Project: **1100**

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

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Ice cloud heterogeneity within model grid boxes was so far not considered in the cloud microphysical scheme. Grid-box mean specific cloud ice mass, q_i, is a prognostic (advected) quantity (Lohmann and Roeckner, 1996). Its sub-scale distribution is only implicitly diagnosed in the parameterization of fractional cloud cover (Sundqvist et al., 1989). We started with an evaluation of the diagnosed q_i variability, following the approach for variability in liquid-water clouds by Brueck (2016). The width of the uniform total-water specific humidity, q_t, PDF around the grid-box mean q_t was diagnosed from a fixed profile of the critical relative humidity, r_{crit} parameter. This approach used relative humidity over liquid down to temperatures of -35°C and over ice beyond, and a profile of r_{crit} that is 0.9 in the boundary layer and decreases to 0.7 in the free troposphere (e.g., Quaas, 2012). We evaluated the variability of specific cloud ice mass, q_i, obtained as the part of the PDF that exceeds saturation q_s. The simulated qi (g kg^{-1}) variability was transformed to ice water content (IWC, g m^{-3}) using the model-simulated grid-box mean temperature and pressure. The obtained distribution and variance, but also mean values, was first compared to satellite observations for a first, global, and superficial analysis based on the CloudSat/CALIPSO raDAR/liDAR retrieval (DARDAR, Delanoë and Hogan, 2008; 2010) followed by a detailed comparison and evaluation with the radar observations.

In the subsequent step, the subgrid-scale variance of q_i was taken into account in the aggregation parameterisation (Lohmann and Roeckner, 1996) following the approach by Mewes () that he used for liquid-clouds (autoconversion process). The results are shown in Fig. 1: The initial revision reduces cloud ice – as expected – due to the stronger sink term. This then allowed to relax the strong artificial tuning constant (Fig. 1, lower panel).

References

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Figures

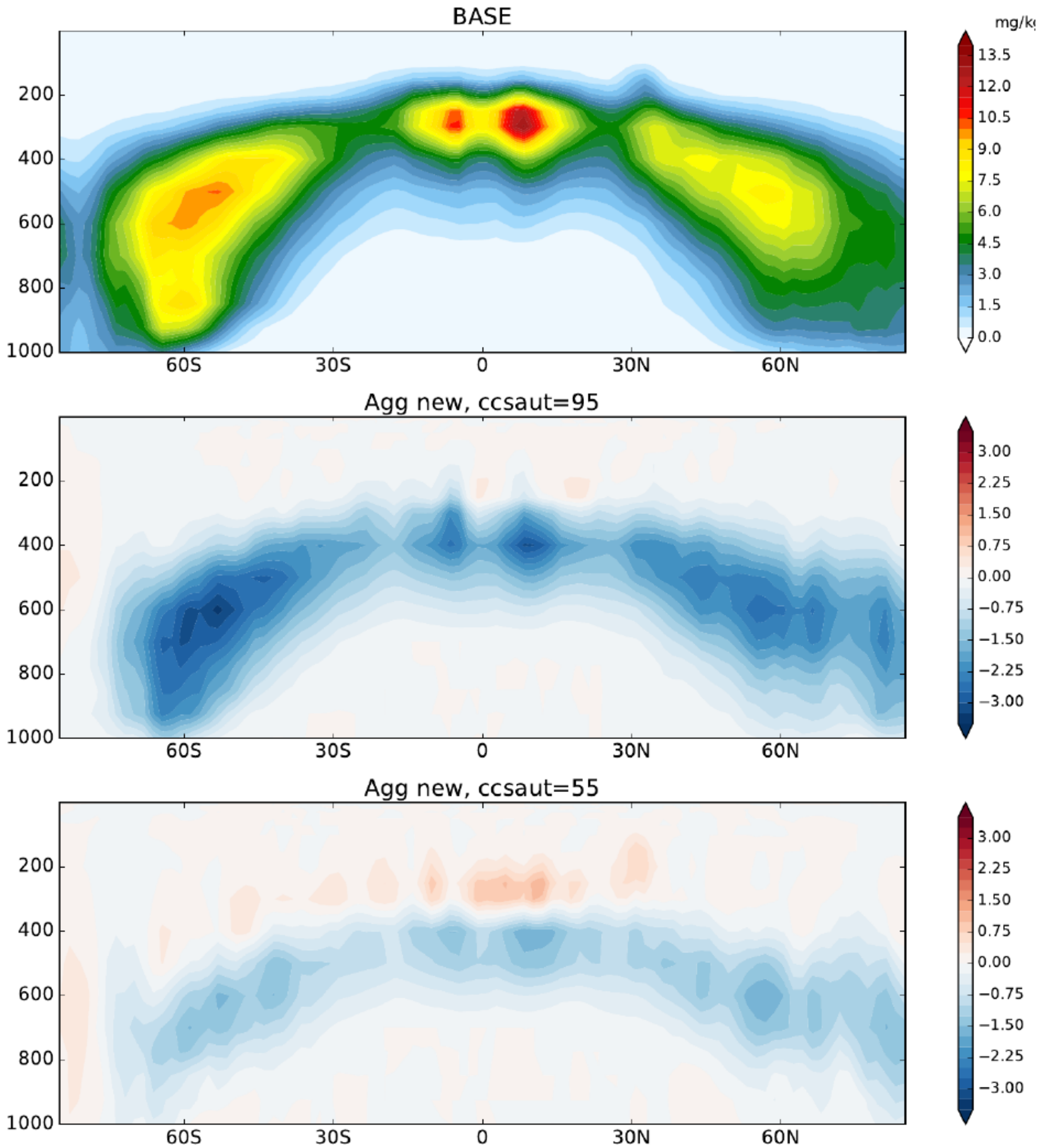

Fig. 1: Results of the implementation of cloud ice subgrid-scale variability for the aggregation process. The top panel shows the cloud ice mixing ratio, q_i, (mg kg^{-1}) as a latitude-height diagraom for the zonal annual average. The second panel shows the difference in q_i between the unmodified ICON and the revised parameterisation. The bottom panel shows the same, but the tuning parameter is reduced by about a factor of two.