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Open Access Earth System Science Data Discussions

Interactive comment on "Snow cover variability across glaciers in Nordenskiöldland (Svalbard) from point measurements in 2014–2016" *by* Marco Möller and Rebecca Möller

Anonymous Referee #2

Received and published: 6 February 2019

General Comments:

This paper reports on in-situ ("glaciological") measurements of snow depth and density in 3 spring seasons across 17 glaciers in south-central Spitzbergen. The survey transects sample elevation gradients, while the study glaciers span a range of longitudes. Numerous local measurements of snow depth using avalanche probes were averaged to obtain the reported values, while densities were measured less frequently by weighting snow cores. Depth and density are combined to estimate SWE and uncertainties assigned using a MC procedure.

The dataset is useful and the paper generally clear and complete. The main concern

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I would highlight is that the method of density estimation at unmeasured sites implicitly assumes an elevation dependence that is apparently unsupported by the data. I recommend the authors undertake an alternative approach for estimating density (see comments) and report on the differences between their chosen method and one that does not assume elevation-dependence. A minor concern is that there are several instances where claims are made in the paper, seemingly on the basis of common knowledge and/or experience, that should be fortified with references and/or evidence. Finally, the paper would benefit from one or two additional figures illustrating the dependence of measured/estimated quantities on terrain parameters.

Specific Comments (by section or page.line):

Abstract: Is there some way to make the relationship between the following combination of numbers more clear: 109 point measurements, 69 locations, 9 transects, 17 glaciers? For example, it is not clear to me how many measurements or transects per glacier were made. 9 transects and 17 glaciers makes it wound like 8 glaciers were not measured which is clearly not the case. Were all 9 transects executed on each glacier? Please clarify in the abstract so the reader does not have to wait for Figure 1 to understand the survey design.

1.23-24. The second type (temporal) could also be derived by means other than firn cores. What about repeat measurements of Type 1 over multiple years?

2.15-16. “Missing data about this infrequently measured snowpack characteristic often prohibit an accurate model calibration”. Would be nice to add a reference for this.

2.23. Omit “precise”. Precision can only be determined by testing, so it seems odd to label the data as precise at this point.

4. 5. “Detection of the last end-of-summer surface by manual sounding is straightforward in Arctic climate settings.” Is there a reference and/or more information that could be added? It is hard to imagine that there are never fall rain or thaw events that would

create ice layers at depth in the ablation area. Are ice layers never found in pits/cores, or are they so thin that they are never misinterpreted as the glacier surface?

4.10-14. Coring procedure. Some more detail would be appreciated by this reader at least who has encountered challenges in making these very same measurements. What were the air temperatures at the time of coring? Were cores always easily recoverable? Were chips always unambiguously able to be separated from cores? How is uncertainty in core mass assessed? Was core mass/density ever compared to snow mass/density as assessed in snow pits or with other coring devices (e.g. SWE tube)?

4.15. Uncertainty in the snow depth soundings arises from small scale snowpack variability => arises in part from

4.15-17. Over what footprint (area) were the 10 measurements made? Given that there are multiple scales of variability in snow-water equivalent, it seems important to define the scale at which uncertainty is assessed.

4.18. "Uncertainty in the determination of bulk snow density arises from the potential undercatch of core weight." This is certainly easy to imagine, but has the core-measured density ever been compared to other density measurements? It is also easy to imagine chips not being entirely separated from the core, and thus contributing to overestimation of density. Can this effect be ruled out?

4.20-21. " However, this loss affects only minor amounts compared to the entire snow core and a fraction of 5% of the density is considered an adequate and rather conservative measure of uncertainty." Please provide a reference or some supporting evidence. This uncertainty assessment seems optimistic.

4.24. " fill up the missing bulk snow density data with adequate substitutes" => estimate snow density where measurements are missing

4.24-25. " As bulk snow density frequently varies with terrain elevation along the transects." In the authors' experience? In general? Please specify. There are examples

where snow density does not vary with elevation. Was this procedure for density assignment tested, e.g., against values of measured density? Is two values the right number? Why not try a fixed search radius instead (with a minimum number of measurements required) so as not to unnecessarily mix spatial scales in different density assignments?

4.33. 900 MC simulations per point value of SWE?

5.8-13. Please also report means and std for the subset of data where density was measured. The values reported include both measured and estimated densities (and therefore SWE values).

5.17. " Bulk snow density, in contrast, does only show very limited evidence for any of such pattern." This observation would appear to undermine the approach taken to estimate densities at the unmeasured locations. Suggest an alternative approach to density estimation using a spatial search radius and no elevation dependence. This calculation should at least be attempted and the differences between it and the current approach reported (or, better yet, included in the uncertainty assessment).

5.20-21. Please include uncertainties on these values. It is not clear whether the values from 2015 and 2014 are indistinguishable.

6.19-20. " The variability of snow water equivalent between individual point measurements is far higher than the variability of bulk snow density or snow depth." This seems true almost by definition, unless variation in depth and density somehow cancelled in the determination of SWE. It would be more informative in the conclusion just to report that snow depth was found to be more variable than density.

Figures. It would be really nice to have some figures that showed the relationship (or lack thereof) between snow depth, density, SWE and elevation, longitude, rather than just the correlations reported in the tables.

Technical (by page.line):

1.16. “inevitable”. Wrong word, but not clear what the correct word would be. “invaluable”?

1.20-24. Grammatically, the last two sentences are not quite right. Should be “The first is spatially distributed and derived from . . .”

2.28. pattern have => patterns have

2.29. insides => insights

3.9. these synoptic-scale forcing => forcings

3.12. {walczowski2011: citation not compiled properly

3.15. “ at the bottom” redundant with depth hoar

3.29. carried out => made

5.12. delete “more”

5.20-21. “2016 sticks out as the year richest in snow” => stands out as the year with the most snow.

6.15. “ Thus, snow water equivalents are accompanied by rigorous uncertainty estimates.” Delete. The sentence before speaks for itself.

Specific questions in review instructions:

Are the data and methods presented new? Data are new, methods are not.

Is there any potential of the data being useful in the future? Yes.

Are methods and materials described in sufficient detail? For the most part. See detailed comments above.

Are any references/citations to other data sets or articles missing or inappropriate? Not to my knowledge.

Is the article itself appropriate to support the publication of a data set? Yes.

Is the data set accessible via the given identifier? Yes

Is the data set complete? Appears to be

Are error estimates and sources of errors given (and discussed in the article)? Yes

Are the accuracy, calibration, processing, etc. state of the art? They are standard

Are common standards used for comparison? N/A

Is the data set significant – unique, useful, and complete? Yes

Consider article and data set: Are there any inconsistencies within these, implausible assertions or data, or noticeable problems which would suggest the data are erroneous (or worse). No. See suggestions about density estimation.

Is the data set itself of high quality? Yes

Is the data set usable in its current format and size? Are the formal metadata appropriate? Yes

Is the length of the article appropriate? Yes

Is the overall structure of the article well structured and clear? Yes

Is the language consistent and precise? Yes. Article would benefit from a final proof-reading by a native speaker.

Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? N/A

Are figures and tables correct and of high quality? Yes, though I recommend adding one or two figures.

Is the data set publication, as submitted, of high quality? Yes

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