Improving turbulence representation in high-resolution numerical weather prediction

Supervisors

Main supervisor: Doctor Robert Beare (University of Exeter)
Co-supervisor: Doctor Adrian Lock (Met Office)
Co-supervisor: Professor John Thuburn (University of Exeter)

Project enquiries - Email: r.j.beare@exeter.ac.uk **Contact number:** +44 (0) 01392 724045

Host Institution: University of Exeter

Project description

High-resolution numerical weather prediction (HR-NWP) provides forecasts for life-threatening events such as: thunderstorms, frosts, fog and severe wind storms. The atmospheric boundary layer is the region adjacent to the surface in which there are significant turbulent fluxes of heat, moisture and momentum. These fluxes connect with the evolution of cumulus and other cloud types. The boundary layer thus plays a key role in the HR-NWP system.

Until recently, HR-NWP models used a horizontal grid length much larger than the size of the boundary-layer eddies. The scale separation meant that column-based sub-grid models (models that represent the fluxes at scales below the grid scale) were justified. However, operational weather centres now run limited area models at horizontal grid lengths as small as a few kilometres, and sometimes even smaller. The ratio of the horizontal grid length to the boundary-layer eddy size is now of order one; such a regime is called the grey zone (see attached figure illustrating the grey zone). The boundary-layer grey zone is now a pressing practical issue for HR-NWP (Beare 2014).

The student will implement and compare novel sub-grid models in the grey zone. The Met Office Large-eddy model will be used as the initial test-bed, followed by implementation in the Met Office Unified Model (MetUM). A key aim is to improve the Smagorinsky model currently implemented in the MetUM. A focus will be the transition from the early morning boundary layer to the subsequent triggering of cumulus clouds. They will also build on the work of the NERC GREYBLS project ("modelling GREY zone Boundary LayerS", PIs Bob Beare and Bob Plant) at the Universities of Exeter and Reading. It is an exciting opportunity for the student to make an impact on state-of-the art weather prediction. It will also provide an excellent environment for training the student in current HR-NWP techniques.

Beare R J (2014) A Length Scale Defining Partially-Resolved Boundary-Layer Turbulence Simulations, *Boundary-Layer Meteorology*, volume 151, p. 39-55.

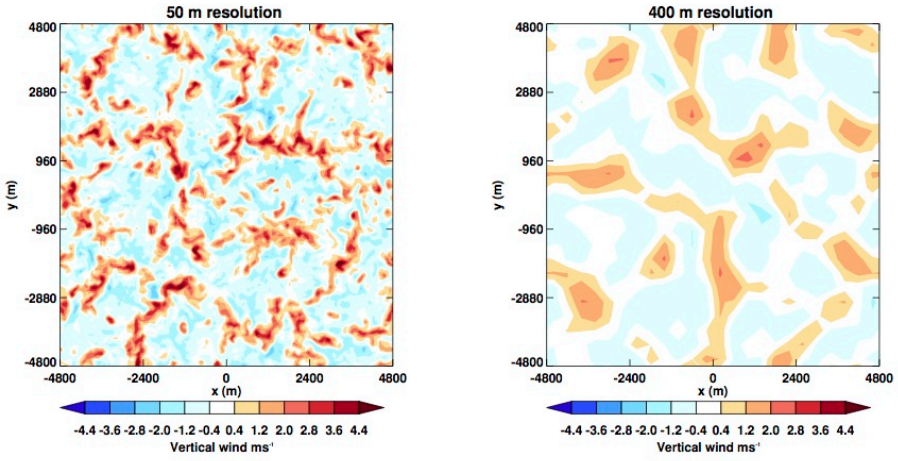

Figure 1: Horizontal cross-sections of vertical velocity from convective boundary layer simulations at a height 500 m for horizontal grid lengths of 50 m (left) and 400 m (right). For this boundary layer (depth 1 km), the 400 m grid length is in the grey zone. Taken from Beare (2014).