

Supporting Data for

## The Penetration of Solar Radiation into Granular Carbon Dioxide and Water Ices of Varying Grain Sizes on Mars

H. E. Chinnery<sup>1</sup>, A. Hagermann<sup>2</sup>, E. Kaufmann<sup>2</sup>, S. R. Lewis<sup>1</sup>

<sup>1</sup>School of Physical Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK.

<sup>2</sup>Department of Biological and Environmental Sciences, University of Stirling, FK9 4LA, UK.

### Contents of this file

Tables S1 to S24

### Introduction

Within this supporting information, the raw light intensity measurements, which were used to calculate the e-folding scales, are presented for each sample, based on ice type and grain size range. This includes measurements of the equipment, which are subsequently used to calculate the mass and density of the ice sample in Table S1, then granular carbon dioxide ice measurements (Tables S2 – S12) and granular water ice measurements (Tables S13 – S24).

Light intensity measurements were made through samples of granular carbon dioxide ice and water ice, of discrete grain size ranges, at decreasing ice thicknesses. Measurements were made using a pyranometer (in millivolts) and a solar simulator lamp; four measurements were made per ice thickness. Details of the experimental set up and procedure can be found in the main manuscript, Table S1 lists the equipment and its mass, which is used to calculate the density of each sample. Multiple samples were used for each measurement which were then averaged to give the results presented in the main body of the paper. All ice samples were stored in sealed containers in the freezer at -86°C, and used on the same day of sample preparation.

Equipment	Mass (g)
20 mm copper ring	83.40
10 mm copper ring	41.73
5 mm copper ring	20.70
Sample base holder	8.28

**Table S1.** Equipment which was used to contain the ice samples were weighed in order to determine mass of snow without having to remove the equipment. This reduced the time taken to weigh the samples, meaning that air exposure, and therefore frost deposition and sintering was kept to a minimum. All copper rings were 86 mm in internal diameter.

Grain Size 5.60 – 8.00 mm								
Sample 1					Sample 2			
Total Mass	335.83 g				338.71 g			
Snow Mass	160.75 g				163.63 g			
Volume	2.03 x10 <sup>-4</sup> m <sup>3</sup>				2.03 x10 <sup>-4</sup> m <sup>3</sup>			
Density	790.67 kg m <sup>-3</sup>				804.84 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	36.137	34.725	38.051	35.590	36.402	40.165	39.471	47.552
10 mm	25.308	24.515	26.107	26.842	26.026	22.019	24.102	25.746
15 mm	19.706	20.620	22.038	21.059	19.127	18.893	20.927	20.610
20 mm	15.498	16.216	18.408	17.011	16.886	16.091	16.537	16.360
25 mm	12.606	13.534	18.487	13.251	13.173	12.476	12.767	13.465
30 mm	10.239	10.248	11.385	11.430	10.341	10.007	11.919	11.955
35 mm	7.742	7.259	8.099	9.842	8.038	7.662	9.089	9.742

  

Sample 3					Mean
Total Mass	335.17 g				336.57 g
Snow Mass	160.09 g				161.49 g
Volume	2.03 x10 <sup>-4</sup> m <sup>3</sup>				2.03 x10 <sup>-4</sup> m <sup>3</sup>
Density	787.43 kg m <sup>-3</sup>				794.31 kg m <sup>-3</sup>
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	30.803	34.571	45.394	36.907	37.981
10 mm	23.323	20.561	22.409	23.376	24.194
15 mm	18.153	17.907	18.918	19.590	19.796
20 mm	14.429	15.116	15.356	14.073	15.998
25 mm	11.809	11.037	11.641	12.516	13.064
30 mm	9.508	10.205	9.729	10.715	10.640
35 mm	7.657	7.001	7.414	8.336	8.157

