Seasonal variation in physical and biological parameters during sea ice melting season in the Southern Ocean

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Carbon sequestration is primarily influenced by primary production and the efficiency of the biological carbon pump. In the Southern Ocean, it is thought that ice edge phytoplankton bloom is one of the most important events to regulate carbon cycling, which is strongly related with the seasonal prevalence of the sea ice. Thus, a relationship between sea ice dynamics and biological activity is a critical factor for understanding not only ecosystem structure and its dynamics but also carbon sequestration. Ice bergs prevent from retrieving continuous data at shallow depth. To assess surface conditions and the export flux from the surface ocean during ice melting season, we designed an ice-resistant GPS buoy for drifter observation.

A drifter observation was conducted in the austral summer 2019/2020 during icebreaker *Shirase* cruise. A drifter with the ice-resistant GPS buoy was composed of four sensor frames, two time-series sediment traps and an Acoustic Doppler Current Profiler (ADCP, 300 kHz) and deployed at 64.26°S, 115.96°E on 9th Dec., 2019 and retrieved at 64.55°S, 104.79°E on 16th Feb., 2020 (Figs. 1-2). Less variability in all depth records indicates that the drifter array was relatively stable even in dense sea ice situation. Sea ice concentration at deployment site was over 90%, which rapidly decreased from end of December to early January. Chlorophyll fluorescence at 20 m depth increased with decrease of sea ice concentration. In particular, a rapid increase in the fluorescence was observed in higher (>50%) sea ice concentration. The euphotic layer depth (the depth at which 1% of photosynthetically available radiation relative to its surface level) was still shallower than 20 m at the same time, and an increase in dissolved oxygen at 20 m depth occurred after the fluorescence peak. These suggested that the fluorescence peak at 20 m depth was caused by accumulating of released ice algae rather than primary production at the depth. After then, increase in fluorescence was also found at 30 m depth, which followed by that at 40 m depth. These changes in peak depth of fluorescence means that temporal changes of productive layer, i.e. transition from ice edge bloom to sub-surface chlorophyll maximum. We will also discuss on responses of primary consumers using information obtained by the ADCP and the sediment trap collected zooplankton.

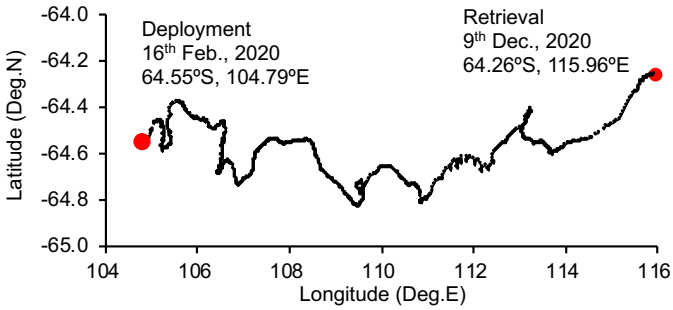

Fig. 1. GPS track of the drifter.

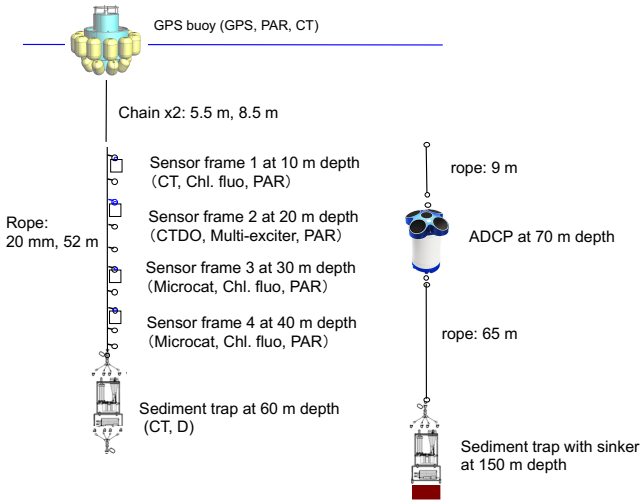

Fig. 2. Schematic diagram of the drifter array.