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# Responses of Summer Sea Ice in the Beaufort-Chukchi Seas to interannual variations of atmospheric Pacific-Arctic Dipole in spring

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Arctic sea ice has been rapidly decreasing over the past three decades, and the rapid retreat of summer ice has led to increased demands for forecasts of sea ice conditions on seasonal to interannual time scales due to social and economic interests. Due to the decreased ice thickness, the increased internal variability has played an important role in several record-breaking minima of ice cover over the last decade. The increased internal variability complicates the prospects for improved forecast skill for near-term ice forecasts. A better understanding of the internal variations in Arctic sea ice is becoming increasingly important for both seasonal predictions and future climate projections of the Arctic.

In our study, we focus on the regional summer sea ice over the Beaufort-Chukchi Sea, where has experienced the greatest decline over last decades. First, we identify an atmospheric dipole in the Pacific-Arctic sector (PAD) in spring and then we investigate its impacts on the following summer sea ice in the Beaufort-Chukchi Sea. These results are obtained using sea ice observations, model-generated data from PIOMAS (Pan-Arctic Ice-Ocean Modeling and Assimilation System), and the European Centre for Medium-Range Weather Forecasts (ECMWF) Re-Analysis. PAD is defined as the second EOF mode of the monthly sea level pressure in the Pacific-Arctic region. A positive PAD mode has a positive anomaly in the Beaufort Sea and a negative anomaly extending from East Siberia to the northwest America. It exhibits an atmospheric mass oscillation between the western Arctic Ocean and the surrounding sub-polar region. In addition, a positive PAD mode is associated with the decreased cyclone activity in the Beaufort Sea and increased cyclone activity in the sub-polar region. Our results suggest that PAD reflects the re-distribution of cyclones due to the modulation of the upper atmospheric circulation in the Pacific-Arctic region.

We find that the spring PAD accounts for about 16% of the interannual variability of the following September sea ice concentration (SIC) in the Beaufort-Chukchi Sea. A positive PAD can also lead to an early retreat in the spring ice in the Beaufort Sea, by as much as two weeks. During a positive PAD, the Beaufort High and the Low (over the sub-polar continent, as above) both tend to be strong in the sub-polar region, and the intensified easterly winds in the Beaufort Sea enhance ice advection from the Beaufort Sea and reduce ice thickness. Also, due to the reduced cloud cover and water content associated with fewer cyclones in the Beaufort-Chukchi Seas, the increased solar radiation further accelerates the ice melting. Thinner ice in the spring fosters a stronger summer ice-albedo feedback resulting in persistent acceleration in the melting of the summer ice, as well as also resulting in more rapid sea ice advection.