**Table S1.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 3, of grain size range 5.60 – 8.00 mm.

Grain Size 4.00 – 5.60 mm								
Sample 1					Sample 2			
Total Mass	275.70 g				278.55 g			
Snow Mass	142.29 g				145.14 g			
Volume	$1.74 \times 10^{-4} \text{ m}^3$				$1.74 \times 10^{-4} \text{ m}^3$			
Density	$816.52 \text{ kg m}^{-3}$				$832.87 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	30.819	28.661	31.209	30.500	33.187	35.609	35.714	31.536
10 mm	21.139	21.438	22.702	21.290	24.175	24.797	24.923	23.740
15 mm	16.976	17.511	19.235	16.819	18.316	20.031	19.844	18.148
20 mm	13.220	14.487	13.798	13.322	15.734	16.549	17.011	16.093
25 mm	10.231	13.002	10.670	11.558	12.209	14.535	14.290	13.723
30 mm	8.022	8.060	9.313	8.948	9.622	11.068	10.640	11.366
Sample 3					Sample 4			
Total Mass	278.83 g				288.27 g			
Snow Mass	145.42 g				154.86 g			
Volume	$1.74 \times 10^{-4} \text{ m}^3$				$1.74 \times 10^{-4} \text{ m}^3$			
Density	$834.48 \text{ kg m}^{-3}$				$888.65 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	33.179	34.990	36.414	31.382	29.572	31.350	36.899	31.049
10 mm	22.687	26.832	26.293	22.620	19.807	21.178	21.609	21.542
15 mm	19.389	23.042	22.135	17.004	14.977	18.535	18.598	14.892
20 mm	16.593	16.808	14.440	14.851	10.862	13.391	13.763	10.973
25 mm	11.489	15.820	13.962	10.467	8.851	9.930	10.832	9.475
30 mm	9.258	10.552	12.009	9.885	6.386	6.289	7.503	7.690
Sample 5					Mean			
Total Mass	282.07 g				280.68 g			
Snow Mass	148.66 g				147.27 g			
Volume	$1.74 \times 10^{-4} \text{ m}^3$				$1.74 \times 10^{-4} \text{ m}^3$			
Density	$853.07 \text{ kg m}^{-3}$				$845.12 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	Mean			
5 mm	25.615	28.970	27.456	26.171	31.514			
10 mm	17.910	17.348	18.725	18.224	21.949			
15 mm	15.323	16.068	16.012	14.730	17.879			
20 mm	10.869	11.710	12.416	12.147	13.952			
25 mm	9.203	11.151	9.914	9.115	11.521			
30 mm	6.783	8.974	8.523	7.880	8.939			

**Table S2.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 5, of grain size range 4.00 – 5.60 mm.

Grain Size 3.35 – 4.00 mm								
Sample 1					Sample 2			
Total Mass	276.95 g				276.35 g			
Snow Mass	143.54 g				142.94 g			
Volume	1.74E-04				1.74E-04			
Density	823.69 kg m <sup>-3</sup>				820.25 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	19.446	18.224	18.500	19.295	16.949	18.863	20.606	18.192
10 mm	15.322	15.041	16.136	14.150	12.485	14.749	16.087	14.815
15 mm	11.781	11.218	12.265	13.183	10.401	14.326	12.502	13.496
20 mm	9.241	8.989	11.407	10.081	8.126	9.704	10.734	9.530
25 mm	7.352	7.466	7.710	8.662	6.929	8.763	10.889	8.754
30 mm	19.446	18.224	18.500	19.295	16.949	18.863	20.606	18.192

  

Sample 3					Mean
Total Mass	280.91 g				278.07 g
Snow Mass	147.50 g				144.66 g
Volume	1.74 x10 <sup>-4</sup> m <sup>3</sup>				1.74 x10 <sup>-4</sup> m <sup>3</sup>
Density	846.42 kg m <sup>-3</sup>				830.12 kg m <sup>-3</sup>
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	18.183	18.521	18.402	18.204	18.615
10 mm	13.275	14.616	12.827	14.077	14.465
15 mm	10.389	12.930	11.040	11.541	12.089
20 mm	8.036	9.581	8.599	10.848	9.573
25 mm	6.756	8.974	7.203	7.555	8.084
30 mm	18.183	18.521	18.402	18.204	18.615

