Comment on acp-2021-136

Anonymous Referee #1

Referee comment on "Measurement report: Vertical distribution of biogenic and anthropogenic secondary organic aerosols in the urban boundary layer over Beijing during late summer" by Hong Ren et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-136-RC1, 2021

Review of "Measurement report: Vertical distribution of biogenic and anthropogenic secondary organic aerosols in the urban boundary layer over Beijing during late summer" by Ren et al.

The manuscript describes observational results of SOA tracers from a tall tower located in Beijing at the end of summer 2015 for about 5 weeks, which encompassed a period of tighter emission control in the end of august. Daily PM2.5 sampling was conducted at three different heights, allowing in turn to study the vertical profiles of biogenic and anthropogenic tracers. This is a quite interesting dataset, particularly showing how different heights ranging from 8m up to 260m at an urban site can lead to quite distinctive conclusions regarding the contribution of SOA precursors. I do identify though some major issues that need to be addressed prior acceptance.

General comments:

#1 – Interpreting changes in SOA (or their tracers), is highly complex because it depends on meteorology (particularly for BSOA), air mass transport, pre-existing aerosol population and so on. The manuscript generally assumes that if concentration at 260m is higher than at 8m, then it's regional, otherwise local, but this is oversimplified (a local VOC source could also produce maximum SOA at 260m high, depending on vertical mixing, oxidation time, etc.). Here are some suggestions to help data interpretation: i) Provide a significantly thorough site description. As most of those tracers can be formed within hours (or less), there is a high potential of a source being local. For example, what is the vegetation cover and its type surrounding the site? ii) prior performing back-trajectories, analyze polar plots of tracer concentration vs wind speed/direction to help identify local vs regional formation; iii) add information of meteorology (particularly including solar radiation) on interpreting SOA tracers temporal variability, which is particularly important on assessing the effects of strict emission controls, but also the pollution events. iv) add any possible ancillary measurements (CO, NOx, O3, VOCs) that

could help better interpret the observations. For example, if CO and DHOPA is higher at 260m than 8m, than its regional contribution is obvious. Eventually EC could also be used as normalizing parameter; v) add information on PM2.5 levels, and if possible its composition, especially during pollution or parade period to link SOA tracers with PM composition.

#2 - I suggest to change the order section 3 is presented. As it stands it starts highly descriptive and offers only generic interpretations (as P6L7-L12, for example) to explain the dataset. Then, some possible impacts of BVOCs (3.1.2) is given, and then finally the actual tracers are used to interpret the data, considering its oxidation steps and different branching, which is the main advantage of such methods compare to bulk analysis such as WSOC or AMS-like source-apportionment. I suggest beginning this section with a discussion on VOC sources, then, as the tracer profiles are presented, interpret them using first and later stage oxidation products, as well as different branchings.

#3 - I invite the authors to give it a careful and complete read to insure high quality text. I found several typos and reported on technical comments, but it's likely that I missed some.

#4 – Lastly, I find that the number of references can be significantly reduced, by at least a factor 3. Reducing the number of references will improve the readability with a clearer information tracing. For broad claims such as P.2L.2, all those 8 references could be replaced by to the latest IPCC report, for example.

Minor comments:

Could you please use colors instead of circle, stars and triangles for the three heights into all plots? It would significantly improve readability.

P3L19-22: As curiosity, is there simulation results that could complement the results presented here?

P4L24: I'm not an expert on this type of analysis, but I understand that recovery rate is an important part of the quantification process. Why recoveries were not used for correction here?

P4L29-P5L5: several minor issues and confusing sentences, please rewrite them in a clearer manner.

P5L7: please define which additional information.

P5L9: How close where the buildings surrounding the sampling site?

P5L12-14: It's difficult to see from the plot, but it seems that at times (e.g. end of E1) there are at most 1-2 degrees difference between lowest and highest level, but >10% RH difference between 120m and 260m. The same is not observed during E3, for example. Why is that? It could be interesting to add solar radiation on this plot, for example.

P5L15: Please rewrite.

P5L15: How were defined the pollution episodes?

P5L20: as it stands, it's difficult to compare OC and WSOC between heights and with variability (std, I assume?), perhaps target only a few values, for the rest it's listed on Table 1.

