

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

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Summary:

In this study the authors use digital elevation models derived from satellite imagery to investigate temporal and spatial observations in iceberg melt rates. The paper builds on previous work to provide estimates of iceberg melt rates across several fjords in Greenland, and demonstrates that iceberg melt rates depend on iceberg draft – with the caveat that draft and melt rates are inferred from calculations of subaerial volume and assumed iceberg geometry. Meltwater from icebergs appears to be an important source of freshwater for fjords in Greenland, and therefore this study has important implications for fjord circulation and submarine melting of glacier termini.

C1

Major comments:

Most of my concerns with this paper are related to understanding the numerous sources of uncertainty that are inherent (and unavoidable) in the authors' calculations. It wasn't until I went back to re-read Enderlin and Hamilton (2014) that I realized that these uncertainties had already been addressed in some detail previously. Therefore I think this paper would benefit from a 1-2 paragraph summary of the sources of error and their impact on the melt flux and melt rate calculations. Presumably this summary would be in Section 2. My sense is that the error in the melt flux calculations is small and that those calculations are therefore pretty robust. The depth-averaged melt rate calculations are more tenuous because they rely on an assumed iceberg geometry, which affects both the submerged surface area and the iceberg draft.

I would also feel more comfortable with the discussion of how submarine melt rates vary with depth if the paper more explicitly referred to the depth-averaged melt rates and drafts as proxies. For example, I believe that the draft is calculated with something like:

$$h' = \text{“draft proxy”} = V_{\text{sa}}/A * \rho_i/(\rho_w - \rho_i),$$

where h' is the draft proxy, V_{sa} is the subaerial volume, A is the cross-sectional area of the iceberg at the waterline, and ρ_i and ρ_w are the densities of ice and water. Including something along these lines would more precisely indicate what is actually being plotted in the various figures. Something similar could be written out to describe the proxy for the depth-averaged melt rate. Not sure if this correct, but:

$$m' = 1 / (h' * 2 * \pi * r) * dV_{\text{sm}}/dt,$$

where m' is the proxy for the depth-averaged melt, r is the average radius at the water line, and $V_{\text{sm}} = V_{\text{sa}} * \rho_i / (\rho_w - \rho_i)$ is the submerged volume. Depending on exactly how this calculation is made, you may be able to cancel out some terms.

My concern is that I'm just not sure how much faith to put in the melt rate vs. draft

C2

figures. There seems to be a pretty nice relationship between meltwater flux and submerged area (based on the assumed geometry). Is there a similarly nice relationship between meltwater flux and submerged volume? If not, maybe that can somehow be used to justify the choice of iceberg shape.

Also, in the discussion of the observed changes in melt rates at Jakobshavn (page 7), it would be nice to have the calculations of melt rates spelled out in more detail. How did you calculate the change in water velocity that would be needed to increase the melt rate? By how much would you have to change the water temperature to get a similar change in melt rate? Can you exclude our potential sources, such as an incursion of warm water? Did the melange remain intact following the calving event?

Minor comments:

p. 1, line 16: Consider pointing out in the abstract that you don't observe longitudinal variations in melt rates. That seems to be a pretty important finding.

p. 1, line 30: Sublimation also contributes to ablation.

p. 2, line 12: Why these seven glaciers?

p.2, line 4: Consider citing Alon Stern's JGR paper: The effects of Antarctic iceberg calving-size distribution in a global climate model

p. 3, line 1: Why the switch in processing schemes?

p. 3, line 22: Are any of the icebergs tabular?

p. 5, line 22: Perhaps cite John Mortenson's paper: Heat sources for glacial melt in a sub-arctic fjord (godthabsfjord) in contact with the Greenland ice sheet

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