Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Semi-implicit iterative methods for low Mach number turbulent reacting flows JONATHAN F. MACART, MICHAEL E. MUELLER, Princeton University — A formally second-order accurate Strang splitting approach has been developed and applied to the solution of scalar transport/reaction equations for Direct Numerical Simulation (DNS) of low Mach number turbulent reacting flows. The temporal discretization errors of this scheme are analyzed and compared with a formally first-order accurate Lie splitting approach and variations on a second-order accurate monolithic preconditioned scheme, utilizing two different preconditioners: the full Jacobian of the chemical source term and its diagonal approximation. The effect of chemical mechanism size on the relative performance of these schemes is assessed with a simple one-dimensional unsteady test case. The improved stability of the full Jacobian preconditioner is found to outpace its increased cost per time step compared to the diagonal approximation, and this advantage is found to increase with mechanism size. Likewise, the Strang splitting scheme is demonstrated to achieve better performance than the other approaches due to greater stability at larger time steps, despite greater cost per step. Finally, the schemes are evaluated with a three-dimensional unsteady turbulent planar jet flame, and similar conclusions are found as for the one-dimensional test case for relative performance.

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Date submitted: 28 Jul 2015 Electronic form version 1.4