Stratification in the northern Bering Sea in early summer of 2017 and 2018

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H. Ueno[a], M. Komatsu[a], Z. Ji[b], R. Dobashi[a],
M. Muramatsu[a], **H. Abe**[a], K. Imai[a], A. Ooki[a] T. Hirawake[a]
(a: Hokkaido Univ., Japan b: Shanghai Ocean Univ., China)

H. Ueno

1. Introduction

In the winter of 2017/2018, the winter-maximum areal sea-ice coverage was extremely low; sea ice arrived late, while warm southerlies in February and March prevented southward migration of sea ice (Stabeno and Bell, 2019). In this study, we investigated spatial and interannual variation in early summer stratification in the northern Bering Sea in 2017 and 2018. In particular, we used the stratification index modified from Ladd and Stabeno (2012) to clarify the impact of record-breaking low sea-ice extent in the winter of 2017/2018 on stratification in early summer 2018.

2. Methods

We used temperature and salinity data obtained by the training ship Oshoro Maru (Hokkaido University) over the northern Bering Sea during the following periods: July 4–9, 2013; July 9–22, 2017; and July 2–12, 2018 (Fig. 1). In this study stratification index (SI) was evaluated as follows:

$$\mathrm{SI} = -\frac{1}{h}\int_{-h}^{0}(\rho - \langle\rho\rangle)gz\,dz \qquad\qquad \langle\rho\rangle = \frac{1}{h}\int_{-h}^{0}\rho\,dz$$

We also calculated the temperature stratification index (SI(T)), that is potential energy due to temperature stratification relative to the mixed state, assuming that the salinity is uniform (= depth-averaged salinity) over the water column. The salinity stratification index (SI(S)) is also calculated.

3. Results

Stratification was significantly weaker in 2018 than in 2017 in Area A and B (Figs. 1 and 2). These results are consistent with the extremely low sea-ice extent observed in the winter of 2017/2018, which would have resulted in less freshwater being supplied to surface layers and warmer and less saline bottom water (Stabeno and Bell, 2019). Conversely, in the area near the Alaska mainland (Area C and D), stratification was as strong in 2018 as in 2017 (Figs. 1 and 2). The warm and low-salinity Alaska Coastal Water (ACW) was observed in this area, forming stratification near Alaska. Broadly, extreme sea-ice conditions in the winter of 2017/2018 had an impact on stratification in the northern Bering Sea, especially in its western part, where the influence of the ACW was considered to be limited.

In addition to interannual variations, a rapid change in stratification (over several days) was observed around the Bering Strait in July 2018. At this time, a low-pressure area passed over the Bering Strait and a strong northerly wind blew over the area for 4 days. The water column had been weakly stratified before the passage of this low-pressure area but became stratified after its passage, particularly in terms of salinity (Fig. 3). We suggest that westward Ekman transport due to the northerly wind brought warm and low-salinity ACW from the Alaskan coastal area to the observation area. However, we have not yet clarified how long the strong stratification caused by this northerly wind persisted.

