Press Releases

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JAMSTEC
Hokkaido University
National Institute of Polar Research,
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Arctic Marine Biological Hotspot Supported by Underwater Storage House of Organic Matters
- First observation of annual variations in phytoplankton biomass -

Overview

A research team led by Dr. Shigeto Nishino at Institute of Arctic Climate and Environment Research, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) analyzed hydrographic and biogeochemical data collected from moorings installed in Hope Valley, the southern Chukchi Sea during July 16, 2012 to July 19, 2014. It identified annual variations in phytoplankton biomass and also found phytoplankton blooms in autumn. By combining the mooring data with the data obtained from the JAMSTEC's research vessel Mirai during September to October in 2012 and 2013, it was indicated that these autumn blooms were triggered by regenerated nutrients associated with the decomposition of particulate organic matters, which were transported and stored at the bottom of the valley. It is the first time such annual variations in phytoplankton were identified in Hope Valley. The work was carried out in collaboration with researchers from Hokkaido University and Research Organization of Information and Systems, as part of GRENE Arctic Climate Change Research Project by Green Network of Excellence (GRENE)[*1].

In the Arctic Ocean, phytoplankton blooms occur when light irradiance necessary for photosynthesis increase with sea ice melting. Because of a large phytoplankton bloom in spring as a source of food for benthic organisms, the southern Chukchi Sea is, in particular, known as a biological hotspot[*2], where various kinds of living organisms exist with feeding relationships. In this study, the mooring-based observations found small blooms also in autumn in Hope Valley in the southern Chukchi Sea. In addition, the ship-based observation data on Mirai indicated that bottom water in Hope Valley forms a dome-like structure, suggesting ocean circulation in a counter-clockwise direction and converge of deep water there. These autumn blooms are, therefore, likely to be associated with particulate organic matters transported into the bottom of the valley, where nutrients such as ammonia are produced to increase phytoplankton with the organic matter decomposition. In other words, Hope Valley is becoming a storage house of organic particles, in which nutrients for phytoplankton are produced.

Marine ecosystems are considered to be largely affected by changes in phytoplankton as it is located in the base line of the oceanic food chain. To grasp and clarify changes in plankton is highly important to understand how biological

hotspots are formed and maintained. Further study will be carried forward to explore how these phytoplankton changes affect higher-trophic level ecosystems.

The above results were published on Biogeosciences issued by European Geosciences Union on April 29, 2016 (JST).

Title: Water mass characteristics and their temporal changes in a biological hotspot in the southern Chukchi Sea

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*1 GRENE Arctic Climate Change Research Project It is an initiative supported by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) for five years from 2011. Under strategic cooperation among universities and research institutes, it aimed to promote the highest level of research and people development in a comprehensive manner. The National Institute of Polar Research (NIPR) acted as a representative organization. 39 organizations including JAMSTEC also participated in the project, seeking to elucidate rapidly changing Arctic climate system and its impact on a global scale.

*2 Hotspot : Here it refers to a region of high biological activity.

