
Response to Reviewer #1

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1. Li et al. present vertically resolved VOC and oVOC measurements from Beijing, China. The measurements were taken in a 325 m tall tower switching between several heights from near the surface (5 m) to the top of the tower (320 m). The authors then use these measurements to model and calculate a variety of atmospheric parameters including OH reactivity, photochemical ozone production, and vertical gradients in VOC concentrations. While the analysis performed is not necessarily novel, the authors present fresh measurements and thorough analysis which contributes to our understanding of vertical VOC distributions and the role of boundary layer dynamics and vertical mixing in ozone formation which is desirable. One of the most important conclusions of the article is the importance of oVOCs at higher altitudes and their ability to contribute to ozone formation which can then affect surface concentrations. Only 35% of the PBL ozone is produced in the first 320 m. The measurements and analysis are sound and support the conclusions of the paper. The article is well written and properly referenced. I believe the article can be published as is. However, isoprene plays a significant role in the chemistry observed and the results and yet the mechanism used to model isoprene, the MCMv3.3.1, is significantly outdated. Wennberg et al. (https://doi.org/10.1021/acs.chemrev.7b00439) published an updated mechanism for isoprene and its oxidation products. The mechanism can be retrieved at (https://data.caltech.edu/records/x88rk-wca37) and it is readily integrated with F0AM. The updated mechanism includes isomerization reactions, additional oVOCs, better representation of isoprene derived organic nitrates, updated reaction rates among many changes, which could significantly affect some of the quantitative results of the modeling work. I do not believe the overall conclusions of the article would change, which is why I support publication as is, however, using an updated mechanism would improve the analysis significantly.

Reply: We appreciate your valuable comments and suggestions, which are very

helpful for the improvement of our manuscript.

We have carefully read the paper "Gas-Phase Reactions of Isoprene and Its Major Oxidation Products" (Wennberg et al., 2018) recommended by the reviewer. The chemical mechanism of isoprene in this paper primarily includes the reactions of isoprene and its products with chlorine radicals (e.g., C_5H_8+Cl, MCK+Cl, MACR+Cl) and the reactions of hydroxymethylperoxide (HMHP) with OH radicals. The MCMv3.3.1 model has integrated most of the mechanisms reported in the literature. The isoprene-related mechanisms mainly based on "The MCM v3.3.1 degradation scheme for isoprene" (Jenkin et al., 2015) and the related parameters are recommended by IUPAC (https://iupac.aeris-data.fr/en/home-english/).

According to the results of previous studies, the oxidation initiated by chlorine radicals is an only minor sink for isoprene, and this oxidation pathway is likely important in the marine boundary layer. However, our research is conducted in inland areas and we thus speculate that the oxidation of isoprene by chlorine radicals is minor. When considering reactions with oxidants such as OH, O_3, and NO_3, there might be some differences in reaction rates or branching ratios between the two mechanisms. However, most of the reaction rates used in the two models are still predominantly based on those recommended by IUPAC. The purpose of this paper is to compare the vertical distributions of different VOC species and their impacts on ozone formation. The addition of the above reactions may not affect the existing results. We are still very grateful for your advice and our future studies regarding the simulation of isoprene and other VOCs will employ this latest mechanism.

Small typos:

2. Line 79: "the ozone formation regime ***like*** undergoes…"

Reply: Thank you for pointing out this mistake. It should be "likely" here and we have corrected it in the revised manuscript. [see P: 4; L: 81-83]

"*The ozone formation regime likely undergoes significant transitions from the ground to the upper boundary layer (Li et al., 2024; Liu et al., 2024a)*"

3. Line 433: “approximately 9.5 ppb at 5 m to 5.0 ***m*** ppb at 320 m…”

Reply: Thank you for pointing out this mistake. It should be “5.0 ppb” here and we have corrected it in the revised manuscript. [see P: 17; L: 434-436]

“*The critical NOx mixing ratios decreased from approximately 9.5 ppb at 5 m to 5.0 ppb at 320 m, primarily caused by the decreases in both NOx concentrations and the OHRs of VOCs.*”