EPN Status and Network Management

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1 INTRODUCTION

The EUREF Permanent Network (EPN) is a network of continuously operating GPS or GPS+GLONASS reference stations maintained on a voluntary basis by the EUREF members. The primary purpose of the EPN is to provide access to the European Terrestrial Reference System (ETRS89) by making publicly available the tracking data as well as the precise coordinates of all the EPN stations.
Today, the EPN network consists of 223 continuously operating GPS or GPS+GLONASS reference stations. The 14 new EPN stations that joined the EPN since June 2008 are shown in Figure 1. As can be seen from Table 1 seven of them stream data in real-time and twelve of them are equipped with GPS/GLONASS receivers. As can be seen from Figure 2 this bring the total number of the EPN stations providing GPS+GLONASS data to 47% which is a 15% increase with respect to June 2008.

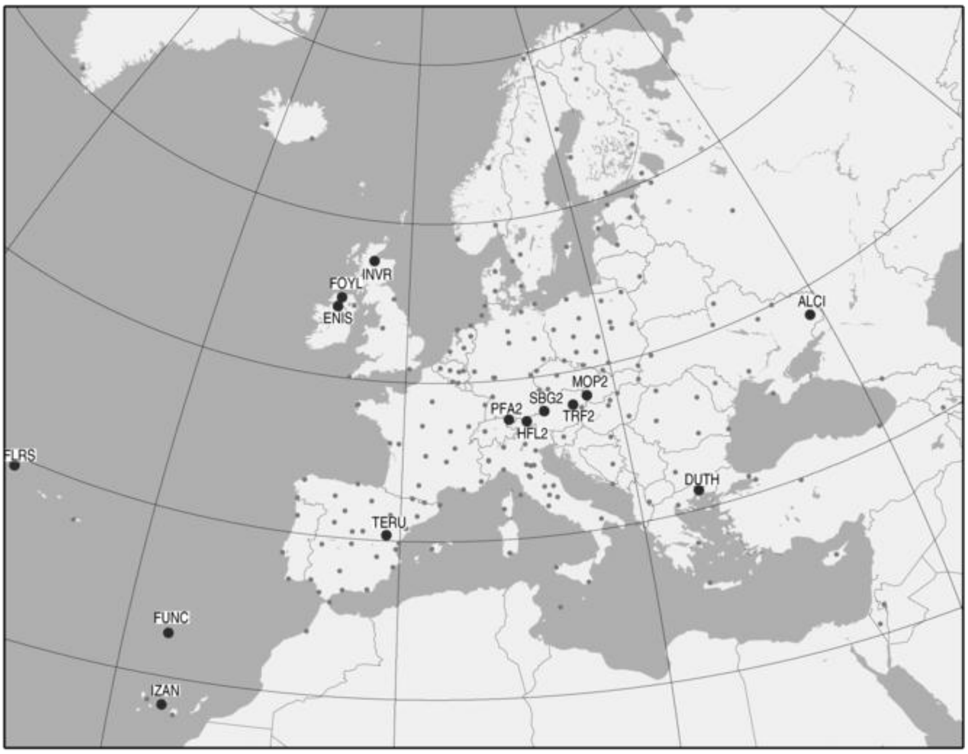

Figure 1 – EUREF permanent GNSS tracking network (status May 2009); big dots: the stations added to the network since June 2008.

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4-CHAR ID	LOCATION	FUNCTION	CALIB	FROM
FUNC	Funchal, Portugal	RT GLO	Type	06/07/2008
MOP2	Modra-Piesok, Slovak Republic	GLO	Indiv.	24/08/2008
FLRS	Santa Cruz das Flores, Portugal	RT GLO	Type	31/08/2008
TERU	Teruel, Spain	RT GLO	Type	28/09/2008
HFL2	Innsbruck, Austria	RT	Indiv.	05/10/2008
PFA2	Bregenz, Austria	GLO	Indiv.	05/10/2008
SBG2	Salzburg, Austria	GLO	Type	05/10/2008
TRF2	Pernitz, Austria	GLO	Indiv.	05/10/2008
IZAN	Guimar, Spain	RT GLO	Type	18/01/2009
DUTH	Xanthi, Greece	GLO	Type	22/02/2009
ENIS	Enniskillen, UK	RT GLO	Type	15/03/2009
FOYL	Londonderry, UK	GLO	Type	15/03/2009
ALCI	Alchevsk, Ukraine		Type	19/04/2009
INVR	Inverness, UK	RT GLO	Type	19/04/2009

Table 1- Tracking stations added to the EPN since June 2008, RT: stations streaming real-time data, GLO: stations equipped with GPS+GLONASS receivers, Type: antenna/radome with true absolute type calibrations; Indiv: antenna/radome with true absolute individual calibrations.