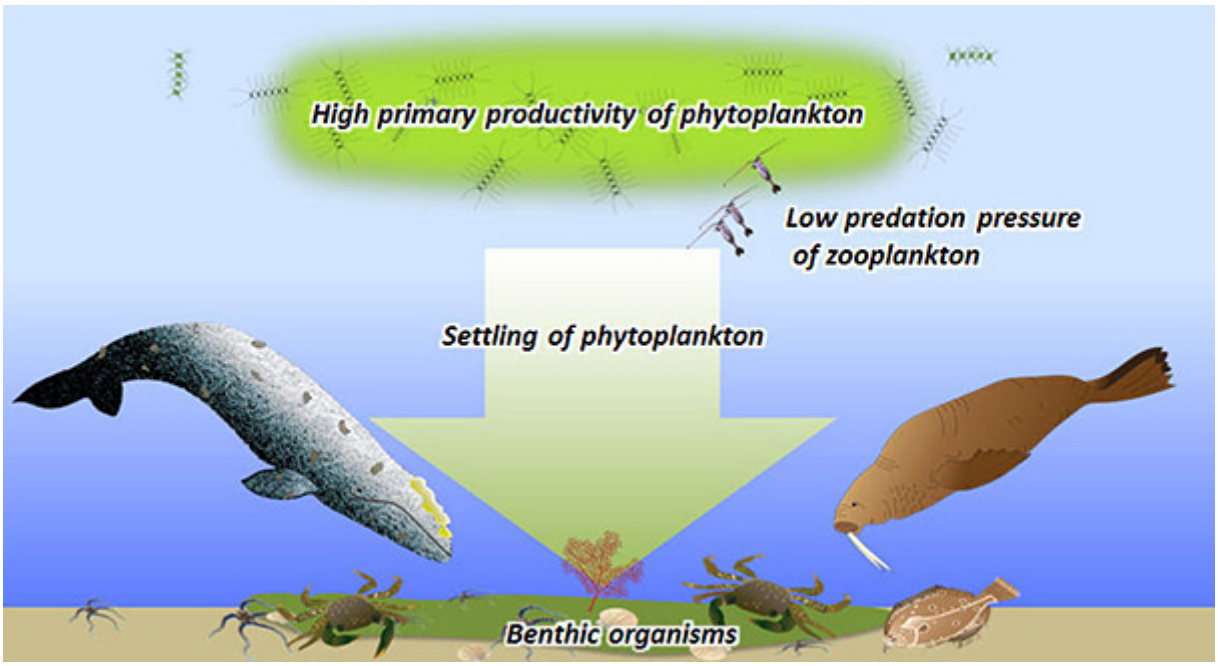

Figure 1. Biological hotspot in the southern Chukchi Sea
In the Chukchi Sea, because of the shallow water depth and low zooplankton densities during phytoplankton blooms in spring, a large number of phytoplankton sinks to the seafloor without the predation by zooplankton and it becomes foods for benthic communities, such as shelfishes and crustaceans. Furthermore, fish, sea birds and marine mammals as benthic feeders also congregate there. Such a region of high biological activity is called a biological hotspot.

