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Investigation of scalar-scalar-gradient filtered joint density function for large eddy simulation of turbulent combustion[1] CHENNING TONG, Clemson University — Honoring Ted O'Brien. The scalar-scalar-gradient filtered joint density function (FJDF) is studied experimentally. Measurements are made in the fully developed region of an axisymmetric turbulent jet (with a jet Reynolds number of 40000) using an array consisting of three X-wires and three resistance-wire temperature probes. Filtering in the cross-stream and streamwise directions are realized by using the array and by invoking Taylor's hypothesis, respectively. The measured mean FJDF conditional on the (subgrid-scale) SGS scalar variance is unimodal when the SGS scalar variance is small compared to its mean. The scalar gradient depends weakly on the SGS scalar. For large SGS variance the FJDF is bimodal and the gradient depends strongly on the SGS scalar. The SGS scalar under such a condition contains diffusion layer structures and the SGS mixing is similar to the early stages of binary mixing. The iso-scalar surface in the diffusion layer has a lower surface-to-volume ratio than those in a well mixed scalar. The conditionally filtered diffusion of the scalar gradient has a S-shaped dependence on the scalar gradient, which is expected to be qualitatively different from that of a reacting scalar under fast chemistry conditions. However, because modeling is performed at a higher level and because the scalar-scalar-gradient FJDF contains the information about the scalar dissipation and the surface-to-volume ratio, the FJDF approach is expected to be more accurate than scalar filtered density function approaches and has the potential to model turbulent combustion over a wide range of Damkohler numbers.

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