Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC1
https://doi.org/10.5194/amt-2021-284-RC1, 2021

Comment on amt-2021-284

Anonymous Referee #1

Referee comment on "Relative errors in derived multi-wavelength intensive aerosol optical properties using cavity attenuated phase shift single-scattering albedo monitors, a nephelometer, and tricolour absorption photometer measurements" by Patrick Weber et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-284-RC1, 2021

General

The paper presents results of laboratory measurements of aerosol optical properties measured with a CAPS PMssa, a nephelometer and a filter-based absorption photometer, the TAP. Different types of BC particles were produced with a nebulizer and a burner. Also purely scattering aerosols (ammonium sulfate) were nebulized. The data were used for calculating scattering and absorption, single-scattering albedo and Ångström exponents of extinction, scattering and absorption. The results show that scattering, absorption and extinction and their wavelength dependencies - except AAE - can be measured in the aerosol phase with the CAPS PMssa with a reasonably low uncertainty. This is very valuable because all filter-based instruments have artifacts in the absorption measurements. It is also valuable that different types of BC particles and size distributions were used in the experiments.

The paper is well written and I can recommend publishing it in AMT after some additions and answers to some questions that puzzle me.

Comments and questions

1) Compared to ambient measurements the concentrations were fairly high. The best results for the absorption coefficient with the CAPS PMssa were observed for absorption coefficients > 10 Mm^{-1} . Such levels are observed in very polluted environments, for instance in China and India. I think you could mention this and also refer to a new intercomparison where the CAPS PMssa was used in real background conditions, see Asmi et al. (2021) (ref below) and also compare your results with theirs.

2) Related to this, I am missing a table where you would show the extensive and intensive aerosol optical properties and the length of each experiment. Maybe in a supplement? Now the tables have various ratios and regression constants – which is important of course – but I think it would be useful to show also the range of absorption and scattering coefficients you have produced. Or if you don't want to make that supplement, at least you could add some lines to the overview table, Table 3: number of experiments, average length of experiments, averages and ranges of scattering and absorption coefficients.

3) The results in the scatter plots and the tables are based on experiment averages or ensemble averages and their ratios. As an example I take Table 5. I do not find anywhere information of how long data are collected for one experiment's average. In the table there are the numbers N=xx. I suppose xx the number of experiments, right? Please explain clearly both in the text and the table captions what N means.

4) Further on the same averaging question. So, the scatter plots are based on averages which I assume means using the average of each experiment. How would the results change, if you used shorter averaging times, from some seconds to minutes? Or was the aerosol production so stable that it would not matter, which averaging time was used? Usually it is assumed that the uncertainty due to noise decreases with one over the square root of averaging time. This then propagates to the uncertainties of the derived optical properties. For instance, I guess that in Fig. 6 the data points would fill in the grey shaded error bands if shorter averaging times were used. Discuss this a bit.

Lines 68 – 73. There is discussion on AAE. It is written that AAE depends on chemical composition and that AAE > 1 is due to brown carbon or mineral dust. This is not the whole truth. It is easy to show with your Mie code and it has been shown in several papers that AAE also depends on the size distribution of the light absorbing particles and that both AAE>1 and AAE<1 values are observed even for pure BC particles. Here are just some references: Gyawali et al. (2009), Lack and Cappa (2010), Lack and Langridge (2013), Liu et al. (2018), Zhang et al. (2020) and Virkkula (20219. Actually, it is interesting that if you compare median diameters the AAE values in your Table 3 with Fig. 6 of Liu et al. (2018) they seem to be qualitatively in agreement

Line 112: " Because all instruments were connected to one central aerosol supply line." The sentence should continue, now there is a full stop.

Line 136: "Data inversion for the nephelometer …". Is "inversion" really the correct term here? The scattering coefficients are simply multiplied with a correction factor that depends on SAE.

Line 199: Size distributions were measured beforehand. Why not all the time? Any idea of the stability of the size distributions?

References

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