GFZ
Helmholtz-Zentrum
POTSDAM

E-GVAP Processing Centre at GFZ: status and future work

Florian Zus, Galina Dick and Jens Wickert

Helmholtz Centre Potsdam
GFZ German Research Centre for Geosciences

EGVAP Meeting, Copenhagen, November 2013

HELMHOLTZ
GEMEINSCHAFT

Content

- Operational Water Vapor monitoring

- ZTDs from GFZ RT-EPOS Software

- ZTDs from single frequency receivers

- Information content of STDs

Operational Water Vapor Monitoring at GFZ

GFZ Helmholtz-Zentrum Potsdam

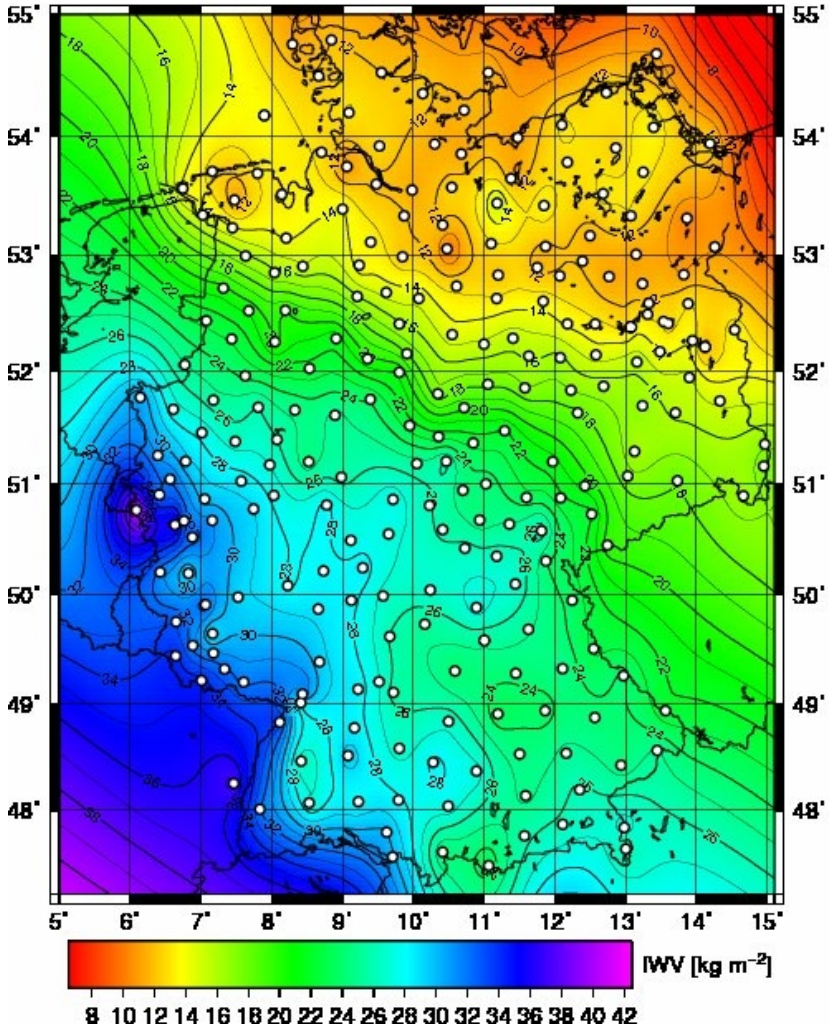
Processing of hourly GNSS data of ~300 stations with EPOS software.

PPP strategy:
- **GFZ orbit/clocks**
- **Processing time: ~10 min**

ZTD is the main product:
- **15 min time resolution**
- **Accuracy: ±6-10 mm**

STD is another product:
- **2.5 min time resolution**
- **Accuracy: ± 0.3-0.5 %**

Arrival statistics of GFZ products at data server of E-GVAP: >90% of data within 1h30min

