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Verification of the meteorological observations on the EPN stations

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Contents

Meteorological data reliability assessment,

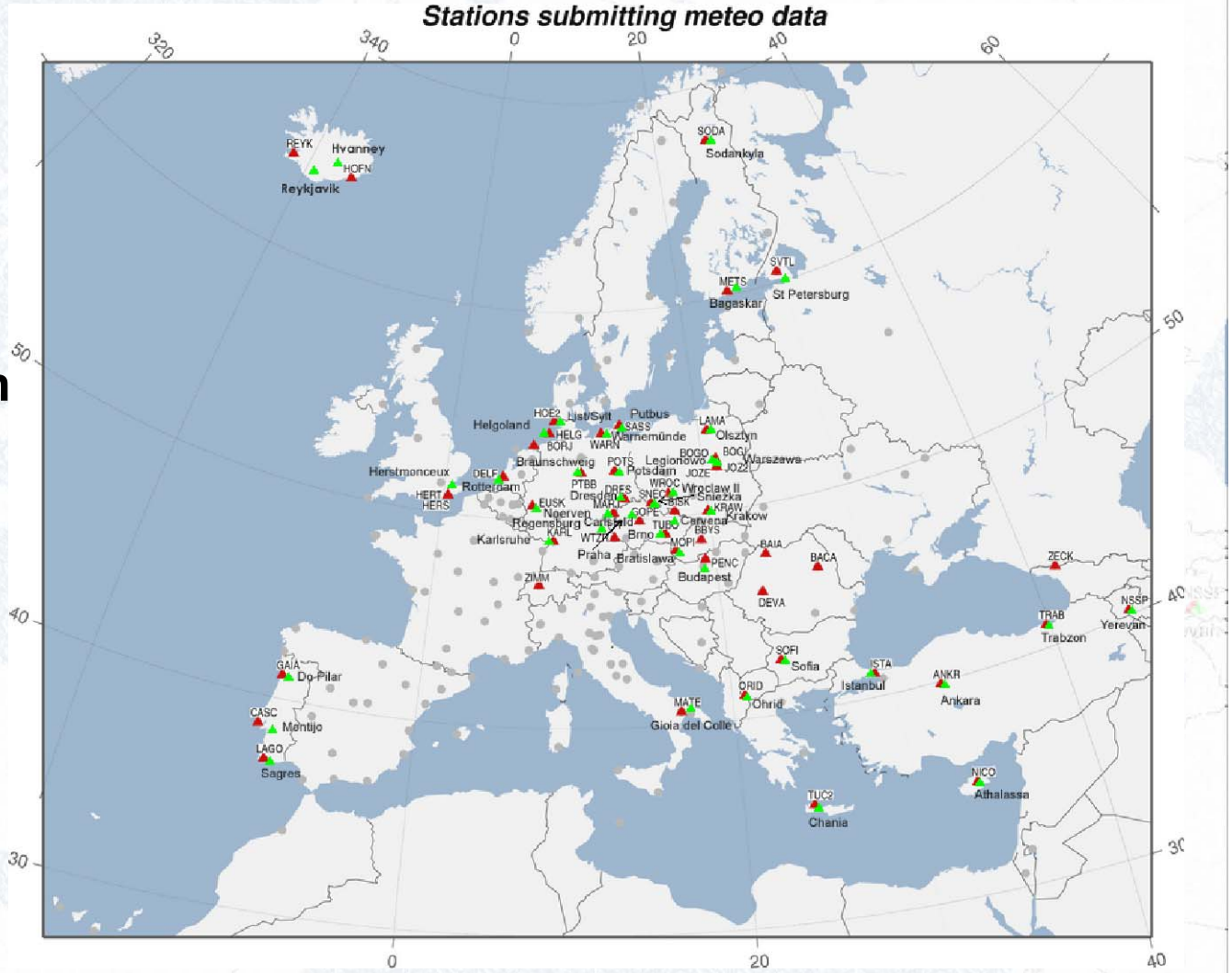
Validation of stations log files, EPN stations RINEX meteo data files and NOAA climate Global Summary Of the Day (GSOD) stations data files,

Verification of common stations list: synoptic and GPS stations,

Comparison of ZTD obtained from mean EPN solutions and local meteo data

Meteorological parameters: stations positions

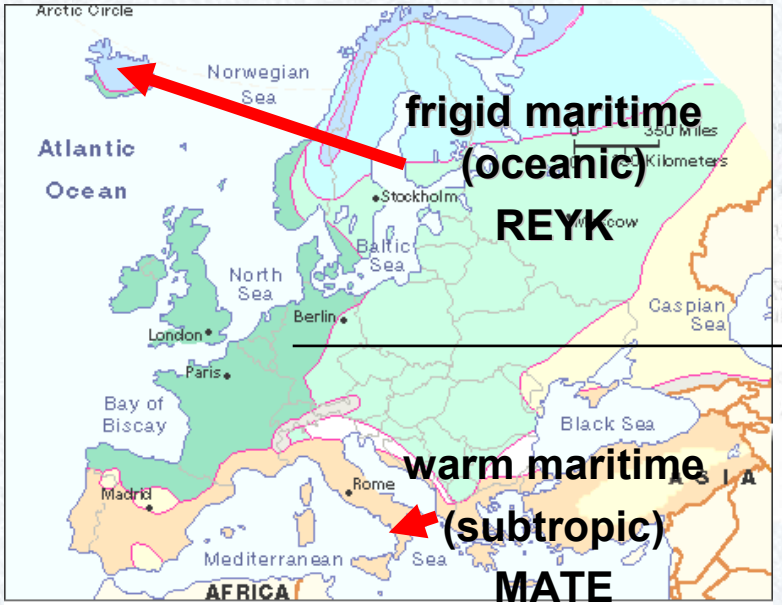
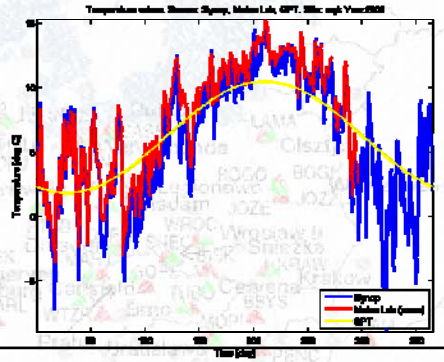
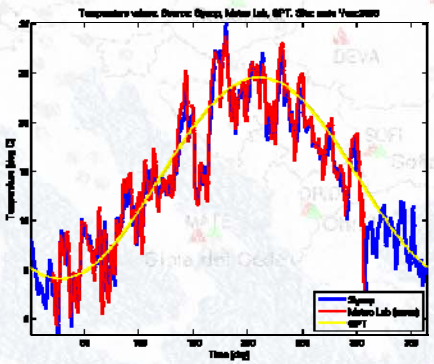
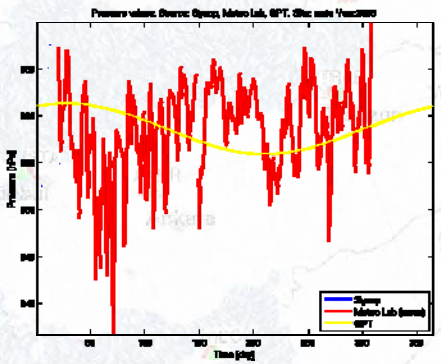
- EPN stations with meteorological sensors
- synoptic stations



Meteorological parameters: sources, year 2006

- meteo sensors mounted close to GPS antena
  - pressure: 0.3 – 0.5 hPa
  - temperature: 0.3 – 0.5 ^{0}C
  - humidity: 3 - 5%
- National Meteorological Services (working in the WMO network)
  - pressure: 0.2 hPa
  - temperature: 0.2 ^{0}C
  - humidity: 2%
- GPT model
  - pressure: 5 hPa
  - temperature: 3 ^{0}C

