Network Coordination of the EUREF Permanent Network

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1. Introduction

This document summarises the major changes to the EUREF permanent network (EPN) since the EUREF symposium of June 22-24, 2000, held in Tromsø, Norway (*Bruyninx, 2001*) and it gives an overview of the network coordination performed at the EPN Central Bureau.

2. Status of the EUREF Permanent Network

Figure 1 shows the status of the EUREF permanent tracking network as in May 2001. The number of stations is 118. 47 % of them belong also to the IGS network. The 23 new EPN stations that joined the EUREF network since June 2000 are given in Table 1.

Figure 1 – Stations included in the EUREF permanent network (status May 2001); the squares show the stations added to the network after June 2000

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Station	4 char ID	Country	Lat (N)	Lon (E)	Agency
Almeria	ALME	Spain	36.94	357.54	IGNS
Borkum	BORK	Germany	53.56	006.75	BKG
Chize	CHIZ	France	46.13	359.59	CLDG
Dubrovnik	DUBR	Croatia	42.65	018.11	BKG
Gaia	GAIA	Portugal	41.11	351.41	IPCC
Lagos	LAGO	Portugal	37.10	351.33	IPCC
Ljubljana	GSR1	Slovenija	46.05	014.54	GDOO
Marne-la-Vallee	MLVL	France	48.84	002.59	IGNF
Metzoki Dragot	DRAG	Israel	31.59	035.39	SOI
Ohrid	ORID	Macedonia	41.13	020.79	BKG
Osijek	OSJE	Croatia	45.56	018.68	BKG
Oslo	OSLS	Norway	59.74	010.37	GINMA
Palma de Mallorca	MALL	Spain	39.55	002.62	IGNS
Ponta Delgada	PDEL	Portugal	37.75	334.34	IPCC
Rabat	RABT	Morocco	33.98	353.14	UNAVCO
Santander	CANT	Spain	43.47	356.20	IGNS
Stavanger	STAS	Norway	59.02	005.60	GINMA
Teddington	NPLD	United Kingdom	51.42	359.66	NPL
Toulouse	TLSE	France	43.56	001.48	CNES
Trondheim	TRDS	Norway	63.37	010.32	GINMA
Valencia	VALE	Spain	39.48	359.66	IGNS
Vardoe	VARS	Norway	70.34	031.03	GINMA
Yebes	YEBE	Spain	40.52	356.91	IGNS

BKG : Bundesamt für Kartographie und Geodäsie, Germany
CLDG : Centre Littoral de Géophysique, France
CNES : Centre National d'Etudes Spatiales, France
IGNF : Institut Géographique National, France
IGNS : Instituto Geografico Nacional, Spain
GDOO : Geoservis, d.o.o, Slovenija
GINMA : Geodetic Institute Norwegian Mapping Authority, Norway
IPCC : Instituto Português de Cartografia e Cadastro, Portugal
NPL : National Physical Laboratory, United Kingdom
SOI : Survey of Israel, Israel

Table 1- New EUREF permanent tracking sites since June 2000

The graph in Figure 2 shows how the EPN has expanded since its start in Jan. 1996.

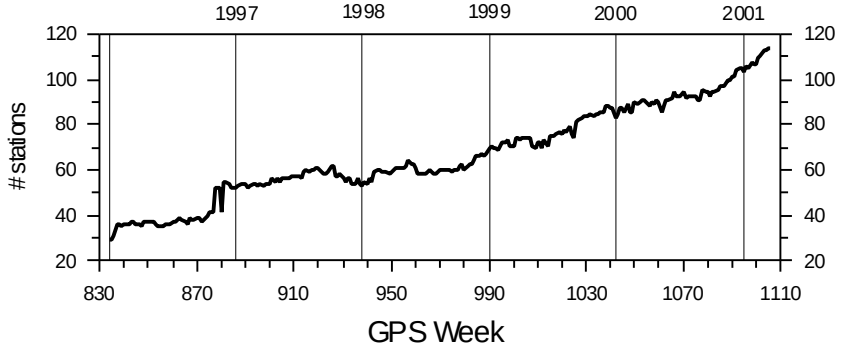

Figure 2 - Growth of the EPN Network

Table 2 gives a list of candidate EUREF permanent tracking sites.

