

Account of the EPN Special Project „Troposphere Parameter Estimation“

Wolfgang Söhne

EPN Troposphere Coordinator

Presented by Heinz Habrich

Bundesamt für Kartographie und Geodäsie

Frankfurt am Main, Germany



Outline



- Changes in analysis software (Bernese 4.2 → 5.0) and effect on Zenith Total Delay (ZTD) parameters
- Example for “sensitivity” of ZTD parameters
- Comparison EPN combination vs. IGS troposphere products
- Conclusions

Note

- The following 2 slides show the development of the Troposphere SP.
- Between weeks 1317 up to 1325 there changed 7 LACs from Bernese version 4.2 to 5.0.
 - Together with the version no. the troposphere model was changed too.
 - V 4.2: „Dry Niell“ mapping function, no a-priori model
 - V5.0: „Dry Niell“ a-priori model and estimation of „Wet Niell“ parameters.

Chronology of the project:

- GPS week 1108: first solutions
- GPS week 1110: Contribution of 4 LACs: ASI, BKG, COE, UPA
- GPS week 1111: Contribution of IGN and LPT
- GPS week 1112: Contribution of OLG
- GPS week 1113: Contribution of WUT
- GPS week 1114: Contribution of NKG
- GPS week 1115: Contribution of GOP
- GPS week 1120: Contribution of BEK
- GPS week 1126: Contribution of IGE
- GPS week 1130: New EUREF processing options
Contribution of DEO and ROB
- GPS week 1143: Switch to new reference frame ITRF 2000
Contribution of SGO
- GPS week 1143: COE using Wet Niell, switching to (unofficial) 5.0
- GPS week 1185: Contribution of SUT as 16th LAC

Chronology of the project (cont'd):

- GPS week 1203: Contribution of EPN troposphere solution to IGS combination of ZTD
- GPS week 1307: GFZ stops EPN combination (IGS troposphere combination is changing from GFZ to JPL)
- **GPS week 1317: LPT switching to 5.0, Wet Niell (EUREF mail 2360)**
- **GPS week 1318: WUT switching to 5.0, Wet Niell (EUREF mail 2363)**
- **GPS week 1319: BKG switching to 5.0, Wet Niell (EPN LAC mail 490)**
- **GPS week 1320: GOP switching to 5.0, Wet Niell (EPN LAC mail 508)**
- **GPS week 1321: NKG switching to 5.0, Wet Niell (EPN LAC mail 505)**
- **GPS week 1324: UPA switching to 5.0, Wet Niell**
- **GPS week 1325: ROB switching to 5.0, Wet Niell**
- GPS week 1335: New interpolation procedure for ASI solution (EPN rapid troposphere combination only)
- GPS week 1346: "Small" outliers rejection improved
- GPS week 1364: IGE switching to 5.0, Wet Niell (EPN LAC mail 623)

Before GPS week 1317

ASI: Microcosm

BEK: Bernese 4.2

BKG: Bernese 4.2

COE: Bernese 5.0

DEO: Gipsy

GOP: Bernese 4.2

IGE: Bernese 4.2

IGN: Bernese 4.2

LPT: Bernese 4.2

NKG: Bernese 4.2

OLG: Bernese 4.2

ROB: Bernese 4.2

SGO: Bernese 4.2

SUT: Bernese 4.2

UPA: Bernese 4.2

WUT: Bernese 4.2

After GPS week 1325

ASI: Microcosm

BEK: Bernese 4.2

BKG: Bernese 5.0

COE: Bernese 5.1

DEO: Gipsy

GOP: Bernese 5.0

IGE: Bernese 4.2 (5.0)

IGN: Bernese 4.2

LPT: Bernese 5.0

NKG: Bernese 5.0

OLG: Bernese 4.2

ROB: Bernese 5.0

SGO: Bernese 4.2

SUT: Bernese 4.2

UPA: Bernese 5.0

WUT: Bernese 5.0

Note

- The following study has the focus on the model changes (after new software version) and its impact on the ZTD parameters.
- For this purpose ZTD results of 2 LACs have been compared each time.

Study:

- Comparison of 2 LACs with same resp. different Bernese software versions.
- Looking only on the impact to the ZTD parameters.
- Period of investigation are weeks 1287 – 1350
- Computation of mean values for weeks 1287-1316 (mostly old model) and weeks 1325-1350 (mostly new model)

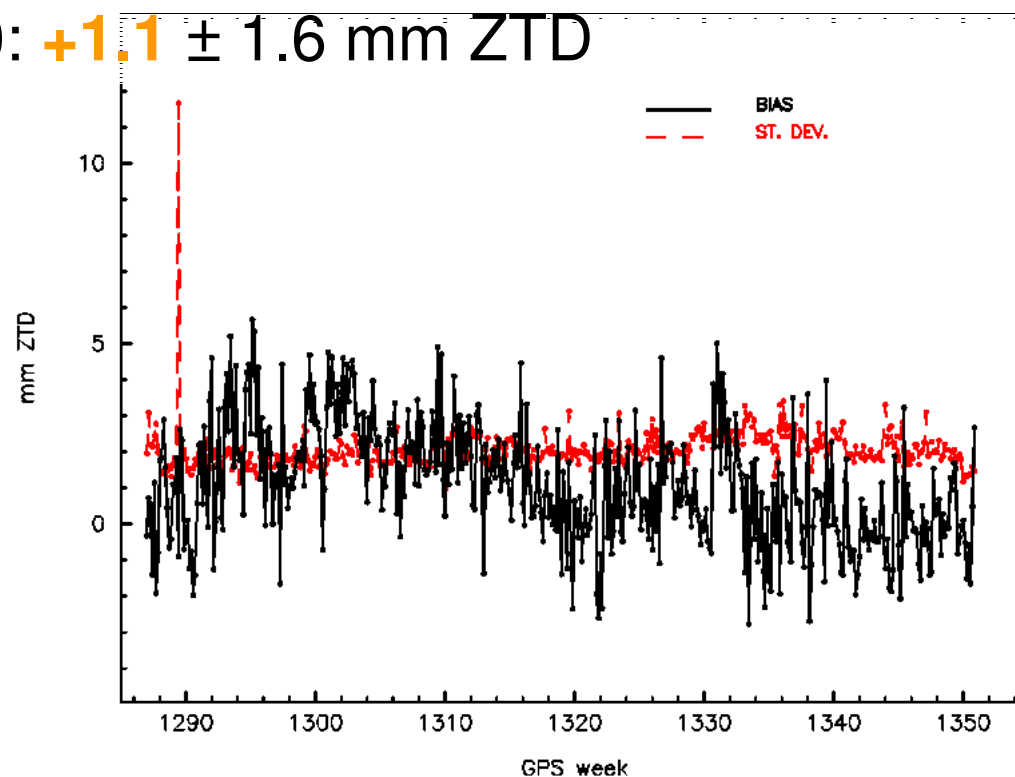
Daily mean bias and standard deviation

BEK vs. IGE: Same software version, all the time, ~ 19 common stations

1287-1316: **+1.9** $\pm$ 1.5 mm ZTD (v 4.2/4.2)

1325-1350: **+0.3** $\pm$ 1.4 mm ZTD (v 4.2/4.2)

1287-1350: **+1.1** $\pm$ 1.6 mm ZTD



Reference for the case of „no change“: Stable bias

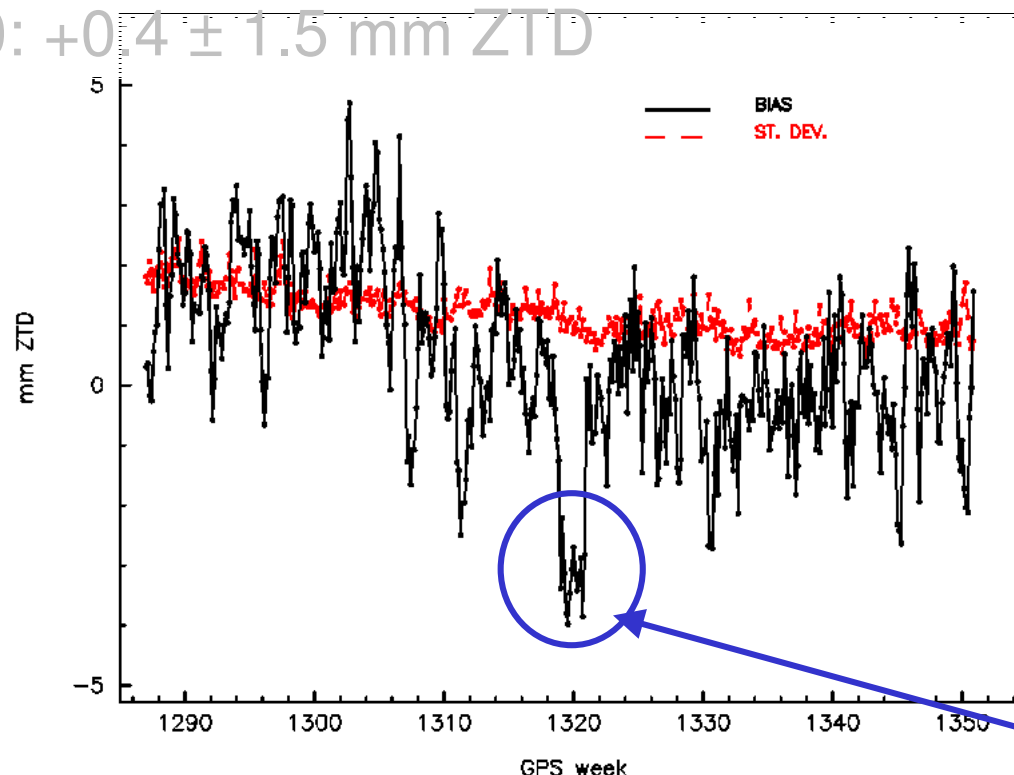
Daily mean bias and standard deviation

BKG vs. NKG: Same software version, with change for both LACs, ~ 21 common stations

1287-1316: **+1.3** $\pm$ 1.3 mm ZTD (v 4.2/4.2)

1325-1350: **-0.2** $\pm$ 1.0 mm ZTD (v 5.0/5.0)

1287-1350: **+0.4** $\pm$ 1.5 mm ZTD



Reduced bias since v 5.0

V 4.2/5.0
Mixed for
2 weeks

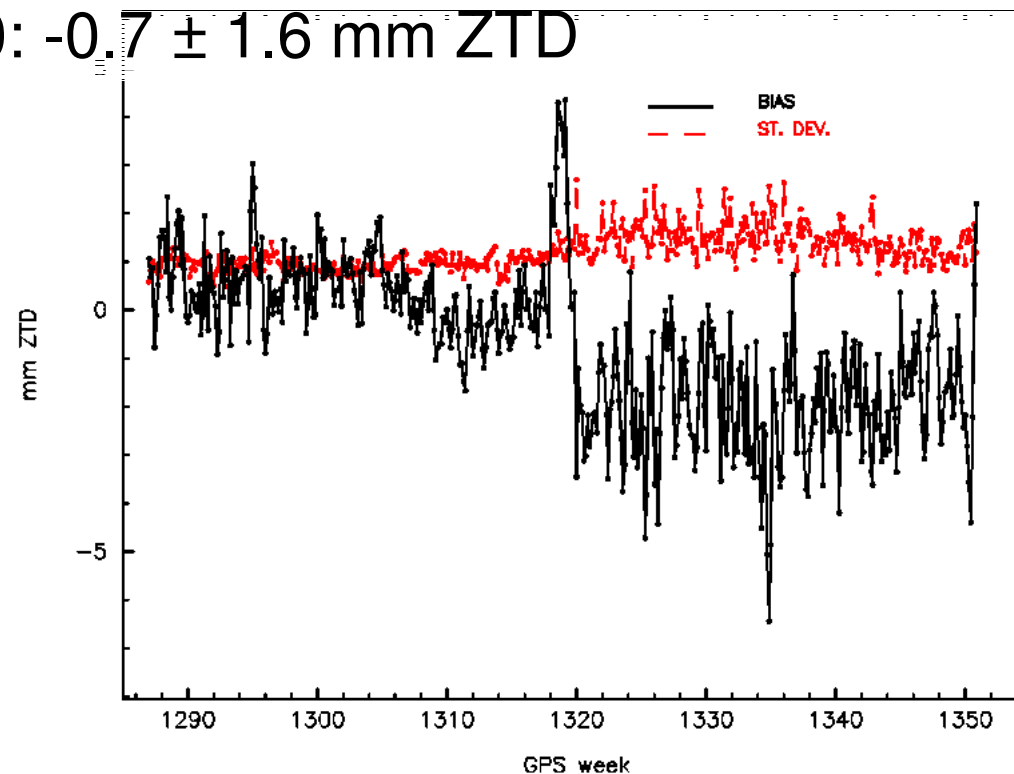
Daily mean bias and standard deviation

GOP vs. WUT: Same software version, with change for both LACs, ~ 18 common stations

1287-1316: **+0.4** $\pm$ 0.8 mm ZTD (v 4.2/4.2)

1325-1350: **-1.9** $\pm$ 1.2 mm ZTD (v 5.0/5.0)

1287-1350: **-0.7** $\pm$ 1.6 mm ZTD



Larger Bias with new version ? Increased formal error ?

