ON THE USE OF THE IGS REPRO1 TROPOSPHERIC PRODUCT FOR CLIMATE ANALYSIS: AN IWV INTER-TECHNIQUE COMPARISON STUDY


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BACKGROUND

Being the most important greenhouse gas in the Earth’s atmosphere, water vapour plays a key role in the climate change debate. However, observing the atmospheric water vapour over climatological timescales in an homogeneous environment remains a challenge.

To this end, water vapour estimations derived from reproposing campaign-operated ground-based global navigation satellite systems (GNSS) observations are very promising. In particular, the IGS tropospheric products from the REPRO1 campaign (E5) provide climate researchers access to a worldwide database of continuous GNSS-based integrated water vapour time series spanning over the last 15 years. The Atmóspheric Monitoring Network (AERONET) also provides such longterm and continuous ground-based observations of the IWV performed with standardised and well-calibrated sun photometers.

OBJECTIVES

The purpose of this study is to compare GPS-based IWV time series derived from the IGS REPRO1 final tropospheric products with simultaneous IWV measurements from colocated ground-based sun photometers and satellite-based (GOME/SCIAMACHY) techniques to evaluate the quality of the one-to-one correspondence between the different instruments, and to assess the applicability of GPS-based reprocessed IWV data for time series analysis and climate trends.

INSTRUMENTS, IWV DATASETS AND COLLOCATION

We searched for collocation between different techniques: 2 ground-based, one in situ and 3 satellite-based. The main advantage and disadvantage of each technique are summarised in Table 1.

Table 1: Comparison of the main advantages and disadvantages of the different techniques highlighted in this work

<table>
<thead>
<tr>
<th>Technique</th>
<th>Main Advantages</th>
<th>Main Disadvantages</th>
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<tbody>
<tr>
<td>GPS</td>
<td>Long-term dataset, high spatial resolution</td>
<td>Poor vertical resolution, data gap issues</td>
</tr>
<tr>
<td>Sun Photometer</td>
<td>High vertical resolution, long-term data</td>
<td>Poor spatial resolution, limited data coverage</td>
</tr>
<tr>
<td>Satellite</td>
<td>Large coverage, high vertical resolution</td>
<td>Poor spatial resolution, limited data coverage</td>
</tr>
</tbody>
</table>

We found suitable collocations between: (a) the GPS-based reprocessed IWVs and sun photometer observations, (b) the GPS-based reprocessed IWVs and satellite-based (GOME/SCIAMACHY) observations, and (c) the sun photometer measurements and satellite-based (GOME/SCIAMACHY) observations.

The IWV INTER-TECHNIQUE COMPARISON

We constructed scatter plots of simultaneous (n=10 inns) for GPS, sun photometer and satellite-based (GOME/SCIAMACHY) IWV measurements between the different devices (using the GNSS as reference, see Fig. 3). These plots show that:

- The mean bias between the different techniques varies between 0.70 and 1.25 mm (GOME/SCIAMACHY) to 0.80 (sun photometer).
- The best correlation and lowest dispersion of the data points were reached for the GPS vs. GNSS comparison.
- The sun photometer works best for daytime measurements (0.70 mm bias). GPS, however, shows better agreement during the night.
- The GPS and sun photometer agree within 0.70 mm, while the satellite-based (GOME/SCIAMACHY) measurements show a larger spread (0.80 mm bias).
- The regression coefficients for both the GPS and sun photometer devices are positive, indicating a good agreement between the two techniques. However, the satellite-based (GOME/SCIAMACHY) measurements show a negative regression coefficient, indicating a systematic overestimation of IWV by the satellite-based technique in comparison to the ground-based measurements.

EXPLOITATION OF THE IWV DATABASES AT BRUSSELS

In a second step, we extended our study worldwide. We created scatter plots similar to Fig. 3 for the selected 28 sites for which we found instrument-collocation results. As summarised in Fig. 5 and 6, we found:

- The GPS instrument compares well with other techniques for IWV measurements (best correlation, lowest scatter).

CONCLUSIONS AND PERSPECTIVES

Ground-based and satellite IWV measurements techniques typically agree at the level of 0.3 mm ± 2 mm of IWV. However, different radiosonde techniques show different performances in different regions, and satellite-based techniques show higher biases and more variability (±4 mm of IWV).

The influence of the cloud on IWV measurements, GNSS measures higher IWV values than CIMEL. Sun photometers require clear sky in the measurement of the IWV, and the satellite-based (GOME/SCIAMACHY) values are more variable, especially for GNSS observations, compared to the sun photometer measurements.

These results highlight the importance of intercomparing different measurement techniques and instruments to obtain reliable and accurate IWV measurements for climate studies.