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黒潮による栄養塩の３次元的輸送が西部北太平洋における陸海間の生物地球化学的相互作用に果たす効果について
Impacts of the 3D nutrient-transport by the Kuroshio on the land-sea biogeochemical interaction in the western North Pac

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The Kuroshio, the western boundary current in the North Pacific, plays major roles in transporting heat and organic/inorganic materials from the subtropical region to the subarctic one, and moreover from the coastal region to the offshore one. The Kuroshio undoubtedly must impact on the ecosystem in its neighboring and downstream regions, however it is generally recognized as a mere boundary between the oligotrophic Subtropical waters to the south and the more productive coastal or subarctic waters to the north. Surprisingly neither quantitative nor qualitative researches have advanced to clarify the actual distribution of nutrients in the Kuroshio region with focus on the impacts of the jet, the core of the current maximum. The transport of nutrient and its impacts on the ecosystem have been still unknown mainly because of lack of simultaneous measurement of both horizontal and vertical fluxes of nutrients around the jet.

In order to clarify the 3D distribution of the water properties in the Kuroshio region and to estimate horizontal and vertical fluxes of nutrients and their impacts on the productivity in the surrounding and downstream regions, an intensive observation was conducted in Apr. 2009 and historical hydrographic data were analyzed. The observation was carried out by the R/V Tansei-maru at intervals of 10 miles along the 5 lines crossing the Kuroshio south of Japan. It obtained the 3D distribution of the water properties by CTD with multi- profilers and bottle-samplings, the horizontal velocity by the shipboard and lowered ADCP, and the vertical turbulent diffusivity by the microstructure profiler. As a result we detected that maxima of nitrate, silicate, phosphate and AOU were located along the jet on the isopycnal surface of 24.5-26.0sigma-theta. It is the first detection of the nutrient/AOU maximum along the Kuroshio jet, and the structure is analogous to the characteristic one well-known as Nutrient Stream found in the Gulf Stream region. Moreover, the nutrient/AOU maximum along the Kuroshio jet was also detected on the 24.5-25.5sigma-theta surface in spring in the whole region of the Kuroshio, by analyzing the historical data of JODC.

It should be emphasized that the nutrient concentration on the isopycnal surface of 24.5-25.5sigma-theta gradually decreases along the jet toward the downstream region. It implies that the high nutrient water is originated from the upstream and its adjacent coastal regions and transported downstream epipycnally along the Kuroshio as is the case with the Gulf Stream. Our observation estimated the maximum of the epipycnal nitrate flux at 10mmolNm^{-2}s^{-1} around the 26.0sigma-theta surface just beneath the current maximum of the Kuroshio jet. A part of the flux is served out to both the northern and southern sides of the jet due to eddy diffusivity, and especially on the northern side the nutrient transport is important for the new production under sufficient irradiance.

Moreover our observation clarified quantitatively that nutrient is supplied upward more intensively on the jet and its inshore side than the offshore side due to higher diapycnal mixing observed by direct measurement of microstructure. The diapycnal flux of nitrate amounts to 3.0x10^{-6} mmolNm^{-2}s^{-1} at the 25.0-25.5sigma-theta just above the core of the epipycnal flux, indicating that the high nutrient transported epipycnally along the jet is supplied efficiently upward by the strong diapycnal mixing and that it contributes significantly to the spring new production around the Kuroshio.

Importantly, on the northern side of the Kuroshio Extension the water mass of 25.0-25.5sigma-theta is distributed at the upper part of the euphotic layer in spring, as a result the nutrient flux via the Kuroshio jet contributes the high productivity around the region, where enhanced concentration of chlorophyll can be seen from the ocean-color map and favorable habitats are formed for various pelagic fishes.

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