Geophysical Research Abstracts,
Vol. 10, EGU2008-A-00827, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-00827
EGU General Assembly 2008

High-order remapping schemes for generalized vertical coordinates in ocean models

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In the past decade or so, much effort has been devoted to the development of hybrid or generalized vertical coordinates that aim to reconcile the best properties of single coordinate systems by use of regridding and remapping schemes. So far, none of the existing techniques has been fully satisfying because the remapping schemes are generally too numerically diffusive and inaccurate and therefore inappropriate for long-term ocean modeling.

In this talk, we present a hierarchy of high-order remapping schemes to design hybrid vertical coordinate systems. The remapping schemes are based on piecewise polynomial reconstructions, such as the third-order piecewise parabolic method (PPM) and the fifth-order piecewise quartic method (PQM). These schemes are locally conservative, monotonicity-preserving and able to operate on highly non-uniform grids. Numerical diffusion is also drastically reduced. By resorting to compact (or implicit) schemes to estimate the cell edge values and slopes, not only are the stencils shortened but the dispersion errors are also significantly reduced. This makes the presented remapping schemes especially adequate in the presence of boundaries and successful in resolving small-scale features. Finally, we note that remapping can be viewed as generalized advection for which the CFL constraint can be relaxed without having to implement an implicit scheme. The remapping schemes are used to implement a hybrid vertical coordinate system in an OGCM. A comparative analysis is carried out.