

Author response to the review of the manuscript “Sea ice melt pond bathymetry reconstructed from aerial photographs using photogrammetry...” by Ellen Buckley

Black: Comments from the reviewer

Red: Responses from the authors

We greatly appreciate the positive feedback and rating of the manuscript. The reviewer, who has great experience in the field, has gratefully read through the manuscript carefully and brought up points that we have all considered in the revision to significantly improve its quality. We are very grateful for this in-depth review and have thoroughly proofread the manuscript.

General:

The Figure captions are pretty short, and sometimes say “described in the text” I recommend adding text to the figure captions so that they can be stand-alone figures. I imagine this will be a useful reference text for future studies and the description of diagrams in figure captions will make the methodology clearer.

We are very grateful for this positive feedback and have checked all captions and adjusted them where necessary.

Specific:

Line 26: awkward phrasing- maybe you mean “rather simply”

According to the other reviewer's suggestion, we changed it to “simplistically”

Comments on Line 29 And Line 42: I disagree that ‘most melt pond depth obs. for models were published in Morassutti and Ledrew’. Melt pond depth measurements from SHEBA (Perovich et al., 2003, Figure 11) were used in CCSM4 parameterizations (Holland et al., 2012). You actually mention this in line 40. These thoughts could be combined.

I don't know if this is based on Luthje 2006. See Holland et al 2012- directly references Perovich et al. 2003 and the SHEBA measurements. Maybe this is true for the Pedersen scheme but certainly no all the links between pond fraction and depth

Many thanks for bringing this unspecific formulation to our attention. We rearranged the paragraphs to clarify the applications of the datasets and models.

Line 34. I would say “Here we define pond bathymetry as...” because some studies will refer to bathymetry as a two-dimensional sample instead of the whole bathymetric floor.

Thanks for this good specification. We changed it to: “However, the actual pond bathymetry, which we define here as the pond depth profile in all directions, and which therefore also yields the actual average pond depth, remains largely undiscussed in the literature.”

Line 50: ICESat-2 (correct capitalization)

We changed it accordingly.

Line 50: Please also include the larger study by Buckley et al., 2023 (Follow on to Farrell et al., 2020) which involves two algorithms (also include Herzfeld et al., 2023 that described the DDA algorithm) to automatically retrieve melt pond depth applied to thousands of ponds in the 2020 melt season. Still not a comprehensive database but showcases the ability to retrieve pond depths at large scales. I suggest you also include this in the discussion section about pond depth and coverage (fraction) evolution.

Many thanks for pointing out these further developments of the ICESat-2 algorithms. We decided to incorporate them stronger into the revised manuscript by mentioning them in the introduction, adding a full paragraph on satellite upscaling to the discussion, and adding a new figure to the result section that displays volume and depth distributions (also in response to your comment on line 398 and the comment of another reviewer). We are convinced that this additional information is worth the slight extension of the manuscript by one paragraph and does not change any methodological aspects.

Line 51. Consider “Orbital path” instead of “flight track lines”

We changed it to “along the ground tracks of the satellite beams.” as we are referring specifically to the track on the ice.

Line 54. Chiroptera flew over sea ice for the ICESat-2 summer validation campaign in 2022 and that is a ALB system. Not sure of any publications that include that information right now though.

Many thanks for spotting this deprecated information. We couldn't find any publications either, just conference abstracts. So, we changed it to: “To our knowledge, such an ALB system over sea ice was only deployed for the first time in 2022 as part of the ICESat-2 validation. “

Figure 1 caption. “Know” to “known”

Changed

Figure 1. can you make sure the arrows are contained within the image – it is hard to tell what they are.

White arrows are connected to the inlets. We reformulated the caption to make this point clearer.

Line 87. I'm confused about the use of "we." You are not the Macke and Flores authors- do you mean they did that? Or the authors on this paper also happened to be on the Polarstern cruise. The second half of this paragraph is in third person. Consider clarifying or putting the whole methods section in third person.

Thank you very much for bringing this to our attention. We have reworded it to clarify our active participation.

Line 101. Replace "most probably" with "most likely" or "likely"

Changed to "most likely"

Line 104: why can't these ponds be designated strictly as melt ponds?

The motivation behind the sentence was the likely first formation by flooding. However, we noted that it can be easily removed to avoid confusion.

Line 111: Reference for cloudy days being more common in Arctic summer?

„Weather conditions on 14 June (Fig. 1b) were exactly the opposite. The entire sky was covered by a stratiform cloud cover, as is usual in central Arctic summers (Cotton et al., 2011) when the average cloud coverage reaches its maximum of about 70% (e.g., Wang and Key, 2005).“

Line 123: change "reached" to "ranged" and "pond depth" to "pond depth measurements"

Check

Line 126: Can you quantify pond coverage increase?