Station	4 char ID	Country	Lat (N)	Lon (E)	Agency
Amman	AMMN	Jordan	32.03	035.88	Royal Jordanian Geographic Centre, Jordan
Boras	SPTF	Sweden	57.71	012.89	National Land Survey of Sweden, Sweden
Caceres	CACE	Spain	39.48	353.67	Instituto Geografico Nacional, Spain
Diyarbakir	DYR2	Turkey	37.92	040.28	UNAVCO, USA
Elba	ELBA	Italy	42.75	010.21	Telespazio S.p.A., Italy
Gjøvik	GJOV	Norway	60.79	010.68	University College of Gjøvik, Norway
København	BUDP	Denmark	55.75	012.60	National Survey and Cadastre of Denmark, Denmark
Linz	LINZ	Austria	48.31	014.28	MA-Linz, Surveyors Office, Austria
Reggio Calabria	TGRC	Italy	38.11	015.65	Italian Space Agency, Italy
Smidstrup	SMID	Denmark	55.65	009.70	National Survey and Cadastre of Denmark, Denmark
Suldrup	SULD	Denmark	56.85	009.85	National Survey and Cadastre of Denmark, Denmark
Trento	TREN	Italy	46.07	011.12	Geology Service of Province of Trento, Italy

Table 2 - Candidate EUREF permanent tracking sites.

In the past year, a lot of EPN stations have made a considerable effort to deliver hourly tracking data: 15 additional stations started submitting hourly data since June 2000, bringing the total number of stations to 54 (Figure 3), which is 45 % of the EPN stations.

Figure 3 - EUREF stations submitting hourly tracking data

All stations that are not included in the combined EUREF solution for a period longer than three months are classified as inactive stations. An updated list of these stations is available at
http://www.epncb.oma.be/inactive.html

3. EPN Data Availability

Due to increase of EPN stations delivering hourly data. ASI, DUT, IGN (LDC) and ROB (see Table 3) started to make available hourly data in the last year. Now all EPN data centres making available these hourly tracking data.

Local Data Centres
Agenzia Spatiale Italiana - ASI, Italy
Federal Office of Cartography and Geodesy - BKG(LDC), Germany
Delft University of Technology - DUT, The Netherlands
Space Research Institute, Department of Satellite Geodesy Austrian Academy of Sciences - OLG, Austria
Institut Géographique National - IGN(LDC), France
Royal Observatory of Belgium - ROB, Belgium

IGS Regional Data Centre
Federal Office of Cartography and Geodesy - BKG(RDC), Germany

IGS Global Data Centre
Institut Géographique National - IGN(GDC), France

Table 3 – EUREF/IGS Data Centres in Europe

4. EPN Data Analysis

4.1 EPN AC Workshop

A third EPN Analysis Centres (AC) Workshop will take place on May 31 to June 1, 2001 in Warsaw, Poland. The main goal of this workshop is to discuss a possible change of the data analysis strategy. The original guidelines were written in 1997 and have clearly aged.
Sessions of the workshop are:

1. Reports of the new developments at the AC's
2. EUREF Special Projects (troposphere and geokinematics)
3. Results of the tests of alternative processing strategies
4. Site/antenna displacements

Figure 4 – EPN subnetwork processed by the DEOS analysis centre

4.2 New EPN Analysis Centre

Due to the growing number of EPN stations located in the Iberian Peninsula (8 new stations!), there was a need for an additional EPN analysis centre concentrating on this region. The Delft Institute for Earth-Oriented Space Research (DEOS), a research group of Delft University of Technology, responded to this need. DEOS has started to process GPS networks on a regular basis since 1994.

Currently, DEOS is processing several permanent and campaign networks in Europe and South-East Asia. A dedicated solution is incorporated in EUREF since February 2001. DEOS is the thirteenth EPN Analysis Centre and it is the first one using the GIPSY software for its contribution to EUREF. The EPN subnetwork processed by DEOS is shown in Figure 4. More details about the integration of the DEOS solution in the EUREF combined solution will be given in the paper by Habrich (this volume).

