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Alpine pasture soils accumulate a large fraction of labile carbon due to combined effects of low temperature, low pH, and poor litter quality on decomposition

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Alpine soils are expected to contain large amounts of labile carbon (C) which may result in a further increase in atmospheric CO2 levels in response to global warming. However, there is little data available on these soils and limited understanding of the influence environmental factors have on soil organic matter (SOM) turnover. We extracted 30 cm deep soil cores from 5 sites along an elevation gradient of an alpine pasture in the central Swiss Alps. Soil fractions obtained by size and density fractionation revealed a high proportion of labile particulate organic carbon (POC), particularly in the uppermost soil layers. POC values in the top 20 cm across the gradient of 2285-2653 m above sea level (a.s.l.) ranged from 39.6-57.6 % in comparison to 7.2-29.6 reported in lower elevation soils of 810-1960 m a.s.l. in previous studies. While soil at all elevations was found to be relatively acidic, C mean residence times (MRTs) were considerably shorter and phytomass was slightly higher at the single site found to have a comparatively less acidic soil pH, although SOC content did not vary from those sites of similar root/litter and stone contents. At all elevations, MRTs increased between fractions of increasing stability from free POM (fPOM) → occluded POM (oPOM) → mineral-associated material (mOM); e.g. at 2653 m MRTs increased in years from 90 in fPOM → 117 in oPOM → 534 in mOM. Depending on elevation and pH, plant community data indicated considerable variation in the source of litter input. The lowest site was dominated by sedges whereas the highest site by lichens and dwarf shrubs, this variation in litter source may be reflected in the dynamics of soil C. While temperature is likely to be a major influence in the low turnover rate observed, other factors such as litter quality and soil pH as well as the combination of these factors are likely to play an important role on the response of SOM in the event of soil warming and require consideration in model applications.