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Combination of Raman Lidar and Microwave Radiometer Sensed Water Vapour Data

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Remote sensing systems; Data fusion approaches based on multiplatform or multiple sensor techniques

The international LAUNCH (International Lindenberg campaign for assessment of humidity and cloud profiling systems and its impact on high-resolution modelling) campaign took place in late summer/early fall 2005. One goal of the campaign was the improvement of remote sensing techniques and algorithms for the advancement of meteorological observations. Apart from the main measurement site in Lindenberg, several outposts in and outside of Germany were part of the observational network.
At the Leibniz Institute for Tropospheric Research in Leipzig, our group assembled the multi-channel radiometer system ASMUWARA (All Sky MUlti WAvelength RAdiometer) (1). This instrument is equipped with nine microwave channels from 17 to 151 GHz, two infrared radiometers measuring in the atmospheric window and a sky camera.
During the campaign, co-located measurements were conducted together with the Temperature-Moisture-Aerosol Raman Lidar (2).
The lidar is able to precisely measure the water vapour mass mixing ratio profile, provided that no clouds are present. In addition, the lidar's height range is reduced during the day because of sunlight contamination in the Raman signal.
The microwave radiometer can measure water vapour density profiles and temperature profiles in almost all weather conditions and during the whole day without reduced data quality, but with the constraint that these water vapor profiles have a coarse height resolution.
We can now combine the two data sets in order to fully benefit from the advantages of the two instruments. We will show the performance of an already existing algorithm based on a Kalman filtering technique (3). This algorithm includes the Integrated Water Vapour (IWV) as the only contribution from the microwave radiometer. As a novelty, we will present a new algorithm based on an optimal estimation technique. This new algorithm includes all channels from the radiometer in order to get more accurate results. We will present results obtained with this data fusion technique and show comparisons with in-situ measurements from a nearby radiosonde station.

(1) Martin, L., Schneebeli, M. and Mätzler, C., 2006. ASMUWARA, a Ground-based Radiometer System for Tropospheric Monitoring. Meteorologische Zeitschrift, vol.: 15, no.: 1

(2) Mattis, I., Ansmann, A., Althausen, D., Jänisch, V., Wandinger, U., Müller, D., Arshinov, Y. F., Bobrovnikov, S. M. and Serikov, I. B., 2002. Relative Humidity Profiling in the Troposphere with a Raman Lidar. Appl. Optics, 41, 64516462.

(3) Han, Y., Westwater, E. R., Ferrare, R. A., 1997. Applications of Kalman Filtering to Derive Water Vapor Profiles from Raman Lidar and Microwave Radiometers. Journal of Atmospheric and Oceanic Technology, vol.: 14, no.: 3