Continuous Dynamic Grid Adaptation for Regional Simulation in a Global Atmospheric Model

J. M. Prusa (1,2) and W. J. Gutowski, Jr. (3,4)
(1) Teraflux Corporation, Florida, USA
(2) Dept. of Mechanical Engineering, Iowa State Univ., USA
(3) Dept. Geological and Atmospheric Sciences, Iowa State Univ., USA
(4) Dept. Agronomy, Iowa State University, USA

Regional climate in global models is often poorly resolved due to the computing demands of lengthy simulation. Stretched grid models attempt to overcome this limitation by using higher spatial resolution in pre-specified regions. We take grid refinement a step further by allowing grid spacing to change dynamically to resolve well-targeted features such as fronts and other convergence zones. Initial study focusing on moisture evolution in an atmospheric mesoscale model shows that the scheme produces much finer resolution of water vapor concentration than static grids using the same number of grid points. The dynamic grid's field is matched by finer, static grids only if they use at least four times as many grid points.

Ongoing effort is using a global atmospheric model developed by Smolarkiewicz and colleagues that is based upon nonoscillatory, forward-in-time (NFT) numerical schemes, an anelastic approximation for deep moist convection and, at this stage of development, limited representations of other model physics. The capability for grid adaptation derives from mapping the evolving grid in spherical coordinates into a uniform, transformed coordinate system on the sphere. The horizontal coordinates in the transformed domain can be any transformation of latitude and longitude that preserves the topology of spherical coordinates. The vertical coordinate is treated separately with a time variable generalization of the terrain following transformation. The vertical transformed coordinate may be stretched in any time variable, nonuniform way that preserves the topology of the reference spherical coordinate system (i.e., it may, in principle, follow isobars or isentropes).

Preliminary results focusing on dynamic core behavior show that the adaptive grid model gives superior depiction of sharply defined circulation features such as zonal jets. Further simulation will be using refined model physics and focus attention on specific problems in regional climate simulation, such as intense convective systems that are not resolved by typical RCM and GCM grids, but which contribute substantially to climatological precipitation.