Title: **Effects of Partial Throughfall Exclusion on Soil Dynamics in Lowland Tropical Forests Across Rainfall and Soil Fertility Gradients**

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Project Abstract (400 word):

Humid tropical forests contain some of the largest soil organic carbon (C) stocks on Earth. Despite the importance of C storage in this biome, controls over variation in soil C stock sizes and depth distribution remain poorly understood. We hypothesized that soil C dynamics and related ecosystem processes are more resistant to drying in lower rainfall and infertile sites, where plant and microbial communities are more adapted to stress. We used a partial throughfall exclusion established in 2018 in four Panamanian forests that span 2350 mm to 3300 mm mean annual rainfall, and variation in soil fertility. We measured soil C storage inputs, losses, microbial community characteristics, and nutrient availability. The experiment excludes ~50% of throughfall from plots using clear roofing over 10 *x* 10 m plots, diverting moisture out past 50 cm-deep plastic-lined trenches (n=4 per site, 32 plots total).

Across the four forests soil C dynamics vary with rainfall and soil fertility, and key processes responded to throughfall exclusion. First, soil respiration was lower in throughfall exclusion versus control plots, with interacting effects of site and season. This was similar to background patterns of decreased soil respiration during the natural dry season, with the magnitude of seasonal respiration shifts were predicted by soil moisture shifts and available phosphorus and base cations. Along with decreased soil respiration, the radiocarbon age of respired soil C was significantly

older in throughfall exclusion versus control plots. The decline in soil respiration could be related to reduced fine root (<2 cm diameter) production during, and/or to reduced microbial biomass, both of which appear to be declining with throughfall exclusion. For example, there was significantly less microbial biomass in throughfall exclusion versus control plots, including decreased fungal biomass. Also, microbial community composition changed with throughfall exclusion in infertile soils, converging toward a "drought microbiome", whereby taxonomically similar bacteria were selected for by drying. At the same time, throughfall exclusion promoted accumulation of soil nitrogen during the dry season, and soil moisture data indicated reduced vertical flushing of soils during rainfall events in exclusion plots. These results suggest that drying in tropical forests is likely to alter soil C storage, although the net balance between reduced soil respiration, reduced root inputs, and changes in microbial processing remain to be seen. Continued research at these sites will be valuable for parameterizing and developing model processes to predict future C storage in tropical forests.