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A near-wall model for LES of an oceanic bottom boundary layer
SUTANU SARKAR, JOHN TAYLOR, U. C. San Diego — The high-Reynolds number turbulent boundary layer over the ocean bottom takes the form of a rough Ekman layer that is subject to a stable stratification imposed from above. Since the LES grid cannot resolve the viscous length scale or the small-scale roughness elements, a near-wall model (NWM) is required in addition to the baseline subgrid model, the dynamic eddy viscosity model in this case. From field data and from our own DNS at lower Reynolds number, it is known that the mean velocity profile admits an overlap log layer. Thus, an approximate instantaneous boundary condition based on the mean log law can be formulated. However, in agreement with the experience of previous investigators, we find that such a boundary condition leads to an overprediction of the near-boundary shear. A novel stochastic forcing of the vertical momentum equation with proportional control is proposed to correct the problem. The forcing is restricted to a narrow envelope, $0 < z < \Delta_f$, and has a small amplitude. The good performance of the NWM is demonstrated using three test cases: a $Re_* = 2000$ smooth channel flow where DNS data is available, rough channel flow with $z_0/\delta = 2.8 * 10^{-3}$ and $Re_* = 5,600$ where laboratory data is available, and a rough Ekman layer with $z_0/\delta = 5.7 * 10^{-3}$, $Re_* = 60,000$, and $N/f = 75$ where field data is available.

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