Design of Atmosphere Models Based on the Nonhydrostatic Unified System of Equations in the Sigma Vertical Coordinates

Ross P. Heikes, Celal S. Konor and David A. Randall

Department of Atmospheric Science
Colorado State University, Fort Collins, CO, USA

Majority of nonhydrostatic models use fully compressible, anelastic or pseudo-incompressible systems of equations in their dynamical cores. The fully compressible system includes vertically propagating acoustic waves, which need to be stabilized in the discrete model to allow the use of reasonably long time steps in the integrations. The anelastic and pseudo-incompressible systems, on the other hand, exclude such waves completely by not allowing elasticity. It is widely accepted that the small-scale atmospheric motion is anelastic. However, the planetary-scale atmospheric waves are elastic.

The nonhydrostatic unified system of equations introduced by Arakawa and Konor in 2009 (published by MWR) for the use in cloud-resolving global models includes elasticity needed for proper simulations of planetary-scales while it filters vertically propagating acoustic waves at their origin (see also Konor, 2014, MWR).

Design of global dry dynamical core based on the unified system in the sigma vertical coordinate will be discussed, with an emphasis on the computational aspects. The performance of the dynamical core will be demonstrated through the results from various global simulations.