Abstract

The Arctic sea ice cover has decreased dramatically in recent decades. By examining satellite observations of sea ice concentration since 1979 and an observational-based reconstruction of sea ice extent since 1850, we assess ongoing and past change in regional sea ice variability in summer and winter. We find an asymmetry between changes in spring and fall, and propose two modes of variability. We speculate that in regions with largest summer trends, the ice loss is due to increased melting (melting mode), while in regions with largest winter changes, the ice loss is due to reduced freezing (non-freezing mode).

Summer and winter changes

The present sea ice extent is the smallest throughout the observational record both during summer and winter, and 30-year trends are record large during the satellite era, especially in summer.

Data

1979–2015: Sea ice concentration from SMMR and SSM/I-SSMIS passive microwave data, NSIDC. Resolution: 25 km x 25 km.

1850–2013: Gridded monthly sea ice extent and concentration, 1850 onward, version 1, NSIDC. Resolution: 0.25° x 0.25°, with 16 different data sources including satellite passive microwave data, ship observations, compilations by naval oceanographers, and analyses by national ice services.

Regional and seasonal contributions

These regions are divided into 13 seas. The Arctic Ocean includes the Beaufort, Chukchi, East Siberian, Laptev, and Kara seas and the Central Arctic.

Asymmetry and modes of variability

Asymmetry: Northern Hemisphere sea ice extent trends are larger in spring (April–July) than fall (November–February).

– Melting mode: Larger trends in spring than fall, possibly indicating that more sea ice melts in spring, but that the ocean still re-freezes quickly in fall. Typical in the Arctic Ocean, here represented by the Chukchi Sea. These Arctic seas typically have strong salinity stratification due to significant river inflow, and the cooling needed before sea ice formations starts in fall is therefore limited.

– Non-freezing mode: Larger trends in fall than spring, possibly indicating reduced sea ice freezing in fall. Typical in the Barents and Greenland seas, Baffin Bay, and Sea of Okhotsk, here represented by the Barents Sea. These seas are more affected by convection and are less stratified. They also have open boundaries to the south, and receive additional heat through ocean heat transport.

Ongoing work assesses the two modes in more detail, by investigating regional changes in the melting and freezing seasons.

References