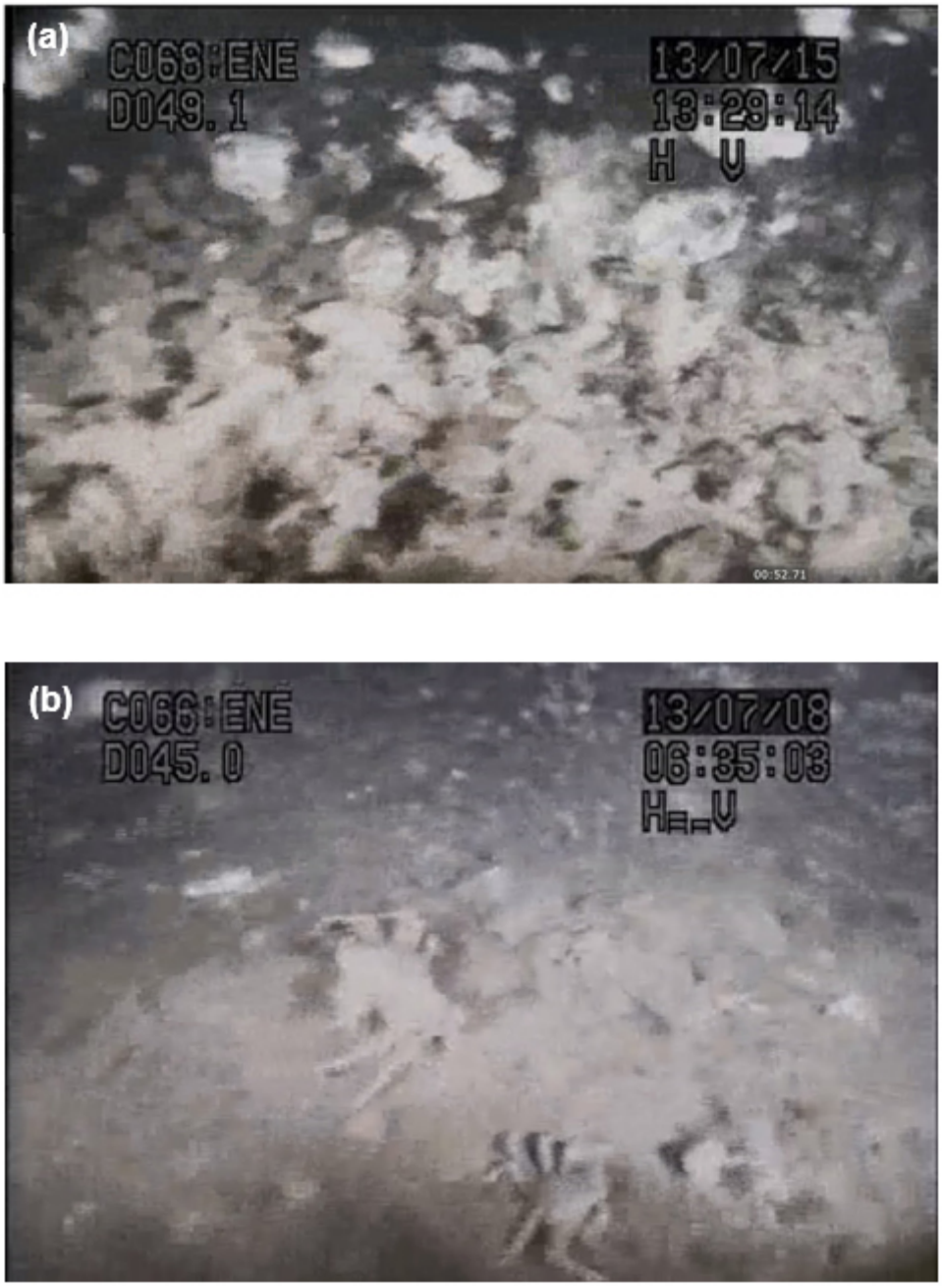

Figure 2. (a) Hope Valley showing increased turbidity with particle organic matter; and (b) Seabed in the northern Bering Strait, where lots of crabs are observed. (Images provided by Faculty of Fisheries Sciences, Hokkaido University, and recorded by Dr. Jun Yamamoto)

