Review of: Buth et al., Characterizing sea ice melt pond fraction and geometry in relation to surface morphology

This study utilizes airborne imagery and altimetry captured on three flights over melting Arctic sea ice. The authors look to identify the link between melt pond fraction and the presence of sea ice ridges but find a complex relationship. The methodology is well described and the discussion topics were well chosen. It is a very interesting paper with a strong analysis. There are many minor comments and revisions for clarity and a few major points that would benefit from further analysis and/or longer discussion. Please find my general and specific comments below.

General:

The introduction reads like a list of references. It doesn't tell a cohesive story. Although the references included are good sources, I recommend a rewrite to make it flow better. Especially the paragraph starting at line 29- you flip back and forth between first year and multiyear ice and include landfast ice and it is all very confusing.

The discussion on pond geometry needs some clarification in the methodological description. How are ponds that intersect with image borders handled? What are the minimum and maximum pond sizes that can be observed in the flights at varying altitudes with the range of pixel sizes and images sizes. Perovich et al., 2002 has a good way to determine these values:

Perovich, D. K., Tucker III, W. B., & Ligett, K. A. (2002). Aerial observations of the evolution of ice surface conditions during summer. *Journal of Geophysical Research: Oceans*, *107*(C10), SHE-24.

Specific:

Line 6: what do you mean by high melt pond fraction (quantify).

Line 29: how do snow dunes affect pond formation- mentioned but not explained

Line 33: for the Eicken et al reference- how does the topography influence pond formation?

Line 34: Doesn't the presence of ridges on multiyear ice limit the spread of pond water as well? This is a confusing sentence

Line 40: which parameterizations in which models is this study referring to? This is a very broad statement.

Figure 1 caption: can you describe the source of the drift trajectories and indicate the way that they are marked (semi transparent dot marked every day?) And does the color correspond to the days since continuous melt onset at the date of the flight or does it change over the course of the drift trajectory? Potentially interesting information, but needs to be described better in the caption.

Table 1: does typical mean average or median or what?

Table 1: What does ground sample distance mean? It is not described in the text.

Figure 2: Can you use a different color for the cable lines in a/d/g and the altimeter measurements in b/e/h?

Line 88: what is a typical RGB sum that corresponds to the surface type? Can you give an average?

Line 100-102: I think this text is more valuable as a figure caption and does not need to be in the main text

Line 108: histogramm → histogram

Figure 3: this figure is a little blurry- I recommend increasing the dpi. The smoothed & filtered dots look more like a line, so I would just call them that in the figure caption

Line 146-150: Can you provide a few more details on how the time offset for the camera is refined based on the altimetry?

Line 152: I believe the references after e.g. should be listed in chronological order but check the style guide.

Line 160: can you remind the reader how many pixels 0.1 m^2 is?

Line 244: fewer → less

Line 246: are the dark/light ponds identified in the classification algorithm or is this a visual qualitative assessment? If included in the algorithm- can you provide numbers?

Figure 4: somewhere in the text can you describe why you think the observed SIC from images is so different from the OSISAF SIC?

Line 278: can you clarify? I think you mean that for the Western flight there is less time between the flight date and the melt onset date and that is why it is lower MPF?

Line 330: Snow depth and distribution is also a factor in melt pond distribution. It would be worth mentioning if not including a full discussion.

Line 370: for the circularity and general pond size distribution analysis, how do you handle the ponds that are on the edges of images? Are they eliminated from the analysis (via border intersection clearing)?

Figure 8. It would be useful to plot a common shape (circle) on the pond perimeter v pond size chart? Or note what it would look like (a straight line?)

Figure 8c. I don't understand what conceptualized and simplified visualization means? Is this just what you expected? Why? Explain in the text. The text currently does not clarify what this is.

Line 387: the description of the figure should be contained within the figure caption.

Line 405: this paragraph (point 3) is confusing. You say high perimeter to area ratio ponds form on more ridged ice across pond sizes. Then later say that this trend is reversed for large ponds and that when the perimeter to area ratio is high, it is on smooth ice. So the statement "broad range of pond sizes" needs to be clarified.

Line 408: Confusing comment about the fractal dimension- can you please clarify? Did you calculate the fractal dimension? With what metric? IF you are referring to another paper's finding please cite here.