Federal Agency for
Cartography and Geodesy

Status of the EPN troposphere product

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Outline

- History
- Status
- Conclusions

History 1/4

- **GPS week 1108: first solutions (June 2001)**
- **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, e.g.,**
  switch to 1 hr ZPD resolution
  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) BSW V5.0**

History 2/4

- **GPS week 1185: Contribution of SUT as 16th LAC (Sep '02)**
- **GPS week 1203: Contribution of EPN rapid troposphere solution to IGS combination**
- **GPS week 1307: GFZ stops EPN combination (IGS troposphere combination is moving from GFZ to JPL)**
- **GPS week 1317: LPT switching to 5.0, Wet Niell mf (EUREF mail 2360)**
- **GPS week 1318: WUT switching to 5.0, Wet Niell mf (EUREF mail 2363)**
- **GPS week 1319: BKG switching to 5.0, Wet Niell mf (EPN LAC mail 490)**
- **GPS week 1320: GOP switching to 5.0, Wet Niell mf (EPN LAC mail 508)**
- **GPS week 1321: NKG switching to 5.0, Wet Niell mf (EPN LAC mail 505)**
- **GPS week 1324: UPA switching to 5.0, Wet Niell mf**
- **GPS week 1325: ROB switching to 5.0, Wet Niell mf**

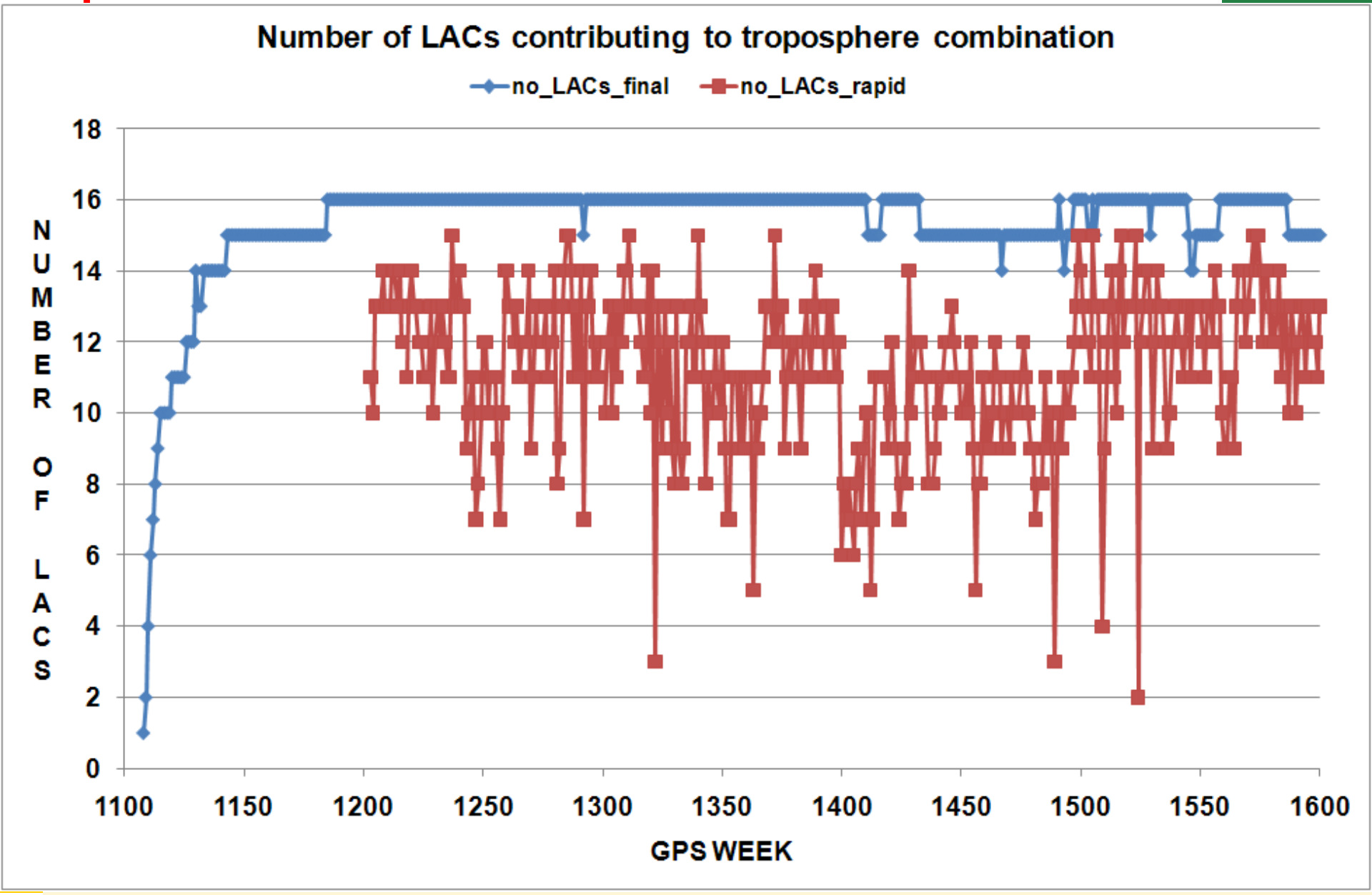
History 3/4

- **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 mf (EPN LAC mail 623)**
- **GPS week 1374: ASI switching from Microcosm 2003.0 to 2005.0**
- **GPS week 1381: SGO switching to 5.0, Wet Niell mf**
- **GPS week 1397: OLG switching to 5.0, Wet Niell mf**
- **GPS week 1399: GFZ stops “classical” IGS combination (IGS mail 5505)**
- **GPS week 1400: BEK switching to 5.0, Wet Niell mf**
  IGN switching to 5.0, Wet Niell mf
  SUT switching to 5.0, Wet Niell mf

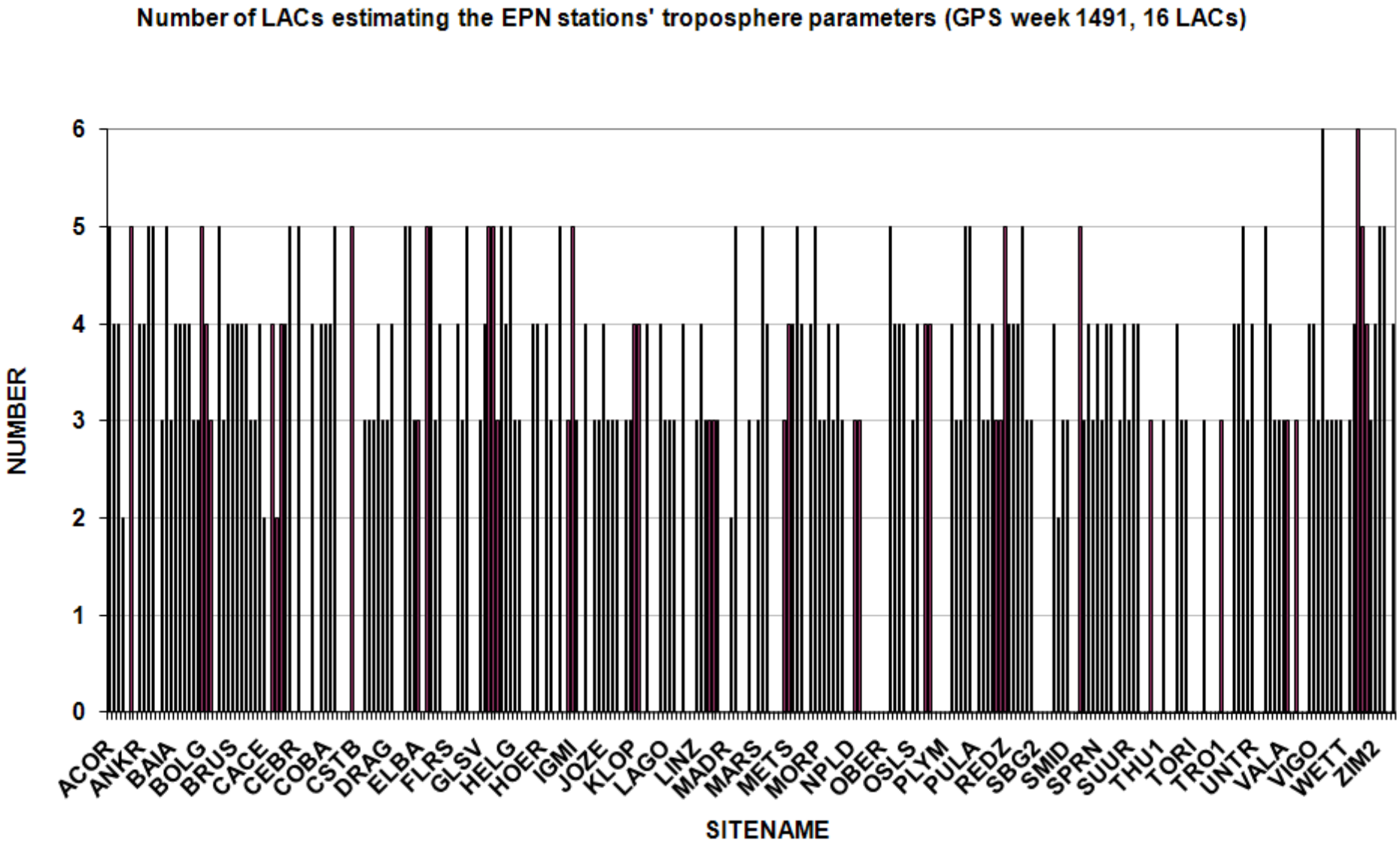
History 4/4

- **GPS week 1400: IGS and EUREF changing to APCV**
  taking into account radome codes
  IGS05 coordinates & velocities
  EPN introducing horizontal tropospheric gradients
- **GPS week 1400: COE using GMF, switching to (unofficial) BSW V5.1**
- **June 2008: resolution #1 at the EUREF symposium => operational status**
- **GPS week 1558: contribution of MUT**
- **GPS week 1600: COE using VMF1**
- **GPS week 160n: ASI with improved contribution**
- **GPS week 16xx: IGS08 coordinates & velocities**

