

Comment on cp-2021-99

Anonymous Referee #1

Referee comment on "Canadian forest fires, Icelandic volcanoes and increased local dust observed in six shallow Greenland firn cores" by Helle Astrid Kjær et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-99-RC1>, 2021

Review of the manuscript "NEEM to EastGRIP Traverse – spatial variability, seasonality, extreme events and trends in common ice core proxies over the past decades", by Kjær et al. cp-2021-99

General comments

The manuscript is focused on the analysis of the chemical records obtained by CFA from 6 shallow firn cores retrieved along the NEEM - EastGRIP Scientific Traverse. The Authors present a study of both spatial variability along the 6 sites spanning West to East Greenland and temporal variability, after yielding an ice core chronology, basing on annual layer counting. As regarding the latter, dust concentration of size-sorted particles was used to spot possible local dust sources, free acidity and conductivity were employed to detect volcanic eruptions and a stacked ammonium record was found as a valuable proxy of forest fires in Northern America.

The paper presents an ample set of new data which can be useful to a broad community of scientists involved in recent climate reconstructions from ice core records and I find it apt to be published on Climate of the Past eventually.

However, I find that the manuscript should go through some consistent revisions.

Some parts of the text, e.g. ice core chronology (see Specific Comments) should be better detailed and deserve a further short discussion.

A general English revision is also suggested: the text is usually easy to read but sometimes sentences look as broken or dashed off hurriedly and should be rephrased.

Furthermore, there are many basic format and punctuation issues which can be easily fixed.

Here below I am listing some specific remarks to help in this process.

Specific comments

Abstract

Line 18 page 1 (and related Table 2). "Annual mean and quartiles of the...": the sentence is not immediately clear upon reading if one has not gone through the text and Table 2 could be accompanied by a figure showing the overlap of data distributions to better appreciate it. For instance, a box and whiskers plot could be helpful, but any other solution is welcome.

▪ Materials and methods

Lines 14-16 page 4. Melting a firn core is always a critical issue and certainly deserves some more precautions with respect to ice core sections. A melt rate of 4 cm/min sounds fine but probably even a higher rate would work. The addition of a metal coin is interesting, and I guess it is to separate the melting section from the head so that the produced water stays in contact with the firn section as little as possible, but the authors are invited to add some details about the metal coin addition. It could be better shown also in Figure S1 (here metal coin is not visible).

Section 2.1. Core chronology. As a general remark on the section, I would invite the Authors to complete it because it lacks some details in my view. In particular, the Authors should find a way to better show the seasonal pattern of the chosen marker, maybe making lines thinner in Figure 2 and possibly adding a figure with a close-up on a few years. It would be also interesting to read a brief discussion on the stability/loss of H₂O₂ seasonality as depth increases. It cannot be appreciated from Figure 2.

Moreover, the Authors are invited to briefly mention the reasons why they have chosen to use only annual layer counting for the dating without using volcanic signatures of acidity and conductivity, since they have used them to study the spatial variability of volcanic eruptions in section 6.1.

- **Spatial variability**

Figure 2 page 6. As mentioned above, Figure 2 is very relevant and necessary to the manuscript but the concentration profiles from all the cores cannot be well appreciated. A simple way to make it all clearer without redrawing completely the figure is to use slightly thinner lines or maybe dashed or dotted lines for one or two cores. Any idea from the Authors in order to make it more readable is welcome.

Lines 13-14 page 7. Is 5 ppb a mean or median or which other reference value? Anyway, one only value as a term of comparison is not sufficient to state that "...no significant recent increase" is observed with respect to the rest of the Holocene. Please, provide a better support to this statement.

Lines 2-4 page 8. More than relative variability (which is lower in the NorthWest than Central and NorthEast – 15% vs. 25%, respectively), absolute values are higher, accordingly with post-depositional processes Authors mention.

Lines 5-6 page 8. Are 2 mS and 5 mS average values? Which is the associated variability? This can be important to know to evaluate if the two values are significantly different.

- **Seasonal cycles**

As a general remark for this section and for Figure 3, I don't find text and figure consistent: Figure 3 displays "formal season" instead of "formal month". Besides, seasons are reported from the right to the left (if I well interpreted) while it would be easier if they were shown in the opposite direction. I can understand that ice core records go backwards in time but in this case I find it confusing.

Also, I would replace the term "Excess" in Figure 3 with "anomaly" or, at least, would explain it well also in the caption.

A higher definition would be helpful for Figure 3.

Line 30 page 10. It is not clear if the Authors refer to reproducibility here, how it is calculated and how "site specific noise" was evaluated. The issue of "noise" is recurring through the text, rightly so, and it deserves a more detailed discussion.

- **Temporal trends**

Line 14 page 11. Again, the reference to "noise" should be made clearer. Do the Authors refer to the whole core or just to the most recent part? Even though median and topical quantiles are reported in Table 2, the calculation of trends and related significance would be important, in my opinion. The possible existence of trend cannot be read immediately from the Table.

- **Extreme events**

I would add a mention in the section (for instance after Line 3 page 15) to the fact that other markers different from the ones analysed here can be more specific for detection and assessment of impact of volcanic eruptions (for instance, non-sea salt sulphate) as well for annual layer counting. The Authors could refer to some topical papers in the field, such as Sigl et al. (2016, CP) and Severi et al. (2012, CP).

Line 32 page 18 – lines 1-2 page 19. Since the Authors state (lines 9-11 page 5) that only hydrogen peroxide (with a supportive contribution of calcium) was used for dating, cannot understand now if the dating of A2 and A4 cores was tuned by using ammonium record, in the end, in order to achieve a definitive ice core chronology. It could be reasonable but it deserves a brief discussion since the time scale is basic to go on with further data interpretation.

