EPN CB Report

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EPN CB

Status of EPN tracking network

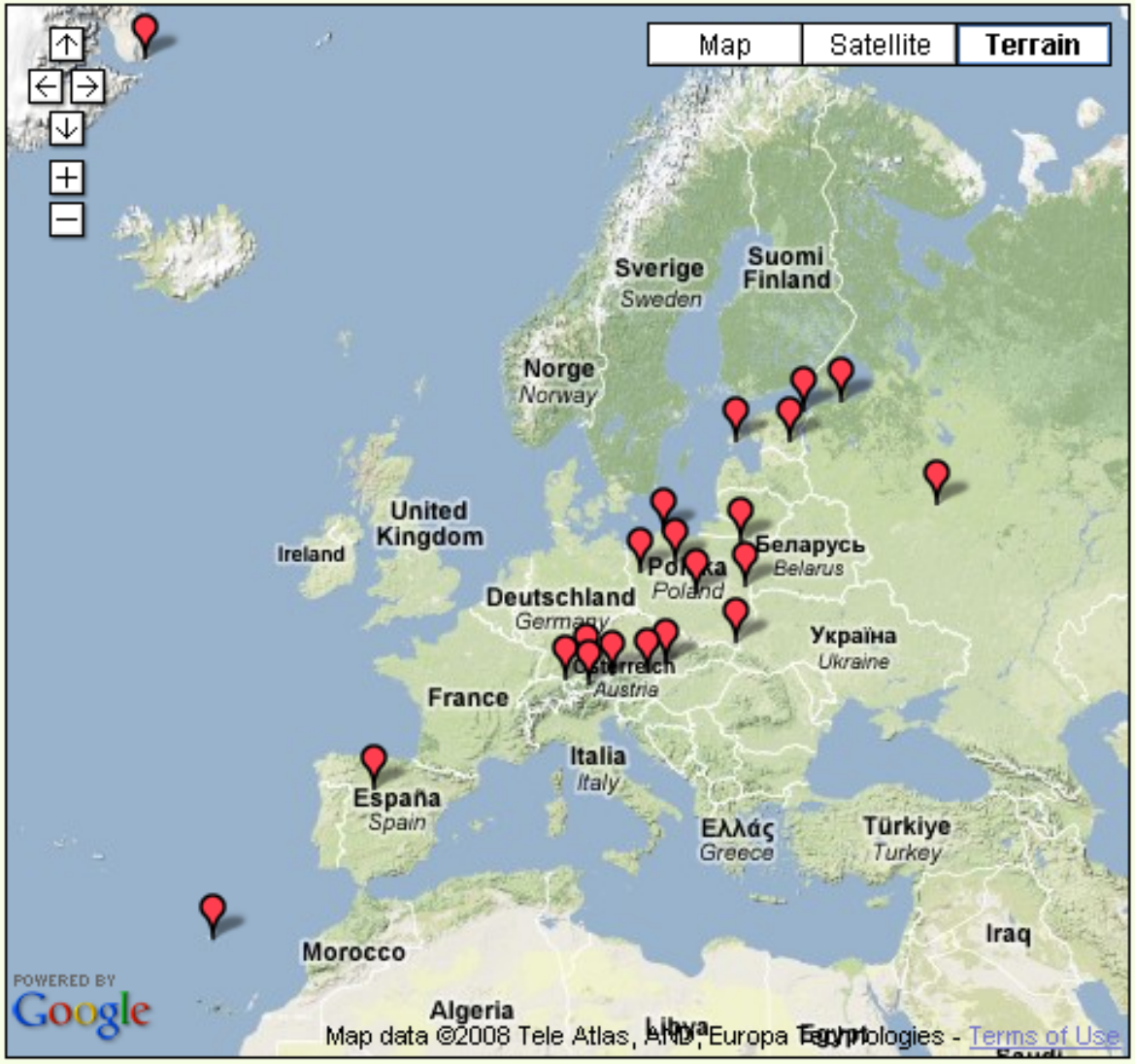
STATUS OF EPN TRACKING NETWORK

- 198 stations
- 2 new: ZIM2 (Zimmerwald, Switzerland), GPS+GLONASS, real-time
  CEU1 (Ceuta, Spain), GPS, real-time
- 7 withdrawn : HFLK, TRFB, SBGZ, PFAN (A), FATA (I), OBE2 (D), MANS (F), NPLD (UK)
  monument changes!
- 90 % hourly
- 43 % real-time
- 27% GPS+GLONASS
- 21 proposed stations

