MS 157-316
4800 Oak Grove Drive
Jet Propulsion Laboratory
Pasadena, CA 91109-8099, U.S.A.
Tel (818) 393-2435
Fax (818) 393-4206
email: eric.larour@jpl.nasa.gov

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Dear editor:

Here is my review of the manuscript entitled " **Influence of Anisotropy on Velocity and Age Distribution at Scharffenbergbotnen Blue Ice Area.** "

General remarks: the manuscript deals with issues that arise in the modeling of Blue Ice Areas (BIAs), in Antarctica, in areas of strong katabatic winds, which expose bare ice even below the ELA line. Such areas exhibit strong gradients in ice fabric between the surface and the bedrock, and it is paramount to better understand the processes involved in the evolution of such BIAs if we are to correctly model their evolution and their impact on the surrounding ice sheet. Here, the authors experiment with several rheologies of the ice and fabric to try and understand isochrone distribution and surface velocities in the Scharffenbergbotnen area, Antarctica.

The manuscript is generally well written, and the science exposed here warrants publications, as it has strong implications in terms of significantly improving ice sheets models and providing benchmarks that can be compared against to check whether our models are capable of modeling different areas of the ice sheet, ranging from fast-flowing areas such as ice streams, to ice divides, or here BIAs.

The only problem I have with the manuscript is the constant intertwining of content relating to the 2D flow-line model and to the 3D full-Stokes model. It is quite difficult to follow the main thread, and I am not sure the flow-line model brings much to the paper, apart from providing nice figures in Fig. 4 and 5 which do not per-se depend on the nature of the model. I am as of this writing still not clear on what the flow-line model is exactly used for compared to the 3D model. The manuscript would gain much in reorganizing to avoid this confusion.

Detailed remarks:

- p 3060: Abstract: abstract is clear, concise, and to the point.

- p 3061: The with respect $->$ With respect to snow-covered areas, lowered surface albedo of BIAs...
- p 3061.l16: this is a very nice segment of the manuscript, which is very useful in understanding why exactly this area is of interest.
- p 3061.l09: It would be interesting to know at this point what is meant by such models, and what is the property here that is of interest in such models that would allow for a better fit to observations. What is exactly the feature of ice flow that is not well reproduced? The ice-bridging effect? The higher-order vertical shear stresses? Is full-Stokes really needed or does a Blatter/Pattyn approach do the trick?
- p 3061: it would be nice to refer to Fig. 1, as modified per remarks below, i.e. in order to give the reader a clear idea of where Scharffenbergbotnen is located.
- p 3062.l27: from the North-West and the West as specific locations?
- p3064.l18: I'm not sure this squares off with the introduction, which strongly argued for full-Stokes higher-order models when here the authors are now discussing flow-line modeling. Such models have serious limitations, even in full-Stokes mode. This should be discussed here, or the rationale for using such models explained from the get go.
- p3064.l29: I have some reservations here as to the rationale of flow-line modeling. In a situtation where the ice essentially stagnates, and where the authors are trying to explain discrepancies in strong vertical velocities, it would seem more natural to carry out a full-scale basin model. Here, a mistake made in the choice of the flow line will result in under or over estimation of lateral shear stresses, resulting in under or over estimation of the backstress component of the ice flow.
- p3065.l6: "Now we think": this goes to my previous remark. It would seem that something more tangible should be at the origin of the flow-line identification, as it is such a critical step if the use of a collapsed formulation is to be realistic. At least, if computational requirements are an issue here, the full-Stokes 3D model could be used in diagnostic mode to correctly capture the flow-line direction, then used to constrain the model setup for the flow-line model. This would ensure a realistic pick for the flow-line path, consistent with the assumptions of the flow-line full-Stokes model.
- p3065.l11: the authors should discuss the geothermal heat flux values, and at least run identical configurations with geothermal heat fluxes from Maule et al. 2005, or discuss the implications of not knowing the geothermal heat flux accurately.
- p3066.l17:20: very nice segment which was clearly needed here.
- p3067.l9: the body of work from Durand et al on this should probably be cited.
- p3067.l17: I don't understand why this is done. In a code like Elmer, these terms are already captured, so why neglect them, when this could lead to some modifications in the results. There is no computational impact to adding these terms in the computation of the thermal regime, so why not play it on the safe side, and include them?
- p3068.l6: correspond with $->$ corresponds to ?
- p3071.l25: is pre-conditioned $->$ are pre-conditioned
- p3072.l1: some details such as number of iterations in the Picard for each model

(thermal and mechanical) as well as the overall model would be nice to have. Were there also locations where convergence could not be reached, such as freeze-on or hot-spots that osciallate through time and never reach convergence (zigzagging)?

- p3073.l11: I would surmise that another hypothesis could be that the isochrones would be better interpreted were they carried out with a basin-wide model, in 3D. If the flow line is not correctly calibrated, the flowline will cross isochrones from other flow-lines, resulting in a bad interpretation of the age record of this particular basin. This really needs to be addressed in the current manuscript I believe.
- p3073: I would like to strike my comment above, as I now realize that a full 3D model was indeed carried out. This is confusing, as I was truly under the impression, up to 5.1, that a full-Stokes flow-line model was what was called the 3D model. I would urge the authors to make the distinction clearer, so as to avoid similar confusion as I went through here. I now also don't understand why a flow-line model is used, if a 3D full-Stokes model was also used in 5.1.
- p3075.l9: shown in Fig. 8?

The figures are generally clear and self-explanatory, except for Fig 1:

- Fig. 1: it would be nice to have an idea of where Scharffenbergbotnen is, I would suggest adding an inset to clearly define the area being studied. Fig. 1 is also overall very cluttered, and quite hard to read. I would suggest splitting velocity and age, so as to make two frames maybe?

Sincerely yours,

Dr. Eric Larour