Green Leaf Volatile (GLVs) Emissions from the Central Amazon

Angela Jardine[1], Kolby Jardine[2], Ana M. Yañez-Serrano[1], Paulo Artaxo[3], Eliane Gomez Alves[1], Françoise Y. Ishida[1], Antônio Manzi[1], and Leif Abrell[4]

[1]Instituto Nacional da Pesquisas da Amazônia (Manaus, Brazil), [2]Lawrence Berkeley National Laboratory (Berkeley, CA), [3]Universidade São Paulo (São Paul, Brazil), [4]University of Arizona (Tucson, AZ)

Introduction

- During the 2010 dry season, the Amazon Basin suffered a severe drought resulting in extensive tree mortality. **(Fig. 1).**
- While generally considered minor components of forest volatile emissions, Green Leaf Volatiles (GLVs) may be emitted by plants in response to abiotic stress during lipid peroxidation, at high rates which may impact cloud condensation nuclei (CCN) properties. **(Fig. 2)**
- We report the first observations of vertically resolved atmospheric GLV concentrations within and above a primary rainforest during the 2010 drought in the central Amazon. **(Fig. 4)**
- Our results suggest that a large number of GLVs are released into the atmosphere in the Basin in direct response to drought stress and associated environmental conditions (i.e. high light and temperature).

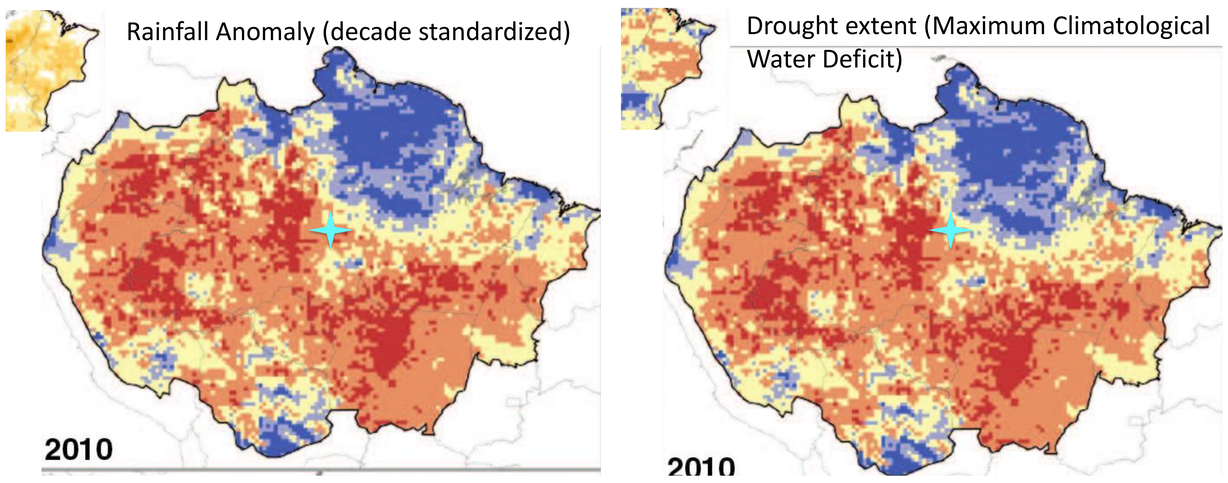

Figure 1. Modified from Lewis, et. al. *The 2010 Amazon Drought,* Science Brevia (2011). Cyan crosses in both panels are approximate site location for this study. **Left:** Decade standardized rainfall anomaly in the Amazon Basin for 2010 (scale is standard deviation units) **Right:** Maximum Climatological Water Deficit as a drought stress index (scale is mm of water deficit).

