Author Response

Anonymous Referee #1

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I believe this is a useful paper and the authors indeed made a number of improvements compared to the original submissions. However, it still needs language improvements, specifically the introduction and conclusion section that include some unclear statements. See several specific comments and notes that I made below referring to particular parts of the manuscript.

- We appreciate the reviewer for the careful review of the paper. The paper has been modified accordingly to address all the reviewer's comments, especially improving the expression and specify the potential scientific contribution in the introduction and conclusion sections. We have attached a point-by-point responses below.

Beyond that I think the authors are not discussing enough and highlight potential contribution of this work for improved understanding of the open biomass burning emissions in China as well as stressing the remaining issues and gaps.

- Thank you for the comment. To address this issue, we have discussed two potential contributions of this work. Firstly, our results improve the understanding on regional PM2.5 characteristics and formation of typical haze pollution episode caused by biomass burning. Secondly, this study gives the quantitative contribution of biomass burning to $PM_{2.5}$ concentration, which are absent in literature. We have revised and added more explanations in the last paragraph of Introduction, as well as the Conclusion.

Finally, I think the paper would benefit from a bit more prominent discussion of the role better control of open burning or its efficient ban could have on successful reduction of exposure to air pollution in this densely populated region.

- Thanks for the reviewer's suggestion. We calculate the $PM_{2.5}$ concentration reduction and exposure level benefit for the whole YRD region under the complete biomass burning control, and the related results are added in the Results and Discussion part and Conclusion part.

Page 14 in Results and Discussion part:
"Based on the WRF/CMAQ simulation results, the average $PM_{2.5}$ concentration for the inner YRD domain is 72.3μgm^{-3}, during the pollution episode. If the biomass burning is completely forbidden, the average $PM_{2.5}$ concentration will reduce to 35.5 μgm^{-3}, only 49% of base case with biomass burning. Then we multiply the

$PM_{2.5}$ concentration with population at each grid cell in the YRD domain to calculate the changes of population exposure. As a result, the exposure level for the YRD domain will be decrease 47%. Significant health benefit due to particulate matter is expected through the efficient biomass burning ban for the whole YRD domain."

Page 15 in Conclusion part:
"The results of this study also indicated that the reduction of biomass burning for the YRD region requires regional-joint management and control strategies. If the biomass open burning is completely banned, the average $PM_{2.5}$ concentration for the whole YRD region would decrease 51%, and accordingly the exposure level would decrease 47% during the post-harvest season."

Abstract:
Line15: I'd suggest saying biomass is rather than biomasses are
- Revised as suggested.

Line17: Suggest to replace would improve with could improve
- Revised as suggested.

Introduction: There are several statements, which require improvements of the language, e.g.,
Page4, line11-14: …decent meteorological conditions…?
- "decent meteorological conditions" has been revised to "synoptic weather influence".

Page4, line16-17: The sentence that starts with Furthermore is not clear, I suggest to simply say In US and Australia…
- Furthermore indeed has no clear meaning here, but the literature also includes the results of Portugal. The sentence has been revised to "Biomass burning usually exhibit in the forms of prescribed burning or residential wood heating in developed countries."

Page4, line27 to Page5, line6: I think the part starting with Although the biomass… until the end of the paragraph should be rewritten or deleted. I honestly do not understand it, or can only guess what the authors wanted to say.
- The part from "Meanwhile, the biomass burning …" to the end of the paragraph has been revised as below:

"The biomass burning contribution to seasonal ambient $PM_{2.5}$ mass is much higher in China, i.e., 12–27 μgm^{-3} (15–24 %) in Beijing (Cheng et al., 2013; Song et al., 2007; Wang et al., 2009), 5.4–25.4 μgm^{-3} (4–19 %) in Guangzhou (Wang et al., 2007) and 8–64 μgm^{-3} (<70 %) in Southeast Asia and south China (Fu et al., 2012). For the YRD region, contribution of biomass burning to the ambient $PM_{2.5}$ concentrations are seldom quantified and reported, especially for heavy haze episode. Such information is vital for development of further pollution control strategies."

Methods and discussion:

Several paragraphs in this part of the paper are very long and should be split; for example section 3.1 starting on page8. The discussion of Figure 2 is divided into two parts interrupted with text about Figure 3 (see page 9-10). I'd suggest to move the text about Fig 2 (see page10, from line 8) before discussion of Figure 3 as I think it would be more logical.

- Our logic is explained as follows:
Firstly we describe the PM mass concentration (as shown in Fig.2), then discuss the chemical species of $PM_{2.5}$ (as shown in Fig.3), finally discuss the characteristics of three phases. The discussion page10, from line 8 (three phases for the episode) is not only about Fig 2, but also based on the data in both Fig.2 and Fig. 3 and Table 1. To avoid confusion, we revised some sentences on page10.

I also believe that it might be useful to add the 75ug/m3 (the standard) line in Figure 2 and stress that the episode is widespread and observed at the same time at several stations (phase II).

- The line of 75 $\mu g/m^3$ has been added to Fig. 2 and the related sentence has been added to the text in the revised manuscript.