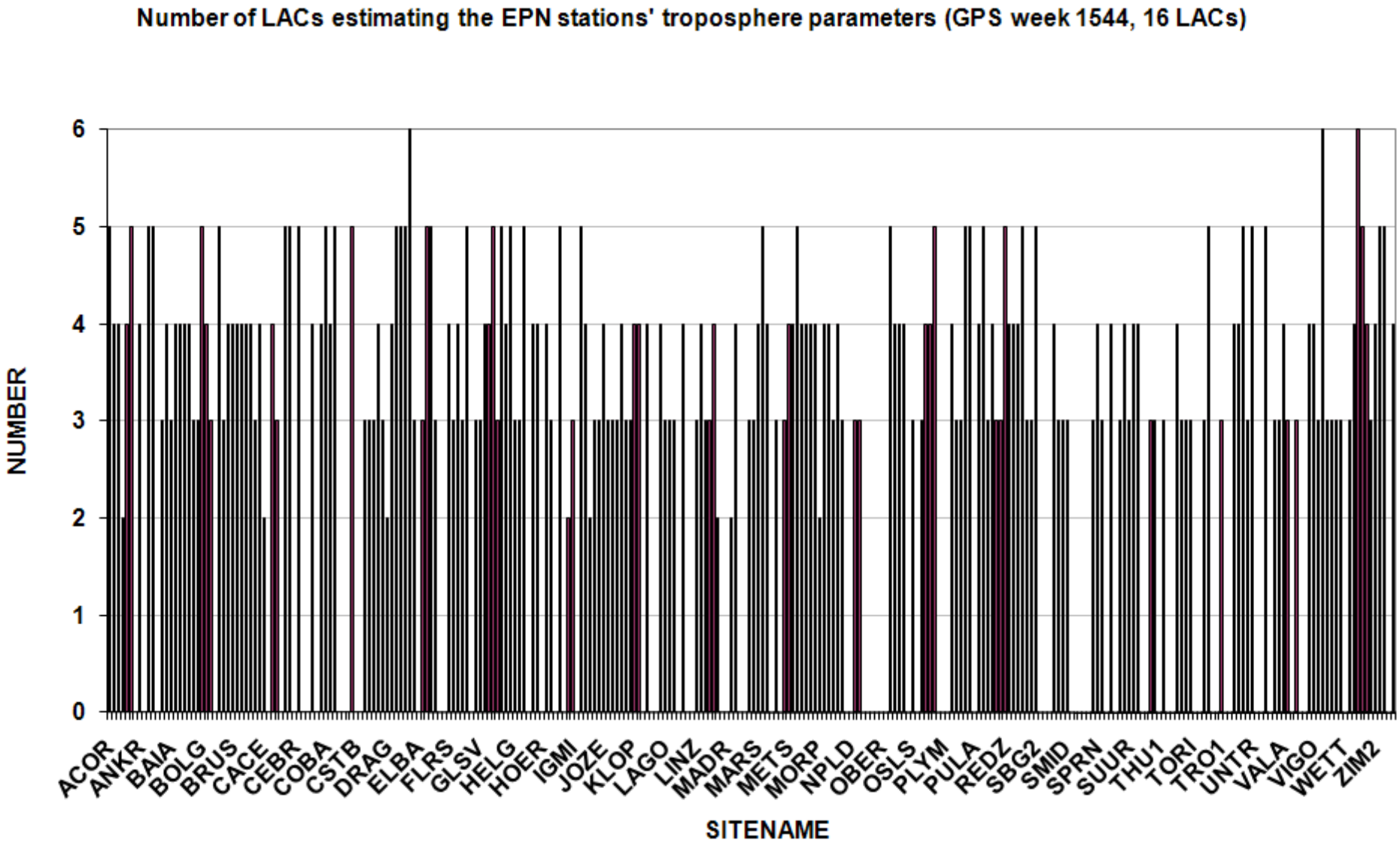
Contribution – rapid and final



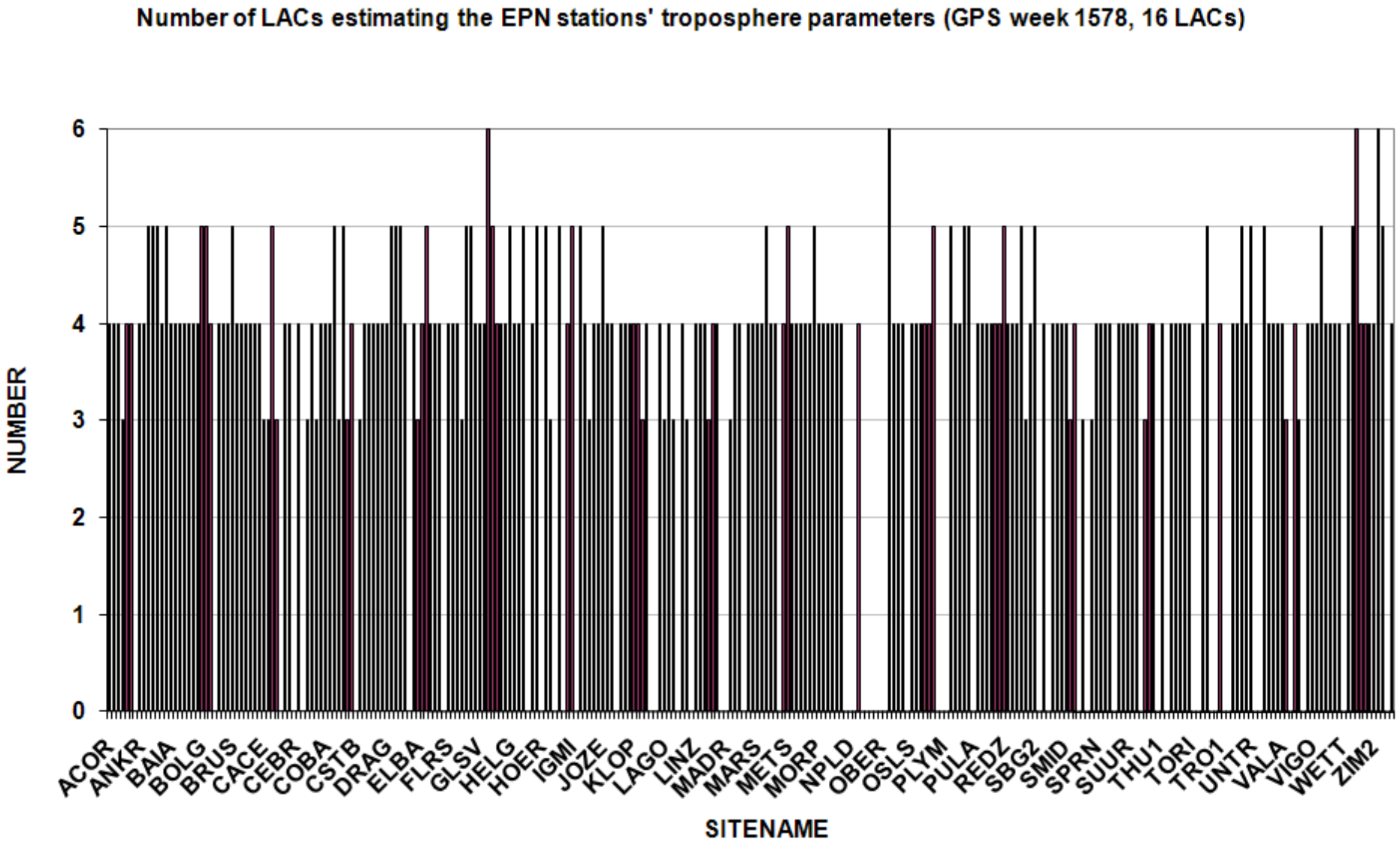
Contribution – stations and LACs (1/4)



