Comments Response

Journal: Atmospheric Chemistry and Physics

Manuscript ID: acp-2020-1302

Title: "Unexpected enhancement of ozone exposure and health risks during National Day in China"

Dear Referee #1,

We appreciate your comments to help improve the manuscript and tried our best to address your comments. The detailed responses and related changes are shown in below. Our response is in blue and the modifications in the manuscript are in red. All figures are included in the attached PDF file.

General:

The manuscript presents a topical research, i.e. to understand the elevated O3 issue in China due to the holiday impact. This study reported that the drastically rising MDA8 O3 were observed during the CNDH with the increasing rate up to 120% even in some pristine regions, which also induced 33% additional deaths through China. It was shown that increased precursor emissions and regional transport were corresponding to the O3 elevation. This is the first comprehensive study to investigate O3 pollution during CNDH at national level and could provide useful suggestion for the policy makers. The manuscript is easy to follow and fit to the scope of ACP very well. I have some minor comments below for the authors to address.

Response: Thanks for the recognition of our study. Below is the response to each specific comment.

Minor comments:

Line 90~91: Could the author explain more for the IPR and PA tools in the CMAQ model?

Response: The IPR (integrated process rate analysis) and IRR (integrated reaction rate analysis) are all defined as the PA (process analysis) in the CMAQ model (https://www.cmascenter.org/cmaq/science_documentation/pdf/ch16.pdf+&cd=1&hl=zh-CN&ct=clnk). PA aims to provide quantitative information on the process of the chemical reactions and other atmospheric processes that are being simulated, illustrating how the CMAQ model calculated its predictions. The IPR analysis quantifies the relative contributions of individual atmospheric physical and chemical processes in the CMAQ model.

Changes in manuscript: (lines 95-100) In the CMAQ model, the IPR and integrated reaction rate analysis (IRR) were all defined as the PA. PA aims to provide quantitative information on the process of the chemical reactions and other atmospheric processes that are being simulated, illustrating how the CMAQ model calculated its predictions. The IPR was used to determine the relative contributions of individual atmospheric physical and chemical processes in the CMAQ model.

Line 135~136: as readers may not be familiar with West China, please add a reference to show that West China has less anthropogenic impacts.

Response: Thanks for the comments. We've added a related reference to show the less anthropogenic impact of West China.

Changes in manuscript: (lines 141-142) Negligible MDA8 O_3 increase in West China is consistent with vast rural areas and less anthropogenic impacts (Wang et al., 2017).

Line 147~148: it should be mentioned that MDA8 O3 in Shanghai during the CNDH slightly decreased compared with that before CNDH.

Response: We have checked the observation data and confirm that the MDA8 O_3 in Shanghai increased from 58.3 ppb to 63.2 ppb during the CNDH (Table S3). The reviewer may refer to the graphical abstract, which shows decreased total daily mortality in Shanghai but not decreased O_3 levels. The model simulation slightly underestimates the observed O_3 levels in Shanghai during the CNDH, which causes the decreased total daily mortality. We have re-arraged the related content to better clarify this point in Line 273-274.

Changes in manuscript: (lines 273-274) Except for Shanghai (in which O_3 is slightly underestimated), the other eight key cities increased their total daily mortality rates from PRE-CNDH to CNDH.

Line 188: could the author explain more about meteorology impacts such as the variation of the temperature on the O3 during the CNDH?

Response: Thanks for the comment. We've added more analysis of the meteorology impacts in section 3.3.

Changes in manuscript: (line 218-224) Regional transport is also a significant contributor to enhanced MDA8 O_3 during CNDH. As shown in Fig. S5, the lower temperature is predicted during the CNDH compared to the PRE-CNDH. In PRD, the average temperature drops from 25 °C to 23 °C, leading to a lower O_3 level in previous studies (Fu et al., 2015;Bloomer et al., 2009;Pusede et al., 2015). Meanwhile, the increasing wind speed is predicted in the PRD, which is able to facilitate regional transport. The higher O_3 production rates that are calculated by the PA process directly in the CMAQ model (increase rate up to ~150%) are predicted mainly in the urban regions (the NCP, YRD, and PRD) in China (Fig. S7).

Line 195: Could the author discuss how will the coefficients from the AMAP be applied in the emission inventory?

Response: In the future study, we consider using the real-time coefficients from the AMAP to adjust the traffic emissions. First, an average emission adjustment factor from AMAP will be applied in the simulation during the CNDH to investigate the impacts on O_3 throughout China. And then, a daily or even hourly adjustment factor (if possible) will be applied in the transport emission. In addition, the localized real-time traffic flow data will be considered (if available) as well as the coefficients from AMAP, aiming to reflect the emission variations during the CNDH on a regional scale. By including the localized real-time data, we will be capable of conducting a more compressive study of the emission changes of the traffic sector during the CNDH.

Line 228: please label the key cities in the PRD in the Figure 4

Response: We have labeled the key cities (GZ: Guangzhou, SZ: Shenzhen, and ZH: Zhuhai) in the revised Figure 5 (Also shown in the figure below R1-1).

