Abstract View

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Poleward Buoyancy Transport in the Ocean and Mesoscale Eddies

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ABSTRACT

There are many dynamic similarities between mesoscale eddies in the ocean, and cyclones and anticyclones in the earth's atmosphere. Observational data, however, are still not adequate to explore this analogy in detail. In the present study a new eddy-resolving ocean circulation model, which includes both wind-driving and buoyancy-driving, is used to determine whether mesoscale eddies play a role in poleward buoyancy transport in any way comparable to the role of synoptic scale motions in transporting heat in the atmosphere. Within an Eulerian reference frame, mesoscale eddies transport buoyancy poleward through two mechanisms. One involves the correlation of time-dependent fluctuations of horizontal velocity and buoyancy. The other transport mechanism involves wave-driven cells in the meridional plane. These cells are analogous to the Ferrel cell in the atmosphere, except that the geometry of the ocean basin allows them to be geostrophically balanced. In an eddy-resolving model of ocean circulation, the two mechanisms for buoyancy transport are almost perfectly compensating. Within a Lagrangian framework, the trajectories of the eddies are largely excursions on isapycnal surfaces. Heat transport may take place by eddies in the renal ocean without eddy buoyancy transport, since temperature gradients always exist on isopycnal surfaces and may be quite strong in polar regions. Mesoscale eddies and the thermohaline circulation in the model can be weakly coupled, because available potential energy created by the large-scale wind stirring provides a primary energy source for baroclinic instability. The model results indicate that the actual measurement of mesoscale eddy transports is extremely difficult, since it involves an accurate determination of the difference between transport by wave-driven, mean flows and by the correlation of the time-dependent fields.

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