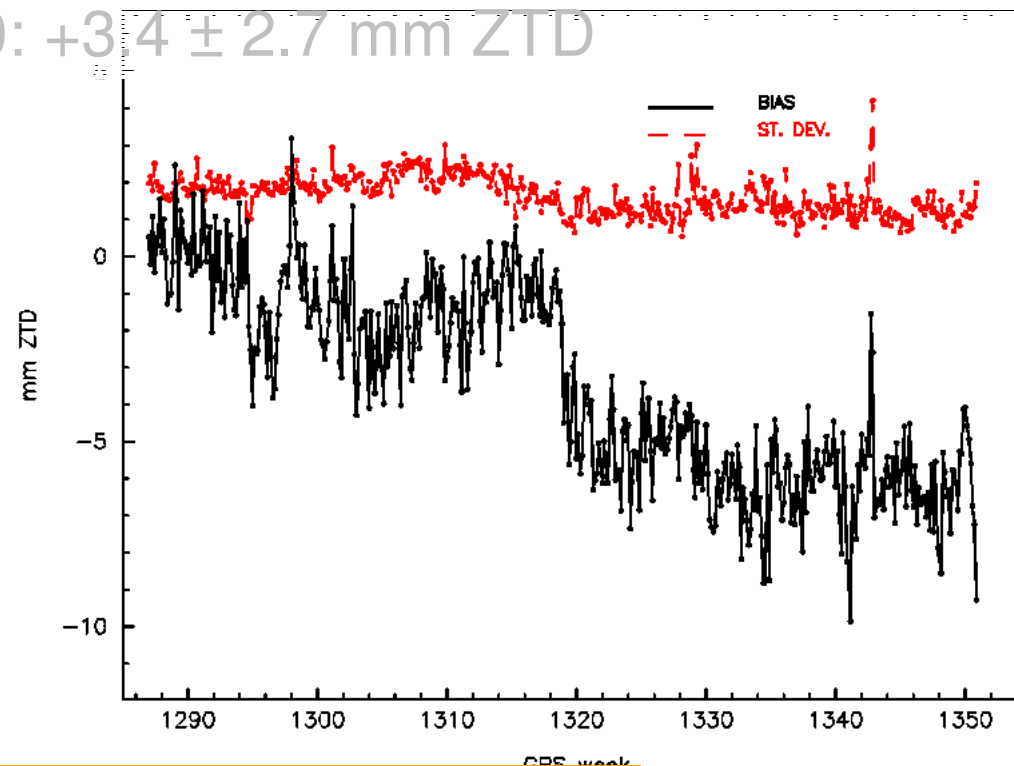
Daily mean bias and standard deviation

BKG vs. OLG: different software version, ~ 15 common stations

1287-1316: **-1.0** $\pm$ 1.4 mm ZTD (v 4.2/4.2)

1325-1350: **-6.0** $\pm$ 1.2 mm ZTD (v 5.0/4.2)

1287-1350: **+3.4** $\pm$ 2.7 mm ZTD



Significant bias for mixed versions.



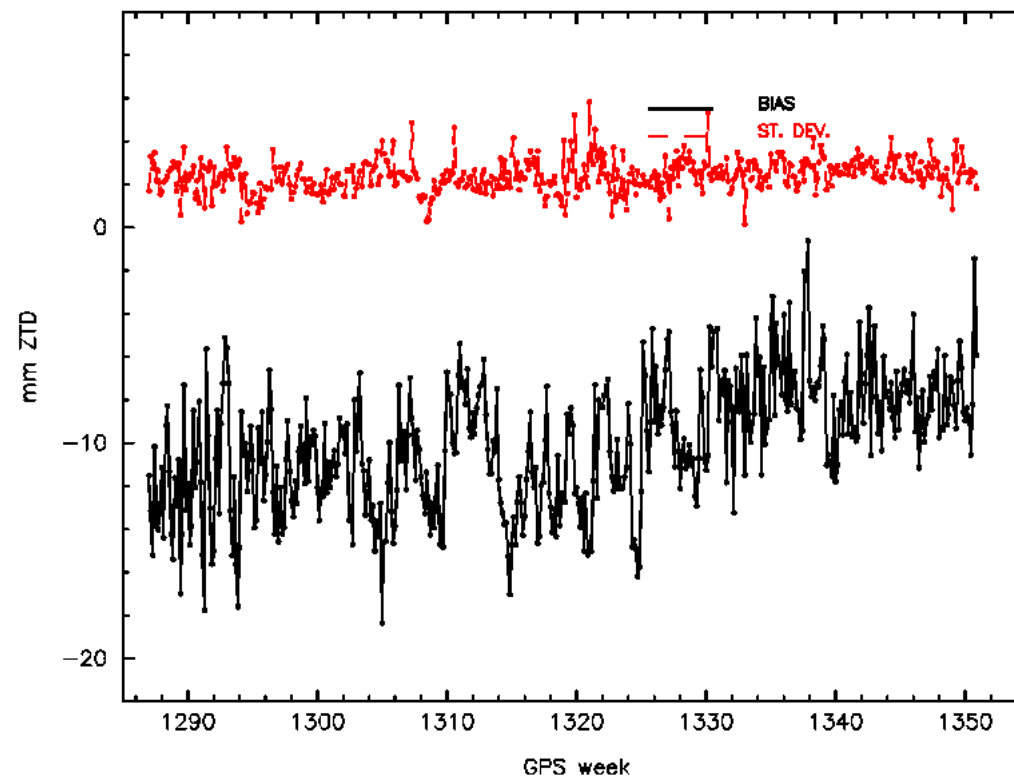
Daily mean bias and standard deviation

DEO vs. ROB: software change, ~ 7 common stations

1287-1316: -11.4 ± 2.6 mm ZTD (GIPSY/v4.2)

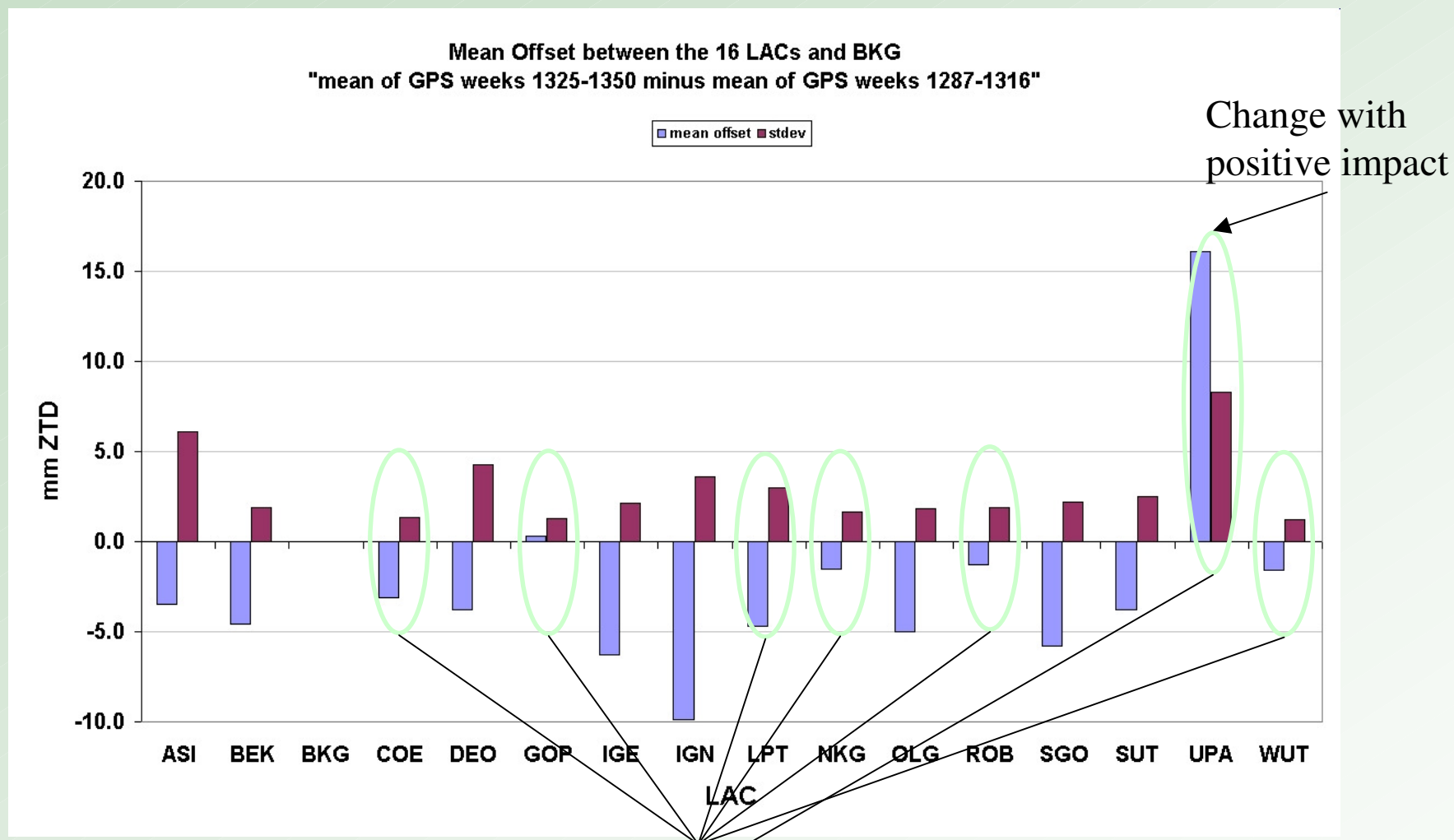
1325-1350: -8.0 ± 2.3 mm ZTD (GIPSY/v 5.0)

