Distributed urban drag parameterization in the sub-kilometre scale
London Model

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Urban environments in numerical weather prediction models are currently parameterised as part of the atmosphere-surface exchange at ground-level. The vertical structure of buildings is represented by the average height, which does not account for heterogeneous building forms at the subgrid-level. The use of city-scale models with sub-kilometre resolutions and growing number of high-rise buildings in cities call for a better vertical representation of urban environments.

We present the use of a newly developed, height-distributed urban drag parameterization with the London Model, a high-resolution version of the Met Office Unified Model over Greater London and surroundings at approximately 333 m resolution. The distributed drag parameterization requires vertical morphology profiles in form of height-distributed frontal area functions, which capture the full extent and variability of building-heights. These morphology profiles were calculated for Greater London and parameterised by an exponential distribution with the ratio of maximum to mean building-height as parameter.

A case study with the high-resolution London Model and the new drag parameterization appears to capture more realistic features of the urban boundary layer compared to the standard parameterization. The simulation showed increased horizontal spatial variability in total surface stress, identifying a broad range of morphology features (densely built-up areas, high-rise building clusters, parks and the river). Vertical effects include heterogeneous wind profiles, extended building wakes, and indicate the formation of internal boundary layers. This study demonstrates the potential of height-distributed urban parameterizations to improve urban weather forecasting, albeit research into distribution of heat- and moisture-exchange is necessary for a fully distributed parameterization of urban areas.