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The vulnerability of organic matter in Swiss forest soils

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Soils contain more carbon than atmosphere and terrestrial vegetation combined [1], and thus are key players in the carbon cycle. With climate change, the soil organic carbon (SOC) pool is vulnerable to loss through increased CO_2 emissions, which in turn can amplify changes with this carbon feedback [2]. The objective of this study is to investigate the variation of indicators of SOC vulnerability (e.g. SOC mineralisation, turnover time, bulk soil and mineralised 14C signatures) and to evaluate climate, soil and terrain variables as primary drivers.

To choose the study locations we used a statistics-based approach to select a balanced combination of 54 forest sites with de-correlated drivers of SOC vulnerability (i.e. proxies for soil temperature and moisture, pH, % clay, slope gradient and orientation). Sites were selected from the forest soil database of the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), which in May 2014, contained data from 1,050 soil profiles spread across Switzerland. We re-sampled soils at the 54 locations during summer 2014. With these samples we run a standardized laboratory soil incubation (i.e. 25°C; soils moisture -20kPa; sieved to $\leq$ 2 mm; 40 g equivalent dry mass; adjusted to 0.8 g cm-3 bulk density) and measured SOC mineralisation on days 4, 13, 30, 63, 121 and 181 by trapping the CO_2 evolved from soils in sodium hydroxide traps [3]. Additionally, we measured the 14C signature of the carbon trapped during last stage of the incubation, and compare it to the 14C signature of the bulk soil.

Based on the cumulative SOC mineralised, we found that despite the well-studied relationship between climate and SOC dynamics [4], temperature did not emerge as a predictor of SOC vulnerability. In parallel, moisture only had a minor role, with soils from drier sites being the most vulnerable. This indicates a possible limitation of heterotrophic activity due to water shortage. On the other hand, soil pH raised as the driver that best explained the variability of SOC vulnerability, with alkaline soils being the most vulnerable. This could be explained by the strongest adsorption of nitrogen organic compounds to minerals at lower pH [5]. We conclude that in temperate forests, the control that soil properties exert on SOC dynamics might outweigh the control of climate. Therefore, soil properties should be appropriately represented in Earth system models to obtain more realistic projections under different climate scenarios.

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