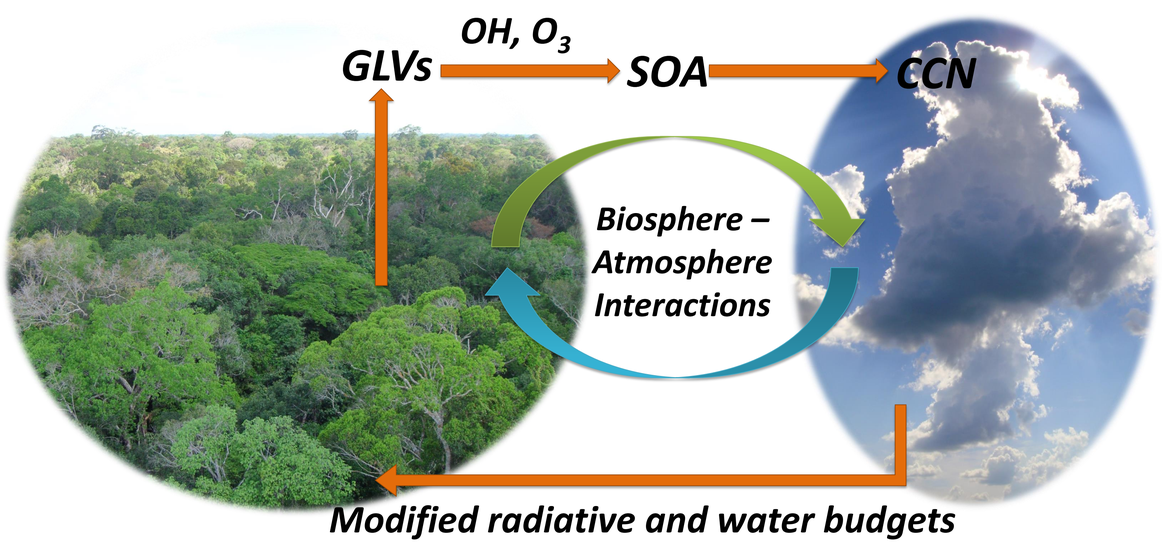

Figure 2. Simplified schematic of the biosphere-atmosphere interactions between GLVs and the hydrologic cycle in the Amazon Basin. GLVs are released to the atmosphere and are oxidized forming secondary organic aerosols (SOA) which may serve as CCN. This interaction, in turn, may have large impacts on regional climate.

Methods

- The BrazilianAir 2010 - 2011 field study ran continuously from September 2010 through January 2011.
- Site location: TT34 tower (2°35.37'S, 60°06.92'W), Reserva Biologica do Cueiras in central Amazonia, 60 km NNW of the city of Manaus, Brazil.
- Six inlets were distributed along the tower at 2, 11, 17, 24, 30, and 40 meter heights and sequentially analyzed (10 min per inlet, one complete canopy profile per hour). **(Figure 3B)**
- Ambient concentrations of GLVs were quantified by a high-sensitivity proton transfer reaction–mass spectrometer (PTR-MS, IONICON, Austria). (**Figure 3A**)
- Cursory identification from tube samples of some GLVs with GC-PTRMS at site. **(Figure 3C)**
- GLVs were monitored with a dwell time of 5 s each. **(Figure 4)**

Results

- **Fig. 4** shows five examples of ambient air concentrations of GLVs monitored during the dry season 2010 Amazon drought.
- Concentrations are plotted with 2m height as background reference.
- GLV concentrations which are highest within canopy suggest net ecosystem emissions. (Figure 4 B,C,E)