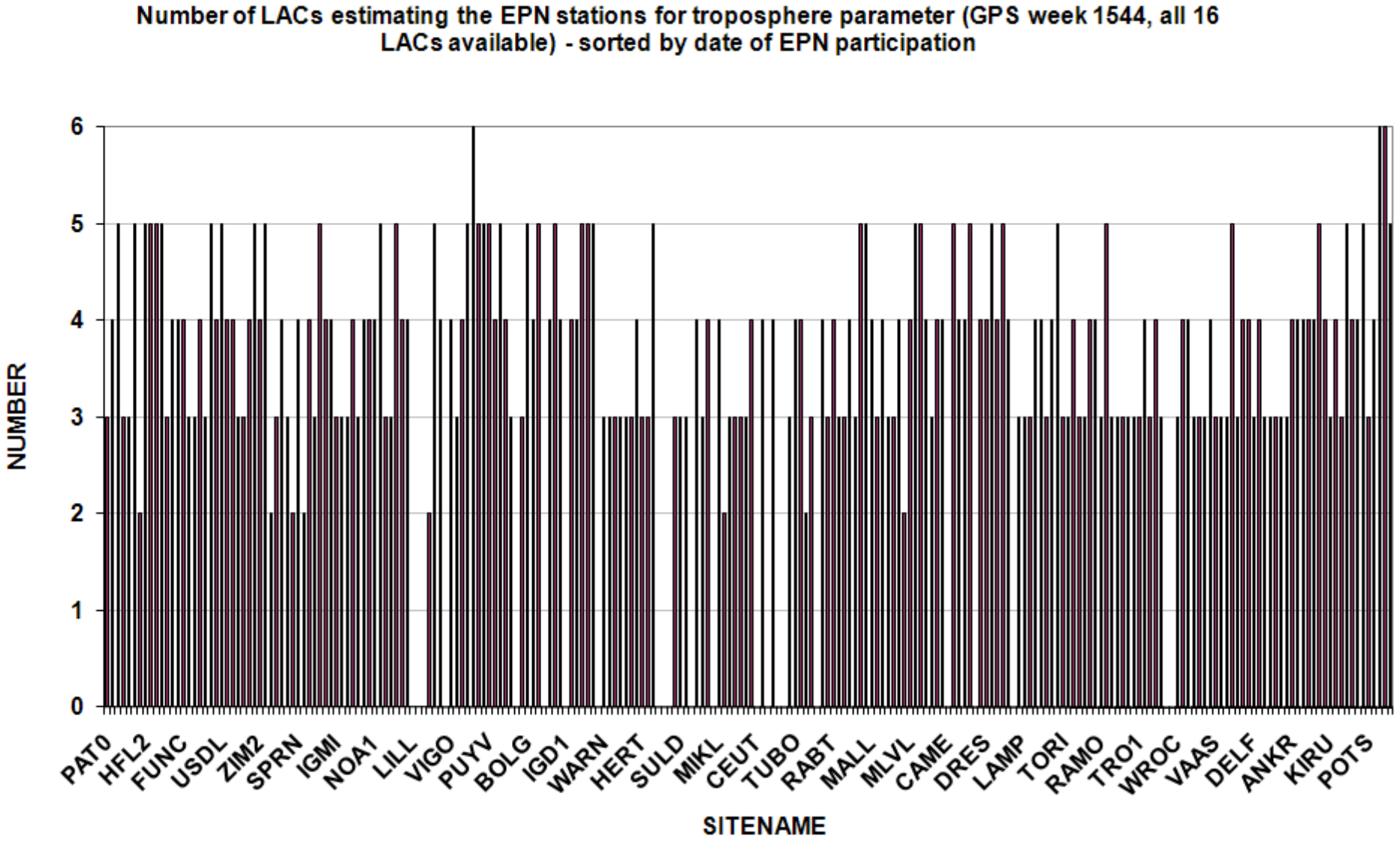
Contribution – stations and LACs (2/4)



Contribution – stations and LACs (3/4)



Contribution – stations and LACs (4/4)

