The deep Pacific meridional overturning circulation simulated by a low-resolution ocean model

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The deep Pacific meridional overturning circulation (PMOC) is composed by the northward transport of deep water originated from the Southern Ocean and upwelling of deep water. Tidal mixing is an important process for maintenance of the upwelling of deep water. Several previous modeling studies suggested that geothermal heating at the sea floor also has a significant impact on the strength of deep PMOC. Many previous modeling studies employed distributions of the tidal mixing enhanced near the ocean bottom (local mixing). A previous modeling study suggested that tidally-induced mixing far from the ocean bottom (remote mixing) significantly influences the strength and structure of PMOC. It is pointed out that the mixing energy depends on the ocean stratification by microscale vertical temperature profiles. In this study, we try to reproduce the PMOC by using the distribution of remote mixing based on the recent observation and geothermal heating.

The model employed in this study is an ocean general circulation model (COCO). Its horizontal grid size is 1 degree (non-eddy-resolving model). The horizontal distributions of local and remote tidal mixing energies are estimated by a tide model. The local mixing energy is enhanced near the bottom and decayed with height. The vertical profile of remote mixing depends on the ocean stratification, which is suggested by many observational and theoretical studies. The heating of bottom water is added based on the horizontal map of geothermal heating.
The strength of deep PMOC is increased by using the stratification-dependent tidal energy of the remote mixing. The geothermal heating also significantly enhances the deep PMOC. The northward volume transport of deep water originated from the Southern Ocean is smaller than an observational estimate by the one-time 17-month moorings. We additionally calculated the isotope ratio of radiocarbon (seawater age) for validation of the strength of the modeled PMOC. When both remote mixing and geothermal heating are applied, the age of seawater in the deep Pacific Ocean is consistent with observation.

Keywords: Pacific meridional overturning circulation, ocean general circulation model, tidal mixing