PROPOSED EPN STATIONS

Site	Location	Proposed at	Documentation			Data compliance			Data flow		Relevance to EPN				Interested analysis centres
			CL	SL	SP	SL	AC	TR	Primary	Secondary	D	H	SP	CI	
BPDL	Biala Podlaska, Poland	20/02/2008	✔	✔	✘	✘	✔	✘	BKGE	OLG	✘	✘	✘	✘	WUT - ? - ?
BYDG	Bydgoszcz, Poland	20/02/2008	✔	✔	✘	✘	✔	✘	BKGE	OLG	✘	✘	✘	✘	WUT - ? - ?
FUNC	Funchal, Portugal	03/09/2007	✔	✔	✔	✘	✔	✘	BKGE	OLG	✘	✔	✔	✘	IGE - BEK - ?
GISH	Moscow, Russia	06/02/2008	✔	✔	✔	✔	✔	✘	OLG	BKGE	✘	✔	✘	✘	WUT - ? - ?
GWWL	Gorzow Wielkopolski, Poland	20/02/2008	✔	✔	✘	✘	✔	✘	BKGE	OLG	✘	✘	✘	✘	WUT - ? - ?
HFL2	Innsbruck, Austria	19/03/2008	✔	✘	✘	✘	✘	✘			✘	✘	✘	✘	? - ? - ?
KURE	Kuressaare, Estonia	14/02/2008	✔	✘	✘	✘	✘	✘			✘	✘	✘	✘	WUT - ? - ?
LODZ	Lodz, Poland	20/02/2008	✔	✔	✘	✘	✔	✘	BKGE	OLG	✘	✘	✘	✘	WUT - ? - ?
MOP2	Modra-Piesok, Slovak Republic	06/02/2008	✘	✘	✔	✔	✘	✘	OLG	BKGE	✘	✔	✘	✘	WUT - ? - ?
OBE3	Oberpfaffenhofen, Germany	22/02/2008	✔	✔	✘	✔	✔	✘	BKGI	IGNI	✘	✔	✘	✘	BKG - ROB - ?
PFA2	Bregenz, Austria	19/03/2008	✔	✘	✘	✘	✘	✘			✘	✘	✘	✘	? - ? - ?
PULK	St.Petersburg, Russia	06/02/2008	✔	✔	✔	✘	✔	✘	BKGE	OLG	✘	✔	✘	✘	WUT - ? - ?
REDZ	Redzikowo, Poland	20/02/2008	✔	✔	✘	✘	✔	✘	BKGE	OLG	✘	✘	✘	✘	WUT - ? - ?
SBG2	Salzburg, Austria	19/03/2008	✔	✘	✘	✘	✘	✘			✘	✘	✘	✘	? - ? - ?
SCOR	Scoresbysund/Ittoqqoormiit, Greenland	28/02/2006	✔	✔	✔	✘	✘	✔	CDDIS	BKGI	✔	✔	✘	✘	NKG - IGE - ?
SWKI	Suwalki, Poland	20/02/2008	✔	✔	✘	✘	✔	✘	BKGE	OLG	✘	✘	✘	✘	WUT - ? - ?
TOIL	Toila, Estonia	14/02/2008	✔	✘	✘	✘	✘	✘			✘	✘	✘	✔	WUT - ? - ?
TORA	Tõravere, Estonia	14/02/2008	✔	✘	✘	✘	✘	✘			✘	✘	✘	✘	WUT - ? - ?
TRF2	Pernitz, Austria	19/03/2008	✔	✘	✘	✘	✘	✘			✘	✘	✘	✘	? - ? - ?
USDL	Ustrzyki Dolne, Poland	20/02/2008	✔	✔	✘	✘	✔	✘	BKGE	OLG	✘	✘	✘	✘	WUT - ? - ?
VALA	Valladolid, Spain	21/02/2008	✔	✔	✔	✘	✔	✘	IGNE	BKGE	✘	✔	✔	✘	? - ? - ?

