

# Assessment on GNSS atmospheric parameters at co-location sites

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# Introduction

- **Tropospheric ties**

- Expected differences between atmospheric parameters at co-located stations
- **Improve** the combination of space geodetic techniques<sup>1</sup>
  - ❖ Along with local ties and global ties

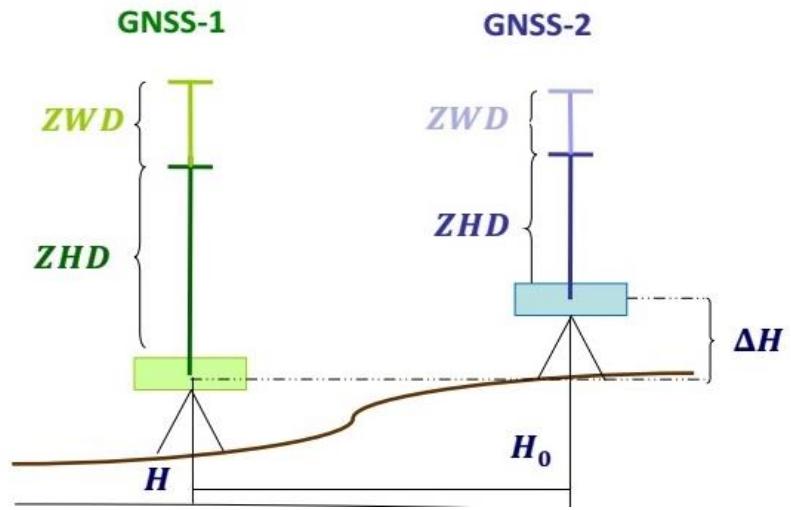


Fig. 1: Co-located GNSS antennas  
(Heinkelmann et al., 2016)

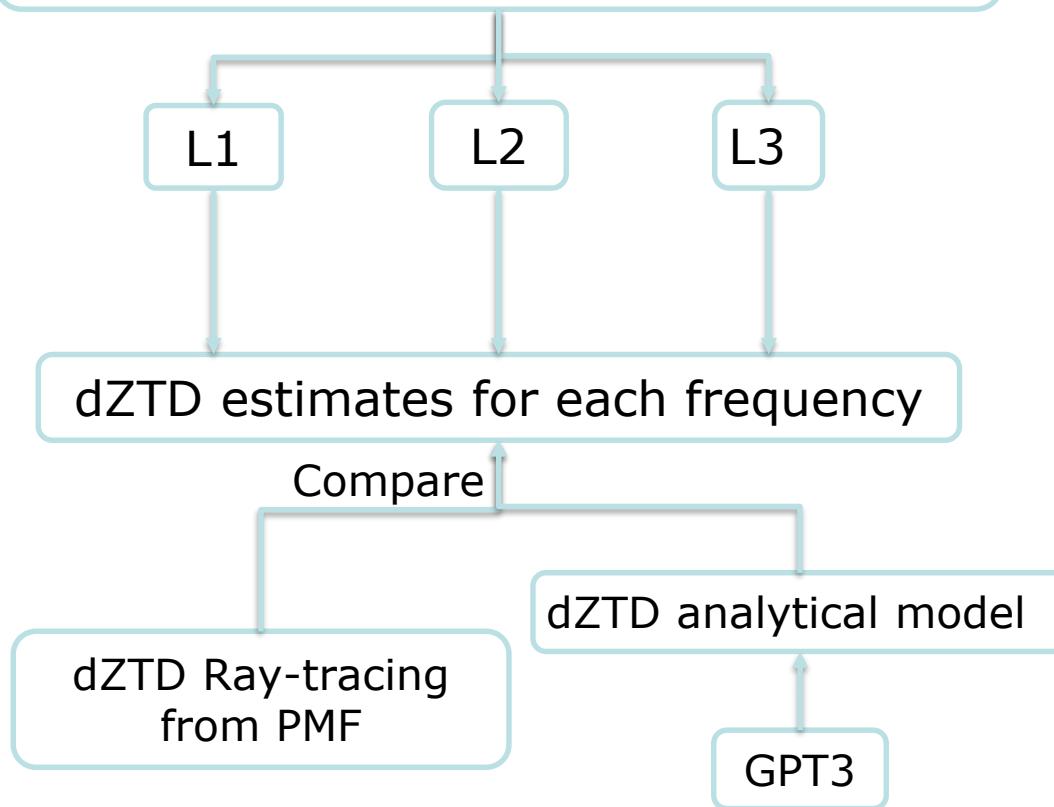
1: IAG JWG 1.3 Term of References <https://iag.geo.tuwien.ac.at/c1/jwg/jwg13/>

# How to obtain tropospheric ties?

- **Analytical models** (Teke et al., 2011)  
based on meteorological information from:
  - Global Pressure Temperature 3 model (GPT3)
  - Numerical Weather model (NWM)
  - Ground meteorological sensor
- **Ray-tracing technique with NWM**
  - Potsdam Mapping Function (PMF) (Balidakis et al., 2018)  
from ERA5
    - Temporal resolution: hourly
    - Horizontal resolution: 31 km

