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Testing for Changes in Biomass Dynamics in Large-Scale Forest Datasets

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The response of tropical forests to ongoing climate and atmospheric changes is critical to future global carbon budgets, but remains highly uncertain. A critical question is whether increasing atmospheric CO_2 and temperature are altering forest dynamics, and if so, to what extent. Some recent studies have reported enhanced forest productivity and increased biomass stocks in old- growth forests, consistent with a fertilization hypothesis. Attribution of such increases to global change is complicated by spatial and temporal variability in biomass associated with the gap- dynamic cycle. Old-growth forests are mosaics of many small patches, with most showing small increases in biomass, and a few showing larger decreases. Hence, temporal variation in disturbances can confound detection of long-term directional change. Thus, studies of biomass dynamics must account for gap dynamics and the distribution of gap phases when testing for changes over time.

We present a new method to account for gap dynamics by analyzing biomass dynamics at the level of 10 by 10 m quadrats, analyzing quadrat-level AGB fluxes as a function of initial quadrat AGB, and evaluating whether these relationships vary over time. Using 30 years (1985-2015) of forest inventories at Barro Colorado Island (BCI), Panama, we demonstrate that AGB fluxes vary strongly with gap phase, and, despite wide inter-annual variability, found a trend in increasing productivity and mortality AGB loss over the past 15 years. Our approach points towards the importance of accounting for initial gap phase distribution in analyses of biomass dynamics, and offers to disentangle potential external forcing from disturbance-recovery dynamics.