Comment on acp-2022-207
Anonymous Referee #2

Referee comment on "Radical chemistry at a UK coastal receptor site – Part 1: observations of OH, HO\textsubscript{2}, RO\textsubscript{2}, and OH reactivity and comparison to MCM model predictions" by Robert Woodward-Massey et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-207-RC2, 2022

This paper presents measurements of OH, HO\textsubscript{2}, RO\textsubscript{2}, and total OH reactivity at a coastal site during the 2015 ICOZA (Integrated Chemistry of OZone in the Atmosphere) campaign. The authors compare the measurements to predictions by both a photostationary state model as well as a zero-dimensional model based on the Master Chemical Mechanism (MCM 3.3.1). The authors find that in general the MCM model was able to reproduce the measured OH concentrations during the campaign, but overpredicted the measured concentrations of HO\textsubscript{2} under lower NO\textsubscript{x} conditions when air arrived to the site from the northwest-southeast sectors, while underpredicting the measurements when more polluted air arrived to the site from the southwest sector. The authors also found that the model underpredicted the measured RO\textsubscript{2} concentrations for both lower and higher NO\textsubscript{x} air that arrived from all sectors. The authors also find that the measured total OH reactivity was consistently greater than that calculated by the model.

The measurements described add to a growing dataset that suggest that our understanding of radical chemistry under a range of conditions may be incomplete, and as a result are of interest to the atmospheric chemistry community. The results are consistent with several previous measurements, and the authors suggest several possible reasons for the model discrepancies based on these previous results, including missing halogen chemistry and autooxidation of RO\textsubscript{2} radicals reducing the rate of conversion to HO\textsubscript{2} radicals. Unfortunately, the impact of these proposals on their model results are not included in this paper, as they are discussed in the companion paper. While the companion paper focuses on the impact of their proposed mechanisms on the radical budgets, this paper would benefit from some additional discussion of the impact of the proposed mechanisms on the modeled radical concentrations.

Specifically, the authors should consider including their model results when they reduced the rate of the RO\textsubscript{2} + NO propagation rate as discussed in sections 4.4 and 4.5 as it appears that a reduction in this rate, perhaps due to the competition of RO\textsubscript{2} autooxidation with radical propagation, improves the agreement with the measured HO\textsubscript{2} and RO\textsubscript{2} concentrations. While including an expanded discussion of the model results would add to an already lengthy manuscript, the authors should also consider condensing and or moving some of the discussion of previous measurements into a supplement.
Additional comments:

1) The authors conducted interference measurements during two different periods, finding that unknown interferences contributed less than 20% to the measured OH signal. It appears that these measurements occurred during both NW-SE and SW periods. Did the authors see a significant difference in the interference measurements from the different wind sectors?

2) The authors should consider highlighting the NW–SE and SW periods on Figure 5 to help illustrate the impact of the different air masses on the radical measurements.

3) Given that the main focus of the paper is on the measurement/model discrepancy of the radical concentrations, there are several sections and figures in the paper that could be moved to a supplement to improve readability. In particular, sections 3.3 and 3.4 along with figures 9 and 10 could be moved to a supplement.

4) The authors could also condense much of the discussion of previous measurements by including a table summarizing the previous measurements/model agreement under the different NO conditions and referencing the table in the discussion.

5) As mentioned above, the authors should consider adding the reduced RO2+NO model results to Figures 5-7 to illustrate how this model improves the agreement with the measurements. This illustration of the impact of the reduced rate is not included in the companion paper.