It is interesting to determine the chemical composition and interactions during SOA formation in mixed VOC systems (photooxidation of α-pinene, isoprene, o-cresol and their binary and ternary mixtures in the presence of NOx and ammonium sulphate seed particles) by using non-targeted LC-Orbitrap MS. The method is innovative. But more detailed information about the methods can be provided.

We kindly thank the reviewer for their time and effort in providing comments for our manuscript. Please see our responses below (shown in blue).

Introduction:

What are the pros and cons of using non-targeted LC-Orbitrap MS analysis for data interpretation can be addressed?

We appreciate the opportunity to expand on the benefits and challenges. We will introduce the advantages of using non-targeted LC-Orbitrap MS analysis for data interpretation in section 1.3, from line 101, which has been changed to *"……application. Non-targeted analysis extracts the chemical information of all detected compounds in a sample dataset, providing tentative identification of unknown compounds via library screening, while allowing the rapid chemical characterisation of complex mixtures through the chemical classification of detected compounds in a given sample Place et al. (2021) and Pereira et. al 2021. Mezcua et al. (2011) reported that 210 pesticides were successfully been detected and identified in 78 positive samples of fruit and vegetable samples by using automatic non-targeted screening method in LC-TOF analysis. High-resolution accurate mass spectrometry (HRAM-MS)-based non-targeted screening analysis were applied in chemical characterized of tobacco smoke, and successfully identified a total of known 331 compounds and 50 novel compounds as being present in the sample (Arndt et al., 2019). "*

The challenges associated with its use will be introduced in section 1.3, from line 108; the section has been rephrased to *"……low concentration species. However, non-targeted screening methods are not infallible and rigorous testing of autonomous platforms must be performed to understand potential limitations of these tools. Moreover, it is challenging to make semiquantitative or quantitative measurements of unknown compounds in complex matrices. It is worth to noting that quantitative measurements of unknow compounds is a general limitations of ESI operation and not directly attributed to non-targted screen method, but arguably become more important. It is difficult to perform quantitative measurement of unknow compounds due to the analytical standards for SOA products are limited and only a few molecules out of the thousands detected compounds might be known. Therefore, it is also challenge to determine sample extraction recoveries during sample extraction procedures. The approach of using the normalized abundance of compounds in the sample does not consider different compound ESI efficiencies, which can be influenced by the molecular structure among other parameters (Priego-Capote and Luque De Castro, 2004) . For example, Cech and Enke (2000) found out that ESI response increased for peptides with more extensive non polar region. Cech and Enke (2001) further examined and concluded that analytes with more polar portion has lower ESI response than the more nonpolar analytes. Differences in ESI efficiencies of*

individual compounds may impact normalized abundance of chemical groupings, particularly when comparing sample compositions which differ appreciably.

Method:

There are lots of anthropogenic VOC precursors, why o-cresol was chosen as an anthropogenic precursor in this study?

The work in this paper is a subset of a more comprehensive chamber study of SOA formation from mixed precursors and here focuses on the chemical composition of the SOA formed using LC-Orbitrap MS. A comprehensive and detailed description about the experimental design of the project is presented in Voliotis et al. (2022), which describes the choice of VOC precursors, and their "representativeness" in section 2.1.

We choose *o*-cresol as a moderate SOA yield anthropogenic precursor with comparable reactivity towards the available oxidants (OH radicals) as the two biogenic VOC in a mixtures (a-pinene and isoprene), such that they each may contribute comparably to the distribution of oxidation products.

Humidity and temperature are important factors for SOA formation, they are controlled by the humidifier and by controlling the air conditioning during the experiment. These parameters should be added in the manuscript.

We included this in section 2.3:

From line 259-261: "*Photochemistry was initiated by irradiating the VOC at a moderate VOC / NOx ratio using the lamps as described above. The temperature and relative humidity conditions were controlled at 50 % ± 5 % and 24 ± 2˚C, respectively during the experiment. The concentration of NOx and O3, particles number concentration and mass concentration were monitored during the experiment using the online instruments (Pereira et al., 2021).*"

Why was the mass concentration of seed particle doubled in single isoprene experiment?

