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Application of Wall-modeled LES to Turbulent Separated Flows
PRAHLADH S. IYER, National Institute of Aerospace, GEORGE I. PARK, Center for Turbulence Research, Stanford University, MUJEEB R. MALIK, NASA Langley Research Center — Resolved Large-Eddy Simulations (LES) and Direct Numerical Simulations (DNS) are unaffordable for very high Reynolds number (Re) wall-bounded flows. While the Reynolds Averaged Navier-Stokes (RANS) based methods predict high Re attached flows accurately with little cost, their fidelity is degraded significantly in flows involving separation. A popular compromise between cost and accuracy is to use a Wall-modeled LES (WMLES) approach. In WMLES, the outer portion of the boundary layer is resolved with LES while the inner portion is modeled. In order to assess the performance of the widely used wall-stress models in separated flows, we perform WMLES simulations using an unstructured, compressible finite volume LES solver. The equilibrium and non-equilibrium wall models that require the solution of the simplified/full RANS on a separate near-wall domain are employed. Two configurations are studied: the shock-induced separation in a transonic flow over an axisymmetric bump placed on a cylinder, and a low-Mach flow past a NACA 4412 airfoil at a near-stall condition. Detailed comparisons will be made with available experimental data to comment on the applicability of WMLES in predicting complex turbulent flows involving separation.

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