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The three-dimensional microphysical and dynamical structure of convective storms

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Forecasting centres routinely run simulations at convection-permitting resolutions, but there is an urgent need for novel radar-observation techniques to evaluate the storm structures produced by these models. A data set of high-resolution radar observations for forty days with convective storms is used to evaluate such storms in the UK Met Office forecast model for the DYMECS project (Dynamical and Microphysical Evolution of Convective Storms). The 3 GHz Chilbolton radar was set up to automatically track convective storms in real-time through a scan-scheduling algorithm linked to a database of storms identified in the Met Office rainfall radar network. Many configurations of the Met Office model have been tested against the Chilbolton observations for their representation of convective storms.

In terms of the detailed three-dimensional microphysical structure, modelled storms are shown to generally have wider horizontal structures for different reflectivity thresholds compared to radar observations, whilst the storm cores are not as deep as observed. For instance, the model does not produce reflectivities above 40 dBZ above the melting layer, which are frequently observed in intense convective storms, but this is improved by the inclusion of prognostic graupel in the microphysics scheme. The dynamical storm structures are analysed in terms of vertical velocity and the size of convective cores, derived from vertical profiling radar scans. Two existing retrieval methods for vertical velocities are presented and compared statistically. Both methods are then combined with radar reflectivity observations to define convective cores and to evaluate the size and intensity of such cores in the model. The results presented here will help improve the microphysics and sub-grid mixing schemes, as well as determine whether even higher resolution (down to 100m) models provide a notably better representation of the three-dimensional evolution of convective storms.