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An open-top chamber system for exposing Amazon understory vegetation to elevated atmospheric CO_2

Iokanam Pereira[1], Bruno Takeshi[1], Alacimar Guedes[1], Crisvaldo Souza[1], Carlos Quesada[1], and David Lapola[2]

[1]National Institute of Amazonian Research, Manaus, Brazil (iokanam.eng@gmail.com)
[2]Center for Meteorological and Climatic Research Applied to Agriculture, University of Campinas, Campinas, Brazil (lapoladm@gmail.com)

Tropical forests play a key role in the flux of terrestrial carbon (C). However, recent studies show tropical forest are losing over the years the ability to sink C from the atmosphere, one of the best explanations for that is the climate change caused by humanity in the last centuries and accelerating slightly every year. One of the ways to understand the changes in C fluxes in forest ecosystems in the short, medium, and long term are the Earth system models (ESMs). Nevertheless, simulations demonstrate that ESMs are not able to represent the decline in C sink by tropical forests in recent decades. Experiments that fertilize the atmosphere with carbon dioxide (eCO_2) are essential to reduce uncertainties in future ESM projections about the possible effects of eCO_2 on the carbon cycle. Open top chamber (OTC) allow the exposure of understory vegetation to eCO_2 allowing the control and monitoring of the microenvironment in which they are inserted. Here, we describe the OTC system currently operating in the Amazon Free-Air CO_2 Enrichment research program (AmazonFACE) in a mature forest in Central Amazonia, the analysis period is from 01/01/2020 to 12/31/2020. Each OTC is 2.40 m in diameter by 3.00 m in height, in which the concentration of CO_2 ($[CO_2]$) is monitored minute-by-minute using infrared gas analyzers, allowing the spatial and temporal control of $[CO_2]$. The operation consists of keeping the $[CO_2]$ in the treatment OTCs (*i.e.*, with eCO_2) ≈ 200 μmol. mol^{-1} above the $[CO_2]$ of the control OTCs (*i.e.,* without eCO_2) in the daytime (between 6:00 am - 6:00 pm). The $[CO_2]$ measurements on the treatment and control OTCs show that the desired concentration was successfully delivered, +262.4 ± 25.5 μmol / mol (mean ± SD) of the desired setpoint, *i.e.*, 31 % above setpoint target. The eCO_2 in the treatment OTCs worked 91% of the analyzed operational time, the remaining time was wasted with engineering failures (3%) and problems with the supply of CO_2 (6%). The system was able to maintain the $[CO_2]$ above the setpoint, showing that the system configuration is capable of exposing understory vegetation even in a highly complex environment. The results demonstrate that the *in-situ* OTC system presented can be reproduced in different types of ecosystems, allowing better knowledge about metabolic processes that occur between atmosphere-plant-soil.