Diagnostic evaluation of vertical mixing effects on meridional overturning circulatoin

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Abyssal vertical mixing is well known to affect meridonal overturning circulation (MOC). However, how the mixing affects MOC remains unclarified. For example, the stronger vertical mixing is sometimes said to promote upwelling and intensifies the MOC by making the deeper water less dense. However, close look at some previous simulations reveals that, for certain horizontal distribution of vertical diffusivity, the stronger vertical mixing can induce weaker MOC while it makes the deeper water less dense. To make clear dynamical relation between the vertical mixing and MOC, we revisited MOC simulated in an idealized rectangular ocean forced by surface differential heating/cooling, and diagnosed its vorticity balance. It is found that geostrophy dominated in the large-scale MOC, and that the vertical mixing effect on the large-scale MOC is to change hydrostatic pressure fields (geostrophic flow fields) rather than to promote the upwelling. In this case, the stronger mixing can either intensify or weaken the large-scale geostrophic MOC. On the other hand, if the mixing was localized, ageostrophic divergent/convergent flows were induced to form the localized MOC. In this small-scale MOC, the stronger mixing always promotes the upwelling and intensifies the MOC. The simulation results presented in this study emphasize scale dependence of the vertical mixing effects on MOC.

Keywords: Vertical mixing, Meridional overturning circulation, Diagnostic evaluation of vorticity balance, Numerical experiments, Process-oriented study