**Table S3.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 3, of grain size range 3.35 – 4.00 mm.

Grain Size 2.00 – 3.35 mm								
Sample 1					Sample 2			
Total Mass	277.64 g				233.40 g			
Snow Mass	144.23 g				121.02 g			
Volume	1.74 x10 <sup>-4</sup> m <sup>3</sup>				1.45 x10 <sup>-4</sup> m <sup>3</sup>			
Density	827.65 kg m <sup>-3</sup>				833.36 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	30.279	31.750	29.478	28.563	24.908	25.459	27.328	25.981
10 mm	20.855	21.359	19.382	19.707	18.689	17.077	17.634	18.320
15 mm	13.245	14.200	13.814	13.476	12.977	13.560	13.121	13.324
20 mm	12.196	13.171	12.495	11.557	10.267	10.371	10.662	10.710
25 mm	8.731	10.208	9.417	9.189	7.719	8.542	7.801	10.023
30 mm	6.568	6.277	6.441	8.622	-	-	-	-

  

Sample 3					Mean
Total Mass	239.31 g				250.12 g
Snow Mass	126.93 g				130.73 g
Volume	1.45 x10 <sup>-4</sup> m <sup>3</sup>				1.55 x10 <sup>-4</sup> m <sup>3</sup>
Density	874.05 kg m <sup>-3</sup>				845.02 kg m <sup>-3</sup>
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	25.640	24.432	24.051	26.350	27.018
10 mm	18.887	17.628	17.803	19.475	18.901
15 mm	13.640	12.971	14.805	13.371	13.542
20 mm	10.166	10.280	10.963	10.705	11.129
25 mm	7.745	8.122	9.364	8.780	8.803
30 mm	-	-	-	-	6.977

**Table S4.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 3, of grain size range 2.00 – 3.35 mm.

Grain Size 1.18 – 2.00 mm								
Sample 1					Sample 2			
Total Mass	238.87 g				231.01 g			
Snow Mass	126.49 g				118.63 g			
Volume	1.45 x10 <sup>-4</sup> m <sup>3</sup>				1.45 x10 <sup>-4</sup> m <sup>3</sup>			
Density	871.02 kg m <sup>-3</sup>				816.90 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	23.779	24.972	25.748	23.693	22.572	21.506	22.186	24.583
10 mm	15.579	15.460	17.123	17.831	13.838	14.601	15.499	15.655
15 mm	10.564	14.158	13.872	11.536	9.550	11.603	13.591	12.136
20 mm	8.239	8.991	11.989	10.263	8.004	10.191	9.839	10.975
25 mm	6.204	7.572	9.070	7.955	6.407	8.028	9.541	9.154

  

Sample 3					Mean
Total Mass	235.64 g				235.17 g
Snow Mass	123.26 g				122.79 g
Volume	1.45 x10 <sup>-4</sup> m <sup>3</sup>				1.45 x10 <sup>-4</sup> m <sup>3</sup>
Density	848.78 kg m <sup>-3</sup>				845.57 kg m <sup>-3</sup>
Ice Depth	Light Intensity (mV)				Mean
	1	2	3	4	Mean
5 mm	21.018	22.004	20.957	22.986	23.000
10 mm	13.114	14.022	16.081	16.150	15.413
15 mm	9.539	10.996	13.890	12.003	11.953
20 mm	7.652	9.225	10.573	10.102	9.670
25 mm	6.228	7.623	8.897	9.066	7.979

**Table S5.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 3, of grain size range 1.18 – 2.00 mm.

Grain Size 1.00 – 1.18 mm								
Sample 1					Sample 2			
Total Mass	308.61 g				230.51 g			
Snow Mass	154.50 g				118.13 g			
Volume	$2.03 \times 10^{-4} \text{ m}^3$				$1.45 \times 10^{-4} \text{ m}^3$			
Density	759.93 kg m <sup>-3</sup>				813.45			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	20.051	20.809	25.110	21.993	24.548	24.164	24.082	23.122
10 mm	13.132	15.875	16.043	14.459	15.106	16.145	15.908	14.429
15 mm	10.377	14.711	14.271	12.400	11.445	13.482	13.177	10.736
20 mm	9.089	11.049	11.171	11.136	8.121	10.903	8.685	9.987
25 mm	6.923	10.664	12.554	9.750	6.133	7.057	6.193	7.845
30 mm	6.051	11.299	10.006	6.060	-	-	-	-
35 mm	4.671	7.724	9.816	5.932	-	-	-	-

