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Scaling and modeling of subfilter-scale heat-release effects in turbulent premixed jet flames

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Flame-induced thermal expansion and its associated turbulence production can render conventional eddy viscosity-type turbulence models inaccurate in low Karlovitz number/high Damköhler turbulent premixed jet flames [1]. In the infinitely thin flame limit, counter-gradient transport in Reynolds-averaged Navier–Stokes simulations can be modeled using thermal-expansion source terms [2], but the analogous challenges in large-eddy simulation (LES) are more nuance†d due to the dependence of the subfilter-scale flame–turbulence dynamics on the the filter-scale Damköhler number [3]. Of particular concern is the "active cascade" regime (moderate Karlovitz number; high Damköhler number) [4], in which large-scale shear production and small-scale thermal expansion compete to determine the local, filter-scale energy dynamics. We present *a priori* direct numerical simulation analysis and *a posteriori* LES predictions of turbulent premixed jet flames at Karlovitz numbers spanning the distributed burning regime to the thin-flames regime. The competing effects of large- and small-scale production are analyzed using resolved and subfilter-scale turbulence kinetic energy and scalar variance budgets, and modeling approaches are proposed.

References

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