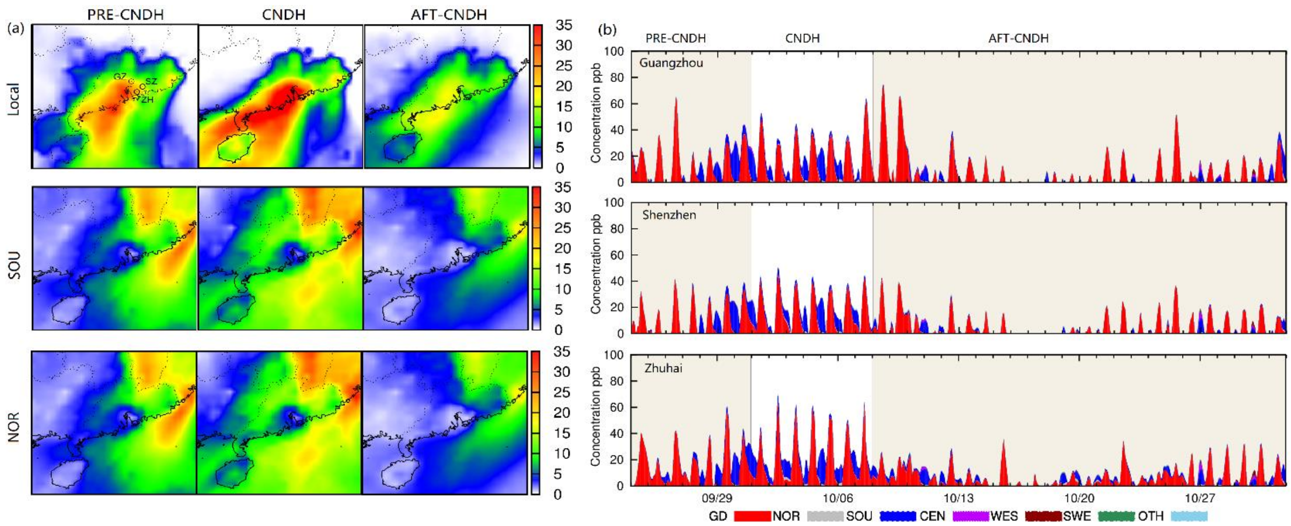

Figure R1-1. (a) Average regional contributions to non-background O_3 from the PRD local emissions and emissions in SOU, and NOR sectors and (b) regional contributions from all sectors to non-background O_3 in the PRD key cities (Guangzhou, Shenzhen, and Zhuhai) during the simulation periods. GZ: Guangzhou, SZ: Shenzhen, and ZH: Zhuhai.

References:

Bloomer, B. J., Stehr, J. W., Piety, C. A., Salawitch, R. J., and Dickerson, R. R.: Observed relationships of ozone air pollution with temperature and emissions, Geophysical Research Letters, 36, 2009.

Fu, T.-M., Zheng, Y., Paulot, F., Mao, J., and Yantosca, R. M.: Positive but variable sensitivity of August surface ozone to large-scale warming in the southeast United States, Nature Climate Change, 5, 454-458, 2015.

Pusede, S. E., Steiner, A. L., and Cohen, R. C.: Temperature and recent trends in the chemistry of continental surface ozone, Chemical reviews, 115, 3898-3918, 2015.

Wang, J., Zhao, B., Wang, S., Yang, F., Xing, J., Morawska, L., Ding, A., Kulmala, M., Kerminen, V.-M., Kujansuu, J., Wang, Z., Ding, D., Zhang, X., Wang, H., Tian, M., Petäjä, T., Jiang, J., and Hao, J.: Particulate matter pollution over China and the effects of control policies, Science of The Total Environment, 584-585, 426-447, https://doi.org/10.1016/j.scitotenv.2017.01.027, 2017.

Comments Response

Journal: Atmospheric Chemistry and Physics

Manuscript ID: acp-2020-1302

Title: "Unexpected enhancement of ozone exposure and health risks during National Day in China"

Dear Referee #2,

We appreciate your comments to help improve the manuscript and tried our best to address your comments. The detailed responses and related changes are shown in below. Our response is in blue and the modifications in the manuscript are in red. All figures are included in the attached PDF file.

This manuscript investigates the causes of high O3 episode during Chinese National Day Holiday using CMAQ modeling. The high O3 concentration is found to be caused by enhanced anthropogenic emissions and regional transport. Further, the health risks of these high O3 episode are estimated based on the response function of premature mortality of O3 exposure. The scope of this manuscript is of interest and fits the Atmospheric Chemistry and Physics journal. However, the illustration of the manuscript makes it a bit difficult to review fairly. The readability can be easily improved by elaborating several key terminologies and large fonts in figures. For example, two terms "O3_VOC" and "O3_NOx" are discussed throughout the manuscript to diagnose the O3 chemistry, but they are not clearly defined in the manuscript. The font of figure 3 is too small. The color scheme in figure 4b is impossible to read. I believe this study is publishable, but requires substantial revisions.

Response: Thanks for the comments. In the revision, we tried our best to modify our manuscript, including the related figures (Figure 3 and Figure 4b) to improve our study. Below is the response to each specific comment.

1. The importance of regional transport. Look at Figure 2a CNDH, the O3 concentration is up to 100 ppb in south China sea around Hainan and it is higher than the mainland China. Is this real? If so, what's the impact of such high O3 concentration on southern China? Is this the major cause of the high O3 episode during CNDH? Figure S5 suggests the prevailing wind direction is from mainland to ocean during CNDH in CMAQ. Is this consistent with local measurements? Line 217 indicates the south wind is prevailing. I am confused.