The seed particles were inadvertently added into the chamber with increased mass concentration for the single isoprene system. Whilst this could have resulted in a greater partitioning of oxidation products leading to more SOA particle mass forming, the particle mass and resulting yield in the single precursor isoprene system was negligible (SOA particle mass concentration ~0 ug/m^3), consistent with other studies using neutral seeds.

How many repeated experiments performed in each experiment type?

Three replicate experiments were conducted for all systems except the single precursor isoprene systems. This information has been added in the section 2.4.2, Line 315: "*To provide confidence in the components in each system detected by the non-targeted method, only those*

compounds found in all three replicate experiments (two in the single precursor isoprene and binary o-cresol/isoprene systems) and not found in any background "clean" experiments were attributed to a particular single precursor or mixed system."

Before filter sampling, any denuder was used to remove VOCs, NOx and oxidants?

No denuder was used to remove VOCs, NOx and oxidants before filter sampling owing to the challenge associated with gaseous denuding at the high sampling flow rate. Chamber air was flushed out at around 3 m^3 min^{-1} onto the filter, taking some 5 minutes for sample collection. Du et al. (2021) had combined the online (FIGAREO-CIMS) and offline mass spectrometric (LC-Orbitrap MS) techniques to characterize the chemical composition of secondary organic aerosol (SOA) generated from the photooxidation of α-pinene in the MAC. The study of Du et al. (2021) reported that the distribution of particle-phase products is highly consistent between the FIGAERO-CIMS and LC-Orbitrap MS negative ionisation mode for the α-pinene SOA products, suggesting near negligible (or at least comparable) gas phase absorption artefact introduced during filter collection in both techniques.

Results and discussion:

Online data from gas chromatography mass spectrometer (GCMS), condensation particles counter, differential mobility particle sizer (DMPS) and aerosol mass spectrometer (AMS) are very useful for data interpretation. But the results were not reported in this study.

As mentioned above, this is part of a more comprehensive study of SOA formation in mixtures. The full instrument description is given in in Voliotis et al. (2022), and the DMPS, GCMS and AMS, along with the online FIGAREO-CIMS, data are presented therein, and in several companion papers (Du et al., 2021; Shao et al., 2022)
The online GCMS data show the decay of precursors at each system in Figure 1(d)-(f). We could not extract more information about the chemical composition of gas-phase products from the online GCMS in our experiments, but the products are reported in Du et al., (2022a,b). The AMS data were utilised to show the evolution of SOA mass of each precursor system and presented in Figure 1(a), but high resolution data are compared in detail with FIGAREO-CIMS data and offline LC-Orbitrap MS data in Shao et al. (2022, in prep).

Lots of data were presented in this study, (e.g. number of detected SOA compounds, molecular composition, compositional analysis). The novel part of this study is about the unique-to-mixture products due to the interactions between VOC products. This section can be extended and provide more mechanistic understanding of their formation.

We thank to the reviewer for this suggestion. To provide more mechanistic understanding of their formation required structure identification and quantification of the unique-to-mixture compounds, which require standards. Mechanistic inferences are provided in the combined use of FIGAREO-CIMS data and offline LC-Orbitrap MS in Du et al. (2022a,b) and further work to elaborate on the potential mechanisms is recommended in line with these studies.

We include this at the end Conclusion section: "*This study did not examine the molecular structure of the unique compounds/potential tracers in the mixture precursors systems. The*

future studies suggest focus on identifying the molecular structure of unique-to-mixture components will help better understand the detailed mechanisms of interactions involved in ambient SOA formation from mixture VOC oxidations."