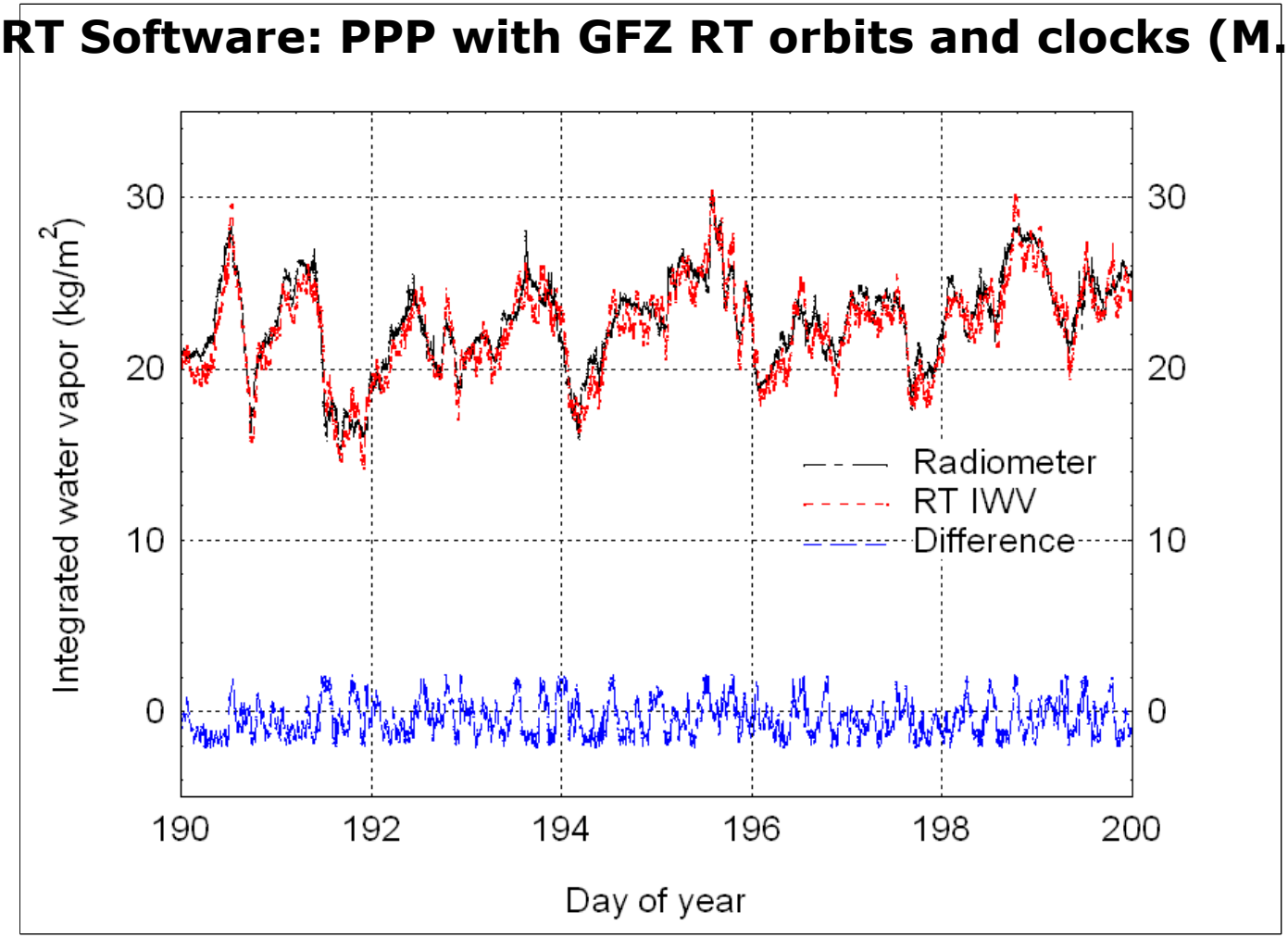


HELMHOLTZ GEMEINSCHAFT

ZTD/IWV from GFZ RT-EPOS Software

GFZ Helmholtz-Zentrum Potsdam

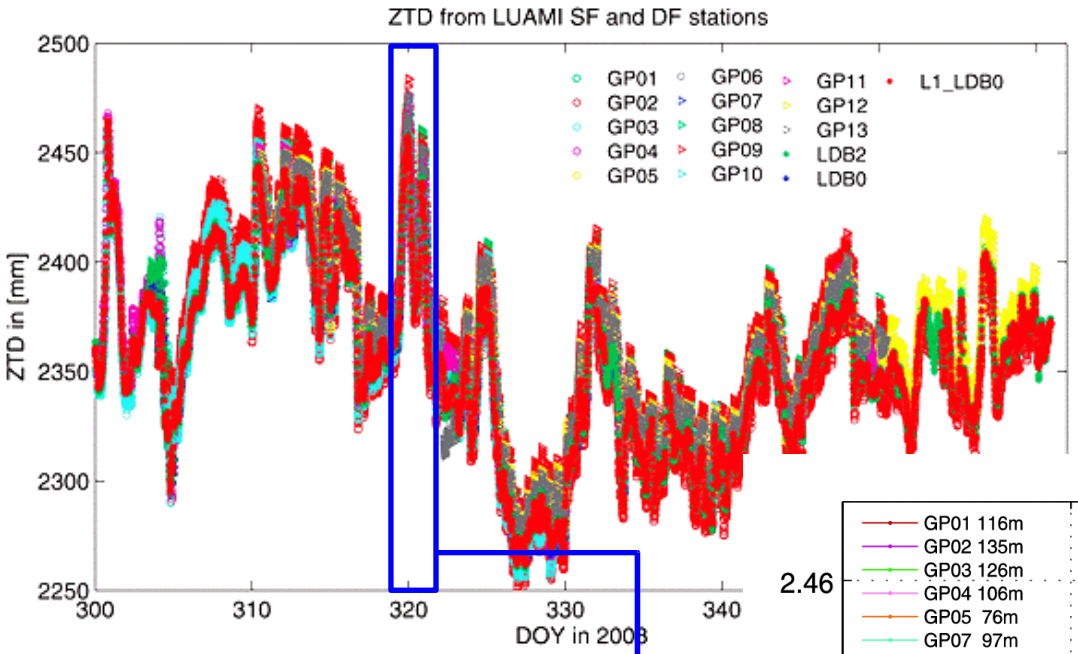
