Weather 65: 307–309

Adapting our cities for Future Climates: 17 February 2010

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Over 50% of humans live in urban areas, occupying less than 3% of land area. Heat, flooding, drought and wind in urban areas were discussed in this meeting at Imperial College organised by Dr Janet Barlow (jointly held with the Wind Engineering Society, WES; www.windengineering.org.uk). Presented material (Table 1) was used when preparing the forthcoming text. Dr Alison Rudd proof-read this report.

Table 1. Summary of poster presentations. Some oral presentation slides are available for download from the RMetS website (http://www.rmets.org/events/detail.php?ID=4360).

Author (with co-authors)	Title
Thomas Smith, King's College London (Duick Young, Thomas Loridan, Sue Grimmond)	QuiNimbus: cloud statistics for urban micrometeorology
Tatiana Prieto-Lopez, e-on and University of Birmingham	Impact of the UHI on transformer ageing
David Brooks, Met Office (Lizzie Good, Mark McCarthy, Martin Best)	UHI in climate datasets
Mariana Gouvea, King's College London (Sue Grimmond, Martin Best)	Modelling urban energy flux partitioning across a range of vegetation plan area fractions
Thomas Loridan, King's College London (Sue Grimmond, Brian Offerle, Thomas Smith, Leena Järvi, John Hom)	LUMPS an urban land surface scheme: evaluation and development of a new longwave parameterization
Simone Kotthaus, King's College London (Sue Grimmond)	Turbulent flux observations in central London

The Urban Heat Island (UHI)

It is long known that some cities are warmer than rural surrounds. Dr Gerald Mills (University College Dublin and President of the International Association for Urban Climate) noted Luke Howard and Tony Chandler; their work was historically important in understanding London's urban heat island (UHI). Urbanites—compared with rural counterparts—also experience reduced wind and relative humidity. During 2003's summer, central London was warmer than rural areas by night by up to 10°C. UHI contributors include (i) anthropogenically-created heat, (ii) heat storage, (iii) the sky-view factor (capture of emitted thermal radiation by other urban fabric), and (iv) often a lack of water or vegetation (energy goes into sensible heat instead of evapotranspiration). Global UHI susceptibility varies; large diurnal temperature range is a rule-of-thumb for UHI potential.

UHIs vary with building morphology: UHIs are warmest for tall and densely-packed buildings. Building morphology databases, such as Virtual London (www.lucid-project.org.uk; www.casa.ucl.ac.uk), can thus be used in models and parametrizations of UHIs. Dr Sylvia Bohnenstengel (University of Reading; co-authors Peter Clark, Stephen Belcher, Steve Evans, Maria Kolokotroni, Ian Hamilton, Michael Davies) presented the MORUSES (Met Office Reading Urban Surface Exchange Scheme; Porson et al., 2009). This new parametrization of urban surface energy balance has been implemented into the Unified Model (Figure 1). A simple 2D geometry (street canyon) is used with a sophisticated urban surface energy balance parametrization. Transport of heat is calculated using a resistance network. Multiple reflections and shading are incorporated. MORUSES's strength is its separately-calculated surface energy balances for the roof and for the canyon. The model has been validated: screen-level temperatures agreed typically better than ± 1°C.

Alex Nickson (Greater London Authority) highlighted that people are ill-prepared for current vulnerability, besides any changes. Strategies to mitigate and adapt to heat include: tree cover and greenery, green roofs, more weather stations, influencing design guidance and heat refuges. Sustainability is important in planning our cities' futures (Mills, 2005).

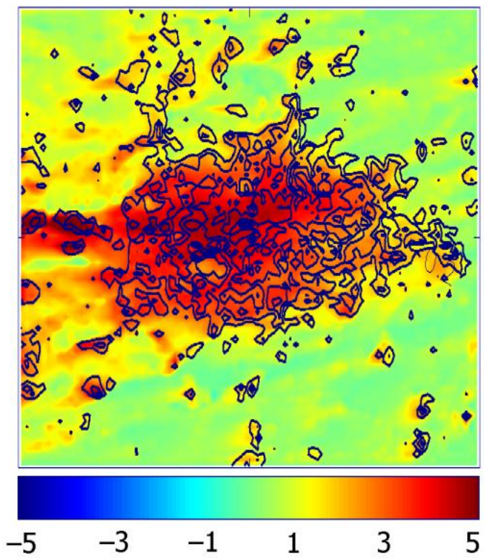

Figure 1. Greater London (80 km x 80 km domain) at 20:00 UTC on 7 May 2008. Colours are screen-level (1.5 m) temperature differences (°C) between a Met Office Unified Model simulation with urban land-use (i) using the new MORUSES scheme and (ii) replaced by grass. Isolines show urban land-use fraction in increments of 0.2. Courtesy of Bohnenstengel et al. (2010) and the LUCID project.

