INFLUENCE OF WARMING ON PLANT- AND MICROORGANISM-DERIVED SOIL ORGANIC MATTER IN A CONIFEROUS TEMPERATE FOREST

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Understanding the effect of warming on plant- and microorganism-derived organic matter in deeper soils is integral to assess the capacity of soils to store carbon under global change. Warming may reduce root inputs and stimulate shifts in microbial communities. Decreasing inputs at depth might lead to an overall loss of soil organic matter (SOM) and changes in contribution of plant- vs. microorganism-derived SOM. Via profile observation and ingrowth cores it is difficult to quantify contribution of plant- and microorganism-derived biomass to SOM. Molecular proxies can provide deeper insight into the source contribution to SOM. A multi-proxy approach was applied to study the effects of 4.5 years of warming (+4°C) on the sources, decomposition and accumulation of molecularly distinct SOM components.

We investigated a long-term whole soil profile warming experiment in a coniferous temperate forest in the Sierra Nevada, California. We analysed above- and belowground plant biomass and soil cores (10 cm increments until 1 m depth) for free extractable lipids (fatty acids and alkanes) to gain an overview of the contribution of plant- and microorganism-derived biomass to SOM and the state of degradation of SOM. Hydrolysable lipids (cutin, suberin) were used to track changes in the contribution of above- and belowground plant biomass to bulk SOM and phospholipid fatty acids (PLFAs) to identify shifts in the microbial community composition. We calculated molecular proxies based on free extractable lipids. The average chain length (ACL) of fatty acids, was used as a proxy for the contribution of microorganism-derived biomass (>C\textsubscript{19}) to SOM. Additionally, the carbon preference index (CPI) served as a proxy for the degree of degradation of SOM. Furthermore, compound-specific stable carbon isotope (\(\delta^{13}\)C) composition of biomarkers was used to assess the effect of reduced water availability on incorporation and degradation of distinct biomarkers.

With warming, the proportion of fine root (< 2 mm) mass significantly decreased in the top 1 m of the soil profile, coinciding with a decrease of soil organic carbon concentration by 18%. In general, C:N (carbon:nitrogen) ratios decrease with increasing soil depth, indicating greater microbial processing of SOM. In the non-heated plots, C:N ratios showed a decrease with depth from 32.3 ± 3.5 (0-10 cm) to 23.2 ± 1.4 (50-60 cm) and increased to 27.2 ± 8.8 (80-90 cm). Concurrence with the C:N ratios, \(\delta^{13}\)C increased from -25.7 ± 0.8‰ (0-10 cm) to -24.0 ± 0.2‰ (50-60 cm) and decreased to -24.5 ± 0.4‰ (80-90 cm). With warming, the C:N ratios decreased with soil depth while \(\delta^{13}\)C increased with soil depth. Warming accentuated the trend observed in the control plots by increasing microbial processing in deeper soils (> 50 cm). The decrease in fine root mass and shift in C:N ratios and \(\delta^{13}\)C indicate that warming accelerates microbial decomposition of SOM. ACL typically decreases with soil depth, indicating that the proportions of microorganism-derived SOM increase on the expense of plant-derived biomass. With warming, ACL values increased in the surface soil (0-20 cm), but decreased below 50 cm. Thus, less altered biomass-derived carbon dominates above 20 cm, whereas microorganism-derived carbon and thus degraded OM dominates below 50 cm. These findings suggest a depth dependent change in SOM degradation with warming. Also, the ratio of

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saturated vs. unsaturated fatty acids argues for accelerated decomposition in deeper soils (> 50 cm) with soil warming. This trend of increased OM degradation in the subsoil is supported by lower CPI values (>70 cm). Similar depth dependent warming response was observed from previous findings from this site (Hicks Pries et al., 2017). Further separation of the lipids into PLFAs and cutin and suberin will reveal in more detail the interlink of above- and below-ground plant biomass and the soil microbial community affected by future warming.

Overall, this study shows that enhanced SOM decomposition under rising temperature may contribute to shorter residence time of SOM. Furthermore, a decrease in fine root mass with increasing soil depth would reduce deep soil organic carbon storage.

References