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Modelled atmospheric response to regional and pan-Arctic sea-ice loss

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The loss of Arctic sea-ice is already having profound environmental, societal and ecological impacts locally. A highly uncertain area of scientific research, however, is whether such Arctic change has a tangible effect on weather and climate at lower latitudes. There is emerging evidence that the geographical location of sea-ice loss is critically important in determining the large-scale atmospheric circulation response and associated mid-latitude impacts. However, such regional dependencies have not been explored in a thorough and systematic manner. To make progress on this issue, this study analyses ensemble simulations with an atmospheric general circulation model prescribed with sea-ice loss separately in nine regions of the Arctic, to elucidate the distinct responses to regional sea-ice loss. The results suggest that in some regions sea-ice loss triggers large-scale dynamical responses whereas in other regions sea-ice loss induces only local thermodynamical changes. Sea-ice loss in the Barents-Kara Sea is unique in driving a weakening of the stratospheric polar vortex, followed in time by a tropospheric circulation response that resembles the North Atlantic Oscillation. For October-to-March, the largest spatial-scale responses are driven by sea-ice loss in the Barents-Kara Sea and Sea of Okhotsk; however, different regions assume greater importance in other seasons. The atmosphere responds very differently to regional sea-ice losses than to pan-Arctic sea-ice loss, and the latter cannot be obtained by linear addition of the responses to regional sea-ice losses. The results imply that diversity in past studies of the simulated response to Arctic sea-ice loss can be partly explained by the different spatial patterns of sea-ice loss imposed.