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Arctic Oscillation and Dipole Anomaly and their contribution to sea ice export from the Arctic in the 20th century

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The winter Arctic Oscillation (AO) and Dipole Anomaly (DA) in the Arctic atmosphere and their contribution to sea ice export are investigated by using a high-resolution coupled general circulation model. The spatial distributions of the first two leading EOF modes of winter mean sea level pressure and geopotential height at 500 hPa north of 70^{o}N obtained by the long-term simulation (1900-2010) are highly similar to them derived from the NCEP/NCAR reanalysis datasets (1948-2004). The first leading mode corresponds to the Arctic Oscillation (AO). The DA is defined as the second-leading mode. The AO and DA account for 66 % and 13 % of the variance, respectively.

Composite spatial patterns of sea level pressure, sea ice thickness and velocity in the extreme years when both the absolute values of PC1 and PC2 exceed 1.0 indicate that the DA plays a great important role in sea ice export from the Arctic Ocean to the Greenland Sea due to its strong meridionality. Sea ice export is highly promoted (restricted) in the positive (negative) DA phase. The dependence of sea ice export on the DA is comparable to or rather larger than that on the AO. However, whether the DA is physically independent of the AO or not has been unknown yet. Composite SLP fields suggest that the location of the most dominant anomaly in the Arctic seems to be characterized by the DA, while the sign of the anomaly is represented by the AO. In future, we should clarify the mechanism for existence of the DA.