Response to Anonymous Referee #1

Thank you, anonymous referee #1, for your useful comments. The manuscript is improved thanks to your input.

Our response is structured as follows: original comments from reviewer #1 are bolded, our responses are in italics, and the revised portions of the manuscript follow in quotation marks with specific changes/additions in red.

Comments

This paper compares the seasonality of bulk aerosol optical properties (either sub-2.5 um or sub-10 um) at six sites in the Arctic for the years 2012 to 2014. The presentation of monthly median values for each site reveals differences in seasonality and boxplots of hourly averaged data reveal monthly-to-month variability. A main conclusion is that optical properties vary regionally across the Arctic primarily due to variability in source regions. The paper is straightforward and well-written. I recommend publication with only the minor corrections listed below.

Table 1. The information in the size cut column is confusing. Should it be aligned with the different instruments? What does NA mean?

We agree that this column in Table 1 is confusing, thus we changed the format within the table so that the size cut is listed in brackets directly after the instrument used in this analysis. In addition, the text describes this size cut information in further detail.

Detailed information on the size cuts is found in the manuscript on the following lines:
ALT size cut information: page 5, lines7-8
BRW size cut information: page 5, lines 17-20
PAL size cut information: page 5, lines 30-31
SUM size cut information: page 6, lines8-9
TIK size cut information: page 6, lines19-21
ZEP size cut information: page 6, line 31

The size cut in Table 1 for PAL was mistakenly reported as 2.5 µm when it should have been 10 µm. This mistake only concerns three sentences in the manuscript. See below: The first sentence is where the size cut is first mentioned along with the description of the station on page 5, lines 30-31. The second sentence on page 14 where lines 17-19 were changed to exclude PAL from the stations with a PM2.5 inlet:

Page 5, lines 30-31~~: PAL and~~ SUM statistical values of SAE are not directly comparable to the other Arctic sites due to ~~their~~the 2.5 µm size cut inlet~~s~~, which limits measurements of large particles that would yield smaller SAE values.

PAL was removed from the sentence and the reasoning from the discussion about light scattering coefficients was added to the different behavior of the SAE values at PAL:

Page 17, lines 6-8: PAL and SUM do not show substantial systematic variability in these optical parameters, likely due to their 2.5 µm size cut inlet (~~PAL and~~ SUM) and/or remote high elevation location (SUM) that limits the measurement of larger particles and thus yields consistently high

SAE values. The different behavior of PAL is likely due to the location of the site (lowest latitude) and difference in the vegetation surrounding the station as discussed earlier.

Figure captions. I realize that the size range of the measurements is given in the text but it would be useful to provide it in the figure captions, too, since many readers may only look at the figures.

We have added size cut information to the captions of Figures 3 and 4, which show seasonality of scattering coefficients and absorption coefficients, respectively.

Page 34, lines 5-6: "Figure 3. Seasonality of aerosol light scattering coefficient (σ_{sp}) at 550nm at all sites. Large plot shows monthly medians of scattering in Mm^{-1} at each station, subplots below show boxplots of hourly average scattering at individual sites with horizontal line at the median, edges of the box at 25th and 75th percentiles, and whiskers at 5th and 95th percentiles. Note that y-axes are different on each plot. Size cuts for the scattering measurements are as follows: 10 µm (ALT), 10 µm (BRW), 10 µm (PAL), 2.5µm (SUM), 10µm (TIK) and no size cut at ZEP."

Page 35, lines 5-6: "Figure 4. Seasonality of aerosol light absorption coefficient (σ_{ap}) at 550nm at all sites. Large plot shows monthly medians of absorption in Mm^{-1} at each station, subplots below show boxplots of hourly average absorption at individual sites with horizontal line at the median, edges of the box at 25th and 75th percentiles, and whiskers at 5th and 95th percentiles. Note that y-axes are different on each plot. Size cuts for the Aethalometer absorption measurements are as follows: 10 µm (ALT), 10µm (SUM), 10µm (TIK) and no size cut at BRW, PAL, and ZEP."

Page 12, lines 12 - 14: What are the April and August peaks in light scattering at Summit due to?

The goal of the analysis presented here is to document seasonality in Arctic aerosol properties and highlight the differences in aerosol property seasonality between stations across the Arctic, and so the analysis performed here does not directly inform why the aerosol properties have this seasonality. Future work is needed to better understand mechanisms driving the differences in seasonality. However, we can draw from previous studies to help shed light on this question. For one, Stohl et al. (2006) show an instance of forest fires in 2004 impacting absorbing aerosols at SUM, and one could speculate that forest fire season impacts light scattering at SUM as well.

Page 12, line 6: It is not clear from Figure 4 that PAL "has the highest absorption coefficients during the summer."

This was perhaps a mistake in phrasing. We meant PAL "has the highest absorption coefficients **of the six Arctic stations** *during the summer".*

During the months of June, July, August, and September, the highest absorption coefficients are measured at PAL (the green line on the plot). Average Pallas absorption coefficients are at least double the average absorption coefficients measured at the other five Arctic stations. This has been clarified in the text.

Page 13, line 6: "…, while PAL has the highest absorption coefficients compared to the other Arctic stations during the summer".

Page 13, lines 28 - 32: Could lower SSA at SUM during September be due to forest fires?

Without forest fire data combined with back trajectories, it is impossible to say with certainty if low SSA at SUM in September is due to forest fires specifically. Attribution of elevated aerosol measurements is outside the scope of this paper. However, we know that this explanation is, in theory, possible, as Stohl et al. (2006) show EBC enhancement at SUM during high forest fire activity in July and August of 2004. The relationship of forest fires to seasonality of aerosol optical properties at SUM might be worth further investigation in a separate analysis.

Figure 9. It would be helpful to have location markers for the stations on the maps.

Thank you for this suggestion. Location markers for the stations have been added to the maps in Figure 9.

References:

Stohl, A., Andrews, E., Burkhart, J. F., Forster, C., Herber, A., Hoch, S. W., Kowal, D., Lunder, C., Mefford, T., Ogren, J. A., Sharma, S., Spichtinger, N., Stebel, K., Stone, R., Ström, J., Tørseth, K., Wehrli, C., and Yttri, K.E.: Pan-Arctic enhancements of light absorbing aerosol concentrations due to North American boreal forest fires during summer 2004, J. Geophys. Res., 111, D22214, doi:10.1029/2006JD007216, 2006.