped operating the EPN/IGS station BRUS (Brussels, Belgium) because the antenna monument had to be destroyed due to the need to remove asbestos in the building around the antenna. A new GNSS tracking station, BRUX, located about 100 m from BRUS has replaced BRUS in both the EPN and IGS tracking networks. BRUS and BRUX operated in parallel from 07-07-2006 until 14-02-2012. The BRUS-BRUX tie was determined both with GPS and terrestrial measurements. The supporting structure was adapted to shield the antenna from the dome below. To achieve this, a metal shield topped with Eccosorb ANW-77 RF absorbing material was applied. The distance between the antenna and the RF absorber was optimized to minimize effects on the antenna PCV. A paper detailing the design of the antenna support is in preparation.

Fig. 1 – New BRUX station integrated in EPN/IGS as replacement of BRUS

Compared to BRUS, BRUX has improved visibility and equipment. The receiver is a SEPT POLARX4TR timing receiver that is able to track the 3 constellations GPS/GLONASS/Galileo on the 3 frequencies L1/L2/L5. In addition, the BRUX antenna (JAVRINGANT_DM/NONE) has been calibrated by the

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University of Bonn. BRUX is submitting daily and hourly data as well as real-time data in the RTCM 3.X format.
BRUX is also contributing to the IGS M-GEX campaign. BRUX daily and hourly RINEX files are available from ftp://gnss.oma.be/gnss/data/rinex/. A real time RTCMv3 stream is available from www.euref-ip.be on mountpoint BRUX0 and a binary SBF stream is available from www.euref-ip.be on mountpoint BRUX1. The latter stream is also used in the IGS-MGEX campaign.
More details on BRUX can be found at
http://www.epncb.oma.be/_trackingnetwork/siteinfo4onestation.php?station=BRUX_13101M010
In 2012, the full ROB network will be upgraded with SEPT POLARX4 receivers (tracking GPS/GLONASS/Galileo on L1/L2/L5) and TRM59800.00/NONE antenna.

1.3 Data Centers and Broadcaster

ROB maintains an historical EPN data center, providing access to all historical EPN data especially targeting reprocessing activities (ftp://epncb.oma.be/ftp/obs/).

Real time data of the ROB stations is available on an EPN NTRIP caster operated by ROB. Besides providing the ROB streams, the streams of other EPN stations are relayed.This way, ROB guarantees load sharing with the main EPN broadcaster at Bundesamt für Kartographie und Geodäsie (BKG), Germany and overall communication traffic reduction. At present about 159 EUREF streams are relayed, from 16 different casters. Users can apply for an account by filling in the web form on http://www.gnss.be/data.php#NTRIPaccess.

1.4 Data Analysis

The ROB EPN Local Analysis Center processing an EPN sub-network located around the Benelux (see http://epncb.oma.be/_dataproducts/analysiscentres/subnetwork.php?lac=ROB).