PROPOSED EPN STATIONS



Overview of EPN products

EPN PRODUCTS

ORGANISATION	TRACKING NETWORK	DATA & PRODUCTS	NEWS & MAILS	FTP & WEB ACCESS
Creation, Management, Structure, Relation to IGS, Projects, Guidelines, FAQ	Maps, Stations, Equipment and calibration, Station coordinates, Site log submission & test	Data access, Analysis centres, Products, Time series, IGS products	News, Mails, Calendar, Papers, Workshops, Web site history	Anonymous FTP, Web site index, Related links

DATA & PRODUCTS > PRODUCTS

PRODUCTS

Station coordinates

The core product of the EPN is the coordinates of the tracking sites which are available with an accuracy of a cm or better. All official site coordinates and velocities in the different realizations of the ITRS and ETRS89 are available here. In addition, updated coordinates using the latest tracking data as well as coordinates for recent sites not yet included in the ITRS are also given.

Coordinate time series

Four different types of time series are made available for the EPN stations. Each of the time series serves different goals, such as e.g. the assessment of the differences between reference frames or the distinguishing between local site effects and real geodynamical site motion.

Site Zenith Path Delays

Within the routine analysis of a network of ground-based GPS receivers, such as the EPN, the tropospheric parameters are a by-product of the parameter estimation. The EPN makes available the tropospheric zenith path delays at all of its stations based on the estimates of all its Analysis Centres.

STATION COORDINATES

EPN station coordinates :
(select a station)

EPN coordinates are given in two ***reference systems***:

- the **International Terrestrial Reference System (ITRS)**, a global system with changing site coordinates due to the motion of the continental plates. The ITRS coordinates of EPN station change about 2,5 cm/y. The ITRS is mostly used for large scale scientific applications. It is also the system in which the precise IGS satellite orbits are given and it is the system from which other regional systems are derived.
- the **European Terrestrial Reference System (ETRS89)**, the regional European system derived from the ITRS (see "Guidelines for Reference Frame Fixing"). The ETRS89 is linked to the stable part of the Eurasian plate and site coordinates are almost constant. The ETRS89 is used as the standard precise GPS coordinate system throughout Europe. Supported by EuroGeographics, this reference system forms the backbone for all geographic and geodynamic projects on the European territory both on a national as on an international level.

The realization of a system (known as the "***reference frame***") consists in identifying a number of markers on the Earth with known coordinates and velocities in the specified system. These coordinates can be determined from, for example, space geodetic observations such as GPS. In Europe, the EPN provides the markers that realize the ETRS89. Throughout the years, each system had different realizations (or frames) which typically are an improvement with respect to the previous ones; more stations have been included and longer space geodetic observation periods are used in order to obtain more reliable station coordinates and velocities. For example the ITRF97 is based on all space geodetic observations up to 1997.

The reliability of the EPN site coordinates depends on the length of the observation period used to determine the coordinates and the possibility to link the GPS-based coordinates to the coordinates obtained by other space geodetic techniques. With this in mind, we distinguish ***3 types of coordinates*** :

1. **(X_{weekly}, Y_{weekly}, Z_{weekly}), the weekly coordinates computed by the EPN Combination Centre**
   These coordinates are extracted from the most recent weekly combined EPN solution which is based on the weekly subnetwork solutions submitted by the EPN Local Analysis Centres.
2. **(X_{EPN}, Y_{EPN}, Z_{EPN}) and (VX_{EPN}, VY_{EPN}, VZ_{EPN}), the coordinates/velocities computed by the "EPN Project for time series monitoring"**
   These monthly-updated coordinates/velocities are the result of a multi-year adjustment of all the weekly combined EPN solutions in which outliers have been eliminated. It can be considered as the EPNs realization of the ITRS.
   They are available through the web page of the EPN Project for "Time series monitoring".
3. **(X_{IERS}, Y_{IERS}, Z_{IERS}) and (VX_{IERS}, VY_{IERS}, VZ_{IERS}), the official coordinates/velocities issued the International Earth Rotation and Reference Systems Service (IERS)**
   These coordinates/velocities are computed by the IERS as a result of a combination of the multi-year coordinate solutions obtained by several space geodetic techniques (GPS, VLBI, SLR, ...). The EPN is one of the networks contributing to the official IERS

