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A mechanism predicting the climate response to sea ice loss from its geometry

Xavier Levine[1], Ivana Cvijanovic[2], Pablo Ortega[1], Markus Donat[1], and Etienne Tourigny[1]
[1]Barcelona Supercomputing Center, Earth Sciences Department, Barcelona, Spain
[2]Barcelona Institute for Global Health, Climate and Health Team, Barcelona, Spain

As climate warms sea ice loss may become a potent climate change feedback, both in the Arctic and at lower latitudes. For instance, extreme events over Europe and North America, such as drought or warm spells, have been attributed to sea ice minima in recent years. Yet a comprehensive understanding of the local or remote impact of sea ice loss on climate is lacking, with the predicted atmospheric and oceanic response to sea ice loss differing between climate studies. In particular, the impact of varying geographical distribution of sea ice loss on regional climatic changes remains uncertain.

Here, we assess the sensitivity of the atmospheric response to various patterns of sea ice loss, at a pan-Arctic or regional scale, by analyzing a set of idealised AMIP-like simulations. Depending on where sea ice is reduced, we find that climatic anomalies can vary widely among experiments, especially the zonal-mean component of the tropospheric circulation: for instance, the subpolar jet and polar cell can strengthen or weaken with sea ice loss, depending on its geographical distribution. We demonstrate that the geometry of the sea ice loss, in particular the degree to which sea ice extent changes is zonally symmetric or asymmetric, controls this disparate climatic response through an atmospheric feedback mechanism. In this feedback mechanism, changes in poleward eddy heat flux and latent heat release over the Arctic in response to a specific sea ice loss pattern can either warm or cool the Arctic troposphere. We discuss the implications of our results for interpreting the apparent discrepancies in the climate response to Arctic sea ice variability among studies.