

## ***Interactive comment on “Measurement of aerosol properties during wintertime in Beijing” by M. L. Zamora et al.***

**M. L. Zamora et al.**

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The authors analyzed the aerosol properties in Beijing via a wintertime field campaign conducted in 2015, aiming to better elucidate the inherent haze formation mechanisms. In general, the paper is well written. However, some concluding remarks claimed by the authors are slightly overstated and many more details should be provided to enhance the readability of this paper. Below are several specific comments for the authors reference. Specific comments: Line 7 of page 2: reference for the citation of Wang et al. (2016) was not provided in the reference list, please add.

Response: We thank the reviewer for pointing out this. We have added the missing reference in the manuscript.

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Line 10 of page 2: the following references can be also added: Li, Z., Guo, J., Ding, A., Liao, H., Liu, J., Sun, Y., Wang, T., Xue, H., Zhang, H., Zhu, B., 2017. Aerosol and boundary-layer interactions and impact on air quality. *Natl. Sci. Rev.* 4, 810–833. <https://doi.org/10.1093/nsr/nwx117> Miao, Y., Liu, S., Guo, J., Huang, S., Yan, Y., Lou, M., 2018. Unraveling the relationships between boundary layer height and PM2.5 pollution in China based on four-year radiosonde measurements. *Environ. Pollut.* 243, 1186–1195. <https://doi.org/10.1016/j.envpol.2018.09.070>

Response: We agree with the reviewer and have added the above two references.

Line 29 of page 2: “: : to better understand the haze formation mechanisms in different seasons”

Response: We thank the reviewer for the suggestion. The sentence has been revised as suggested.

What do w and d stand for in equation 2? Please detail their meanings in the following main text to avoid readership gap.

Response: We thank the reviewer for pointing out this. The following sentence has been added to clarify equation 2: “The subscript s and w represent the parameters for solute and water, respectively.”

Line 18-19 of page 4: How about the accuracy of the derived PBL from the HYSPLIT model? Why did not the authors use the radiosonde measured profile to retrieve PBL?

Response: The PBL retrieved from the radiosonde measurement is no doubt more accurate than that derived from HYSPLIT model. Unfortunately, we were not able to employ any radiosonde measurements during the campaign in 2015 winter. In this study, the PBL information is to help qualitatively understand the reason for the haze cycles in Beijing. Therefore, the HYSPLIT derived PBL is accurate enough to meet our requirement.

Line 30 of page 4: the full name of NPF should be provided here when the acronym

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comes out for the first time. “: :with an new particle formation (NPF) event,: :”

Response: We thank the reviewer for pointing out this. The sentence has been revised as suggested.

Line 1 of page 5: wind speed was not depicted in Fig. S1, please add a diagram showing the wind speed at the sampling site during the study period to support your claim.

Response: We have modified Fig. S1, which now includes the wind speed and direction at the sampling site in winter 2015.

Line 3 of page 5: is there any explanation for the observed data gaps in the total number concentration time series as shown in Fig. 1C?

Response: This is because an error during the data processing. We have fixed this error, reprocessed the data and remade the figure. We thank the reviewer for pointing out this.

Line 9–16 of page 5: the synoptic weather pattern should be provided as well to ease the readership.

Response: We thank the reviewer for this suggestion. The wind information has been added in Fig. S1.

Line 20-22 of page 6: is there any reference to support your claims? If so, please add the relevant references.

Response: We thank the reviewer for the suggestion. We have added one reference to support this statement.

Line 33 of page 6: please clarify why stronger solar irradiation would result in larger particle diameter.

Response: We thank the reviewer for the suggestion. We have added the following

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discussion here. “Studies have demonstrated that large particle mass growth always occurs concurrently with elevated daily ozone concentrations and solar irradiation (Guo et al., 2014; Peng et al., 2016), particularly during clean periods, suggesting the importance of photochemical activity in the growth of particles.”

Line 1–3 of page 7: did the author meant to say that higher mixing layer would renders the particle growth and secondary aerosol formation more efficient? Any explanation?

Response: We are sorry for this confusion. We didn't mean that “higher PBL would render the particle growth and secondary aerosol formation more efficient.” Here, we want to discuss that even though the PBL is much higher in autumn (which causes much more horizontal dilution of pollutants and lowers the secondary aerosol formation), particle growth is still faster in autumn than in winter. This indicate that if the PBL in autumn was similar to that in winter, the particle growth would be much faster. We have modified the content as follows to avoid confusion from the readers. “Furthermore, such faster particle growth in autumn was observed when PBL in autumn was nearly twice as high compared with that in winter (Fig. S1). If the PBL was the same, the particle growth and the secondary aerosol formation in autumn would likely be even more efficient.”

Line 22–23 of page 7: “We show that the periodic cycles of haze episodes during the autumn and winter seasons in Beijing are closely linked to the meteorological conditions”. This claim might be not fully supported by the current results as shown in Fig. S1. It shows that the mixing layer height after September 26 varied with small deviations for the subsequent days, which suggests that meteorological condition is not the key factor in modulating the PM concentrations during this time period and thus the observed haze events should be attributed to other reasons.

Response: The reviewer made an important point here. First, it is true that sometimes the wind is not very strong and the mixing layer does not increase much, but the concentration of pollutants dramatically decreased, e.g., on Jan 24 (Fig. 1 and

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Fig. S1). This is because in these cases the polluted air mass within the North China Plain (NCP) exhibits noticeable edge in the north and shifts northerly or southerly due to the fluctuation in the wind field, resulting in a significant fluctuation of pollutant concentrations in the north of the NCP such as in Beijing. Second, the meteorological conditions are not only represented by the mixing layer, but also demonstrated by the wind field. In the case after Sep. 26, the mixing layer didn't change much, but there is strong northwest wind (Guo et al., 2014). Therefore, the decrease of pollution is still caused by the meteorological conditions. Anyway, we agree with the reviewer that that statement is slightly overstated. We have modified the statement as "We show that the periodic cycles of haze episodes during winter seasons in Beijing are regulated by meteorological conditions."

Lines 26–29 of page 7: "Our results imply that an effort to solely control emissions of primary particles would result in only a minor reduction of the PM<sub>2.5</sub> mass concentration, while the reductions in the emissions of the aerosol precursor gases, i.e., VOCs and NO<sub>x</sub> from local transportation and SO<sub>2</sub> from regional industrial sources, are critical for remediation of the haze pollution in Beijing". The results in the current study may be inadequate to support such a pollution control strategy and more relevant results are required to bridge the gap.

Response: We thank the reviewer for this comment and agree with the reviewer that the claim here is slightly overstated. We have modified the sentence as follows. "From the perspective of pollution control, it may be feasible to suppress the aerosol growth processes to reduce the PM<sub>2.5</sub> levels in Beijing. Our results imply that the reductions in the emissions of the aerosol precursor gases, i.e., VOCs, NO<sub>x</sub> and SO<sub>2</sub>, are critical for suppressing the aerosol growth and thereby the remediation of the haze pollution in Beijing. Such a viewpoint of severe haze formation is critical for improving formulating effective regulatory policies by decision-makers at the central and local government levels. "

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