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ORAL paper presentation preferred
("Profiling of wind, water vapor, temperature, and trace gases"
("Validation of measurements and models with in-situ and remote sensors")

Paper title:
Using microwave profiling to evaluate mesoscale model boundary layer forecasts

Abstract
Ground-based microwave remote sensing is a well established technique to observe temperature and humidity profiles as well as cloud liquid water path (LWP). Recently, advances in instrument sensitivity, stabilization and automatisation have made them a valuable tool for continuous monitoring of the atmosphere. Typically, the radiometer is operated in zenith direction which is preferable for synergetic use with cloud radar or lidar. In the zenith observation mode the profiles of humidity and temperature are retrieved from the spectral characteristics of the 22 GHz water vapor line and the 60 GHz oxygen band, respectively. The accuracy for the absolute humidity is below 1 gm^{-3} and 2 K for temperature with a vertical resolution of 1 km close to the surface which decreases strongly with altitude.Under the assumption of horizontal homogeneity a much better resolution in the boundary layer can be achieved by adding angular information in addition to the spectral one: The lower the elevation angle the more information comes from the lowest atmospheric layers. For the highly opaque channels of the oxygen line this information is only useful when the brightness temperatures can be observed at least with an accuracy of 0.1 K putting high constraints on radiometer accuracy. If this achieved the uncertainty in the temperature profile reduces to 0.5 K in the lowest kilometer with a vertical resolution of about 100 m. Above about 2 km the boundary layer scan can not achieve a better accuracy than the zenith pointing mode. In the past mesoscale models have shown problems in accurately forecasting inversion strength and height. These analyses are based on comparisons with conventional radiosoundings which are typically performed twice per day. The microwave observations will deliver continuous observations, however, the vertical structures will be smoothed stronger which might better represent the model grid box. The possibility of sensing temperature and humidity profiles already indicates that information about the atmospheric stability might be deduced. Therefore as a completely new application, retrieval algorithms to derive stability indices like the KO-index, showalter index and the convective available potential energy (CAPE) were developed on the base of a large radiosonde data set.

With the products described above a continuously operating microwave radiometer is well suited to describe boundary layer process like the temporal development of temperature inversions, the activity of convection judged by water vapour fluctuations and cumulus cloud formation (LWP time series) and the thunderstorm potential. Here we will present observations of the microwave radiometer HATPRO performed during the LAUNCH campaign in mid-latitude summer 2005 at Lindenberg, Germany. The quality of the observations will be assessed through intercomparison with the auxiliary measurements like radiosoundings, high spatial resolution radar etc. In addition, the boundary layer parameters will be used to evaluate model forecast by the Lokal-Modell Kürzestfrist (LMK) of the German Weather Service operating at a spatial resolution of 2.8 km.