Title: Importance of fire for functional biogeography across tropics

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Project: NGEE-Tropics (led by Berkeley Lab)
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Project Abstract:
Fire regimes are changing over much of the world. Fire risk has already increased across much of the tropics. Projecting the impact of these changes in global scale simulation requires that we are able to capture and understand how fire acts as a driver of biogeography. Utilizing the Functionally Assembled Terrestrial Ecosystem Simulator (FATES), a size-structured Vegetation Demographic Model, with the fire behavior and effects module SPITFIRE, we test how various fire regimes and contrasting fire tolerance plant traits interact to determine tropical biogeography of forests and grasses. Observations demonstrate that geographic variability in bark thickness is explained in part by burned area, with frequently burned areas having trees adapted with thicker bark. Fire tolerance strategy in FATES is based on tree bark thickness, crown size and foliage resistance to heat, which are key fire-tolerance traits across woody plants. Simulations demonstrate reasonable productivity and capture observed patterns of aboveground biomass for the recent historical period. Burned fraction from the model is over predicted in areas with grass dominance, but resulting biogeography of fire-tolerant thick bark trees and -intolerant thin bark trees correspond to observations across the tropics. Comparisons of size-based fire mortality show that the fire-tolerant thick bark trees escape mortality through height and fire resistant traits more effectively than the thin bark trees. Drier fuels in simulation are shown to promote increased burning, an expansion of grass and thick bark tree area and loss of area for fire-intolerant thin bark trees. Conversely simulations without fire result in exclusive dominance of the thin bark tree, which is less resource expensive compared to the thick bark tree. These results suggest that thin bark forests are vulnerable to increased fire. Our ability to capture the connection between active fire and plant's fire tolerance strategies in determining biogeography provides an essential tool for assessing the vulnerability and resilience of these critical carbon storage areas under changing conditions across the tropics.