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**Spectral Element DNS of a Laboratory-Scale Non-Premixed Jet in Vitiated Turbulent Cross-Flow**[1] CHAO XU, MUHSIN AMEEN, PINAKI PAL, SIBENDU SOM, Argonne National Laboratory — This work presents a direct numerical simulation (DNS) study of a laboratory-scale non-premixed jet in vitiated turbulent cross-flow (JICF), using a highly scalable spectral element CFD code, Nek5000. The computational domain targeting an experimental configuration is larger than those in previous DNS studies, allowing for investigation of practical turbulent flow patterns. A non-reacting JICF DNS is first performed using the mixture-averaged molecular transport model to account for differential diffusion. Two-dimensional velocity and vorticity profiles from the simulation are compared with experimental measurements and show good agreement. Three-dimensional vortex structures and their formation mechanisms are analyzed in detail using the high-fidelity data. A reacting JICF DNS with a diluted hydrogen jet is then performed using a detailed chemical kinetic mechanism. The operator-splitting scheme along with an advanced chemistry solver are employed to accelerate the simulation. Predicted flame structures in both windward and leeward sides of the reacting jet are compared with experimental OH PLIF measurements. Effects of flames on the vortex structure are finally discussed by comparing the non-reacting and reacting JICF simulations.

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