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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Measurements of biogenic volatile organic compounds at a grazed savannah-grassland-agriculture landscape in South Africa" *by* Kerneels Jaars et al.

**Anonymous Referee #1**

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Jaars et al. report interesting measurements and analysis of biogenic VOC concentrations from an African grassland savannah ecosystem. The data from these regions are extremely limited and difficult to collect but are desired by the scientific community to understand the biological processes as well as the atmospheric abundance and fate of these molecules in these unexplored ecosystems. The paper should be an important reference and could inspire more research in those regions. Overall, I enjoyed reading the paper, thank you very much for this nice contribution, and I think the collected dataset is in itself extremely interesting so it deserves acceptation in ACP. However, I still feel the story has a significant potential for a little more in-depth analysis. In the relatively minor comments/questions below I just want to inspire some additional thoughts



and suggestions for further manuscript enhancement.

1) The paper is focused on the biogenic VOCs while the same authors described anthropogenic VOCs at Welgegund in a separate paper (Jaars et al. 2014) which maybe could be specified as a companion paper. I wonder if it could be interesting for the atmospheric chemistry context to try and look more closely at anthropogenic vs biogenic VOC interactions. For example, have you tried categorizing the data into pollution and clean periods based on high aromatics/NOx/SO2/O3 episodes to see for example if there is a difference in stress related monoterpenes or how different would be ozone and particle formation in these contrasting scenarios?

2) The paper suggests the concentrations of the biogenics were actually quite low compared to other woody biomass regions. Indeed, it could be very interesting to contrast this type of ecosystem to forests or tree plantations in Africa and elsewhere. One general issue is that the concentrations cannot tell us everything because despite the low concentration of a molecule there could still be a substantial flux and I was wondering if the authors have tried scaling these concentrations to turbulent parameters? In addition, isoprene concentration are known to exhibit strong diurnal variation as a function of time of day so there is implication of the sampling time (always the same time of day) at least for isoprene which warrants more dicussion. What percentage of isoprene concentration maximum was captured by these measurements could be easily inferred from a MEGAN algorithm for isoprene if the data for PAR and temperature are available.

3) The results of soil moisture relationship to monoterpene concentrations is very interesting. It would be instructive to see if the response was more like the threshold or did it exhibit a gradual dependence? It might be useful for potential modeling to see the actual scatter plots of soil moisture vs monoterpene concentration.

4) I was particularly intrigued by substantial concentrations of estragole (p-allylanisole). Unfortunately, this incredibly interesting aromatic compound is only listed in the tables

but I think it could be really nice to discuss this compound, in particular its likely origin (basil, anise, fennel, pines, palms?) and maybe even its behavior as a function of time/season. For example, I am wondering where it might be coming from and what its function is in this ecosystem. Could it be a pollinator attractant emitted by flowers (Misztal et al., 2010) or an insect deterrent emitted by conifers (Bouvier-Brown et al., 2009)? An additional minor suggestion would be to place p-allylanisole and p-cymene in a different category because these compounds are not strictly monoterpenes. You could consider something like "biogenic benzenoid" or "monoterpene-related BVOCs". AMCH is not strictly a monoterpene either but can be considered an oxygenated terpene.

5) Have you observed any monoterpenes (or other BVOCs) related to stress? For example $\beta$-ocimene, methyl salicylate, green leaf volatiles?

6) Could some emissions at the Welgegund site have floral origin which could further explain why isoprene is relatively low whereas monoterpenes (and potentially other compounds such as p-allylanisole) are relatively abundant? Is the flowering happening an entire year round or seasonally? It would be very interesting because floral BVOCs from meadow-like flowering ecosystems can sometimes be abundant but receive relatively little attention compared to foliar emissions.

7) Table 4 contains interesting correlations, in particular, that MBO correlates with monoterpenes. Are these compounds coming from a conifer-like sources? On the other hand, I wonder if the result of isoprene correlating with MBO is more unexpected and it is also not discussed. Baker et al. 2001 found that if MBO is thermally treated (as is the case in GC) it can dehydrate and be detected as isoprene. Do you think this could be the case? While this is not meant to be a criticism, and given the different wind-roses and dependence on soil moisture/temperature perhaps the issue was probably minor but I still think it is worth giving this potential issue a general thought and discuss implications for isoprene/MBO data interpretation.



8) Figure 4. This is an interesting figure. It seems that it is adopted from a different manuscript but clearly shows beautiful CO2 assimilation during the day and respired carbon during the night. If the data were available, it might be worth coloring these markers by PAR to better visualize assimilation vs respiration vs potentially anthropogenic CO2(?).

9) It is mentioned several times (abstract, P22 L15 and in other places) that isoprene concentrations were higher from the western direction. "western direction" is not very informative for a reader in particular in the abstract. Careful reading points to the sentence in P5 L11 that "...western sector contains no major point sources and can therefore be considered to be representative of a relatively clean regional background". Maybe you meant to say that this direction does not contain any *anthropogenic* point sources of isoprene? Otherwise I wonder where this isoprene is coming from? If isoprene concentrations exhibit temperature dependence, it implies biogenic source but if there is no vegetation to the west, could there be a different source (e.g. heated rubber?). My suggestion would be simply to expand more clearly on the potential sources of the western isoprene.

10) I understand the median is often used to represent more episode-free concentration scenario. However, isoprene is only emitted during the day, so does it still make sense to show the monthly median for isoprene? Because you were collecting data both during the day and at night, I think it could be very interesting to separate day and night concentrations. In particular because monoterpenes unlike isoprene can often accumulate during the night in a shallow boundary layer so the overall median (or mean) concentration differences between the compounds (e.g. isoprene and monoterpenes) may not reflect strictly their emission strengths or true variability. I wonder if looking at some of the episodic events of high concentrations would not be an even more interesting opportunity to understand the chemistry scenarios.

11) Further to the point above, you are talking about ozone formation potentials from these BVOCs but maybe it would be worthwile to show some oxidant data. I am just

curious how ozone (and also NOx, SO2, etc.) concentrations varied during the daytime and nighttime VOC sampling times and if it could teach us anything about the chemistry at the site.

12) It is recommended that the conclusions are made more succinct and emphasize major take-home messages which should be even more impressive than just the summary of the paper. For example, one could consider concluding about the implications for atmospheric chemistry and air quality in the region. In particular, the last two sentences of conclusions are unclear but the synopsis of future measurements is definitely needed to attract more attention and support more measurements in these almost completely unexplored regions of Africa.

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