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Interactive Comment

Interactive comment on "The "dual-spot" Aethalometer: an improved measurement of aerosol black carbon with real-time loading compensation" *by* L. Drinovec et al.

Anonymous Referee #5

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This paper presents the operating principle of a new version of a commercially available Aethalometer where the measurement artefact caused by the filter loading effect is continuously measured. The instruments firmware corrects the measured values for this systematic error.

My main criticism is that this paper focuses predominantly on the filter loading effect. I agree that the new instrument can correct for this bias, but the fundamental weaknesses of the Aethalometer are neither addressed nor is it carefully discussed. The paper is not balanced, and it appears that it was written from the "manufacturer perspective" with the goal to promote the new feature of this instrument.

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Interactive Discussion
Discussion Paper

It should be made clear that the correction of the filter loading effect does not solve the basic problem of this method. The main uncertainty in the derived values (measured light absorption coefficient or black carbon concentration) is caused by unknown multiple scattering of light in the filter. The optical path within the filter is larger and therefore the particle's absorption is principally overestimated. This correction (expressed as a factor C) is much greater und more uncertain than the presented correction of the loading effect. According to the literature the correction factor for this enhanced absorption lies between 2 and 6. The C-values are dependent on various factors such as the filter material, the amount of light scattering particles embedded in the filter, the mixing state of scattering and absorbing particles, the face velocity, relative humidity, etc. The wavelength dependence of C is unknown, and it is often assumed to be constant. Therefore, more discussion on the uncertainty related to C (and MAC) should be given in the paper.

It is necessary to present all assumptions in the calculation of BC. You may argue that eq. 6 gives the answer, but there the discussion is passed on the definition of parameter sigma which is not well introduced and contains two unknowns (C and MAC). Please address all these uncertainties and mention all assumptions (e.g. ignoring the wavelength dependence).

For curiosity: unpublished studies found indications that the two artefacts depend on the instruments flowrate. An explanation is that the depth, at which the particles are incorporated into the filter matrix, depends on the filter face velocity. Did you find such indications with the new instrument? If yes, this would mean that it is important to assure that the face velocities are equal on both filter spots (which is not the case).

Other issues:

The Aethalometer measures an apparent absorption coefficient which is translated into an apparent black carbon and – in a next step – into a "true" black carbon mass concentration. In the paper, only the term BC is used and I emphasise that it is clearly stated where BC was corrected and were not (as in Virkkula et al., 2007). I further recommend to adopt the nomenclature presented in Petzold et al., ACP, 2013.

Page 10185; Line 10: The MAC Value of 7.77 m2/g is low. The former instrument used an apparent MAC value of 16.6 m2/g at 880 nm. Where does this difference come from? Is 7.77 m2/g not the apparent value? Again: a description is needed which presents all assumptions and shows how this MAC value is incorporated into the calculation of BC. How was b_abs (Fig 4) calculated (C-value)?

P. 10185; L. 20: “When the attenuation reaches a certain threshold. . .” at which wavelength?

P. 10186; L. 6: Mention here that changing the filter type is expected to influence the optical filter properties and therefore change the corrections (both, the multiple scattering and loading artefact).

P. 10187; L. 4: Looking at Fig. 3: it’s not true that BC(ATN) can well be approximated with a linear fit. Why?

P. 10195; L. 24: I do not clearly understand how C was determined. For this you need to compare the Aethalometer measurement to an independent reference (ideally measuring true absorption). As this was not available in Klagenfurt, I have to assume that you rely on to C=2.14 for quartz filters. As this value has uncertainties (C ranges from 2 to 6), only ratios of C for different filter materials can be reported. Please clarify.

Fig. 1: How is the flow through S1 controlled? It is unclear to me what orifice 1 is good for.

Fig 2: in a) BC conc. in the ATN range 25-30 is approximately 4000 ng/m3. The corresponding peak in c) is at 2000 ng/m3. This is not consistent.

Fig 2&3: I understand that BC was calculated using 880 nm. Therefore, it makes sense that the ATN values in Fig 2 range up to 60. Why are ATN values in Fig 3 range up to 120? Is this for a different wavelength? Please clarify.

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Fig 3: The green curve has a slight curvature. But: the Virkulla correction is linear and therefore the green curve should be a line.

Fig 11: The interpretation of the slope makes no sense as long as these values are not known: sigma or MAC value used by the MAAP, MAC value of the Aethalometer, C-Value. Also indicate the wavelength of the measurements as these values are wavelength dependent.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 10179, 2014.