Quantification of BVOC emission flux from *Swietenia macrophylla* King using a Dynamic Branch Cuvette and PTR-MS

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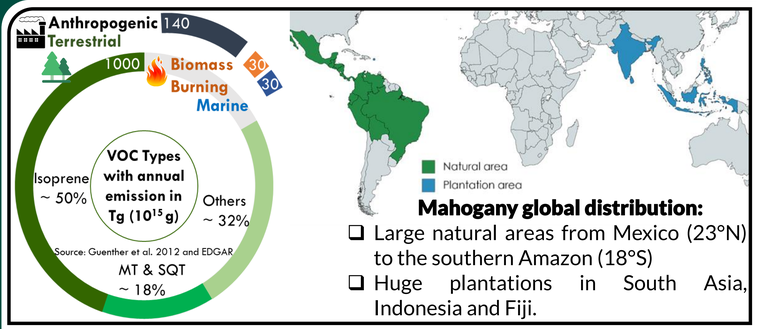

Mahogany global distribution:

- Large natural areas from Mexico (23°N) to the southern Amazon (18°S)
- Huge plantations in South Asia, Indonesia and Fiji.

OBJECTIVES

i) Quantify BVOC emission flux from mahogany

ii) Investigate the seasonal dependence and variation of BVOC emission flux with carbon dioxide (CO_2) assimilation, temperature and photosynthetically active radiation (PAR)

iii) Estimate global BVOC emissions from Mahogany

iv) Enhance the selectivity of the PTR-MS to identify the structural isomers of monoterpenes from Mahogany

Key points: 1. A recent study in the Amazon rainforest has reported high dimethyl sulfide (DMS) and concluded that there is a net ecosystem source for DMS[1]

2. Mahogany has huge natural cover in Amazon forests

METHODS

- BVOC emission was measured using PTR-MS[2]
- BVOC emission flux, EF_{BVOC} was calculated as:

$$EF_{BVOC}\ (\text{nmol m}^{-2}\ \text{s}^{-1}) = \frac{m_{out,BVOC} - m_{in,BVOC}(\text{nmol mol}^{-1})}{V_m(\text{m}^3\ \text{mol}^{-1})} \times \frac{Q\ (\text{m}^3\ \text{s}^{-1})}{A\ (\text{m}^2)}$$

- Ancillary carbon dioxide (CO_2) measurement was done using cavity ring down spectrometer[3]
- CO_2 assimilation rate, A_{net} was calculated as:

$$A_{net}(\text{nmol m}^{-2}\ \text{s}^{-1}) = \frac{[CO_{2,in}] - [CO_{2,out}]\ (\mu\text{mol mol}^{-1})}{V_m\ (\text{m}^3\ \text{mol}^{-1})} \times \frac{Q\ (\text{m}^3\ \text{s}^{-1})}{A\ (\text{m}^2)}$$

- Experiments conducted on a 7 year old Mahogany tree
- **Summer** - 22 May - 24 May 2018
- **Monsoon** - 25 September - 4 October 2018
- **Post-monsoon** - 15 November - 22 November 2018
- **Winter** - 24 January - 29 January 2019
- Additionally, samples were also measured from three different mahogany trees of 5-7 years of age during the winter season - 1 February - 10 February 2019.

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Group website

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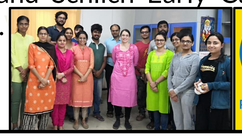

