AGU PUBLICATIONS

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Supporting Information for

From Bright Windows to Dark Spots: The Evolution of Melt Pond Optical Properties during Refreezing

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Figure S1: Photograph as of 23 August illustrating that refrozen melt ponds have a recessed topographic position within the adjacent bare ice.

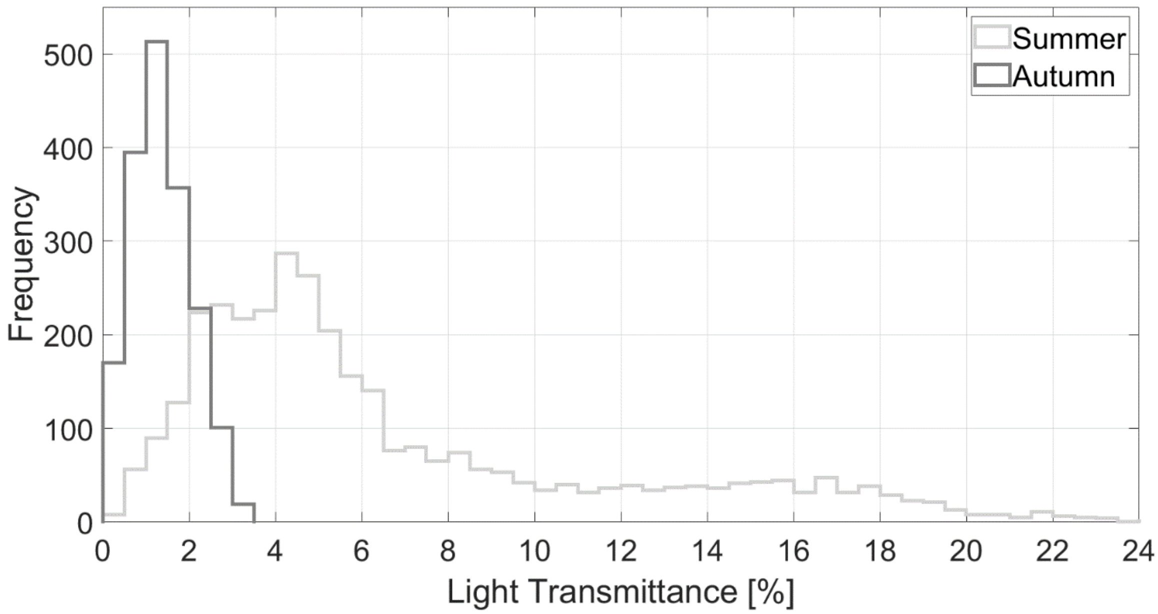

Figure S2: Histograms of light transmittance as measured on 24 August (summer) and 13 September (autumn) of melt ponds and bare ice combined.

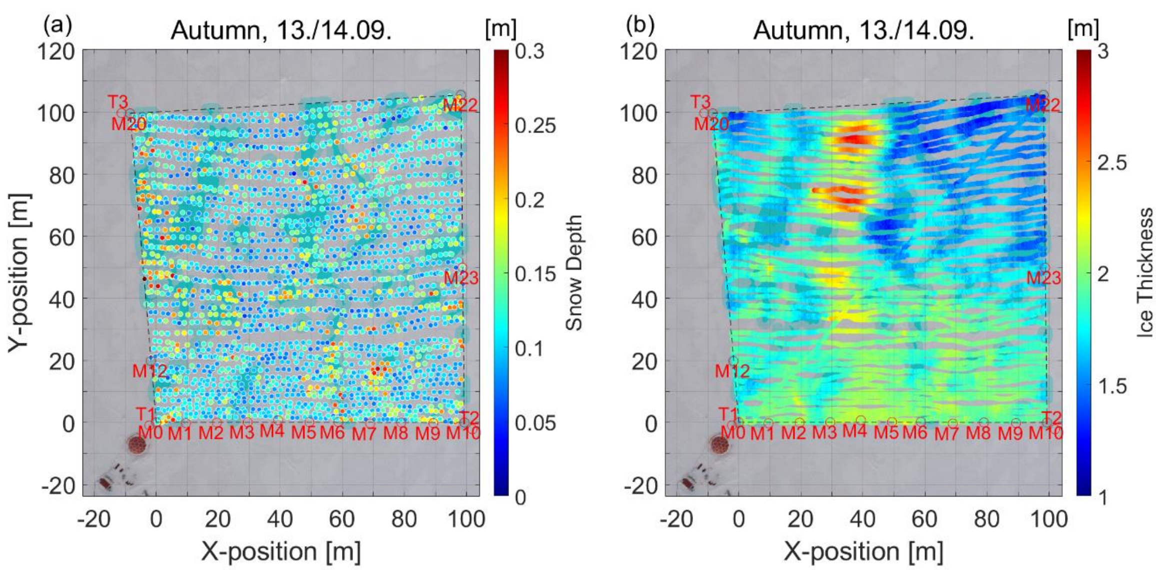

Figure S3: (a) Snow depth and (b) ice thickness on ponded sea ice as measured on 14 September (autumn). The background images are orthorectified aerial images acquired during a drone flight on 13 September. Pixels within the area of focus that were classified as melt pond during the summer are colored in light blue to illustrate the refrozen and snowcovered ponds during autumn. The edges around the melt ponds were dilated by a buffer of about 2 m. This area is indicated by a brighter blue. Red labels indicate the marker (M) and transponder locations (T). The ROV tent and control hut are visible on the lower left corners of the images.

Table S1: Parameters used in the radiative transfer model. SSL is the surface scattering layer. The melt pond depth is based on the in-situ average melt pond depth measured at six marker locations. The scattering coefficient for cold dry snow was provided by Perovich (1990). The other parameters were chosen with respect to Ehn et al. (2008), Light et al. (2008), Petrich et al. (2012), and Katlein et al. (2021) and adjusted so that they resulted in transmittance values similar to our observations. A Henyey–Greenstein phase function with an asymmetry parameter g = 0.9 was used for all layers.

Type	Layer Thickness [m]		Scattering Coefficient $[m^{-1}]$	Absorption Coefficient $[m^{-1}]$	Refractive Index
	Bare	Pond			
Snow	0 - 0.2	0 - 0.2	800	0.15	1.33
SSL	0.1	-	250	0.15	1.33
Interior ice	2.0	1.8	25	0.15	1.33
Pond	-	0.3	0	0.10	1.30

Table S2: Statistics of measured light transmittance (%), snow depth (m), and ice thickness (m) of melt ponds and bare ice. N is the number of measurements. The modes were read from histograms (Figure 2) with bin widths of 0.5 %, 0.01 m, and 0.10 m, respectively.

Variable	Date	Type	N	Min	Max	Mean	Std	Median	Mode
Transmittance [%]	Summer 24.08.	Bare	830	0.7	15.5	4.1	1.9	3.9	4.5
		Pond	859	1.6	23.2	8.9	5.5	7.1	5.5
	Autumn 13.09.	Bare	466	0.2	3.4	1.8	0.7	1.9	2.0
		Pond	328	0.4	3.1	1.3	0.6	1.2	1.0
Snow Depth [m]	Autumn 14.09.	Bare	1 308	0.04	0.25	0.11	0.03	0.10	0.90
		Pond	887	0.05	0.32	0.14	0.05	0.13	0.10
Ice Thickness [m]	Autumn 14.09.	Bare	26 831	1.25	2.83	1.90	0.21	1.92	2.00
		Pond	18 794	1.14	2.32	1.73	0.19	1.75	1.80

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