2. Services and Products Based on the EPN

2.1 European VTEC maps

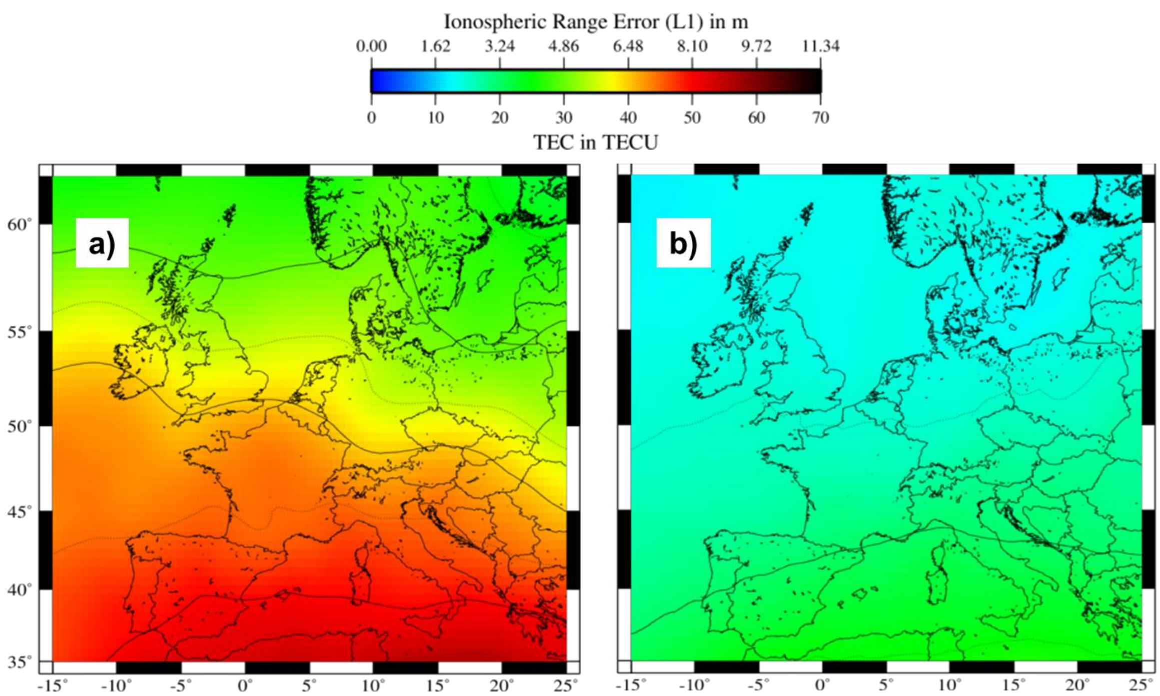

Figure 2: Ionospheric VTEC maps of a) the 17/09/2011 at 13:30 UTC and b) Median of the ionospheric activity at 13h30 over the previous 15 days (2/09/2011-16/09/2011)

A new web product to monitor the ionosphere in near real-time over Europe using GPS observations was put into operation at ROB. The service is available from the gnss.be website (http://gnss.be/Atmospheric_Maps/ionospheric_maps.php) and has been integrated in the Solar Influences Data Centre (SIDC) web portal (http://sidc.oma.be/). These European near-real time ionospheric Vertical Total Electron Content (VTEC) are based on the real-time GPS data available from the EUREF Permanent Network. Two different products are proposed to the user community:

(1) an interactive product (e.g. movies, VTEC values);
(2) a static product with statistics (e.g. differences with respect to the previous 15 days ionospheric activity).

2.2 E-GVAP Analysis Centre

The ROB develops and maintains a GNSS analysis centre to participate in the EUMETNET EIG E-GVAP program. This service provides the European Meteorological Agencies with Europe-wide near real-time Zenith Tropospheric Delays (ZTD) estimated from GPS observations to enhance Numerical Weather Prediction (NWP). In October 2011, a new IT infrastructure to sustain and maintain the E-GVAP activities at ROB has been installed. All programs related to the E-GVAP service have been adapted and optimized. It results in a 44% increase in the number of stations included while speeding up the processing by at least a factor of 2 (the processing time was decreased from 10-25 min to 5-7 min) and while keeping the same level of precision in the ZTD determination. Since November 2011, this new service runs in parallel with the current official service in order to carry out extensive comparisons/validations. Averaged over the 323 GNSS stations included in the analysis, the new service shows a median bias of about 1.4 mm and a std. dev. of about 7.7 mm w.r.t. the U.K. Met Office Regional NAE and global models (median bias over the 2-15 April 2012 period). This step is mandatory before that the new service can become the ROB official solution within E-GVAP (probably mid 2012).

The ROB is also preparing a (sub-hourly) service to provide E-GVAP with 15-min updated tropospheric delays. This service will be used by Meteorological Agencies to enhance high-resolution rapid-update NWP and nowcasting applications. This new service is based on the processing of real-time GNSS observations from the EPN and from national network densifications (e.g. WALCORS and RGP).

