Answers to Interactive comment by Anonymous Referee #3 on "Differences in Aerosol Absorption Ångström exponents between correction algorithms for Particle Soot Absorption Photometer measured on South African Highveld" by Backman et al. 2014

Answers to the specific comments

Comment: "*Equation 1: 'C' is not explained. Another often used definition of the Ångström exponent is:*

$$\ln\left(\frac{\sigma(\lambda_1)}{\sigma(\lambda_1)}\right) = -AE \cdot \ln\left(\frac{\lambda_1}{\lambda_2}\right)$$
$$\Leftrightarrow \ln(\sigma(\lambda_1)) - \sigma(\lambda_2) = -AE(\ln(\lambda_1) - \ln(\lambda_2))$$
$$\Leftrightarrow \ln(\sigma(\lambda_1)) = -AE \cdot \ln(\lambda_1) + AE \cdot \ln(\lambda_2) + \ln(\sigma(\lambda_2))$$

If λ_2 is considered to be a constant base wavelength, the term $AE \cdot ln(\lambda_2) + ln(\sigma(\lambda_2))$ can be associated with the term C. But since AE is part of that term, the definition as shown in Equation 1 could be misleading, since C is not a constant."
Answer: The equation above represents the two wavelength calculation of the AE (Moosmüller and Chakrabarty 2011). However, more generally, Eq. (1) in the manuscript is the optical property as a function of wavelength and its relation to the AE. The work by Ångström (1929) noted that the spectral dependence of atmospheric light interaction can be represented by the relationship $\tau(\lambda) = K\lambda^{-AE}$ where τ is the extinction optical depth which becomes

$$\tau(\lambda) = K\lambda^{-AE} \Leftrightarrow \ln(\tau(\lambda)) = -AE \cdot \ln(\lambda) + \ln(K) \quad,$$

which is equivalent to Eq. (1) in the manuscript. The constant C, here represented by ln(K) is called the aerosol turbidity and is not relevant in the manuscript (Schuster et al. 2006). The turbidity (K) of the aerosol is the approximated τ of the aerosol at a wavelength of 1 μm (i.e. the logarithm of the regression intercept).

Comment: "*Page 9736, line 8: typo, singular "absorb"*""
Answer: The typo was corrected accordingly.

Comment: "*Section 3.1: The MAAP suffers from a scattering artefact as shown in Fig. 12 in Petzold et al. (2005) and Fig 12 in Müller et al. (2011b). Was the scattering artefact considered in the data evaluation? Is the scattering artefact relevant in cases of high single scattering albedos?*"
Answer: As pointed out by the referee, the MAAP suffers from a scattering artefact. The authors are aware of this and is one of the reasons that it cannot be considered to be a true reference instrument, as stated in the manuscript. However, in the revised manuscript this issue will be explicitly stated. The scattering artefact is a function of filter transmittance as shown in Müller (2011b) Fig. 12. The filter transmittance of the MAAP was—unfortunately—not logged and cannot therefore afterwards be used to compensate for the known artefact. Given the range of the scattering artefact of the Fig. 12 in Müller (2011b) it would be unjust in this casse—in the authors' opinion—to apply a constant value for the scattering artefact for the MAAP and was therefore not included in the data evaluation. The study of Müller (2011b) highlights that there is still much work to be conducted to understand the cross sensitivity of both the PSAP and the MAAP to light scattering aerosol and that the scattering correction should be a function of filter loading. As the referee points out, the scattering artefact would be most significant at high single-scattering albedoes. The bivariate regression of Fig. (3) in the manuscript was tried using data which only comprised SSA<0.9. The criterion did not change the figure nor did it affect the correlation coefficients between the two instruments. For a data set with much of the data with a SSA above 0.9, the situation could be, however, very different.

Comment: "*Reviewer comment to core–shell particle model: Page 9748, line 16 to end of section: In Fig. 1 in Ma et al. (2012) it was shown, that the hemispheric backscattering fraction can provide information if particles are mixed internally, externally, or even if a core–shell model is more appropriate. For a core–shell mixing the hemispheric backscattering is larger than for the other mixing states. For a larger hemispheric backscattering typically the asymmetry parameter also is larger. In Mueller et al. (2013) it is shown, that the scattering artefact of filter based absorption photometer depends on the asymmetry parameter. In summary it can be stated that the mixing state has influence on the basic corrections of filter–based absorption photometers and also on the derived absorption Angström exponents. Additionally there are the effects described in Gyawali et al. (2009) and Lack and Cappa (2010). The reviewer knows, that is difficult to*

distinguish between instrumental correction functions and uncertainties in the aerosol properties due to the unknown mixing state. Differences in absorption Angström exponents for different aerosol are shown in Figure 5 a,b. Could the author estimate to what degree the differences are due to the properties of the aerosol type or due to uncertainties of PSAP corrections (having in mind that correction could depend on aerosol type)."

Answer: The mixing state of the aerosol will certainly influence the measurements as the referee points out. The work by Ma et al. (2012) showed—using Mie calculations, a monte carlo based aerosol physics box model coupled with a aerosol chemistry model—that a qualitative parameter for the mixing state of the aerosol can be derived from the hemispheric back scatter fraction (*b*) using nephelometry and number size distribution measurements. The study pointed out that *b* is sensitive to the mixing state and can be used to provide an estimate of the fraction of externally mixed light absorbing species in relation to the non-absorbing species. As the referee rightfully points out, different mixing states should therefore impact the filter-based absorption measurements since *b* is related to the asymmetry parameter of the aerosol. The asymmetry parameter, in turn, is a parameter that affects filter-based absorption photometers (Müller et al. 2013). The method of Ma et al. (2012) that provides a qualitative estimate of the mixing state is rather extensive and would be outside the scope of this manuscript. The different aerosol characteristics of the aerosol shown in Fig. (5a) and (5b) is addressed solely on the basis of the AAE and SAE which in the authors' opinion better fits within the scope of the manuscript. To be able to provide a estimate for the impact of aerosol type on the performance of different corrections a true reference instrument would be required, as discussed in the manuscript. Moreover, given the multitude of aerosol parameters that influence filter-based photometers, constraints for the aerosol type would need to be introduced to a greater extent than possible with this data set; laboratory experiments would be authors' preferred choise of approach for the referees question about the aerosol types impact on the observed behaviour.

Comment: Line 9750, line 25: typo "an aerosol"
Answer: Corrected.

Comment: Line 9751, lines 10&11: check sentence
Answer: The sentence was changed to "It should be noted, however, that Fig. (6) depends on Tr which inherently is a result of the type of aerosol particles. Furthermore, there is likely a cross dependency between Tr and SAE which is not considered if Fig. (6)." to make the message more clear.

Comment: Line 9752, line 7: no blank in "V20 10"
Answer: Corrected.

Comment: Line 9752 , line 25, typo in "differences"
Answer: Corrected.

Comment: Running title: Typo in 'PASP'
Answer: Corrected.

References

Moosmüller, H. and Chakrabarty, R. K.: Technical Note: Simple analytical relationships between Ångström coefficients of aerosol extinction, scattering, absorption, and single scattering albedo, Atmospheric Chemistry and Physics, 11, 10677-10680, 10.5194/acp-11-10677-2011, 2011.

Schuster, G., Dubovik, O. and Holben, B.: Angstrom exponent and bimodal aerosol size distributions, J. Geophys. Res. -Atmos., 111, D07207, 10.1029/2005JD006328, 2006.

Ångström, A.: On the Atmospheric Transmission of Sun Radiation and on Dust in the Air, Geografiska Annaler, 11, 156-166, 1929.