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Interactive comment on "The color of melt ponds on Arctic sea ice" *by* Peng Lu et al.

Anonymous Referee #3

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General Comment:

This paper describes investigation of the color of melt pond on the Arctic sea ice simulated by the radiative transfer model and validation using field observations. Such sensing and analyzing melt pond may become increasingly important for detecting progress of warming in the Arctic Ocean. Therefore I recommend this paper for publication. However, I have a couple of major and minor comments that should be considered.

Major comment 1): In section 3.1, the authors mention the effects of melt depth and underlying ice thickness (P6. L18 – P7.L5). In addition, the effects of albedo and color of melt pond are also considered. The authors describe the pond color depends on underlying ice thickness and the possibility of estimation of ice thickness from the pond color. Basically, the pond color on first-year ice (FYI) containing brine and sea water indicates various gray depending on pond depth. The pond color on multi-year

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ice (MYI) displays green and blue. Thus the pond color also depends on underlying ice types (FYI or MYI). I recommend to add a description about the effect of ice type difference for same ice thickness. This explanation is expected to make the validity of this manuscript increase.

Major comment 2): I agree the result of the comparisons with field observations described in section 3.5. However, the description of the quantitative measurements for pond color by Istomina et al. (2016) is incomplete. Fog appears frequently during summer and observation of pond color seem to be affected by fog. The authors should mention the influence of fog during summer.

Major comment 3): According to Fig. 11, a good agreement can be found for thin ice with ice thickness < 1 m (P12. L19-L20). I would like to suggest that the color-retrieval method using a RTM is useful to estimate thin ice thickness because sea ice thickness has been declined in recent years. This is not discussed in a convincing way. In order to understand the argumentations given in the manuscript, I recommend to add discussion about when and where the color-retrieval method is useful. I think the valid area and period of the color-retrieval method are mainly ice edge and in late-summer, respectively.

Major comment 4): The manuscript describes that the result shown in Fig. 11 is still encouraging (P13. L1-L5). However, it is difficult to agree a new way of determining the sea-ice thickness. To clarity the validity of the color-retrieval method using RMT, I recommend to redraw plots of the ice thickness less than 1 m and more than 1 m separately in Fig. 11b. Adding the correlation coefficients, significance levels, and root mean square errors in Fig. 11 is also recommended.

Minor comments:

1) P2-L1: Studies on melt ponds area more than three aspects. For example, the studies using synthetic aperture radar and passive microwave sensor should be included. There are not many papers about remote sensing of melt pond by satellite. Recently

Tanaka et al. (2016) reported estimation of melt pond fraction using satellite microwave radiometer. I recommend to cite their paper in this section. Tanaka, Y., K. Tateyama, T. Kameda, and J. K. Hutchings (2016), Estimation of melt pond fraction over high concentration Arctic sea ice using AMSR-E passive microwave data, J. Geophys. Res. Oceans, 121, doi:10.1002/2016JC011876.

3) P3-L14: RTM was investigated the dependence of apparent optical properties (AOPs), particularly albedo and transmittance, on sky conditions, pond depth, ice thickness, and the inherent optical properties (IOPs) of ice and water (Lu et al., 2016). That is worth mentioning as well. For example, it would be essential to show about the broadband albedo were higher on overcast days than on clear days by 0.01 in August.

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