Meteorological parameters in different climatic zones

meteorological parameters /climatic zone	T temperature [^{0}C,^{0}K]	P pressure [hPa, mbar]
		not avalible
		

Meteorological parameters in different climatic zones

with continental influences frigid

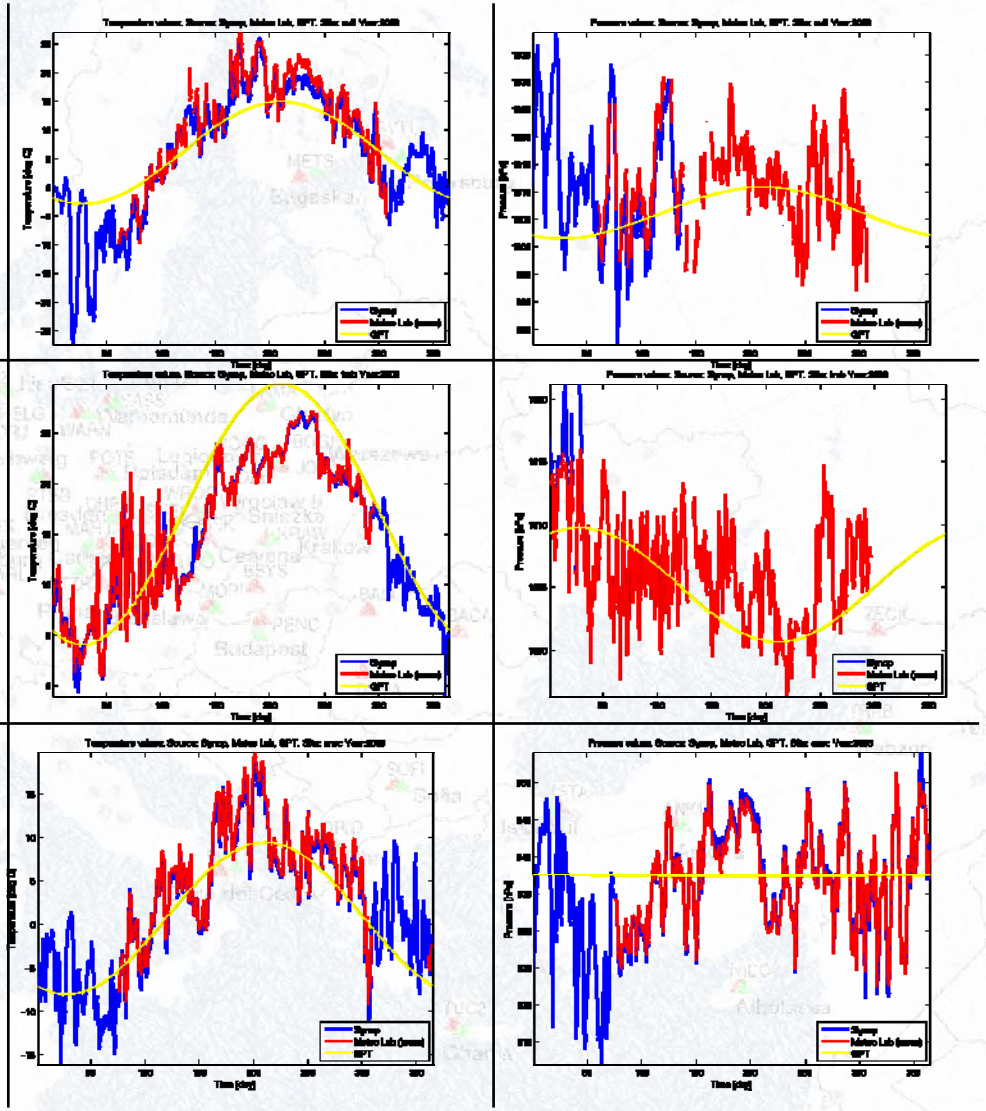
SVTL

with continental influences warm

TRAB

mountain

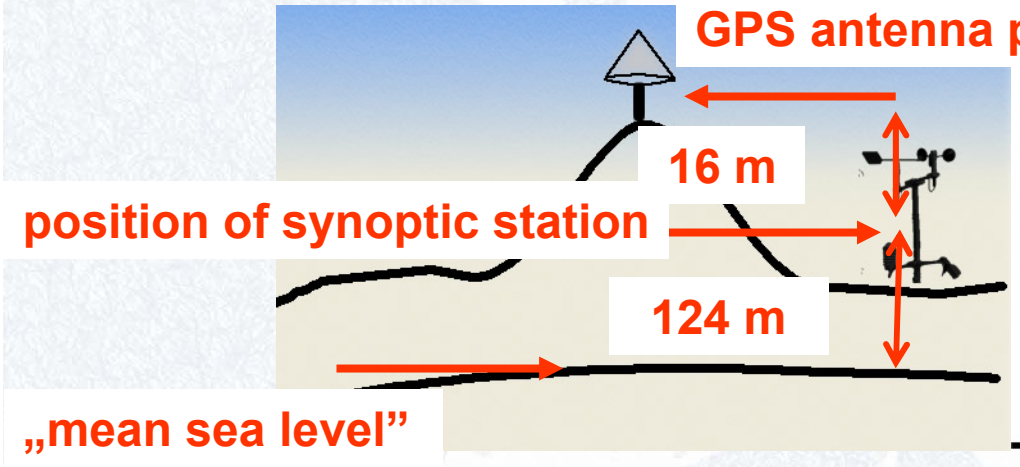
SNEC

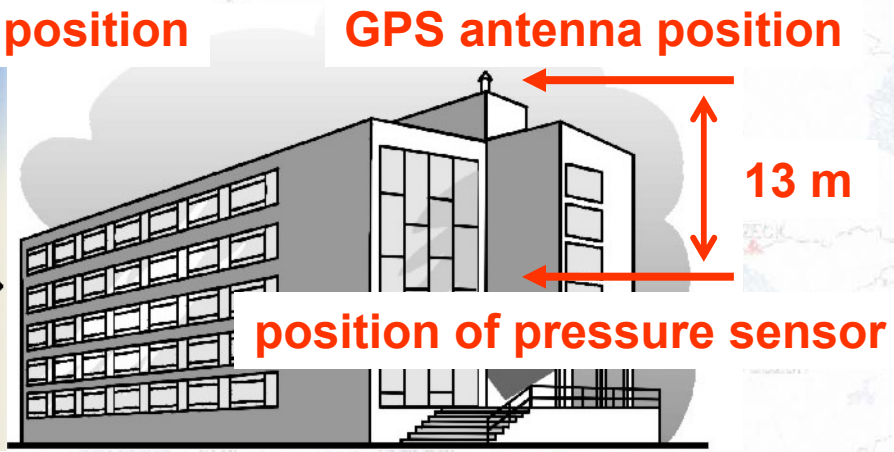


Meteorological parameters:
data interpolation comparison and calibration

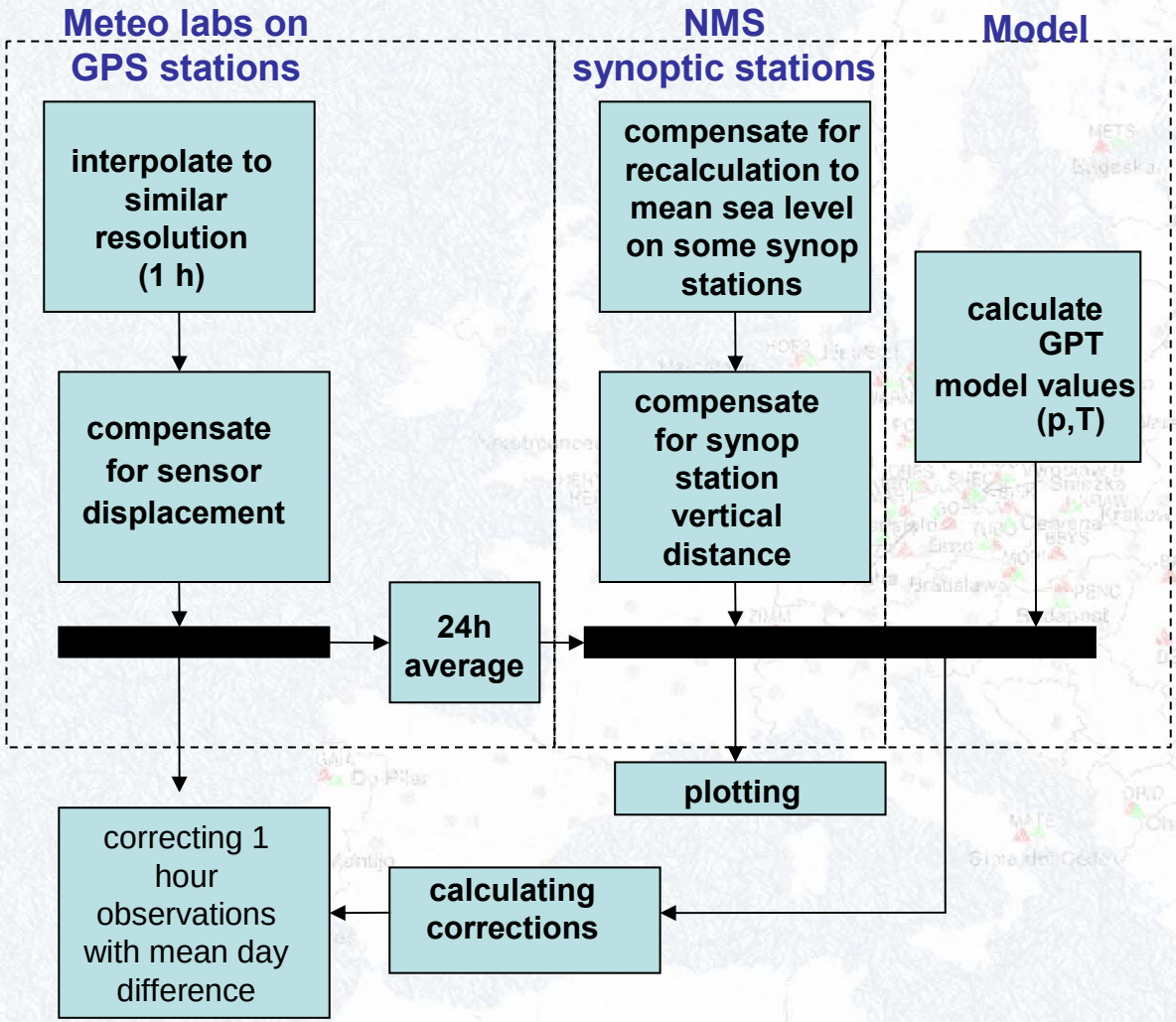
compensate for recalculation to mean sea level on some synop stations

compensate for synop station vertical distance





Meteorological parameters:
data interpolation,comparison and calibration



Examples of data resolution

Station	meteo files time resolution [s]
WROC	300
GOPE	60
BISK	30
SNEC	30

Meteorological parameters:
results of calibration

Bias is a mean difference between calibrated and not calibrated data

Error is a standard deviation of difference between calibrated and not calibrated data

station	bias press (hPa)	error press (hPa)	bias temp (⁰C)	error temp (⁰C)
karl	-0.22	0.41	0.10	0.34
wtzr	-0.52	1.16	0.54	0.71
mate	0.69	0.00	0.20	0.56
pots	2.33	0.47	0.35	0.34
ptbb	-0.92	0.48	0.12	0.45
bisk	23.95	1.27	0.79	1.03
casc	0.46	0.37	0.17	0.87
delf	-0.02	0.33	0.10	0.42
eusk	-0.25	0.87	-0.66	1.14
gaia	0.06	0.58	0.65	0.68
wroc	0.98	0.74	0.79	0.57
hers	0.09	0.50	0.63	0.43
hert	-0.02	0.51	0.65	0.51
ista	-2.08	0.50	-0.09	0.65
joz2	0.91	0.49	0.17	0.42
kraw	-0.94	1.92	0.70	0.74
lama	7.57	11.27	-0.38	2.38
helg	-0.35	0.37	0.04	0.13
orid	-0.22	0.37	0.33	0.41
pdel	0.47	0.53	1.75	0.38
mets	-0.72	0.57	0.17	0.85
reyk	NaN	NaN	0.48	0.54
sass	0.42	0.30	0.30	0.33
snec	-0.07	0.39	0.21	0.37
sofi	-0.33	0.91	0.15	0.70
svtl	2.15	0.62	0.51	0.93
trab	-0.66	0.56	0.08	0.31
tubo	-0.02	0.67	0.30	0.32
warn	0.24	0.79	-0.23	0.49
gope	-0.98	1.03	0.11	0.71
nico	-0.12	0.42	-1.13	0.65

data with bias above 1 hPa or 1 ⁰C

Problems: Station list

Using the list of coupled meteorological and GPS stations *„Surface meteo observations from the European Centre for Medium – Range Weather Forecasts (ECMWF) for the STARTWAVE atmospheric water database”* Stefan Wacker

- **very useful**
- **sometimes with mistakes (HERT, PTBB, REYK):**