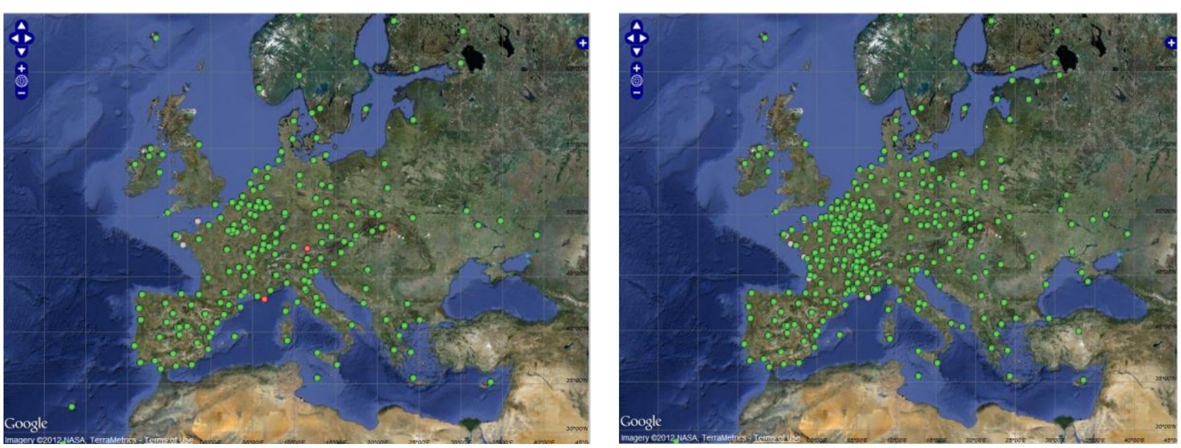

Figure 3: GNSS network processed in near-real time in the framework of E-GVAP. (Left): Current official service. (Right): New service under validation. (Status: 6 February 2012)
(some stations are located outside the region represented by the map)

Finally, the ROB is also developing a new web tool to monitor the European wet tropospheric delay estimated from GNSS data and provided by the near real-time E-GVAP service running at the ROB. This interactive web product provides movies and ZTD values over Europe (Figure 4).

