Isoprene emission structures tropical tree biogeography and community assembly responses to climate

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Background: There is an urgent need to understand the physiological traits that define tropical tree responses and feedbacks to climate. Temperature and drought frequency are increasing in the tropics, and we are only beginning to understand why some tree species are resilient while others succumb. Isoprene emission from leaves has been shown to enhance plant tolerance to climatic stress. About a third of tree species make isoprene, a volatile secondary metabolite produced in the chloroplast. With analyses of tree community assembly, we test the hypothesis that isoprene emission affects species relative performance and mortality responses to climate in species-rich tropical forests. **Methods:** We analyzed changes in the proportional abundance of isoprene-emitting species (pIE) across climates throughout the tropics, and through time at three focal sites responding to anomalous high temperatures or drought. Species trait values (emitter or non-emitter) were assigned by taxon-matching to a dataset of new measurements and literature data. Missing trait values were imputed at the genus level by a probabilistic method. Bootstrap iterations allowed us to analyze the effect of trait uncertainty on the community assembly results. **Results:** Site pIE increased with mean annual temperature across the tropics (ΔpIE = 0.034 per ˚C), but decreased with dry season length (ΔpIE = −0.012 per month) (linear regressions, $p < 0.001$). The sign of each regression slope was consistent across > 99% of trait imputations. A linear model accounting for covariation between environmental variables explained 32% of variation in site pIE ($p < 0.001$). All three focal sites showed an increase in pIE through time. At the high-temperature site, pIE increased by 52%, with the sign of ΔpIE consistent across all imputations. At the two drought sites, pIE increased by 14% and 16%, but not significantly across imputations (< 97.5% positive ΔpIE). **Discussion:** Our results support a benefit of isoprene to trees under high temperatures but not drought. Enhanced tolerance of isoprene emitting species to the increasing temperatures of the Anthropocene is a mechanism for forest composition shifts. Understanding the implications of such shifts to biodiversity and climate feedbacks requires better knowledge of the basic ecology and evolution of isoprene. For example, future work should determine how isoprene covaries with other traits as a component of the integrated functional strategies of tropical trees.

Keywords: isoprene, climate, drought, temperature, physiology

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Individual and ecosystem scale responses to El Niño drought in an eastern Amazon forest.

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Background: Coupled climate-carbon cycle models indicate that Amazon forests may be vulnerable to drought, with some predicting climate change-induced collapse of the Amazon forest and conversion to savanna, while others predict resilience. Much progress has been made in understanding tropical forest drought response, but integration of individual with ecosystem scale responses remains a challenge. **Method:** Here we analyze the response of eastern Amazonian forests at ecosystem and individual scales to the El Nino-induced drought of late 2015/ early 2016 using both eddy flux measurements of net ecosystem exchange of latent and sensible heat fluxes, and the ecohydrological responses, including leaf water potentials and stomatal conductances, of individual trees of species representing a large fraction of the site's basal area. **Results:** Whole-forest water (latent heat) fluxes normally reach their annual peak during the dry season, driven by the dry-season maximum in solar energy input. However, during the 2015-2016 El Nino dry period (August 2015 through June 2016), latent energy fluxes declined relative to the average across all years, and sensible heat fluxes significantly increased, reflecting a strong shift in energy partitioning indicative of water limitation. Individuals, however, exhibited a variety of responses, consistent with a diversity of plant hydraulic strategies, with most species showing statistically significant declines in leaf water potential and stomatal conductance, but with a range across species that varied from no response to large magnitude declines. **Conclusion:** Understanding and predicting whole-forest responses to strong drought is a critical priority for tropical forests, but may depend on accurate assessment of composition of species and their associated functions and hydraulic strategies.

Keywords: Amazonia, El Nino, drought, fluxes

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