

The Cryosphere Discuss., referee comment RC2
<https://doi.org/10.5194/tc-2021-173-RC2>, 2021
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Review of Mas e Braga and others, "Nunataks as barriers to ice flow: implications for palaeo ice-sheet reconstructions"

Anonymous Referee #2

Referee comment on "Nunataks as barriers to ice flow: implications for palaeo ice sheet reconstructions" by Martim Mas e Braga et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-173-RC2>, 2021

In this manuscript, the authors apply the ice sheet model Ua to an idealized, rectangular geometry including Gaussian nunataks, and investigate how the ice flow and geometry react to these barriers. They report that, for conditions mimicking those typical for Antarctica, nunataks can influence the geometry significantly, such that the ice thickens upstream and thins downstream of the obstacle. Details vary depending on scenarios and mesh resolution. The results are relevant because they point out that the interpretation of cosmogenic exposure dating in the vicinity of nunataks in terms of past ice-thickness changes is far from being straightforward and can be grossly wrong if the flow disturbance caused by the nunataks is ignored.

This is a novel contribution with important implications for reconstructions of past ice-sheet geometry. The presentation is generally good. Referee #1 has already pointed out a number of detailed issues, which I am not going to repeat. However, I would like to raise two major issues that deserve some attention:

(1) I have some doubts whether the shelfy-stream approximation (SStA) is appropriate for the tackled problem. SStA is SSA (shallow-shelf approximation) with basal drag, thus it assumes plug flow and a shallow geometry without sharp gradients. Especially when zooming in high resolution to the immediate vicinity of nunataks, these conditions are certainly violated, as the flow regime is strongly 3D and steep surface gradients occur. I think that a proper simulation of this behaviour requires nothing less than full-Stokes dynamics. There is probably not much to be done about the shortcoming at this stage, but at the minimum, the limitation should be discussed very openly and clearly.

BTW, which boundary condition is applied at the nunataks? I suppose they are treated like the ice base?

(2) What I am also missing is a discussion about the potential impact of crevassing in the vicinity of nunataks. I would expect that crevasses often occur around such flow obstacles, with the consequence that the ice is effectively softened and the large-scale flow less disturbed than under the assumption of undamaged ice that has to find its way around the obstacle. This effect has the potential to alter/weaken the described influence on the ice surface significantly. At least, a qualitative discussion about it seems appropriate. Even better would be to investigate the effect by running some tests with an assumed softening around the nunataks.