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Reply on RC2

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Author comment on "Diagnosing ozone–NO_x–VOC sensitivity and revealing causes of ozone increases in China based on 2013–2021 satellite retrievals" by Jie Ren et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-347-AC2, 2022

We thank the reviewer for the thoughtful and constructive comments, which will greatly assist in revising the manuscript. Here is a short response to the major comments first.

1.Indeed, ozone is produced from NO_2, and continued reduction of NOx will eventually reduce O_3 concentrations. Our results show that the NOx-limited regime exists in a large area of China currently, where NOx reduction is effective in controlling ozone pollution. However, at present, key city clusters and urban areas are dominated by VOC-limited and transitional regimes. If the scheme of no VOC reduction and NOx reduction only is adopted, the O3 concentration cannot be effectively reduced until NOx is reduced to a very low level to lead the O_3 formation regime to shift to NOx-limited, which requires a very long time and high cost. In contrast, a strong effort to reduce VOCs and increase the VOCs/NOx reduction ratio is the immediate and effective way to reduce O3 concentrations.

The results of Wang et al. (2022) show that VOC reduction would significantly decrease O_3, while NOx reduction would only slightly decrease O_3 at two urban sites in Beijing and Shanghai from June to August after 2019. This is consistent with our findings from April to September in Beijing and Shanghai that VOC reduction is more effective than NOx reduction for controlling O3 pollution. We provide the spatial distribution of ozone sensitivity in China, and different regions should adopt different emission reduction strategies.

2.Although the HCHO yields of different VOC species differ, the changes in satellite HCHO can roughly indicate changes in total VOC emissions, which has been applied in several previous studies. (Li et al., 2020; Shen et al., 2019; Zhu et al., 2014)

Our results show that there is no significant overall decrease in satellite HCHO concentrations in most of eastern China since 2013, which is similar to the estimated trends of anthropogenic VOC and biogenic VOC emissions in China (Zheng et al., 2018; Simayi et al., 2022; Li et al., 2020). Biogenic VOC emissions are difficult to control, and anthropogenic VOC emissions are much higher than biogenic VOC emissions in urban areas of China, so it is the lack of anthropogenic VOC emission reduction that has not significantly decreased HCHO.

Overall, the long-term changes in HCHO are driven by several factors, such as anthropogenic and biogenic emissions, OH abundance, and NOx concentrations, which deserve further investigation in future studies using more adequate observational data. Most relevant to our study is that HCHO has not declined as dramatically as NO_2, i.e., the

overall change in VOC is much smaller than NOx reductions over the past 9 years.

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