Author's response to the editor's comments:

I have checked through your responses to the reviewers and the changes that you have made to the manuscript and I am happy that the remaining queries they raised have been adequately addressed. There are a few typos that I spotted whilst reading the manuscript listed below which need to be corrected. Once these changes have been made, I am happy for the manuscript to be published in ACP.

We extend our sincere gratitude to the editor's thorough review and valuable guidance provided throughout the review process, which have significantly contributed to the paper's quality. Our responses are listed below, presented in red, following the reviewers' comments, which are in black. The revisions made to the manuscript are highlighted in yellow.

Line 64: VOC-sensitive regime O_3 decreases with increasing NOx and increases with increasing VOC (so will impacted by both changes in NOx and VOC concentrations). Also change 'VOCs' to 'VOC'

Thanks for the correction. We have changed the sentence to "A "NOx-limited" regime has higher VOCs/NOx ratios and the O_3 formation is sensitive to NOx concentration changes, while a "VOCs-limited" regime has lower VOCs/NOx ratios and the O_3 formation decreases with increasing NO_X and increases with increasing VOC."

Line 77: 'VOCs' to 'VOC'

Ok. We changed 'VOCs' to 'VOC'.

Line 213: add 'to' before 'persist'

Ok. We added 'to' before 'persist'.

Line230: 'last' to 'least'

Sure. We changed 'last' to 'least'.

Line 251: Change 'The concentrations of 56 NMHC species in the canister analyzed by GC-MS/FID were calibrated daily using the mixture of a photochemical assessment monitoring stations (PAMS) standard gas and pure N2' to 'The concentrations of 56 NMHC species in the canister were analyzed by GC-MS/FID which was calibrated daily using the mixture of a photochemical assessment monitoring stations (PAMS) standard gas and pure N2'

Ok. We changed the sentence to "The concentrations of 56 NMHC species in the

canister were analyzed by GC-MS/FID which was calibrated daily using the mixture of a photochemical assessment monitoring stations (PAMS) standard gas and pure N_2." in lines 252-253 in the modified manuscript.

Line 279: 'recylces' to 'cycles'

Ok. We changed 'recylces' to 'cycles'.

Line 301: 'modelling' to 'model'

Ok. We changed 'modelling' to 'model'.

Line 356: ' VOCs' to 'VOC'

Ok. We changed 'VOCs' to 'VOC'.

Line 413: 'through' to 'though'

Ok. We changed 'through' to 'though'.

Line 498: ' explored' to 'explore'

Ok. We changed 'explored' to 'explore'.

Line 505: 'discussed' to 'discuss'

Ok. We changed 'discussed' to 'discuss'.

Line 527: 'manus' to 'minus'

Ok. We changed 'manus' to 'minus'.

Line 534: 'error caused by light-enhanced loss of O3' this shouldn't contribute at night, so suggest removing this error as the possible cause of P(Ox)net

Sorry for the confusion description. We primarily meant this is included in the measurement uncertainty of $P(O_X)_{net}$. We have changed the sentence to "During nighttime, $P(O_X)_{net}$ should be zero without sun radiation, the significant $P(O_X)_{net}$ shown in Fig. 5 may be due to the measurement uncertainty of $P(O_X)_{net}$, which is determined by the measurement error of O_X of CAPS-NO_2 monitor in the reaction and reference chambers (as discussed in Sect. S4)." in lines 535-537 in the modified manuscript.

Line 569: 'to upward directions' to 'upwards'

Sorry for the unappropriated description, we changed 'to upward directions' to 'upwards'.

Line 647: 'the lack of correction for the decomposition of CH3O2NO2' is a potential interference in RO2 measurements – it isn't a modelling problem, so I suggest removing this as a possible factor.

Indeed. We removed 'the lack of correction for the decomposition of $CH_3O_2NO_2$' as a potential interference' in modelling approaches in the modified manuscript.

Line 696: 'exhibiting' to 'exhibit'

Ok. We changed 'exhibiting' to 'exhibit' in the modified manuscript.

Line 756: remove 'that the'

Ok. We removed 'that the' in the modified manuscript.

Line 784: remove 'should'

Ok. We removed 'should' in the modified manuscript.

Line 838: 'Base' to 'Based'

Ok. We changed 'Base' to 'Based' in the modified manuscript.

Line 823: 'the OFP was primarily attributed to OVOCs..' but on line 871 ' most sensitive to AVOC..' need to be consistent.