Fig. S1-S2: Have you performed a polar plot analysis of SOA concentration considering wind direction and intensity? This would help identify the role of local vs regional sources before assuming all is long-range transport and could be explained by back-trajectories.

Fig. S4: What are the values showed to the right on the vertical profile? Average and std?

Table S1: Is it for the whole period or just during the period impacted by restrictions linked to the parade. Please correct the caption if that's not the case.

Table S2: This table is not very clear, with the a's, b's and b^b's. If the objective is identify statistically meaningful difference those can be indicated in bold, for example. Also, please rewrite the caption (perhaps "difference" was meant?).

P6L7-11: Globally I agree with the three points indicated by the authors, but I do not

classify them equally to explain the differences on tracer levels among the three heights. I believe that it's a local vs regional impact (argument #2) that explains such variability. This is a strong result presented by the paper, raising a caveat on observations conducted at 8m (which is already quite high for typical urban sites, ranging usually to 3 or 4 meters) as representative of regional chemistry to be compared with meso-scale 3d models, for example.

Figure2: As suggestion, the caption could be "SOA tracers of (a) isoprene, (b) monoterpenes and (c) sesquiterpenes. Measurement heights are 8m (triangles), 120m (circles) and 260m (star) in PM2.5. Relative mass fractions are shown in (d)." I remind also the authors that monoterpenes and sesquiterpenes make a group of several species (unlike isoprene, which is a single compound), so they should be referred in plural. I suggest modifying other captions as well to reduce repetitions and make easier to understand.

Figure3: Figure difficult to read.

P7L2-3: Be careful not to mix tracer concentration with SOA concentration (as later discussed in section 3.3).

Figure 7: perhaps would be more interesting to compare sum of SOC to WSOC (as a proxy for total SOC), it would probably correspond to about 50% of total SOC.

Section 3.1.3: It could be interesting to calculate enrichment factors during the pollution events (perhaps normalized by deltaEC, or deltaCO, if available, from non-pollution periods).

P10L10-L15: Be mindful that correlation and causality are not the same thing. The fact that there is correlation between isoprene tracers and DHOPA, or that traffic can emit some VOC is not itself an indicative of biogenic-anthropogenic interaction.

P10L25: Difficult to read when so many values are listed with their standard deviation.

Section 3.3: Could you add a discussion on the SOC mass ranges using the defined uncertainties for the ratios? Is there perhaps more up-to-date values to be used?

P11L12-L14: To improve readability, could you compare Parade with average before and after?

Technical comments:

Please check section numbering, 3.1.2 is repeated, and the reason to change from 3.1.3 to 3.2 is unclear to me.

Fig. 1: Unclear what the authors meant by "Obvious meteorological conditions were found during the sampling period."

P2L1: I think the authors mean "can impact radiative forcing".

P2L6: remove "a" between "photooxidation" and "of".

P2L15: This sentence could be review – changing CCN size also affects the radiative forcing. I suggest "…influencing the climate negatively impacting human health" given that those aspects were already described earlier.

P2L22: "…events in China highlights the urgent..." & "…processes of SOA formation in the atmosphere"

P2L26: "…urban boundary layer are lacking, …"

P2L30-34: Unclear the objective of this sentence, please rewrite to make it clearer.

P3L3: "severe" instead of "serve".

P3L3-6: Please rewrite this sentence. It feels like it's repeating several times the same phrase "understand SOA formation mechanisms to improve air quality".

P3L8: "emission control" & "improve" instead of "guarantee the".

P3L9: remove "the chemical behaviours and regional transport of"

P3L16-17: this sentence is unclear

P3L17: "To THE best of our knowledge".

P3L19: "megacity in China" or "chinese megacity".

P3L24: I missed here a more detailed description of the site location itself, such as lat/long for example.

P4L2: Do not skip line here.

P4L3: Change Tem for T, also in the figure.

P4L24: "blank"

P5L8: Do you mean something like: "Whereas the prevailing winds at 8m were either easterly or westerly, at 260 m the wind direction was dominated by northerlies."?

P5L22: Table S2

P6L31: "…, while tracers of monoterpenes and sesquiterpenes SOA did not show a marked increase with height."

P7L1-2: repetition of information.

P8L15: Which other pollution events? I thought they were only three.

P11L12: "Before".

P11L16: remove "obviously"

P1L27: please rephrase.