# Methodology

GPS data analysis with Bernese GNSS software v5.2



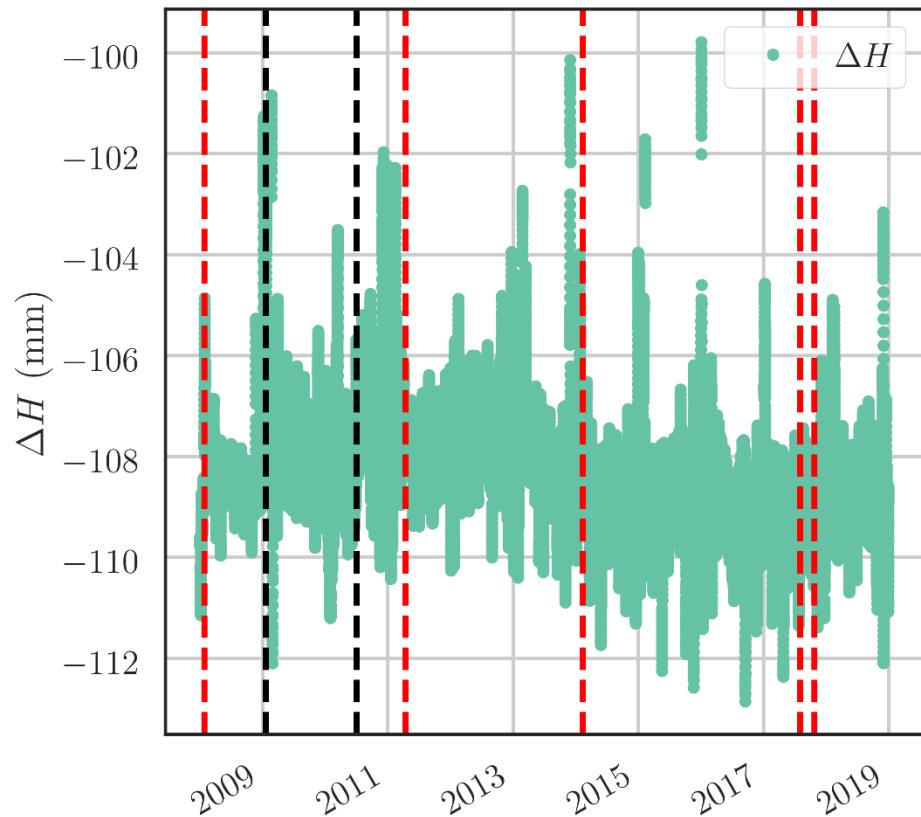
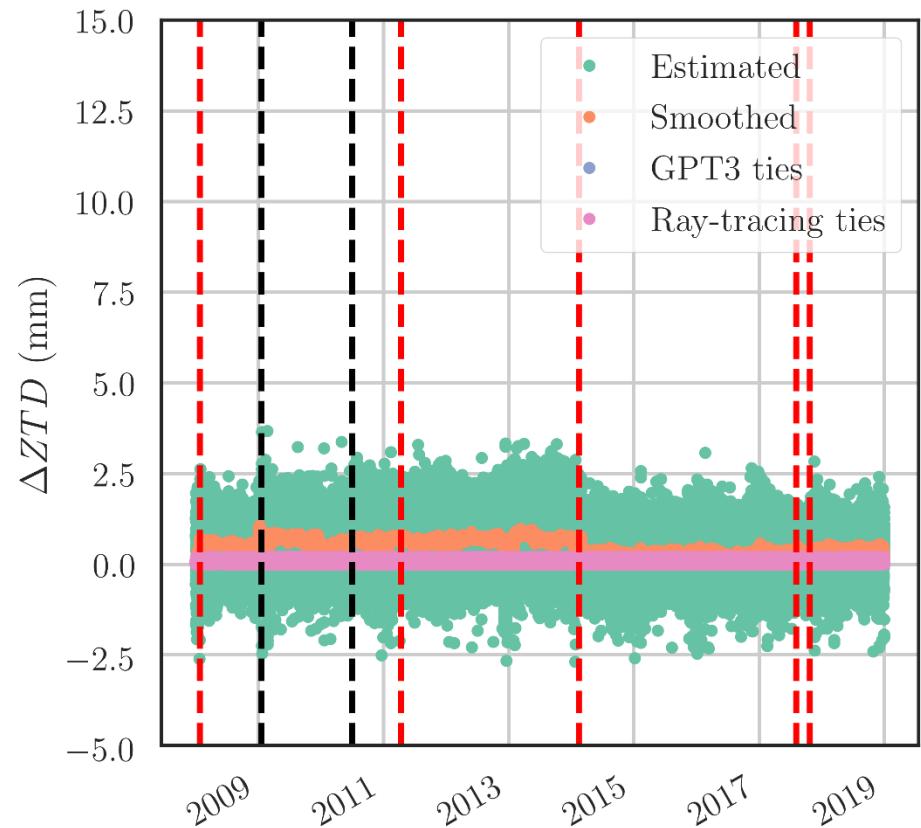
- 4 GNSS stations were taken from Wettzell co-location sites for 11 years (2008-2018)
  - WTZA
  - WTZR
  - WTZS
  - WTZZ
- Orbit and clock information were provided from IGS final product (Johnston et al., 2017)
- **WTZA** is selected as a **reference** station for comparison

# Methodology

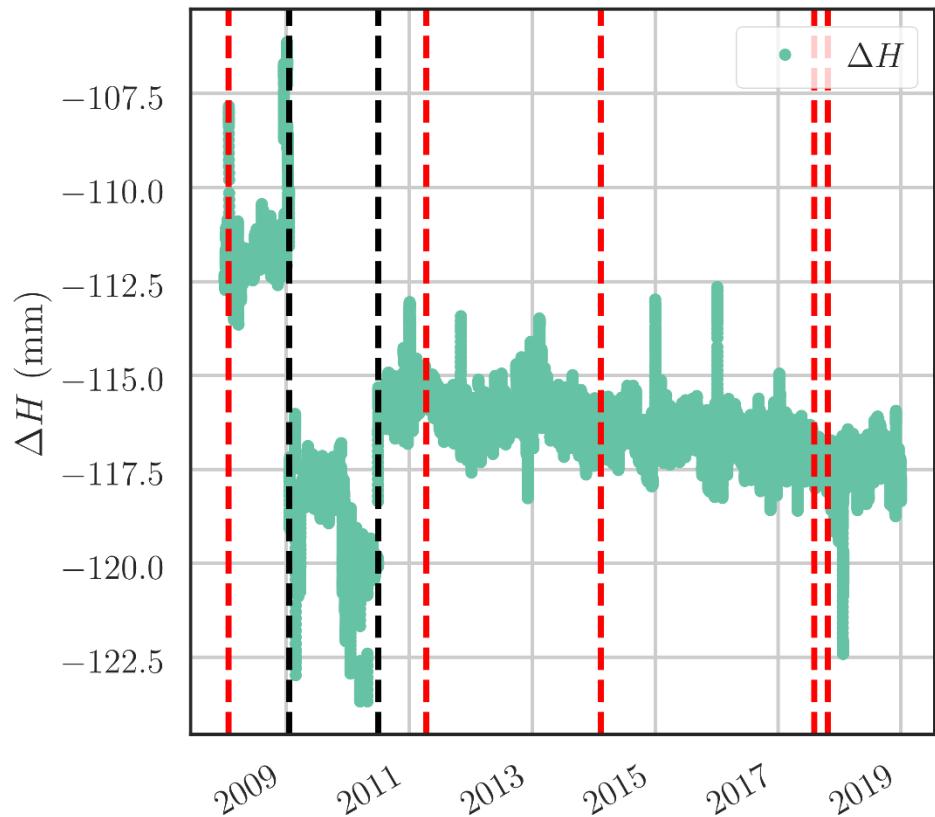
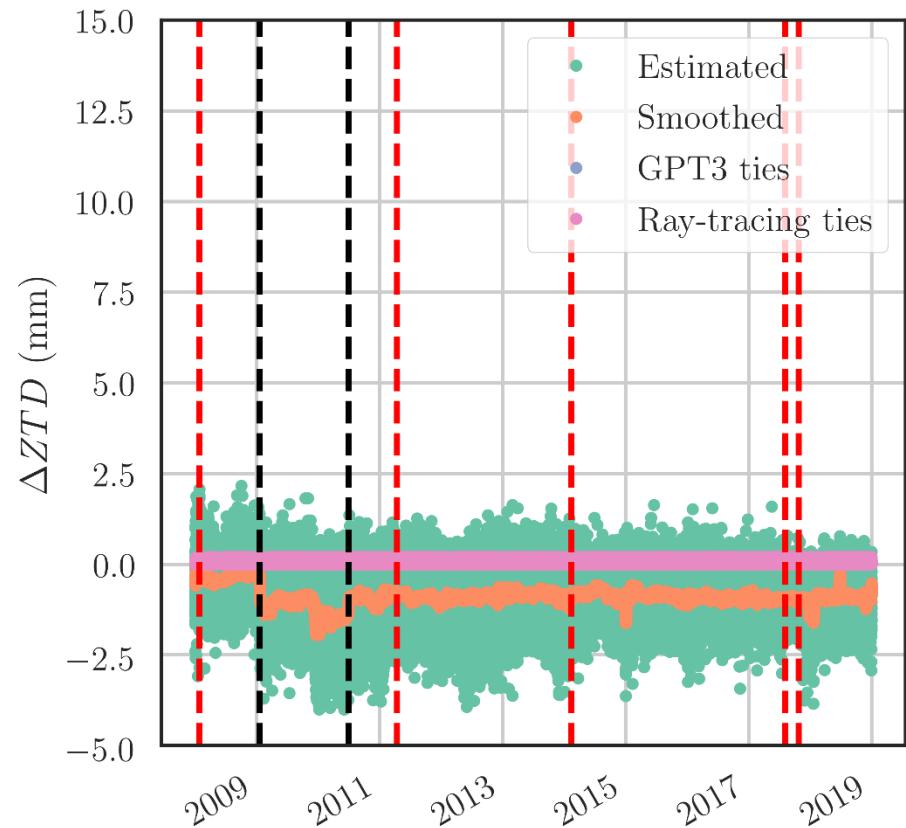


