Activity Report from the NKG EPN Analysis Center for the period 1998-2002

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Introduction

A decision was taken in May 1996 to establish the NKG Regional GPS Data Analysis Centre for EUREF/IGS. The NKG EPN Analysis Center (NKG EPN AC) is a co-operation within the WG of Satellite Geodesy (1996-98 in the WG of Permanent geodetic stations).

Since October 1996, NKG has contributed to the continuous processing, based on daily solutions, of the EUREF Permanent Network (EPN). The actual processing contributing to the EUREF EPN Analysis was until year 2001 performed at the Onsala Space Observatory and from year 2002, the National Land Survey of Sweden runs this processing. In this presentation we report on the station network, data flow, data processing and changes during the period 1998-2002.

EUREF and IGS have during the last years started to focus on near-real-time data. As a consequence many IGS and EPN stations submit hourly data today. The NKG EPN AC has, besides the daily processing, started the analysis of hourly data. This task is at the moment performed at Onsala Space Observatory and the Norwegian Mapping Authority.

Furthermore, over the years since 1996 the NKG EPN AC has contributed to processing of GNSS for other special projects within EUREF and IGS.

Continues Daily Processing

NKG EPN AC has contributed to the continuous processing of EPN, based on daily solutions, since October 1996.

Today the analysis of EPN is distributed among 15 regional analysis centers (AC), together processing 129 EPN stations. NKG EPN AC is one of those 15 ACs. The distribution among the ACs are made in such a way that each stations is processed by at least 3 ACs.

The NKG sub-network

The sub-network processed by the NKG EPN Analysis Center, consists mainly of stations in northern Europe– see figure 1. Many of the stations are operated by NKG members or have been established with support from NKG. May 1998, 27 stations were included in the NKG subnetwork and today there are 35 stations processed by NKG.

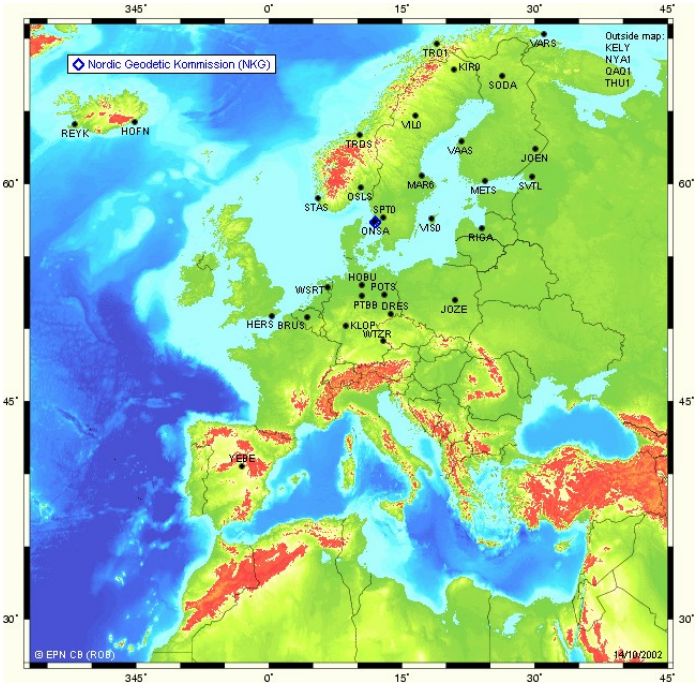

Figure 1: *The EPN sub-network processed by NKG EPN AC. VLNS (Vilnius) which is included in the processing again from GPS-week 1187 is not shown in the map. Four stations far north (Greenland and Ny-Ålesund) are outside the map.*

The following stations have been added during the last four-year period: DRES (Germany), HERS (GB), HOBU

(Germany), KLOP (Germany), SPT0 (Sweden), YEBE(Spain), PTBB(Germany) and QAQ1 (Greenland). The station VLNS (Lithuania) has both been excluded and included again after some years during the period. The same goes for the Norwegian stations OSLO, STAV, TRON and VARD, which after inclusion were renamed to OSLS, STAS, TRDS and VARS. As soon as the three Danish stations BUDP, SMID and SULD are available for EPN, the NKG EPN AC will include also those stations in the processing.

