Stochastic algorithms for simulation and analysis of turbulent premixed combsution

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Recent progress in the development of discretization methodology for reacting flows combined with high-performance parallel architectures have made it possible to simulate turbulent premixed combustion using detailed chemistry and transport without explicit subgrid models. The capability to perform these types of simulations raises questions about how to most effectively apply existing tools to the study of premixed flames. In this talk, we consider the application of stochastic algorithms to two different aspects of the problem. First, we discuss a stochastic control algorithm to stabilize an inherently unstable flame geometry. The control algorithm allows us to perform simulations in which the flame is statistically stationary without introducing geometric complexity. We illustrate the control approach for two and three dimensional methane flames. The second topic we discuss is the analysis of time-dependent flame data with detailed chemistry and transport. To study a flame, we can imagine hypothetically tagging specific atoms and monitoring their progress through the system. Although this concept is not viable experimentally, given simulation data we can perform this "experiment" computationally. This process can be described mathematically in terms of a deterministic model for advection combined with stochastic models for species transport and chemical reactions. We discuss the components the model and illustrate its application to a variety of flame configurations.