## **Overall comment:**

This work by Luo et al. examined HOM formation from limonene + OH and highlighted the importance of the H-abstraction pathways, in addition to the well-known OH-addition pathways. The main conclusion is well supported by the observations of C10H15Ox-RO2 as well as their termination products. These results are also in line with the authors' recent publication on H-abstraction derived HOM for alpha-pinene + OH chemistry (Shen et al., 2022 Sci. Adv.). Therefore, I believe that the underscored H-abstraction pathways for monoterpene + OH chemistry are important and should be considered in future chemical mechanisms. However, there are a number of major issues that need to be addressed before consideration for publication, as discussed below.

## Detailed comments:

1. Estimation of HOM yields. This work used NO3-CIMS to estimate HOM yields and relative contributions of the H-abstraction vs. OH-addition pathways, assuming unified sensitivity for all the HOMs products. However, this approach may have large uncertainties. For example, Berndt et al. (Nature Comm. 2016, 7, 13677) demonstrated that NO3-CIMS could underestimate HOM formation from OH-addition pathways for alpha-pinene and beta-pinene. This might also be the case for limonene. If this is true, then the contribution of OH-addition to limonene HOMs as well as the total HOM yields could be underestimated. Better constraints on these aspects are needed.

2. RO2 chemistry. In Page 2, the RO2 reactions are listed. However, there are a few missing pathways. First, the RO2 + HO2 reaction may only partially form ROOH and could also produce RO (Kurten et al., JPCL, 2017, 8, 2826). The branching ratios of the two pathways likely depend on the RO2 structure. In addition, RO unimolecular isomerization could produce RO2 in the same CHO family. For example, C10H15Ox RO could form C10H15O(x+2) RO2. Therefore, this pathway needs to be included in the data analysis. Lastly, the RO2 + RO2 reaction described in (R2) is only correct for primary and secondary RO2. For tertiary RO2s, carbonyls cannot be formed. Without considering these above-mentioned pathways, the estimation of contributions from C10H15Ox vs. C10H17Ox to C10H16Ox (i.e., Eq. 2 - Eq. 8) is wrong.

3. Products in the low-NO conditions. A range of NO concentration was reported (0.1 ppt – 0.2 ppb) for the low-NO conditions. So, I assume there were multiple experiments performed under low-NO conditions with varied NO concentrations from as low as 0.1 ppt up to 0.2 ppb. Then, I would expect the product distributions under varied NO concentrations to be reported. However, in Figures 2 and 3, only one set of results were shown for low-NO. What is the NO concentration for the low-NO conditions shown? It is even more confusing that the fractions of C6-C9 fragmentation products (Figure 2) and organic nitrates (Figure 3) are not significantly lower for the low-NO experiments in comparison to the high-NO experiments. Even at 0.2 ppb for low-NO, it is ~ 100 times lower than the high-NO condition. But the fragmentation products are only different by 7%, and organic nitrates are 34% vs. 73%. More thorough analysis is needed to verify the difference.

4. Product distributions. In Figure 3, what is there a strong NOx dependence for the C10H15Ox/C10H17Ox ratio? Why are the ratios of C10H18Ox/C10H17Ox fairly constant (28% vs.

19%) between the two NO conditions, but C10H16Ox(R-OH/OOH)/C10H15Ox ratios are very different (51% vs. 0%)? The relationships between different families under different NO conditions need to be discussed in-depth.

5. The authors suggest that some C10H17Ox and related products may be from secondarygeneration reactions. For example, the first-generation product limonaldehyde (C10H16O2) could react with OH and form C10H17Ox. In the same way, H-abstraction in limonaldehyde reacting with OH to form C10H15Ox RO2 and further products. In MCM, H-abstraction in this reaction has a branching ratio of ~28.8%. Could this reaction explain some or a major fraction of total C10H15Ox products?

Minor comments:

1. The concentration of limonene used in the experiments are not mentioned in the main text.

2. Suggested references:Line 72. For HOM dimers: Zhao et al. PNAS, 2018, 115, 12142.Line 89. For limonene + NO3: Mayorga et al., ES&T, 2022, 56, 15337.

3. Line 84. Should be C10H14-18O7-11.

4. Line 93. Here the actual HOM yield from Jokinen et al. should be mentioned.

5. NOx analyzer. What is the detection limit of the NOx analyzer? The manuscript says low-NO has NO concentration of 0.1 ppt – 0.2 ppb but did not clearly say that the NOx analyzer measured the NO concentration.

6. Line 146-147. This sentence should move to the results section.

7. Line 163. How are epoxides formed?

8. In the equations, sometimes R<sub>-H</sub>=O is used for carbonyls and sometimes R=O is used. They need to be the same.

9. Line 394. Carbonyls may also be formed from RO + O2 if the RO is primary or secondary.

10. Line 503. Molar yields? Line 505. SOA mass yields?

11. Line 522. Significant contribution of RO2 + HO2 after 2 h at low NO. But this study only focused on within 1 h after oxidation, correct?