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Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "A comparison of three optical absorption photometers at a boreal forest site – effects of different correction algorithms" *by* Krista Luoma et al.

**Anonymous Referee #1**

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This paper described results from the comparison experiments using three different light absorption filter-photometers, MAAP, PSAP, and Aethalometer, at a boreal forest site in Northern Europe. Correction of the output from these instruments has been considered one of the most important issues on the accurate determination of light absorption coefficient babs. In this study, authors conducted systematic comparison works to derive corrected babs from the measurements using three filter-photometers with different algorithms. The topics with which this paper deals meet the scope of Atmospheric Measurement Techniques (AMT); however, there are some points to be addressed before accepting the manuscript as an AMT paper. Please consider the following comments for the revision.



Major comments

1. Relative humidity of air for babs measurement by MAAP In this study, Cref was determined by the Equation (19). One of the bases of this way is the accuracy of $\sigma$abs,ref measured using the MAAP. In my reviewing process, I could not find very important related studies, for example Kanaya et al. (2013). In their study, BC concentrations measured using a MAAP (BCMAAP) were compared with those measured using a different filter photometer, COSMOS (Miyazaki et al., 2008). The dependency of MAAP sensitivity on relative humidity (RH) in MAAP has been discussed in relation to the changes in the optical properties of the glass filter tape (e.g., surface roughness). This change can be related to an increase in the surface roughness parameter to be used for the radiation transfer calculation (Petzold and Schönlinner, 2004) together with the RH. According to their studies, BCMAAP, namely $\sigma$abs,ref can be affected by RH in MAAP, even though the values of RH were lower than the recommended value (<40%). I believe that authors should refer these papers in the discussion on the RH dependence of MAAP and discuss such uncertainty of MAAP related to RH condition. Some of conclusions, related to RH effect, should also be modified according to the discussion on the MAAP uncertainty.

2. Readability Authors described the details of all the algorithms to correct the outputs of filter-photometers used in this study. I also believe that these descriptions are important, however, I, as one of readers, felt that the descriptions are somewhat lengthy because they are from previous studies, not originally from this study. To enhance the readability, I strongly recommend to reorganize the structure of the manuscript around the sections 2.3.1 and 2.3.2. The main part of these descriptions can be moved to Supporting Information or Appendix (which will be newly prepared in the revised manuscript). Only the essences (what types of correction algorithms were used for AE31 and PSAP with proper references, what kinds of input parameters are needed for each algorithm, and so on) should be included in the main text.

Specific comments

P4-P5; The section 2.2 (instrument set-up) should be reorganized. The most important information is the set-up used in this study. So, the explanations about Fig 2 with the instrumental information should be describe as the basic experimental setup earlier than other information like the modification of the measurement flow line, the data availability, and the RH condition.

P11 L8-17; RH of air directed to the Nephelometer should be described in this section (2.4) to clarify the humidity condition of light scattering measurements and its impact on the hygroscopic growth of water-soluble aerosols.

P11 L19-21; Authors should describe why the difference in the size cut did not so greatly affect the results of the comparison experiments. Were there little impacts of (local) dust particles at the site?

P13 L29; The Cref values determined by different algorithms were described. Together with these values, their variabilities (e.g., 95% confidence interval) should be clarified here to show the statistical significance of the similarity and difference among correction algorithms. Statistical tests can help the discussion on the differences among variables.

P14 L14-16; It is hard for me to understand this explanation. This can only describe the possibility to describe one of the reasons of differences between CARN and CNC, and never account for the higher CARN than CNC. Please clarify the what this describes here. And again, without the significance of the differences, this kind of comparison works could not be established.

P16 L11; If the possible reasons of the lack of seasonal variations of CARN are added, authors can discuss the difference in the potential benefits of CARN compared to others (because the lack of seasonal variation is obviously beneficial). I believe that authors should discuss this point here to clearly differentiate the correction algorithms by their performance.



P17 L29-P18 L5; I am suspicious about how largely the particles can grow by water vapor at such low values of RH. Typical inorganic species never indicate large hygroscopic growth at RH <40%, because their DRH are typically higher than 40% or so (even though considering the dehumidification process from higher RH condition). Furthermore, penetration depth of particles in filter is dependent on not only the particle size but also filter material properties and sampling flow rate (i.e., single fiber width, density of the fibers, and face velocity of air). The discussion here is highly speculative and fragmentary. Revisions to this discussion are strongly needed to better show precise interpretations.

P18-P19 (sections 4.2 and 4.3); The performances of the correction algorithms as a function of ATN or Tr were evaluated in these sections. The slopes of $\sigma$abs,AE31 (or $\sigma$abs,PSAP)–$\sigma$abs,ref correlations and values of Absorption Ångström exponent $\alpha$abs were determined by the linear regression analysis. For better evaluations, it is beneficial to include the analyses of r2 values as a function of ATN and Tr. In terms of the measurement precision, ATN and Tr should be considered for quality control and quality assessment of the data obtained using filter-photometers. As an example, an evaluation of a miniaturized Aethalometer (AE51) in a previous study (Miyakawa et al., 2020) suggested that AE51 showed lower precision (i.e., lower r2) results in case of heavy aerosol loading on a collection filter (than not-used filter case).

P19 L17; I believe that this sentence is not correct and not scientific (not -slope of a linear fit, simply slope of linear fit, because "-1" was multiplied in front of the slope term). So, this should be rephrased by using an equation or a proper expression.

P22 L25-28; These sentences should be included in discussion part, because they are not the actual outcome from this study.

Captions of Figures 7, 8, 9; I think that "The explanation for the boxplots is the same as in Fig. 3" not Fig. 5. Furthermore, the marker types indicating the mean values are not always same for all figures (Figs. 3, 7, 8, 9). Please confirm the consistency and

properly revise them.

References for the comments

Kanaya, Y., F. Taketani, Y. Komazaki, X. Liu, Y. Kondo, L. K. Sahu, H. Irie and H. Takashima (2013) Comparison of Black Carbon Mass Concentrations Observed by Multi-Angle Absorption Photometer (MAAP) and Continuous Soot-Monitoring System (COSMOS) on Fukue Island and in Tokyo, Japan, Aerosol Science and Technology, 47:1, 1-10, DOI: 10.1080/02786826.2012.716551.

Miyakawa, T., P. Mordovskoi and Y. Kanaya (2020) Evaluation of black carbon mass concentrations using a miniaturized aethalometer: Intercomparison with a continuous soot monitoring system (COSMOS) and a single-particle soot photometer (SP2), Aerosol Science and Technology, 54:7, 811-825, DOI: 10.1080/02786826.2020.1724870.

Miyazaki, Y., Kondo, Y., Sahu, L. K., Imaru, J., Fukushima, N. and Kanno, A. (2008) Performance of a Newly Designed Continuous Soot Monitoring System (COSMOS), J. Env. Monit., 10: 1195-1201. doi:10.1039/b80 6957c

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