

Interactive comment on “Spatial-temporal variations of surface ozone and ozone control strategy for Northern China” by G. Tang et al.

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Received and published: 28 December 2011

We would like to thank anonymous referees for his/her comments and helpful suggestions. We revised our paper according to these comments and suggestions.

Major comments:

Question 1: The analysis is based on data from a 1-year field campaign conducted in June 2009– September 2010. My main concern is how representative the meteorological conditions during this time period are in comparison to the long-term climatology. The authors state multiple times in the manuscript (e.g. P26080, L13) that meteorological conditions during summer are very similar from year to year. I think a quantitative proof for this argument would be valuable. Therefore, I suggest that the authors in-

C13630

clude a comparison of the meteorological conditions of the campaign period with the long-term climatology in the paper. Especially, as some confusion occurs as in the later sections the authors state that July and June had specific meteorological conditions in 2010.

Response: Thanks for your suggestion, we accepted and revised it as follows. We used ten weather stations in the last manuscript. In order to better compare simulated data with measured data, we get more meteorological data from China Meteorological Data Sharing Service System (<http://new-cdc.cma.gov.cn:8081/home.do>). The period of this data is from 1951 to 2010 include 27 sites over Northern China. We added the quantitative proof though comparison between the long-term and one-year data in our revised manuscript.

Question 2: The authors suggest possible control strategies for air pollution in Northern China based on the findings of their study. Following the points raised above, the proposed measures might just be effective if the meteorological conditions of 2009–10 are representative. In addition did the authors perform any sensitivity analysis on how changing emissions would affect the effectiveness of the proposed control strategies and/or performed or intend to perform any scenario analysis to which extent such measures would help to improve local/regional air quality? This might be an important issue considering the increasing trends reported in section 4.

Response: We definitely agreed your suggestions and we have prepared another manuscript named “Sources and sinks of regional ozone over northern China and responses to meteorology and emissions using MM5-CMAQ modeling system” and will submit it to ACP after a while. In this paper, I will do some sensitivity analysis on how changing emission would affect the effectiveness of the proposed control strategies and will give you some results about which emission sources most important for ozone formation.

Question 3: How did the authors determine statistical skills on regional basis? Is it the

C13631

mean over all n stations for each individual region or was any area weighted calculation performed? How did the authors deal with spatial dependence among the individual sites – or was this not considered in the analysis?

Response: We are sorry for these confusions. As to meteorological evaluations, we used all 27 weather stations for each individual region to determine statistical results. However, as to NO_x and ozone concentrations, R, CV and COD are calculated in each category to exhibit the homogenous characteristic of ozone and O₃_max for each group. We will revise these sections for easy understanding.

Question 4: Although the minor and technical comments below include several suggestions to enhance readability, I would kindly ask the authors to check tense, grammar and spelling again for the revised version of the manuscript.

Response: We accepted the suggestion and revised it in the manuscript.

Minor comments:

1. Title:

Response: We accepted the suggestion and revised it in the manuscript.

2. Abstract

Response: We accepted all your suggestions and revised them in the manuscript.

3. Introduction:

Response: We accepted all your suggestions and revised them in the manuscript.

4. Methodology:

Response: We accepted all your suggestions and revised them in the manuscript.

5. Results:

P26069, L15: replace 'skill' with 'statistical skill'

C13632

P26069, L20&23: shouldn't MB be ME?

Response: We accepted your suggestions and revised them in the manuscript.

P26070, L17: replace 'North China Plain' with 'plain'

Response: North China Plain is proper noun, so I think we should capitalize the first character in word 'plain'

P26070, L20: remove 'the' before spring... please check throughout the manuscript as this is often the case for different seasons

P26071, L3: The authors state that seasonal distribution patterns are similar to annual ones. This would be interesting to see, especially for summer as the authors discuss in particular this season. I would suggest to add seasonal panels either directly in Fig.5 or in a supplementary/additional Figure. Same is true for Fig. 6. Anyway as suggested below I would combine Figures 5 and 6.

Response: We accepted your suggestions and revised them in the manuscript.

P26071, L13-14: the sum of the individual contributions is 94.1%. Which source is the remaining fraction attributed to? Or is there a typo?

Response: The remaining fraction is residential sources. We have revised it in the manuscript.

P26071, L21: replace 'plains areas' with 'plains'. Same for L24 on this page.

P26072, L16: replace 'inconsistent' with 'different' – please change this throughout the manuscript.

