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A Mechanistic Understanding of NPP Partitioning between Leaves and Roots across an Amazon Rainfall Gradient: The Role of Traits and Carbon Economics

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The allocation of NPP between leaves and roots is a major determinant of forest carbon dynamics, yet the veritable drivers of NPP partitioning remain unclear. Optimal partitioning theory suggests that plants actively apportion NPP between leaves and roots to maximise uptake of the most limiting resource, however, evidence from some tropical forests present a divergent trend. Across an Amazon rainfall gradient, leaf:root NPP increased significantly with forest dryness (R2=0.51, p=0.046). To understand the interaction between NPP partitioning and resource availability, we explore the effects of leaf:root allocation on carbon cycle dynamics. The soil plant atmosphere model (SPA), was calibrated to plots across the aforementioned precipitation gradient (1400-2800mm) using detailed measurements of LAI, carbon fluxes and plant traits from extensive field campaigns by the Global Ecosystems Monitoring network. Carbon dynamics were simulated at each plot across the gamut of NPP partitioning between leaves and roots. The viability of low leaf:root NPP allocation was constrained by leaf lifespan, whereby faster leaf turnover in dry forests necessitated higher leaf:root NPP allocation. As leaf:root allocation increased so too did total photosynthesis. However, the simultaneous decline in root carbon stocks reduced water acquisition, causing a decline in net canopy carbon export. Realised leaf:root NPP cohered with that which maximised net canopy carbon export (R2=0.60, p=0.02). We therefore surmise that the partitioning of NPP between leaves and roots was constrained by both leaf traits and carbon economics. The effect of resource availability on leaf:root NPP partitioning was driven indirectly through the covariation of precipitation and leaf traits. These results offer new insight into the allocation of NPP between leaves and roots, and the role of resource availability in apportionment. This work advances the development of mechanistic NPP partitioning within ecosystem models, aiding expansion of model application to areas where field data may be limited.