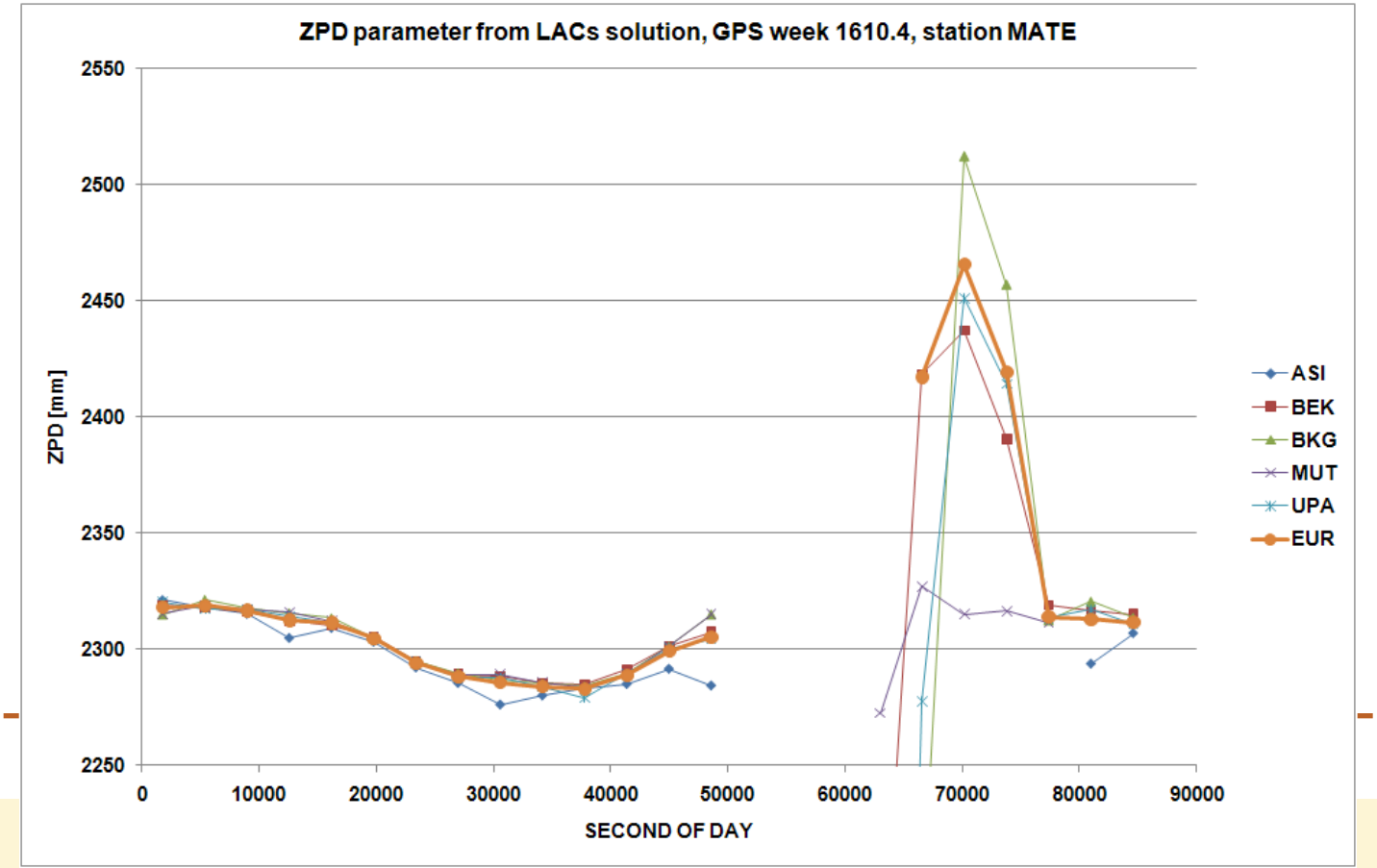


Combination: Status

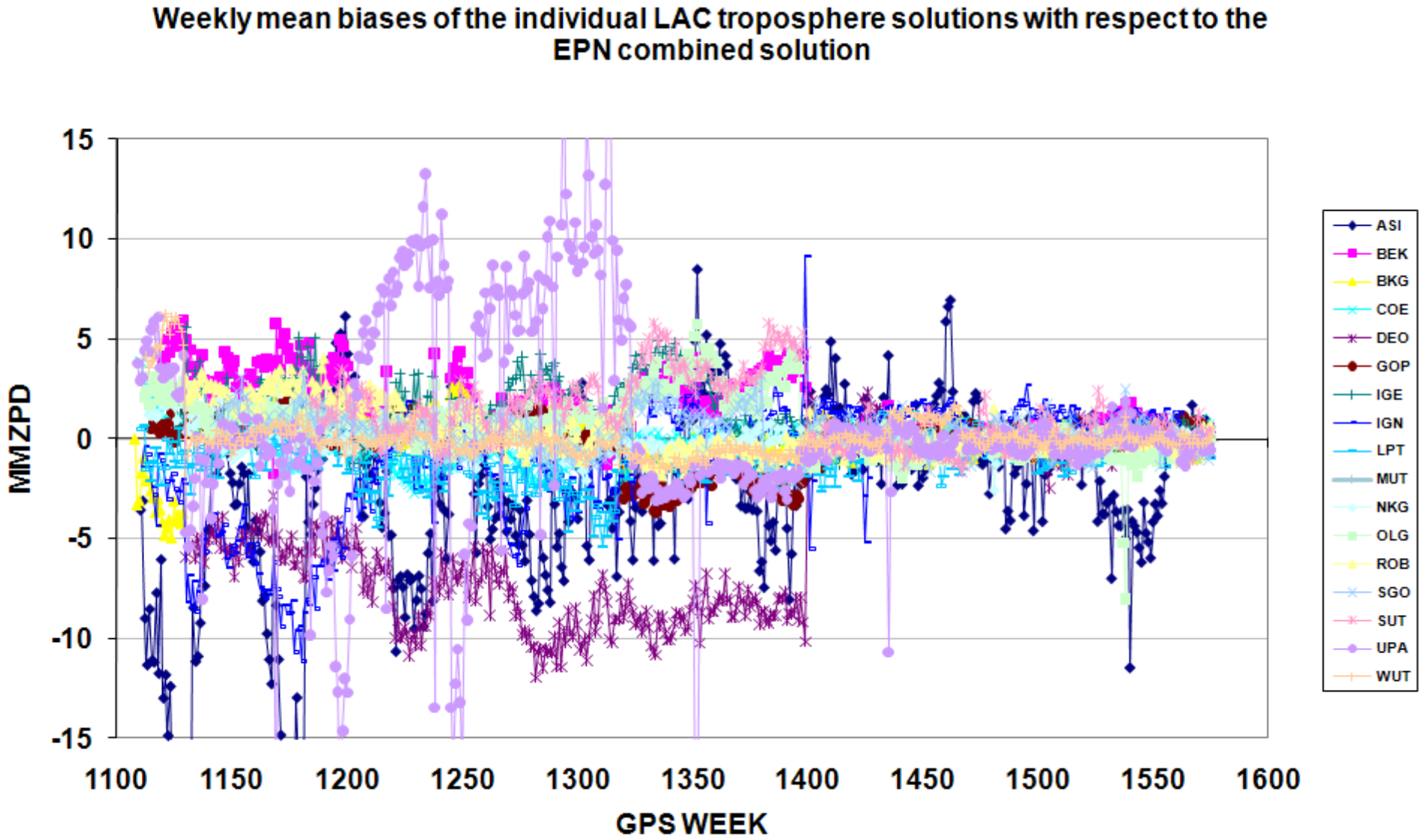
- EPN troposphere combination still done by a mixture of Perl scripts, Fortran programs and shell scripts
- Combination procedure still based on the scheme developed by Gerd Gendt for the IGS combination in 1997
- Combination still in two steps
  - "Rapid" solution each Friday night (i.e., 8 days after IGS finals) → to find big errors, missing solutions etc. to inform the LACs at an early stage
  - Final solution following SNX combination (no fixed date)

Combination: typical issues

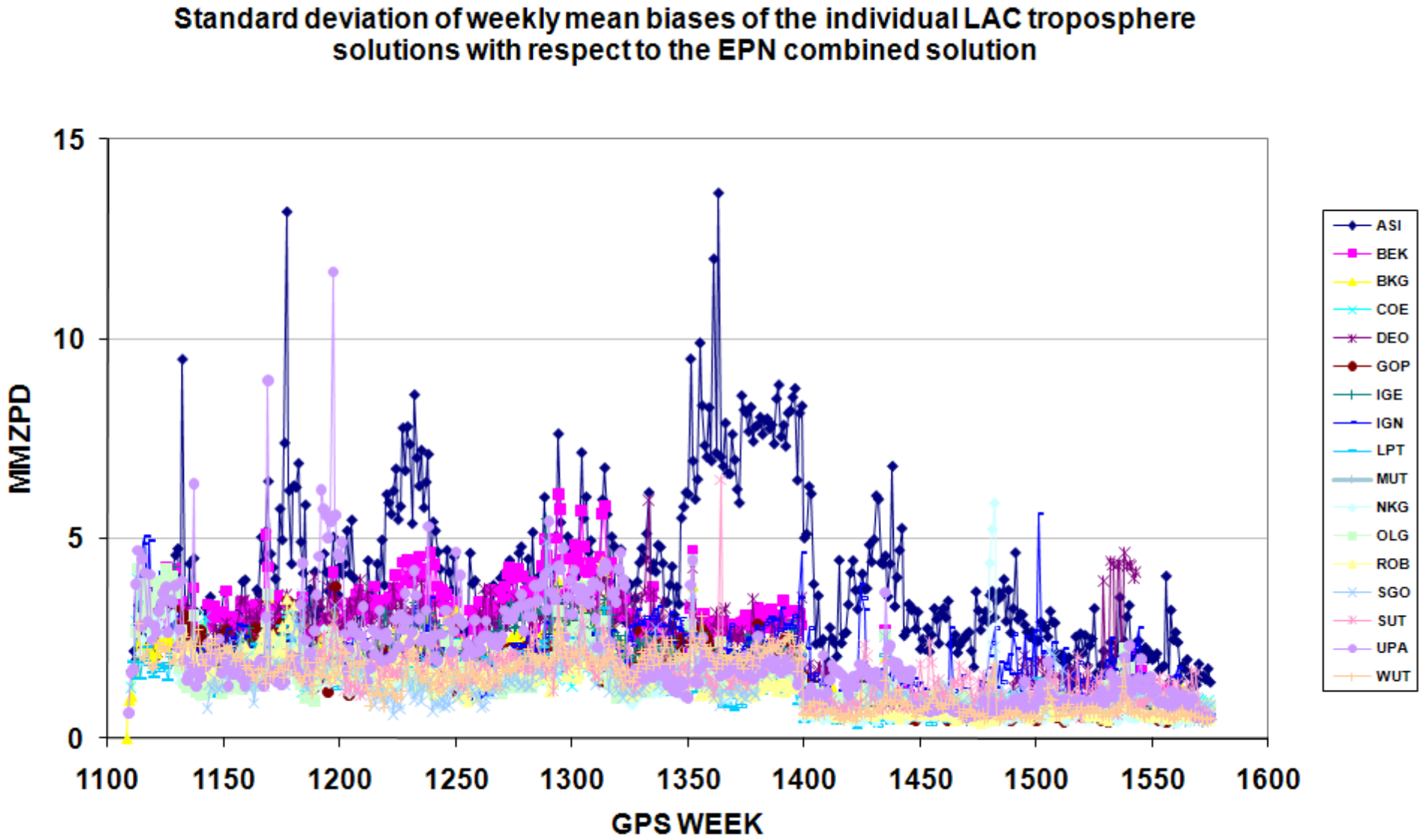
- ASI and MOPS: high bias → excluded
- KELY and QAQ1: large differences / high stdev at 01800 and 84600
- “short baseline” effects



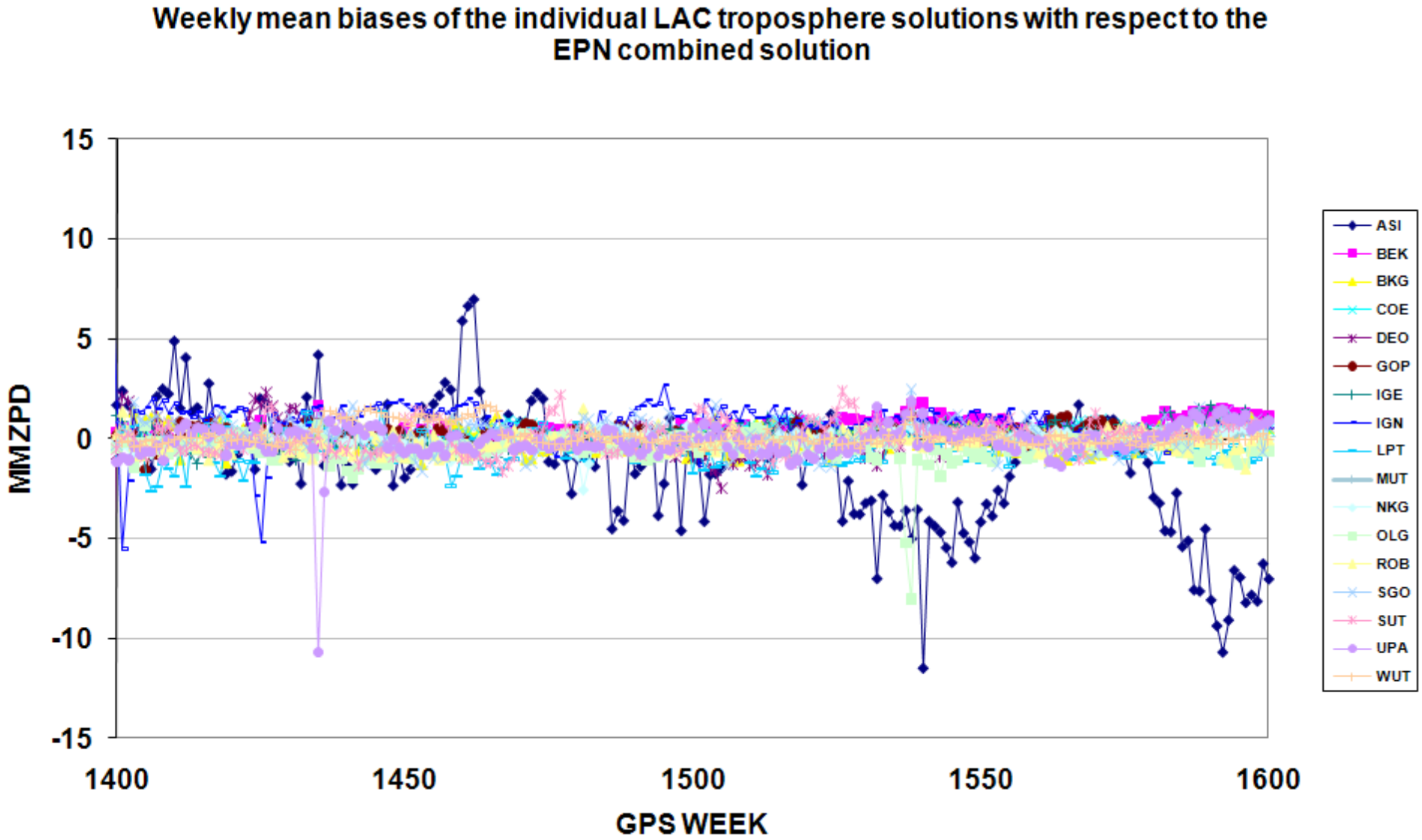
Combination: internal precision (1/4)



