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Antarctic Atmospheric River Life Cycles

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The mass balance of Antarctica is sensitive to intrusions of extremely warm, moist airmasses from the mid-latitudes in the form of atmospheric rivers (ARs). These storms provide a sub-tropical link to the Antarctic continent and engender extreme atmospheric conditions that are largely consequential to surface melt, snowfall, and ice-shelf stability. Using an AR detection algorithm designed for polar regions, we characterize the AR life cycle and describe the atmospheric conditions conducive for ARs to reach the Antarctic continent.

Despite their rarity of occurrence over Antarctica (maximum frequency of ~3 days per year over a given point), ARs have a relatively large impact on the surface melt processes in West Antarctica and snowfall patterns across the whole continent. During the summer season along the Antarctic Peninsula ice shelves, AR landfalls lead to conditions (i.e. extreme temperatures, rainfall, surface melt, sea-ice clearing, ocean swell enhancement), that act to destabilize the leeward ice shelves. Current research is exploring the origins of AR genesis and moisture pathways with a focus on the relationship between atmospheric blocking in the Southern Ocean and AR behavior over East Antarctica.

When examining the life cycles of ARs and non-AR synoptic analogues occurring at Dumont d'Urville (DDU) Station, Antarctica, the AR events often have moisture sources further north in the Southern Ocean than the non-AR analogues. These more northern moisture sources correspond with enhanced latent heat release over anomalously warm sea surface temperatures in northern regions of the Southern Ocean which trigger Rossby wave propagation that enhances upper-level potential vorticity. A highly amplified wave pattern allows for intense poleward moisture transport towards DDU and downstream ridging from the AR position. Thus, any future changes in atmospheric blocking or tropical-polar teleconnections, which control AR behavior around Antarctica, along with further global warming, may have significant impacts on future mass balance projections and subsequent sea level changes.