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Comment on amt-2021-166

Anonymous Referee #2

Referee comment on "Estimates of mass absorption cross sections of black carbon for filter-based absorption photometers in the Arctic" by Sho Ohata et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-166-RC2, 2021

Review of the manuscript "Estimates of mass absorption cross sections of black carbon for filterbased absorption photometers in the Arctic" submitted to Atmos. Meas. Techn. by Ohata et al.

The presented article is an important contribution to the understanding of the relationship between black carbon and light absorption in Arctic regions. The methods used are appropriate for the available data and the results are well supported with figures and tables. In general, the manuscript is well written.

However, the reviewer disagrees with the authors in one particular point in the interpretation of the results. The reviewer recommends the manuscript for publication after considering the comments.

General comment:

The authors use a filter-based absorption photometer to determine the mass concentration of black carbon. In line 136, the authors write: "We critically re-examine the concepts underpinning the use of filter-based instruments to estimate M_{BC}." This approach should have been discussed more critically.

The COSMOS is basically a filter-based absorption photometer that evaporates the volatile components by heating, so that only the absorption of a soot core is measured. This device was "calibrated" (compare lines 641 to 644) using an SP2 with one type of aerosol. This is critical because two different properties of the soot were compared. However, the determination of a value for MAC(COSMOS) for this aerosol type is correct. In this study, an application to arctic aerosols was tested. Although comparisons of M_{BC} with COSMOS and SP2 for Alert and Fukue Island stations agreed within the uncertainties, the conclusions should not be that the COSMOS using a universal MAC value is a "secondary reference device" for M_{BC}. As with any filter-based absorption photometer, the result should be labelled as "equivalent mass concentration" (see Petzold et al. 2013) using a specific MAC.

The comparison of two filter-based absorption photometers, where the volatile shell is removed in one device, thus shows the light absorption enhancement factor, which is an important component of the MAC. Furthermore, like all other filter-based absorption photometers, the COSMOS is subject to certain errors such as uncertainty due to particle penetration depth (see Nakayama et al. 2010).

In the view of the reviewer, in this study only the comparisons of a light absorption photometer with an SP2 strictly fulfil the conditions to derive MAC values. The other comparisons of COSMOS with other filter-based absorption photometers are rather studies on the enhancement factor.

The reviewer does not want to criticise the quality and overall results of this study, but to point out that soot in particular is a sensitive issue due to different metrics and the common nomenclature should therefore be followed very strictly. The reviewer proposes to refer to the facts described above and to denote the BC mass concentrations derived from COSMOS as "equivalent" mass concentrations.

Further comments:

Line 177: better use attenuation coefficient instead of extinction coefficient

Line 188: give values for f_{fil}

Lines 191 – 207: It is common for filter based instruments to report equivalent black carbon assuming an MAC. But in this case it is unfortunate to have to different MAC values when changing the filter type. The MAC is a property of the particle and not of the instrument. The reviewer suggests to attribute the changes of the sensitivity to the value of f_{fil} instead of MAC.

Line 271: Magnetite is not a good proxy for iron oxides to the reviewer's knowledge. The imaginary part of magnetite seems to be very high. This value cannot explain the reddish colour of many minerals. Alternatively, the refractive indices of hematite could be considered (e.g. Sokolik et al. 1999).

Lines 315–320: How large are the uncertainties of the correction value C0?

Line 335: The MAAP was originally calibrated for the wavelength 670 nm. Was the correction factor of 1.05 taken into account to adjust the wavelength (see Müller et al. 2011)?

Line 877: Line break between Petzold (2004) und Petzold (2005)

References:

Petzold, A., Ogren, J. A., Fiebig, M., Laj, P., Li, S.-M., Baltensperger, U., Holzer-Popp, T., Kinne, S., Pappalardo, G., Sugimoto, N., Wehrli, C., Wiedensohler, A., and Zhang, X.-Y.: Recommendations for reporting "black carbon" measurements, Atmos. Chem. Phys., 13, 8365–8379, https://doi.org/10.5194/acp-13-8365-2013, 2013.

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