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Compressible turbulent channel flow with impedance boundary conditions CARLO SCALO, Purdue University, JULIEN BODART, Universite de Toulouse, ISAE, SANJIVA LELE, Stanford University — We have performed large-eddy simulations of compressible turbulent channel flow at one bulk Reynolds number, Reb = 6900, for bulk Mach numbers Mb = 0.05, 0.2, 0.5, with linear acoustic impedance boundary conditions (IBCs). The IBCs are formulated in the time domain following Fung and Ju (2004) and coupled with a Navier-Stokes solver. The impedance model adopted is a three-parameter Helmholtz oscillator with resonant frequency tuned to the outer layer eddies. The IBC's resistance, R, has been varied in the range, R = 0.01, 0.10, 1.00. Tuned IBCs result in a noticeable drag increase for sufficiently high Mb and/or low R, exceeding 300% for Mb = 0.5 and R = 0.01, and thus represents a promising passive control technique for delaying boundary layer separation and/or enhancing wall heat transfer. Alterations to the turbulent flow structure are confined to the first 15% of the boundary layer thickness where the classical buffer-layer coherent vortical structures are replaced by an array of Kelvin-Helmholtz-like rollers. The non-zero asymptotic value of the Reynolds shear stress gradient at the wall results in the disappearance of the viscous sublayer and very early departure of the mean velocity profiles from the law of the wall.

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