Preliminary response to the review of TC-2019-208 "Investigation of spatiotemporal variability of melt pond fraction and its relationship with sea ice extent during 2000–2017 using a new data" by Yifan Ding, Xiao Cheng, Jiping Liu, Fengming Hui, and Zhenzhan Wang

General comments:

"*The authors train a neural network with MODIS data and in-situ melt pond observations to retrieve the melt pond fraction (MPF). This is similar to the approach of Rösel et al. (2012) but with a major difference. Rösel et al. (2012) use the mixing equation to solve for three unknown surface types: open water, melt ponds, and snow and ice. This means Rösel et al. estimate the melt pond fraction with respect to the ice surface. The sea ice concentration results as an independent quantity from the MODIS retrieval. In my understanding, the authors of the present manuscript do not retrieve the ice concentration as an independent parameter which means that the coverage of melt ponds is not correctly estimated in areas with ice concentration below 100%. This is obvious in gradients of the MPF in the marginal ice zone where a coverage of >50% is estimated (e.g. Fig. 11 and 12). This is a clear artefact and does not resemble the real melt pond coverage. The new MPF seems to be highly influenced by the ice concentration and is not an independent measure, see Kern et al. (2016) for further details.*

Kern, S., Rösel, A., Pedersen, L. T., Ivanova, N., Saldo, R., and Tonboe, R. T.: The impact of melt ponds on summertime microwave brightness temperatures and sea-ice concentrations, The Cryosphere, 10, 2217–2239, https://doi.org/10.5194/tc-10-2217-2016, 2016."

Response:

We appreciate the reviewer for the helpful comments on the manuscript. Our preliminary response is attached as a supplement. It should be noted that, we are currently working on the reviewer's comments (see the third point below). Therefore, this response only clarifies some issues in the comments. Later, we will upload another supplement with detailed results to respond to all the issues in the comments.

First, we would like to provide a description of the deep neural network training in the manuscript. For the training, the input data is the spectral reflectance from four bands of MODIS (Moderate Resolution Imaging Spectroradiometer Terra MOD09A1 Version 6, https://lpdaac.usgs.gov/products/mod09a1v006/) on the 500 m polar stereographic grid. The training (target) data is the field observed melt pond fraction (MPF) relative to grid from six different sources (HOTRAX, DLUT, TransArc, PRIC-Lei, NSIDC, NPI). In the present network, the training (target) data does not include sea ice concentration (SIC) which has been pointed out as a possible issue in the reviewer's comment. However, the field observed SIC from the six sources has been used to transform the MPF relative to sea ice to the MPF relative to grid in the network training.

Second, the reviewer mentioned that "*the authors of the present manuscript do not retrieve the ice concentration as an independent parameter which means that the coverage of melt ponds is not correctly estimated in areas with ice concentration below 100%*" and "*This is obvious in gradients of the MPF in the marginal ice zone where a coverage of >50% is estimated (e.g. Fig. 11 and 12)*". **In our results (from Fig. 5 to Fig. 15 as well as Table 2), we have transformed the output of MPF relative to gird to the MPF relative to sea ice (see our figure captions)**. It should be noted that Fig.1 to Fig.4 and Table 1 in the manuscript are based on the MPF relative to grid. For the

transformation, we used the SIC from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data developed by a revised NASA Team algorithm (NASA Team SIC, https://nsidc.org/data/nsidc-0051). The NASA Team SIC data is independent from the MPF retrieved by our network. Therefore, all our analyses (from Fig. 5 to Fig. 15 as well as Table 2) are based on the MPF relative to sea ice, which means the MPF is estimated in areas with ice concentration below 100% (Note: we only consider the grid cell with NASA Team SIC greater than 15%, as mentioned in line 201 in the manuscript.). The grid cell with MPF greater than NASA Team SIC have been removed in our analysis. Table 1 (below) shows the percentage of grid cell with MPF greater than NASA Team SIC (Note: these grid cells are considered as bad retrieval). The results show that only less than 2% and less than 0.1% of the grid cells have bad MPF retrieval when considering grid cell with SIC>15% and SIC>30%, respectively. This means that the bad MPF retrievals are primarily located in the sea ice edge area (with small concentration).

Third, the reviewer mentioned that the network should also include the SIC as an independent quantity (Note: the current manuscript used the NASA Team SIC as an independent quantity to restrain the grid cell with retrieved MPF over sea ice cover area and make sure the MPF is smaller than the ice concentration.). In order to further address the reviewer's concern, we are currently trying to add the SIC as the training data in the network. The work is underway, and detailed results will be given in the later supplement.

Table 1. The percentage (%) of the grid cell with MPF relative to grid greater than NASA Team SIC

Year	MPF> NASA Team SIC (SIC>15%)	MPF> NASA Team SIC (SIC>30%)	Total girds (average per day)
2000	1.92	0.09	49127
2001	1.77	0.12	45253
2002	2.13	0.13	47358
2003	2.37	0.12	48097
2004	1.93	0.10	47545
2005	2.24	0.14	45805
2006	1.99	0.14	45281
2007	2.53	0.08	42082
2008	2.09	0.09	43445
2009	1.92	0.08	44937
2010	2.07	0.09	42775
2011	2.31	0.07	41503
2012	2.22	0.09	39476
2013	1.28	0.06	43269
2014	1.76	0.07	43127
2015	1.54	0.03	41843
2016	2.04	0.09	40403
2017	1.38	0.04	41081
Average	1.97	0.09	44023