

Interactive comment on “Inferring paleo-accumulation records from ice-core data by an adjoint method: application to James Ross Island’s ice core” by C. Martín et al.

Anonymous Referee #3

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The paper proposes an adjoint-based method to infer accumulation records using ice-core age data. The subject is definitely interesting as it addresses the important issue of recovering paleo-accumulation records with a novel approach that seems fairly promising if used with full depth vertical velocity measurements from sensitive radar. The authors present the method in a rather clear way, and perform different sensitivity studies to assess the effectiveness of the proposed approach. In particular, they investigate how the method performs in presence of noise on the age data, gap in the age data and uncertainty in the vertical flow model. However, the authors have made strong assumptions without discussing their effect on the recovered accumulation rates (see major comments below). The numerical method used to solve the problem is fairly

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standard and probably adequate to solve this relatively simple problem.

Major concerns are:

1. The authors neglect horizontal advection in their model, however they do not discuss this (strong) assumption. In fact, this would lead to significant errors, in particular when the ice geometry (surface and bedrock topography) present spatial gradients. The effect of this assumption might be modelled with an error term added to the right-hand side of eq. (1); it would be interesting to see a sensitivity analysis on this. Also, the authors should discuss the assumption that the thickness does not change in time (over thousands of years). In my understanding, the errors introduced by these assumptions will not be mitigated by the use of full-depth vertical velocity measurements obtained with phase sensitive radar.
2. The adjoint-based minimization proposed in eq. (3) has accumulation, melting and the initial age distribution A_0 as control variables. However, in the numerical experiment, they assume A_0 to be given and the melting to be zero. These are strong assumptions and the authors do not discuss their effects.

Minor issues:

Pag. 3825 I would recommend that the authors explain how eq. (1) is derived. In my understanding the equation is derived by differentiating in time the equation $A(t, \mathbf{x}(t)) = t + A_0(\mathbf{x})$ and neglecting the horizontal advection.

Section 3.1 What are the spatial and time steps used in these simulations? What expression for A_0 has been used? Please, explain more precisely how you add 1% of random

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uniform noise. Do you mean that you add to each A_i^{ref} a value independently sampled uniformly in $[-0.01 A_i^{ref}, 0.01 A_i^{ref}]$ to the reference solution A_i^{ref} ?

Section 3.2 What are the spatial and time steps used in these simulations? What expression for A_0 has been used?

Section 4 I would avoid using the term “propagation of uncertainty” as it has a specific meaning in the Uncertainty Quantification literature, whereas here is used for a sensitivity study.

Interactive comment on Clim. Past Discuss., 10, 3821, 2014.