DEKLIM: Regional Process Studies Wrap-Up

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The regional process studies in the Baltic Sea area of the German Climate Research Programme DEKLIM have come to a finalisation in 2005. The final symposium in Leipzig in May has been highlighted already in the last issue (# 7) of this newsletter; but we feel that a concluding presentation of these projects which have been at the core of BALTEX is worthwhile. The following 17 pages show summary articles of the projects: what was intended, what was achieved.

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APOLAS - More Accurate Areal Precipitation over Land and Sea

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Abstract
Long term field comparisons of four progressive precipitation sensors demonstrate their superior performance. Measurements yield differences in cloud micro physics between land and sea and between surface and higher altitudes. A pattern recognition algorithm based on CAPPI-fields of Rostock weather radar was developed to separate convective from stratiform rain areas.

Introduction
All efforts in modelling precipitation necessitate reliable data bases, highly resolved in space and time. Unfortunately, standard instruments as used at synoptic stations show a number of systematic errors especially at high wind exposure as it is typical for a marine environment. Weather radar networks like NORDRAD (Michelson and Koistinen, 2000) or other remote sensing techniques may provide such precipitation fields, but a sufficient accuracy can be achieved only by making use of auxiliary in-situ measurements of both, precipitation rate and precipitation micro physics. The main goal of APOLAS was therefore to investigate the performance of novel sensors and to demonstrate the usefulness of these sensor data for an improved radar based precipitation measuring concept.

Results
Ship rain gauges (SRG, Hasse et al., 1998), optical disdrometers (OD, Großklaus et al., 1998), a prototype of a mini sodar (MS, Pang and Graßl, 2005), and micro rain radars (MRR, Peters et al., 2002) were tested against classical Joss Waldvogel (JW) disdrometers. While SRG gives rates only, all other instruments provide also drop number densities (DSD) as a function of drop diameter. The OD is an in-situ instrument like the JW, sampling volumes are of comparable size. The MS and MRR are vertical sounding remote sensors, with sounding ranges up to a few decametres (MS) to some kilometres (MRR) and much larger sampling volumes than in-situ sensors. Measurements were performed at several sites at the German coast of the Baltic Sea and onboard of RV ALKOR.

Measurements were classified according to the kind of precipitation, stratiform or convective, rain rate, and wind speed including moderate and extreme conditions. To separate precipitation events in convective and stratiform ones, a new procedure based on weather radar measurements has been developed.

During moderate conditions, all sensors show satisfying performance with some differences in drop size densities of smallest and largest measured drops. Under extreme weather conditions the sensors' performance differ considerably. The JW shows a systematic underestimation of the number of small drops under both, high winds and heavy rain (Figure 1). In contrast, the MRR and the OD show nearly no influence of wind speed on the shape of measured spectra. Measured rain rates of the MS prototype correlate well with those measured by other sensors, correlation coefficients reach from 0.82 (JW) to 0.96 (OD). However, for heavy showers with strong winds, the MS gives higher rain rates than all other devices. Radar reflectivities of the MRR and Rostock radar show unexpectedly high correlations.

A statistical analysis of OD data classified in rain rates show that almost all mean DSDs measured over land contain smaller drops than DSDs derived over sea. Since artefacts due to measurement techniques can be excluded, the differences are real and reflect different meteorological conditions over land and sea, e.g. stability. Profile measurements of MRRs support these results; for all rainfall classes the velocity jump at the height of the melting layer is significantly higher over Christiansø (close to conditions over sea) than over Zingst (conditions over land), indicating larger drops over Christiansø.

