

Response to Referee #1

We thank the Referee for the comments, which have helped improve the manuscript. The Referee suggestions are shown in italic font marked as R# and our detailed response/revisions are indexed as A#.

R1. GENERAL COMMENTS:

This manuscript presents a valuable observational dataset of in-situ aircraft measurement of BrC and BC optical profiles in Beijing. The corresponding influences on heating rate and radiative forcing are analyzed and extensively compared with AERONET dataset. Although the pollution and meteorology interaction over North China Plain (NCP) were widely investigated through surface observations and modelling, limited studies have considered the evolution of pollutants in vertical profile. This work could fill this gap well. The method and uncertainties are well described and discussed. The manuscript is well-written, but some parts of it are not clear enough. I would recommend for publication after the authors address the following specific comments:

A1. We thank the positive comments from the referee.

SPECIFIC COMMENTS

R1. line 22: “replying” or “relying” ?

A1. This typo is corrected.

R2. line 68-69: “and regional transport will introduce enhanced aerosol loading to high level”. Please introduce the corresponding vertical transport processes in more details base on previous studies over NCP, such as the influence of mountain valley breeze led by the special topography over Beijing.

A2. We have added the mountain chimney effect in the revised manuscript.

P3, Line 68: “**such as the mountain chimney effect over Beijing region may introduce enhanced aerosol loading to high level (Chen et al., 2009).**”

R3. line 73. Suggest delete “successive”, which is too subjective.

A3. Corrected.

R4. line 77. Suggest delete “for the first time”. There are lots of previous studies regarding aerosol optical property observations over NCP, although may not elaborate the detailed BrC properties as this work does. The “first time” description is not appropriate here.

A4. It has been corrected in the revised manuscript.

R5. line 86. At which temperature level are maintained?

A5. The information is added:

Page 5. Line 103. “**The maintained room temperature (25 °C) in the cabin had self-**

drying effect when the temperature inside was higher than outside the cabin, in addition to which, a silicate drier was utilized ahead of all instruments to maintain the sampling RH lower than 40%.”

R6. line 93. Please give the criteria of screening out the “in-cloud data”.

A6. We have added the following:

Page 5. Line 112. “The in-cloud data in this study was screened out according to the in-situ measured cloud number concentration and liquid water content, with a total number concentration of more than 10 cm^{-3} and liquid water of more than 0.001 g m^{-3} are not included in the following analysis (Deng et al., 2009).”

R7. line. 116. “which is independent of the filter artifacts”. I do not understand here.

A7. This has been clarified as:

Page 6. Line 138. “The multiple scattering artifact of AE33 was corrected by measuring the ambient aerosol in parallel with photoacoustic spectrometer (PASS3, DMT Inc, USA), and latter is independent of the filter artifacts.”

R8. Eq.3. Please modify it as the same format of the Eq.1.

A8. Corrected.

R9. line 152. Please specify the values (with units) of “air mass density” and “Cp” here.

A9. Corrected.

Page 9. Line 197: “where ρ and C_P are the air mass density (kg/m^3) and heat capacity ($1.007 \text{ J/g}\cdot\text{K}$), respectively.”

R10. line 269. Where was the study of Andrews et al. (2017) conducted?

A10. This has been added:

Page 13, Line 326: “This is consistent with previous findings conducted over US that the retrieved AAOD from AERONET was biased higher when compared to in-situ measurement (Andrews et al., 2017).”

R11. line 384. They are the heating rate at which level? And are they the rate at noon time? Please clarify it.

A11. This is added:

Page 18. Line 454: “BC was the main heating species, having 0.05 K/h, 0.1 K/h and 0.15 K/h heating rate at local time 12:00 to 15:00 in the PBL during pollution initialization, transition and full development respectively,”

R12. line 386. “when regional transport”. I do not understand here.

A12. this is revised:

Page 18. Line 456: “showed positive vertical gradient of heating during regional

transport period when pollution was advected at high level from the polluted south region outside of Beijing (Tian et al., 2019).”

R13. line 386. “contribution of BrC” to what? You mean contribution to the aerosol mass or heat rate or light absorption, or what?

A13. This is revised.

Page 18. Line 457: “The contribution of BrC to heating rate was found to increase by 20 % throughout the column from CP to HP period”

R14. Figure 1. The title of Fig. 1c is difficult to understand. And please add labels for the colorbar.

A14. The labels are added for the colorbar now.

R15. Figure 2 and following profile figures. Here, use blue, black and red to indicate the clean, transition and polluted period, respectively. However, it is ambiguous that in one profile belongs to two different period (black for lower part, but red for upper part). In my understanding or the common understanding the “period” is separated by time windows.

A15. In this figure, vertical profiles for clean, transition and heavy pollution period was shown in the left, middle and right panel. Black and red color in each panel was used to denote inside and above the PBL.

R16. Figure 4. The quality of this figure is poor and unreadable.

A16. This figure is revised.