Responses to Review #3

Ozone pollution is becoming a growing challenge in China, and the meteorology plays a significant role in how it changes. The study by Yang et al. investigated the meteorological characteristics during the high ozone months in four polluted cities in China. They also looked at how these meteorological factors have changed in the past and might change in the future, thereby providing implications for ozone control strategies. The topic is clear and interesting, and the paper is well organized and easy to follow. The results emphasize to the community that future climate warming could exacerbate ozone pollution in China.

We thank the reviewer for the helpful comments. Below, please see our point-by-point response (in blue) to the specific comments and suggestions and the changes that have been made to the manuscript, in an effort to take into account all the comments raised here.

The one difficulty I have with judging the relevance of the findings is that they only analyzed one specific month with extremely high ozone in each region, and all the subsequent statements rely on the meteorological conditions prevalent during those specific months. It seems potentially non-representative. The paper would be much stronger if the authors would evaluate all the high ozone months for each region or convincingly demonstrate to readers that the representativeness of the selected months.

Response:

Thank you for the suggestion. We agree with the reviewer that more analysis would be better for the understanding the meteorological characteristics of ozone (O_3) pollution in China. Many previous studies have analyzed the synoptic patters of regional O_3 pollution in China and found several meteorological conditions could lead to O_3 pollution. In this study, we focus on the most extreme O_3 pollution cases in many regions of China rather than the high O_3 pollution cases in a particular region. The similar scientific question and method have been applied in aerosol pollution studies (e.g., Li et al., 2018; Yang et al., 2021). We admit that other meteorological conditions besides the ones we analyzed in the manuscript can also cause regional O_3 pollution. However, these high pollution cases are much more complicated and are suit for further analysis in the individual regions.

We have now added a statement in the discussion as “In addition, this study focuses on the most extreme O_3 pollution in several polluted areas of China. However, many other meteorological conditions can also cause O_3 pollution, although they may not be as extreme as the cases analyzed in this study, which requires comprehensive analysis for individual regions in future studies.”

Specific comments:

1. The authors looked at ozone during April-September. Please consider extend it to October since the warm season is longer in PRD.

Response:

Thank you for the suggestion. We have now included October and the results do now change.

