Response to the review of "Impact of western pacific subtropical high on ozone pollution over eastern china":

We thank the referee for the detailed and constructive comments. We respond to each specific comment below. The referee's original comments are shown in blue. Our replies are shown in black. The corresponding changes in the manuscript are shown in *Italic black*.

Anonymous Referee #3

This paper is studying the impact of Western Pacific Subtropical High (WPSH), a major synoptic system bringing specific meteorological conditions, on ozone over Eastern China in the summer months. It shows that when this system is strong, Northern China is seeing higher ozone compare to normal WPSH conditions. When the system is weak, Southern China is seeing higher ozone compare to normal WPSH conditions. Using the CTM GEOS-Chem, the authors show that chemistry (net chemical production = reaction rate and amount of ozone precursors) has a decisive role for ozone changes with respect to WPSH conditions. Natural emissions of precursors from biogenic and soil sources which are impacted by the temperature modulated by WPSH shows a non-negligible role to ozone changes. The paper is investigating in more details the role of WPSH on ozone variability, complementing the work of Zhao and Wang 2017, using the CTM GEOS-Chem, which is very much appreciated. The manuscript is well written and the figures well displayed. I am in favor of its publication after taking into account the following minor remarks.

Abstract:

L 19-20: The sentence implies that meteorological conditions is the main factor that controls ozone production when it is only one of several factors (emissions of ozone precursors, amount of ozone precursors, amount of other species such as PM2.5, chemical regimes, etc. . .). The authors mention it at the end of the

abstract but it should be clear right in the beginning of the paragraph.

Thanks for pointing this out. We acknowledge that ozone production is also influenced by some other factors. We now also mentioned other factors at the beginning of the paragraph. However, as the meteorological conditions is the major focus of this study, we added discussions of its relevance with other factors rather than putting these factors in a juxtaposition structure.

[Abstract, Lines 19-22]:

The formation of surface ozone pollution highly depends on meteorological conditions which are largely controlled by regional circulation patterns, which can modulate ozone concentrations by influencing the emission of the precursors, the chemical production rates, and regional transport.

Introduction:

L. 48: The authors should add the following publications Mills et al. (2018) and Fleming and Doherty et al. (2018) from the Tropospheric Ozone Assessment Report (TOAR):

Tropospheric Ozone Assessment Report: Present-day tropospheric ozone distribution and trends relevant to vegetation. Mills G, Pleijel H, Malley CS, Sinha B, Cooper OR, Schultz MG, Neufeld HS, Simpson D, Sharps K, Feng Z, Gerosa G, Harmens H, Kobayashi K, Saxena P, Paoletti E, Sinha V, Xu X,. Elem Sci Anth. 2018;6(1):47. DOI: 10.1525/elementa.302.

Tropospheric Ozone Assessment Report: Present-day ozone distribution and trends relevant to human health. Fleming, Z.L., Doherty, R.M., von Schneidemesser, E., Malley, C.S., Cooper, O.R., Pinto, J.P., Colette, A., Xu, X., Simpson, D., Schultz, M.G., Lefohn, A.S., Hamad, S., Moolla, R., Solberg, S. and Feng, Z., 2018. Elem Sci Anth, 6(1), p.12. DOI: 10.1525/elementa.73.

Thanks for your suggestion. We have added these two references accordingly.

Data and methods:

L. 141: The authors should further explain and detail the composite analysis.

Thanks for pointing this out. We explained the detail of the composite analysis.

[Main text, Lines 159-168]:

Composite analysis of observed and simulated surface ozone, meteorological variable as well as related model processes are performed based on these three types. We first calculate the composite mean of each variable for the 46 days of each WPSH type. As we focus on the ozone and meteorology differences induced by WPSH variation, we further calculated and discussed the difference of the composite mean between strong and normal WPSH as well as between weak and normal WPSH. The statistical significance of the difference is tested using the Student's-t test. We consider that the two composite means are statistically different if the test result is significant above 95% level. All figures except Figure 1 are displayed in the form of the differences between composite means.

Results:

L.212: Typo, change "," to "."

Revised as suggested. Thank you.

L.218: As already mentioned, the composite analysis should be further explained and detailed in the method section.

We have added details of the composite analysis in the method section, and we answered this above.

L. 263: The authors should clarify they interpretation of ozone enrichment and dilution from the wind anomalies (strong versus normal or weak versus normal WPSH).

Thanks for pointing this out. We clarified this by adding the specific ozone change directions corresponding to the wind anomalies.

[Main text, Lines 315-321]:

(2) the transport indicated by wind anomalies serves to enrich or dilute ozone concentration depending on the wind direction. Take Southern China as an example, the anticyclonic wind anomalies under strong WPSH tend to dilute ozone and the cyclonic wind anomalies under weak WPSH tend to enrich ozone, which is also confirmed in the budget analysis in section 3.4 below. Alternatively, this wind anomaly pattern drives an opposite change in ozone pollution over Northern China.