1287-1350: -10.0 ± 3.0 mm ZTD



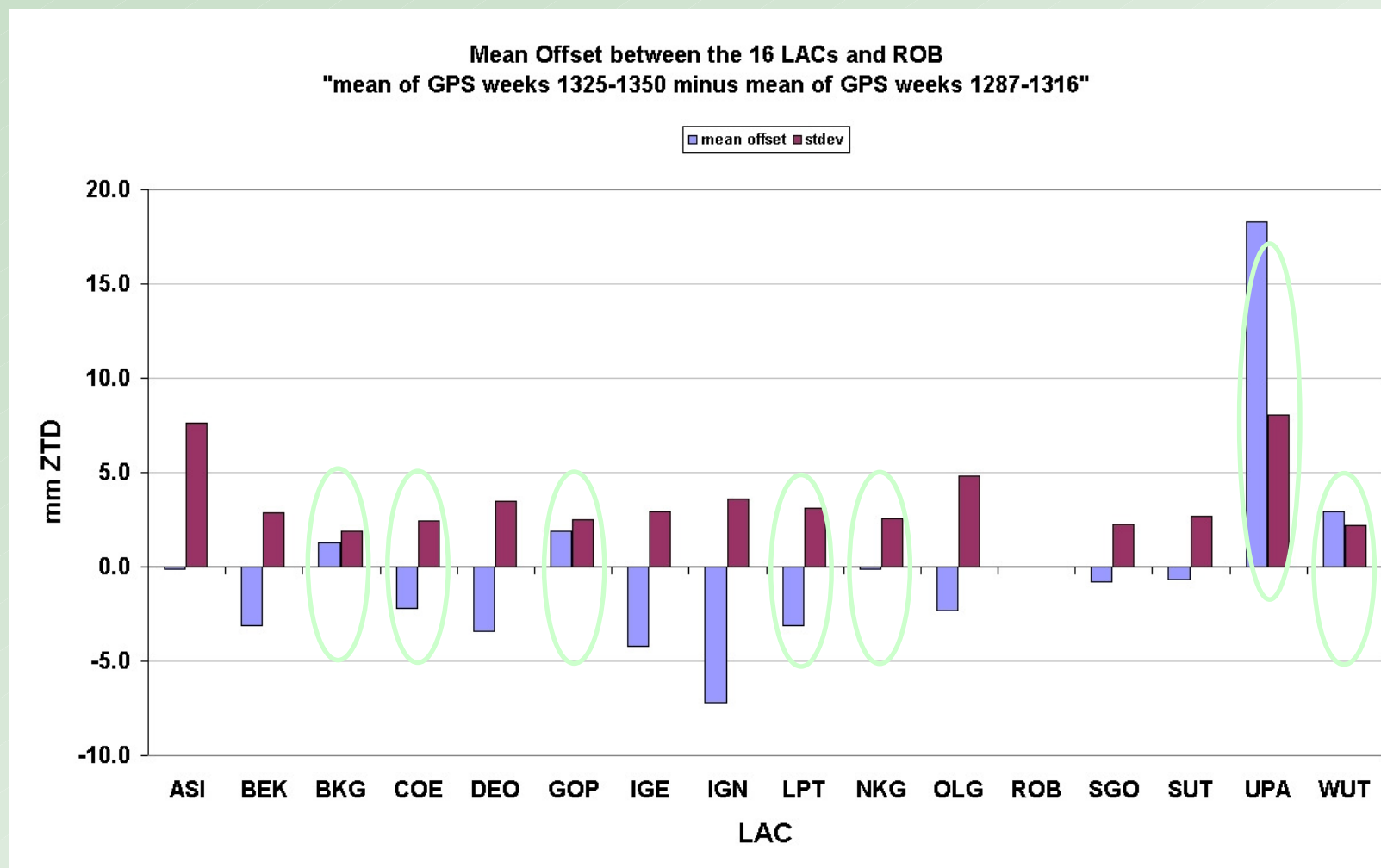
Reduced bias w.r.t. „non-Bernese“ software

Daily mean bias and standard deviation



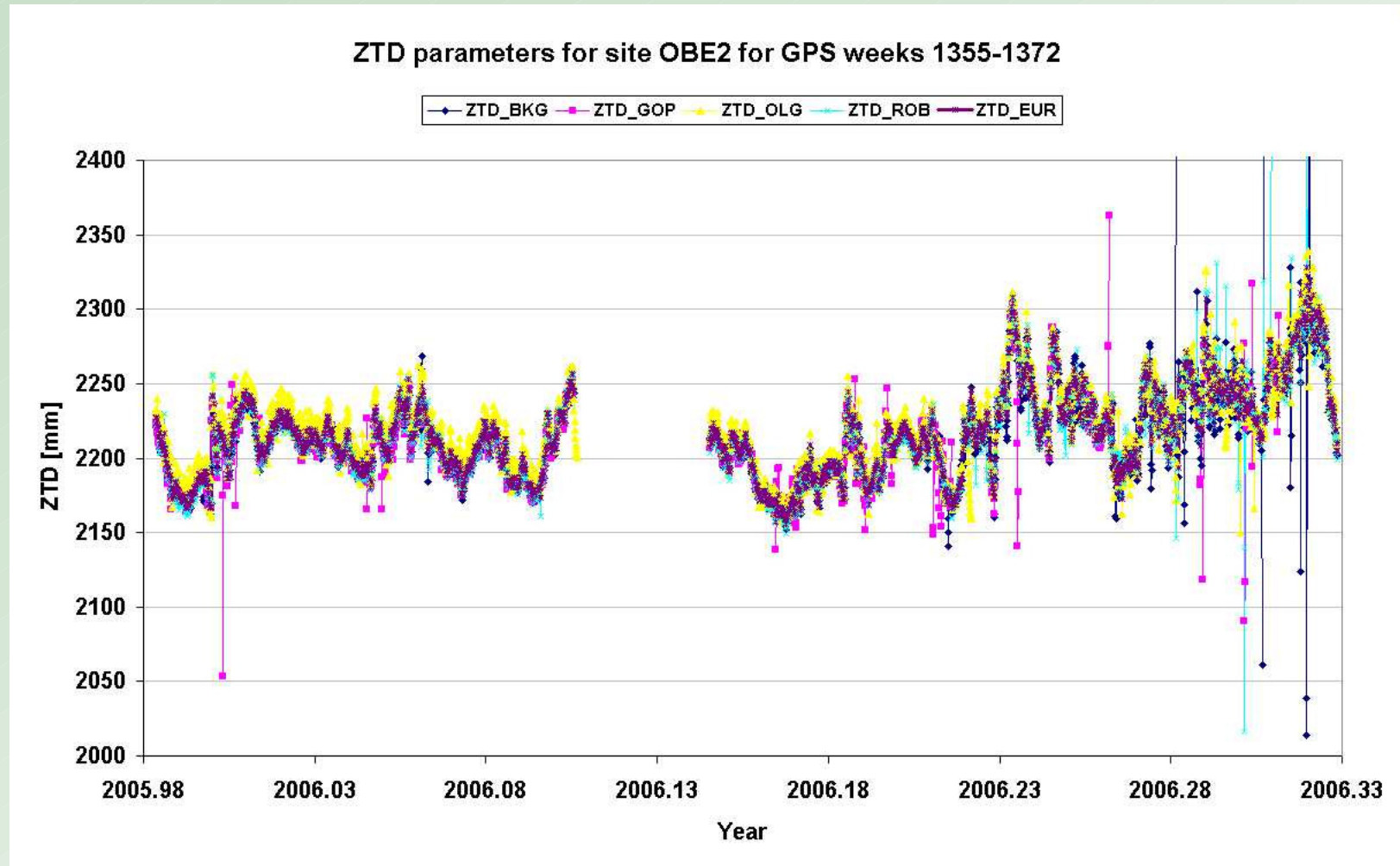
„old“ minus „new“ referenced on BKG (double difference of ZTD)
 -> no significant signal on that level with exception for UPA

Daily mean bias and standard deviation



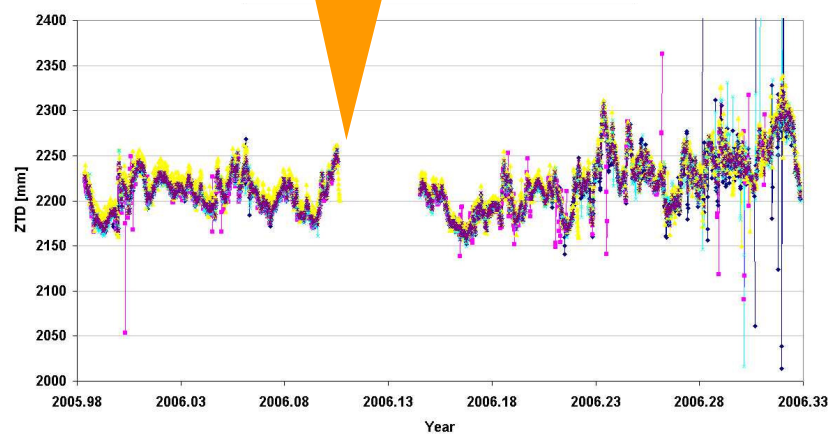
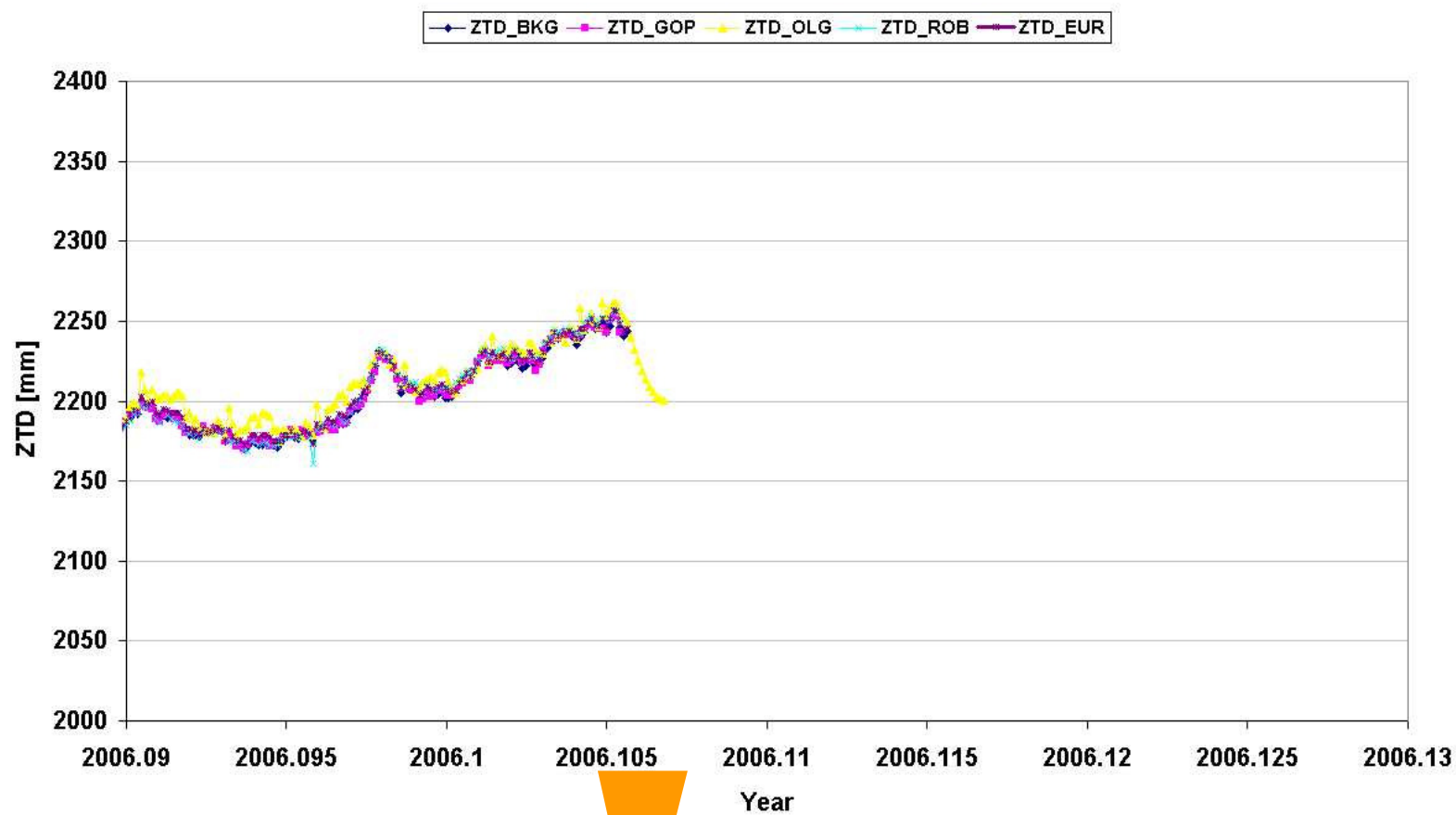
„old“ minus „new“ referenced on ROB (double difference of ZTD)

