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Thermal boundary condition effects on compressible turbulent boundary layers[1] IZAAK BEEKMAN, Princeton University, PINO MARTIN, University of Maryland — Numerous questions about the physics of compressible boundary layers, and their modeling remain open. While Morkovin's hypothesis has proven remarkably robust for zero pressure gradient, smooth wall, compressible, turbulent boundary layers, accounting correctly for thermal energy transport and its impact on the density and momentum fields remains challenging. We use spatially developing DNS data over strongly and weakly adiabatic walls at Mach 3 and Mach 7. The strongly adiabatic boundary condition further stresses common assumptions of weak direct compressibility and weak total temperature fluctuations. We observe non-trivial differences between the two cases. The simulations are performed at $Re_\tau \approx 500$ on very large domains in the streamwise and spanwise directions, approximately 50 by $10\delta_{inlet}$, with a rescaling method providing the inflow. We examine the effects of this boundary condition on common scaling laws, temperature-velocity relations, and suggest improvements, where possible. A dimensionless parameter is proposed, the "fluctuation Nusselt number," to quantify the impact of the wall material for laboratory and engineering flows and relate it to these idealized, numerical boundary conditions.

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