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Geoscientific Model Development Discussions

Interactive comment on "Towards a better ice sheet model initialisation and basal knowledge using data assimilation" *by* Cyrille Mosbeux et al.

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This paper addresses a well-known issue in ice sheet modelling: the fact that even if a model can be tuned to give a very good match to observed velocity, errors in the ice thickness result in implausible thickening rates. There is widespread agreement among ice sheet modellers, especially those concerned with near term simulations, that accurate maps of ice thickness (and so bedrock) are needed. Ideally, of course, these things would be measured to the required resolution and precision, but given the distance between airborne radar tracks, the difficulty in making such measurements to coincide with measurements of ice velocity, and the inevitable approximations in ice flow models, methods of the sort described here, where ice thickness is estimated at the same time as basal traction (and also englacial viscosity), are also required.

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Discussion paper

The authors try out two approaches in the context of a synthetic inverse problem, where they attempt to recover known fields . In one (ATP) they attempt to optimize the basal traction and thickness simultaneously, using a gradient based method. In the other (ANP) they construct an iterative procedure, alternating between optimization of the the basal traction and evolution of the bedrock through the mass conservation equation with an extra a source term. Both methods appear to work well in regions of fast flow. Overall, I suggest publication with some minor alterations.

1 Specific Comments

L22/23 and elsewhere: Inverse methods? Although this phrase seems to be gaining in popularity, it does not tell us much. I'd prefer more specific terms, e.g gradient-based optimization methods (used to solve an inverse problem)

L50: 'no guarantee...' true, but since models like ISSM can be tuned to give a close match to the observations of velocity, the discrepancy may not be all that great.

L86: 'To our knowledge...[claim of novelty]' A number of journals specifically forbid this phrase, and I agree with them. Maybe it is OK in GMD. By the way, I am aware of at least one other paper (accepted at J. Glac.) that takes the ANP approach - obviously it is not citable at this time.

L99: 'effective mean viscosity' $\rightarrow$ 'vertically averaged effective viscosity'

L129: 'find the parameter space' $\rightarrow$ 'find the parameter vector' (which sits inside the parameter space)

L137-144: I think a bit more clarification - with formulae - is needed here. A good part of Martin and Monnier (2013) relates to the inclusion of terms arising from the dependence of ν on ∇u.

section 3.2 - perhaps these short sections could be merged (e.g section 3.2.3 is a single sentence)

L258/eq 12 : $|u|, |\theta|$ rather than u, θ?

L274: 25%, and similar elsewhere - in what norm?

L275 'more than 10 times less' $\rightarrow$ 'less than 10 times'

L395: 'no need to inverse a shape variable...' I think a bit of rewording is needed here, along the lines of L78 (ref to Perego 2014)

All figures : plots show the drag coefficient (β), rather than the traction itself ($|\tau_b| = \beta|u|$). Either is fine, but I suggest that $|\tau_b|$ is the real result. If you switched to a nonlinear basal friction law, you would get the same (or similar) $|\tau_b|$ but a different β. β is useful in maps because it shows the difference between slippy and sticky regions, but that doesn't apply so strongly here.

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