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Response of London's urban heat island to a marine air intrusion in an easterly wind regime

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London is long known to develop a pronounced urban heat island (UHI) resulting primarily from the storage of heat in the urban fabric during the day and released during the night, the differences in thermal and radiative properties of the surface between urban and rural areas, and lack of evapotranspiration in urban areas. Under calm, clear, and dry weather conditions, the difference in near-surface air temperature between two representative urban centre and rural locations at a given time typically reaches several degrees (i.e. warming) during the night and can be negative (i.e. cooling) during the day.

Like the majority of large cities in the world, London is located in a coastal area. On certain occasions cooler marine air from the North Sea is advected across London by a sea breeze or easterly winds. In our work we examine the effects of a marine air intrusion, in an easterly wind regime, on the structure of London's UHI for a case study on 7 May 2008. For this purpose, numerical simulations with the Weather Research and Forecast (WRF) model are performed for multiple nested domains with the innermost domain covering London and its rural surroundings at the kilometre scale.

A sensitivity study is undertaken to assess how the categorisation of the urban land use and the parameterisation of the urban canopy in the model affect its performance characteristics for the near-surface air temperature field. The categorisation of the urban landuse, according to the fractional area that is built-up within each grid cell, is found to be key to capturing the spatial pattern of the temperature field. Using a multilayer rather than single layer urban canopy model improves the representation of the variability of the pattern and the intensity of the UHI. A notable outcome of this work is that the inclusion of building anthropogenic fluxes is comparatively less important as regards model performance for near-surface air temperature.

The effects of the marine air intrusion on the urban boundary layer and the intensity of the UHI are also examined through numerical simulations. The advection of cooler air from the North Sea reduces the UHI on the windward suburbs and displaces it several kilometres to the west, in good agreement with observations. Passive tracers are released within the urban area to investigate the impact of the marine air intrusion on transport characteristics above London's atmosphere. Cooler air advection across London was found to efficiently cleanse the urban area of passive tracers. Implications for urban air quality are discussed in the light of results from this case study.

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