EPOS-RT Software: PPP with GFZ RT orbits and clocks (M. Ge/X.Li)



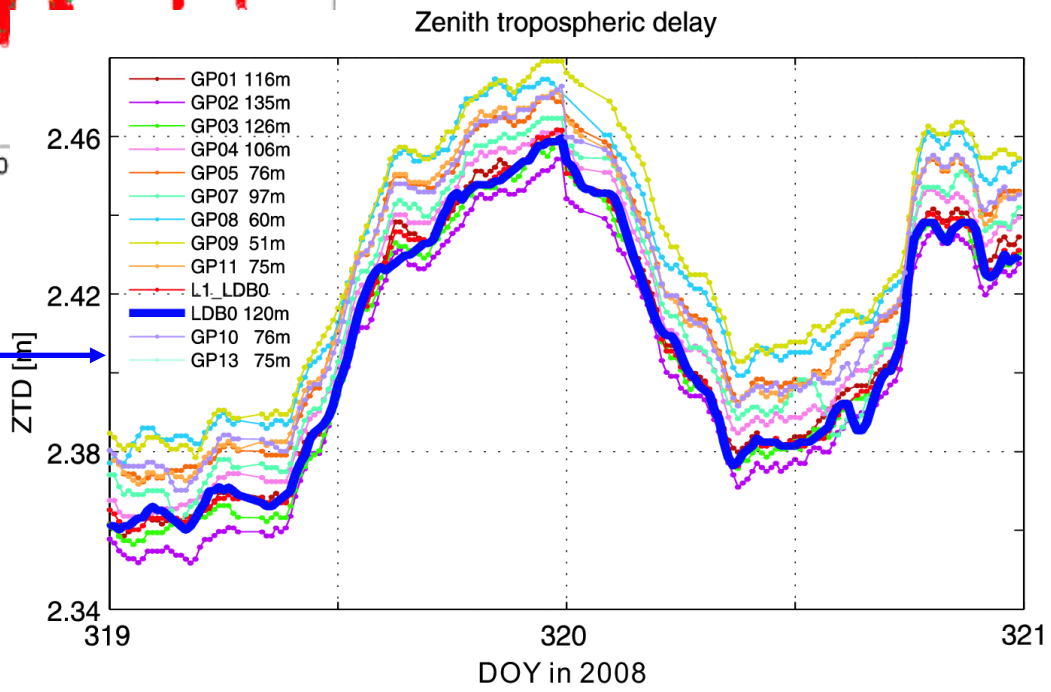
RT IWV and IWV from microwave radiometer (HATPRO, GFZ) show good agreement (DOY 190-200, y2013)