P26074, L1: replace 'lowest' with 'particularly low'.

P26074, L7: replace 'emission' with 'emissions'.

P26075, L1: reword to "The results showed that a larger cloud fraction is directly correlated with more precipitation".

C13633

P26075, L11: ... replace 'need to be deeply studied...' with 'need further investigation and additional observational and modeling studies (although beyond the scope of the present analysis) are suggested for further work.'

P26075, L27: remove 'the' before ozone and replace 'peak' with 'peaks' and remove 'of ozone' after photochemical formation

P26076, L2: remove 'those' before in other seasons

Response: We accepted your suggestions and revised them in the manuscript.

6. Discussions:

Section 4.1: I suggest moving this section in the results section of the manuscript

Response: We accepted your suggestions and revised them in the manuscript.

P26077, L1: The authors provide information on how often Grade II is exceeded. How do the statistics for Grade I look like and how large is the threshold for this Grade?

Response: The threshold of ozone is classified into three grades in China. Grade I focuses on natural scenic spots, while Grade II focuses on human beings, and Grade III focuses on industrial areas. For ozone, three grades are 160, 200 and 200 $\mu\text{g}/\text{m}^3$ respectively. P26077, L16: replace 'will be obtained' with 'can be suggested and evaluated'

Section 4.2: as section 4.1. I suggest moving this section in the results section of the manuscript

P26078, L6: replace 'The southern plains area presented modest exceedances...' with 'Over the southern plains moderate exceedance of...'

P26078, L28: 'while ...' replace by 'Meteorological conditions are found to be the main driving force for temporal variability. Yet, there is the unanswered question, what controls spatial variability in O₃?'

C13634

P26079, L4: replace: 'exhibit inconsistent' with 'show different meteorology'

P26079, L19: replace: 'clearly displayed' with 'shows a clear'

P26079, L26: reference for Zhang et al., 2009, should the reference not be included after automobiles?

P26080, L5: replace 'plains areas' with 'plains'

P26080, L6: replace 'In summary we arrived at two major conclusions' with 'From the results presented above two major conclusions can be drawn...'

P26080, L14: replace 'abatement' with 'reduction' and 'diminish' with 'decrease' Response: We accepted your suggestions and revised them in the manuscript.

P26081, L2: I would suggest moving the last part of section 4.2 starting with 'Since 1997, with the strong ...' into the Discussion section and rename section 5 to 'Conclusions and Discussion of implications for future air quality control strategies in Northern China'

Response: We accepted your suggestions and rearranged the structure of our manuscript.

7. Conclusions:

P26082, L2: reword to 'The major field campaign conducted in 2009-10 allowed for the first time observation of the concentrations and spatial-temporal variations of ozone and nitrogen oxide over Northern China'

P26082, L16: remove 'an' before 'increasing ozone dry deposition'

P26082, L20: remove 'are' before 'the eastern...'

P26082, L22: replace 'inconsistent' with 'different'

P26082, L24: insert 'frequency of' before 'exceedances' and 'of national air quality thresholds' before 'after 'exceedances'

C13635

P26082, L30: replace 'are dominated' with 'are found to be mainly dominated'

Response: We accepted your suggestions and revised them in the manuscript.

8. Tables:

Table 1: provide explanation for ME, MBE, RMSE and R in Table caption Table 2: see several comments provided above Table 3: provide explanation for R, CV and COD in Table caption Response: We accepted your suggestions and revised them in the manuscript.

9. Figures:

Figures 1, 5, 6, 12,13,15: For better readability the Figure legend should be centered over the Yellow Sea or in a box outside of the Figures.

Fig.3: Font size should be increased for better readability, also as black and red lines are the same in all 4 panels it would be sufficient to present the legend once. The Figure could be arranged in a (2,2) illustration to enlarge the individual panels. Also labeling ((a)-(d)) is missing.

Fig.4: Font size of axis labels and legend should be increased for better readability. Further as color scheme is similar for all 4 panels one large color bar right of panel b and d would be sufficient and increase readability.

Fig.5 and Fig.6 could be combined in one figure with panels (a) and (b).

Fig.7: see comment to Fig.4.

Fig.9: Vd for dry deposition is missing in the caption.

Fig.10 and Fig.11: Captions miss explanation on regional grouping.

Fig.12 and Fig.13 could be combined in one figure with panels (a) and (b).

Response: We accepted your suggestions and revised them in the manuscript.

C13636

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 26057, 2011.

C13637