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Warming and elevated CO_2 promote incorporation of plant-derived lipids into soil organic matter in a spruce-dominated ombrotrophic bog

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More than one third of global soil organic matter (SOM) is stored in peatlands, despite them occupying less than 3% of the land surface. Increasing global temperatures have the potential to stimulate the decomposition of carbon stored in peatlands, contributing to the release of disproportionate amounts of greenhouse gases to the atmosphere but increasing atmospheric CO_2 concentrations may stimulate photosynthesis and return C into ecosystems. Key questions remain about the magnitude and rate of these interacting and opposite processes to environmental change drivers.

We assessed the impact of a 0–9°C temperature gradient of deep peat warming (4 years of warming; 0-200 cm depth) in ambient or elevated CO_2 (2 years of +500 ppm CO_2 addition) on the quantity and quality of SOM at the climate change manipulation experiment SPRUCE (Spruce and Peatland Responses Under Changing Environments) in Minnesota USA. We assessed how warming and elevated CO_2 affect the degradation of plant and microbial residues as well as the incorporation of these compounds into SOM. Specifically, we combined the analyses of free extractable *n*-alkanes and fatty acids together with measurements of compound-specific stable carbon isotopes ($\delta^{13}C$).

We observed a 6‰ offset in $\delta^{13}C$ between bulk SOM and *n*-alkanes, which were uniformly depleted in $\delta^{13}C$ when compared to bulk organic matter. Such an offset between SOM and *n* -alkanes is common due to biosynthetic isotope fractionation processes and confirms previous findings. After 4 years of deep peat warming, and 2 years of elevated CO_2 addition a strong depth-specific response became visible with changes in SOM quantity and quality. In the upper 0-30 cm depth, individual *n*-alkanes and fatty acid concentrations declined with increasing temperatures with warming treatments, but not below 50 cm depth. In turn, the $\delta^{13}C$ values of bulk organic matter and of individual *n*-alkanes and fatty acids increased in the upper 0-30 cm with increasing temperatures, but not below 50 cm depth. Thus *n*-alkanes, which typically turnover slower than bulk SOM, underwent a rapid transformation after a relatively short period of simulated warming in the acrotelm. Our results suggest that warming accelerated microbial decomposition of plant-

derived lipids, leaving behind more degraded organic matter. The non-uniform, and depth dependent warming response implies that warming will have cascading effects on SOM decomposition in the acrotelm in peatlands. It remains to be seen how fast the catotelm will respond to rising temperatures and atmospheric CO_2 concentrations.