GPS_station_name	abbrev.	alt.[MSL]	WMO_meteostation	lat.[°]	long.[°]	alt.[MSL]	dh[m]	WMOcode
Wroclaw(Poland)	WROC	140	Wroclaw II	51.10	16.88	124	16	12424
Geoservis(Slovenia)	GSR1	352	Ljubljan	46.07	14.52	298	54	14015
WesterborkSynthesis(NL)	WSRT	41	Hoogevee	52.73	6.52	16	25	06279
Herstmonceux(England)	HERS	30	Herstmonceux	50.90	0.32	52	-22	03882
WaterTowermonument	HERT	83	Herstmonceux	50.90	0.32	52	31	03882
Hohenbuenstorf(Germany)	HOBU	112	Fassberg	52.92	10.18	88	24	10246
Yebes(Spain)	YEBE	919	Guadalajara	40.67	356.83	640	279	08226
Hoefn/Iceland	HOFN	17	Ivanney	64.23	344.80	5	12	04180

```
City or Town                  : Hailsham
State or Province             : East Sussex
Country                       : United Kingdom
Tectonic Plate                : Eurasian
Approximate Position (ITRF)
  X coordinate (m)            : 4033461.0378
  Y coordinate (m)            : 23537.6625
  Z coordinate (m)            : 4924318.1656
  Latitude (N is +)           : +505202.9218
  Longitude (E is +)          : +0002003.665
  Elevation (m,ellips.)       : 00083.3
Additional Information        : (multiple lines)
```

The height of GPS point – ellipsoidal not msl (as stated)

Problems: EPN stations log files

Height Different to Ant : measurement not unified (examples): KARL, HERS, DELF, TUBO, GOPE

KARL

```
8.2.1 Pressure Sensor Model    : APS 9215
      Manufacturer             : ROESSLER + CIE
      Serial Number            :
      Data Sampling Interval   : 900
      Accuracy                 : 0.5
      Height Diff to Ant       : 2.0
      Calibration date         : (CCYY-MM-DD)
      Effective Dates          : 1997-03-20/CCYY-MM-DD
      Notes                    : Pressure Sensor is below
                               : the antenna
```

TUBO

```
8.1.1 Humidity Sensor Model    : HG421.65
      Manufacturer             : COMET SYSTEM, CZ
      Serial Number            : 01430040
      Data Sampling Interval   : 60 sec
      Accuracy (% rel h)       : 2 % rel h
      Aspiration               : UNASPIRATED
      Height Diff to Ant       : -1.16 m
      Calibration date         : 2005-12-15
      Effective Dates          : 2001-08-28/CCYY-MM-DD
      Notes                    : Sensor is 1.16 m under GPS antenna.
                               : First calibration 2001-08-08
```

