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Traits mediate global change effects on wood carbon fluxes

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CO2 fluxes from wood decomposition represent an important source of carbon from forest ecosystems to the atmosphere, which are determined by both wood traits and climate influencing the metabolic rates of decomposers. Previous studies have quantified the effects of moisture and temperature on wood decomposition, but these effects were not separated from the potential influence of wood traits. Indeed, it is not well understood how traits and climate interact to influence wood CO2 fluxes. Here, we examined the responses of CO2 fluxes from dead wood with different traits (angiosperm and gymnosperm) to drought and nutrient enhancement across seasonal temperature gradients. Our results showed that drought significantly decreased wood CO2 fluxes, but its effects varied with both taxonomical group and drought intensity. Drought-induced reduction in wood CO2 fluxes was larger in angiosperms than gymnosperms for the 35% rainfall reduction treatment, but there was no significant difference between these groups for the 70% reduction treatment. This is because wood nitrogen density and carbon quality were significantly higher in angiosperms than gymnosperms, yielding a higher moisture sensitivity of wood decomposition. Further, nutrient additions significantly increased wood CO2 fluxes via fungal composition, but effects varied with nutrient types and taxonomic groups. Specifically, phosphorus addition significantly increased wood CO2 fluxes (65%) through decreased acid phosphatase activity and increased abundance of fast-decaying fungi (e.g., white rot), while nitrogen addition marginally increased it (30%). Phosphorus addition caused a greater increase in CO2 fluxes in gymnosperms than in angiosperms (83.3% vs. 46.9%), which was associated with an increase in Basidiomycota:Ascomycota operational taxonomic unit abundance in gymnosperms but a decrease in angiosperms. Our results highlight the key role of wood traits in regulating moisture and nutrient response of wood CO2 fluxes. Given that the range of angiosperm species may expand under climate warming and forest management, our data suggest that expansion will increase drought effects but decrease nutrient effects on forest carbon cycling in forests previously dominated by gymnosperm species.