Title: **FATES-SPITFIRE: Dynamic Ecosystem Assembly Through Interaction of Disturbance, Vegetation Strategies and Structure in the Tropics**

Jacquelyn Shuman,[1*] Rosie Fisher,[1,2] Charlie Koven,[3] Ryan Knox,[3] Chonggang Xu,[4] and Sam Levis,[3]

[1]National Center for Atmospheric Research, Boulder, CO;
[2]Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique (CERFACS), Toulouse, France;
[3]Lawrence Berkley National Laboratory, Berkley, CA; and
[4]Los Alamos National Laboratory, Los Alamos, NM

Contact: (jkshuman@ucar.edu)
Project Lead Principle Investigator (PI): Jeff Chambers, LBNL
BER Program TES
Project: NGEET-Tropics
Project Website: https://ngee-tropics.lbl.gov/

Project Abstract: Within the tropics, fire acts to determine vegetation size distribution, biomass accumulation, and the dominance or coexistence of trees and grasses in part setting the forest- savanna biome boundary. This results from complex feedbacks and interactions between vegetation, fire, and climate. Tropical forests are a critical part of the global cycle for carbon and water, thus it is important to analyze how the interaction of climate and fire drive forest-savanna transitions. Utilizing the Functionally Assembled Terrestrial Ecosystem Simulator (FATES), a size-structured demographic vegetation model, with the fire behavior and effects module SPITFIRE we explore functional thresholds of trees and grass across the tropics with active fire disturbance. SPITFIRE is updated to include new fire behavior formulations for fire intensity, scorch height, fuel consumption and coarse woody debris fractions, as well as live grass fuel moisture dynamics based on climate, and the ability to read spatially and temporally varying lightning datasets. With these updates FATES-SPITFIRE captures observed interannual and seasonal burned fraction variability for the recent historical period. FATES-SPITFIRE tracks size-structured plant mortality during fire events and captures 'fire-trap' dynamics where trees escape fire by achieving a canopy height above the flames or through fire resistant traits. In simulations, fire limits tree extent, with wetter areas retaining a higher stable tree fraction under an active fire regime. Transitional and drier moisture zones across South America demonstrate dominance of trees or grasses conditional on vegetation traits and strategies, with more expensive traits leading to lower compositional dominance and biomass accumulation compared to similar plants. These results capture critical size-structured competitive interactions, degradation and loss. FATES-SPITFIRE demonstrates that it captures ecosystem assembly of forest- grassland transitions across moisture and disturbance gradients within the tropics through the fire-vegetation feedbacks that are critical for prediction of ecosystem resilience and shifts under current and future conditions.