EPN Status and New Developments

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Abstract

This document describes the present status of the EUREF Permanent Network (EPN) by concentrating on the major changes to the EPN since the EUREF Symposium of June 2006 held in Riga. The major updates to the EPN guidelines concern the inclusion of specifications for the real-time data streams and calibration of the antenna/radome pairs installed at the EPN stations. The EPN CB quality check programs have been updated to include the checking of GLONASS observations which evidenced tracking problems in some of the GPS/GLONASS tracking stations. The raw time series allow now to monitor the station coordinate with a 1-day delay. Finally, new procedures routinely monitor the latency and meta-data of the real-time data streams.

1. INTRODUCTION

The EUREF Permanent Network (EPN) is a network of continuously operating GPS or GPS+GLONASS reference stations maintained in close cooperation with the IGS (International GNSS Service). The primary purpose of the EPN is to maintain and provide access to the European Terrestrial Reference System (ETRS89) and EUREF does this by making publicly available the tracking data as well as the precise coordinates of all the EPN stations.

While all contributions to the EPN are voluntary, the reliability of the network is based on the principle of redundancy together with extensive guidelines guaranteeing the consistency of the raw GNSS data to the resulting station coordinates. Next to its key role in the maintenance of the ETRS89, the EPN supports a wide range of scientific applications such as geodynamics, sea level monitoring and weather prediction.

The EPN Central Bureau (CB), headed by the network coordinator, 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. The EPN CB maintains and verifies the correctness of the station meta-data information, monitors the quality of the RINEX data, the data flow and the station coordinates and sends notification emails to station operators when abnormal conditions occur. It makes all this information available through its website http://epncb.oma.be/.

2. STATUS OF THE EUREF PERMANENT NETWORK

Today, the EPN network consists of 200 continuously operating GPS or GPS+GLONASS reference stations (Figure 1). The 11 new EPN stations that joined the EUREF network since June 2006 are indicated with circles in Figure 1. All of them submit hourly data, three of them stream data in real-time and five are equipped with a GPS/GLONASS receiver.

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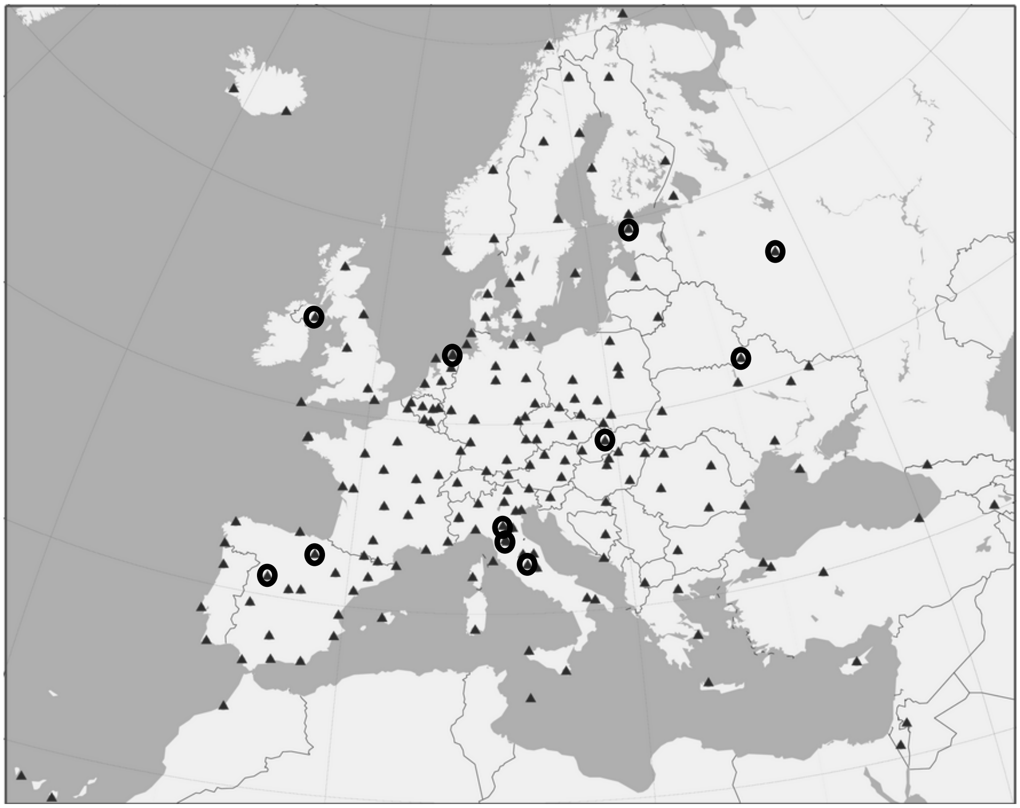


Figure 1 – EUREF permanent tracking network (status June 2007); the circles indicate the stations added to the network after June 2006.

Station	4char-ID	Country	Date inc.				
Zaragoza	ZARA	Spain	25-June-2006	H	RT		ABS
Tallin	SUUR	Estonia	01-Oct.-2006	H			ABS
Chernihiv	CNIV	Ukraine	29-Oct.-2006	H			ABS
Salamanca	SALA	Spain	12-Nov.-2006	H	RT		ABS
Borkum	BORJ	Germany	04-Dec.-2007	H	RT	GLO	IABS
Belfast	BELF	United Kingdom	28-Jan.-2007	H			ABS
Firenze	IGMI	Italy	28-Jan.-2007	H		GLO	ABS
Banska Bystrica	BBYS	Czech Republic	04-Feb.-2007	H			ABS
Mendeleevo	MDVJ	Russia	04-Mar.-2007	H		GLO	ABS
Terni	UNTR	Italy	04-Mar.-2007	H		GLO	REL
Modena	MOPS	Italy	23-Apr.-2005	H		GLO	ABS

Table 1 - Tracking stations added to the EPN since June 2006, H: stations providing hourly data, RT: stations streaming real-time data, GLO: stations equipped with GPS+GLONASS receivers, ABS: stations with antenna/radome with true absolute type calibrations; IABS: stations with antenna/radome with true individual absolute calibrations, REL: stations with antenna/radome with absolute type calibrations converted from relative calibrations (more details in Section 4).

EPN stations make available the following GNSS data:

- All EPN stations make mandatory 30-sec RINEX files available on a daily basis. The latency of these files should be below the latency of the IGS final orbits (2 weeks) so that the station data can be incorporated in the different subnetworks processed by the analysis centres as soon as the IGS precise orbits become available.
  The EPN CB routinely checks the availability and meta-data of these files.

- 84% of the EPN stations provides today in addition RINEX data in hourly batches. The maximum latency that is accepted is 10 minutes so that the data can still be used for near real-time applications like EGVAP.
  The EPN CB routinely checks the latency of the hourly data files, but no meta-data checks are performed.
- 26% of the EPN stations provides real-time GNSS data in several formats. Both the latency and meta-data are checked routinely by the EPN CB (see section 8 for more details).

