Spatial distribution of phytoplankton in relation to the sub-circulation in the Indian Sector of the Southern Ocean

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The Southern Ocean acts as the strongest region for the uptake of carbon dioxide. Recently, Landschutzer *et al*. [2015] discussed the reinvigoration of carbon sink since 2002, and also showed relatively positive increasing trend of sea-surface chlorophyll. They attributed them in all three sectors to a tendency toward a zonally asymmetric atmospheric circulation. The variability of carbon uptake in the synoptic scale can be explained by the atmospheric pattern in same scale. In reality, phytoplankton dynamics is governed by not only atmospheric circulation but also ice-ocean circulation and relevant phenomena, such as frontal structure and eddies, especially, in high productive shelf-slope area.

This study investigated the spatial distribution of phytoplankton and a possible mechanism controlling it in the Indian Sector of Southern Ocean. Hydrographic observations were made in our study area (12 stations, 60-65° S, 106°-113°E) from January 7th to January 18th in 2017. CTD casts with water samplings were conducted, and also identification of phytoplankton species was carried out. Results show that east-west asymmetry of cell density of phytoplankton, both Diatoms and *Haptophytes* along 63.5°S line (6 stations). In particular, *Phaeocystis spp.* was well dominant (> 10^6 cells/L) in the western side of this line. Also *Fragilariopsis nana* and *F. cylindrus* (both are very abundant in sea ice) were found in the same area and at stations along 110°E. Hydrographic observations indicate the clockwise sub-circulation whose center is at around 63-64°S in this region. To confirm spatial pattern of ocean circulation field and phytoplankton distributions, satellite-derived absolute dynamic topography (ADT) were analyzed. ADT in sea ice area and open water area were constructed based on the method of Mizobata et al. [2016]. Satellite-derived ADT confirmed that clockwise sub-circulation, which is quite similar with “eddies” found by Wakatsuchi et al. [1994]. Although the volume transport of this sub-circulation is fluctuating, it is always there. Our results indicate that northward advection due to this clockwise sub-circulation contributes to difference in the spatial distributions of phytoplankton species and following variability of primary productivity in this area. Certainly, interpretation of phytoplankton dynamics using synoptic-scale phenomena only (e.g., atmospheric circulation) is not enough to understand the spatio-temporal variability of carbon uptake in this area.

キーワード：植物プランクトン、南大洋インド洋セクター、海洋循環
Keywords: Phytoplankton, Indian Sector of the Southern Ocean, Ocean circulation

