

Review of Zhu et al. Manuscript

This manuscript presents a new model that carry out inversions for the basal geothermal heat flux from surface velocity observations. This is the first piece of work I am aware of to present such a model, and does so very clearly. The manuscript is extremely well written and I would say it is almost ready to be published as it is. Not being an expert in numerics I am probably not the best person to assess the discussion in section 4, but hopefully another reviewer can analyse this section more carefully.

The one major thing I question about this work is the applicability of it to real data. Given uncertainties surrounding other parameters, could such an inversion really give us sensible predictions for the geothermal heat flux? This question does not take away from the interest of the paper as a mathematical exercise, but since it is for a cryospheric journal it would be good if the potential of the model (or lack of) was discussed a bit further in this paper.

To address this point I suggest you add in a section before the conclusions about applicability of the method and future work. You say in the first paragraph of the introduction that you want to study the prospects for, and limitations of, inferring the geothermal heat flux form surface ice velocities, but where really is any discussion of this? Your assessment of the ability to invert depending on length scales of heat flux and the noise level in velocity observations is obviously very relevant but how does this correspond to what we expect from real data?

Minor comments

- **Abstract, lines 17-19** Long sentence. Split into two.
- **Page 6, line 15.** Aren't there some more recent estimates for geothermal heat flux in certain areas of Antarctica? e.g. Fisher et al, 2015, Science.
- **Equations 19-23** Could we have a table of variables etc to reference? Had to spend some time going back to remind myself of what e.g. \mathcal{B}^* is.
- **Equations 19-23** explain why some terms in blue.
- **page 15, line 5** Figure 3 referenced before Figure 2 (page 16, line 10). Swap order of figures.
- **Figure 4** Legend label overlapping with surrounding box.