Reply to the Reviewers

---For the manuscript “egusphere-2025-5992”

Reviewer 2#:

In this study, the key role of NH_3 on SOA formation during the photo-oxidation of mixed VOCs of anthropogenic (n-heptylcyclohexane) and biological (α-pinene) sources was revealed by a large-scale outdoor photochemical smog chamber experiment. The results showed that NH_3 significantly accelerated the degradation of VOCs and increased the quantity and mass concentration of SOA by promoting nucleation and particle-phase reactions (e.g., acid-base interaction, Maillard reaction). It especially enhanced the production of nitrogenous light-absorbing substances (e.g., imidazoles), which may contribute to climatic impacts through the radiative effect of brown carbon and cloud interaction. Meanwhile, NH_3 inhibits the formation of OOMs by mediating the gas-particle partitioning of medium molecular weight compounds, which hinders the cross-reactions necessary for OOMs production. Additionally, elevated temperatures inhibit SOA production. The study elucidates how NH_3 affects the co-oxidation of ambient anthropogenic and biogenic gases, and deepen the understanding of its role in SOA generation, particularly light-absorbing aerosols, in the AVOC-BVOC mixed system. It is recommended that the paper be accepted after major revision. In addition, there are some issues that need to be clarified, which are list below:

1. The NH_3 concentrations tested (74.85–748.5 ppb) span a wide range. Does the particle size distribution reveal any systematic trends with NH_3 concentration?

   Thanks for the question. When NH_3 at varying concentrations was introduced into the reaction system, the SOA particle size distribution exhibited rapid growth within the first hour, subsequently approaching a steady state after approximately two hours. Notably, lower NH_3 concentrations (74.8 ppb) corresponded to larger maximum particle diameters observed during the reaction period, whereas at elevated NH_3 concentrations (133.7 ppb and 748.5 ppb), the maximum particle sizes were comparable between the two experimental groups. By the conclusion of the reaction, the maximum particle diameters

under all three NH_3 concentration conditions converged to statistically similar values. These findings have been incorporated into the revised manuscript. Detailed revisions can be found on page 5, line 153–154 of the revised manuscript and Figure S1 of the revised supporting information.

2. Why was n-heptylcyclohexane chosen to represent AVOC? Is its chemical structure (cyclically branched alkanes) prevalent in the actual urban atmosphere?

Thanks for the question. n-Heptylcyclohexane, as a representative long-chain alkane, significantly influences the yield and production efficiency of anthropogenic SOA (ASOA) as well as atmospheric oxidizing capacity. This compound is ubiquitously distributed in the urban atmosphere, originating from diverse sources including volatile chemical products such as coatings and vehicular exhaust emissions, thereby representing an important potential contributor to ASOA. The photochemical reactivity and SOA formation potential of long-chain alkanes are profoundly governed by their structural characteristics: cycloalkanes exhibit the highest reactivity and greatest SOA formation potential, followed by branched alkanes, with linear alkanes being the least reactive. Consequently, cyclic branched alkanes serve as ideal model species for investigating SOA formation under varying conditions. n-Heptylcyclohexane, a hybrid hydrocarbon possessing both cyclic and branched alkyl moieties, provides critical insights that can be extrapolated as an important reference for ASOA derived from long-chain alkanes. We have added clarifications regarding this issue to the revised manuscript. Detailed revisions can be found on page 2, line 49–51 and 56–58 of the revised manuscript.

3. Is the mixing effect of other BVOCs (e.g. isoprene) considered for α-pinene as a typical representative of BVOCs? Are the experimental results generalizable?

Thanks for the question. This study primarily focuses on the mixed oxidation of representative AVOCs and BVOCs, with the latter being predominantly monoterpenes; the effects of other BVOCs such as isoprene were not considered. Given the robust representativeness of α-pinene within the monoterpene class, the experimental results are inferred to possess a certain degree of generalizability to the reaction systems involving

AVOCs and monoterpenes.

4. Were multiple replications of the experiment performed to verify the stability of the results?

   Thanks for the question. Repeated experiments were conducted in this study to ensure the stability and reliability of the results. Details are provided in Table S1.

5. Some of the terms (e.g., "VOC/NOx ratio") are not clearly explained in their abbreviated meanings, which may affect the understanding of lay readers.

   Thanks for the recommendation. “VOC/NOx ratio” means the reactive organic compounds-to-primary NOx concentration ratio. We have added clarifications regarding this issue to the revised manuscript. Detailed revisions can be found on page 5, line 153–154 of the revised manuscript.