Building-scale Processes

UHI control requires management of both individual buildings and neighbourhoods. Intelligent buildings can use non- or low-energy methods to modify internal climate (Hacker et al., 2005). Changing building materials—such as green roofs—is expected to bring benefits: mitigation of flooding, insulation during winter and cooler rooftops inlet positions for air-conditioning (cf. black/tar roofs).

Effects of building morphology (e.g. funnelling and eddies caused by tall buildings and building shapes) cause locations of high mean wind speed and/or gusts. Dr Mark Sterling (University of Birmingham) talked on risks of wind to life and property (Sterling et al., 2003): (i) pedestrian comfort to wind and turbulence, (ii) flying debris and (iii) forces exerted on buildings. Using time and area mean values at one's site of interest includes the need for corrections (slope of land, roughness values and changes, gust ratio and directional dependences). Wind tunnels and computational fluid dynamics (CFD) are key research tools. However, development of Excel tools is important: ensuring research is used by various users (e.g. authorities, consultancies).

Individual buildings are perhaps more easily and frequently designed than neighbourhoods, but design of both individual buildings and neighbourhoods have an impact on urban micro-climate (Barlow and Coceal, 2009). Different solutions are required at different scales for different cities (changing future cities is perhaps paramount: with fastest urban growth in Africa, South America and Asia). City layout is interlinked with efficient energy use (densely-packed cities, such as Hong Kong, are more efficient than spread-out cities, such as Houston; Newman and Kenworthy, 1989)**.** There is a strong link between development, cities, energy use and greenhouse gas emissions.

Environmental Change

Dr Mark McCarthy (Met Office; co-authors Martin Best, Richard Betts, Clare Goodess, Colin Harpham, Phil Jones) emphasised that UHIs are not overtly expressed in climate change projections. Cities are smaller than most global climate models can represent; even UK Climate Projections (UKCP09) only has 2–6 model grid-squares for Greater London (ukcp09.defra.gov.uk). UHIs, and changes therein, must be considered additionally to regional climate change (McCarthy et al., 2009). Do UHIs' intensities increase with climate change (mechanisms include cloud cover and soil moisture changes)? Rates of UHI increase are estimated at 0.2°C for each 5°C in global warming. However, London does *not* appear to be warming any faster than the region.

Alex Nickson highlighted London's water challenges. Most world cities are coastal, low-lying and/or on rivers (15% of London lies on floodplains of current—or former—rivers). The Thames Barrier helps to prevent fluvial and tidal flooding. A 1-in-100-year pluvial-flooding event is a risk to 680,000 Londoners; debris in drains exacerbates this. Water stress is also a problem: in a dry year, SE England has an 80 million litres/day deficit. Moreover, Londoners use more water than the national average, perhaps partly since only 20% of London homes have a water meter. A **water hierarchy** was proposed: lose less, use less, recycle more. Climate change projections of seasonal changes in rainfall will be important to consider for future planning.

Final Remark

An audience member asked if enough high quality wind observations are available in cities. Communication between engineers and atmospheric scientists is needed in using existing data and when designing future installations. Some long-term research-grade measurements of atmospheric quantities in London are already under way: such as those by Prof. Grimmond's group (geography.kcl.ac.uk/micromet) and Dr Barlow's ACTUAL project (Atmospheric Climate Technology Urban Atmospheric Laboratory, www.actual.ac.uk). Information also needs to continue to be exchanged between researchers and authorities, perhaps through workshops like those organised by the Air Pollution Research In London (APRIL) network (www.imperial.ac.uk/environmentalpolicy/research/environmentalquality/april).

References

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