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

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PAMIP zonal mean zonal wind multi-model mean

Results from the currently available Polar Amplification Model Intercomparison Project (PAMIP) models illustrate a clear weakening of the northern hemisphere mid-latitude jet in response to Arctic sea ice loss. This is evident in the DJF zonal mean zonal wind anomaly between a future sea-ice loss case and a present day case (Fig. 1). Most models also show an equatorward shift of the jet.

Influence of model resolution on the response

Two model resolutions of HadGEM3 are compared (N96 and N216). The higher resolution model shows evidence of a more pronounced equatorward shift of the mid-latitude jet, but this difference is not statistically significant (Fig. 2, upper panels). The magnitude of the jet weakening is similar for both resolutions. Differences in the geopotential height anomalies (Fig. 2, lower panels) show no statistical significance.

For the whole PAMIP ensemble, there is evidence that model resolution contributes to a larger jet shift (Fig. 3), although the p-value of the trend is moderately high (0.124).

Arctic sea-ice loss response dependence on QBO phase

The Arctic sea-ice response is modulated by the quasi-biennial oscillation (QBO) phase:
- QBO phase influences the zonal wind response, particularly in the stratosphere (Fig. 4), although the stratosphere difference is not statistically significant.
- For HadGEM3 N96, QBO-E shows a stronger jet weakening compared to QBO-W.

Polar cap height response to sea-ice loss is QBO phase dependent:
- Geopotential height anomalies for 60-90N (polar cap height) indicate that QBO-E results in a weakening of the polar vortex in November, which descends to the surface by January (Fig. 5).
- QBO-W polar cap height shows no indication of this weakening.
- This is evidence that the QBO phase modulates the ice-loss response, or that the QBO is itself modulated by the sea-ice decline.