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Discussions

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Interactive comment on "Spatial and temporal variability of snow accumulation for the South-Western Greenland Ice Sheet" *by* Achim Heilig et al.

Anonymous Referee #2

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OVERVIEW

This paper tries to answer the question of how representative point measurements of snow accumulation are for the larger regional scale. This subject is important, urgently needs attention, and this paper fills a void in our knowledge on the connection between the observation scale and the (regional) climate modelling scale.

Scientifically, the paper is solid, and I have few methodological remarks. In terms of presentation however, I have quite a few remarks. Changing a word or sentence here or there won't fix the fact that the paper is quite tough to read.

GENERAL

- Various terms are used interchangably, without a proper definition. Snow accumulation, SMB, SWE, snowfall, snow depth. Please have a critical look at the terminology, simplify, and make uniform.

- I had to dig quite deep in my memory to connect the dots between variograms, nuggets, space-invariance, isotropy and stationarity. Would it be feasible to ease the text in section 2.3?

- The abstract is particularly awkward in grammar and style, as if it was the last part that was written and not checked before submission. I'll give three example sentences and how to make this readable:

1. "Density variations per site for snow pits within distances of up to 1 km are found to be consistently within 5%."

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"Within one km of each site, the density consistently varied within 5%."

2. "It occurs that with a probability of $p = 0.8$ (KAN-U) to $p > 0.95$ (Swiss Camp and Dye-2), randomly selected snow pits are representative in snow accumulation for entire regions with an offset of 10% from arithmetic means."

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"We found that snow accumulation from a randomly selected snow pit is very likely representative of the regional scale ($p = 0.8$ for a value within 10% of the regional mean for KAN-U, and $p > 0.95$ for Swiss Camp and Dye-2)."

3. "Interannual accumulation pattern at Dye-2 are very persistent for two subsequent accumulation seasons with similarity probabilities of $p > 0.95$, if again an error of 10% is included."

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"At Dye-2, we found that the spatial pattern of snow accumulation was very similar for two consecutive years."

So please revise the manuscript text and simplify, simplify and simplify.

- In several parts, you claim that snow accumulation should be established for an area of at least 20 x 20 m. This seems a very important implication for future field work. However, I miss the quantitative underpinning of these numbers. Why not 10 x 10, or 25 x 25 m? And how should this be done if no GPR is available? This is such a crucial part of the manuscript that I expect some more discussion of the implications on field practice.

- The title is inappropriate. My suggestion would be: "Representation of point measurements for regional-scale snow accumulation in/on the southwestern Greenland Ice Sheet."

- Throughout the paper, you seem to use rho_s mostly as a bulk parameter: a mean over a certain depth. Can you more clearly distinguish between the actual snow density and this vertically integrated bulk density, and define the bulk density clearly?

SPECIFIC REMARKS

- Title: "South-Western". I looked it up but this should be either "southwestern Greenland" or "Southwest Greenland".

- L1: significant changes. In what?

- L3: remove the sentence "Data sources ... coverage"

- L3: remove "at least"

- L11: "per regional scale"?

- L11: "to analyze for". To analyze is a transitive verb. Suggestion "we investigate". This recurs frequently in the text (e.g. P1L17)

- L18: "cannot be evidenced" -> "At Dye-2, we found no evidence of..."

- L27: SMB related processes -> SMB

- L35: "certainly contribute" -> "may also contribute"

- L52: remove "at the GrIS"

- L57: point -> location

- L70: suggest "To improve our understanding of the representativeness of ..."

- L71: "in area for two sites" -> " in areas around two sites"

- L72: I have once been taught that one paper answers one major question. Your one major question is about representativeness of point measurements. All other questions are hurdles that you come across while answering that question. My suggestions would be to rephrase, and to formulate L70-80 such that you introduce the different steps needed to answer your "major question" with associated sections.

- L72: "equilibrium line of altitude" -> "equilibrium line"

- L125: numerous -> several

- L144: range -> ranges

- L146: constantly -> always

- L172: more constraint -> better constrained

- L181: remove "a realm of"

- L197: Do not start a sentence with a mathematical symbol.

- L196 - 206: past and present tense are used here interchangably. Please unify.

- L217: snow depths -> snow depth

- L217: why call this ice volume fraction? Suggestion to simplify these sentences:

"We investigate the error that we introduce by assuming a single bulk density in the conversion from TWT to snow depth for an entire GPR transect. For that, we use a collection of snow pits, several from each of five locations, that were collected in a period of three years (table 2)."

- L243: above average -> above-average (idem below-average)

- L261: equals to -> equals

- Figure 4: consider inverting the color scale. Blue = low accumulation, yellow is high accumulation

- L293: awkward construction. Rephrase

- L316: Not all of the collected radar transect patterns (grids?) ...

- L327: larger scale -> larger-scale

- L341: north to south direction -> north-to-south direction

- L347: this sentence is not complete

- L368: LaTeX error

- L387: 40% -> 40% lower

- L408: The conclusion about persistence is unsatisfactory, and you seem to be shifting goal posts in the manuscript. In the abstract you write that interannual accumulation patterns "are very persistent". In section 3.3, the 2016 and 2017 data are "very similar". Then in L408 you say that "results suggest persistence". I think you should refrain at all from inferring persistence based on two data points. It's ok to mention that the patterns were similar in both 2016 and 2017, but I don't think there is enough argument here to start discussing persistence.