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Large-Eddy Simulation of a Nonpremixed Turbulent Reacting Flow with Thermal Radiation and Turbulence/Radiation Interactions[1]

ANKUR GUPTA, DANIEL HAWORTH, MICHAEL MODEST, The Pennsylvania State University — Large-eddy simulation (LES) has been performed for a planar turbulent channel flow between two infinite, parallel, stationary plates. The capabilities and limitations of the LES code in predicting correct turbulent velocity and passive temperature field statistics have been established through comparisons to DNS data from the literature for nonreacting cases. Mixing and chemical reaction (infinitely fast) between a fuel stream and an oxidizer stream have been simulated to generate large composition and temperature fluctuations in the flow; here the composition and temperature do not affect the hydrodynamics (one-way coupling). The radiative transfer equation is solved using a spherical harmonics (P1) method, and radiation properties correspond to a fictitious gray gas with a composition- and temperature-dependent Planck-mean absorption coefficient that mimics that of typical hydrocarbon-air combustion products. Simulations have been performed for different optical thicknesses. In the absence of chemical reaction, temperature fluctuations and turbulence/radiation interactions (TRI) are small, consistent with earlier findings. Chemical reaction enhances the composition and temperature fluctuations, and hence the importance of TRI. Contributions to emission and absorption TRI have been isolated and quantified.

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