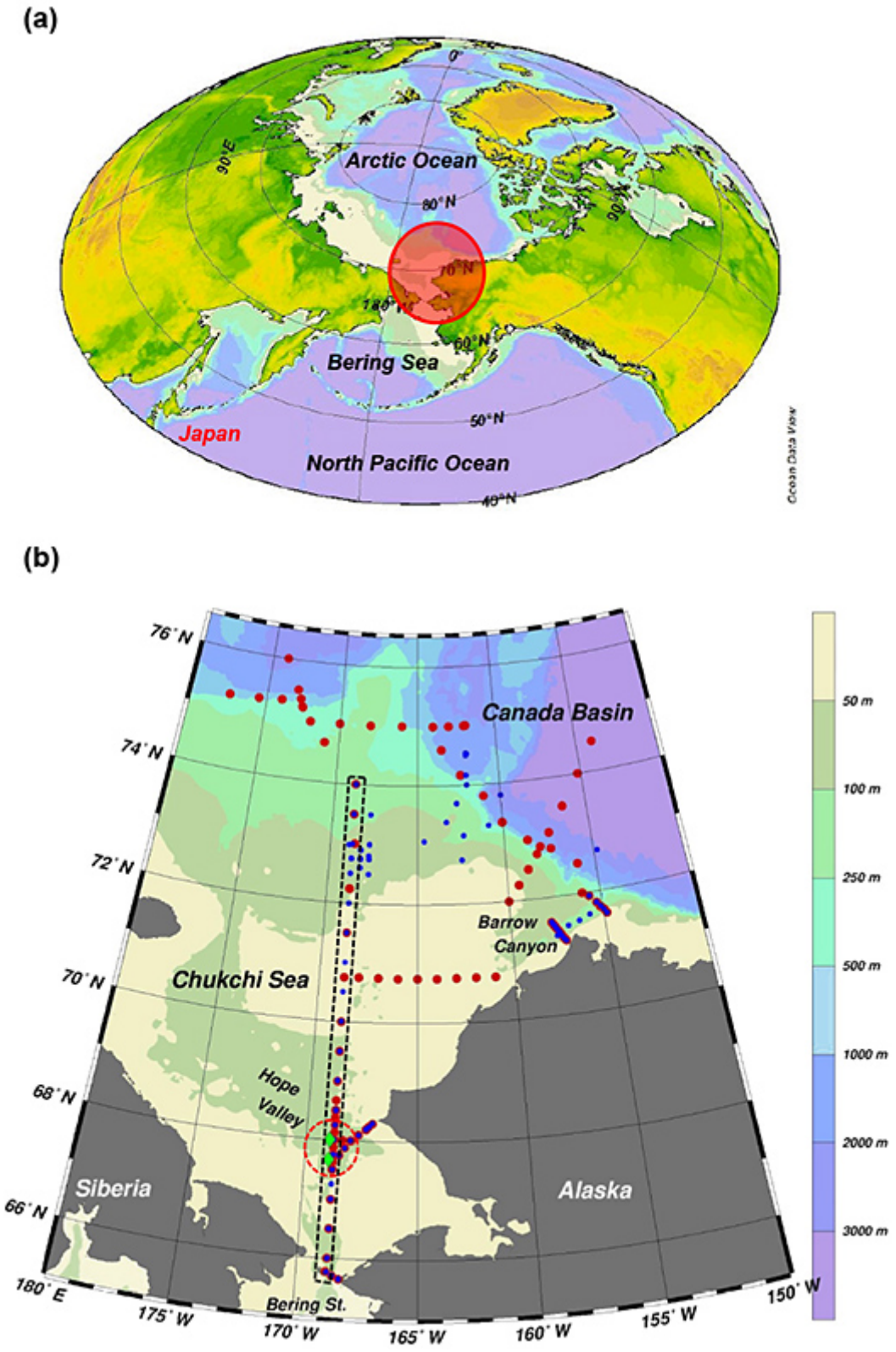

Figure 3. Maps showing the bathymetric features of the study area and the hydrographic stations for the R/V Mirai cruises in 2012 (red dots) and 2013 (blue dots). Green diamonds indicate mooring sites. Data from the stations enclosed by black dotted lines were used for the illustrations of vertical sections shown in Fig 6. The area enclosed by the red dotted circle is the southern Chukchi Sea biological hotspot, where the moorings were deployed and detailed hydrographic surveys were carried out.