Data Sampling Interval: information about values

HERS

```
8.2.1  Pressure Sensor Model   : DPI 140 series
       Manufacturer            : Druck
       Serial Number           :
       Data Sampling Interval  : Every 5 mins
       Accuracy                : 0.1 mb
       Height Diff to Ant      : GPS is 1.1 m above barometer reference point
       Calibration date        : (CCYY-MM-DD)
       Effective Dates         : 1997-06-04/CCYY-MM-DD
       Notes                   : (multiple lines)
```

Problems: EPN stations log files

unnecessary units after values – problems with data reading:

log file construction description

```
8.    Meteorological Instrumentation
---------------------------------------------------------------------
       Height Diff to Ant      : (m)
Positive numbers indicate met instrument is ABOVE GPS antenna.
Do not forget to remove the unit "(m)".
```

GAIA

```
8.2.1 Pressure Sensor Model    : Met3
      Manufacturer             : Paroscientific
      Serial Number            :
      Data Sampling Interval   : 900 sec
      Accuracy                 : 1 hPa
      Height Diff to Ant       : 0.3 m
      Calibration date         : (CCYY-MM-DD)
      Effective Dates          : 2000-01-02/CCYY-MM-DD
      Notes                    : (multiple lines)
```

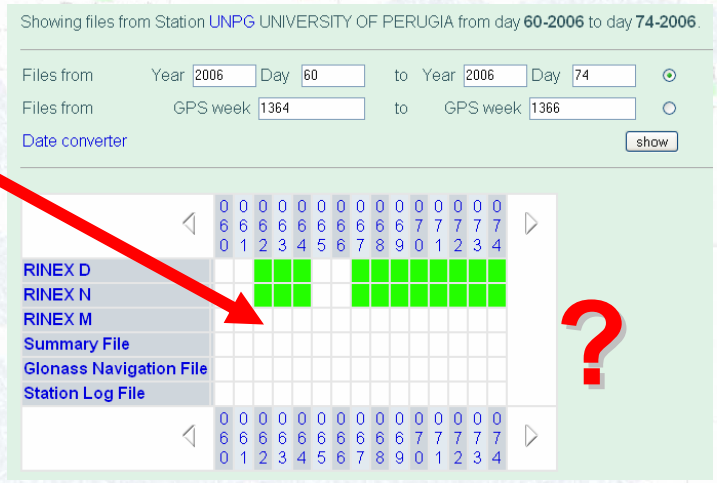
showing sensor but not transferring data to EUREF data center:

log file

```
8.2.1 Pressure Sensor Model    : PTU200
      Manufacturer             : VAISALA
      Serial Number            : 1730002
      Data Sampling Interval   : 2sec
      Accuracy                 : 0.10hPa
      Height Diff to Ant       : 1m
      Calibration date         : (CCYY-MM-DD)
      Effective Dates          : 2005-06-09/CCYY-MM-DD
      Notes                    : (multiple lines)
```