Both the hourly and daily tracking data are available through the two EPN Regional Data Centres located at BKG and OLG. The real-time data streams can all be accessed through the EPN Regional Broadcaster at BKG. Figure 2 shows which stations are submitting real time data streams, hourly data and daily data.

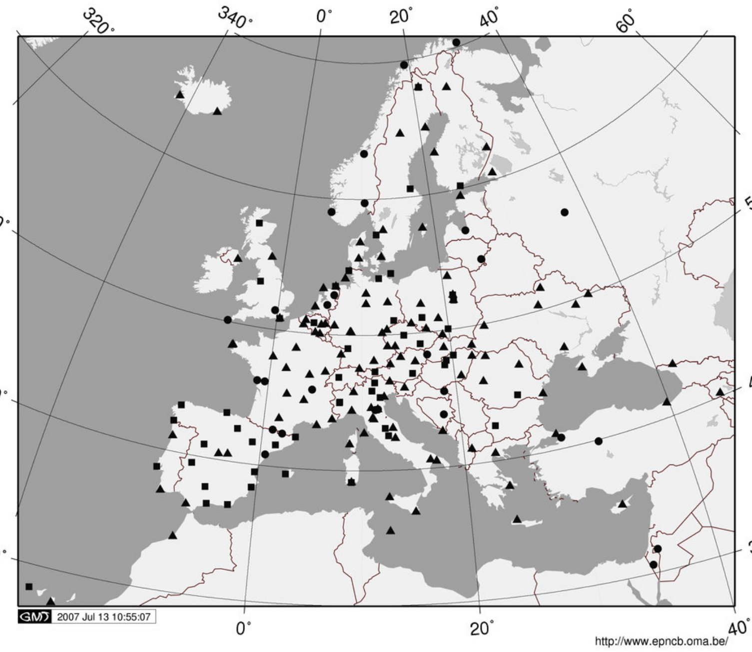


Figure 2 – EPN stations classified following data flow. Stations indicated with a square stream data in real-time. Stations indicated with a triangle make available hourly data and stations indicated with a circle make available daily data only.

3. New EPN guidelines for stations streaming real-time data

In Dec. 2006, the EPN guidelines have been extended in order to include guidelines for those stations streaming real-time data (see http://epncb.oma.be/_organisation/guidelines/). To accommodate for these new data streams, three new components were introduced in the EPN:

1.1 Network Components

- **Local Broadcaster (LB):** It receives the real-time data streams from the stations in a local network and disseminates them, without changing them, on request to clients. Clients may be users, monitoring tools, data centers, or analysis centers.
- **Regional Broadcaster (RB):** It receives all the EPN real-time data streams and disseminates them, without changing them, on request to clients. Clients may be users, monitoring tools, data centers, or analysis centers.
- **High Rate Data Centre (HDC)**: It collects the real-time data from all EPN stations, archives them in RINEX format and makes them available to the users.

The EUREF regional broadcaster can be accessed through the address www.euref-ip.net and it is maintained by BKG. The high rate data centre is under development and is expected to be operational in the near future.
The guidelines then define the real-time data flow as follows:

3.3 Real-time Data Flow

3.3.1 For standard operations the data should be sent in real-time using the Ntrip-client software (http://igs.bkg.bund.de/index_ntrip.htm) to the Regional Broadcaster. The minimal requirement for data submission is 1 Hz containing full code and carrier phase observations.

3.3.2 After a communication outage or reception of a NABU message, the data flow should be restored as quickly as possible, preferable using an automated procedure.

Additionally desired characteristics are:

3.3.3 In addition to the data upload to the Regional Broadcaster, stations are encouraged to upload their data to a Local Broadcaster.

EPN real-time data streams should mandatory include full code and carrier phase information. More details are in the guidelines:

3.7 Format of real-time data

3.7.1 EPN real-time data streams must contain code and carrier phase observations and therefore only formats allowing this possibility are accepted, eg RTCM (2.1, 2.2, 2.3, 3.0 or 3.1, see http://www.rtcm.org/), some raw data formats or the SOC data format, developed by the IGSRT working group (see http://igscb.jpl.nasa.gov/projects/rtwg/). Raw data formats and the SOC data format are only accepted if the software to convert the format to RINEX is freely available for several platforms (eg teqc).

3.7.2 RTCM code and phase observations should not be corrected to refer to the antenna reference point (correction is typically known as the antenna phase center correction).

3.7.3 Stations streaming RTCM2.x (x=1, 2, 3) must at least stream message types 3, 18 and 19 (see Table 1).
The coordinates in message type 3 should be in accordance with the agreed upon coordinate table available from the EPN Central Bureau.
If other message types containing meta-data are streamed, their information should be in full accordance with the site log information, and antenna description and calibration file available from the EPN CB.

Message type	Content
3	(X,Y,Z) coordinates of antenna phase center, cm-precision
18	Code data
19	Carrier phase data
22	(dX, dY, dZ) corrections to message 3 coordinates to achieve mm-precision for L1 and L2 antenna phase center + height of antenna phase center above marker
23	Antenna and radome type definition
24	(X,Y,Z) coordinates of the antenna reference point

Table 1: RTCM 2.x (x=1, 2, 3) message types

3.7.4 Stations streaming RTCM3.x (x=0,1) must at least stream message types 1004 (use 1003 only if 1004 is not available), 1006 (or 1005) and 1008 (or 1007) (see Table 2). GPS/GLONASS stations streaming RTCM 3.x should stream in addition message type 1011 (use 1012 only if 1011 is not available).
The coordinates in message type 1006 (1005) should be in accordance with agreed upon coordinate table available from the EPN Central Bureau.
If other message types containing meta-data are streamed, their information should be in full accordance with the site log information, and antenna description and calibration file available from the EPN CB.

Message type	Content
1003	GPS code and carrier phase observations
1004	GPS code and carrier phase observations + CNR (carrier to noise ratio) + code ambiguity
1005	(X,Y,Z) coordinates of the antenna reference point
1006	(X,Y,Z) coordinates of the antenna reference point + height of antenna reference point above marker
1007	Antenna and radome type definition
1008	Antenna and radome type definition + antenna serial number
1011	GLONASS code and carrier phase observations + CNR (carrier to noise ratio) + code ambiguity
1012	GLONASS code and carrier phase observations

Table 2: RTCM 3.x (x=0,1) message types

Additionally desired characteristics are:

3.7.5 The preferred format for real-time data streams is RTCM3.x (x=0,1) and stations are encouraged to use this format.

3.7.6 Stations streaming RTCM 2.x (x=1, 2, 3) are encouraged to stream messages types 22, 23 and 24 in addition to message types 3, 18 and 19.