L. 281: Does 0.57 translate a reliable model performance? It seems rather modest. The authors should give a range of reliable models and their performance in terms of correlation coefficients. That would guide readers who are not experts in models performances. Could the authors add the (normalized) mean bias as well? This more exhaustive evaluation for summer months would nicely complement the work on spring months in Ni et al. (ACP 2018) cited by the authors.

Ni, R., Lin, J., Yan, Y., and Lin, W.: Foreign and domestic contributions to springtime ozone over China, Atmos. Chem. Phys., 18, 11447–11469, https://doi.org/10.5194/acp-18-11447-2018, 2018.

Thanks for pointing out this problem. We acknowledge that the coefficient of 0.57 is a modest value; however, it is acceptable in terms of model simulations. As the coefficients always varied with many factors such as years and the number of sites, it is difficult to provide a definable range for a reliable model. What we can do is to compare these evaluating parameters with previous model studies, which we find are close to our results. We added the normalized mean bias of the summer seasonal mean surface ozone MDA8 in the supplementary (Figure S5); we also added discussions about model performance in the main text.

[Main text, Lines 334-342]:

The spatial correlation coefficients (R) between the observed and simulated seasonal mean MDA8 concentrations for summers from 2014 to 2018 are 0.57, 0.59, 0.70, 0.81, and 0.81, respectively. The mean bias (normalized mean bias) between the observed and simulated seasonal mean MDA8 concentrations are in the range of 7.1-9.4 ppbv (13%-22%) for summers from 2014 to 2018 (Figure S5). These evaluation results are comparable to those reported in previous studies (Lu et al., 2019b; Ni et al., 2018), despite the slight differences due to differences in season and sampling, proving the confidence of using GEOS-Chem to simulate ozone concentrations.

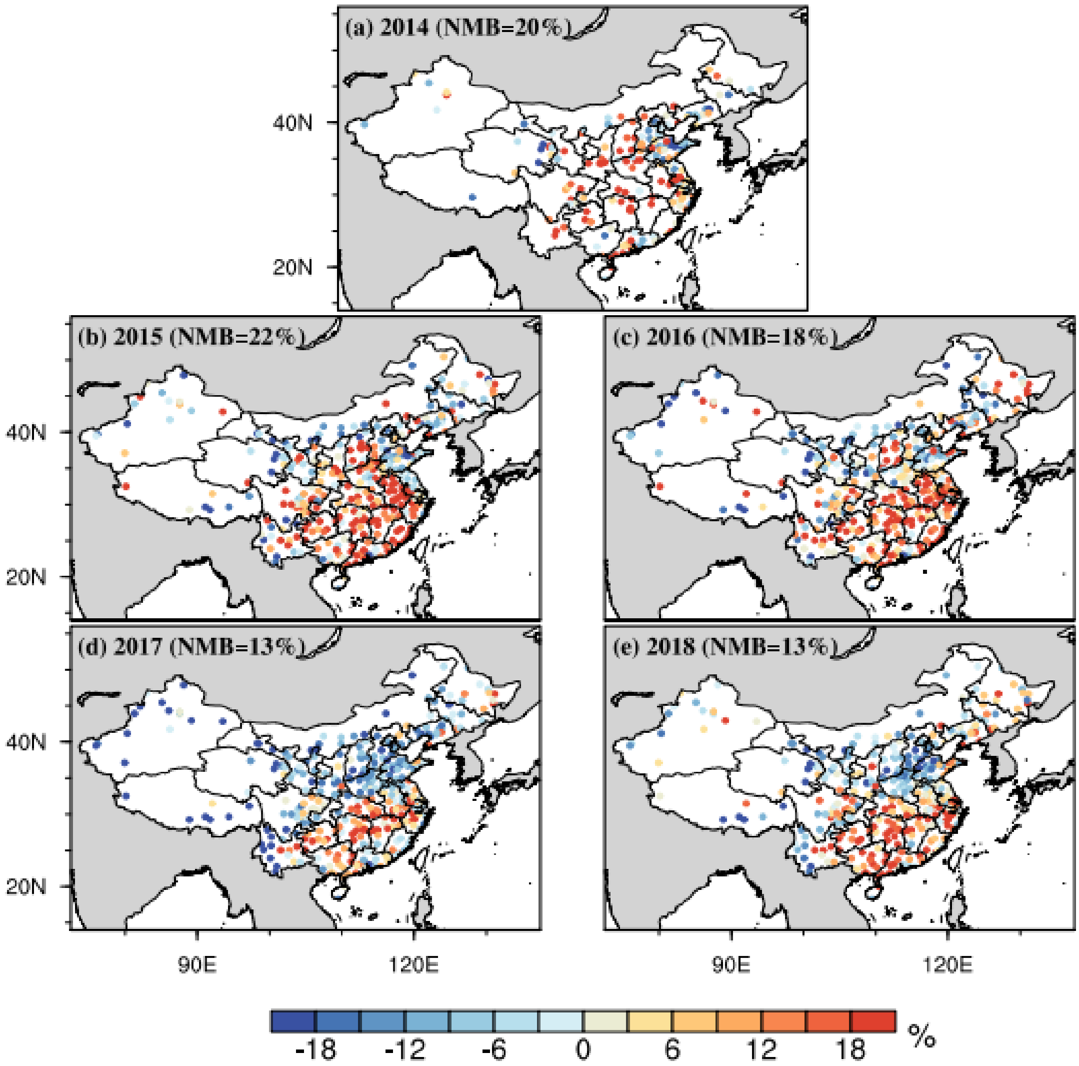

Figure S5. Normalized mean bias (%) between simulated and observed seasonal mean surface ozone MDA8 concentration (ppbv) over China for summer from 2014 to 2018 (a-e).