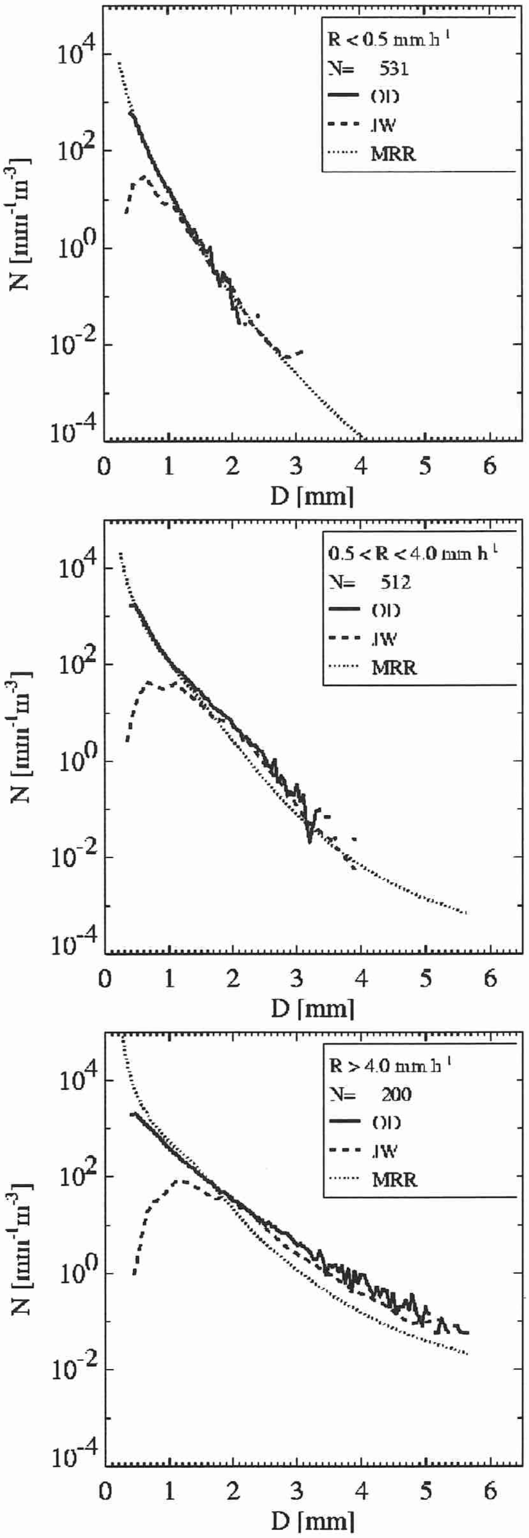

Figure 1. *Average drop size densities as a function of drop diameter for light, moderate, and heavy rain (from top to bottom), as measured by the OD, JW, and MRR in Westermarkelsdorf at wind speeds exceeding 5ms^{-1}*

For estimating areal precipitation, an advanced CAPPI (Constant Altitude Plan Position Indicator) has been developed (Figure 2). Unlike conventional CAPPIs, all radar range bins intersecting a grid pixel are used with appropriate weighting. Corrupted pixels are effectively reduced by filtering. The pattern recognition algorithm, mentioned

