Review of the manuscript “Seasonality of aerosol optical properties in the Arctic” by Lauren Schmeisser et al.

This manuscript presents the seasonality of aerosol particles optical properties at six Arctic observatories. Aerosol scattering and absorption, scattering Angstrom exponent (SAE), single scattering albedo (SSA) and asymmetry parameter (g) are presented and discussed.

In the abstract and in the introduction the authors comment about the importance of studying the in-situ surface aerosol optical properties in the Arctic given the sensitivity of the Arctic climate to short-lived climate forcers.
In general, more speculations about the reasons explaining the observed differences among the stations are needed to improve the scientific significance of the presented work.
In most cases the manuscript presents a list of extensive and intensive values/properties at each station but the reasons behind the observed aerosol optical properties is sometimes missing.
The manuscript should be more focused on the Arctic haze phenomenon. For this, a reorganization of the manuscript is needed. Some suggestions are given below.

1) The six stations included in this work have two types of filter based absorption instruments: the “reference” instrument (CLAP, PSAP, or MAAP) and the Aethalometer model AE31. The AE31 attenuation data are corrected with the Arctic specific correction factor from Backman et al. (2017). The same C_f (= 3.20) is used to correct the AE31 data from the six observatories. Absorption data collected with the AE31 at 550 nm are presented in this manuscript. The absorption at 550 nm is calculated using the absorption Angstrom exponent (AAE) calculated from the 7-λ aethalometer measurements. The authors show that the comparison between absorption from the “reference” instrument and the AE31 is “imperfect and variable among stations”.

   Why not present the absorption measurements from the “reference” instruments rescaled to 550 nm using the AAE from the AE31 instruments? If CLAP, PSAP or MAAP are considered as “reference” instruments, then data from these instruments should be presented in the manuscript. Moreover, the same C_f is applied to the seven absorption measurements from the AE31 instruments thus meaning that the AAE from uncorrected AE31 data and the AAE from corrected data should be approximately the same.

2) Alternatively, if the authors think that the AE31 data are sufficiently robust to be presented in the manuscript (note that the supplemental material is not provided by the authors, so it is difficult to evaluate the goodness of the corrected AE31 data (and consequently SSA values)), then they should take more advantage of the multi-wavelength absorption measurements from AE31 instruments.

   Is there any specific/interesting feature in the AAE seasonality at the six stations?
   Why not study the spectral dependence of the single scattering albedo (SSA)? For example, presenting the SSA not only in the green, but also in the UV and near IR?
   The variability of these two quantities (AAE at least) should be discussed in the manuscript.

3) In the manuscript the Arctic Haze (AH) phenomenon is discussed together with the scattering and absorption measurements. ALT, BRW, TIK, and ZEP stations present an increase in both scattering and absorption in late winter/spring related to the AH phenomenon.

   However, there is no mention to the AH phenomenon in the sections presenting the intensive aerosol optical properties.

   a) A table presenting the mean SAE, SSA, *g* (and possibly AAE) during AH period versus non-AH period should be presented and discussed. The spatial differences (from one site to another) in the intensive optical properties during AH period should be also discussed. For example, the seasonality of scattering and absorption at ALT, BRW, TIK and ZEP is very similar (and ascribed by the authors to the AH phenomenon) whereas the intensive properties are very different. For example, the SSA at ALT during AH is much higher (and different in term of seasonality) from the SSA observed at TIK during the AH period. The authors should comment/discuss the possible reasons explaining why the intensive properties change from one site to another during AH period.
   b) It is interesting the fact that the effect of AH on intensive properties is not observed at PAL and SUM which are located at higher altitude compared to the other stations. Is there any relationship between altitude of the station and AH phenomenon?

4) The authors say that "..surface Arctic aerosol optical properties in particular can help define and constrain inter-annual, seasonal and diurnal variability" (Pag. 2, Line 22-23). Why not present the diurnal cycles of both extensive and intensive aerosol particle optical properties? This can be done comparing AH period versus non-AH period.

5) Improve the abstract. In the present form the abstract present a list of lowest/highest values of extensive and intensive properties at the six observatories, but the reasons/speculations behind the variability of the reported values is missing.

6) Pag. 8, Line 31. Figure 2 shows the time series of monthly median corrected AE31 data. Why not present the daily median? Note also that the supplemental material was not uploaded. Consequently, it is very difficult to evaluate the goodness of the comparisons using just monthly medians.

