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Dynamic LES of stably-stratified flow over a hill

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Large-eddy simulation (LES) is used to simulate stably-stratified turbulent boundary-layer flow over a steep two-dimensional hill. To parameterize the subgrid-scale (SGS) fluxes of heat and momentum, three different types of SGS models are examined: (a) the Smagorinsky model, (b) the Lagrangian dynamic model, and (c) the scale-dependent Lagrangian dynamic model (Stoll and Porté-Agel 2006). Simulation results obtained with the different models are compared with data from wind tunnel experiments conducted at the Environmental Flow Research Laboratory (EnFlo), University of Surrey, U.K. (Ross et al., 2004). It is found that, in this stably-stratified boundary-layer flow simulation, the scale-dependent Lagrangian dynamic model is able to account for the scale dependence of the eddy-viscosity and eddy-diffusivity model coefficients associated with flow anisotropy in flow regions with large mean shear and/or strong flow stratification. As a result, simulations using this tuning-free model lead to turbulence statistics that are more realistic than those obtained with the other two models. These results are consistent with previous findings obtained for SGS stress models in simulations of neutral boundary-layer flow over a sinusoidal hill (Wan et al., 2007).