The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
https://doi.org/10.5194/tc-2022-164-RC2, 2022

Comment on tc-2022-164

Till Wagner (Referee)

Referee comment on "Automated ArcticDEM iceberg detection tool: insights into area and volume distributions, and their potential application to satellite imagery and modelling of glacier–iceberg–ocean systems" by Connor J. Shiggins et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2022-164-RC2, 2022

In this manuscript, C. Shiggins and co-authors present an algorithm and user interface to detect icebergs and compute iceberg size distributions (area and volume) near the termini of Greenland tidewater glaciers by combining the computationally efficient Google Earth Engine tools with the high-resolution 3-D ArcticDEM product.

The paper is very well written and structured, clearly illustrated, and the subject matter is a good fit for The Cryosphere. The user interface is readily usable and the algorithm has the potential to help researchers shed light on calving and fjord dynamics on a pan-Greenland scale, as well as relevance for operational iceberg forecasts and a wide range of possible applications for the broader cryospheric and climate science communities.

In light of this I recommend the paper for publication after minor revisions, with my comments detailed below.
I have aimed to not double-up on the first reviewer's comments.

General Comments:

1) Availability of ArcticDEMs and picking the right ROI. I was able to run the code on SKJI without much trouble and could also approximately reproduce some of the distributions in the paper (e.g. something similar to those in Fig 6). However, when I tried to explore other random glaciers around Greenland I struggled to find ones with any available ArcticDEM scenes. I randomly tried ~10 or so glaciers in different regions and only 2 identified any ArcticDEM scenes (2 scenes each) for the ROIs that I picked. It was not clear to me from the manuscript how exactly to pick the ROIs and I tried to emulate the shapes provided in Fig 1 but realized I had no further knowledge how these were determined. This may be part of the reason why I couldn't detect more DEM scenes. I was

also struck by the fact that picking slightly different ROIs in front of SKJI resulted in detecting a different number of scenes and also in somewhat different slopes for the area distributions. I appreciate that a comprehensive account of where ArcticDEM scenes are available may be beyond the scope of this study, but the lack of information in this regard limits the utility of the product. Relatedly, it would be helpful to have some practical guidance of how to draw the ROI polygons to best harness the strengths of the algorithm. Finally, a discussion of how much the results depend on the number of scenes available would be helpful. This could for example be explored by running the analysis on subsets of the SKJI scenes and showing the resulting spread in power law slopes, or similar?

2) Degree of automation. There are a couple of user inputs which are not straight-forward to set, namely the ROIs (see comment above) and the elevation threshold. The elevation threshold seems to be somewhat of a complex issue (see also the other reviewer's comments about distinguishing rafted vs non-rafted iceberg clusters). However, from looking at Fig 5 it looks like key statistics such as iceberg frequencies and the power law slope are not overly sensitive to this threshold, and I was wondering whether a 1.5m cutoff could simply be applied to all glaciers (including SKJI) at least in the paper, with a discussion that one may want to adjust this for certain purposes (such as focusing on the specific distribution of small icebergs); I am such mostly suggesting a minor reframing of the language here. As an alternative (and more involved) approach, one could come up with an optimization scheme that picks the threshold for each glacier depending on specific output statistics? Relatedly, it would help clean up the presentation if a single x_min could be picked for the glaciers in the paper (with an accompanying discussion analogous to the one for the elevation threshold)? As a minor point I would suggest removing the word "fully" from l.12.

Specific Comments:

l.59 is solar illumination also a limiting factor for the DEMs?

l.69 "iceberg area distribution" vs l.70 "area-size distributions" I presume this refers to the same thing, so maybe pick one?

l.70 Just a side note: we also used such size distributions to look at iceberg decay in Antarctica in England et al "Modeling the breakup of tabular icebergs". Science Advances 6.51 (2020): eabd1273. This was based on the Antarctic size distributions in Tournadre et al "Antarctic icebergs distributions 1992-2014". J. Geophys. Res. Oceans 121, 327–349 (2016). You may not want to bring in Antarctic references here, so feel free disregard this comment.

l.75 I suggest explicitly stating what "x" represents (surface area in m^2 (?)). I was also wondering whether "a" or "A" may be better since "x" often refers to a distance and since in the vert. axis label of Fig 6 you write "P(A>a)", so if you stick with "x" you may want to adjust this label.

l.88 maybe add "([as discussed] in Scheick et al., 2019)", otherwise it reads as if Scheick et al were misrepresenting the data

l.91 "determine" instead of "interrogate" (?)

l.102 Similar to the comment on Scheick et al.: it is not quite clear whether Sulak et al were among the few studies to directly estimate iceberg volume (maybe just move the reference to right after "few studies"?)

l.140 maybe clarify over which time period this retreat happened?

l.184-194 (see also general comment 2): this reads a little like picking the right threshold is more of an art than a science. I'd suggest reframing this a bit.

l.210 5.3 "km^2" to 41 "km^2"

Table 1: How are the uncertainties in the power slopes calculated? There also seems to be a rogue "-" after 8.629 (and the misplaced line number 225). Out of mere curiosity I was wondering whether there is much of a seasonal fluctuation in any of these statistics? I guess you only have summer DEMs?

Fig 3: The automated and manually detected volume sums for KNS are almost identical, much closer than for the other two - yet their power law slopes (Fig 6c) are more divergent than for the other two glaciers. Could you comment on that? I also noted that SKJI has a rather large % difference in manually and automatically detected iceberg volume. Could you comment on why that is and why we need not be concerned about that (or should we)?

Fig 5 and Fig 6.: The given value for alpha(KNS) in Fig 6c is -2.38, while the KNS alpha values range from -2.1 to -2.3, and close to -2.25 for threshold = 1.5m. Why is there this discrepancy?

Fig 6: I was initially confused that the slopes on the log-log plots of figure 6 have are approx 1, whereas alpha =~ 2. I then realized that you are plotting CDF and the slope for a CDF = alpha -1. Maybe this could be noted in the text or caption?

Fig 7: The 5th and 95th percentile are given as power law relationships, for which I would have expected straight (dashed) lines in the figure, but the lines are somewhat wiggly. Why is that?

Fig 8: The resolution of this fig is somewhat low (also the horizontal label of panel a is cut off?)

Fig 9: horizontal axis label: "iceberg area (m^2)" (not increments)

l.487: delete "is achievable" (or "it is able")

l.542: I would suggest replacing "excellent" with "good" (?)