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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Methanol and Isoprene Emissions from the Fast Growing Tropical Pioneer Species *Vismia guianensis* (Aubl.) Pers. (Hypericaceae) in the central Amazon Forest" *by* K. J. Jardine et al.

Anonymous Referee #2

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Jardine and coworkers show exciting research rich in hypotheses, useful observations and stimulating speculations to understand carbon allocation by tropical pioneer plant species as observed through field measurements. The work focuses on methanol and isoprene emission variance as a function of temperature, PAR and leaf age. This is an important issue as the forest regrows trying to compete for limited nutritional and energetic resources when it must necessarily be difficult to predict how the emissions will change due to anthropogenically influenced global change. The general lack of knowledge of VOC emissions from these neotropical species comes mainly from the unavailability of BVOC measurements in the field which is why more of such studies

are needed. However, similarly pioneering measurements were already done a decade ago by Harley et al. (2004) and the isoprene emission factors were consistent within a factor of four which points to the need of further explorations to understand the mechanisms behind plant's VOC emission and uptake.

More than anything, this reviewer appreciates how difficult it is to collect VOC data in the tropical rainforests and even for this reason the paper is strongly recommended for publication, almost as is. Thank you very much. It will certainly be a very useful contribution for the ACP community. While extremely enjoying the coherent story, I came up with just a few relatively very minor comments/suggestions which hopefully can inspire further discussion of this fascinating science direction and maybe some figures could be made even more clear.

General: 1) Why is the focus almost exclusively on methanol and isoprene? These are certainly extremely interesting and often most abundant BVOCs, but these plants must emit numerous other compounds such as stress tracers (e.g. temperature stress), higher terpenes, latex constituents, microbial VOCs, which could facilitate further understanding of issues such as uncoupling from Pn, photorespirations, biotic stress. I would be very surprised if these plants did not take up any of the VOCs to regenerate at least some carbon lost but this is not discussed.

2) Ideas that isoprene protects against temperature stress and that methanol is a growth-related BVOC are not very new hypotheses although perhaps still not perfectly supported. It seems to me that isoprene at least in part can just be a byproduct in the metabolism towards production of more specific compounds such as carotenoids, stress or microbially-induced monoterpenes such as b-ocimene. During stress, the requirement for production of larger stress molecules such as higher terpene antioxidants may be much larger potentially leading to higher emission of volatile byproducts. Thus, my question is if we can assume that a single compound such as isoprene or methanol plays a single, and non-complex role?

3) Further to previous comment, is there a reason why only a single role for methanol is seen? Methanol has numerous sources within plants, both emissions and deposition have been observed in ecosystem studies (e.g. Wohlfahrt et al., 2015). While it is well-known that methanol emissions are higher during plants' growth, other sources/sinks may be less known such as that it can be microbial substrate or a product of foliar microbiota.

4) Until very recently, the presence of microbes on leaf surfaces has been almost completely ignored in BVOC literature. This is shocking to me because there are $\sim$10,000,000 microbes in 1 cm2 of phyllosphere (Lindow and Brandl, 2001) and they are not just hanging out there. In the tropics I would expect even higher densitities of foliar microbes and they are known to be amazingly efficient chemical biolaboratories which require energy for multiplication. I think it could be relevant for this story (and other enclosure studies) at least giving a thought about the fact that epiphytic microbes interact with plants and recent studies clearly suggest that these microbes can significantly impact plant's metabolism (Peñuelas et al., 2014, Kanchiswamy, 2015). Example questions that remain to be answered are how microbial diversities change on the leaves during the rapid growth of pioneer species and if there is a shift in pectin decomposers which could explain methanol differences or if the microbes chew up on red latex to release additional source of isoprene to gain energy for division?

Specific

5) L. 106 ". . .possible connections between volatile isoprenoid emissions and increased photorespiration during high leaf temperatures". In your photorespiration hypothesis, do you account for microbial respiration?

6) Figure 2a.

- The slope of isoprene increase following PAR changes seems a little different at low PAR than at high PAR. This is a little surprising because isoprene is not sticky so I would expect almost instantaneous Is response. Can you exclude possibility of sticky

isoprene moiety from latex-conversion products at low PAR? At high PAR it becomes more clear that isoprene dominates the signal as the equilibration is much faster. Is it because it takes more time for the metabolic machinery to reach a steady state at low PAR than it is the case for high PAR?

- The figure suggests that isoprene emission in the dark is well above zero which is incredibly interesting so I wonder if it can explain the microbial and/or latex decomposition hypotheses.

7) Figure 4.

- Again, isoprene creeps up slowly (never reaching a steady state?) while much stickier methanol responds much faster. For quantification, did you trim out the unequilibrated portion or did you leave it in? How significant difference would this make? For the future studies I think it would make sense to suggest longer than 10 min sampling times to allow for full equilibration. It might be an instructive exercise to extract the fresh red latex from these plants and sniff with the PTRMS when heated to different temperatures. I might be wrong, but I would not be surprised if you saw some signal consistent with isoprene from these interesting poly-isoprene biopolymers.

- Further, if a and b denote different plants (the caption was not very clear to me) is it not surprising that isoprene emission at standard conditions is a factor of $\sim$2 higher in "young mature" leaf in b) than that in a)? It almost seems as if the "young mature" leaf was swapped with "mature" leaf in b) or is it the circadian rhythm of basal emission rates (e.g. Hewitt et al., 2011)? I also wonder why the "young mature" leaf in b emitted more isoprene at negative Pn? If Pn measurement worked well, and given the observed equilliration time, does this complete uncoupling suggest more like the isoprene moiety or conversion product from a different compound (possibly constituent of red latex)?

- Finally why does methanol show somewhat a logarithmic decay across all the samples in a) but less so in b)?

- Would you mind making the scale for methanol consistent in both panels?

8) Again, this study is extremely well done opening more doors to further hypotheses. In the conclusions, it would be nice to see suggestions for future work and further hypotheses that should be tested.

Technical: 9) L. 89 “These hypotheses predicts” should be “These hypotheses predict”.

10) L. 433 should be “consistent with”

11) L. 598 Harley 2007, bgd. Did you mean to cite the discussion paper instead of the published version?

12) Figure 2, why is the PAR line ∼15:20 inclined? If this is due to a gap in the sensor data it would be better to show the gap as NaN instead of interpolation.

13) Figure 5. This is a beautiful graph showing the essence of the story! For consistency, consider changing “meOH” to “MeOH”.

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