Local-scale and spatially explicit response of tropical forests to climate change

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Currently applied dynamic vegetation models do not realistically represent forest ecosystem processes and thus are not able to reproduce in-situ observations of forest ecosystem responses to drought. This is due to the fact that models typically rely on plant functional types to forecast the functional response of vegetation to climate change and to anthropogenic disturbance. However, recent observations of divergent ecosystem responses between topographic forest sites, differing in the availability of water and nutrients, indicate that we should no longer rely on this outdated concept but rather should explore new avenues of representing vegetation dynamics and associated climate change response in next-generation approaches.

Global climate change scenarios forecast increasing severity of climate extremes in association with El Niño–Southern Oscillation (ENSO). Such climate anomalies have been shown to affect forest ecosystem processes such as net primary productivity, which is determined by climate (precipitation, temperature, and light) and soil fertility (geology and topography). However, more recently it has been suggested that the impact of such climate fluctuations on forest productivity was strongly related to local site characteristics, which determined the sensitivity of forest ecosystem processes to climate anomalies.

We propose a novel approach integrating in-situ observations with remotely sensed estimates of forest aboveground productivity for parameterization of next-generation vegetation models capable of forecasting realistic forest ecosystem responses under future scenarios. Our approach considers local site characteristics associated with topography and disturbance history, both of which determine the sensitivity of forest aboveground productivity to projected climate anomalies. Our results therefore should have crucial implications for management and restoration of forest ecosystems and could be used to refine estimates of forest C sink-strength under future scenarios.