

Overview of the EUREF Permanent Network and the Network Coordination Activities¹

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1. Introduction

This document summarises the major changes to the EUREF permanent network (EPN) since the EUREF symposium of June 2-4, 1999, held in Prague, Czech Republic (BRUYNINX, 2000).

The steady growth of the EPN, together with its data and products, has drawn the interest of a wide variety of scientific users. This issue was addressed at an EUREF Analysis Centres (AC) Workshop, organised in Marne la Vallée, in September 1999. The recommendations of this workshop reflect the openness of the EUREF AC's to deliver products that are useful for a wide range of applications. Possible

improvements to the existing products and new directions to take have been discussed.

In order to prepare the EUREF permanent network for multi-disciplinary applications, and in addition, continue to monitor the growing network efficiently, a revision of the coordination tasks was put forward.

2. Status of the EUREF Permanent Network

Figure 1 shows the status of the EUREF permanent tracking network as in July 2000. The number of stations is almost 100. 50 % of them belong also to the IGS network. The list of new EPN stations that joined the EUREF network since June 1999 is summarised in Table 1.

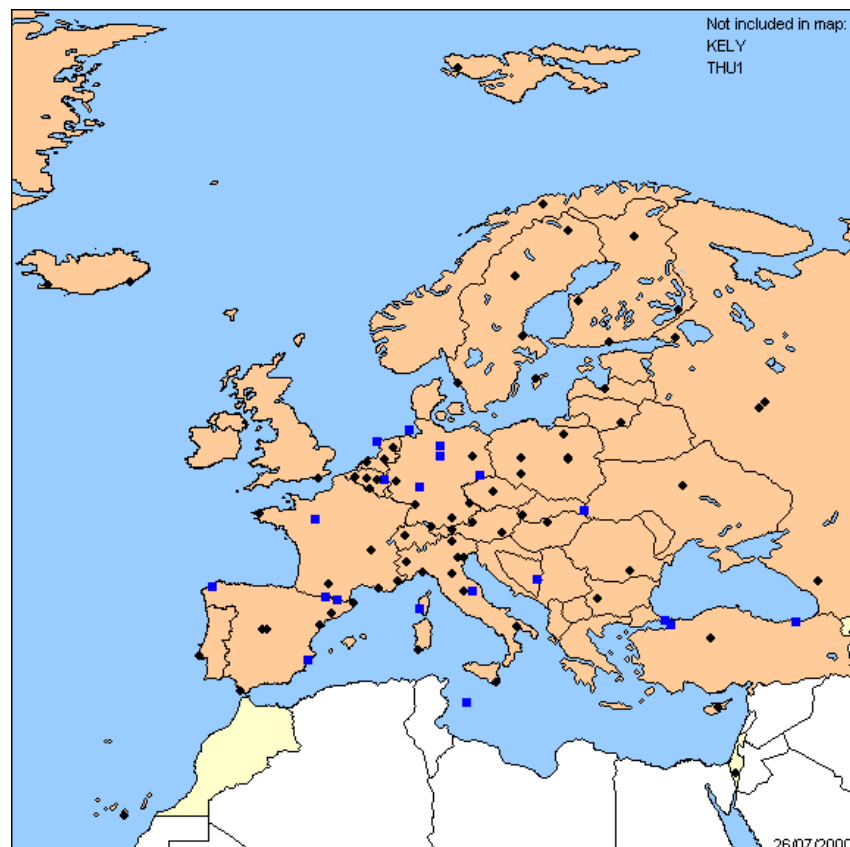


Figure 1: Stations included in the EUREF permanent network (status June 2000); the squares show the stations added to the network after June 1999

¹ Concerning this topic cf. also the report C. BRUYNINX: *Review of the Coordination Tasks within the EUREF Permanent GPS Network (EPN)*, printed on p. 381, this vol.