Fig. 2: Wettzell GNSS co-location site.  
Picture from EUREF

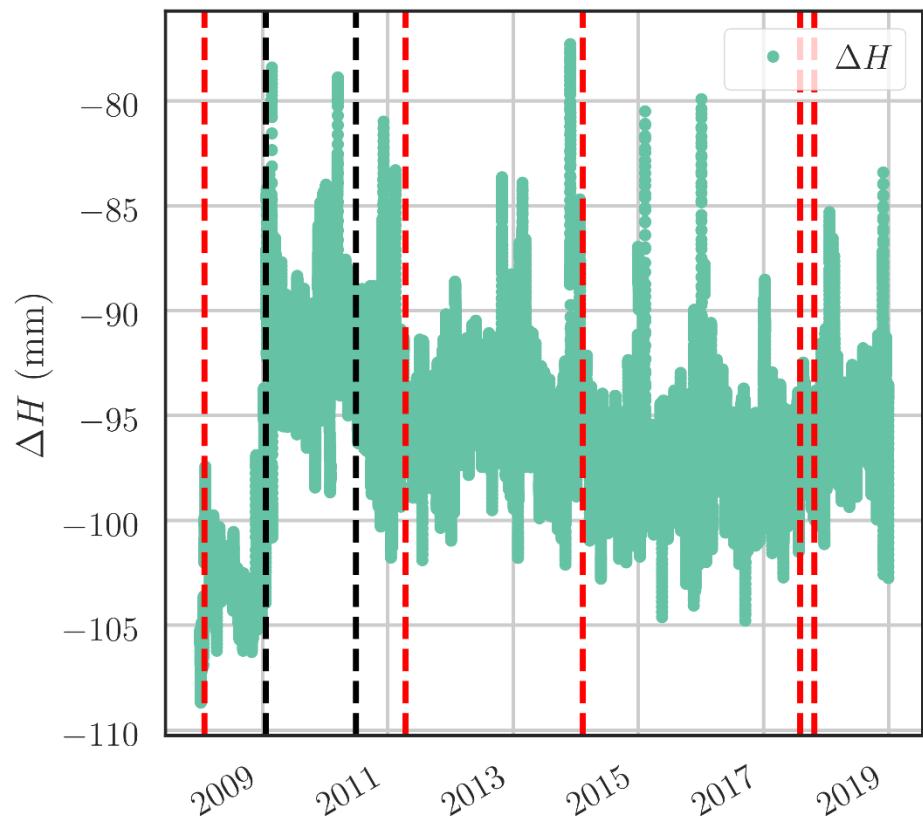
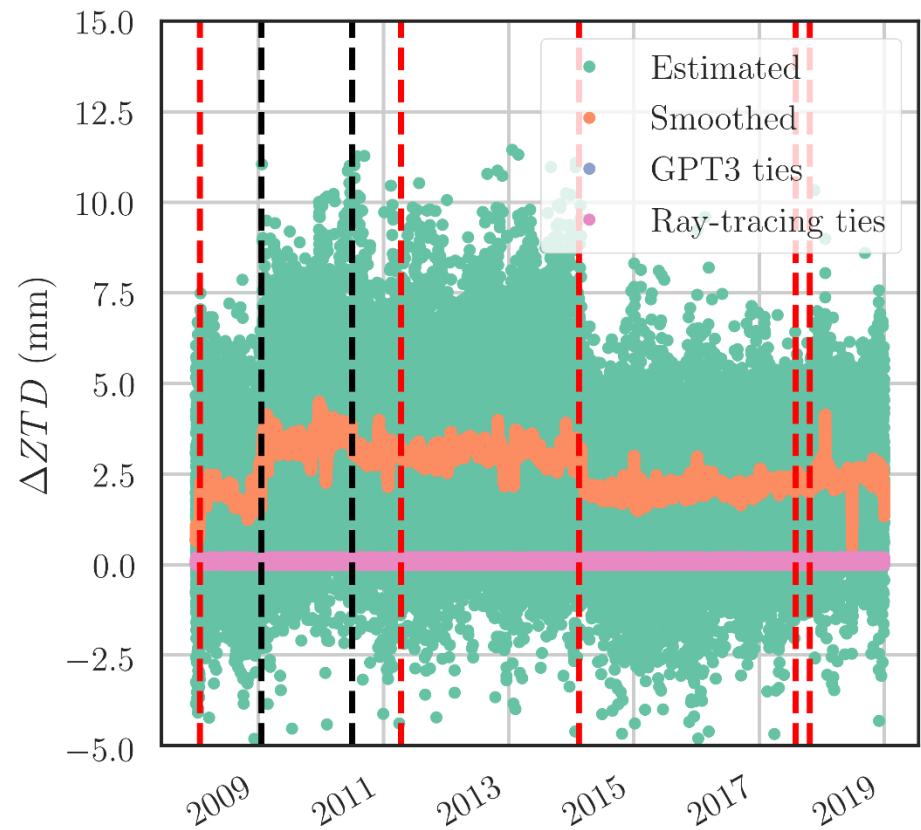
# L1:WTZA-WTZR ( $\Delta H \approx 0.1$ m)



