The Cryosphere Discuss., 7, C2901–C2906, 2013
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The Cryosphere
Discussions
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Interactive comment on "Transition of flow regime along a marine-terminating outlet glacier in East Antarctica" *by* D. Callens et al.

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Received and published: 31 December 2013

Interactive comment on "Transition of flow regime along a marine-terminating outlet glacier in East Antarctica" by Callens et al.

Dear Editor,

We would like to thank both referees for the thorough job on judging our paper submitted to TCD. Please find below our answers to the query of both referees of our paper. Especially Referee #1 had a number of remarks that made us change some sections of the manuscript in a more profound way. Therefore, the section on numerical modelling has undergone a complete overhaul, in which we used a simple SIA model (following the advice of Referee #1) and applied an inverse modelling technique to infer the

basal conditions. This is a more sound approach than the one previously designed (more complex model, but results simply compared to observations). This also led us to take another co-author on board (Emmanuel Witrant), who is specialized in inverse problems and currently collaborating with us at ULB.

Sincerely,

Denis Callens

Anonymous Referee #1 Received and published: 7 November 2013

Major Points

[REF] Section 5. I understand that you don't know the impurity content when estimating the attenuation, but some discussion of the implications of increased attenuation from impurities on the bed reflection power is needed. I guess it doesn't make much difference to the interpretation, but it needs to be spelled out.

[AUTHOR] We adapted the text. We point out that, following MacGregor et al. (2007) and Matsuoka et al. (2012), the relevance of taking impurities into account decreases with increasing englacial temperature.

[REF] Section 6: 4923 11-13. I don't understand this – it looks like you are trying a clever way of avoiding tuning the sliding coefficient. Is it correct that both velocity components set to zero? Vertical I understand, but horizontal I don't, given that you are trying to estimate deformation and sliding components. I think that you could get away with your approach if the sliding velocity were uniform, which would be indicated by a spatially uniform mismatch for each temperature case. You don't have this, so in consequence you aren't computing the contribution the changes in sliding velocity make to the longitudinal stress gradients. In summary, I think that this is wrong. Actually I would adopt a balance velocity approach, perhaps using the approach I suggest in the next paragraph.

[AUTHOR] We completely rewrote the modelling section. We adopted a new approach

by inverse modelling leading to an unambiguous characterisation of basal friction. We minimised the mismatch between satellite surface velocities (observation) and the modelled surface velocities through an optimization of the basal friction parameter. The forward model employs the Shallow-Ice Approximation. The use of simple model was the idea of the referee. However, we did refrain from the use of balance velocities to guide the process; there is no reason to believe that everywhere along the longitudinal section of the profile the glacier would be in steady state. Furthermore, balance velocities are the combined basal and deformational velocity needed to balance the accumulation rate; so, by using the balance velocity we would miss our point, i.e., retrieving basal velocity/friction. We are of the opinion that the inverse model makes much more sense than the previous experiments. This expertise was not available to the authors at the moment the first draft of the manuscript was written. See the uploaded figure for the results (caption below). "Fig. 5. (A) Observed surface speed (dashed black line) and optimized surface speed profiles along the central flowline of Western Ragnhild Glacier; (B) Basal speed profiles according to the optimization and observed surface speed (as panel a); (C) Basal friction along the flowline."

[REF] Section 6. 4923 17-23 This is a bit odd. I don't see that there is a problem in assuming a surface temperature, starting off with say a linear vertical velocity profile, calculating the temperature, using this to calculate a modified vertical velocity profile and iterating in order to get the deformational velocity profile. At the moment your uniform temperature assumption of -2C etc. are somewhat plucked out of thin air, and I don't really see why the results are of general interest.

[AUTHOR] As stated above, we changed our approach completely. However, we still perform several experiments for different values of the flow parameter in Glen's flow law, hence englacial temperatures. The experiments now clearly show what the effect of temperature is. However, they also demonstrate that for any value of A(T), the downstream section of Ragnhild Glacier is dominated by basal sliding. We think that with the redefined model approach, the results are much more straightforward than the

previous ones.