4. NEW EPN GUIDELINES CONCERNING ACCEPTED ANTENNA/RADOME COMBINATIONS

Since GPS week 1400 (Nov. 2006), the IGS is using absolute corrections for modelling the antenna phase centre (APC). In order to keep its consistency with the IGS, the EPN analysis centres also switched to the usage of absolute APC models in November 2006.

Two types of absolute antenna phase centre corrections are presently available:

- APC models based on true absolute calibrations (e.g. robot calibrations). Here we have to distinguish between type calibrations (valid for all antennae/radomes of a specific type) and individual calibrations (valid only for a specific antenna/radome with a given serial number). Today the robot calibrations are performed by the firm GEO++. GEO++ has given the IGS the permission to publish freely the type calibrations it computes for the antenna/radome combinations used in the IGS network. These values are available from the igs05.atx file from the IGS CB web-site. However, GEO++ does not allow EUREF to do the same and as a consequence, EUREF can only use the type calibrations available through the IGS. This means that if an antenna/radome combination is used in the EPN, but not (yet) in the IGS, EUREF cannot distribute freely the type calibrations computed by GEO++ for that antenna/radome calibration. To find a solution to this problem, the individual antenna calibrations can help. The individual antenna calibrations can be freely distributed by each station manager under the condition that he can guarantee that these individual calibrations are only used with the specific individual antenna/radome from which they have been derived. EUREF can distribute these individual calibrations to the users of the EPN data as long as the users agree with the condition mentioned above. The EPN CB therefore maintains and makes available the password-protected file epnc_05.atx containing the individual calibrations of some of the EPN stations (see http://epncb.oma.be/_trackingnetwork/equipment_ calibration/ to request the password to access this file).

- APC models obtained from a conversion of the old relative models. These converted models are less precise than the true absolute models because they are only valid for elevations above 10° and they do not have azimuthal dependencies like the absolute values obtained from robot calibrations.

The antenna/radome combinations presently installed within the EPN must have absolute calibrations (taking radome into account). Table 3 gives an overview of the situation in the EPN. Presently some older antenna/radome combinations do not have any absolute calibrations. In that case the absolute calibration of the antenna type, but with radome 'NONE' are applied. It is clear that a modeling error is made in this case. The updated EPN guidelines try to remove this equipment gradually from the EPN by imposing that when an antenna/radome is replaced, the new equipment should have true absolute calibrations. In addition, since Dec. 6, 2006 all stations proposed to the EPN are only accepted if their antenna/radome combination has true absolute calibration (taking radome into account). These can be type calibrations from the igs05.atx maintained by IGS or individual calibration from the epnc_05.atx file maintained by EPN CB.

Exceptions are only allowed for antenna/radome pairs where the effect of radome on phase center is negligible, or antenna/radomes which cannot be calibrated, or stations that provide a clear added-value to the EPN.

As we could see in Table 1, all new EPN stations have today true absolute antenna calibrations with the exception of the station UNTR which was already proposed to the EPN before Dec. 6, 2006.

STATIONS WITH ANTENNA/RADOME WITH INDIVIDUAL ABSOLUTE CALIBRATIONS		
AOAD/M_T	NONE	WTZR
LEIAT504	LEIS	TUBO
LEIAT504GG	LEIS	HOBU
TPSCR3_GGD	CONE	BORJ DRES HOE2 SASS WARN
TRM29659.00	NONE	KLOP
TRM29659.00	SNOW	BORK
TRM41249.00	NONE	BADH
TRM55971.00	NONE	GANP
STATIONS WITH ANTENNA/RADOME WITH ABSOLUTE TYPE CALIBRATIONS (FROM ROBOT)		
AOAD/M_B	NONE	METS
AOAD/M_T	NONE	ANKR BOR1 MAS1 MORP NICO NPLD OBE2 ORID POTS REYK SOFI SUUR TRO1 VILL ZECK
ASH700936A_M	NONE	AJAC SJDV VLNS
ASH700936C_M	SNOW	BOGO
ASH700936D_M	NONE	RIGA
ASH700936D_M	SNOW	BUCU DRAG DUBR HELG ISTA NEWL TRAB
ASH700936E	NONE	HERS
ASH700936E	SNOW	INVE OSJE PTBB
ASH701073.3	NONE	MLVL
ASH701945B_M	NONE	BRUS CHIZ COST LROC
ASH701945C_M	NONE	DENT DOUR IENG KELY REDU
ASH701945C_M	SNOW	BOGI KATO KIRU KRAW ZYWI
ASH701945E_M	NONE	GRAS WARE
ASH701946.2	NONE	HERT
JPSREGANT_DD_E	NONE	CAGZ MDVJ UNPG
LEIAT504	LEIS	ACOR AUT1 BACA BAIA BELF BSCN BZRG COBA DARE DEVA EGLT GSR1 GUIP NOA1 PLYM ROVE SVTL VFCH
LEIAT504	NONE	BRST CASC FATA GAIA LAGO LILL PDEL TARS TUC2
LEIAT504GG	LEIS	WROC
LEIAT504GG	NONE	MOPS
TRM14532.00	NONE	JOZE NYIR
TRM22020.00+GP	NONE	SRJV
TRM29659.00	NONE	ALAC ALME AQUI BELL CAGL CAME CANT CNIV EBRE ELBA EUSK EVPA GENO GLSV GRAZ HOFN IGMI KARL KHAR LAMP LLIV MATE MEDI MILO NOT1 NOTO OSLS PADO POLV PRAT PULA RIOJ SFER TLSE TORI UZHL YEBE ZIMM
TRM29659.00	TCWD	CACE CEUT LPAL MALA MALL VALE VIGO ZARA
TRM41249.00	NONE	BBYS CREU MIKL PENC SULP
TRM55971.00	NONE	OSLS STAS TRDS
STATIONS WITH ANTENNA/RADOME WITH ABSOLUTE TYPE CALIBRATIONS CONVERTED FROM RELATIVE MODELS		
ASH700936A_M	SNOW	JOEN VAAS
ASH701941.B	NONE	VENE
ASH701945B_M	SNOW	RAMO

ASH701945C_M	SCIT	ZOUF
ASH701945E_M	SCIS	AUTN ENTZ MARS PUYV QAQ1
LEIAT302+GP	NONE	BOLG
LEIAT303	NONE	MANS
LEISR399_INT	NONE	MSEL
TPSCR3_GGD	CONE	COMO GOPE POUS SNEC
TPSCR3_GGD	NONE	UNTR
TRM14532.10	NONE	OROS
TRM29659.00	SCIS	RABT VARS
TRM29659.00	UNAV	DELF EIJS LINZ TERS TUBI
TRM33429.20+GP	TCWD	BUTE
STATIONS WITH ANTENNA/RADOME WITHOUT ABSOLUTE CALIBRATIONS		
AOAD/M_B	DUTD	KOSG
AOAD/M_B	OSOD	ONSA
AOAD/M_T	DOME	IAVH
AOAD/M_T	DUTD	SODA WSRT
AOAD/M_T	OSOD	KIR0 MAR6 SKE0 SPT0 VIL0 VIS0
ASH700936F_C	SNOW	LAMA
ASH701073.1	SCIS	THU3
ASH701073.1	SNOW	NYA1
ASH701941.1	SNOW	WROC
ASH701941.B	SNOW	JOZ2
ASH701941.B	UNAV	BUDP SMID
ASH701945C_M	GRAZ	PFAN
ASH701945C_M	UNAV	NSSP
ASH701945E_M	UNAV	SULD
ASH701946.2	SNOW	BISK MARJ VACO
LEIAT504	GRAZ	TRFB
TPSCR3_GGD	GRAZ	SBGZ
TRM14532.00	DOME	MOPI
TRM29659.00	DOME	ESCO
TRM29659.00	GRAZ	HFLK

Table 2 – Antennae/radomes used today within the EPN.

