Li et al.: **Development of a Universal Correction Algorithm for Filter-Based Absorption Photometers**
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Review

General

The paper presents a new algorithm for calculating absorption coefficient from CLAP, TAP, and PSAP data. It looks interesting and it may prove to be a very good one. The authors even give an Igor code for using it which is good, people can test it. The authors first evaluate older algorithms, the Bond et al. (1999) and the Virkkula et al. (2005) algorithms and then present their own and evaluate its performance. The data for the evaluations come from both lab-based and field measurements which is also good.

However, I found serious issues in the paper that should be corrected before the paper can be published in AMT. They are presented in the detailed comments below.

Detailed comments

- The algorithm is shown in Eq. (9) Looks interesting although quite complicated. How did you get AAE into it? Please show intermediate steps from Eqs. (8) to (9). I read the supplement but did not find steps leading to Eq. (9).

Discussion on Fig 2 and Table 3.

There are three strange things in your Fig. 2.

- If I compare the scatter plots in Fig. 2a of V2005 where the B1999 correction was used as such, with Fig. 3 in Virkkula (2010) where the B1999 correction with the coefficients updated by Ogren 2010 the regression lines don't change nearly as much as as in your Fig. 2. The difference between the original B1999 and that adjusted by Ogren (2010) is not big, definitely not as much as in your Fig. 2. and in Table 3. For instance, now you claim that the slope for the green changes from 2.5 to 1.01 when using the original B1999 formula and the one adjusted by Ogren (2010). That cannot be true. The additional correction factor Ogren (2010) derived was 0.97 ± 0.01. Otherwise it is B1999. Also in your Table 3 the change of the slope from 2.83 to 1.03 when using either the original V2005 or the corrected constants in Virkkula (2010) is far from realistic. Both of these can easily be tested by using the constants from those papers. I have added some examples below.

- The second observation is that in the above-mentioned scatter plots in V2005 and Virkkula (2010) the absorption coefficients calculated with the B1999 correction without and with the updates are either lower than or close to the absorption standard. The V2005 correction and its adjustment in Virkkula (2010) resulted in increasing the absorption close to the 1:1 line of the respective scatter plots, not decreasing like in your Fig. (2). This is obvious especially for dark aerosol with SSA < 0.3 in those two papers.

- The third observation is that you get essentially the same absorption coefficients with B1999 and V2005 and their respective updates. In Fig 2 the data points are almost on top of each other. And their regression lines are almost identical. This would be correct for high SSA (>0.7) but now your SSA went down to < 0.6 for the FIREX data (your Fig 6) and < 0.5 in the SGP data (your Fig 9). For such low SSA the two methods do not yield so similar absorption coefficients unless you used only data where transmittance > 0.8. What Tr range was used for the regressions?

To evaluate the possibiity of getting such strange relationships I present some calculations here.

By using the symbols of the paper the Bond et al. (1999) correction is

$$\mathrm{Babs} = \frac{1}{\mathrm{C_2 Tr} + \mathrm{C_3}}\mathrm{Batn} - \mathrm{C_1 Bscat}$$

In Bond et al. (1999) Eq. (12) is

$$\mathrm{Babs} = \frac{1}{1.22}\left(\frac{0.873}{1.079\mathrm{Tr} + 0.71}\mathrm{Batn} - 0.02\mathrm{Bscat}\right) \approx \frac{1}{1.5087\mathrm{Tr} + 0.9922}\mathrm{Batn} - 0.016\mathrm{Bscat}$$

$\Rightarrow C_1 \approx 0.016$, $C_2 \approx 1.509$, $C_3 \approx 0.992$

Ogren (2010) added a very small adjustment factor, 0.97, so that the equation becomes

$$\mathrm{Babs} = \frac{1}{1.22}\left(\frac{0.97 \cdot 0.873}{1.079\mathrm{Tr} + 0.71}\mathrm{Batn} - 0.02\mathrm{Bscat}\right) \approx \frac{1}{1.556\mathrm{Tr} + 1.023}\mathrm{Batn} - 0.016\mathrm{Bscat}$$

$\Rightarrow C_1 \approx 0.016$, $C_2 \approx 1.556$, $C_3 \approx 1.023$

The algorithm in Virkkula et al. (2005) is of the form

$B_{abs} = (C_4 + C_5(C_6 + C_7 SSA)\ln(Tr))B_{atn} – C_1 B_{scat}$

For 530 nm the constants were

$C_4 = 0.306$, $C_5 = -0.522$, $C_6 = 1.234$, $C_7 = -0.952$ and $C_1 = 0.016$ in Virkkula et al. (2005) and
$C_4 = 0.358$, $C_5 = -0.64$, $C_6 = 1.17$, $C_7 = -0.71$ and $C_1 = 0.017$ in Virkkula (2010)

If we assume Batn = 500 Mm^{-1}, Tr = 0.9 and Bscat = 100 Mm^{-1} the absorption coefficient calculated from the orginal B1999, corrected with Ogren (2010), Virkkula et al. (2005), and the corrected Virkkula (2010) equations are ~211 Mm^{-1}, 204 Mm^{-1}, 176 Mm^{-1} and 209 Mm^{-1}, respectively.
At Tr = 0.5 the respective values are ~285 Mm^{-1}, 276 Mm^{-1}, 325 Mm^{-1}, and 406 Mm^{-1}.
Note that Babs calculated with the corrected Virkkula (2010) coefficients are close to the B1999 values only at high Tr. Note also that Babs calculated with the corrected Virkkula (2010) coefficients are higher than those calculated with the coefficients in the Virkkula et al. (2005). The ratio Babs(V2005)/Babs(V2010) is ~0.8 but it depends on Tr and SSA. But it is not the other way like in your Fig. 2.

So there is definitely some big mistake in the calculations. They have to be corrected for the revised manuscript. This means a large fraction of the paper has to be corrected because comparisons between your new method and the old ones are presented throughout the paper.