Intensive mixing along the Kuril island chain controls upward micro-, and macro-nutrient supply in the western subarctic North Pacific

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In the subarctic North Pacific, physical processes that transport macro- and micro-nutrients from the meso-pelagic layer to the surface have not been clearly identified. *Sarmiento et al.* [2004] used the combined distributions of silicic acid and nitrate to trace the main nutrient return path from deep water to above the thermocline (approximately 26.8 $\sigma_\theta$in the subarctic Pacific) and pointed out the existence of a return process in the northwest corner of the Pacific where there is enhanced vertical mixing, perhaps driven by tidal mixing at the Kuril Islands chain (KIC). Therefore, detailed investigation of material fluxes in water flowing through the KIC is important for understanding macro- and micro-nutrient supply to the surface.
In 2006, 2007, 2010, we conducted direct observation around the KIC during R/V *Professor Khromov* cruise, and chemical measurements were carried out for clarifying vertical distribution of micro-(dissolved-Fe (Fe)), and macro-(nitrate + nitrite (N)) nutrients. From the results, we estimate the vertical fluxes of dissolved Fe and N from the subsurface to the surface at Bussol' Strait (the deepest strait along the KIC) using the equations,
Dissolved-Fe Flux = - K_ρ x(dFe/dz), Nitrate + nitrite Flux = - K_ρ x(dN/dz),
where K_ρ is vertical diffusivity and dFe/dz and dN/dz are the vertical gradients of dissolved-Fe and N concentrations, respectively. Our measured vertical profiles of dissolved-Fe and N in Bussol' Strait display the influence of strong mixing in their disrupted gradients. Therefore, these gradients are not suitable for estimating material flux from intermediate to surface waters. Instead, we used the vertical profile obtained at station in the Kuril Basin to approximate the state of the water before the mixing process. The vertical gradients of dissolved-Fe (dFe/dz) and N (dN/dz) at station in the Kuril Basin are 0.0052 μmol m^{-4} and 0.073 mmol m^{-4}, respectively. Combining these gradients with 1-day average vertical diffusivity for depths of 100–500 m in Bussol' Strait reported by *Yagi and Yasuda* [2012] (K_ρ = 1 x10^{-3} m^2 s^{-1}), the estimated fluxes are 0.45 μmol m^{-2} day^{-1} for dissolved-Fe and 6.3 mmol m^{-2} day^{-1} for N. These fluxes are two orders of magnitude greater than that estimated in the open ocean in the western subarctic Pacific, indicating strong upward vertical transport around the Bussol' Straits.
Our results provide observational evidence that strong vertical tidal mixing in the KIC at the margin of the Pacific Ocean plays a pivotal role in transporting Fe and nutrients from deep water to the surface.

References

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