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Simulating Multi-Species Compressible Reactive Flow at Low-Mach Number with a High-Order Fully-Implicit All-Speed Flow Solver[1]
BRIAN WESTON, ROBERT NOURGALIEV, MATT MCCLELLAND, Lawrence Livermore National Laboratory, LAWRENCE LIVERMORE NATIONAL LABORATORY COLLABORATION — We present a high-order, fully-implicit all-speed fluid dynamics solver for simulating multi-species compressible reactive flow at very low-Mach numbers. The work is motivated by the development of high-explosive cookoff simulations, which requires modeling multi-species/multi-phase reactive melt convection physics over long time-scales. The governing equations are discretized in space up to 5^{th}-order accuracy with a reconstructed Discontinuous Galerkin method and integrated in time with L-stable fully implicit time discretization schemes. The resulting set of non-linear equations is converged using a robust physics-block based preconditioned Newton-Krylov solver. We demonstrate that our fully-implicit flow solver is able to robustly converge multi-species compressible flow calculations with Mach numbers less than 10^{-5}. Furthermore, our fully-implicit framework allows for large time steps relative to fast chemical kinetic timescales, which result in highly stiff linear systems.

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