Response to Anonymous Referee #1

The presented manuscript describes a new way how to measure size-resolved black carbon mass using a combination of two established aerosol instruments, aerodynamic aerosol classifier and aethalometer. Authors also provide a comparison of the new method to the measurement using SP2 and discuss the uncertainty of the new method. From the presented analyses, the new method seems promising.

Response: Thanks for the positive comments.

Major comments:

1) The structure of the text may be slightly altered, for example 2. Methods, 2.1. Instrumental setup, 2.2.1. AE, 2.2.2. AAC, 2.2. Field measurement, 2.3. Size resolved calculations, 2.3.1. binned AC, 2.3.2. BCMSD? Also, the conclusions text is a summary rather than conclusions, and L291 to 296 is a summary of a summary and most of the text could be omitted.

Response: Thanks for your suggestion. And we changed the structure of the text according to your advice. The title of Sect. 5 was changed from "conclusions" to "summary". Text from L291 to L296 was removed.

2) In Fig. 1, and the connected text, some more information on the sampling system would be useful; in the plot, it looks as all the instrumentation was on one inlet. Is it so? What was the cut-off? What was the flow? How did authors solved sampling with instruments with very different flow rates (those could be also added to the picture, for an easier understanding of the sampling)? Was an isokinetic subsampling considered?

Response: Thanks for your comments. We replotted Fig. 1 with more information and added more description of the sampling system in Sect. 2.1. All the instruments used one inlet with cut-off size and flow rate of aerodynamic diameter of 10 μm and 16.67 L min^{-1}, respectively. An advanced flow splitter was adopted for isokinetic sampling. There were other instruments, such as nephelometer (Aurora3000, ecotech, Australia, 5 L min^{-1}), also connected to the splitter to make flow rate approximately 16.67 L min^{-1}.

3) The agreement between the new method and SP2 data could be made stronger, for example:

- ***In Fig. S2, the two regressions are somehow confusing and not explained in the text? Could this be added?***
- ***Could the data from Fig. 2a be presented in a scatter plot with a linear regression to see the agreement?***
- ***Would not be better to correlate the below 720 nm data with those 720 to 1500 nm data to see if these are connected, rather than regress them with data not measured in the size range? (L173 to L177)***

Response: Thanks for your comments. We made corresponding changes according to your suggestion. Fig. S2 was replotted into 2 subplots in the supplement and explained in the text. Fig. S2a was the comparison between $m_{eBC,bulk,AAC\text{-}AE33,200\text{-}720}$ (eBC mass concentration integrated from $eBCMSD_{AAC\text{-}AE33}$ ranging from 200 nm to 720 nm) and $m_{rBC,bulk,DMA\text{-}SP2,200\text{-}720}$ (rBC mass concentration integrated from $rBCMSD_{DMA\text{-}SP2}$ ranging from 200 nm to 720 nm) to see the agreement of data from Fig. 2a. Fig. S2b depicted the comparison between $m_{eBC,bulk,AAC\text{-}AE33,720\text{-}1500}$ (eBC mass concentration integrated from $eBCMSD_{AAC\text{-}AE33}$ ranging from 720 nm to 1500 nm) and $m_{rBC,bulk,DMA\text{-}SP2,200\text{-}720}$ to see if these two size ranges were connected.

4) In the uncertainty analysis, if the BCMSD was negative for below 23 % (L227), does it mean it is the limit of the method? If so, this should be somehow more explained and highlighted. If it is not so, what does it mean for the method if it brings negative values…? It seems a larger problem than the resulting uncertainty in Fig. 4b? Similarly, what is the reason of the incomplete parametrization? (L232) Would it be applicable to all measurements? Can the parametrization be improved?

Response: Thanks for your comments. If the $eBCMSD_{AAC\text{-}AE33}$ was negative for μ_Ω below 23 %, it did not mean it was the limit of the method. It meant that $eBCMSD_{AAC\text{-}AE33}$ was not valid for μ_Ω below 23 % under setting of AAC used in this study ((Q_{sheath}, Q_{sample}) = (7.5 L min^{-1}, 3 L min^{-1})). $eBCMSD_{AAC\text{-}AE33}$ could be positive for μ_Ω below 23 % by increasing Q_{sheath}. Because desired μ_Ω parameterization was found at 77% of its original value, we did not change Q_{sheath} of AAC.

The reason of the incomplete parameterization was that μ_Ω was highly dependent on (Q_{sheath}, Q_{sample}) and parametrization scheme proposed by Johnson et al. (2018) ($\mu_{\Omega,Johnson}(D_p)$) did not consider all possible cases of (Q_{sheath}, Q_{sample}). The parameterization in this study was applicable to measurements where AAC setting was (Q_{sheath}, Q_{sample}) = (7.5 L min^{-1}, 3 L min^{-1}). The parameterization could be improved by studying μ_Ω under more cases of (Q_{sheath}, Q_{sample}).

Technical corrections:

1) L101, "a" should be omitted?

Response: Thanks for your comment. "a" at L101 was deleted in the revised manuscript.

2) L112, "c" in Cunningham should be in capital?

Response: Thanks for your comment. "c" in Cunningham at L112 was written in capital in the revised manuscript.

3) L118, a verb is missing?

Response: Thanks for your comment. we added a "was" to L118 in the revised manuscript.

4) L119, why not to be specific and state that AE33 did not need any correction, instead of "the instrument downstream"?

Response: Thanks for your recommendation. We replaced "data measured by the instrument downstream AAC" with "AE33" in the revised manuscript.

5) L134, why the constant MAC is stated when not used in the calculations? L134 and 135 may be omitted.

Response: Thanks for your suggestion. L134 and L135 were removed in the revised manuscript.

6) L143, one "bin" may be omitted?

Response: Thanks for your comment. We deleted one "bin" in the revised manuscript.

7) L164, could be the pollution episodes somehow highlighted in the plot?

Response: Thanks for your comment. We replotted Fig. 2a and highlighted the pollution episodes with orange shades in the revised manuscript.

8) In Fig. 3, the dotted line does not denote mean +- std, only std.

Response: Thanks for your comment. We replotted Fig. 3 and replaced the legend "mean $\pm$ std" with "std" in the revised manuscript.

9) L205, S2b should be S3b?

Response: Thanks for your comment. We changed "S2b" into "S3b" in the revised manuscript.

10) L230, is the 1 % uncertainty or difference?

Response: Thanks for your comment. It should be "1% difference", and we replaced "uncertainty" with "difference" in L230 of the revised manuscript.

11) L253 and 254, what was the correlation between the two lines?

Response: Thanks for your comment. determination coefficient (R^2), slope (b_1) and intercept (b_0) between the instrumental noise and $\sigma_{ab,bulk}$ were 0.0, 0.0 and 0.1 Mm^{-1}, respectively. We added the correlation results to the

revised manuscript.

12) L264, limiting instead of limited?

Response: Thanks for your comment. It should be “limiting” and we changed “limited” to “limiting” in the revised manuscript.

References

Johnson, T. J., Irwin, M., Symonds, J. P. R., Olfert, J. S., and Boies, A. M.: Measuring aerosol size distributions with the aerodynamic aerosol classifier, Aerosol Science and Technology, 52, 655-665, 10.1080/02786826.2018.1440063, 2018.