Atmos. Chem. Phys. Discuss., 5, S3967–S3971, 2005
www.atmos-chem-phys.org/acpd/5/S3967/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Spectral light absorption by ambient aerosols influenced by biomass burning in the Amazon Basin – I. Comparison and field calibration of absorption measurement techniques" *by* O. Schmid et al.

Anonymous Referee #1

Received and published: 17 November 2005

The manuscript reports results from a calibration of aerosol absorption measurement techniques performed in the field during the LBA-SMOCC study in Amazonia. Considered measurement techniques are a photoacoustic spectrometer (PAS), a single-wavelength Particle Soot Absorption Photometer (PSAP), and a multiple-wavelength Aethalometer. Supporting data on aerosol extinction and aerosol scattering were obtained by a long-path extinction cell and an integrating nephelometer during additional laboratory experiments using test aerosols. The study covers almost all currently used

aerosol absorption measurement methods. The PAS technique was set as in-situ reference method in the field, while laboratory data were used for the validation of the PAS method referenced to extinction and scattering methods. The study focuses on the investigation of possible parameters influencing the determination of the aerosol absorption coefficient by filter-based methods. Among those effects are the filter loading of the probed samples, the single scattering albedo of the sampled aerosol (not investigated here), relative humidity of the sample air and possible adsorption of gaseous compounds on the filter matrix. The study makes a relevant contribution to the research area of instrumentation for aerosol absorption measurement techniques and deserves publication in ACP. However, major revisions are required as discussed in the following.

GENERAL COMMENTS

1) The authors do not distinguish properly between light attenuation and light absorption which definitely describe different physical processes. In the Introduction Section and particularly in the Sections on Photoacoustic Spectrometry and on the Aethalometer, these terms are mixed. As an example, Eq. (2) states that light attenuation through the photoacoustic resonator is governed by the aerosol absorption coefficient. However, this is not true since also light scattering either by particles or by gas molecules contributes to light attenuation, or extinction, respectively, while the photoacoustic method is indeed only sensitive to light absoprtion. In the same section, the authors plot extinction measured by an extinction cell against absorption measured by a photoacoustic spectrometer (Fig. 2). These are different quantities. Also in the last paragraph of Section 3.2.2, the authors state that light scattering may be interpreted erroneously as light attenuation. However, scattering contributes also to attenuation. The issue of absorption and attenuation requires careful revision of the manuscript.

2) Section 2.4 on the correction of the Aethalometer requires a clear definition of used properties. Symbols like σ_{aeth} and σ^*_{aeth} are introduced without definition. Eq. (16) is obtained using the assumption that $\sigma_{aeth} = \sigma^*_{aeth}$. Since Eq. (16) is widely used in the study, this assumptions requires explanation and discussion. The use of correction

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functions f and R(ATN) which describe the influence of filter loading on the measured absorption coefficient needs clarification. An additional figure showing the variation of attenuation ATN with wavelength for one example would be illustrative. In the concluding paragraph of Section 2.4 the authors adopt calibration factors f which are not given explicitly. Please quantify these calibration factors and define the method how they have been obtained. Again, a figure showing the factors f for different wavelength would be helpful. Such a figure would also justify the statement that the factors f are independent of the wavelength. Related to this topic, Fig. 5 showing the fitting lines which are used to derive the factors f needs a more detailed discussion. Furthermore, the authors state in the Conclusions Section that the correction factors C and f are almost independent of the wavelength. This statement contradicts the calculations shown in Table 1 where the factor C varies by a factor of approx. 1.5 from 370 nm to 950 nm. The entire issue of Aethalometer data correction needs clarification.

3) The authors show an influence of relative humidity on the PSAP data analysis. The observed influence is largest for low relative humidities and vanishes for moderate RH values. These observations point in the opposite direction as expected from involved physical processes. The authors do not offer an explanation for their observation, but note that low RH data originate exclusively from night-time periods. Since it is known that the PSAP photodetector efficiency shows some dependence on the operation temperature of the instrument, the authors should check whether the RH effect does or does not translate into a temperature effect. During the Reno Aerosol Optics Study (Sheridan et al., 2005) the corrected PSAP showed excellent agreement with a photoacostic instrument for dry aerosol. Please discuss the discrepancies between the observations and results from previous studies.

4) The section on an influence of gaseous adsorption on the absorption measurement requires justification of the drawn conclusions. The data analysis builds exclusively on the assumption that the pollution of sampled air by gaseous compounds correlates well with the pollution by particulate compounds which, however, must not be the case.

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The observation that the deviation of the multiple-scattering correction factor C for high pollution levels from an average value is a function of the property σ_{aeth} may also be explained by having a look at Figs. 4 and 6a/b. The authors derive the factors C as arithmetic mean values from the respective data sets. However, Figs. 4 and 6a/b show that the scatter of $\sigma_{aeth}/\sigma_{PAS}$ is largest for absorption coefficients < 10 Mm^{-1}. When excluding PAS data < 10 Mm^{-1} from the data analysis, the obtained factors C will be different. The authors should investigate to what extent these modified C factors influence their conclusion on an effect of gaseous adsorption on the Aethalometer performance.

5) In the conclusions on a recommended practice for the correction of Aethalometer data the authors define a "best practice" value of C = 4.2. This value deviates both from the value derived for the Amazonia aerosol and from the values reported by Weingartner et al. (2003) for coated and pure combustion particles. It seems more appropriate to use different C factors for different aerosol types, since following Eq. (20), the factor C contains the influence of the aerosol light scattering fraction.

SPECIFIC COMMENTS

Entire manuscript: the frequent use of the word "relatively" should be restricted. It should be replaced by a more precise description wherever possible.

Introduction, 2nd paragraph: clarify the use of absorption, attenuation and extinction. State, that the difference methods relies on the relationship extinction = scattering + absorption; photoacoustic spectrometry uses the thermal expansion of light-absorbing particles caused by the transfer of radiative energy into thermal energy, please clarify.

Introduction, 3rd paragraph: Multi-angle absorption photometry is not an advanced Aethalometer but a totally different technique which uses radiative transfer methods for the data inversion, please revise the respective sentence.

Introduction, 4th paragraph: The difference methods needs an extinction cell plus an

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integrating nephelometer, which makes it difficult for field work, please add this clarification to the text.

Section 2.5: There is no Eq. 33.5, please correct.

Table 1: Specify values for C* and m^s which were used for the calculation of C. The values may be given either in the text or in a footnote to Table 1.

Figure 2: Correct the label of the y-axis, it should read $\sigma_e - \sigma_s$.

Figure 8: Plot axis labels at the bounding frame of the figure.

REFERENCES

Sheridan, P.J., Arnott, W.P., Ogren, J.A., Andrews, E., Atkinson, D.B., Covert, D.S., Moosmüller, H., Petzold, A., Schmidt, B., Strawa, A.W., Varma, R., and Virkkula, A. (2005) The Reno Aerosol Optics Study: Overview and Summary of Results, Aerosol Sci. Technol., 39, 1-16.

Weingartner, E., Saathoff, H., Schnaiter, M., Streit, N., Bitnar, B., and Baltensperger, U. (2003), Absorption of light by soot particles: Determination of the absorption coefficient by means of aethalometers, J. Aerosol Sci., 34, 1445-1463.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 9355, 2005.