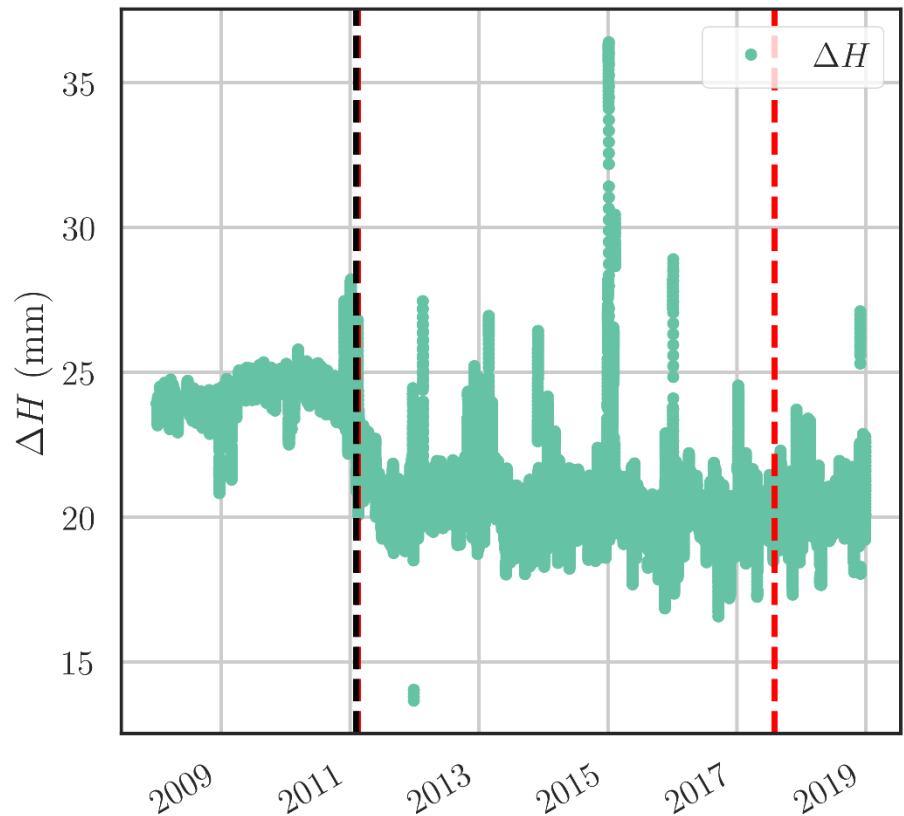
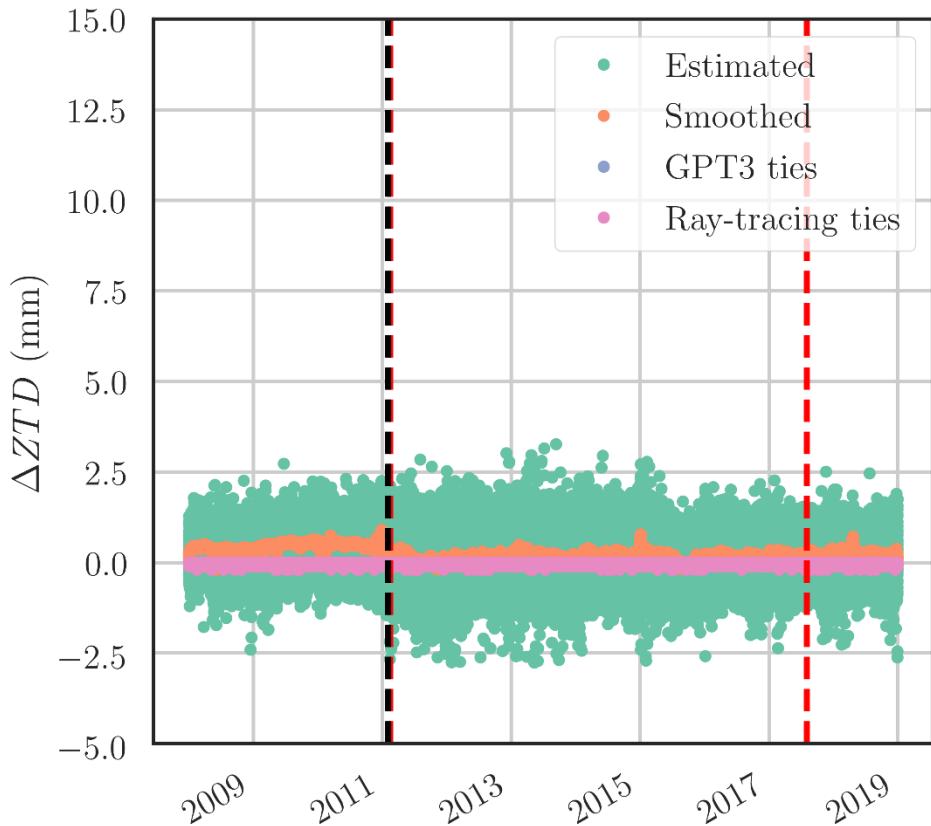
## L2:WTZA-WTZR ( $\Delta H \approx 0.1$ m)



