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Summary: We describe a new diabatic primitive equation model for studying regional and basin-scale ocean circulation processes. The model features coordinate transformations that efficiently incorporate moderately irregular basin geometries and large variations in bottom topography, and permits the inclusion of both thermal and wind forcing. A novel semi-spectral solution procedure, in which the vertical structure of the model variables is represented as a finite sum of user-specifiable structure functions (e.g., Chebyshev polynomials), provides faster-than-algebraic convergence of the vertical approximation scheme. Model performance is assessed on a variety of test problems drawn from coastal and large-scale oceanography including unforced, linear wave propagation in both regular and irregular geometries; nonlinear flow over rough bottom topography; and eddy/mean flow interaction in a wind-driven, mid-latitude ocean basin. Computational efficiency of the model is found to be comparable to other existing primitive equation ocean models despite the utilization of the higher order spectral methods.

MSC:

76M25 Other numerical methods (fluid mechanics) (MSC2010)
76B60 Atmospheric waves (MSC2010)
86A05 Hydrology, hydrography, oceanography

Keywords:
diabatic primitive equation model; regional and basin-scale ocean circulation; thermal and wind forcing; Chebyshev polynomials; nonlinear flow over rough bottom topography; eddy/mean flow interaction; wind-driven, mid-latitude ocean basin; higher order spectral methods

Full Text: DOI

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