Geophysical Research Abstracts
Vol. 15, EGU2013-5372, 2013
EGU General Assembly 2013

The representation of convection in high resolution (km-scale) NWP models.

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As the resolution of NWP models increases, the representation of physical processes in the model may change. The aim of this work is to improve the representation of convection in the Met Office Unified Model (UM) in high resolution (km gridlengths and below) models and at these resolutions explicit representation of convection may replace parametrisation. However, the exact resolution at which this transition takes place is not clear cut leading to the problem of the so called "grey-zone".
The Met Office highest resolution operational model uses a gridlength of 1.5km and subgrid mixing is represented by a boundary layer scheme and a Smagorinsky-type turbulence scheme, not a convection scheme. At this resolution, convection is still under-resolved and convective cells are often seen to be too large, too far apart and overall there is too much heavy rain and a lack of light rain.

Improvements have been seen in the precipitation fields by increasing the vertical resolution and results can also be sensitive to the details of the subgrid mixing scheme. This work aims to determine the optimum configuration of the UM at various high resolutions, in particular with a gridlength of 1.5km.

Computer power puts constraints on the resolution, both horizontal and vertical, used in operational models but a study of convection in models with horizontal gridlengths as small as 100m may inform decisions on the improvement of convection in km-scale models as well as providing an understanding of the trends of model behaviour with gridlength and an assessment of the capability of future high resolution forecast systems.

Investigations into how well convection is represented in models with gridlengths of a kilometre and below are being carried out using a suite of nested UM models centred over the Chilbolton Advanced Meteorological Radar in southern England. The models have gridlenths of 4km, 2.2km, 1.5km, 500m, 200m and 100m with each model downscaling the next larger one. A statistical assessment has been carried out, using data gathered on 40 days during the DYMECS (Dynamical and Microphysical Evolution of Convective Storms) project, a collaborative project between The University of Reading and the Met Office. Comparisons are also made with NIMROD radar data. Diagnostics including trends in size, number and strength of convective cells, mass fluxes and spectra of vertical velocity as the resolution increases are studied to understands trends in the behaviour of the models at different resolutions. Evidence of convergence of results with increasing horizontal resolution and the optimum configuration will also be discussed.