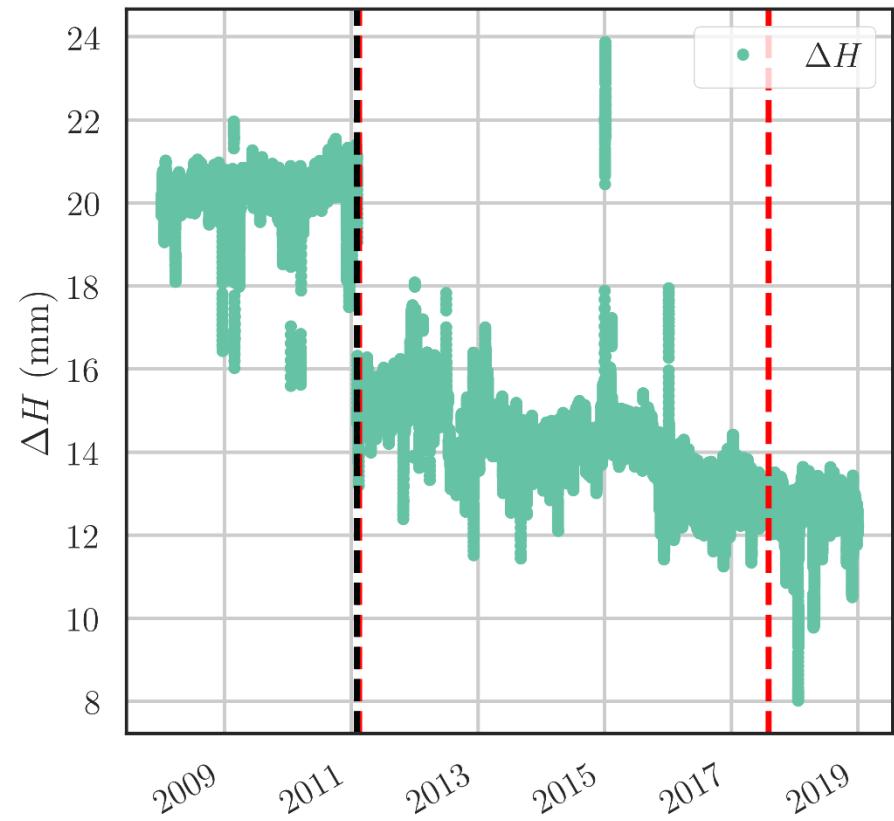
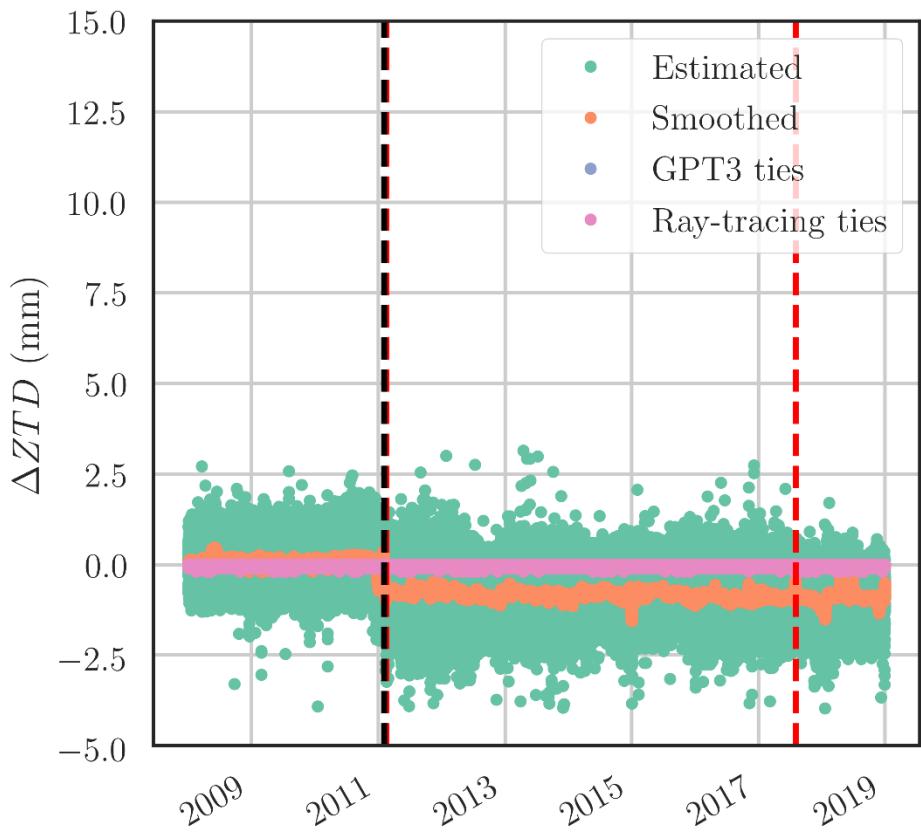
# L3:WTZA-WTZR ( $\Delta H \approx 0.1$ m)



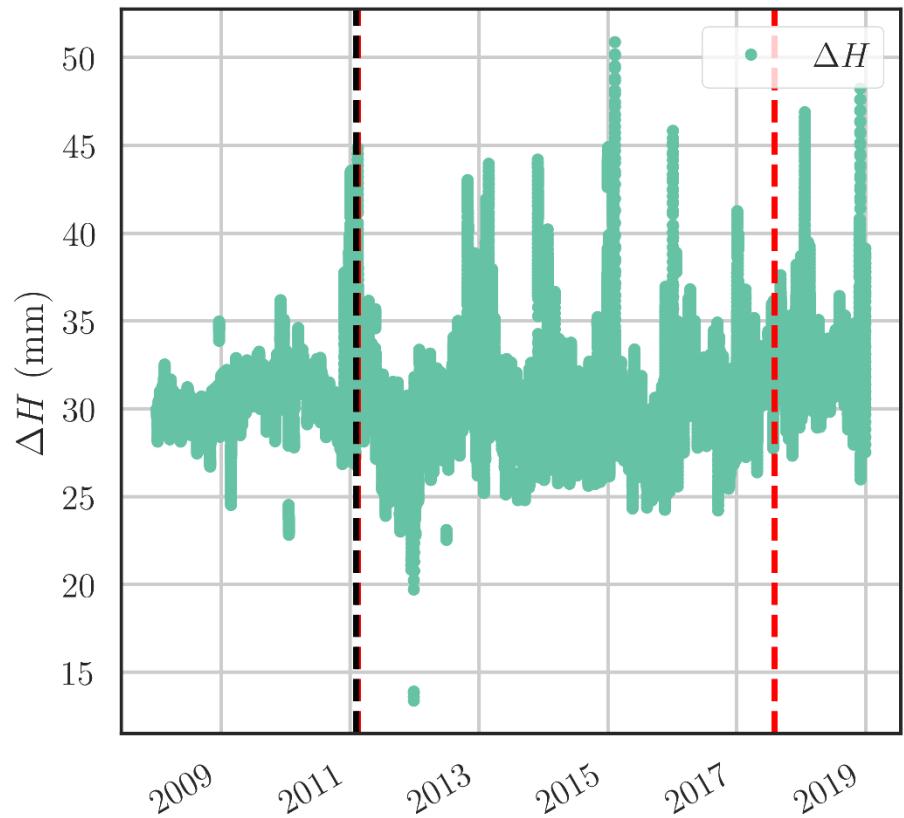
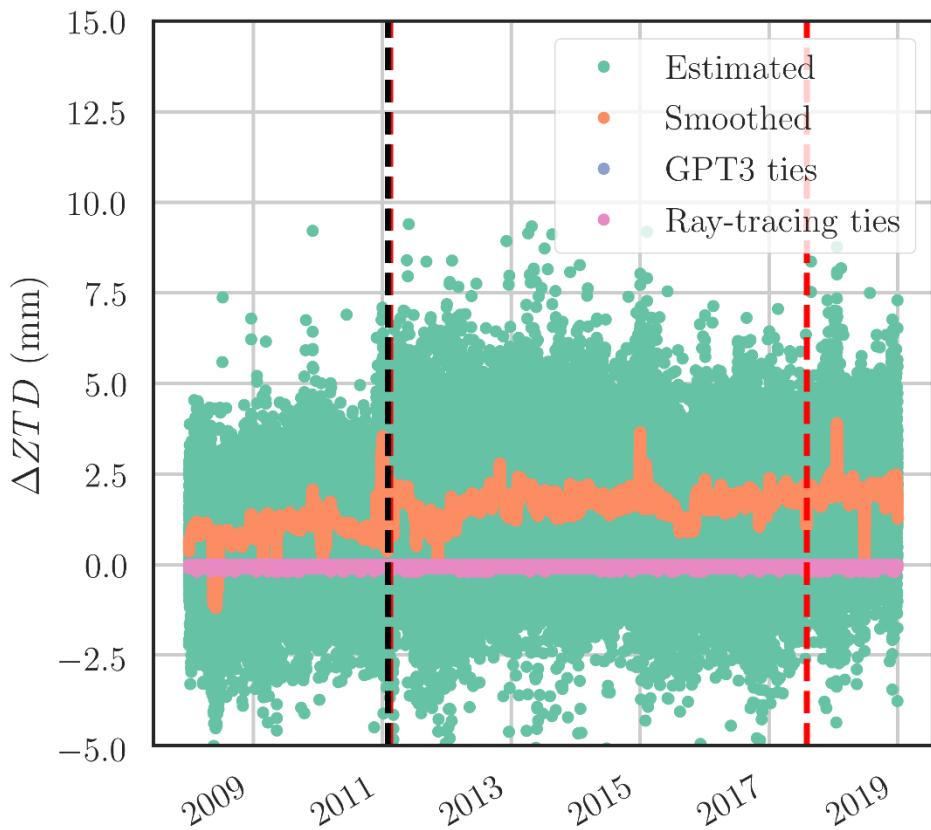
# L1:WTZA-WTZZ ( $\Delta H \approx 0.03$ m)



