Abstract

The present work is devoted to the study of Numerical Weather Prediction pertaining to a limited area model. For this, a two-time-level semi-Lagrangian semi-implicit (SLSI) model is developed, and the time dependent elliptic type equations appearing in the model are solved by using a multigrid solver. The computational efficiency of this model is compared with a corresponding Eulerian barotropic model and found to be many times faster than the latter. A simple version of the implicit nonlinear normal mode initialization (INMI) scheme has been implemented in the model. The INMI scheme is found to be efficient in removing spurious gravity wave noise from both the models. Even with topographical forcing the scheme performed very well. The prediction of the movement of the depression was of limited accuracy.

The inclusion of β-terms in the linearization of shallow water equations, for deriving the general INMI algorithm makes the scheme computationally more expensive. A multigrid technique is developed to solve the elliptic equations for INMI as well as variational implicit normal mode initialization (VINMI) schemes. In order to study the sensitivity of β-terms, two domains of horizontal extent $O(10^3km \times 10^3km)$ and $O(10^4km \times 10^4km)$ are used. For domains of smaller horizontal extension the β-terms are found to be insensitive. The VINMI is also tested in these domains and the results show that the inclusion of β-terms are necessary for larger domain, in order to derive the full benefits of this scheme. A digital filtering initialization (DFI) is also implemented to the model in a barotropic case. A DFI scheme with 12 hours period cutoff removes the undesirable gravity wave oscillation. However it is still inferior to the INMI scheme.

The barotropic model is further extended to an adiabatic 6-layer baroclinic model in 2-D, two-time-level scheme. The model is integrated over 24 hours using typical monsoon depression data and with topography. The prediction at higher levels are found to be satisfactory (within the limitation of an adiabatic model). At 850 mb the flow became erroneous at higher latitudes of the domain where the topographical effect is more dominant. The cross equatorial flow and other monsoonal features are predicted well in this case.

The INMI and DFI schemes are implemented in the model. The INMI scheme with 2 vertical modes initialized is compared with a DFI scheme with a period cutoff of 6 hours. The INMI scheme with two vertical modes initialized converges in 3 iterations of the scheme. The convergence rate decreases with increasing time step for the higher vertical modes. The scheme diverges when more than 3 vertical modes are being initialized. However INMI with 2 vertical modes initialized is comparable to DFI with 6 hours of period cutoff. The efficiency of the DFI scheme is dependent on the model time step, and hence for higher resolution Limited Area Model (LAM), INMI may be preferable to DFI.