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Comment on acp-2022-800

Anonymous Referee #2

Referee comment on "Impact of HO_2 aerosol uptake on radical levels and O_3 production during summertime in Beijing" by Joanna E. Dyson et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-800-RC2, 2023

This paper presents an analysis of the impact of heterogeneous HO2 radical uptake on aerosols on the concentration of HO2 and its impact on the sensitivity of ozone production in Beijing during the AIRPRO campaign. Recent studies have suggested that efforts to reduce high concentrations of particulate matter may result in increased ozone production due to the increased concentration of HO2 radicals resulting from a reduction in the heterogeneous loss of HO2 radicals on aerosols. The authors incorporate heterogeneous loss of HO2 into their model to determine its impact on the modeled radical concentrations. They find that the loss of HO2 has a negligible effect on the modeled concentrations, suggesting that HO2 uptake on aerosols is not important under most of the conditions encountered during AIRPRO. Heterogeneous loss of HO2 can be important under the lower NO conditions often observed in the afternoon and that under cleaner conditions, a decrease in aerosol surface area could lead to increased HO2 concentrations that could impact ozone production. The authors evaluate the impact of heterogeneous loss of HO2 on the sensitivity of ozone production, finding that NOx control strategies may not be as efficient at reducing ozone production as expected given the impact of reduced heterogeneous loss of HO2 with decreasing aerosol concentrations.

The paper is well written and provides some new information regarding the importance of heterogeneous HO2 uptake on ozone production. While a previous paper by this group (Whalley et al., 2021) touches on the potential impact of HO2 uptake on ozone production, this paper provides a more detailed analysis. The paper would be acceptable for publication after the authors have addressed the following comments:

- Since the measured and modeled OH, HO2, and RO2 concentrations have been discussed in detail in Whalley et al., 2021, the authors should focus this paper on the impact of HO2 uptake on the modeled concentrations. In that light, I would recommend removing Section 2.2 and referencing the Whalley et al., 2021 ACP paper (and updating the reference to the discussion paper).
- I would also suggest moving the description of the LN/Q and absolute O3 sensitivity calculation (lines 570-603) to section 2 after the model description, and instead focusing on the results in Section 3.
- The authors provide a brief description regarding potential reasons for the discrepancy between the modeled radical concentrations with the measurements, which are discussed in detail in Whalley et al. (2021). However, at first read the description here does not appear to be consistent with the description in Whalley et al. For example, line 462 states that the overprediction of HO2 by the model may be due to "an under-prediction in the rate of reaction of RO2 with NO to produce a different RO2 species…"

while the conclusion in Whalley et al. 2021 is that the "propagation rate of RO2 to HO2 may be substantially slower than assumed." While I believe the reasoning is consistent between the two papers, the wording here could be clarified to remove any potential confusion.

- Similar to that described in Sakamoto et al. (2019), the authors include uptake of RO2 radicals into account when analyzing the impact of aerosol uptake on ozone production sensitivity. Given the authors suggestion that the overprediction of HO2 and underprediction of RO2 is due to isomerization of complex RO2 or RO radicals that effectively increases the lifetime of RO2 radicals and slows the propagation of RO2 to HO2, can the authors comment on whether uptake of RO2 radicals in this scenario could impact the concentration of RO2 radicals and the rate of ozone production? What effective lifetime of RO2 radicals would heterogeneous uptake be competitive and impact RO2 concentrations? Perhaps include a plot similar to Figure 8 for RO2 loss to address this?