

Review of: Glaciological settings and recent mass balance of Blåskimen Island in Dronning Maud Land, Antarctica, Goel and others, tc-2017-61

This paper provides a study of the glacial conditions, largely concerning mass balance, of one of Antarctica's larger ice rises, which is situated in the DML sector. Most of the content is a straightforward report of a field measurement campaign, where much of the motivation is to assess the ice rise's mass balance. The main conclusions are that the mass balance of the ice rise has been positive over the last decade, and that the ice rise has likely been stable for at least the last ~600 years.

The paper certainly presents data that are worth publishing and that will interest a number of readers. Down the line the data should provide a useful resource for calibrating regional mass balance measurements. The paper also represents a further case study of ice-rise conditions to complement the recent work on Derwael and Halvfarryggen. For all of these reasons it is a useful contribution.

A previous version of the paper was reviewed by two different reviewers, and the response has certainly moved the paper towards a form that is better structured and more compelling. My comments are, therefore, largely directed towards improving the efficiency and correctness of the writing.

## Comments

### ***Universal changes throughout manuscript:***

There is no need for the word "the" in front of e.g. Fimbul Ice Shelf, Jelbart Ice Shelf. Additionally, when used as proper nouns, e.g. in Fimbul Ice Shelf, Jelbart Ice Shelf, or even Fimbul and Jelbart Ice Shelves, then Ice Shelf/Shelves should be capitalised. Use lowercase when referring to ice shelf/shelves more generally.

You introduce the acronym SMB for surface mass balance multiple times, and even sometimes use the full words again rather than taking advantage of having introduced the acronym early in the paper. Please go back through the manuscript sticking to this convention:

- Use surface mass balance (full words) in abstract.
- Introduce acronym SMB at first opportunity in main text (as you have done on P1 L16)
- Be consistent thereafter in using only the acronym SMB
- Optionally, you might choose to keep the full words "surface mass balance" in Figure captions and Section 7 Conclusions, catering for readers who might skim-read in the first instance.

Please avoid split infinitives. Currently there are examples at P2 L3, P3 L10. You can search for these comprehensively by searching for the word "to".

Anywhere where you describe e.g. ice sheet versus ice-sheet thinning, ice shelf versus ice shelf thinning, ice rise versus ice-rise elevation, and so on, you should not use a hyphen when just referring to e.g. the ice sheet, but you should introduce the hyphen into it when describing e.g. the ice-sheet thinning. Most of the time you follow this rule well, but there are exceptions, and I recommend you search these out, and correct/confirm on a case-by-case basis. You might do this by using the search function for "ice" (and "radar", as, for example, in radar-detected features).

You interchange the terms ice divide, flow divide and ice-flow divide. You could clean this up a bit by using a single term.

Some of the writing in Section 4 oscillates between being written in the past tense and the present tense. It would generally be better written consistently in the past tense.

## **Figure ordering**

I suggest you reverse the order of Figures 2 and 3. My reasoning is explained in the line by line comments.

## **Line by Line**

Title. I am not sure “glaciological setting” is really capturing what you do, nor is it that compelling as part of a paper’s title. Would the paper be better titled: “Mass balance and stability of Blåskimen Island, Dronning Maud Land, Antarctica”? Much of the paper’s focus is essentially on the present and past mass balance, with stability in the title representing the elements of the study that investigate whether the mass balance has changed significantly over time.

I am not convinced the abstract really sells the paper all that well, nor captures the full logic of the paper.

Suggested restructure:

First sentence: East Antarctica’s Dronning Maud Land ice-shelf-fringed coast contains numerous ice rises that influence the dynamics and mass balance of the region.

P1, L12: Insert commas: “...shelves, together...” “...rumples), regulate...”

P1, L17-18: Start with: “Hence, although...” insert “areal” before “footprint” and remove *the* in L18.

P1, L20: Rewrite as “...evolution of ice rises and adjacent ice bodies over...”

P1, L23-24: More efficiently phrased as: “...Kingslake et al., 2016), supplementing ice-core-derived climate records (e.g. Mulvaney et al., 2002, 2014).

P2, L1: Capital L: Land

P2, L3: Better to substitute shape with dynamics here.

P2, L6: plural, beds

P2, L7: plural, contrasts, emplace comma after slopes

P2, L8: “...that both of these ice rises...”

P2, L8-9: “...5000 years), despite being separated by...” “and ranging across variable glaciological settings.”

P2, L12: This final sentence of the paragraph would be better written along the lines of: “These existing observations underscore the requirement for further detailed investigations of ice rises in DML.”

Section 2. I felt this section could be written with a more finessed logic. I suggest the very first sentence is:

“Blåskimen Island (Fig. 1a; total area 651 km<sup>2</sup>; Moholdt and Matsuoka, 2015) is the most seaward of a series of isle-type ice rises (totally surrounded by floating ice) and promontory-type ice rises (elongated extensions of the ice sheet into an ice shelf) that partitions Jelbart Ice Shelf from Fimbul Ice Shelf.

