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How vegetation drives initial soil development together with soil organic matter accrual in maritime Antarctica

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Antarctica with its unique conditions for soil development offers the opportunity to disclose basic soil biogeochemical processes in an environment with a low degree of ecosystem interactions. The region's climate is divided by the mountain ridge of the Antarctic Peninsula: on the South Shetland Islands (King George Island (KGI)) in the west a maritime cold climate prevails, while James Ross Island (JRI) in the east faces the continental cold climate of a polar desert with less precipitation and distinctly more pronounced temperature variations throughout the year. In addition, the autochthonous vegetation differs; while it solely consists of cryptogams on JRI, on KGI two vascular plants (Dechampsia antarctica, Colobanthus quitensis) are endemic. This scarce vegetation patterns together with land surfaces ice-free for several millenia allows studying the complex interaction between soil organic matter (SOM) sequestration and soil structure development with respect to the varying presence and growth of vegetation.

The main aim of our study is to decode the mechanisms determining the fate of SOM in maritime Antarctica and to understand how the scarce vegetation drives the chemical composition and distribution of SOM within specific physical SOM fractions. Therefore, we sampled transects ranging from vegetated patches to plant-free soil surfaces. The distance to these vegetation patches was reflected in clear variations in the distribution of carbon and nitrogen and in a decrease in labile SOM constituents as revealed by ^{13}C-CPMAS NMR spectroscopy, while clay-sized mineral-associated SOM dominated the carbon storage throughout all sites. The ongoing climate change is assumed to significantly alter the vegetation distribution and thus drive the storage and composition of SOM. In the future, this will also strongly affect soil microbial activity and land-ocean transitions in Antarctica.