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All stations which 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 the <http://homepage.oma.be/euref/inactive.html>

Table 1- New EUREF permanent tracking sites since June 1999

Station	4 char ID	Country	Lat (N)	Lon (E)	Agency
A Coruna	ACOR	Spain	-8.40	43.36	ICC
Ajaccio	AJAC	France	8.76	41.93	IGN
Alicante	ALAC	Spain	-0.48	38.34	ICC
Braunschweig	PTBB	Germany	10.46	52.30	BKG
Camerino	CAME	Italy	13.13	43.12	ASI
Dresden	DRES	Germany	13.73	51.03	BKG
Gebze	TUBI	Turkey	29.45	40.79	ESRI
Helgoland	HELG	Germany	7.90	54.17	BKG
Hohenbünstorf	HOBÜ	Germany	10.48	53.05	BKG
Istanbul	ISTA	Turkey	29.02	41.10	BKG
Kloppenheim	KLOP	Germany	8.73	50.22	BKG
Llivia	LLIV	Spain	1.98	42.48	ICC
Naut Aran	ESCO	Spain	0.98	42.69	ICC
Sarajevo	SRJV	Bos./Herc.	18.41	43.86	ISR
Trabzon	TRAB	Turkey	39.78	40.99	BKG
Uzhgorod	UZHL	Ukraine	22.29	48.63	NASU

ASI: Agenzia Spaziale Italiana, Italy

BKG: Bundesamt für Kartographie und Geodäsie, Germany

IGN: Institut Géographique National, France

ESRI: Earth Sciences Research Institute; Turkey

ICC: Institut Cartografic de Catalunya, Spain

ISR: Institute for Space Research, Austria

NASU: National Academy of Sciences of Ukraine, Ukraine

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

Table 2 - Candidate EUREF permanent tracking sites.

Station	4 char ID	Country	Lat (N)	Lon (E)	Agency
Amman	AMMN	Jordan	32.03	35.88	Royal Jordanian Geographic Centre
Boras	SPTF	Sweden	57.71	12.89	National Land Survey of Sweden
Gjøvik	GJOV	Norway	60.79	10.68	University College of Gjøvik
København	BUDP	Denmark	55.75	12.60	National Survey and Cadastre of Denmark
Lagos	LAGO	Portugal	37.10	08.67	Instituto Portugues de Cartografia e Cadas-
Marne la	MLVL	France	48.50	02.35	Lnstitut Géographique National de France
Metzoki	DRAG	Israel Kingdom	31.59	35.39	Survey of Israel
Ochrid	ORID	Macedonia	41.13	20.79	Bundesamt für Kartographie und Geodäsie
Ponta Delgada	PDEL	Portugal (Azores)	37.75	25.66	Instituto Portugues de Cartografia e
Porto	PORT	Portugal	41.11	08.59	Instituto Portugues de Cartografia e
Smidstrup	SMID	Denmark	55.65	09.70	National Survey and Cadastre of Denmark
Suldrup	SULD	Denmark	56.85	09.85	National Survey and Cadastre of Denmark
Trento	TREN	Italy	46.07	11.12	Geology Service of Province of Trento

3. EUREF Analysis Centres Workshop

In order to discuss how the EUREF permanent GPS network can contribute to other scientific disciplines, an EUREF Analysis Centre workshop has been organised in Paris, France on September 9-10, 1999. The working theme of the workshop: "Towards Multi-disciplinary EUREF products" aimed at addressing issues such as the creation of

a future troposphere product. This workshop was a response to Resolution 4 of the EUREF Symposium in Prague, June 1999.

Extract of resolution 4:

The IAG Subcommission for Europe (EUREF) considering that the primary purpose of establishing the EUREF Permanent Network was the maintenance of the ETRS89,

and recognising the achievements of the project, recognising that the data, structure and results of the Permanent Network are valuable for a wide variety of scientific investigations, invites agencies and organisations interested in these investigations (such as geodynamics, sea level monitoring and meteorology) to closely collaborate with EUREF.

Topics discussed at the workshop included:

- Deliverance of a EUREF troposphere product
- Creation of European ionospheric maps
- Processing of the hourly data files
- Collaboration with COST Action 40 (sea-level monitoring) and COST Action 716 (Ground-based GPS for weather prediction troposphere)
- Release of new Bernese version
- Change of EUREF combination centre
- Coordinate time series: seasonal effects, geophysical periods,...

