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THE APPLICATION OF REDUCED GRID FOR GLOBAL OCEAN MODELING

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ABSTRACT

A limitation of global climate models with explicit finite-difference procedures, is the time step restriction caused by the decrease in cell size associated with the convergence of meridians near the poles. To keep the longitudinal width of model cells as uniform as possible, a reduced grid is applied to a three-dimensional primitive equation ocean climate model. With this grid, the number of cells in the longitudinal direction is reduced at high latitudes. The grid consists of sub grids with changing in resolution, which interact at interfaces along their northern and southern boundaries. In this paper the finite difference technique to these interfaces has been extended. The reduced grid allows an increased time step while eliminating the need for filtering and reduces execution time per model step about 20%. The reduced grid model has been implemented for parallel computing with two-dimensional domains. Small solution effects and considerable execution time improvements has been shown.

1. INTRODUCTION

Global ocean models usually use of finite difference explicit time stepping method in spherical coordinates. At the poles, the coordinate system has a singularity and also the stability conditions of the method, depends on the size of grid cells. So, the convergence of meridians towards the poles in spherical coordinates occurs. In this work, the number of grid cells in the longitudinal direction is decreased near the pole. So, the cells remain uniform in size (Fig. 1). Filtering of high frequency components at higher latitudes allows the use of larger time steps without instability.

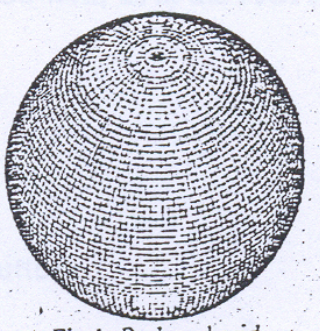

Fig 1. Reduced grid

The advantage of using reduced grid, is an increase in the allowable time steps and a decrease in the number of grid cells and grid modifications at small number of latitudes.

2. GOVERNING EQUATIONS

Ocean circulation model has been used in this modeling. The total velocities are split into barometric and baroclinic modes.

$$(u, v) = (\overline{u}, \overline{v}) + (\hat{u}, \hat{v}) \qquad (1)$$

Barametric velocities are defined as follows, where η is the surface height and H is the depth: