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Turbulence-Radiation Interactions in Large-Eddy Simulations of Nonpremixed Turbulent Jet Flames D.C. HAWORTH, The Pennsylvania State University, A. GUPTA, Rolls-Royce, M.F. MODEST, University of California, Merced — Large-eddy simulation (LES) has been performed for four piloted nonpremixed turbulent jet flames: a nonluminous laboratory-scale flame, a luminous (sooting) laboratory-scale flame, a nonluminous larger-scale flame, and a luminous larger-scale flame. These flames range from optically thin to moderately optically thick. The simulations feature a transported composition filtered density function (FDF) method to account for the influence of subfilter-scale fluctuations in composition and temperature on resolved chemical reaction rates and radiative emission, and a photon Monte Carlo (PMC) method with line-by-line spectral resolution to model radiation heat transfer including re-absorption. New optimized FDF/PMC algorithms and parallelization strategies have been developed, such that fully coupled LES/FDF/PMC is computationally tractable. The model fully captures both emission and absorption turbulence-radiation interactions (TRI), and is exercised to quantify the contributions of subfilter-scale TRI. For mesh resolutions that are representative of those used in typical turbulent combustion LES studies (approximately 85 percent of the turbulence kinetic energy is resolved), subfilter-scale emission TRI are found to be important in all cases and subfilter-scale absorption TRI are negligible.

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