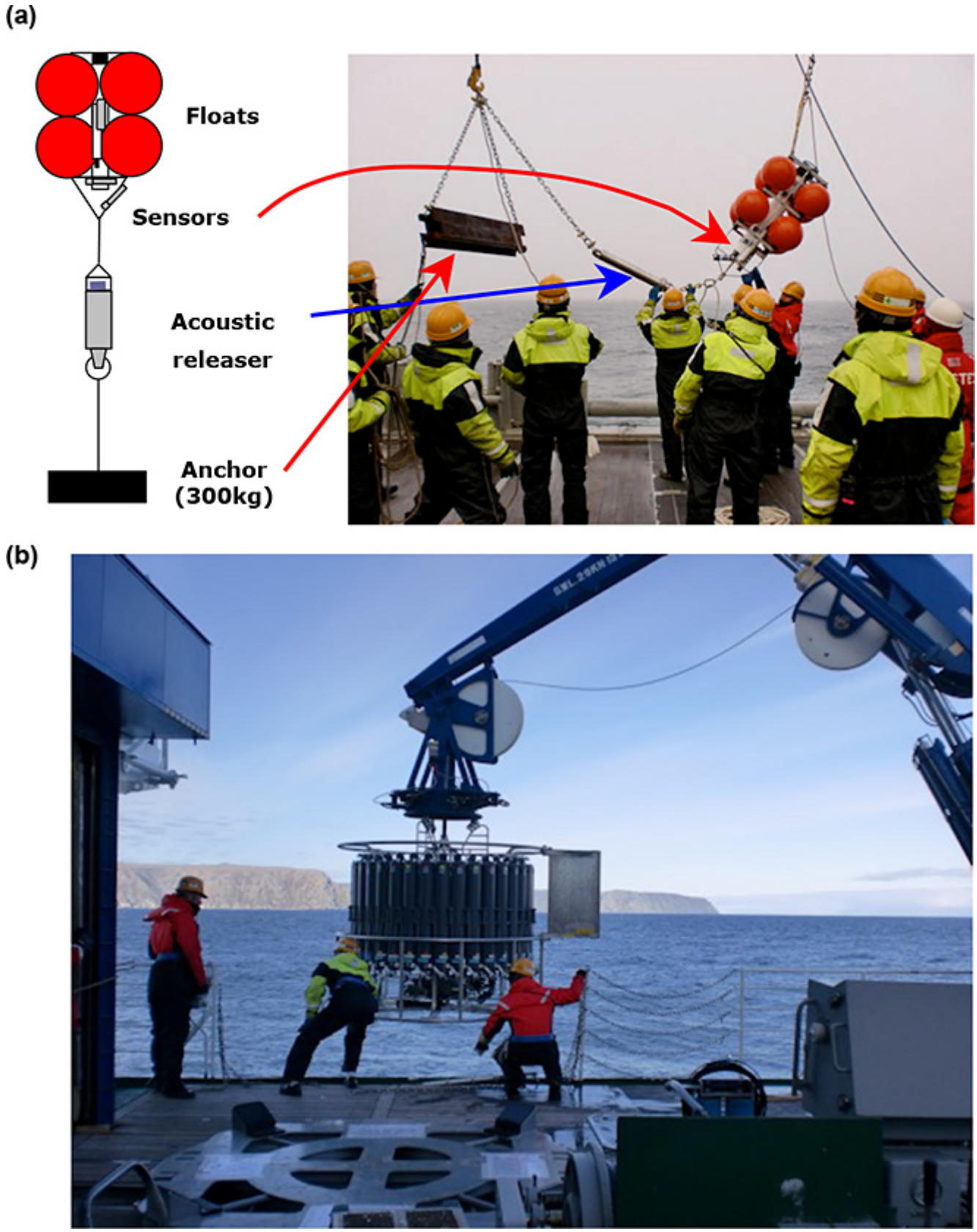

Figure 4. (a) Deployment work of the mooring system in Hope Valley in the southern Chukchi Sea on R/V Mirai (October 3, 2012). The left shows components of mooring systems. In this mooring system, observation data such as temperature, salinity, dissolved oxygen, turbidity, and chlorophyll a were collected every one hour at a depth of 7m from the bottom of the sea. (b) Launching of CTD (Conductivity-Temperature-Depth Profiler) system and water samplers into the sea from R/V Mirai (August 31, 2013).

