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Numerical investigation of non-equilibrium effects in hypersonic turbulent boundary layers PILBUM KIM, JOHN KIM, XIAOLIN ZHONG, JEFF ELDREDGE, University of California, Los Angeles — Direct numerical simulations of a spatially developing non-equilibrium hypersonic turbulent boundary layer have been conducted. A pure oxygen flow over a non-catalytic flat plate at the wall temperature, $T_w = 1,000\ K$, is considered. The boundary edge conditions are given as $M_e = 9.1$, $T_e = 792\ K$, and $P_e = 6,565\ Pa$, which are corresponding to flow conditions around a blunt wedge with a 3.174 mm radius and 7° half angle at $M_\infty = 15.3$, $T_\infty = 285\ K$, and $P_\infty = 664\ Pa$. The initial conditions are obtained from a turbulent boundary layer simulation of a perfect gas. In addition, the species concentrations and vibrational temperature at the inlet are prescribed as equilibrium concentrations and the translational/rotational temperature, respectively. The data samples are collected at a downstream location at which a statistically stationary state has been achieved. From the collected data set, turbulence quantities are computed and compared with those from a perfect gas simulation in order to investigate the effects of thermal and chemical non-equilibrium on turbulent boundary layers. Those comparisons will be reported.

Pilbum Kim
University of California, Los Angeles

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