Examples



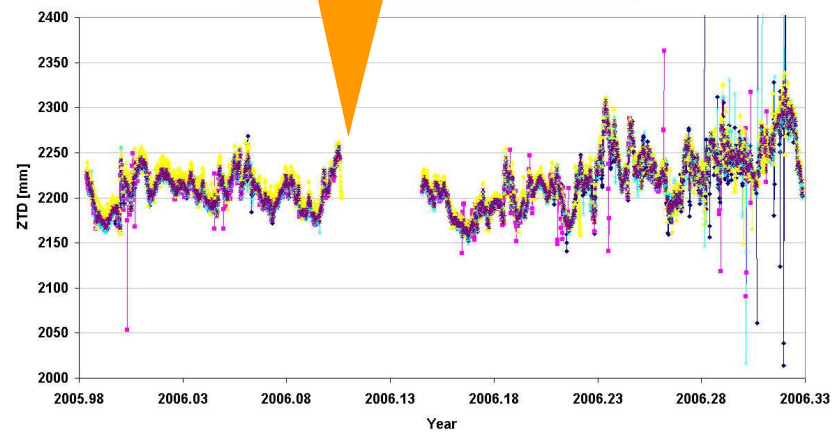
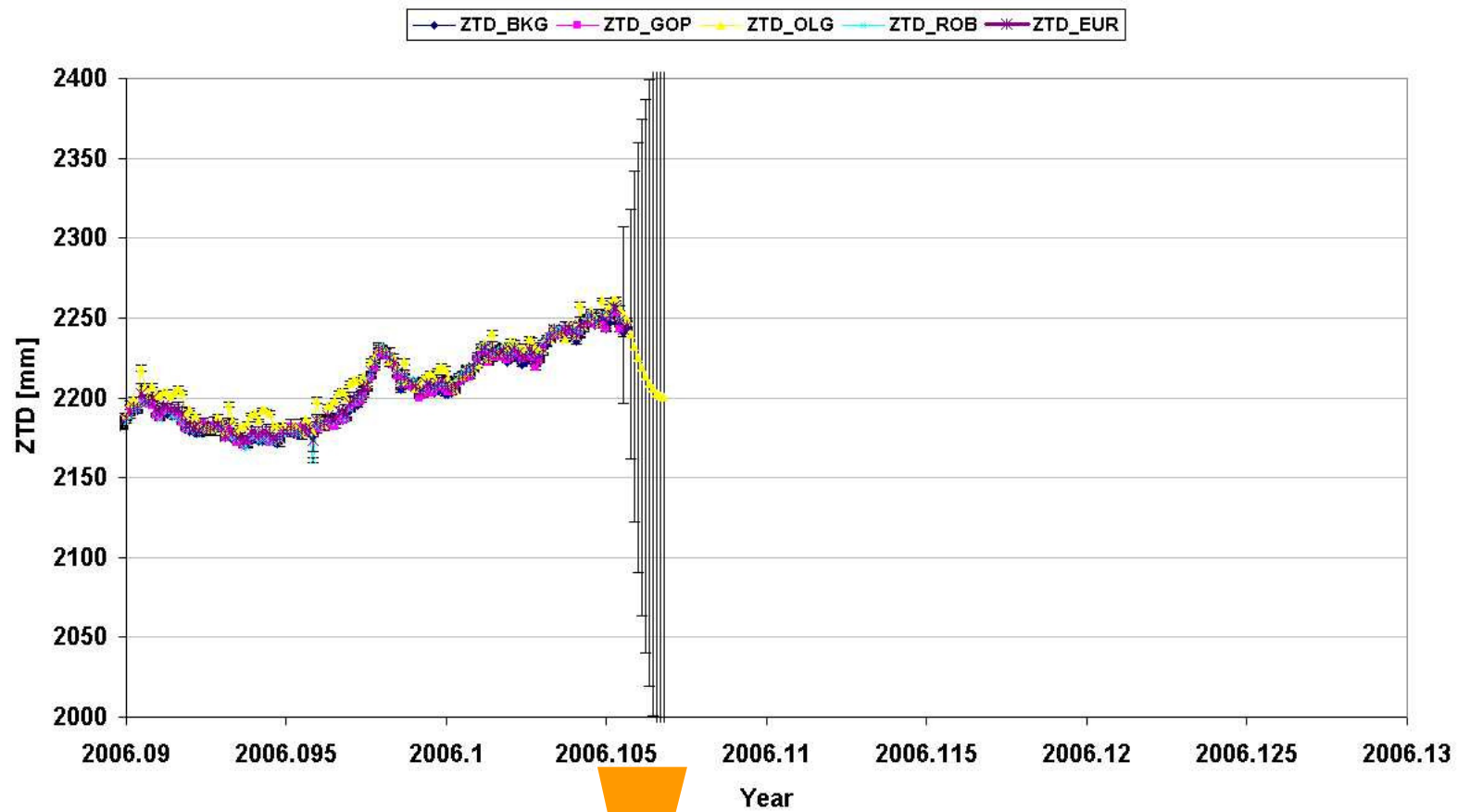
Comparison of ZTD from 4 solutions, appr. 4 month period

ZTD parameters for site OBE2 for GPS weeks 1355-1372



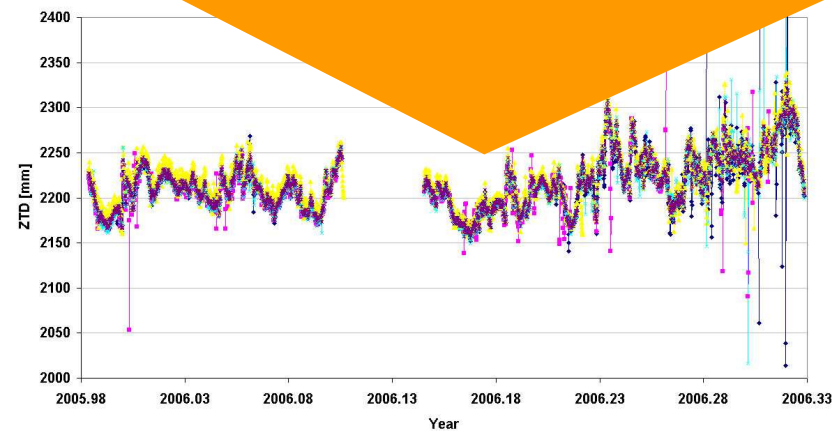
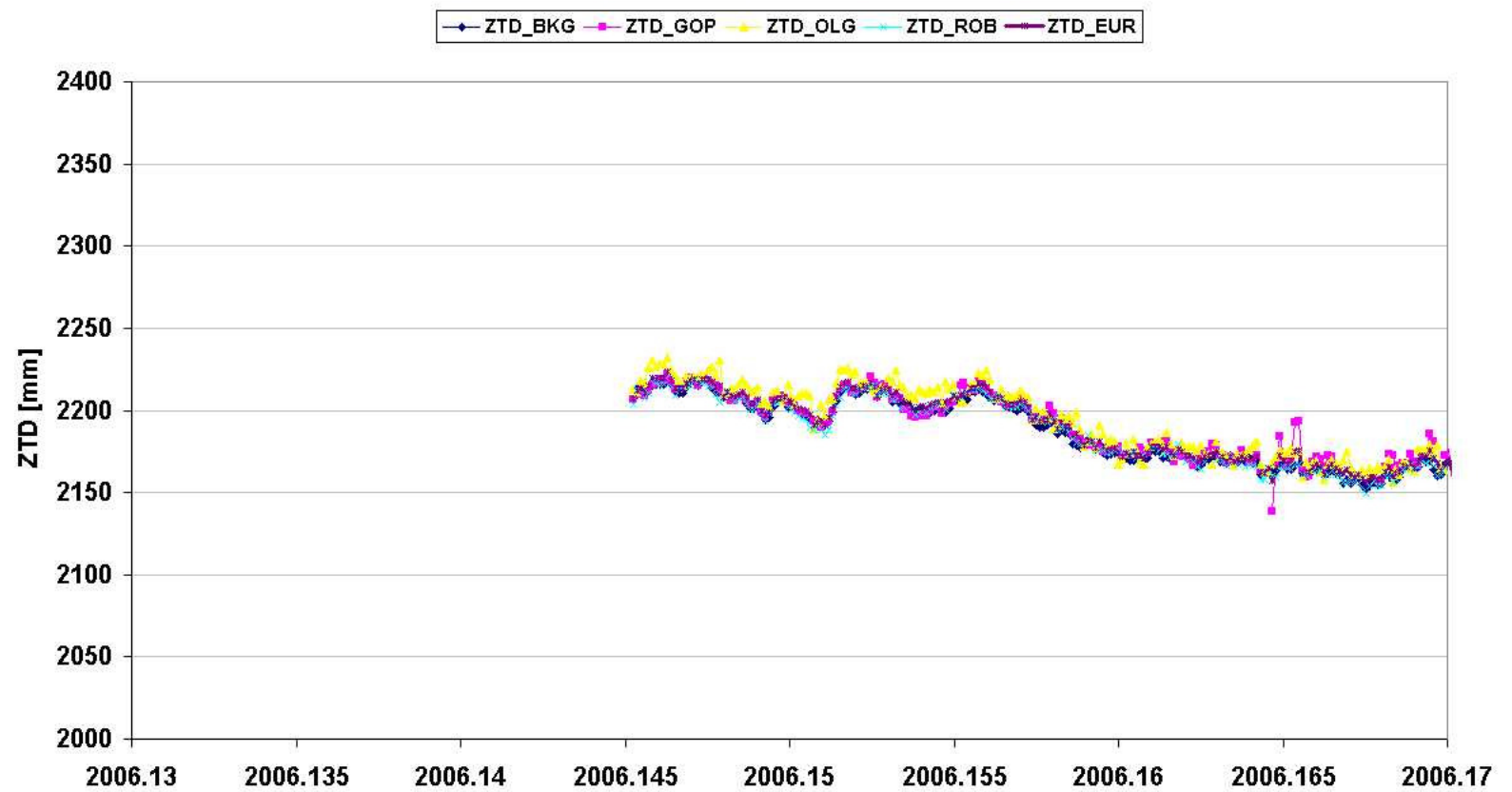
“Acco

