INVESTIGATION OF SPATIAL WATER VAPOR AND LIQUID WATER INHOMOGENEITY WITH SCANNING MICROWAVE RADIOMETRY

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1. INTRODUCTION

In the framework of the Convective and Orographically-induced Precipitation Study (COPS; [1]) in 2007, the University of Cologne deployed a newly developed scanning microwave radiometer (MWR) within the Black Forests Murg valley, Germany. The instrument was installed in May 2007 on the site of the Atmospheric Research Measurement (ARM) Programs Mobile Facility (AMF) and remained there until the end of the year. The instrument is a 14-channel microwave radiometer, e.g. the Humidity and Temperature Profiler (HATPRO), with an option to scan both in the azimuth and elevation. Additionally an infrared (IR)-radiometer was attached to the MWR which can detect even thin or ice clouds and in cloud free cases water vapour anomalies in the scan direction of the MWR. This gives additional and independent information about cloud and water vapour distribution. The instrument combination allows us to expand the view from standard zenith observations to the spatial distribution of integrated water vapor and cloud liquid water in almost every weather condition. In order to study the additional information of these data we analyzed different weather situations, e.g. clear sky cases, developement of convection and stratiform cloud layers within the COPS experiment. The full data should also help to answer important questions for atmospheric model evaluation and/or data assimilation concerning the representativity of column observations for a model grid box or the possibility to gather statistical information for the development of stochastic parameterizations.

2. MEASUREMENTS

Different kinds of automated scan patterns were run in order to best characterize atmospheric variability. While elevation scans are best suited to derive high resolution temperature profiles [2], azimuth scans are well suited to investigate the spatial variability of the cloud field at a rather shorter time [3]. For this study we analysed the full azimuth scans with fixed 30 deg. elevation and 5 deg. azimuth angle resolution which were run every 15 minutes from July to August 2007. Even in cloud free scenes, significant variability of a few mm in integrated water vapor content (IWV) could be observed – sometimes showing organized structures. The measurements of the temporal-spatial water vapor distribution further help to analyze case studies within the COPS experiment. From the end of August 2007 until the end of the year the radiometer performed full hemispheric scans with about 10 deg resolution lasting about 6 min.

3. EVALUATION

The availability of very different instruments at the AMF-supersite, especially multi-wavelength and Doppler lidars, wind profiler, cloud radar, radiosondes (4 times a day) and a sky imager, makes it possible to evaluate the potential of the new full scanning MWR to detect spatial and temporal variations of the water vapour and cloud field. To further investigate finescale atmospheric structure in the Murg valley the Metair-DIMONA research aircraft flew distinct flight patterns over the supersite on two cloud free days. During two flights on July 26 and August 1 significant variability (up to a factor of 2 in water vapour mixing ratio on short distances) could be revealed [4]. At the same time, the new MWR-system performed vertical scans in the azimuth direction of the flight path. The in situ aircraft measurements serve as a baseline to validate boundary layer observations by the radiometer. The results from HATPRO's different scan modi show good structural agreement with the aircraft-derived humidity fields and reveal the difficulty in describing the water vapour field only from single column observations.

4. STATISTICAL ANALYSIS

The influence of the local orography on the initiation of convection is one of the major scientific questions of the COPS experiment. In order to investigate the spatial distribution and variability of water vapor and cloud water we statistically analyzed the spatial structure for different weather situations. The results show for example, that on average the liquid water field has a significant spatial dependence on the local orography with about 20 % higher values above the mountain ridges while the water vapor field is almost independent on the azimuth direction, e.g. deviations are less than 1 %. In the future a more detailed analysis which stratifies the observation for different weather conditions will be performed.

5. REFERENCES

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