Sorry for the confusing description. The description in line 823 'the OFP was primarily attributed to OVOCs.' was based on the OFP calculated from different VOCs categories, including OVOCs, aromatics, alkyne, alkene, and alkane as shown in Fig. 3. To make the description clearer, we changed the sentence lines 479-480 to "We further plotted the OFP of different VOCs categories at various altitudes, including OVOCs, aromatics, alkyne, alkene, and alkane, …" .

The description in line 871 'O_3 formation is most sensitive to AVOC,' is derived from the relative incremental reactivity (RIR) of various VOC groups, including anthropogenic volatile organic compounds (AVOC), biogenic organic compounds (BVOC), oxygenated volatile organic compounds (OVOC), and the non-methane hydrocarbons (NMHC). We clarify in the revised manuscript that AVOC in this study includes both OVOCs and NMHC. As shown in Fig. 9, the combined RIR of OVOC and NMHC is nearly identical to that of AVOC alone. Additionally, it is evident that the RIR of OVOC significantly exceeds that of NMHCs. The VOC species categorized under OVOC primarily originate from anthropogenic sources, but can also originate from biogenic precursors (Wu et al., 2020; Park et al., 2013). This potential overlap suggests that the RIR of AVOC may be overestimated. Consequently, it is more accurate to conclude that the O_3 formation is most sensitive to OVOC rather than AVOC. We have added this discussion in the revised manuscript concerning this in lines 747-753:

"We note that AVOC includes both NMHC and OVOC. Figure 9 demonstrates that the aggregate RIR of OVOCs and NMHCs is nearly identical to that of AVOC alone. Recognizing that VOC species within the OVOC category are primarily originate from anthropogenic sources, but can also originate from biogenic precursors (Wu et al., 2020; Park et al., 2013), we acknowledge the possibility of an overestimated RIR for AVOC and due to this overlap."

And lines 768-772:

"given that the AVOC includes NMHC and OVOC, there is urgent need to reduce NMHC and OVOC emissions to mitigate O_3 pollution in this area. Additionally, it is evident that OVOCs have a substantially higher RIR than NMHC, therefore, it is more accurate to conclude that the O_3 formation is most sensitive to OVOC rather than AVOC."

This conclusion is consistent with the conclusion of OFP was primarily attributed to OVOCs in Sect. 3.1.2.

Accordingly, we changed the conclusion in lines 796 in the modified manuscript and Table S4:

"We further identified and presented the three VOC species with the highest OFP in NMHC and OVOC groups during different episodes and non-episodes in Table S4."

we changed the "AVOC group" to "NMHC group" in lines 798 in the modified manuscript:

"Results show that compounds such as toluene, *m/p*-xylene, and n-butane in NMHC group, formaldehyde, hydroxyacetone, and ethanol in OVOC group have identified as the most significant contributors to the total OFP in all episodes and non-episodes."

Also, we changed in lines 804-805 "Priority of these emission sources should be given to reducing AVOC and OVOC to mitigate O_3 pollution in the PRD area of China." to "Priority of these emission sources reducing should be given to mitigate O_3 pollution in the PRD area of China."

Furthermore, we modified the sentence in lines 48-50 in the introduction:

"The vertical and temporal O_3 formation is most sensitive to OVOC, suggesting that targeting specific VOCs for control measures is more practical and feasible at the observation site."

And the sentence in lines 878-880 in the conclusion:

"Nonetheless, throughout all episodes and non-episodes, O_3 formation is most sensitive to OVOC at various heights, emphasizing the urgent need to reduce emissions of these compounds and their precursors to mitigate O_3 pollution in this area."

References:

Park, J. H., Goldstein, A. H., Timkovsky, J., Fares, S., Weber, R., Karlik, J., and Holzinger, R.: Active atmosphere-ecosystem exchange of the vast majority of detected volatile organic compounds, Science, 341, 643–647, 10.1126/science.1235053, 2013.

Wu, C., Wang, C., Wang, S., Wang, W., Yuan, B., Qi, J., Wang, B., Wang, H., Wang, C., Song, W., Wang, X., Hu, W., Lou, S., Ye, C., Peng, Y., Wang, Z., Huangfu, Y., Xie, Y., Zhu, M., Zheng, J., Wang, X., Jiang, B., Zhang, Z., and Shao, M.: Measurement report: Important contributions of oxygenated compounds to emissions and chemistry of volatile organic compounds in urban air, Atmos. Chem. Phys., 20, 14769-14785, 10.5194/acp-20-14769-2020, 2020.