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Interactive comment on "Greenland Iceberg Melt Variability from High-Resolution Satellite Observations" *by* Ellyn M. Enderlin et al.

Anonymous Referee #2

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This paper investigates iceberg submarine melt variability in fjords for icebergs calved from seven large tidewater glaciers around the Greenland coast between 2011-16. The paper uses a method developed and presented previously in a detailed paper (Enderlin and Hamilton 2014) and utilises Worldview Imagery to generate iceberg DEMs. The paper shows clearly how the estimated iceberg submarine melt-rates show distinct melt patterns that one would expect based both on hydrographic observations and variations in latitude and iceberg draft. In the main, the paper is very clearly written and the findings are well supported by the analyses and data while the conclusion provides a very succinct and clear summary of the paper highlighting the key findings and the considerable potential of the method utilised.

There are a few areas where the paper is a little unclear and these are outlined below;

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in particular, some changes to the Figures would improve the clarity of the paper. On occasions, just a little more text is needed to aid the reader and any such additions will not detract from the paper as it is not overly long.

P1, l17 – I was a somewhat unclear what you meant in the abstract when stating that you do not resolve “coherent” temporal variations in melt rates. After reading the paper, this became clearer but I think it makes sense to state more clearly here in the abstract that you do resolve coherent ‘seasonal or interannual patterns in your iceberg melt-rates’.

P1, l27 – worth adding that the size distribution of the calved icebergs as well as the volume calved is crucial to the spatial distribution of iceberg freshwater fluxes.

P2, l17-18 – important to add the caveat here that this is true as long as the iceberg in question is floating.

P2, l21-23 – I think that you should also add other satellite platforms to your list of additional potential methods that could be used to derive elevation time-series.

P2, l31-32 – You state that “A comparison of the DEMs produced using the SETSM and ASP algorithms indicates that the accuracy of iceberg elevations is unaffected by the choice of the algorithm used to construct DEMs”. You have presumably carried out some kind of analysis to demonstrate that this is the case; in which case, it would be beneficial to report briefly (even in one line) what “unaffected” means by referring to one example of the results derived from analysis on one of your iceberg data-sets.

Fig. 1. Each location map (insets b – h) needs a scale (unless the scale is the same in all of them in which case a scale is still needed somewhere). Furthermore, it would help to show clearly where the calving fronts of the glaciers are; this may be obvious in some figures either from visual clarity (g) or site familiarity (e) but for many, especially d, f and g, it’s not really clear where the icebergs have come from. (I might add that it does become clear when I enhance the scale on the pdf to 400%, as the images are

very high quality, they are just very small at the resolution of the current figure). And this information is needed to help make sense of the text on P3, l26-29.

Furthermore, in Figure 1 and in all subsequent figures, I think you should re-order the glacier legend box and symbols from b) to h) i.e. Kong Oscar, Alison, Upernavik etc ending with Koge Bugt rather than alphabetically as currently which is much more confusing for the reader.

Fig. 2 and p4, l6. It would be very helpful to include the estimated submarine melt rates, derived from each linear polynomial, within the individual figure boxes (a – g).

P4, L16. Ref. should be to Jackson and Straneo, not et al.

P4, l18 – there are seven plotted symbols in Figure 1h) associated with Koge Bugt, not the six suggested in the text. Why the discrepancy?

P4, l21. The confidence for the Koge Bugt datasets, as currently explained, seems a little misplaced given the sample size. In particular, from Fig 1, it looks as though one of the icebergs sampled is a considerable distance from the others and perhaps in more open waters 'atypical' of the other fjord samples. As such, are you sure you are observing "typical melt conditions" and not getting spurious results due to anomalous sampling (particularly given the small sample size and thus significance of one anomalous data point to your overall results for KB).

P4, l31 – will detailed in-situ data become more widely available as part of the OMG programme?

P5, l8 – The results for individual glaciers (b-h) would be of much more use if the y scale was reduced from 0 – 0.4 m/d as opposed to 1m (with the exception of Koge Bugt) so that the (valuable) details in the variable melt-rates could be seen more clearly.

P5, L12-13. The broad description relating to melt rate with iceberg draft is not really correct when integrating the Upernavik and Jakobshavn Isbrae results. The melt rate actually continues to decrease in draft bin 200-250m at JI, not "increase" again as suggested in L13. Hence the dip is broader than the 150-200m dip that you suggest. I think you just need to be a bit broader in your depth categorisation for the "approximate depth of the interface" for the cold-warm boundary (and I presume that it does vary between fjord systems). Furthermore, the melt rate appears to dip again at JI in the 350-400 m bin (actually dropping back to shallow 'cold' water values). Given the integrative nature of your area averaged melt rate estimates (L20), this low value for the 350-400m bin would pretty much suggest zero melt rates at the 350-400 depth given the much higher median melt rate from the previous 300-350m bin. Can you comment on either the reliability of this 350-400m estimate (there are zero error bars so presumably it is just one estimate) or whether this sudden drop may be meaningful in terms of a dramatic decrease in melt rate at a certain depth in Ilulissat Isfjord?

P5 re depth dependency and Fig. 3. In addition to the above, I think that suggesting that depth the dependency "is particularly pronounced for icebergs calved from the Upernavik glaciers (Fig. 3d) and Jakobshavn Isbræ (Fig. 3e)" is rather misleading. With the normalised data, it is perhaps most pronounced at Helheim and Zachariae. Based on Fig. 3a, one might argue that JI is the most atypical in the 200-400m depth bins.

P5, l22-24 – presumably extent of sea ice and melange are also relevant to the stratification and circulation over different timescales?

Fig. 4. I found this Figure extremely hard to interpret, in particular because it was very hard to see the gray-scale 'colour' of the year fill, especially when stars are used as symbols at JI and Koge Bugt. I would suggest changing the symbols so that they are all squares or circles (like Upernavik or Alison – check to see which looks better) and put the name of each glacier in the top left corner of each box (i.e. a) Kong Oscar through g) Koge Bugt).

In reality, there is so much complexity in the plots, I am not sure whether a seasonal or interannual pattern would be visible even if one were present. As such, I feel that the

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line that “the lack of a coherent temporal signal across all study sites does not preclude the existence of temporal variations” is pretty much spot on. It would be good to see on a single graph, for your most frequently sampled glacier, a time series of melt-rate v time (on x-axis) for each 50m draft bin. I am sure that you have tried this but I just think it would be good to show, in a more visibly obvious way, that there is no clear seasonal or temporal pattern, something which I feel Fig. 4 fails currently to do.

Fig. 5. Again, I think the choice of stars as the symbol makes the gray scale fill very hard to see.

P7, l5-6. If you are not going to go in to the details of your velocity change calculation, you at least need to refer to the paper/equation/parameterisation that you use to make the claim that “the water velocity would need to increase from an average of approximately 0.05m/s to 0.3 m/s to produce the ∼0.12m/d to ∼0.46m/d increase in the area-averaged melt rate”. It would also help to know what change in water temperature would also give the increased melt rate if you kept the velocity at 0.05 m/s?

P7, l7. Full stop after “hypothesis”.

P7, l8. Better to say “..from Sermilik Fjord in south-east Greenland suggests that. . .”

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