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Representing the Long-term Impacts of Forest Degradation in Amazon Forests in Dynamic Ecosystem Models

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Deforestation and forest degradation are major drivers of changes in tropical forests and both contribute roughly equally to carbon stock depletion of tropical forest ecosystems worldwide. In the Amazon rainforest, the largest tropical forest in the world, deforestation rates have significantly decreased since 2005, but there is increasing evidence that forest degradation rates have not followed the downward trend. In contrast to deforested areas, sites that are disturbed by selective logging and understory fires — the main drivers of tropical forest degradation — retain some, albeit severely altered, forest structure and function. Most dynamic global vegetation models still have overly aggregated representation of the ecosystems, limiting their ability to properly represent the dynamics of tropical forest degradation. In this study we implemented a new selective logging module in the Ecosystem Demography Model (ED-2) to investigate the impact of a broad range of logging techniques, harvest intensities, and recurrence cycles on the long-term dynamics of Amazon forests. Model results were evaluated using eddy covariance towers at intact and logged sites at the Tapajos National Forest in Brazil and data on long-term dynamics reported in the literature. ED-2 is able to reproduce both the fast (< 5yr) recovery of water, energy fluxes compared to flux tower, and the typical, field-observed, decadal time scales for biomass recovery when no additional logging occurs. The results also indicate that under high-intensity, conventional logging, both the drying near the ground due to canopy opening and the additional fuel loads due to the logging disturbance have the potential to support more intense fires. These results indicate that under intense degradation, forests may greatly increased fire frequency, severely reducing carbon stocks, and inducing long-term changes in forest structure and composition from recurrent fires. The insights obtained from ED-2 shed lights on future directions in representing tropical forest degradation and recovery in similar ecosystem models, such as the Functionally Assembled Terrestrial Ecosystem Simulator (FATES) (See Huang et al., Poster).