Assessment of integrated water vapor inferred by GPS, miscellaneous measurements and atmospheric models

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Multi-instrument Comparison

The GPS antenna of the Geoforschungszentrum Potsdam (GFZ), a microwave radiometer, and a sunphotometer provide continuous measurements of integrated water vapor (IWV). During HD(CP)² Observational Prototype Experiment (HOPE) in April/May 2013 a large number of radiosoundings is available. These measurements and the infrared and near infrared measurements of MODIS are compared to each other and the model output of ICON.

Results

Comparison:
- GPS, MWR and sunphotometer agree well with RMSE around 1 mm
- GPS drier than MWR
- radiosondes are drier than GPS (0.7 mm) and MWR (0.9 mm)
- Sunphotometer and MODIS-NIR show low RMSE (0.65 mm) due to same observation principle
- MODIS IR largest bias & RMSE in comparison to other instruments
- Too few data sample for RS – MODIS IR & NIR

Mean daily cycle:
- Well-defined daily cycle in both MWR and GPS
- Offset at beginning/end of day due to varying daily mean
- Larger offset in GPS due to processing

Resolved variability:
- Noise level of MWR matches MDS
- Variability in ICON-DE smaller than in COSMO-DE and measurements (due to forcing)
- Variability in COSMO larger than in measurements
- Why mean STD MWR 15 min eventually larger than MWR 5 s?

Model Evaluation

The high-resolution COSMO reanalysis (COSMO-RE: dx = 7 km) performed within the Hans Ertel Centre is assessed in terms of water vapor using GPS measurements provided by GFZ relative to ERA-Interim (dx = 50 km) and ERA-Interim downscaling (COSMO-DS).

Results

Comparison of the integrated water vapor (IWV) from measurements by ground stations of the GNSS (Global Navigation Satellite System) network (uncertainty: 1 kg/m²) with simulated IWV from COSMO-RE: output every 15 min of the year 2011.

→ In general, COSMO-RE: is drier than the GNSS measurements.

→ While the bias of each reanalysis is very similar, the RMSE of COSMO-RE: is significantly smaller especially than COSMO-DS

→ High temporal variability of IWV is well represented with COMO-RE:.

Fig. 1: Time series of IWV at JOYCE for April and May 2013. COSMO-DE data courtesy of David Wicka, DWD.

Fig. 2: Scatter, bias, RMSE, correlation coefficient, slope, and intercept parameter for all instruments at JOYCE during HOPE in kg/m². Lower-left half: When the two compared instruments measure the same quantity. Upper-right half: Only when ALL instruments measure simultaneously.

Fig. 3: Mean daily IWV cycle from GPS and MWR at JOYCE for April – May 2013.

Fig. 4: Variation of mean standard deviation with length of time period (4 Apr. – May 2013). Noise level of MWR given as black dot on y-axis.

Fig. 5: Time series (Dec/Jan) of a) IWV measured with GNSS, b) Difference COSMO-RE: — measurements, c) COSMO-DE — measurements, d) Difference ERA-Interim — measurements.


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