Biogeochemical impacts of isopycnal nitrate transport along the Kuroshio

*Kosei Komatsu[1,2], Yutaka Hiroe[3], Ichiro Yasuda[2]

1. Graduate School of Frontier Sciences, The University of Tokyo, 2. Atmosphere and Ocean Research Institute, The University of Tokyo, 3. National Research Institute of Fisheries Science, Japan Fisheries Research and Education Agency

Recently the Kuroshio draws attentions as an important supply route of nutrient in the western North Pacific, although it has been 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. The effective processes of the nutrient supply into the euphotic layer in the adjacent and downstream regions of the Kuroshio were reviewed on the basis of our recent in situ observations and retrospective analyses of historical observational and data-assmilated reanalysis datasets. The observation data revealed that the nutrient maximum was distributed along the jet on the isopycnal surface of 24.5-25.5sigma-theta in the whole region of the Kuroshio from the East China Sea to the Kuroshio Extension, and that the along-jet-maximum structure was detected only in spring, although the structure was analogous to the characteristic one well-known as the Nutrient Stream found in the Gulf Stream region. The concentration of the nutrient maximum gradually decreased along the jet toward the downstream region, implying that the high nutrient water was originated from the intermediate layer in the upstream and its adjacent regions. Isopycnal transport of nitrate along the jet was estimated at 800 $kmolNs^{-1}$ by integrating from the layer of 27.5sigma-theta to the sea surface in the midstream region south of Japan, where the core of isopycnal downstream flux amounted to 10 $mmolNm^{-2}s^{-1}$ on the surface of 26.0-26.5sigma-theta. The isopycnal transport plays the main role on the nutrient supply to the downstream, but on the way to the downstream, diapycnal upward flux due to turbulent diffusion whose net intensity amounts to $O(10^{-6})$ $mmolNm^{-2}s^{-1}$ at the front supplies the nutrient effectively into the euphotic layer from the nutricline. Moreover lateral exchanges with the Slope or Shelf Waters due to both mesoscale and sub-mesoscale processes modifies the nutrient concentration in the Kuroshio jet, where the lateral flux due to horizontal diffusion was estimated at $O(10^{-2})$ $mmolNm^{-2}s^{-1}$ at the front on the scale of O(10) km. The isopycnal surface at the nutricline depth in the upstream gradually shallows along the jet toward the downstream and finally reaches the winter mixed layer in the Kuroshio Extension to induce the nutrient supply into the euphotic layer. The nitrate flux due to the induction process can be estimated at $O(10^{-5})$ $mmolNm^{-2}s^{-1}$, some of which are transported eastward along the jet or recirculated to the subtropical region and the others are to the Kuroshio-Oyashio (K-O) interfrontal zone. The latter part suggests significant contribution of the isopycnal nutrient transport along the Kuroshio to the high productivity in the K-O zone.

Keywords: Kuroshio, isopycnal transport, Nutrient Stream, induction