ZTD parameters for site OBE2 for GPS weeks 1355-1372



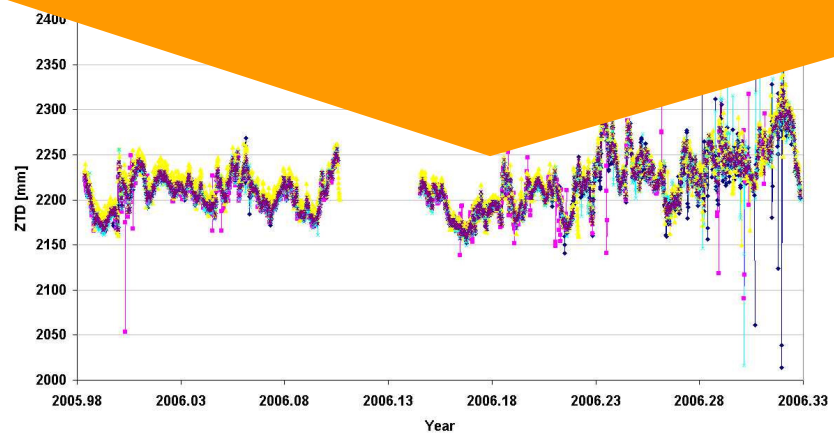
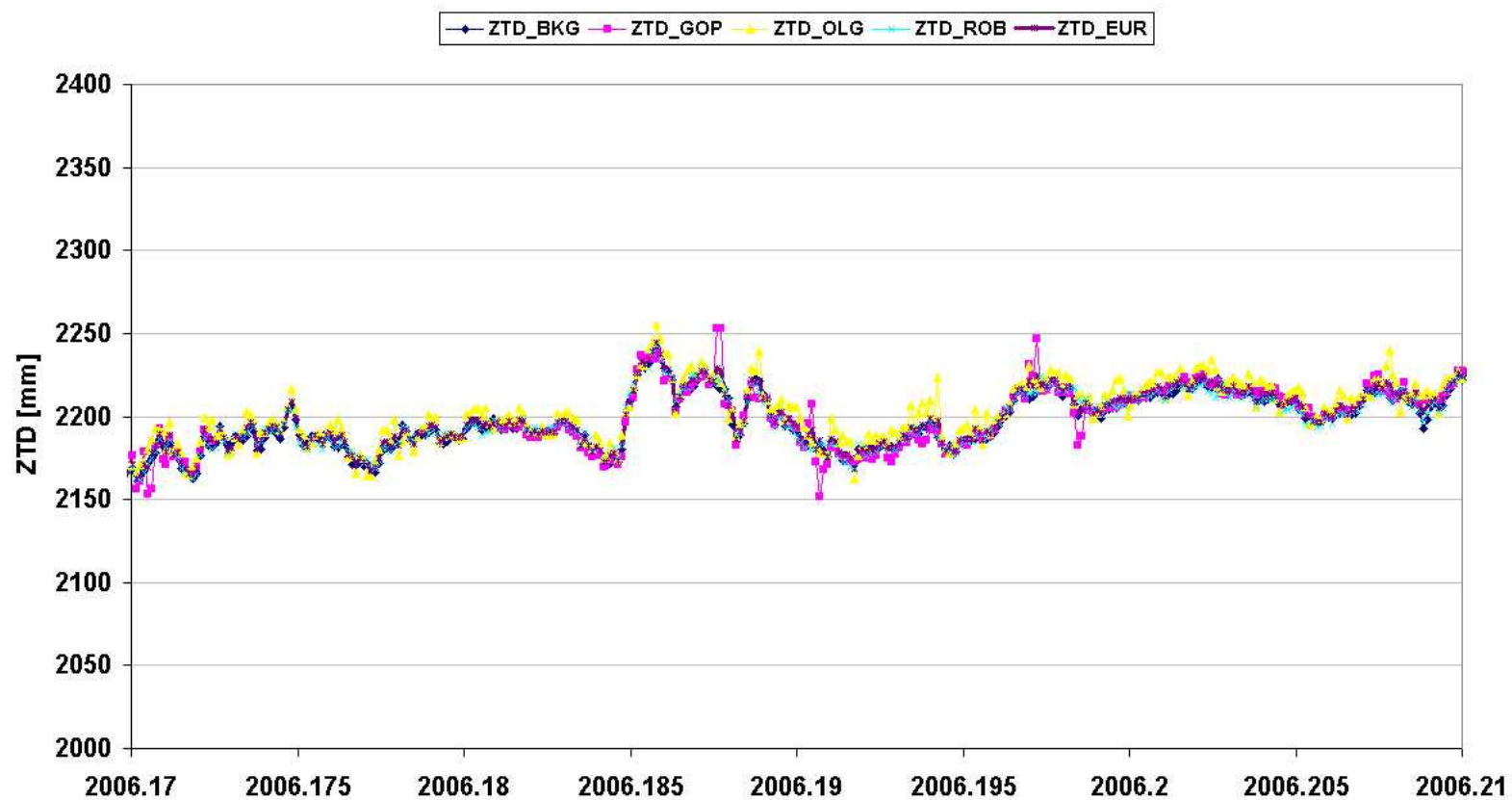
“Acco

ZTD parameters for site OBE2 for GPS weeks 1355-1372

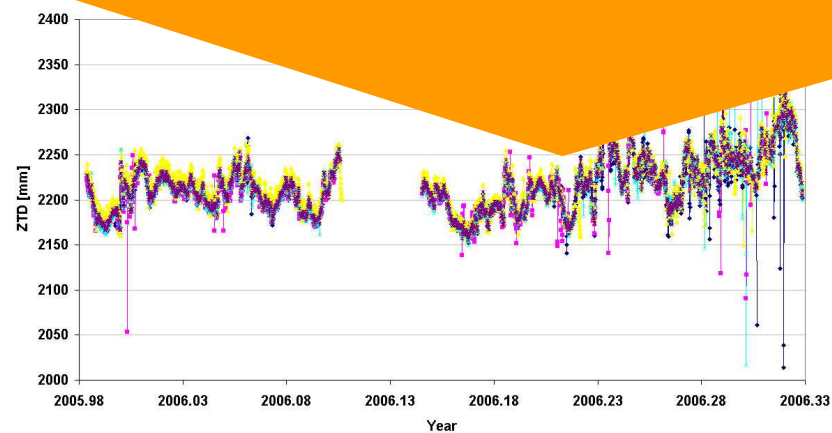
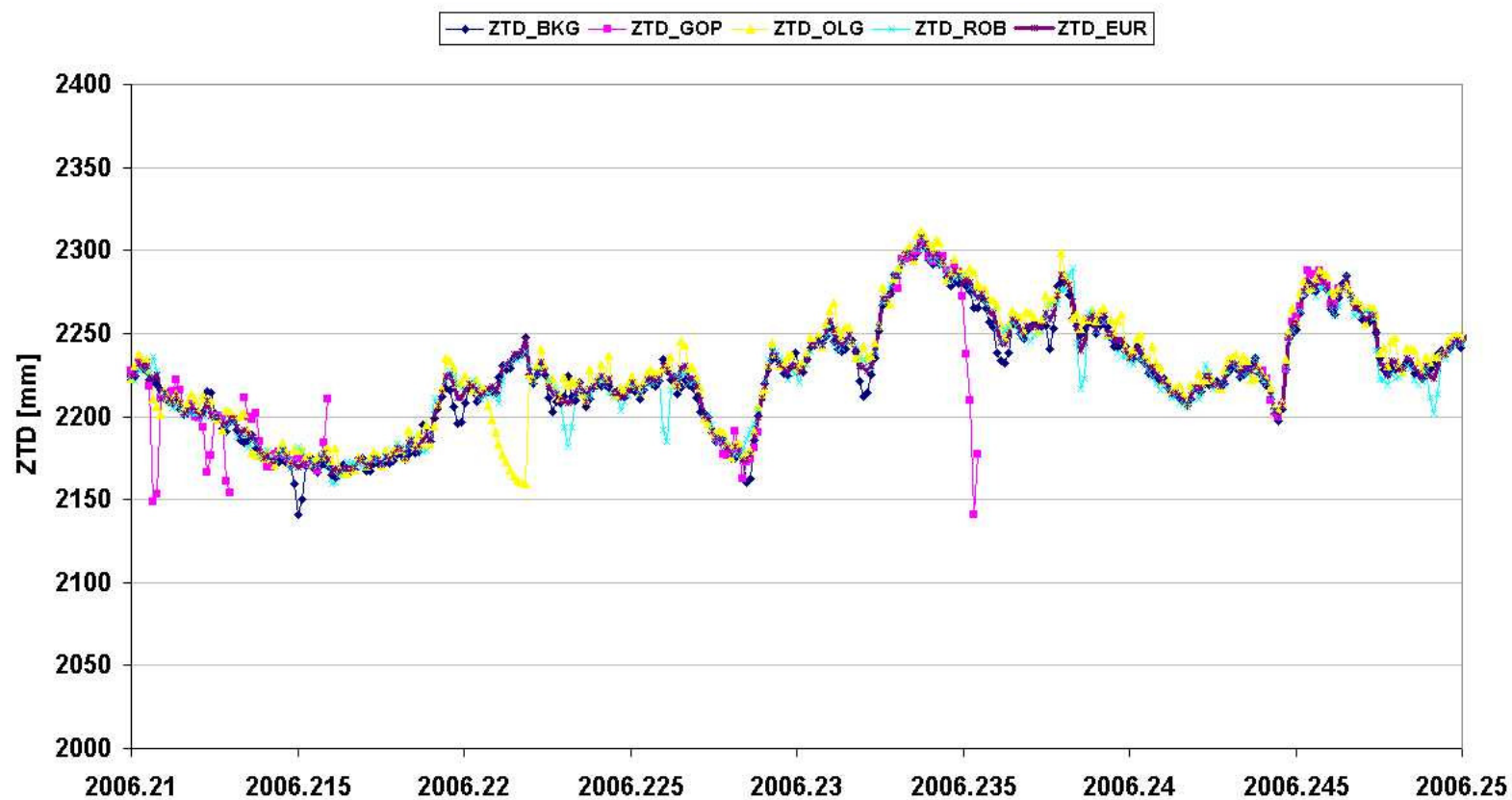


“Account of the EPN Spe

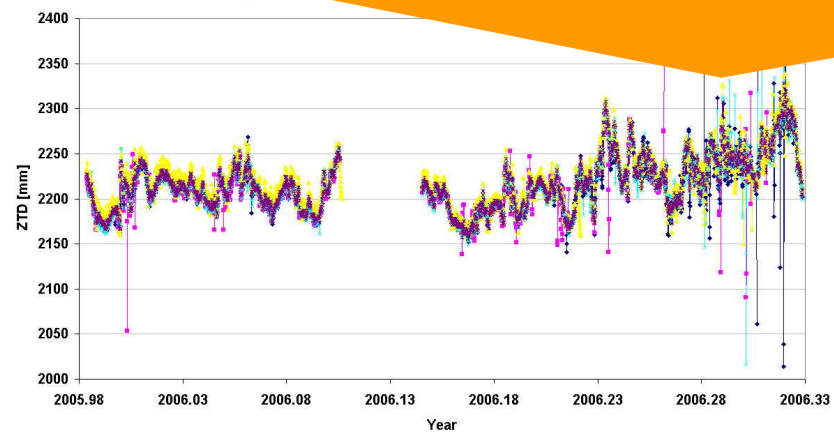
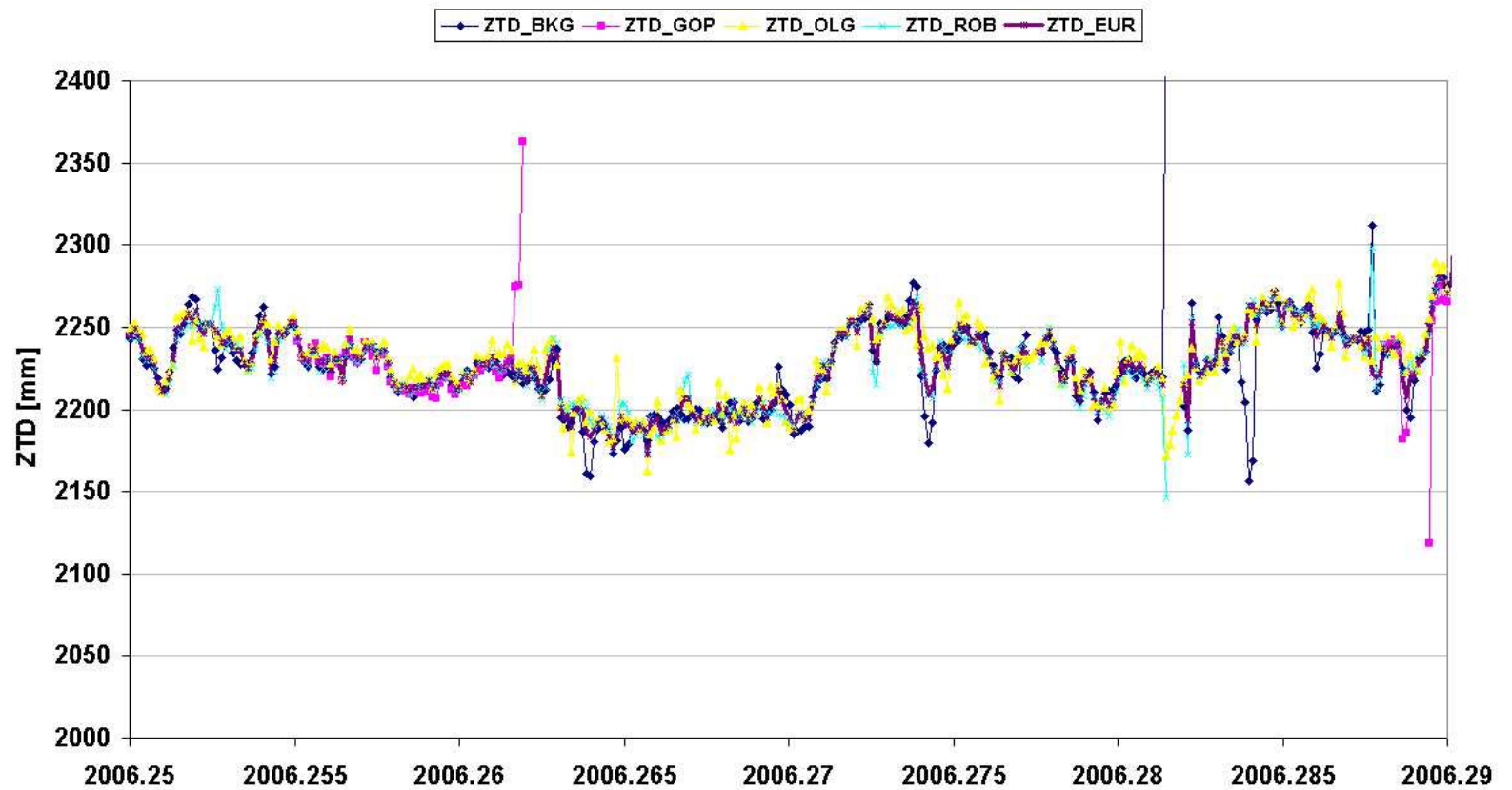
ZTD parameters for site OBE2 for GPS weeks 1355-1372



