

## Review of MacFerrin et al. (essd-2021-274)

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Referee comment on "The Greenland Firn Compaction Verification and Reconnaissance (FirnCover) dataset, 2013–2019" by Michael J. MacFerrin et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2021-274-RC3>, 2021

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This manuscript introduces FirnCover, which is a unique dataset of firn compaction measurements taken between 2013 and 2019 at eight locations on the Greenland Ice Sheet. MacFerrin et al. detail the methods used to obtain the measurements, describe the format of the dataset, and include a preliminary analysis and interpretation of the data. Data from strainmeters, air temperature sensors, and firn temperature sensors at eight sites with different climates provide the opportunity to investigate variability in firn compaction based on climatic factors. Moreover, this dataset of in-situ observations from 50 strainmeters can act as a comparison for existing firn models, which the authors point out use different densification schemes and often disagree with one another. FirnCover is a novel, high-quality, and well-prepared dataset that will be a valuable contribution to the firn modeling and observation community.

Overall, this paper is very well-written and the dataset is of high quality. Included are two general comments as well as line-by-line technical corrections. Once these comments have been addressed, I recommend this manuscript be published in Earth System Science Data.

### General Comments

**1) Data overview and preliminary analysis** - The data description and analysis (Section 5) is important to include in the manuscript since it describes and shows the actual data included in FirnCover. Since the goal of the paper is to present the dataset, finding a balance in the amount of preliminary analysis to include is difficult, and I think that toning back some of the analysis (or even including more of the raw data) could help

reach this balance. This section could benefit from showing more of the raw data and focusing less on the analytical choices (e.g., averaging window, amount of smoothing, how much initial data to ignore), especially since the authors have included the full record of unsmoothed data in the publicly available dataset (a very good decision). For example, in Section 4, lines 192-198, the authors describe how the dataset includes the first month of measurements, but those data have been discarded for the analysis presented in the manuscript. Since users of the dataset will likely have to decide on how to filter these data for their own analysis, showing a figure of the full, unsmoothed record could be beneficial. This could even just be for one example record rather than all of them.

**2) Interpretation** – On a similar note, I would consider adjusting the amount of interpretation included in Section 5. There are a few instances where the authors state the reasons for higher firm density without referencing a figure or table (e.g., line 223-224), and it's unclear whether these interpretations are based on the data itself or knowledge from prior studies. If based on the data, specifically referencing figures that support the interpretation will make the claim stronger. More specific examples regarding this comment have been listed in the line-by-line section below.

## **Minor Comments and Technical Corrections**

Lines 53-58: It seems that this section might need a citation to better support these statements.

96: Consider expanding the description of these existing measurements and maybe even include them in Figure 1. If they are in regions or climates that are different from those in FirnCover, this would help amplify the need for FirnCover.

140: To what is the 2.032 m range referring? The lengths of the boreholes are several meters, so is this range the amount of length change that can be detected?

192: Wouldn't the instrument settling depend on the snow surface density, such that the lower the snow density, the longer the settling time? If I'm interpreting this correctly, wouldn't the one-month settling time of the high-density ice site be the minimum settling time among all sites? This seems to be mentioned later in lines 239-241. Consider combining this discussion or changing it to discuss how surface density affects settling rates, and the settling period is likely different for each site.

204: Explain why a period of two months is chosen for the running mean. Users of the

dataset may be looking for guidance in processing/analysis, so a description of the authors' reasoning may help.

211: Why are these data suspicious? Consider elaborating on the suspicious nature or showing them in a figure

223: Change "this is due" to "this is likely due" and consider adding a citation or referencing a figure to back this claim.

Figure 3: The first line of the caption is confusing. The current wording makes it seem as though time is being added to depth. Is this record starting 120 days after the installation *date*? If so, why?

240: Consider changing "deformation" to "settling"

244: Is this really "noise" or this is a result of the densification processes mentioned? This is an area where I would be cautious of over-analyzing/interpreting for the purposes of this paper.

246: Earlier it was stated that KAN-U is completely ice (line 194), but here the authors write that it contains a 5-m ice slab. Consider updating either line 194 or 246 to reflect the same meaning.

249: Reference Figure 4 at the end of the sentence.

249-251: The wording in the sentence is confusing. Remove the "(resp. \_\_\_)" and split into two distinct sentences.

Figure 4: Since there is dependency on borehole depth (line 237), could you also label the different lines by depth (in addition to instrument ID)? This could also apply to Figure 3.

257: Consider changing "compaction rates" to "surface height" since the referenced figures are showing surface height.

Figure 6: It seems these firn temperatures are interpolated; that should be mentioned in the caption. Also, it seems there was a different color bar used in the Summit plot. Consider flipping the color bar so warmer=redder, or consider using a perceptually uniform sequential color map (e.g., viridis) that has a larger range of colors and can visually capture small variations better.

268-270: Provide a clearer description of what two variables are being compared. Over what period is the average air temperature calculated? Is the firn temperature averaged over 10 m and over time, or is it the firn temperature taken at 10 m and averaged over time?

268-270: I wonder if this comparison would have more significance if examined seasonally rather than averaged over time. This is an area where I would consider being cautious with the interpretation since it seems to require a more in-depth analysis, which is not necessarily the focus of this manuscript.

284-287: Consider adding this information to either Table 1 or 2 so the reader can easily see what existing data are available at each FirnCover site.