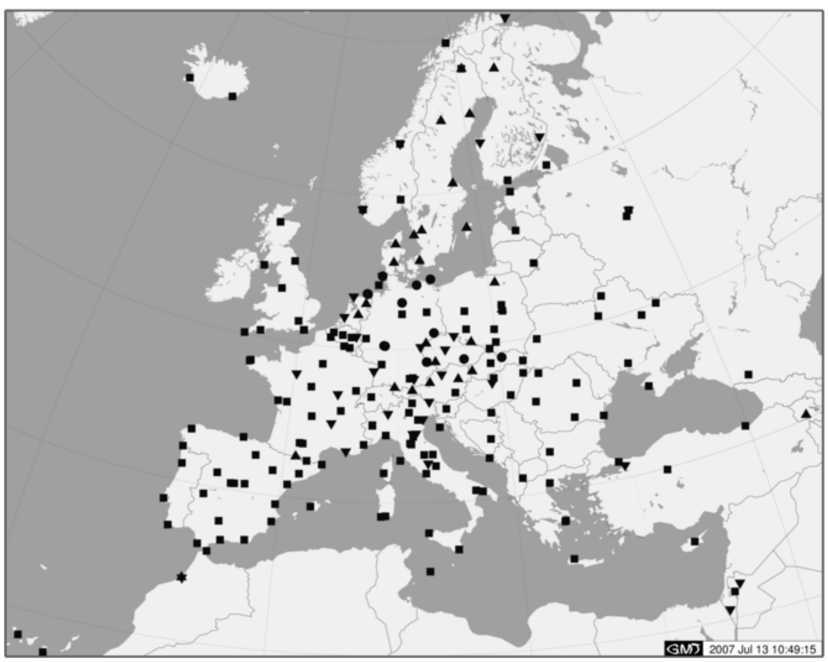


Figure 3 – EPN stations classified following availability of absolute calibrations for their antenna/radome pair. Circles: stations with antenna/radome with individual absolute calibrations, squares: stations with antenna/radome with true absolute calibrations, inverse triangles: stations with antenna/radome with absolute calibration converted from relative and triangles: stations with antenna/radome without any absolute calibration.

5. GPS/GLONASS Tracking

The operation of multi-GNSS receivers (GPS+GLONASS) is stimulated within the EPN. Today 37 EPN stations provide GPS+GLONASS observations and two of the EPN Analysis Centres (LPT and ROB) process, since November 2006, both GPS and GLONASS data for their contribution to the combined EPN solution.

To account for this new evolution, the EPN CB has upgraded its quality check software. The graphs that display the monthly snapshots of the satellites tracked at each station also include now the GLONASS satellites. These results are obtained by using the GLONASS broadcast orbits.

Examples of the generated graphs are given in Figure 4 for the GPS+GLONASS station SKE0 in Sweden.

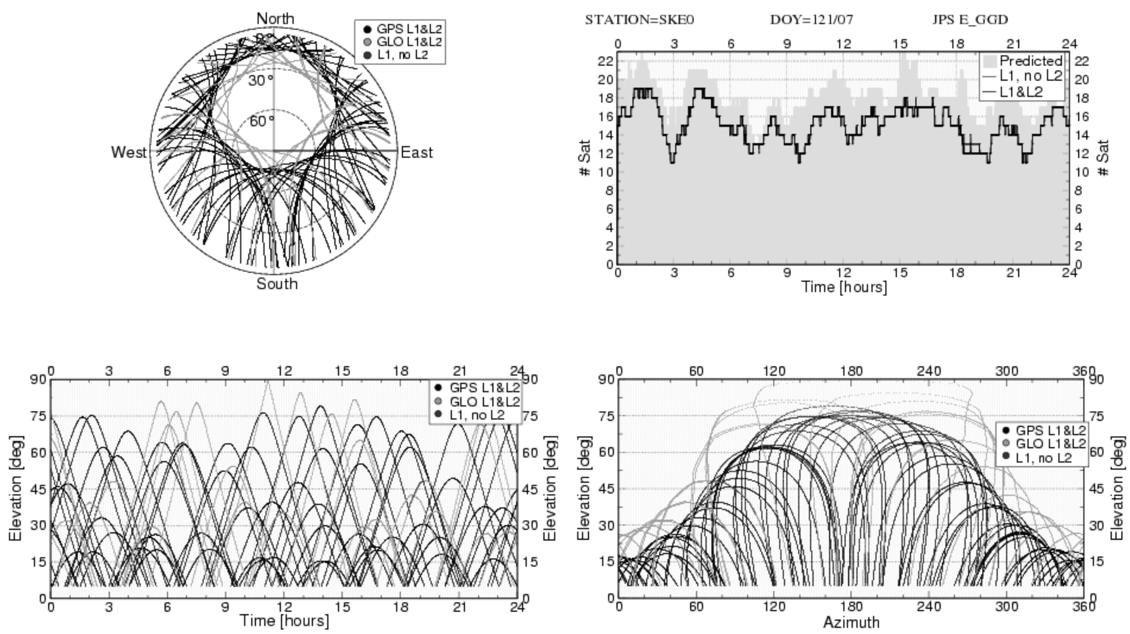


Figure 4 – Left: Azimuth and elevation of the tracked GPS and GLONASS satellites; Top-right: Number of predicted visible GPS+GLONASS satellites; Bottom-right: Elevation versus time of the observed GPS and GLONASS satellites.

The quality graphs that are computed using teqc have not been updated because the teqc software (http://facility.unavco.org/software/teqc/teqc.html) is not able to perform a quality check of the GLONASS observations. But, even in its present form, the percentage of observed versus predicted number of observations, as given by teqc for GPS can provide us interesting information, even for GPS+GLONASS tracking stations. An example is shown in Figure 5 for the EPN station WROC in Poland where an ASHTECH Z-18 receiver was replaced by a LEICA GRX1200GGPRO receiver. Both receivers track GPS as well as GLONASS signals, but the due to the number of channels attributed in the ASHTECH Z-18 receiver to the GPS satellites, it did clearly not track all visible GPS satellites. As a consequence, more that 10% of the GPS satellites above 15° of elevation were not tracked and about 30% of the GPS satellites above the horizon were lost. The fact that this effect is not station-dependent, but receiver-dependent, is illustrated by the similar values for the station HERT (UK) where also an ASHTECH Z-18 receiver is installed. Other stations affected are BISK, GOPE, JOZ2, MARJ, VACO, and VENE.

