Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2020-400-RC2, 2021

Atmospheric Measurement Techniques Discussions

Interactive comment on "Characterizing the Arctic absorbing aerosol with multi-instrument observations" *by* Eija Asmi et al.

Anonymous Referee #2

Received and published: 15 January 2021

This manuscript describes measurements of aerosol concentrations and optical properties (absorption, scattering, extinction) measured during a month-long period at the Pallas ground site in northern Finland. Filter-based aerosol absorption instruments include two models of aethelometers, a MAAP, a PSAP, and COSMOS. Extinction and scattering coefficients are obtained from CAPS and nephelometer instruments, respectively. Information on black carbon mass and coating thickness is obtained from an SP2, while particle number concentrations are measured by a CPC. In total, this is a comprehensive aerosol measurement suite!

The primary focus of the study is to examine the instrument consistency during two time periods – Period 1 is characterized by relatively low aerosol scattering coefficients, while Period 2 sees higher particle scattering coefficients. Aerosol absorption

coefficients and number concentrations are similar across both periods, after removing cloud/fog artifacts when ambient visibility was greatly reduced. Backtrajectories are included to provide context for air mass history, which indicate consistently northeasterly winds during Period 2, while the wind directions during Period 1 are much more variable. Despite some degree of variability between the two time periods, the overall aerosol absorption, scattering, and number concentrations are quite low, which would be expected for the Pallas region (far from continental pollution aerosol sources). This challenges many of the instrument comparisons because the measurements are close to the the lower limits of detection, and it appears that the data are highly-averaged to reduce noise (which is appropriate and fine).

Overall, the manuscript is well written, enjoyable to read, and nicely describes the Pallas scientific instruments and the observations obtained during this time period; although, the scientific importance of these observations is not clear from the paper. The depth of analysis is pretty shallow as only a short period of time is being examined and the mean concentrations shown in Table 2 tend to be close to zero (with large standard deviations relative to the magntitude of the mean), which makes it hard to draw conclusions regarding instrument agreement/disagreement. I'm also unsure if AMT is the appropriate journal for this manuscript. All instruments are commercially available and have previously been described in the literature, and there don't seem to be novel conclusions related to their performance and/or operation that would be informative to the broader scientific community. Since I do not think that the present paper would be acceptable for publication without bringing in additional data and completely rewriting/reframing its scope, I recommend that it be rejected for publication in AMT.

Specific Comments:

1) As stated above, the depth of analysis in this paper is low. Simply comparing the data from multiple, filter-based aerosol optical property measurements for a month and reporting summary statistics that largely overlap with zero provides little value regarding the instrument operation or the remote measurement site characteristics. One way to increase the depth of analysis might be to reframe the paper to describe the annual aerosol climatology relevant to the Pallas site. This might include monthly and seasonal data from satellites and/or models that provide some long-term context for the site measurements. It would also be great if more in situ data could be included beyond a single month; although, I recognize that that might be prohibitive. Having more in situ data might allow for more dynamic range in the aerosol abundance and optical properties. Another approach to increase the depth of analysis might be to examine the Pallas aerosol instrument suite response to laboratory-generated aerosol under very controlled conditions to understand their interconsistency and accuracy. These results could then be compared to the ambient measurements to understand/evaluate the instrument performance. These are just a couple of ideas for the authors' consideration in a potential future manuscript.

2) The sensitivities and lower detection limits given in the abstract (and elsewhere) need to include the averaging interval. I'm assuming that 0.05 Mm^{-1} was achieved by averaging for > 1 hr. What are the overall instrument accuracies?

3) On Line 24, what is meant by the statement, "additional activation of secondary particle formation mechanisms"?

4) Strike first sentence on Line 29 as not relevant. The second sentence is referencing a filter-based measurement method, which I'm assuming is of aerosol absorption yes? Also please correct typos on Line 29 (begun -> began) and Line 31 (graphic -> graphitic).

5) On Line 96, it is noted that the Arctic aerosol absorption measurements are "de-

manding". Is this related to the low concentrations due to a lack of local combustion sources? If so, it might be worthwhile to clarify that, while also noting that such, low-aerosol conditions are also not unique to the Arctic.

6) Is the mass absorption coefficient (MAC) defined on Line 145 the same as the MAC used on Line 200? On Line 146 it is called a "wavelength dependent specific attenuation".

7) What value(s) of the MAC were applied as mentioned on Line 201?

8) On Lines 248 (and elsewhere), I find the extinction-minus-scattering (EMS 1 2) terminology confusing because this is neither an instrument nor a complex method. Rather, it's just a difference between two values. I suggest that it would be worth denoting as $\sigma_{\mathrm{CAPSex}} - \sigma_{\mathrm{TSI}}$ and $\sigma_{\mathrm{CAPSssa}} - \sigma_{\mathrm{AUR4}}$ to help avoid confusion and to be consistent with the notation in Figure 1.

9) On Line 257, it is noted that differences in CAPS instrument response may be due in part to "discrepancies in inlet tubing sizes and flow rates", which seems unlikely to me. Can this sentence be clarified to explain how these differences would affect the aerosol measurements?

10) On Lines 274-275, Table 2, and elsewhere, I note that the magnitudes of arithmetic standard deviations often exceed the magnitudes of the arithmetic means, which gives implies non-physical, negative values. Is this because of instrument noise that results in a negative baseline or is this because the observational data are not normally distributed about the mean. At least in the case of the CPC data reported in Table 2, it would seem that the latter explanation is correct, in which case it would be appropriate to report the summary statistics as either a geometric mean */ one geometric standard deviation or as median and percentiles.

11) Rather than using the qualitative SP2 lag times, can the data be reanalyzed to provide quantitative coating thicknesses? I think that this is important and would help

to increase the paper depth of analysis.

12) What support is there for the statement made on Lines 310-11 that the more thickly coated aerosols have longer atmospheric ages?

13) The final conclusions on Lines 429-434 are not really connected to the data that are presented in this manuscript. What site- and aerosol-specific filter artifacts were presented and overcome? How were good measurement practices and careful data post-processing demonstrated in this study that differ from conventional techniques? To put it bluntly, what is new or novel from the present paper in terms of measurement techniques?

14) There seem to be too many significant figures presented in Table 3, which imply the absorption coefficient measurements can be made with a precision of 0.001 Mm^{-1}. I realize that the're a lot of averaging going on here to help tamp down the noise, but I suspect that at least the last digit is probably not significant.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2020-400, 2020.