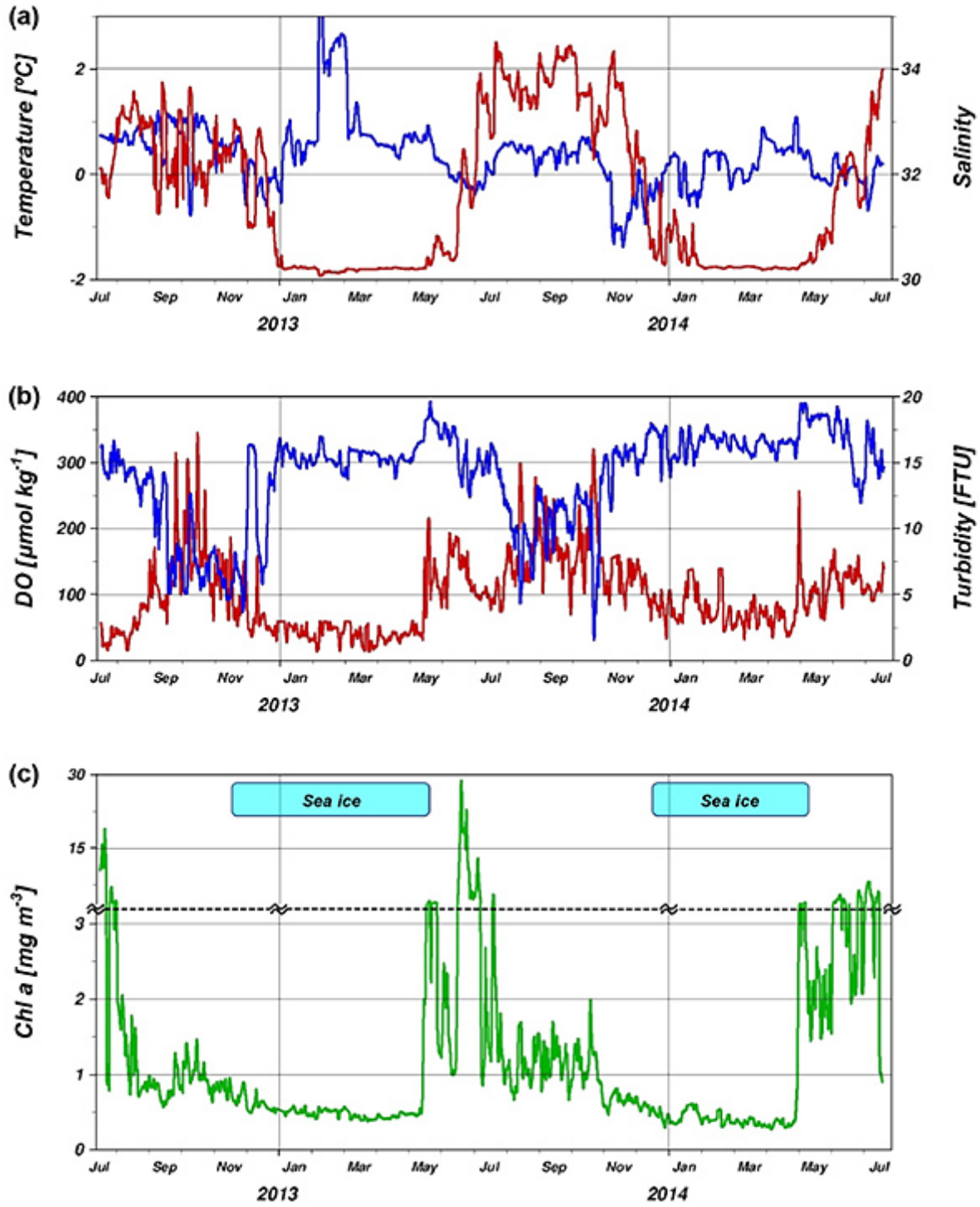

Figure 5. Time series of (a) Temperature (red) and salinity (blue); (b) Turbidity (red) and dissolved oxygen (blue); and (c) Chlorophyll a (green)
The vertical axis scale in the (c) below the dotted line is exaggerated where the concentration is < 3 mg m^{-3}. Periods when sea ice concentration was > 50% at the mooring site are indicated by blue bars. In the (c), time series of chlorophyll a, phytoplankton bloom are occring both in spring and autumn in the southern Chukchi Sea. As shown in the (b), autumn blooms are observed with increased turbidity and decreased oxygen, which suggests particulate organic matter is transported and accumulated in Hope Valley (turbidity increase) and decomposed using oxygen (oxygen decrease) with regeneration of nutrients. Such environments are considered to be triggering autumn blooms.

