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Wood Decomposition: Understanding Processes Regulating Carbon Transfer to Soil Carbon Pools Using FACE Wood at Multiple Scales

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Dead wood is a significant terrestrial carbon (C) pool, comprising approximately 20% of the forest biomass in the U.S. A major uncertainty in the terrestrial C cycle is the transfer of C from that dead wood into the underlying mineral soil C pool, where it may be incorporated into recalcitrant or protected soil C pools during the decomposition process. Documenting the fate of wood C during the decomposition process is difficult because (1) wood decomposition is inherently slow, (2) C from decomposing wood often cannot be differentiated from C in the soil matrix, and (3) microbial decomposers with distinct mechanisms can drive distinct outcomes, poorly predicted by climate alone. While Specific wood-decay fungi (brown rot & white rot) and invertebrates, especially termites, are understood to be the principal agents mediating wood decay, little is known about their ecology or their interactions, nor the process and pathways affecting the transfer of wood to the soil.

The FACE Wood Decomposition Experiment (FWDE) was established with wood grown under the elevated CO_2 in the free-air carbon dioxide enrichment (FACE) experiment. By using that $\delta^{13}C$ signature in three species of wood from two FACE sites, we are effectively continuing the FACE experiment by using wood grown under elevated CO_2 as the key component to monitor wood decomposition, measure the amounts of wood C incorporated into soil organic matter pools, and determine factors regulating decay processes mediated by fungi and termites within nine major forest – bioclimatic zones within the continental U.S. Our specific objectives are:

a) Determine the influence of wood biochemistry, microbial process, soil properties, and climatic factors on log decomposition and incorporation of wood-C into mineral soil C pools;
b) Determine the incidence of termite foraging, interaction between termite and fungal community activity and effects on the rate of wood decomposition and incorporation of wood C into mineral soil C pools;
c) Develop a module within the biogeochemical model Forest DNDC to improve estimates of log decomposition and wood C movement into the mineral soil.

The work is being conducted principally on the continental-scale (FWDE), where ambient and elevated CO_2 FACE logs were placed in 2011 on nine experimental forests, on representative soil types within different bioclimatic zones across the U.S. An established field-scale termite exclusion experiment provides unique capabilities to assess interaction among microbial communities and subterranean termites. Assays from the FWDE affirm that the $\delta^{13}C$ signature of the FACE wood can be traced into the mineral soil. A field campaign was completed in 2017 to establish what, biologically, is mediating the amounts of C we are tracing in soil, with specific interest in dominant fungal rot types and the role of termites. Also, during 2017, the framework for a module within Forest DNDC was developed to better reflect the dynamics of wood decomposition,

mechanistically, thereby enhancing a proven platform for simulating forest C dynamics at multiple scales under current and future climate conditions and management scenarios.