

On design of a Height-Based Terrain-Following Coordinate in the Atmospheric Numerical Model: Theoretical Analysis and Idealized Tests

ABSTRACT

Several kinds of typical height-based terrain-following coordinates, such as Gal-Chen&Somerville coordinate (hereafter 'Gal.C.S' coordinate), smoothed level vertical coordinate (hereafter SLEVE coordinate) and a new coordinate called as cosine-smoothed coordinate(hereafter 'COS' coordinate),were theoretically analyzed and intercompared with each other in the induced errors by calculations of the PGF(Pressure Gradient Force) for a rest atmosphere and the 2D-ADV(2-dimensional mass advection) tests. The results of calculation of the PGF showed that the errors of the calculation of the PGF induced by using a terrain following coordinates, were significantly decreased by using SLEVE1, SLEVE2 and COS coordinates in comparison to Gal.C.S coordinate.SLEVE2 and COS coordinates were relatively better in reduction of the errors of the PGF calculation. The decaying coefficient 'b' and its Jacobian derivative played a deterministic role in reduction of the errors. The similar remarks could be made for the tests of 2D-ADV calculation. The errors of the 2D-ADV calculation by using the COS coordinate were the smallest as those of the reference test in which there were no terrain. The COS coordinate was most advantageous to other coordinates in tests.

Keywords: Atmospheric numerical model, Height-based terrain-following coordinate, Pressure gradient error, Two-dimensional mass advection-diffusion