Seasonal oceanic variability and associated biogeochemical responses around a ridge area along the Kuroshio off Japan

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Biological processes have strong effects on the global carbon cycle on all time scales. In general, the nutrient fluxes from the nutrient-rich subsurface to the nutrient-depleted surface are substantial for maintaining primary production. The Kuroshio is one of the most energetic western boundary currents, significantly affecting biogeochemical productivity in the Pacific marginal seas off Japan. In addition, the Kuroshio flows through an oceanic ridge that is located at the south coast of Japan. This unique topography has remarkable influences on the Kuroshio currents, further affecting the associate biogeochemical responses. In the present study, a climatological regional oceanic modeling was conducted based on ROMS coupled with an NPZD biogeochemical model, encompassing the Kuroshio region and the Izu-Ogasawara ridge with a horizontal grid spacing of 3 km. The model was run for ten years and the tenth year output was used for the analysis. The nutrient concentration is significantly higher on the western side of the ridge rather than its eastern side. The primary production also occurs more actively in the western region, which is generally consistent with the subsurface nutrient distribution. Upward eddy-driven nutrient transport occurs in the western area near the ridge, while a downward flux appears in the eastern area. However, in colder seasons, the baroclinic instability due to the surface cooling and mixed layer deepening promotes a weak eddy-driven downward nutrient transport in Enshu-nada Sea, which is situated further west of the ridge, suppressing the biological production. By contrast, the shear instability occurs with considerable spatial variability and insignificant seasonal difference. The positive barotropic conversion rate shed by ridge topographically promotes much greater eddy-induced vertical flux in the eastern part of the ridge.

Keywords: Biogeochemistry, Kuroshio, eddy-induced nitrate flux, baroclinic instability

