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The DYMECS Project: A Statistical Approach for the Evaluation of Convective Storms in High-Resolution NWP Models

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National weather services increasingly use convection-permitting simulations to assist in their operational forecasts. The skill in forecasting rainfall from convection is much improved in such simulations compared to global models that rely on parameterisation schemes, but it is less obvious if and how increased model resolution or more advanced mixing and microphysics schemes improve the physical representation of convective storms. Here, we present a novel statistical approach using high-resolution radar data to evaluate the morphology, dynamics, and evolution of convective storms over southern England. In the DYMECS project (Dynamical and Microphysical Evolution of Convective Storms) we have used an innovative track-and-scan approach to target individual storms with the Chilbolton radar, which measures cloud and precipitation at scales less than 300m out to 100km. These radar observations provide three-dimensional storm volumes and estimates of updraft core strength and sizes at adequate scales to test high-resolution models. For two days of interest, we have run the Met Office forecast model at its operational configuration (1.5km grid length) and at grid lengths of 500m, 200m, and 100m. Radar reflectivity and Doppler winds were simulated from the model cloud and wind output for a like-with-like comparison against the radar observations. Our results show that although the 1.5km simulation produces similar domain-averaged rainfall as the other simulations, the majority of rainfall is produced from storms that are a factor 1.5-2 larger than observed as well as longer lived, while the updrafts of these storms are an order of magnitude greater than estimated from observations. We generally find improvements as model resolution increases, although our results depend strongly on the mixing-length parameter in the model turbulence scheme. Our findings highlight the promising role of high-resolution radar data and observational strategies targeting individual storms and we propose that model development should focus on the parameterisation of turbulent mixing in convective environments.