

## Marine ecosystem monitoring

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### Background

Japanese Antarctic Research Expedition (JARE) has started “Marine ecosystem monitoring” since JARE-07 (1965/66) as one of “Routine Observations”. The initial interest was to detect variation of phytoplankton distributions in relation to the ocean frontal structure. During the early stages of “Marine ecosystem monitoring”, chlorophyll *a* concentrations were determined, using the surface water samples were collected by bucket along the cruise track. Since JARE-14, zooplankton samples have been collected using North Pacific Standard Net (NORPAC net). From the first expedition (JARE-52, 2010/11) of JARE Phase XIII, Station observation in sea ice zone has begun, and *p*CO<sub>2</sub> observation has been moved to “Marine ecosystem monitoring” from “Monitoring of greenhouse gases”. The results of “Marine ecosystem monitoring” are published in JARE DATA REPORTS or submitted to the international organizations as soon as possible. The comprehensive datasets are valuable to detect climate change impact on the pelagic ecosystem in the Indian sector of the Southern Ocean.

### Some highlights

**Chlorophyll *a* observation:** Surface and station chlorophyll *a* observations started in the 1965/1966 (JARE-07) and the 1972/1973 (JARE-14), respectively. Chlorophyll *a* concentrations (chl-*a*) along 110 ° E in early December show that ratios of the occurrence frequency of chl-*a* exceeded 0.5 mg m<sup>-3</sup> to total occurrence frequency of chl-*a* have gradually been changing from the 1960s to the 2010s. The similar long-term trend was also found in vertically integrated chl-*a* standing stock. Additionally, recent observation during Umitaka-maru cruise revealed that sub-surface chl-*a* maximum with relatively high standing stock frequently occurred in seasonally sea ice zone in January.

***p*CO<sub>2</sub> observation:** In order to elucidate the secular trends of oceanic CO<sub>2</sub> uptake as well as Oceanic Acidification in the Indian sector of the Southern Ocean, *p*CO<sub>2</sub> has been measured since 1987 on board Shirase. Meridional distributions of *p*CO<sub>2</sub> along 110 ° E in early December clearly show steep changes at such fronts as Subtropical Front, Subantarctic Front, and Polar Front. *p*CO<sub>2</sub> of each zone divided by the fronts can be distinguished from the others by the difference of averaged *p*CO<sub>2</sub> in the zone. Although *p*CO<sub>2</sub> of each zone shows large interannual variation, secular trend is detectable.

**Zooplankton species:** The zooplankton monitoring by NORPAC net started in the 1972/73 (JARE-14) austral summer and continued for over 40 years. Zooplankton samples were also collected using a Gamaguchi net in various sea-ice environments: fast-ice, pack-ice, and ice free areas, as part of monitoring program for the sea-ice zone from JARE-52. The major contributors to the total zooplankton abundance were small sized copepods, and they tended to be ubiquitously distributed from open ocean to under first-ice region. They are considered to be key species of the change of planktonic food web of the Southern Ocean.

**Continuous Plankton Recorder:** JARE initiated an annual Continuous Plankton Recorder (CPR) survey beginning in 1999 (JARE-41) as member of the Southern Ocean CPR (SO-CPR) Survey. JARE CPR data is widely used by various agencies, researchers, and graduate studies because the SO-CPR has developed into the big project in which numerous countries join now. Also, SO-CPR was important foundation members of the Global Alliance of CPR Surveys (GACS) which places the Southern Ocean CPR data in a global context.