Abstract View

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Global-Scale Water Masses, Meridional Circulation, and Heat Transport Simulated with a Global Isopycnal Ocean Model*

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ABSTRACT

The goal of this study is to fill the gap in equilibrium solutions of the global-scale water masses, meridional circulation, and heat transport with isopycnal ocean models. To this end, a global isopycnal ocean general circulation model is described and used in the present study. A distinguishing feature of the isopycnal model is that it is formulated in the same parameter space, boundary conditions, and model configurations except the vertical coordinates are those of the GFDL model used by Danabasoglu et al. with an isopycnal-depth diffusion parameterization of eddy-induced tracer transport. With the global isopycnal model, the author repeated Danabasoglu et al.'s coarse-resolution simulation for a direct comparison.

For the same parameter values (except lateral viscosity), the isopycnal model is able to produce a larger northward heat transport in the Northern Hemisphere, and a better latitudinal dependence of heat transport in the Southern Hemisphere, than the GFDL model. The model is also able to produce a reasonable amount of total meridional overturning mass transport, which is in good agreement with the observations in the North Atlantic Ocean. The most significant result obtained in this study is that the model-simulated climatological vertical profiles of the globally averaged potential temperature and salinity are both more realistic than those simulated by the GFDL model with the isopycnal-depth diffusion parameterization. The model-simulated vertical temperature profiles show a significant improvement on both the chronic warm bias of the thermocline with the horizontal/vertical mixing parameterization and the cool bias of the abyss with the isopycnal depth-diffusion parameterization in the GFDL model. The model-simulated vertical salinity profiles are also in reasonable agreement with the observations. In particular, the observed salinity minimum at the intermediate depth is well represented. On zonal average, the model thermocline structure is in better agreement with that observed than in Danabasoglu et al. Salinity tongues associated with the global-scale water masses are also well simulated by the model, except the North Pacific Deep Water. Influence of vertical resolution on the model water mass properties in the deep ocean is discussed. In the model, the transport of the upper Deacon cell is not changed by different zonal integrations of the meridional streamfunction nor by isopycnal-depth diffusion. This result differs from those of Doos and Webb, and Danabasoglu et al. The reasons for the difference are discussed.

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