  

Sample 3					Mean
Total Mass	235.00 g				258.04 g
Snow Mass	122.62 g				131.75 g
Volume	$1.45 \times 10^{-4} \text{ m}^3$				$1.65 \times 10^{-4} \text{ m}^3$
Density	844.37 kg m <sup>-3</sup>				805.92
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	20.976	19.708	20.304	20.770	22.136
10 mm	13.916	14.263	14.058	12.955	14.691
15 mm	10.137	11.414	11.655	9.867	11.973
20 mm	9.359	10.931	12.024	8.293	10.062
25 mm	6.152	6.805	7.187	6.015	7.773
30 mm	-	-	-	-	8.354
35 mm	-	-	-	-	7.036

**Table S6.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 3, of grain size range 1.00 – 1.18 mm.

Grain Size 0.85 – 1.00 mm								
Sample 1					Sample 2			
Total Mass	302.72 g				228.01 g			
Snow Mass	148.61 g				115.63 g			
Volume	2.03 x10 <sup>-4</sup> m <sup>3</sup>				1.45 x10 <sup>-4</sup> m <sup>3</sup>			
Density	730.96 kg m <sup>-3</sup>				796.24 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	18.969	24.781	22.968	18.618	22.178	20.199	20.121	24.072
10 mm	12.410	16.815	20.031	15.805	13.998	13.983	13.414	13.558
15 mm	8.737	16.044	20.183	12.807	12.579	13.082	12.849	11.099
20 mm	7.629	15.762	15.668	9.319	9.931	11.076	9.771	8.045
25 mm	5.862	11.884	8.837	7.337	6.681	8.391	6.287	6.625
30 mm	5.717	5.876	7.515	6.725	-	-	-	-
35 mm	4.407	5.184	6.912	7.530	-	-	-	-

  

Sample 3					Mean
Total Mass	228.62 g				253.12 g
Snow Mass	116.24 g				126.83 g
Volume	1.45 x10 <sup>-4</sup> m <sup>3</sup>				1.65 x10 <sup>-4</sup> m <sup>3</sup>
Density	800.44 kg m <sup>-3</sup>				775.88 kg m <sup>-3</sup>
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	25.830	24.897	24.740	24.544	22.660
10 mm	14.202	13.844	13.134	13.962	14.596
15 mm	11.378	12.724	11.296	10.211	12.749
20 mm	8.230	9.705	8.499	7.807	10.120
25 mm	6.028	7.479	6.459	6.837	7.392
30 mm	-	-	-	-	6.458
35 mm	-	-	-	-	6.008

**Table S7.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 3, of grain size range 0.85 – 1.00 mm.



Grain Size 0.71 – 0.85 mm								
Sample 1					Sample 2			
Total Mass	229.00 g				232.61 g			
Snow Mass	116.62 g				120.23 g			
Volume	1.45 x10 <sup>-4</sup> m <sup>-3</sup>				1.45 x10 <sup>-4</sup> m <sup>-3</sup>			
Density	803.06 kg m <sup>-3</sup>				827.92 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	21.671	21.546	20.503	20.285	18.595	17.716	19.393	17.140
10 mm	13.146	13.983	12.857	12.452	12.255	12.342	13.870	11.669
15 mm	10.288	12.033	11.316	9.312	8.427	8.058	10.603	8.467
20 mm	7.041	8.556	7.757	7.584	7.041	8.439	8.316	7.034
25 mm	6.329	7.862	6.346	5.567	4.945	4.641	7.976	5.893