Response: From Figure 2a and Figure S5, the high O_3 in the sea around Hainan is mainly due to the regional transport under the impact of the north wind. The O_3 observation data in the south China sea is not available, so we couldn't further evaluate the O_3 level in the ocean. While Table S5 and Figure 2a showed our predicted O_3 agreed well with the observed O_3 throughout China, which could provide robust results for the air quality analysis. Our study also concluded that the regional transport corresponds to the elevated O_3 during the CNDH (in section 3.3). In addition, we also compared the observed and predicted wind field in the key cities (Guangzhou and Shenzhen; Zhuhai's data was not available) in the attached PDF file (Figure R2-1 and R2-2). It is shown in Figures R2-1 and R2-1 that the prevailing wind direction is north, which is consistent with the prediction. The line 217 should be "north wind". Sorry for the mistake and we have corrected it in the revised manuscript.

Changes in manuscript: (line 236-238) The SOU sector is the most crucial contributor among all these regional sectors outside Guangdong due to the prevailing north wind.

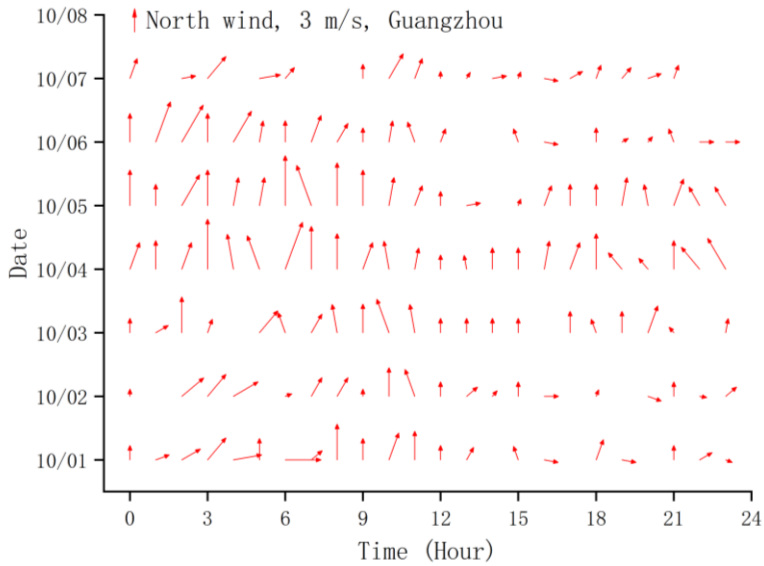

Figure R2-1. The observed wind field in Guangzhou during the CNDH.

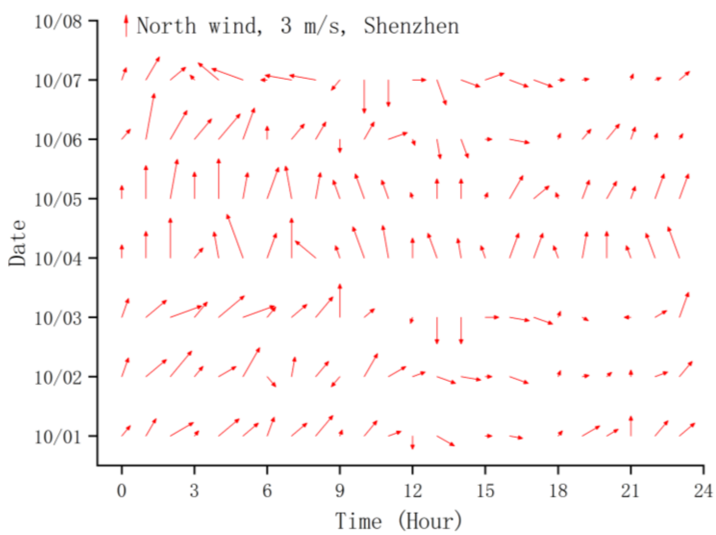

Figure R2-2. The observed wind field in Shenzhen during the CNDH.

2. Line 24. This “303%” overstates the health risk, because the absolute difference is small (0.4 vs 1.6 in Figure 5).

Response: Thanks for the comment. We used the absolute number in the revised manuscript instead of the increasing, which may avoid the ‘overestimation’ of the health risk. The aggravated health risk in the tourist cities such as Sanya is a crucial message for our study, and we prefer to keep this message in the abstract.

Changes in manuscript: (line 23-24) Moreover, in tourist cities such as Sanya, daily mortality even increases significantly from 0.4 to 1.6.

3. The following terminologies/calculations should be elaborated: O3_VOC, O3_NOx, O3 production rate, and exceeding rate (Figure 1c).

Response: Thanks for the comment. We have elaborated these terminologies in the manuscript and corresponding figures caption.

