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Simulations of a Normal Shock Train in a Constant Area Duct Using Wall-Modeled LES ZACHARY VANE, IVAN BERMEJO-MORENO, SANJIVA LELE, Stanford University — Large-Eddy Simulations (LES) of a turbulent boundary layer interacting with a normal shock train in a constant area duct (STCAD) are performed using an unstructured solver. Comparisons between wall-modeled LES (WMLES) and wall-resolved LES (WRLES) calculations of a spanwise-periodic flow at M=1.61 and Re = 16,200 are used to evaluate an equilibrium wall-model's ability to replicate the wall-resolved results. The WMLES approach is then used for simulations at the flow conditions (M=1.61, Re=162,000) of the Carroll & Dutton STCAD experiments where traditional WRLES was inaccessible. Spanwise-periodic WMLES calculations were unable to duplicate the experimental wall pressure and Laser Doppler Velocimetry data obtained along the spanwise center plane of the duct. Investigations of the full, low aspect ratio duct geometry were then performed using WMLES. Comparisons with experimental data provide an assessment of the wall-model's ability to simulate realistic, high Reynolds number, non-equilibrium flows. However, the lack of information with respect to the sidewall boundary layers from the experiment led to a WMLES parameter study of the effects of boundary layer confinement on the shock train. Initial results suggest that the tunnel blockage due to the boundary layer displacement thickness determines many of the STCAD's characteristics. A possible improvement to the wall-model through the inclusion of previously omitted non-equilibrium terms is currently being pursued.

Zachary Vane
Stanford University

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