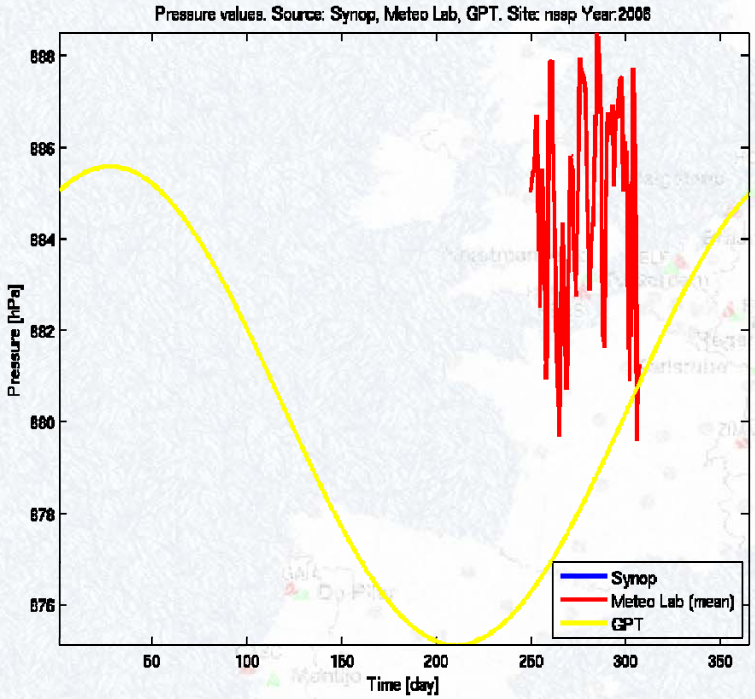
UNPG

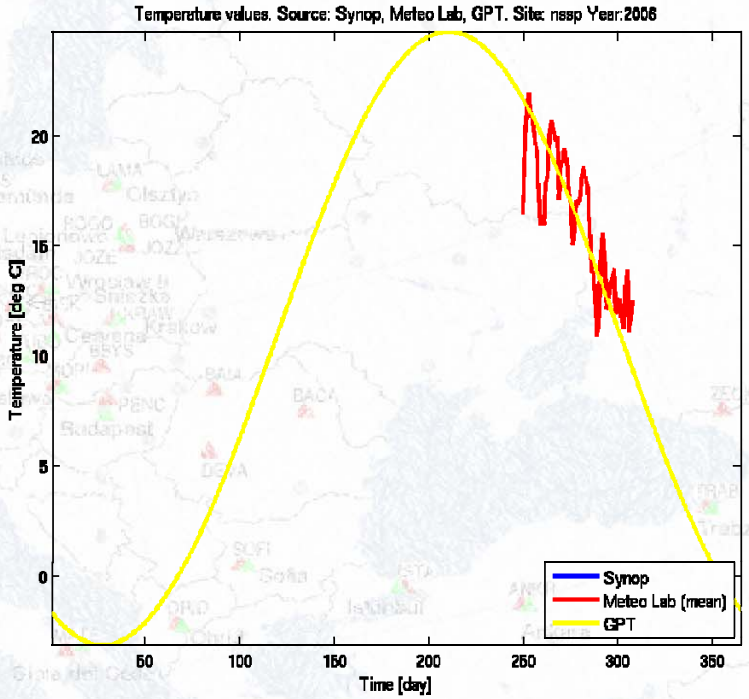
BGK data center site



Problems: EUREF stations meteorological data

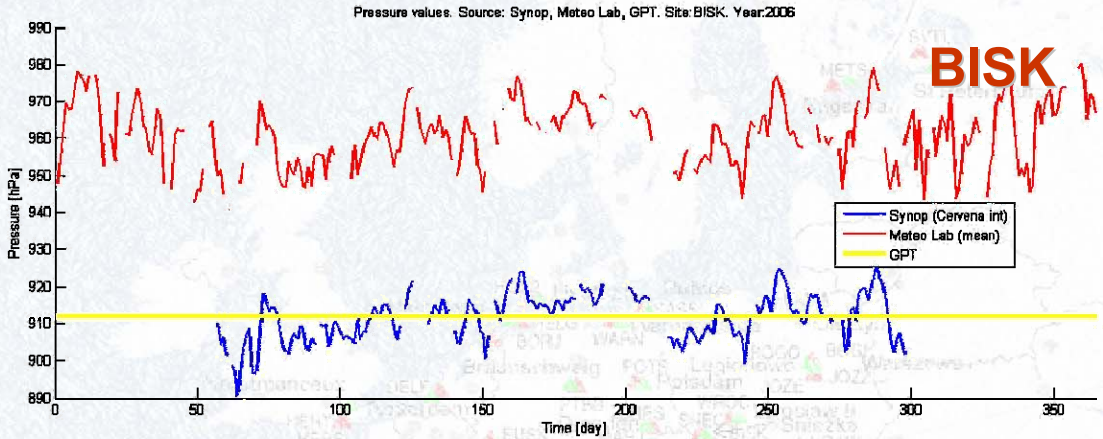
huge data gaps on some stations: NSSP



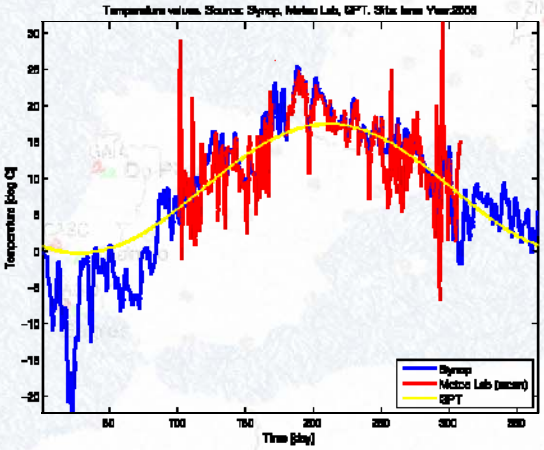


Problems: EPN stations meteorological data

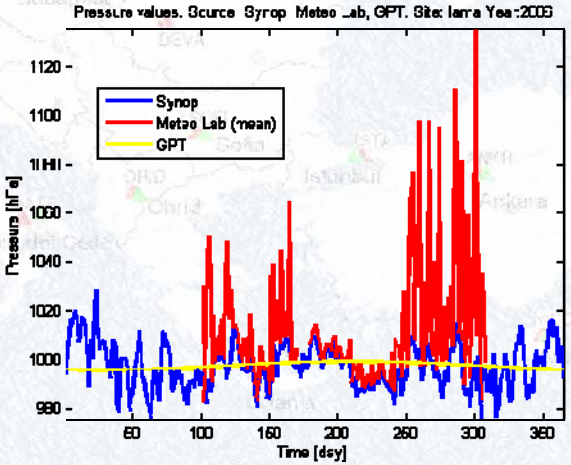
sensor damage (BISK)



sensor probably under temperature strong influence (LAMA)



LAMA



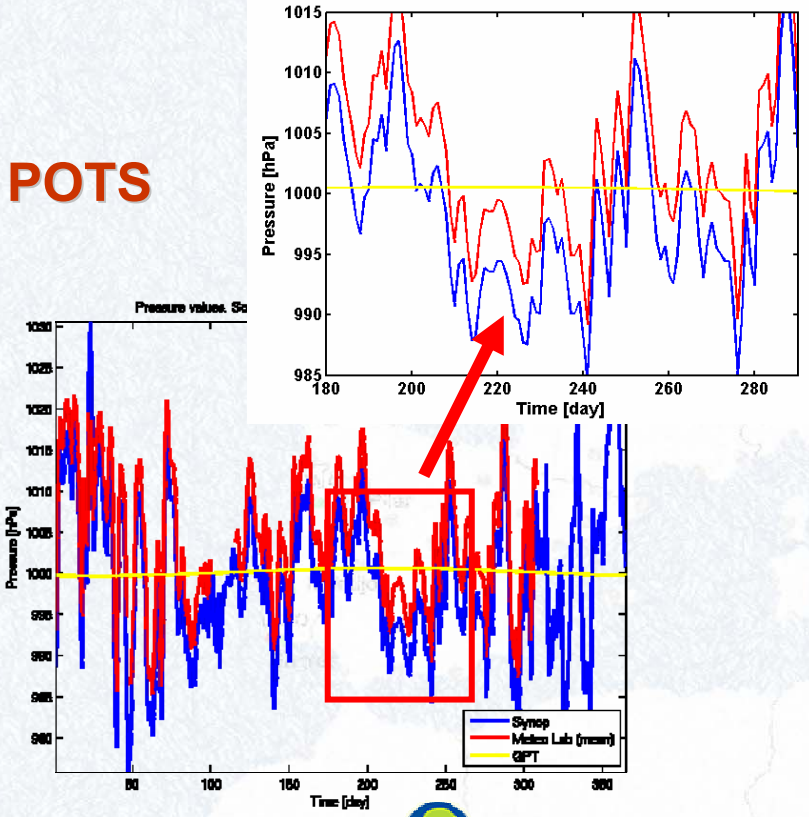
Problems: Synoptic stations data

missing data on NOAA server or OGIMET (examples):

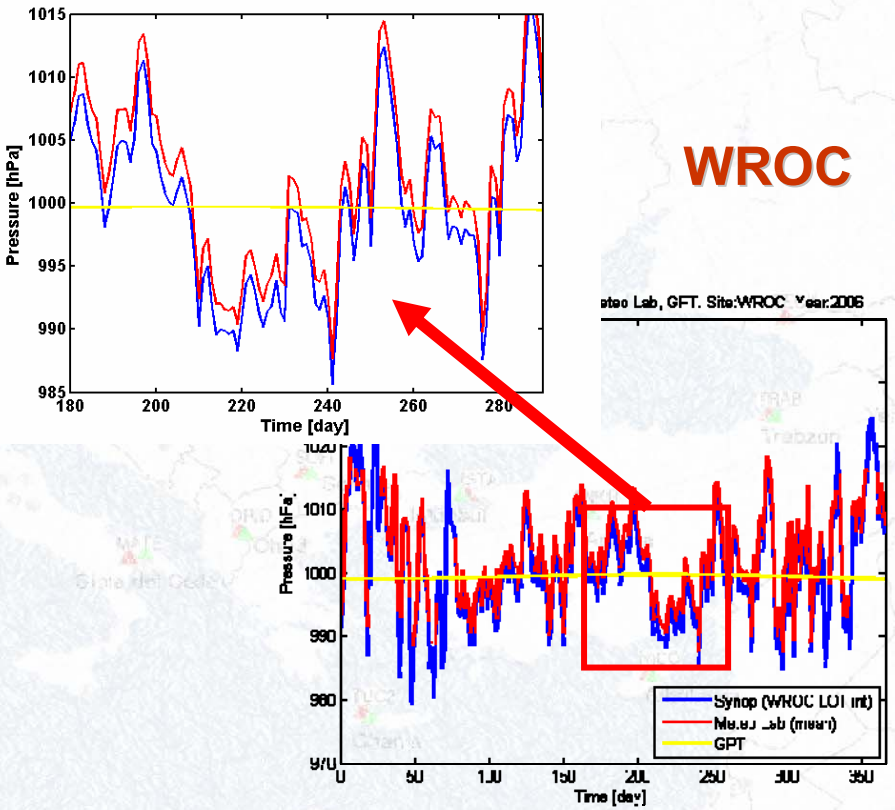
- 12374 - Legionowo
- 17130 - Ankara,
- 37789 - Yerewan

