Status Report of the EPN Special Project "Troposphere Parameter Estimation"

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Abstract

After three years of routine processing within the EUREF Special Project "Troposphere Parameter Estimation" an updated status report is given. Results and statistics about the combination of the Zenith Total Delay (ZTD) parameters, estimated by the 16 Local Analysis Centres (LACs) of the EUREF Permanent Network (EPN), are presented. Additionally, ZTD comparisons for some specific sites within the EPN are shown. At least, a first rough comparison with ZTD estimates from the International VLBI Service (IVS) is given.

Introduction

Since the last of the 16 LACs started its contribution in GPS week 1185 more than 80 weeks of routine processing without major changes in the processing strategies took place. Details about the chronology of the project and a description of the analysis strategy can be found in [Söhne, Weber, 2003].

Combination results

For the combination of the individual solutions a weekly mean bias with its standard deviation over all sites is computed for every LAC to have an indicator for the overall agreement of the individual contributions (figures 1 and 2). Most of the biases are in the range of ± 2 mm with a standard deviation of the same order. Some deviations can be seen for some LACs which reflect problems or changes in the processing.

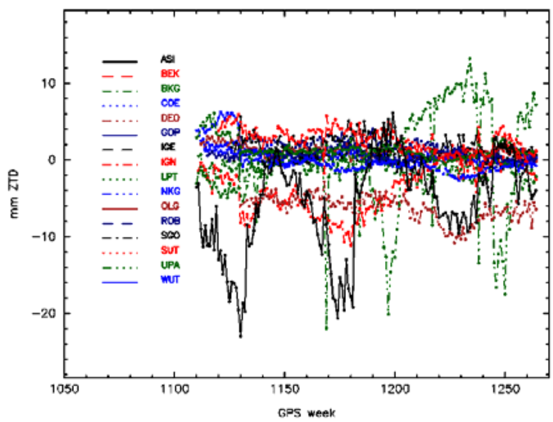

Fig. 1: Weekly mean biases for the Local Analysis Centres compared to the weekly combined solution (GPS weeks 1110-1263)

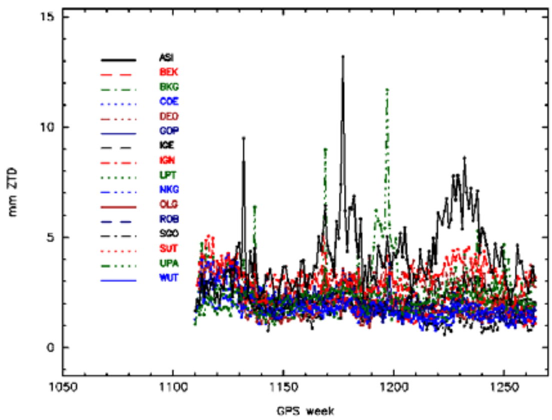

Fig. 2: Standard deviation of the weekly mean biases (GPS weeks 1110-1263)

For a better insight into the quality differences of individual solutions some results for exemplary stations are presented in the following. Each of the stations have been analysed by more than three LACs. The numerical examples started with GPS week 1185 because no changes took place from that time on.
Station KLOP (Kloppenheim) in the middle of Germany has been analysed by four LACs which all use the same software and fix the coordinate solution exactly. The station SFER (San Fernando) in Spain has been processed by five LACs. Here some major differences between the participating LACs are stated: ASI produces two hour solutions of ZTD, DEO and IGN do not fix the coordinates to ITRF2000. The daily biases for both stations are shown in figures 3 and 4. The day-to-day repeatabilities are given in table 1. The day-to-day repeatability for KLOP is well below 2 mm and represents the achievable precision for good sites. The day-to-day repeatabilities for SFER are worse, they reflect the different analysis strategies, software packages and processing options.

