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Terascale Direct Numerical Simulations of Turbulent Combustion[1]

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The rapid growth in computational power in the past decade has presented both opportunities and challenges for high-fidelity simulations of turbulent reacting flows. The advent of terascale computing power has made it possible to glean fundamental physical insight into fine-grained "turbulence-chemistry" interactions in simple laboratory-scale turbulent flames from direct numerical simulation at moderate Reynolds numbers with detailed chemistry. Recent DNS results are presented to elucidate the role of autoignition and large-eddy mixing on the stabilization of a lifted ethylene-air jet flame in a heated coflow. The role of scalar dissipation rate on modulating ignition delays or lift-off heights is discussed. The simulations were performed at a jet Reynolds number of 10,000 and required 1.3 billion grid points to resolve the turbulence and flame structure. In a second related topic, the morphology of the scalar dissipation rate field in a turbulent jet flame is examined using topological methods, in particular the Morse-Smale Complex, which provides a natural segmentation of dissipation rate elements or "features." These features are tracked in time, and conditional feature statistics are presented.

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