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Large-eddy simulations of rough-wall turbulent boundary layers: examining the logarithmic law for turbulence fluctuations[1] DACHUAN FENG, Hong Kong University of Science and Technology, VIKRANT GUPTA, Southern University of Science and Technology , LARRY K.B. LI, Hong Kong University of Science and Technology, MINPING WAN, Southern University of Science and Technology — We study rough-wall turbulent boundary layers (TBLs) for their ability to represent the lower region of the atmospheric flow in which wind farms operate. In this region, the logarithmic law dictates that the streamwise and spanwise velocity variances u'^2 and v'^2 scale log-linearly and that the wall-normal variance w'^2 remains nearly constant. To date, all these predictions have been observed in experiments and direct numerical simulations, but only the u'^2 prediction has been observed in large-eddy simulations (LES). This is partly because most studies focus only on u'^2, which contains most of the turbulent kinetic energy in TBLs. In wind farms, however, v'^2 and w'^2 are also important because of their pronounced effect on wake meandering and hence turbulence generation. Here we perform LES using a finite-volume code in order to parametrically study the effects of (i) the grid resolution and grid-cell aspect ratio, (ii) the wall model and (iii) the subgrid-scale model. We find that although all of these factors affect the accuracy of LES, it is the grid-cell aspect ratio that affects v'^2 and w'^2 the most. In particular, we find that using nearly isotropic grid cells causes all three components of the velocity variance to agree with the logarithmic law.

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