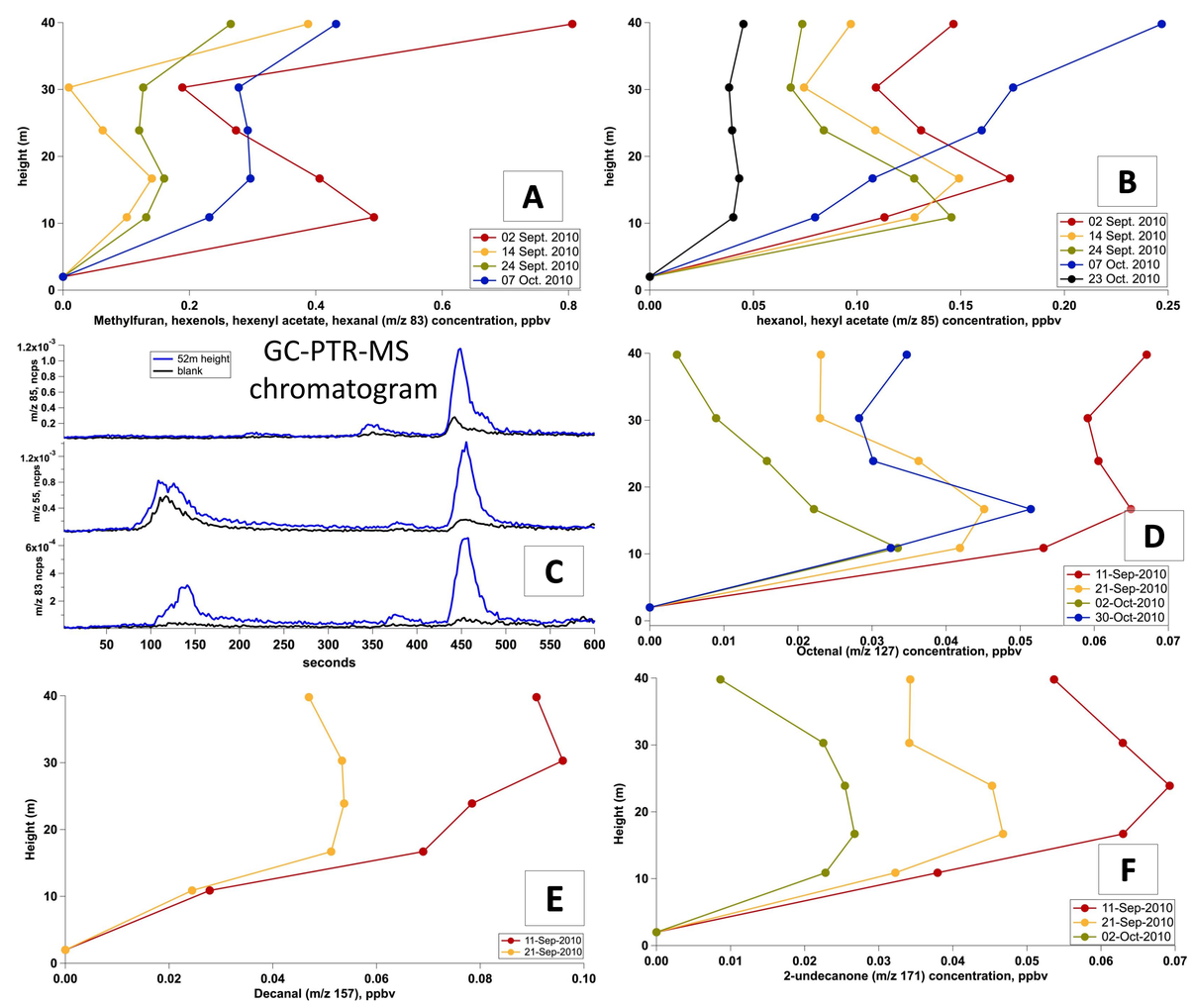

Figure 4. PTR-MS vertically resolved daytime averages of Green Leaf Volatiles ambient concentrations within and above the 30m Amazon canopy during the 2010 dry season. **A:** m/z 83 – methylfuran, hexenols, hexenyl acetate, hexanal **B:** m/z 85 – hexanol, hexyl acetate **C:** GC-PTR-MS identification of m/z 83, 85, and 55 indicating the presence of 3-methylfuran, hexenols, hexenyl acetates, hexanal (m/z 83, 55) as well as hexanol and hexyl acetate (m/z 85). **D:** m/z 127 – octenal **E:** m/z 157 – decanal **F:** m/z 171 – 2-undecanone.

Conclusions

• First ambient GLV concentration measurements in the Amazon suggesting net ecosystem emissions during the widespread 2010 dry season drought.

•Several GLVs have never been observed in ambient air from any ecosystem (e.g. octenal, decanal, undecanone).

•Future research will focus on improved GLV identification (GC-MS), and seasonality of net ecosystem fluxes (REA) with a focus on relationships to environmental conditions under drought (soil moisture, light, temperature).

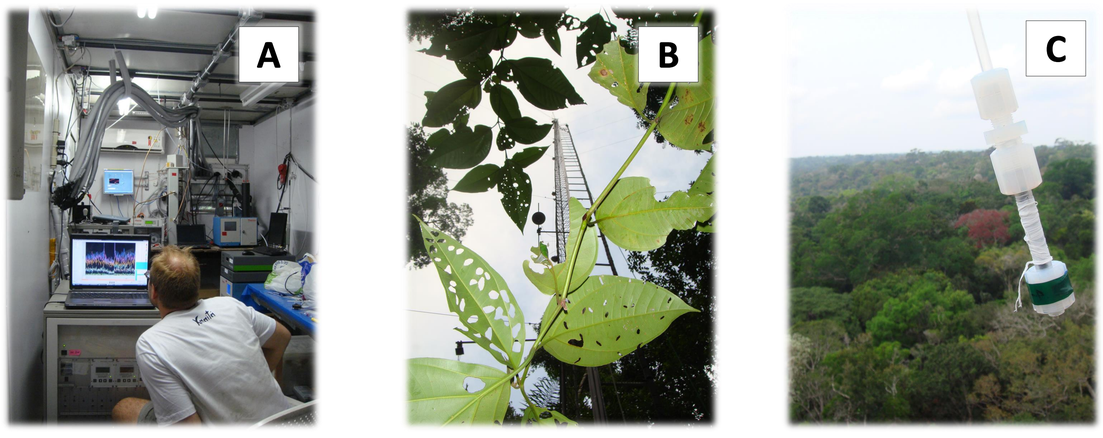

Figure 3. Data collection during the BrazilianAir 2010-2011 field campaign. **A:** Inside the instrument container with inlets connected to PTR-MS. B**:** View of tower through surrounding vegetation. **C:** Collecting a tube sample above the canopy for GC-PTR-MS identification