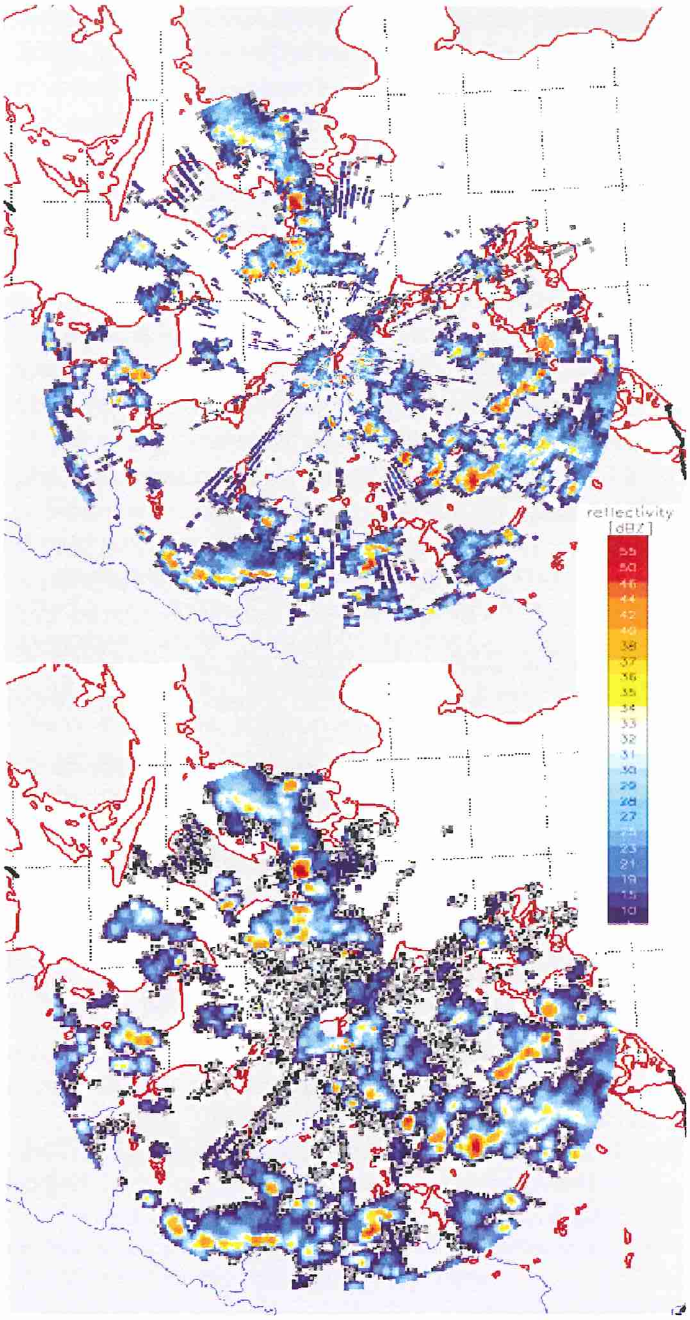

Figure 2: *Lowest PPI of a precipitation event from September 2003 (upper) and lowest CAPPI of the same event (lower), derived from Rostock weather radar reflectivities*

above, is based on these CAPPIs. Two characteristics of convective cells (the higher vertical extent and higher maximum reflectivity) are used to detect the cell core. Several control mechanisms including temperature data from radiosondes are part of the algorithm.

Seasonal precipitation fields, estimated from SRG measurements over the Baltic Sea on merchant ships and RV ALKOR (Clemens and Bumke, 2002) were compared to synoptic rain gauge data, corrected for systematic errors (Rubel and Hantel, 1999) and the regional climate model output as part of BALTIMOS (Jacob et al., 2005). While SRG measurements compare well with synoptic rain gauge data at coastal sites and on islands, REMO overestimates precipitation especially in autumn along all coasts with mainly onshore wind conditions (Ober-Bloibaum, 2005).

Conclusions

Although precipitation is one of the most important of all weather elements, it is predicted with lowest quality. The combination of novel in-situ instruments, vertically sounding instruments, and a weather radar gives promising prospects to improve precipitation fields from weather radar reflectivities. Such improved areal precipitation fields are a prerequisite to improve precipitation forecast, important also for water management or agriculture and at least important for climate modelling.

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BALTIMOS - Development and Validation of a Coupled Model - System in the Baltic Region

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In the frame of BALTEX, a fully coupled model system for the Baltic Sea region, called BALTIMOS (http://www.baltimos.de), was developed by linking existing model components for the atmosphere (REMO, Jacob 2001), the ocean including sea ice (BSIOM, Lehmann and Hinrichsen, 2000, 2002) and for hydrology (LARSIM, Bremicker, 2000), as well as for lakes and vegetation (Figure 1). This investigation was funded by DEKLIM (German Climate Research Programme 2001-2006; http://www.deklim.de) as a combined effort of 10 different German institutions, coordinated by the Max Planck Institute for Meteorology in Hamburg.

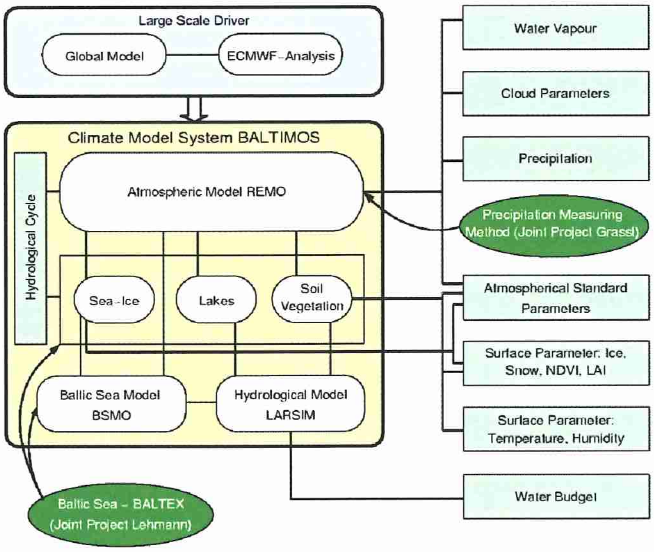

Figure 1. *BALTIMOS including the validation parameters*

The focus of the development was on model validation rather than on long-term climate simulations (which will be performed later). Thus, the simulated water and energy budget of the Baltic Sea area undergoes a comprehensive validation, including means as well as extremes like the salt water inflow 2003 (Lehmann et al., 2004).

With BALTIMOS, the energy and water budgets in the period from 1999 to 2003 have successfully been recalculated and a detailed inter comparison against available observations of the water cycle components on different time and space scales has been carried out (for more details see www.baltimos.de). The results of the coupled model BALTIMOS demonstrate the powerful applicability of coupled numerical simulations. The strategy behind BALTIMOS is to develop a model system which can be utilized for present day simulations of the Baltic area with the focus to understand present day climate variability, and which can also be used to study possible changes in the water and energy budgets under climate change scenarios.

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