Then discuss Jelbart Ice Shelf, fed by Schytt Glacier, then Fimbul Ice Shelf, fed by Jutulstraumen but buttressed near the western calving front near Blåskimen by the further ice rises/rumples.

Then finish with a sentence along the lines of: “In summary, ice flow to the south and north of Blåskimen Island is slow; ice flow to its east is also slowed by the ice rises and rumples on the western shear margin of the otherwise fast-flowing Fimbul Ice Shelf; and hence the fastest flow near Blåskimen Island occurs to its west where it abuts the eastern shear margin of Jelbart Ice Shelf.

P3, L2-4: Conflate to a single sentence, requiring one instance of replacing surveys with measurements:  
“We carried out field measurements of...” “...2013-2014, comprising kinematic...” “...(Section 3.2), and  
firn coring...”

P3, Opening section. I think this small opening paragraph would benefit from a small expansion explaining  
WHY you gathered each of the named datasets. Currently readers are only being fed this information  
later in the manuscript.

P3, L10: Introduce comma: “...ice rise, and...”

P3 P15: More efficiently phrased as: “...(Matsuoka et al., 2012b), and 90 reoccupied in January 2014, the  
remaining 7 being lost to snow burial or found to be tilting by > 20°. Note that this no longer specifies  
that 6 were buried and one tilted but I suspect readers have negligible interest in that specificity.

P3 L21: Remove comma: “...kinematic and...”

P3 L22: ...using TRACK software, part of the GAMIT/GLOBK GPS package (Herring...”

P3 L29: sp. descent

P3 L31: Insert “a”: “...operated a GSSI...”

P3 L32: “...Hawley et al., 2014). Both radar surveys...”

P4 L13: I think “record” is more suitable here than “develop.”

P4 L21: “Hereafter we refer to mean density as...”

P4 L24: “...estimating SMB below 3 m depth, we...”

#### Section 4.1

Nowhere as the 2x methods for determining SMB are introduced is there a helpful and immediate  
clarification that the two methods have relative merits in terms of the simplicity of the measurements  
versus the timescales of information they address. I’d like it to be made more upfront in the opening to  
this section that the stake method is undertaken because it can inform quickly on the broad patterns of  
change between 2013 and 2014, albeit with an overall uncertainty of 6%, but that the radar method can  
give a longer-term view.

P4 L31: “...accounting for snow...”

P5 L5: “...reflectors is solely...”

P5 L6: “Thus the shallow-ice...” “...when the depth...”

P5 L11: “...which have been found...”

P5 L12: Substitute “Such upward” with “Raymond”

P5 L14: “...demonstrated that the amplitude of Raymond arches...”

P5 L16: There’s no need to refer to Figure 2 here. The main effect is to distract the reader. It seems that  
your purpose in referring to Figure 2 at this point is simply to illustrate a typical Raymond arch, but I  
strongly suspect your target readership knows what this is already. If they don’t, they should be  
referring to Raymond 1983!

P5 L26 and L28: Replace “is” with “was”.

P5 L28: “method is to invert simultaneously for spatial variations in...” and cut all words from altogether to the citation.

The only explanation (as such) you give for the inversion is to refer to an in prep manuscript. There is no description of the technique given at all. This issue was also raised by Reviewer#1 first time around, and I don't think you have addressed it. If you are going to use results from this technique at all in the paper, there needs to be some more information on it. Is the Brown/Matsuoka inversion at least part derived from an earlier method that can be cited here?

P6 L8: “...melting, as a one-dimensional...”

P6 L9: The author's full surname(s) – admittedly an unusual form – is Fox Maule (n.b. no hyphen). Thus it should appear as Fox Maule et al here, and should be listed in the reference list as Fox Maule, C.

P6 L9: I think it would be appropriate to insert a word like “Moreover,” to start this sentence.

P6 L10: I think that here, as with P5 L16, there's not a big need to refer to Fig. 2 yet. The flow of the paper would be improved by having people first look at the results figures in the results section.

P6 L13: Insert and: “...column, and  $\gamma$ ..”

P6 L18: “...over a non-sliding bed and using the shallow-ice...”

P6 L20-21: “...Drews et al., 2015), giving  $\gamma$  between...”

P6 L17-L28: Make all this a single paragraph.

P6 L22-23: Suggest: “However, because the ice is not isothermal and, near the ice divide, the shallow-ice approximation is also invalid, in reality the range of  $\gamma$  is wider.”

P6 L31: “For the thermomechanical...”

P7 Section 4.2.2. I would consider this section to be more logically ordered throughout as (1) flowband method, (2) polygon setup, and (3) grid setup. The first represents the most direct reliance on the field measurements, the other two rely more on interpolation to expand the coverage. I note that in your results (Section 5) you follow this order in the text, so it would be better streamlined writing to discuss the method in the same order here.

P8 L14: Here, if you agree with my earlier suggestions that there has not yet been a need to refer readers to the radargrams in Fig. 2, then it would be better to order the current figures so that Fig. 2 is now the 3 panel figure of surface/bed/velocities. Hence change text here to refer to Fig. 2a.

