Abstract Submitted
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The effects of signaling speed and density on the compressible boundary layer ROBERT BREIDENTHAL, University of Washington — Density effects are known to be weak in the free shear layer, yet they are commonly assumed to be strong in the compressible boundary layer. This apparent inconsistency is addressed in a single model by assuming that the acoustic signaling speed rather than density variations always controls the physics, in both free shear and wall flows. The model assumes that turbulent transport by an eddy requires information to propagate across the diameter of that eddy during the period of one eddy rotation, the time interval of importance in the physics. The turbulent fluxes are dominated by these 'sonic' eddies, whose rotational Mach number is about one. In this view, acoustic signaling controls the velocity fluctuations, which in turn determines the density field through the Reynolds stress. The density field is a consequence of the effect of finite signaling speed. According to the model, the skin friction coefficient and the velocity fluctuations normalized by the edge velocity both vary inversely with edge Mach number. The predictions of the model are in accord with the direct numerical simulations of Duan et al. (2011). Mach number plays a dual role in supersonic flow, measuring both kinetic energy and relative wave speed. Turbulent transport is controlled by the latter.

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