

Adaptive numerical simulation of low Mach number combustion

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Numerical simulation of reacting flows with comprehensive kinetics is one of the most demanding areas of computational fluid dynamics. High-fidelity modeling requires accurate fluid mechanics, detailed models for multicomponent transport and detailed chemical mechanisms. In this talk we describe methodology to simulate time-dependent reacting flows in three dimensions. This approach is based on a specialized form of the low Mach number equations that conserves mass and energy. The low Mach number equations, derived from asymptotic analysis, are structurally similar to the incompressible Navier-Stokes equations. Our basic computational approach uses a generalized projection formulation that exploits this similarity. The core discretization algorithm is embedded in an adaptive projection framework that uses structured hierarchical grids with subcycling in time. The discrete conservation properties and second-order accuracy of the underlying single-grid algorithm are preserved. The adaptive framework is implemented using a software infrastructure that supports distributed memory parallel architectures. We illustrate the methodology on several examples of two- and three-dimensional flames.