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Surface and atmospheric driven sensitivity of the single-layer urban canopy model under clear sky conditions in London

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Urban canopy models (UCMs) are necessary tools for forecasting near surface weather conditions in urban areas and are widely incorporated as parameterization schemes in numerical weather predictions models. The performance of UCMs depends on the adequate prescription of the urban surface morphological parameters. Variations in the surface parameters often results in substantial variation in model performance. However, this surface-parameter driven variability is not the only source of uncertainty in model performance. Atmospheric processes like radiation, turbulent mixing intensity between surface the overlying boundary layer, as well as advection can influence the performance of an UCM. In this study we investigate the relative importance of surface and atmospheric driven model sensitivity of the single-layer urban canopy model (SLUCM) fully interactive in a 1D configuration of the weather research and forecasting model (WRF). As a case study we use a 24-hour period between 23 - 24 July 2012 over London with clear sky conditions. For understanding the model sensitivity to changes in surface parameters and atmospheric processes, we use a relatively new approach, the so called process diagrams, which can highlight how the relation between two interdependent variables (i.e. near surface temperature and net radiation) change as a function of varying surface parameters' values and atmospheric processes. The process diagrams analysis allows us to identify physical process that can explain variations between model and observations, and also identify differences in the description of these physical processes between different model configurations. Our results suggest that the intensity of turbulent mixing, moderated through the exchange coefficient of heat, can explain much of the deviation seen between model and observations, especially related to the near surface temperature, net radiation and long-wave upward radiation during daytime, while not deteriorating night-time model performance at the same time. The advection intensity for heat, moisture and the anthropogenic heat flux strongly impact near surface temperature, and distribution of surface heat flux and storage flux, with minimal impact on the daytime radiation balance and can partially explain the mismatch between observed and modeled near surface temperature and boundary-layer height. Finally variations in thermal coupling between the urban surface and the overlying atmosphere can account for biases between observed and modelled surface heat flux and long-wave upward radiation.