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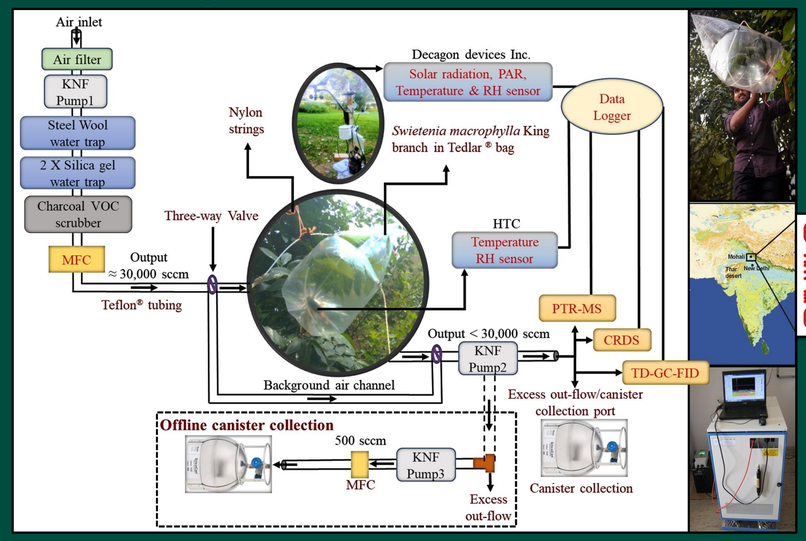
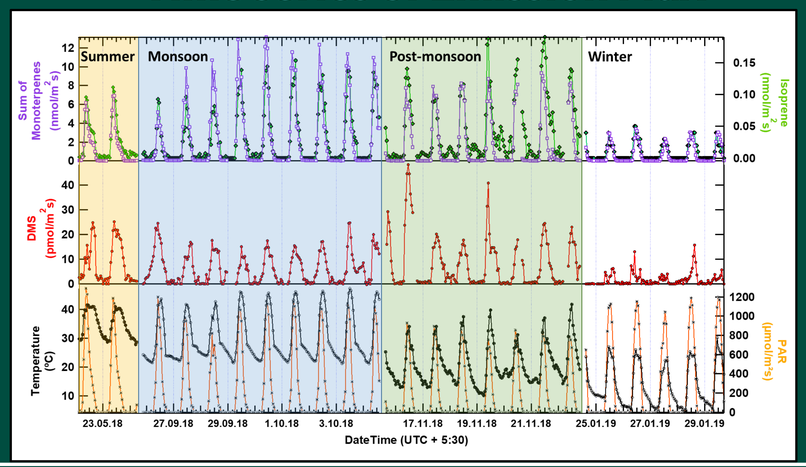
Dynamic branch cuvette

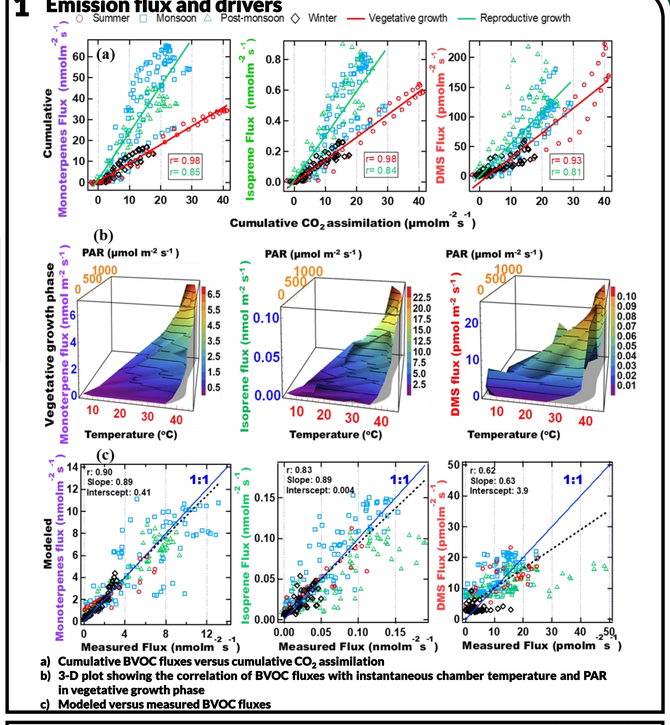


Swietenia macrophylla King (Big-leaf Mahogany) emits monoterpenes and DMS at very high rates

