**Title**: **Depth Distribution of Fine Roots and Organic Carbon Across Fertility and Rainfall Gradients in Lowland Tropical Forests of Panama**

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**Project Abstract**: Humid tropical forests contain some of the largest soil organic carbon (SOC) stocks on Earth. Much of this SOC occurs at depth in the soil profile, but the controls on SOC distribution with depth, including root inputs, climate, and soil fertility, remain poorly understood. To address this, we measured the depth distribution of SOC, fine root biomass, and nutrients in 43 lowland tropical forest soils in central Panama spanning gradients of rainfall and fertility. We hypothesized that SOC depth distributions reflect rooting depth distributions. We used fitted $\beta$ parameters to characterize depth distributions, where $\beta$ is a numerical index based on the asymptotic equation $Y=1-\beta^d$, in which $Y$ is the cumulative proportion of roots or SOC to depth d. Root $\beta$ values ranged from 0.82 – 0.95 across sites and were best predicted extractable potassium (K) stocks and pH. The three most acidic (pH < 4) and K-poor (< 20 g K m$^{-2}$) soils contained 76 ± 5 % of their fine root biomass in the upper 10 cm of the profile, while the three least acidic (pH > 6.0) and most K-rich (> 50 g K m$^{-2}$) soils contained only 41 ± 9 % of root biomass to that depth. Surprisingly, $\beta$ values for roots were inversely related to those for SOC, such that sites with large root biomass at the surface contained large stocks of SOC in the subsoil. $\beta$ values for SOC were best predicted by soil pH and base cation stocks, such that the three most base-poor soils contained 34 ± 8 % of SOC below 50 cm, while the three most base-rich soils contained only 9 ± 2 % of their SOC below this depth. Structural equation modelling suggested direct effects of K and pH on Root $\beta$, and base cations and pH on SOC $\beta$, with an endogenous relationship between Root $\beta$ and SOC $\beta$. Nutrient depth distributions, in turn, were not related to either Root $\beta$ or SOC $\beta$, with uniformly small stocks of nutrients at depth in infertile soils, and large subsurface nutrient stocks in fertile soils. These results suggest that global change effects on surface root growth in tropical forests are likely to have cascading effects on subsurface SOC storage, impacting large stocks of tropical C.