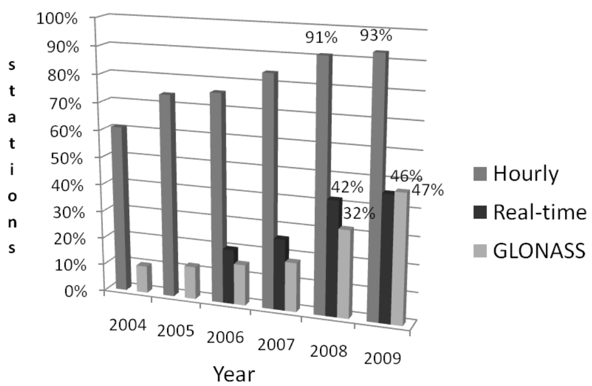

Figure 2 – Evolution of the number of EPN stations providing hourly, real-time and GLONASS data.

Calibration	*Dec. 2006 (% of stations)*	*May 2009 (% of stations)*
Individual absolute	5	15
Type absolute	64	66
From (relative) field measurements	14	9,5
No (radome not calibrated)	17	9,5

Table 2 – Evolution of the type of calibrations available for the EPN stations.

As can be seen from Table 2, thanks to the introduction of the request ('Guidelines for EPN stations and Operational Centres, Dec 2006) to only use antenna/radome combinations with true absolute calibrations when introducing a new station in the EPN or replacing the equipment in an existing station, the number of EPN stations without true absolute calibrations is slowly decreasing. In contrary to the old relative antenna calibrations, absolute antenna calibrations go down to a 0° elevation cut off angle and are elevation as well as azimuth dependent. Thanks to the improved modeling of the variations of the antenna phase center variations, it is expected that the introduction of the absolute antenna phase center variation models would reduce the coordinate jumps associated with antenna changes. Figure 3 shows that even with these new antenna models, still some coordinate jumps remain visible after an antenna change (line on the graphs).

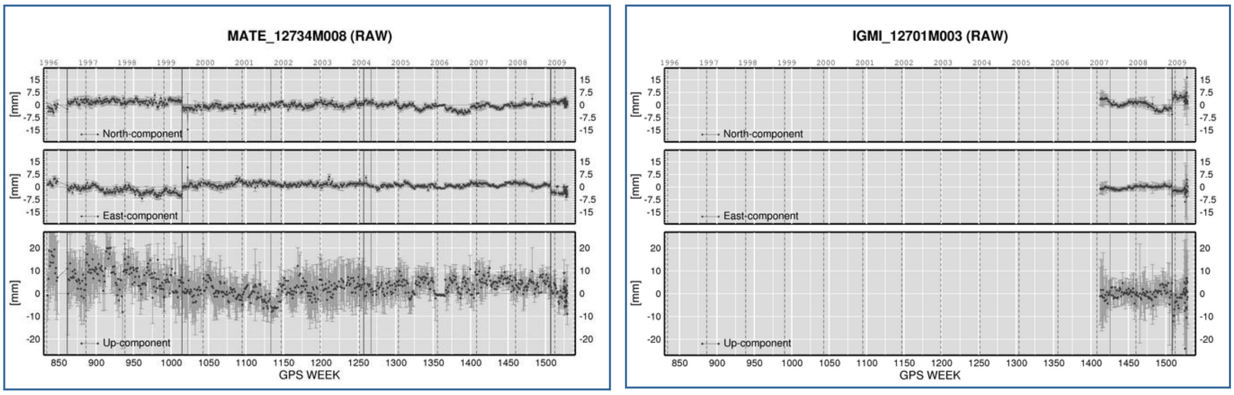

Figure 3 – Example of EPN stations with coordinate jump after an antenna change. The antenna/radome combination used before and after the switch have true absolute calibrations.

Since June 2008, 31 new antennas/radomes (new stations or replacements at existing stations) where introduced in the EPN. As can be seen from Table 3, 28 of them are already multi-GNSS replacements. Taking into account that antenna/radome replacements continue to introduce jumps in the station coordinates (even with absolutely calibrated antenna/radome combinations) and that today the large majority of antennas installed are already multi-GNSS antennas, it is strongly recommended to, in the case an antenna has to be replaced, replace it with a multi-GNSS antenna.

GPS		***GPS/GLONASS***		***GPS/GLONASS/GALILEO***	
Name	***No***	***Name***	***No***	***Name***	***No***
AOA/M_T	1	LEIAT504GG	17	LEIAR25	3
ASH701945E_M	1	NOV702GG	1	TPSCR.3G	3
ASH700936E	1	TPSSCR3_GGD	1	TRM59800.00	1
		TRM55971.00	2		
Total	***3***	***Total***	***21***	***Total***	***7***

Table 3 - Antennas introduced in the EPN since June 2008 with an indication of the GNSS satellite systems they have been designed for.