Sample 3					Sample 4			
Total Mass	234.49 g				234.31 g			
Snow Mass	122.11 g				121.93 g			
Volume	1.45 x10 <sup>-4</sup> m <sup>-3</sup>				1.45 x10 <sup>-4</sup> m <sup>-3</sup>			
Density	840.86 kg m <sup>-3</sup>				839.62 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	18.075	16.589	17.707	17.327	19.337	19.635	21.374	19.967
10 mm	11.842	11.257	12.918	11.583	12.039	15.459	16.125	13.904
15 mm	9.184	8.091	9.636	8.592	10.157	12.653	13.150	10.378
20 mm	6.538	7.880	7.874	8.999	6.518	11.374	10.103	9.453
25 mm	5.885	6.283	10.473	6.241	5.267	8.512	8.726	7.884

Mean	
Total Mass	233.80 g
Snow Mass	121.42 g
Volume	1.45 x10 <sup>-4</sup> m <sup>-3</sup>
Density	836.13 kg m <sup>-3</sup>
Ice Depth	(mV)
	Mean
5 mm	19.179
10 mm	12.981
15 mm	10.022
20 mm	8.157
25 mm	6.802

**Table S8.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 4, of grain size range 0.71 – 0.85 mm.

Grain Size 0.60 – 0.71 mm								
Sample 1					Sample 2			
Total Mass	215.32 g				184.62 g			
Snow Mass	102.94 g				72.24 g			
Volume	1.45 x10 <sup>-4</sup> m <sup>3</sup>				1.16 x10 <sup>-4</sup> m <sup>3</sup>			
Density	708.85 kg m <sup>-3</sup>				621.81 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	22.118	21.175	18.203	19.763	15.809	15.791	17.744	14.988
10 mm	11.377	11.921	11.498	13.244	10.626	10.740	11.732	11.215
15 mm	8.955	11.136	11.085	9.070	7.265	8.433	10.814	7.703
20 mm	7.522	8.868	8.524	6.750	6.713	7.238	8.157	8.677
25 mm	6.274	7.851	5.927	6.291	-	-	-	-

  

Sample 3					Mean
Total Mass	189.71 g				196.55 g
Snow Mass	77.33 g				84.17 g
Volume	1.16 x10 <sup>-4</sup> m <sup>3</sup>				1.26 x10 <sup>-4</sup> m <sup>3</sup>
Density	665.63 kg m <sup>-3</sup>				665.43 kg m <sup>-3</sup>
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	17.933	18.640	16.631	17.015	17.984
10 mm	10.436	9.762	12.470	10.516	11.295
15 mm	6.803	7.358	8.205	7.026	8.654
20 mm	5.560	6.873	7.071	5.566	7.293
25 mm	-	-	-	-	6.586

**Table S9.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 3, of grain size range 0.60 – 0.71 mm.

Grain Size 0.50 – 0.60 mm								
Sample 1					Sample 2			
Total Mass	171.34 g				186.12 g			
Snow Mass	79.66 g				94.44 g			
Volume	$1.16 \times 10^{-4} \text{ m}^3$				$1.16 \times 10^{-4} \text{ m}^3$			
Density	$685.68 \text{ kg m}^{-3}$				$812.90 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	16.775	16.274	15.325	17.402	13.616	16.667	14.969	15.435
10 mm	11.210	11.771	10.764	10.691	11.023	11.327	12.996	9.789
15 mm	7.136	9.791	8.235	8.533	7.940	10.410	8.403	6.528
20 mm	5.441	7.283	6.438	6.455	6.531	6.910	8.837	5.246

  

Sample 3					Sample 4			
Total Mass	170.22 g				180.41 g			
Snow Mass	78.54 g				88.73 g			
Volume	$1.16 \times 10^{-4} \text{ m}^3$				$1.16 \times 10^{-4} \text{ m}^3$			
Density	$676.04 \text{ kg m}^{-3}$				$763.75 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	13.856	21.498	18.220	15.775	17.984	21.492	20.309	18.262
10 mm	8.632	15.955	11.030	8.257	9.756	13.691	12.065	11.396
15 mm	7.543	9.092	11.131	6.144	7.650	10.448	11.359	8.919
20 mm	4.129	8.516	6.051	5.856	5.034	6.792	8.868	7.753

