GNSS-derived IWV using G-Nut/Tefnut vs. radiometer data: a case study

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MOTIVATION

• COST ES1206 Benchmark Campaign dataset.

• Validation of GNSS derived ZTD and IWV by comparing it to the microwave radiometer data.

• Testing the software capabilities for future research and applications.
Microwave radiometer

• Two microwave radiometers are located in POTSDAM and LINDENBERG.
• High quality IWV data.
• Benchmark for the GNSS-derived ZTD/ZWD estimates.
Case study

• Data was collected from COST ES1206 Benchmark Campaign repository.
• Two radiometers from benchmark: POTSDAM and LINDENBERG.
• 26 days: 29.05 – 23.06.2013
• Period includes the occurrence of severe weather events.
Data and software configuration

G-Nut/Tefnut processing:
• GNSS data processed in PPP mode.
• IGS final orbit and clock corrections.
• Troposphere a priori model – GPT.
• Time interval – 5 min.

IWV conversion:
• IWV = $\frac{ZWD}{10^{-8}(k_2' + \frac{k_3}{T_m})R_w}$
• Refraction index from Bevis et al.(1992)

Reference data:
• Potsdam time interval – 5 min
• Lindenberg time interval – 10 min
Radiometer data screening

- IWV values for Potsdam and Lindenberg exceeded respectively 200 kg/m$^2$ and 300 kg/m$^2$.
- Range check – deleting values exceeding 50 kg/m$^2$.
- Outliers check – deleting values exceeding $(\text{median} + 2.5 \times \text{std})$. 

![Graph showing IWV values with outliers circled.](image)
IWV at POTSDAM

Correlation = 92.27%

IAG Commission 4 Positioning and Applications Symposium, Wroclaw 2016
Residuals chart at POTSDAM

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Data statistics at POTSDAM

<table>
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<th>max</th>
<th>min</th>
<th>mean</th>
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</thead>
<tbody>
<tr>
<td>Residuals</td>
<td>2.710</td>
<td>8.759</td>
<td>-23.410</td>
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RMS 3.050 kg/m²
IWV at LINDENBERG

Correlation = 90.36%

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Residuals chart at LINDENBERG
Data statistics at LINDENBERG

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<tr>
<td>GNSS</td>
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<td>37.073</td>
<td>7.342</td>
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<td>9.516</td>
<td>-22.776</td>
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RMS 3.239 kg/m²
Sensitivity of radiometer

According to historical weather data, the storm events occurred in Berlin i.a.:

- 30.05.2013
- 14-15.06.2013
- 20-21.06.2013

Mostly, these events are correlated with the extremely high values of IWV measured with the radiometer located in Potsdam.

Example link: https://www.wunderground.com/history/airport/EDDT/2013/6/20/WeeklyHistory.html?req_city=Potsdam&req_state=&req_state_name=Germany&reqdb.zip=00000&reqdb.magic=1&reqdb.wmo=10379
Summary

Conclusions:
• GNSS-derived IWV is highly correlated with the radiometer data, mean residuals do not exceed 8-10%.
• G-Nut/Tefnut software is sufficiently accurate with the ZTD/ZWD estimation for IWV conversion.
• Radiometers have their disadvantages

Plans for future:
• Perspectives for real-time solutions.
• IWV estimates from near real-time PPP solution for Polish network.
• Testing various forecasting methods.
Thank You!

This work has been supported by Polish National Science Centre grant No. UMO-2015/19/B/ST10/02758.