

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2021-491

Anonymous Referee #2

Referee comment on "Controls on surface aerosol particle number concentrations and aerosol-limited cloud regimes over the central Greenland Ice Sheet" by Heather Guy et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-491-RC2>, 2021

The manuscript presented by Guy and coauthors is of both excellent scientific quality and presented in an excellent language. It features highly valuable measurements, that fill a "blank spot on the map" in the understanding of the aerosol-cloud-climate system in the Arctic. The methodology is of sound quality. It was both interesting and a pleasure to read.

General comment:

The manuscript is somewhat long in its current form, and the central points and conclusions would be communicated better, if the manuscript was shortened, where possible. The case studies are presented with a lot of information and very dense plots, and the discussion section feels unnecessarily lengthy. I suggest that the autothors consider where the manuscript can be shortned if/where they find it suitable.

Specific comments:

Lines 5-6, 560: The statement that the annual pattern of N20 is opposite that of other Arctic sites, is speculative at best. Please see Freud et al. 2017, Atmos. Chem. Phys., 17, 8101–8128, 2017 in this matter. There is also not a 1-to-1 comparison between N20 used here, and the lower cut-offs and size distributions reported by different authors.

Lines 62-63: There is only a very weak link between CCN and INP, as ice nucleation and the initiation of freezing can happen through several mechanisms, that differ from the condensation of a cloud droplet. The sentence can be read, is if INP is a subset of CCN. This is no the case.

Lines 146-149: There is no information presented about the particle sizes samples by the CPC. While this is perfectly legitimate, there are reports of elevated sub-30 nm particle concentrations at Summit (Ziemba et al. 2010, Atmospheric Environment 44 (2010) 1649-1657). Combined with the size dependent losses of the CPC sampling inlet, this will lead to underestimation of the reported N20 in some occasions. Can the authors elaborate on the uncertainties expected to be affiliated with the reported N20.

Line 176: "00Z, 12", and 18Z daily" Can it be expected that the majority of readers will be familiar with time given as zulu time?

Line 216-218: Is an assumed mean diameter of 2.5 μm justified? I would expect 2.5 μm particles to only contribute minimally to N20. The authors state, that parameter variations have been made. Would it be more relevant to include FLEXPART calculations based on a particle size that is closer to the expected mean particle diameter?

Line 243: While eventually not relevant in the whole picture. The process described in Ziemba et al. 2010 could contribute to CCN relevant N20 locally.

Figure 5: While obvious, formally the abbreviation Precip has not been introduced. The short form is not required here, as there is sufficient space.

Figure 6: How can the pink line increase in some instances? Also, "Precip" is used again here.

Figure 7a: This is a dense, and eventually unnecessarily complicated plot. Could a scatterplot of surface pressure anomaly vs. N20 anomaly be a simpler and clearer way of showing the correlation?

Line 296: It is implied that the particles that are referred to, as being primarily above the boundary layer, are simulated particles. This could be stated explicitly, to avoid confusion.

Line 298-302, figure 9: Is it justified to average trajectories of respectively high- and low N20 events of the entire sample period of one year, given the seasonal variations? E.g. are the trajectories yielding low N20 during winter, similar to those during summer etc.

Figure 11: The legend of figure 11a states $SBI > 2 \text{ }^\circ\text{C}$, while the figure text states $SBI > 3 \text{ }^\circ\text{C}$. Also $> 3 \text{ }^\circ\text{C}$ is stated earlier in the text. Likely a typo.

Figure 13: Same as figure 11

Lines 401-403: While I agree on the general concept, that the observed decrease in particle number concentration during fog closely reflects the number concentration of fog droplets, additional particles could be lost to scavenging onto the droplets. Also the statement is not logically sound, as it combines an absolute statement "equal" with a more relative "not necessarily". If something is equal to something, then it absolutely, and not only eventually, excludes anything else.

Lines 521-523: This is somewhat confusingly written, can this be stated simpler and clearer?

Line 524: "begin" is written in present tense, should be past tense

Line 526: "reduction in the strength" could be substituted with "weakening"

With best regards