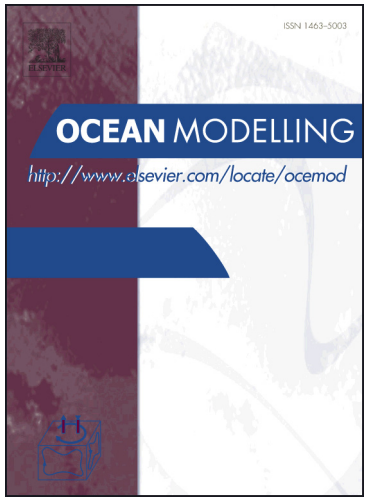

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Evaluation of the arbitrary Langrangian-Eulerian vertical coordinate method in the MPAS-Ocean Model

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Abstract

The vertical coordinate of the Model for Prediction Across Scales-Ocean (MPAS-Ocean) uses the Arbitrary Lagrangian-Eulerian (ALE) method, which offers a variety of configurations. When fully Eulerian, the vertical coordinate is fixed like a z-level ocean model; when fully Lagrangian there is no vertical transport through the interfaces so that the mesh moves with the fluid; additional options for vertical coordinates exist between these two extremes, including z-star, z-tilde, sigma, and isopycnal coordinates. Here we evaluate spurious diapycnal mixing in MPAS-Ocean in several idealized test cases as well as real-world domains with full bathymetry. Mixing data is compared to several other ocean models, including the Parallel Ocean Program (POP) z-level and z-star formulations. In three-dimensional domains, MPAS-Ocean has lower spurious mixing that other ocean models. A series of simulations show that this is likely due to MPAS-Ocean's hexagon-type horizontal grid cells combined with a flux-corrected transport tracer advection scheme designed for these unstructured meshes.

The frequency-filtered vertical coordinate of Leclair and Madec (2011) (also called z-tilde) has been implemented and analyzed in MPAS-Ocean. This addition allows low-frequency vertical transport to pass through the vertical interface in an Eulerian manner, while high-frequency vertical oscillations, such as internal gravity waves, are treated in a Lagrangian manner.

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