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Controls over Greenhouse Gas Emissions from Puerto Rican Tropical Rainforest Soils

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Wet, tropical ecosystems are responsible for a significant proportion of greenhouse gases into the atmosphere, and a large proportion of tropical gas emissions are due to soil microbial respiration. Landscape position, however, exerts key controls over whether emissions consist of carbon dioxide or methane, and the involvement of terminal electron acceptors ranging from oxygen to sulfate. This poster will summarize a variety of lab- and field-based approaches for understanding greenhouse gas emissions along a 6-point valley to ridgetop transect in the El Yunque National Forest in Puerto Rico. Soils were collected seasonally, characterized, and incubated to quantify carbon dioxide (CO_2) and methane (CH_4) emissions under a variety of moisture conditions, oxygen levels, terminal electron acceptor availability, including nitrate, iron, manganese, and sulfate, and also to capture seasonal variations. Variations in soil moisture changed CO_2 and CH_4 emissions in both valley and ridgetop soils. Valley soils wetted to increase soil moisture content by 25 or 40% emitted more CH4 than control soils, whereas soil dried to decrease moisture content by 25% or 40% did not emit detectable concentrations of CH_4. CO_2 emissions increased in dried valley soils and decreased in wetted valley soils. Ridgetop soils did not emit CH_4 regardless of treatment, but CO_2 emissions increased in wetted treatments and decreased in dried treatments. Incubations on soils collected four times in one year reveal soils are primed based on topographic location to emit either CH_4 or CO_2. Ridgetop soils consistently emitted more CO_2 than valley soils, and never emitted detectable levels of CH_4, unlike valley soils which did emit CH_4 under anaerobic conditions. These results were consistent with field- scale measurements of CH_4 and CO_2 along a valley to ridgetop transect using a Picarro G-2508, in which CH_4 emissions were only observed for valley soils. The addition of terminal electron acceptors to incubation experiments changed CH_4 and CO_2 production rates in both ridgetop and valley soils. Field measurements of soil water were also influenced by topographic position, where nitrate and sulfate disappearance coincided with the appearance of iron and manganese, but only in valley soils. Our work suggests that proportions of greenhouse gas emissions depend on a wide variety of factors, including moisture content, oxygen levels, landscape position, available terminal electron acceptors, and very likely, microbial capabilities. The challenge moving forward will be how to incorporate the information into a model that improves representation of greenhouse gas emissions while representing complexities in landscape position, moisture, and time.