P8 L20 and Fig. 3b, now suggested to be Fig. 2b: Perhaps add the profile numbers 1-1', 2-2' etc as also marked on Fig. 1b. Figs. 2 and 3 will be located close to each other in the final paper, so this might save readers having to flick back to Fig. 1 to locate the radargram positions. If you do this, then you should change the locational reference in the text to “2-2' in Figs. 1b and 2b”.

P8 L21, L22: Here it now makes logical sense that you introduce readers for the first time to the plots of surface slope and radargrams respectively. But they would now be labelled Fig. 3a, b, c.

Below this point in the paper, swap all references to Figs 2 and 3.

P9 L13: Not really sure why it's especially specified here that the study area is 20 x 20 km. You've already stated the area in Section 2, and a reader can see the area on Figs. 1b, 3, 4. It just seems to make the sentence overlong. There does, however, seem to be a discrepancy between the 20 x 20 km of these figures and the value of 651 km<sup>2</sup> written in P2 L19 (and in P11 L9). How is the smaller area of 651 km<sup>2</sup> defined specifically?

P9 L14: Is it not more correct to note that the main contrast is between the northwest and the southeast?

P9 L23: "...are controlled primarily by SMB versus the Raymond effect..." "we measured the amplitudes..."

P9 L24: Extra "the" needed x2: "We used the two deeper arches of the three that we used for SMB..."

P9 L29: represent (not represents)

P10 L16-19 and Figure 6. I suggest rearranging Fig. 6 panels so that panel a is flowband, panel b polygon and panel c grid. This would make all of Section 4.2, 5.3 and Fig. 6 consistently ordered. You could easily introduce some more specific references to Fig 6a, b and c where relevant in L16-19.

P10 L21-23: This reads like a sentence that should have been used back in Section 4.2.

P10 L25: gives

P10 L29: southeasternmost?

P10 L31-32: I'm not sure I follow what you mean by thickening and thinning in this sentence. Does this refer to the trend for mass balance to increase/decrease upslope/downslope in slopes A and F? I see that in slope A the lowermost polygon has a much lower mass balance than the upper two polygons in slope A, but I do not see the reverse trend in slope F – in slope F the mass balance looks pretty similar in each polygon. I see that the average mass balance of slope A is lower than the average mass balance of slope F, although whether the average mass balance is actually the lowest of all slopes is not clear, because slope D has low values too. Similarly, it's not clear (if this is what you're trying to say) that slope F has the highest mass balance of all slopes, at least from the information one can draw from Figure 6.

P11 L1: Suggest rephrasing: "Together, the measurements show that Blåskimen Island had positive mass balance between 2005 and 2014."

P11 L2-4: Another opportunity to re-order.

P11 L4: Use the symbol for gamma as you have done elsewhere.

P11 L13-L24: There are some missing words in the current sentence but in any case there's no real need to specify that your DEM comes from GPS at this stage of the paper. Suggest: "Our detailed surface DEM (Fig. 2a) reveals a number of surface topographic features that are smoothed over in continent-wide DEMs (e.g. Bamber et al., 2009; Fretwell et al., 2013). It confirms, for example, that the lineations in satellite imagery observed in satellite imagery over Blåskimen Island correspond to surface undulations (c.f., Goodwin and Vaughan, 1995)" N.b., the c.f. is important, because Goodwin and Vaughan didn't refer to this location. Start the final paragraph essentially with a rewritten version of the current paragraph's second sentence: "We further note that the summit height of Blåskimen Island is 24-40 m higher in our DEM compared with the lower resolution DEMs"

.... However, can you clarify for sure that this is not a consequence of the different products being referenced to different vertical datums?

I think it is disingenuous to describe the Bamber/Bedmap2 as an "inaccurate description of topography". It's lower resolution, which is not the same thing at all.

P11 L28: This is an inappropriate use of “inferring”. You could replace it with: “from which we infer”

P11 L29: vary should be varies.

P12 L1: Suggest: “...SMB has been observed on other Antarctic ice rises. For example, King (2004) showed...”

P12 L7: “The net impact...” “...coast has been examined using the RACMO2...”

P12 L16: “...Derwael Ice Rise, where it was attributed to wind...”

P12 L29: Here, if you do not already have data or a different publication to cite that gives the modelling results, you would be better advised to write: “...which are likely Raymond arches, though ice-flow modelling would be required to confirm this interpretation.”

P13 L13-L20: I’m not convinced this paragraph is really saying anything that couldn’t have been said in the absence of all your new data. Certainly the final sentence is inappropriate for a published paper.

P13 L22: Past tense: “investigated”

Figure 1

Ice Shelf should be written with capital letters in both labels on Fig. 1a.

Since you mention Schytt Glacier in the main text this may also be worth marking on Fig. 1a.

Figure 4

Did you think about producing a difference map as a third panel, to help in the general comparison of the results?