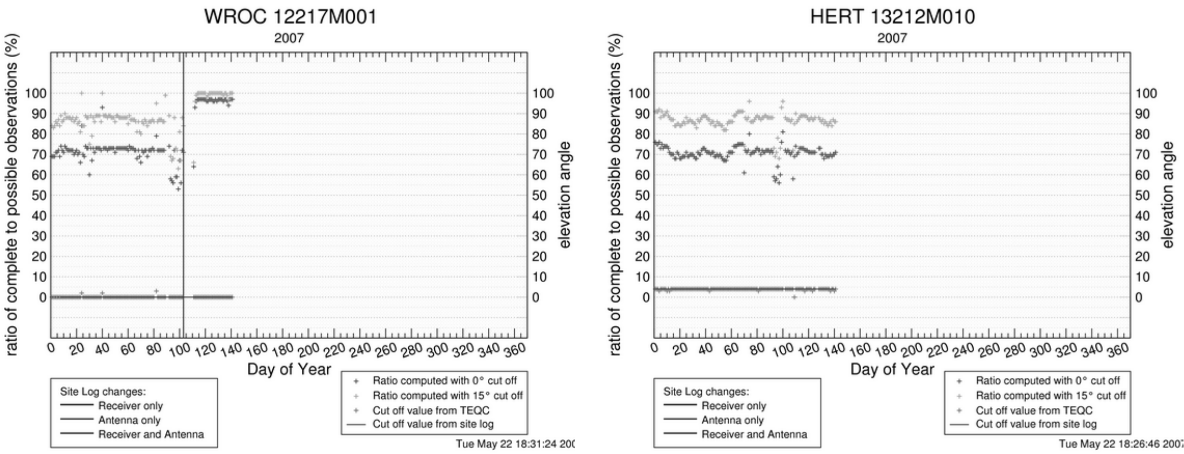
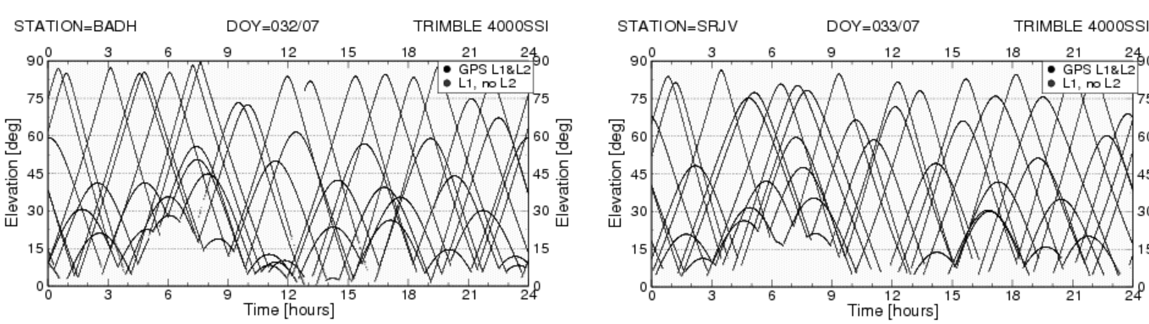


Figure 5 – Percentage of the number of complete observations (both the L1 and L2 frequencies are observed) with respect to the number of predicted observations. The percentage in light grey is computed for a fixed elevation cut off angle of 15°. The percentage in grey is computed for a fixed elevation cut off angle of 0°. Left: the EPN station WROC; Right: the EPN station HERT.

Another problem appearing for a specific GPS+GLONASS receiver (LEICA GRX1200GGPRO) is that depending on the version of the receiver firmware, the station is not tracking GLONASS satellites at all (station HOBU, firmware 5.00/3.013) or tracking one day GPS only and another day GPS+GLONASS satellites (station MOPS, firmware 4.10/3.012) or tracking GPS+GLONASS without any problems (stations WROC, firmware 5.10/3.013).

6. GPS TRACKING FOR OLDER 9-CHANNEL RECEIVERS

The majority of GPS receivers presently operated within the EPN have 12 or more channels. However, some older receivers like the TRIMBLE 4000SSI (or SSE) exist in a 9-channel version. Figure 6 shows the elevations of the GPS satellites observed at several EPN stations operating a TRIMBLE 4000SSI/SSE receiver for day of year 32, 33 or 34 of 2007. As we can see, all plots show that between 4:00AM and 10:00AM low elevation satellites, up to an elevation of 20°, are not tracked. From Figure 7, we can see that the decrease of tracked satellites at low elevations is correlated with the number predicted of satellites which exceeds 13 for the specific period. What happens is that the receiver firmware selects the 9 satellites to be tracked based on their elevation and keeps the satellites with the highest elevations. In the 8-channel ROGUE SNR-8000 receivers, the receiver firmware uses another algorithm for the selection of the satellites to be tracked as can be seen from Figure 8.



