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Incorporation and Turnover of Plant-Derived Polymers in a Warmed Peatland

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Soils of boreal peatlands are among the largest terrestrial reservoir of organic carbon (C), yet their long-term response to warming remains uncertain, especially regarding C turnover and stabilization.

Located in a northern American boreal peatland, the SPRUCE (Spruce and Peatland Responses Under Changing Environments) site is a unique warming experiment, which is partially exposed for ten years to warming and elevated CO_2 concentration. Here, we aim to assess how different temperature gradients (+0, +2.25, +4.5, +6.75, and +9°C) and CO_2 addition (+500ppm above ambient) affected the quantity and quality of soil organic matter (SOM) in a 2 meter deep soil over a 10-year period. Our approach integrates lignin-derived phenol analysis with stable isotope ($\delta^{13}C$) measurements to disentangle C incorporation and decomposition in SOM at the molecular level.

Ten years of applied soil warming and elevated CO_2 concentration have altered OM quality and quantity, with contrasting effects in topsoil and subsoil. Warming promoted plant-derived C loss through accelerated decomposition of labile C inputs. Although still unclear, the response to elevated CO_2 shows a pattern of increased plant productivity and OM incorporation, which may partly offset C losses. Biomarkers and isotope analyses prove that SOM molecules undergo rapid turnover, demonstrating C instability in soils subject to warming in these vulnerable ecosystems.