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Inner-Scale Effects of Heat Release in Reacting Turbulent Shear Flows[1] ZACHARY NAGEL, WERNER J.A. DAHM, The University of Michigan — Comparisons are presented from the first inner-scaled measurements of velocity gradient quantities in reacting and nonreacting versions of otherwise identical turbulent shear flows. Distributions of gradient quantities are obtained for outer-scale Reynolds numbers $Re_\delta \equiv u_c\delta/\nu$ from 7,200 to 200,000. The local outer length scale δ and velocity scale u_c and associated inner scaling $\overline{(\partial u_i/\partial x_j)^n} \sim (\nu/\lambda_\nu^2)^n$ are used to identify the dominant physical mechanisms that produce heat release effects on the inner scales. In the nonreacting cases, classical inner scaling with the viscosity ν and inner (viscous) length scale $\lambda_\nu \sim \delta \cdot Re_\delta$ removes most differences in distributions measured at different Re_δ, with remaining differences being due to incomplete resolution of λ_ν with increasing Re_δ. Inertial and dissipation range spectra allow the measurement resolution scale Δ^* and the proper resolution-corrected inner scaling to be determined, with the resulting scaling verifying near-perfect similarity for all Re_δ. In the reacting cases, departures from this similarity reveal the true inner-scale changes due to heat release. Results clearly show that when inertial and body force effects on δ and u_c are accounted for via the equivalent density, and viscous effects are accounted for via the mixture-fraction-averaged viscosity, the resolution-corrected inner scaling reveals remaining effects of heat release on turbulent shear flows to be remarkably small.

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