Journal: Climate of the Past

Manuscript ID: cp-2023-95

Title: Air temperature changes in SW Greenland in the second half of the 18th century

Dear Chandal Camendish

Editor, Climate of the Past

We would like to thank you and the anonymous reviewers for providing positive feedback and constructive comments on our manuscript. All comments were carefully considered, and we believe they helped us improve the description of our work. The detailed corrections/modifications are listed below, point by point.

(Note: The changes in the text and the answers to the reviewer's questions/suggestions are marked in red font. We revised the text, taking into account all comments and suggestions proposed by the reviewers. All changes have been carefully applied to the text.)

Referee No. 1.

In this work, the sub-daily temperature records of two periods in southwest Greenland, 1767.9.1-1768.7.22h and 1784.9-1792.6 respectively, were used to analyses the climate conditions in the second half of the 18th century. The results were displayed through various statistical and visual methods, combined with some weather and climate indexes. It is important to increase the understanding of the climate in this region of high latitudes at an earlier time. This work has significant implications for increasing the understanding of earlier climate in this region of high latitude. The manuscript has a detailed narrative with rich results and in-depth discussion. However, we still recommend that the readability of the paper be improved through minor revisions and adjustments. Here are a few specific suggestions.

1. Here are 2 minor fallacies in the formulas and charts:

- On page 6, line 139, in equation (4), is there a missing T in front of 21?

ANS: corrected

- In the picture in Figure 7, the letter numbers are in upper case, and in the name of the figure, they are in lower case.

ANS: corrected

2. We suggest a more detailed, systematic and independent description of the sources of the data, the way they are observed, the form in which they are recorded, etc, which are rather scattered and abbreviated in the current text. (Such as the data sources are in the remarks to the figure, the means of observation and missing measurements are briefly mentioned in paragraph 4.) Thus, we recommend a separate subsection in Part 2 to display them, as well as, a basic presentation of the data through statistics and visualization, including time periods of valid data, etc. This will be more visual than a text description. We believe that this will allow readers from different professional backgrounds to be more aware of the observation record and increase the credibility of the analysis results.

ANS: Thank you very much for this suggestion. We have distinguished subsection 2.1 in which we described in detail all available metadata and data. We want to stress again that the presented meteorological data are the oldest that exist for the Arctic, and that in the manuscript we informed

readers about all the metadata that exist. But for greater clarity we added information that the sources give only the time of measurements and the thermometrical scale used. Unfortunately, the information about detailed place of measurements, sheltering and exposure, manufacturers of thermometers, etc. is not available for both series. We also added to the manuscript an additional figure (see below) which presents for the period 1784–92 the availability of data for analysis. This will definitely help readers more easily to estimate the availability of data.

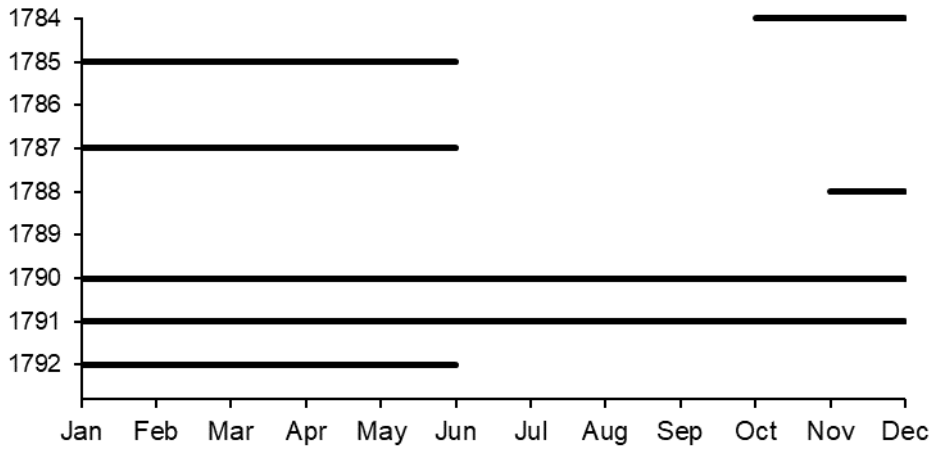

Figure. Coverage of air temperature observations in Nuuk (orig. Godthaab) in the period 1784–92

3. How the records were further analyzed could also be a separate section in Part 2. In this section, we think it would have been better to give the reasons for the selection of each climate or weather indices (Table 2). Because it seems that from the results alone, these indices do not give some new and interesting insights other than adding to the richness of the presentation. Therefore, we believe it would be better if the purpose of selecting these indices for analysis was mentioned in the methodology section to help the reader understand the purpose and results, also better echo what would be discussed in part 4.

