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Evaluation of model constant sensitivities for subfilter mixture fraction variance using adjoint and sensitivity derivative approaches
KEVIN GRIFFIN, Stanford University, MICHAEL MUELLER, Princeton University — The subfilter mixture fraction variance is a critical quantity in Large Eddy Simulation (LES) models for turbulent nonpremixed combustion. In the transport equation for the subfilter mixture fraction variance, two terms require modeling: the subfilter mixture fraction dissipation rate and the subfilter scalar flux. Conventional models for both of these terms require specification of model constants: the subfilter mixture fraction dissipation rate model constant and the subfilter turbulent Schmidt number. In this work, two approaches are compared for computing the sensitivity of the subfilter mixture fraction variance to these two model constants. In the first approach, explicit transport equations are derived and solved for the sensitivity derivatives. In the second approach, the sensitivity is obtained from the continuous adjoint equation of the subfilter mixture fraction variance. To stabilize the forward solution of the adjoint equation in LES, an efficient bootstrapping approach is proposed. The two methods are applied to a non-reacting nonpremixed bluff body flow, and the relative magnitudes of the two model constant sensitivities are discussed. The two methods are compared in terms of computational cost and apparent accuracy.

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