Tab. 1: Day-to-day repeatabilities for two EPN stations (GPS weeks 1185-1263)

KLOP		SFER	
LAC	repeatability [mm]	LAC	repeatability [mm]
BKG	± 1.1	ASI	± 6.9
NKG	± 1.1	BEK	± 2.0
ROB	± 1.3	DEO	± 2.5
SUT	± 1.6	IGE	± 2.3
		IGN	± 3.4

This can also be seen in the corresponding ellipsoidal heights taken from the header of the troposphere SINEX files (TRO files). For KLOP the height differences within one week are in the ± 1 cm range and the variation over 80 weeks is in the range of ± 2 cm. For SFER the differences and variations again reflect the different strategies used in the different software packages (e.g. fixing coordinates or not).

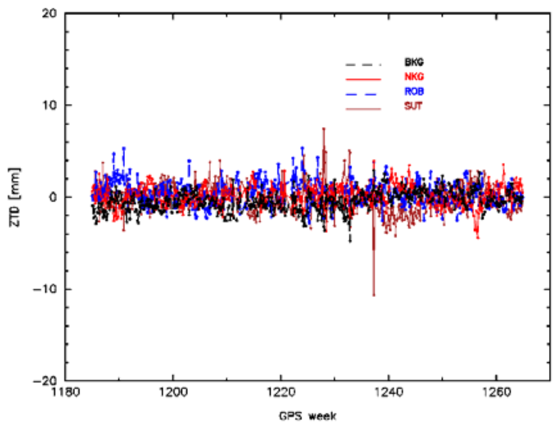

Fig. 3: Daily biases for station KLOP (GPS weeks 1185-1263)

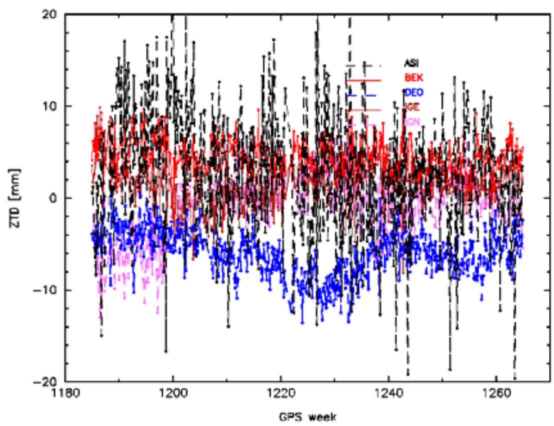

Fig. 4: Daily biases for station SFER (GPS weeks 1185-1263)

