Physical and biogeochemical processes from winter to spring in the south of the Kuroshio Extension

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In a subtropical region south of the Kuroshio Extension (KE) in the Western North Pacific, large ocean heat loss in the surface layer during winter makes a deep mixed layer. Then, a part of CO_2 dissolved from air to surface ocean is transformed to particulate organic matters via photosynthesis using nutrients which are supplied from deeper layer. Eventually particulate organic matters are transported to deeper layer. In this oligotrophic region, winter mixing is a critical process to supply nutrients to the euphotic zone, which supports high chlorophyll concentrations in early spring are clearly seen by satellite observations. Therefore, it is important to understand effects of nutrient transports by physical processes on biogeochemical material transport and cycle in this period. However, there are few physical and biogeochemical data during winter in this region because of the difficult circumstances in observation.

In this study, we deployed two biogeochemical Argo (BGC-Argo) floats in 33°15’ N, 142°30’ E on January 28th, 2018 during the Shinsei-maru KS-18-1 cruise and recovered them in 35°31’ N, 143°11’ E and 35°43’ N, 143°29’ E on April 20th, 2018 during the Shinsei-maru KS-18-4 cruise. During these two cruises, CTD observations and water samplings were conducted to validate sensors (temperature, salinity, oxygen, chlorophyll, nitrate, and backscatter) attached to floats. BGC-Argos observed 82 profiles from 2000 m depth to the surface every day.

Those floats were kept staying around the deployment position for a month, then moved to southwestward in the middle of March, and were to northward near KE until the recovery. In the first half of the observation period, intermittent mixed layer deepening and subsequent restratification were repeated in the top 300 m depth. High chlorophyll concentrations and backscatter values were observed in the surface layer when upper layers were stratified. After March 17th, oxygen concentration increased, nitrate concentration decreased, and chlorophyll concentration and back scatter value were stable in the subsurface (100 to 300 m). After that, oxygen concentration, chlorophyll concentrations and back scatter values increased (nitrate decreased) coincided with stratification in the surface layer until April 2nd. In the subsurface layer, chlorophyll concentration and back scatter value decreased suddenly, which might mean that biogenic particulate organic matters transported by the deep mixing were quickly decomposed in the layer. Furthermore, a water with low oxygen and high nitrate intruded in the layer 50 to 100 m around March 30th. The origin of this water would be relative deeper layer because of low chlorophyll concentration and back scatter values.

The BGC-Argo observation in the south of KE for three months revealed that physical processes with various time scales in the surface layer from winter to spring affect the primary productivity of phytoplankton and the material distribution.

Keywords: BGC-Argo, Spring restratification, biological response, material transport