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The role of soil moisture on the coevolution of soil and vegetation in mountain grasslands

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One of the key variables controlling the organization of vegetation and the coevolution of soils and landforms is soil moisture content (SMC). For this reason, understanding the controls on the spatial and temporal patterns of SMC is essential to predict how perturbations in vegetation and climate will affect mountain ecosystem functioning.
In this contribution, we focus on the dynamic of surface SMC of water-limited alpine grasslands in the Long Term Ecological Research area Mazia Valley in the European Alps. We analyze the impacts of different land managements (meadows versus pastures) and its relationships with climate and topography.
The area has been equipped since 2009 with a network of more than 20 stations, measuring SMC and climatic variables and with two eddy-covariance stations, measuring surface fluxes over meadows and pastures. Monthly biomass production data have been collected and detailed soil and spatial soil moisture surveys are available. Moreover, high spatial resolution SMC maps have been derived from satellites Synthetic Aperture Radar Radar (SAR) images (Sentinel 1 and RADARSAT2 images).
Both ground surveys and remote sensing observations show persistent landscape-level patterns. Meadows, in general located in flatter areas, tend to be wetter. This leads to higher vegetation productivity and to the development of soils with higher water holding capacity, thus to a positive feedback on SMC. In contrast, pastures, located on steeper slopes with lower vegetation density and higher soil erosion, tend to be drier, leading to a negative feedback on SMC and soil development. This co-evolution of land cover and SMC leads therefore to persistent spatial patterns.
In order to understand quantitatively such linked interactions, a sensitivity analysis has been performed with the GEOtop hydrological model. Results show how both abiotic (mainly slope and elevation) and anthropogenic (irrigation and soil management) factors exert a significant control on SMC distribution and therefore on soil and vegetation development.