

Dr Asmi:

Thank you for the changes to the manuscript in response to the second review. The manuscript is now ready for publication in AMT following technical edits. The only really substantive change I request is in the last three sentences of the conclusions, which are rather cryptic and not specific.

Deleted: substantive

Thanks for your responsiveness to the referees. I think this manuscript has substantially improved as it has progressed through revisions.

Technical edits:

- 1) Line 1. Change to "during a one-month field campaign"
- 2) Line 3. Change to "instruments' " (possessive)
- 3) Line 9. Change to "data were" (data is a plural noun)
- 4) Line 12. Change to "in the COSMOS inlet".
- 5) Line 13. Change to "A scattering correction"
- 6) Line 15. Clearly state what you mean by "best correlations". Slope closest to 1? Highest correlation coefficient?
- 7) Line 16. Change to "The sample pre-treatment in the COSMOS instrument resulted in the lowest fitted slope."
- 8) Line 18. Change to "method was not adequate to measure the low absorption values found at the Pallas site."
- 9) Line 19. Change to "the lowest absorption at which the EMS signal could be distinguished from the noise"
- 10) Line 20. Change to "cross-section (MAC) value measured was calculated using the MAAP and a single particle soot photometer (SP2), resulting in a MAC value of 16.0 m²g⁻¹ +/- x.x." Please add the standard deviation of the MAC measured.
- 11) Line 25. Change to "filter-based aerosol absorption".
- 12) Line 30. Replace "Meanwhile" with "However".
- 13) Line 31. Change to "filter tape mass loading and the interference by aerosol"
- 14) Line 34. Change to "of the light source".
- 15) Line 48. Change to "allows derivation of the aerosol".
- 16) Line 54. Change "convergence" to "agreement".
- 17) Line 56. Don't capitalize "Organic Carbon"--it's not a place or product name.
- 18) Line 58. Change to "absorbing particles are analyzed".
- 19) Line 62. Don't capitalize "Polar Regions".
- 20) Line 62. Change to "Aerosol light absorption, "
- 21) Line 65. Change to "yet instrument inter-comparisons are few."
- 22) Line 66. Change to "showed good agreement".
- 23) Line 67. Change to "did not include aethalometer or MAAP instruments. Co-located aethometers"
- 24) Line 69. Change to "filter-based instruments in pristine field environments are lacking, leading to a poorly quantified".

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- 25) Line 73. Change to "used co-located measurements".
- 26) Line 74. Change to "but a parallel comparison of all relevant instruments at one site has never been performed."
- 27) Line 74. Change to "would help estimate the uncertainties associated with these measurements and improve understanding of reported differences in baseline absorption at different Arctic stations."
- 28) Line 76. Can you provide a reference for the EMPIR BC project?
- 29) Line 81. Replace "conclude on" with "evaluate".
- 30) Line 84. Remove "The".
- 31) Line 89. Remove "also".
- 32) Line 91. Remove "earlier".
- 33) Line 94. Change to "instruments' " (possessive).
- 34) Line 96. Change "target to achieve" to "measure".
- 35) Line 98. Remove the sentence, "Sigma_{AP,lambda} is a measure of the" I don't think this sentence says anything useful.
- 36) Line 99. Change "This cross-section" to "Sigma_{AP,lambda}" (in symbols).
- 37) Line 100. Change to "normalized by particle mass, yielding a simple factor called".
- 38) Line 106. Change to "the ratio of the aerosol scattering coefficient sigma_{SP,lambda} to the aerosol extinction coefficient sigma_{EP,lambda}"
- 39) Line 115-116. What is this "simple relation"? Please delete the part of the sentence about variation and high-noise, or explain it more clearly.
- 40) Line 119. Change to "aerosol extinction, and one instrument that measures refractory BC, are used."
- 41) Line 122. Change to "with a volumetric flow calibrator (Gilian model xxx, city, country).
- 42) Line 124. To which instruments was the Bond et al. correction applied?
- 43) Line 126. Change to "The [aethalometer](#) Model AE31 (Magee Scientific Inc., city, country).
- 44) Line 127. Are these broad-spectrum measurements centered at these wavelengths, or are they made with lasers? Please state the bandwidth of this and other instruments (e.g., PSAP, COSMOS).
- 45) Line 132. Change to "The AE31 change the filter spot".
- 46) Line 134. Change to "converted with a wavelength-dependent specific attenuation and MAC values".
- 47) Line 139. Change to "station-specific"
- 48) Line 161-162. Please report band-widths for the wavelengths.
- 49) Line 164. Is this volumetric l/min, or mass-based (STP)?
- 50) Line 165. Change to "The PSAP records".
- 51) Line 179. How uncertain? Can you give a rough estimate?
- 51) Line 179. Delete everything in the sentence following "Figure 7".
- 52) Line 186. Change to "Due to elimination of most aerosol scattering artifacts and lensing enhancements of absorption, this method is typically".
- 53) Line 206. What is "CAPSex"? You define a CAPS PMex, but not a CAPSex.
- 54) Line 212. Change to "calibration-free".
- 55) Line 215. Change to "requires initial calibration"

