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Comment on acp-2021-708

William Stockwell (Referee)

Referee comment on "Direct measurements of ozone response to emissions perturbations in California" by Shenglun Wu et al., Atmos. Chem. Phys. Discuss.,
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A key policy question for policy makers: "Is ozone formation limited by the available nitrogen oxide emissions ($\text{NO}_x = \text{NO}_2 + \text{NO}$) or by available volatile organic compounds (VOC)? Often this important question is addressed by assessments of emissions inventories followed by air quality modeling. The authors have developed a mobile set of three identical Teflon "smog chambers" that are mounted on a truck. The chambers can be moved to make measurements across California. One chamber serves as the control while additional NO_x is added to another chamber and VOC is added to the third. Ozone measurements are made as the air in the chambers is irradiated with UV lights. Comparison of the ozone formed in the three chambers allows the direct determination of the NO_x -limitation (VOC-rich) or VOC limitation (NO_x -rich) formation of ozone at a site. Most of the authors' measurements were made in Sacramento, California.

The authors used satellite observations made with the TROPOspheric Monitoring Instrument (TROPOMI) to test their direct measurements and to extend their results to the entire state of California. The TROPOMI measurements were consistent with a strong seasonal dependence of ozone sensitivity to NO_x and VOC in Sacramento. Higher emissions of VOC during the summer months appear to be the primary source of the seasonal variation.

Clearly this research is very relevant to policymakers for the development of emission control strategies to improve air quality. This study is not the first to develop and apply mobile smog chambers to air quality measurements at specific sites. For example, Mobile Smog Chamber, <https://www.psi.ch/en/lac/mobile-smog-chamber>; Kaltsonoudis et al., A portable dual-smog-chamber system for atmospheric aerosol field studies, Atmos. Meas. Tech., 12, 2733–2743, 2019. I believe that there was even a commercial chamber, about the size of a soccer ball, that was marketed to directly measure NO_x and VOC limitation by an Australian company (I apologize for not being able to find a reference). My point is that the authors should include a couple of paragraphs summarizing previous mobile chambers and discuss how their new system is an improvement.

The TROPOMI measurements are especially interesting in that they indicate how important biogenic emissions may be in California. I commend the authors for including both Figure 9 and Figure 10. Examination of Figure 9 seems to suggest that the HCHO/NO₂ ratio in the most populated regions, the San Francisco Bay Area and Los Angeles South Coast Air Basin (SoCAB), do not have a strong seasonal dependence while Figure 10 makes it clear that they have some. It might be good if the authors expanded their discussion of the relative and rather strong seasonal differences in the HCHO/NO₂ ratio between different sites in California.

My recommendation is that this paper is interesting, the research is sound but that the presentation could benefit from some minor revisions as suggested above.