Due to the constrained size of the measurement site in the ridge area, we describe this change only qualitatively, as a quantitative analysis would require an arbitrary definition of the study site size.

Line 134: either leave out "pandemic related" or include COVID-19 (hopefully people in 100 years will be reading this paper and may not know what this is referring to)

Haha, fingers crossed. We changed it to "because of an inevitable crew exchange on Svalbard".

Line 135: I think you said this somewhere else but can you remind us the age of the new ice floe?

We added that information.

Line 141: 2 km x 2 km you mean?

Many thanks for noting this mistake. We changed it and later occurrences

Line 146: how much error does this introduce?

Since we're using a flat plane to remove the vertical offset of the DEM from sea level, the standard deviation remains unaffected. However, the offset reduced from 0.49m to 0.05m on 2020-06-30 and from 1.11m to 0.04m on 2020-07-17. Due to the lack of further reliable data (such as a large number of ground control points), we cannot quantify the error further.

Line 209: can you make Snell's law a proper numbered equation in the text, or refer to Eqn. 1 here.

We added a reference to the previous equation.

Line 255: (e.g., Hutter et al., 2023) – im sure there are others so add the e.g.

Perfectly correct, we added „e.g.,“

Line 267: (Jordahl et al., 2020; Perry, 2015; Gillies, 2013). Either but these in chronological order or if these refer to the python libraries in order add “,respectively”

Thanks for the suggestion. We added “respectively”

Line 276: is the algo description in Fuchs 2023a or Fuchs 2023c- both are included here- what is the difference

Thanks for pointing towards this unclear formulation. We added a note, that the source code is available in Fuchs 2023a, while methods are described and evaluated in 2023c.

Line 279: perhaps here can you list the main classes and not just refer to Table 3

Thanks for the suggestion. We added that.

Line 301: if you include the QGIS version here, you should include it everywhere

Thanks for spotting this inconsistency. We removed the version information here as it contains no essential information.

Figure 11: Consider a gray or dark background so the light points stand out.

Many thanks for noting this possible ambiguity in the interpretation. We have adjusted both the color scale and the caption accordingly.

Line 370: Again the pandemic comment

Removed as previously.

Line 376: Sentence doesn't make sense – especially the ending “with partially more than 2 m)

We changed it to “On 30~June, several very large, exceptionally deep ponds (>2~m) had formed on the MOSAiC floe, along with many smaller ponds”

Line 381: relatively high underestimation is a confusing statement

Changed to “strong underestimation”

Line 385: does vertically elevated mean above sea level?

Changed to above sea level

Line 398: this is confusing. Pond volume across the floe was constant (in space or time?) And what do you mean “has not changed much either”... has not changed since when? And then the next clause you say the ponds do deepen?

Many thanks for making us aware of this unclear formulation. To make this point clearer, and also in response to the other reviewer's question about distribution functions, we have decided to add a figure that shows these relationships more clearly and provides an overview of the pond volume, depth, and area evolution on the MOSAiC floe. Consequently, we modified the section in the results and referred to it again in the discussion, where we also linked it to the newly added discussion on satellite upscaling (as previously mentioned in response to the earlier comment on the Buckley et al., 2023 paper).

Line 404: what do you mean both Webster et al., 2022? If you are talking about the ossp classification in webster, cite webster in the first set of brackets with Wright and Polashenski

Thanks for noting. We made this more precise: “In the following, we compare the aerial derived data to available results from high-resolution satellite observations (Webster et al., 2022, using the Wright and Polashenski (2018) classification algorithm OSSP) and in situ transect lines (Webster et al., 2022) to assess the accuracy of our results and the representativeness of observed areas.”

Line 410: can you describe what you see in Fig 15a and quantify how well they match.

We added a more specific description of the differences between the satellite-, aerial-, and in situ-derived pond coverage evolution.

Figure 15: can you explain the recalculation, has this been fixed in the Webster manuscript? If so can you reference the correction?

The calculation used a wrong factor. We confirmed again that the journal is working on the correction. If it is completed by the time of final publication, we will include it here.

Line 476: all other instances of Mystery Lake do not have lake capitalized. Be consistent.

Changed to Mystery lake

Line 479: too few

Changed

Line 525: sentence starting with “most interestingly...” does not make sense.

We agree that this was unnecessary wording. We deleted it.

Line 545: “the here” doesn’t make sense

We removed “here”