Deleted: aethalometer

- 56) Line 216. Change to "The extinction signal from each instrument was calibrated using the nephelometer (Sect. 2.3.8) at the beginning".
- 57) Line 225. What is meant by the "(180)" and "(90)" values? Total scattering is integrated across all angles (0-180 degrees, minus truncation), and backscattering from a nephelometer is hemispheric backscattering integrated from 90 to 180 degrees (minus truncation).
- 58) Line 228. Change to "gas at the beginning and end of the campaign."
- 59) Line 245. Change to "calibrations yielded correction factors of 1.21".
- 60) Line 247. Change to "The two CAPS used identical"
- 61) Line 248. Delete "(reference points)".
- 62) Line 249. Change to "discrepancies between the nephelometers were very minor (~x%) in comparison with those between the CAPS instruments and the nephelometers (~y%)."
- 63) Line 252. Change "The bulk" to "most".
- 64) Line 252. Don't capitalize "particulate matter".
- 65) Line 255. Change to "cylindrically symmetric [exit](#) tubes".
- 66) Eq. 5. How is the "t" in the left hand side of the equation related to the "j" on the right hand side? Is t the time at point j? Please clarify.
- 67) Line 271. Change to "during a 6-hour period of clean".
- 68) Line 277. Change to "a white-noise-dominated system".
- 69) Line 279. Change to "systematic drifts".
- 70) Line 283-284. I don't understand what this sentence means or accomplishes. Maybe change to "It is known that even the single-instrument EMS approach is subject to considerable uncertainty at low values of absorption (Modini et al., 2021)."
- 71) Line 288. Change to "each other, the instruments' detection limits".
- 72) Line 289. Change "predetermined" to "stated".
- 73) Line 293. Change to "measure the atmospheric aerosol in the Pallas campaign."
- 74) Line 297. Change to "The values of $\sigma_{AP,630nm}$ measured by the EMS methods differed 10-fold, giving a range".
- 75) Line 298. Delete the sentence [beginning](#) "In qualitative terms".
- 76) Line 300. Maybe at the end of this sentence add, "noise numbers than also have significant bias and drift relative to one another."
- 77) Line 301. Change to "increased slightly during the second half".
- 78) Line 302. What is " $\sigma_{EX,630 nm}$ "? See comment #38 above.
- 79) Line 304. Change to "wavelength-dependent".
- 80) Line 209. Change to "the campaign ranged from 0.07 to 0.09".
- 81) Line 312. Change to "instruments' " (possessive).
- 82) Line 313. Change to "with the lowest inter-quartile range (Fig. 3, Table 2)."
- 83) Line 314. Change to "effectively removes light-scattering particles and coatings, thereby".
- 84) Line 325. Change to "The calculated standard deviation around the average $\sigma_{AP,\lambda}$ for all three EMS methods encompassed zero (Table 3).
- 85) Line 328. Change to "The absorption [coefficients](#) measured during this project were in the lower end of those typically observed at the Pallas site. Long-term analysis (Lihavainen et al., 2015) showed that the".
- 86) Line 333. Replace "conclusions" with "analysis".
- 87) Line 334. Change to "during the Pallas campaign represent well those observed".

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88) Line 338. Change "bright" with "white". "Bright" implies intensity (e.g., a bright red light), while "white" implies color.

89) Line 342. Delete "between each others".

