Atmospheric River Precipitation over Antarctic Sea Ice

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Abstract

In 2016, Antarctic sea ice experienced a regime shift when a persisting decreasing trend emerged from a relatively stable annual cycle. Drivers of the sea ice regime shift and future projections of Southern Ocean sea ice remain unresolved. One possible contributing phenomena are atmospheric rivers (ARs), which are long, narrow, and transient features responsible for the majority of global poleward water vapor transport. Though infrequent over Antarctica, ARs wield a substantial influence on the Antarctic ice mass balance. Previous studies highlight their significance, attributing 35% of the interannual precipitation variability over the Antarctic Ice Sheet (AIS) to ARs. The interaction between ARs and Antarctic sea ice has not been as clearly defined. Our ongoing work uses ERA5 reanalysis data, results from an AR tracking algorithm, and passive microwave sea ice concentration data from 1980 to 2023 to examine the relationship between ARs and Antarctic sea ice, especially in the context of the changing sea ice state. In this study, we determine the portion of precipitation over Antarctic sea ice that is attributable to ARs. On average, ARs account for 11% of total precipitation over Antarctic sea ice. The greatest contribution to precipitation over sea ice occurs in Austral spring where ARs bring 12% of both rainfall and snowfall. Through a regional analysis, we find that ARs contribute between 10-14% of the rainfall and snowfall over sea ice across all Southern Ocean sectors except for winter in the Weddell Sea, where ARs contribute 25% of rainfall over sea ice. The trends of AR precipitation falling on sea ice are not regionally nor seasonally uniform. For example, while the Weddell Sea (Ross Sea) has an increasing (decreasing) trend across all sesaons, the Amundsen-Bellinghausen Sea has experienced an increasing trend in all seasons except for summer. These findings underscore the importance of the AR interaction with Antarctic sea ice, particularly in the context of seasonal and regional variability. This work will improve our understanding of the spatiotemporal variability and trends of ARs as precipitation mechanisms, which is vital for understanding and predicting sea ice mass balance in a changing climate.

Keywords: atmospheric river, ARs, sea ice, ice, precipitation, Antarctica

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