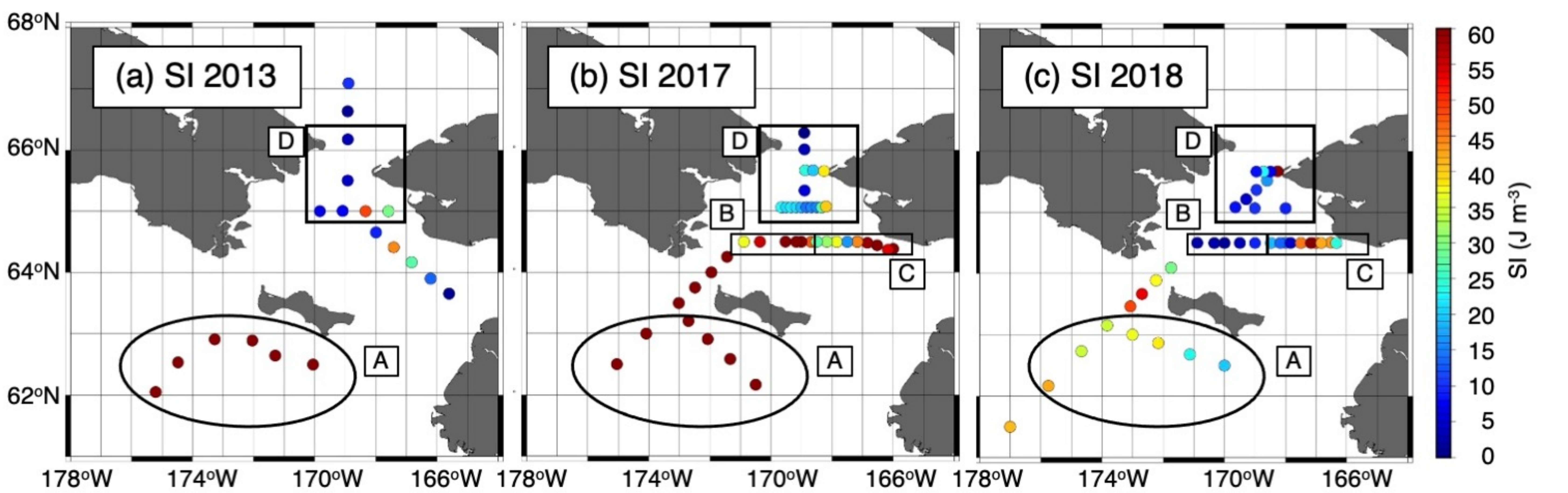

Fig. 1 Stratification Index (SI, J m^{-3}) in early summer of 2013, 2017 and 2018.

