Title: Oscillating Redox Conditions Controlled Greenhouse Gas Dynamics in Wet Tropical Forest Soils

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BER Program: ESS

Project: Early Career Award

Project Website: n/a

Project Abstract: Wet tropical forest soils can oscillate between fully oxygenated and fully anoxic conditions, which can differentially influence the dynamics of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) as a function of landscape topography. To gain a better understanding of in situ processes, we mimicked the dynamic redox oscillations in a laboratory incubation using soil samples collected from valley and slope positions along a catena near the El Verde Field Station, Luquillo Experimental Forest, Puerto Rico. Sixty grams of fresh soil was incubated under static oxic, static anoxic, and alternating redox conditions (every 4 days) over 76 days. The dynamics of greenhouse gases, redox-sensitive elements (total/reduced iron, ammonium, nitrite, and nitrate), extractable organic acids, pH, microbial biomass, hydrolytic enzymes, dissolved organic carbon, and organic/inorganic phosphorus were monitored. Overall, net CO_2, CH_4, and N_2O fluxes followed the pattern of alternating > oxic > anoxic, anoxic > alternating > oxic, and oxic > alternating > anoxic treatments, respectively. We observed higher reduced iron concentrations under the anoxic treatment and in the valley soils. Soil pH partially followed the pattern of reduced iron, especially for the anoxic treatment. Valley soils had greater nitrate than slope soils, especially under the oxic treatment. Landscape topography exerted an opposite effect on microbial biomass phosphorus, where valley > slope, and phosphorus-degrading enzymes phosphatase and di-phosphatase, where slope > valley. However, microbial biomass phosphorus and phosphorus-degrading enzymes followed a similar pattern under redox treatments (oxic > alternating > anoxic). Hence, both redox conditions and landscape topography influenced soil biogeochemistry and altered greenhouse gases dynamics. We used a geochemical modeling

framework, PHREEQC, to represent the tight coupling and rapid dynamics of carbon, nitrogen, phosphorus, and iron cycles and associated greenhouse gases dynamics in wet tropical forest soils. This research will aid in understanding and predicting the high degree of variability of greenhouse gas emissions in tropical climates.