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The linkage between active layer thickness, soil moisture and vegetation on James Ross Island, Antarctica

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Soil moisture is one of the most important parameters of the terrestrial environments in Antarctica. The seasonal amount and availability of liquid water have an essential impact on the abundance and health of the vegetation. Simultaneously, soil water can significantly affect the periglacial environments as its variability can moderate the heat conditions and transport in the active layer and permafrost. It can significantly influence many geomorphological or soil-forming processes. Our contribution evaluates the interactions between surficial soil water content, active layer thickness, and vegetation abundance in the study site on James Ross Island, northern Antarctic Peninsula.

The study area called Berry Hill slope is located in the northern part of James Ross Island. The area is a part of the Circumpolar Active Layer Monitoring – South (CALM-S) network. The study site is about 1 km far from the coastline, about 50 to 60 m a.s.l. In the area, the probing measurements of active layer thickness and surficial volumetric soil moisture in the layer of 0-12 cm were done in February 2018 and 2020. Further, the topography and vegetation extension mapping was carried out using UAV.

The active layer thickness in the CALM-S ranged between 75 and 100 cm. Notably, the lowest values of ALT were detected in the wettest area with an abundance of vegetation. We expect this fact to be caused by both thermal insulations of vegetation carpets and very high soil moisture. The high moisture and almost fully saturated soils prevent active layer thawing propagation due to high latent heat consumption. We found a clear pattern between the abundance of vegetation connected to soil moisture. We observed that the soil moisture threshold allowing vegetation abundance is around 40 %. In contrast, the vegetation misses the rest of the study site, which also has relatively high soil moisture (ca 25-35 % VWC). Considering the warming and drying climate scenario for the region of north-eastern AP, we assume that the active layer will be getting warmer and thicker due to the ongoing climate warming. Active layer deepening might lead to the redistribution of the soil water and the drying of the surficial layers of soil. Consequently, a lack of available soil moisture in the surficial parts can significantly threaten the area's vegetation communities.