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Comment on acp-2022-603

Anonymous Referee #2

Referee comment on "Biogenic and anthropogenic sources of isoprene and monoterpenes and their secondary organic aerosol in Delhi, India" by Daniel J. Bryant et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-603-RC2, 2022

Bryant et al. present a nice analysis showing the seasonality of isoprene, monoterpene, and subsequent SOA products in Delhi, India. The authors highlight the importance of anthropogenic sources on the mixing ratios of isoprene and monoterpenes, and demonstrate the contribution of isoprene and monoterpene organosulfate and nitroxy-organosulfate products in SOA filter extracts. These observations are important for identifying key contributors to PM2.5 in highly polluted regions, such as Delhi.

The paper is very well written and presented. The results will be useful to the community, and I support publication. My comments are generally minor, but I do wonder if there is additional information that could be extracted from the monoterpene measurements that could directly point towards the impact of anthropogenic monoterpenes on the SOA markers observed in filter extracts. I'm curious if the authors have considered exploring the distribution of monoterpene OS_{MT} and NOS_{MT} shown in Table 1 to assess an anthropogenic fingerprint in these measurements.

Main comments

Line 35 – 36. The statement "this is one of the first observations in Asia, suggesting monoterpenes are dominated by anthropogenic sources" should be refined or removed, since work by Stewart et al and Nelson et al. already detail these observations for Delhi. This statement doesn't seem necessary given that the main focus of the manuscript is on isoprene and monoterpene SOA markers.

Lines 229- 246 and Fig 1. These mixing ratios (and the differences across seasons) are impressive, but it's difficult to see the details in the seasonal patterns in just a time series. It would be very helpful to see a third column where these gas-phase measurements are presented as diurnal patterns in order to see the seasonal and hourly differences. I would recommend this for Fig S1 as well to give the reader a better visual reference for how the meteorology impacts these mixing ratios. The authors provide a very nice discussion of the meteorological impacts in section 3.1, but I believe overlaying the diurnal patterns seasons would be very helpful.

Lines 383 – 408 : The results and discussion about monoterpenes presented here reiterate many of the conclusions drawn by Stewart et al. 2021 and Nelson et al. 2021 (i.e., abundant anthropogenic source of monoterpenes). Are there other insights that can be drawn from the monoterpene data presented here? It would be helpful to see how the monoterpene distribution changes between by season or time of day (perhaps a pie chart of nighttime mixing ratios). Figure 2 suggests that alpha-pinene is the dominant monoterpene observed during the pre-monsoon season, while limonene seems to dominate during post-monsoon season. Does this point to a specific source in Delhi? Limonene is a key component of fragrances (Gkatzelis et al. 2021, Coggon et al. 2021, Peng et al. 2022) and cooking spices (Klein et al. 2016), and could be a component of biomass burning. Does this differ from the expected distribution of biogenic monoterpenes from the vegetation in Delhi?

Line 407: Please provide references to the OH sources noted here.

Figure 5: The legend for the pie chart is very small and difficult to read. Please make this larger to help those of us with poor eyesight!

Lines 515 – 538: The authors mention here and elsewhere the role of high NO in quenching NO3 radicals. Indeed, the NO is very high, but I don't have a sense for how this stacks up against the other species with high reactivity towards NO3. I think this discussion could benefit from a pie chart showing the distribution of NO3 reactivity based on the VOC and inorganic gas measurements, but recognizing that NO3 reactivity may be missing from the measurements (e.g. Fig 4, Liebmann et al.). I believe this would help to supplement the discussion of Figures 5 and 6.

Table 1: I feel like there could be very valuable information in these distributions of isoprene and monoterpene products, and specifically for the OS_{MT} and NOS_{MT} speciation. Have the authors considered exploring the speciation of MT SOA markers and relating these back to the monoterpene mixing ratios observed by GC?

Minor Comments:

Line 402: The reference to Coggon et al. (2018) should be updated: https://www.pnas.org/doi/10.1073/pnas.2026653118.

References:

Klein, F. et al. Indoor terpene emissions from cooking with herbs and pepper and their secondary organic aerosol production potential. Sci Rep **6**, 36623 (2016). https://doi.org/10.1038/srep36623

Coggon M. et al. Volatile chemical product emissions enhance ozone and modulate urban chemistry. PNAS 18, 13 (2021). https://doi.org/10.1073/pnas.2026653118.

Gkatzelis, G. et al. Identifying volatile chemical product tracer compounds in U.S. Cities. Environ Sci Technol, 55, 1, (2021). https://doi.org/10.1021/acs.est.0c05467.

Peng, Y. et al. Source apportionment of volatile organic compounds and evaluation of anthropogenic monoterpene emission estimates in Atlanta, Georgia. Atmos. Environ. 228 (2022). https://doi.org/10.1016/j.atmosenv.2022.119324.

Liebmann, J. M. et al. Direct measurements of NO_3 reactivity in and above the boundary layer of a mountaintop site: identification of reactive trace gases and comparison with OH reactivity, Atmos. Chem. Phys., 18, (2018). https://doi.org/10.5194/acp-18-12045-2018