90) Line 344. Change to "has been widely utilized in the past as a practical field reference method (provide literature reference)."

91) Line 353. Change to "done for the PSAP data, which adds noise from the [nephelometer](#) measurement (literature reference), is a plausible explanation".

Deleted: nephelometer

92) Line 356. I was very confused here, because the r^2 values already stated were 0.87 and 0.85. Do you mean "slope of the fitted line" instead of "correlation"?

93) Line 362. The sentence beginning "In case of the PSAP" makes no sense to me. What is "this"? What discrepancies at high single scatter albedos? Please clarify and rewrite.

94) Line 364. Change "correlations" to "correlation coefficients (R^2)".

95) Line 365. Suggest you add a sentence: "This suggests that the filter techniques examined here can provide useful data with an accuracy of ~40% for 1-2 hour averages even at the very low absorption values encountered. However, slopes and intercepts are sensitive to different selection of data outliers at such low absorption values."

96) Line 366. Suggest inserting a paragraph break, then beginning the paragraph with, "[Comparison](#) of $\sigma_{AP,\lambda}$ measured with."

Deleted: Comaprison

97) Line 367. Suggest adding to this new paragraph, "Our observations do not support the use of EMS methods in such pristine environments."

98) Line 371. Replace "SP2, extending the range" with "SP2 over the range". You aren't extending anything.

99) Line 379. Change to "Pallas site using the MAAP and SP2".

100) Line 376. In addition to the Ohata et al. (2020) reference, Zanatta et al. (2018) may provide useful support for such high MAC values.

Zanatta, M., Laj, P., Gysel, M., Baltensperger, U., Vratolis, S., Eleftheriadis, K., Kondo, Y., Dubuisson, P., Winiarek, V., Kazadzis, S., Tunved, P., and Jacobi, H.-W.: Effects of mixing state on optical and radiative properties of black carbon in the European Arctic, *Atmos. Chem. Phys.*, 18, 14037–14057, <https://doi.org/10.5194/acp-18-14037-2018>, 2018.

101) Line 387. Replace "were in range" with "ranged from".

102) Line 290. Change to "EMS methods are not usable at $\sigma_{AP,\lambda} < 0.1 \text{ Mm}^{-1}$, at least for the high ω_0 values encountered in this study."

103) Line 393. Where did "15-20%" come from? Slopes for two of the techniques vs. MAAP were 0.62 and 0.68, which suggests ~40% accuracy.

104) Line 394. Change to "The values we measured were at the lower edge of absorption typically measured at the Pallas site, but well represent Arctic summer conditions encountered at other sites."

105) Line 397. Change to "values, but likely led to".

106) Line 397. Change to "noisy AE31 data".

107) Line 402. Change "correlation" to "fitted".

108) Line 404. Change to "and is consistent with previous values measured during Arctic studies (literature references)."

109) Line 407. Change to "Sufficient averaging of data to reach minimum instrument detection limits and a utilization of".

110) Line 409. Change to "post-correction are necessary."

111) Lines 409-412. These sentences are all very vague. Please specify what "special caution" is needed. Please specify what is meant by "modernization". Which of these instruments are considered modern? Can you just say, "don't use the AE31" (or whichever is least appropriate)? What are the "means for field instruments' reference"? Should each site have a MAAP? Should MAAPs be shuttled around the Arctic to different sites? Can the COSMOS be a transfer standard since it's very stable and eliminates the scattering correction? Please be specific and very clear, since this is the "take-home" message the reader will get. Make sure this message is also in the abstract.

112) References. Not all the references are in Copernicus format. Some titles are capitalized, some are not. Some journals are abbreviated, some are not. This is a consequence of reference manager software. Please save the time of the technical editors by fixing everything before submission, since you'll have to do it anyway.

113) Figures 1, 2 and 4 will be very hard for anyone with a color impairment to read (~8% of European men). If you are using Igor, EOSSpectral16 is more friendly. In Figs. 1 and 2 you can distinguish curves using different symbols or line types in addition to making good color choices.

114) Fig. 4. Please make all fonts bigger. The figure caption should state "1-hour averaged absorption coefficient. . . colored by 1-h averaged $\omega_{0,635}$ nm. The solid lines are bivariate fits to the data, and the dashed lines are the 1:1 values. The corresponding. . ."

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