L. 310: How do the authors conclude about dilution and accumulation of ozone based on maps of wind anomalies only? This statement deserves more details and/or references.

Thanks for pointing this out. First, the budget change in Figure 4c and the maps of wind anomalies are mutually verified. We are not concluding about dilution and accumulation of ozone solely based on the maps of wind anomalies. Second, the correlation analysis with winds (shown below in the bottom row of Figure S3) also supports this conclusion. We added details in the main text to emphasize this point.

[Main text, Lines 377-383] :

For strong WPSH, the change of ozone budget due to transport exhibits an asymmetric pattern with decreases in most parts of Southern China and increases over Northern and Northeastern China (Figure 4c). As the correlation analysis shows that ozone responds to meridional wind positively in the north and negatively in the south (Figure S3i), the changes in transport budget are consistent with the WPSH-induced wind anomalies (Figure 3a), which tends to dilute surface ozone in the south and enhance it in the north.

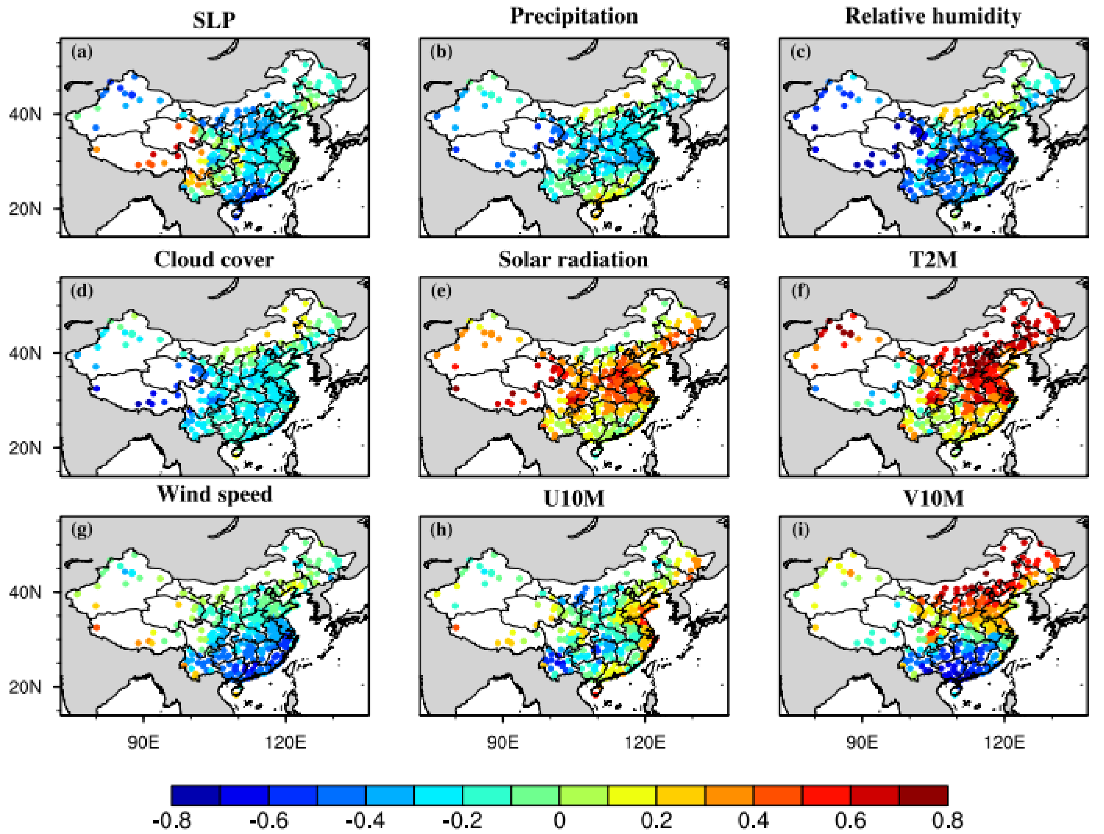

Figure S3. Correlation coefficients, between simulated daily MDA8 ozone concentrations and meteorological variables including SLP, precipitation, relative humidity, cloud cover, solar radiation, 2 m temperature, wind speed, 10 m U wind, and 10m V wind calculated for the summer periods from 2014 to 2018.

L.315: Did the authors mean "free troposphere"?

Revised as suggested. Thank you.

L. 356: Add "(see Section 3.3)" as it seems to refer to the findings above.

Revised as suggested. Thank you.