Real-time ZTD from a local network of low-cost dual-frequency GNSS receivers

Tomasz Hadaś, Grzegorz Marut, Jan Kapłon, Witold Rohm
IGoR - IoT GNSS Low-cost Receiver:
accuracy against Final ZTD @ IGS station WROC

Final IGS, geodetic grade receiver
Real-time, geodetic grade receiver
Real-time, IGoR ($\sigma_{ZTD}=4.1$ mm)
Real-time, u-blox receiver & antenna
Real-time, u-blox receiver & antenna + ground plane

2\sigma \leq 15 \text{ mm } ZTD \approx 2.3 \text{ kg/m}^2 \text{ IWV}
2\sigma \leq 8 \text{ mm } ZTD \approx 1.2 \text{ kg/m}^2 \text{ IWV}
**Local Network of Low-Cost GNSS Receivers:**

ZTD & ΔZWD (ΔIWV) time series; high-res WRF as reference

- 17 low-cost stations @ c.a. 300 km²
- ≥13 for 15 days (since DoY 72, 2021)
- dynamic weather conditions

\[
IWV = \frac{ZWD}{Q}
\]

\[
Q = 10^{-6} \rho_w R_w \left( \frac{k_3}{T_m} + \left( k_2 - k_1 \frac{M_w}{M_d} \right) \right)
\]


\[
\Delta IWV = \Delta ZWD
\]

% of ΔZWD (ΔIWV) exceeding 1σ / 2σ / 3σ = 31% / 11% / 4%
LOCAL NETWORK OF LOW-COST GNSS RECEIVERS:

ZWD & ΔIWV distribution and dynamics

ZWD [mm]

ΔIWV [kg/m²] (GNSS-WRF)
Real-time ZTD from a local network of low-cost dual-frequency GNSS receivers

ZWD & IWV videos:
https://www.youtube.com/playlist?list=PL1gisBn7WurAVhtcW0BZK2AR_f2OMCfMP

Thank you!

Corresponding author: Tomasz Hadas

e-mail: tomasz.hadas@nav.uni-stuttgart.de / tomasz.hadas@upwr.edu.pl
phone: +49 711 685-83461
http://www.nav.uni-stuttgart.de / http://www.igig.up.wroc.pl/igg/

University of Stuttgart
Institut for Navigation
Breitscheidstrasse 2
70174 Stuttgart / Germany

Wrocław University of Environmental and Life Sciences
Institute of Geodesy and Geoinformatics,
Grunwaldzka 53
50-357 Wroclaw / Poland

Tomasz Hadaš has received funding from the European Union’s Horizon 2020 research and innovation program under the Marie Skłodowska-Curie Grant Agreement No. 835997

Grzegorz Marut has received funding from the project European Plate Observing System (EPOS-PL+) POIR.04.02.00-00-C005/19, funded by the Operational Programme Smart Growth 2014–2020, Priority IV: Increasing the research potential, Action 4.2: Development of modern research infrastructure of the science sector and co-financed by the European Regional Development Fund