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Verification and uncertainty analysis of clouds and precipitation in high resolution models using 3D radar data

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Our project HD(CP)2 (High Definition Clouds and Precipitation for Climate Prediction) provides an unprecedented data set of high resolution model simulations, O(100m), along with a wealth of observations. In order to use this data set to improve the representation of clouds and precipitation in climate forecasts we must be able to quantify to what extent the high resolution simulations represent clouds and precipitation. Therefore, our work aims to develop verification methodologies for evaluating clouds and precipitation in high resolution model data representing small scale phenomena using three dimensional radar data. In addition, special interests are given to the uncertainties in the applied verification methodology itself as well as to the uncertainties in the precipitation forecasts compared to observations (radar).
An object-based method 3D-SALH has been developed to be able to reveal the differences of the complex 3D characteristics between the forecasted and observed precipitation fields. The validation score consists of four distinct components that consider aspects of the structure (S), amplitude (A), location (L), and height (H) of the precipitation objects. Moreover, a fuzzy concept is applied to estimate the uncertainties of precipitation forecasts in terms of timing, i.e. to detect a potential time shift between the simulated and observed precipitation fields. If a time shift is revealed, it can be considered in the validation approach. Thus the timing errors can be separated from the errors in the simulated 3D characteristics. Furthermore, the uncertainties in the application of verification methodology with respects to the definitions of precipitation objects are also analysed. Different thresholds are used to define a precipitation object and the sensitivity of 3D-SALH to the definition is discussed.
The methods are applied to several cases representing different meteorological conditions with a special focus on high impact precipitation events. Comparisons are performed between 3D radar data (reflectivity) from the German radar network and COSMO-DE (2.8km horizontal resolution) simulations as well as HD(CP)2 simulations (625m and 1250m).