Geoscientific

Model Development

Interactive comment on "Assessment of the uncertainty of snowpack simulations based on variance decomposition" *by* T. Sauter and F. Obleitner

Anonymous Referee #2

This paper tackles an interesting topic that is seldom properly covered and is based on a robust methodology. This paper has the potential to greatly benefit the community once its shortcomings would be addressed. Such shortcoming include the following points:

- the paper should be reworked to ensure better clarity (including some parameter definitions that are missing). Quite a few things should be rephrased for clarity and/or grammar and some sections are badly structured (see in the detailed comments).

- the reference scenario should be properly shown: very few information are given.

A graph giving an overview of the forcing together with the temporal evolution of the snow height could really help the reader to make up his mind about this scenario. A graph showing the evolution of the energy balance components could also prove very useful when linked with the impact of the uncertainty on various parameters.

- the graphs showing the uncertainty provide some kind of a worst case scenario (multiple parameters combining their worst case values). This is very interesting but also very surprising at first because the amplitudes of the effects of such uncertainties are beyond common expectations and experience. I even set up a similar simulation with the SNOWPACK model in order to check the numbers because this seemed so surprising compared to regular simulations (and finally SNOWPACK shows very similar results to the CROCUS results shown here). To my understanding, even simulations with very poor datasets tend to fare better than the worst case combinations as presented here because some errors compensate each other (for example the Undercatch would be compensated by Incoming Long Wave parametrizations leaning toward clear skies). I think the surprisingly large amplitude of the uncertainty of the results should be better explained/demonstrated and potentially compared to real life data sets. For example, a graph showing the min/max/avg snow height development when only one parameter is changed; or showing how a few low quality datasets would compare to the findings presented here (although this would involve quite some work and would be based on other locations where both low quality and high quality data are available). An alternative approach would be to synthetically generate degraded parameters out of your data set mimicking the data quality issues of real, low quality sites. If these suggestions are impractical, in any case the authors should consider how they could bridge the gap between the common perception of model users (even when dealing with low quality data sets) and their findings.

- the authors did not mention if (or how much) the CROCUS team was involved.

Since the new snow density was tweaked to better fit the results, one is left to wonder if there was any discussion with the CROCUS authors on this topic (although this matches a similar value for Arctic conditions in the SNOWPACK model).

- the authors emphasize the effects of the interactions although these only represent 7% of the ensemble spread... Doesn't this mean that first-order, linear effects are by far dominants (pages 2824 and 2828)?

- the figure 8 is very interesting and therefore should be better explained and emphasized in the text, the last paragraph of section 3.3 should be expanded.

- I would suggest writing equations (1), (2) and (3) in a more consistent way, making sure all parameters are described properly and maybe considering basing them on a positive energy change instead of negative.

- one single year of validation data is a little short. Would it be possible to expand the reference period?

Detailed comments: most of these comments relate to sentences that are not very well written and should be rephrased in a more natural manner.

- the title should be improved to mention the Arctic conditions

- page 2809, rephrase lines 12 ("through to detailed"), 13 ("Besides all advantages"), 19 , 26-27, 29 (replace "apportioned" by "distributed" or something similar)

- page 2810, rephrase line 5

- page 2813, rephrase lines 5 ("measured input except of outgoing infrared") and 13-15

- page 2814, rephrase lines 11-12, 14, 21-22

- page 2814, the glacier flows north-westwards!

- page 2815, rephrase line 4-5

- page 2816, line 16, remove the word "changes"

- page 2819, the same things are said twice in the same paragraph

- page 2819, replace "starts at ..." by "starts on ..." and similarly for "ends at ..."

- page 2819, line 20, consider specifying that the measurements are hourly?

- page 2819, line 21 "these data", which ones?

- page 2819, rephrase lines 24-25

- page 2821, line 1, a ")" is missing

- page 2821, rephrase line 4

- page 2821, rephrase line 25

- page 2822, rephrase lines 15-16, 19-20 and fix spelling on line 25

- page 2823, line 14, please define all terms

- page 2824, line 15 replace "proof" by "prove"

- page 2825, rephrase line 26

- page 2826, rephrase lines 7-8

- page 2828, line 20 replace "firstly" by "first" and line 21 "secondly" by "second"

- page 2829, line 1 replace "proofed" by "proved" and line 2 replace "provides" by "provided". Remove "by" on line 3

- page 2829, rephrase lines 4, 7, 10, 22 and 25-26

- page 2829, line 13 "considerably" and "This lower proportion"

- page 2829, please define Q on line 20

- page 2830, rephrase line 3-4

- page 2838, fig. 1, rephrase "Map demonstrating"

- page 2841, fig 4, "snow albedo at the KNG8 location"

- page 2842, fig 5, idem

- page 2844, fig 7, please define the parameters. I also don't find this graph very clear, improvements would be welcomed

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