

Interactive comment on “Modelling annual mass balances of eight Scandinavian glaciers using statistical models” by M. Trachsel and A. Nesje

Anonymous Referee #1

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This paper describes the analysis of long-term mass balance series in Scandinavia using statistical models. The importance of winter precipitation and summer temperature regarding annual mass balance is assessed. The authors apply different statistical models with varying complexity ranging from simple climate indices to additive models. Results are interpreted using atmospheric indices (NAO, AMO) and differences among the glaciers' sensitivity are highlighted. Sensitivities inferred in this study are compared to those obtained from more complex modelling studies. The statistical models are also applied to estimate future mass balances of Scandinavian glaciers. The paper investigates some interesting aspects of glacier mass balance variability, the relation to NAO and AMO, and focuses on long time scales and different glacier responses with a regional setting influenced by different climatological characteristics. However, I have some substantial comments regarding the presentation of the data and some of the

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analyses performed. Thus additional work is required to make this paper acceptable for publication in The Cryosphere.

General comments:

- Goal of the study: The most important deficit of the manuscript at the present stage is, in my opinion, that it does not clearly state in the introduction which problem is actually addressed. The motivation for applying highly simplified models - that completely neglect many processes - to glaciers that have been extensively studied using physically-based approaches remains unclear. I am sure the authors are able to place their research in the current science and highlight the gap that has not been addressed by the previous studies. With this comment I would also like to support the Short Comment by S. Mernild. The gap in science needs to be emphasized, stating what has been done and which analysis is still lacking.

- Statistical models – feedbacks: The advantage of statistical models is their simplicity. They can well be tuned to measured data and be used to extract information from them. However, statistical models perform inherently bad if one goes beyond the period in which they have been calibrated as they do not describe changes in the processes and thus completely neglect feedbacks. Two of those feedbacks do, in my view, inhibit the application of statistical models to estimate mass balances in the future: (1) Changing fractions of solid and liquid precipitation. For the maritime glaciers of Norway I expect such changes to be highly important. The issue is already shortly addressed by the authors but no conclusive analysis of the impact is provided. (2) The effect of glacier retreat on mass balance. Glaciers are expected to strongly shrink in response to the negative mass balance projected. Thus, a statistical model that is calibrated for the current glacier extent (with relatively small changes over the last 50 decades) will be unable to reliably predict the mass balance over a completely different glacier geometry by e.g. 2100. The above effects need to be discussed in more details by the authors and the effects should be investigated, i.e. the authors need to show that results are meaningful despite these feedback effects. If this is not possible, some of the analyses

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should be removed from the paper.

- Figures and Tables: The figures and tables need some improvements. They are partly unclear and the axis labels are difficult to read/understand.

Detailed comments:

- Page 384, line 23: What about summer accumulation and winter melting? Throughout the entire paper the authors only talk about winter accumulation and summer ablation. Of course, these components are the most relevant ones, but for maritime glaciers considerable snow fall amounts can also occur during summer in the higher regions, and the glacier tongues can experience melting over the winter season. These problems are not discussed at all.

- Page 385, line 21: This sentence appears to be circular to me – or maybe too complicated to get its essence. It occurs in similar form several times in the paper.

- Page 386, line 13: The uncertainty in the mass balance data is not addressed. At least for some of the maritime glaciers, there is an indication that the glaciologically derived mass balances are significantly more positive than mass balance based on long-term geodetic surveys. As the mass balance data are the backbone of the study, more effort could be invested to discuss the uncertainty in the input data and potential effects on the results.

- Page 387, line 15: Here and elsewhere. Why not simply “winter” balance and “summer” balance? The use of “ablation-season mass balance” etc is relatively complicated and sometimes awkward.

- Eq 1: explain symbols s_T and s_P explicitly. And not using another abbreviation (SD).

- Page 392, line 25: What is the objective of analysing positive and negative AMO phases separately? I.e. what do the authors want to find out?

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- Section 2.2.6.: The first paragraph should rather be in the data section

- Page 395, line 21: Complicated sentence, simplify

- Tables 1 and 2: I would strongly suggest simplifying the two tables. Even after looking at them for quite some time and re-reading the caption I was not able to understand all the information contained in them. There are many unexplained abbreviations and symbols that make it difficult for the reader to get the most important statements of the tables. It might also be a possibility to split the tables, or just to omit some of the variables that are less important. Especially table 2 needs revision as the experiments are unclear, there is too much information and no units are given.

- Figure 1: maybe indicate position of weather stations as well?

- Figure 3: What is on the y-axis? The label is tiny. Better use text. Furthermore, I found the point cloud not very intuitive. When printed in black-white the information is almost impossible to extract. Also the experiments are difficult to understand from the caption. It might also be reasonable to reduce the number of experiments shown.

- Figure 4: add (a), (b) etc to the panels. What is on the x- and y-axis? It would be much more intuitive when writing “Summer temperature” and “winter precipitation” -

Figure 5: add (a), (b) etc. Shouldn't this figure be flipped by 90 degrees?

- Figure 6: I really have troubles with this figure. The labels are tiny! Furthermore, even after re-reading the text, the figure is difficult to understand. The approach of evaluation, the presentation of the results and their interpretation (text) should be improved.

Interactive comment on The Cryosphere Discuss., 9, 383, 2015.

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