One of the outcome of the workshop was a endorsement of the strength of the multi-centres data analysis (at least three analysis centres for each EUREF station) and a formal engagement of the EUREF AC's to extend their subnetworks in order to continue to guarantee this principle. As a result, at the end of 1999, 90 % of the EUREF stations were processed by 3 AC's, 8 % by 4 AC's and 2 % of the stations is only processed by two AC's.

In the past year, a lot of EPN stations have made a considerable effort to deliver hourly tracking data: 20 additional stations started submitting hourly data since June 1999, bringing the total number of stations to 38 (Figure 2).

The availability of hourly data is useful for the near-real time determination of total zenith path delay (TZD) estimates, which can be input in numerical weather prediction models. A second application, climate research, can use GPS-derived Water Vapor information if it is based on a network of highly stable GPS stations (equipment, monumentation, and environment). This necessities a rigorous documentation of all changes at and around the GPS antenna, similar to what is needed for the maintenance of a reliable reference frame. The investigation of all these topics is one of the goals of COST Action 716 ("Exploitation of ground-based GPS for Climate and Numerical Weather Prediction (NWP) Applications") (VAN DER MAREL and PESEC, 2000).

Only a few of the EUREF analysis centres presently attempt to apply their GPS-derived tropospheric zenith path delays to meteorology. An example is the GOP analysis centre (J. Dousa, *in this volume*). At the AC workshop, the representative of COST 716 agreed to accept a representative of the EUREF AC's within COST 716. This more formal participation of EUREF to COST 716 will guarantee that any future steps towards an EUREF troposphere product will be in full compliance with the COST 716 recommendations.



Figure 2 - EUREF stations submitting hourly tracking data

Recommendations of the EUREF AC workshop included:

- [A] Maintain more complete site information at the EPN Central Bureau, including info about geology and site stability, collocation with meteorological instruments and tide gauges.
- [B] Express towards the IGS, the interest of EUREF for near real time IGS orbits. Inquire the policy of the IGS for making available these orbits.
- [C] Distribute the residuals of the weekly combination solution for the individual subnetwork solutions among the AC in order to have a better view on possible errors.
- [D] Distribute a unique set of ocean loading parameters for the EUREF permanent network among the EUREF AC's
- [E] Update the Data Analysis Guidelines

The minutes of the workshop are available at

<http://homepage.oma.be/euref/papers/elacw002/elacw002.html>

4. Management and Coordination

The EUREF Technical Working Group (EUREF TWG) is responsible for the general management of the EUREF Permanent GPS network.

In 1995, when EUREF started to coordinate the activities related to the permanent GPS stations in Europe, the coordination task was attributed to one network coordinator. The main usage of the network was at that time purely reference frame related: the realization and maintenance of the ETRS89.

Since that time, the EUREF network has evolved from about 30 permanent tracking sites processed by four analysis centres to close to 100 stations and twelve analysis centres. In addition to this, the data, structure and results of the EPN have drawn the interest of a wide variety of scientific users.

In order to continue to provide a high quality data and products, EUREF decided, at its tenth Symposium in Tromsø, June 22-24, 2000 (Resolution of the Tromsø Symposium, *in this volume*) to formally establish an EPN Coordination Group, an EPN Central Bureau and EPN Special Projects.

The Coordination Group (CG) coordinates all activities related to the permanent network and special projects and proposes policy to the EUREF TWG. All members of the Coordination Group make a minimal commitment of 4 years.

The EPN Coordination Group consists of a :

✓network coordinator

CARINE BRUYNINX, Royal Observatory of Belgium
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✓data flow coordinator

GÜNTHER STANGL, Space Research Institute of the Austrian Academy of Sciences
stangl@flubpc14.tu-graz.ac.at

✓analysis coordinator

MATTHIAS BECKER, Bundesamt für Kartographie und Geodäsie, Germany
Becker@ifag.de

✓representative of the EUREF TWG

WERNER GURTNER, Astronomical Institute, University of Bern, Switzerland
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✓special project liaisons

EPN Special Projects are set up by the CG for a minimal period of 4 years in order to introduce new applications into the EPN or study special aspects of the EPN.