(from 361/98)							
ETRF2005 (from 093/05)	2000.0	4231162.8060 ± 0.0010	-332746.9230 ± 0.0000	4745130.7080 ± 0.0010	-0.0014 ± 0.0001	0.0003 ± 0.0000	-0.0008 ± 0.0001
ETRF2005 (from 147/07)	2000.0	4231162.8100 ± 0.0010	-332746.9150 ± 0.0000	4745130.7040 ± 0.0010	-0.0014 ± 0.0001	0.0003 ± 0.0000	-0.0008 ± 0.0001

Official coordinates/velocities issued by the IERS

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	epoch t_0	Position (m)			Velocity (m/y)		
		X_{IERS}	Y_{IERS}	Z_{IERS}	VX_{IERS}	VY_{IERS}	VZ_{IERS}
ITRF2005	2000.0	4231162.6380 ± 0.0040	-332746.7640 ± 0.0010	4745130.8590 ± 0.0040	-0.0111 ± 0.0009	0.0162 ± 0.0003	0.0134 ± 0.0009
ITRF2000	1997.0	4231162.6770 ± 0.0060	-332746.8250 ± 0.0010	4745130.8370 ± 0.0060	-0.0133 ± 0.0021	0.0184 ± 0.0004	0.0085 ± 0.0022

	epoch t_0	Position (m)			Velocity (m/y)		
		X_{IERS}	Y_{IERS}	Z_{IERS}	VX_{IERS}	VY_{IERS}	VZ_{IERS}
ETRF2005	2000.0	4231162.8110 ± 0.0040	-332746.9060 ± 0.0010	4745130.7040 ± 0.0040	-0.0005 ± 0.0009	-0.0011 ± 0.0003	0.0027 ± 0.0009
ETRF2000	1989.0	4231162.8370 ± 0.0220	-332746.9210 ± 0.0050	4745130.7210 ± 0.0220	-0.0033 ± 0.0021	0.0003 ± 0.0004	-0.0017 ± 0.0022

To obtain the site coordinates at an epoch t different from t_0 apply the site velocities:

$X(t) = X(t_0) + (t-t_0)*V_X$

$Y(t) = Y(t_0) + (t-t_0)*V_Y$

$Z(t) = Z(t_0) + (t-t_0)*V_Z$

BRST_10004M004

Weekly coordinates computed by the EPN Combination Centre

These coordinates are extracted from the most recent weekly combined EUREF solution which is based on the weekly subnetwork solutions submitted by the EPN Local Analysis Centres.

	Position (m)			
	epoch t_0	X_{weekly}	Y_{weekly}	Z_{weekly}
IGS05	2008.0 (Wk No 1463)	4231162.5475 ± 0.0003	-332746.6241 ± 0.0001	4745130.9527 ± 0.0003

Based on most recent solution: EUR14637.SNX.Z

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	epoch t_0	Position (m)			Velocity (m/y)		
		X_{EPN}	Y_{EPN}	Z_{EPN}	VX_{EPN}	VY_{EPN}	VZ_{EPN}
ITRF2005 (from 361/98)	2000.0	4231162.6400 ± 0.0000	-332746.7690 ± 0.0000	4745130.8710 ± 0.0000	-0.0120 ± 0.0001	0.0175 ± 0.0000	0.0100 ± 0.0001
ITRF2005 (from 093/05)	2000.0	4231162.6380 ± 0.0010	-332746.7720 ± 0.0000	4745130.8730 ± 0.0010	-0.0120 ± 0.0001	0.0175 ± 0.0000	0.0100 ± 0.0001
ITRF2005 (from 147/07)	2000.0	4231162.6420 ± 0.0010	-332746.7650 ± 0.0000	4745130.8680 ± 0.0010	-0.0120 ± 0.0001	0.0175 ± 0.0000	0.0100 ± 0.0001
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ETRF2005 (from 093/05)	2000.0	4231162.8060 ± 0.0010	-332746.9230 ± 0.0000	4745130.7080 ± 0.0010	-0.0014 ± 0.0001	0.0003 ± 0.0000	-0.0008 ± 0.0001
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TIME SERIES