Changes in manuscript: (line 76-80) Two non-reactive O_3 species: O_3_NO_x and O_3_VOC are added in the CMAQ model to quantify the O_3 attributable to NO_x and VOCs, respectively. In particular, O_3_NO_x stands for the O_3 formation is under NO_x -limited control, and O_3_VOC stands for the O_3 formation is under VOC-limited control. The details of the 3R scheme and the calculation of O_3_NOx and O_3_VOC are described in *Wang et al.* [2019]. (line 157-160, caption of Figure 1) Figure 1. (a) The observed average MDA8 O_3 in PRE-CNDH, CNDH and AFT-CNDH in South, East, West and North China in 2018; (b) The increase rate of observed MDA8 O_3 during CNDH; (c) The exceeding rate of observed MDA8 O_3 in CNDH and October (the exceeding days during the CNDH divided by that during the October, exceeding_CNDH/exceeding_October). (line 181-183, caption of Figure 2) Figure 2. (a) Comparison of observed (circle) and predicted MDA8 O_3; (b) Spatial distribution of O_3_NO_x; (c) Spatial distribution of O_3_VOC in China in PRE-CNDH, CNDH and AFT-CNDH, respectively. Units are ppb. O_3_NO_x and O_3_VOC are the O_3 attributed to NO_x and VOCs, respectively. (caption of Figure S7 in the supplement) The O_3 production rates stand for the total production of O_3 by adding all reactions that O_3 is defined as a product. (line 222-224) The higher O_3 production rates that are calculated by the PA process directly in the CMAQ model (increase rate up to ~150%) are predicted observed mainly in the urban regions (the NCP, YRD, and PRD) in China (Fig. S7).

4. To corroborate the estimated health risks, the estimated daily mortality (non-accidental causes) should be compared to real mortality data, if possible.

Response: Thanks for the comment. The real mortality data is not available although we have tried our best to find this data.

Reference:

Wang, P., Y. Chen, J. Hu, H. Zhang, and Q. Ying (2019), Attribution of Tropospheric Ozone to NOx and VOC Emissions: Considering Ozone Formation in the Transition Regime, *Environmental Science & Technology*, *53*(3), 1404-1412, doi:10.1021/acs.est.8b05981.

Comments Response

Journal: Atmospheric Chemistry and Physics

Manuscript ID: acp-2020-1302

Title: "Unexpected enhancement of ozone exposure and health risks during National Day in China"

Dear Referee #3,

We appreciate your comments to help improve the manuscript and tried our best to address your comments. The detailed responses and related changes are shown in below. Our response is in blue and the modifications in the manuscript are in red. All figures are included in the attached PDF file.

General:

The paper investigates the causes of increase in surface ozone concentration in China during the Chinese National Day Holidays (CNDH) in 2018. The authors used CMAQ model to simulation O3 production during three periods of pre, during, and after (CNDH). The result shows that the increased O3 values during CNDH are due to increase in precursor emissions and also regional transport. The impact of enhanced O3 during CNDH on public health and mortality rate in major cities in China.

The paper is well-written and fits to scope of ACP. However, it needs some clarifications on the changes in the anthropogenic emissions in the three periods. If no changes were made to the anthropogenic emission inventory to reflected the changes in emissions due to the national holiday how are you attributing the changes in O3 to this event? The relative contribution of biogenic vs. anthropogenic emissions needs to be discussed further in the paper. It may play an important role in the variation in O3 concentrations and it is totally dismissed. Please see the comment sections for the details.

Response: Thanks for the recognition of our study. We've tried our best to address these comments to improve our research. Below is the response to each comment.

General comments:

What does regional transport mean in the scale of your study? All the paper on regional transport in China that are cited in the introduction discuss one region in China and the impact of transport from a region to another hence "regional transport". Specifically, I am referring to P3, L61 where you stated the rapid increase of O3 throughout China is attributed partly to regional transport. What does this mean if the transport is between subregions in your domain?

Response: In our study, the regional transport of O_3 means the O_3 concentrations are from other regions (including one region and multiple subregions) and transported to the target region. In our model, we could track O_3 from one or multiple subregions (provinces in our study) by tagging its precursors [*Wang et al.*, 2019; *Wang et al.*, 2020] and quantify their contributions to the target region (in our study is Guangdong province). In the sentence, we inclined to emphasize the elevated O_3 during the CNDH is partly due to regional transport. For example, we tagged the O_3 percussor emissions in Beijing and other regions. Then, they formed O_3 that was transported to Shanghai under the impact of northerly wind. This is what we define as regional transport in our study.

Section 2.1: Please note in the main text that October emission is industry and residential sectors are higher than September emissions. The monthly variation in emission inventory (between September and October) can play a role in variations in O3 concentrations and it is not discussed in the paper.

Response: Thanks for the comment. We've added more related discussion in the revision.

Changes in manuscript: (line 89-90) The higher emissions rates were found during October from the residential and industrial sectors, while they kept the identical levels from transportation and power sectors. (line 195-196) These increasing O_3 precursors emissions are mainly from the residential and transportation sectors (Table S1), indicating their important roles in the elevated O_3 during the CNDH.

Section 2.1: I am not familiar with MEIC inventory, does it have a diurnal or monthly variation? Please provide more information.

Response: The detailed information of MEIC inventory could be found at http://meicmodel.org/?page_id=560. The MEIC inventory provides both annual and monthly variation inventories, and you can download this emission inventory at either temporal-resolutions. The MEIC emission did not provide the diurnal variation. In our study, we used the annual MEIC emissions and re-distributed them to monthly/daily resolution according to [*Zhang et al.*, 2007] and [*Streets et al.*, 2003]. We've added more descriptions of MEIC inventory at the revision.