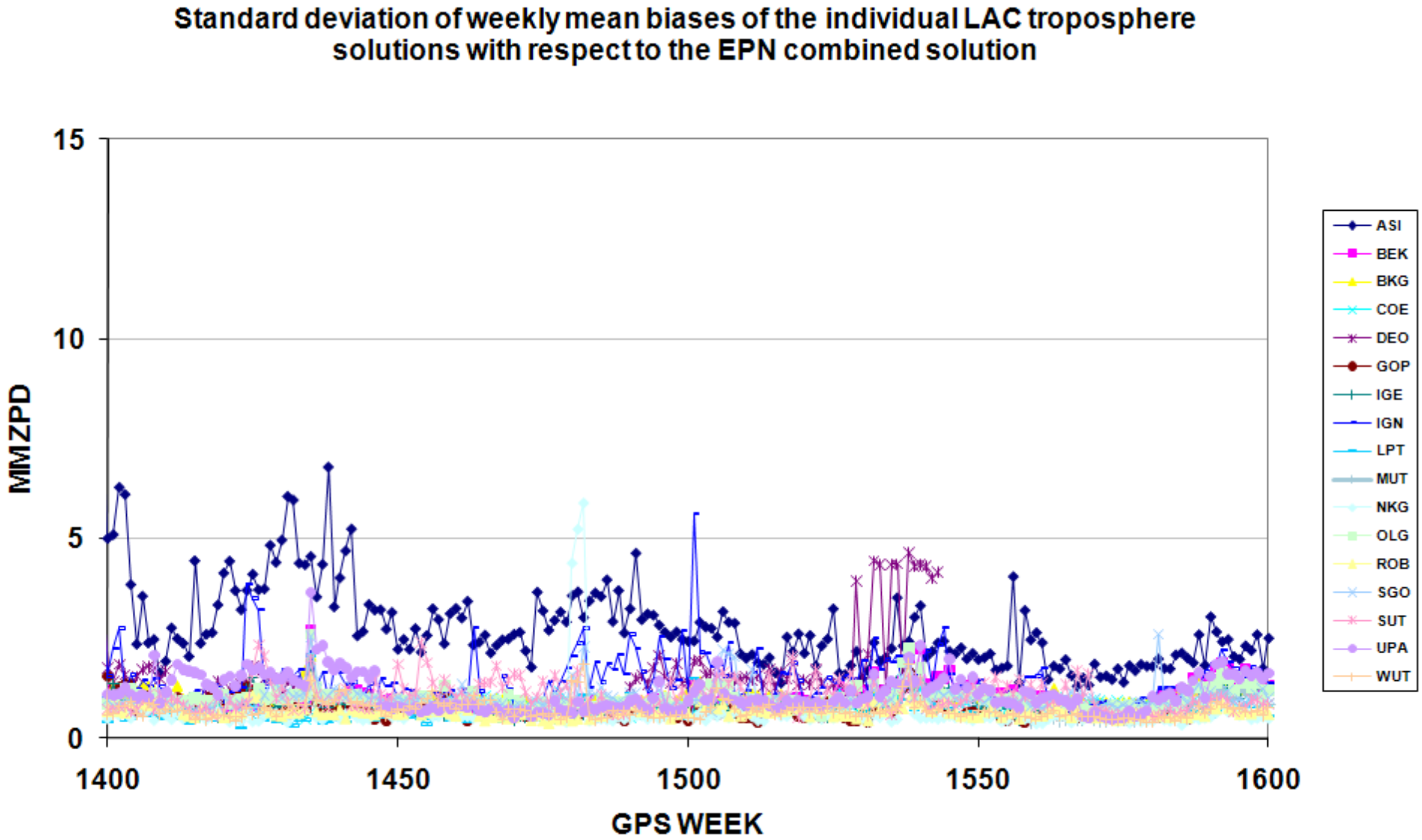
Combination: internal precision (2/4)



Combination: internal precision (3/4)



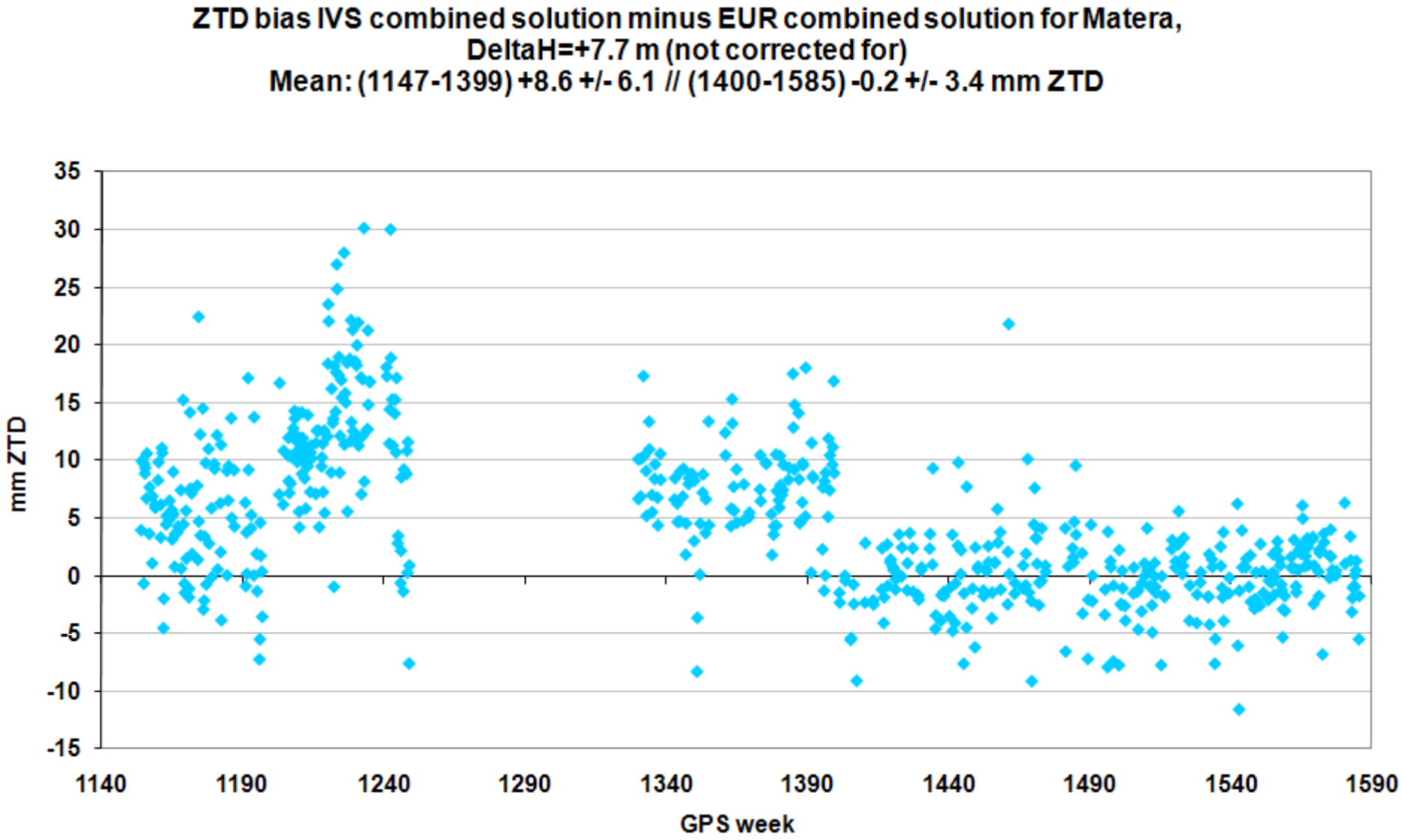
Combination: internal precision (4/4)