Data flow

Daily RINEX-files are retrieved from the IGS and EUREF data centers at BKG and IGN and final IGS orbits and earth orientation parameters (EOP) from IGSCB. IGS ITRF-coordinates for each month and a file with satellite problems are fetched from the Astronomical Institute of the University of Berne (AIUB), Switzerland.

The processing is performed with a time delay of 3-4 weeks, which is just after the last available input-data (the final IGS EOPs) are available.

Daily solutions are produced and finally combined to a weekly solution. Furthermore hourly troposphere parameters are produced for each day, based on the co-ordinates from the weekly combined solution.

The weekly solution and the troposphere parameters are submitted to the EPN combination centre at BKG, where the solutions are combined with solutions from the other 14 ACs.

Data processing

The analysis is performed with the Bernese GPS Software (today version 4.2) using the Bernese processing engine (BPE). Final IGS-products and ocean-tide loading coefficients from Hans-George Scherneck are used.

The pre-processing consist of receiver clock offset estimation using code measurements, tripple difference solutions for cycle-slip fixing e.t.c. and float solutions for removal of outliers. New ambiguities are set up if necessary based on the data screening in the trippel difference solutions. The pre-processing is performed in baseline mode. Baselines are formed with the OBSMAX strategy, which selects the baselines in such a way that number of used observations are maximised.

Ambiguities are resolved using the QIF-strategy (quasi ionosphere free method) in conjunction with a regional ionosphere model and a troposphere model resolved in previous steps.

The final solution is an ionosphere free linear combination of L1 and L2 with fixed ambiguities. (The ambiguities that have been satisfactory resolved are fixed.) Troposphere parameters are estimated for every hour.

The solutions are tied to ITRF/IGS by heavily constraint on the following IGS-stations: BRUS, METS, NYA1, ONSA, POTS, REYK, TRO1 and WTZR. GPS-week 1143 IGS00 was introduced instead of IGS97 for the co-ordinate constraint.

From GPS-week 1130 major changes of the processing strategy was introduced to all EPN ACs.

Until GPS-week 1129 (August 2001) 15 °elevation cut-off angle and Saastamoinen apriori troposphere model in combination with the mapping function 1/cos z was used.

From GPS-week 1130 (September 2001) the elevation cut-off angle was changed to 10°and the elevation dependent weighting model was adopted. No apriori troposphere model in combination with the dry Niell mapping function is now used when estimating troposphere parameters. All ACs should also use final IGS-products, which NKG EPN AC has done from the very beginning.

