Final Report for Project **1100**

Project title: **Climate model PArameterizations informed by RAdar**

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The project “Climate model PArameterizations informed by RAdar” (PARA) was a collaboration between Leipzig University (PI Johannes Quaas, ICON climate modelling) and the University of Bonn (PIs Silke Trömel and Clemens Simmer, polarimetric radar observations) that aimed at improving the representation of clouds and precipitation in the ICON general circulation model with the help of innovative radar observations.

It was a project in the context of the DFG Priority Programme SPP 2115 “Fusion of Radar Polarimetry and Numerical Atmospheric Modelling Towards an Improved Understanding of Cloud and Precipitation Processes” (PROM).

An adequate representation of moist diabatic processes in clouds and precipitation in climate models is challenging, because these spatially unresolved processes are subject to sub-grid parameterizations, which must be informed by observations and/or models resolving these processes. Radar polarimetry provides most suitable observations on cloud and precipitation microphysics via microphysical retrievals and process fingerprints. PARA focused on ice water content heterogeneity and precipitation generation via the ice phase.

PARA investigated four processes both by polarimetric radar retrievals and the evaluation and revision of their representation in the ICON general circulation model: (i) ice generation and spatial heteorogeneity of ice water content at ICON-GCM sub-grid scales, (ii) the role of both in snow formation like aggregation, (iii) melting of snow falling through the 0°C isotherm, and (iv) evaporation of rain below the melting layer.

To achieve these goals, simulations with the ICON-GCM were conducted for multiple sensitivity studies. The simulations were instrumental in making progress in revising the cloud microphysical parameterisations. An example is shown in Fig. 1: Using the subgrid scale variability, typically the ice conversion to snow is enhanced, and subsequently cloud ice is reduced. The GCM work on PARA progressed further in particular in terms of the evaluation using observational data. A large effort was necessary to make the satellite-retrieved and the simulated ice number and mass consistent.

Further work was on a detailed comparison between the ICON-GCM and radar observations. Some results of the comparison are presented in Fig. 2, these are now being used in the PhD thesis by Sabine Doktorowski.

References

Doktorowski, S., J. Quaas, J. Kretzschmar, O. Sourdeval, and M. Salzmann, Subgrid-scale variability of cloud ice in the ICON-GCM, Geosci. Model Devel. Discuss., submitted.

Sourdeval, O., E. Gryspeerdt, M. Krämer, T. Goren, J. Delanoë, A. Afchine, F. Hemmer, and J. Quaas, Ice crystal number concentration estimates from lidar-radar satellite remote sensing. Part 1: Method and evaluation, Atmos. Chem. Phys., 18, 14327-14350, doi:10.5194/acp-18-14327-2018, 2018.

Figures

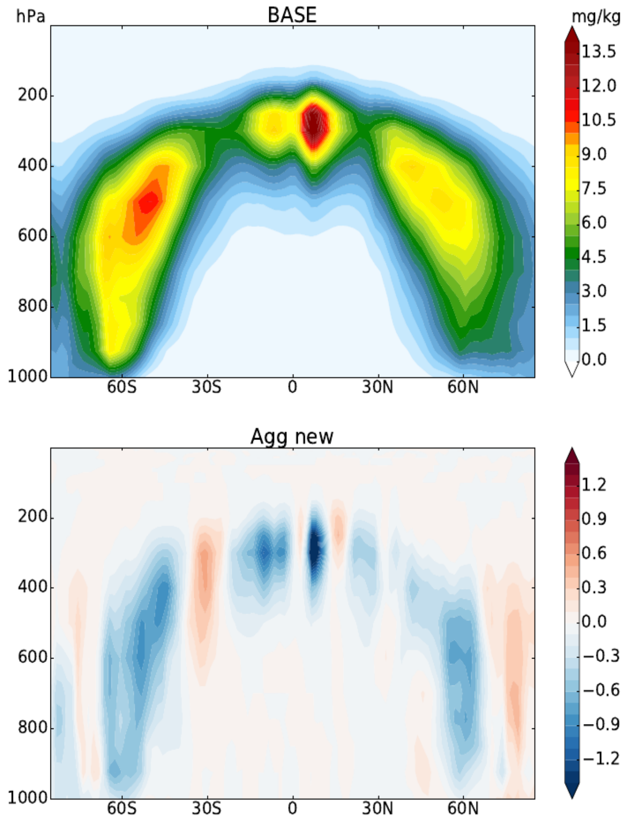

Fig. 1. Specific cloud ice with a new subgrid-scale variability scheme that now is tied to the variability as constrained by satellite observations. Using the subgrid scale variability, typically the ice conversion to snow is enhanced, and subsequently cloud ice is reduced.

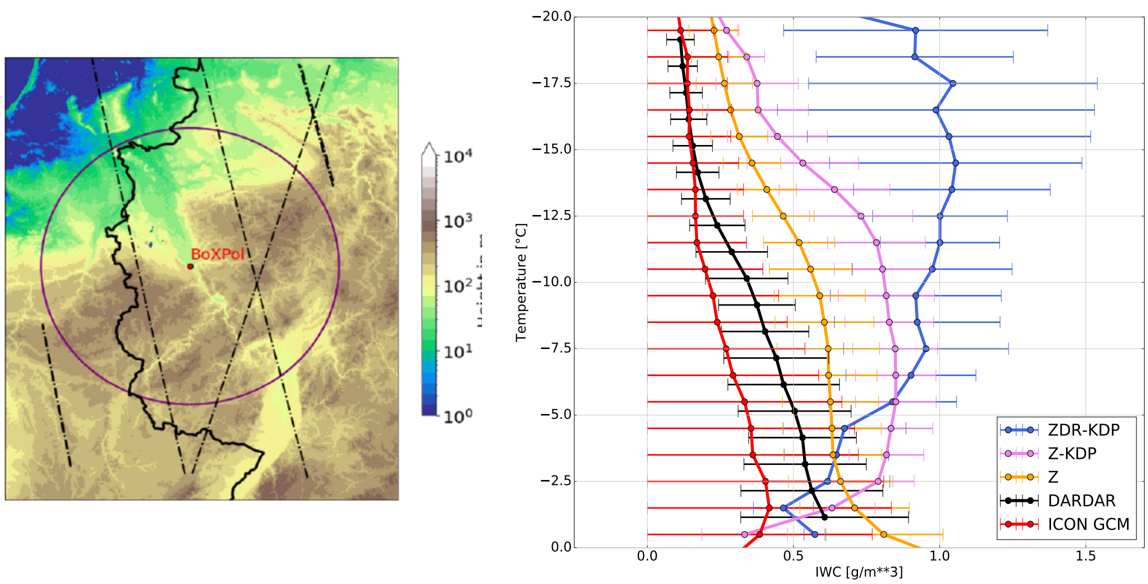

Fig. 2. Detailed comparison between the radar at the University of Bonn (BoXPol, red dot in the left panel, with its scan range indicated as purple circle; in the right panel different methods to retrieve the ice water content, IWC, are shown as blue, pink, and yellow lines) satellite retrievals from the DARDAR product (Sourdeval et al., 2018; tracks shown in panel a as dash-dotted lines and in panel b as black curve) and results from detailed analysis of the ICON GCM (red curve).