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A Priori Analysis of Flamelet-based Modeling for a Dual-Mode Scramjet Combustor JESSE QUINLAN, JAMES MCDANIEL, University of Virginia, TOMASZ DROZDA, NASA Langley Research Center, GUILHEM LACAZE, JOSEPH OEFELEIN, Sandia National Laboratories — A priori analysis of a dual-mode scramjet combustor is performed using a Reynolds-Averaged Navier-Stokes simulation dataset utilizing finite-rate kinetics to investigate the applicability of flamelet-based combustion models. The HIFiRE Direct Connect Rig flow path is simulated in a dual-mode configuration for the combustion of a JP-7 fuel surrogate using an 18-step chemical mechanism. Simulation results are validated using experimental time-averaged wall pressure measurements. Analysis of the flame structure and combustion mode suggests that combustion regions are predominately of a non-premixed nature and of a high Damkohler number, thereby suggesting the applicability of non-premixed flamelet-based modeling techniques. Regions of premixed combustion were detected but with significantly lower heat-release contribution when compared to the non-premixed combustion regions. Representative flamelet boundary conditions are estimated using an analysis of probability density functions for temperature and pressure. The effects of compressibility on the flame structure and corresponding flamelets are investigated. Insights and future work regarding development of non-premixed flamelet-based models for high-speed compressible flows are discussed.

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