5. EPN Network Coordination

5.1 Change of web/ftp site

On April 9, 2001 the EPN Central Bureau has changed the address of both its web and ftp sites: the new addresses are ftp.epncb.oma.be/epncb and www.epncb.oma.be.

5.2 Update of Guidelines

The EUREF Technical Working Group updated the "Guidelines for EUREF stations and Operational Centres" (http://www.epncb.oma.be/g_sta_oc.html) in order to:

- *Improve the hierarchy in the EPN data flow*

  Introduction of the Local Data Centre in the EPN Data flow (EUREF Mail 691):

  "Stations have to make available their data (hourly/daily) in **one of the LDC's** from where it will flow to the RDC (Regional Data Centre).
  If no LDC is available, then the data can be directly uploaded to the RDC. Check the appropriate Data Centre Form for detailed upload instructions."

- *Encourage the installation of EPN stations in less dense regions*

  Instructions about the station location (EUREF Mail 691):

  "The site must occupy a relevant location into the EUREF Permanent Network.
  For stations installed primarily to contribute to the maintenance of the ETRS89, **a minimal distance of 300 km** to already existing EPN stations is required, accepting the interest of each nation to have at least one EPN station. **Exceptions** to this rule are possible for stations submitting **hourly data** or contributing to EPN Special Projects, by e.g. collocation with other instruments relevant to the purposes of EPN."

In addition to this, instructions for the hourly data upload (EUREF mail 765) were added to the Guidelines.

5.3 Coordinate Time Series

The coordinate time series, computed by the EPN CB, have been reviewed. The new figures indicate now directly on the graph when the antenna/radome configuration has been changed. This allows seeing directly if a coordinate jump is correlated with a change of the station equipment. An example is shown in Figure 5.
In addition, the "Time Series" Web page (http://www.epncb.oma.be/series.html) now includes links to two types of time series:

1. Standard time series for monitoring the quality of the estimated station coordinates
2. Improved time series prepared for geokinematic interpretation (Kenyeres and Bruyninx, 2001)

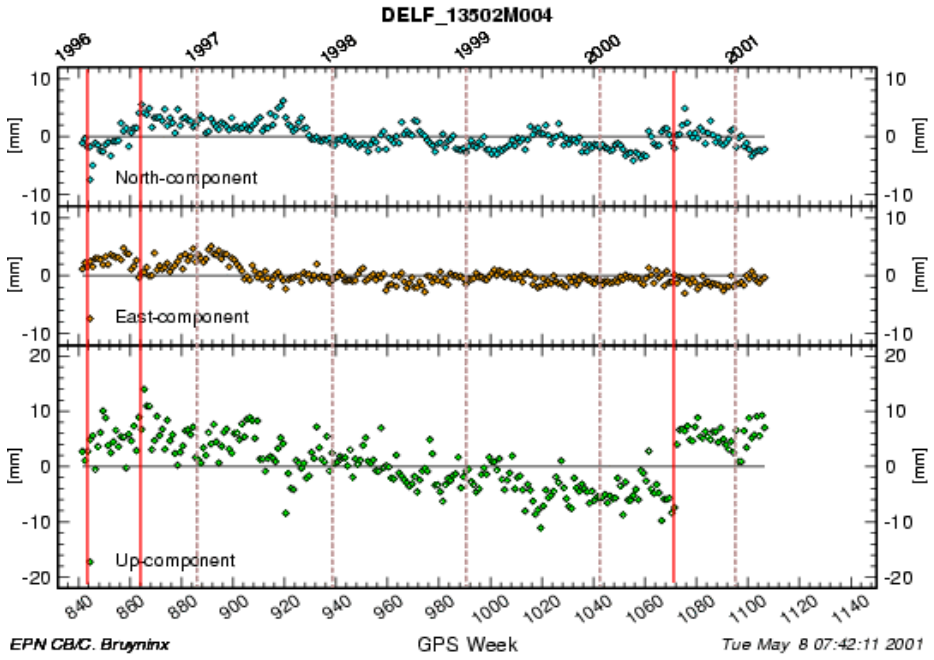

Figure 5 - Coordinate Time Series as computed at the EPN CB

5.4 Monitoring of the station tracking performance

The EPN CB has started to make available at its web site graphs that display the GPS satellites tracked at the EPN stations. For this purpose we have created two graphs:

- Azimuth/elevation graphs
- Graphs displaying the number of visible satellites versus the predicted number

Inputs for these graphs are daily RINEX observation files. Presently the graphs are made available with a six-month interval for each station. Detailed results can be found in the paper by Takacs and Bruyninx (this volume).

