

The Cryosphere Discuss., referee comment RC1  
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## Comment on tc-2022-97

Anonymous Referee #1

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Referee comment on "Analytical solutions for the advective-diffusive ice column in the presence of strain heating" by Daniel Moreno-Parada et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2022-97-RC1>, 2022

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### General comments:

This manuscript highlights the computational efficiency of using the method of separation of variables to solve the diffusion equation rather than direct numerical methods. While this is well-known, the application to the basal temperature evolution in an ice column had previously only been done for infinitely deep ice; this manuscript considers the case of a shallow ice sheet and performs some example calculations for different initial conditions and boundary conditions.

Overall, I was somewhat disappointed that the authors did not go into more depth in analysing and describing their results, in particular exploring the wealth of curious trends shown in figure 4 - most of the paper is instead given over to a routine description of the method of separation of variables. In particular, given the stated threshold of 2km for the solution to approach the infinite depth limit, it would be nice to explore what factors set this threshold. Looking at figure 5 there seems to be a rather narrow band of depth values for which T is finite but larger than the MacAyeal solution. I think figure 4b also shows this rather sudden regime change.

### Specific comments:

If Equation (6) were given as  $\cot(L\sqrt{\lambda}) = \beta\lambda$ , there would be no need to treat  $\beta=0$  as a special case.

Figure 4 - the values of the parameters held fixed are not given.

Figure 4d - interesting that T is non-monotonic with L at  $-14^{\circ}\text{C}$ . Why is this?

Figure 4c - this figure shows the most interesting trends, but is barely discussed in the text. Perhaps using  $\theta_{\text{I}}/L$  as the primary variable instead would clarify the impact of the temperature gradient on the basal evolution.

Line 162 - where T saturates to above 25kyr, are we in fact in a limit where T is infinite?

Convergence towards no dependence on the detailed surface boundary conditions as  $L \rightarrow \infty$  could be moved to an appendix for better flow of the manuscript.

**Technical corrections:**

Figure 4 colorbar caption could be oriented to match the axis label.