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The Cryosphere Discussions

Interactive comment on "Simulating melt, runoff and refreezing on Nordenskiöldbreen, Svalbard, using a coupled snow and energy balance model" *by* W. J. J. van Pelt et al.

A. Wright (Referee)

a.p.wright@ed.ac.uk

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General comments

This paper presents a thorough and detailed mass balance modelling study of a large Svalbard glacier in a region with limited data availability. The authors draw substantially on modelling methodologies developed in earlier papers and these are referenced appropriately. The novelty of this study is in the application of rigorous methods to a glacier which (unlike much previous work on small, data-rich glaciers) is much more representative of the bulk of the ice in the region. The calibration and validation of the mass balance and subsurface model is conducted thoroughly and is described well in

the paper.

The discussion focuses on the importance of the refreezing of meltwater and the effects of incorporating seasonality in future climate change predictions of mass balance. These are interesting questions and the authors' conclusions are a valuable contribution.

An important weakness of the study is that no attempt has been made to incorporate ice dynamics in the calculation of glacier mass balance. This is recognised by the authors, however, and its difficulty is understandable without measurements of ice thickness. Potential changes to the hypsometry of Nordenskoldbreen, however, either in the past or in the future may have a considerable effect on the cumulative surface mass balance of the glacier. It would strengthen the paper substantially if the authors could show that the reasonable magnitude of such changes likely to occur/have occurred within their study time period would not significantly impact their calculations.

Specific comments

(212, 10-12) "a major impact on future mass balance and ELA estimates" – could the nature of the impact be stated more specifically in the abstract.

(214, 23) I would change the title of this section, the word "grid" seems out of place. The resolution of the DEM should also be stated somewhere in this section, presently I don't think this is given until the numerical set-up is discussed in section 4.3.

(215, 2-5, 21-22) a reference should be given for this GPR work.

(216, 5) The altitude of the AWS should be given here.

(216, 19-24) "The mean observed precipitation rate at Svalbard Airport (27ma.s.l.) over the period 1989–2010 of 191mm is used to compute a mean altitude of 971 m a.s.l. above which precipitation is constant." I think this sentence probably needs some more explanation.

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(216, 25-27) Could the RACMO grid resolution be given somewhere here.

(217, 24-25) “We therefore decided not to use RACMO data for those variables for further analysis.” Could this sentence be replaced with a concise description of what was used instead?

(219, 22) slope “aspect” and “gradient” should probably replace “orientation”.

(220, 17-20) This sentence could do with re-writing.

(224, 3-8) I would like to be convinced here, or somewhere else, that dynamic changes to the glacier hypsometry do not have a substantial effect at the timescales which you are interested in.

(224, 20-22) This sentence does not make sense in its current form.

(229, 19-21) This may be true, but the results are later used to extrapolate the mass balance right back to 1912, when calving would certainly have contributed significantly to the mass budget.

(237, 11-12 and 24-25) “The time-series are scaled to match the simulated gridded mean for Nordenskioldbreen for 1990–2010.” – What is the scaling factor? This sentence is a bit vague at present. It is also repeated later on but again without the relevant details.

(240, 1-5) These ice dynamic factors may be quite important, but are only very briefly mentioned. I appreciate that predicting the dynamic response of the glacier is a completely different study, but some estimates of the maximum/minimum effect of realistic hypsometric changes might be possible and would substantially improve the validity of Figure 16, for example.

Technical corrections

The manuscript is generally well written, there were very few places that were not sufficiently explained. Here are some suggestions to improve the readability:

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- The +/- symbol appears to have cropped up several times where it isn't supposed to be.

- You should always have a space between a number and its unit.

- Figures with multiple parts should be described either before their identifying letter is given in the caption or after, currently there is a mixture of both.

(212, 22) "proven useful to analyse" should probably be "proved useful in analysing" or similar

(213, 2) "been" is missing between "have" and "shown"

(213, 24) "to" missing before "study"

(213, 27) no comma is necessary before "based"

(213, 29) full stop after the reference, then start the new sentence with "This is then used to"

(214, 25) "On its way down" doesn't sound very technical

(215, 7) no comma is necessary after "images"

(215, 21) "an ice thickness of up to more than" – this sentence needs re-writing, it is currently not clear whether 600 m is the minimum or maximum ice thickness?

(216, 9) "used" in place of "adopted"

(216, 21-24) I think I know what you're getting at, but this sentence is very awkward.

(217, 27) should be "have been" rather than "are"

(218, 1) replace "have been" with "were"

(220, 22) remove "on the grid"

(221, 8) Two separate equations here should probably have separate numbers.

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(221, 9) should this read “represents heating by a vertical diffusive heat flux”?

(222, 2) I would remove the comma before “respectively”.

(222, 2-4) “Tavg denotes the temporal mean subsurface temperature and is dynamically computed by taking the mean subsurface temperature of the preceding year.” This sentence needs a bit more explaining.

(222, 9) “rain fall” – all one word.

(222, 17) Full stop after “layer”, start next sentence from theta mi.

(223, 11) “runoff”, in this case, is two words.

(223, 20) “is” should be “are”

(224, 11) add a comma after “considered”?

(224, 13) replace “by” with “due to”

(224, 24) possibly remove “Without calibration,” and start the sentence with “The”

(225, 5) probably an “F” missing after “(2)”

(227, 3-4) Where possible the same units should be used for comparable quantities, here the ppt gradient is mm per km, whereas maximum ppt is m w.e. per year. Use either m or mm but best to be consistent.

(227, 20) should be “on the order” I think

(227, 23) replace “employed and serve as” with “used as a”

(228, 3 and 17) Temperatures are given in both C and K in this section, better to stick with one or the other, throughout the paper if possible?

(228, 26) remove “already”

(229, 8) no need for a comma after “runoff”

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(234, 9) should be kg m-3

(235, 20) Possibly replace “relevance” with “benefit”

(235, 24) “sensitivity to” here could be “change of”

(237, 3) “invariant” might be better as “uniform”?

(240, 18) should “best” be replaced with “optimal”

(241, 14-15) “disregardence” is a horrible ‘word’!

(243, 1) missing “the” before “absence”

(243, 8-10) This sentence reads very awkwardly

(243, 19) “like” should be “as”

(251, Fig. 1 caption) Last sentence should read: “In the inset contour map of Svalbard, the locations of Nordenskioldbreen (NB) and Svalbard Airport (SA) are indicated.”

Interactive comment on The Cryosphere Discuss., 6, 211, 2012.