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## Warm hole in Pacific Arctic sea ice cover forces mid-latitude Northern Hemisphere cooling during winter

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In North America and Asia, extreme cold weather characterized the winter of 2017–18. At the same time, the Pacific Arctic regions -- Chukchi and Bering Seas --experienced the historical lowest sea ice extent. Because the shape of the ice-free ocean appears as a hole in the larger ice cover, we refer to this sea ice hole as a warm hole. The jet stream dividing cold Arctic air from warm air deviated from normal zonal patterns northward into the ice-free areas north of the Bering Strait. Large southward jet stream pathways formed over Asia and America, allowing cold air to spread into Asia and the southern areas of North America. We hypothesise that the warm hole and Pacific atmospheric rivers were partially responsible for the cold winter. We used data analyses and numerical experiments to test this hypothesis. We propose a positive feedback mechanism between the sea ice anomaly and atmospheric river activity, with anomalous south winds toward the sea ice anomaly potentially leading to more warm water injected by the wind-driven current through the Bering Strait. Our findings suggest that Poleward propagation of the atmospheric rivers made upper air warm, leading to their upgliding, which further heated the overlying air, causing poleward jet meanders. As a part of this response the jet stream meandered southward over Asia and North America, resulting in cold intrusions.

We speculate that the positive feedback mechanism observed during the 2017–18 winter could recur in future years. This winter may be the first year when the warm hole shifted the dynamics of hemispheric climate to the new state, because ice retreat has not abated, and the warm hole would be expected to appear again and again. This would provide Eastern Eurasia and North America with cold winter in the new era of the warm hole. This study was recently published in Scientific Reports [1].

### References

[1] Tachibana, Y., K. K. Komatsu, V. A. Alexeev, L. Cai, and Y. Ando, Warm hole in Pacific Arctic sea ice cover forced mid-latitude Northern Hemisphere cooling during winter 2017-18, Scientific Reports, **9**, 5567, DOI: 10.1038/s41598-019-41682-4, (2019)