

## ***Interactive comment on “In-situ vertical characteristics of optical properties and heating rates of aerosol over Beijing” by Ping Tian et al.***

**Anonymous Referee #2**

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This manuscript presents aerosol optical properties and heating rate along vertical profiles. Due to the several feedbacks triggered by the vertical forcing behaviour I encourage the publication of this work after a serious revision as some parts are not clear enough and other require an improved description. Finally, a comparison with other data available in literature is required. A final improvement of the english is mandatory due to the several typos present along the paper.

Major comments are reported here below:

1- Introduction and line 75-78: It is obviously clear that the focus of the paper is to describe the situation over Beijing, however a world-wide contextualization of existing heating rate data (along vertical profiles as well as at ground) is mandatory concerning the importance of this topic.

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2- Section 2, Line 88 and section 3.4 lines 263-265: "silicate direr (change to dryer) instruments was utilized (better used) ahead all instruments to maintain the sampling RH lower than 40%" and "Improved agreement between both may beachieved by considering the particles hygroscopic growth, which requires composition measurement to constrain this factor but this was not available inthis study". This is a serious lack in the work due to the aim to perform radiative transfer calculations. The choice to measure dry aerosol optical properties (especially for scattering) seriously affect the SSA, the Extinction and the asymmetry parameters making the results valid only in dry sky conditions. This is valid along the paper only in Clean Period (CP, Fig. 2g) but not in half of the profiles measured during Transition Period (TP, Fig. 2h) and Heavy pollution Period (HP, Fig. 2i) when RH reached values up to 90%. Thus, I recommend to maintain the obtained results as baseline but also to add new calculation in supplementary material trying to use the best hygroscopic growth function available for North China Plain and to discuss and compare the related uncertainty (or the range in the radiative transfer calculation) both in optical properties as well as in heating rate profiles.

3- Section 2, Line 93-94: "The in-cloud data in this study was screened out according to in-situ measured RH and liquid water content, thus only the out-of-cloud data is reported here". This comment is related to number 2. If in cloud data were collected and after removed how did you closed the missing parts of profiles to perform radiative transfer calculations. Please add a detaile explanations reporting the frequency of clouds, their altitude and thickness and how you solved the aformentioned issue.

4- Section 2.1 lines 132-133: "All the data related to volume concentration was (better were) corrected for standard temperature and pressure (STP, 1013.25hpa , 273.15K)". The sentence is not clear: did you report the data in STP, or did you transform STP data collected by devices into ambient concentrations at ambient T and P? In the first case I remember you that the feedbacks related to heating rate profiles depends on the ambient values of them and not on the values standardized at STP. Please clarify this point.

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5- Section 2.3, DISORT calculations: This section requires a big expansion due to the unreported conditions for those calculation. DISORT calculations were performed in clear-sky approximation? Please clarify and discuss the uncertainties with respect to question 3 due to the presence of clouds during the campaign. At which time DISORT calculations were performed? Noon? With which Zenith angle? Actinic fluxes were calculated and divided in Figure 6 into direct, diffuse up and diffuse down. Connected to this: calculations were performed as difference in the model with and without aerosol? Or these data refers to aerosol presence together with standard gaseous atmosphere? How did you close the gap between 2500 m (max altitude of profiles) and the top-of-atmosphere in DISORT application for what concern the aerosol properties? Please specify it clearly.

6- Eq. 4 please cite the reference for this equation.

7- Sections 3.2-3.3-3.4-3.5: despite the issues posed in the previous questions, the ambient discussion reported here is very well described. As these are not the only heating rate BC and BrC data and heating rate profiles available in literature, I strongly suggest you to cite and compare your results with literature data collected in other places of the world to give to your paper a wider view. In this respect your results are incredibly close to those reported in ACP by Ferrero et al. (2014; Atmos. Chem. Phys., 14, 9641–9664) but a comparison is also called for with the good works of Ramana et al. (2010; Nat. Geosci., 3, 542–545, doi:10.1038/ngeo918) and Chakrabarty et al. (2012; Geophys. Res. Lett., 39, L09804, doi:10.1029/2012GL051148) and Kedia et al. (2010; J. Geophys. Res., 115, D07205)

8- Section 3.5 and 3.6 and Figure 8: this part are very important for their implications. however due to the uncertainties related in TP and HP calculations due to the untreated humidity effect in optical and radiative transfer data, could you compare and discuss the BrC contribution with respect to this point and with other available data? For example experimental BrC heating rate data are available in Ferrero et al. (2018; Environ. Sci. Technol. 52, 3546–3555) while other important data are reported in Chung et al. (2012;

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Proc. Natl. Acad. Sci. U.S.A., 109 (29), 11624–11629) and in Shamjad et al. (2015; Environ. Sci. Technol., 49 (17), 10474–10481).

Minor comments are reported here below:

1- Line 266. Fig 7d-f: maybe figure 5d-f

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