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A priori comparison of RANS scalar flux models using DNS data of a Mach 5 boundary layer KALEN BRAMAN, VENKATRAMANAN RAMAN, Department of Aerospace Engineering and Engineering Mechanics, The University of Texas at Austin — In order to investigate the applicability of Reynolds-averaged scalar flux models (SFM) to scalar dispersion in high speed turbulent flows, a priori comparisons have been performed utilizing the results of direct numerical simulations (DNS) of a Mach 5 boundary layer. At a small patch on the solid surface boundary, a scalar was introduced into the flow at a rate depending upon the local surface temperature. This configuration mimics surface ablation in hypersonic flows. In different simulations, the scalar injection rate was varied, and the scalar was treated as both passive, not affecting the flow field, and active, affecting the flow field due to having different molecular properties than the bulk flow and having an injection velocity. Statistics of the simulated scalar fields have been calculated and compared a priori with terms from SFMs. Comparisons from the passive scalar case show that the scalar flux terms in the standard gradient diffusion model fail to predict even the trend of the DNS values. The generalized gradient diffusion models, while an improvement for the streamwise component of scalar flux, nevertheless fail to predict the wall normal and spanwise fluxes. Additionally, production and dissipation models for the scalar variance equation are evaluated.

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