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A new ODE-based wall model for boundary layers accounting for pressure gradient and Re effects[1] KEVIN GRIFFIN, LIN FU, PARVIZ MOIN, Center for Turbulence Research, Stanford University — In wall-modeled large-eddy simulations (WMLES), the near wall model plays a significant role in predicting the skin friction, although the majority of the boundary layer is resolved by LES. In this work, we propose a new ODE-based wall model for boundary layers accounting for pressure gradient and Reynolds number effects. The new model sensitizes the law of the wall to the boundary layer shape factor. By consulting the local outer profile, the inner wall model can incorporate the non-equilibrium effects captured by the outer LES solver as well as the non-universality of the law of the wall at low Reynolds number. As a result, the proposed wall model greatly extends the predictive capability of WMLES for flows with strong pressure gradients and a wide range of Reynolds numbers . Specifically, the wall model improves the skin friction prediction in simulations of canonical favorable pressure gradient flows (pipes and channels), zero and adverse pressure gradient flat plates, and the flow over a NACA 4412 airfoil at an angle of attack of 5 degrees and Re_c in the range of 100,000 to 1,000,000. The suite of test cases exhibits a range of friction Reynolds numbers between 130 and 8000 and Clauser pressure gradient parameters in the range of -0.3 and 4.

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Kevin Griffin
Center for Turbulence Research, Stanford University

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