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**A numerical study of compressible turbulent boundary layers** MAHER LAGHA, JOHN KIM, JEFF ELDREDGE, XIAOLIN ZHONG, Ucla — Compressible turbulent boundary layers with free-stream Mach number ranging from 2.5 up to 20 are analyzed by means of direct numerical simulation of the Navier–Stokes equations. The simulation generates its inflow condition using the rescaling-recycling method. The main objective is to study the effect of Mach number on turbulence statistics and near-wall turbulence structures. The present study shows that the main turbulence statistics can be correctly described as variable-density extensions of incompressible results. We show that the apparent increase in the magnitude of the fluctuating Mach number with increasing free-stream Mach number is a variable-property effect. Using the mean density to scale the fluctuating Mach number collapses results for different freestream Mach number. The increase in the pdf tails of the dilatation is also shown to be a variable-property effect. Compressible boundary layers are shown to be similar to incompressible boundary layers in that, without the linear coupling term, the turbulence cannot be sustained. The linear coupling term is necessary to generate the wall-layer streaks. For an adiabatic wall, the near-wall structure exhibits the same characteristics as in incompressible turbulent flow in terms of the spanwise spacing of the streaks ($\approx 100^+$). For isothermal walls, near-wall turbulence structures show their dependence on the surface heat flux.

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