Reference:

Arndt, D., Wachsmuth, C., Buchholz, C., and Bentley, M.: A complex matrix characterization approach, applied to cigarette smoke, that integrates multiple analytical methods and compound identification strategies for non-targeted liquid chromatography with high-resolution mass spectrometry, Rapid Communications in Mass Spectrometry, 34, 10.1002/rcm.8571, 2019.

Cech, N. and Enke, C.: Practical Implications of Some Recent Studies in Electrospray Ionization Fundamentals, Mass spectrometry reviews, 20, 362-387, 10.1002/mas.10008, 2001.

Cech, N. B. and Enke, C. G.: Relating Electrospray Ionization Response to Nonpolar Character of Small Peptides, Analytical Chemistry, 72, 2717-2723, 10.1021/ac9914869, 2000.

Du, M., Voliotis, A., Shao, Y., Wang, Y., Bannan, T. J., Pereira, K. L., Hamilton, J. F., Percival, C. J., Alfarra, M. R., and McFiggans, G.: Combined application of Online FIGAERO-CIMS and Offline LC-Orbitrap MS to Characterize the Chemical Composition of SOA in Smog Chamber Studies, Atmos. Meas. Tech. Discuss., 2021, 1-42, 10.5194/amt-2021-420, 2021.

Mezcua, M., Malato, O., Martinez-Uroz, M. A., Lozano, A., Agüera, A., and Fernández-Alba, A. R.: Evaluation of Relevant Time-of-Flight-MS Parameters Used in HPLC/MS Full-Scan Screening Methods for Pesticide Residues, Journal of AOAC INTERNATIONAL, 94, 1674-1684, 10.5740/jaoacint.SGEMezcua, 2011.

Pereira, K. L., Ward, M. W., Wilkinson, J. L., Sallach, J. B., Bryant, D. J., Dixon, W. J., Hamilton, J. F., and Lewis, A. C.: An Automated Methodology for Non-targeted Compositional Analysis of Small Molecules in High Complexity Environmental Matrices Using Coupled Ultra Performance Liquid Chromatography Orbitrap Mass Spectrometry, Environmental Science & Technology, 55, 7365-7375, 10.1021/acs.est.0c08208, 2021.

Place, B. J., Ulrich, E. M., Challis, J. K., Chao, A., Du, B., Favela, K., Feng, Y.-L., Fisher, C. M., Gardinali, P., Hood, A., Knolhoff, A. M., McEachran, A. D., Nason, S. L., Newton, S. R., Ng, B., Nuñez, J., Peter, K. T., Phillips, A. L., Quinete, N., Renslow, R., Sobus, J. R., Sussman, E. M., Warth, B., Wickramasekara, S., and Williams, A. J.: An Introduction to the Benchmarking and Publications for Non-Targeted Analysis Working Group, Analytical Chemistry, 93, 16289-16296, 10.1021/acs.analchem.1c02660, 2021.

Priego-Capote, F. and Luque de Castro, M. D.: Analytical uses of ultrasound I. Sample preparation, TrAC Trends in Analytical Chemistry, 23, 644-653, https://doi.org/10.1016/j.trac.2004.06.006, 2004.

Shao, Y., Voliotis, A., Du, M., Wang, Y., Pereira, K., Hamilton, J., Alfarra, M. R., and McFiggans, G.: Chemical composition of secondary organic aerosol particles formed from mixtures of anthropogenic and biogenic precursors, Atmos. Chem. Phys. Discuss., 2022, 1-41, 10.5194/acp-2022-127, 2022.

Voliotis, A., Du, M., Wang, Y., Shao, Y., Alfarra, M. R., Bannan, T. J., Hu, D., Pereira, K. L., Hamilton, J. F., Hallquist, M., Mentel, T. F., and McFiggans, G.: Chamber investigation of the formation and transformation of secondary organic aerosol in mixtures of biogenic and

anthropogenic volatile organic compounds, Atmos. Chem. Phys. Discuss., 2022, 1-49, 10.5194/acp-2021-1080, 2022.