1st International Workshop on Arctic Ocean Observation
Future Collaboration by
Research Vessels and Icebreakers

Name of session:
Technology & Engineering: Data-driven approach for sustainability
Chair: Takatoshi Matsuzawa (Japan Agency for Marine-Earth Science and Technology, JAMSTEC/National Maritime Research Institute, NMRI)

The Arctic Research Vessel currently built by JAMSTEC will be able to navigate through the ice and reach waters close to the North Pole. The vessel will provide a prosperous opportunity for science and engineering to collect valuable data. Navigating ships in ice still needs to be explored, primarily due to a need for more knowledge, but meanwhile, the vessel will be equipped with various scientific instruments which are also helpful for advancing engineering. The engineering challenges, such as safety and economy, highly incorporate full-scale demonstration. The full-scale data is also indispensable for physical model validation. In this session, we presented three questions to clarify fundamental issues in the engineering field as follows:

a. What knowledge is needed in the Arctic engineering field,
b. How to utilize the Arctic Research Vessel to retrieve data needed,
c. And proposals for research collaboration with the Arctic Research Vessel.

In the break-up session on Day 1, the four invited speakers from Canada, Germany, and Japan made their presentations and discussed the above topics with audiences under the chairmanship of Dr. Takatoshi Matsuzawa (JAMSTEC / National Maritime Research Institute, Japan). The summary of each presentation is described below.

Prof. Takenobu Toyota (Hokkaido University, Japan) presented his experiences of scientific cruises on a coastguard icebreaker. He overviewed the recent sea ice extent trend in the Northern Hemisphere and pointed out the similarity with the trend in the Sea of Okhotsk, a seasonal ice area. In his long-term monitoring of the Sea of Okhotsk, sea ice characteristics such as the deformation in growth processes have been revealed. He pointed out the importance of combining field data with satellite data to investigate the interannual variability of sea ice area. These topics are interdisciplinary for science and engineering; thus, he encourages intersectional approaches.

Prof. Rocky Taylor (Memorial University of Newfoundland, Canada) introduced details of ongoing arctic development projects and demanded ice-related technology in response to the projects in Canada. He underlined that full-scale data are essential for ice engineering research with state-of-the-art technologies such as satellite observations, cloud computing, and machine learning/artificial intelligence. The impacts of the Arctic Research Vessel is

expected not only for ship design but also for many other ice engineering applications, including adaptation to climate change. To make collaboration regarding ice engineering and science, he also introduced Canadian potential research communities, facilities, vessels, and fund opportunities.

Prof. Franz von Bock und Polach (Hamburg University of Technology, Germany) introduced the EU's comprehensive Arctic strategy from the motivation to the structure of a research project. Because of the rapid changes in Arctic conditions, we need new data on ice properties, ice dynamics, and wave-ice-structure interaction to update previous design regulations. Therefore, full-scale data becomes indispensable for validating physical models for future predictions. He emphasized the importance of the harmonization of scientific and engineering data, as well as of long-term measurements. A German national research project, "PolarSens," which will start in 2024, was introduced. It features autonomous measurement and data management.

Prof. Takuji Waseda (JAMSTEC / University of Tokyo, Japan) presented a series of national Arctic research projects, such as "ArCS" and "ArCS II," which have been promoted in Japan since 2000. Among them, he has carried out sea ice monitoring onboard MIRAI, SHIRASE, and SOYA, as well as numerical modeling. He pointed out that the decreasing trend of sea ice boosts wave-ice interaction, which causes safety problems on ships/offshore structures and coastal erosion. He suggests further buoy deployment onboard and developing wave-ice detecting methods to obtain wave-ice data needed in Arctic engineering. He also proposed bridging between science and engineering with international research collaboration on the axis of the JAMSTEC's Arctic Research Vessel.

In the wrap-up session on Day 2, Dr. Matsuzawa integrated opinions and suggestions from all speakers on Day 1. The summary is described below.

1) One of the motivations in ice engineering today is the Arctic Ocean's likely shift to a seasonal ice zone. This shift possibly enhances wave-ice interaction, for example, around utilized areas, but the knowledge and validation are insufficient due to poor multi-scale data.
2) JAMSTEC's new Arctic Research Vessel can impact sea ice science and engineering to fill knowledge gaps. Long-term monitoring and good data management systems should be crucial to maximize the achievement.
3) We need an interdisciplinary approach and international collaboration to share knowledge and data between science and engineering. Some specific projects are underway or planned in Canada, Germany, and Japan.