A TIME-SPLITTING SCHEME FOR NONHYDROSTATIC ATMOSPHERIC MODEL

ANDREI BOURCHTEIN AND LUDMILA BOURCHTEIN

Abstract. Continuously increasing power of computers has reached the point when real-time simulations based on the fully compressible equations of the atmosphere became possible. Although the hydrostatic assumption is proved to be a good approximation for synoptic and global scale processes, there is a strong current trend to return to the use of non-filtering governing equations in order to improve the forecasting skills for meso-scale phenomena where hydrostatic balance is not quite accurate [1,2,4]. Analysis of the linearized Euler equations reveals three principal types of atmospheric waves: acoustic, gravitational and inertial waves. The propagation speed of these waves is very different as well as their energy contribution. Opting to employ the full atmospheric equations for better description of the principal phenomena, one automatically involves the fastest acoustic and gravity waves and, therefore, should solve a stiff system [1,3,4].

In this research we construct a time-splitting finite difference scheme for the nonhydrostatic atmospheric model. Applying time-splitting, the fast acoustic and gravity waves are approximated implicitly, while relatively slow advective terms and Rossby modes are treated explicitly. Stability analysis of the scheme shows that the time step is not subjected to rigid limitation of the CFL condition with respect to fast modes and can be chosen according to physical considerations of accuracy. The performed numerical experiments show computational efficiency of the designed scheme and accuracy of the predicted atmospheric fields.

Keywords: numerical weather prediction, finite difference schemes, time-splitting methods

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Pelotas State University
E-mail address: bourchtein@gmail.com

Pelotas State University
E-mail address: ludmila.bourchtein@gmail.com