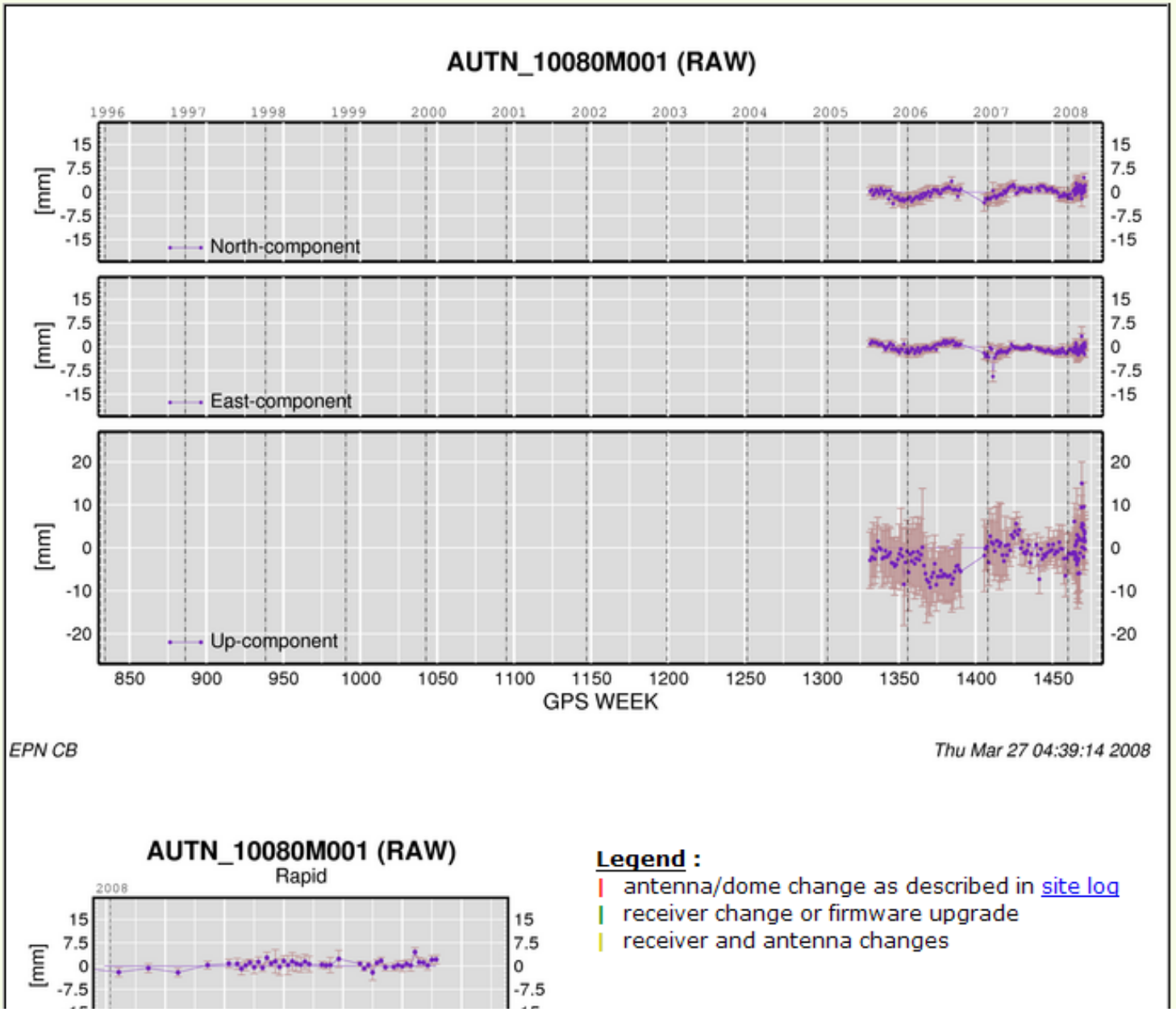
The time evolution of the coordinates of the EPN stations (=coordinate time series) are obtained using four different approaches classified following increasing complexity :

