Greenland and Canadian Arctic ice temperature profiles database

Response to Referee Comments on tc-2022-138

Anonymous Referee #1

We thank you for the time and energy that you have invested in reviewing our community paper. Below, please find responses to all comments. Your comments are in colored and italic text, and our replies are in black and plain font style.

(1) In Table 1, four measurement methods are presented. However, the digital sensor string and thermistor string are not mentioned in the text. It is better to explain more details of the two measurement methods.

In the text, 'sensor string' includes both the digital and analog variants. We have revised the text to make this more clear.

(2) In Figure 1, the drill site location in the green box is not shown in Figure 1A. It is better to show the Jakobshavn glacier.

We do not fully understand this comment. All drill sites are shown in this summary figure. Subplot 1B, with the green border, shows the upstream outer region of Jakobshavn Glacier. The location of this subplot, with boreholes therein, is indicated by the green square in Fig 1A.

(3) Line 95: Please check the ice thickness in Tuto_D-11 borehole, it looks from the Figure 2 that the ice sheet thickness is 200 ft, which is about 61 m.

A large length of the thermistor string is exposed on the ice sheet surface. From zooming into Figure 2, its text says "* 44 feet of thermocouple string was exposed on the ice beside the tube". Full resolution figure can be found at https://github.com/GEUS-Glaciology-and-Climate/greenland_ice_borehole_temperature_profiles/tree/main/boreholes/Tuto_D-11 where we add our notes, "Depth from text interpreted to mean that ice surface starts at 44 ft on cable and bottom is at 200 ft on cable. This yields an ice thickness of 156 ft or 156*0.3048 = 47.5488".

(4) In the database, it is better to presented the temperature measurement methods (e.g., type and accuracy of temperature sensors) and depth measurement methods (e.g., type and accuracy of encoder) for the readers to evaluate the uncertainty of data source.

We agree that additional metadata fields regarding uncertainty would be desirable. However, we cannot easily compile the original measurement method and its accuracy for each borehole. Many historical products provide limited information on the temperature sensor, and none on the depth estimate method. Because we provide detailed information on the upstream (original) data sources, readers can still come up with their own uncertainty for any individual borehole if needed. We also provide guidance for assessing total measurement uncertainty, which includes all mentioned sources of uncertainty. Future versions of the database will likely have additional metadata fields added, including uncertainty, which will be populated through expert elicitation and described in a future database description article.

(5) Line 210-220: the paper of V. Zagorodnov et al. presented more detailed disturbance uncertainty of mechanical drill and some discussion can be included in the manuscript. (Zagorodnov, V., Nagornov, O., Scambos, T. A., Muto, A., Mosley-Thompson, E., Pettit, E. C., & Tyuflin, S. (2012). Borehole temperatures reveal details of 20th century warming at Bruce Plateau, Antarctic Peninsula. The Cryosphere, 6(3), 675-686.)

We now include a statement that the temperature disturbance caused by mechanical drilling with fluid-filled boreholes dissipates to the level of precision within five days, and include this citation.

(6) Section 6: Please provide more details how the author determined surface mass balance regime, the basal thermal state regime and ice dynamic regime. A table with accumulation/ ablation rate, basal temperature and strain rate is preferred.

We now more fully describe these selection criteria. More specifically, surface mass balance regime is determined by whether the borehole is located below the snow line, in the ablation area, or above snow line, in the accumulation area, in contemporary satellite imagery (Figure 1). The basal thermal state regime is based on whether the ice-bed interface is measured to be below the pressure-melting-point temperature (i.e. frozen), or not (i.e. temperate). In instances where the borehole does not each the bed, we extrapolate the basal thermal state where reasonable (i.e. FladeIsblink06 is likely frozen), or we list basal thermal state as "unknown" where the extrapolation distance seems unreasonable (i.e. CampVI_50 is unknown). Finally, ice dynamic regime is classified as high strain when the ice flow is channelized, and low strain when sites are located in sheet- or divide-flow.

In addition, some technical errors should be corrected.
(1) Line 15: "the thermal state of the sheet" should be "the thermal state of the ice sheet".

Fixed - "ice" was included in the sentence.

(2) Line 20: "thermo-mechanical" or "thermodynamic" or "thermomechanical"? Descriptions should be consistent throughout the manuscript.

We now use "thermo-mechanical" throughout the manuscript for consistency.

(3) Line 25: Please check the sentence "borehole logging where a temperature sensor is moved up or down the borehole measuring either "continuously" as the probe moves down". Borehole logger is used only when moves down? or, it can be used when moving down or up.

I have deleted the word "down" so now the sentence reads: "...borehole logging where a temperature sensor is moved up or down the borehole measuring either continuously as the probe moves or is stopped to measure at every depth known as 'stop-and-go'."

(4) Line 25: "fiber-optic distributed temperature sensing", "Fiber optic distributed sensing string"? The hyphenation between fiber and optic should be consistent throughout the manuscript.

Fixed - a dash has been added so the manuscript now consistently has "fiber-optic".

(5) Figure 1: The units of Celsius should have the same format throughout the paper.

Figure 1 does not contain any temperature units. We suspect this comment perhaps refers to Figure 2, which is a reprint of a figure from the original study containing the DYE-3 temperature data with units “degC” (Gundestrup and Hansen, 1984). We cannot modify the figure that we are reprinting. Elsewhere, we have ensured we use (°C), rather than [°C], throughout.

(6) Section 4: There are two “Figure 1” in the first sentence of the section.

Fixed - the extra “Figure 1” has been removed.

(7) Line220 and 230: “hot-water-drilled borehole” or “hot-water drilled borehole”? The style should be consistent throughout the manuscript. I think it should be “hot-water drilled borehole”.

Fixed - the dash was removed in line 230, now it reads “hot-water drilled” as suggested making the style consistent throughout the manuscript.

(8) Table 4: The caption of the table 4 is the same as the table 3.

Fixed - the caption has now been updated to match table 4 instead of table 3. New caption: “Overview of the number of profiles in the three regimes before and after excluding profiles not usable for the model comparison analysis.”

(9) The style of the references should be consistent, for example, the first letter of each word in the title of references should be lowercase. Please carefully check your references.

The over capitalized references have now been changed, so the reference style is consistent.

Please also note the supplement to this comment:
https://tc.copernicus.org/preprints/tc-2022-138/tc-2022-138-RC1-supplement.pdf

We have addressed all comments in this response.