Surface Fluxes, temperatures and boundary layer evolution at the building greyzone in London

Supervisors: Professor Sue Grimmond, Department of Meteorology, University of Reading; Dr Sylvia Bohnenstengel (Met Office@Reading), Dr Humphrey Lean (Met Office@ Reading), Dr Martin Best (Met Office, Exeter)

Funding: NERC Case Studentship (with the Met Office)

The next generation of weather and climate models will have higher spatial resolution. Versions now under development are at 500, 330, 100 and 50 m resolution compared to the current 1.5 km used routinely by the Met Office (the so-called UKV version of the Unified Model (UM)).This greater resolution will enable conditions across cities to be resolved with important implications for forecasts and decision-making, particularly under hazardous situations. The proposed research will assess these new modelling capabilities, specifically using a network of observations in London to identify deficiencies/strengths and to work to improve their performance.

In the context of cities, enhanced spatial resolution of the UKV means that the 3-dimensional nature of the urban environment has to be addressed in more detail. To do this the urban land surface model used within the UKV is being updated to include MORUSES (Met Office Reading Urban Surface Exchange Scheme, Porson et al. 2010, QJRMS) (via JULES - Joint UK Land Environment Simulator). MORUSES calculates the surface energy balance as a function of the spatially varying street canyon geometry. MORUSES uses grid scale building geometry to calculate effective roughness lengths for heat via a resistance network taking into account 3 different flow regimes in street canyons. This allows the variability of sensible heat over urban areas (well documented observationally) to be captured. MORUSES simulates fluxes of heat and momentum in the inertial sublayer at resolutions of O(1km). However, higher resolutions approach the 'building grey zone', where large buildings/streets start to become resolved. The building greyzone problem, and larger inhomogeneity at O(100m) scales, raise questions as to whether the 'effective roughness length' concept for heat and momentum can parametrise these exchanges, or if a vertically distributed approach to parametrise these exchanges is needed.

The research proposed here aims to test MORUSES (and higher resolution models) in London for a wide range of meteorological conditions using a wide range of point and spatially representative meteorological observations drawing on data from the London Urban Meteorology Observatory (LUMO)(www.met.reading.ac.uk/micromet). . The London observational network also provides a unique opportunity to undertake 3-d model evaluation at multiple, nested scales. Data to be used include turbulent sensible heat fluxes determined by eddy covariance (EC) and scintillometry techniques; boundary layer height and cloud cover using ceilometry; and surface temperatures from fast response infra-red cameras.

Specifically the student will
* develop O(100m) input dataset for MORUSES and compare against UKV
* develop scale-appropriate products for model evaluation
* compare performance of MORUSES at different resolutions against observations
* test the MORUSES approach for high-rise buildings
* test evolution of the boundary layer simulated by the model against lidar derived BL height

The studentship provides an excellent opportunity to gain skills in state of the art observations and their analysis; insights into urban land-surface schemes; and real-time assessment. This research will improve state of the art modelling in urban environments and make significant contributions to urban observational work, theory and modelling.