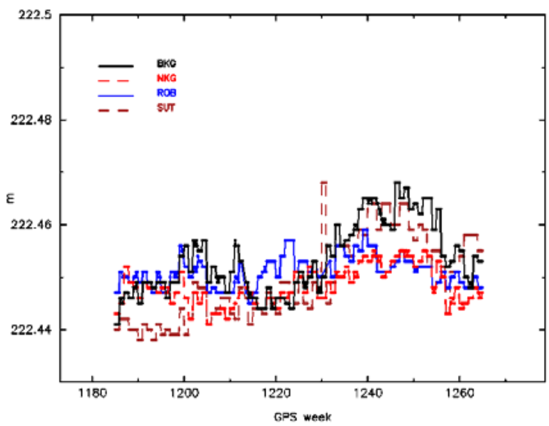

Fig. 5: Ellipsoidal height values taken from the TRO files for station KLOP

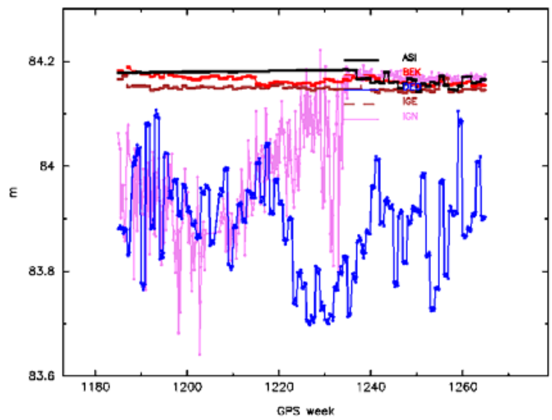

Fig. 6: Ellipsoidal height values taken from the TRO files for station SFER

Site-specific results

Within the EPN there are few sites with two stations (more or less) close together and analysed by the same LAC. Some results are shown in this chapter. More station-dependent analyses can be found in [Kruczyk et al., 2004] and [Söhne et al., 2004]. At the fundamental site Kiruna there are two stations KIRU and KIR0 with few kilometres distance. Both sites have been analysed by LAC COE. Even in the absolute time series one can see the bias between them due to the height difference of about 100 m (figure 7). The mean difference between the ZTD parameters of KIRU and KIR0 of –28.9 ± 4 mm (figure 8) agrees well with the height difference of about 100 m if the rule of thumb "10 m height change corresponds to –3 mm ZTD change" is taken into account.

In the figure 8 of the differences one can see „anomalies" at the beginning of 2002 and 2004 of about 10 mm ZTD. Comparing these variations in the ZTD differences to the height differences between both sites taken from the COE solutions (figure 9) there is a very good agreement showing rapid changes in the height differences up to 5 cm in winter time. Therefore, snow covering can be assumed as the reason. Comparison with site TRO1 which is also included in the COE analyses shows that site KIRU is responsible for the changes because of a positive height change. The offsets are also visible in the time series available at the EPN homepage (www.epncb.oma.be/_dataproducts/timeseries/series/kiru.html) and are discussed in [Kaniuth, Vetter 2004].

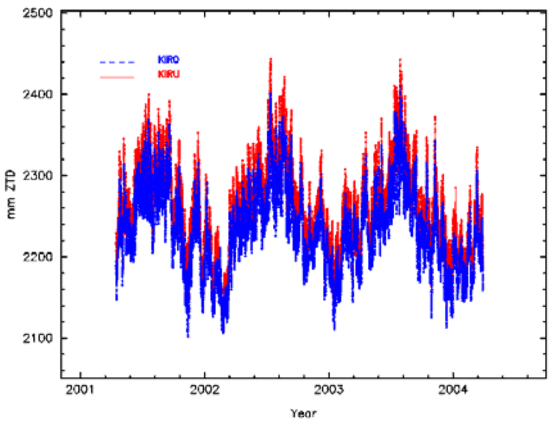

Fig. 7: ZTD parameter of stations KIRU and KIR0 from COE analysis (GPS weeks 1108-1263)

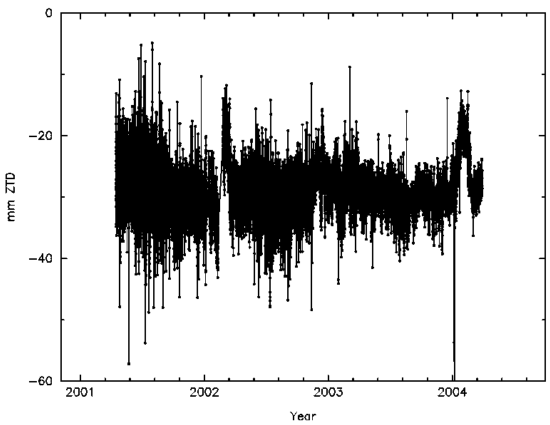

Fig. 8: Differences of ZTD parameter of stations KIRU and KIR0 from COE analysis

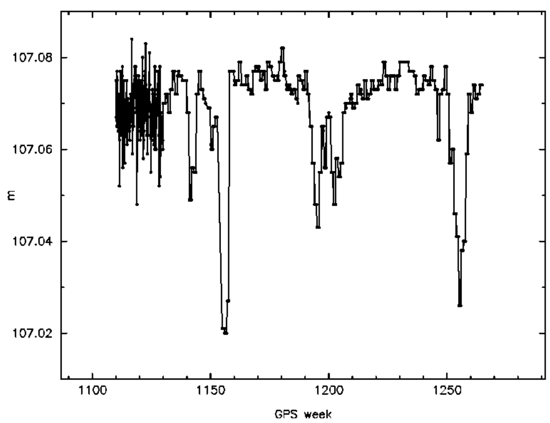

Fig. 9: Ellipsoidal height differences of stations KIRU and KIR0 from COE analysis

