Optimising future observing networks for the evolving urban landscape

Lead Supervisor: Sue Grimmond, University of Reading, Department of Meteorology
Email: c.s.grimmond@reading.ac.uk

Co-supervisors: Humphrey Lean, Cristina Charlton-Perez and Sue Ballard, MetOffice@Reading

Urban areas will soon be simulated in remarkable detail in both climate and weather models as these models are rapidly moving toward resolutions of 10's of kilometres and 100's of metres, respectively. This move towards high resolution modelling begs for the use of data gathered from densely populated, high-resolution observation networks both for verification and data assimilation purposes. Novel data types such as those observed using ceilometers are already being evaluated at the Met Office (MO) for use in data assimilation for numerical weather prediction. At the moment there are no MO ceilometer sites installed within urban areas; however, by pooling resources with London Urban Meteorological Observatory (LUMO) http://www.met.reading.ac.uk/micromet/ we can study a ceilometer network that can sample the atmosphere over both urban and rural areas. A ceilometer is a type of lidar that uses a laser to measure the light backscattered by particles in the atmosphere such as cloud droplets and aerosols. From the backscatter, cloud base and boundary layer height can be determined.

This project is motivated by the question: What is the appropriate density of a network of ceilometers, with particular reference to determining the impact of the network on measuring the important meteorological characteristics of urban areas? Modellers are often asked this challenging question. The answer will depend on factors including the large-scale geography of a region, the size of urban areas and their location within the landscape. Ceilometer data from the rural MO network and the urban LUMO network will be analysed and compared to forecasts of cloud, aerosol, fog and boundary layer height from the 1.5 km MO operational model (UKV) and from an experimental 333 m configuration of the MO weather forecast model over London that is being run routinely in the MO with a view to improving fog and temperature forecasts.

There is considerable uncertainty about the behaviour of high resolution models and there are many open questions on how the urban surface should be represented. For the purpose of measuring aerosol and BL characteristics, the lower elevations of the ceilometer vertical profiles of backscatter provide information over a larger footprint than single-point surface measurements. Therefore, information from a ceilometer would be less spatially variable than, for example, surface based fluxes or temperature. Thus, the data from ceilometers and companion instruments could be used to quantify the model errors and inform future model development.

Training opportunities: Opportunities for observational fieldwork in London and training in observing systems at the Met Office in Exeter will be available.

Student profile: This project would be suitable for students with a degree in physics, mathematics or a closely related environmental or physical science or engineering. It would be good to have programming skills such as FORTAN, Python, R and experience with instrumentation.

Funding particulars: Met Office will provide some additional instruments to support this project.

http://www.reading.ac.uk/nercdtp