

Quantifying Eddy-influenced Nutrient Availability in the Upper North Pacific Subtropical Gyre using Rare Earth Element

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Nutrient contributions influenced by eddies in the upper southwestern North Pacific Subtropical Gyre (NPSG) play a pivotal role in primary production and CO₂ uptake. However, quantitative studies on water/nutrient transport influenced by eddies are not clear. Based on observations in spring and summer, this study identified the effects of various eddies and quantified the water/nutrient contributions through horizontal and vertical mixing by optimal multiparameter analysis using hydrographic properties and rare earth elements. The results show that (i) the North Equatorial Current is the dominant source of water (25%–91%), with Equatorial water (0–33%) and northern NPSG water (0–43%) partially influencing the water composition; and (ii) vertical mixing explains an average of 8% of the water. Nutrient availability in spring and summer was further estimated based on the water contribution. Eddies, especially cold eddies, can enhance the associated vertical mixing through uplift and sink effects. The mean vertical fluxes of DIN at stations affected by warm and cold eddies were estimated, suggesting that vertical supply may be important for biological processes in the bottom euphotic layer. Meanwhile, the vertical transport of DIN influenced by warm and cold eddies can be further quantified in a study area of approximately $\sim 10^6$ km². These vertical nutrient supplies explain $\sim 1/5$ of the POC production in this region. Further quantification of water and nutrient supply affected by eddies in other regions of the global ocean can be considered.

Keywords: nutrient, eddy, rare earth elements, North Pacific Subtropical Gyre, ocean mixing