

Evaluation of nutrient flux enhanced by double diffusion in the Kuroshio using glider measurements

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Kuroshio is a very strong current, western boundary current of North Pacific subtropical current system. Strong vertical mixing intensifies through various physical processes were reported in the vicinity of the Kuroshio system. Consequently, this enhanced mixing is considered to supply the nutrients from the lower layer to the euphotic layer and improve the biological productivity.

Extensive measurements were carried out to investigate the detailed structures of turbulence, hydrography, chlorophyll-a using a glider, SeaExplorer manufactured by Alseamar whose 1st science mission, equipped with two shear probes, fast response thermistor, CTD, dissolved oxygen sensor, fluorometer. The fine measurement of 66 casts lasted for 7 days during 20-27, June 2017. Although only 30 % of data acquired by shear probe were survived under the criterion following Peterson et al., (2014), a newly developed method estimating turbulent intensity using a FP07 sensor was introduced.

While, calculated vertical nutrient flux is not quite high supporting biological productivity as we expected. Contribution of double diffusion which intensify the vertical diffusivity could be considered as development of chlorophyll-a patch at subsurface. Previous research already introduced the possibility of enhanced mixing from double diffusion (Nagai et al., 2015, Inoue et al., 2007) and Hamilton et al., (1989) showed underestimation of vertical nutrient flux without using vertical eddy diffusivity for salt in case of salt finger. Interacted with low salinity water which was occurred during our mission show another evidence for supporting this hypothesis.

Following the parameterization of McDougall and Ruddick (1992), mixing efficiency for salt finger and enhancement of salt(nutrient) flux were estimated to be somewhat effective. Parameterized nutrient flux in salt finger favorable layer is 37% larger than the turbulent nutrient flux accepting mixing efficiency 0.2 proposed by Osborn et al., (1980). This value needs to be examined through statistical approach or more careful insight and will be discussed later.

The full path of glider shows Kuroshio interact with various waters with different salinity and temperature. For example, low salinity and low temperature water intruded at subsurface during 23-24, June. Around 600 m during 26-27, June we also found salinity minimum which was assumed with North Pacific Intermediate Water. This feature reminds us considerable nutrient flux with vertical mixing by double diffusive processes in addition to mechanical turbulence. Double diffusive process might be attributed to the intrusion, development, modification of relatively low salinity waters. We found double diffusive regime occurs especially at upper boundary of relatively low salinity layer.

Keywords: Vertical mixing, Double diffusion, nutrient flux, Kuroshio