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Drought effects on net primary productivity and its allocation in an east-central Amazon forest: results from a throughfall exclusion experiment

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Large areas of Amazon forest are exposed to severe drought stress, and may experience greater drought stress in the future through the interacting effects of global warming, ENSO, and deforestation-inhibition of rainfall. We established a partial throughfall exclusion experiment (one-hectare treatment and control plots) in east-central Amazonia (FLONA Tapajós) in 1998 to help provide a more integrated understanding of forest responses to drought. During the first year of the experiment, partial (40%) throughfall exclusion induced a decline in both leaf photosynthetic capacity and diameter growth of small trees. During the second year of throughfall exclusion, when deep soil depletion occurred, stem growth of trees up to 50 cm dbh was suppressed at the rate of 2 Mg biomass ha⁻¹ yr⁻¹. It was only after excluding a total of 1600 mm of throughfall, during the second post-treatment, dry season, that pre-dawn leaf water potential declined, inhibiting leaf production and lowering LAI by 1.5 units. Hence, leaf fall responded to drought only after 2 years of treatment; the mortality of understory trees (<2 cm dbh) increased three-fold after two years. In sum, this Amazon forest effectively avoided drought-induced leaf shedding and mortality of adult trees during two years of partial throughfall exclusion by tapping soil moisture to 20 m depth. Carbon accumulation in stems—the aboveground C pool with the slowest turnover rate—was the most sensitive to drought.

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