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Further development of the unified multiscale Eulerian model for a broad range of spatial and temporal scales within the new National Environmental Modeling System

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A unified Nonhydrostatic Multiscale Model on the Arakawa B grid (NMMB) designed for a broad range of spatial and temporal scales has been under development within the Earth System Modeling Framework (ESMF) at the National Centers for Environmental Prediction (NCEP) as a part of the new National Environmental Modeling System (NEMS). The model follows the general modeling philosophy of the NCEP's WRF NMM grid-point regional dynamical core. The model uses the regular latitude-longitude grid for the global domain, and a rotated latitude-longitude grid in regional applications. The nonhydrostatic component of the model dynamics is introduced through an add–on module that can be turned on or off depending on resolution. The "isotropic" quadratic conservative finite-volume horizontal differencing employed in the model conserves a variety of basic and derived dynamical and quadratic quantities and preserves some important properties of differential operators. Among these, the conservation of energy and enstrophy improves the accuracy of the nonlinear dynamics of the model on all scales. "Across the pole" polar boundary conditions are specified in the global limit and the polar filter selectively slows down the wave components of the basic dynamical variables that would otherwise propagate faster in the zonal direction than the fastest wave propagating in the meridional direction.

Several upgrades have been recently incorporated into the model. As a compromise between requirements for affordability and accuracy, a fast Eulerian conservative and positive definite scheme has been developed for model tracers. Conservative monotonization is applied in order to control over-steepening within the tracer advection scheme. The tests performed so far have been encouraging concerning the tracer mass conservation and shape preservation, as well as computational efficiency. As an effort for unification among NEMS models that was expected to improve data assimilation, several algorithms for generating general hybrid pressure-sigma coordinates have been examined. The requirements imposed were that the transition to the full pressure coordinate be below the tropopause level, and that the tropopause be well resolved. A coordinate formulation has been selected that allows that the transition point be as low as 300 hPa in the global domain without compromising vertical resolution away from high topography. The top of the model atmosphere has been raised to 0 hPa. There has been no stability problems, but it turned out that it was desirable to enhance the horizontal divergence damping in the uppermost 1-1.5% of the mass of the atmosphere in order to eliminate noise occasionally propagating downward from the top.

Examples demonstrating the impact of model changes will be shown. Within NEMS, the regional version of the NMMB is planned to replace the WRF NMM as the NCEP's main regional North American Model (NAM) in 2010.