Quantifying the association between Antarctic atmospheric river characteristics and their impacts using extreme-value statistics

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Abstract

Though Antarctic ARs are classically detected based on an extreme threshold of poleward water vapor transport, they differ from each other in characteristics like moisture content, windiness, landfalling orientation to the continent, spatial extent, and landfalling duration. In this study, we quantify the strength of association between such AR characteristics and their thermal and precipitation impacts on the Antarctic Ice Sheet. To accomplish this, we first note that many existing AR catalogs in the Atmospheric River Tracking Method Intercomparison Project (ARTMIP) identify the presence or absence of AR conditions at locations in space across time, but they do not group these points into coherent storm events. We apply density-based clustering algorithms to an existing Eulerian catalog to track Antarctic ARs as discrete objects and construct a database of these events. The database includes summary statistics that characterize each storm and its impacts, such as maximum/cumulative landfalling precipitation and temperature, spatial extent, duration, maximum integrated vapor transport, and landfalling orientation, facilitating investigation of AR lifecyles and their varying characteristics on an Antarctic-wide scale. We then investigate relationships between AR characteristics and impact variables using extreme-value statistical methods. We also highlight our use of Cryocloud, a cloud-based computing platform, in conducting this analysis.

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