J. Hutchings (Editor) Received and published: 27 November 2017

The authors are grateful to the editor for the constructive comments. These comments have been helpful to improve the manuscript a lot. Our responses to the comments are addressed point by point.

Dear Peng Lu and co-authors, Thank you for your contribution. I am interested in receiving your response to the reviews. I have provided some additional comments below. At this stage I have not checked the paper for continuity. I do note that the paper is well written and English clear (thank you), and as I expect you will make some substantial revisions to the paper I am holding off on a through proof-read until after revision.

Please consider another paper in the Cryosphere Discussion that is on the topic of reflectance of melt ponds. I would be very interested in your opinion on the complimentary nature of your work to this. You can find the paper at https://www.the-cryospherediscuss.net/tc-2017-150/tc-2017-150.pdf, or I can send you a pdf if you need.
Reply: Thanks for your promotion. Actually Larysa Istomina and Georg Heygster in that paper Malinka et al. (2017), are also co-authors of this paper.

In Malinka et al. (2017), a RTM for melt ponds different to ours is developed based on Makshtas and Podgorny (1996), and the melt-pond reflectance was estimate by using their RTM, and pond depth and ice thickness were also retrieved using measured spectral albedo. The latter part of Malinka et al. (2017) has the same focus with the discussions in section 4.2 of our paper, but the models and the parameters employed to retrieve are different with each other. We also now cited their results in the conclusion part as "A recent publication by Malinka et al. (2017) suggested another way to determine pond depth and ice thickness from measured spectral albedo of melt ponds. They obtained better retrievals of Hi and Hp partly because they used more complicated spectra as input compared with our case.".

We think these two papers not only prove that problems on melt ponds are really focus of scientists, but also can promote the improvements in the scientific field through academic debate.

In general, please check that you are citing the original source of information. Was Polashenski and Perovich (2012), line 15, page 2, the original source of the 7 stage model for albedo evolution in summer? I recall Hajo Eicken and Don Perovich talking about this much earlier.
Reply: We checked the paper of Perovich and Polashenski (2012). The seven-phase evolution is a main finding of that paper, and was also clearly stated in the abstract section of Perovich and Polashenski (2012). So it should be the original source.

I am curious, could your model be extended to clear skies with non-diffuse illumination? Would this allow you to identify the thickness of ice under melt ponds from satellite imagery such as provided by MODIS? Is this inverse problem one you considered? How much influence does assuming overcast skies have on the comparison with in-situ observations? Did you only consider the sub-set of overcast data in the comparison, or does this include data for all skies?

Reply: (1) A diffuse incident solar radiation is the basic assumption of the present radiative transfer model, so non-diffuse illumination under clear skies cannot be investigated in this study. It is the same with the studies of Perovich (1990), Taylor and Feltham (2004), Flocco et al. (2015) who employed the similar two-stream radiative transfer model for sea ice or melt pond. Besides, overcast sky is prevailing although not always during summer in Arctic. It is acceptable if most situations can be treated in this paper.

(2) The spatial scale of melt ponds is small as comparing with the resolution of satellite instruments such as MODIS. So we think it is very difficult to observe pond color by satellite remote sensing, as one of the reviewers said. But hand-held photography, shipboard photography, and aerial photography are very effective ways to get the small-scale information on ice surface. Especially, with the wide applications of unmanned aerial vehicles (UAV) in sea ice investigations, it is easy for UAVs equipped with a digital camera to get the information of pond color although within a relative small scale. During Chinese Arctic Expeditions, such kind of equipment has been tested and pictures were obtained. This is exactly what we considered the inverse problem for.

We now added a new paragraph in section 4.2 to clearly state the limitations and applicability of the color-retrieval method, including the ideas presented in (1) and (2).

(3) During in-situ observations, the sky conditions were reported overcast during the optical measurements. It agreed with the assumption in the present model, and the influence of the assumption on the comparison can be ignored. We now add a detailed description on field conditions during the measurements of Istomina et al. (2016).

In the figure captions, I assume "true color" refers to the modeled color of the melt pond. Can you clarify.

Reply: Yes, it is the “simulated color”.

I had some difficulty in following your discussion on retrieval of ice thickness from pond color. I feel you need to clarify the discussion as to the parameters that confound the inverse solution. It would help to provide the evidence for this. In particular, the paragraph on lines 10-15, page 12, is vague what the competing parameters in the sky and ice conditions are and how they counteract each other such that it might not be possible to find a single solution based on melt pond color. Given you are justifying the value of your work based on the possibility of developing ice thickness products from satellite and camera observations I feel this needs to be addressed much more carefully in your analysis and discussion.

Reply: We revised the section 4.2 and the revised contents include:

(1) Pond color is a function of pond depth, underlying ice thickness, IOPs of sea ice, and incident solar radiation in the present study. Among them, pond depth and underlying ice thickness are the primary factors according to the sensitivity analyses, and IOPs and incident solar radiation can be assigned with empirical constants for melting sea ice in summer. Then there is (color) = $f(H_i, H_p)$, and the inverse problem we focused on is $(H_i, H_p) = f^{-1}$(color).

(2) The paragraph on lines 10-15, page 12 is a little confusing because it provided a comparison between Fig. 10 (results of the positive problem) and Fig. 11 (results of the inverse problem). So we removed this paragraph, and focused only on the inverse problem in section 4.2.

(3) The retrieving model to solve the inverse problem was now improved in Eq. (7), and different contributions from the hue, saturation, and luminance values of pond color were considered according to the statistical analyses in Istominia et al. (2016). Then the retrievals of ice thickness were highly improved as comparing with in-situ measurements, especially for thin ice with $H_i < 1$ m. It also argued for the possibility of our method.

Details can be seen in our reply to the last comment of Referee #2.

(4) We added a new paragraph in section 4.2 to clarify the limitations and applicability of the color-retrieval method. Satellite remote sensing is not the direct application of the method. Instead, UAVs equipped with a digital camera are able to get the information of pond color within a relative small scale, and such equipment has also been tested during Chinese Arctic Expeditions. More validations are of course necessary to improve the robustness of the method, but at least in present, the possibility of the new method is still encouraging.

Please consider acknowledging those who collected the data you use in this study. Looking forward to your response, Jenny

Reply: Yes, we added such acknowledgement: "The authors are grateful to the scientific party of the ARK 27/3 cruise for making the sea ice optical measurements possible. Special thanks are expressed to Marcel Nicolaus for organizing the logistics and to the Sea Ice Physics group on board for assisting with the measurements. Three anonymous reviewers and the editor Jennifer Hutchings are also acknowledged for their constructive comments to highly improve the manuscript".

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