Assessment of integrated water vapour and its variability inferred by satellite, ground-based measurements and atmospheric models

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1. Goals
   - Assess accuracy of various techniques to measure interpolated integrated water vapour (IWV).
   - Exploit continuous ground-based measurements at the Jülich Observatory of Cloud Evolution (JOYCE) and two month field campaign
   - Investigate the variability of IWV on small scales

2. HD(CP)2 Observational Prototype Experiment (HOPE)
   Within the project High Definition Clouds and Precipitation for advancing Climate Prediction (HD(CP)2) HOPE took place in the vicinity of JOYCE
   - April and May 2013
   - Measurements of integrated water vapour (IWV) with microwave radiometers (MWR), Global Positioning System (GPS), sunphotometer, and radiosounding
   - Standard infrared (IR) and near infrared (NIR) and NIR Freie Universität Berlin (NIRFUB) Moderate Resolution Imaging Spectroradiometer (MODIS) retrievals from Aqua and Terra overflights

3. MODIS-NIRFUB retrieval
   - Reduction of forward operator uncertainty due to adaption of temperature and water vapour profiles for atmospheric transmittance calculations
   - Consideration of scattering processes on aerosols
   - Iterative inverse modeling scheme using Newton method exploiting three absorption bands
   - Uncertainty estimates considering all error influences on a pixel by pixel basis

4. Can measurements capture small-scale IWV variability?
   MODIS can show spatial variability, ...
   ![Image](image1.png)
   But no temporal small-scale variability. These can be captured by continuous measurements from the ground:
   ![Image](image2.png)

5. Which error can occur due to temporal/spatial mismatch?
   Use of high resolution (156 m) ICOsahedral Non-hydrostatic (ICON) weather prediction model run to investigate temporal and spatial mismatch simultaneously
   - ICON model shows that correlation (standard deviation) decreases (increases) distinctly with temporal and spatial mismatch
   - 2 MWRs 3.3 km apart from each other confirm ICON results

6. Multi-instrument comparison
   ![Image](image3.png)
   - GPS: offset at beginning of the day due to near real time processing
   - MODIS-NIR: Insufficient cloudmask, cloudy pixels not included in sunphotometer comparison
   - MODIS-NIRFUB: too dry, better detection of clouds
   - If only coincident measurements of MWR, sunphotometer, GPS and radiosounding are compared → reduction of random error due to mostly clearsky and not raining events

Reference: