2023 PAMIP Webinar Series

Consistent but more intense atmospheric circulation response to Arctic sea ice loss in CMIP6 experiments compared to PAMIP experiments

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Abstract

The atmospheric circulation response to Arctic sea ice loss may differ depending on the region of sea ice loss but also on the methodology used to study this impact. Examining the different possible atmospheric circulation responses to sea ice loss is essential, as the Arctic sea ice is not melting uniformly. In this study, we examine the atmospheric response in winter to regional sea ice loss using two different approaches across seven climate models. The sea ice anomaly areas are the pan-Arctic, the Barents-Kara Seas only, and the Sea of Okhotsk only. The first approach involves sensitivity experiments performed within the Polar Amplification Model Intercomparison Project (PAMIP), while the second approach entails a composite analysis in long pre-industrial control simulations from CMIP6. Our results reveal that both approaches lead to consistent atmospheric circulation responses to pan-Arctic sea ice loss, characterized by a negative phase in the North Atlantic Oscillation and a weakening of the stratospheric polar vortex. Similar responses to BK sea ice loss are simulated, albeit with more spread in the PAMIP experiments. The responses to Okhotsk sea ice loss differ and are uncertain in both approaches. Furthermore, larger changes are detected in the composite analysis than in the sensitivity experiments, likely due to a different background state and the presence of confounding factors in the composite analysis. We also find that the atmosphere-ocean coupling does not imply larger circulation changes or a better representation of the eddy momentum feedback in the climate response. These results highlight that sea ice loss in sensitivity experiments yields a weaker atmospheric circulation response compared to the pre-industrial simulations in CMIP6 where the sea ice loss is governed by internal climate variability. A quantification of the role played by factors related to sea ice loss that amplifies the response should be further investigated.

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