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Reply on RC1

Suping Zhao et al.

Author comment on "Measurement report: Contrasting elevation-dependent light absorption by black and brown carbon: lessons from in situ measurements from the highly polluted Sichuan Basin to the pristine Tibetan Plateau" by Suping Zhao et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-241-AC1, 2022

The manuscript presented the observational results of the first in-situ measurement of atmospheric aerosols, especially aerosol absorption properties, at six sites along eastern slope of the Tibetan Plateau. In general, the paper is well written and presented in a logical way. It is a timely and important piece of work, and of general interest for Tibetan Plateau and atmospheric aerosol related communities. I therefore recommend publication of this paper in Atmospheric Chemistry and Physics after minor revisions.

Thank you for your positive comments on our manuscript (Title: Measurement report: The first *in-situ* PM_1 chemical measurements at the steep slope from highly polluted Sichuan Basin to pristine Tibetan Plateau: light absorption of carbonaceous aerosols, and source and origin impacts, ID: acp-2022-241). Your constructive suggestions are very valuable for improving the quality of our manuscript. The corresponding revisions will be conducted in the new manuscript. The responses to the comments are given in detail as follows.

- **Major Comments: Using Equation (5) to separate total aerosol absorption into EC and BrC absorption is an objective and effective method. But the shortcomings of the method should be kept in mind when analyzing and discussing the results. For example, the method does not consider the absorption of mineral dust (or fine soils), which accounts for very small percentage for most urban sites but might account for a large proportion of total aerosols for some other sites. Previous studies have revealed that the mineral dust is an important species of the atmospheric aerosols over the Tibetan Plateau (e.g., Zhang et al., 2021). Besides, assuming AAE of EC as 1 does not take into the aging of EC.**

Response: Thank you for your suggestions and providing the important recent study on mineral dust over the TP (Zhang et al., 2021). As you said, the main shortcoming of the separation of total aerosol absorption into EC and BrC (Eq. 5) is lack of considering the mineral dust impacts. According to the recent study of Zhang et al. (2021), mineral dust may be an important species of the atmospheric aerosols over the Tibetan Plateau. However, the study region is located at the eastern slope of TP during our campaign, which is more easily affected by anthropogenic sources from heavy polluted Sichuan Basin than natural sources such as mineral dust as compared to the north areas close to Taklimakan and Gobi Deserts. One main aim of this study is to reveal the gradient

distributions of aerosol optical properties from the pollution Sichuan Basin to eastern TP, and thus the impact of the shortcoming may be less when studying the spatial heterogeneity of aerosol optical properties at relatively small spatial scale. In addition, AAE of EC is assumed as 1, and the aging of EC did not take when separating the total aerosol absorption into EC and BrC (Eq. 5) in our study. The above explanations will be added and the recent study will be cited in the revised manuscript.

- **Page 5, Line 5: Is the meteorological data available for each site? Are the sampling sites near the meteorological observation sites?**

Response: Thank you for your question. The meteorological data (temperature, RH, wind speed and direction) from China Meteorological Data Service Center (CMDSC) is available for each sampling site. PM_1 samples were collected near the meteorological observation sites, and thus the meteorological variables can represent the situation at the study region. The above statements will be added to the revised manuscript.

- **Page 6, Line 21: "These are wavelength independent factors." Revise this sentence since it might be misleading.**

Response: Thank you for your reminder. "These are wavelength independent factors." will be changed to "They do not change as the wavelength." in Line 21 of Page 6 of the revised version of our manuscript.

- **Page 6, Equation 5: Separating total aerosol absorption into EC and BrC absorption is applicable for urban sites with severe anthropogenic pollution and little mineral dust (fine soils).**

Response: Thank you for your suggestion. The shortcoming of the separating method cannot be omitted when it is used at the locations with more mineral dust. However, as the response to your Comment 1), the study region is located at the eastern slope of TP during our campaign, which is more easily affected by anthropogenic sources from heavy polluted Sichuan Basin than natural sources such as mineral dust (Yin et al., 2020) as compared to the north areas close to Taklimakan and Gobi Deserts. The explanations will be included in the revised manuscript.

- **Page 6, Equation 5: Assuming AAE of EC as 1 excludes the influence of EC aging, which causes higher AAE than 1.**

Response: Thank you for your suggestion. AAE of EC is assumed as 1, and the aging of EC did not take when separating the total aerosol absorption into EC and BrC (Eq. 5) in our study. The above statements will be added to the revised manuscript.

- **Page 7, Line 6: The assumption of no vertical gradients within the PBL might overestimate the radiative forcing of aerosols.**

Response: Thank you for your suggestion. We assumed no vertical gradients of aerosols within the PBL. The assumption might overestimate the radiative forcing of aerosols, while it has less effect on the radiative forcing of BrC relative to EC (*f*). The latter is more important for our study. The corresponding explanations will be given in the revised version of our manuscript.

- **Page 7, Line 12: Why choose 405 nm as the lower limit of the integral?**

Response: Thank you for your question. The 405 nm is the lower limit of detection by the instrument of DRI-2015. Therefore, the radiative forcing of BrC relative to EC (f) is obtained by numerical integration of the above formula in the wavelength range of

405-980 nm and 405-445 nm for each sample. The explanation will be added to the revised manuscript.

- **Section 2.5: Which version of the EPA PMF model was used in the study?**

Response: Thank you for catching that. EPA PMF 5.0 was used to apportion the sources in this study, which will be revised in the new manuscript.

- **Table 1: The abbreviations of the site names were not defined in the manuscript.**

Response: Thank you for your reminder. In Table 1, Chengdu, Sanbacun, Wenchuan, Lixian, Maerkang and Hongyuan are abbreviated as CD, SBC, WC, LX, MEK and HY, respectively. The definition will be given in the table caption in the revised manuscript.

- **Page 12 and Figure 7: The physical meaning of the parameter (radiative forcing of BrC relative to EC) is recommended to be further discussed. Were the nighttime samples used when calculating this parameter?**

Response: Thank you for your suggestions. The nighttime samples were excluded when calculating the radiative forcing of BrC relative to EC. The parameter (radiative forcing of BrC relative to EC) reflects light absorption strength of BrC at the shorter wavelengths as compared to that of EC aerosols at the whole wavelengths. The much higher *f* values indicated that radiative forcing of BrC aerosols is much stronger for the similar EC radiate forcing, and thus this parameter can be used to better understand the radiative forcing of secondary aerosols relative to primary aerosols at a specific location. The above discussion will be added to Page 12 of the revised manuscript.

- **Figure 9: Black lines and circles are recommended. It is not necessary to use too many colors in this figure.**

Response: Thank you for your suggestions. Figure 9 and the similar figures in the supplemental materials will be revised according to your recommendation in the revised manuscript.

- **Page 16, Line 14: Delete "full".**

Response: Thank you for catching that. The "full" in Line 14 of Page 16 will be deleted in the revised version of our manuscript.

References

Tian, P. F., Zhang, L., Ma, J., Tang, K., Xu, L., Wang, Y., Cao, X., Liang, J., Ji, Y., Jiang, J. H., Yung, Y. L., and Zhang, R. Radiative absorption enhancement of dust mixed with anthropogenic pollution over East Asia, Atmospheric Chemistry and Physics, 2018, 18, 7815-7825.

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