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Multi-scale Eulerian NMMB model within the NOAA Environmental Modeling System: advances on global and meso scales

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The unified Non-hydrostatic Multi-scale Model on the B grid (NMMB) is being developed at NCEP as a part of the National Environmental Modeling System (NEMS). The finite-volume horizontal differencing employed in the model preserves important properties of differential operators and conserves a variety of basic and derived dynamical and quadratic quantities. Among these, conservation of energy and enstrophy improves the accuracy of nonlinear dynamics. The nonhydrostatic dynamics were formulated in such a way as to avoid overspecification. In the global limit, conservative polar boundary conditions are used, and the polar filter selectively slows down the wave components that would otherwise propagate faster in the zonal direction than the fastest wave propagating in the meridional direction. The physical package of the model has been developed from the standard NCEP's WRF NMM physics, and includes updated radiation, turbulence, moist convection and gravity wave drag.

A global forecasting system based on the NMMB was run for more than a year in order to test and tune the model, and in particular, to examine its potential for medium range weather forecasting. The system was initialized and verified using the spectral analyses of NCEP's Global Forecasting System (GFS). Note that the spectral model data cannot be perfectly converted into grid point model data due to differences between the two modeling approaches. Nevertheless, the skill of the medium range forecasts produced by the NMMB was comparable to that of other major medium range forecasting systems. Interestingly, even though the NMMB and GFS were starting from very similar initial conditions, the skill of the two individual medium range forecasts was often disparate. When one model produced a bad forecast, the forecast from the other model could be quite good. Such behavior appears potentially advantageous for application of the two models for ensemble forecasting. The computational efficiency of the model on parallel computers was good.

On the mesoscales, the NMMB is planned to replace the WRF NMM in operations as the North American Model (NAM), and in a number of nested high resolution runs. Within efforts to upgrade the physical package on the small scales, a new approach is being investigated concerning the problem of shallow cloud topped marine boundary layers. The problem of application of deep moist convection parameterization with single digit resolutions has been addressed within the context of the BMJ scheme. Being an adjustment scheme, the application of the BMJ scheme at high resolutions is not in conflict with the basic parameterization assumptions. The proposed approach reduces excessive precipitation bias, and at the same time preserves realistic spatial structure of precipitation forecasts in high resolution runs. No detrimental effect on the timing of precipitation due to the parameterized convection could be noticed. Most near-surface, and upper-air skill scores were improved.