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A Lagrangian particle dispersion model for urban applications

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In this contribution we investigate how well a Lagrangian particle dispersion model can resolve the urban canopy layer. We build on a dispersion model that already takes the urban roughness sublayer into account, is valid for the urban neighborhood scale and assumes horizontal homogeneity. Then, we use profile data from literature to extend the necessary turbulence profiles into the canopy. Since it is virtually impossible to retrieve spatially averaged flux measurements between full-scale buildings, most of the profiles stem from wind tunnel and numerical modeling studies. This is a first order approach to test to what degree the urban canopy impacts the model results, i.e. concentration distributions.

The impact of the parameterized turbulence profiles in the canopy layer is tested via sensitivity studies and comparisons of model results with tracer dispersion experiments in different urban areas, namely the BUBBLE (Basel UrBan Boundary Layer Experiment), MUST (Mock Urban Setting Test), URBAN 2000 (Salt Lake City), Barrio Logan (San Diego, 2001), and Madison Square Garden 2005 experiment (New York City).

Results suggest that the concentration field output depends significantly on the new urban canopy layer treatment. Generally speaking, the simulated concentration near the ground seems to increase, which improves some error statistics while impairing others. Results from the sensitivity study suggest that the model's concentration field output reacts strongly to changes in the mean wind speed profile of the urban canopy layer. Additionally, in stable cases the output is sensitive to changes in the dissipation rate, while, for unstable cases, it is most sensitive in the second and third moment of the vertical velocity.

As a next step in this project we will implement the knowledge gained from urban dispersion simulation to an existing footprint model (LPDM-B), thus extending the footprint model to application over very rough (i.e. urban) surfaces.