

【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

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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).

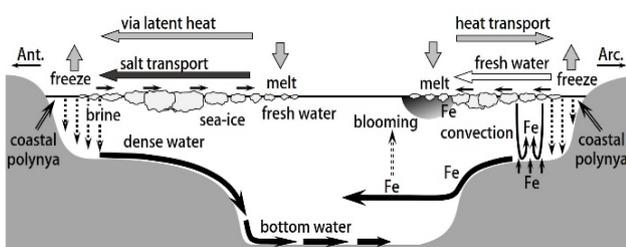


Figure 1: Global transport of heat, salt (freshwater), and materials (iron etc.) by sea-ice production and melt

【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】

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

Broad Section K



Title of Project : Systematization of Halogen Control Technologies toward Environmental Impact Reduction

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Research Project Number: 20H05708 Researcher Number : 30241532

Keyword : Halogens, Chlorine Circulation, Plastic recycling, deductive LCA, Environmental Impact Assessment

【Purpose and Background of the Research】

The global production, use, and disposal of plastics are following a growth trend and are expected to further increase in the future. This situation urgently calls for deliberation on how to recycle plastics. However, the recycling of plastics, regardless of the technical method, faces a bottleneck that is the question as to how to handle halogens.

Halogens become repellents in the process of plastic recycling. However, this research project aims to academically explore the possibilities of deploying technologies centered on dehalogenation while viewing halogens as “circular resources.” Dehalogenation technologies are generally divided into “dry” and “wet” methods. This study will develop technologies for the removal, and effective uses of halogens to turn used plastic into secondary raw material, chemical raw material, and high-quality fuel, making maximal use of the advantages of both types methods. Furthermore, concurrently with the technological development, this study will analyze the latest trends in deductive LCA and international technologies/policies and conduct interdisciplinary research aimed at optimizing the speed of technological introduction and its compatibility with social systems.

【Research Methods】

This study will seek technical methods that can be developed and deployed around dehalogenation technologies, attempting to systematize the underlying technologies. This study will thereby aim to construct a platform for technological development purposed for the circulation of halogens and effective use of plastics. In addition to the “process development” itself, data measured and obtained in this manner will be used for MFA and LCA as shown in Figure 1, to analyze material flows and evaluate environmental impacts. Furthermore, through “research on international trends in technologies/policies,” this study will evaluate and analyze the possibilities of industrial uses of plastic-derived secondary raw materials in relation to legal regulations both in and outside Japan. These three different fields of research, which differ in specialization, will be fused, aiming for a multifaceted approach involving technological, environmental, and social

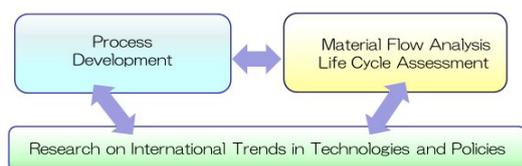


Figure 1 The structure of this research

perspectives.

【Expected Research Achievements and Scientific Significance】

The recent development and spread of the use of high-function and compound plastics have made the process of separation and sorting for recycling difficult. Halogens such as chlorine, bromine become repellents in the process of recycling. As shown in Figure 2, efficient removal of these halogens can raise the efficiency of separating useful substances such as metals while also raising the value of renewable resources. Halogens have been a major hindrance to the circular use of plastic. This study, however, views halogens as circular resources and aims to optimize dehalogenation not only from the viewpoint of maximizing it but also from the viewpoint of “control” by which plastic-derived secondary resources can be improved to standards acceptable by industries. Furthermore, through scrutinizing and systematizing the underlying technologies, this study aims to construct a platform for the technical processes of recycling that could contribute to the reduction of environmental impacts.

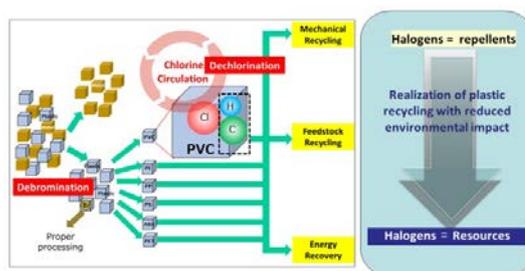


Figure 2 Overview and Scientific Significance of this research

【Publications Relevant to the Project】

- Shogo Kumagai, Jiaqi Lu, Yasuhiro Fukushima, Hajime Ohno, Tomohito Kameda, Toshiaki Yoshioka, Resources, Conservation & Recycling, 133, 354-361, (2018)
- Jiaqi Lu, Siqingaowa Borjigin, Shogo Kumagai, Tomohito Kameda, Yuko Saito, Toshiaki Yoshioka, Waste Management, 99, 31-41 (2019)

【Term of Project】 FY2020-2024

【Budget Allocation】 153,700 Thousand Yen

【Homepage Address and Other Contact Information】

<http://www.che.tohoku.ac.jp/~env/index.html>