Reviewer #3
Received and published: 6 October 2020
This paper derives the melt pond faction in month of April derived from Radarsat-2 imagery to predict the resulting sea ice area over the ensuing summer melt season within the Canadian archipelago, from years 2009-2018. The best results were found to be between stage of development in April and melt pond fraction, following the related paper by Scharien et al., 2017. Other comparisons were more challenging but were well explained. Due to my tardiness with this review, which I apologize for, I did read the other two reviews and the authors' response to both. I generally agreed with the reviewers comments and the responses were well posed. I will only add a couple of additional comments, that may be a little different.

Howell et al.
We have addressed all the Reviewer's comments. The MODIS spatial resolution suggestion was particularly useful for improving the manuscript.

Reviewer #3
1. Figure 7. As with the other two reviewers, I had some concerns with this figure, due to the relatively limited area of the lidar observations. The inclusion of the aerial photography and SAR comparisons that were added in Figure 7b are a valuable addition. Going back to Figure 7a, the Radarsat results themselves have no response to the changing melt conditions before, during and after. There is little change between the two years. Before the addition of Fig. 7b, I was thinking of not including it. I now wonder if they included a few more surrounding pixels to examine, like a 3X3 window, some variation might appear. How many R2 frames were examined during the field measurements periods?

Howell et al.
There is little variability using a 3x3 window near the LiDAR site and in this case we feel a direct one-to-one comparison is best. The individual RADARSAT-2 frames are averaged into a mosaic for the year and on average there are between 6 and 11 overlaps (Figure 2) with 8 in 2011 and 5 in 2012 over the LiDAR site. However, the point raised by the Reviewer is that it is important to mention uncertainty in the text and fewer pixel overlaps could also result in a reduction of the RADARSAT-2 peak pond fraction estimate. In 2012, the RADARSAT-2 peak melt pond fraction at the LiDAR pixel could be 0.1 higher according to Figure 2 which would be closer to the LiDAR values.

Revised Section 3.2 as follows:
This is likely due to the short duration but very high maximum f_p of 0.78 in 2012 as Scharien et al. (2017) found that equation (1) sometimes underestimates very high f_p due to the low γ^o signal associated with very smooth FYI. Another consideration is the uncertainty in RADARSAT-2 f_{pk} estimates is least 0.1 (Figure 2) which would bring the RADARSAT-2 f_{pk} values closer to the *in situ* values.

Reviewer #3
2. Section 3.2, first paragraph regarding R2 and Sentinel-1. Please add that S1 data collections for sea ice nominally also use HH polarization, same as R2. I am wondering about differences in the noise floor and SNR between the two systems that may be leading to some of the differences

seen in Fig. 6. Were an approximately equivalent number of images used by both sensors about the same or different, thinking about Fig. 2?

Howell et al.
We do not think it is a noise floor issue but rather it is an incident angle issue as we mention explicitly in the text. There were more Sentinel-1 images used to cover the CAA than RADARSAT-2 images but they were constrained to a certain incidence angle range. This was not possible with RADARSAT-2 and to create a close-to-seamless mosaic across the CAA with RADARSAT-2 we needed to take the average of the overlapping peak melt pond fraction values. Overall, the distributions are in very good agreement despite the different approaches.

Reviewer #3
3. Modis comparisons with R2, section 3.2 and Fig. 8. Please specify the resolution for the Modis products. What is the sensitivity of Modis to melt pond size? If one makes the assumption that Modis may not detect smaller ponds, that by itself may account for the differences seen in Modis Max pond fraction and R2 results, couldn't it? Also the 8-day composite of Modis may limit small pond fraction. Please clarify the impact of Modis resolution on pond fraction.

Howell et al.
This is a very good suggestion. By itself, the MODIS product spatial resolution is unlikely to be the primary cause since the temporal domain spans 8-days but the fact that the 12.5 km grid cell is made up of smaller 500 m pixels likely at different stages of pond evolution is another reason why the peak fraction is difficult to capture with MODS. We have inserted another sentence into our revised the MODIS comparison.

Revised Section in 3.2:
Moreover, MODIS f_p values are essentially aggregated from 500 m clear-sky pixels within a 12.5 km x 12.5 km grid cell (Rösel et al., 2012) and the 500 m spatial resolution may limit detection of smaller pond fractions as well as not all of the 500 m pixels within the 12.5 km x 12.5 km grid cell are likely to be at the same melt pond stage evolution.

Revised Data and Methods:
Finally, we made use of 8-day composite satellite observations of f_p obtained from the MODIS Arctic melt pond cover fractions dataset that has a spatial resolution of 12.5 km for the period of 2009-2011 (Rösel et al., 2012).

Reviewer #3
4. Regarding Figs. 3 and 4 and Fig. 9 and 10. The relationship between stage of development and pond fraction was quite clear, shown in Fig.3-4. The greatest extent of low fractions were nearly all up in the northern CAA, with more variability, higher fractions in other areas. Then you come to Fig. 9 where any possible trend that one might expect in the MY/low fraction area in the north and in other regions goes away. The authors explain the variations in A and B, in melt pond fraction/week of strongest correlation, by dynamics, southward transport of lower pond fraction ice. The patterns in Fig3-4 were so clear and then it becomes unclear, although there is some similarity in patterns between Viscount-Melville and McClintock in Fig. 10. It's all pretty interesting and rather surprising. I urge the authors to continue to investigate this topic. Perhaps

the addition of ice motion drift can provide more insight.

Howell et al.
We agree and tracking the floes will likely improve the relationship which is something we are working on. Indeed, Viscount-Melville and the M'Clintock Channel have similar patterns because they have similar ice regimes (stagnant) so it is good to see agreement between them.