Chapter 6

Conclusion and Outlook

The goal of this work was the development and validation of retrieval algorithms for atmospheric water vapour from satellite measurements and their application to a data assimilation system for a numerical weather prediction model. Algorithms were developed for two satellite instruments, the *Medium Resolution Imaging Spectrometer* MERIS on board Envisat and the *Moderate Resolution Imaging Spectroradiometer* MODIS on board TERRA. For both instruments, two slightly different algorithms were developed, one for the retrieval of total columnar integrated atmospheric water vapour above land for cloud free pixels, the other for integrated water vapour above cloud tops for cloudy pixels. Both algorithms are based on measurements of backscattered solar radiation, therefore allowing measurements during daytime satellite overpasses only.

The rapid processing of satellite data shortly after the overpass is a necessary prerequisite for its use within data assimilation. In order to meet this requirement, a near-real-time processing system was developed for the automated processing of satellite level1b data on a scalable distributed computer system. This system is currently used operationally at the *Institut für Weltraumwissenschaften* for the retrieval of water vapour and other cloud products from MODIS data. Products are derived and the results are displayed in the internet within ~20 minutes after the ftp transfer of level1b data from the receiving station and ~ 90 minutes after the beginning of the satellite overpass.

Results from the water vapour retrieval algorithms were validated using a) mea-

surements of the Microwave Water Radiometer at the ARM-SGP site in Oklahoma, USA, b) ground-based GPS stations in Germany and c) radio soundings in central Europe. All three were used for the validation of derived total columnar integrated water vapour above cloud free land pixels, the radio soundings were also used for the validation of MERIS measurements of integrated water vapour above cloud tops. The root mean square deviation between the satellite measurements and the validation data was generally in the order of 2 mm, with biases mostly smaller than 1 mm. The comparison with ground-based GPS measurements showed the highest agreement.

MODIS measurements of integrated water vapour over cloud free land pixels were used for an assimilation experiment with the 3-dimensional variational data assimilation system of the limited area numerical weather prediction model HIRLAM of the Swedish weather service SMHI. The experiment was carried out for the first two weeks of July 2002. Two model runs were performed, one reference run with all operational observation data included and an experimental run with additional MODIS data. It was shown that the MODIS data was accepted by the model during the assimilation and that humidity fields were modified in agreement with the observations. However, the additional information was generally washed out fast in the subsequent forecasts. The impact of the MODIS water vapour observations on the forecasts was investigated with respect to precipitation. The strongest modifications of total precipitation over the experiment period occured towards the eastern model boundary in the area most often covered by MODIS overpasses. Nevertheless, non-negligible modifications were also visible in the western model areas where no MODIS observation occured. The forecast quality was evaluated by comparison of predicted precipitation fields with radar-based precipitation estimates over the BALTEX area. The differences between the HIRLAM forecasts and the radar observations of total precipitation over the experiment period are generally much larger than the differences between the two HIRLAM runs. Consequently, no significant impact on the deviation between radar observations and HIRLAM forecasts was observed.