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Numerical and experimental investigations of atmospheric flow in urban canopies

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About 50 % of the world population lives in urban areas; this percentage rises to about 75 percent in developed countries. However, our understanding of urban environments is somewhat lagging behind; for example, we still do not fully understand the dynamics of land-atmosphere interaction and the coupling of flow and transport in urban boundary layers. Part of the problem is the heterogeneity and complexity of urban environments and the inadequacy of some classic experimental and numerical tools to deal with flow and transport in such complex domains. Results of an on-going research effort to integrate new-generation numerical and remote sensing techniques to study flow over the EPFL campus are presented. On the numerical side, we use large-eddy simulation with a scale dependent Lagrangian dynamic model and immersed boundary method representation of bluff bodies. Validation tests confirm that the LES is able to capture the complex physics of the flow around buildings and in the vicinity of walls. Simulation results suggest that a high level of representation is needed for buildings to capture the flow in the urban canopies; however, for average fluxes over urban areas, the requirements on buildings representation seem to be less stringent. Experimentally, we measure surface fluxes using the scintillation technique and vertical profiles of wind and temperature using a sound-ranging and detection (SODAR) system coupled with radio-acoustic sounding (RASS) system. Initial results are presented and compared to LES data.