Changes in manuscript: (line 86-89) The annual MEIC emission inventory was applied in this study and the monthly profile of the anthropogenic emissions was based on *Zhang et al.* [2007] and *Streets et al.* [2003] as shown in Table S1 to represent the emissions changes between September and October.

Section 2.1: This is my main questions to the authors: Is the anthropogenic emission different during CNHD? If no then how are you attributing changes in emission as one the reasons for enhanced O3. If yes then please provide more information about the changes.

Response: As shown in Table S1 and Figure S4 (now Figure 4 in the revision), the anthropogenic emissions are different in September and October, and these changes had already been applied in the air quality model as the inputs. The higher anthropogenic emission rates, including VOCs and NO_x were distributed in October, leading to elevated O_3 during the CNDH.

Changes in manuscript: (line 86-89) The annual MEIC emission inventory was applied in this study and the monthly profile of the anthropogenic emissions was based on *Zhang et al.* [2007] and *Streets et al.* [2003] as shown in Table S1 to represent the emissions changes between September and October. The higher emissions rates were found during October from the residential and industrial sectors, while they kept the identical levels from transportation and power sectors. (line 195-196) These increasing O_3 precursors emissions are mainly from the residential and transportation sectors (Table S1), indicating their essential roles in the elevated O_3 during the CNDH.

Section 2.1: PRE-CNDH and CNDH periods have 6 days and AFT-CNDH is 23days. Is there a specific reason for this? This makes your statistical comparisons (for example in fig 1) not fair because you are including more days in one of the periods compared to others.

Response: We included all the rest days in the AFT-CNDH to better understand the elevated O_3 in the PRD region. In this study, we found that the prominent increase of O_3 occurred in the PRD and previous studies also reported that peak O_3 always occurred in October in the PRD [*Shen et al.*, 2015; *Zhang et al.*, 2008]. In addition, as shown in Figure 2 and Figure 3, the O_3 concentrations all dropped throughout China during the AFT-CNDH. Including the 23 days in the AFT-CNDH would not change our conclusion that O_3 concentration decreased during the CNDH. Moreover, this 'unfair' approach is widely applied to analyze the changes of O_3 [*Chen et al.*, 2020] as well as other major pollutants such as ammonium [*Wu et al.*, 2019].

Figure 1. Can you add model values to plots a and b to show if model captured the variation in the MDA8 O3?

Response: The main purpose for the Figure 1 is to show the O_3 variation from the observation instead of the model performance. The model performance was comprehensively demonstrated in Figure 2 and Table S5 by comparing the prediction and observation data. The dots in Figure 2 covered all cities in Figure 1a. From Figure 2 and Table S5, we clearly showed that our model prediction was able to catch the O_3 variations and spatial distributions (Figure 2) and meet the evaluation stands (Table S5). Hence, we suggested no further revision of Figure 1.

Figure 1. Can you show on one of the maps where each the regions in plot (a) are? Why AFT-CNDH in east China is so much lower than PRE-CNDH?

Response: We've already added Figure S3 in the supplemental information (also shown below Figure R3-1) to illustrate the locations of these regions. From Figure S5, we can find the temperature dropped significantly from the CNDH to AFT-CNDH in east China from 20 to 15 °C, which leads to the lower O_3 level [*Bloomer et al.*, 2009]. In addition, the lower temperature also decreased the biogenic emissions, which further prohibit the O_3 formation. Simultaneously, the lower wind speed slowed down the regional transport of O_3 from the North China Plain to east China. All these factors comprehensively led to the lower O_3 level during the AFT-CNDH in east China.

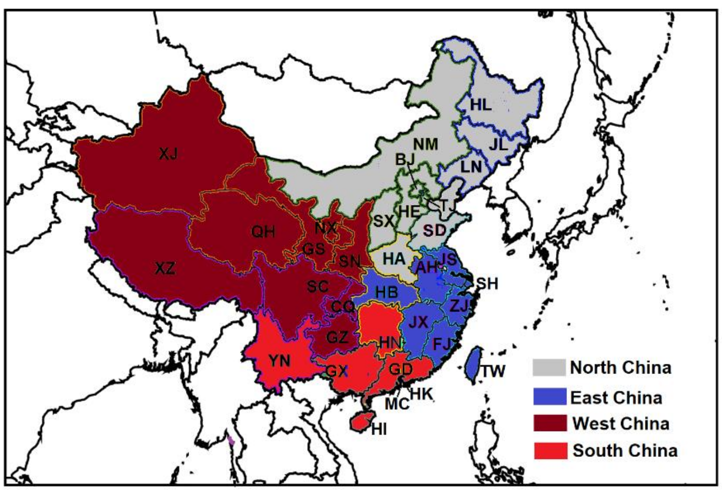

Figure R3-1. Major region locations in China.

P6 – section 3.2: Having a discussion on changes in O3 production regime in valuable. However, I suggest starting this section by discussing the differences between emissions. This way you can better distinguish between uncertainties in emissions and in the uncertainties in simulation of O3 production process.

Response: Thanks for the comments. We have re-arranged the order in the paragraph to discuss the difference in emissions followed by the changes in the sensitivity regime.

