Multiscale Modeling of Chemically Reactive Flows

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In this work we construct reduced model equations obtained by equilibrating the fast dynamics of closely coupled reaction/transport systems and combine this with an efficient method to account for detailed spatial structures. To address the temporal multiscale characteristics of such systems, we construct, as an extension of the finite dimensional method of Intrinsic Low Dimensional Manifolds (ILDMs), an infinite dimensional Approximate Slow Invariant Manifold (ASIM) on which slow reactions and transport evolve. To address the spatial multiscale characteristics, we employ a Wavelet Adaptive Multiscale Representation (WAMR) algorithm to capture the important large and small scale phenomena. The efficacy and accuracy of these algorithms are demonstrated for the simple model systems of an ozone laminar flame and a shock tube ignition delay problem in hydrogen/oxygen/argon.