Evaluation of Mixing Coefficients in the Deep Ocean

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On the basis of an accumulation of observational results obtained mostly in the upper ocean, the mixing coefficient Γ in the Osborn's diapycnal diffusivity model is usually treated as a constant, $\Gamma = 0.2$. However, it has not been fully addressed whether Γ remains constant throughout the deep ocean. To address this issue, we estimate Γ using deep profiles of the turbulent kinetic energy dissipation rate ε and the temperature variance dissipation rate χ_T obtained in various regions such as the Izu-Ogasawara Ridge, the Emperor Seamounts, the Aleutian Ridge, and the Southern Ocean. The estimated Γ is surprisingly variable, possibly depending on the density ratio R_ρ, the buoyancy frequency N, and the buoyancy Reynolds number $Re_b = \varepsilon / (\nu N^2)$ with ν as the kinematic viscosity. While the estimated Γ remains to be around the conventional value of 0.2 in the temperature-stratified upper ocean with $R_\rho > 2$ or $R_\rho < -1$, Γ tends to increase to ~1 not only in the salinity-stratified upper ocean with $|R_\rho| << 1$ but also in the deep ocean. The increasing trend of Γ in the deep ocean appears to be related to the decreasing trend of N and/or the increasing trend of Re_b. This study thus suggests that the diapycnal diffusivity in the deep ocean might be significantly larger than ever thought.

Keywords: Mixing coefficient, Diapycnal diffusivity, Density ratio, Buoyancy frequency, Buoyancy Reynolds number

