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The Cryosphere
Discussions

Interactive comment on "Sensitivity of basal conditions in an inverse model: Vestfonna Ice-Cap, Nordaustlandet/Svalbard" *by* M. Schäfer et al.

Anonymous Referee #1

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The authors present a study of the Vestfonna Ice Cap, Svalbard, using the Elmer finite element code, and describe the application of an inverse method to obtain a spatially-varying basal friction parameter. The ice cap chosen for study is attractive because it is self-contained, is computationally tractable, and has sufficient data available. Nevertheless, it still exhibits some of the aspects (such as embedded fast flow features) one would need to deal with in applying the technique to a larger ice mass.

Overall, I am of the view that the work is sufficiently interesting and important to be published in The Cryosphere, where it will be of particular interest to glacial modellers, but also more broadly within the field. In my opinion, the manuscript does not need

substantial work before publication: the authors have done a commendable job in explaining and justifying their approach, and analysing their results clearly. I think they are correct to focus here on the technique itself, and its sensitivity of the outcome to uncertainties in the various input datasets.

I have just one suggestion for a slight elaboration which I hope will clarify the manuscript: in section 3.2.1 ("The inverse method"), I suggest introducing the iteration procedure in a little more detail. In particular, a more physical explanation of why there are two surface boundary conditions applied separately (Dirichlet/Neumann), and how they lead on to the definition of the cost function, would help the less-mathematically-inclined reader get an intuitive understanding of how the iterative procedure works. Assuming I have understood the method correctly, this could be something along the lines of "The Neumann condition at the surface represents the case where the surface velocity is freely determined from the ice geometry, basal friction parameter, etc, whereas the Dirichlet condition constrains the model according to the measured ice velocities. In the latter case, the upper surface stress field is allowed to vary in response. We require a cost function which is minimised when the Dirichlet condition on velocity and Neumann upper-surface free-stress condition are both satisfied, hence...", etc.

The authors should consider the use of the calligraphic letters $\mathcal{S}$ and $\mathcal{B}$ in the text. In the *Discussions* version of this manuscript, the letter $\mathcal{S}$ especially is almost indistinguishable from the standard letter. This may not be a problem in the final version typeset for TC, but needs examination at this stage.

I spotted a few typos and have a few other suggestions:

p.432, line 5: "...fast outlets are concentrated in a small area..." (not 'on')

p.436, line 20: comma not required

p.437, line 6: if using calligraphic letters (see above), it would be better not to begin the sentence with a symbol: "The calligraphic letters $\mathcal{S}$ and $\mathcal{B}$ denote..."

p.438, line 13: “Weertman”

p.438, line 19: presumably “the basal velocity and stress components parallel to the bed”?

p.439, line 2: replace comma with semicolon

p.441, line 13: probably better to put the expression for the update as a numbered equation, so it can be referred to more easily on the following page (line 9)

p.441, line 22: "...sufficiently complete that small..."

p.442, line 23: "...by interpolation, and the Dirichlet..."

p.442, line 6: Generally, it is good style not to start a sentence with a symbol. Here, for example “The value of $\beta_{\mathsf{max}}\ldots$”

p.448, line 1: “Finnish Academy”

p.461, caption to figure 7: “inset” rather than “inlet” in line 4.

p.464, figure 10: the boundary separating the final bin from the rest of the histogram looks hand-drawn, and thus somewhat incongruous. The figure would benefit from being redrawn to avoid this.

Figs. 11 and 13: Probably best to put the units in the captions for these figures, as their position on the figures themselves is inconsistent.

Interactive comment on The Cryosphere Discuss., 6, 427, 2012.