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Detonation simulations by solving the spatially-filtered Euler equations ALEXANDRA BAUMGART, GUILLAUME BEARDSELL, GUILLAUME BLANQUART, Caltech — The presence of both shocks and chemical reactions in detonations poses a challenge for simulation efficiency. Detailed chemical kinetic models require one equation per chemical species in addition to the compressible Navier-Stokes equations, quickly increasing the computational cost. To model hydrogen combustion, nine species are needed; for hydrocarbon fuels, there may be hundreds or even thousands of species to consider. The cost of chemistry has been addressed for subsonic reacting flow simulations using the tabulated chemistry method, in which one (or a combination of) species mass fraction tracks the progress of reactions in a system. However, species concentrations also depend on the thermodynamic state, as temperature and pressure affect reaction rates. In compressible flows, these thermodynamic variables, along with the progress variable, are used to describe all other species mass fractions, greatly reducing the computational cost. This work extends the methodology that has been implemented for turbulent flames to include one-dimensional detonations. The reduced-order chemical model is validated against simulation data obtained with detailed chemistry.

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