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Synthesis of Tropical Forest Sapflow Responses to the 2015-2016 ENSO Event: Insights into Key Plant Traits and Mechanisms

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Tropical forest responses to moisture remain poorly understood, in part because of the large diversity of plant hydraulic traits found therein. Changing moisture regimes, such as more frequent drought events, are expected to interact with these diverse hydraulic traits and other requirements of tropical trees in complex ways, making prediction of ecosystem-scale responses and community compositional trajectories difficult. A first step towards discerning such responses is in the analysis of how plant hydraulic and edaphic conditions control trajectories of individual trees' water use over pre-drought, drought, and recovery periods. We took advantage of the 2015-2016 ENSO event, which induced drought over much of the tropics, to collect sap flow data from more than 50 trees across multiple sites situated along a precipitation gradient, enabling us to determine a range of responses to decreasing water resources. Where available, via measurements on conspecific individuals or species-mean values in trait databases, plant hydraulic traits were associated with individual sap flux trajectories, in addition to site-specific soil properties and climate. We found a large heterogeneity of sap flow responses during the ENSO within and among study regions. The diversity of strategies to deal with drought stress was partially explained by species functional traits, background climate and intensity of soil water depletion during the ENSO. Preliminary simulations of drought responses using the Community Land Model coupled to the hydraulically-enabled Functionally Assembled Terrestrial Ecosystem Simulator (CLM-FATES-Hydro) are used to demonstrate multiple mechanisms, both edaphic- and plant trait-related, responsible for the divergence in observed sap flow responses, as well as highlight critical field measurements needed to discern among these mechanisms.