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Adjoint-based ignition sensitivity in turbulent combustion[1]
DAVID BUCHTA, University of Illinois at Urbana–Champaign, JESSE CAPECELATRO, University of Michigan, JONATHAN FREUND, University of Illinois at Urbana–Champaign — We demonstrate adjoint-based sensitivity calculations for large-scale turbulent combustion simulations, with the goal of identifying, quantifying, and reducing prediction uncertainties. It is demonstrated on a non-premixed turbulent shear layer, a reacting jet-in-crossflow, and ignition in decaying turbulence. We distinguish sensitivities between a detailed and a global one-step hydrogen-air mechanism. The primary model system is the ignition of a turbulent jet by a laser-induced optical breakdown (LIB). Ignition, defined by a space-time integral of temperature, is most sensitive to the modeled plasma kernel geometry and its energy deposited on the gas phase. Thus, combining the adjoint-based sensitivity with the LIB's aleatoric interspersed plasma kernels, these parameters dominate the propagated output uncertainty, which is local to the inputs. The present combustion sensitivity studies are a component of a multi-scale, multi-physics combustion application, which is also discussed for context.

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