ITRS time series	ETRS89 time series	RAW time series	CLEANED time series
Coordinate Time Series in ITRS extracted from weekly EPN combined solution.	Coordinate Time Series in ETRS89 extracted from weekly EPN combined solution.	Residuals of cummulative coordinate/velocity solution based on the weekly and rapid combined EPN solutions (no corrections) prepared for monitoring the quality of the estimated station coordinates.	Residuals of cummulative coordinate/velocity solution based on weekly EPN combined solution (outliers eliminated and discontinuities corrected) prepared for geokinematic interpretation.
Updated weekly (select a station) Purpose : • Evaluate influence of the different ITRS realisations on the station coordinates • Visualise large periodic signals in EPN combined solution • Easily distinguish between constrained and non-contrained stations in EPN combined solution	Updated weekly (select a station) Purpose : • Evaluate influence of the different ETRS89 realisations on the station coordinates • Visualise common signatures in EPN combined solution • Easily distinguish between constrained and non-contrained stations in EPN combined solution	Updated weekly (select a station) Purpose : • Detect coordinate outliers & coordinate jumps (+ correlation with equipment changes)	Updated periodically (select a station) Purpose : • Elimination of outliers and introduction of offsets indicated in the "RAW" time series. • Velocity estimation based on the cleaned time series.

RAW AUTN_10080M001

OTHER TIME SERIES

Cleaned
ITRS
ETRS89



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TROPOSPHERE PARAMETER ESTIMATION

Within the routine analysis of a network of ground-based GPS receivers, the tropospheric parameters are a by-product of the parameter estimation. These zenith path delays (ZPD) can be used for meteorological purposes in two ways:

- long series of (post-processed) ZPD can be used for climate monitoring and climate research;
- near real-time processing can be used within numerical weather prediction (NWP).

The extended network of EPN permanent stations, with its high number of Local Analysis Centres (LAC), is well suited for contributing to these investigations.
Therefore EUREF decided to create a Special Project "Troposphere Parameter Estimation". Chair of the project is Dr. W. Soehne, Federal Agency for Cartography and Geodesy (BKG), Germany. He is responsible for the project coordination and the generation of the EUREF ZPD product.

Project members and participation

This project is fully suported by the EUREF Local Analayis Centres. They provide ZPD estimates for the EPN stations in the subnetwork they are analysing routinely within the frame of the reference frame maintenance.

The following institutions are participating to the project by delivering different types of solutions (status: GPS week 1119):

Real-time data streams

EUREF Permanent Network

EUREF HOME

EPN CB HOME

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ORGANISATION > PROJECTS > EUREF-IP

EUREF-IP

euref-ip 2002-2007

Today, real-time data streams are part of the EPN routine operations, see Data Access > Real-time

EUREF - Real Time

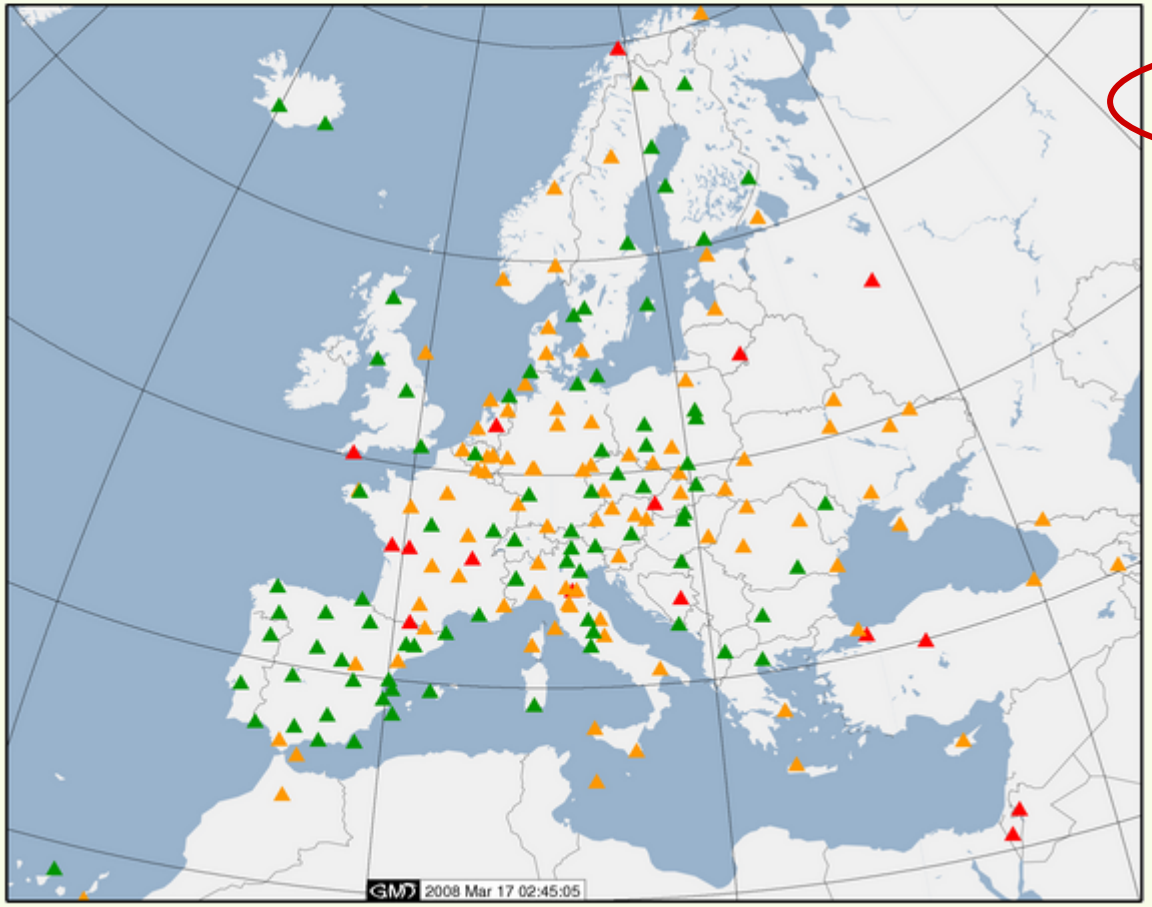
With the increased capacity of the Internet, applications that transfer continuous data streams by IP-packages, such as Internet Radio, have become well-established services. Compared to these applications, the bandwidth required for the transmission of real-time GNSS data is relatively small. Consequently, EUREF decided in June 2002 to set up and maintain a real-time GNSS infrastructure on the Internet using stations of its European GPS/GLONASS Permanent Network EPN. Although today´s primary objective is to disseminate RTCM corrections over the Internet for precise differential positioning and navigation purposes (see Resolution), various other applications are in sight like real-time orbit determination and ionosphere or troposphere parameter estimation.

