Urban Climate Monitoring in London

Duick Young, Simone Kotthaus, Mark Thomas and Sue Grimmond
King's College London, Department of Geography, Environmental Monitoring and Modelling Group
duick.young@kcl.ac.uk, simone.kotthaus@kcl.ac.uk, sue.grimmond@kcl.ac.uk

Introduction

Surprisingly, despite current estimates predicting that in Europe 75% of people will live in towns and cities by 2020 (UN, 2007) there are relatively few representative meteorological measurements made in urban areas. This lack of data leads to uncertainty in making predictions as to the effects of climate change and how these will effect urban inhabitants. Here an overview is presented of meteorological and micrometeorological measurements made in London – both at King's College London and across the city – and their applications (both current and potential).

Urban Micrometeorology @ KCL

We, the urban micrometeorology group at KCL, currently operate four field sites across central London (Fig. 1). At these sites there is a range of meteorological and micrometeorological instrumentation deployed including two flux towers and remote sensing devices (Ceilometers and LAS).

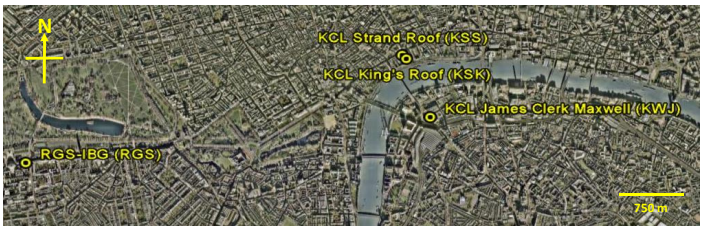

Figure 1: London field site locations (Google Earth, 2009).

KSK Tower

Tower mounted equipment on the KSK roof (Fig. 3) has been collecting data since the end of 2006. Data are recorded at regular intervals by data loggers and then stored and processed using custom written programs in Matlab, R and Python. Data plots are created daily (Fig. 4) and uploaded onto the web:
http://geography.kcl.ac.uk/micromet/

Skye Instruments
- UVA, UVB and PAR (photosynthetically available radiation)
- Assess impacts on urban **vegetation and human health.**

Figure 3: Tower instruments at KSK (looking South)

Vaisala WXT510 Automatic Weather Station
- Measures air temperature, barometric pressure, humidity, wind and precipitation.
- Provides meteorological reference data.

Kipp & Zonen CNR1 Net-Radiometer
- Measures incoming and reflected solar and incoming and outgoing longwave radiation.
- This allows the calculation of albedo and net all-wave radiation, which are used in the modelling and forcing for all processes in the surface energy balance.

CSAT3 & Li-Cor 7500
- Measures three dim. wind components, turbulent fluxes of sensible, latent heat & CO_2.
- Data used for modelling of UWB and urban parameters (e.g. in LUMPS, UCM).

Ceilometer

- Two Vaisala CL31 Ceilometers (Fig. 2a) are deployed at (1) KSS and (2) RGS.
- High frequency laser to measure cloud height and backscatter from aerosols in the atmosphere.
- Cloud data are used to determine cloud cover, backscatter data are processed to identify Mixing Layer Height (MLH).

➡ **Air pollution application** as MLH is limit of vertical mixing of pollutants (Fig. 2b).

- The ceilometers are located 4.5 km apart to allow the investigation of spatial variability of both cloud and MLH.

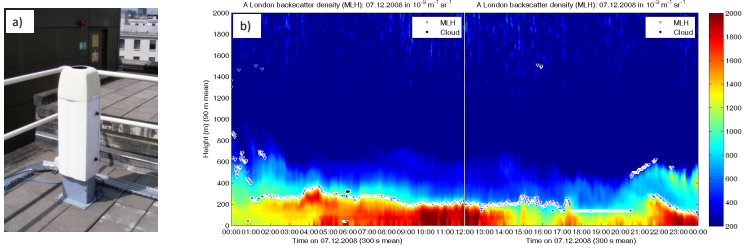

Figure 2: a) Vaisala CL31 Ceilometer located at KSS. b) Ceilometer density plot from a cloudless day (Dec 7th 2008). Notice the clear distinctive layer near the surface which indicates high air pollution concentrations the top of which is the MLH.

