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Discussions

Interactive comment on "Importance of basal processes in simulations of a surging Svalbard outlet glacier" *by* R. Gladstone et al.

Anonymous Referee #1

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Gladstone et al describe numerical ice flow experiments of Austfonna Ice Cap in Svalbard focusing on the flow of Basin 3, one of the fastest outlet glacier of Svalbard and suspected to have surge-type behavior. Their objective is to link observed changes in ice speed and possible surge-type behavior to basal conditions and processes. The paper is interesting and easy to read and provides some information about the state of the bed. Nevertheless I think the paper would benefit from more analysis and detailed simulations. The results are somewhat ambiguous and don't provide clear-cut evidence for what is happening at the bed of Austfonna. Some discussions regarding till behavior read like if till was included in the model when it isn't. Suggestions are given below in comments.

Abstract 9-10 I could not find results about the 3 steady state temperatures for the three

time periods. These results would be interesting to include. Is there an increase in the area of warm bed with time? Does that match the area of fast sliding/surface speed?

Abstract 15. Why use the word 'error'? Why not use 'difference' since your are not checking against data here.

Abstract 17- Some specific conclusions about feedback mechanisms would be welcome here.

p5827 You indicate that Svalbard glaciers surge phase is longer and velocities (relative to quiescent phase) not as high as in other surge-type glaciers. Can your simulations and feedback mechanisms explain why Svalbard glaciers behave as such? Can you state later in the discussion some hypotheses or directions for further work?

p5828 18. How can your simulations guide future till model development? I could not see a discussion of this later in the manuscript.

p5830 21. Can you indicate what year that surface elevation was taken from?

p5832 9. You use C earlier for basal drag coefficient and β now.

p5832 9. It would be interesting to see how the distribution of β matches areas of the bed that are at the melting temperature for both 1995 and 2011 (and may be 2008 to better see the evolution, see comment on abstract).

p5832 21. A figure of just τ_b and ice thickness would be very useful. No numbers are given so it's hard to get an idea of the absolute values of the basal shear stress. Would be extremely interesting.

Figure 4. Does the pattern of β changes if the mesh resolution is increased? Looks like variations of β are occurring over single elements.

p5832 10. "Basal sliding ...". That sentence seems out of place since that can't be deduced from the figure which shows only the basal sliding coefficient.

p5834 8-9. Don't start a new paragraph for this lone sentence.

p5834 10-13. 100 years seems short for temperatures to reach steady state. Some back-of-the-envelope calculations on the diffusion and advection time scale would be useful as indicators.

p5834 16. Is this a temperature only simulation? If this is then I don't see the usefulness of it.

p5838 12-13. 1995 and 2011 model calculations indicate a reduction in the value of τ_b under B3 (would be nice to see figures of it). If till is present this means higher water pressure in 2011 caused by more water at the bed as mentioned. I don't follow the argument that this water comes from basal friction. This would imply that the ice is sliding faster but then what caused that? This looks like a circular argument to me. Seems to me that the water must be coming from the increased melting at the surface (warmer temperatures in the 2000s).

p5838 14. If till has been deforming for some time then the argument of overconsolidation does not hold: the till is in critical state and no longer dilates. I don't understand why the till would be overconsolidated in 1995 more so than at other time periods.

p5838 16-19. This sentence should be rephrased to say first that the highly variable basal stress is due to the noisy surface velocity field which may be due to sticky spots. Could the noisy stress field be due to the coarseness of the mesh (see comment above)?

p5838 26- I don't understand the reasoning here. Both simulations SS and SSNG have the same ice thickness so how can one say something about the link between bed temperatures and the gradual thickening of ice? Results of SSNG are obvious: lower basal heat flux implies lower bed temperatures. I think these two runs (without advection) don't provide much information. It would be more interesting to run full thermo-mechanical simulations with the geothermal heat flux halved.

p5839 3-. There is something strange about Figure 7 bottom left: in that simulation, fast ice is observed where the bed is cold, something that is highly unlikely. What causes this effect? Can you reconcile the inversion model (low values of β under fast moving ice) with the 'cold spot'? I don't understand how advection of warm ice by sliding would make the bed cold where it's moving fastest (given that there is no change in ice thickness in all models presented on Fig. 7).

p5839 15. Change 'errors' to 'differences'.

Fig. 7. Is there significant differences in ice thickness (and thus pressure) that it would be better to plot the temperature relative to the melting temperature (corrected for pressure) to see exactly the extent of the warm bed?

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