The stations JOZE and JOZ2 at site Jozefoslaw in Poland have a horizontal distance of only 80 m and the height difference is –11.1 m. Both stations have been analysed by three LACs, OLG, SUT and WUT, for half a year. Figure 10 shows the ZTD differences between the stations for all three LACs. The agreement of the mean biases is very good whereas the standard deviations are not on the same level of accuracy the three centres.

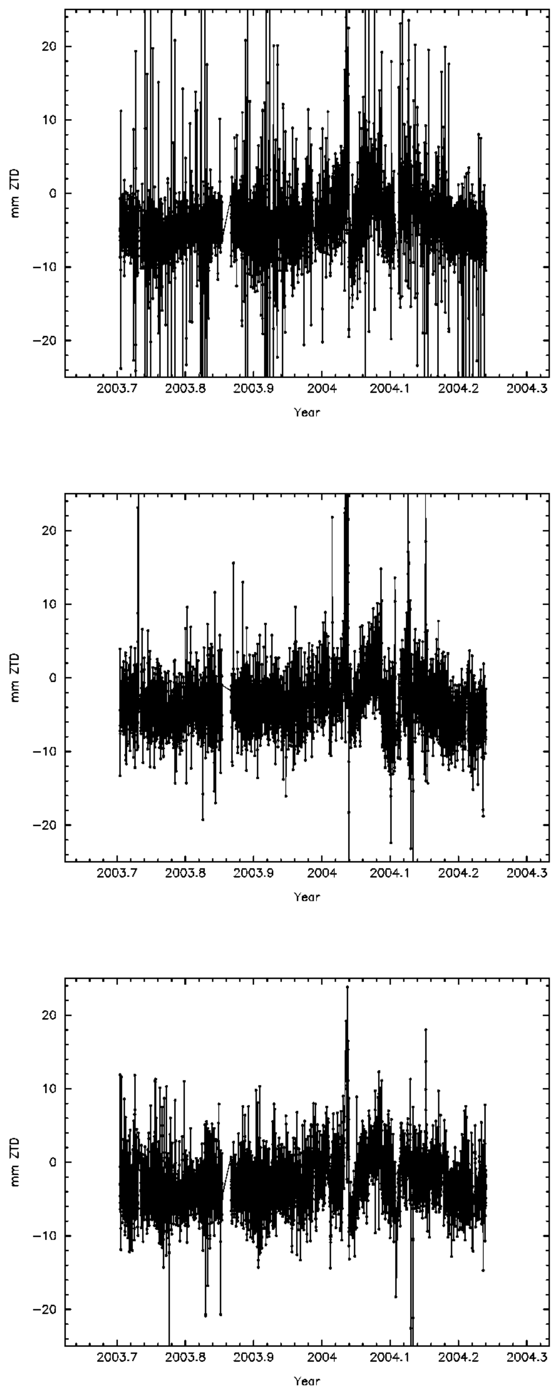

Fig. 10: Differences of ZTD parameters of stations JOZE and JOZ2 from OLG (top), SUT and WUT (bottom) analyses Biases: -4.1 ± 6.5 mm (OLG), -3.4 ± 4.6 mm (SUT), -2.8 ± 4.0 mm (WUT)

