

Authors answers to tc-2022-266 comments

January 29th, 2024

Dear Editor,

We are pleased to submit our revised manuscript “Using Icepack to reproduce Ice Mass Balance buoy observations in land-fast ice: improvements from the mushy layer thermodynamics” to *The Cryosphere*.

We would like to thank the reviewers for their useful comments and suggestions. We revised the manuscript accordingly, which increased the clarity of the article substantially. We also revised equations and variables according to *The Cryosphere*'s conventions.

Thank you for your consideration for publication.

Sincerely,

On behalf of all the authors,
Mathieu Plante

Note:

- The referee comments are shown in black,
- The authors answers are shown in blue,
- Quoted texts from the revised manuscript are shown in italic and in dark blue.

Answers to tc-2022-266 RC1

January 29th, 2024

Note:

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The revised manuscript showed some improvement in its clarity. However, there are still aspects that need to be improved before I can recommend this manuscript for publication.

We thank the reviewer for their 2nd review of the manuscript, and address their comments below:

1) In my previous review, I suggested authors use the terminology "SIMBA" to replace SAMS IMB. The authors responded: "We change any reference to the SAMS IMB for "SIMBA" in the revised manuscript. Note that we sometimes keep the term IMB to refer more generally to ice mass balance buoys (for instance describing our algorithm, which we also use for SIMB3 buoy data)."

However, this is not good enough and didn't bring better clarity but rather confusion. Please rename "IMB" in all figures and figures' captions to SIMBA for better consistency.

We changed the IMB1 and IMB2 references to SIMBA1 and SIMBA2 in all figure legends and captions in the revised manuscript. We hope that this satisfies the reviewer and improves clarity.

2) Please still check all the figures.

a) I don't see black and blue lines in Fig1a

Indeed, these lines were missing, and we thank the reviewer for catching this. This is corrected in the revised manuscript.

b) Please update all figures' x-axis tick. The current ticks are too sparse.

We updated the x-axis from bi-monthly to a weekly frequency in all figures in the revised manuscript.

c) The SIMBA temperature regime figures applied vertical position with a negative distance value, which is confusing. Please change it to depth preferably using the initial snow-ice interface as the zero-reference level.

We changed the zero-reference level as requested by the reviewer in the revised manuscript. We did not change the label to “depth” given that in the SIMBA profiles, the y-axis in the temperature profile figures does not show depth, but the sensor position along the thermistor string. This does not exactly correspond to depth or even vertical position, since the thermistor string is not completely vertical with a section laid flat on the snow-ice interface. We also clarified this in the revised manuscript and changed the labels to “sensor position” in Fig. 3 and 4.

d) Since SIMBA figures are illustrated with ice growth downward. Please revise the modelled ice thickness results to the same style as SIMBA, i.e, the ice growth downward.

Ice growth actually occurs both in the upward (snow-ice formation) and downward (congelation) directions. We also note that ice growth is always a positive thickness change, regardless of the direction. This is now clarified at L321-322 in the revised manuscript:

“The changes in ice thickness can thus be associated with an upward displacement of the snow--ice interface (defining the snow-ice contribution to the mass balance), or a downward displacement of the ice bottom interface (defining the congelation contribution to the mass balance).”

All figures already use the same convention: snow-ice is shown as an upward migration of the snow/ice interface, while congelation is shown as a downward migration of the ice/ocean interface. In the Icepack simulations, there is simply more upward growth due to the earlier and larger snow-ice formation.

e) When plotting the SIMBA temperature regimes, please make sure to slightly enlarge a bit the y-axis range at the lower end so one can see the axis ticks.

We updated the x-axis with new ticks that are well visible in all figures in the revised manuscript.

Answers to tc-2022-266 RC2

January 29th, 2024

Note:

- The referee comments are shown in black,
- The authors answers are shown in blue,
- Quoted texts from the revised manuscript are shown in italic and in dark blue.

Comments on the 2nd version of paper by Plant et al. “Using Icepack to reproduce Ice Mass Balance buoy observations in landfast ice: improvements from the mushy layer thermodynamics”

I have commented on the previous version of this paper and made several remarks which were adequately addressed by the authors. I see that this new version has major differences from the previous one. In fact, whereas in the previous version the authors detected and described some problems with the thermodynamic schemes in reproducing ice mass balance buoy observations, in this version they tried to improve the mushy thermodynamics and they seem to have succeeded to some degree. I believe that this work should be published and may be a relevant contribution to sea ice modeling.

I attach the paper pdf with some remarks/comments/suggestions which are just minor things. One of the main critics I have is the very short description of model experiments that made it a bit more difficult to sort out some of their details. So, please, do not rely only on Tables 1 and 2 but add more detail to describe the experiments in the text.

We thank the reviewer for their 2nd review of the manuscript. We clarified sentences that were highlighted in the pdf, and address specifics comments below.

Comments:

L148 : I suggest replacing this with: "same forcing": [This is corrected in the revised manuscript.](#)

L284-286 : May you confirm if this is the way it is implemented already or part of the changes you made? I am asking because when I look at CICCE documentation I have I don't find snow ice implemented this way but I may have outdated documentation.:

We confirm, it is the way it is implemented in CICE / Icepack and not part of the changes we made: this description corresponds to what is done at L. ~3430-3480 in the Icepack code:

(https://github.com/CICE-Consortium/Icepack/blob/main/columnphysics/icepack_therm_mushy.F90)

We nonetheless clarified these lines in the revised manuscript (L284-286) as follows:

Instead, snow flooding is parameterized by adding sea water to a fraction of the snow layer, thus assuming that sea-water is either advected laterally or percolates through the ice layer.

Note that indeed, there were sign errors in Eq. 23 (and 26). These are corrected in the revised manuscript.

L391: I miss here an explanation of the simulations. Pointing to Tables 1 and 2 is not enough. I suggest you explain the rationale of the experimental simulations specifying the parameters that were changed.

We added a paragraph in section 4.3. to explain the experiments and the elements that are tested for each series of simulations.

L470: (due to a lack of variation) Explain what you mean:

This is clarified as follows in the revised manuscript:

“remaining mostly constant except for the occasional increases associated with precipitation events.”

L516: I think this is the first time this parameters is mentioned in the text, whereas it is shown in Tables 1 and 2 and in some figures. I suggests you explain better its meaning above when mentioning the model experiments. This comment aligns with what I suggested above about describing the experiments with more detail.

We now better introduce this parameter in the model section 3.3.4 at L296-297 and mentioned this experiment in the method section 4.3 in the revised manuscript.

L518: Maybe you could show the results of all simulations using the color maps? Or at least of those that you emphasize here. You may also add them to supplementary info.

Adding the colormaps for all experiments would be very extensive, and we do not believe it necessary or worthy of supplement data with its own DOI. However, we added them to the Zenodo repository associated with this manuscript.