Atmospheric Measurement Techniques Discussions

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Comment on amt-2021-265

Anonymous Referee #2

Referee comment on "Design and characterization of a semi-open dynamic chamber for measuring biogenic volatile organic compound (BVOC) emissions from plants" by Jianqiang Zeng et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-265-RC2, 2021

This study examines the transfer efficiency of different BVOC in a self-made cylindrical semi-open dynamic chamber designed to conduct BVOC measurements from a branch enclosure. The results show how the higher airflow through the cuvette system reduces the equilibration time, adsorptive loss of volatiles, as well as the differences between the ambient and enclosure temperature and relative humidity. Furthermore, the authors found that the transfer efficiency was low for some BVOC (i.e. α-pinene and β-caryophyllene) even at the condition with low residence time. The authors conclude that performing the BVOC measurements on a well-characterized cuvette system is paramount to determine correct emission factors.

Overall, I appreciate the technical characterization of the cuvette system, and I fully agree that it is important to test a new cuvette system before starting BVOC measurements. However, it is known that heavier volatile such as the C10-C15 analyzed in this study, a significant loss of volatiles occur due to adsorbance to surfaces and tube system (e.g., Bourtsoukidis et al. 2012, Niinemets et al. 2011). A way to consider that loss is to perform the calibration by passing a certified BVOC standard mixture throughout the whole system (e.g. Ghirardo et al. 2011, 2020). Because the instrument's sensitivities are based on measurements performed at steady-state conditions and are calculated using the inlet air standard concentrations, the potential loss of volatiles (due to any chamber effects, including adsorption, gas-phase reactions etc.) won't affect the correct determination of the emission factors. Since BVOC standards are available (and some companies offer a broad customized mixture) and in any case are required for the calibration of PTRMS or GCMS instruments, it remains unclear why the chamber-based BVOC measurement technique could not be based on such a commonly used calibration procedure. Therefore, I do not see how this paper makes a substantial contribution to the field.

Other limitations:

Ozone: the system does not use ozone-free conditions, meaning that some of the VOC will disappear by reacting with O3. Given that the lifetime of b-caryophyllene (one major sesquiterpene) in the presence of 40 ppb of O3 is of ~1.5min-1 (Rinne et al. 2007) and that the measurements were performed using conditions that lead to a residence time of 0.9-4.5 min., I would expect that a significant part of the SQT will be lost mainly by O3 reaction (but also with OH and NO3). Notably, because the OH, NO3, and O3 concentrations cannot be controlled and their concentrations are fluctuating through the day/weeks, and ozone levels might reach 100ppb in your study (L200), how can the authors measure reliable emission factor of SQT under variable pollutant conditions with the proposed cuvette/chamber method?

Temperature sensors: Are leaf temperatures being recorded to link ambient to leaf temperatures beside the inside and outside air temperatures of the cuvette?

The methods describing the enclosure experiments using standards in the laboratory are not given.

How does humidity affect the sensitivities of the VOC? Here it would be helpful to separate chamber effects to instrumentation challenge (humidity can strongly affect the sensitivity of the PTRMS of some VOCs). Also, it is important to separate VOC according to their octanol/water coefficient and polarity, as there are clear humidity effects for e.g, oxygenated monoterpenes compared to isoprene.

The first paragraph of the results section does not report any results but rather some method and discussion. Therefore, this should be fixed.

L187: I do not think so. See my comment above.

Minor comments:

L24: why "absorption" and not "adsorption"?

L205: which compounds have been used for testing? Did you include sesquiterpenes?

L208: Fig. S2 contains the schema of the experiment. It would be helpful to see the data.

L253: "concentrations" are not "emitted by plants".

L321-326: that depends on the calibration procedure…

References:

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