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Model and state dependence of the atmospheric response to Arctic sea-ice loss

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The climate response to Arctic sea-ice loss is highly uncertain. There exists considerable disagreement between observational and modelling studies, and between models, for reasons that remain poorly understood. To make progress, the Polar Amplification Model Intercomparison Project (PAMIP) was designed to provide coordinated experiments, with consistent sea-ice loss applied in multiple models. Results from the PAMIP are presented, focussing on the robustness of the atmospheric response to Arctic sea-ice loss across models and, within individual models, the dependence of the response on the mean state.

In the troposphere, the mid-latitude jet is either weakened and/or shifted towards the equator in all models, albeit with varying magnitudes. We hypothesise that the magnitude of the jet response is sensitive to the atmospheric model resolution. To test this, and to more broadly identify the aspects of the atmospheric response that are sensitive to model resolution, we compare like-for-like experiments with two versions of the HadGEM3 model at low (N96) and high (N216) horizontal resolution.

The stratospheric polar vortex response to Arctic sea-ice loss is not consistent between models, and appears to be influenced by both the size of the ensemble for each model and the phase of the Quasi-Biennial Oscillation (QBO). The possible modulating effect of the QBO is further explored using new simulations with background atmospheric states representing the easterly and westerly QBO phases.

A surprising early result from the PAMIP simulations were sizeable changes in the Southern Hemisphere in response to Arctic sea-ice loss and significant changes in the Northern Hemisphere in response to Antarctic sea-ice loss, even in atmosphere-only model experiments. The robustness of such apparent interhemispheric connections across models, ensemble sizes and mean states is investigated.