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Spherical multiple-cell grid suitable for ocean models

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The longitude-latitude grid is widely used in atmospheric and oceanic models, in which the longitudinal grid spacing decreases with latitude. As Eulerian advection scheme is subject to the CFL restriction, one direct consequence is the reduced time step due to the diminished longitudinal spacing towards the poles. Another drawback of the conventional grid is that land points, though not used by ocean models, have to be included in advection computation. These land points not only waste a lot of memory space in ocean models but also lead to redundant computations. A spherical multiple-cell grid is devised to tackle both the CFL restriction at high latitudes and to remove unwanted points out of the advection computation. The new grid is similar to unstructured grid but preserves the conventional finite difference algorithm by using pre-calculated neighbouring cell pointers. It doubles the longitudinal cell length in a few steps towards the poles like the adaptive grids so that actual longitudinal spacing remains comparable to the equatorial ones and hence achieves relaxed CFL condition. Two Upstream Non-Oscillatory advection schemes of 2nd- (UNO2) and 3rd- (UNO3) order accuracy have been devised for this grid and illustrated by a solid spherical rotation over global ocean surface. Zero coastal boundary condition as in ocean surface wave model is used in the test. Other boundary conditions may be implemented with slight modification. Spherical deformation test will also be presented though coastlines hinder direct comparison with its analytical solution, which is derived on a full sphere. Numerical results confirm that the multiple-cell grid and the UNO2/3 schemes are suitable for ocean models.