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# ***Interactive comment on “Committed near-future retreat of Smith, Pope, and Kohler Glaciers inferred by transient model calibration” by D. N. Goldberg et al.***

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Received and published: 25 September 2015

Goldberg and co-authors introduce a method, 'transient model calibration' to initialize an ice flow model of the Smith, Pope, and Kohler Glaciers with several years worth of velocity and surface observations, and compare their method with the more common 'snapshot calibration' based on single instances of surface and velocity observations, often from different periods but assumed to be close enough to be considered contemporaneous. There are two innovations: the transient calibration techniques themselves, and the construction of an inverse boundary-stress problem, where the ice shelves are replaced by vertically integrated horizontal stresses at the grounding

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line, which are then sought at the same time as the basal traction field to match observations. The transient calibration produces quite distinct parameters, and results in less medium term thinning, but more grounding line retreat (more intense localized thinning), which would seem to be consistent with the ice shelf pulling harder (being buttressed less) on a stronger bed.

I rate this paper highly and recommend publication. The methods represent substantial innovation, they appear to work well, and I think we can be confident that ice sheet modellers across the world will be keen to make use of them. The paper is well enough written for modellers who are not inverse problem specialists to understand. In particular the authors decision to make a medium term prediction based on their calibration – and show how different the results are if the usual method is followed, makes it clear that this is not just extra complexity for its own sake. I look forward to surviving to 2040 to find out if the authors are correct.

I have some minor comments

## General Comments

I thought that section 5.2, “Adjustment of control parameters”, was a bit brief, and there are some points that I would like to see expanded on

1. “It is possible that our snapshot calibration is equifinal” : that seems likely – if you have the same number of beta values as velocity values, and a normal stress too, then even in 1D there is a null-space. I think it is a vector made up from a perturbation to beta-squared one cell upstream from the face and a perturbation to the normal stress. But even if that were eliminated, there are a number of vectors associated with small singular values – such as oscillations in beta-squared some way upstream – which might end up being determined by the initial guess/choice

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- of iterative method/regularization rather than data
2. “The additional information provided by the transient observations is sufficient to generate a better ice-stream state estimate” is a big claim in that case (not saying it is not true), but how does it come about? It seems to me that the transient calibration might work out better just because it matches velocity and surface in time. Put another way, the snapshot might be weaker largely because it mismatches, so that it insists on acceleration extending further upstream from the grounding line than it ought, which would look like a lighter pull (more buttressing) on a weaker bed.
  3. Stronger bed: Not uniformly stronger, though ? There is also an interesting ribbed structure in fig 4c (with a rib of strong bed close to where the GL seems to slow in the prediction).
  4. Negative buttressing: I like the idea that an  $H\sigma$  that is larger than the non-ice shelf value might imply that the DEM  $h$  is too low. Might there be another explanation, too? That some parts of the grounding line are being pulled by faster flowing parts via the ice shelf. In that case you might expect the negative buttressing to line up with shear margins, which looks like it might be the case in fig 4a

### Specific Comments

Abstract: 'inverse methods'. This seems a bit slang to me.

P4465, line 14-: The text doesn't actually say which method (AD, correct?) is used to compute the gradient of  $J_{\text{trans}}$ . Is there space for a one or two sentence summary of the particular AD method?

P4467, line 27 : not so much the thickness, but the vertically integrated effective viscosity including crevassing etc.

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p4470, line 1 ; 'high accuracy': maybe give numbers

p4470, line 11, 'very weak bed' : perhaps give a number

P4474 : line 8 : 'decreasing beta anywhere increases ice loss, lowering the bed only increases ice loss upstream of the projected 2041 grounding line.' is that quite correct? For the most part, there seems to be no sensitivity to beta downstream of the 2014 GL. The region where it seems to matter most and the bed does not look to correspond to a grounded promontory in 2014. Is that bit lightly grounded?

Fig 6 : I'd like to see the same figure for the snapshot calibration. I'm guessing it has more even thinning?

Fig 7: the legend has 'linear friction parameter', which I confused with a linear sliding law until I read the text properly. Maybe 'time dependent friction parameter'

Fig 9 (a): Do the upper schematics (the views of the front/join) add much? The planview could be larger without them.

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Interactive comment on The Cryosphere Discuss., 9, 4459, 2015.

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