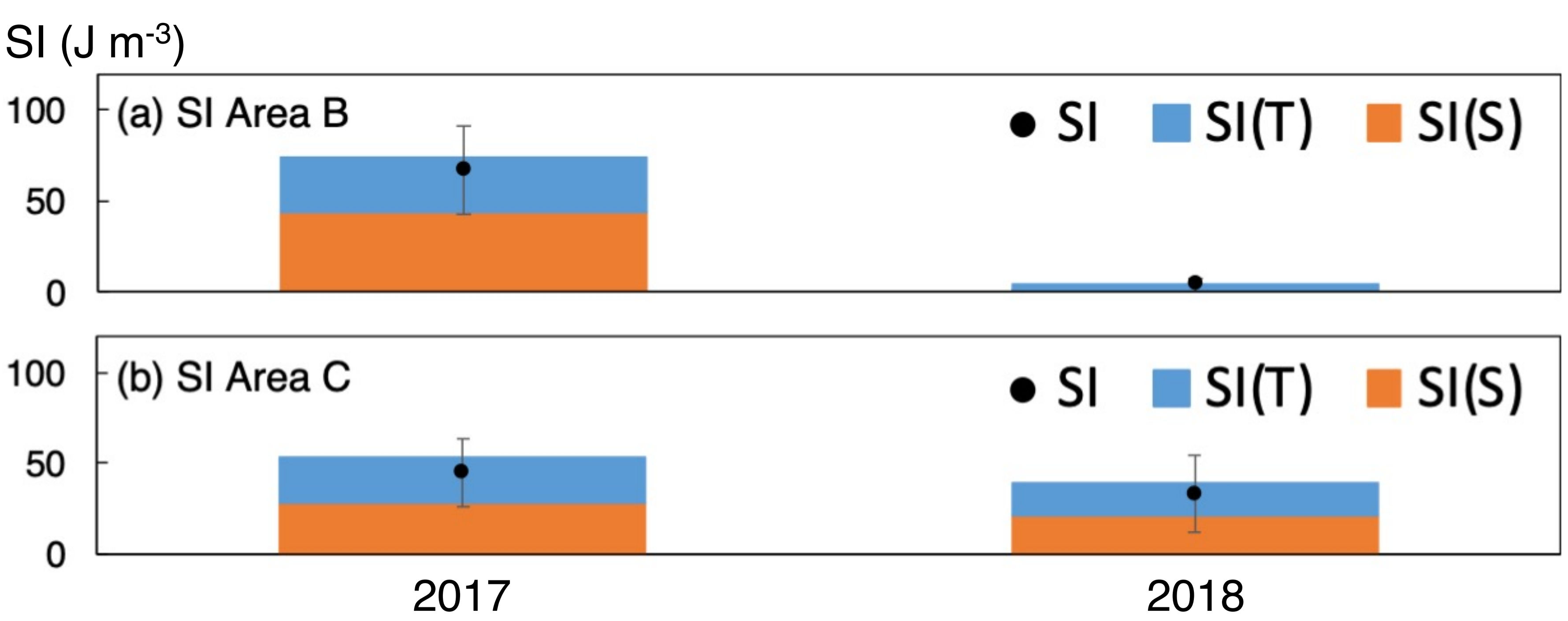

Fig. 2 SI averaged in Area B & C in early summer 2017 & 2018

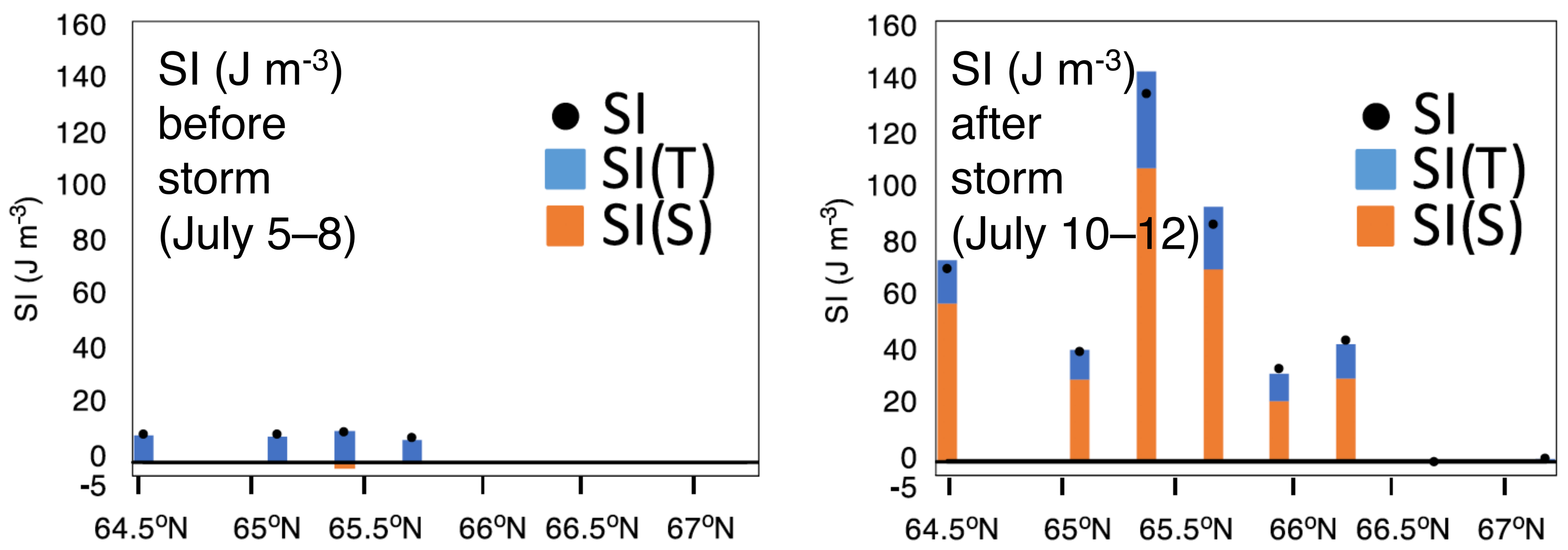

Fig. 3 SI along 169°W before and after storm in 2018

Reference

Ueno, H., Komatsu, M., Ji, Z., Dobashi, R., Muramatsu, M., Abe, H., Imai, K., Ooki, A., Hirawake, T., 2020. Stratification in the northern Bering Sea in early summer of 2017 and 2018, Deep-Sea Research Part II, 181–182, 104820. https://doi.org/10.1016/j.dsr2.2020.104820