

## ***Interactive comment on “Seasonal monitoring of melt and accumulation within the deep percolation zone of the Greenland Ice Sheet and comparison with simulations of regional climate modeling” by Achim Heilig et al.***

### **Anonymous Referee #1**

Received and published: 27 January 2018

#### Review of

Seasonal monitoring of melt and accumulation within the deep percolation zone of the Greenland Ice Sheet and comparison with simulations of regional climate modeling

by Heilig and others

#### Summary

This paper addresses an important topic, the observation of snow mass, liquid water content and percolation depth in the firn layer of the Greenland deep percolation zone.

C1

The method has been used before in seasonal snow packs and uses upward looking radar, which is less destructive than similar studies using thermistors and other sensors that must be inserted in the snow. A comparison is then made with output of a regional atmospheric climate model (MAR). Good agreement is found in the magnitude and timing of snow accumulation events, but important biases are identified for bulk snow density, liquid water content, percolation depth and refreezing rate and depth.

#### Assessment

The paper is original with good scientific quality and impact. The technical quality of the manuscript leaves some things to be desired; the text must be cleaned up, the introduction section restructured, see comments below. These are all relatively minor issues.

#### Major comments

Unfortunately, the manuscript text contains multiple typo's and generally suffers from mediocre readability because of frequent unclear formulations. For instance, the introduction requires close scrutiny, several statements are unclear or inaccurate, see (non-exhaustive) listing below under minor comments. The introduction would also benefit from a more logical structure starting with the mass loss from the Greenland ice sheet and then stepwise building up to the importance of meltwater retention, its observation (especially the lack thereof) and model evaluation.

Adjust the number of significant digits throughout the manuscript to represent the real accuracy of the results. For instance (both on page 12), temperature probably is less significant than stated at 0.01 degree, and mass transfer and/or SWE not at 0.1 kg m<sup>-2</sup>.

Section 3.5: Surely, MAR output must be available at a higher time resolution than 1 day? The model time step must be typically several minutes, so the line 10 statement that "these generate MAR output with a daily temporal resolution" appears inaccurate.

C2

Why does forcing MAR with different reanalysis data (NCEP and ERA-Interim) produce such large differences in surface density and refreezing characteristics, if the same snow model is used (Figs. 8 and 9)? This touches directly upon model performance and deserves to be discussed in more detail. A paragraph with discussion of possible causes for the biases found in the model is also warranted.

Minor comments

p. 1, l. 5: are observable -> have been observed (?). Also p. 2, l. 27 and 28.

p. 2, l. 4: "...average negative mass balance all over the ice sheet...": this is unclear; what you probably mean to say is that the ice sheet mass balance became persistently negative.

p. 2, l. 5: multiplied -> increased

p. 2, l. 6: "...Negative annual surface mass balances over the same time period are attributed to an increase in surface melt and runoff...": inaccurate: surface mass balance integrated over the ice sheet has not yet been negative; locally it has, of course. Do you mean: Negative trends in surface mass balance?

p. 2, l. 9: "...Since melt conditions are expected to continue...": unclear; do you mean: are expected to continue to increase?

p. 2, l. 16: "...cause a large fraction of uncertainty cause a large fraction of uncertainty...": consider replacing with: "...is a major component of the uncertainty..."

p. 3, l. 1: "...few existing automatic weather stations ...": Nowadays there are two major WS networks on the GrlS: GC-Net and PROMICE.

Table 2 does not add much information, and its contents can be absorbed in the main text.

p. 12, l. 20: "...increases in accumulation ...": increases in SWE (?)

C3

p. 12, l. 22: how is 'contemporary snow' defined?

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2017-277>, 2018.

C4