Summary

The major goal of this project was to contribute improvements to the infrastructure of an Earth System Model in order to support research in the Multiscale Methods for Accurate, Efficient, and Scale-Aware models of the Earth System project. In support of this, the NCAR team accomplished two main tasks: improving input/output performance of the model and improving atmospheric model simulation quality. Improvement of the performance and scalability of data input and diagnostic output within the model required a new infrastructure which can efficiently handle the unstructured grids common in multiscale simulations. This allows for a more computationally efficient model. Simulation quality of the model was improved by reducing grid-point noise in the spectral element version of the Community Atmosphere Model (CAM-SE).

Final Report

During this project, we accomplished tasks in two main areas as outlined in the work associated with Variable Resolution Dynamical Frameworks (section 2) and Process Integration (section 3.3).

At the beginning of this project, we found that CAM infrastructure did not meet the needs of incorporating variable resolution dynamical frameworks while maintaining computational efficiency. To enable the goals of section 2, over the course of this project, new infrastructure was implemented which performs initial-condition input and diagnostic output in a parallel, scalable, and efficient manner. In particular, regional output is much faster and interpolated output is more flexible. The new infrastructure also provides flexibility for adding new types of diagnostic output.

One area of process integration (section 3.3) which we have addressed is the source of grid-point noise in many Community Atmosphere Model Spectral Element (CAM-SE) studies. Our solution has been to implement the column physics package on a finite volume grid created by subdividing each spectral element into an equal area grid. This new process allows us to send the physics an area-averaged state (rather than a point value) and to work to mitigate the effect of the uncoordinated tendencies from the physics package causing nonphysical effects when applied in the SE dynamical core. Since this new infrastructure allows for varying the size of the physics columns, we are currently studying subdividing each spectral element into 2x2, 3x3 and 4x4 finite volume grids.

The publications below make use of the infrastructure described above:

Lauritzen, P. H., M. A. Taylor, J. Overfelt, P. A. Ullrich, R. D. Nair, S. Goldhaber, and R. Kelly, 2017: CAM-SE-CSLAM: Consistent coupling of a conservative semi-Lagrangian finite-volume method with spectral element dynamics. Monthly Weather Review, 145, 833-855, doi:10.1175/MWR-D-16-0258.1.

Thayer-Calder, K., and Coauthors, 2015: A unified parameterization of clouds and turbulence using CLUBB and subcolumns in the Community Atmosphere Model. Geoscientific Model Development, 8, 3801-3821, doi:10.5194/gmd-8-3801-2015.