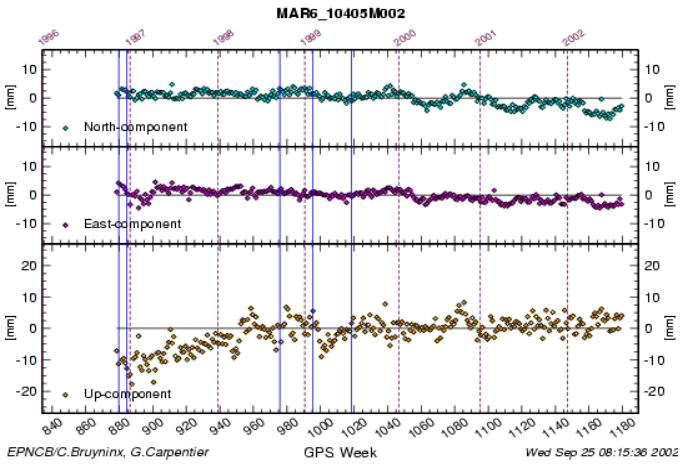

Figure 2: *MAR6 before and after GPS-week 1130.*

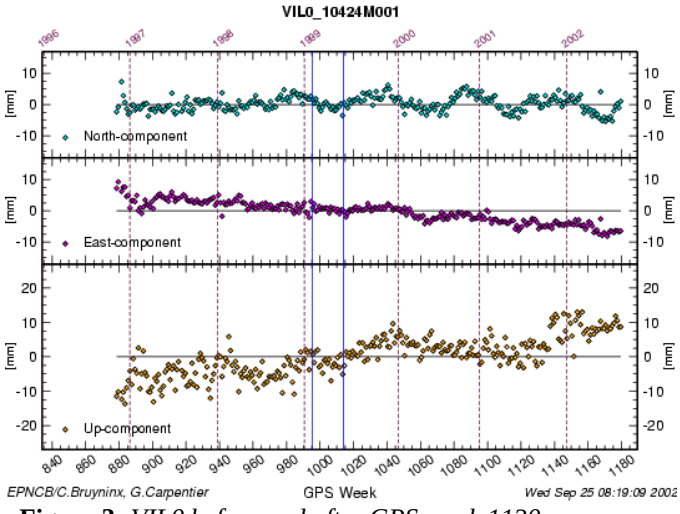

Figure 3: *VIL0 before and after GPS-week 1130.*

The old standard solution with 15° and Saastamoinen used until GPS-week 1129 is still produced but not submitted to

EUREF. In addition to this several other solutions with different elevation cut-off angles (10°, 15° and 20°) have been produced since the beginning 1996.

The new processing strategy introduced GPS-week 1130 has resulted in a decrease of the final rms from c. 2 mm to 1 mm, slightly better daily repeatability in the height components and a lower rate of resolved ambiguities. For most of our stations the change of processing strategy is not clearly visible in the time series, but for some stations a small jump in the height component could be seen – see figure 2 and 3 for some examples.

Another change during the last four-year period is that the processing moved from Onsala Space Observatory to Lantmäteriet. This change implies also a change of processing environment from LINUX to Windows, but in principle the same version of the Bernese GPS Software is used. Lantmäteriet started to submit solutions to EUREF from GPS-week 1147, the first week of year 2002.

Before the processing was moved some GPS-weeks were processed in parallel at both places and compared. Both the comparison of quality measures and weekly co-ordinates show that the differences introduced by the change of active processing office are negligible – see table 1 and 2.

Table 1: *Comparison of quality measures.*

Quality Measures						
GPS Week	1141		1142		1143	
AC	OSO	LMV	OSO	LMV	OSO	LMV
Resolved amb %	68	69	82	83	69	71
rms final sol	1,3	1,2	1,3	1,2	1,3	1,2

Table 2: *Comparison of weekly co-ordinates.*

Coordinate comparison rms			
GPS Week	1141	1142	1143
N (mm)	1	1	1
E (mm)	1	1	1
U (mm)	2	3	2

Near-Realtime Processing

The near-realtime processing is based on hourly files from IGS, EUREF, SWEPOS and SATREF. Data from a dense network in Denmark will soon also be added.

For the moment the primary objective of this analysis is the estimation of atmospheric propagation path delay but future initiative includes also near real-time positioning applications.

GNSS Processing for Special Projects

During the last four year period the NKG EPN AC has contributed with processing for the following projects; EUVN 97(European Vertical Reference Network 97) and the IGS/BIPM pilot project for the combined use of GPS and GLONASS, IGLOSS. NKG EPNAC has also participated in the EUREf special project “Monitoring of the EUREF permanent network to produce co-ordinate time series suitable for geokinematics”.

Concluding Remarks

The NKG EPN AC is a good example of a successful collaboration within NKG. The centre has been operating for six years now by members of the working group of Satellite Geodesy, both university institutions and mapping authorities are involved in the operating work.

References

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EUREF (2002) The EUREF EPN web page http://www.epncb.oma.be/