Investigating the response to doubling the CCN concentration in ICON LEM model simulations

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In the framework of the High Definition of Clouds and Precipitation for Climate Prediction (HD(CP)²) Project, simulations with the ICOsaedral Non-hydrostatic atmosphere Large Eddy Model (ICON-LEM) have been performed over Germany [1]. Here, we investigate the adjustments of clouds and precipitation to a doubling the cloud condensation nuclei (CCN) concentration by the use of one day of simulations (02/05/2013) with the current concentrations in 2013, as a control, and the homogeneously doubled CCN concentration (representative for 1985), as perturbed simulation.

Thanks to the fact that the high resolution cloud resolving model has an advanced two-moment mixed-phase bulk micro-physical parametrization scheme (Seifert and Beheng), the effects can be studied by the analysis of the number concentration and specific content profiles of five hydrometeors, as well as for the integrated spatial distributed variables (e.g. liquid water path (LWP)) and macroscopic characteristics (e.g. cloud fraction, and rain rate), among others.

Although we find more and smaller cloud droplets in the perturbed simulation (as expected [2]), we only detect slightly increased LWP (~5%) and negligible changes in the solar radiation at the top of the atmosphere (TOA). With smaller cloud particles the collision-coalescence should be reduced [3] and we find reduced rain water and suppressed rain specifically at onset and towards the end of the major convection event. This event is accompanied by an increase in ice particle concentration and ice water path (~12%). Regarding also to the effects to cloud phase, we find a decreased ice fraction at the expense of liquid fraction in mixed-phase clouds, probably due to the smaller cloud droplets delaying the onset of freezing [4]. Finally, regarding the vertical extent effects, we see slightly thicker clouds, and slightly higher cloud tops and bases.

References

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