# Disentangling temperature-driven influences to water and carbon plant physiological processes in the Central Amazon during the 2015/16 El Niño

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Tropical forests cycle more carbon and water than any other terrestrial biome, but are highly sensitive to warming climates. Improvement of terrestrial carbon and water cycling predictions requires a better understanding of the physiological mechanisms underlying forest response to warming. The 2015/6 drought associated with El Niño in the Amazon Basin offered a unique opportunity to collect coupled field observations of plant physiological and environmental variables which are indicated by models to be the most critical for predicting the future of tropical forest carbon, water, and energy fluxes. Observations from the Central Amazon have found leaf temperature to strongly control both water and carbon plant physiological processes. In situ measurements of net photosynthesis and stomatal conductance peaked in the morning and showed a clear mid-day/post-midday depression associated with temperatures passing the optimal value for net photosynthesis (~32 °C). Despite assumptions of a significant time delay, tight temporal correlations were found between sap velocity (1m) and crown leaf temperature. Leaf water potential ($\Psi_L$), which reflects the balance between sap flow and transpiration, is assumed to reach a minimum during mid-day. However, in-situ observations show that despite high leaf temperatures, dramatic recoveries (20-70%) in $\Psi_L$ occur around mid-day in Central Amazonian trees, potentially due to an increase in the sap flow/transpiration ratio influenced by a both a decrease of stomatal conductance after 10:00 am and the strong coupling of sap flow with leaf temperature. Additionally, plant monoterpenes protect photosynthesis during high temperature stress, but little is known about the composition of monoterpenes in tropical ecosystems. Here we show that monoterpene emissions from leaves are linked with recent photosynthesis and demonstrate distinct temperature optima for five monoterpene groups, potentially corresponding to different enzymatic reaction pathways within the β-ocimene synthase family. As temperatures increased during the 2015 El Niño in the Central Amazon, diurnal and seasonal leaf and ecosystem emissions showed strong linear increases in the relative abundance of linear β-ocimenes (+4.4% $ºC^{-1}$) at the expense of cyclic and bicyclic isomers (e.g d-limonene and α-pinene, respectively). The negative temperature sensitivity of α-pinene, currently assumed to dominate tropical monoterpene emissions, could not be reproduced using current global emission models. Given that β-ocimenes are highly reactive with respect to atmospheric and biological oxidants, these observations suggest a functional role at high temperatures through cloud condensation nuclei formation and within-plant antioxidant roles. The results demonstrate a strong coupling of sap flow and leaf temperature and demonstrate monoterpene emission composition as a new highly relevant signal for warming impacts on tropical terrestrial carbon cycling in future studies.