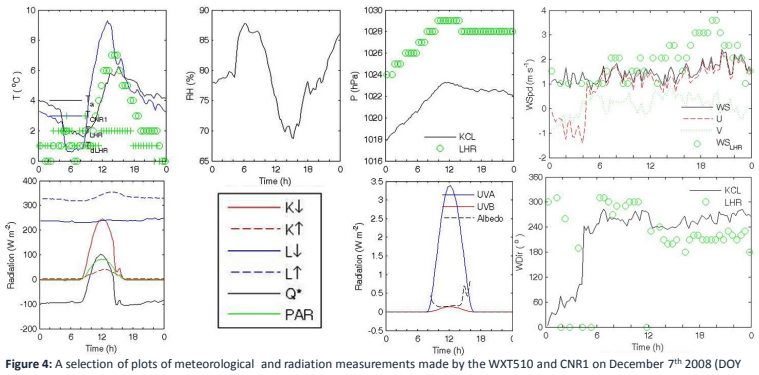

Figure 4: A selection of plots of meteorological and radiation measurements made by the WXT510 and CNR1 on December 7th 2008 (DOY 342) at KSK. Additional data observed at London Heathrow Airport (green circles) are included for comparison purposes.

London Meteorological Database

Across London there are a number of networks measuring meteorological observations ranging from individual weather enthusiasts to research level monitoring stations (Thomas 2008). As of yet no attempt has been made to collate this data into a single database for use in temporal spatial studies utilising standard meteorological observations. A data base of standard observations (wind speed, wind direction, air temperature, dew point temperature, relative humidity, barometric pressure and incoming solar radiation) made at 164 stations is compiled using data available on the internet. The four main sources of data are

- Stations operating with WMO standard (NOAA)
- Private weather stations (Weather Underground)
- Private weather stations, stations for purpose of education (London Grid for Learning)
- Research stations (London Air Quality Network, King's College London)

Potential applications for this data are the study of the **urban heat island** (Fig. 5), humidity, flow patterns and calculation of the sensible heat flux using the Aerodynamic Roughness Method (Voogt and Grimmond 2000).

This project is continuously being expanded and we would appreciate information about any additional meteorological observations made within London that are currently not included in the database.

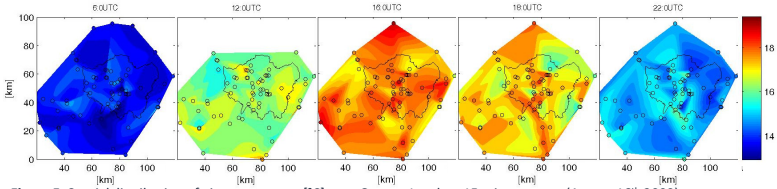

Figure 5: Spatial distribution of air temperature [°C] over Greater London, 15 min averages (August 16th 2009)

References

Google Earth, 2009. Available from: *http://earth.google.co.uk/*

Thomas, M., 2008: Visualisation and Analysis of Spatial Variability of Atmospheric Temperature in London, MSc Thesis, MSc Environmental Monitoring, Modelling and Management, King's College London, 128 pp.

United Nations, 2007: World Urbanization Prospects: The 2007 Revision Population Database, *online. http://esa.un.org/unup/index.asp?panel=1* [Last accessed Feb 2009].

Voogt, J. A., and C. S. B. Grimmond, 2000: Modelling surface sensible heat flux using surface radiative temperatures in a single urban area. *Journal of Appl. Meteorol.*, 39, 1679-1699.

Acknowledgements

Funding by
European Commission under the seventh framework programme: BRIDGE, Grant agreement no.: 211345
RGS and KCL for providing site access.
We would like to thank the following for their contributions to installation and running of our field sites - Alastair Reynolds (KCL), Dr. Shatish Kundaiker (KCL) and Christoph Münkel (Vaisala) for ceilometer technical help. Further we thank all those undergraduate, masters and PhD students and post docs who help with the daily operations.