Assessment of integrated water vapor and its spatio-temporal variability inferred from GPS, miscellaneous measurements and atmospheric models

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Water vapor is the most important and frequent atmospheric green house gas. It influences the Earth's radiation budget, cloud evolution, and with that precipitation formation. Various techniques exist to measure the amount of integrated water vapor (IWV) and they differ greatly in temporal and spatial resolution, accuracy, continuity and atmospheric conditions under which they are applicable.

The High Definition Clouds and Precipitation for advancing Climate Prediction (HD(CP)²) Observational Prototype Experiment (HOPE) took place in April and May 2013 in the rural environment of Jülich, Germany. During this two-month period, the standard instrumentation for detecting water vapor at Jülich Observatory for Cloud Evolution (JOYCE), i.e. the GPS antenna of the Geoforschungszentrum Potsdam (GFZ), a scanning microwave radiometer, and a sunphotometer, which is part of AERONET, was complemented by over 200 radiosoundings, additional microwave radiometers and several lidar systems. Instruments were operated in a dense network of a few kilometer. Additionally, IWV from two Moderate Resolution Imaging Spectroradiometer (MODIS) retrievals, infrared and near infrared, are available from Terra and Aqua overflights. With these data a multi-instrument comparison of IWV focusing on small-scale variability is performed. In particular, we will show how the high spatio-temporal variability of water vapor influences the assessment of the accuracy of larger scale atmospheric model simulations.

HOPE observations are accompanied by modeling activities with the operational weather forecasting model COSMO-DE (Consortium for Small-scale Modeling) with 2.8 km resolution, a 1 km resolution COSMO application and Large Eddy Simulations with a few hundred meter resolution. The suite of observations allows to evaluate the model performance and investigate the ability of the models to reproduce water vapor variability. By using a water vapor gradient detection based on scanning microwave measurements we aim to identify the relative contributions of advective and turbulent variations and to analyze how these are reproduced in the models.

While the analysis of HOPE data focuses on small scales, water vapor variations for central Europe are assessed using a high resolution reanalysis and GPS observations. This regional reanalysis is produced in the Hans Ertel Centre for the years 2007 to 2012 with the COSMO model of Deutscher Wetterdienst (DWD) for the European CORDEX EUR-11 domain. To evalutate the IWV of the reanalysis, measurements at 157 GPS stations are provided by GFZ. These are independent measurements with a good spatial coverage of the model domain and the same temporal resolution (15 minutes) as the model output. The comparison focuses on the dependence of errors on the diurnal and annual cycle, weather conditions, and geographic location.