Evaluating three urban canopy models against in-situ observations for a heat-wave case in Amsterdam

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With increasing urbanization and ongoing climate change there is a need to develop and evaluate modelling infrastructure for urban weather and climate. In this study we evaluate three urban canopy models for a heat-wave case study in Amsterdam (The Netherlands), notably the single-layer urban canopy model (SLUCM) and the building environment parameterization (BEP) and the BEP+BEM (BEP+Building Energy model) urban canopy models within the WRF infrastructure. Model results are evaluated against a network of near surface observations of air temperature, turbulent surface fluxes, SODAR wind profiles, and radio soundings of temperature and humidity taken in the city center of Amsterdam.

We find that the BEP+BEM model outperforms the other schemes for the near surface air temperature, with a bias of -0.66 K for BEP+BEM, -1.51 K for BEP and -1.56 K for SLUCM. However, WRF produces an elevated inversion level that, at the same time, is substantially (~ 2-8 K) weaker than observed in the radiosoundings.

To estimate the future increase in energy demand by air conditioning, we project this heatwave case study to the future. To do so, we force the WRF model with increased temperatures in initial and boundary conditions following the four KNMI climate scenarios. With the climate scenario with the largest warming (WH-scenario) we find a 2-m temperature increase of ~3 K during daytime compared to the current climate. Finally we find that for this scenario the energy consumption by air-conditioning increases between 25% and 40% in the city center compared to the current climate (with constant number of airco’s installed).