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Interactive comment on "Observations of Sea Ice Melt from Operation IceBridge Imagery" *by* Nicholas C. Wright et al.

Anonymous Referee #1

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The paper describes an analysis of surface conditions of Arctic sea ice in summer. The images are processed from a previously developed algorithm, which is approved upon and well-described, and all methods and output are made publicly available. The paper is very well-written, logically organized, and the figures are illustrated clearly. More details need filling in for parts of the methods, which should be straight-forward to address. The largest concerns I have are the testing of the hypothesis that melt pond coverage over first-year ice is higher than that of multiyear ice and the two pathways of melt pond evolution suggested for first-year ice. These concerns can be remedied by reconsidering the argument and taking into account the following points:

(1) Melt pond evolution is variant in nature, particularly over first-year sea ice. Operation IceBridge sampled melt ponds at different stages of melt given the long distances

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covered. To assume all pond formation and evolution progressed the same, for example assuming all ponds had drained (as in the discussion), is a stretch even within the same survey line. By sampling over such large, regional areas, these surveys are sampling different states of melt pond evolution. (2) The bimodal pathway argument of pond evolution for FYI is a gross oversimplification. While it is an interesting idea to consider, the argument that FYI is either pond-free or heavily ponded during summer is weakly supported. Melt pond coverage on first-year ice ranges from no ponds to heavily-ponded with everything in between based on available data.

Please see the following suggestions for further improvements: L49. Relatively calm Arctic. Calm relative to what? The Arctic seas are dynamic.

L57-60. The introduction would benefit from more description about melt pond evolution. One aspect that's missing is the transitory coverage of melt ponds with melt. At one stage, FYI melt ponds may have lower coverage than MYI melt ponds. At a later stage of melt, the same FYI melt ponds may have greater coverage than MYI melt ponds. Pond coverage can change substantially depending on the ice state and progression of melt.

L67-68. I recommend tweaking the language here. While the results do show low and high coverage of melt ponds on FYI, which is a valuable finding, the results do not directly link together melt pond coverage and the processes posed in Polashenski et al. 2017.

L77. No flights took place during melt or freeze onset transitional phases. How was this determined?

L116-117. Were there specific cases of high-quality imagery discarded using this method? It's worth mentioning in the text in case there are any biases worth considering.

L131-132. Are these limits subjective to each image or is a standard value applied to

all? How were the limits determined?

L134. Is a clear, binary division true for flights where freezing and recent snowfall took place?

L137-140. Is there an option for using melt pond and shadow detection in the algorithm on late spring or early summer images when both conditions are present? It would be worth noting this in text here.

L144/Section 2.3. What new information does the number of pond-free areas provide that the areal ice fraction doesn't? It would be helpful to discuss this in a sentence or two here. For one, the distribution of pond-free ice has implications for disparate surface melt rates and the new pond-free metric would seemingly give more information in this respect.

L148/L152. 15 m and 27.5 m values are specific. How were they chosen?

L170. What is meant by targeted processing?

L176. What are the results exactly? Are they segmented images or simply surface fractions of all images? Please clarify here.

L177. Please define melt pond fraction. Is it the areal fraction of the image scene or of the sea ice? How are melted-through ponds within an ice floe classified?

L177-178. Why were images with 70% ocean area discarded? Melt pond fractions in these images would be useful information.

L179. What is meant by low source image quality? Does this mean that there were images that had low light, were hazy, that the automation didn't catch before? If so, it would be helpful to state how many images (the fraction of the total) the automation removed. This can tell us how much work the automation saves us from doing and approximately how much work is left to do using this method.

L180. Not enough to do what? Do the authors mean that there was no usable imagery

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from that flight?

L189-190. It would be useful to see the equivalent segmented image of 6c as an additional panel to the figure.

L196-198. What's the error associated with the ice type classification? How was second-year ice classified?

L214-215. How were the ice types distributed along the surveys? Were FYI and MYI well-mixed or was one ice type located predominantly north, east, etc.? It'd be helpful to note their distribution here.

L217-219. The first sentence needs more description. Work by Eicken et al. 2002 and Webster et al. 2015 demonstrated the same result, but what this analysis shows is that it can happen on a regional scale rather than a local scale, and that's important. The second sentence can also be expanded on. Several previous studies showed pond evolution between FYI and MYI differ. What's new with this study is the link to the large-scale variability in pond coverage. For example, one could hypothesize that there should be less spatial variability in MYI pond coverage on a regional scale because it's less variable in time relative to pond evolution on FYI. These results support that hypothesis.

L231-232. This sentence is unclear.

L241. How was "most" defined? Was this 51% of the ice area or more than 10 times?

L243/Figure 10. This is a nice result. I was hoping to see the equivalent segmented image. It'd be worthwhile to include this either in the main text or as supplementary information.

L250-253. Is this shorefast ice? It's worth stating so if it is, as it may be typical for shorefast FYI in this region.

L254-255. I'd suggest rephrasing this to "infrequent" to the OIB observations, since it

may be a common phenomenon.

L256. It would be helpful to circle or highlight the sediment-laden ice as it's not apparent in this image. It also raises the question, does the algorithm also detect sediment-laden ice or is it detected as a melt pond?

L258/Figure 11. Similar comment as Figure 10, it'd be helpful to see the segmented equivalent in the main text or supplementary information.

L267-319/Section 4.1. Please see main concerns above.

L280-281. The lack of ponds in Polashenski et al. 2017 seemed to be due to a snowfall event and freezing conditions rather than high permeability and a lack of snow.

L284-287. Do the results from earlier works using MODIS data not apply here?

L289. How was high permeability and pond drainage determined on such a large spatial scale? Figure 10b shows no drainage features. This surface condition was classified as common in the dataset, which conflicts with the next sentence.

L293-294. Is this what's being suggested for the pond-free FYI areas? Before, the argument was that ponds never formed?

L296. It's not clear what is meant by if subtle topography is powerful.

L298-300. This is not clear.

L312-313. Is this statement in reference to the OIB data set? For previous works, this was not found to be the same. It would be worth clarifying here.

L322-324. This description should be described near the beginning of the manuscript. Submerged ice may contribute to a larger proportion of pond fraction for FYI than MYI.

L333-335. Similar to the main concerns above, a snapshot of lower FYI pond coverage than MYI pond coverage does not address the hypothesis. Previous works have shown pond coverage on FYI to be highly temporally variable over summer compared to that

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on MYI. The temporal average of melt pond fraction for FYI and MYI over the melt period may indeed support the hypothesis.

Figure 4. It would be helpful to use a more dynamic color scheme for the melt pond fraction. It's difficult to see the distribution along the survey lines.

Figure 8. It would be helpful to know the sample size for each case.

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