Linking tropical forest structure from regional-scale airborne lidar data to terrestrial ecosystem models

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Tropical forests are complex ecosystems that show high spatial variability in vertical structure and functional diversity, yet our understanding on how forest structure modulates the ecosystem functioning is still limited. Also, regional terrestrial biosphere models seldom account for forest structure heterogeneity within biomes, limiting their ability to explore this potentially important characteristic on the water and carbon cycles. To understand and quantify the role of forest structure on ecosystem, we used airborne lidar data in conjunction with forest inventory plots collected over a broad range of climates, soils and degradation regimes in the Amazon to calibrate and contrast two approaches to obtain forest structure from the point clouds: one based on leaf area index profile, and another based on individual tree crown decomposition. We then use the airborne-lidar based forest structure to provide initial conditions to the Ecosystem Demography Model (ED2), which accounts for vertical and horizontal heterogeneity of tropical forest ecosystems. We assessed the model over multiple sites in the Amazon that also had eddy covariance towers, and found that the model realistically represents the magnitude, seasonality and spatial variability of water fluxes and productivity. Preliminary simulations using the lidar derived initial forest conditions under simulated drought, the most degraded, low-biomass forests suffer water stress, significantly higher ground temperatures, and increased flammability earlier in drought periods than old-growth forests. Our results suggest that the structure of Amazon forests can contribute to the response of these forests to extreme events.