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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Long-term Variations in Ozone Levels in the Troposphere and Lower Stratosphere over Beijing: Observations and Model Simulations" *by* Yuli Zhang et al.

Anonymous Referee #1

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This paper presents ozonesonde observations of ozone in the troposphere and stratosphere in Beijing during 2002-2018. The data are analyzed with a stratospheric ozone tracer model and discussed qualitatively in the context of recent emission changes in Beijing and satellite NO2 data. The ozonesonde data provide valuable information on the ozone variations during this period of drastic changes in anthropogenic pollutants in Beijing and are an important contribution to ozone and climate research. I have some concerns on analysis and interpretation of the results. The paper can be accepted after these concerns have been addressed.

Major comments:

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Discussion paper

(1) A sudden drop in lower tropospheric ozone (< 3 km) after 2011 is surprising. It is inconsistent with satellite NO2 data shown in Fig 5 (and NOx emission inventory) which indicate gradual decrease in NOx emission after 2011. Recently reported surface measurements at two rural sites near Beijing (Shangdianzi and Gucheng) also did not observe sudden ozone drop around 2011/12 (Xu et al., 2020). I suggest comparing satellite observed tropospheric ozone to verify the sudden change observed in the present study. If no problem is found on data quality, the stepwise change is most likely due to change in large scale dynamics after 2011. The stratospheric model used in this study shows little change in stratospheric contribution to lower tropospheric ozone, but it may be the case that transport within the troposphere played a role. I suggest author add more analysis in this direction. For example, back trajectories can be calculated to see if there was change in transport from other parts of troposphere after 2011.

(2) The trend analysis can be improved; it is not clear why the trend calculation in the main text is different from the linear regression shown in the figures. In addition, the level of statistical significance in trend analysis should be provided.

(3) The lower tropospheric ozone in the present study appeared to have a small positive trend after the 2011 drop (Fig 3). This trend is not supported by author's contention that NOx reduction has decreased ozone. It is instead similar to surface ozone increase observed in many urban areas from the Ministry of Ecology and Environment network since 2013, which has been attributed to the nonlinear chemistry of ozone precursors (NOx emission decrease and VOC emission increase) and aerosol decrease, as well as being affected by meteorological variation (see for example, Li et al., 2019; Liu and Wang, 2020).

Minor comments:

Page 2, line 40-42, "Increasing surface ozone . . ." . Please note that recent studies have shown levelling off/decrease in surface ozone levels in rural areas of eastern China and in outflow of eastern China air masses (Xu et al., 2020; Wang et al., 2019).

Page 2, line 56, Consider modifying the statement “it is not known. . .” as it contradicts the author’s earlier review of Dufour (2018) on the lower tropospheric ozone trend in NCP (which includes Beijing).

Page 2, line 100, Define “average percentage method”, and clarify why a different (linear regression method) is used in the figures.

References

Xu, X., Lin, W., Xu, W., Jin, J., Wang, Y., Zhang, G., Zhang, X., Ma, Z., Dong, Y., Ma, Q., Yu, D., Li, Z., Wang, D. and Zhao, H., 2020. Long-term changes of regional ozone in China: implications for human health and ecosystem impacts. Elem Sci Anth, 8(1), p.13. DOI: http://doi.org/10.1525/elementa.409

Wang, T, Dai, J, Lam, KS, NanPoon, C and Brasseur, GP. 2019. Twenty-five years of lower tropospheric ozone observations in tropical East Asia: The influence of emissions and weather patterns. Geophys Res Lett 46. DOI: 10.1029/2019GL084459

Li, K., Jacob, D. J., Liao, H., Shen, L., Zhang, Q., and Bates, K. H.: Anthropogenic drivers of 2013-2017 trends in summer surface ozone in China, P Natl Acad Sci USA, 116, 422-427, 2019.

Liu, Y., and Wang, T.: Worsening urban ozone pollution in China from 2013 to 2017 – Part 1: The complex and varying roles of meteorology, Atmos. Chem. Phys. Discuss., 2020, 1-28, 10.5194/acp-2019-1120, 2020.

Liu, Y., and Wang, T.: Worsening urban ozone pollution in China from 2013 to 2017 – Part 2: The effects of emission changes and implications for multi-pollutant control, Atmos. Chem. Phys. Discuss., 2020, 1-27, 10.5194/acp-2020-53, 2020.

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