Up to now two EPN Special Projects have been initiated:

✓"*Generation of an EUREF tropospheric product*", chaired by GEORG WEBER, Bundesamt für Kartographie und Geodäsie, Germany (weber@ifag.de)

✓"*Monitoring of the EUREF Permanent Network to produce Coordinate time series suitable for geokinematics*" (see EUREF mail No 572), chaired by AMBRUS KENYERES, FOMI Satellite Geodetic Observatory, Hungary
(Kenyeres@sgo.fomi.hu)

The EPN Central Bureau, managed by the network coordinator, is responsible for the day-to-day general management of the EUREF permanent network consistently with the directives, policies and priorities set up by the EUREF TWG.

The EPN Central Bureau is located at :

Royal Observatory of Belgium
Av. Circulaire 3
B-1180 Brussels
Belgium
Tel: +32-2-373 02 92 (2 45)
Fax: +32-2-374 98 22
E-mail : eurefcb@oma.be or epncb@oma.be

More details are available in "*Guidelines for the coordination of the EPN Activities*" set up by the EUREF Technical Working Group at

<http://homepage.oma.be/euref/managemt.html>;

it is part of a the re-styled EPN web-site:

<http://homepage.oma.be/euref/> (Figure 3)

including clickable maps, updated guidelines for the network components, etc....

