Correspondence to Anonymous Referee #3

The authors of the manuscript entitled "Intercomparison and characterization of 23 Aethalometers under laboratory and ambient air conditions: Procedures and unit-to-unit variabilities", acknowledge the valuable feedback given by the Anonymous Referee #3. We have addressed all the concerns raised. Next, we respond to each one of your comments.

Comment 1: L206 AMCA? What does this stand for? Why 21.1°C? The most commonly used standard temperatures are 0°C and 25°C.

Response: AMCA stands for Air Movement and Control Association International (amca.org). This is a North American body generating standards for air movement including ventilation and air conditioning; the values of 21.1°C and 1013 hPa, are the air standard temperature and pressure established by the AMCA. These are the default standard conditions used by the flow sensors in the AE33, to report the measured mass flow (Magee Scientific, 2018). We feel it is best to report raw measurements in addition to the processed ones. Although the flow reporting conditions can be modified in the instruments, we assured all the aethalometers used the AMCA in the laboratory as these are the most regularly used conditions in the AE33.

This information was included as a footnote in Table 2.

"AMCA (Air Movement and Control Association International) are the default standard conditions used by the flow sensors in the AE33, to report the measured mass flow (Magee Scientific, 2018)".

Comment 2: L377-378 " ... From the mathematical definition (Eq. (3) and Eq. (4)) the k values are inversely proportional to eBC, ..." First, this claim is not intuitively clear from Eqs. (3) and (4). I wish you derived the relationship, for instance this way:

$$b_{abs} = \frac{s(\Delta ATN/100)}{F_1(1-\zeta)C(1-kATN)\Delta t} = \frac{1}{1-kATN}\frac{s(\Delta \mathrm{ATN}/100)}{F_1(1-\zeta)C\Delta t}$$

Here, the last term is the non-compensated absorption coefficient $b_{abs,nc} = \frac{s(\Delta ATN/100)}{F_1(1-\zeta)C\Delta t}$

Then the compensation parameter can be calculated as a function of absorption coefficient

$$\Rightarrow b_{abs} = \frac{1}{1-kATN}b_{abs,nc} \Leftrightarrow 1-kATN = \frac{b_{abs,nc}}{b_{abs}} \Leftrightarrow kATN = 1-\frac{b_{abs,nc}}{b_{abs}}$$

$$k = \frac{1}{ATN}\left(1 - \frac{b_{abs,nc}}{b_{abs}}\right) = \frac{1}{ATN}\left(\frac{b_{abs} - b_{abs,nc}}{b_{abs}}\right)$$

And when the relationship $eBC = b_{abs}/\sigma_{air}$ is used for both b_{abs} and $b_{abs,nc}$:

$\Rightarrow k = \frac{1}{ATN}\left(\frac{eBC - eBC_{nc}}{eBC}\right)$, where the eBC_{nc} is the non-compensated eBC concentration.

Or if you don't want to write all the steps you could at least write the last equation to support your claim. It shows that for a given ATN, if eBC > eBC_{nc} then k > 0 and k is inversely proportional to eBC. There is no doubt that for the generated BC and nigrosin particles this is the case. However, it should not be written as if this were true for all aerosols. In the ambient aerosol the compensation parameter can also be close to zero or even negative, possibly depending on the coating of particles, as has been noted by (Virkkula et al., 2015; Drinovec et al., 2017; Greilinger et al., 2019).

Response: We totally agree with your comment, the statement "the *k* values are inversely proportional to eBC" is not naturally seen from equations 3 and 4. We modified the narrative and the derivation according to the reviewer's suggestion. In summary, the description given in section 2.1 explains the algorithm as follows:

1. The attenuation of both spots is calculated as:

$$\mathrm{ATN}(\lambda) = -100 * \ln\left(\frac{I}{I_0}\right) \quad (1)$$

2. The compensation parameter is estimated from the proportionality of the loading from both spots, to the airflows F1 and F2:

$$\frac{\mathrm{F}_2}{\mathrm{F}_1} = \frac{\ln(1 - k * \mathrm{ATN}_2(\lambda))}{\ln(1 - k * \mathrm{ATN}_1(\lambda))} \quad (3)$$

3. The attenuation is used to estimate the uncompensated absorption:

$$b_{abs}(\lambda)^{non\ comp.} = \frac{s * (\Delta\mathrm{ATN}_1(\lambda)/100)}{F_1 * (1 - \zeta) * C * \Delta t} \quad (2)$$

4. The values of *k* are used to calculate the compensated absorption:

$$b_{abs}(\lambda)^{comp.} = \frac{b_{abs}(\lambda)^{non\ comp.}}{(1 - k(\lambda) * \mathrm{ATN}_1(\lambda))} \quad (4)$$

5. The compensated eBC mass concentration is finally estimated using the BC mass absorption cross section:

$$eBC(\lambda)^{comp.} = \frac{b_{abs}(\lambda)^{comp.}}{\sigma_{air}(\lambda)} \quad (5)$$

In the subsection 3.1, we have modified the paragraph as follows:

The k values also depend on the filter type as the different materials determine the filter loading rate, consequently the moment when the threshold attenuation (ATN_{TA}) is attained. In addition, the k values are susceptible to the type of aerosols measured (composition and size) and their mixing state (Drinovec et al., 2017). If the equation 4 is rearranged and expressed in terms of eBC, the k values could be defined as a function of the non-compensated and compensated black carbon mass concentration:

$$k = \frac{1}{ATN}\left(\frac{eBC^{comp.} - eBC^{non\ comp.}}{eBC^{comp.}}\right) \quad (8)$$

According to Eq. 8, for a given attenuation, if the compensated eBC is larger than the uncompensated, k will be positive and inversely proportional to the eBC mass; this was observed for the instruments D04 and D05, with higher and positive deviations from our reference aethalometer (Fig. 6b).