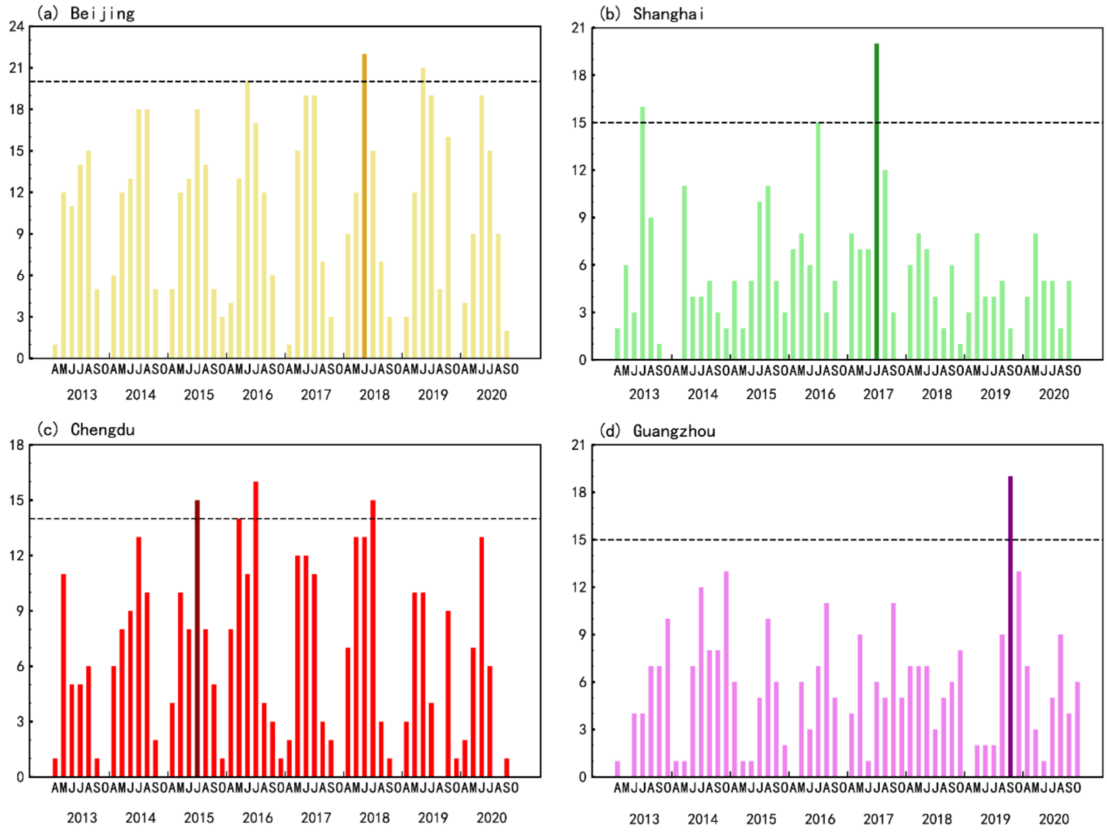

Figure 1. Time series of frequencies of severe O_3 pollution days (defined by daily maximum of 8-h average ozone (MDA8-O_3) concentration greater than 160 μg m^{-3}) in Beijing, Shanghai, Chengdu and Guangzhou (a–d) from April to October during 2013–2020. The dark-colored bars represent the most severe month (second most for Chengdu) that has the highest frequency of O_3 pollution days for the individual cities.

2. Figure 8, could the authors explain more on how they calculated the spatial correlation?

Response:

The spatial correlation is calculated between SLP/GPH anomalies over East Asia and Western Pacific (EAWP, 90°–160°E, 20°–60°N) in the polluted month, June 2018 for example, and those over the same region in the target month (June as example) of each year during 1980–2020. The method has been widely used in determining the similarity of atmospheric circulation patterns. We have modified the description in the figure caption.

3. Line 161, “simulations” is misspelled.

Response:

Corrected.

4. Line 196, “northwesterly winds” is inconsistent with the following description “from the north and east”.

Response:

Thank you for pointing out this typo. It has been corrected to “from the north and west”.

5. Figure 2, please consider enlarging the font size.

Response:

Done.

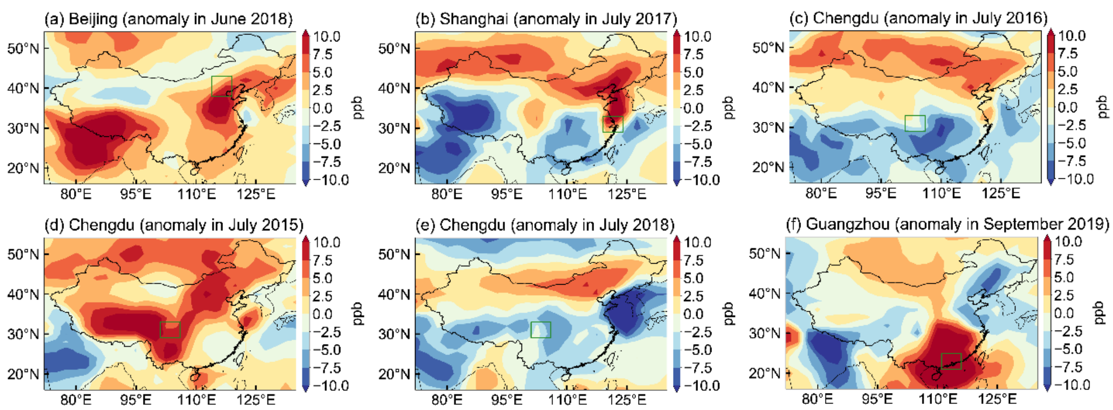

Figure 2. Spatial distribution of monthly O_3 concentration anomalies (part per billion, ppb) in June 2018 (a), July 2017 (b), July 2016 (c), July 2015 (d), July 2018 (e) and September 2019 (f) relative to 40-year (1980–2019) monthly average for June (a), July (b, c, d, e) and September (f), simulated in the GEOS-Chem model. The green boxes mark NCP (a), YRD (b), SCB (c, d, e) and PRD (f).

6. Figure 9, please consider labeling each subplot with its corresponding target region.

Response:

Added.