7) Pag. 9, Line 33: The authors should explain where the data came from. For example, was it downloaded from EBAS. Or was it provided by data providers?

8) Pag. 10, Line 8: Add that also *g* was one of the variables considered in the manuscript.

9) Pag. 10. How were the intensive properties calculated? Using all the scattering and absorption data or using only data above a given threshold (i.e. >1 Mm^{-1})?. Calculating

the intensive properties using scattering or absorption data higher than a given threshold is important in order to remove undesired noise in the calculations.

For example: In Figure 2 the SSA at ALT and SUM in July and September, respectively, presents the lowest values when also scattering and absorption are low. The same is observed for the scattering Angstrom exponent at SUM in winter or the asymmetry parameter at SUM in January (for example).
How do these figures (Figures 5, 6, 7) change if a threshold is applied before calculating the intensive properties? In the case of SSA at SUM in September the authors speculate that the low SSA is related to an increase in flights and transportation activity. However, for other stations/seasons no explanations are given to justify why the 5th and 95th percentiles are too low or high. It is important to demonstrate that these high deviations of intensive properties at some stations are not due to noise.

10) Pag. 10, Equation 2: Why not present the differences between the SAE calculated between 450 and 550 nm and the SAE calculated between 550 and 700 nm? Is there any interesting difference between the two SAE during the AH phenomenon versus periods without AH phenomenon?

11) Pag. 10. The AAE from AE31 was used to calculate the absorption at the same wavelength of the "reference" instrument. How was the AAE calculated? Were used all the wavelengths or only those close to the reference wavelength?

    Moreover, (end of Pag. 10 – beginning of Pag. 11), the authors say that the SAE was also used for the wavelength adjustment of nephelometer data. However, the TSI nephelometer works at 550 nm which is the wavelength used to present the results. So, no adjustment of nephelometer data is in principle needed. Please, clarify.

12) Pag. 13, Line 6. PAL -> SUM

13) Pag. 13, Lines 16-18: Explain why at ALT the SSA values drop during July (any physical explanation or noise?)

14) Pag. 13, Line 18: Explain why the SSA values at BRW are the highest during September-October.

15) Pag. 13, Lines 22-24 ("This is explained by .... is low and scattering is high"). Remove the sentence. This is obvious.

16) Pag. 13, Line 25 and Lines 27-28: The high scattering at PAL in summer is probably due to the enhanced formation of BSOA. This is probably consistent with the fact that absorption does not show the same increase in summer. Consequently, the SSA is the highest in summer (with quite low standard deviation of the data) and reflects the

presence of very "white" particles. However, the authors say (Line 25) that there is an increased contribution from continental air masses in the summer at PAL. So, what is driving the evolution of the extensive and intensive properties at PAL in summer? The arriving of continental air masses (probably containing less "white" particles) or the BSOA formation (Lines 27-28)?

17) Pag. 14, Lines 24: Also here it is important to demonstrate that the large variability in SAE in July-September at TIK (when scattering and absorption are very low) is not due to noise. It is important to know if any threshold has been applied before calculating the intensive properties.

18) Pag. 14, Line 32: It seems that *g* also varies quite a lot from one station to another, whereas the authors say that "the asymmetry parameter, *g*, is similar for all sites except for SUM". Please, clarify/expand.

19) Pag. 15, Line 7 and Figure 8: Why not show the *g* too?

20) Table 2: SUM station registers the highest SAE (small particles) and also the highest *g* (large particles). Any explanation for this?

21) Section 4.3: Figure 10 is nice. It seems that there is a relationship between the time spent above open water and sea ice and Figures 3 and 4. For example, at TIK the scattering is the lowest when air masses spent more time over sea ice and open water (June to September). At ZEP the reduction of scattering between June and October reflects the relative increase of time spent over sea ice and open water (and less time spent over land). Can the authors say something more about Figure 10? Is it possible to relate the time spent over land with the Arctic haze phenomenon? The paragraph at Pag. 18, Lines 16-29 should be expanded.

    Figure 9 seems less useful. The highest frequency is always observed for regions close to the stations. Why not use, i.e., the potential source contribution function or the concentration weighted trajectory? (Both are available for example in the OPENAIR r package). These plots could be colored by levels of scattering and absorption to get a clearer idea about source regions. The differentiation in terms of air masses between AH periods versus non-AH periods should be introduced and discussed.