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Scales of spatial & temporal variability in radiocarbon contents of organic carbon across different regions in Swiss soils

Tessa S. van der Voort1, Cameron McIntyre2, Claudia Zell1, Xiaojuan Feng1,3, Frank Hagedorn4, Patrick Schleppi4, Timothy Eglinton1

[1] *Institute of Geology, ETH Zürich, Sonneggstrasse 5, 8092 Zürich, Switzerland*
[2] *Department of Physics, Laboratory of Ion Beam Physics, ETH Zurich, Otto-Stern-Weg 5, 8093 Zurich*
[3] *Institute of Botany, Chinese Academy of Sciences, 20 Nanxincun Xiangshan, Tuzilou 218 Beijing 100093, China*
[4] *Swiss Federal Research Institute WSL, Forest soils and biogeochemistry, Zürcherstrasse 111, 8903 Birmensdorf, Switzerland*

Soil organic matter (SOM) forms the largest terrestrial pool of carbon outside of sedimentary rocks, and it provides the fundamental reservoir for nutrients that sustains vegetation and associated microbial communities. With ongoing changes in land-use and climate, SOM is subject to change, with potentially major consequences for soil as a resource and for global biogeochemical cycles. Radiocarbon is a powerful tool for assessing OM dynamics and is increasingly used in studies of carbon turnover in soils. However, due to the nature of the measurement, comprehensive ^{14}C studies of soils systems remain relatively rare. In particular, information on spatial variability in the radiocarbon contents of soils is limited, yet this information is crucial for establishing the range of baseline properties and for detecting potential modifications to the SOM pool.

The present study aims to develop and apply a comprehensive four-dimensional approach to explore heterogeneity in bulk SOM ^{14}C, with a broader goal of assessing controls on organic matter stability and vulnerability in soils across Switzerland. Focusing on range of Swiss soil types, we examine spatial variability in ^{14}C as well as ^{13}C and C:N ratios over plot (decimeter to meter) to regional scales, vertical variability from surface to deeper soil horizons, and temporal variability by comparing present-day with archived (legacy) samples.

Preliminary results show that differences in SOM ^{14}C age across small lateral and vertical distances within soil systems can be as large as those between regions, underlining the importance of considering compositional heterogeneity in assessing SOM dynamics. These studies of bulk variability are being followed up with analyses of SOM sub-fractions, including ^{14}C measurements at the molecular level in order to SOM components that are most sensitive to climate change and anthropogenic pressures. Such investigations of ^{14}C variability over various space and time domains will shed light on the scales of processes that drive the composition and vulnerability of SOM, and provide valuable constraints on models of SOM turnover.