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Effects of Mach Number on Near-Wall Turbulence Structures in Supersonic Turbulent Boundary Layers[1] MAHER LAGHA, JOHN KIM, JEFF ELDREDGE, XIAOLIN ZHONG, UCLA — In order to examine the effects of high Mach number on turbulence structures in compressible turbulent boundary layers, we performed direct numerical simulation of a spatially evolving supersonic turbulent boundary layer. A hybrid numerical method coupling the 5th-order WENO scheme with a 5th-order upwind finite-difference scheme was used in order to compute turbulence accurately while capturing sharp gradients that might exist in high Mach number flows. The rescale-and-recycle method was used for the inflow boundary condition. The Mach numbers were varied from 2.5 to 7 while the Reynolds numbers based on the boundary-layer displacement, wall-shear velocity and the viscosity at the wall were kept about the same. In order to determine the relative importance of the true compressibility effect and the variable-property effect in high Mach number boundary layers, we also solved modified Navier-Stokes equations, in which the energy equation was modified to include a heat sink term (Coleman, Kim and Moser, J. Fluid Mech. 305). The effects of Mach number on turbulence statistics as well as an analysis of the near-wall turbulence structures will be presented.

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