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Optimizing inflow boundary conditions for LES of wind loading.[1]

GIACOMO LAMBERTI, CATHERINE GORLE, Stanford University — Large-eddy simulations (LES) have promising capabilities to complement wind tunnel testing for assessing wind hazards, but modeling the mean flow and turbulent statistics representative of a specific atmospheric boundary layer (ABL) is not straightforward. In the present work, we focus on applying a divergence-free digital filter method to generate an ABL inflow condition. The method requires the specification of the mean velocity profile, the turbulence length scales, and the Reynolds stresses at the inlet, to produce a turbulent inflow condition with exponential correlation functions in space and time. However, when imposing the profiles for the target ABL at the inlet, they develop downstream towards an equilibrium solution that depends on the numerics, the subgrid model, and the wall functions used. The resulting ABL statistics at the location of interest in the computational domain can vary considerably from those of the target ABL. To overcome this problem, we propose adjusting the inflow parameters using a gradient-based optimization, such that the required statistics are obtained at the building location. The implementation of the method is tested for an ABL simulated in an empty wind tunnel, and the results are compared to the experimental data. The expected monotonic behavior is found, where higher Reynolds stresses at the inflow result in higher Reynolds stresses at the location of interest. Hence, this approach is a promising tool for defining inflow boundary conditions for LES of wind loading

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