Poster# 87

Recovery Time of Carbon, Structure and Functioning of Degraded Forests in the Amazon

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Land use and land cover changes have a major impact in the global carbon cycle, and the impact of these changes in tropical forests are of particular interest because they store about a quarter of total terrestrial carbon stocks. Deforestation in the Amazon, the largest contiguous tropical forest, has declined over the last decade, yet forest degradation from logging, fire, and fragmentation continues to impact forest carbon stocks and fluxes. The magnitude of this impact remains uncertain, and observation-based studies are often limited by short time periods or small study areas.

To better understand the long-term impact of forest degradation and recovery, we are developing a framework to simulate the impact of forest degradation and quantify the typical recovery time for biophysical properties, carbon stocks, and forest structure. This framework integrates forest inventory plots and airborne lidar measurements in intact and degraded forests (conventional and reduced-impact logging, logging and burning, and multiple burns) in the Ecosystem Demography Model (ED-2), a cohort- and process-based ecosystem model that represents changes in carbon stocks and forest structure and functional groups. Based on the model projections initialized with contemporary forest structure and composition, most degraded forests rapidly recover (30 years) water and energy fluxes compared with old-growth forests, even at sites that were affected by multiple fires. However, degraded forests maintained lower carbon stocks and distinct forest structure even after 100 years without further disturbances, because of persistent differences in forest structure and composition. Simulations that included fire suggest that the most degraded forests would take much longer to recover biomass typical of old-growth forests because open canopies and drier microclimates in degraded forests increased the frequency and intensity of recurrent fires. Our study highlights that recovery of degraded forests may act as an important carbon sink over multidecadal to century-long time periods, given fire exclusion to sustain forest recovery. Preliminary results on the recovery of degraded forests following selective logging with different degradation levels using another cohort-based model, the Functional Assembled Terrestrial Ecosystem Simulator (FATES) coupled to the Community Land Model, will also be discussed.