Changes in manuscript: (line 186-200) From Figure 4, the anthropogenic O_3 precursor emissions (NO_x and VOCs) increase throughout China. Increasing NO_x emissions are observed in South China, especially in Guangxi and Guangdong, with a relative increase of up to 100% during CNDH. Considering O_3 sensitivity regimes (determined by Eq. (1)), no noticeable differences are observed between PRE-CNDH and CNDH (Fig. S4). During CNDH, the VOC-limited regions are mainly in the NCP and YRD accompanied by high O_3_VOC. In South China, O_3 formation is under a transition regime in most regions, and NO_x-limited areas are in Fujian and part of Guangdong and Guangxi where have rising NO_x emissions. This is corresponding to an increasing in O_3 in these regions (Fig. 2 and Fig. 4). Simultaneously, higher anthropogenic VOC emissions are also observed during CNDH in South China, leading to elevated O_3 in the transition regime when VOCs and NO_x jointly controlled O_3 formation. These increasing O_3 precursors emissions are mainly from the residential and transportation sectors (Table S1), indicating their important roles in the elevated O_3 during the CNDH. In contrast, during AFT-CNDH, more areas turn into a transition regime in South China. The decreases in biogenic VOCs (BVOCs, compared to CNDH) (Fig. 4) due to temperature (Fig. S5) decrease MDA8 O_3 for regions in transition regime during AFT-CNDH. Accordingly, changes in O_3 highly depend on its precursor (NO_x and VOCs) emissions and the sensitivity regime.

Having a figure that shows the differences between NOx and VOC emissions (in different periods within your simulation) as one the main figures will be very helpful.

Response: Thanks for the suggestion. We've moved the original Figure S4 (the emissions differences figure) to the main text (now Figure 4 in the revision).

P8 – Discussion on changes in transportation emission.

I think making these changes in transportation sector emission and running another simulation can reflect the actual changes that occur in the emissions during the national holiday. Without considering these changes the conclusion seems weak and incomplete to me. I'm not suggesting to add a real time vehicle emission inventory. You can simply increase the emission from transportation sector by factor of 2.2 during the national holiday and study the impact on O3 values.

Response: Thanks for the comment. We conducted the test case (adjustment case, ADJ case) by increasing the MEIC transportation emissions by a factor of 2.2 during the CNDH (Figure R3-2). From Figure R3-2, the O_3 increased in the ADJ case in vast areas of China, especially in the YRD and PRD regions (up to ~10 ppb). The higher emission rates in transportation lead to higher O_3 levels during the CNDH. However, the ADJ case may overestimate the impacts from the travel activities during the CNDH on O_3. The adjustment factor (2.2 in the ADJ case) should only be applied in the vehicle emissions, while we used it in the entire transportation sector that includes non-road sources. The MEIC emission inventory only provides the total transportation emissions instead of the more explicit sectors. Consequently, we did not make changes in the revision since we prefer more accurate results to be shown in the manuscript. In the following study, we'll continue developing real-time vehicle emissions and have a more comprehensive understanding of the holiday impacts of O_3.

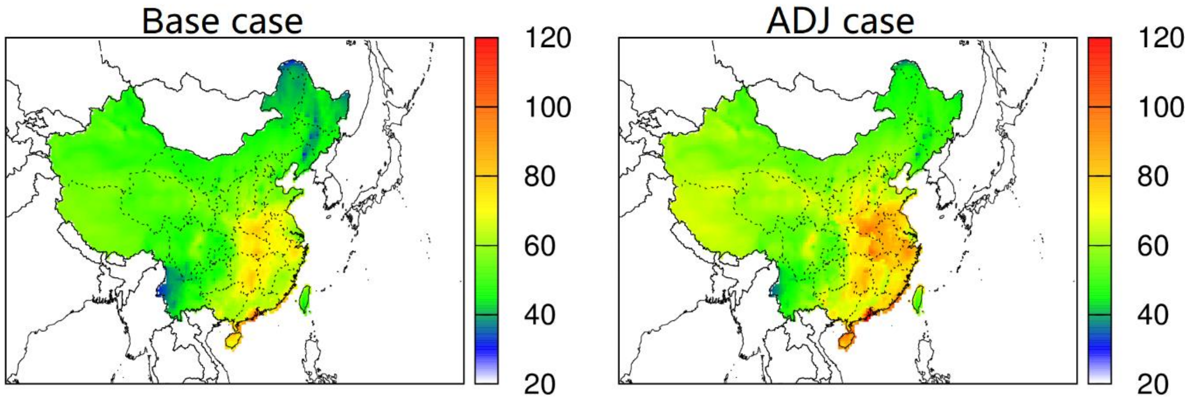

Figure R3-2. The MDA8 O_3 from the Base case and ADJ case during the CNDH. Unit is ppb.

Specific comments:

P4 – L83. It is not clear to me if or how much the anthropogenic emission has changed on CNDH days. Also having September and October months in the simulation, probably biogenic emission changes as well. Please be more specific about changes in emissions during the simulation period.

Response: The anthropogenic and biogenic emissions have different temporal resolutions. The temporal resolution for anthropogenic emissions is monthly and hourly for biogenic emissions. For anthropogenic emissions, although we used hourly emissions in the air quality model, we just allocated the annual amount to different months and used the same hourly profile for each day (difference between workdays and weekends). As a result, we discussed the monthly difference (September and October) to investigate the elevated O_3 issue, and the anthropogenic emissions remained the same from CNDH to AFT-CNDH. For the biogenic emissions, we used the MEGAN model [*Guenther et al.*, 2012] to generate. The MEGAN model requires the hourly meteorology data as inputs to reflect the hourly differences each day.

