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A DETAILED NUMERICAL INVESTIGATION OF RADIATIVE HEAT TRANSFER IN NONPREMIXED LAMINAR FLAMES

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ABSTRACT. A series of laminar flames is simulated in this study using a newly developed laminar flame solver. Combustion chemistry is accounted for by a 16-species chemical mechanism and radiation is captured by a forward Monte Carlo ray tracing solver coupled with a line-by-line model. A backward Monte Carlo solver is also developed for the nongrey inhomogeneous condition and compared with the forward Monte Carlo solver. The laminar flame solver is first validated against detailed measurements of a laminar methane flame, and then applied to the target flames where only heat flux measurements are available. Good agreement with experiments is observed for all three flames, with larger discrepancy observed at downstream locations for the largest flame. Iso-contours of radiation-related scalars indicate that the laminar flames are within the optically-thin limit. Results obtained from the backward Monte Carlo solver show sensitivity to the choice of equivalent temperature that is employed for sampling wavenumbers.