2024 Biogeomon

Title: Coupled biogeochemistry modeling in the ELM-FATES modeling for understanding tropical forest regrowth dynamics

Jennifer Holm, Mingjie Shi, Ryan Knox, Xinyuan Wei, Lara Kueppers, Charlie Koven, Polly Thornton, Jessica Needham, Eileen Helmer, Michele Thornton, Shih-Chieh Koa, Jeffery Chambers

Abstract:

Nutrient control of productivity, allocation, and turnover is a critically important issue in tropical forests, which are for the most part located on highly weathered soils that are deficient in essential plant nutrients. Due to the importance of tropical forests in their global carbon sink potential, understanding and correctly representing both nutrient controls and disturbances within ecosystem models is required. However, how plant nutrient availability regulates carbon allocation is a key source of uncertainty in model predictions of tropical forest responses to environmental change.

Most current Earth System Models are limited in ecological detail and realism (e.g., ecosystem structure, demography, and disturbances). Failing to mechanistically represent mortality, recruitment, and disturbance limits the ability of these models to realistically forecast ecosystem responses to future climate stressors. To be able to accurately predict these complex ecological processes we use the vegetation demographic model FATES (Functionally-Assembled Terrestrial Ecosystem Simulator) that is coupled to the land surface model ELM. We present here an overview of the newly implemented representation of nutrient competition, acquisition, and extensible approach of nutrient and carbon allocation within plants, that has coupled the interactions of nutrients between soil biogeochemistry in ELM and plant productivity and carbon in FATES. This presentation will highlight the on-going work from multiple modeling studies located in Puerto Rico from NGEE-Tropics team members. One testing the new nutrient enabled ELM-FATES at Luquillo, another using ELM-FATES to understand hurricane disturbance induced forest recovery using a light demanding and shade tolerant Puerto Rican plant-functional types. Simulation results examine aboveground biomass, leaf biomass, and litter pre- and post-Hugo hurricane compared to observations. This work is important for understanding long-term recovery in an island where hurricanes might become more frequent or intense. Early-stage work also aims to deepen the current understanding of carbon dynamics in secondary forests recovering from abandoned agricultural fields in Puerto Rico, and the influence of degraded lands and soils on forest regrowth and sustained recovery. With two new updates, 1) downscaled DayMet meteorological forcing and 2) updated raw datasets that include land surface and land-use change parameters, the ELM model has the capability to simulate the land surface at high spatial resolutions and heterogeneity at the 1-km scale, making it possible to address fine scale land-use and biogeochemistry questions in Puerto Rico in an Earth System Model.