

Overall comments:

The study by Harb et al. investigates the formation of secondary organic aerosol (SOA) from oxidation of α - and β -phellandrene by nitrate radicals (NO_3). This oxidation pathway denotes an important oxidation and SOA formation pathway during nighttime. The experiments are carried out in the laboratory and a suite of instruments is deployed to characterize both particle and gas phase during their experiments. The authors find relatively high SOA yields for both precursors studied and considerable fraction of condensed phase organic nitrates. Reaction mechanisms are proposed and cross reactions of RO_2 radicals (RO_2+RO_2) are found to be a dominant for the conditions of their laboratory experiments. Overall, I find this study to be an important contribution to the literature of SOA formation by NO_3 oxidation, which compared to oxidation of VOCs by OH or O_3 is understudied.

The manuscript is very well written and structured, allowing the reader to follow the analysis of the experimental results and the interpretation thereof. I therefore recommend publication of this manuscript, after the authors have addressed the few specific comments that I list below.

Specific comments:

L100-104: More quantitative information should be added to the emission strength of α - and β -phellandrene. Knowing the area covered by the stated Eucalyptus species is good to know, but I am curious how much vapors get emitted into the atmosphere of a given VOC type. How does this compare to other major SOA precursors such as α -pinene? What is the global atmospheric relevance of the systems studied? Please extend the discussion in the manuscript.

L117: It is not obvious to me how the low level of electrostatic charges on the chamber wall leads to longer aerosol lifetime in the chamber? I assume this is due to reduced diffusional loss? Please extend the discussion and provide appropriate references.

L215-219: In Section 2.3, I would appreciate it if the authors could be a bit more quantitative. E.g., What was the air flow rate over the crystals? Over which range was the temperature varied/adjusted? This information could easily be added to the text.

L225: "organic nitrate yield" use the introduced acronym, i.e.: "ON yield"

Table 1:

- Please add information about what the stated values and the range indicated by " \pm " means to the Table caption. How is this uncertainty calculated?
- Please decide if you want to report your SOA yields as percent values (see my comment below to Fig. 2).

L299-301: "... allowing a good fit using only one class of products." How can I see this from your Fig. 2? Is it possible to add a fit line (e.g., as dashed line) to your Fig. 2 where you only use the term for the first class of products of eq. (4)? To visualize this effect.

L304: Replace "Odum parameterization" with "eq. (4)"

Fig. 2:

- SOA yield is not given in units of %, as suggested by the y-axis. In general, I find it hard that you switch back and forth between yields given in percent vs. fractional values between Table 1, the Figures and the text. I would encourage you to choose e.g. %-values and consistently use these throughout.
- Left-side panel: The x-axis is cut, the upper limit should be "450", not "45".
- Change caption to read on L310: "... colors and Odum parameterization corresponds to the black solid curves (eq. 4)."
- Please use panel labels (a), (b), ... for this figure as you do in Fig. 1, for consistency. This also applies to other figures, e.g., Fig. 3 and Fig. 8.

L342-342: "... the total ON concentration in the aerosol phase even though it is associated with large uncertainty due to assumptions made for the data treatment." What are the assumptions and how large

are these uncertainties? These uncertainties are not reflected in the values listed in Table 1 (at least the uncertainties listed there seem small to me), please clarify.

L347-348: Please add uncertainties as e.g. “range from $8 \pm xx$ to $18 \pm xx$ %” and consider reporting yields in units of % also in Table 1. Also, according to your Table 1 (column Y_ONp,ACSM) it appears that the smallest ON mass yield was 10% (06/02/2021), and not 8%.

L350: add “can reach up to approximately 50%.” (the largest yield value in Table 1 is 0.47)

L356: “plot reveals a non-zero slope at the origin”. It is unclear to me what you mean here?

L361: “to be less than 10%”. On L197 you claim less than 5%, please choose appropriately.

L450: Looking at your Fig. S2 it appears that some of the traces slope downwards. On L194 you state that your data is wall loss corrected, so I would have expected the traces in Fig. S2 to stay constant at a certain value, after the initial increase. Why is this not the case?

L464: I cannot find any “Table 3”.

L470: Please put comma in front of “which” (almost always)

L477: note correct formatting of parenthesis: “(e.g. Shen et al., 2021)”.

L494: Delete “recent”

L508: “Remarkably, following the drop of the dimer signals to zero, the number of particles formed, and their total mass reached their peak values.” (and your statement on L518-519) Can you visualize this by adding traces for the particle mass concentration of e.g., your SMPS data to Fig. S2?

L527: Replace “which” by “that” (also on L546)

L529: Would it be more appropriate to say “...also contribute to SOA formation and growth.”? Otherwise, how do you disentangle formation and growth from your experimental data?

L573: “... constitutes of the SOA, ...” I feel it would be more appropriate to say “particle phase” here instead of SOA, at least this is how I understand your statement. Might be good to clarify your statement here.