# Sea ice loss and Arctic cyclone activity from 1979 to 2014

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*1. Introduction*

During the last four decades, Arctic sea ice extent (SIE) has declined by more than 40% (Stroeve et al. 2012). Accordingly, the air above the expanding open water areas is warmed and influences on air temperature and precipitation through atmospheric advection and mixing are expected.

This study analyzes Arctic cyclone frequency and intensity in response to sea ice loss and changes in relevant parameters.

*2. Methodology and Data*

We utilize the Serreze et al. (1997) method to identify and track cyclones, where cyclones are tracked based on a series of search patterns to define occurrences when sea level pressure (SLP) is at least 1hPa lower than adjacent grid points. We also evaluate vertical temperature difference, baroclinic instability, cyclone intensity, and frequency of extreme cyclones. The Eady growth rate (Hoskins and Valdes 1990) provides a measure of baroclinicity and is determined by changes in static stability and vertical wind shear. When the SLP for a specific grid cell at a certain time is at least 40hPa lower than the climatological value, it is assumed that an extreme cyclone occurred.

We rely on the National Centers for Environmental Prediction and National Center for Atmospheric Research (NCEP/NCAR) reanalysis (Kalnay et al. 1996). Two more modern products, ERA-Interim and MERRA, are utilized to verify the robustness of the results.

We focus our analysis on relationships between mean September SIE and cyclone activity from September to November for several different time-periods. These are defined by sorting the September SIE north of 60˚N in ascending order, pentad, decade, and 18-year duration periods. Extreme high and low sea ice years are additionally determined by selecting years with values greater than ±1.0 standard deviation from the standardized time-series.

*3. Summary*

Enhanced turbulent heat fluxes and longwave radiation in autumn and winter from sea ice loss have reduced the atmospheric static stability, as evidenced by increases in vertical temperature differences between 500 and 925 hPa. This has made the Arctic atmosphere more prone to baroclinic instability. Eady growth rate suggests that baroclinic instability over Greenland has increased as Arctic sea ice cover has decreased in autumn. Combined these results suggest an increased potential for cyclogenesis during low sea ice years.

Detected cyclones based on NCEP/NCAR reanalysis does not suggest that there has been an increase in autumn cyclone activity following years with low September SIE (see Figure). However, DJF extreme cyclone tracks are shifted westward in the North Pacific Ocean while the frequency of extreme cyclones in the north Atlantic storm track has generally declined in response to sea ice loss.

Expanding open water areas in the Arctic have led to increasing transfer of heat and moisture from the ocean to the atmosphere, warming and moistening the Arctic atmosphere and increasing the potential for cyclogenesis. However, a coherent change in autumn cyclone frequency has not yet manifested despite evidence of a relationship between extreme cyclones and sea ice loss. This suggests that while there is some evidence that sea ice changes are impacting the potential for cyclogenesis, their effect on cyclone metrics is indistinct.

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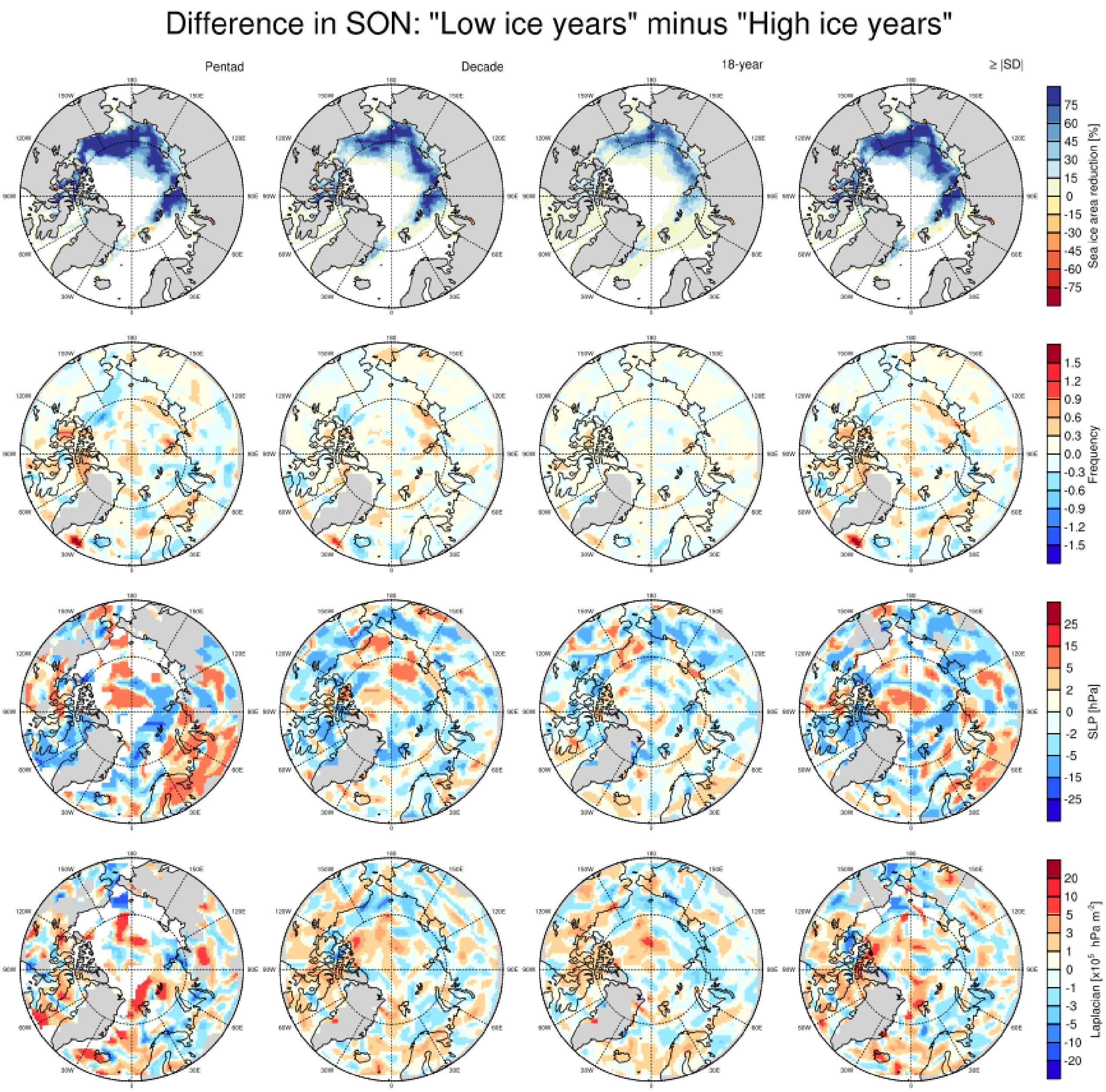
Difference in SON: "Low ice years" minus "High ice years"
Pentad
Decade
18-year
≥ |SD|
Sea ice area reduction [%]
Frequency
SLP [hPa]
Laplacian [x10^5 hPa m^-2]

 