David Gardner

# Implicit Time Stepping and Preconditioning for Global Atmospheric Dynamics in Climate Simulation

Lawrence Livermore National Laboratory
7000 East Ave L-561
Livermore
CA 94550
gardner48@llnl.gov
Richard Archibald
Katherine Evans
Carol Woodward

High resolution, long-term climate simulations are critical to investigating multiscale behavior in global climate simulations and understanding regional climate variation on the decade scale. Implicit time stepping methods provide a means to increase efficiency by taking time steps commensurate with the physical processes of interest rather than step sizes limited by model resolution. We present results utilizing a second order implicit time stepping method and Trilinos solvers in the hydrostatic spectral element dynamical core of the Community Atmosphere Model (CAM-SE), the atmosphere component of the Community Earth System Model (CESM) and the Accelerated Climate Model for Energy (ACME). The growth of linear iterations in the Newton-Krylov method applied to the nonlinear residual equation highlights the need for scalable preconditioning to reduce the cost of ancillary linear system solves. We discuss the impact of an approximate block factorization preconditioner on solver efficiency and scalability when utilizing a globally assembled Jacobian matrix for the spectral element discretization.

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-ABS-681040