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A NEGATIVE PHASE SHIFT OF THE WINTER AO/NAO DUE TO THE RECENT ARCTIC SEA-ICE REDUCTION IN LATE AUTUMN

Tetsu Nakamura *(National Institute of Polar Research, Japan)*
Koji Yamazaki *(National Institute of Polar Research, Japan)*
Katsushi Iwamoto *(National Institute of Polar Research, Japan)*
Meiji Honda *(Niigata University, Japan)*
Jinro Ukita *(Niigata University, Japan)*
Yasunobu Miyoshi *(Kyushu University, Japan)*
Yasunobu Ogawa *(National Institute of Polar Research, Japan)*

nakamura.tetsu@ees.hokudai.ac.jp

This study examines the possible linkage between the recent reduction in Arctic sea-ice extent and the wintertime Arctic Oscillation (AO)/North Atlantic Oscillation (NAO). Observational analyses using the ERA interim reanalysis and merged Hadley/OI-SST data reveal that a reduced (increased) sea-ice area in November leads to more negative (positive) phases of the AO and NAO in early and late winter, respectively. We simulate the atmospheric response to observed sea-ice anomalies using a high-top atmospheric general circulation model (AGCM for Earth Simulator, AFES version 4.1). The results from the simulation reveal that the recent Arctic sea-ice reduction results in cold winters in mid-latitude continental regions, which are linked to an anomalous circulation pattern similar to the negative phase of AO/NAO with an increasing frequency of large negative AO events by a factor of over two. Associated with this negative AO/NAO phase, cold air advection from the Arctic to the mid-latitudes increases. We found that the stationary Rossby wave response to a sea-ice reduction in the Barents Sea region induces this anomalous circulation. We also found a positive feedback mechanism resulting from the anomalous meridional circulation that cools the mid-latitudes and warms the Arctic, which adds an extra heating equivalent to about 60% of the direct surface heat release from the sea-ice reduction to the Arctic air column. The simulation results also suggested an important role of the stratosphere in deepening the tropospheric annular mode in mid to late winter through stratosphere–troposphere coupling.