Improvement of model parameterizations. For that purpose:

- the prototype of a European Cloud Observation Network (ECON)
- consisting of ground-based stations and satellite observations was setup
- three measurement campaigns took place namely two CLIWA-NET Network campaigns covering North Central Europe and the BALTEX BRIDGE Campaign (BBC) covering the Netherlands
- CNN1: August-September 2000
- CNN2: April-May 2001
- BBC: August-September 2001
- short-term forecasts of four European NWP and climate models (ECMWF, RACMO, RCA and LM) were thoroughly evaluated with the observations
- a "low cost" microwave radiometer optimized for operational networks was designed

Observations: LWP

Within the ground-based network microwave radiometers were flown on three research planes since this technique is by far the most direct and accurate method to determine the cloud liquid water and its vertical structure. All stations were equipped with lidar ceilometers measuring the cloud base height and infrared radiances which can observe the cloud base temperatures.

Continuous time series for every day were gathered at every station.

Precise knowledge of rain events turned out to be crucial for the validation of observations. Due to frequent pauses, microwave radiometer measurements are meaningless as long as the water on the instrument has not completely evaporated. Rain detectors, preferably with dual instrument, were used to filter rainfall events. Based on these experiences a low-cost radiometer (see above) includes a rain sensor which controls a shutter system protecting the antenna in case of precipitation.

Observations: LWC

The synergy of different sensors, e.g. infrared cloud detector, infrared and microwave radiometer together with information of close-by reprofiling sondes can be exploited to closely the vertical distribution of clouds.

In case of single layer water clouds the integrated Profiling Technique (IPT) can be applied to simultaneously retrieve profiles of temperature, humidity and liquid water content (LWC) in a physically consistent way.

The IPT was applied over the full two month period of the BBC campaign corresponding to about 7.3 percent of the total time. The model predicted vertical structure of temperature, humidity and cloud liquid water has been evaluated on the basis of the IPT retrievals at Cabauw. The model predictions are continued to time slots for which profile information was successfully retrieved from the measurements. Model predicted profiles are furthermore restricted to cases without model precipitation reaching the surface. Significant differences are found between the various model predictions both in total LWC amounts as in the altitude where the LWC is largest. The ECMWF model tends to slightly overpredict LWC in the very rainy BBC period, whereas RCA and RACMO show differences in the order of magnitude as observed. The ECMWF model predicts the level with largest LWC much too high in contrast the LM predicts the level of the maximum below 1000 m and its profile exhibits much smaller amounts of LWC than is observed.

The RCA model shows the level of liquid water not evident in the observations nor in the other models.

Introduction

The EU-project CLIWA-NET (2000-2003) focused on observations of cloud liquid water and its vertical structure, and the evaluation and improvement of model parameterizations. For that purpose:

- the prototype of a European Cloud Observation Network (ECON)
- consisting of ground-based stations and satellite observations was setup
- three measurement campaigns took place namely two CLIWA-NET Network (CNN) campaigns covering North Central Europe and the BALTEX BRIDGE Campaign (BBC) covering the Netherlands
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Model Setup

Global modeling

- ECMWF: spatial resolution: eff. 55 km (6) vertical layers, \( \Delta t = 30 \text{min} \)

Regional models

- KNMI/RACMO: spatial resolution: 18 km (24) vertical layers, \( \Delta t = 2 \text{min} \)
- Rosby Center/RCA: spatial resolution: 18 km (24x4x6) vertical layers, \( \Delta t = 5 \text{min} \)

Non-hydrostatic model

- Local-Model (LM) of Deutscher Wetterdienst: spatial resolution: 7 km (30 vertical layers, \( \Delta t = 4 \text{h} \))

Evaluation: LWP

Time series of observed liquid water path (LWP) have been compared to model forecasts for every station. Daily mean values show a good agreement in integrated water vapor (IWV) variation which occurs as the water on the instrument has not completely evaporated. Rain detection, preferably with dual instruments, was used to filter rainfall events. Based on these experiences a low-cost radiometer (see above) includes a rain sensor which controls a shutter system protecting the antenna in case of precipitation.

Evaluation: LWC

The integrated Profiling Technique (IPT) can be applied to simultaneously retrieve profiles of temperature, humidity and liquid water content (LWC) in a physically consistent way.