Poster #9-11

Understanding the Control of Hydraulic Traits in Tropical Forests Using a Hydrodynamic Model within a Demographic Vegetation Model

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BER Program: TES
Project: NGEE-Tropics
Project Website: https://ngee-tropics.lbl.gov/

Vegetation plays a key role in global carbon cycles and thus is an important component within the Earth system models (ESMs) to project future climates. A recent trend for ESM vegetation modeling is to incorporate size- and succession-stage-structured demographic models. These models make it feasible for more realistic representation of key processes that control vegetation dynamics. In this study, we reported a new hydrodynamics (HYDRO) model within the DOE- sponsored the dynamic vegetation model, the functionally assembled terrestrial simulator (FATES-HYDRO). The HYDRO model is built on the size and canopy structure representation within FATES and is expected to better capture the control of hydraulic traits in both vegetation dynamics and carbon/water fluxes. As the first step, we conducted a parameter sensitivity analysis using the distribution of biologically-interpretable and measurable plant hydraulic traits. We focused on tropical forests, where co-existing species have been observed to possess large variability in their hydraulic traits. We first assembled 10 distinct datasets of plant hydraulic traits of stomata, leaves, stems, and roots, determined the best-fit theoretical distribution for each trait, and linked these based on taxonomically-standardized species names to generate a rank correlation matrix, which quantified the degree of interspecific (between-species) trait-trait coordination. Our analysis showed that hydraulic traits that determine the soil-root connection and the stomata control are more important for dry periods, while hydraulic traits that determine the whole tree conductance are more importance for wet periods. We also linked the loss of hydraulic conductivity to tree mortality related to hydraulic failure and then compared the sensitivity of mortality to three hypothesized mechanisms: carbon starvation, hydraulic failure, and a combination of carbon starvation and hydraulic failure based on a d13c isotopic approach. Our preliminary results show that there is a substantial difference in the simulated mortality depending on the mortality mechanisms selected. Our analysis suggests that hydraulic traits could play an important role in carbon and water fluxes and vegetation dynamics in tropical forests and further measurements to capture the hydraulic control on stomata, root-soil interface and whole tree resistance could improve our prediction of future tropical forests within ESMs.