

# ***Interactive comment on “A new spatially and temporally variable sigma parameter in degree-day melt modelling of the Greenland Ice Sheet 1870–2013” by A. E. Jowett et al.***

**Anonymous Referee #3**

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Review of Jowett et al.

I find that this manuscript could be a valuable contribution to the important discussion of ice sheet melt-model parameters and their relation to the physical world, with significant revisions. However, in some respects I must also agree with the first reviewer's comments, namely that this paper is arguably more focused on producing the dataset and analyzing aspects of it, rather than applying it in a PDD model. Whether this topic is fit for publication in TC is a question for the editor, although to me it seems quite fitting and scientifically worthwhile for the journal.

What concerns me in the analysis is the marked shift in variability pre- and post-1940s.

Even by eye, Fig. 4 (and several panels in Fig. 3) shows that the temperature time series are quite different in these two periods. The authors briefly mention that this could be related to the lack of observations used for assimilation in the early period. But this is not satisfactory given that it is precisely temporal trends in sigma that are discussed! If this shift is a model artifact, then the authors should discard the data from the prior time period.

I also find the explanation concerning the NAO/GBI unconvincing. If the shift in sigma in the 1940s is not an artifact as suggested above, then the climatic justification should be stronger. According to the figures, the correlation coefficient appears to be extremely low almost everywhere on the ice sheet (< 0.2), except in some marginal regions.

Minor comments

Eq. 4: PPD => PDD

R-squared values: please round these off to 2 or at most 3 decimal places. Five decimal places adds no value and decreases readability.

Spatial plot colors: please consider improving the color scheme used in several plots. For example, white or a lighter color would be a better choice for correlation levels around zero, whereas right now the green/cyan dominates the plot. Same with the trend plots: the colors are confusing given the opposite direction of the colors in the correlation plots. Again it would help to make the zero trend white or a light color rather than red.

Spatial plot legends: It would be helpful to have more values along the legend than just the min and max values. Particularly for the p-value plots, where 0.05 is deemed the important value, it is impossible to see where that lies exactly.

Fig. 6 / Fig. 12: I am curious about the speckled red pattern of near the margin of the ice sheet, particularly in the East. What would cause such low sigma values in winter-time (when there is presumably no melt) in these regions, as well as no discernable

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trend, in stark contrast to the rest of the ice sheet? Could this be an artifact of some kind?

Fig. 6 / Fig. 9: Have you considered plotting the residual and sigma versus temperature instead of elevation? I think it would show something similar to the relationship with elevation, but be more directly meaningful, since the relationship is probably more related to absolute temperature levels than elevations. Figure 4c of Wake and Marshall (2015) is an excellent example of this relationship.

Fig. 7: This is a very valuable figure, especially in light of the goals of presenting a new sigma parameter. It would be interesting to see how this compares to Fig. 3 of Wake and Marshall (2015), as well as how it looks for only the modern period. These two additional mean lines could be added (without the uncertainty) to get an idea of how close they are.

Fig. 10: These R-squared values are so small as to render the regression rather uninformative. Consider removing this figure and related discussion. Also this sentence in the caption is unclear: "The latitude is displayed in decimal degrees to 3 d.p. owing to the latitude of the AWS used in validation."

Fig. 12: Are the statistically insignificant areas outlined in black? It is counter-intuitive that the smallest trends would be the most significant. Also, the legend label needs a time unit, such as "°C/year".

## Reference

Wake, L. and Marshall, S.: Assessment of current methods of positive degree-day calculation using in situ observations from glaciated regions, *Journal of Glaciology*, 61 (226), 329-344, 2015.

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Interactive comment on *The Cryosphere Discuss.*, 9, 5327, 2015.

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