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Soil organic carbon sources in a warmer world: Using molecular marker as proxies for microbial, above- and belowground plant biomass

Nicholas O.E. Ofiti (1), Cyrill U. Zosso (1), Emily F. Solly (1), Jennifer L. Soong (2), Margaret S. Torn (2), Guido L.B. Wiesenberg (1), and Michael W.I. Schmidt (1)

(1) University of Zurich, Department of Geography, Zürich, Switzerland (nicholas.ofiti@geo.uzh.ch), (2) Lawrence Berkeley National Laboratory, California, USA

Warming may overall increase the proportions of above- and belowground derived plant and microbial biomass, probably differing in degradability and potential to form soil organic carbon (SOC). Using traditional techniques (profile observation, ingrowth core, rhizo-camera) it is difficult to quantify contributions of above- and below ground plant biomass and from microbial biomass to SOC for the whole soil profile. Molecular proxies can help to quantify.

In a coniferous temperate forest in the Sierra Nevada, California, we studied the effects of 4.5 years of warming (+4°C) on the input, decomposition and accumulation of molecularly distinct SOC components throughout the whole soil profile to 1 m depth. We analyzed above- and belowground plant biomass and soil for free extractable lipid fractions (fatty acids and alkanes) and hydrolysable lipids (cutin, suberin) and their stable carbon isotope (δ13C) composition. These lipid compounds are proxies for the presence of microbial fatty acids with shorter average chain lengths, than plant biomass. Additionally the carbon preference index (CPI) serves as a proxy for the degree of degradation SOC, and cutin and suberin are indicative for the presence of above- and belowground plant biomass.

With warming, overall SOC concentrations in the top 1 m decrease by 18%, coinciding with a significant reduction in the proportion of fine root (< 2 mm) mass. The average chain length (ACL) typically decreases with depth, indicating that proportions of microbial-derived SOC increase on the expense of plant biomass. Warming accentuates this natural trend. In the surface soil (0- 20 cm) ACL values increase, but decrease below 50 cm. Thus less altered biomass-derived carbon dominates above 20 cm, whereas microbial-derived carbon dominates below 50 cm. This trend of increased microbial processing in the subsoil is confirmed by lower CPI values (>70 cm), indicative for increased degradation. Further separation of the lipids into cutin and suberin compounds will reveal in more detail how warming affects contributions of above- and below-ground plant biomass to SOC with depth.

Eventually we aim to quantify how warming influences the contributions of above- and belowground plant-biomass and microbial sources to SOC.