

## ***Interactive comment on “Rapid formation of intense haze episode in Beijing” by Yonghong Wang et al.***

**Anonymous Referee #1**

Received and published: 24 November 2018

This paper presents valuable observational evidence for interactions between boundary layer mixing properties and haze aerosol loading. It describes an important set of long-term measurements from a polluted urban location in Beijing, combining atmospheric composition measurements at a number of different altitudes with ceilometer measurements of atmospheric mixing height. This provides a unique opportunity to provide conclusive evidence for a feedback between aerosol and mixing height, but unfortunately this has not been fully achieved, and the claims that are made are not fully supported.

The study shows that PM is higher when the mixing height is lower, but does not present deeper analysis. The inverse relationship between aerosol and mixing height may represent a dynamical feedback, or it may just reflect the one-way control of PM

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levels by mixing height. It is ascribed to the former here (line 178), but the evidence provided to back this up is weak, and no argument is presented on why the simpler mechanism (reduced vertical mixing alone) is insufficient to explain it. This needs to be addressed before the paper is suitable for publication.

The ratio between NO<sub>x</sub> and PM shown in Fig S5 could potentially provide valuable new insight into the mechanisms involved, but this is not explored in the paper. Similarly, increases in secondary aerosol production shown in Fig S6 are interesting but not properly explored. Neither Fig S5 nor Fig S6 are even referred to in the paper.

The paper calls for the feedback between aerosol and boundary layer turbulence to be included in air quality models. In practice online models already include this process, and what is missing is strong observational evidence to back up existing theory and validate our current understanding. The study described in this paper has the potential to provide this important evidence, and I strongly encourage the authors to complete this analysis and revise their paper, after which it could make a valuable and important contribution to the scientific literature.

### General Comments

The conclusions of the paper remain weak and speculative, principally because clear evidence has not been provided in the paper to support the suggestions made.

The figures in the supplementary material are not labelled or described well, and their relevance to the body of the paper is unclear. Please justify their inclusion carefully. Figures S5-S7 are not referred to in the text, and should be introduced or removed. Further specific comments are provided below.

The written English in the paper is reasonable but does not fully reach the standards needed for a scientific publication, and some polishing of this will be required in the final version.

### Specific Comments

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Page 3: particle concentrations are often not uniform in the mixed layer, particularly near sources or where there are residual layers present. How does the approach used resolve multiple layering? The maximum gradient approach used has known deficiencies; how sensitive is the mixing height retrieval to the approach taken?

Line 80: Please describe where these measurements were made.

Line 132: Fig 1 does not show reduced temperatures: the temperature appears higher than before or after

Line 154-156: The study of TKE is essential for supporting the links between mixing height and PM levels, but it is not mentioned again except in reference to Fig 4 in the following paragraph.

Line 167: What is the justification for fitting an exponential curve to the data in Figure 3? Fitting a reciprocal curve would make more sense (doubling mixing height halves concentrations). Please explain the rationale here and the evidence supporting it.

Line 171-7: These arguments are the most important made in the paper, and need clear observational support. What relationship is shown in Figure 4? What is the signal underlying the scatter? Extracting a quantitative relationship from the data shown here and using it to support the arguments made would strengthen the paper greatly.

Line 202: Anthropogenic heating isn't mentioned in the paper prior to this.

Line 316: The references from this point onward are out of alphabetic sequence in the reference list.

Line 391: What is the distinction between the yellow and green mixing height lines in Figure 2? This needs to be explained more clearly in the caption.

Fig S1: Please simplify this figure (perhaps by reducing to 4 panels) as there is too much extraneous detail here. Annotate to highlight key features that you want the reader to be aware of. Please label High and Low pressure systems more clearly, and

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label each panel with the date and time.

Fig S2: Make figure clearer, label panels and state the time period used. There is no analysis of this figure in the text; please state how it contributes to the arguments in the paper (or otherwise remove it).

Fig S3: The panels in this figure are small and difficult to read, and there is no apparent connection between them. If they are needed, present as two separate figures. In the first, explain what is meant by direct radiation (what wavelength range? excluding all diffuse components?) and use a compatible color scale between the two panels so that the results can be compared easily (dark blue is 8m haze in one panel and 280m clean in the other). X-axis labels are missing in the PM1 figure.

Fig S4: Please state the time period and explain x-axis (no axis label is provided)

Fig S5: Define Fb here. This figure does not appear relevant to the paper, and should be removed.

Fig S5(2): Please correct the numbering of this and subsequent figures

Fig S6: The increase in secondary aerosol is interesting here, but it would be more informative to show how the contribution of secondary aerosol to total aerosol changes here. However, the figure is not discussed in the paper, and should either be discussed or removed.

Fig S7: What period is this over? Again, this figure should be discussed or dropped.

Typos and minor issues

Please use European date order conventions (day, month, year) throughout. The x-axis labels in Fig 1 use US conventions, while Fig S5 in the supplement uses Chinese conventions.

Title: episode -> episodes

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line 107: in -> on (or at)

line 111: remove to

line 118: 220-400?

line 142: microgram unit missing

line 178: assign -> ascribe

line 184: bot ??

line 396-7: stand for -> represents

line 415: date -> data

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2018-1079>, 2018.

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