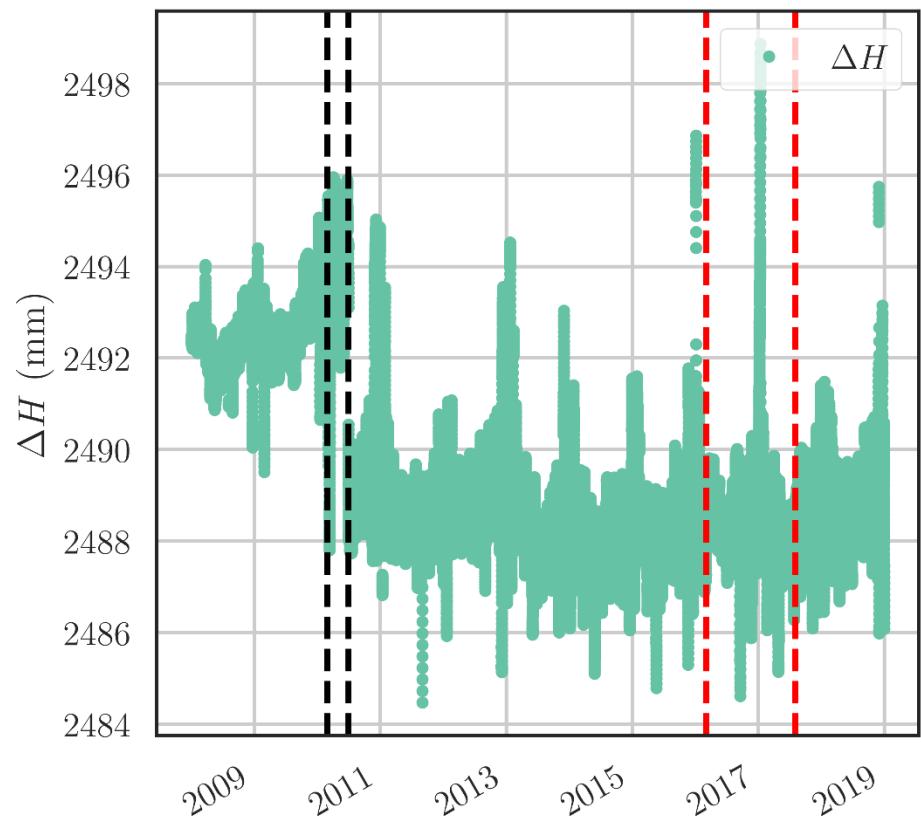
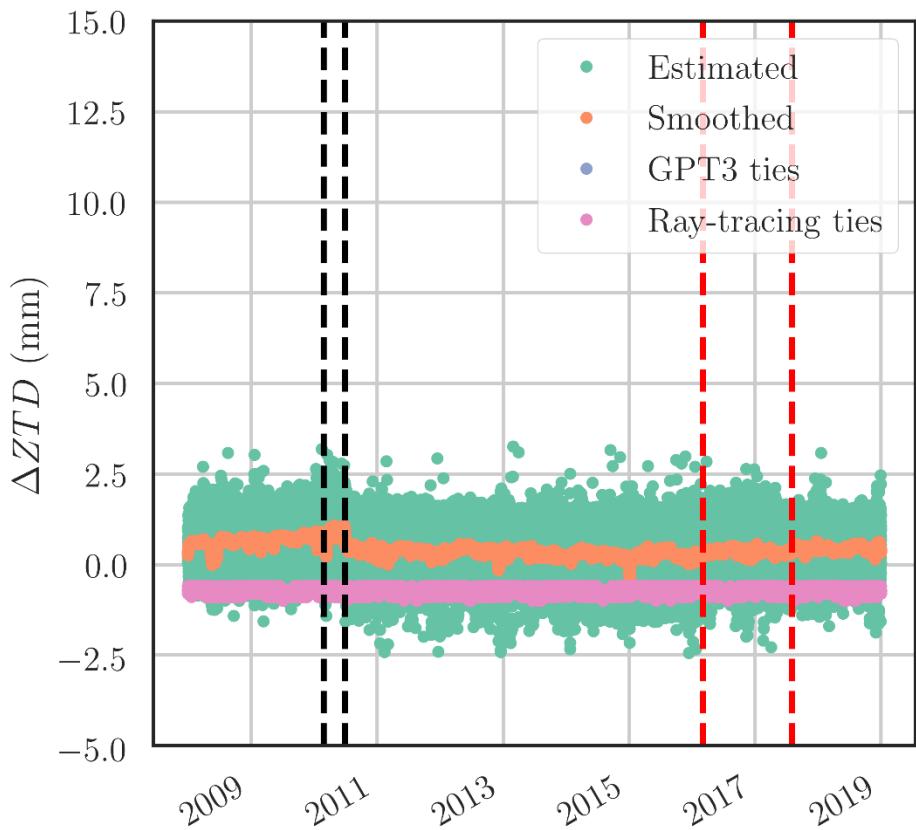
# L2:WTZA-WTZZ ( $\Delta H \approx 0.03$ m)



