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Assessing the climate response to regional sea ice change across all Arctic regions.

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Climate models predict that sea ice cover will shrink--even disappear-- in most regions of the Arctic basin by the end of the century, triggering local and remote responses in the surface climate via atmospheric and oceanic circulation changes. In particular, it has been suggested that seasonal anomalies over Europe and North America in recent years could have been caused by record low Arctic sea ice cover. Despite an intense research effort toward quantifying its effect, the contribution of regional sea ice loss to climate change and its mechanisms of action remain controversial.

In this study, we prescribe sea ice loss in individual sectors of the Arctic within a climate model, and study its effect on climatic anomalies in the Northern Hemisphere. Using the EC-EARTH3.3 model in its atmospheric-only and fully coupled configuration, and following the PAMIP protocol, sea ice cover is set to either its present day state, or a hypothetical future distribution of reduced sea ice cover in the Arctic. This pan-Arctic sea ice loss experiment is then complemented by 8 regional sea ice loss experiments.

Comparing those experiments, we assess the contribution of sea ice loss in each region of the Arctic to climate change over Europe, Siberia and North America. We find that sea ice loss in some sectors of the Arctic appears to matter more for Northern Hemisphere climate change than others, even after normalizing for differences in surface cover. Furthermore, the climatic effect of regional sea ice loss is compared to that of a pan-Arctic sea ice loss, whose associated climate anomalies are found to be strikingly different from that expected from a simple linear response to regional sea ice loss. We propose a mechanism for this nonlinear climate response to regional sea ice loss, which considers regional differences in the strength of the thermal inversion over the Arctic, as well as the relative proximity of each Arctic region to features critical for stationary wave genesis (e.g. the Tibetan plateau).

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