The anthropogenic emissions, including NO_x and VOCs, increased from September (PRE-CNDH) to October (CNDH and AFT-CNDH). The discussion of biogenic emissions from CNDH to AFT-CNDH illustrates its role in decreasing O_3 in the AFT-CNDH. We also investigated the difference in biogenic emissions between PRE-CNDH and CNDH (Figure R3-3). The biogenic emissions have slightly decreased during the CNDH in the PRD due to the lower temperature. However, the increasing anthropogenic emissions and regional transport enhanced the O_3 concentrations during the CNDH. We also modified Figure S4 (now Figure 4 in the revision also Figure R3-4 in the response) to show these emission differences better.

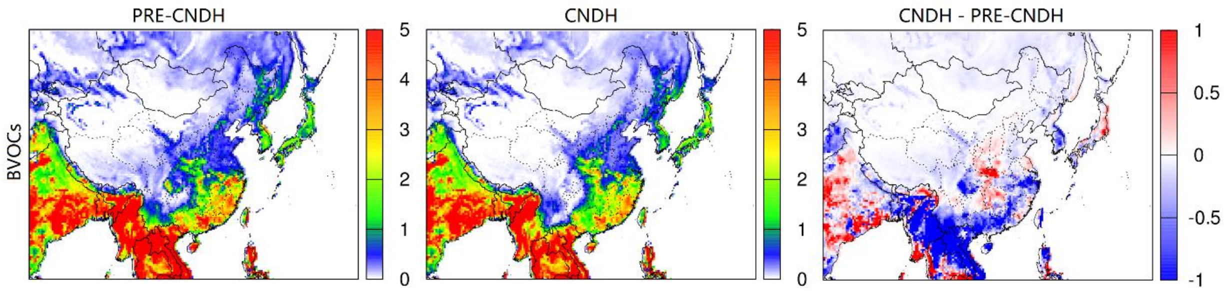

Figure R3-3. Variations of BVOC emissions from PRE-CNDH to CNDH.

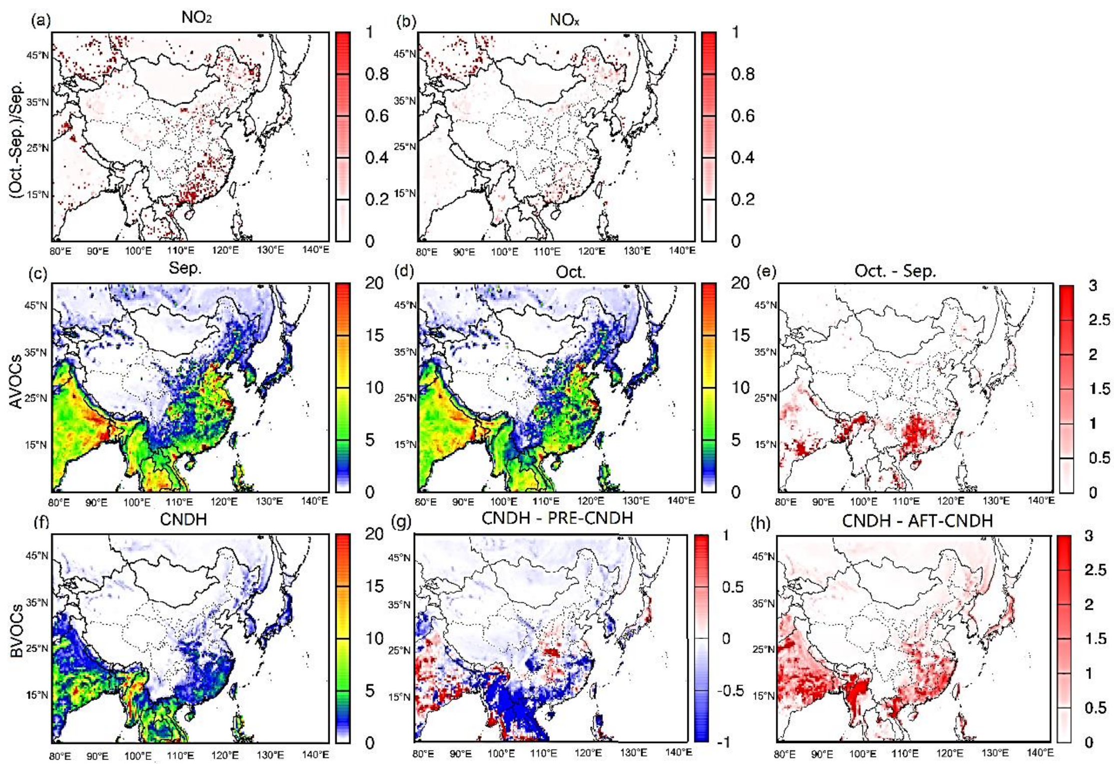

Figure R3-4. Changes of emissions in relative differences ((Oct.-Sep.)/Sep.) of (a) NO_2 and (b) NO_x. Averaged emissions rates of AVOCs from MEIC emission inventory in (c) September and (d) October and their difference (e). Averaged BVOC emission rates from the MEGAN model in (f) CNDH and their differences (g) CNDH subtracts PRD-CNDH and (h) CNDH subtracts AFT-CNDH. Units are moles/s for (c)-(h).

