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Drivers of soil carbon emission in warmed tropical soil

Andrew Nottingham[1,2], Erland Bååth[3], Kirk Broders[2,4], Patrick Meir[5], Maria Montero-Sanchez[2], Kristin Saltonstall[2], Alicia Sanjur[2], Jarrod Scott[2], and Esther Velasquez[2]

[1]School of Geography, University of Leeds, Leeds, UK
[2]Smithsonian Tropical Research Institute, 0843-03092, Balboa, Ancon, Republic of Panama
[3]Section of Microbial Ecology, Department of Biology, Lund University, 22362, Lund, Sweden.
[4]USDA, Agricultural Research Service, National Center for Agricultural Utilization Research, Mycotoxin Prevention and Applied Microbiology Research Unit. Peoria, IL. 61604, USA
[5]School of Geosciences, University of Edinburgh, Crew Building, Kings Buildings, Edinburgh, UK

Soil microbes form some of the most diverse biological communities on Earth and are fundamental in regulating the terrestrial carbon cycle. Their response to climate warming could therefore have major consequences for future climate, particularly in tropical forests where high biological diversity coincides with a vast store of soil carbon. We used an *in-situ* soil warming experiment to test the response of tropical forest soil microbial communities, growth, enzyme activities and respiration to three years of soil warming. We first determined the response to warming of the microbial community composition and asked whether community change was related to a change in the intrinsic sensitivity of microbial growth. Second, we asked whether the response to warming of microbial growth sensitivity could explain the response of heterotrophic soil CO_2 emission under in situ warming. The experiment, SWELTR (Soil Warming Experiment in Lowland TRopical forest) consists of five pairs of circular control and warmed plots (whole-profile warming, using buried resistance cables) distributed evenly within approximately 1 ha of semi-deciduous moist lowland tropical forest on Barro Colorado Island, Panama. Each warmed plot is heated across the full soil profile, resulting in a total of 120 m^3 of warmed soil for the experiment. For this study we established two subplots per treatment plot that differed with distance to the heating source, thus providing two treatments of, on average, 3ºC and 8ºC warming of surface soils and performed field campaigns during the wet season (when soil moisture was not limiting to microbial activity). Microbial diversity declined markedly, especially of bacteria. As the microbial community composition shifted under warming, many taxa were no longer detected and others, including taxa associated with thermophilic traits, were enriched. The activity of 7 out of 10 measured soil enzyme activities increased with warming. The community shift resulted in an adaptation of growth to warmer temperatures, which we used to specify a microbial model to predict changes in soil CO_2 emissions. However, the observed *in situ* soil CO_2 emissions increase exceeded the rates predicted by our model three-fold. Our results show that the soil microbial community and growth response to warming was decoupled from large increases in CO_2 emission, which was potentially boosted by an abiotic effect of warming on soil enzyme activity. Our results suggest that warming of tropical forests will have rapid, detrimental consequences both for soil

microbial biodiversity and future climate.