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How does leaf phenology define upper canopy functional structure in a central Amazon upland forest?

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Leaf phenology impacts carbon, nutrient, and hydrological cycles from local to global scales. In central Amazon rainforest, the timing of leaf flush and abscission promotes a seasonal change in leaf age composition of the upper canopy. It has been singled out as the most important driver of photosynthetic capacity (PC) seasonality. However, limitations concerning on two important issues must be raised: 1) canopy leaf age temporal variation has not been directly assessed and 2) this approach has an empirical assumption that canopy leaf area should be fully replaced after 12 months. The first issue implies PC to be obtained by flux-towers measurements to estimate leaf age composition of the upper canopy. So, it is not a reliable representation of age distribution of the upper canopy. The concerning about the second issue relies on that tropical rainforest trees are known to present different leaf phenological patterns (e.g. deciduousness and evergreenness) which are correlated to leaf lifespan (LL), like for a year or more. Besides, leaves presenting higher LL show differences on PC compared to those of short ones, both in their maximum PC and its decay rate while aging. That means if leaves from plants with different leaf phenological pattern have the same age (e.g. in months), they will differ on their PC. Therefore, there is a necessity to elucidate leaf phenological patterns and unravel temporal changes on leaf age composition of upper canopy and LL variability. From August 2016 to November 2019 at the Amazon Tall Tower Observatory (ATTO), tagged leaves were censused monthly on ten upper canopy branches per tree (n = 36 trees). Temporal variation of storage, flush and abscission of leaves were recorded. Chronological ages were only possible for leaves flushing during the study period. Similarly, LL was obtained from leaves when both flush and abscission date were observed throughout the monitoring period. Around 80% of the trees flushed new leaves massively during the dry season. Eight of them (22%) fell into brevi-deciduous category while twenty-eight (78%) into evergreenness. Canopy leaf quantity proved to be nonseasonal as expected. On the other hand, seasonal change in leaf age composition of the upper canopy was confirmed. Still, it sheds light on its complex and diverse stratification. In the last month of monitoring, leaf age ranged from 0 to 43 months with only half of the leaves being younger than a year. Thus, leaf flush and leaf abscission present a seasonality. However, at least almost half of them have a lifetime longer than a year. This result suggests that half of the leaves from upper canopy are being neglected by the models. The LL

presented a bimodal distribution (n = 2552 leaves) with two peaks around one year and two years, respectively. This suggest there are annual and biannual leaf phenological patterns between upper canopy trees. However, individual trees still show a bimodal distribution of LL frequency. This implies LL should not be used as a leaf functional trait to define plant functional groups.