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Very High Resolution NWP Research at the Met Office

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Since 2009 the Met Office has been running a 1.5km gridlength version of the Unified Model (UM) over the UK (the UKV) to provide local NWP forecasts. This model has provided a step change in the representation of convection when compared to earlier and coarser models including a convection parameterisation. However it is clear that problems still remain ? much convection in the UK is still under-resolved in a 1.5km model, hence the often used term “convection permitting” to describe these models.

In this paper we describe research on much higher resolution versions of the UM. The first reason for this work is that an understanding of the behaviour of models as a function of gridlength is important in order to understand the processes in the model. This will aid improving the configuration of the models at lower resolutions also. Secondly we are looking ahead to the benefits from future increases in resolution.

The UM has been run experimentally with order 100m gridlength in several contexts. The first was cold pooling in valleys (which were too small to resolve in the 1.5km model) as part of the LANFEX field experiment. A 100m model was shown to provide good forecasts of cold pooling in the valleys and downslope flows.

A second context in which a 100m version of the UM has been applied has been to has been modelling London. Comparisons with lidar observations made as part of the Actual field project have been made to understand the representation of the convective boundary layer. It is found that most of the vertical heat flux is carried explicitly in a 100m model. We will also discuss results from this model regarding downslope flows into London at night and the representation of sea breezes (both of which are improved by the 100m model). We will also mention an experimental 300m model being run routinely for London.

The largest area of research with 100m scale models has been deep convection. We have used observations from the DYMECS project to investigate the detailed representation of convection in models with gridlenghs from 1.5km down to 100m. It is clear that in the 1.5km model much convection in the UK is under-resolved which manifests itself as the convective cells being too large and too few in number. HIgher resolution helps many aspects (for example improves the representation of small cells) but not others. For example the model has a tendency to collapse larger convective cells down to be too small when measured by the rain or cloud. The same thing is less clear when measured by the size of the convective updrafts. It is also noticeable that the problem, in the 1.5km model, of there being too much heavy rain and not enough light rain is not helped by going to higher resolution. These issues may be related to the microphysics but may also be dynamical, for example the downdrafts might be too strong. A crucial aspect at these resolutions is the handling of the grey zone of turbulence which impacts on convective entrainment etc.

Finally we will describe some order 100m modelling on some major US tornado outbreaks. The Met Office has been running 4.4km and 2.2km models over the US Great Plains as part of the NSSL/SPC Hazardous Weather Testbed experiment. The 2.2km model was nested down to 500m, 200m and 100m. The 200m and 100m models produce tornado like vortices as part of realistic supercell structures. The vortices are weak compared to real tornados but their location and movement are realistic.

A number of key themes arise from order 100m models in all of these contexts. As already mentioned one is partially resolved turbulence which can be important for the behaviour. A related issue is that spin up of turbulence at the inflow boundary can be very important. Currently this is circumvented by using large domains but suitable addition of noise in the boundaries may mitigate this in the future.

Keywords: Numerial Weather prediction, High Resolution, Convection permitting, Turbulence pemitting