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Title: Seasonal and Experimental Drying Effects on Soil Carbon and Nutrient Cycling across Four Distinct Panamanian Forests

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Climatic drying has been predicted and documented in many tropical regions, but its consequences for belowground dynamics remain unclear. Tropical forests hold some of the largest carbon (C) stocks globally, with the largest and most long-term storage occurring in soils, yet little is known about how these C stocks will respond to drying at an ecosystem-scale. The Panama Rainforest Changes with Experimental Drying (PARCHED) experiment was developed to address this gap by investigating seasonal and experimental chronic drying effects in four lowland Panamanian forests that vary in background precipitation and soil fertility. We hypothesized that drying would alleviate anaerobic conditions in wetter forests to increase soil respiration, but suppress soil respiration in drier sites because of decreased decomposer connectivity to fresh C inputs and nutrients. We also hypothesized that microbial communities would be more resistant to chronic drying in drier sites compared with wetter sites, reflecting adaptation to longer, stronger dry seasons. Finally, we hypothesized that drying would promote root mortality and suppress root production most in wetter, following dry season trends. We predicted that soil fertility would be less important than background rainfall in predicting forest responses to chronic drying.

The first five years of results suggest that chronic drying will substantially alter tropical forest soil C cycling, with the largest effect differences according to soil fertility. We found that all forests initially had suppressed soil respiration with drying, but by the third year of the experiment the most fertile forest developed a positive drying effect on soil respiration. The suppression of soil respiration in infertile forests was characterized by proportionally larger losses of older soil C,

as characterized by radiocarbon measurements, potentially indicating reduced connectivity of fresh organic C inputs or nutrients to decomposers. Suppressed soil respiration with drying was also accompanied by nutrient accumulation in surface soils during the dry season. In these infertile forests, chronic drying shifted the microbial community toward a common "drought microbiome," but there were no changes in the fertile soils. Finally, chronic drying suppressed fine root turnover across sites, with fine roots contributing ~50% of soil respiration during the wet season. Together, these results indicate that chronic drying in tropical forests on infertile soils could reduce both inputs of root C to soils, and reduce soil respiration losses of C, such that net effects on soil C stocks remain unclear. The recent positive drying effect on soil respiration in the fertile forest, together with decreased root C inputs, suggests that declines in soil C stocks might be more likely in fertile tropical forests. Ongoing measurements in this experiment are being integrated with soil biogeochemical models to improve predictions of tropical forest-climate feedbacks.