Minor Points

[REF] âËŸA ′c 4914: 10 "Spectrum analysis" -> "Spectral analysis" (and presumably many other places) [AUTHOR] Done : pg 4914 L10 [AUTHOR] Done : pg 4916 L15

[REF] âËŸA ′c 4914: 19 "region which" -> "region, which" ('which' only appears after comma) [AUTHOR] Done

[REF] âËŸA ′c 4915: 7 Statement about E Antarctica needs to be a bit more nuanced, see e.g. Rapid, climate-driven changes in outlet glaciers on the Pacific coast of East Antarctica B. W. J. Miles, C. R. Stokes, A. Vieli & N. J. Cox Nature 500, 563-566 doi:10.1038/nature12382 [AUTHOR] We took this comment in account when we rewrote the first part of the introduction

[REF] âËŸA ′c 4915: 15 "are not yet" -> "have yet to be"? [AUTHOR] Done

[REF] âËŸA ′c 4915: 20 "reach up to the continental shelf" -> "reach out to the continental shelf edge"? [AUTHOR] Done

[REF] âËŸA ′c 4915: 26 "one" is redundant. [AUTHOR] Done

[REF] âËŸA ′c 4915: 26 "away" -> "upstream"? [AUTHOR] replaced by from

[REF] âËŸA ′c 4916: 4 "characterized" -> "dominated"? [AUTHOR] done [REF] âËŸA ′c 4917: 11 "low" -> "deep" [AUTHOR] done

[REF] âËŸA ′c 4917: 21 "topography" -> "topography between..." – sentence doesn't quite scan at the moment. [AUTHOR] We rephrased the sentence, so that it doesn't sound awkward.

[REF] âËŸA ′c 4919: 3; "perform" -> "to be able to peform" [AUTHOR] done

[REF] âËŸA ′c 4919: 19: Are the characteristics of the upstream area roughness such that you can rule out glacigenic sedimentary landforms such as drumlins? [AUTHOR]

No, the magnitude of topographic variation is too high to be glaciogenic in origin; we are therefore confident that the changes are orogenic.

[REF] âËŸA ′c 4922: 22: “compared to the” -> “compared with our” [AUTHOR] This section has been rewritten

[REF] âËŸA ′c 4923: 24: “derived” -> “derived the” [AUTHOR] This section has been rewritten

[REF] âËŸA ′c 4923: 25 “use” -> “used” [AUTHOR] This section has been rewritten

[REF] âËŸA ′c 4923: 27 “because of the presence of sediment” – this seems to imply that the sediment is releasing heat – doesn’t seem right to me. [AUTHOR] This section has been rewritten

[REF] âËŸA ′c 4925: 1: The reference to Hindmarsh 1993 is a bit bizarre in this case, I’m not convinced it’s relevant. I would start with looking at Barcilon and MacAyeal (J. Glac., early 90s) [AUTHOR] This section has been rewritten

[REF] âËŸA ′c 4926: 3: How far upstream of the grounding line would buttressing slow the icestream? There is a paper by Van der Veen and others (J. Glac, 2011?) on Jokabhavn Isbrae which addresses this issue, and comes to answer of kilometres. Maybe you could try the same approach – I suspect the answer will be quite small. [AUTHOR] This remark is no longer relevant since we changed our modelling strategy. âĂČ

Interactive comment on The Cryosphere Discuss., 7, 4913, 2013.

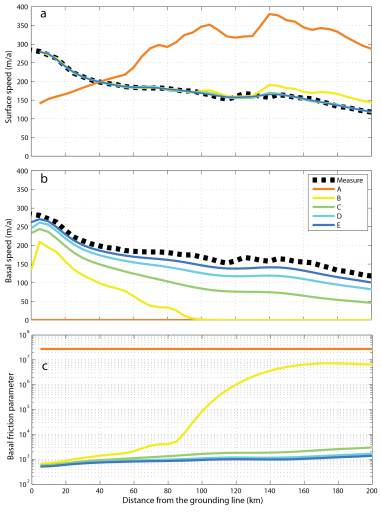

Fig. 1. Fig. 5.