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A Discrete Adjoint-Based Method for High-Fidelity Simulations of Turbulent Reacting Flows ALI KORD[1], University of Michigan, JESSE CAPECELATRO[2], University of Michigan, Ann Arbor — In recent years, direct numerical simulation (DNS) and large-eddy simulation (LES) have gained in popularity for simulating turbulent reacting flows within the scientific and engineering community. However, due to their high computational cost, they have mainly been employed to investigate micro-scale physics or develop new sub-grid scale models. Meanwhile, using such approaches for design or optimization requires performing many simulations. Adjoint-based methods provide local sensitivity to a quantity of interest to a potentially large number of parameters without requiring repeated simulations. However, special care needs to be taken when employing adjoint methods to turbulent reacting flows. In this talk, we present a discrete adjoint method with attention paid to ensure the method retains desirable properties of the forward solution, i.e. boundedness, accuracy, and robustness. The method is implemented using high-order finite difference operators coupled with tabulated chemistry. An adaptive discretization scheme is presented to ensure scalar boundedness. Tabulated chemistry allows for chemical mechanisms to be varied without requiring reformulation and implementation of the adjoint equations. The approach is demonstrated on a series of cases with varying complexity.

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