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Evaluation of the representation of warm convective cloud fields in a large eddy simulation with Meteosat observations

Sebastian Bley (1), Hartwig Deneke (1), Fabian Senf (1), and Leonhard Scheck (2)

(1) Leibniz Institute for Tropospheric Research, Leipzig, Germany (bley@tropos.de), (2) Ludwig Maximilian University of Munich, Munich, Germany, (leonhard.scheck@lmu.de)

Warm convective clouds possess a high spatio-temporal variability, which complicates their realistic representation in atmospheric models, and also causes significant uncertainties in passive satellite retrievals. Thus comparisons between simulated and observed convective clouds are essential to better understand these uncertainties, and to quantify the impact of the spatial resolution of simulations and satellite sensors.

Various metrics are studied to evaluate simulated convective cloud fields from the ICON-LES model with varying spatial resolutions between 156 m and 625 m over Germany, which was developed within the HD(CP)^2 project. The time series and frequency distributions of convective cloud fraction and liquid water path are analyzed. Furthermore, the study focuses on the sensitivity of the investigated metrics to the spatial resolution.

At 156 m spatial resolution, the model shows a higher frequency of large liquid water path values, and an underestimate in convective cloud fractions by a factor of two to four. These differences are essentially removed if the simulated cloud fields are coarse-grained to the optical resolution of Meteosat. The distribution of simulated cloud sizes compares well with the observations. A lower limit of simulated cloud sizes, however, is found, which is 8-10 times the native grid resolution of the model. This has implications to the scaling behavior of the convective cloud properties below that resolution, which most likely marks the effective resolution of the model. The observed spatiotemporal decorrelation scales are finally compared to those for the simulated cloud fields at both the native grid resolution and coarse-grained to the resolution of Meteosat. At the scale of the observations, a good agreement is found. These decorrelation scales of the simulated cloud fields are, however, substantially decreasing at a higher spatial resolution. These results have implications for the planning of future modeling studies. Furthermore, it will be discussed, how this analyzed can help to quantify the satellite sensor limitations.