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Inner-outer predictive wall model for wall-bounded turbulence in hypersonic flow[1] M. PINO MARTIN, CLARA M. HELM, University of Maryland — The inner-outer predictive wall model of Mathis et al. (JFM 2011) is modified for hypersonic turbulent boundary layers. The model is based on a modulation of the energized motions in the inner layer by large scale momentum fluctuations in the logarithmic layer. Using direct numerical simulation (DNS) data of turbulent boundary layers with free stream Mach number 3 to 10, it is shown that the variation of the fluid properties in the compressible flows leads to large Reynolds number (Re) effects in the outer layer and facilitate the modulation observed in high Re incompressible flows. The modulation effect by the large scale increases with increasing free-stream Mach number. The model is extended to include spanwise and wall-normal velocity fluctuations and is generalized through Morkovin scaling. Temperature fluctuations are modeled using an appropriate Reynolds Analogy. Density fluctuations are calculated using an equation of state and a scaling with Mach number. DNS data are used to obtain the universal signal and parameters. The model is tested by using the universal signal to reproduce the flow conditions of Mach 3 and Mach 7 turbulent boundary layer DNS data and comparing turbulence statistics between the modeled flow and the DNS data.

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