ZTD parameters for site OBE2 for GPS weeks 1355-1372

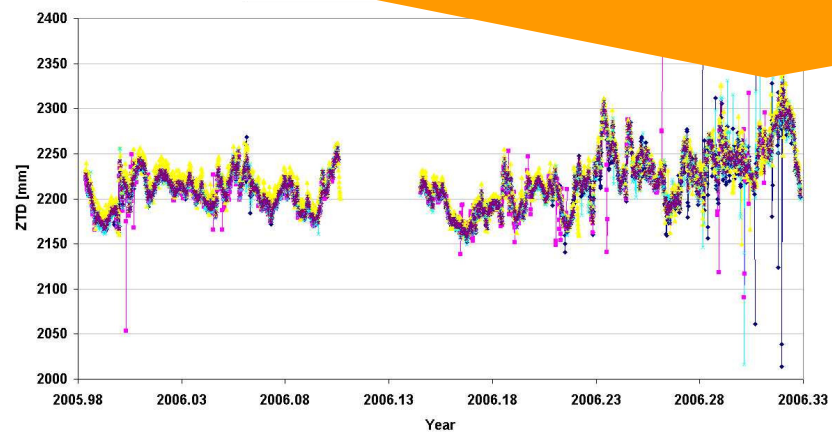
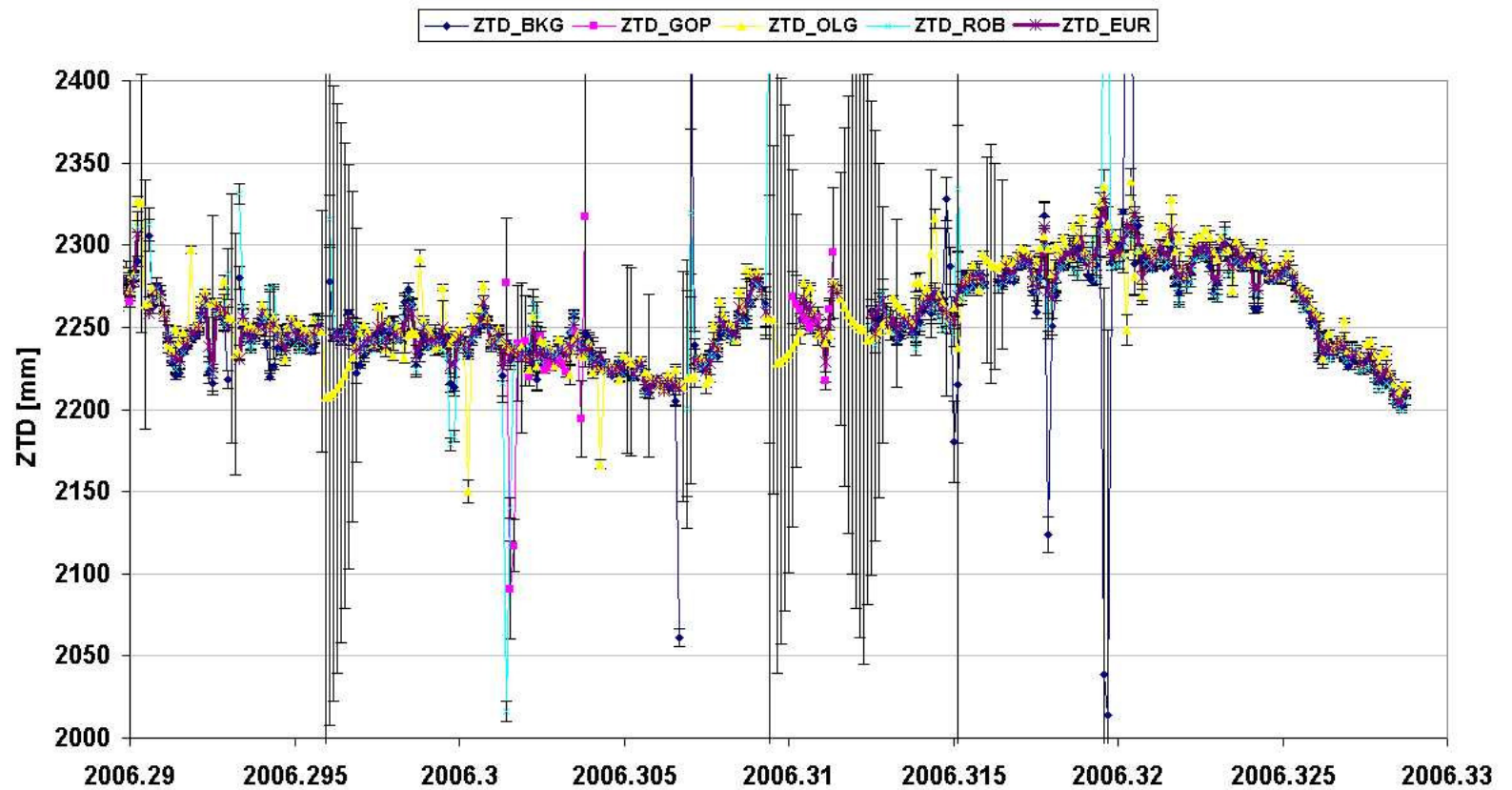


ZTD parameters for site OBE2 for GPS weeks 1355-1372



Parameter Estimation"