ANS: Thank you for this comment and suggestion. We have added more information about the indices used and their importance in improving the knowledge of climate in the study area. We think that the presented threshold statistics make the description of climate and weather and their changes in comparison to present conditions more comprehensive and complex and, importantly, very useful for scientists investigating other components of the Arctic Climate System (biosphere, lithosphere, hydrosphere and cryosphere). For example, the GDD index or number of growing days significantly "impacts plants' and animals' activity and growth, which in the Arctic region may start as soon as snow melting has taken place" (Nordli et al. 2020). On the other hand, the ATI index is often used in permafrost engineering, engineering design and for estimations of active layer thickness over the permafrost (Instanes 2016). The PDD index, in turn, is also commonly used by glaciologists, e.g. for modelling glacier or snow melt, which is possible only when the temperature is above 0 °C. The PDD can therefore be thought of, according to Huybrechts and Oerlemans (1990), as the total energy available for melting snow and ice over the course of one year. The temperature oscillation around the 0 °C threshold is also extremely important for studying, e.g., mechanical and chemical weathering processes in the Arctic. Also of importance is the fact that we calculated all of these indices and presented the results in the paper describing temperature change in Svalbard in the period 1898–2018 (see Nordli et al. 2020). Thanks to that, it is possible (and will be possible in future works) to compare the results between the pre-anthropogenic period (in the Arctic *ca* before 1950) and recent warming in both areas (i.e. Greenland and Svalbard).

Huybrechts, P., and Oerlemans, J.: Response of the Antarctic Ice Sheet to future greenhouse warming. Climate Dynamics 5, 93-102, https://doi.org/10.1007/BF00207424, 1990.

Instanes, A.: Incorporating climate warming scenarios in coastal permafrost engineering design—case studies from Svalbard and northwest Russia. Cold Regions Science and Technology 131, 76–87, https://doi.org/10.1016/j.coldregions.2016.09.004, 2016.

Nordli, Ø., Wyszyński, P., Gjelten, H. M., Isaksen, K., Łupikasza, E., Niedźwiedź, T., and Przybylak, R.: Revisiting the extended Svalbard Airport monthly temperature series, and the compiled corresponding daily series 1898–2018, Polar Res., 39, 3614, http://dx.doi.org/10.33265/polar.v39.3614, 2020.

4. We would also like to see more inferences or insights in the discussion that are closely related to the results or conclusion of this paper. For example, we are curious if the results of 1767-68 being warmer than now and 1784-92 being colder than now are reliable, over what range, and whether there is similar corroboration in other regions. As well, is this phenomenon just indicating exceptional years, or is it actually somewhat indicating that the climate becoming colder during 20 years (which means the end of the warm period in 18th century). We believe that such issue to be discussed can enhance the significance of the whole study.

ANS: Thank you for this comment and suggestion. Yes, we agree that it is a little surprising that the year 1767/68 belonging to the Little Ice Age period was significantly warmer than the present reference period. But this is only one year, and it is not really exceptional that so high temperatures occurred. The lack of data does not allow us to check whether this year was as warm in other areas of the Arctic, especially in Greenland. But we have at our disposal short synthetic descriptions of weather for each month written by Cranz (1820). Analysis of these descriptions indicates the occurrence of exceptionally mild weather in the study historical year in many months. For example, he wrote that mild weather conditions occurred in the cold half-year in December, March and particularly in January. About the latter month Cranz wrote: "*This month, which in Germany was colder than in the year 1740, was in Greenland remarkably mild.*" Also, it was warm from April to July, but especially in June. The latter month was summarised by him as follows: "*The air of this month was generally mild, excepting some cloudy forenoon: there was almost constant sunshine and agreeable spring weather, which is rare in Greenland.*" If the thermometer was not correctly protected against the sun rays (at this time screens were not used) such weather (i.e. very sunny weather) could have caused some warm bias in measurements. Warm bias in June was also probably partly connected with the relocation of the measurement site to Pissiksarbik, where, according to Cranz (1820) "*... the sun's rays are more powerful*". In addition, we also checked whether in present times such warm years as the historical year 1767/68 have occurred. Calculations of mean temperature in Nuuk for a comparable period (Sep–May) revealed that in the contemporary period (Sep 1990–May 2020) warmer years than in 1767/68 (-1.92 °C) have occurred three times: 2009/10 (-0.96 °C), 2003/04 (-1.78 °C) and 2012/13 (-1.90 °C).

We sincerely hope that our suggestions can better improve the quality of manuscripts, which we believe to be of great scholarly value.

ANS: Thank you for all your valuable suggestions. We hope that we have answered them satisfactorily. We confirm that all suggestions were very helpful in improving the readability of the paper.