Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2021-650

Anonymous Referee #1

Referee comment on "Influence of convection on the upper-tropospheric O_3 and NO_x budget in southeastern China" by Xin Zhang et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-650-RC1, 2021

The manuscript by Zhang et al. provides a detailed analysis of the ozone and the NOx produced by two active thunderstorms in Nanjing. They combine lightning data, radar measurements, ozonesonde data and NOx and cloud measurements from space provided by TROPOMI. The ozone data shows an enhancement of the ozone concentration in the upper troposphere, which is investigated by using the WRF model. The authors estimate the role of convection and chemical production in the observed enhancement of ozone. In addition, they provide a new estimation of the NOx produced by lightning (LNOx) in one of the studied case.

The manuscript is well written and easy to read. The methods and conclusion are clearly explained, and the results are new. In particular, detailed studies of the chemical influence of thunderstorms in the atmosphere in the studied region are scarce because of the lack of aircraft campaigns. I do not have any major concern about this manuscript. However, I recommend that the authors clarify the following comments before the article can be published:

- Line 18: Huntrieser et al. (2016) measured ozone gradients in thunderstorms. Please cite and explain their results here. Mention again in lines 36-40.

Huntrieser, H., Lichtenstern, M., Scheibe, M., Aufmhoff, H., Schlager, H., Pucik, T., ... & Barth, M. C. (2016). On the origin of pronounced O3 gradients in the thunderstorm outflow region during DC3. Journal of Geophysical Research: Atmospheres, 121(11), 6600-6637.

- Lines 19 - 24: Murray et al. (2012) and Gordillo-Vázquez et al. (2019) used global models to study the relationship between LNOx and other trace gases. Please cite here.

Murray, L. T., Jacob, D. J., Logan, J. A., Hudman, R. C., & Koshak, W. J. (2012). Optimized regional and interannual variability of lightning in a global chemical transport model constrained by LIS/OTD satellite data. Journal of Geophysical Research: Atmospheres, 117(D20).

Gordilloâ□□Vázquez, F. J., Pérezâ□□Invernón, F. J., Huntrieser, H., & Smith, A. K. (2019). Comparison of six lightning parameterizations in CAM5 and the impact on global atmospheric chemistry. Earth and Space Science, 6(12), 2317-2346.

- Lines 43-44: Please give a brief explanation on why thunderstorms and lightning have increased due to urbanization. Is it because of the effect of aerosols on cloud electrification [Tao et al. (2012), Pérez-Invernón et al. (2021)]?

Tao, W. K., Chen, J. P., Li, Z., Wang, C., & Zhang, C. (2012). Impact of aerosols on convective clouds and precipitation. Reviews of Geophysics, 50(2).

Pérez-Invernón, F. J., Huntrieser, H., Gordillo-Vázquez, F. J., & Soler, S. (2021). Influence of the COVID-19 lockdown on lightning activity in the Po Valley. Atmospheric Research, 263, 105808.

- Line 46: Although described in other part of the manuscript, it could be useful for the reader giving a reference for TROPOMI here, as it is the first time it appears.

- Line 74: intro-cloud -> intra-cloud

- Section 2.2: The main weakness of the manuscript is the poor estimation on the DE of the employed lightning systems. A reliable estimation on the total number of lightning flashes is needed to calculate the LNOx. Would it be possible combining the lightning data from the used lightning dataset with lightning data from ISS-LIS in order to evaluate the combinience of using the 3:1 ratio? ISS-LIS reports IC+CG lightning. The DE of ISS-LIS is well established and quite constant all around the world [Blakeslee et al. (2020)].

Blakeslee, R. J., Lang, T. J., Koshak, W. J., Buechler, D., Gatlin, P., Mach, D. M., ... &

Christian, H. (2020). Three years of the lightning imaging sensor onboard the international space station: Expanded global coverage and enhanced applications. *Journal of Geophysical Research: Atmospheres*,*125*(16), e2020JD032918.

-Equation (1): I think a more detailed explanation on eq. (1) is needed.

- Lines 174- 176: Ripoll et al. (2014) developed a detailed chemistry model for lightning channel including ozone. It would be benefitial for the manuscript citing it at this point.

Ripoll, J. F., Zinn, J., Jeffery, C. A., & Colestock, P. L. (2014). On the dynamics of hot air plasmas related to lightning discharges: 1. Gas dynamics. Journal of Geophysical Research: Atmospheres, 119(15), 9196-9217.

- Line 246: There is still a significant uncertainty in the lifetime of NO2 in or near the field of convection [e. .g, Beirle et al. (2010), Pickering et al. 2016 ...]. According to literature, the lifetime can vary between 3 h and 2 days. Although it is mention below, please mention here.

- Lines 257-263: Comparing the sources of uncertainty in the text is hard. A Table for the uncertainties could be useful.

- Lines 276-279: Mention explicity if TROPOMI is useful or not here.