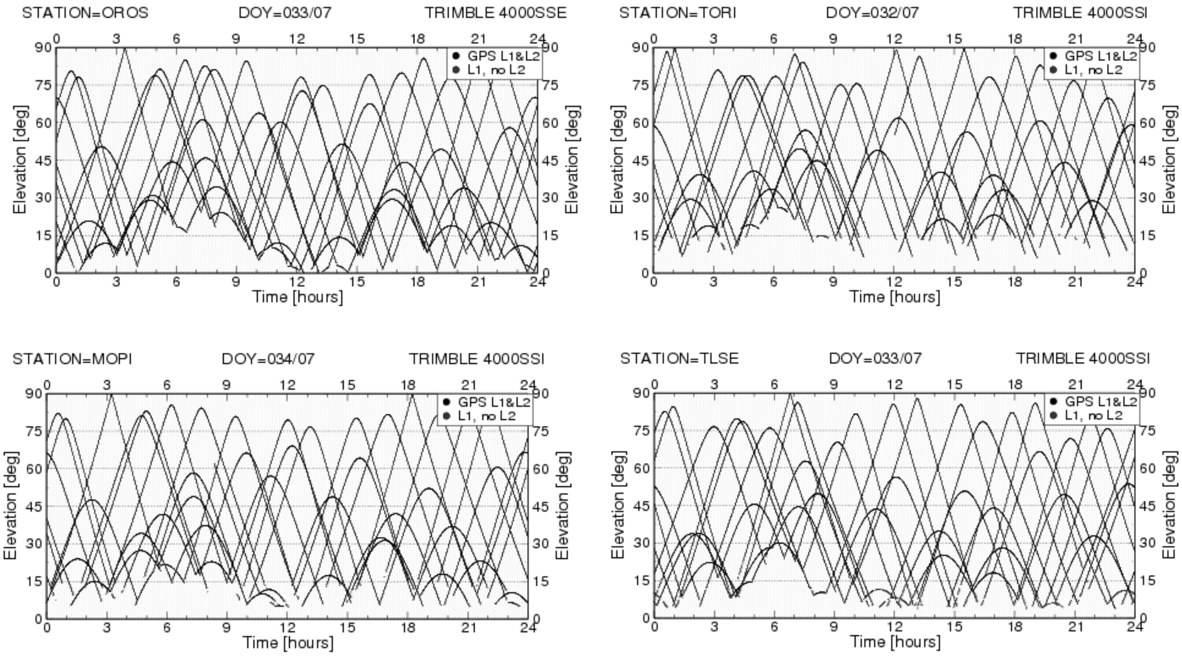


Figure 6 – Elevations of the satellites observed in the stations BADH (Germany), SRJV (Croatia), OROS (Hungary), TORI (Italy), MOPI (Czech Republic) and TLSE (France).

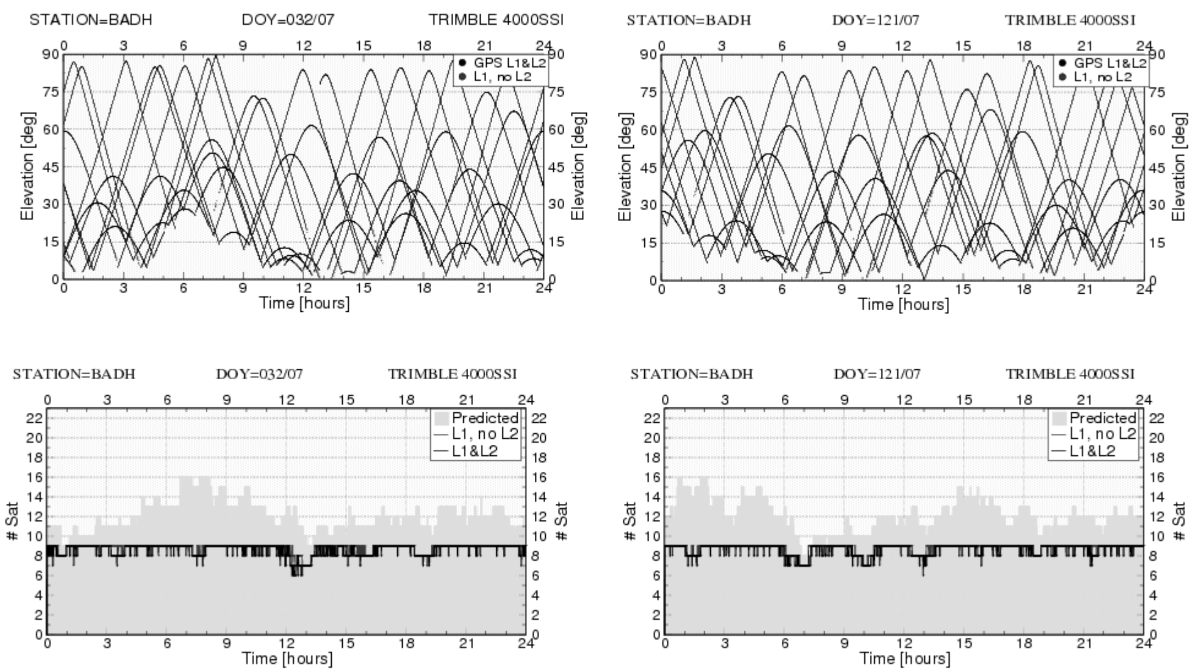


Figure 7 – Top: Elevation of the satellites observed at BADH on DOY 37/2007 (left) and DOY 121/2007 (right). Bottom: Predicted number of visible GPS satellites and actual number of observed satellites at BADH on DOY 37/2007 (left) and DOY 121/2007 (right).

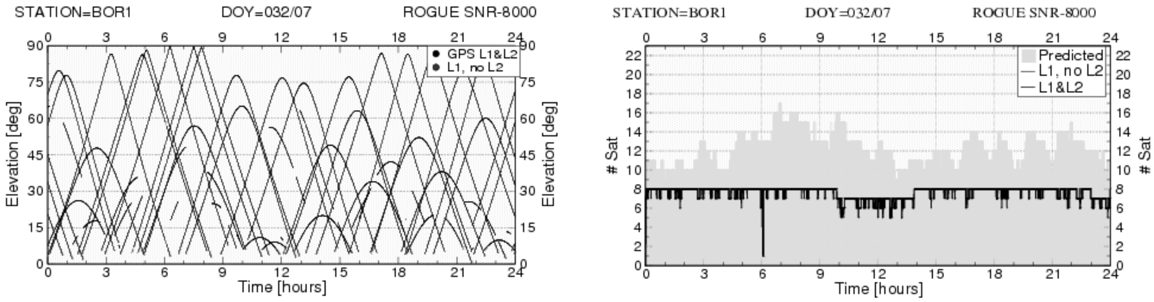


Figure 8 - Left: Elevation of the satellites observed at BOR1 on DOY 32/2007. Right: Predicted number of visible GPS satellites and actual number of observed satellites.

7. RAPID MONITORING OF STATION COORDINATES

The latency of the combined EPN solution is about 1 month and can grow up to 4 months. This solution is consequently not suitable to provide a rapid monitoring of the EPN station coordinates. Today, 7 LACs are submitting daily SINEX files computed using the IGS final orbits and 4 (ASI, BKG, IGE, ROB) using the IGS rapid orbits. These last solutions have typically a 1-day latency. At BKG, each of these solutions is combined together each day to create a daily combined EPN solution. The daily solutions based on final orbits are combined with a delay of 30 days and the daily solutions based on the rapid orbits are combined with a delay of less than a day.
The EPN CB is using the daily solutions to complement the raw time series which were previously obtained using weekly EPN solutions only. In this way, the plots provide the necessary information to perform a quick monitoring of the EPN station coordinates. The new raw time series are updated daily but since today just 4 LACs are contributing to this rapid solution, about half of the EPN stations are not included in the rapid solution.