recalculation to mean sea level not always successful – POTS, WROC

POTS

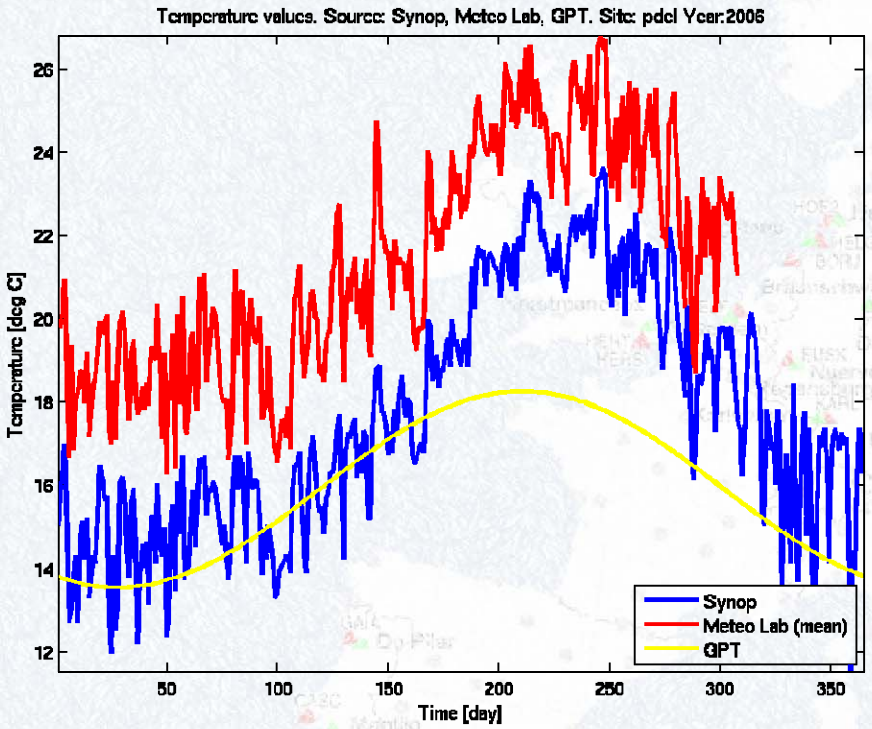


WROC

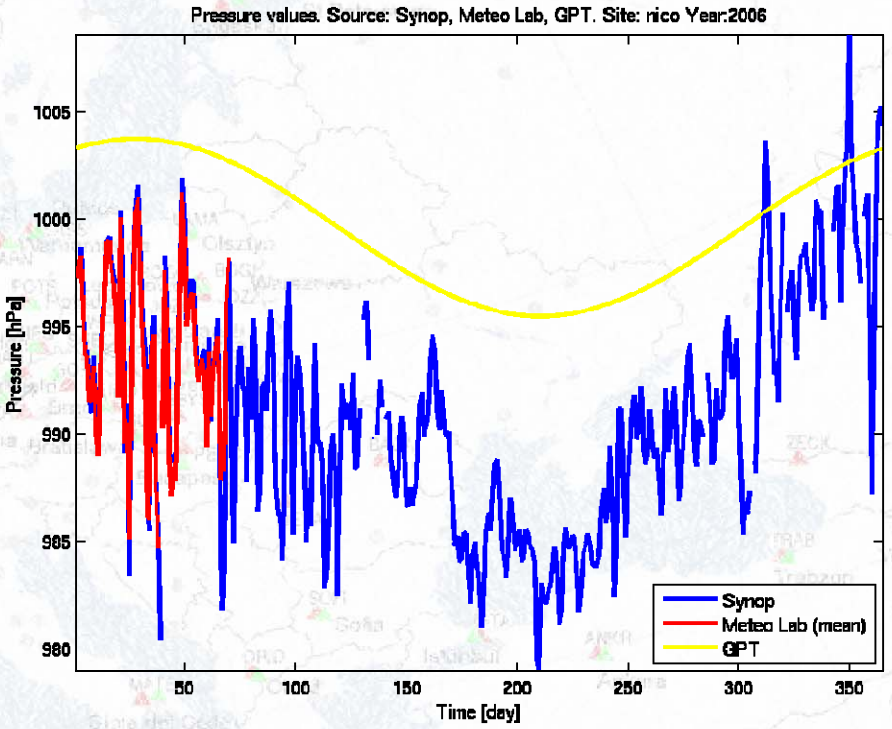


Problems: other

PDEL - temperature

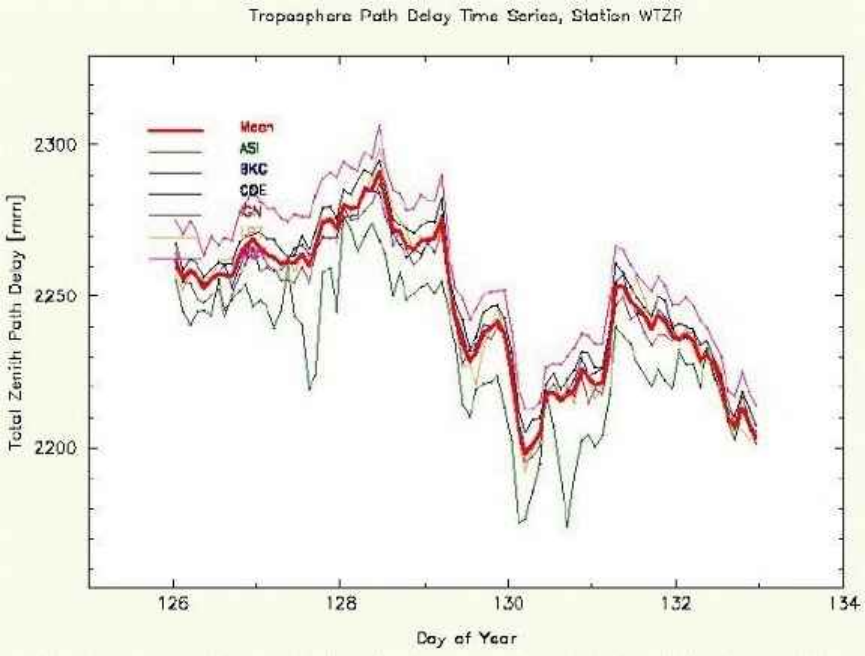


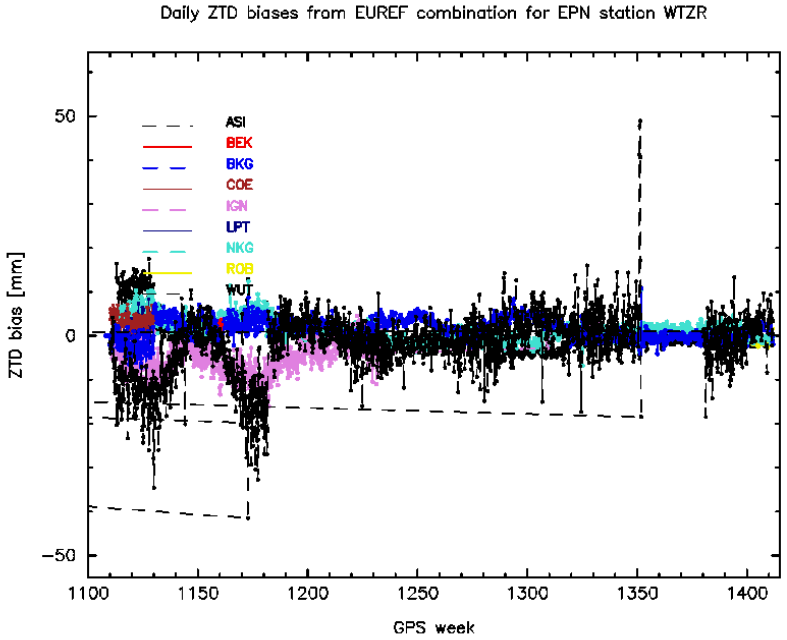
NICO - pressure



Tropospheric Delay: Sources

EUREF ZTD: weekly mean solution from all EPN LAC's





ZTD based on the local meteo: Saastamoinen model:

