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Comment on acp-2021-445

Anonymous Referee #1

Referee comment on "Seasonal and diurnal variations in biogenic volatile organic compounds in highland and lowland ecosystems in southern Kenya" by Yang Liu et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-445-RC1, 2021

This manuscript by Yang Liu and coauthors investigates the seasonal and diurnal variations of biogenic volatile organic compounds (BVOCs) ambient concentrations in southern Kenya. The authors focused on two contrasting ecosystems (highlands with agroforestry and lowlands with bushland and agriculture mosaic landscapes) during both the rainy and dry seasons. They report higher BVOC ambient concentrations in highlands vs. lowlands and during the rainy vs. dry season. The manuscript is very well written and will be suitable for publication after the authors address the following issues. I think that they do not go far enough in the discussion and do not really discuss nor explain the above-mentioned key results. In addition, key information is missing in the Methods section. Please find below detailed comments and suggestions that might help strengthen the manuscript.

General comments

Section 2.2: More detailed information is needed here regarding both the sampling and analytical methods.

- How were the samples stored and for how long (temperature and light conditions)?
- Did the authors check for potential losses of analytes during transport, storage, and chemical analysis? See for example Ortega and Helmig, 2008; Ortega et al., 2008; Angot et al., 2020.
- What was the temperature of the cartridges during sampling? A temperature > ambient temperature is generally used to prevent water accumulation on the adsorbent bed (Karbiwnyk et al., 2002).
- Please indicate the analytical uncertainty and detection limit for the compounds of interest.

Section 2.5: More detailed information is also needed here to make this inverse modelling approach convincing.

- Please give the equations (rather than citing Guenther et al., 2012).
- Describe how the activity factors were calculated. According to the Guenther et al. equations, one should use the average temperature and PFPD over the last 24 and 240 hours. Is that what you did? How about the use of leaf temperature, did you use ambient temperature instead? How do these values compare in the studied environment?
- I would like to see a discussion on model performances with figures/tables (this can be in the supplement). How do predicted and observed mixing ratios compare? This is absolutely essential; I won't trust the inverse modelling results without this additional section.

Lines 231-246 and Figure 4: in the text, the key message is the difference between the dry and rainy seasons. However, the way results are presented makes it easier to compare the two ecosystems rather than the two seasons. I would suggest reorganizing the structure of several sentences to show the difference between dry and rainy instead of highlands and lowlands (if that's what's intended). Example below:

"(…) the daily mean mixing ratio was higher during the rainy season than during the dry season. The daily mean isoprene mixing ratios ranged from 134 to 442 pptv in the highlands and from 22 to 69 pptv in the lowlands in the rainy season. (…) During the dry season, the isoprene mixing ratio ranged from 36 to 150 pptv in the highlands and from 6 to 15 pptv in the lowlands".

Could be transformed into:

"(…) the daily mean mixing ratio was higher during the rainy season than during the dry season. In the highlands, the daily mean isoprene mixing ratios ranged from 134 to 442 pptv in the rainy season vs. 36 to 150 pptv in the dry season. In the lowlands, the daily mean isoprene mixing ratios ranged from 22 to 69 pptv in the rainy season vs. 6 to 15 pptv in the lowlands".

Same comment for lines 239-246.

Same comment for Figure 4: this figure shows the difference between highland and lowland while the discussion focuses on the difference between rainy and dry seasons. The scale is different on the two panels making it really difficult to compare the results. I do not really like this figure (see same comment below on Fig. 3), really hard to read. How about a boxplot instead if you do not really care about showing the temporal variability (that is not discussed anyway)? Something like that:

Panel a) isoprene, b) MTs, c) SQTs.

For each panel: y-axis is mixing ratio, x-axis shows boxplot for (1) rainy highland, (2) dry highland, (3) rainy lowland, (4) dry lowland.

Lines 250-253: I do not think that Fig. 5 clearly describes what is discussed here. I would like to see an additional figure describing the diurnal cycle (something like Fig. 8 in Angot et al., 2020). In addition, is this diurnal cycle in line with that of environmental conditions (e.g., ambient temperature, light)?

Lines 263-266: Hard to see this on Fig. 5. I would convert panels c to f from mixing ratios to % contribution (similar to panels a and b). I would add the diurnal cycle of the various species on the additional figure discussed above. For this additional "diurnal cycle" figure, I suggest the following:

One panel per species: a) isoprene, b) MTs, c) SQTs, d) limonene, e) alpha pinene. Then 4 different colors per panel showing (1) rainy highland, (2) dry highland, (3) rainy lowland, (4) dry lowland.

In addition, I think the manuscript does not really discuss/explain why:

- Ambient concentrations are higher during the rainy season. Is it due to different humidity or ambient temperature?
- Ambient concentrations are higher in the highlands. Is it due to different tree species or different humidity/temperature?

These hypotheses can (and should) be tested using the model.

Emission factors:

- According to Fig. 7, isoprene emissions are not seasonally dependent. In that case, what's driving higher concentrations during the rainy vs. dry season?

- Since limonene is the only species showing a seasonal behavior, why don't you explore dependency on parameters such as light, temperature, soil moisture? (This is only done for isoprene and soil moisture).

- For isoprene, the authors investigated the influence of soil moisture. How about dependency on other factors such as light and temperature? This could help explain why concentrations are higher during the rainy vs. dry season.

Additional line-by-line comments

Line 84: Could you please add 1-2 sentence(s) in the introduction on why MBO is of particular interest?

Line 91: replace "considerable" by "significant".

Line 92: Typo “We interested in the diurnal…”.

Section 2.1: One field campaign was performed in April, i.e., during the long rains, and another one in September, i.e., during the cool and dry season. The authors should perhaps mention the fact that no measurements were performed during the hot and dry season (Jan-Feb). There might be significant differences in BVOC ambient concentrations during the two dry seasons because of the difference in ambient temperature.

Figure 3: This figure is really hard to read and thus not really useful as is. At minimum, please use the same y-axis during the rainy and dry seasons for easier comparison or provide a Table with mean values over the 4 campaigns. Another approach could be the use of boxplots (see comment on Fig. 4).

Line 180: “O3 column densities to estimate surface (?) O3 concentrations”.

Lines 261-262: “MTs thus dominated the total BVOC mixing ratio during nighttime”. Is this due to higher MTs at night or to a sharp isoprene diurnal cycle with low concentrations at night?

Lines 281-291: okay but why?

Table 1: For each species and study, please add mean or median value in parenthesis.

Line 393: why not in the highlands as well?

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