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Multimodel evidence for an atmospheric circulation response to sea ice loss in the CMIP5 future projections

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The polar amplification of global warming has been identified as one of the drivers that influence the mid-latitude atmospheric circulation response to climate change, and previous single model experiments have found that Arctic sea-ice loss plays an important role. To evaluate this process in a multi-model ensemble, we introduce a novel approach that enables to directly evaluate the teleconnection between Arctic sea-ice loss and the mid-latitude circulation in the future projections from the CMIP5 models. In particular, the influence of sea-ice loss is estimated by comparing the circulation response in the RCP8.5 scenario against the circulation response to sea surface warming and CO_2 increase inferred, respectively, from the CMIP5 AMIPFuture and AMIP4xCO_2 experiments, where sea-ice is unperturbed. In particular, the AMIPFuture and AMIP4xCO_2 experiments are scaled and combined so that the resulting response, here called AMIPsst+co2, has comparable radiative forcing and surface warming to RCP8.5. The focus is placed on the response of mid-latitude jets and the robustness of the findings is tested by considering the Abrupt4xCO_2 and 1% per year CO_2 increase experiments in place of RCP8.5.

In the RCP8.5 scenario, the North Atlantic jet is projected to shift poleward, but not in late winter (January to March) when the signal is small. In contrast, the North Atlantic jet shows a year-round poleward shift in both the AMIPFuture and AMIP4xCO_2 experiments, thus implying that, in the absence of sea ice changes, sea surface warming and CO_2 increase are unable to capture the seasonality in the jet latitude response. Comparing the RCP8.5 and AMIPsst+co2 responses confirm that the influence of sea-ice loss on atmospheric circulation and surface pressure peaks in late winter, when the sea-ice related surface heat flux perturbation is largest. In JFM, sea-ice loss acts to suppress the projected poleward shift of the North Atlantic jet, to increase surface pressure in Northern Siberia and to lower it in North America. The westerly jet is weakened around 60N and the Arctic response evolves from being baroclinic in early winter (OND) to barotropic in late winter (JFM). While this approach relies on assumptions on the linearity and state–independence of the circulation response to forcing, it represents the first attempt to identify the impact of sea–ice loss on atmospheric circulation in a large ensemble of climate models. The identified features are consistent with previous single-model experiments and the present results indicate they are robust to model formulation.