Arctic amplification: New research reveals how surface types play a role

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A robust phenomenon termed the Arctic Amplification (AA) refers to the stronger warming taking place over the Arctic compared to the global mean. The AA in the Arctic's different surface types exhibits various warming characteristics.

To further explore the impact of surface type on the seasonality and inter-model uncertainty of AA, a research team with Sun Yat-sen University and Southern Marine Science and Engineering Guangdong Laboratory used 17 CMIP6 models to divide the Arctic region into four surface types: ice-covered area, ice-retreat area, ice-free area, and land for analysis.

The research team analyzed the difference between the abrupt-4 × CO_2 and pre-industrial experiments of 17 CMIP6 models. The results of the multimodal ensemble mean show that the seasonal pattern of Arctic warming—with maximum warming in winter and weak warming in summer—takes occurs in all regions except for ice-free regions.

The ice-retreat region has the strongest warming and the largest seasonal contrast of AA. This result can be explained by the seasonal energy transfer mechanism, which refers to that during summer when sea ice melts, a large amount of heat is absorbed and stored by the open ocean, and released in winter.

Their findings are published in the journal *Advances in Atmospheric Sciences*.

Some studies have proposed that the changes in effective thermal inertia can lead to seasonal amplification in the Arctic. In summer, a larger ocean heat capacity will suppress warming, while in winter, a smaller heat capacity will accelerate warming, thereby amplifying the seasonal warming in the Arctic.

Therefore, the research team also explored the impact of changes in the effective thermal inertia (ETI) of different surface types on AA. The research results indicate that there is a transition from sea ice to the ocean in the ice-retreat regions, resulting in the greatest thermal inertia change, which explains the most significant seasonal difference in the region. The weak thermal inertia changes in ice-free regions explain the uniform warming throughout the year.

The research team concluded that the seasonal energy transfer mechanism and the changes in ETI work together to contribute to the seasonality of AA. As the model simulation is the main mean of predicting future Arctic climate, the team focused on the sources of inter-model uncertainty in AA.

The team discussed the inter-model uncertainty of AA in different surface types and quantitatively analyzed the inter-model differences in various feedbacks. The results show that the ice-covered regions exhibit the maximum inter-model uncertainty in the January-February-March (JFM) months, which is mostly caused by the oceanic heat storage term.

In addition, the ice-albedo feedback shows a large inter-model difference in ice-covered regions and ice-retreat regions, and the correlation between the ice-albedo feedback and Arctic warming is more than 0.66.

"Narrowing the differences in sea ice simulation is of great significance for better predicting Arctic climate in the future," said Dr. Xiaoming Hu, the corresponding author of the study.

More information: Yanchi Liu et al, Influence of Surface Types on the Seasonality and Inter-Model Spread of Arctic Amplification in CMIP6, *Advances in Atmospheric Sciences* (2023). DOI: 10.1007/s00376-023-2338-9