Comment on acp-2021-756
Anonymous Referee #2

Referee comment on "Pan-Arctic seasonal cycles and long-term trends of aerosol properties from ten observatories" by Julia Schmale et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-756-RC2, 2021

Review of “Pan-Arctic seasonal cycles and long-term trends of aerosol properties from ten observatories” by Schmale et al. in ACPD.

The manuscript presents a coherent analysis of an extensive Arctic dataset on aerosols and aerosol properties, focusing on uncovering their seasonal and decadal variability. Both natural and anthropogenic aerosol tracers are considered in the analysis and manuscript discussion, accurately highlighting the complexity of the issue. The manuscript describes nicely how different sources are important on different sides and at different times showing that the Arctic is not a homogenous area in this respect. The manuscript is well written, enjoyable to read and makes an important contribution for the scientific field.

Most of the data for the analysis are gathered from a publicly available nilu/ebas database. Although a fraction of data with supporting conclusions have been presented in previous literature, the systematic and comprehensive analysis and the new, previously unpublish data bring clearly new perspectives and conclusions. I recommend publishing the manuscript in ACP after modifications. I consider that the requested modifications do not require a major work and are therefore minor.

General comments:

My main general comment is about the description of the methodology. The manuscript concludes (action item 4) on the importance of standardized measurement and data practices. Was this met here? For example, was ebas level2 data always used? If so, were the data that were taken from personal communication treated (and measured) similarly? This should be mentioned in the text. Why Tiksi nephelometer was measuring at “ambient humidity”? How much was the RH? How the data flags (in ebas) were considered in data analysis? Which flags were included and which were omitted from final analysis? Would you please consider adding some relevant information on at least these, and other according to your consideration, in the methods section and data availability section (also see my comment regarding Table 1). In principle, information should be sufficient to repeat this study.

Another minor general comment I have on the discussion of primary aerosol sources (mainly sea spray and dust here). Their concentrations are not solely dependent on the changes in air flow routes and availability of the source (open sea water, open land areas)
but the resuspension depends largely on the winds (speed). The seasonality of the winds over different sea areas around the Arctic could be mentioned somewhere in the text, and maybe some information added if there were notable changes in storms or other wind patterns in recent decades?

As a final general comment I add that from northern Scandinavia (e.g. Pallas) there are additional long-term data series on aerosol chemical composition available in ebas that the authors could consider adding in the analysis if they find that those could add to the conclusions.

Minor comments:

p3. l100. Although aerosol optical parameters in Pallas have been measured since 2000, aerosol number and ionic composition measurements in Pallas started earlier, in 1990s (data in ebas). Since this sentence refers to Arctic pollution monitoring maybe a better reference of the historical development of Pallas research activities and monitoring would be Lohila et al., 2015:

Lohila A., Penttilä T., Jortikka S., Aalto T., Anttila P., Asmi E., Aurela M., Hatakka J., Hellén H., Henttonen H., Hänninen P., Kilkki J., Kylönen K., Laurila T., Lepistö A., Lihavainen H., Makkonen U., Paatero J., Rask M., Sutinen R., Tuovinen J.-P., Vuorenmaa J. & Viisanen Y. 2015: Preface to the special issue on integrated research of atmosphere, ecosystems and environment at Pallas. Boreal Env. Res. 20: 431–454. http://hdl.handle.net/10138/228278

p4. l119. Consider starting “the surface aerosol observations”, since it is not clear what “observations” are meant, especially after a long paragraph solely on eBC.

p5. L268. Figure 1 does not show data.

p10. l311. What do you mean with “prior deseasonalization”?

p15. L362. Could you be more specific with what is meant by “ammonium’s statistical distribution”?
p22. l431. Even though it’s difficult to compare the bars in fig2 only, but for Tiksi it looks like the absorption is much higher in comparison to Barrow and Alert (10-fold) than the EBC is (3-fold), and not really 1:1? Check.

p28 l 504-506. First sentence says that emissions rise in the 2000s. Second sentence says that EBC concentrations do not show decline, likely due to short measurement period and variability. Why is it assumed that a decline should be seen, especially if emissions increase?

p29. l529. What is “this” pattern? The pattern observed in Eastern Arctic countries, or elsewhere, or Asia..?

p32. l631. “They” should be “they”

p33. l638-641. Unclear sentence, rephrase.

p34. l663. Interesting that here Pallas shows negative SAE trend in summer while previous studies (Collaud Coen et al 2013; Lihavainen et al., 2015) have shown this trend for winter. But as pointed out several times in the manuscript, the trends are also sensitive to the method and with such short time series should be interpreted with caution.

p41. l850. Might consider adding that the aerosol microphysical properties also provide data on aerosol quantities that are directly connected with their climatic impacts.

p40-41 action items / conclusions: Conclusions and action items very strongly seem to highlight the need for additional monitoring and analysis of natural Arctic aerosols. Why is this emphasized? Or do you mean there is a lack of data on the aerosol organics, more specifically? In my view, the results presented support the need for intensified aerosol monitoring around the Arctic (due to complexity and variability of the sources), importance of long-term efforts (for understanding the trends) and need for interdisciplinary collaboration (for complexity of the sources and processes).

Tables:

Table 1. Sometimes both an article and ebas are indicated as data sources. Why? If an article is provided where the data are used and measurements described more in detail, it should be done systematically for every dataset, or any. Was the article (e.g. in case of Gilardoni, Dutkiewich, Heslin-Rees, etc.) really the data source or a personal communication? Does ebas provide EBC values for absorption measurements (Alert, Tiksi)? Using what MAC? For Alert, Barrow and Tiksi, what measured wavelength was used to convert data to abs coef @550 nm? In addition, would you be able to provide a link to specific datasets in ebas and access date, instead of referring to a general database? I understand if this last point is adding too much data in table, then current form is ok.

Figures:

Figure 1. Missing Pallas station.

Figure 2. Tiksi EBC concentrations (1st panel) appears to be about 3 times higher than in Alert and Barrow, however, the absorption is 10-fold? Is also Tiksi scattering multiplied by 0.1? Color shading for grey and black are not possible to separate from each others.

Figure 4 (and corresponding text). Is western Arctic including all the continental territory of USA and Canada? And does Eastern Arctic include all the Russia? Is that overlapping with Asia? Reference to AMAP, 2021 is given, but this report does not have a reference yet
so a short explanation here could be given. In addition, should NO2 be NOx?