Comments on “Constrained two-stream algorithm for calculating aerosol light absorption coefficient from the Particle Soot Absorption Photometer” by T, Müller et al.

General comments:

This paper proposed an interesting way to obtain the particle absorption coefficient from filter based measurements such as PSAP. This is an important topic in many aerosol related fields. Due to the simultaneous presence of absorption and scattering, it is challenging to accurately separate absorption from scattering in this type of measurements. The authors developed a novel correction method aiming at obtaining accurate aerosol absorption coefficient from filter based measurements. The development of the novel correction method seems rigorous. However, two key equations, Eqs. (31) and (33), were found to contain errors, which casts doubt on the correctness of some the results presented in this paper. Details will be given later.

In Eq. (5) on page 8, the summation is over all particles. For individual particles the concept of scattering coefficient does not apply. The average g should be weighted by particle scattering cross section. Below Eq. (5), there is a typo in the transmittance, $T = I_t/I_r$. At the beginning of page 10, it is commented that Eq. (11) is symmetric. Eq. (11) possesses the symmetry only if $R_1 = 1-T_1$, i.e., both filter layers are non-absorbing. This point should be made explicitly. In this paper μ_1 is assigned a value of $1/\sqrt{3}$ (Table 2) without any justification. The relative optical depth of a particle-loaded two-layer system given in Eq. (12) is a very important quantity in this paper. It is dependent on the particle and the filter properties as well as the particle concentration profile through the relative particle penetration depth η_f. Near the end of page 14, a value of 0.2 was chosen in this paper to match the enhancement factor of Bond et al. (1999). Although it is not clearly indicated in the paper, I assume that $\eta_f = 0.2$ was assumed throughout this paper. By fixing the value of η_f it is effectively assumed that particles do not penetrate further into the filter, see Fig. 2. Is this realistic? In reality should η_f vary with time? It is not clear to me how to understand Eq. (22). To obtain F_f^{mod} from Eq. (22) it is necessary to know δ (the denominator). My understanding is that δ in the denominator of Eq. (22) is also calculated or modeled using Eq. (12). If this is indeed the case, δ in Eq. (22) should be written as δ^{mod}.

The derivation of Eq. (31) given in Appendix A contains errors. By following the derivation given in Appendix A I arrived at

$$\delta(\delta_{ap}) = \ln\left(\frac{(c_1+c_2)e^{c_2\delta_{ap}} - c_1}{c_2}\right) \tag{31}$$

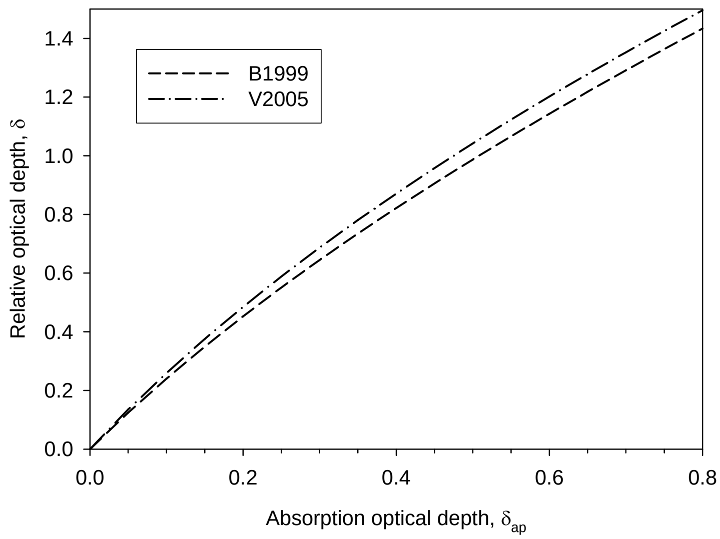
The derivation of Eq. (33) from Eq. (32) for black particles is also incorrect. For black particles Eq. (33) should be

$$f_{tr,V2005} = c_1 - c_2(h_0+h_1)\ln(\tau) \tag{33}$$

It is therefore expected that Eq. (34) is also incorrect. From following the steps of derivation given in Appendix B, but starting from Eq. (33) given above, I arrived at the following expression for Eq. (34)

$$\delta(\delta_{ap}) = \sqrt{\frac{2\delta_{ap}}{-c_2(h_0+h_1)} + \left(\frac{c_1}{c_2(h_0+h_1)}\right)^2} + \frac{c_1}{c_2(h_0+h_1)} \tag{34}$$

By using Eq. (31) and Eq. (34) given above for B1999 and V2005, respectively, and the parameters given in the paper Fig. 8 is revised as follows



The B1999 curve does not change too much from that given in Fig. 8 of the paper. However, the V2005 curve changes significantly from that shown in Fig. 8 of the paper. In addition, the two curves are very close to each other. Since the errors in Eqs. (31) and (34) of the paper are critical to the rest of the paper, some of the results should be re-calculated using the correct expressions of these equations.