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An integral wall model for Large Eddy Simulation (iWMLES) and applications to developing boundary layers over smooth and rough plates[1] XIANG YANG, JASIM SADIQUE, RAJAT MITTAL, CHARLES MENEVEAU, Johns Hopkins University — A new wall model for Large-Eddy-Simulations is proposed. It is based on an integral boundary layer method that assumes a functional form for the local mean velocity profile. The method, iWMLES, evaluates required unsteady and advective terms in the vertically integrated boundary layer equations analytically. The assumed profile contains a viscous or roughness sublayer, and a logarithmic layer with an additional linear term accounting for inertial and pressure gradient effects. The iWMLES method is tested in the context of a finite difference LES code. Test cases include developing turbulent boundary layers on a smooth flat plate at various Reynolds numbers, over flat plates with unresolved roughness, and a sample application to boundary layer flow over a plate that includes resolved roughness elements. The elements are truncated cones acting as idealized barnacle-like roughness elements that often occur in biofouling of marine surfaces. Comparisons with data show that iWMLES provides accurate predictions of near-wall velocity profiles in LES while, similarly to equilibrium wall models, its cost remains independent of Reynolds number and is thus significantly lower compared to standard zonal or hybrid wall models.

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