

Review: “Analytical solutions for the advective-diffusive ice column in the presence of strain heating”

by Daniel Moreno-Parada et al.

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1 General

In this paper, the authors analyze the temperature structure of glaciers as a function of advection, shear heating, and surface forcing. They develop analytical solutions using classical applied mathematics yielding interesting, unwieldy, and dumbfounding expressions. It is not clear that their analysis presents new applied mathematics, except for a new solution to an ODE, and does not clearly answer a glaciological problem. The work is of publishable quality and I won't stand in the way, but I am not sure what goal this paper is achieving.

2 Specific comments

1. line 1 in the abstract: ‘of paramount importance’ is ‘paramount’
2. line 5 in the abstract: ‘sophisticated’ can be replaced by ‘Robin-type’
3. line 6 in the abstract: non-equilibrium temperature and non-equilibrium thermodynamics are very different, but I think the authors are referring to the former, here and throughout. I suggest clarifying the language.
4. line 8 in the abstract: the surface insolation number? As I note later, it is typically called the Biot number.
5. line 9 in the abstract: there is a typo in ‘Brinkman’ in many places throughout the text as ‘Brikman’.
6. equation (7): I would put $Pe\xi$ into the equation for w so that the system is closed and all of the parameters are clear.
7. seemingly much of this analysis is presented in Hills et al. (2023).
8. in figure 2, why does changing β have little effect?
9. There are positive and negative vertical velocities presented, what is the physical mechanism of positive vertical velocity?
10. Brainstorming a few ideas: this analytical solution is likely relatively fast to compute, could this be a good initialization for an ice sheet model? I know there is an interest in Heinrich events from the coauthors, could it be a better analytical model to use in a thermodynamically coupled ice sheet model?

References

- B. H. Hills, K. Christianson, R. W. Jacobel, H. Conway, and R. Pettersson. Radar attenuation demonstrates advective cooling in the Siple Coast ice streams. *J. Glaciol.*, 69(275):566–576, 2023. doi: 10.1017/jog.2022.86.