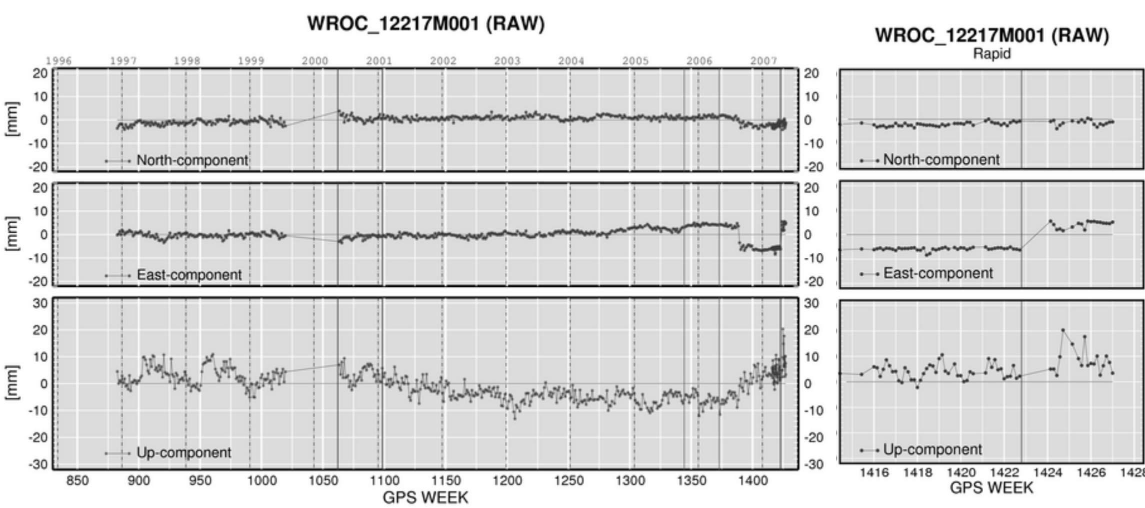


Figure 9 – Raw coordinate time series for the station WROC. The plot on the left shows a zoom on the last rapid solutions for this station.

8. MONITORING OF REAL-TIME DATA STREAMS

The real-time data streams provided by the EPN stations are monitored by both BKG and the EPN CB. The EPN CB concentrates its monitoring on the verification of the meta-data included in the stream and the data latency.

The directory ftp://epncb.oma.be/pub/station/real_time/ contains the results of a regular monitoring (typically each 2 hours) of the latency and the meta-data of the EPN real-time data streams available from www.euref-ip.net. The following files are available:

1. **monitor.ant** (for RTCM data streams) showing the agreement of antenna/radome information contained in the stream with the site log information. Streams with erroneous information are indicated by an "*".
2. **monitor.coord** (for RTCM data streams) showing the agreement of the coordinate and antenna height information (see Figure 10) contained in the stream (STR) with the official EPN coordinates (REF). The label APC indicates that the coordinates refer to Antenna Phase Center and the label ARP indicates that the coordinates refer to Antenna Reference Point. All values are given in meters. Streams with erroneous information are indicated by an "*".
3. **monitor.latency** indicating the latency of the code and phase observations
4. **monitor.error** providing a summary of the errors found in the real-time data streams

In addition, the file **monitor.rec** compares the receiver type input in the caster source table with the receiver type mentioned in the site log.

Station coordinates, antenna height and antenna type are only checked for streams in the RTCM format and the check is based on the following Message Types:

- For RTCM 2.2 and 2.3: Message Type 3, 22, 23 and 24
- For RTCM 3.0: Message Type 1005, 1006, 1007 and 1008

The meta-data in the streams are compared to reference values for

- the antenna and radome type (including serial numbers) extracted from the site logs available from ftp://epncb.oma.be/epncb/station/log .
- station coordinates are extracted from the solutions of the EPN Special Project for Time Series Monitoring ftp://epncb.oma.be/pub/station/coord/EPN/EPN_ITRF_XYZ.SSC . For recent stations without coordinates computed by the Special Project, coordinates are extracted from the weekly EPN solution (label WEEK). If these are not yet available, the coordinates are extracted from the site log (label NEW). All coordinates are given in the ETRS89 at epoch 2007,0 (realization ETRF2005). The file ftp://epncb.oma.be/pub/station/coord/EPN/RTCM.CRD gives a list of these coordinates.
- The height of the antenna reference point above the station marker (MRK→ARP) is extracted from the site log
- The height of the antenna reference point above the station marker (MRK→APC) is extracted from the site log and the file ftp://igscb.jpl.nasa.gov/pub/station/general/igs05.atx containing the absolute antenna calibrations

In addition to these data files, the individual station web-pages now also indicate now information on the availability and latency of the real-time data streams as shown in Figure 11.

