

## Authors' Response to Anonymous Referee #1

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### Overall:

We thank the reviewer for the careful reading and the valuable comments that helped improving our paper.

In the original manuscript, there were two problems argued by the three reviewers. One was section 3.3.4 “New particle formation”, the other was section 3.2.6 “Visibility empirical equation”. We thought over and over about these two questions and analyzed the data in depth. Lastly, we reorganized the original section 3.2.4 “New particle formation” with section 3.2.4 “Gas to particle conversion and aerosol growth”. We merged the section 3.2.6 “Visibility empirical equation” into the section 3.2.5 “Impact of hygroscopic growth for aerosol scattering  $f(\text{RH})$ ” in the revised manuscript. In addition, we tried our best to analyze the meteorological condition in depth. We also deleted some incorrect sentences and conclusions in the revised manuscript.

We would like to answer the comments and suggestions one by one as following.

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The authors use a suite of measurements to determine spatial propagation, boundary layer heights, gas-phase speciation, and  $\text{PM}_{2.5}$  mass concentrations. The analysis is mostly fine and publishable, but the conclusions are too broad and unhelpful and the authors should present the haze event as having anthropogenic origins for this one-week observation period, but not extend their results to a set of general policy recommendations.

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### *Response:*

In section 3.2.2, we presented the AOD (aerosol optical depth) data illustrating the origin and development of the pollution in order to clarify that this one-week haze event in Beijing had anthropogenic origins. In section 3.2, we tried our best to clarify the formation and evolution mechanism of this haze. So, we accepted this suggestion and rectified the section 3.2.2 “source of pollution” with “local source of pollution”, and rectified the content accordingly. Additionally, we also recognized that only one week of data extended to the policy recommendations was unsuitable. So, we merged section 3.2.5 with section 3.2.6 and rectified the conclusions accordingly. Policy

recommendations were deleted in the revised manuscript and we only analyzed the relationship among visibility, PM<sub>2.5</sub>, and RH.

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The main issue is the generalizations made from a week's worth of measurements. How would the power law with RH vary when the source of PM<sub>2.5</sub> is not urban air pollution as in this week's case? The coefficients are valid for PM<sub>2.5</sub> for similar chemical composition, which is not to be consistent through the year. For instance, what about Asian dust events in the region? From a perspective of frequency, it is difficult to recommend that the government regulate anthropogenic sources of PM<sub>2.5</sub> for reasons of haze if dust and aged transported to the city is more frequent annually or inter-annually (or if the meteorological conditions favorable for anthropogenic pollution events described in this manuscript is not frequent). Also, the chemical speciation is not specific enough to make over-arching recommendations for PM mitigation when the sources are not known. Even if SO<sub>2</sub> is responsible for nucleation, What is the source of SO<sub>2</sub> in the region? If the nucleation mechanism is ternary, are there not possibly more effective measures for reducing the occurrences of these events? Even after nucleation, condensational growth is an important part of growth which contributes to increase in size and light-scattering; could not the sources of organic aerosols regulated instead if they are anthropogenic? The authors' recommendation to control "industrial factories" and reduce vehicle usage is based on too little information, too general, and not insightful.

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***Response:***

We agreed with the reviewers' comments and accepted this suggestion. Different aerosol styles (urban aerosol, rural aerosol, marine aerosol; new-formed and aged aerosol, ..... ) have different characterization in chemical, physical, and optical properties. It was difficult to extend one-week measurement to long-term policy recommendation. So, we merged section 3.2.5 with section 3.2.6 and deleted the sentences for policy recommendations. In the revised manuscript, we only studied the relationship among PM<sub>2.5</sub>, RH and visibility degradation during this 8-day measurement.

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Fig8: keep same axis units as Figs1, 2, and 6.

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***Response:***

We accepted this suggestion and rectified the axis unit of figure 8 in the revised manuscript.

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**Lastly, we would express our appreciation to anonymous reviewer and editor for their warm-hearted help and useful suggestions. Thank you very much!!!!**