HELMHOLTZ GEMEINSCHAFT

ZTDs with Single Frequency Receivers



ZTDs from SF and DF stations show a good agreement



Estimation of ionospheric corrections using DF stations

Deng et al. GRL, 2011

The information content of GPS STDs

GFZ Helmholtz-Zentrum Potsdam

Two methods to estimate the atmospheric induced Signal Travel Time Delay (STD) for a station-satellite link:

#1 GPS phase measurements: The PPP strategy produces GPS STDs (EPOS, G. Dick).

#2 NWM refractivity field: The Direct Numerical Simulation produces NWM STDs (DNS, F. Zus)

NWM STDs contain gradient information. What about GPS STDs?

HELMHOLTZ GEMEINSCHAFT

Estimate horizontal & vertical N-gradients

Given a bunch of NWM STDs for a single station, estimate the refractivity profile N and the North-South gNS and East-West gEW gradient (Chen & Herring 1997):

Input: NWM STD

$$NWM\ STD_1 = S_1\left[N_{0,\ldots}, N_1\right] + c_1 \cdot gNS + a_1 \cdot gEW$$
$$NWM\ STD_2 = S_2\left[N_{0,\ldots}, N_1\right] + c_2 \cdot gNS + a_2 \cdot gEW$$
$$NWM\ STD_3 = S_3\left[N_{0,\ldots}, N_1\right] + c_3 \cdot gNS + a_3 \cdot gEW$$
$$NWM\ STD_4 = S_4\left[N_{0,\ldots}, N_1\right] + c_4 \cdot gNS + a_4 \cdot gEW$$
$$\ldots$$

S … point-to-point raytrace operator
C & A … some factors (not estimated)

