PDF-based simulations of turbulent spray combustion in a constant-volume chamber under diesel-engine-like conditions

Transported probability density function (PDF) methods are used to account for turbulent fluctuations in composition and temperature in simulations of liquid fuel injection (n-heptane), vaporization, mixing, autoignition, combustion and soot formation for a constant-volume combustion chamber. Both stochastic Lagrangian particle and stochastic Eulerian field methods are used to solve the modeled PDF transport equation. Model results are compared with experimental measurements from the Engine Combustion Network for nonreacting vaporizing sprays and for cases with autoignition and combustion. Parametric studies are performed with variations in key physical models and numerical parameters to establish sensitivities. Results obtained using the PDF method are compared with results obtained by neglecting turbulent fluctuations to determine the extent to which turbulence-chemistry interactions (TCI) influence the results. Depending on the choice of chemical mechanism, a model that neglects turbulent fluctuations in composition and temperature can reproduce the measured trends in ignition delay and liftoff length with variations in the thermochemical environment. However, the computed turbulent flame structure is qualitatively incorrect when TCI are ignored, and there are significant differences in computed soot distributions between simulations that consider TCI and simulations that do not. Quantitative differences in computed ignition delays and liftoff lengths between simulations that include TCI and simulations that do not are larger for the less robust combustion environments that are expected to be representative of those in advanced compression-ignition engines (e.g., low temperatures and/or low oxygen levels).

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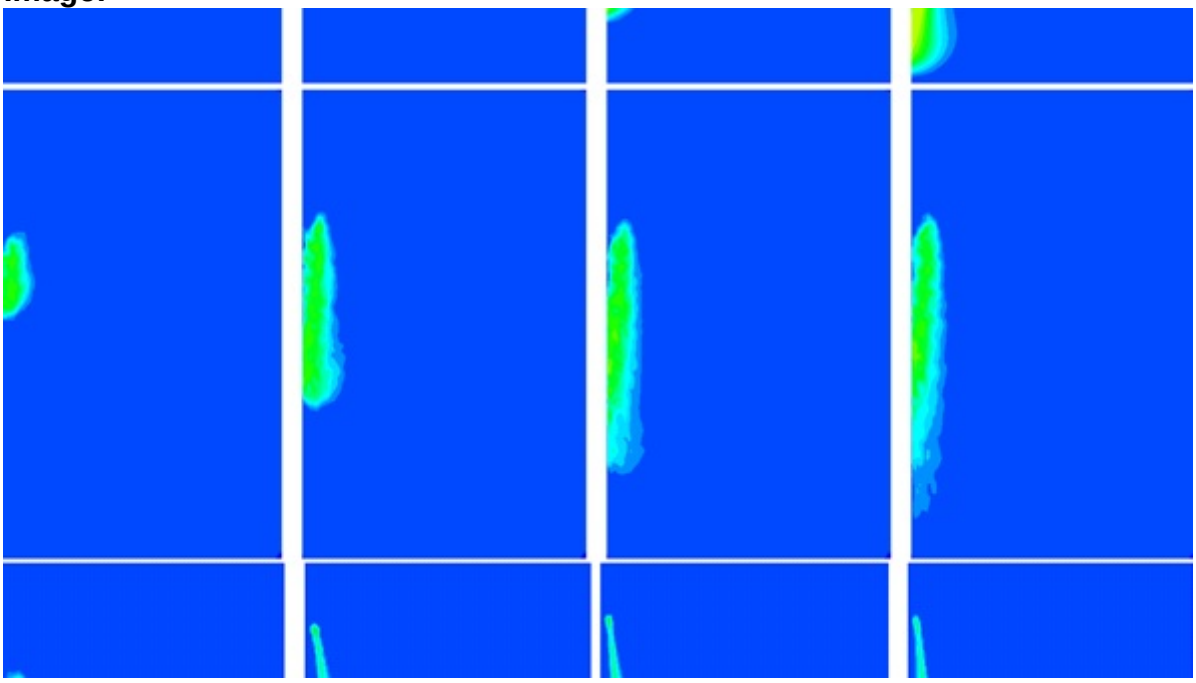

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