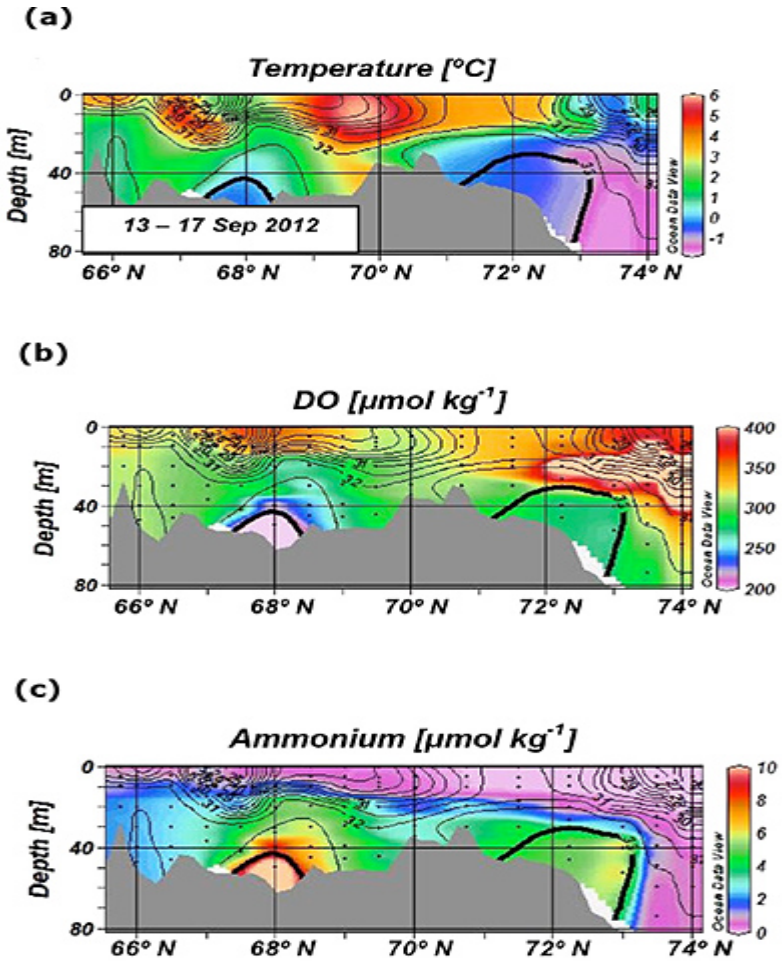

Figure 6. Data obtained during the R/V Mirai cruise from September 13 to 17 in 2012. (a) temperature; (b) dissolved oxygen; and (c) ammonium (observation data from stations enclosed by black dotted lines in the figure 3 are used.) The contour lines indicate distribution of salinity. A dome-like structure of water mass with low temperature, high salinity, low disolved oxygen and high concentration of ammonium is identified near latitude 68°north.

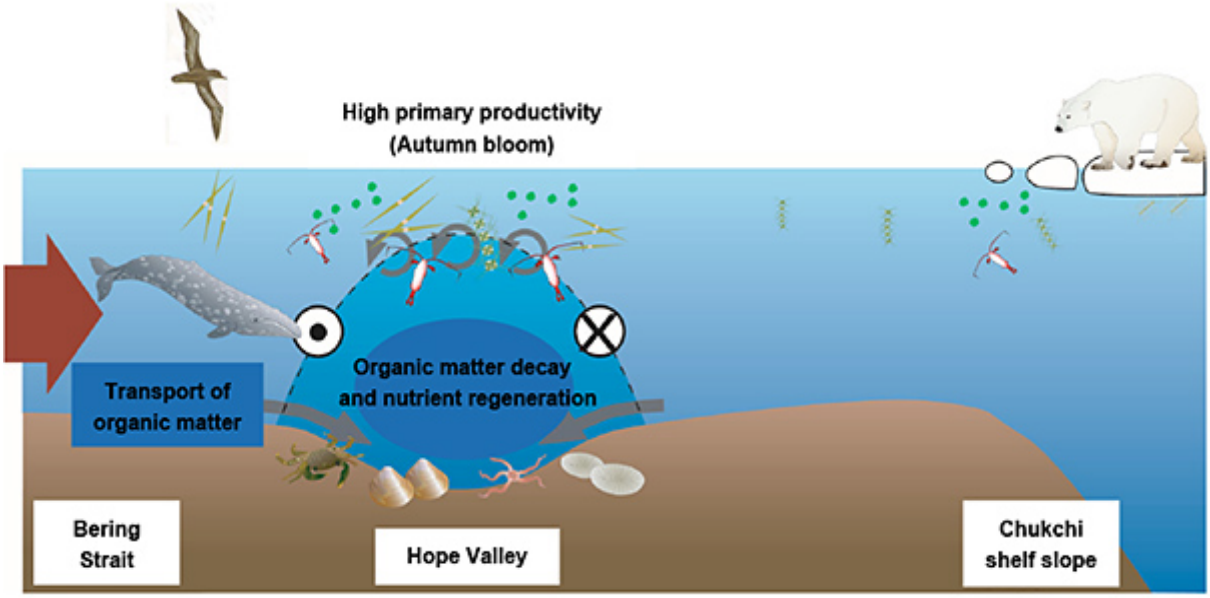

Figure 7. Autumn bloom in Hope Valley in the Chukchi Sea
Circles with a dot and x represent flows from the back to the face of the figure and from the face to the back of the figure, respectively. Over the Hope Valley, there is a dome-like structure of the bottom water, suggesting ocean circulation in a counter-clockwise direction and converge of deep water there. The autumn blooms are,

therefore, likely to be associated with particulate organic matters transported into the bottom of the valley, where nutrients such as ammonia are produced to increase phytoplankton with the organic matter decomposition.

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