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## Comment on acp-2022-591

Anonymous Referee #2

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Referee comment on "A full year of aerosol size distribution data from the central Arctic under an extreme positive Arctic Oscillation: insights from the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAIC) expedition" by Matthew Boyer et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-591-RC2>, 2022

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### Summarisation

This paper describes particle number size distribution (PNSD) and 'black carbon' observations from the Mosaic field study. They investigate seasonality and sources of the observed aerosol and relate the observations to other sites in the Arctic. They find that meteorological and dynamical conditions (temperature and the Arctic oscillation) have an important impact on the aerosol characteristics.

### General comments:

This manuscript does an excellent job of citing recent papers, but to my mind misses some of the initial work on which the more recent papers rely. For example, Quinn et al, JGR, 2002 discusses seasonal changes in aerosol sources at UtqiaĀivik/Barrow, while Schmeisser et al, ACP, 2018 describes seasonal aerosol variability at 6 Arctic land-based sites.

Lines 207-209 - Could your filtering be more restrictive than the filtering applied at ground sites? Perhaps if your filtering technique/algorithm had been applied to the land-based datasets they would not exhibit higher values than the Mosaic dataset. Also, i am not sure it's of use to provide the values for constants 'm' and 'a' without any further details. Just refer to Beck publication (unless the Beck publication is more general and doesn't use those specific values?)

Line 220-223 - how different were the results of masking from the two measurement containers? Were the inlets that different? I find that somewhat disturbing.

Figure 2 - How would the results in Figure 2b differ if used a midpoint of the entire cruise rather than the cruise track? Same question for Figure 7.

Figure 4 - What causes the abrupt shift in PNSD in June 2020? I would expect more of a gradient. Is it due to course changes - the excursion to Svalbard? or perhaps not enough representative days to get a monthly average?

The manuscript defines the Central Arctic as above 80 N. UtqiaĀivik, Tiksi and Kevo, while in the Arctic, are all further south and closer to 70 N. Because of that, it seems not too surprising that they are less representative of the 'Central Arctic' than the more northerly sites. Their lower latitudes not only make them closer to continental source regions (Europe/N. America/N. Asia), but it also makes them relatively more temperate, resulting in more local/regional populations and sources and warmer temperatures.

The manuscript discusses how the size distribution changes during the Mosaic measurements as a function of air temperature (e.g. Fig 4). Is air temperature seasonality also relevant to the observed seasonality of size distributions at the various ground-based sites mentioned in the manuscript?

### **Data source and attribution of the 'UtqiaĀivik' data**

The proper name of the location at which the UtqiaĀivik data were acquired is the NOAA Barrow Atmospheric Baseline Observatory which is near the village of UtqiaĀivik in Alaska: [https://gml.noaa.gov/news/brw\\_dedication.html](https://gml.noaa.gov/news/brw_dedication.html)

It would be appropriate to mention in the text the station's full name at least once and to note that it is a NOAA site since neither the 'UtqiaĀivik' BC or PNSD measurements would be possible without the infrastructure provided by NOAA - particularly since there are no NOAA co-authors on the manuscript. Schmale et al 2022 referred to this data as 'UtqiaĀivik/Barrow'. NOAA is not mentioned anywhere in the manuscript in relation to the measurements. Readers should not have to dig into datasets to find out exactly where the measurements were made.

Related - it's unclear to me if the other Arctic ground sites are represented by co-authors on the manuscript's author list - if not, then it would be good to ask someone from the unrepresented sites how they want their sites to be referred to.

The authors cite Freud et al (2017) on the the PANGAEA archive as the source of the

UtqiaĀivik PNSD data. These data were generated by IfT in Leipzig (Ali Wiedensohler's group) from instruments deployed at NOAA's Barrow Atmospheric Observatory near UtqiaĀivik. I do not see an IfT co-author cited for this dataset in the data availability section. Before using this dataset, I would recommend that the authors check with the data generators (IfT) on the quality and attribution of these data.

The Freud paper which developed the data set on the the PANGAEA archive says they obtained the raw UtqiaĀivik PNSD data and did some filtering based on wind direction. That sounds different than the data treatment described in Kolesar et al 2017 (written by scientists from IfT) which is cited by this manuscript to describe data treatment of the UtqiaĀivik PNSD data.

### **Minor comments**

Line 51 "...surface energy budget and has..." -->"...surface energy budget and have..."

Line 79-80 "At the same time this demonstrates the importance of aerosol particles in cloud formation processes." Unclear what this sentence refers to as demonstrating the importance of aerosol particles in cloud formation processes.

Line 100 - Might make sense to caveat the identification of anthropogenic and natural sources. Some sources (fires/dust) might be enhanced by human-caused warming, drying or land-management practices.

Line 111 - what is meant by 'targeted monthly approach'

Line 121 - the central Arctic is mentioned in the first paragraph of the methods section but then not actually defined until lines 135-136. Move definition earlier.

Line 175- Kuang 2016b is not in references (neither is Kuang 2016a)

Line 179 - please use the proper diacritical marks for UtqiaĀivik - there is a dot on top of the g.

Line 192 - "...while this measurement represents equivalent BC (eBC)." --> "...while properly this measurement should be referred to as equivalent BC (eBC)."

Line 198-200 - The full time series of NOAA's Barrow Atmospheric Baseline Observatory absorption data from PSAP and CLAP for 1997-2021 (which is what the BC data in the Schmale et al data sets is calculated from) is available from both from NOAA: <https://gml.noaa.gov/aftp/aerosol/brw/> and from EBAS: <https://ebas.nilu.no>.

This would enable you to include UtqiaĀivik BC data in Figure 12.

Line 254 - How many 5 min scans were required to have an acceptable hourly mean?  
How many acceptable hourly scans were required to have an acceptable daily mean?

Line 255 - what is meant by 'vector length' in this context?

Line 267 - what wavelength is the short-wave DW radiation?

Line 279-280 - North America appears to be most important in May-August based on Figure 2b which contradicts the statement "Much lower contributions from the continental regions were observed during May - July."

Line 285 - "...a shrinking effect of the polar dome, or a meteorological..." --> "...shrinking of the polar dome, a meteorological..."

Figure 2 - caption - describe the mask first or switch the position of figure a and b.

Figure 3 - what is the variability in the average size distributions? Show with shading

Line 375 - "Stohl., 2006" --> "Stohl, 2006"

Line 390 - "May itself represents..." --> "May represents..."

Figure 8 - use same color scheme as Fig 2b (North America is a different color)

Figure 12 - Include UtqiaĀivik BC - can get the absorption data for year of Mosaic from EBAS or from NOAA. Just need to apply whatever mass absorption efficiency Schmale et al 2022 applied to convert absorption into BC concentrations.