How atmospheric water vapor and energy transport affect sea ice variations

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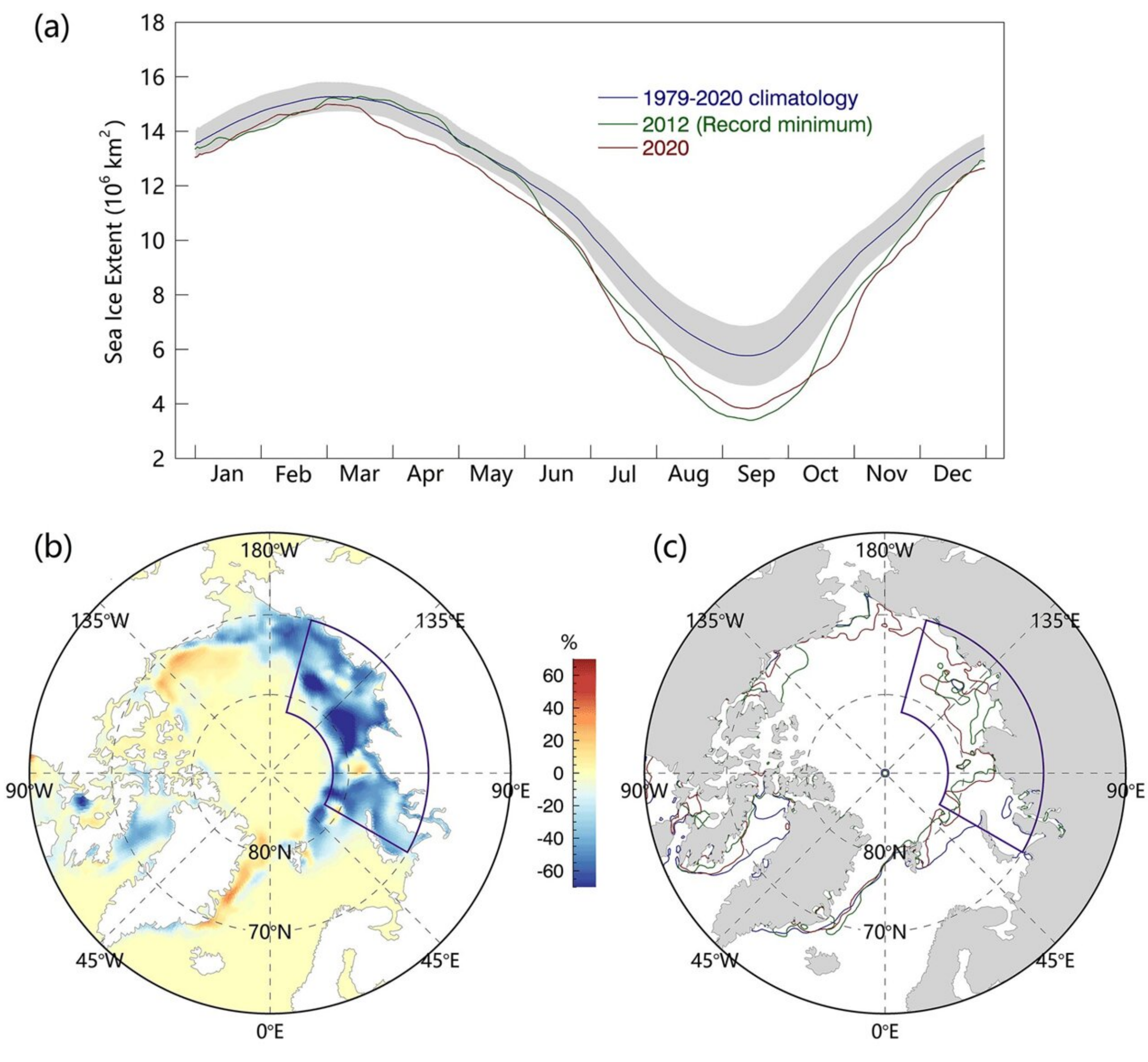

(a) Daily SIE of the Arctic in 2020 and 2012, and the climatology during 1979–2020. The shadows denote mean plus or minus 1 standard deviation. (b)

Spatial patterns of SIC anomalies (shading) and (c) the SIEs in typical years (bold lines). The red line represents the SIE in July 2020. Green and navy-blue lines denote the SIE in July 2012 and the 42-year average of the period 1979–2020, respectively. The anomalies are computed as the difference between the fields in July and the corresponding climatology over the past four decades (1979–2020). Purple polygons encapsulate areas where substantial sea ice cover loss (60–165◦ E, 70–82◦ N) was observed in July 2020, which represents the study area of this paper. Credit: *The Cryosphere* (2022). DOI: 10.5194/tc-16-1107-2022

Atmospheric water vapor and energy transport play an important role in the Arctic climate. Changes in atmospheric energy and water vapor influx to the Arctic would have a significant impact on the interannual variations and long-term trend of sea ice through a variety of mechanisms.

Recently, a research team led by Prof. Huang Haijun from the Institute of Oceanology of the Chinese Academy of Sciences (IOCAS) provided new insights into the impact of atmospheric moisture and energy transport on sea ice loss.

The study was published in *The Cryosphere* on March 31.

Satellite observations showed an unprecedented reduction in sea ice extent (SIE) observed in July 2020 since 1979, especially in the Eurasia shelf seas including the Kara, Laptev, and East Siberian Seas.

Based on reanalysis and modeled sea ice thickness, the researchers suggested that anomalously high advection of energy and water vapor prevailed during spring 2020 over the regions where conspicuous sea ice retreat occurred in the following July. The convergence of the transport increased the temperature and specific humidity of the local atmosphere.

The enhanced greenhouse effect thereby led to strengthened downward longwave radiation plus turbulent fluxes at the surface, which initiated the earlier melt onset of sea ice in the study area. After the melt commenced, the enhanced net solar radiation absorbed by the ocean-ice system produced an accelerated decline in SIE through the ice-albedo feedback.

A key driver of the anomalous high transport of the total energy and moisture during spring 2020 was a persistent atmospheric pattern, featuring unusually low sea level pressure (SLP) over the north pole which extended through the Barents-Kara Sea to Eurasia and unusually high-pressure centers over Eastern Siberia and the Norwegian Sea. Cyclones served as another important carrier of the large energy and moist fluxes into the study area.

"In general, the typical trajectories of the synoptic cyclones that occurred on the Eurasian side in spring 2020 agree well with the path of the intensive total energy and water vapor transport," said Dr. Liang Yu, first author of the study. Besides, anomalously frequent and intense cyclones in the Arctic during spring 2020 coupled with large-scale atmospheric circulation, further strengthened the cyclonic wind and ice motion, which could lead to extensive sea ice melt through the large formation of the cracks.

"This study sheds light on the regulation and mechanism of atmospheric water vapor and energy transport on sea ice variations, and helps deepen the understanding of the atmospheric-sea ice interaction in the Arctic under the background of climate warming," said Prof. Huang.

More information: Yu Liang et al, Contribution of warm and moist atmospheric flow to a record minimum July sea ice extent of the Arctic in 2020, *The Cryosphere* (2022). DOI: 10.5194/tc-16-1107-2022

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