Title: Determining the Best-Fit Model for Tropical Soil Phosphorus Sorption with Relevance to Earth System Models

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Project Abstract:
Low phosphorus (P) availability in tropical soils is thought to limit forest productivity. These soils often have high sorptive capacities due to high contents of clay particles and iron (Fe) and aluminum (Al) oxides, which form strong bonds with orthophosphate (PO_4^{3-}). Improving the understanding of soil sorptive characteristics will help Earth system models (ESMs) better estimate plant nutrient availability and the productive capacity of tropical forests. Sorption isotherms have been widely described using the Michaelis-Menten type Langmuir equation, particularly because it provides readily-interpretable parameters, such as the maximum sorption capacity (*Qmax*) of the soil. *Qmax* values are typically quite large, often reaching values >1000 mg PO_4-P per kg of soil (mg/kg). Non-agricultural tropical forests are unlikely to be exposed to this much PO_4, so the high values of the *Qmax* do little to describe soil P sorption dynamics at lower concentrations which represent more realistic amounts soil solution P. We conducted 41 equilibrium batch isotherm experiments, covering 8 soil series within 4 soil orders from Puerto Rico, using concentrations of P ranging from 0 to 1000 mg PO_4-P per L. Isotherms were quantified by fitting the data to both Langmuir and Freundlich (power-law) equations. At the low end of the isotherm, where 7 to 40 mg PO_4-P/L was added to the soils, the Langmuir equation greatly underestimated the amount of P sorbed to the soil, which translates to an overestimate of the bioavailability of P. In contrast, the Freundlich equation consistently provided an accurate estimate of bioavailability at low concentrations of added P. Our initial findings indicate that the Freundlich equation provides more realistic estimates of the soil P sink. The Freundlich equation would therefore provide more accurate representation of tropical-soil P sorption in ESMs that aim to project soil P interactions moving forward.