NTRIP

The service that EUREF wants to establish, called "EUREF-IP" (IP for Internet Protocol), is based on a dissemination standard, called "Networked Transport of RTCM via Internet Protocol" (Ntrip). Ntrip is a generic, stateless application-level protocol based on the Hypertext Transfer Protocol HTTP Version 1.1. It is designed to disseminate differential correction data (e.g. in the RTCM-104 format), or other kinds of GNSS streaming data, to stationary or mobile users over the Internet, allowing simultaneous PC, Laptop, PDA, or receiver connections to a broadcasting host. Ntrip supports Wireless Internet access through Mobile IP Networks like GSM, GPRS, EDGE, or UMTS because of using the TCP/IP protocol. Please visit the Ntrip homepage for further information.

EUREF-IP Network

DATA ACCESS



The GNSS data from the EPN stations are freely available through the internet. Depending on the station data policy, daily (mandatory), hourly (90% of the EPN stations) and real-time (42.3% of the EPN stations) data are made available (see map).

The two Regional Data Centres (RDC), located at BKG (Federal Office of Cartography and Geodesy, Germany) and at OLG (Austrian Academy of Sciences) provide access to the daily and hourly data from all the EPN stations.
The regional EUREF broadcaster www.euref-ip.net makes available the EPN real-time data streams.

green: stations delivering real-time data
orange: stations delivering hourly data
red: stations delivering daily data

REAL TIME DEVELOPMENTS

Below you can find details on the **EPN stations providing free of charge real-time GNSS data** through the Internet using Ntrip. For more details on the EPN real-time activities, please consult the White Paper on Real-Time GNSS in Routine EPN Operations.

Participating GNSS Stations

All EPN stations contributing to the EUREF-IP network follow guidelines specified in Guidelines for EPN Stations and Operational Centres. Depending on the station, the data are made available in different formats: RTCM, SOC or the receiver priopriety format (RPF or RAW). **Operation details for each station are available from here.**
Stations wishing to join the EUREF-IP network should apply to become an EPN station and follow the Procedure for Becoming an EPN Station.

Users

To receive the EUREF-IP real-time GNSS data streams, free Ntrip client software (available for several platforms) can be downloaded from here after completing the user registration. Authorization (user-ID and password) will be provided by BKG which operates the main (regional) EPN (or EUREF-IP) Broadcaster.