ZTD parameters for site OBE2 for GPS weeks 1355-1372

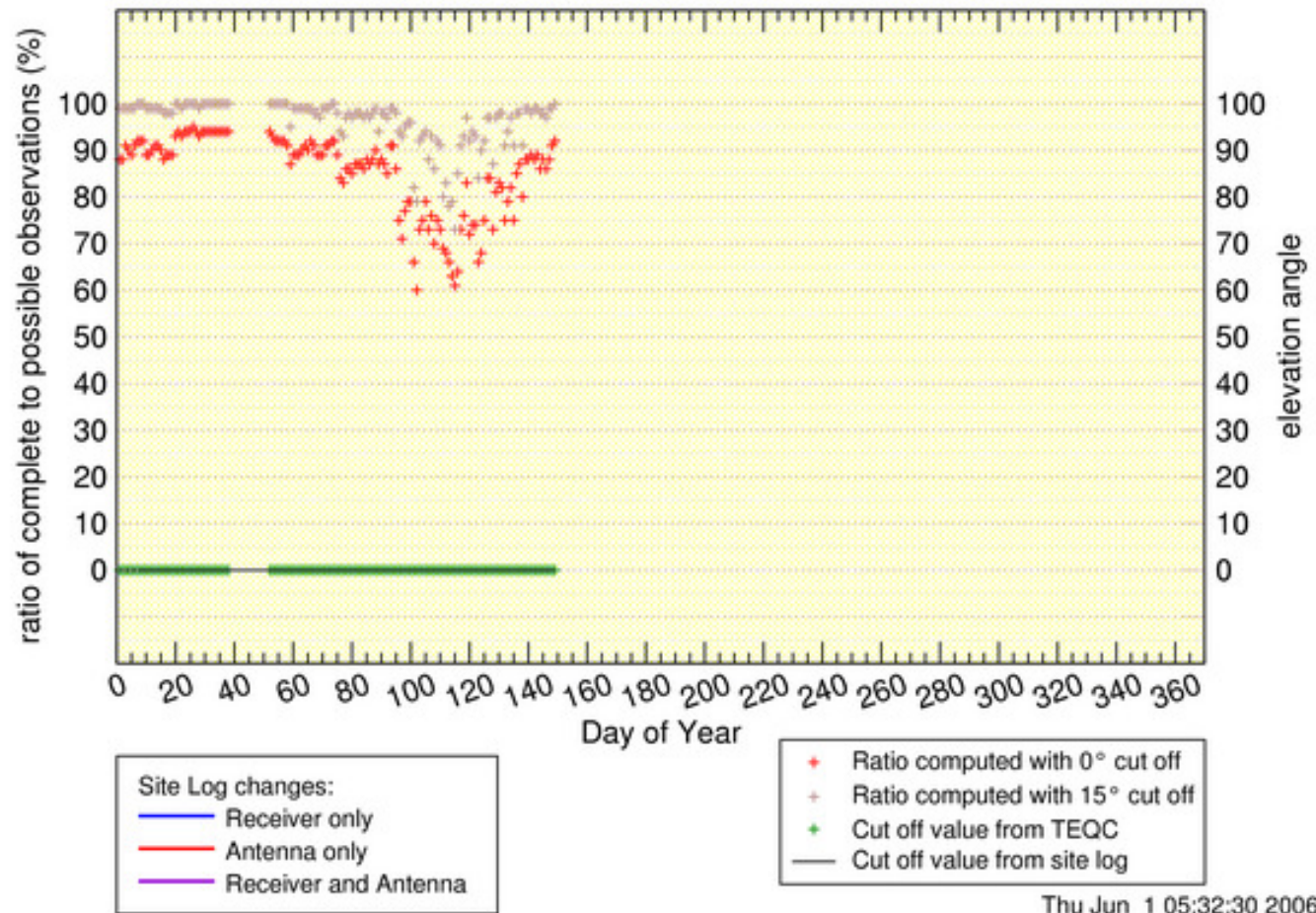


Parameter Estimation

Examples

OBE2 2006

From EPN Central Bureau

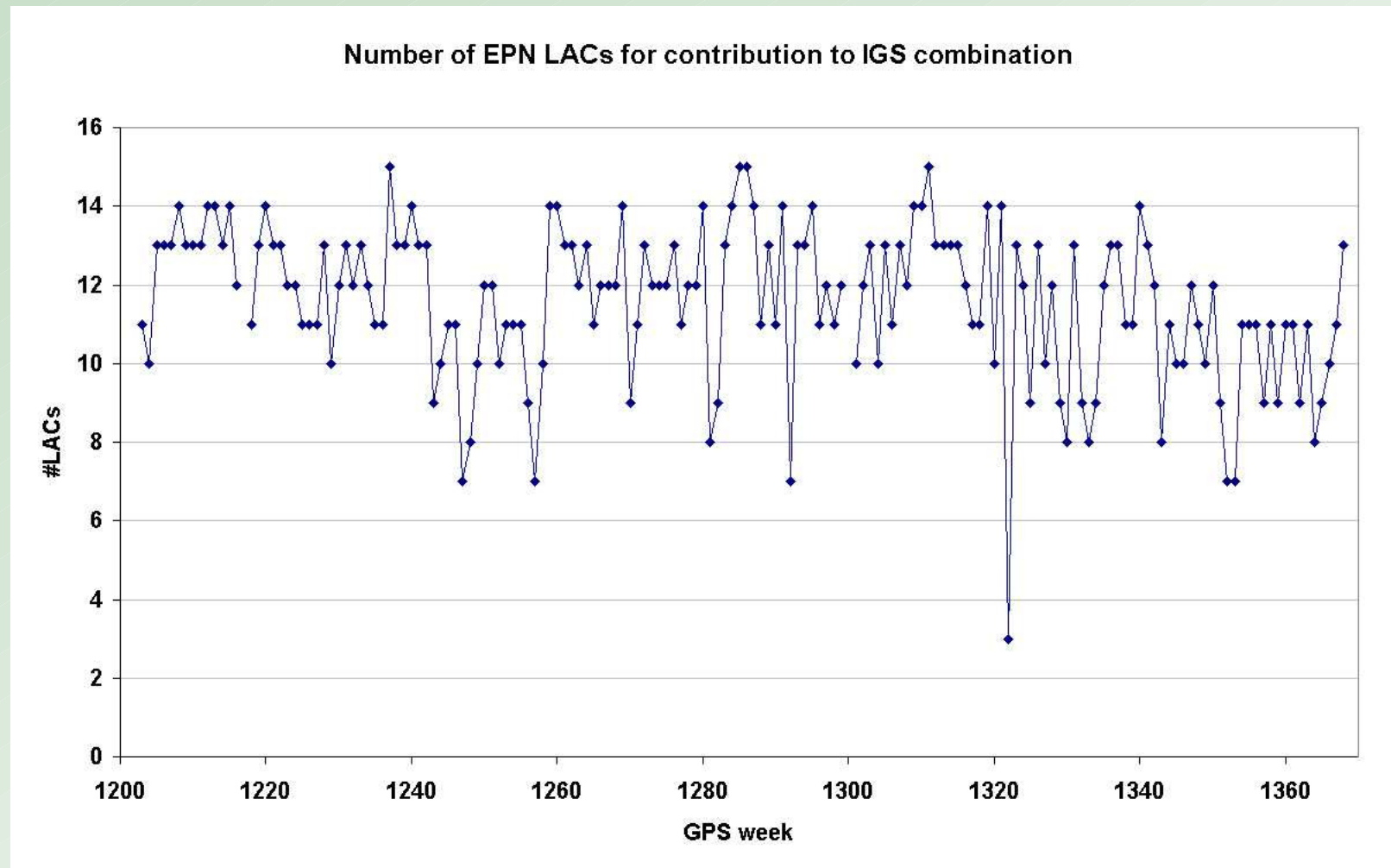


Thu Jun 1 05:32:30 2006

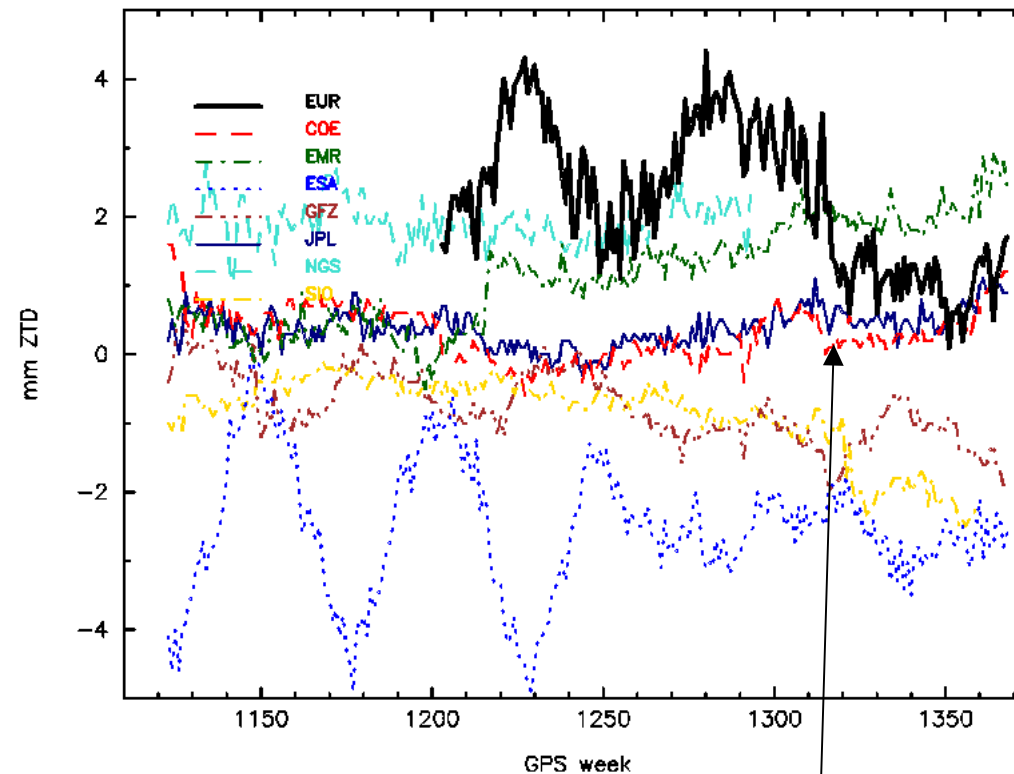
Actually three different products available from IGS (<ftp://cddis.gsfc.nasa.gov>):

- combined product with two hours solution (where EPN is contributing with the “rapid” troposphere solution, computation 1 week after final IGS orbit)**
- combination of ultra-rapid tropospheric zenith path delay, with one hour solution and update every three hours**
- new product, with five minutes solution, more than 250 stations, precise point positioning**

Number of EPN LACs contributing to “rapid” combination

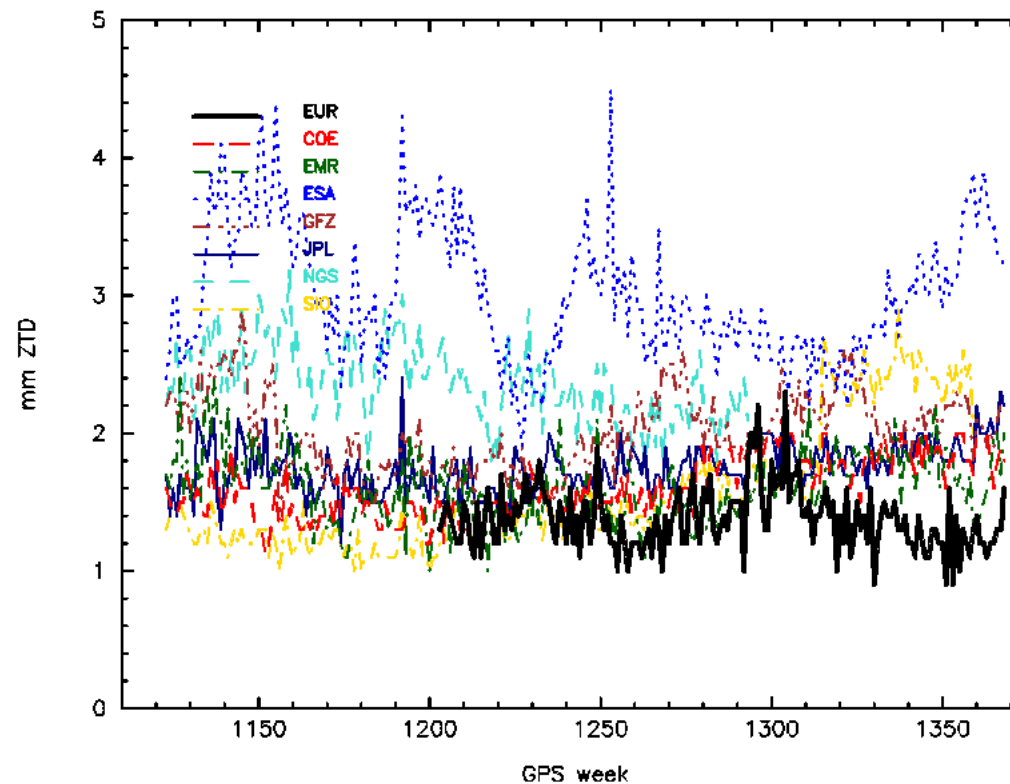


Weekly mean biases for all IGS LACs (taken from the IGS combination summary)

