The Cryosphere Discuss., 2, S336–S339, 2008
www.the-cryosphere-discuss.net/2/S336/2008/

The Cryosphere Discussions

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

G. H. Gudmundsson and M. Raymond

Received and published: 9 October 2008

I would like to thank both of the reviewers for very helpful reviews. I've benefited greatly from both reviews.

Below is a point by point answers to issues raised by referees.

Referree M. Truffer:

- As suggested, more introductory material on Bayes inversion has been added.

- I was a bit surprised by the request for list of symbols. The symbols used follow a fairly standard convention. Velocity components are (u,v,w), surface is s, bedrock b, slipperiness c. Tilde is used for all a priories, hat for updated estimates. All covariance

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

matrices are written in upper case C with double index relating to corresponding quantities. All this is stated clearly in the text. No list-of-symbols has been added, but I'm happy to do so if requested by editor.

- Measured basal topography is included as part of the data and with corresponding errors. This is the prior estimate of the basal topography. The methodology in the manuscript focuses on how to update prior information on basal properties (basal topography, basal slipperiness) using surface data. I've added a paragraph in the introduction explaining this and I've changed a few sentences in some other places to stress that estimates/measurements of basal topography form the prior for the basal topography.

- The geometry of the domain for which the flow is solved is explained in more detail. This should address points raised by both reviewers about steady-state assumptions and surface mass-balance.

- A paragraph explaining basal slipperiness and its relation to slip ratio when non-dimensional units had been added.

- $\lambda_{\tilde{b}}$ is not related to the transitional wavelength between skin drag and form drag. The linearised forward model does not account for any form drag.

- Spatial correlation for the a priori slipperiness does affect the 'roughness' of the retrieved basal slipperiness as suggested by reviewer. However, it is not identical to an actual minimisation of roughness.

- The contradiction is between Schoof, and Raymond and Gudmundsson (2005), i.e. not between this paper and Schoof. This point has already been stated in Raymond and Gudmundsson (2005) although possibly in a bit too polite manner to be noticed.

Referee A Vieli.

- There is not need to know the slipperiness perturbation to within 10%. Any error estimate will do. The 10% value was chosen for convenience and we felt that in the

TCD

2, S336–S339, 2008

examples given it would be good to keep the relative errors of the priors for bed topography and basal slipperiness equal. This was done to make the effects of data errors on basal topo and basal slip more comparable.

- Yes this is all limited to small perturbations. The case for large perturbation and non-linear media and non-linear sliding law is considered in a manuscript soon the be submitted to TCD. It turns out that the non-linear problem can be takled fairly easily using standard iterative methods solving a sequence of linearized problems. So everything done in this manuscript is of importance for the fully non-linear problem as well.

- (Sensitivity of basal slipperiness retrieval as a function of mean slip ratio). This is a good question. We don't know the exact answer to it though, basically because it falls outside of the scope of the paper. We deliberately limited the discussion to ice streams. This is were most of the interest in surface-to-bed inversion has been focused on.

- There is no need to assume uncorrelated measurement errors for the method to work. The method described, and all the equations shown, can be used for full covariance matrices.

- Slip ratio/basal slipperiness now explained in text.

- Zero surface mass balance now explained in more detail in text.

- One additional paragraph on Bayesian inverse methods has been added.

- No not really. The number of resolved quantities by the prior must decrease with increasing errors in the prior simply because the larger the prior errors (very large prior errors) are, less and less weight is given to the prior in the final updated estimate.

- I thank the referee for spotting that one of the symbols in eq. 4 was not in bold face. This has now been corrected.

Greetings

TCD

2, S336–S339, 2008

Hilmar Gudmundsson

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

TCD

2, S336–S339, 2008

Interactive Comment