  

Mean	
Total Mass	178.92 g
Snow Mass	87.24 g
Volume	$1.16 \times 10^{-4} \text{ m}^3$
Density	$750.90 \text{ kg m}^{-3}$
Ice Depth	(mV)
	Mean
5 mm	17.116
10 mm	11.272
15 mm	8.704
20 mm	6.634

**Table S10.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 4, of grain size range 0.50 – 0.60 mm.

Grain Size 0.355 – 0.500 mm								
Sample 1					Sample 2			
Total Mass	169.30 g				180.02 g			
Snow Mass	77.62 g				88.34 g			
Volume	$1.16 \times 10^{-4} \text{ m}^3$				$1.16 \times 10^{-4} \text{ m}^3$			
Density	$668.12 \text{ kg m}^{-3}$				$760.40 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	15.823	16.909	16.872	16.233	13.815	14.446	15.524	12.667
10 mm	7.705	10.603	9.688	8.111	8.884	11.039	9.195	8.810
15 mm	5.951	7.392	8.863	7.807	5.751	7.754	8.010	6.783
20 mm	3.844	5.499	6.332	4.497	4.915	4.330	5.713	6.015

  

Sample 3					Sample 4			
Total Mass	178.09 g				172.04 g			
Snow Mass	86.41 g				80.36 g			
Volume	$1.16 \times 10^{-4} \text{ m}^3$				$1.16 \times 10^{-4} \text{ m}^3$			
Density	$743.78 \text{ kg m}^{-3}$				$691.71 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	14.237	15.973	17.891	14.395	14.375	16.678	18.716	15.944
10 mm	8.219	9.922	11.005	7.887	9.020	12.801	12.693	10.009
15 mm	5.504	6.577	9.856	6.872	6.571	10.083	10.374	8.370
20 mm	4.087	4.929	6.625	4.801	5.423	7.471	7.506	7.397

  

Mean	
Total Mass	176.72 g
Snow Mass	85.04 g
Volume	$1.16 \times 10^{-4} \text{ m}^3$
Density	$731.96 \text{ kg m}^{-3}$
Ice Depth	(mV)
	Mean
5 mm	15.656
10 mm	9.724
15 mm	7.657
20 mm	5.587

**Table S11.** Raw light intensity measurements through granular carbon dioxide ice Samples 1 – 4, of grain size range 0.355 – 0.500 mm.



	<b>Mean</b>
Total Mass	276.79 g
Snow Mass	119.19 g
Volume	$2.08 \times 10^{-4} \text{ m}^3$
Density	$573.32 \text{ kg m}^{-3}$
<b>Ice Depth</b>	<b>(mV)</b>
	<b>Mean</b>
5 mm	44.747
10 mm	26.310
15 mm	17.387
20 mm	13.136
25 mm	10.189
30 mm	8.598
35 mm	6.125
40 mm	4.469

**Table S12.** Raw light intensity measurements through granular water ice Samples 1 – 6, of grain size range 5.60 – 8.00 mm.

Grain Size 4.00 – 5.56 mm								
Sample 1					Sample 2			
Total Mass	230.35 g				230.07 g			
Snow Mass	96.94 g				96.66 g			
Volume	$1.74 \times 10^{-4} \text{ m}^3$				$1.74 \times 10^{-4} \text{ m}^3$			
Density	$556.28 \text{ kg m}^{-3}$				$554.68 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	44.827	43.739	45.021	48.032	46.229	44.807	45.956	39.736
10 mm	21.332	19.016	20.597	24.626	21.745	20.164	21.198	24.473
15 mm	15.198	14.189	15.478	16.452	16.086	13.431	15.545	16.732
20 mm	12.608	12.564	11.061	13.669	11.303	11.380	9.705	13.204
25 mm	10.037	10.340	8.351	12.024	8.926	7.989	7.288	10.132

  

