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Perturbation growth at the convective scale

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The development of ensemble forecasting techniques specific to the convective scale is now an active area of research. The aims of this study are to identify the physical processes that lead to perturbation growth at the convective scale in response to model state perturbations and determine the sensitivity to the characterisation of the perturbations. The Met Office Unified Model is run for case which is strongly upper-level forced but for which the detailed mesoscale/convective-scale evolution is dependent on smaller-scale processes. This case was observed during Intensive Observing Period 18 (IOP18) of the Convective Storms Initiation Project (CSIP). Potential temperature is perturbed at a specific model level within the boundary layer. The effects on perturbation growth of both the amplitude and typical scale-length of the perturbations are investigated and perturbations are applied either sequentially (every 30 min. throughout the model simulation) or at specific times.

The direct effects (within one timestep) of the perturbations are to generate propagating Lamb and acoustic waves and produce generally small changes in cloud parameters and convective instability. In exceptional cases a perturbation at a specific gridpoint leads to switching of the diagnosed boundary-layer type or discontinuous changes in convective instability, through the generation or removal of a convective lid. The indirect effects (during the entire evolution) of the simulations are changes in the intensity and location of precipitation and the cloud-size distribution. Qualitatively different behaviour is found for strong (1K amplitude) and weak (0.01K amplitude) perturbations with sensitivity to the time of day found only for the weaker perturbations. However, the overall perturbation growth (as measured by the root mean square error of the accumulated precipitation) reaches similar values at saturation, regardless of the perturbation characterisation.