2 New EPN Special Projects

2.1 Real-time Analysis

47% of the EPN stations stream real-time GNSS data today through the EUREF broadcaster maintained by BKG, Germany. The EPN Special Project "Real-time Analysis", created at the EUREF Technical Working Group meeting in Munich (3-4 Nov. 2008), aims at processing these real-time data to derive and disseminate new (or extended) real-time GNSS products. In addition, the Special Project will develop and implement a plan to increase the reliability of the real-time data flow through a more distributed approach and will at the same time decrease the workload on EUREF's regional broadcaster located at BKG. The Special project is chaired by W. Söhne and will close collaborate with the IGS Real-Time Pilot Project. More information is available from http://epncb.oma.be/_organisation/projects/RT_analysis/ .

2.2 Reprocessing

A pilot reprocessing of the complete EPN has been done in 2008 by the MUT (Warsaw) and ROB (Brussels) analysis centres clearly demonstrating an improvement of the EPN time series which were previously inconsistent due to the analysis and modelling changes since 1996. In order to coordinate an EPN reprocessing between all EPN Local Analysis Centres a new EPN Special Project was created at the EUREF Technical Working Group meeting held in Budapest on Feb. 26-27, 2009. The Special Project is chaired by C. Völksen. More information on the objectives of this Special Project as well as its work plan is available from http://epn-repro.bek.badw.de/ .

3 New at EPN Central Bureau

The EPN Central Bureau (CB) is responsible for the day-to-day management of the EPN and acts as liaison between station operators and analysis centres, providing the necessary station configuration metadata and ensuring the datasets meet the requirements of the analysis. It makes all the EPN-related information available through its website http://epncb.oma.be/.

3.1 On-line Site Log Validation and Submission

A new tool to manipulate and submit site log files has been developed at the Central Bureau. It consists of an on-line tool available through http://epncb.oma.be/_networkdata/sitelogsubmission/ and allows to:

- Create a new site log
- Upload a site log from the EPN CB data base or from the local disk
- Update the site log
- Save the site log on the local disk or update it in the EPN CB data base.

3.2 EPN Data Centre Dedicated to Reprocessing

In support of the EPN Special Project on Reprocessing, the EPN Central Bureau has set up a new data centre which archives all historical daily EPN data. The headers of all the data in the data base have been updated to be consistent with the site logs. The data base can be accessed through ftp://epncb.oma.be/pub/obs/ .
At the moment, the data base is only containing EPN stations during the periods the station was declared active. In addition, only data from 1996-2008 are on-line. Data from 2009 will be uploaded later. The next step will be to check the data base for completeness and populate it with missing data. Then we will see if some of the data from periods that a station was inactive (due to site log unknowns at that time), can be included in the data base.

3.3 Performance of EPN Local Analysis Centres

The EPN Local Analysis Centres (LAC) compute permanently the positions of the EPN stations as well as the tropospheric Zenith Path Delays (ZPD) at the EPN stations. Each week the computed positions (in SINEX format) and the tropospheric parameters from the individual analysis centres are combined by the EPN Analysis Coordinator (H. Habrich) and the coordinator of the EPN troposphere product (W. Söhne) to generate weekly EPN final position and troposphere products. During the combination

process, the solutions from the individual analysis centres are compared against the combined product and associated statistics are generated. They are distributed to the LAC through LAC mail.
Based on these reports, new web pages have been created at the EPN Central Bureau http://www.epncb.oma.be/_productsservices/analysiscentres/LACreports.php . They display

- The general agreement between analysis centres showing the time evolution of the
  - The RMS of the Helmert transformation (as well as the values of the Helmert parameters) between each weekly LAC network and the combined EPN position solution. A priori values (before outlier rejection) and final values (after outlier rejection) are provided.
  - The mean bias (and standard deviation) of the tropospheric zenith path delay estimations by each LAC with respect to the EPN tropospheric ZTD solution.
- The comparison between the LAC solutions for a specific EPN stations
  - The RMS of the differences (after a Helmert transformation) between the weekly positions estimated by the LACs and the position from the weekly combined EPN solution. A priori values (before outlier rejection) and final values (after outlier rejection - available since GPS week 1526) are provided.
  - The differences (after a Helmert transformation) between the weekly position estimated by each LAC and the position from the weekly combined EPN solution. A priori values (before outlier rejection) and final values (after outlier rejection - available since GPS week 1526) are provided.
  - Biases and standard deviations between the Tropospheric Zenith Path Delays (ZPD) estimated by each LAC and the combined EPN tropospheric ZPD solution.

4 SUMMARY

Since last year, 14 new EPN stations joined the EPN bringing the total number of EPN stations to 223. The EPN tracking network is slowly preparing for multi-GNSS tracking with a 15% increase of the number of GPS+GLONASS tracking stations within the last year. Also the number of EPN stations equipped with antenna/radome pairs with absolute calibrations is growing demonstrating the importance of strategic guidelines aiming at slowly upgrading the EPN.
Recent upgrades to the EPN Central Bureau monitoring system include dedicated web pages with the comparison of the LAC solutions with respect to the combined EPN solution, a new on-line site log submission tool and a data centre dedicated to reprocessing.

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