Sample 3					Sample 4			
Total Mass	224.96 g				228.83 g			
Snow Mass	91.55 g				95.42 g			
Volume	$1.74 \times 10^{-4} \text{ m}^3$				$1.74 \times 10^{-4} \text{ m}^3$			
Density	$525.35 \text{ kg m}^{-3}$				$547.56 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	44.245	37.833	49.293	63.256	39.854	40.066	35.758	35.081
10 mm	23.009	22.795	24.962	30.360	24.543	24.595	22.980	22.811
15 mm	15.073	16.748	14.683	17.062	18.431	21.392	20.357	16.639
20 mm	12.931	12.959	11.108	14.409	13.946	15.067	13.799	12.670
25 mm	9.687	8.886	8.360	10.807	9.587	10.448	8.556	9.814

  

Sample 5					Mean
Total Mass	225.85 g				228.01 g
Snow Mass	92.44 g				94.60 g
Volume	$1.74 \times 10^{-4} \text{ m}^3$				$1.74 \times 10^{-4} \text{ m}^3$
Density	$530.46 \text{ kg m}^{-3}$				$542.87 \text{ kg m}^{-3}$
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	48.362	31.457	53.061	45.870	44.124
10 mm	22.050	21.968	21.370	24.933	22.976
15 mm	18.412	19.279	17.955	16.662	16.790
20 mm	14.021	13.830	13.984	12.409	12.831
25 mm	11.076	10.155	11.815	8.769	9.652

**Table S13.** Raw light intensity measurements through granular water ice Samples 1 – 5, of grain size range 4.00 – 5.56 mm.

Grain Size 3.35 – 4.00 mm								
Sample 1					Sample 2			
Total Mass	227.29 g				222.91 g			
Snow Mass	93.88 g				89.50 g			
Volume	1.74 x10 <sup>-4</sup> m <sup>3</sup>				1.74 x10 <sup>-4</sup> m <sup>3</sup>			
Density	538.72 kg m <sup>-3</sup>				513.59 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	29.369	26.266	30.008	43.532	26.955	28.190	27.173	26.957
10 mm	17.489	16.926	15.227	20.629	16.706	18.328	15.620	17.819
15 mm	13.656	15.031	16.697	15.038	12.605	12.258	14.395	14.193
20 mm	10.506	9.474	9.327	11.876	10.467	16.355	13.521	10.020
25 mm	8.649	7.753	7.868	10.736	7.365	8.893	7.930	9.867
30 mm	5.459	4.930	7.168	8.167	5.182	9.745	6.447	8.786
Sample 3					Sample 4			
Total Mass	225.07 g				222.85 g			
Snow Mass	91.66 g				89.44 g			
Volume	1.74 x10 <sup>-4</sup> m <sup>3</sup>				1.74 x10 <sup>-4</sup> m <sup>3</sup>			
Density	525.98 kg m <sup>-3</sup>				513.24 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	28.439	34.605	27.694	25.529	38.153	38.604	40.852	32.040
10 mm	18.992	20.097	19.189	19.282	22.377	24.978	28.697	23.699
15 mm	13.611	13.875	18.751	14.203	15.562	19.234	18.761	15.744
20 mm	9.315	10.079	11.973	12.412	12.271	14.980	13.073	11.664
25 mm	8.273	9.195	9.466	10.013	8.306	10.178	8.591	8.806
30 mm	5.175	6.475	7.588	8.174	6.993	7.107	6.998	7.631
Sample 5					Mean			
Total Mass	224.09 g				224.44 g			
Snow Mass	90.68 g				91.03 g			
Volume	1.74 x10 <sup>-4</sup> m <sup>3</sup>				1.74 x10 <sup>-4</sup> m <sup>3</sup>			
Density	520.36 kg m <sup>-3</sup>				522.38 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	Mean			
5 mm	36.553	33.948	35.271	40.165	31.523			
10 mm	22.005	22.547	22.894	25.872	19.753			
15 mm	18.293	15.637	20.120	16.632	15.226			
20 mm	13.182	12.432	16.120	12.285	11.707			
25 mm	9.372	10.966	10.728	7.636	8.868			
30 mm	5.734	7.251	7.291	6.450	7.002			

**Table S14.** Raw light intensity measurements through granular water ice Samples 1 – 5, of grain size range 3.35 – 4.00 mm.



