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Synoptic conditions and atmospheric moisture pathways associated with virga and precipitation over coastal Adélie Land, Antarctica

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Precipitation falling over the coastal regions of Antarctica often experiences low-level sublimation within the dry katabatic layer. The amount of water that reaches the ground surface is thereby considerably reduced. We investigate the synoptic conditions and the atmospheric transport pathways of moisture that lead to virga – when precipitation is completely sublimated – or actual surface precipitation at Dumont d'Urville (DDU) station, coastal Adélie Land, Antarctica. We combine ground-based radar measurements, Lagrangian back-trajectories, Eulerian diagnostics of extratropical cyclones and fronts as well as with moisture source estimations based on ERA5 reanalyses. Virga periods – corresponding to 36% of the precipitating events – often precede and sometimes follow surface precipitation periods. Pre-precipitation virga, surface precipitation and post-precipitation virga correspond to different phases of the same precipitating system. Precipitation and virga are always associated with the warm front of an extratropical cyclone that sets to the west of coastal Adélie Land but the exact locations of the cyclone and front differ between the three phases. On their way to DDU, the air parcels that ultimately precipitate above the station experience a large-scale lifting across the warm front. The lifting generally occurs earlier in time and farther from the station for virga than for precipitation. It is further shown that water contained in the precipitation falling above DDU during pre-precipitation virga has an oceanic origin farther away (30 degrees more to the west) from Adélie Land than the one that precipitates down to the ground surface.