5.5 SINEX template

Similar to the IGS Central Bureau, the EPN CB is creating daily, since April 2001, an euref.snx file (ftp://ftp.epncb.oma.be/epncb/station/general/euref.snx) that can be used by the AC's as input to their data analysis; it gives a historical overview of all the receiver/antenna equipment and antenna heights ever used at each EPN site based on the info in the site log files.

6. Outlook

6.1 IGLOS Pilot Project

The International GPS Service expects to launch the IGLOS (International GLONASS) Pilot Project around June 2001. At that time all dual frequency combined GPS/GLONASS IGLOS sites will become bona fide IGS stations and their mixed GPS/GLONASS data (RINEX 2.1.0 format) will appear in the same directories as the GPS-IGS stations.

As a consequence, the EUREF and IGS stations operating combined GPS/GLONASS receivers will stop delivering separate GPS-only observation files. Affected EPN sites are WROC (Wroclaw, Poland) and GOPE (Pecny, Czech Republic).

With the start of the IGLOS Pilot Project, the IGS precise ephemeris (SP3 files) will also contain both GPS and GLONASS orbits.

For those users, unable to read mixed RINEX or SP3 files, the EPN CB will make available the necessary programs to discard the GLONASS part from both the combined RINEX as the SP3 files.

6.2 New site log format

In support of GLONASS data and to improve the geophysical information available in the site logs, the International GPS Service plans to change the format of the site log forms. Within the EPN, we will switch to the new site log simultaneously with the IGS. The implementation will be done as follows: in a first step, the EPN CB will convert all existing site log files to the new format. In a second step, all station operators will be asked to review the reformatted site log and complete the missing information. The switch is expected around June 2001.

The new site log format is available at ftp://ftp.epncb.oma.be/epncb/station/general/draft.log together with ftp://ftp.epncb.oma.be/epncb/station/general/sitelog_instr.txt giving detailed instructions.

Major changes to the new site log with respect to the previous one, are:

- More detailed *Monument Description*
- Info about *nearby fault zones*
- Added *receiver elevation cut off setting*
- Added *North/East Antenna eccentricity*
- Added info about *antenna cable type and length*
- Added info about *local conditions possibly affecting computed position* (e.g. radio interferences, multipath sources, signal obstructions)
- Added info about *local episodic effects affecting data quality* (e.g. tree clearing, construction)

6.3 Future activities

It is clear that the EPN Central Bureau urgently needs to adapt for the near real-time activities of the network.

This includes:

- Automated site log submissions (web, ftp, e-mail?)
- RINEX-site log consistency checks for hourly data + automated e-mails to station managers
- Dynamically map availability of hourly data for all EPN data centres
- Decrease “Time to alarm” for stations with degraded tracking performance
- Include more dynamical web-pages

These topics are the first priority for the EPN CB during the next year.

In addition, we consider general improvements such as:

- Creation of a separate mailing list for report-type EUREF mails
- Improved follow-up of station tracking performances
- Extended FAQ

7. References

Bruyninx C. (2001)

Overview of the EUREF Permanent Network and the Network Coordination Activities
EUREF Publication, EUREF Publication, Eds. J. Torres, H.Hornik, Bayerischen Akademy der Wissenshaften, München, Germany, No 9, pp. 24-30

Kenyeres A. and Bruyninx C. (in press)

EPN multi-year Solutions – Combination Considerations and time-series Analysis
(This volume)

Takacs B. and Bruyninx C. (in press)

Quality Checking the RINEX data of the EUREF Permanent Network
(This volume)