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Direct numerical simulations of the double scalar mixing layer
CHONG M. CHA, Rolls-Royce Corporation, STEPHEN M. DEBRUYNKOPS, University of Massachusetts Amherst — The use of complex, multi-stream mixing scenarios abound in practical combustion devices. The double scalar mixing layer (DSML) is a canonical problem for studying the turbulent mixing of multiple streams and, with reaction, combustion of the partially-premixed type. In a DSML, a third stream consisting of a premixture of the reactants is introduced in between the pure fuel and air streams of the classic twin-feed or binary mixing problem. Direct numerical simulations (DNS) are performed to test micro-scale mixing models which are required to practically compute turbulent combustion problems of engineering interest. Here, the mixing statistics of the passive scalar is considered. It is shown that modeling based on statistical inference alone, e.g., the popular beta-pdf and Pope's statistically most-likely distribution are inadequate or require too many statistical moments to construct a good representation of the fine-scale mixing. A mapping closure model which describes the mixing of multiple streams by Navier-Stokes turbulence is shown to yield excellent agreement with the DNS with only two moments of the mixture fraction.

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