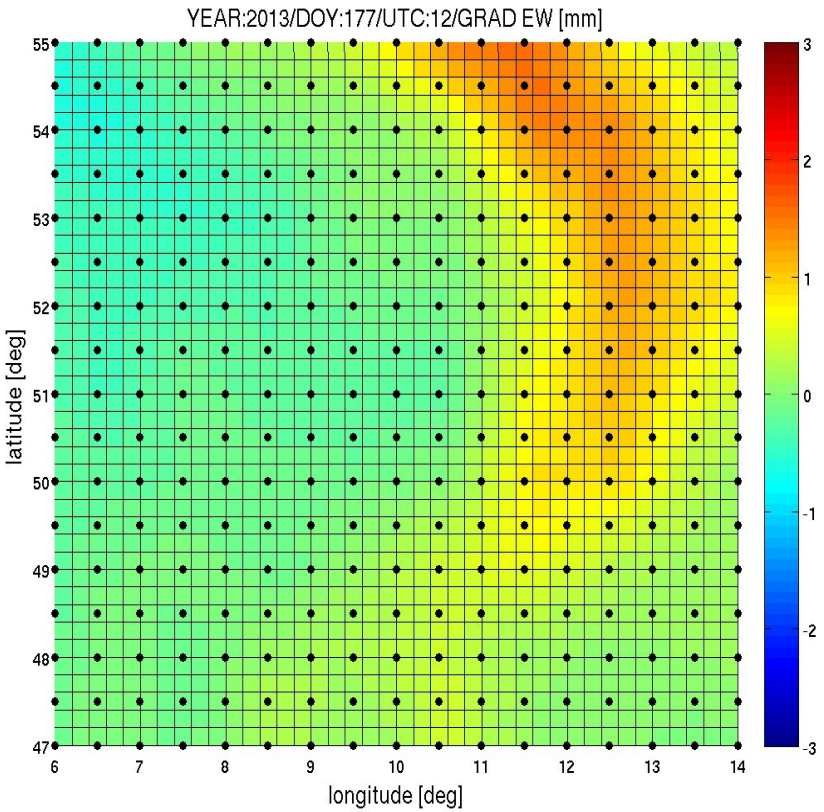
Output: N, gNS & gEW

Algorithm: non-linear least square adjustment

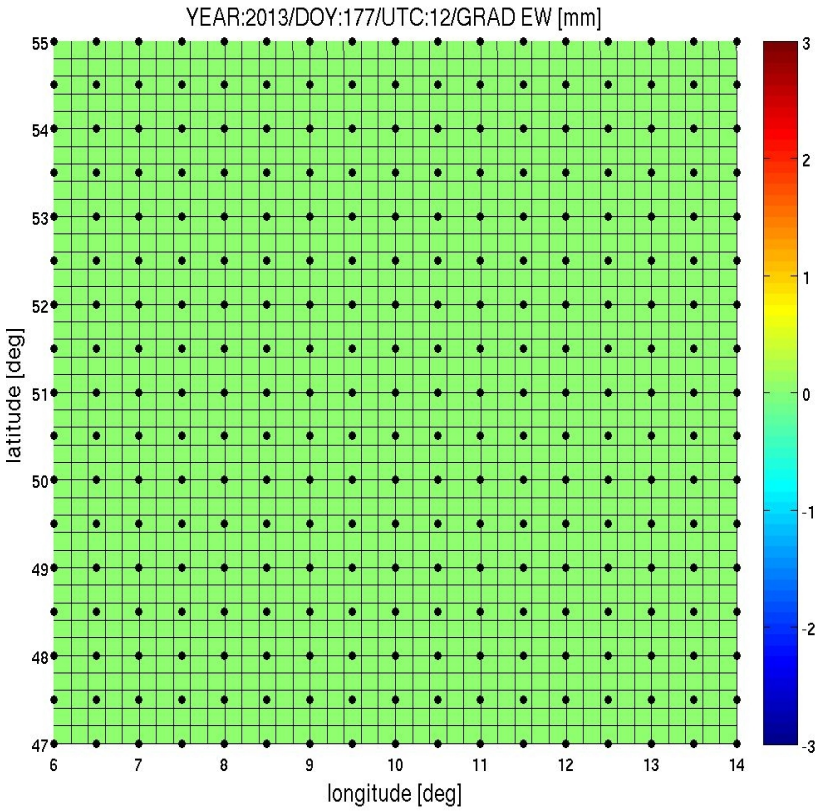
Artificial stations & station-satellite links:

For a single station we collect STDs and estimate refractivity gradients.
The NS (EW) horizontal gradients [mm] are assembled and produce a map.

NWM



PMF & ZTDs



Now, we replace NWM STDs by GPS STDs.

Input: GPS STD

$$GPS\ STD_1 = S_1\left[N_{0,\dots},N_1\right] + c_1 \cdot gNS + a_1 \cdot gEW$$
$$GPS\ STD_2 = S_2\left[N_{0,\dots},N_1\right] + c_2 \cdot gNS + a_2 \cdot gEW$$
$$GPS\ STD_3 = S_3\left[N_{0,\dots},N_1\right] + c_3 \cdot gNS + a_3 \cdot gEW$$
$$GPS\ STD_4 = S_4\left[N_{0,\dots},N_1\right] + c_4 \cdot gNS + a_4 \cdot gEW$$
$$\dots$$

