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Orographic Flow Influence on Precipitation During an Atmospheric River Event at Davis, Antarctica

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Snowfall in Antarctica is the main input to ice sheet mass balance, which is heavily influenced by the frequency and intensity of maritime moisture intrusions from lower latitudes. The most intense moisture incursions often occur as narrow corridors of enhanced vapor transport, called atmospheric rivers (ARs). However, the fate of ARs depends on the state of the coastal boundary layer. For instance, katabatic or foehn winds can lead to a subsaturated boundary layer, which can cause total snowfall sublimation. In this study, we use recent data collected during the Precipitation over Land And The Southern Ocean (PLATO) campaign to investigate how the synoptic evolution and the local orography influenced the sublimation of snowfall during an AR event (08 – 10 January 2019) at Davis, East Antarctica. The dataset includes scanning polarimetric and vertically pointing Doppler radar, radiosounding, and Raman lidar measurements. We also make use of simulations from the Weather Research and Forecasting (WRF) model. Our analysis revealed that orographic gravity waves (OGWs), generated by a north-easterly flow impinging on the ice ridge upstream of Davis, were responsible for snowfall sublimation through a foehn effect. Despite the strong meridional moisture advection associated with the AR during this event, almost no precipitation reached the ground at Davis. We found that the direction of the synoptic flow with respect to the orography determined the intensity of OGWs over Davis, which in turn directly influenced the snowfall microphysics. We hypothesize that turbulence induced by the OGWs likely enhanced the aggregation process, as identified thanks to dual-polarization and dual-frequency radar observations. This study suggests that despite the intense AR, the snowfall distribution was determined by local processes tied to the orography. It also stresses the importance of studying local effects when interpreting the impact of ARs on the Antarctic surface masse balance. Finally, the mechanisms found in this case study could contribute to the extremely dry climate of the Vestfold Hills, one of the main Antarctic oases.