

Poster #9-34

Tropical Forest Response to a Drier Future: Measurement and Modeling of Soil Organic Matter Stocks and Turnover

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BER Program: TES

Project: Early Career Research Program

Tropical forests account for over 50% of the global terrestrial carbon sink and 29% of global soil carbon, but the stability of carbon in these ecosystems under a changing climate is unknown. Recent work suggests moisture may be more important than temperature in driving soil carbon storage and emissions in the tropics. However, data on belowground carbon cycling in the tropics is sparse, and the role of moisture on soil carbon dynamics is underrepresented in current land surface models limiting our ability to extrapolate from field experiments to the entire region. We measured radiocarbon (¹⁴C) and calculated turnover rates of organic matter from 37 soil profiles from the Neotropics including sites in Mexico, Brazil, Costa Rica, Puerto Rico, and Peru. Our sites represent a large range of moisture, spanning 710 to 4200 mm of mean annual precipitation, and include Andisols, Oxisols, Inceptisols, and Ultisols. We compared measured soil C stocks and ¹⁴C profiles to data generated from the Community Land Model (CLM) v.4.5 and have begun to generate data from the E3SM Land Model v.1. We found a large range in soil ¹⁴C profiles between sites, and in some locations, we also found a large spatial variation within a site. We found that modeled carbon stocks were consistently higher than measured stocks, modeled soil carbon ages were older than measured values near the surface (upper 50 cm), and that modeled soil carbon ages for deep soil carbon were younger than measured deep soil carbon ages. Additionally, the models did not capture the variation in ¹⁴C and C stock profiles that we observed in measured soil carbon profiles between and within the sites across the Neotropics.

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-ABS-736060.