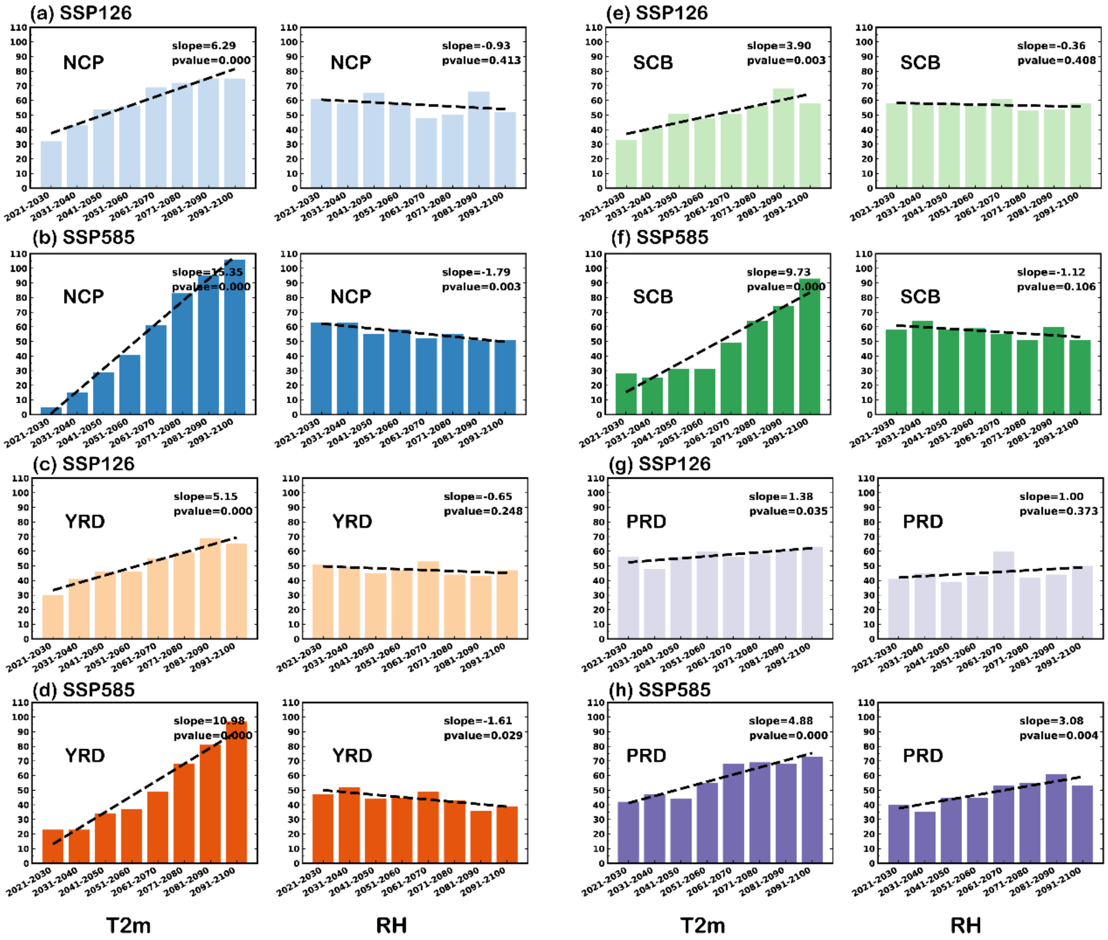

Figure 9. Frequencies of extreme months with T2m or RH anomalies exceeding the 80th percentile or below the 20th percentile of the distributions over NCP (115°–120°E, 38°–44°N) (a, b), YRD (120°–125°E, 28°–32°N) (c, d), SCB (102.5°–105°E, 30°–32°N) (e, f) and PRD (110°–115°E, 22°–26°N) (g, h) in each 10-year interval during 2021–2100 under two SSPs future scenarios of 13 CMIP6 models. The two SSPs are SSP1-2.6 and SSP5-8.5. The slope and P values of the linear regression during 2021–2100 are shown in the upper right of each panel.

References:

Li, K., Liao, H., Cai, W., and Yang, Y.: Attribution of anthropogenic influence on atmospheric patterns conducive to recent most severe haze over eastern China, Geophys. Res. Lett., 45, 2072–2081, https://doi.org/10.1002/2017gl076570, 2018.

Yang, Y., Zhou, Y., Li, K., Wang, H., Ren, L., Zeng, L., Li, H., Wang, P., Li, B., and Liao, H.: Atmospheric circulation patterns conducive to severe haze in eastern China have shifted under climate change, Geophys. Res. Lett., 48, e2021GL095011, https://doi.org/10.1029/2021GL095011, 2021.