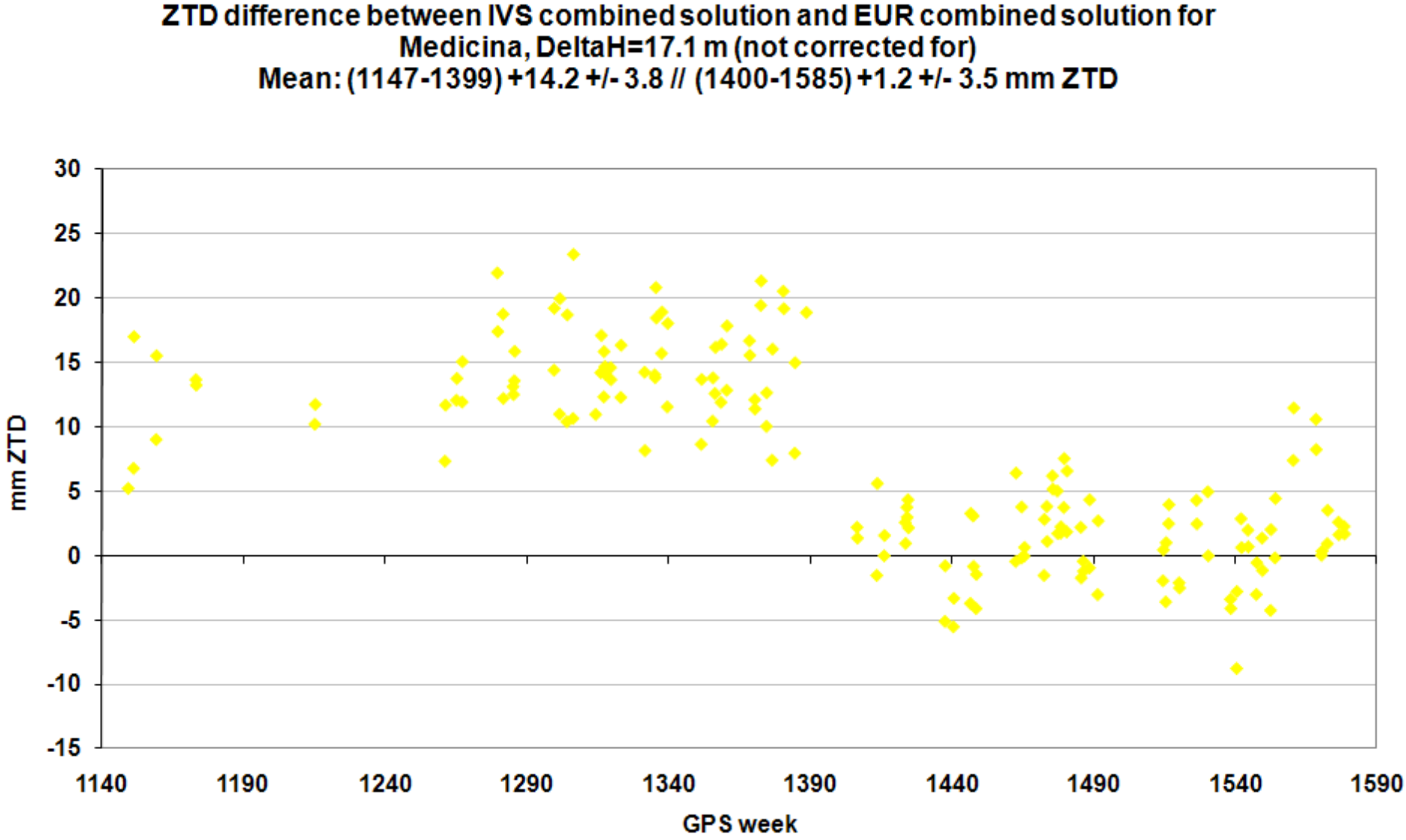
Inter-technique comparison (1/12)

- Comparison with VLBI results
- Combination within International VLBI Service (IVS) by R. Heinkelmann (TU Vienna, now DGFI)
- IVS results available since GPS week 1147
- Only few co-locations with EPN stations available

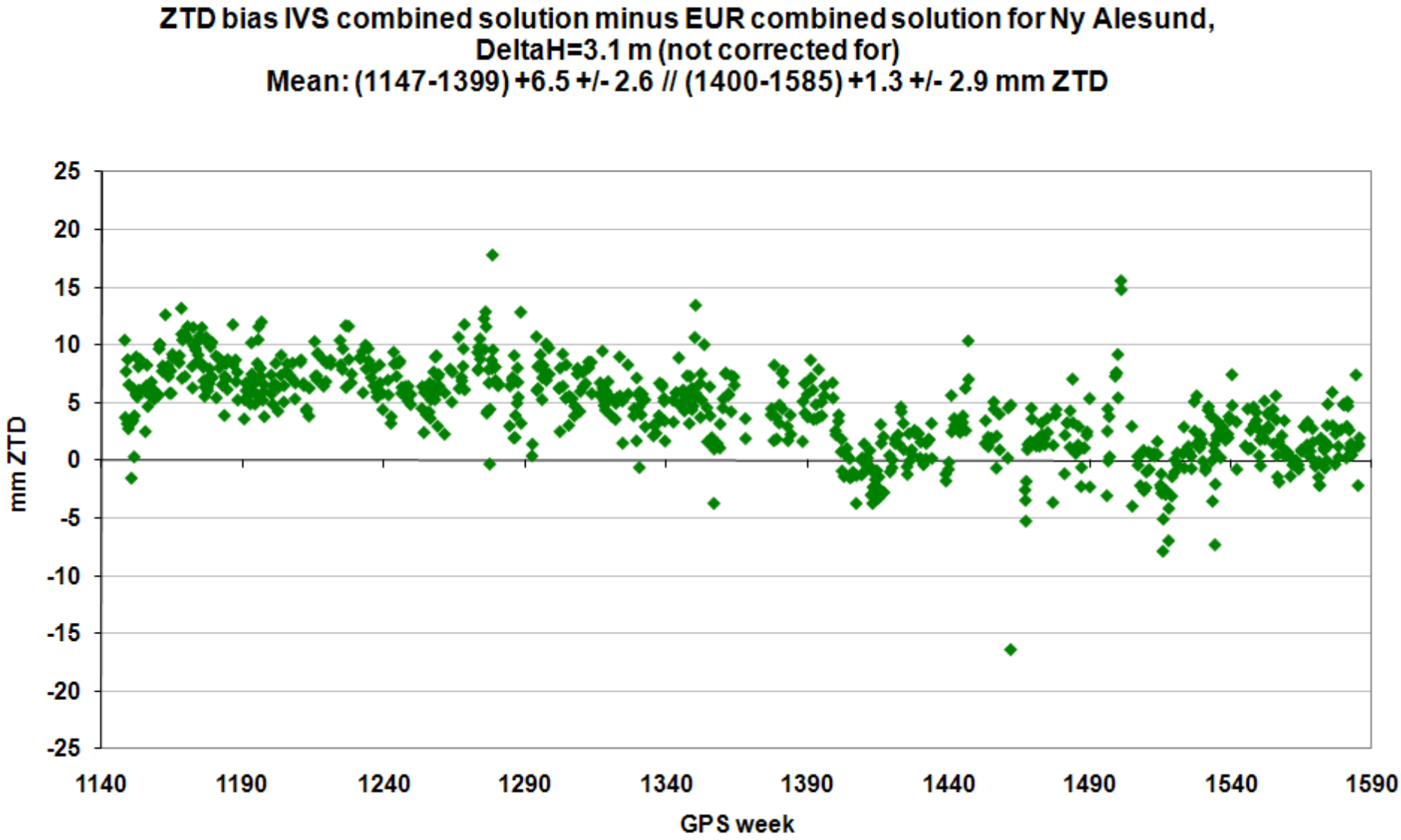
Inter-technique comparison (2/12)



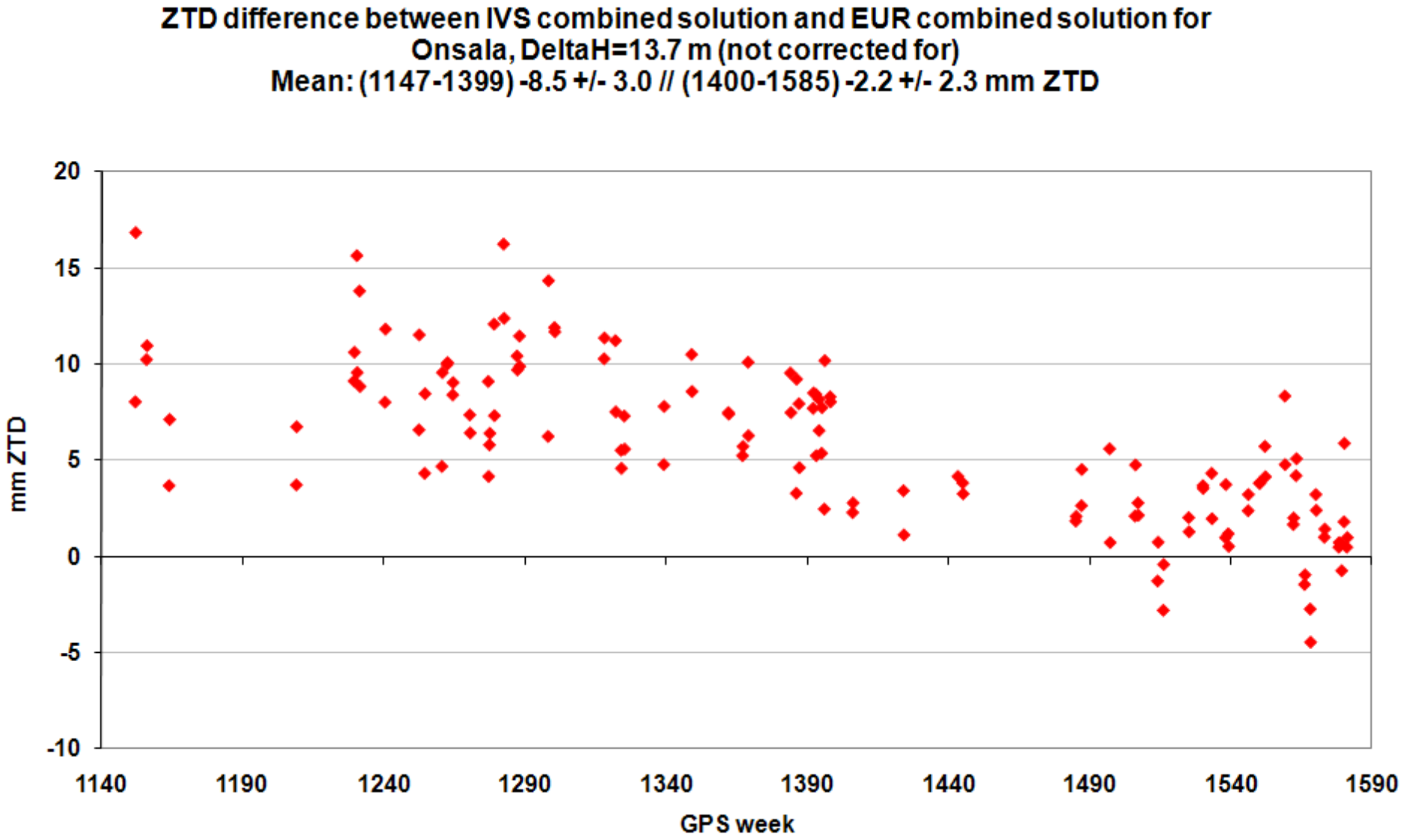
Inter-technique comparison (3/12)



