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Modelling high-altitude Critical Zone in Alpine meadows

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The Critical Zone Observatory established in 2017 in the Western Italian Alps at Pian del Nivolet (about 2500 and 2700 meters amsl) of Gran Paradiso National Park (CZO@GPNP) is an excellent test site to study a Critical Zone (CZ) experiencing extreme conditions and rapid changes. At high altitudes, the CZ is very sensitive to climatic and environmental perturbations. At the CZO@GPNP, primary meteorological variables are periodically monitored from June to October. Four test sites, identified on the basis of geological conditions (i.e. soils formed on carbonate rocks, gneiss, glacial deposits and alluvial deposits respectively) have been considered to explore the effects of different soil texture and composition on the surface exchange of gases and water. Here, we discuss the implementation of a conceptual numerical model for the water and carbon dynamics at these sites. We adopted a coupled ecohydrological box modelfor the local soil moisture and vegetation cover to identify the key components of the hydrologic cycle in sustaining the fragile meadow. The measured daily precipitation (from 1962 onwards) is given as water input, while deep leakage and evapotranspiration determine the water loss of the reference area. Plant abundance is determined by the soil moisture. In turn, the amount of soil colonized by grass drive the evapotranspiration to evaporation rate. The model alternates productive and frozen periods in which the soil is respectively free or covered with snow, reproducing the succession of summer and winter seasons. Comparing two years of measurements with the simulation outcomes, we obtained a good agreement between measured data and numerical results. In future work, we shall use this model to better understand the biophysical processes characterizing alpine grasslands and to estimate expected ecosystem modifications in climate change scenarios.

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