

Interactive comment on “Long-term surface energy balance of the western Greenland ice sheet and the role of large-scale circulation variability” by Baojuan Huai et al.

Anonymous Referee #1

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General comments

In this manuscript, the authors present the surface energy balance throughout western Greenland over a long-term AWS recording period. The paper provides a nice, detailed process-based analysis of similarities and differences in the surface energy balance between sites, and the controls exerted by elevation and latitude on these observed differences. Another strength of this work is that it provides one of the first validation studies of the ERA5 reanalysis over the Greenland Ice Sheet, finding that this dataset improves upon ERA-Interim only in the representation of albedo and is still inferior to the RACMO model. Although the scientific results presented in the paper are generally

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timely and sound, it suffers from poor presentation quality in a number of instances, particularly related to the figures. In my opinion these issues, as detailed in the specific comments and technical corrections below, must be amended before I can recommend publication of this paper in The Cryosphere.

Specific comments

L11-12: What constitutes “reasonable agreement” between modeled and observed melt? Be more specific with numbers here, as you were with the RMSEs for modeled versus observed surface temperatures.

L138-139: This sentence requires a lot of work from the reader, forcing them to scroll up and down repeatedly to compare Figs. 2, 4, and 6. It would help to add short descriptions of each figure to the sentence, i.e. something like “Data points used in the model validation scatter plots (Figure 4) coincide with the time series of each variable in Figure 2, while the analysis of surface height changes in Figure 6 starts in 2008.”

Figure 2: This figure would be easier to read with tighter y-axis limits, particularly the lower limits. Temperatures appear to never exceed $\sim 10\text{C}$ or drop below $\sim -45\text{C}$ at any station, so the y-axis ranges can be made smaller.

Figure 2: This figure would also be more effective if the x-axes on all panels covered the same time period (i.e. ending all time series plots in 2019 instead of ending some in 2017 and others in 2019), even if the data at all stations is not available for the same record length. Why do the S5, S6, S9, and S10 records only extend through late 2016? The data gaps at S6 during 2008, 2010, 2012, and 2015 are addressed in the text, but I don't see anywhere in the text where the truncation of these records in 2016 is addressed.

L217-223: How are periods of ice- and snow-covered surface determined? Is this information derived from albedo calculations using the station data?

L259-260: It is again not entirely clear what “reasonable agreement” means in quantita-

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tive terms here. Is “reasonable agreement” a qualitative assessment of the percentage differences reported in the last sentence of the next paragraph?

L291-294: More recent references on the post-2012 slowdown in GrIS mass loss could be cited here and in L351-353, including Mougnot et al. (2019) and the Shepherd et al. (2019) paper already cited in the introduction.

Figure 6 and Figure 7: The color-coding of lines in these figures should be matched so that the same stations are plotted with the same colors in each figure, unless there is a compelling reason not to do this.

Figure 7: In my opinion, this figure would be easier to intuitively interpret if the y-axes were flipped so that more positive values indicate greater melt.

General comment on figures: Text size should be increased by a moderate amount on all figures to increase legibility. Text in Figures 8, 9, and 11 is particularly difficult to read at normal zoom levels for reading.

Figure 8: Why are q2m and 10-m wind speed plotted on a shared y-axis? I understand the authors need to conserve the use of space in this multi-panel figure, but it seems more logical that q2m would be plotted on the same panels as t2m, as these two variables are measured at the same level and can be expected to be highly correlated due to Clausius-Clapeyron.

L370-371: The meaning of the sentence “Specific humidity largely follows temperature” is not entirely clear. I assume it means that specific humidity increases alongside temperature due to the greater water vapor capacity of warmer air, but this should be stated clearly if so.

Figure 9: Following the sign conventions of the SEB terms on this plot, should melt energy values be positive?

L405-409: From examining Figure 9, it appears the summer Qh peak is as high or higher than the winter peak at S5, KAN_L, and THU_L. Consider rephrasing L406 to

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say that “*Most* stations show a maximum in winter. . .”

