PAMIP Webinar Series

The atmosphere-ocean responses to Antarctic sea ice loss

Holly Ayres

University of Reading

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lantao.sun@colostate.edu.

Abstract

Antarctic sea ice is projected to decrease by the end of the 21st century in response to increasing greenhouse gas concentrations. Sea ice plays a significant role in the climate of the high latitudes of the Southern Hemisphere, whereby changes may have resultant consequences on the large-scale atmospheric circulation. Limited studies so far have examined the coupled atmosphere-ocean response to Antarctic sea-ice loss. We isolate the response to Antarctic sea-ice loss in the atmosphere and ocean using bespoke sea-ice albedo perturbation experiments with HadGEM3-GC31-LL, provide the first detailed examination of the global ocean response, and quantify the importance of atmosphere-ocean coupling, through comparison to uncoupled experiments with prescribed Antarctic sea-ice loss. Our results show a lower tropospheric warming and moistening over regions of sea-ice loss and the nearby Southern Ocean are simulated in both coupled and uncoupled configurations but are of greater magnitude in the coupled model. A weakening and equatorward shift of the tropospheric westerly jet are simulated in both configurations, but are also larger in the coupled model. Ocean coupling allows the warming response to spread northward. Warmer tropical sea surface temperatures enhance atmospheric convection, driving upper-tropospheric warming and triggering atmospheric teleconnections to the extratropics, including a weakened Aleutian Low. A 20% reduction in Antarctic Circumpolar Current transport and a weakening of the shallow tropical convergence cell are simulated. Surface waters warm and freshen globally, becoming more stratified and stable in the Southern Ocean, with similar changes, but of lesser magnitude, in the Arctic Ocean, where sea ice declines. Our results suggest that the climate effects of Antarctic sea-ice loss stretch from pole-to-pole and from the heights of the tropical troposphere to the depths of the polar oceans.

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