

PAMIP Webinar Series

Observed Statistical Connections Overestimate the Causal Effects of Arctic Sea Ice Changes on Midlatitude Winter Climate

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Abstract

Disentangling the contribution of changing Arctic sea ice to midlatitude winter climate variability remains challenging because of the large internal climate variability in midlatitudes, difficulties separating cause from effect, methodological differences, and uncertainty around whether models adequately simulate connections between Arctic sea ice and midlatitude climate. We use regression analysis to quantify the links between Arctic sea ice and midlatitude winter climate in observations and large initial-condition ensembles of multiple climate models, in both coupled configurations and so-called Atmospheric Model Intercomparison Project (AMIP) configurations, where observed sea ice and/or sea surface temperatures are prescribed. The coupled models capture the observed links in interannual variability between winter Barents–Kara sea ice and Eurasian surface temperature, and between winter Chukchi–Bering sea ice and North American surface temperature. The coupled models also capture the delayed connection between reduced November–December Barents–Kara sea ice, a weakened winter stratospheric polar vortex, and a shift toward the negative phase of the North Atlantic Oscillation in late winter, although this downward impact is weaker than observed. The strength and sign of the connections both vary considerably between individual 35-yr-long ensemble members, highlighting the need for large ensembles to separate robust connections from internal variability. All the aforementioned links are either absent or are substantially weaker in the AMIP experiments prescribed with only observed sea ice variability. We conclude that the causal effects of sea ice variability on midlatitude winter climate are much weaker than suggested by statistical associations, evident in observations and coupled models, because the statistics are inflated by the effects of atmospheric circulation variability on sea ice.



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