Time series of Emission Flux



1 Emission flux and drivers

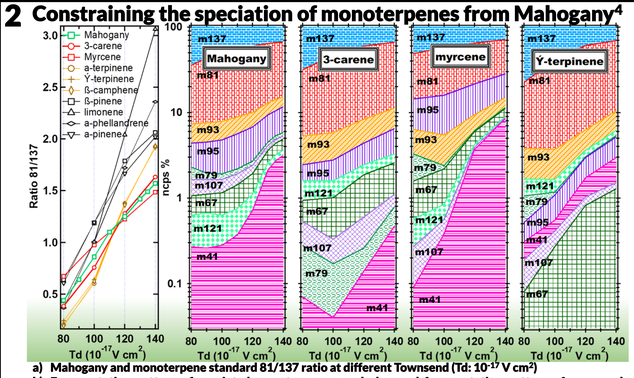


a) Cumulative BVOC fluxes versus cumulative CO_2 assimilation

b) 3-D plot showing the correlation of BVOC fluxes with instantaneous chamber temperature and PAR in vegetative growth phase

c) Modeled versus measured BVOC fluxes

2 Constraining the speciation of monoterpenes from Mahogany[4]



a) Mahogany and monoterpene standard 81/137 ratio at different Townsend (Td: 10^{-17} V cm^2)

b) Fragmentation pattern of speciated monoterpenes and observed fragmentation pattern of measured mahogany monoterpenes at different Td

3 Global BVOC emission estimate from Mahogany

Country	Natural Area[i] (10^4 km^2)	Plantation Area[ii] (km^2)	Density[iii] (100 km^{-2})	Leaf area[iv] (km^2)	Monoterpenes ($\times 10^3$ Mg/yr)	Isoprene (Mg/yr)	DMS (Mg/yr)
Brazil	139.6	-	0.014-1.17[b]	1564-10756	10-69	82-565	17-119
Peru	56.5	-	-	9042	58	475	100
Bolivia	18.9	-	0.1-0.2[c]	1512-3025	9.7-19	79-159	17-33
Nicaragua	5	-	0.6	2400	15	126	27
Mexico	3.6	-	1.0	2881	18	151	32
Ecuador	3.5	-	-	2801	18	147	31
Colombia	2.6	-	-	2080	13	109	23
Guatemala	2.8	-	0.2-2.0	448-4480	2.9-29	24-235	4.9-49
Honduras	1.7	-	2.0	2720	17	143	30
Venezuela	1.2	-	1.0[d]	960	6.1	50	11
Panama	1	-	0.1	80	0.5	4.2	0.88
Belize	1	5.91	1.0-2.5 119-288[e]	825-2061	5.3-13	43-108	9.1-23
Costa Rica	0.3	-	0.5-2.5	120-600	0.77-3.8	6.3-32	1.3-6.6
Indonesia	-	1160	-	3410	22	179	38
Fiji	-	420	-	1235	7.9	65	14
Philippines	-	250	-	735	4.7	39	8
Sri Lanka	-	45	-	132	0.85	6.9	1.5
Guadeloupe	-	40	-	118	0.75	6.2	1.3
Martinique	-	15	-	44	0.28	2.3	0.49
Puerto Rico	-	13.81	66.7-200[e]	33-99	0.21-0.64	1.8-5.2	0.37-1.1
Kerala, India	-	1.7[e]	-	5	0.03	0.26	0.06
Honduras	-	1.5	-	4	0.03	0.23	0.05
St. Lucia	-	1.0	-	3	0.02	0.15	0.03
TOTAL	237.7	1953.92		33154-49674	212-317	1740-2607	366-548

[i]Blundell (2004), [ii]Lugo and Alayón (2003), [iii]Gillies et al. (1999), [iv]Grogan et al. (2008), [v]Gullison, et al. (1996), [vi]Kammesheidt et al. (2001)

Crown radius (m)= 0.139 x diameter (cm) - 2.82(10^{-4}) x [diameter (cm)]^2; r^2 = 0.97 (Gullison et al., 1996)

Leaf Area Index: 2.94 (Jhou, Wang, Wu, Yu, & Chen, 2017)

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