Integrating the Urban Canopy Layer in a Lagrangian Particle Dispersion Model

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Traditional Lagrangian particle dispersion models reflect particles at the zero-plane displacement height and therefore cannot properly take near-ground effects into account. In this study, we investigate whether including the urban canopy layer improves the performance of such a Lagrangian particle dispersion model. Here, spatially averaged flow and turbulence profiles throughout the urban canopy are constructed based on data from the literature (mostly from wind tunnel and numerical modeling studies).

We apply a first-order approach to test to what degree the explicit inclusion of the urban canopy changes the simulated concentration distributions. In a comprehensive sensitivity study, we show that most of the parameters introduced to describe the turbulence and flow profiles in the canopy have a relatively minor impact on the dispersion (and hence concentration distribution) – despite their inherent uncertainty. In particular, concentration fields are more sensitive to previously existing parameters of the model. One exception is a parameter describing the mean canopy wind speed profile, to which the model is sensitive.

When compared to data from the BUBBLE tracer experiment, the results show that the inclusion of the urban canopy layer slightly improves the modelled concentration values. The improvement is minor and might likely differ when comparing with other field experiments. However, the key point here is that the increased complexity and added capability of near-ground concentration simulation did not fundamentally change the model performance.

Ultimately, inclusion of the urban canopy layer will allow the model to be used as the dispersion core for an urban footprint model with footprint estimates near the ground.