Orographic precipitation in the vicinity of Princess Elisabeth Antarctica station as seen by a transect of MRR-PROs

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Abstract

Measurements of precipitation in inland Antarctica are scarce, with estimates often derived from indirect means. This scarcity contrasts with the importance of snowfall, which constitutes one of the main water mass input to the Antarctic ice sheet.

During the austral summer 2019-2020, three vertically-pointing K-band Doppler profilers (MRR-PRO) were deployed along a 20 km transect across the Sør Rondane Mountains, directly south of Princess Elisabeth Antarctica (PEA). The radars were placed at different stages of the interaction between the typical flow associated with the precipitating systems and the orography. These measurements are complemented by a vertically-pointing W-band Doppler cloud radar, installed at the base.

Using the data collected by these four profilers, alongside information derived from the ERA5 reanalysis and a set of high-resolution WRF simulations covering the previous three years, we investigated the behavior of precipitation across the transect.

Different proportions of virga and surface precipitation have been recorded by the three MRR-PRO. An analysis of the WRF outputs reveals the presence of a dry layer, whose top height remains constant across the transect. Due to the complex orography, the depth of the layer varies across the locations of the three radars, resulting in different amounts of sublimation and, consequently, virga proportions. The analysis of the circulation at the three sites suggests that virga and surface precipitation often take place at different stages of the same precipitation events. It moreover suggests that orographic lifting is responsible for a larger precipitation frequency at the site closest to the mountain peaks.

Overall, this study shows that precipitation at PEA exhibits a significant degree of variability on relatively small scales (10 to 20 km). Complex terrain can play a significant role even at small scales, which questions the representativity of measurements collected only in the immediate vicinity of scientific bases.