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Interactive comment on “On the limit to resolution and information on basal properties obtainable from surface data on ice streams” by G. H. Gudmundsson and M. Raymond

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Review of On the limit to resolution and information on basal properties obtainable from surface data on ice streams by Gudmundsson and Raymond

This paper follows logically from a sequence of papers that examine the transfer from basal perturbation to the surface of an ice stream. It uses previously derived transfer functions to invert measurements at the surface for perturbations in basal topography and slipperiness. This is a great contribution that can be published essentially as it stands now. The comments below might lead to a few minor revisions:

Some general comments

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- A short introduction to Bayes' Theorem might be appropriate. You do give the reference, but most glaciologists will not be familiar with this, and a short summary of the essential ideas could be useful.
- A table with the symbols used would help readability of the paper. For example, I started keeping notes on the side as to which symbol signified prior vs posterior estimates, etc.
- The usual data situation is that basal topography is also measured. It would be beneficial to have a short discussion why it is not treated as part of the data with its associated error. Part of the answer is provided on p. 432/433. But that only explains that bedrock topography should not be taken as fixed, because it can lead to large errors in slipperiness retrieval. However, it is not clear whether specifying bedrock as data with an error estimate would lead to the same mistake.
- On p.416 it might be worth pointing out that the misfit to surface measurements can generally be made to vanish, but that this is not desirable.
- On p.417 you claim that you solve for steady state conditions with no accumulation/ablation. But then you solve for a vertical velocity component as measured. Wouldn't the correct statement be that you assume that ablation/accumulation exactly balances the slope corrected vertical velocity? This comment also applies to the discussion p. 433/434.
- Basal slipperiness is defined as the ratio between basal stress and basal velocity on p. 417, but it is also defined as the ratio of basal velocity to deformational velocity on p.425. This might be the same in a normalized world, in which case you should state that.
- λ_b (p. 421) should be related to the transitional wavelength between skin drag vs form drag. That is, what you call bedrock topography is not the actual bedrock

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- topography, but a smoothed version to which the sliding law applies. This would be an appropriate place to discuss that.
- p.421: I believe that introducing a spatial correlation for c has the same effect a minimizing a measure of roughness as done in Truffer2004.
 - State what $P(s, u, w)$ is in Eqn. 16 and give a reference for Eqn. (17)
 - p. 432: The insensitivity to vertical velocities is good news when using velocities derived from speckle tracking or image correlation techniques; they are not capable of resolving vertical velocity.
 - p.433: If we trust the assumption that the shallow shelf equations are good approximations to full Stokes for ice streams, then the essential difference between Joughin et al and the present paper is the non-linearity and not the full Stokes issue.
 - End of section 4: It would be appropriate to elaborate on this contradiction between Schoof and the present result.

Grammatical and spelling issues

In the following, numbering is page.line, and corrections are in bold face.

414.6 The **method** requires

414.7 surface data **affect** estimates

415.12 which **maximise** the conditional

416.13 of a **constraint** on the

416.23 a linear **medium** where

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- 417.19 Fourier space **where** all variables
- 418.6 the **error** in the
- 418.17 the transfer **functions** presented by
- 418.19 the subscript for x should be k
- 419.13 the covariance **matrix**
- 420.19 **Due to the** lack of
- 420.21 for them **to** be well resolved
- 421.23 Using **Bayes'** theorem
- 424.14 be as **little mixing** as possible between
- 427.15 **Similarly**, for each
- 430.6 between measurement **sites** at the
- 434.12 media and **a** linear sliding
- 434.14 but including **a** non-linear sliding law **exist**
- 435.15 and **a** definite answer
- 436.9 as general **a** description
- 436.12 based on **an** analytical approach
- 437.7 with **the** exact number
- 437.13 to unity down **to a** spacing between

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441 Capitalize 'Prior' in last sentence of figure caption

444.4 the second *s* should be a *w*.

444.7 leave out 'almost'

Interactive comment on The Cryosphere Discuss., 2, 413, 2008.

TCD

2, S147–S151, 2008

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