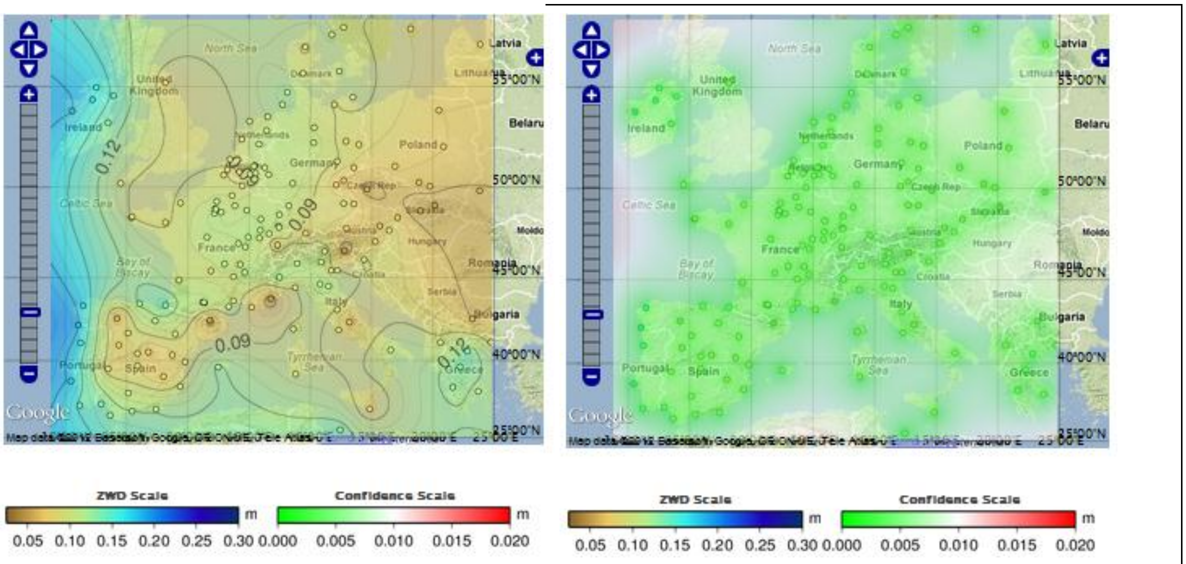

Figure 4: Web-based user interface providing access to the wet tropospheric delay maps and animations. (Left): Map of the wet tropospheric delay. (Right): Map of the confidence level (Status: 6 February 2012)

3. Research Activities

3.1 IAG Working Group 'Integration of Dense Velocity Fields in the ITRF'

In an effort to obtain a global dense velocity field capable of monitoring long-term ground deformations from GNSS, ROB is investigating methods to combine different GNSS position/velocity solutions from permanently tracking GNSS stations in a consistent way. Using the EPN data, we have shown that the network effects between GNSS solutions used in the combination must be taken care of by examining the best possible agreement between the solutions, by increasing as much as possible their coverage, and by maximizing the redundancy between regional and global solutions. This finding has been illustrated by working on the particular case of the ULR (University of La Rochelle) solutions, North American and South American solutions, EUREF solutions, and the newly determined ITRF2008. They will be applied within the frame of the Working Group on "Integration of dense velocity fields into the ITRF" chaired by ROB.

3.2 Receiver Antenna Calibration Models

ROB studied the impact of an update of the GPS receiver antenna calibration model on the estimated station position when high precision GNSS estimation techniques are used. We showed for the first time that this effect is significant for the EPN stations and that it requires to be taken into account when considering the long-term ground deformations derived from these stations. The analysis of the EPN data shows that position change induced by an update of the antenna calibration model can reach 4 mm in horizontal and 10 mm in the vertical component. Consequently, we computed for all the EPN stations correction tables which will be used by EUREF for correcting this effect.

ROB also studied the impact of the calibration method on the estimated station positions. For that purpose, 6 antennas individually calibrated by Geo++ - using robot calibration – and by the University of Bonn – using a chamber calibration – have been installed at ROB. The analysis of the data shows a position change that can reach 3 mm in horizontal and 7 mm in vertical.

3.3 Long-term Stability of GNSS-based ZPD

ROB has started a new collaboration with the Royal Meteorological Institute (RMI) of Belgium and the Belgian Institute of Space Aeronomy (BISA) on the inter-comparison of atmospheric water vapour observed by several ground-based (GNSS, sun-photometers), in-situ (radiosondes) and satellite-based (GOME/GOME2/SCHIAMACHY) techniques. The IGS REPRO1 troposphere product has been used to produce GPS-based IWV data. The inter-comparison has been carried out for 28 IGS sites world-wide having a colocation with the other instruments (max. colocation distance of 30 km). Results for the station of Brussels are shown in 5. For the 28 colocation sites, results demonstrate that the CIMEL sun-photometer, the radiosonde and the GNSS techniques are in very good agreement. Averaged over the 28 sites, the mean bias between the 3 techniques is less than -0.3 mm of Integrated Water Vapor (IWV) and the mean RMS remains below 2.2 mm of IWV. Comparisons between GNSS-based and satellite-based measurements show slightly higher bias and larger variability (mean RMS of 3.8 mm).

