Strong vertical turbulent nitrate flux in the Kuroshio across the Tokara Strait and the Izu Ridge

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In the oligotrophic Kuroshio / Kuroshio Extension region, vertical turbulent mixing is considered to be an important driver to supply nutrients to maintain the biological production in the euphotic zone and high fisheries productions (e.g. Kaneko et al. 2013). Besides, in the intermediate layer below the euphotic zone, vertical mixing is also thought to be an important process to transport nutrients upward from the North Pacific Intermediate Water (NPIW, e.g. Reid 1965), which provides a nutrient source to the Kuroshio as suggested by Sarmiento et al. (2004). However, due to the lack of sufficient data on turbulence and nitrate, where and how much nitrate is supplied along the Kuroshio / Kuroshio Extension from down below and what impact this nitrate flux would have on the primary production have not been fully quantified yet.

In the present study, by using observational data on turbulence intensity and nitrate, we estimate the vertical turbulent nitrate flux near the Tokara Strait and the Izu Ridge, where the Kuroshio flows over steep bottom topography. The vertical mixing within the Tokara Strait is often found 1-2 orders of magnitude larger than the background value of $K\rho = O(10^{-5})$ [m^2/s] and is intermittently enhanced to $\varepsilon = O(10^{-6})$ [W/kg] and $K\rho = O(10^{-1})$ [m^2/s] at 26 –26.5 σ_θ. The vertical turbulent nitrate flux, F_{NO3}, is thus often enhanced by 1-2 orders of magnitude from the background value of $F_{NO3} = O(10^{-3})$ [mmolN/m^2/day] and intermittently reaches $F_{NO3} = O(1)$ [mmolN/m^2/day]. The mean nitrate flux across the whole Tokara Strait $<F_{NO3}> = O(10^{-1})$ [mmolN/m^2/day] just below the euphotic zone and at about 26.5 σ_θ. In the proximity to the Izu Ridge within the Kuroshio, the mean nitrate flux with the same order of magnitude is also observed both just below the euphotic zone and at about 26.5 σ_θ. These results suggest that these two mixing hotspots in the Kuroshio may provide large portion of the new production in the euphotic zone and may draw sufficient nitrate upward from the NPIW to impact the downstream.

Keywords: turbulent mixing, nitrate flux, Tokara Strait, Izu Ridge, Kuroshio