Title: **Ancient peat carbon is released as greenhouse gases following whole ecosystem warming in a northern Minnesota bog.**

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Project Abstract: Increases in temperature and atmospheric CO_2 concentrations have the potential to stimulate the return of stored soil C to the atmosphere as CO_2 and/or CH_4, acting as a feedback to environmental change. The Spruce and Peatland Responses Under Changing Environments (SPRUCE) project investigates the response of deep peatland C to rising temperatures and elevated atmospheric CO_2 concentrations (eCO_2) in a whole ecosystem warming experiment. This project combines advanced analytical chemistry and isotopic measurements with mult-omics approaches to elucidate the response of the belowground carbon cycle to environmental change. Early results after soil heating alone indicated that deeply buried peat was relatively insensitive to increasing belowground temperatures despite exponential increases in surface CH_4 emissions and production[1]. However, more pronounced impacts to the belowground C cycle are now observed after subsequent whole ecosystem warming[2]. Increased heterotrophic respiration was shown by accumulation of porewater CO_2 throughout the peat profile and CH_4 in the peat surface (< 50 cm). This was likely stimulated by increased availability of sugar substrates, which were shown by metabolomics to increase in concentration with warming in the surface peat. Using a combination of natural abundance stable (^{13}C) and radiocarbon (^{14}C) isotopic analysis, significant ageing of the dissolved belowground CO_2 radiocarbon signature was observed, indicating that peat plays an increasingly important role as a substrate for microbial decomposition at warmer temperatures. Specifically, evidence indicates that up to 30% of the CO_2 produced at any particular depth is directly fueled by ancient peat buried at that depth. In addition, multiple lines of evidence demonstrated that the peatland is becoming more methanogenic with warming, as shown by observed decreases in the ratios of CO_2:CH_4 and increasing ^{13}C content of CO_2 in runoff from warmed chambers. Complementary metagenomics and proteomics analyses of the microbial community are consistent with enhanced rates of methanogenesis particularly via the methylotrophic pathway. The combination of enhanced stimulation by root exudates and increasing contribution of old peat to production of CO_2 are consistent with a potential priming effect wherein highly labile substrates facilitate the decomposition of previously less bioavailable peat C compounds. The implications of this are that previously sequestered peat C appears to be mobilized with warming, contributing to a potential destabilization of the large peat carbon bank.

References:
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[2]Hopple,A.M.et al. 2020.Massive peatland carbon banks vulnerable to rising temperatures, Nature Communications,In revision