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Interactive comment on "A linear model to derive melt pond depth from hyperspectral data" *by* Marcel König and Natascha Oppelt

Anonymous Referee #1

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This manuscript describes a model for the retrieval of melt pond depth from melt pond reflectance at 710 nm wavelength. The model was validated using numerous spectra / depth measurements from three unique melt ponds at a single location on a single day.

The manuscript is easy to read, mostly clearly written (see minor points below), and of general interest to the sea ice remote sensing community.

The authors make the assumption that the reflectance spectra of light and dark bare ice can serve as proxies for the reflectance spectra of the pond floors of light and dark ponds. I think this likely not true. Melting bare ice typically develops a surface scattering layer, which is likely not present where the ice is ponded. If I follow the arguments made by the authors later in the manuscript, it may turn out that their model

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is very insensitive to this assumption, which is good. But, I do think the assumption merits some discussion when it is first presented (section 2.1.1).

It appears that there are 49 data points used in the validation of this model. That sounds like a large number, but I am concerned that they all come from only 3 distinct ponds. It is not stated whether the site was first-year or multiyear ice. Presumably, unless the pond floors were rafted ice, the optical properties of the pond floors for each pond were likely homogeneous? I suspect there is considerable variability in pond floor properties beyond what was sampled in these three ponds.

I wonder if it would be useful to compare the spectra shown in Fig. 5 with the spectra shown in Fig. 4 of Light et al. (2015; https://doi.org/10.1002/2015JC011163)? Eyeball comparison suggests the albedos in that study are spectrally flatter than the reflectance spectra shown here.

In the discussion (line 206) the authors declare the "universality" of this approach. I would argue that data from 3 melt ponds (all observed on the same day) likely does not show convincing universality! Also, the fact that the model is only valid for solar angles between 58.9 and 61 degrees makes it not truly universal.

Minor points: I think it would be helpful to include "sea ice" in the title. This study is specific to ponds on sea ice, and it may not be applicable to other types of ponds (e.g., on glaciers, ice shelves).

Line 7: "vertical melt pond evolution" is not clear. Do the authors mean "melt pond deepening"?

Line 10: "slope of the log-scaled remote sensing reflectance..." Isn't it really the "slope of the log-scaled reflectance as a function of depth"?

Line 24: It is not clear what is meant here by "open"? Do the authors mean "ponds with no ice at their surface"?

Line 49 (and other places as well, line 55, etc.): sampling rate < 1 nm? The unit "nm"

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is a length, not a rate?

Line 54: "...within the scope of a goniometer experiment"– OK, so goniometer is a tool used in that experiment, but it would be helpful to give that experiment a more general name– maybe "...within the scope of an angle-resolving BRDF experiment"?

Line 69: ". . . negligible standard deviation" of what?

Line 85: Please give the time of the measurements in local solar time. I understand UTC is useful for syncing across datasets, but local solar time is essential for interpreting optical measurements.

Line 96: "expert knowledge" would help if this could be more specific.

Line 102: "spectral libraries of melt pond spectra" redundant wording

line 107: this means there are no constituents contributing to the absorption or scattering, but the absorption of the pure water is still accounted for?

Line 131: It should be noted that the Beer-Lamber law applies strictly to media that have no multiple scattering, in one-dimensional domains, in regions not affected by boundary conditions. The ponds in this study should be good candidates for the application of this law, but strictly speaking, it is an approximation to a full radiative transfer treatment.

Figure 6: The relationships shown here are just confirmation that the model used (Eqs 4, 5) satisfy Beer's Law, yes?

Line 239 (numerous other instances throughout manuscript): data "are" not "is"

line 245: "widely independent"? This needs to be clarified. Is "independent" sufficient?

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