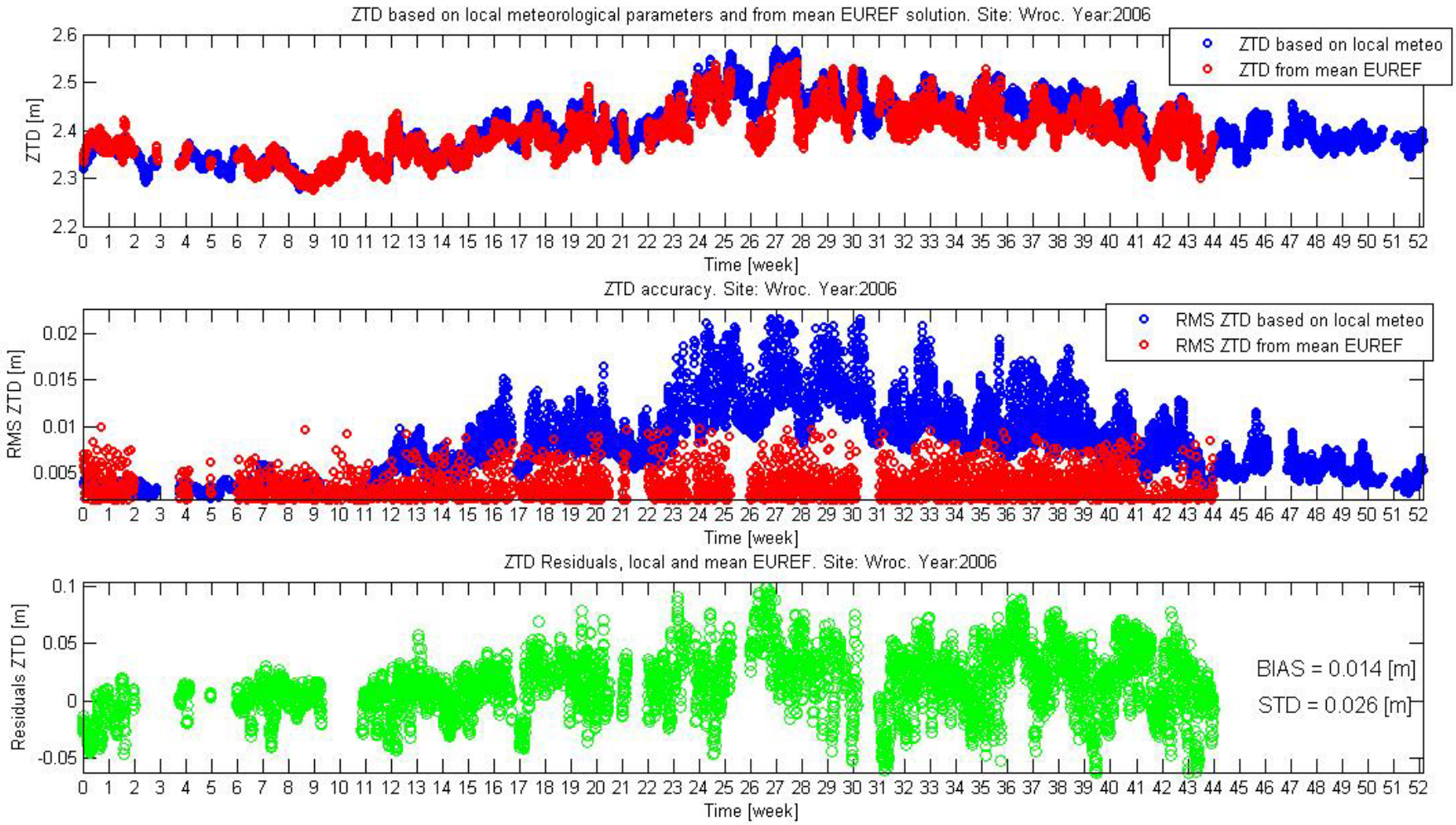
$$ZWD = 0.002277 \cdot \left(\frac{1255}{T_0[^oK]} + 0.05 \right) \cdot e_0[hPa]$$

$$ZHD = \frac{0.0022767 \cdot \left[\frac{m}{hPa} \right] \cdot P_o}{1 - 0.00266 \cdot \cos 2\varphi - 0.00028 \cdot \left[\frac{1}{km} \right] \cdot h_e}$$