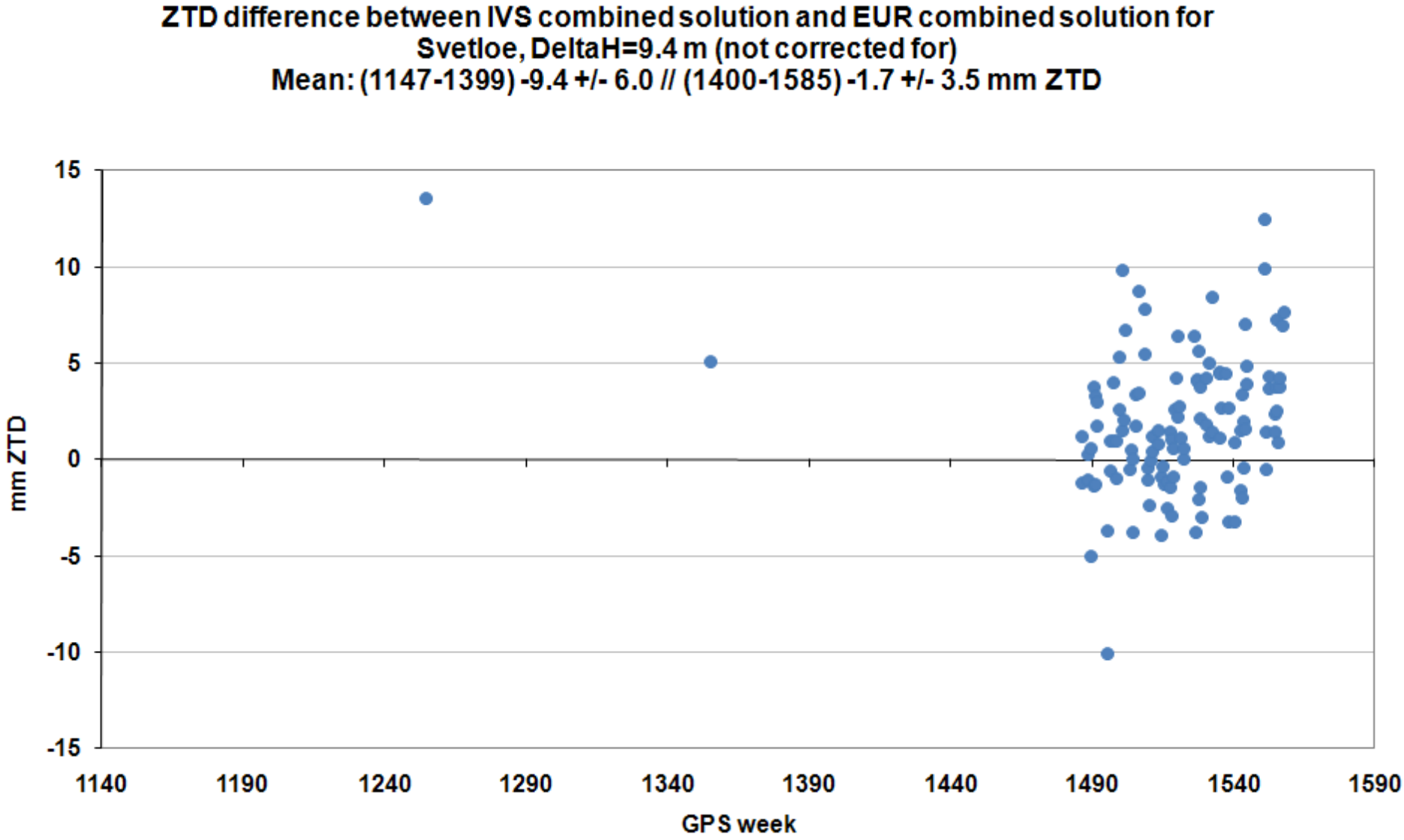
Inter-technique comparison (4/12)



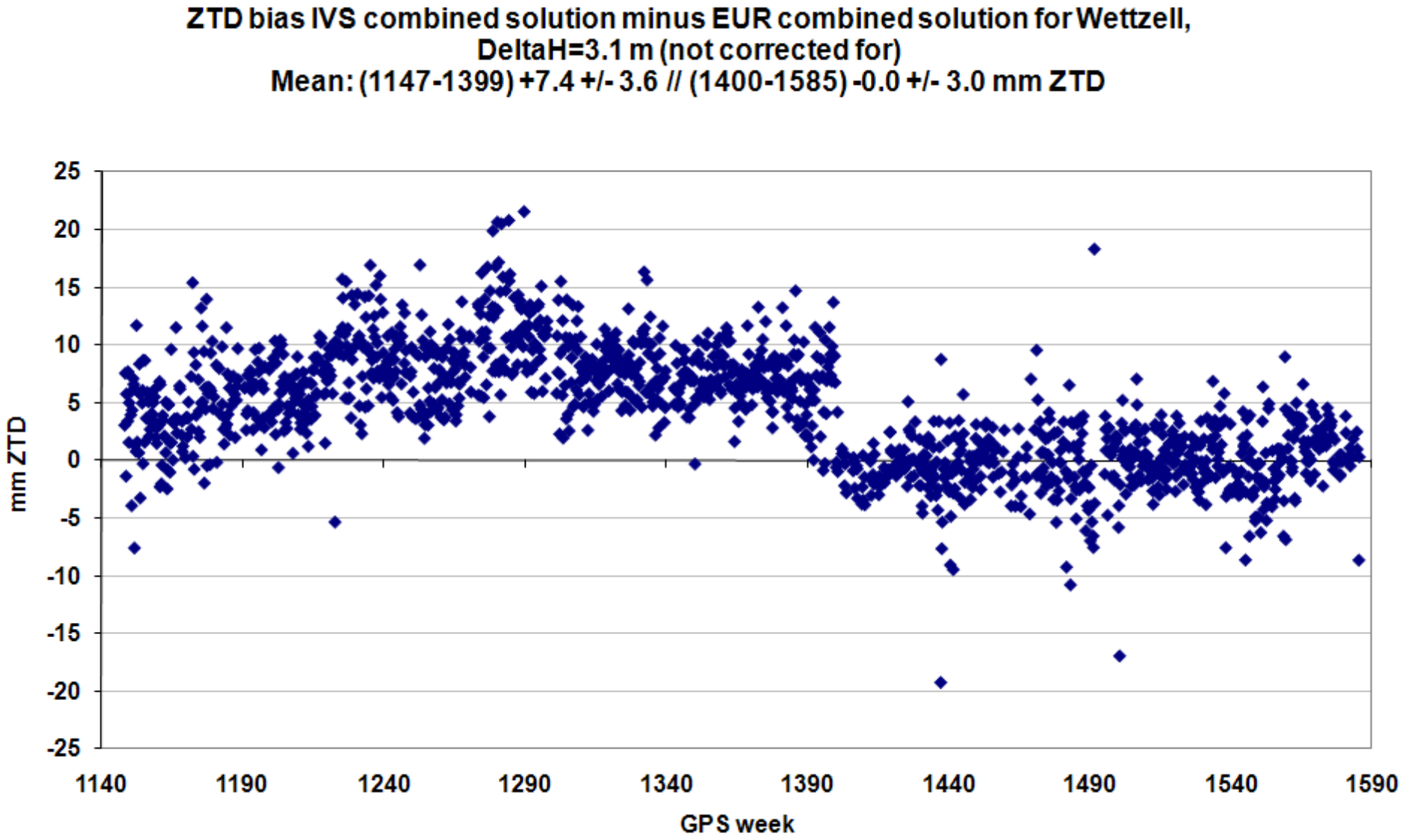
Inter-technique comparison (5/12)



