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

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Globally, forest soils store ~two-thirds as much carbon (C) as the atmosphere. Although wood makes up the majority of forest biomass, the importance of wood contributions to soil C pools is unknown. Even with recent advances in the mechanistic understanding of soil processes, integrative studies tracing C input pathways and biological fluxes within and from soils are lacking. Therefore, our research objectives were to assess the impact of different fungal decay pathways (i.e., white-rot versus brown-rot) - in interaction with wood quality, soil temperature, wood location (i.e., soil surface and buried in mineral soil), and soil texture - on the transformation of woody material into soil $\text{CO}_2$ efflux, dissolved organic carbon (DOC), and soil C pools. The use of 13C-depleted woody biomass harvested from the Rhinelander, WI free-air carbon dioxide enrichment (Aspen-FACE) experiment affords the unique opportunity to distinguish the wood-derived C from other soil C fluxes and pools.

Progress to date includes: 1.) Established treatment plots across six field sites (three sand and three loam textured soil) with Aspen-FACE wood chips inoculated with white rot (Bjerkandera adusta) and brown rot (Gloeophyllum sepium) fungal cultures; 2.) 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; 3.) Instrumented treatment plots with lysimeters, temperature data loggers, and open-topped, passive warming chambers; 4.) Initiated laboratory incubations to test the effect of wood quality and fungal inoculation on $\text{CO}_2$ flux rates and isotopic signatures of wood and $\text{CO}_2$; and 5.) Measured soil 13$\text{CO}_2$ efflux, DO13C over one growing season.

Initial conditions for soil $\delta^{13}$C 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 Aspen FACE treatments had an average $\delta^{13}$C value of -39.5‰ (se 0.10). The >12 ‰ isotopic difference between the soil and wood chip $\delta^{13}$C values provides the basis for tracking the wood-derived C through the early stages of decomposition and subsequent storage in the soil. Results from our first year of field soil $\text{CO}_2$ efflux measurements indicate that fungal pathways and wood placement (i.e., surface versus buried) have an impact on the soil $\text{CO}_2$ flux rates. A greater proportion of white rot fungal treatment soil $\text{CO}_2$ efflux comes from wood-derived C compared with that of brown rot treatments, 50% and 39%, respectively.