$$ZTD = ZWD + ZHD$$

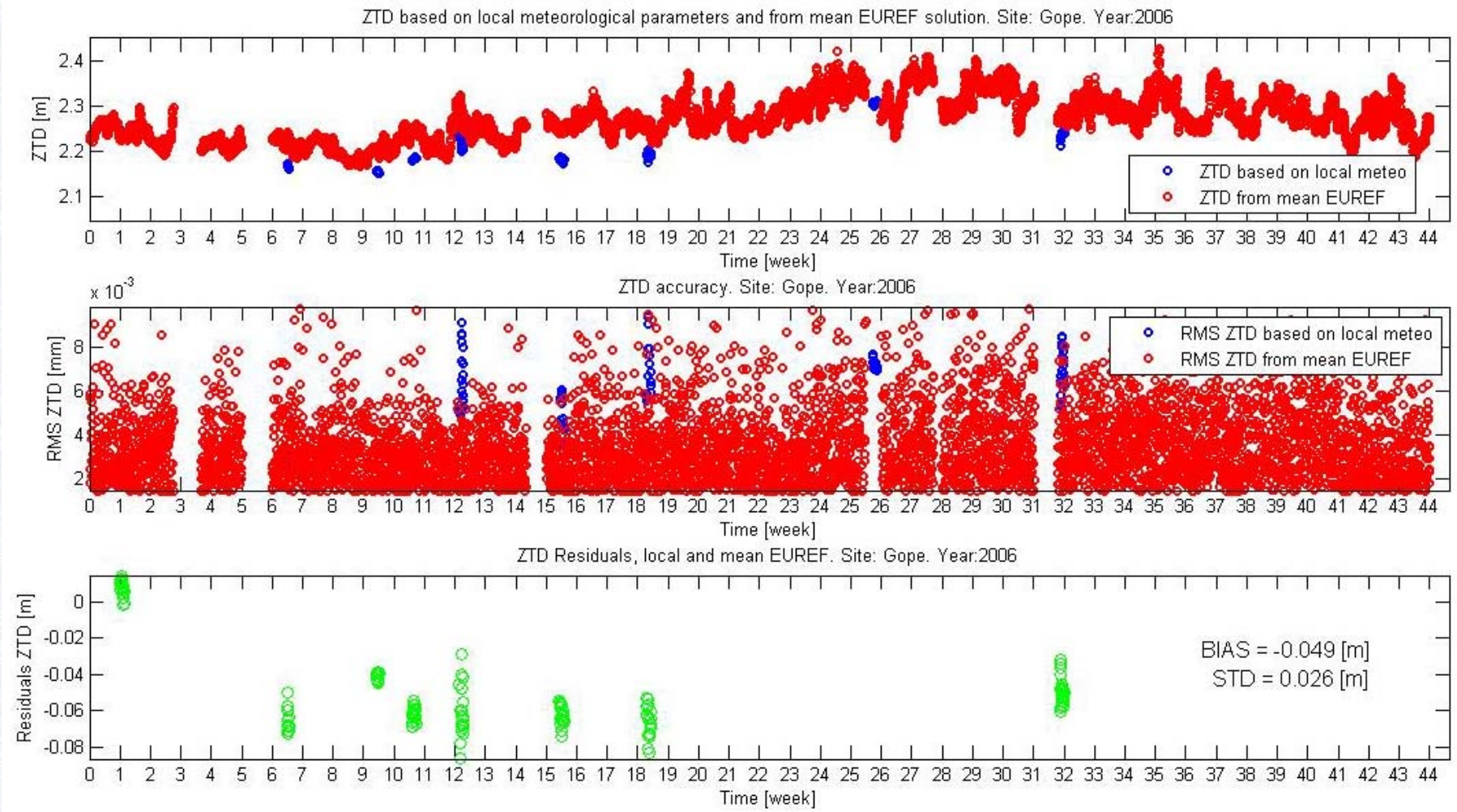
Tropospheric Delay: Comparison

WROC: year 2006



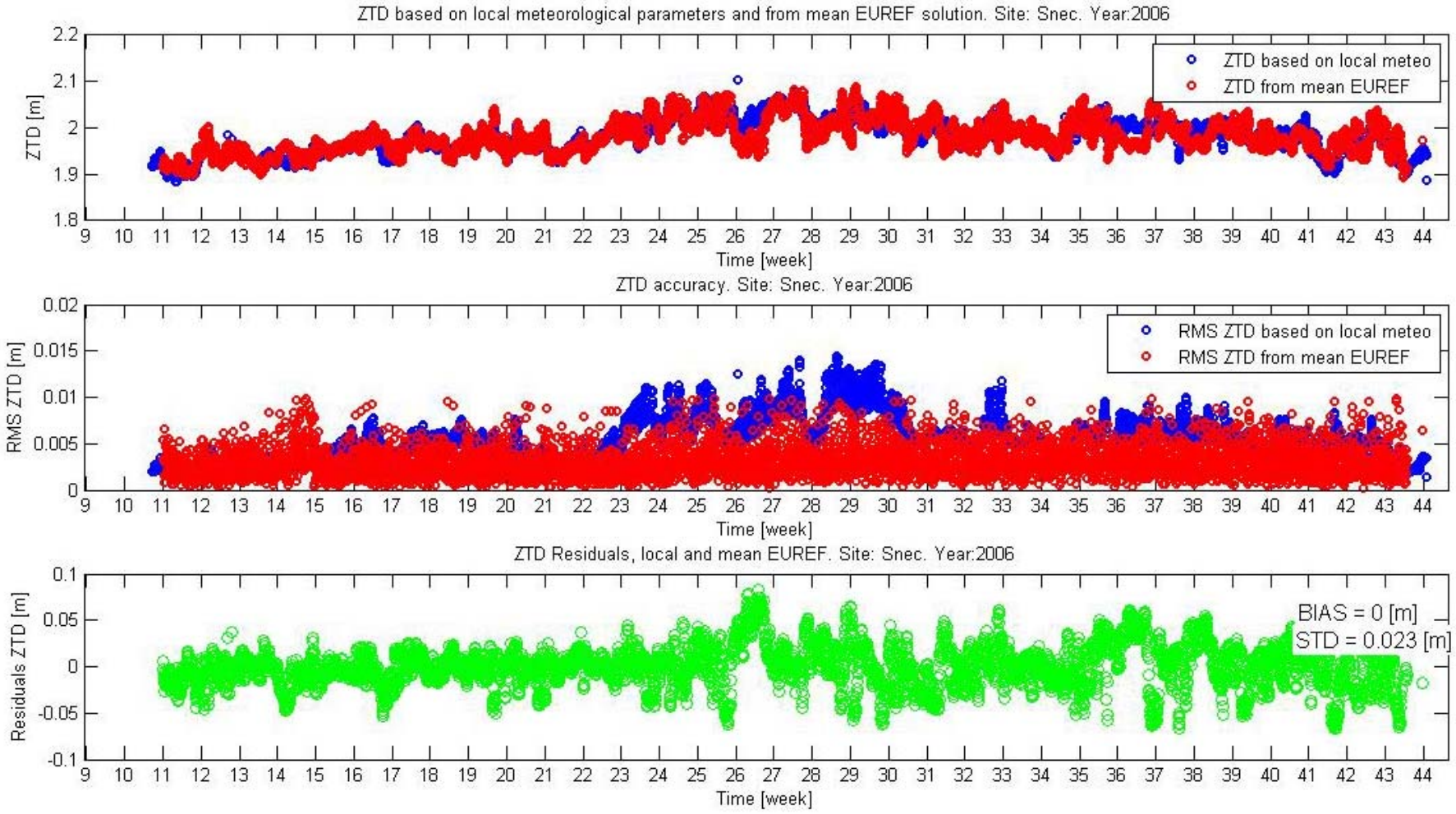
Tropospheric Delay: Comparison

GOPE : year 2006



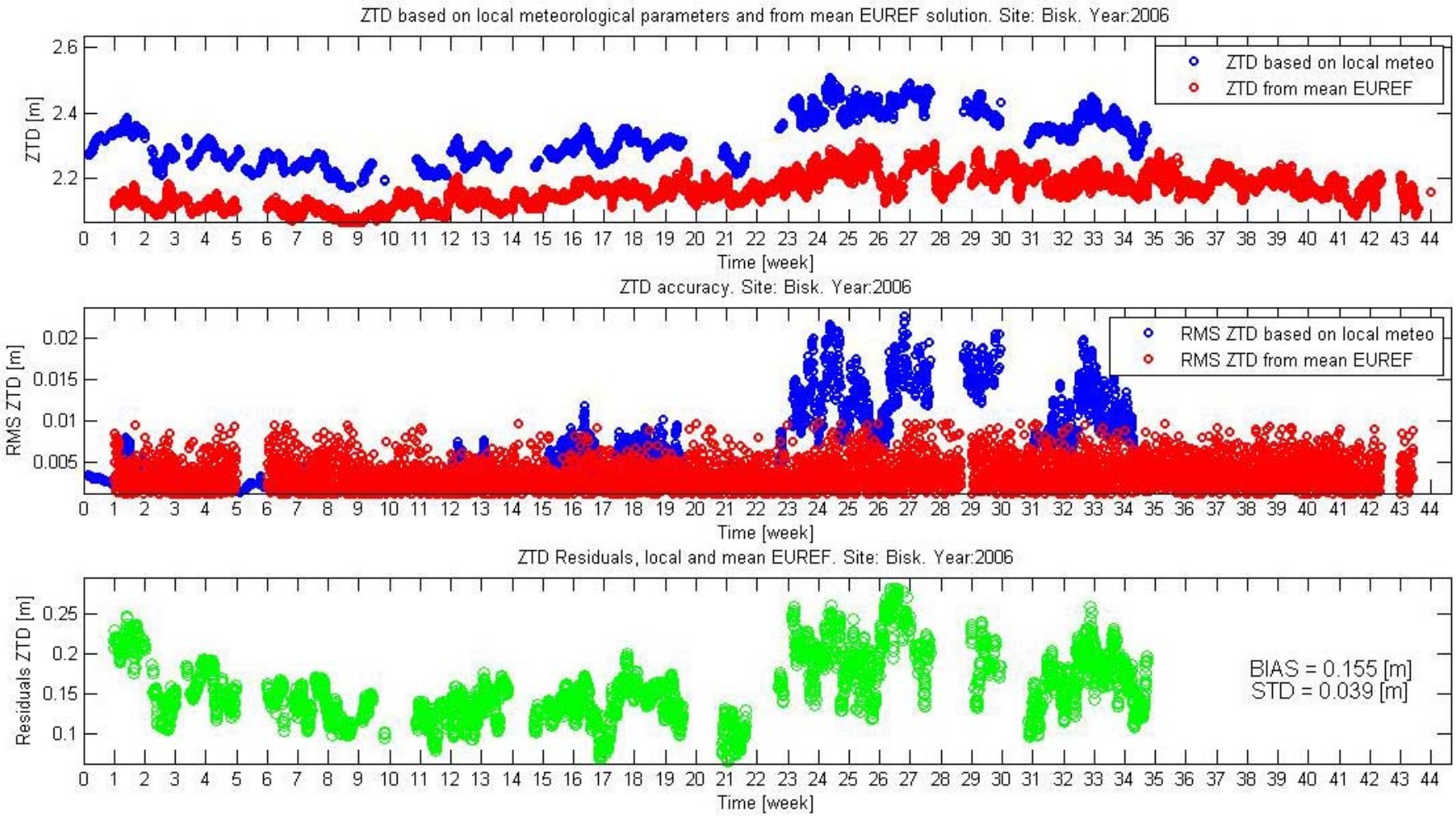
Tropospheric Delay: Comparison

SNEC : year 2006



Tropospheric Delay: Comparison

BISK : year 2006



Conclusion

- 31 EPN stations (from all number of 184) transferring meteorological data to Data Centres. Some station have problems with sensors (BISK, LAMA);
- Most of the station logs are not easily for automatic reading and the log's files need unification;
- Problems with height measurements on synoptic stations (pressure bias POTS, NICO, WROC);
- Pressure data accuracy varies from almost zero bias and 0.2 hPa error to bias 24 hPa on BISK station and error 11 hPa on LAMA station;
- Temperature data accuracy varies from almost zero bias and 0.1 ^{0}C error to bias 1.75 ^{0}C on PDEL station and error 2.4 ^{0}C on LAMA station;
- Some biases have unclear source (NICO, PDEL) and need to be investigated in the future.

Thanks for your attention