Review_acp-2022-280: James Brean et. al.,

Collective geographical eco-regions and precursor sources driving Arctic new particle formation

General comments: This manuscript analyzes atmospheric particle formation and growth rates for six Arctic sites.

The manuscript provides some useful scientific contribution associated with new particle formation (NPF) in the Arctic. It is a similar idea like the paper from Sellegri et. al., 2019 [Atmosphere 2019, 10, 493; doi:10.3390/atmos10090493] for different high mountain research stations. This paper was not cited. a reference to this paper would have been very helpful here and also a short introduction of the theory to explain the key processes. This is totally missing. The manuscript concentrates too much on statistics and source area and the information on the specific aspects for the different locations are more or less missing. This is much better explained by the Sellegri paper. Some changes in the structure and presentation would be nice. The following questions/concerns should be satisfactorily addressed prior to final publication.

Specific comments

Figure 1: show the general seasonality of the different parameters: J10, GR, CS and Q. here is missing the data availability of the different stations – is the time period the same and the amount of data's for the different stations. This figure is too general and only J10 and Frequency have the same signature.

Figure 2: Here is the information, separated for the six stations and also not really clear message. Different values for the parameter at different stations. It would be better, to use Figure 1 to say the NPF Frequency is highest in June/July/August and present in Figure 2 the data sets only for these three months. Then the differences between the station can be better explained….

Figure 3: a specific inside view in the source area seems better instead of this extreme general picture over the entire data set. For me is here Figure S5 much better and Figure 3 should remove for Figure S5.

Figure 4: is very clear and good described in the discussion (starting L253)

Figure 5: I don't see a big motivation for this figure, could be remove

Figure S1: this is mandatory in the manuscript, and not in the supplementary! But you see the limited data basis and also the lack of data from different station for different time period. This long measurement period from Zeppelin to compare with other station with very limited time span seems critical and should be better discussed in the text. Only 2015 show an observation overlap from 5 station. A specific discussion of this time period is here recommended. Is the result from this period similar / same for the entire period?

Figure S3: why as example only type 1,2,3 for Tiksi – is that a typical signature or a special in compare to the stations?

L66: It is not enough to write, NPF is a deeply complex process – a little bit more on the theory and main processes would be very helpful

L81: It is here missing to mention, what are the key parameter for NPF in the Arctic. Are the same like in other regions or not.

L82: The sentence should end with dot, that is missing

L89-105: The table S1 on the station is not complete, the used instruments is here also recommended, including the specific information, whether the different systems at the different stations means special constrains for the data analysis. How big are the differences between TSI 3034, TSI 3772 CPC and twin DMPS, custom built SMPS and TSI 3010 CPC. This could show very easy in a table…

L114: Is the condensation sinks CS the main parameter identity NPF or the particle growth GR. I think the formulas are for this manuscript secondary. The list of priority for the Arctic site seems more attractive.

L143/144: The explanation, why only type A and type B are used for the identification of NPF, is missing.

L184: the discussion of the spatial variability is in general attractive, but the information in the following lines up to 245 is very unstructured. Here a table with the different mean parameter for the three regions makes the discussion on the differences and explanation of reason much easier.

L249/250: I see also a variation of CS at the different sites and a focus to the high frequency period of the NPF could be bring a better inside view.

L253-255: what is the motivation for Figure 5 and this sentence? Please explain it.

L303-311: Here the message is not clear enough. Figure 1 for example show a high seasonality and for the different parameter not a complete peak for summer, sometime also NPF events in winter. Too much statistics is here not perfect. A specific final statement, what is the key parameter for the NPF event in the Arctic and what are the difference between the three locations would be helpful.