Decadal Changes in the Leading Patterns of Sea Level Pressure and Their Impacts on the Arctic Sea Ice Variability in Boreal Summer

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In the recent decade, the Arctic sea ice has experienced rapid melting with a record breaking minimum in 2012. To examine the major driver of sea ice melting, we focus specifically on the changes in the atmospheric circulation over the Arctic. The Empirical Orthogonal Function (EOF) analysis to the sea level pressure (SLP) to the north of 70°N is performed to identify the leading patterns of the atmospheric circulation. The first pattern is known as the Arctic Oscillation (AO) and the second pattern is defined as the Arctic Dipole (AD). We also analyze the third EOF pattern, referred to as A3 in this study.

To compare the decadal variability, we separated the data into two periods: the former period (1982-1997) and the latter period (1998-2013). Among the three leading patterns, the AD shows the most significant change between the two periods, where the time correlation between the time series associated with AD and the index of sea ice extent in September has jumped from 0.06 in the former period to 0.62 in the latter one. The other patterns, AO and A3 do not show significant correlation in both periods. These results are also confirmed by the multiple regression method in predicting the interannual variability of the sea ice extent index of September, with the highest contribution by AD.

We further discuss the dynamical and thermodynamical processes that might be responsible for the rapid sea ice melting in the latter period. We suggest the shift in the center of AD tends to intensify the transpolar winds across the Arctic and increase sea ice drift and discharge from the Arctic to the North Atlantic in negative AD phase.

Key words: Atmospheric circulation, Arctic Oscillation, Arctic Dipole, Arctic Sea ice