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The Importance of Hydraulic Traits to Tropical Forest Dynamics

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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. In this study, we conducted a global sensitivity analysis to better under the hydraulic trait control on tropical forest dynamics. 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. 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.