

Interactive comment on “The GRISLI ice sheet model (version 2.0): calibration and validation for multi-millennial changes of the Antarctic ice sheet” by Aurélien Quiquet et al.

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Received and published: 4 June 2018

This paper describes the numerical ice-sheet model GRISLI ver 2.0, in particular, with the application for the Antarctic ice sheet simulation. I think this paper is fairly well written with some exception below, and can be accepted with minor revision.

One thing better to include is technical (numerical) procedures and properties adopted in the model. Since the source code is not opened to public, information how to solve the model equation is useful for those who has not contact with the model. For example, how to solve the Eq.(2), (thickness evolution)? Explicit, implicit or others? How to solve the linear equations, direct, alternate-direction, conjugate gradient, or other

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method? How to solve the non-linear ice-shelf equation (Eq.12)? Linearize them? Or the velocity-dependent viscosity ($\bar{\eta}$) at the previous time step is used? How to determine the convergence of the solutions where the iterative solver is involved? Such details are all necessary to evaluate the numerical accuracy of the model, if they want. I suppose they are more or less the same as the original version of the model (Ritz et al. 1997,2001), but repetition (or at least citation of the old papers) are needed for completeness of the model description.

Another thing better to rewrite is the lateral boundary condition of the ice shelf, which is still unclear to me. As described in Sec 2.3, the ice shelf is extended towards the edges of the model domain. As far as I understand, to remove row i from the matrix corresponds to set horizontal velocity as zero at the front. I am not sure this is what the authors expect. I suggest to rewrite the second paragraph of the Sec.2.3 to clarify how to formulate the matrix in the model.

In addition, I definitely agree to the specific comments 3 and 4 by the referee #1. The authors should clarify the formulation and the procedures to compute basal hydrology and the back-force coefficient.

Some minor points (PmLn corresponds to the line number n in page m)

Units: use $\text{\unit{}}$ macro.

P1L6: ‘or Tsai et al...’ may be better?

P2L16: ‘right’ might not be a right word for this context. How about ‘practical tool for...’

P3L19 Eq(1): Divergence, not Gradient (need dot).

P3L22 Eq(2) and after: \bar{u}_x is better than \bar{u}_x .

P3L26 Eq(3) and similar array equations: Use \displaystyle .

P4L1 or around: Need definition like $\sigma_i = \tau_{ii}$, otherwise the paper misses the equation for longitudinal stress components, since Eqs 5, 6, 8, 9 are described with

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τ_{ij} .

P4L11 Eq(7) or (9): The enhancement factor should be inserted. Otherwise $E_{\{SIA\}}$ in P12L1 is confusing.

P4L16 Eq(8): Need range of i, j .

P4L25 Eq(9): No explicit formulation of $B_{\{AT1\}}$ and $B_{\{AT3\}}$. Are they documented in Dumas (2002)?

P5L10 Eq(10): i in $\rho_{\{i\}}$ conflicts with row i .

P5L9: (for $i = x, y$) not (for $i = x, y, z$). When $i = z$ in Eq(11), the coefficient 2 must disappear.

P5L10 Eq(11): no definition of B . B may conflict with $B_{\{AT\}}$, which is better to avoid.

P5L21: S is already defined in L9.

P5L23: (see also 2.3 numerical feature)

P5L26: The basal drag is very small but not necessarily zero. All we can do is to neglect it.

P7L12 Eq(16): No definition of H_g . Typo of $H_{\{gl\}}$?

P8 Sec2.1.6. Need to mention how to compute the vertical velocity. I suppose vertical velocity is not directly computed as Ritz et al. (1997).

P8L10: 'zero' requires the unit. I prefer to write as 'the melting point'.

P8L25 Eq(22) Write \exp (backslash before \exp) following LaTeX convention.

P9L27, Better to cite Le Meur and Huybrechts after ELRA sentence also.

P10L26: Better to avoid to use A and B for matrix and vector, which conflict with the rate factor or bedrock elevation.

Table 1: Unit of the acceleration should be m/s. Really same values for ice and mantle

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thermal conductivity?

Figure 1: If z at the ice bottom is always zero as the figure, you need to reformulate all the governing equations using z .

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Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2018-105>, 2018.

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