L460-462: Can the authors provide any reasoning as to why ERA5 improves on ERA-Interim for albedo? Is there perhaps a revised surface scheme for ice sheets in ERA5?

L463: Why is this section called the “Discussion”? It seems to me to be a continuation of the reporting of the study results, and it doesn’t seem that there is a separate “discussion” section in this paper per se. I would recommend renaming this section.

Figures 11-13: For clarity, units of the regression slope ($W\ m^{-2} / \sigma_{\text{GrIS,NAO}}$) should be included as labels of the y-axes in Figure 11 and the colorbars in Figures 12-13.

Figure 12 and Figure 13: The color ramps on these maps appear more suited for sequential rather than diverging data. To make it easier for the reader to discern areas of positive and negative regression slopes, a diverging color ramp should be used (for example the cmoccean “balance” color map, for implementation in MATLAB see <https://www.mathworks.com/matlabcentral/fileexchange/57773-cmocean-perceptually-uniform-colormaps>). Additionally, the color scale should be set with a midpoint at zero to ensure that warm colors show above-zero values and cool colors show below-zero values.

Figure 12: Coastlines should be included in panels e and f.

L532-534: Figure 13 can be used to infer southwesterly advection of warm and humid air to NW Greenland given the spatial pattern of the regression slope. However, the maps do not show actual 500 hPa height contours or any wind vectors, so the figure does not directly show this phenomenon. This sentence should be amended to clearly indicate that this southwesterly advection has been inferred rather than directly shown.

Technical corrections

Title, L6-7, and elsewhere: My personal preference is to capitalize “Ice Sheet” in the phrase “Greenland Ice Sheet”, since these letters are capitalized in the abbreviation “GrIS” throughout the paper. However I recognize that opinions differ on this and will

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leave it to the authors' discretion.

L14: "show" → "shows"

L19 and elsewhere: Capitalize the first "I" in "ERA-Interim"

L23 and elsewhere: Be consistent with using a hyphen or no hyphen in the words "reanalysis" and "reanalyses" (i.e. L23 says "re-analyses" while L24 says "reanalyses").

L52: "described" → "have described"

L68: This is a misquote of Rajewicz and Marshall (2014). The actual quote from this paper is "... in Greenland" rather than "... in GrIS".

L77: Remove "i.e." from this sentence.

L83-85 (and elsewhere?): Be consistent with saying "over the GrIS" versus "over GrIS".

L83 says "over GrIS" while L85 says "over the GrIS".

Table 2: There appear to be errors in text spacing and punctuation for the description of the wind speed and direction instruments. Are these sensors named "05103-5" and "05103-L" and manufactured by the same company (R. M. Young)?

Table 2: "Kipp Zonen" → "Kipp & Zonen"

L149: "time" → "temporal"

L164: This sentence would be easier to interpret with a comma after the word "evaluation".

L198: "sites" → "site"

L318: "ice sheet" → "ice sheet surface"

L488: "clearsky" → "clear-sky"

L506: "axis" → "axes"

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L522: "response" → "responses"

L539-542: This sentence doesn't make sense as written. Is the Hanna et al. 2013 reference supposed to be in the parentheses as an additional reference in support of the claim that "high summer GBI episodes are clearly linked to exceptional GrIS melt years"?

L575, 583: "~" → "-"

L592: "show" → "shows"

L593: "similar" → "similarly"

L601: "as" → "and"

References

Mouginot, J., Rignot, E., Bjørk, A. A., van den Broeke, M., Millan, R., Morlighem, M., et al. (2019). Forty-six years of Greenland Ice Sheet mass balance from 1972 to 2018. *Proceedings of the National Academy of Sciences*, 116(19), 9239–9244. <https://doi.org/10.1073/pnas.1904242116>

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-138>, 2020.

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