



Large-eddy simulation of atmospheric boundary layer flow and passive scalar dispersion over idealized urban surfaces

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Accurate prediction of atmospheric boundary layer (ABL) flow and its interaction with urban surfaces is critical for understanding the transport of momentum and scalars within and above cities. This, in turn, is essential for predicting the local climate and pollutant dispersion patterns in urban areas. Large-eddy simulation (LES) explicitly resolves the large-scale turbulent eddy motions and, therefore, can potentially provide improved understanding and prediction of flows and scalar transport inside and above urban canopies. In this study, LES is used to simulate the dispersion of passive scalar over idealized urban surfaces represented by uniform arrays of cubes. A modulated gradient subgrid-scale (SGS) model is used to parametrize the SGS fluxes of momentum and scalar, and an immersed boundary method is used to model the presence of cubes. A similar LES framework for flow was validated in our previous studies in simulations of turbulent boundary-layer flow past a 2D block and a uniform array of cubes. Here, the LES framework is further validated with wind tunnel experimental data of passive scalar dispersion within and above a staggered array of cubes with a localized scalar source at ground level. Good agreement between the simulation results and experimental data are found in the vertical and horizontal profiles of scalar concentration in different streamwise locations. After the validation, the LES framework is used to simulate the scalar transport at rural-to-urban flow transition region and the results obtained are presented.