Changes in the manuscript: (line 86-90) The annual MEIC emission inventory was applied in this study and the monthly profile of the anthropogenic emissions was based on *Zhang et al.* [2007] and *Streets et al.* [2003] as shown in Table S1 to represent the emissions changes between September and October. The higher emissions rates were found during October from the residential and industrial sectors, while they kept the identical levels from transportation and power sectors. (line 227-229) The enhanced regional transport and the increasing anthropogenic emissions synergistically lead to the rising O_3 during the CNDH, offsetting the impacts from the lower BVOC emissions (Fig. 4).

P4 – L100-107. I suggest briefly explain which benchmarks you used for meteorology and O3 performance in this paragraph.

Response: Thanks for the comment. We've added the related references in the revision.

Changes in the manuscript: (line 107-109) All the statistics results of the WRF model are satisfied with the benchmarks [*Emery et al.*, 2001] except for the GE of temperature (T2) and wind speed (WD) went beyond the benchmark by 25% and 46%, respectively (Table S4). (line 112-114) The model performance of O_3 was within the criteria [*EPA*, 2005] with a slight underestimation compared to observations, demonstrating our simulation is capable of the O_3 study in China (Table S5).

P6 – L158. In south China…

Are you referring to model or obs values? Please clarify.

Response: It refers to the model values. Sorry for being unclear, and we've already changed it in the revision.

Changes in the manuscript: (line 167-168) In South China, the predicted MDA8 O_3 reaches ~90 ppb that is approximately 1.2 times of the Class II standard with an average increase rate of 30%.

P6 – L 159. In contrast…

What is the reason for this?

Response: The "in contrast" is used to describe the O_3 variation during the AFT-CNDH, which is quite different from that in the CNDH. We removed the "in contrast" in the revision.

Changes in manuscript: (line 167-168) The highest MDA8 O_3 drops sharply to 60 ppb in the same regions in AFT-CNDH.

P6-L160. High O3_NOx…

What is a high O3_NOx and O3_VOC level? Also in Fig 2 b and c can you use same range for O3_NOx and O3_VOC? And perhaps a better color bar? The values of O3_NOx in south China during CNDH are not readable.

Response: We used "high" in order to describe the increasing trend of O_3_NO_x and O_3_VOC during the CNDH compared to PRD-CNDH. Sorry for being unclear, and we changed the corresponding content. We also improved the range for O_3_NO_x and O_3_VOC in Figure 2 to better reflect their variations from PRE-CNDH to AFT-CNDH.

P8 – L183 – Fig S4:

This is the part that confuses me the most. Is the increase of NOx (and AVOC) emission in Oct due to the national holiday or it is for the whole month? If it's for the whole month how are you attributing it to the national holiday (only from Oct 1-7)?

Response: Sorry for being unclear. The increase of NO_x and AVOC emissions in October is for the whole month in October compared to September. So, in the emissions comparison figure (Figure 4 in the revision), we only compared anthropogenic changes at a monthly scale. We will work on the real-time emission inventory in the CNDH, trying to develop a more comprehensive understanding of O_3 holiday impacts.

The differences between e and f (if it shows biogenic VOC emissions) is a natural occurring event and not related to changes in anthropogenic activities. How much of the changes in ozone can be attributed to this? I would like to see BVOC emission maps for PRE-CNDH as well given the highest temperature occurred in PRE-CNDH. Can this justify lower O3 values in AFT-CNDH that we see in Fig 1?

Response: The change of the biogenic VOC (BVOC) emissions is a naturally occurring event, which highly depends on the meteorological parameters and land covers [*Guenther et al.*, 2012]. Since the BVOCs are regarded as an important precursor, their variations could affect the O_3 level. We showed the BVOC emissions in PRE-CNDH in Figure R3-3. On average, the BVOC emissions during the PRE-CNDH. A recent study reported that when the BVOC emissions decreased 40%, the O_3 would drop ~3-4 ppb [*Wang et al.*, 2021]. The lower BVOC emissions may decrease the O_3 concentration in the CNDH, similar to that in the AFT-CNDH.

Changes in manuscript: (line 227-229) The enhanced regional transport and the increasing anthropogenic emissions synergistically lead to the rising O_3 during the CNDH, offsetting the impacts from the lower BVOC emissions (Fig. 4).

Can you provide difference plots for AVOC and BVOS plots? Also, why different time frames are considered for BVOC plots?

Response: We've added the difference plots for AVOC and BVOC in the revised Figure 4 (also Figure R3-4). As we explained in the previous response, we used different temporal resolutions when we generated the AVOC and BVOC emissions. For AVOC emissions (MEIC emission inventory in this study), we used the annual inventory and re-distributed it into the different months. In each month, we only have two different patterns: weekdays and weekends (the temporal profile is the same for each month). So, the AVOC emissions only reflect the monthly differences. The BVOC emissions were generated using the MEGAN model that requires the hourly meteorology parameters as inputs. So, the BVOC emissions can reflect the daily or even hourly differences.

P9 – L 221: Fig S11 and Fig S12. this is not correct.

Response: Thanks. We've corrected it in the revision.

Changes in the manuscript: (line 242-243) The O_3_NO_x shows more significant regional transport characteristics than that of the O_3_VOC (Fig. S11 and Fig. S12).

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