

# **Cold winters in mid-latitudes coincident with but not caused by reduced Arctic sea ice**

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Rapid Arctic warming has coincided with a spate of cold winters over midlatitude continents. Previous work has proposed that warming over the East Siberian-Chukchi Sea causes cold winters over North America, whereas cold winters across East Asia are driven by warm conditions over the Barents-Kara Sea. However, this work is based upon correlation and causality has not been established. Here we use large ensemble simulations from two coupled climate models to elucidate whether reduced Arctic sea ice contributes to cold midlatitude winters. The models are able to accurately capture the two aforementioned observed modes of interannual variability between reduced sea ice and cold midlatitude winters, and the anomalous large-scale circulation patterns in which they are embedded. However, these associations are only present during winters when reduced sea ice coincides with a downward turbulent heat flux anomaly, implying the atmosphere is driving the sea ice. No midlatitude cooling is found during winters when reduced sea ice coincides with an upward turbulent heat flux anomaly. This strongly suggests that severe midlatitude winters are not caused by sea-ice loss, but instead that anomalous large-scale atmospheric circulation simultaneously drives cold midlatitude winters and contributes to mild Arctic conditions.

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