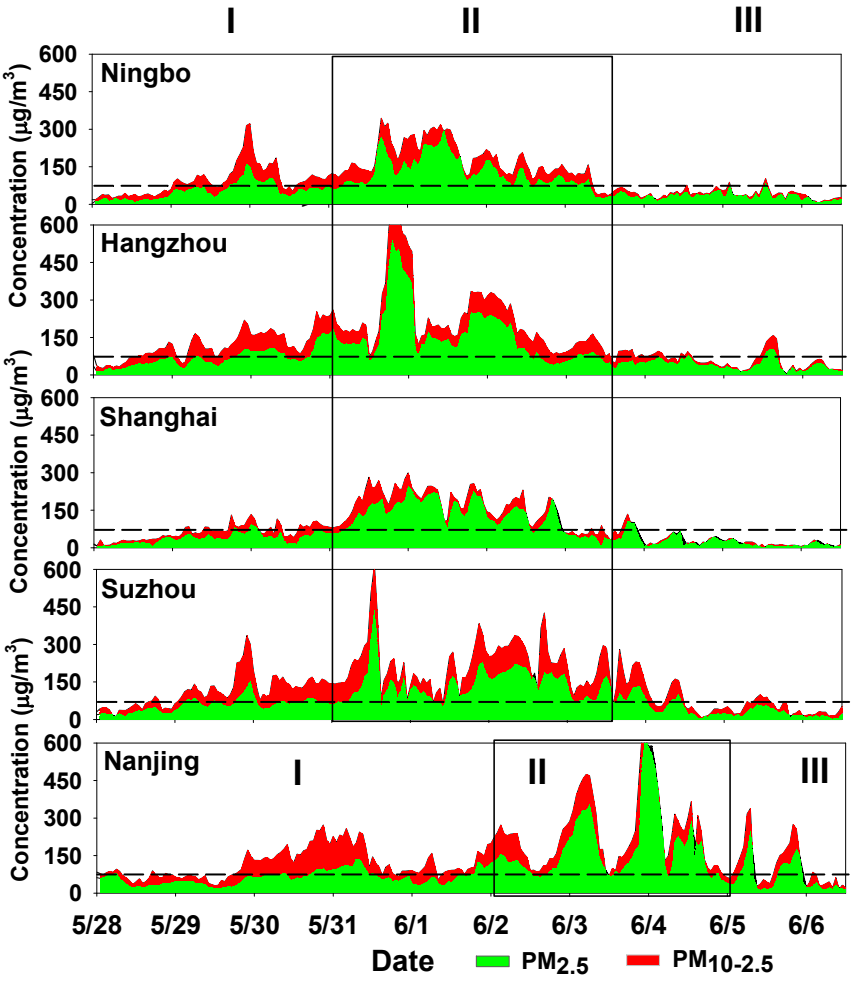

Fig. 2. Evolution of TEOM $PM_{2.5}$ (green) and $PM_{10-2.5}$ (red) mass concentrations during the

monitoring period. The black lines show different phases described in the text. The horizontal long dash line represents the level of 75 μg/m^3 (the China's national standard).

Page 5, line 18: The authors use here and in several other places past tense when referring to the data presented in some tables or supplementary materials… details were… I think it should be rewritten in present tense.

- We have checked the text throughout the paper and corrected them accordingly in the revised manuscript, i.e., past tense for the major part of Abstract, Materials and method and Conclusion, present tense for the major part of Introduction, Results and discussion.

Page 6, line 3: little error, it says TOEM rather than TEOM

- Revised as suggested.

Page 9, line 24: organic matters… should be organic matter…

- Revised as suggested.

Page15, line27: …weakened light efficiently… I think I know what the authors mean but this is an unfortunate formulation and this sentence should be rewritten/reformulated.

- The sentence has been revised to "indicating that biomass burning has significant impacts on $PM_{2.5}$ mass, especially for the carbonaceous species which can extinguish incident light efficiently and result in haze phenomena."

Page16, line3: it says …social-economics… but it should be rather socio-economic and it would be desirable to be more specific giving examples and add some references.

- The term of "social-economics" is unclear. The sentence has been revised from "resulting in severe social-economic impacts every year." to "resulting in a threat to public health and hot spot of social attention every year (http://www.chinanews.com/gn/2012/06-12/3958032.shtml)".

Page 16, line4: the sentence with …further verified … what does it mean. Again, I might be guessing what is meant, possibly using …confirmed... might be more appropriate, but please revise the sentence.

- Revised as suggested.

Conclusions: An important message is missing, i.e., implications for policy making. This is mentioned in the discussion but I feel it should be stressed here. In this respect, also the scale of these episodes can be highlighted form the perspective of how many people are affected.

- The last paragraph has emphasis the implication for policy making as:
"The results of this study also indicated that the reduction of biomass burning for the YRD region requires regional-joint management and control strategies. If the complete banning of open biomass burning is achieved, the average $PM_{2.5}$ concentration for the whole YRD region could reduce 51%, and accordingly the exposure level in this could reduce 47% for this densely populated region."

- The above conclusion is based on the added sentences in Results part as:
"Based on the WRF/CMAQ simulation results, the average $PM_{2.5}$ concentration for

the inner YRD domain is 72.3μgm^{-3}, during the pollution episode. If the biomass burning is completely forbidden, the average $PM_{2.5}$ concentration will reduce to 35.5 μgm^{-3}, only 49% of base case with biomass burning. Then we multiply the $PM_{2.5}$ concentration with population at each grid cell in the YRD domain to calculate the changes of population exposure. As a result, the exposure level for the YRD domain will be decrease 47%. Significant health benefit due to particulate matter is expected through the efficient biomass burning ban for the whole YRD domain."

Some of the statements shall be rewritten, e.g., Page16, line12: increase in PM2.5 and K+ does not confirm environmental impacts but rather contribution/importance of biomass burning to elevated concentrations.

- It has been revised to "confirmed the contributions of biomass burning to elevated PM concentrations."

Page16, line24: again the biomasses should be rather biomass is…

- Revised as suggested.

I find the last paragraph in conclusions does not really add anything important the way it is formulated now. The statements are rather general and could have been formulated without the results of this work. If the authors want to highlight the contribution of this work to improved understanding of open burning PM2.5 profiles in China then this paragraph should be reformulated.

- We agree with the reviewer's comment and delete these sentences. The detailed implication has been given in the first comment answer of the Conclusion part.