

【Grant-in-Aid for Scientific Research (S)】

Broad Section K



Title of Project : Global redistribution of heat, salt and materials induced by sea-ice processes

OHSIMA Keiichiro.

(Hokkaido University, Institute of Low Temperature Science, Professor)

Research Project Number: 20H05707 Researcher Number : 30185251

Keyword : sea-ice production, sea-ice melt, microwave radiometer, bio-logging, thermohaline circulation

【Purpose and Background of the Research】

Heat and salt/freshwater are redistributed by freezing and melting of sea ice via latent heat and brine rejection (Fig.1). Dense water formed by sea-ice production sinks and drives the global thermohaline circulation. It is suggested that the Antarctic Bottom Water formed by high ice-production in the Southern Ocean has decreased significantly (IPCC, AR5). Such deep/intermediate water change under the global warming potentially affects the global thermohaline circulation and thus earth climate. The deep/intermediate water change with timescale of several decades is possibly linked with variation of sea-ice production/melt. However, its linkage has not been clarified at all, because there have been no long-term data sets of ice production/melt so far. The purpose of this study is to create a global 45-year data set of ice production/melt and to elucidate the linkage between ongoing deep/ intermediate water change and heat/salt transport by sea ice. Further, we aim at clarification of material transport processes by sea ice such that sediment/iron is incorporated into sea ice at the formation and its release at ice melting induces a large phytoplankton bloom (Fig.1).

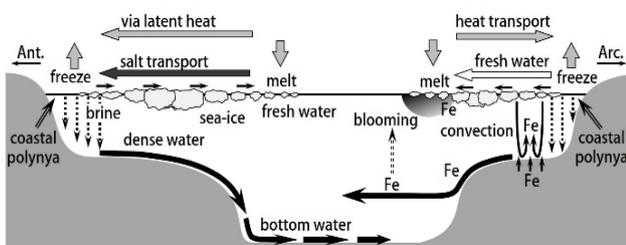


Figure 1: Global transport of heat, salt (freshwater), and materials (iron etc.) by sea-ice production and melt

【Research Methods】

Regarding sea-ice production, our team has developed the method to detect high ice-production areas (coastal polynyas) and to estimate sea-ice production there using satellite microwave radiometer data first in the world. However, the data sets have been made only for limited areas and only after 2013 with the AMSR sensor. In this study, we plan to develop pan-global algorithms of sea-ice production for the four generation's microwave sensors to create seamless 45-year data set since 1978. As comparison/validation data, our mooring data of sea ice and ocean at several coastal polynyas will be used. We will challenge creation of ice-melt data set, which has never been made.

We combine the satellite microwave data, heat-budget calculation, and high-resolution ice-drift data to infer ice-melt amount. As comparison/validation data, data from profiling floats and bio-logging will be used. Further, intensive observations aboard the icebreakers and fishery boats are planned in the southern part of the Okhotsk Sea as a target area, with biogeochemical floats, to clarify the relationship between the phytoplankton bloom and ice melt.

【Expected Research Achievements and Scientific Significance】

The 45-year data set of sea-ice production would provide its linkage with ① Reduction of Antarctic Bottom Water, ② Weakening of North Pacific overturning from the Okhotsk Sea, ③ Deep water formation in the Bering Sea, and the data set of sea-ice melt would provide its linkage with ④ Freshening and density decrease of Antarctic Intermediate Water. As such, the linkage between sea-ice production/melt and intermediate/deep water change is expected to be clarified. Because this global ice production/melt data set will be the first one, the data set is expected to be used as validation and boundary condition data for various models. These will promote understanding of role of sea-ice production/melt in climate change. On the other hand, once processes of material/iron transport through sea ice will be understood, those processes can be parameterized into the ice production/melt data set, which will lead to understanding of global material/iron transport by sea ice.

【Publications Relevant to the Project】

· Ohshima, K. I., S. Nihashi, and K. Iwamoto, Global view of sea-ice production in polynyas and its linkage to dense/bottom water formation. *Geoscience Letters*, **3**:13, doi:10.1186/s40562-016-0045-4, (2016).

【Term of Project】 FY2020-2024

【Budget Allocation】 151,700 Thousand Yen

【Homepage Address and Other Contact Information】

<http://www.lowtem.hokudai.ac.jp/wwwod/~ohshima/>
ohshima@lowtem.hokudai.ac.jp