Ocean wave observation by multiple drifting buoys in Beaufort Sea of the Arctic Ocean

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In the Arctic Ocean, wave phenomena have changed in recent years as a result of the reduction of sea ice. However, there have been few observations of these phenomena. In Arctic open water, the sea ice to its north controls the effective fetch (Thomson and Rogers, 2014). Fetch from the ice edge is difficult to determine due to the high temporal variability in sea ice edge location. The objective of this study was to observe how Arctic Ocean waves grow under off-ice wind conditions where fetch is controlled by the sea ice.
For this purpose, multiple small drifting wave buoys were deployed for direct observation. A total of 15 wave buoys were deployed in the Beaufort Sea in the Arctic Ocean on 2 Sep 2022 during a voyage by the JAMSTEC Research Vessel Mirai (MR22-06C, 11 Aug 2022 ~ 29 Sep 2022) as part of Arctic Challenge for Sustainability II, ArCS II. Two types of buoys were used: 3 SOFAR Spotter buoys (S/N : SPOT-1730, SPOT-1732, SPOT-1803) (https://www.sofarocean.com/products/spotter) and 12 FZ buoys (S/N : FZ02, FZ28~FZ30, FZ33, FZ35~FZ41) produced by our research group. Both buoys use GNSS or Inertial Measurement Units (IMU) to measure the selevation of the sea surface and perform spectral analysis, and transmit the data using Iridium satellites. Some buoys stopped transmitting data by 19 Sep 2022 for several reasons.

The trajectories of the buoys from the time of deployment to 19 Sep 2022 are shown in Figure 1. Also shown is a contour map of sea ice concentration by the AMSR2 satellite on 19 Sep 2022. The buoy was deployed on return from observations in the Marginal Ice Zone (MIZ) during the cruise and was deployed from 71°40'N to 70°20'N around 136°W. The buoy drifted westwards due to the Beaufort Gyre. Each buoy drifted but changed little in relative position.
The significant wave heights and mean periods measured at the buoys during the same period are shown respectively at the top and bottom of Figure 2. The buoys shown above have observed waves with a similar trend for most of the period. However, on 5-6 September 2022, the wave heights and periods were significantly different for each buoy.
The power spectrum density of the buoys around 16:00 (UTC) on 5 Sep 2022, when the difference was the largest, is shown in Figure 3. Together with Fig. 1, it can be seen that buoys located more southerly have observed higher wave heights and longer period waves. This is thought to be due to wave growth caused by winds from the north and requires quantitative analysis. We will furthur investigate the wave growth under off ice wind condition by comparing fetch estimated based on satellite data and also based on fetch laws with the observed buoy data.

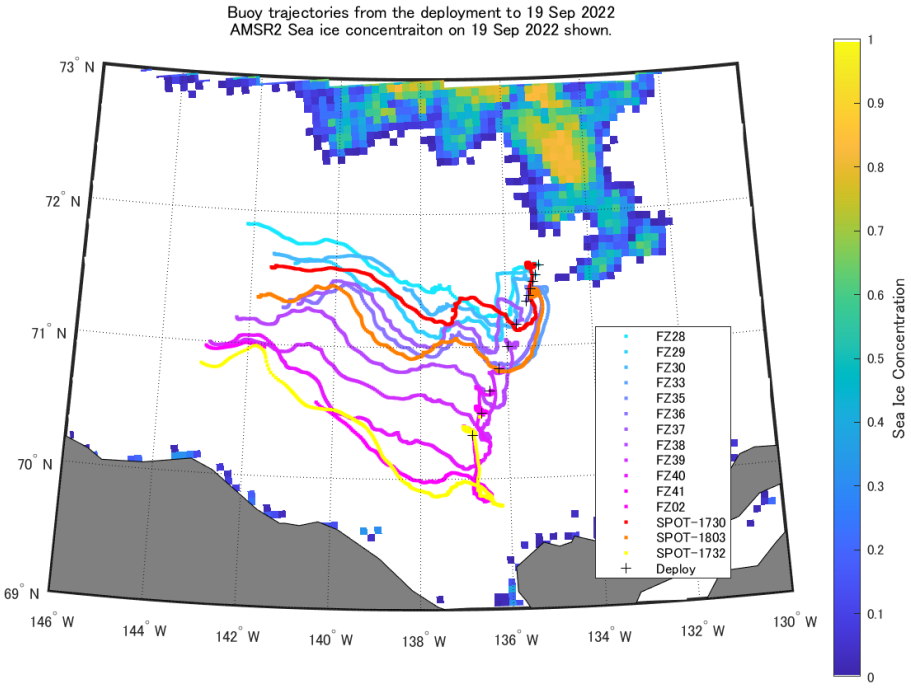

Figure 1. Buoy trajectories from the deployment date (2 Sep 2022) to 19 Sep 2022. The color shows AMSR2 sea ice concentration. Black crosses are the deployment places.