Inter-technique comparison (6/12)



Inter-technique comparison (7/12)



Inter-technique comparison (8/12)

- Comparison with Radiosonde (RS) results
- Thanks to the MoU between EUREF and EUMETNET
- Started April 2008
- RS data available since January 2004
- 226 RS available at all
- Program by H. Vedel (DMI) used
- On EPN webpage available since May 2008
- „Co-location“ criterion < 0.6 degree used (too loose? E.g. ElJS and EUSK (distance 77 km) use same RS)
- 99 EPN stations (September 2010) (stations with very sparse time series manually removed)

MORE INFORMATION	METEO DATA: available SATELLITE SYSTEM: GPS

Data Processing

BY

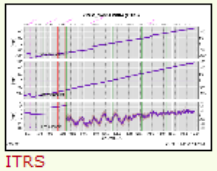
LAC	FROM (GPSWEEK)	TO (GPSWEEK)
COE	0834	now
LPT	0834	now
MUT	1558	now
OLG	0834	now
SUT	0834	now

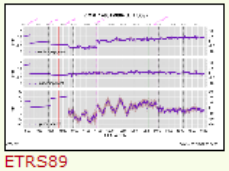
COMBINED SOLUTIONS

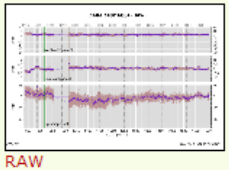
EXCLUSION PERIODS

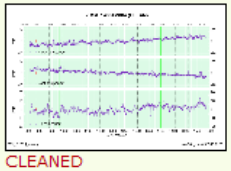
- 305/1998 (GPSweek No 0982) - 311/1998 (GPSweek No 0982) : antenna change.

TIME SERIES

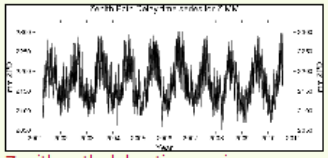

ITRS

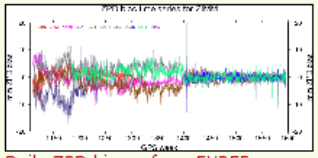

ETRS89

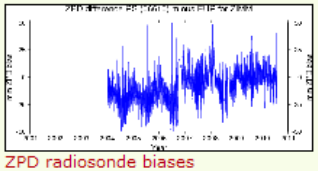

RAW


CLEANED

TROPOSPHERE


Zenith path delay time series


Daily ZPD biases from EUREF combination


ZPD radiosonde biases

Mails and Remarks

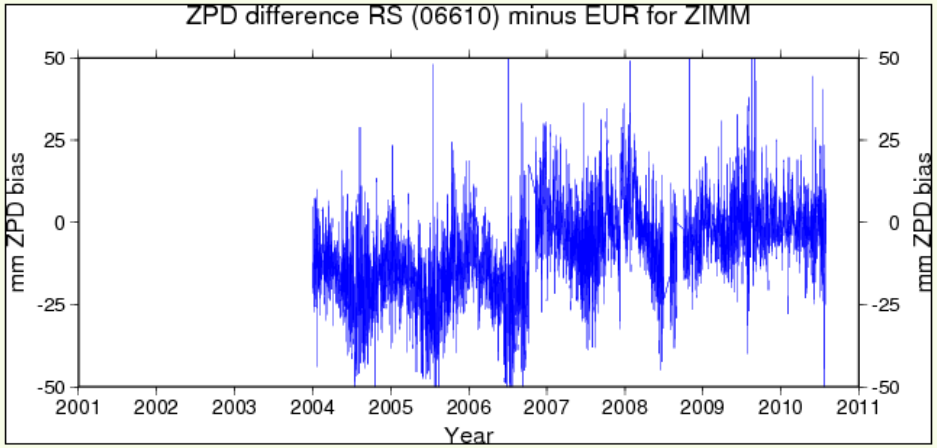
EUREF MAILS	No 5472 (16-Oct-2010) - ZIM2/ZIMM hourly/daily data again available (by E. Brockmann) View
IGS STATION MAILS	(select a mail)
IGS MAILS	Due to the modification of the IGS mail archives (see announcement) the direct links to the IGS mails related to ZIMM are momentarily not available. However, these mails are still available from the IGS Central Bureau web site.
REMARKS	Official station web site.

EUREF HOME

EUREF Permanent Network

EPN CB HOME

ZPD RADIOSONDE BIASES



Explanations

Purpose

- Validate EUREF combined Zenith Path Delay (ZPD) parameters with ZPD derived from radiosonde (RS) data at co-located sites
- Variations and differences are influenced by the horizontal distance between the two stations
- Time series of differences reflect changes in analysis strategy

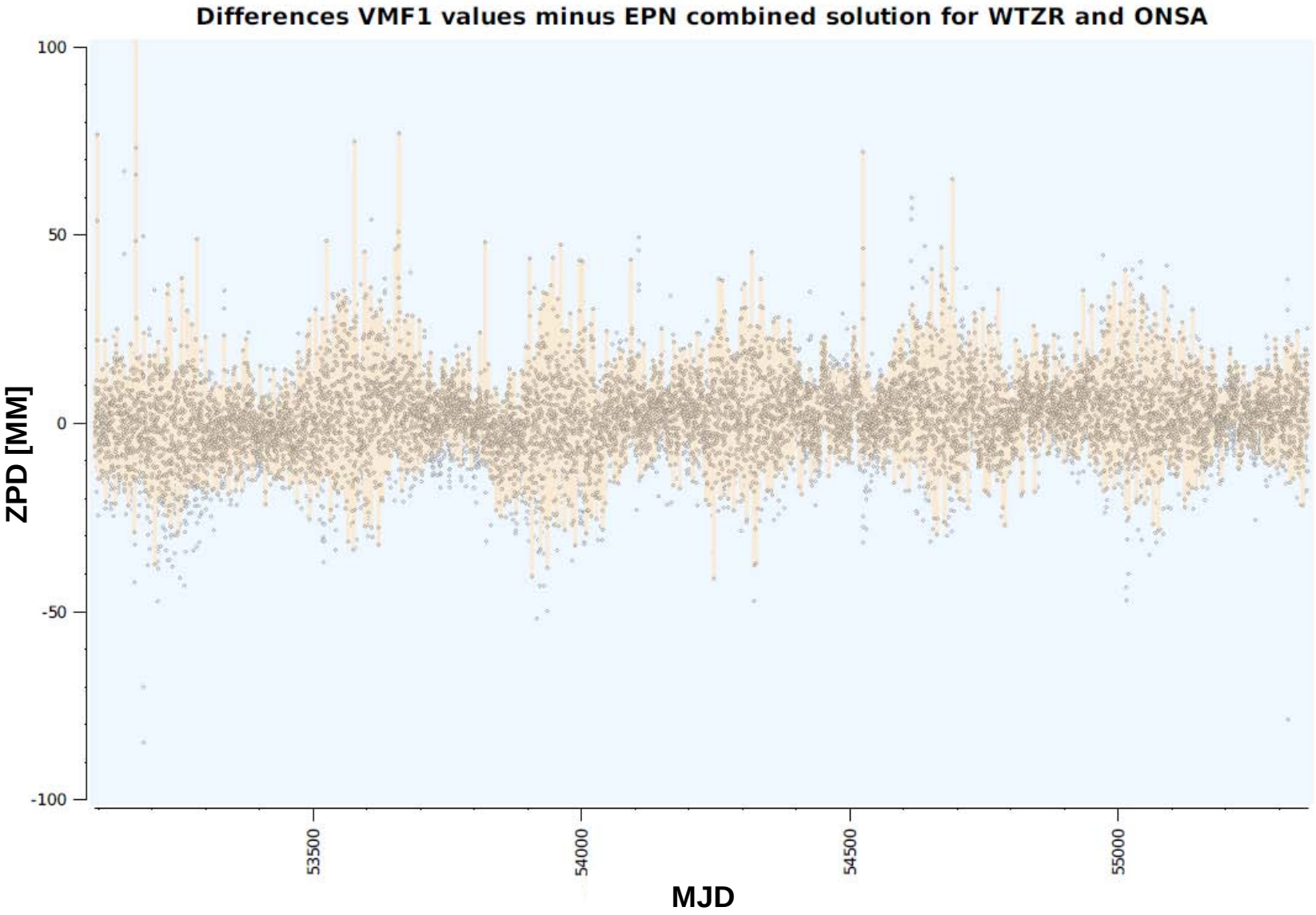
Procedure

- Download of RS data provided by EUMETNET, based on the EUREF-EUMETNET MoU
- Processing ZPD parameters (software provided by H. Vedel, Danish Meteorological Institute (DMI))
- Geoid undulations at co-located sites are taken into account
- Differences at co-located sites for identical points in time

Inter-technique comparison (11/12)

- Comparison with VMF1 results
- Provided by TU Vienna
- Available since GPS week 1264
- Several co-locations with EPN stations available

Inter-technique comparison (12/12)



Conclusions

- **Regular contribution of all EPN LACs within a defined time span useful for early inspection**
- **Improving automatic outlier elimination**
- **Include more comparisons on EPN webpage (VLBI etc., „super-sites“)?**