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A stochastic backscatter turbulence parameterisation for large-eddy simulation of the urban boundary layer

J. O'Neill and X. Cai
University of Birmingham, GEES, Birmingham, United Kingdom (jjo925@bham.ac.uk)

A subgrid-scale (SGS) turbulence model allowing for the stochastic backscatter of energy from sub-grid to resolved scales (Mason and Thompson, 1992) has been implemented in the large-eddy simulation (LES) model at the University of Birmingham, and further modified for simulation of the urban boundary layer (UBL). Mason and Thompson (1992) demonstrated that the inclusion of backscatter in their SGS model led to improved near-wall performance of LES in the case of neutrally stratified turbulence over a homogeneous surface. The UBL, however, is characterised by underlying buildings and other obstacles that generate additional sources of small-scale (sub-grid) turbulence. In this study we propose a modification to the standard backscatter model to account for the backscatter of energy from building-induced turbulence in an urban setting. We compare the performance of our new SGS model, both against a Smagorinsky model (without backscatter) and the Mason and Thompson (1992) backscatter model, in our simulations of the UBL. Allowing for the additional backscatter of energy in an urban environment will lead to an improved understanding of the mean flow and turbulence characteristics in the near-surface region of the UBL, to the benefit of urban meteorology and dispersion modellers.