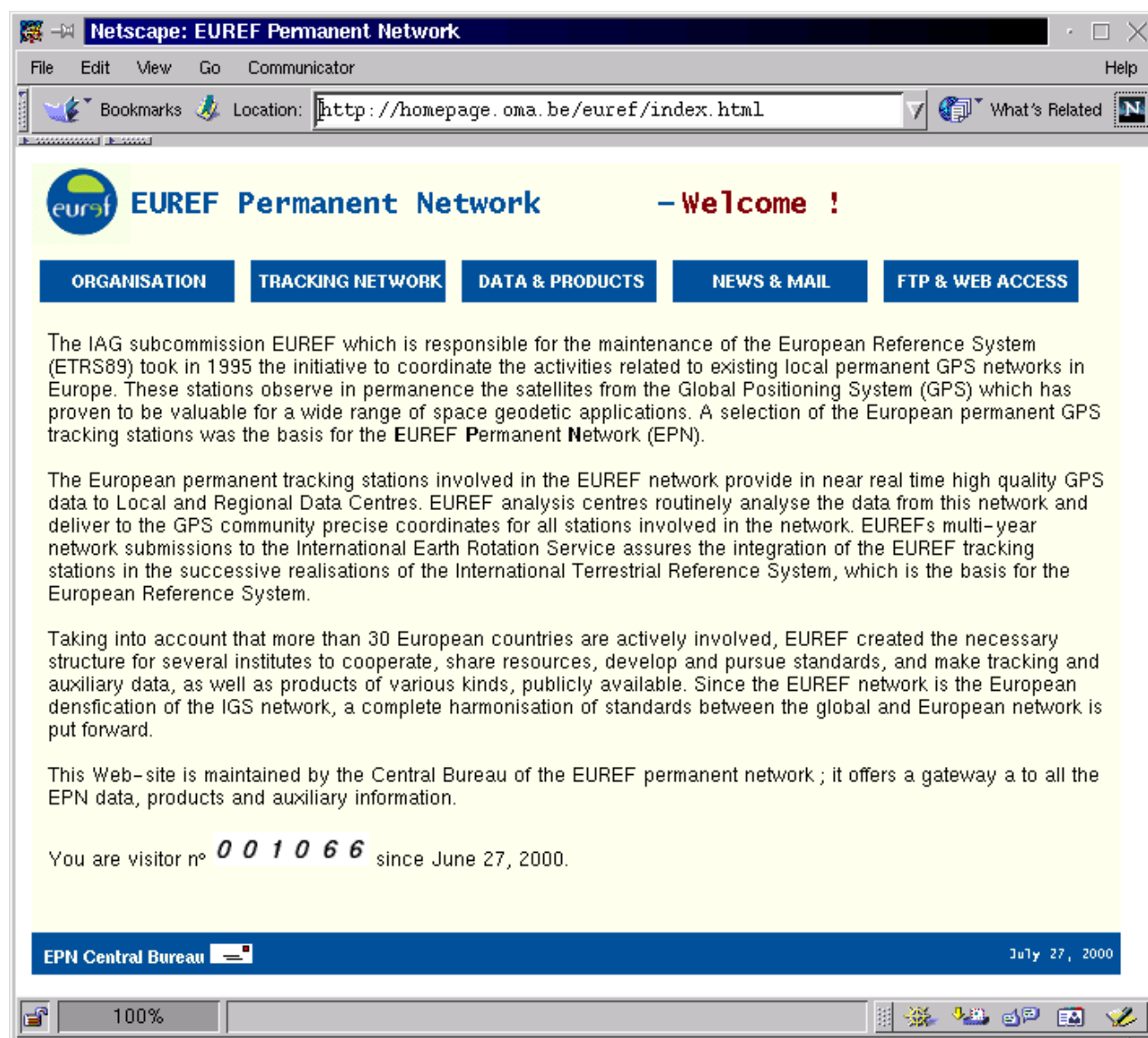


Figure 3 - Screen shot of the re-styled EPN web-site

As part of this effort, following Recommendation [A] of the AC Workshop, individual site information pages have been created. In addition to the site description logs, these pages also contain additional information (e.g. meteorological data, site pictures, collocation with tide gauges) responding to a request for more detailed documentation as needed for other scientific applications :

<http://homepage.oma.be/euref/siteinfo.html>

Some of the other workshop recommendations have also already resulted in concrete results. Since October 1999, the data analysis coordinator distributes the residuals of the weekly combination solution for the individual subnetwork solutions among the EUREF AC's (BECKER, *in this volume*). These weekly reports are archived at

<ftp://omaftp.oma.be/pub/astro/euref/product/report/>.

Tables with the ocean loading parameters have been kindly provided by H.-G. Scherneck from the Onsala Space Observatory. The file

ftp://gere.oso.chalmers.se/pub/hgs/oload/GOT99.2-euref_pp.blq

contains the phases and amplitudes necessary to correct all EPN stations for the effect of ocean loading (Recommendation [D]).

Recommendation [B] became expired when some of the IGS analysis centres started to make available ultra-rapid orbits in October 1999.

Table 3: Weekly station inconsistency reports distributed by the EPN CB through EUREF mail

EUREF Electronic Mail05-Jul-2000 11:08:02 CETMessage Number 0559

Author: EPN CB/Bruyninx C.

Subject: Wk 1068 Station Inconsistencies

Dear colleagues,

The information listed below reflects the consistency between the "RINEX headers" and "site log files" for all stations in the EUREF network for the GPS-Week no 1068 (DOY 177/2000 --> 183/2000).

This consistency check was generated on 5/07/2000.

RINEX data files are obtained from the Regional Data Centre for Europe at BKG and from the EUREF local data centres (details at <http://homepage.oma.be/euref/datacent.html>)

Station log files are taken from the EPN Central Bureau ftp site (<http://homepage.oma.be/euref/siteinfo.html>).

Legend

"X" : no inconsistencies

"0" : error in RINEX header or site log, details below

"-" : no data available

GPS-Week no 1068 (DOY 177/2000 --> 183/2000)