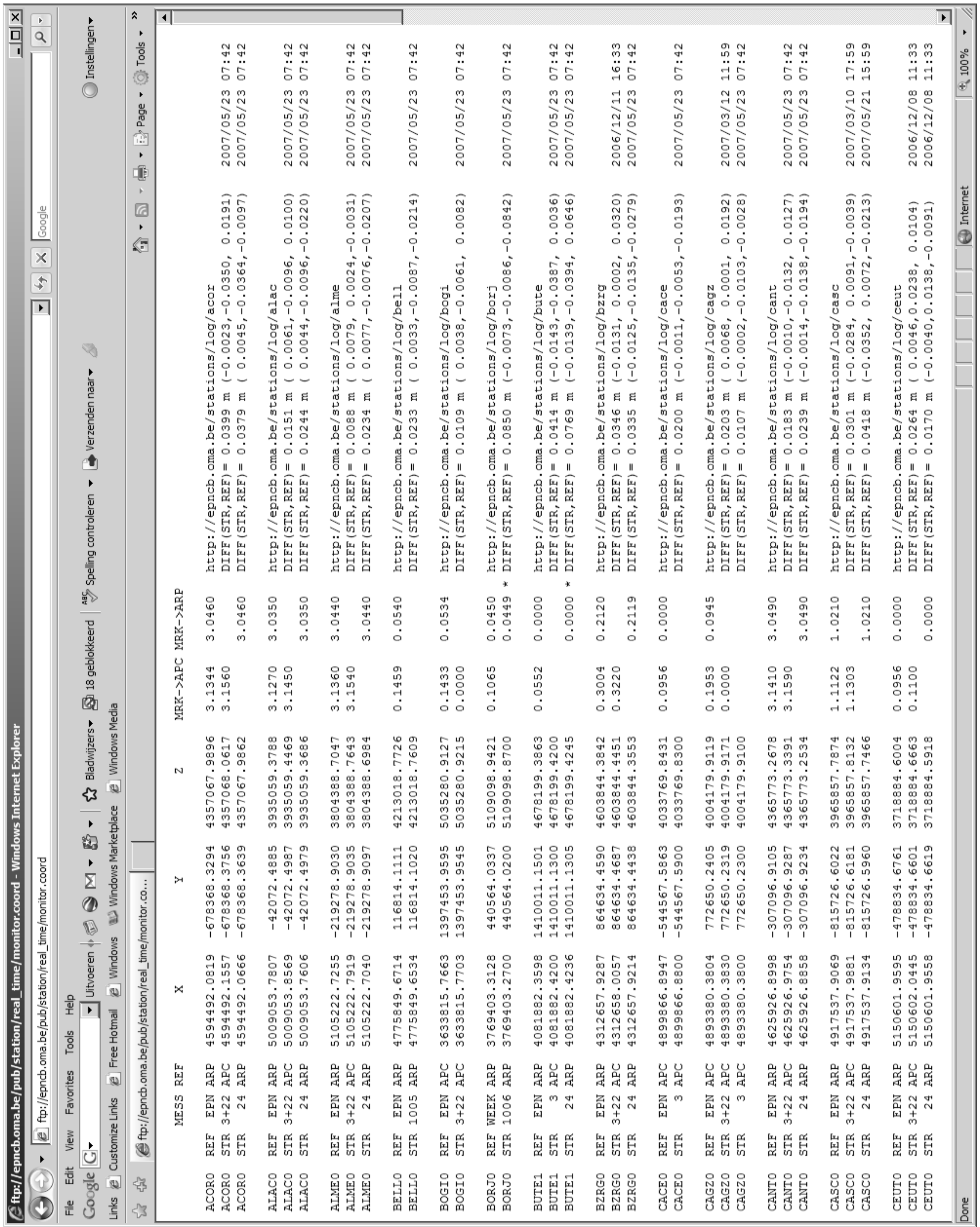


Figure 10 – Extract of the `monitor.coord` file available from the EPN CB and giving an overview of the coordinate-related meta-data in the real-time data streams.

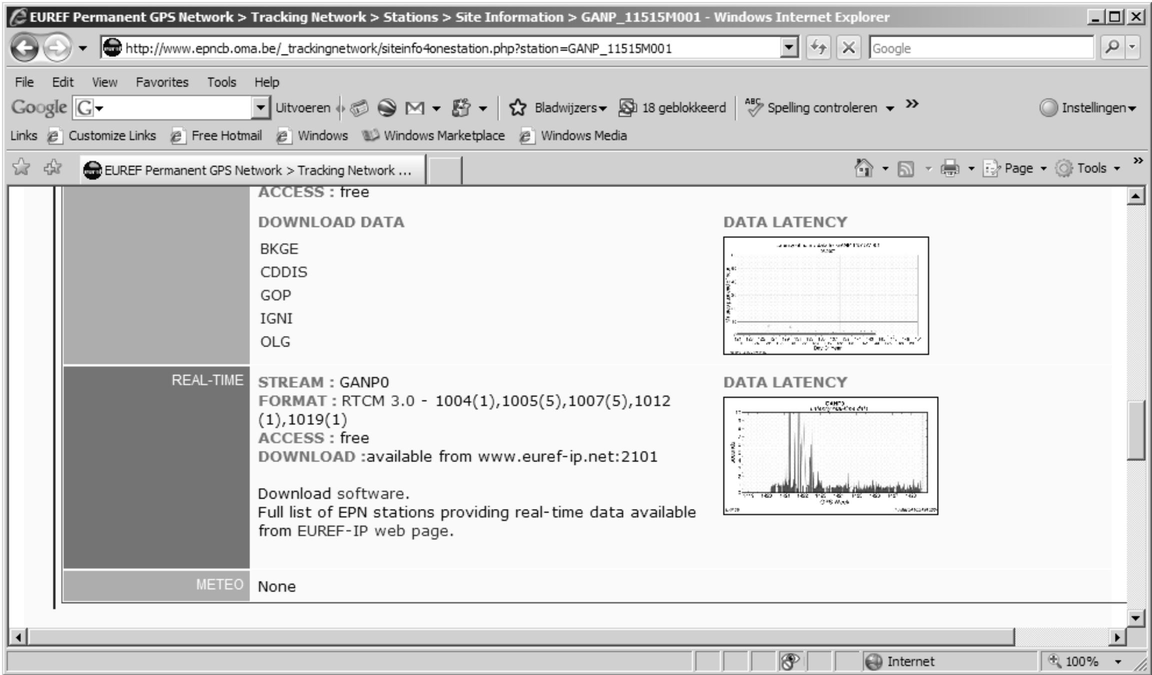


Figure 11 – Information on the real-time data stream extracted from the individual station web-page for the station GANP.

9. EPN REPROCESSING

Since the first EPN solutions in the beginning of 1996, numerous model changes related to the satellites, the propagation media, the receiver units or geophysical phenomena such as tidal forces, and loading related to ocean, have changed in time in the EPN processing. As a consequence, the time series of EPN products (coordinates and ZTD) are inhomogeneous and e.g. EPN positions based on the combined EPN weekly solution can show artificial variations that are not related to the true ground motions. For that reason, several of the EPN analysis centres have reprocessed, or are in the process of reprocessing, the subnetwork they routinely submit to EUREF. Figure 12 shows the example of the reprocessing done at the ROB analysis centre for the station Waremme (Belgium) in comparison with the EPN raw time series for that station. The improvement is clearly visible.

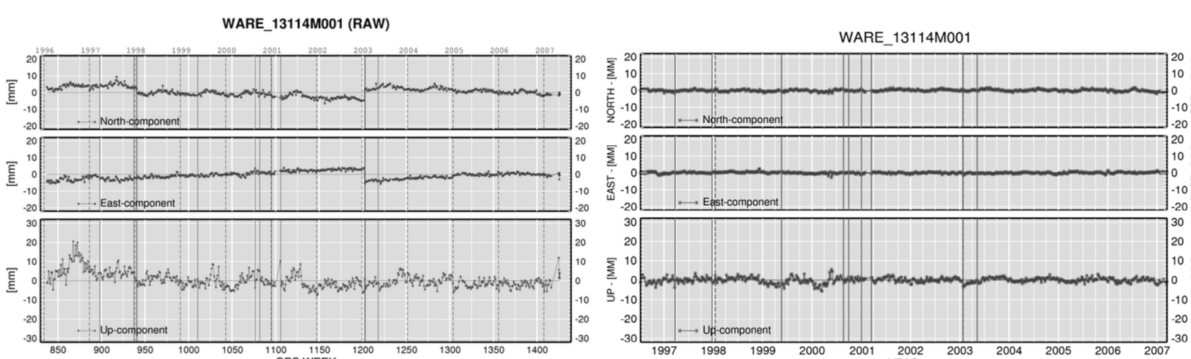


Figure 12 – Coordinate time series for the station WARE (Waremme, Belgium). Left: raw times series, right: reprocessed time series.

10. SUMMARY

Since last year, 11 new EPN stations joined the EPN bringing the total number of EPN station to 200. In Dec. 2006 the EPN station guidelines have been updated in order to include guidelines for stations providing real-time data streams. Also the specifications for the antenna/radome combinations used within the EPN have changed: today all antenna/radomes introduced within the EPN must have true absolute calibrations (taking radome into account).
Since recently two of the EPN analysis centers routinely process GPS and GLONASS data for their data submission to the EPN. Also the EPN CB has extended its quality checks in order to also monitor the GLONASS data. The EPN CB also updated it raw time series in order to include the results of the new rapid daily combined solutions provided by BKG in its plots. This allows station managers to quickly check the coordinates obtained for their station.

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