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ABSTRACT TITLE: Interactive effects of climate change and decomposer communities on the stabilization of wood-derived carbon in soils: Catalyst for a new study

ABSTRACT: 
Globally, soils store twice as much carbon (C) as the atmosphere, with forest soils comprising about a third of this soil C pool. Changes in the rate at which soils store or lose carbon could either attenuate or exacerbate increases in atmospheric CO2. As such, mechanisms mediating soil organic carbon (SOC) sequestration in the face of an altered climate predicted for the future have been the focus of much study in recent decades. However, even with recent advances in the collective mechanistic understanding of soil processes, integrative studies tracing input pathways and biological fluxes within and from soils are lacking. The objective of this study is to assess interactions among different fungal decay pathways, wood quality, soil texture, soil temperature, and initial contact with mineral fractions (i.e., buried versus surface placement of wood) in stabilizing wood-derived C in soil. The use of 13C-depleted woody biomass harvested from the Rhinelander, WI free-air carbon dioxide enrichment (FACE) experiment affords the unique opportunity to track the fate of wood-derived C as it is transformed into CO2, dissolved organic carbon (DOC), and soil C pools derived from two distinctly different fungal decomposition pathways.

Six aspen sites were cleared to deploy a series of field decomposition experiments to investigate the stabilization of FACE wood C in soils. The research experiments include the following treatments: soil texture (sand, loam), wood quality (wood grown in +CO2, +CO2+O3, and ambient atmosphere), fungal inoculation (white-rot, brown-rot, and natural rot), wood location (buried in the mineral soil vs. surface application), temperature (warmed via open-topped chambers and ambient), and no-wood controls. To compare the C dynamics of different treatments, stable carbon isotope techniques are being used to distinguish wood-derived C in CO2, DOC, SOC, and SOC density fractions.

Progress to date includes: 1. Transported (from WI-FACE site to Michigan Tech) and chipped over 2700 kg of wood; 2. Created white rot (Bjerkandera adusta) and brown rot (Gleoeephyllum sepiarium) fungal cultures to inoculate wood chip treatments; 3. Inoculated and incubated wood chip treatments for 3 months to ensure colonization; 4. Cleared six sites (1600 m² each) of all woody stems and established plots; 5. Cored soils to 30 cm in 0-15 cm and 15-30 cm segments and analyzed soils for initial stable carbon isotope values and CN concentrations; 6. Deployed inoculated chips on treatment plot on surface or buried 15 cm in soil profile; 7. Instrumented treatment plots with lysimeters and temperature data loggers; 8. Fabricated open-topped chambers (OTC) for deployment to field sites when snow melts; 9. Initiated laboratory incubations to test the effect of wood quality and fungal inoculation on CO2 flux rates and isotopic signatures of wood and CO2.

Initial conditions for soil δ13C values and CN concentrations averaged across the six sites were -26.8 % (standard error = 0.04), 2.46% (se = 0.11), and 0.15% (se = 0.01), respectively. The labeled wood chips from the elevated CO2, and elevated CO2 + O3 FACE treatments had average δ13C values of -39.5 % (se 0.10). The >12 % isotopic difference between the soil and wood chip δ13C values provides the basis for tracking the wood-derived C through the early stages of decomposition and subsequent storage in the soil. Early results from our laboratory incubations indicate that fungal pathways have an impact on both the C flux rates from the wood chips and difference between the respired CO2 and wood chip isotope signatures.