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Comment on acp-2021-278

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Referee comment on "In situ ozone production is highly sensitive to volatile organic compounds in Delhi, India" by Beth S. Nelson et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-278-RC2>, 2021

The authors presented a relatively comprehensive analysis on the Ozone-NO_x-VOCs sensitivity analysis for the megacity - Dehli in India. The analysis is based on a comprehensive field measurements equipped with VOCs, oVOCs, NO_x, CO, SO₂, O₃ and HONO, jO₁D, jNO₂, etc in urban Dehli in the framework of APHH-India. According to the observations presented here in the paper, the analysis represent a special photochemistry took place in a highly polluted environments (NO can be up to more than 300 ppb and the total OH reactivity can be up to larger than 200 s⁻¹) . Interestingly, the ozone concentrations here in Dehli as well as the diagnosed ozone production rates were not higher compared to other cities such as Beijing, Shanghai, Guangzhou (Tan et al., ACP, 2019) and Los Angeles (Pollack et al., JGR, 2013) with the presence of much less NO_x and VOCs, etc. After a series of sensitivity analysis toward NO_x, VOCs, ASA and photolysis rates, the authors pointed out that coordinated reduction of Volatile Organic Compounds, Nitrogen Oxides as well as that of fine particles are necessary to avoid increased ozone pollutions in Dehli. Overall, this is a nice paper which fits the scope of ACP. I recommend publication after addressing the following comments.

Specific comments

- As the observed NO_x and VOCs is very high in Delhi (much higher than previously published conditions in urban areas since 1990s), it is very interesting why the observed O₃ concentrations were actually not high in Delhi. I compared the conditions of Dehli with that of Los Angels, and it is found that the current condition of Delhi is similar to that of 1970s in Los Angels (cf. Pollack et al., JGR, 2013). Nevertheless, in 1970s, the ozone concentrations were about 400 ppbv in Los Angels. So, it is actually quite useful for the authors to compare the observed conditions of air masses and the diagnosed ozone production rates and their controlling factors to other urban areas of the world (e.g. US, EU and China).

- Followed by comment 1, it would be useful to present the diurnal variations of the diagnosed P(O₃) in Section 3.4.
- Section 3.5 and 3.6, the study of the VOCs sensitivities by class may be represented by a well established metrics in the study of ozone photochemistry - relative incremental reactivity (C.A. Cardelino and W.L. Chameides, J. Air & Waste Manage. Assoc. 1995).
- Section 3.7, the study on the impact from the aerosol uptake and radiative forcing is very useful. Nevertheless, the study needs to be projected with more reality. With respect to the aerosol uptake effect, it can change the HO₂ uptake rates when NO is small which is not the case for Delhi; but it can also change the HONO production rate which might be more important for Delhi in this case (high NO₂ and high ASA). With respect to the change of the photolysis rates, the impact of aerosol could be complicated, the photolysis rates may be reduced in the near surface but enhanced in the higher place in the boundary layer when the aerosol SSA is high. The box model to diagnose the photochemistry processes is normally running with an assumption that the air mass is well mixed for the planetary boundary layer. Thus, the photolysis rates used in the model may be slightly different from the surface observations especially for the high aerosol atmosphere (i.e. Castro et al, AE, 2001). In short, the change of photolysis rates has to be much smaller than the current range and the discussion with that of aerosol shall be improved in this direction.
- The emission of monoterpene from anthropogenic sources is a new point worth to be highlighted. Even a paper Cash et al., 2021, in preparation is mentioned in the text some more description will be valuable also for this paper. The emissions from the process emission sector needs some more explains (e.g. which processes?).

Technical comments

- Indian megacity of Delhi, may be better writes like "the megacity Delhi, India", I think Delhi is a megacity also world wide.
- Cash et al., 2021, in preparation. should not be included in the reference list, it may be simply wrote in the line of 393 as (Cash et al., 2021, in preparation)
- Figure 9, the isopleth can be improved if more sensitivity model runs are included.