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Interactive comment

Interactive comment on "Role of black carbons mass size distribution in the direct aerosol radiative forcing" *by* Gang Zhao et al.

Anonymous Referee #2

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This paper reports a method combing a DMA with an aethalometer to obtain the BC mass size distribution (BCMSD). Two modes of the BCMSD are observed in their ambient measurement in the North China Plain with the new method. Also, they found that the BCMSD and their mixing state are equally important in estimating the aerosol direct radiative forcing, and suggested that the BCMSD should be fully considered in climate models. The method is a novel design and useful for understanding the relationship of BCMSD and their optical properties. The paper is interesting and well-organized. The conclusion is sound and may have profound impacts on the estimation of BC radiative forcing. I will recommend this manuscript for publication in ACP as long as the following comments are properly addressed.

Specific comments:

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1. Line 245 and fig. 2. It seems that the shift of particle peak diameter for BCPMSD is much more significant than PMSD. Is there any explanation? The correction procedure should be the same for both. 2. Line 306 and fig. 3. It looks strange that there is nearly no BC in the size range of 200nm-300nm. Any explanation? What does the PMSD look like? To me, it looks like the consequence of overestimation of multiple charging of BC. If the data is confirmed to be correct, proper explanation is necessary. Besides, the authors cited several SP2 measurement to support BC peak diameter range from 100nm to 200 nm. However, if I understand correctly, SP2 measures the diameter of BC core, while this study measures the size of entire particles. More references of studies with other methods may be needed. 3. Line 48, I would add another BC microphysical property –hygroscopicityâĂŤin this sentence, which plays an important role in BC direct and indirect radiative forcing. (Zhang et al., 2008;Peng et al., 2017) 4. Line 275: Please add full name of GSD. 5. Line 277, "wea" should be "was" 6. Line 279, should the BC density differ with different mixing state assumption? Externally mixed BC normally exhibits lower density. The authors can considered this as future improvement direction. 7. Line 329, "larger particles grew relative slower in diameter." why? I would say larger particles grew slower in diameter in a log-normal scale. If this is what the authors meant, please verify. 8. Fig. 4 should be improved for better understanding by readership 9. Fig. 6, is the figures made with the assumption of the same particle number concentration? If so, please verify. 10. Table 1. The mixing state here is assumed to be internally mixed, externally mixed, and core-shell mixed. But what is the mixing state assumption for the estimation with BCMSD?

Peng, J. F., Hu, M., Guo, S., Du, Z. F., Shang, D. J., Zheng, J., Zheng, J., Zeng, L. M., Shao, M., Wu, Y. S., Collins, D., and Zhang, R. Y.: Ageing and hygroscopicity variation of black carbon particles in Beijing measured by a quasi-atmospheric aerosol evolution study (QUALITY) chamber, Atmospheric Chemistry and Physics, 17, 10333-10348, 2017. Zhang, R. Y., Khalizov, A. F., Pagels, J., Zhang, D., Xue, H. X., and McMurry, P. H.: Variability in morphology, hygroscopicity, and optical properties of soot aerosols during atmospheric processing, P Natl Acad Sci USA, 105, 10291-10296,

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