

Lag effect of tropical sea surface temperature on sea ice variability in the Sea of Okhotsk

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The Sea of Okhotsk is unique in that it has the lowest latitude sea ice extent in the world. The sea ice in the Sea of Okhotsk fluctuates remarkably from year to year, and the northwesterly winds from Siberia in winter and the decrease in temperature around the Sea of Okhotsk are known to be the factors. In addition, a previous study showing the relationship between sea ice variability in the Sea of Okhotsk and the tropical oceans pointed out that the sea ice extent in the Sea of Okhotsk increases in years of El Niño events. However, this study looked at the relationship between sea ice variability in the Sea of Okhotsk and El Niño events during the same period, and did not consider the lag effects from the tropical ocean. In this study, we aim to examine the lag influence of the tropical ocean on the sea ice variability in the Sea of Okhotsk.

We used the maximum sea ice extent from the Japan Meteorological Agency (JMA) as the sea ice data for the Sea of Okhotsk. We also used the Hadley Centre sea ice and sea surface temperature (HadISST) for SST data. Atmospheric field and land surface data were obtained from the Japanese 55-year reanalysis (JRA-55). In addition, Outgoing Longwave Radiation (OLR) from the US National Oceanic and Atmospheric Administration (NOAA) was also used. Both data are monthly averages and the analysis period is 39 years from 1982 to 2020. First, the sea ice index of the Sea of Okhotsk was constructed from the sea ice data of the Sea of Okhotsk. Then, the Niño 3 index was created by averaging the SSTs in the Niño 3 region (5°S-5°N, 150°W-90°W) over a 3-month period. Each index was subjected to linear trend removal and standardization. The correlation coefficients between the Niño 3 index and the sea ice index were calculated by shifting the month of the index by one month. A lagged regression of the sea ice index and the Niño 3 index on the variables used was also performed.

The lag correlation analysis showed that the correlation between the Niño 3 index for December-February one year ago and the sea ice index was -0.33, which was significant at a confidence coefficient of 95%. The regression of the December-February Niño 3 index of one year ago on the OLR of the following June-August period indicates strong convective activity near the Philippine Sea. The OLR index in that region was calculated as follows. When the OLR index was constructed over this area and regressed on the 850-hPa geopotential height in July-September, a positive PJ pattern was observed. This result is consistent with the occurrence of a PJ pattern in the summer after El Niño. Low pressure anomalies were also observed around Siberia, which were regressed on soil temperature as low temperature anomalies. A significant signal persisted until November-January when soil temperature indexes were constructed in the area and autolagged correlations were examined. This suggests that the La Niña event of one year ago may have generated a PJ pattern in the following summer and affected sea ice fluctuations in the Sea of Okhotsk via the Siberian soil.

Keywords: Sea ice variability in the Sea of Okhotsk, La Nina events, Lag effect