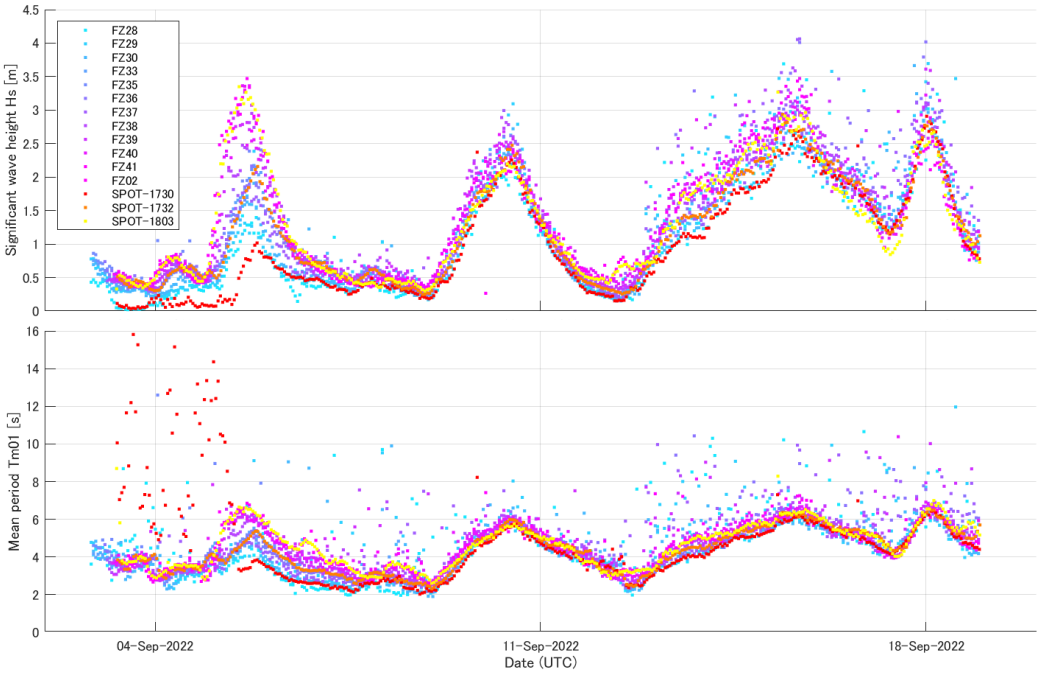

Figure 2. Measured significant wave height (H_s) on the top and mean wave period (T_{m01}) from the deployment date (2 Sep 2022) to 19 Sep 2022.

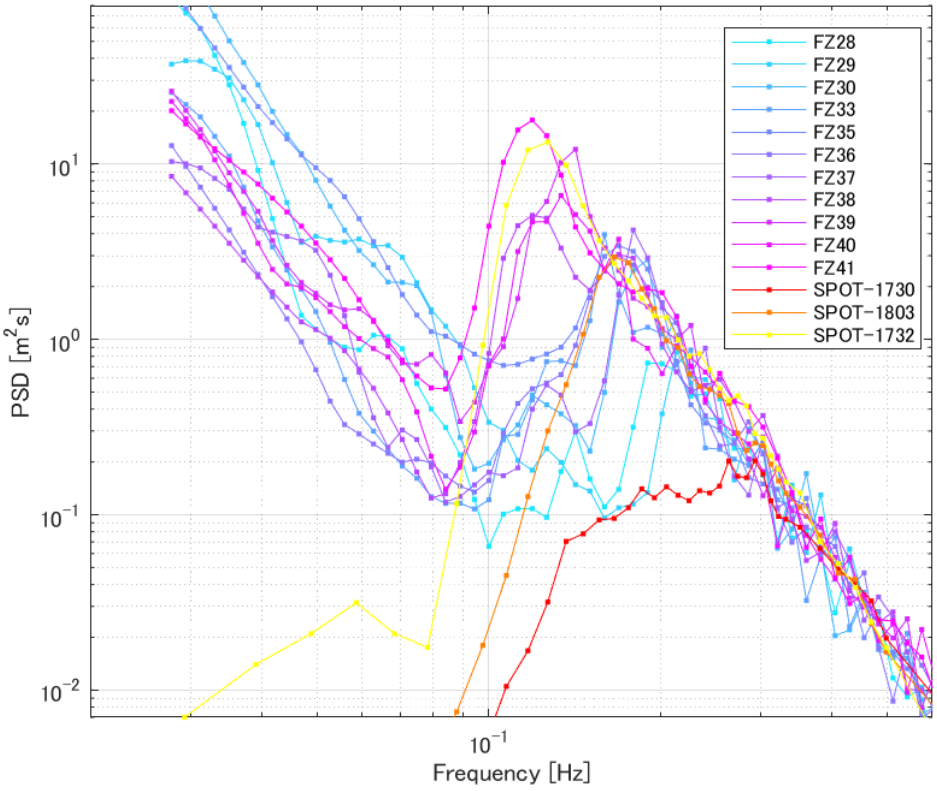

Figure 3. Power spectral density acquired at 15:45~16:15 (UTC) on 6 Sep 2022 for each buoys. For the FZ buoys, the smaller numbered buoys are located further north. For the Spotter buoys, SPOT-1730, SPOT-1803 and SPOT-1732 are deployed from north to south.

References

Thomson J., and W. E. Rogers, Swell and sea in the emerging Arctic Ocean, Geophysics Res. Lett., 41(3136), 2014.