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Isolating the atmospheric circulation response to Arctic sea-ice loss in the coupled climate system

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In the coupled climate system, projected global warming drives extensive sea-ice loss, but sea-ice loss drives warming that amplifies and can be confounded with the global warming process. This makes it challenging to cleanly attribute the atmospheric circulation response to sea-ice loss within coupled earth-system model (ESM) simulations of greenhouse warming. In this study, many centuries of output from coupled ocean/atmosphere/land/sea-ice ESM simulations driven separately by sea-ice albedo reduction and by projected greenhouse-dominated radiative forcing are combined to cleanly isolate the hemispheric scale response of the circulation to sea-ice loss. To isolate the sea-ice loss signal, a *pattern scaling* approach is proposed in which the local multidecadal mean atmospheric response is assumed to be separately proportional to the total sea-ice loss and to the total low latitude ocean surface warming. The proposed approach estimates the response to Arctic sea-ice loss with low latitude ocean temperatures fixed and vice versa. The sea-ice response includes a high northern latitude easterly zonal wind response, an equatorward shift of the eddy driven jet, a weakening of the stratospheric polar vortex, an anticyclonic sea level pressure anomaly over coastal Eurasia, a cyclonic sea level pressure anomaly over the North Pacific, and increased wintertime precipitation over the west coast of North America. Many of these responses are opposed by the response to low-latitude surface warming with sea ice fixed. However, both sea-ice loss and low latitude surface warming act in concert to reduce storm track strength throughout the mid and high latitudes. The responses are similar in two related versions of the National Center for Atmospheric Research earth system models, apart from the stratospheric polar vortex response. Evidence is presented that internal variability can easily contaminate the estimates if not enough independent climate states are used to construct them.

References: Blackport, R. and P. Kushner, 2017: Isolating the atmospheric circulation response to Arctic sea-ice loss in the coupled climate system. J. Climate, in press. Blackport, R. and P. Kushner, 2016: The Transient and Equilibrium Climate Response to Rapid Summertime Sea Ice Loss in CCSM4. J. Climate, 29, 401–417, doi: 10.1175/JCLI-D-15-0284.1.