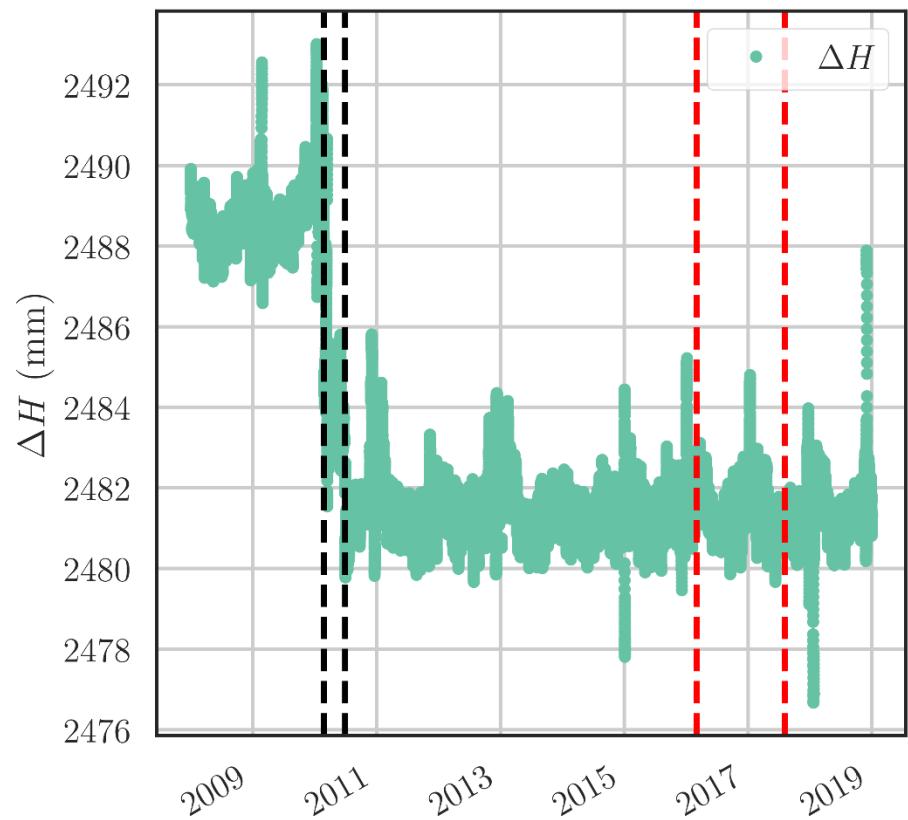
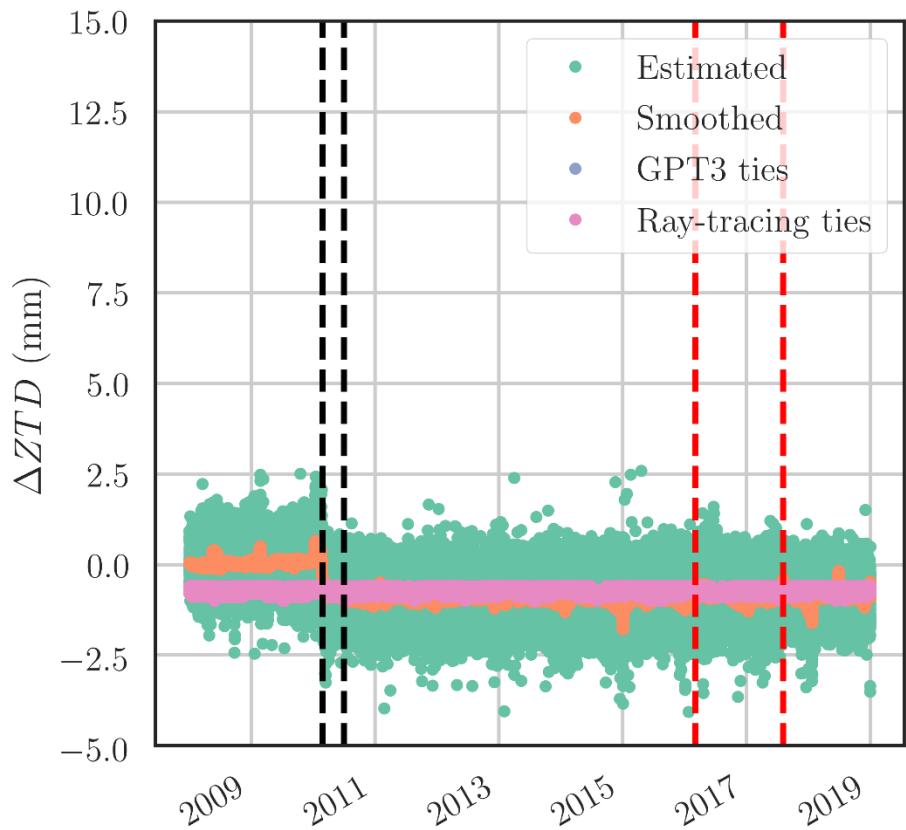
# L3:WTZA-WTZZ ( $\Delta H \approx 0.03$ m)



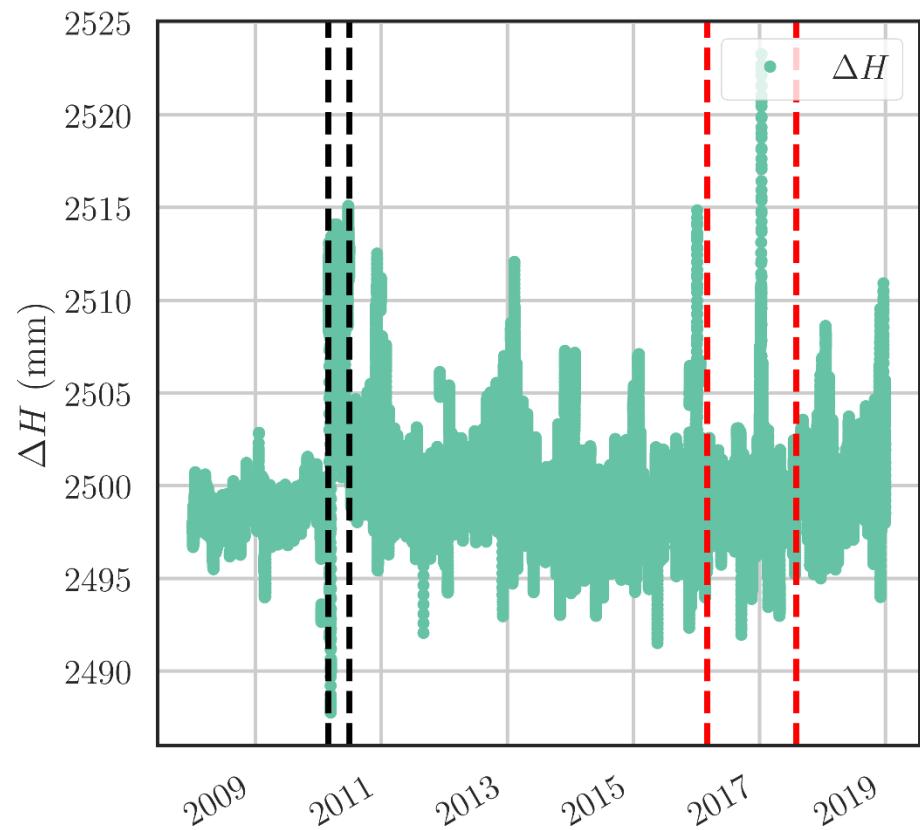
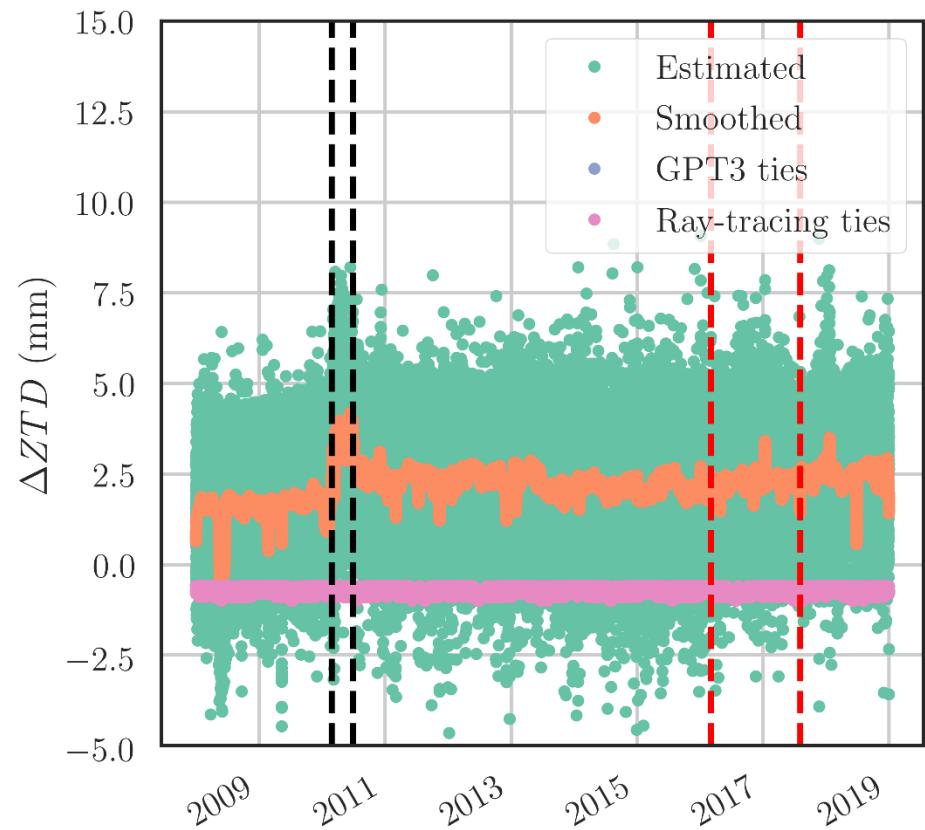
# L1:WTZA-WTZS ( $\Delta H \approx 2.5$ m)