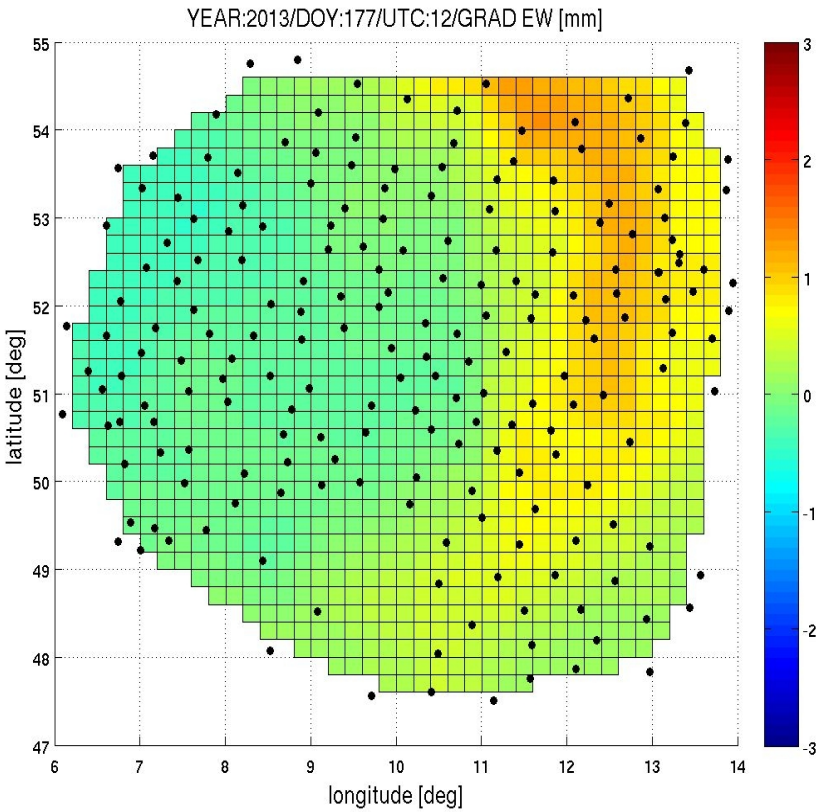
Output: N, gNS & gEW

Question: Do the NWM and the GPS gradient map look similar?

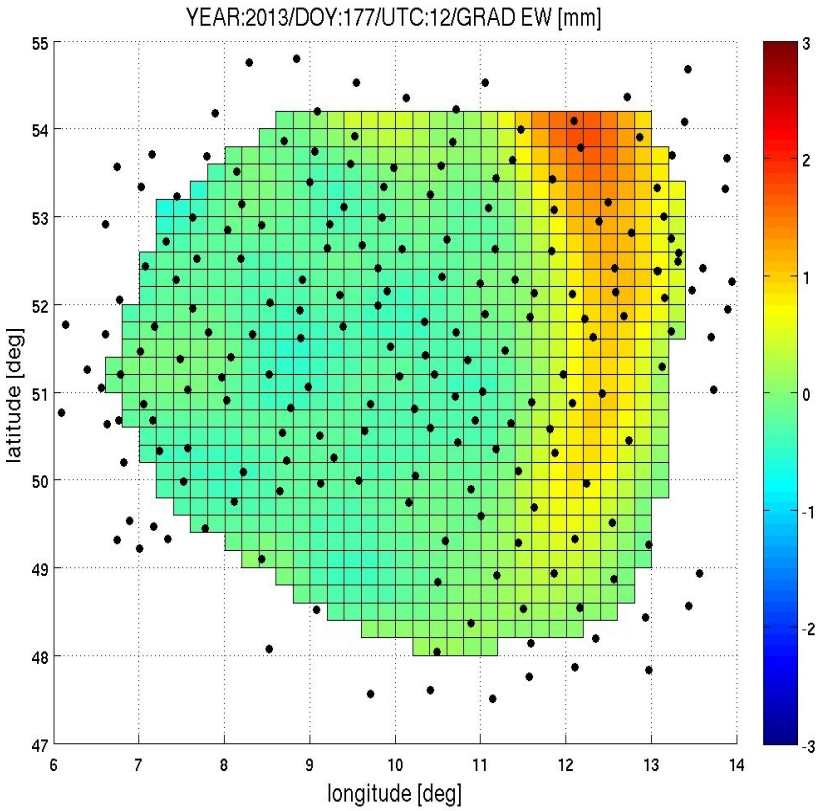
Real stations & 20 minutes station-satellite links:

For a single station we collect STDs and estimate refractivity gradients. The NS (EW) horizontal gradients [mm] are assembled and produce a map.

NWM



GPS



Conclusion: GPS STDs contain the gradient information!