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Parametric study of sub-grid-scale flame–turbulence interactions in jet flames using a simplified kinetic model JONATHAN MACART, University of Notre Dame — Thermal expansion effects in turbulent premixed flames are known to invalidate gradient-diffusion assumptions of conventional eddy-viscosity-type turbulence models. The resulting counter-gradient transport can be accounted for in the Reynolds–Averaged Navier–Stokes (RANS) context by augmenting conventional dissipative models with thin-flame thermal-expansion source terms, but associated challenges in Large-Eddy Simulation (LES) are significant due to the dynamical nature of sub-grid-scale flame–turbulence interactions. Of particular concern is the active-cascade regime (moderate Karlovitz number; high Damköhler number), in which large-scale shear production and small-scale thermal expansion compete to determine the local filter-scale energy dynamics. Using a single-step Arrhenius kinetic model, Reynolds- and Damköhler-number-parameterized Direct Numerical Simulation (DNS) databases of turbulent premixed jet flames are obtained in the low- to moderate-Karlovitz-number regime. Competing effects of large- and small-scale production are analyzed using resolved and sub-grid-scale turbulence energy and scalar variance budgets, and modeling approaches are proposed.

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