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APPLICATION OF HIGH-ORDER SPHERICAL HARMONICS METHODS FOR RADIATIVE TRANSFER IN SIMULATION OF A TURBULENT JET FLAME

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ABSTRACT. Computational studies of the effects of radiative transfer in combustion have been hindered for a long time by the lack of relatively accurate and computationally affordable radiation models. The Photon Monte Carlo (PMC) method with line-by-line (LBL) database is very accurate but can be quite expensive if a large number of photon bundles are to be traced. One possible alternative is to use high-order spherical harmonics (P_N) methods for solutions of the Radiative Transfer Equation (RTE) combined with the full-spectrum k-distribution (FSK) method for the spectral model. In this study, high-order spherical harmonics (P_N) methods up to the order of P_7 together with an FSK look-up table have been applied to study nongray radiative transfer in the combustion simulation of an artificial turbulent jet flame, Sandia Flame D$\times$4, which is scaled up from the well-studied Sandia Flame D. Comparing the results of the PMC+LBL and P1+FSK in a coupled simulation, it is found that the scalar fields predicted by high-order P_N methods are only marginally better than that from the P1+FSK results and are still different from the PMC+LBL result. Following the coupled simulation, a snapshot study based on a frozen field of Sandia Flame D$\times$4 is carried out to further investigate the potential and limitation of high-order P_N method for this specific type of flame.