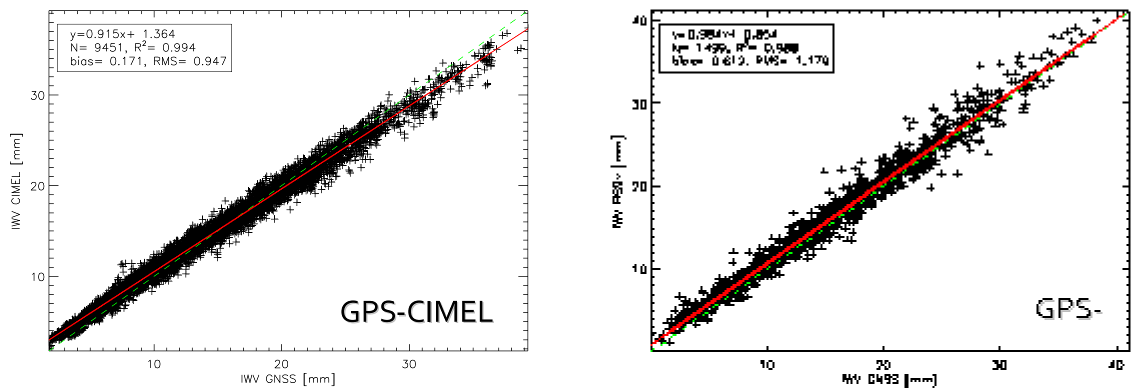

Figure 5: Scatter plots of simultaneous IWV measurements from different instruments (Left: CIMEL sun-photometer, Right: radiosonde) with respect to the GPS-based IWV estimates for the site of Brussels, Belgium over a period of 6+ years.

3.4 Geological Study of Belgian GNSS Station Locations

When looking at the residual position time series of the GNSS stations in Belgium, some variations may still exist. In order to explain these variations, ROB recently started studying the local geology of the locations of these GNSS stations and considers meteorological effects as one of the possible causes of these variations. When precipitation falls onto the ground, a part of it will evaporate while another part will be absorbed by the underlying soil and geological deposits. Depending on their composition, the precipitation will have an effect on the volume and loading of the underlying deposits, causing micro scale deformation of these sediments. Another meteorological effect considered is the temperature and therefore a process of freeze and thaw which affects the moisture present in sediments and will again cause the deformation of sediments.

More information on the activities of the GNSS research group of the Royal Observatory of Belgium can be found at http://www.gnss.be/.

4. Terrestrial observations for the BRUS-BRUX tie

The terrestrial measurements to determine the local tie between BRUS and BRUX have been executed twice. In October 2010, the first series of observations, using a 'Leica TCRA 1101plus' total station, were done. Using five local auxiliary points, a strong, geometrically well balanced local network was created to determine the vector between the two antennas as accurate as possible. However, the metal shield with RF absorbing material (more details in §1.2) was placed after this date, so we repeated our observations, using the same instruments, in march 2012 to check if the position of the BRUX hadn't changed. The results for the tie (obtained by GNSS as well as terrestrial observations) are available in the station log file on the EPN website.

5. Future plans: Improvement of the height correction model

In 2003 the geoid model BG03 was computed, using several kinds of data: a global field model, gravity data and a digital terrain model. The geoid was combined with a set of 4000 GPS leveled points, on one hand to validate data and methods, on the other hand to adapt the geoid to the specific needs of leveling by GPS. This operation resulted in a 'height correction model' hBG03 for which independent tests showed that its accuracy is 2 cm (standard deviation).

In the future, determination of heights will be done more and more using GNSS, as spirit leveling is very time consuming. But when transforming GNSS heights to DNG (Second General Leveling, the height reference system for Belgium), the error introduced using the existing model is rather high. We believe that the quality of the data of the 4000 GPS leveled points is not always sufficient. The observations are a compilation issued from very diverse terrain campaigns with varying accuracies and sometimes there is a time span of several years between the two height measurements.

In the years to come we will try to improve the height correction model by creating a new network of GNSS leveled points. Each point will be placed in the immediate surroundings of the markers of the existing leveling network in order to reduce the length of the leveling section. Also the static GNSS observations will be performed as good as possible, taking into account that the points are situated on public domain and consequently very long observation periods are excluded. Furthermore, for at least a part of these new points, we consider adding gravity observations as well.

Acknowledgements

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References

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