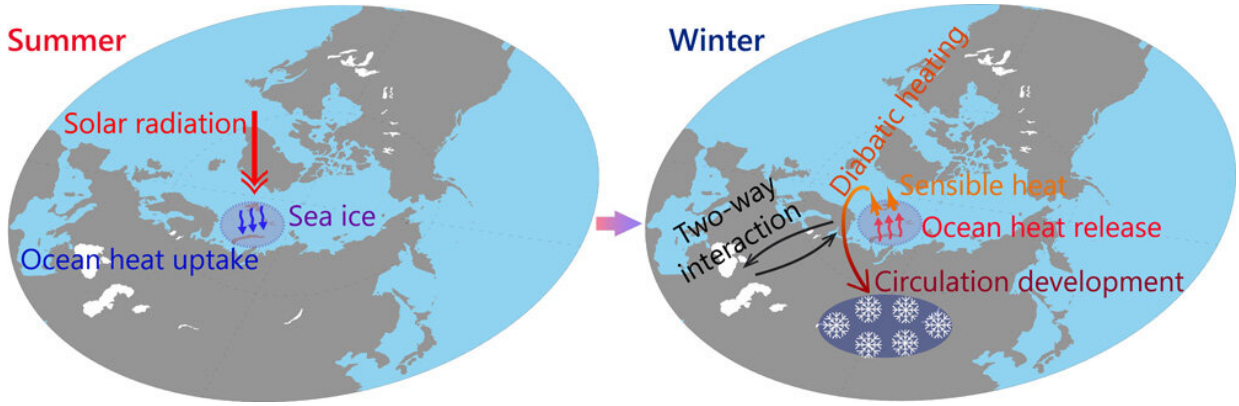
Multi-sphere interactions underlie impacts of the Arctic on Eurasian climate change

December 30 2021, by Li Yuan



Schematic view of the multisphere interactions. Credit: Xie Yongkun

Observations suggest a warming trend in the Arctic, and a cooling trend in Eurasia during the past several decades. Is there a cause-and-effect relationship in this pattern? The question has been hotly debated for quite a while.

A study published in *Climate Dynamics*, by researchers from the Institute of Atmospheric Physics of the Chinese Academy of Sciences and Lanzhou University, gives clues to the question. It suggests that the Arctic climate is one of the factors driving the overall trend and decadal variability of Eurasian temperature.

The researchers proposed a dynamic and thermodynamic coupling view of how the Arctic drives Eurasian climate variability and underlying multi-sphere interactions. Additionally, they compared cases in various time scales, i.e., overall trend, decadal and interannual variability.

"In summer, the key factors in multi-sphere interactions are sea ice, surface solar radiation, and subsurface ocean heat uptake," said Dr. Xie Yongkun, the lead author of the study. "In winter, the key factors are sea ice, surface sensible heat, diabatic heating of the atmosphere, interaction between the Arctic and mid-latitude, and large-scale circulation."

The story, according to the team, starts from summer when absorption of solar radiation by the subsurface ocean over the sea ice loss region (Barents-Kara Sea) is enhanced. The energy is then released to the atmosphere via sensible heat in winter through vertical diffusion and causes local circulation anomaly and enhanced warming.

The background strong baroclinicity of the atmosphere in mid-high latitudes further stimulates the interactions between atmospheric circulation and sea surface sensible heat, and eventually generates the anticyclonic circulation over the Arctic-Eurasia sector and warm Arctic-cold Eurasia (downstream of the enhanced Arctic warming) pattern.

"The comprehensive mechanisms from the summertime Earth's surface and subsurface ocean to the wintertime atmosphere suggest a driving role of the Arctic," said Prof. Liu Yimin, the corresponding author of the study.

Many previous studies jumped to conclusions by generalizing interannual variability to overall trend and therefore caused much debate. The study may clarify the dispute by pointing out that the situation in interannual variability is more complex than the overall trend and decadal variability. It is because the persistence of the influence of

summertime sea ice on wintertime climate variation is weak in terms of interannual variability.

More information: Yongkun Xie et al, A dynamic and thermodynamic coupling view of the linkages between Eurasian cooling and Arctic warming, *Climate Dynamics* (2021). DOI: 10.1007/s00382-021-06029-8

Provided by Chinese Academy of Sciences