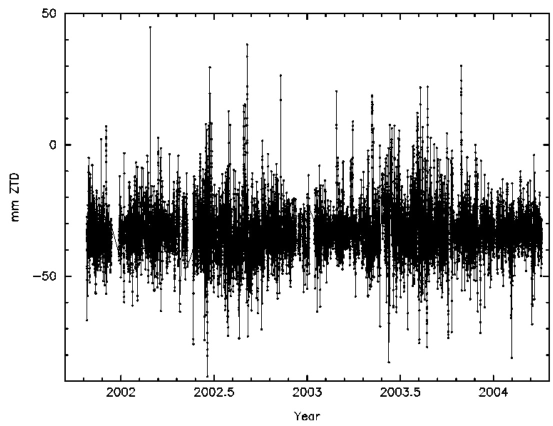

Fig. 11: Differences of ZTD parameters of stations EUSK and TITZ from BKG analysis Mean bias –33.2 ± 8.8 mm ZTD, ellipsoidal height difference ~ 90 m

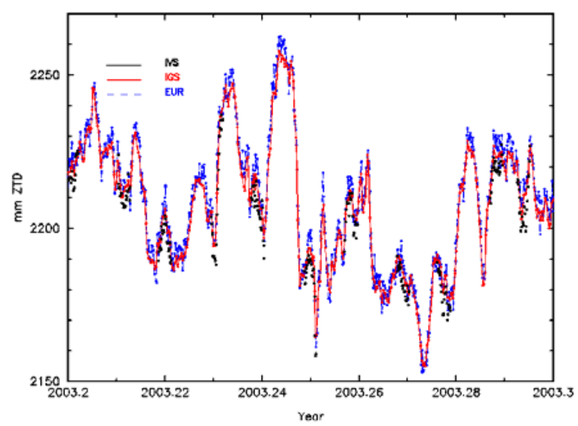

Fig. 12: ZTD parameter for Wettzell from different combinations

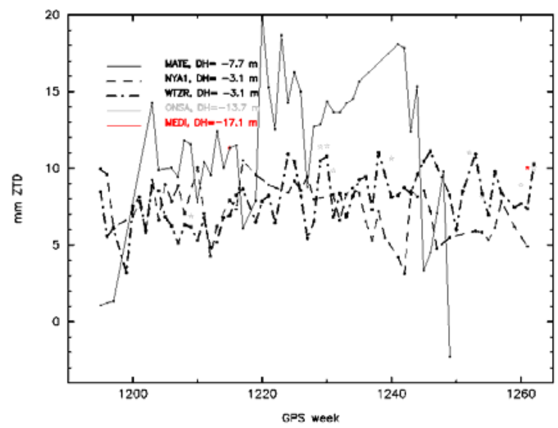

Fig. 13: ZTD biases between EUR (GPS) and IVS (VLBI) solution for European sites

At least figure 11 shows the ZTD differences for the two stations EUSK and TITZ from the BKG analysis. Both stations are about 40 km apart from each other but the correlation between the estimated ZTD parameters is still good (0.98). The seasonal variations of the ZTD differences can be seen which are much noisier during summer time showing the higher temporal and/or spatial variability of water vapour during this season.

Comparison with IVS results

Not only from GPS but also from VLBI a combined troposphere product is computed (see IGS mail 4940, http://igscb.jpl.nasa.gov/mail/igsmail/2004/msg00163.html). Here at least six individual solutions were combined within the IVD using a similar strategy used by GPS. One ZTD parameter is computed every two hours.

The main characteristic of the VLBI solutions is that the observations – and the analysis – are made in sessions. These sessions usually last about 24 hours but with overlapping days, with 1 or 2 sessions per station and week (figure 12).

In figure 13 are the rough ZTD biases between the EUR (GPS) and the IVS (VLBI) solutions for the European sites which are included in both techniques. The biases would still have a positive sign if the height differences (DH) between GPS and VLBI were taken into account which has not be done here. For the sites Wettzell and Ny Alesund the biases are relatively stable in the range between 5 and 10 mm ZTD. For Matera the differences are higher and are varying more. For Onsala and Medicina there were only few events available for comparison.

Acknowledgement

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