Supplementary Material

Figure S1. As mentioned above, please add the detail of the metal coin to the figure, since I have gathered that it is relevant to prevent the by-side effect to "backward sucking" and cannot be appreciated from the figure.

Besides, a slightly higher definition for the figure would be welcome.

Technical corrections

Abstract

Line 23 page 1. I would replace "contribute" with "ascribe"

Line 29 page 1. English check suggested: "peak ammonium" and "peak volcanic layers" should be corrected.

▪ **Introduction**

Line 8 page 2. English correction: "ammonium peak concentration" should probably be "ammonium concentration maxima" or similar.

Line 12 page 2. Add full stop and the end of the sentence (similar missing punctuation issues all through the text).

Line 15 page 2. English change suggested: maybe "has facilitated" could be replaced by something more apt, such as "allowed obtaining".

- **Methods**

Lines 26-27 page 2. Please check the format of NEEM and EastGRIP site coordinates.

Lines 5 and 6 page 2. Check punctuation: remove an "and" and insert semicolon.

Figure 1 page 3. The labels of the red circles indicating the drill sites overlap one with the other and cannot be read easily.

Table 1 caption, line 7 page 3. The reference is written in a different format from the rest of the text.

Line 6 page 4. In my opinion, "acid" is too vague and not corresponding to what is measured. It should be replaced by another expression, such as "acidic content", "free acidity" or just "H+" or any other apt wording. This remark holds for the whole paper (e.g. already a few lines later, line 8, again "acid").

Line 10 page 4. I guess the Authors refer to 8 pieces, each 55 cm long, please correct the expression in brackets.

Line 17 page 4. Please correct ammonium formula using superscript. Check carefully these format issues all through the text.

Line 20 page 4. I would replace "in sufficient resolution" with "with sufficient resolution".

Line 22 page 4. I would write "it is produced" adding a verb. Otherwise, please rephrase.

Line 27 page 4. "Sufficiently high enough" contains a repetition, I find.

Line 3 page 5. Please use the same shortened name for the same core (e.g. 2015T-A6 or T2015-A6).

Lines 6-11 page 5. There is probably an issue with tense of verbs; please choose past tense (as mostly used in the rest of the text) or present.

Table 2 caption page 7. It is quite peculiar that you use 15th and 85th percentile here while you use 16th and 84th percentile in Figure 3; I don't think it changes the result, of course, am just curious to know.

- **Spatial variability**

Figure 2 caption page 6. As remarked earlier, I would replace the expression "acid", here and through all the text.

Table 2 (page 6 and 7). Please, check the format of the analysed parameters (namely superscripts and symbol for "micro").

Table 2 caption (page 6 and 7). I would add some details for the unit of measurement for dust in the Table or in the caption. Is it "#" referring to the total number of particles or to one particular size range?

Line 10 page 6. They are not "estimates", actually; I would use the word "measurements".

Line 11 page 7. "Lower estimate": what do the Authors mean with it? The minimum value? A small percentile?

Line 15 page 7. Please, add the right symbol (\pm).

Line 20 page 7. "Counts mL⁻¹" is an unit of measurement for a signal, not for a concentration, which I find it more correct, to estimate a noise (signal is highly variable among different instruments, also in the case of dust measurements, I believe).

- **Seasonal cycles**

Line 5 page 10 (also line 18 page 18). Please add brackets for publishing year for Gfeller et al. (2014).

Line 8 page 10. As above.

- **Temporal trends**

Line 19 page 11. The reference does not appear in the Reference list.

Line 21 page 11. Please, correct of format of "micro", also later in the section

Line 29 page 11. "assuming all spheres were perfectly round": would rephrase f.i. "assuming all particles are perfectly round".

Lines 4-5 page 12. Please, rewrite the sentence starting with "Thus"; it appears to be broken.

Line 6 page 12. I would complete the sentence this way: "...parting the data set this way..."

Table 3 page 13. check format (width of the first column, superscript in header of the second column, ...)

- **Extreme events**

Line 3 page 16 and line 5 page 17. Check format (superscript in km³).

Line 17 and line 31 page 16. Please, do not use the shortened expression "1986 Nov" and similar in the text

Line 5 page 17. After "...eruption signal" the sentence is not clear, please rewrite.

Line 23 page 18. Naming the sites located west of the ice divide would help the reader who is not extremely familiar with Greenland morphology.

Lines 28-29 page 18. Please check the format of p value.

Figure 6 page 19. Dotted lines for the fire records are not well visible.

Line 5 page 19. ">97.5% of full records": I assume the Authors refer to the 97.5th of each full record but it would be useful if they report it explicitly.

Line 18 page 20. No capital letter is needed for "levoglucosan"

Line 19 page 20. I believe "high concentration values" or "concentration peaks" are missing in the sentence. Same at line 10 for dehydroabietic acid and **line 14** for fire tracers.

Line 13 page 20. NEEM is with capital letters.

Line 21 page 20. I am sure this correlation coefficient (is it R or R^2 , by the way?) is highly significant but the Authors could report the associated significance and the number of data as well.

- **Conclusions**

Line 7 page 21. Please correct the symbols of "micro".

Lines 9-10 page 21. Please, correct the format of publication year for Nagatsuka et al. and Amino et al. Again, the sentence starting with "Thus" appears to be broken, please rephrase.

Data availability

Please check punctuation and core names.

References

Lines 24-26 page 24. This paper should be published now and not on TCD anymore; please, update.

Supplementary Material

Line 3 page 3. Please correct format for hydrogen peroxide (subscripts)