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Atmospheric response to reduced Antarctic sea ice drives ice sheet mass and energy flux anomalies

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The mass balance of the Antarctic ice sheet is intricately linked to the state of the atmosphere and ocean surrounding the continent. As a direct result, improving projections of future sea level change relies on understanding change in the Antarctic atmosphere and Southern Ocean, as well as the processes that couple these systems. Here, we explore the influence of sea ice cover on the overlying atmosphere and subsequently the energy and mass budgets of the adjacent Antarctic ice sheet. We investigate these processes using simulations of the Community Earth System Model 2 (CESM2) developed as part of the Polar Amplification Model Intercomparison Project (PAMIP). Specifically, we explore an ensemble of atmosphere-only time slice experiments where the sea ice cover is altered. Results highlight atmospheric warming in all seasons in response to sea ice loss, but particularly pronounced warming at the surface and during non-summer seasons. Sea ice reductions further drive positive anomalies in atmospheric moisture and liquid-bearing clouds, resulting in both enhanced precipitation and downward longwave radiative fluxes over the ice sheet, particularly in West Antarctica. We furthermore explore the impact of sea ice loss on primary modes of atmospheric variability, including the Amundsen Sea low and Southern Annular Mode. These results highlight the potential impact and importance of proper simulation of the Southern Ocean sea ice cover for determining the surface mass balance of the adjacent Antarctic ice sheet. Given that the current generation of coupled climate models struggle with representing observed sea ice dynamics, our results indicate this may likely contribute to uncertainties in the simulation of recent and future Antarctic ice sheet mass balance.