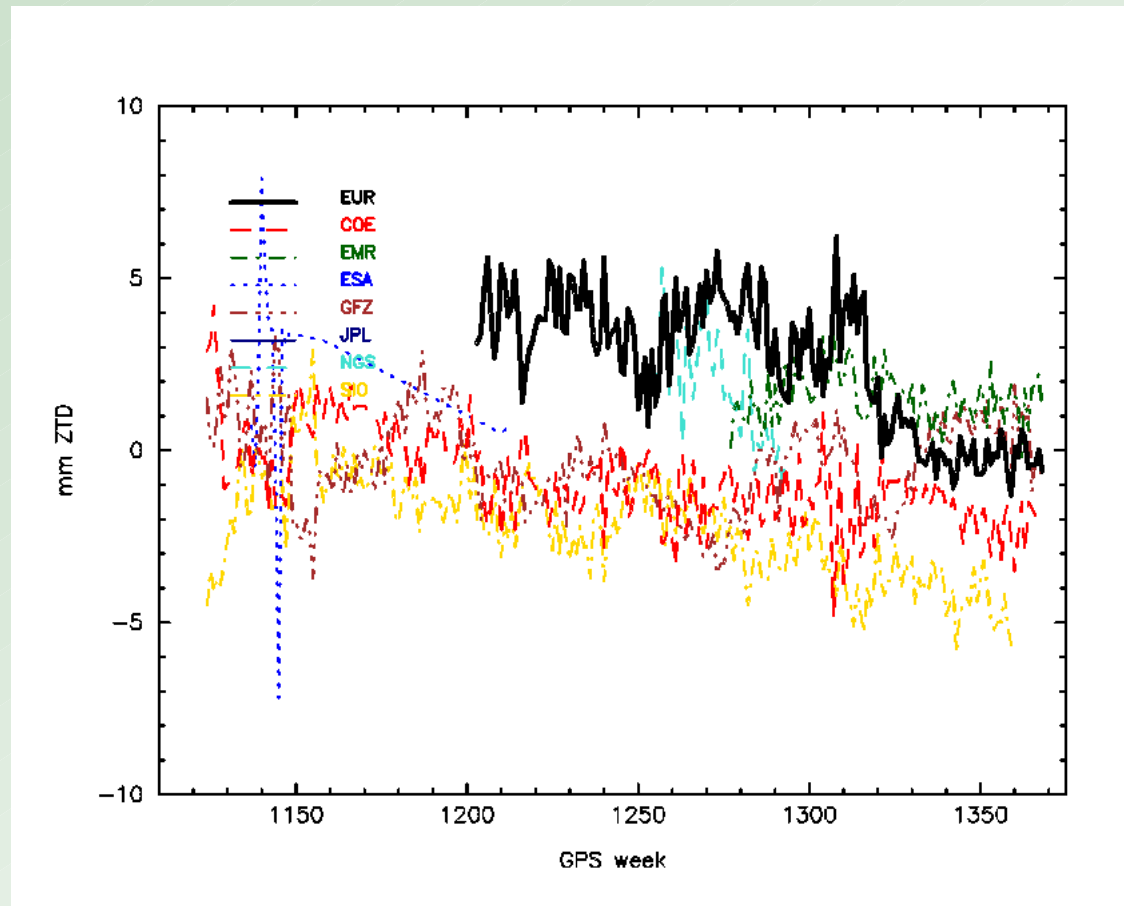


New model for EUR

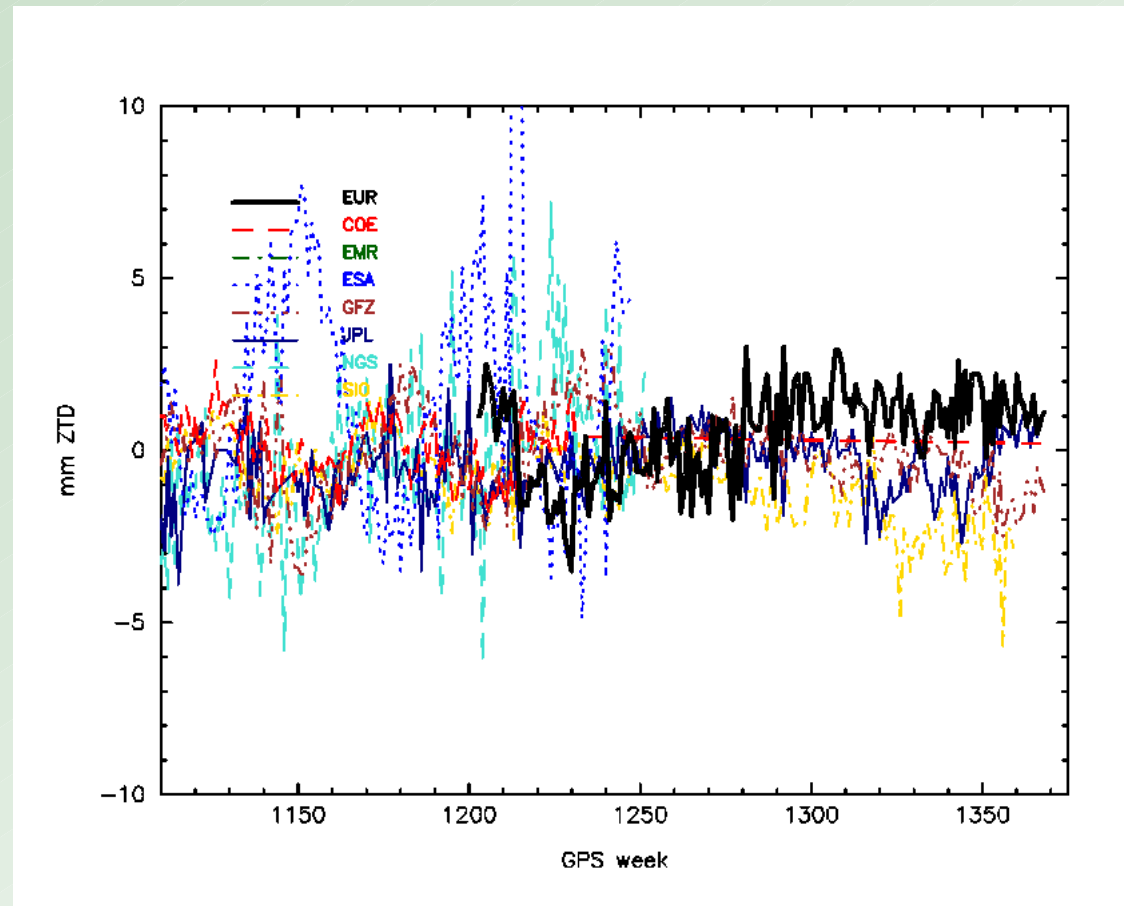
Standard deviation of weekly mean biases for all IGS LACs



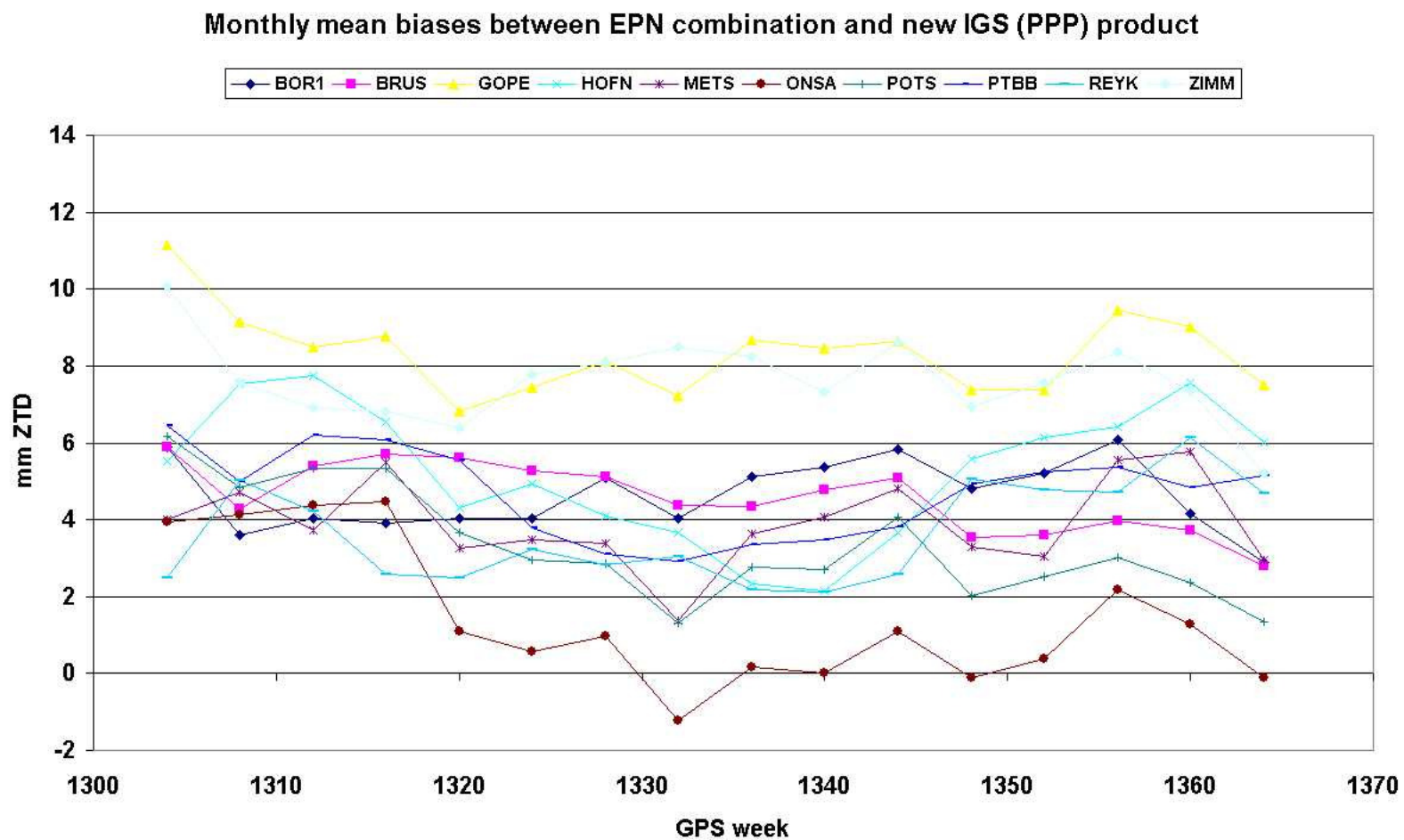
Weekly mean biases for all LACs – site HOFN



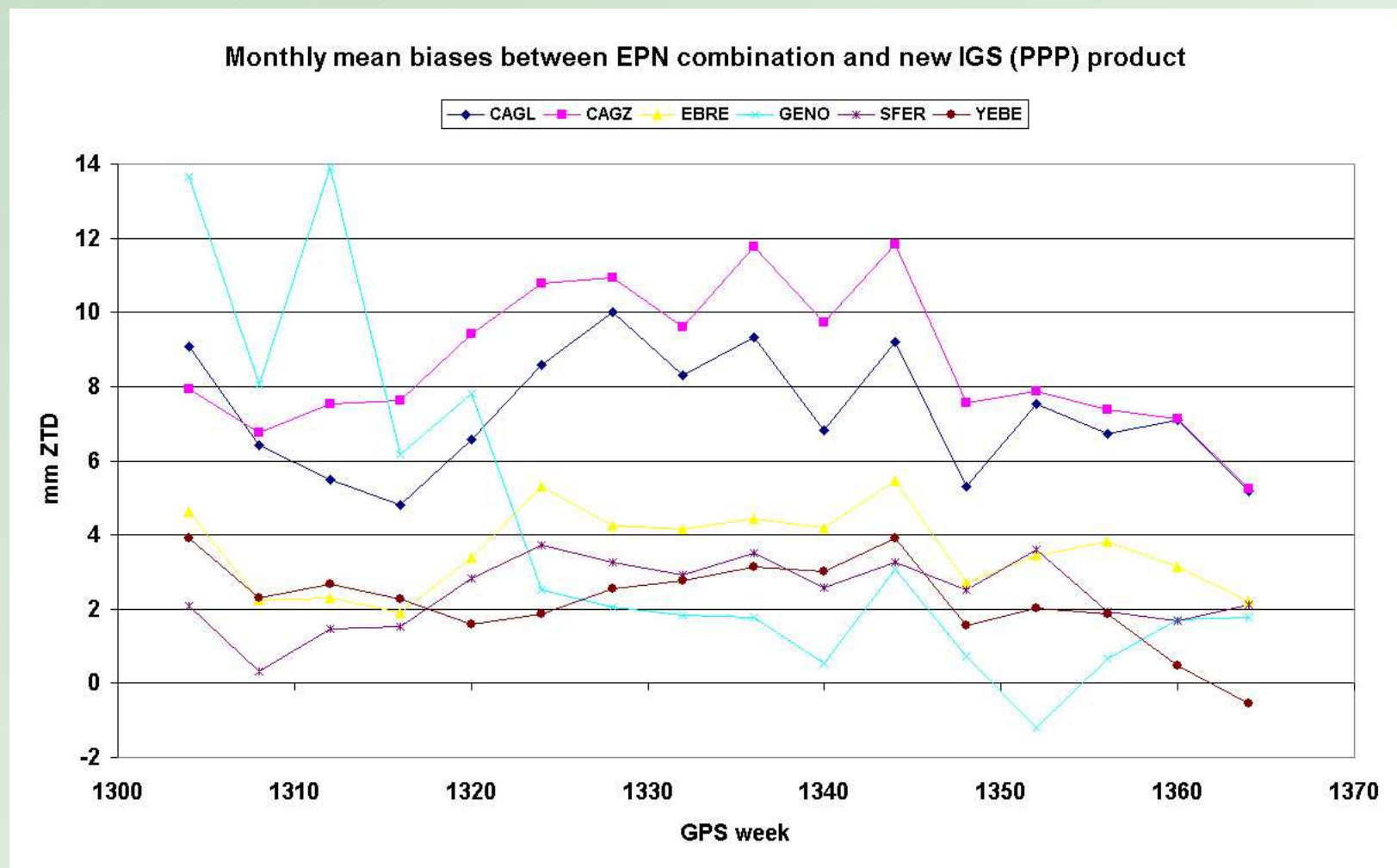
Weekly mean biases for all LACs – site REYK



IGS troposphere parameter products



IGS troposphere parameter products



Conclusions

- Change from Bernese version 4.2 to 5.0 gives biases up to 5 mm ZTD
- Biases to IGS combined solution reduced
- Comparison to IGS PPP product shows site dependent differences
- Investigations concerning combined GPS / GLONASS analyses planned