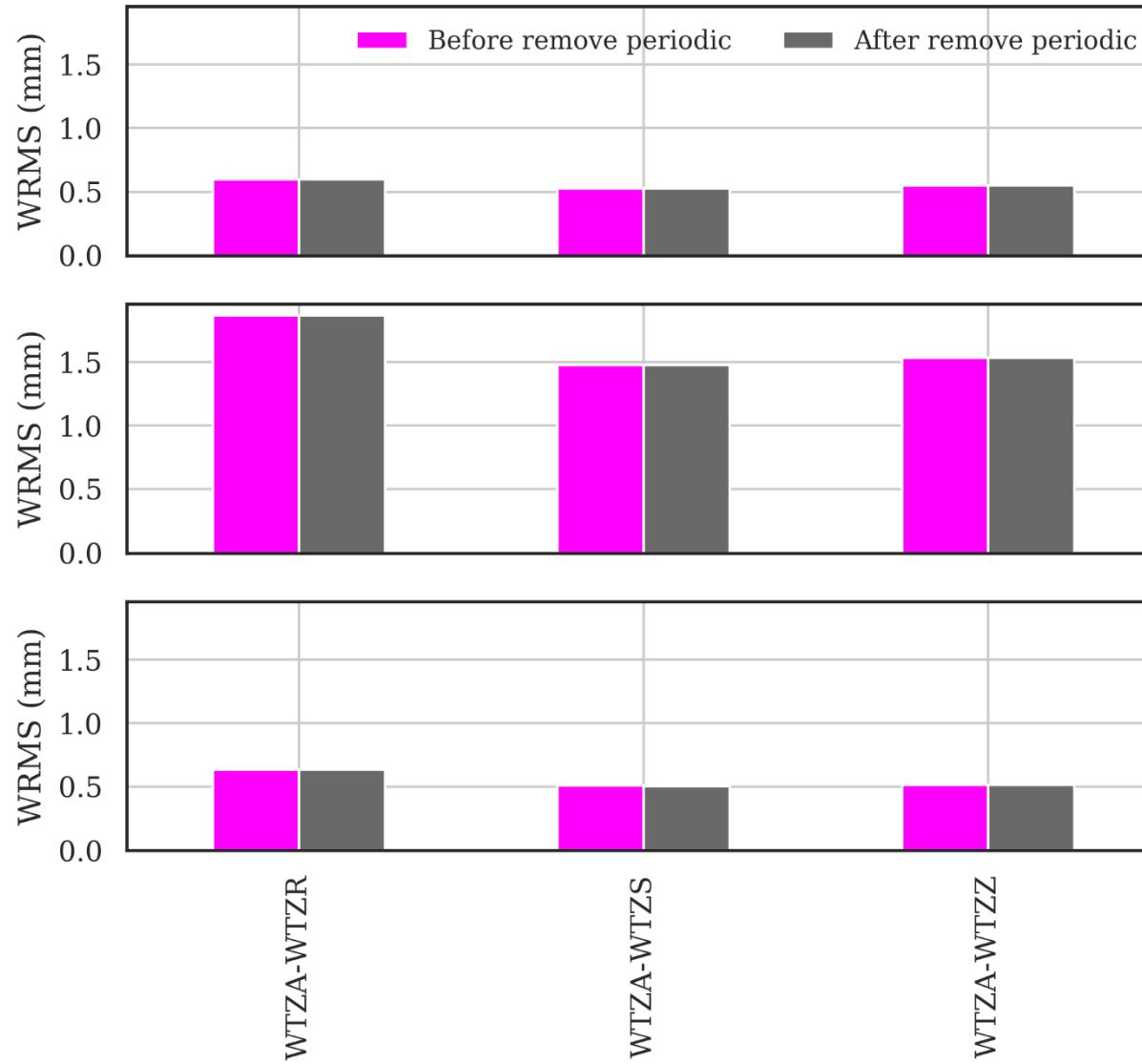
## L2:WTZA-WTZS ( $\Delta H \approx 2.5$ m)



# L3:WTZA-WTZS ( $\Delta H \approx 2.5$ m)



# WRMS before and after removal annual and semi-annual signal



L1

L2

L3

# Conclusions

## ➤ Conclusions

- **Equipment change** affects troposphere parameters
  - Estimated coordinates as well
- Observed tropospheric delay differences from **L1 and L2** observations are less noisy compared to **L3**
- Observed tropospheric delay differences from **L3** have **large biases**
- Seasonal signals are not significant for **small heights differences**
- Tropospheric ties from **analytical models** and **ray-tracing** are not reached with observed values for **small heights differences**
- For **small heights differences**, the effect of observed tropospheric delay differences is **dominated by equipment effect**

## ➤ Outlooks

- Extend tropospheric ties model based on equipment
- Compare cases where there are large height differences
- Compare with VLBI and DORIS

# Bonus

- PMF provided completed-history data for VLBI and SLR analysis (40 years)

For VLBI



<ftp://ftp.gfz-potsdam.de/pub/home/kg/kyriakos/PMF/>

For SLR



<ftp://ftp.gfz-potsdam.de/pub/home/kg/zusflo/TRO/>

Contact: [kyriakos.balidakis@gfz-potsdam.de](mailto:kyriakos.balidakis@gfz-potsdam.de)

# References

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