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Direct Numerical Simulation of the Temporally-Evolving Reacting Jet for Model Error Assessment of RANS-based Closures for Non-Premixed Turbulent Combustion BRYAN REUTER, TODD OLIVER, ROBERT MOSER, Oden Institute for Computational Engineering and Sciences, UT-Austin — High-fidelity DNS data of the temporal reacting jet is generated using a laminar flamelet closure, the same chemistry model as is typically employed in RANS-based approaches. The simulations solve the low-Mach Navier-Stokes equations with a pseudospectral Fourier-Galerkin/B-Spline collocation approach and a novel second-order, explicit time marching scheme. The turbulence is fully resolved, but the chemistry is modeled by obtaining the density from a flamelet library which is a function of the local mixture fraction and scalar dissipation rate. This methodology allows for a clear assessment of the errors that arise from the three aspects of a model for combustion: turbulence closures, modeling the turbulence-chemistry interaction, and chemical kinetics closures. As there is no conflation of errors arising via the chemical kinetics, the data can be used to directly assess the performance of RANS closures in representing the turbulence and the turbulence-chemistry interaction. Conversely, by comparing our DNS with one closed with a higher fidelity chemistry model from Attili and co-authors, any discrepancies can be attributed to the different chemical kinetics closures. Results are shown for the $k-\varepsilon$ model with presumed-PDF approach for a non-premixed $n-$heptane flame.

Bryan Reuter
Oden Institute for Computational Engineering and Sciences, UT-Austin

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