ABSTRACT

Title: Experimenting with the GMAO 4D Data Assimilation

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The Global Modeling and Assimilation Office (GMAO) has been working to promote its prototype four-dimensional variational (4DVAR) system to a version that can be exercised at operationally desirable configurations. Beyond a general circulation model (GCM) and an analysis system, traditional 4DVAR requires availability of tangent linear (TL) and adjoint (AD) models of the corresponding GCM. The GMAO prototype 4DVAR uses the finite-volume-based GEOS GCM and the Grid-point Statistical Interpolation (GSI) system for the first two, and TL and AD models derived from an early version of the finite-volume hydrodynamics that is scientifically equivalent to the present GEOS nonlinear GCM but computationally rather outdated. Specifically, the TL and AD models hydrodynamics uses a simple (1-dimensional) latitudinal MPI domain decomposition, which has consequent low scalability and prevents the prototype 4DVAR from being used in realistic applications.

In the near future, GMAO will be upgrading its operational GEOS GCM (and assimilation system) to use a cubed-sphere-based hydrodynamics. This versions of the dynamics scales to thousands of processes and has led to a decision to re-derive the TL and AD models for this more modern dynamics, thus taking advantage of a two-dimensional MPI decomposition and improved scalability properties. With the aid of the *Transformation of Algorithms in FORTRAN (TAF)* automatic adjoint generation *tool* and some hand-coding, a version of the cubed-sphere-based TL and AD models, with a simplified vertical diffusion scheme, is now available, enabling multiple configurations of standard implementations of 4DVAR in GEOS.

Concurrent to this development, collaboration with the National Centers for Environmental Prediction (NCEP) and the Earth System Research Laboratory (ESRL) has allowed GMAO to implement a hybrid-ensemble capability within the GEOS data assimilation system. Both 3D- and 4D-ensemble capabilities are presently available thus allowing GMAO to now evaluate the performance and benefit of various ensemble and variational assimilation strategies. This presentation will cover the most recent developments taking place at GMAO and show results from various comparisons from traditional techniques to more recent ensemble-based ones.