Poster #95

Extrapolating Carbon Dynamics of Seasonally Dry Tropical Forests Across Geographic Scales and into Future Climates: Improving Simulation Models with Empirical Observations

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BACKGROUND-- Seasonally dry tropical forests (SDTFs) experience a pronounced dry season lasting 3 to 7 months, and once accounted for approximately 40% of all tropical forest. Dry forests are understudied compared to tropical rainforests, and are poorly represented in earth system models. Thus, it is unknown whether SDTFs are uniquely vulnerable or resilient to global environmental changes including climate change and nitrogen deposition. We hypothesize that the responses of STDFs to global change depend critically on belowground processes, but we lack empirical data to verify this.
OBJECTIVES—The objectives of this project are to quantify how above- and belowground processes mediate the responses of SDTF carbon dynamics to environmental change, and incorporate that understanding into two state-of-the-art models, ED2 and ACME. To do so, we are using an interdisciplinary approach that integrates: 1) field observations of ecosystem processes and plant functional traits across a range of dry forest sites in Costa Rica, Mexico, Puerto Rico, and Colombia, 2) forest-scale experiments that manipulate water and nutrient availability in Costa Rica, and 3) model simulations that quantify sensitivity of ecosystem carbon cycling to external forcings. Ultimately, our combined measurement and modeling approach will elucidate controls on C cycling in SDTFs and yield improved models for the global change research community.
RESULTS AND PROGRESS-- Empirical results We established a large-scale factorial nitrogen (N) and phosphorus (P) fertilization experiment in Costa Rica. We have found that belowground processes respond rapidly to fertilization, especially relationships with symbionts. Mycorrhizal colonization decreased dramatically in the N+P treatment only, while nodulation more than tripled in the +P treatment. Ongoing work includes a large-scale throughfall exclusion experiment and observations of ecosystem processes across the network of sites. Soil biogeochemical data suggest that correlations among soil N and P pools and cycling vary among sites.
Modeling results: (1) We used the Ecosystem Demography model 2 (ED2) to simulate field sites in Costa Rica spanning a soil fertility gradient. We compared simulated and observed measures of above- and belowground productivity. On long time scales, we are finding a strong potential for nitrogen limitation of plant productivity. In the model, this nitrogen limitation can be relieved in part by symbiotic nitrogen fixation and changes in microbial biomass and functioning. (2) In response to the empirical results, we are testing the parameterization of a new microbial model. (3) We developed a new leaf longevity parameterization based on both carbon optimization and hydraulic limitation.