Day of weekDay of weekDay of week

012345601234560123456

ACOR XXXXXXXXAJAC XXXXXXXXALAC XXXXXXXX

ANKR XXXXXXXXBELL XXXX--XBOGO XXXXXXXX

BOR1 XXXXXXXXBRST XXXXXXXXBRUS XXXXXXXX

BUCU XXXXXXXXBZRG XXXXXXXXCAGL XXXXXXXX

CAME XXXXXXXXCASC XXXXXXXXCREU XXXXXXXX

DELF XXXXXXXXDENT XXXXXXXXDOUR XXXXXXXX

DRES XXXXXXXXEBRE X--XXXXEIJS XXXXXXXX

ESCO ---XX-XEUSK XXXXXXXXGENO XXXXXXXX

GLSV XXXXXXXXGOPE XXXXXXXXGRAS XXXXXXXX

GRAZ --X---XHELG X-XXXX0HERS XXXXX--

HFLK XXXXXXXXHOBU XXXXXXXXHOFN XXXXXXXX

ISTA XXXXXXXXJOEN XXXXXXXXJOZE XXXXXXXX

KARL XXXXXXXXKELY XXXXXXXXKIRO XXXXXXXX

KIRU XXXXXXXXKLOP XXXXXXXXKOSG XXXXXXXX

LAMA XXXXXXXXLAMP XXXXXXXXLLIV XXXXX--

MAD2 XXXXXXXXMANS XXXXXXXXMAR6 XXXXXXXX

MARS XXXXXXXXMAS1 XXX----MATE XXXXXXXX

MDVO XXXXXXXXMEDI XXXXXXXXMETS XXXXXXXX

MOPI XXXXXXXXNICO XXXXXXXXNOTO XXXXXXXX

NSSP -----NYA1 XXXXXXXXOBER XXXXX--

ONSA XXXX-XXPENC XXXXXXXXPFAN XXXXXXXX

POTS XXXXXX-PTBB XXXXXXXXRAMO XXXXXXXX

REYK XXXXXXXXRIGA XXXXXXXXSBGZ XXXXXXXX

SFER XXXXXXXXSJDV -XXXXXXSODA --XXX--

SOFI XXXXXXXXSRJV --XXXXXSVTL XXXXXXXX

TERS XXXXXXXXTHU1 XXXXXXXXTORI XXXXXXXX

TOUL XXXXXXXXTRAB XXXXXXXXTRO1 XXXXXXXX

TUBI -----XXUNPG XXXXX--UPAD XXXXX--

UZHL X-X-XXXVAAS XXXXXXXXVENE XXXXXXXX

VIL0 XXXXXXXXVILL XXXXXXXXVIS0 XXXXXXXX

VLNS -----WARE XXXXXXXXWROC XX-XXXX

WSRT X--XXXXWTZR XXXXXXXXZECK XXXXXXXX

ZIMM XXXXXXXXZWEN XXX----

| STAT | DOY | ERROR TYPE | LOG | RINEX HEADER |

| HELG | 183/2000 | ANTENNA TYPE | ASH700936D_M SNOW | Default |

| HELG | 183/2000 | MARKER NUMBER | 14264M001 |

| HELG | 183/2000 | RECEIVER TYPE | ASHTECH Z-XII3 | Ashtech Z12 |

Kind regards,

EPN Central Bureau/Bruyninx C.

eurefcb@oma.be

[Mailed from: "EPN Central Bureau/Bruyninx C." <md@oma.be>]

The EPN Central Bureau distributes since GPS week 1061 an overview of inconsistencies between RINEX headers and site log files for all EPN stations. This overview (Table 3) is created 5 days after the end of the GPS week and it reflects the situation at that specific moment. Main goal of this initiative is to encourage the late stations to reduce the delay of their data availability and to give a quick notification of errors to possible users.

5. References

- BRUYNINX C. (2000) *Status and Prospects of the Permanent EUREF Network*, Proc. of "Symposium of the IAG Subcommittee for Europe held in June 1999 Prague", Ed. E. Gubler, J.-A. Torres, H. Hornik, EUREF Publication, No. 8, pp. 42-46
- MAREL H. VAN DER, Pesec P. (2000): *Exploitation of ground based GPS for climate and numerical weather prediction applications – Status of Cost action 716*, Proc. of "Symposium of the IAG Subcommittee for Europe held in June 1999 Prague", Ed. E. Gubler, J. A. Torres, H. Hornik, EUREF Publication, No. 8, pp. 51-53