Grain Size 2.00 – 3.35 mm								
Sample 1					Sample 2			
Total Mass	222.27 g				224.01 g			
Snow Mass	88.86 g				90.60 g			
Volume	1.74 x10 <sup>-4</sup> m <sup>3</sup>				1.74 x10 <sup>-4</sup> m <sup>3</sup>			
Density	509.92 kg m <sup>-3</sup>				519.90 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	18.885	24.859	19.527	21.864	24.780	17.402	20.466	26.445
10 mm	10.749	15.945	15.688	12.361	11.341	12.132	11.667	15.540
15 mm	9.577	14.290	14.995	9.156	8.281	16.134	8.687	9.152
20 mm	7.647	10.172	10.164	8.635	7.864	10.236	12.073	7.162
25 mm	6.056	9.122	9.296	8.751	5.129	10.905	9.622	6.611
30 mm	3.496	4.457	5.645	5.906	3.342	4.204	6.971	7.489
Sample 3					Sample 4			
Total Mass	225.64 g				221.51 g			
Snow Mass	92.23 g				88.10 g			
Volume	1.74 x10 <sup>-4</sup> m <sup>3</sup>				1.74 x10 <sup>-4</sup> m <sup>3</sup>			
Density	529.25 kg m <sup>-3</sup>				505.55 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	21.796	22.219	24.981	26.015	34.417	35.179	32.735	29.979
10 mm	16.602	17.800	16.296	18.157	18.639	19.891	21.293	18.198
15 mm	11.854	13.356	12.054	11.971	13.970	16.946	18.132	13.045
20 mm	9.437	10.119	11.764	11.838	11.136	13.429	12.478	10.521
25 mm	8.207	11.043	12.297	10.359	9.594	9.792	11.481	8.536
30 mm	4.486	6.837	4.608	7.093	5.166	5.880	4.876	6.535
Sample 5					Mean			
Total Mass	231.85 g				225.06 g			
Snow Mass	98.44 g				91.65 g			
Volume	1.74 x10 <sup>-4</sup> m <sup>3</sup>				1.74 x10 <sup>-4</sup> m <sup>3</sup>			
Density	564.89 kg m <sup>-3</sup>				525.90 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	Mean			
5 mm	31.260	32.831	31.058	27.264	26.198			
10 mm	20.139	26.055	21.447	18.673	16.931			
15 mm	16.575	19.029	17.504	11.959	13.333			
20 mm	12.085	11.849	14.135	9.730	10.624			
25 mm	8.543	7.974	8.019	6.611	8.897			
30 mm	4.780	5.911	6.252	5.936	5.494			

**Table S15.** Raw light intensity measurements through granular water ice Samples 1 – 5, of grain size range 2.00 – 3.35 mm.

Grain Size 1.18 – 2.00 mm								
Sample 1					Sample 2			
Total Mass	185.28 g				185.84 g			
Snow Mass	72.90 g				73.46 g			
Volume	1.45 x10 <sup>-4</sup> m <sup>3</sup>				1.45 x10 <sup>-4</sup> m <sup>3</sup>			
Density	502.00 kg m <sup>-3</sup>				505.85 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	21.895	27.075	19.472	26.167	18.676	20.771	23.182	20.347
10 mm	12.317	11.725	13.696	14.557	10.703	10.871	12.402	13.364
15 mm	9.712	11.805	8.947	12.470	8.004	7.996	10.527	11.059
20 mm	6.681	8.845	9.307	9.589	7.316	10.871	8.447	8.127
25 mm	5.294	8.592	8.854	8.915	4.281	8.129	7.396	8.206

  

Sample 3					Sample 4			
Total Mass	182.54 g				185.27 g			
Snow Mass	70.16 g				72.89 g			
Volume	1.45 x10 <sup>-4</sup> m <sup>3</sup>				1.45 x10 <sup>-4</sup> m <sup>3</sup>			
Density	483.13 kg m <sup>-3</sup>				501.93 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	18.275	22.635	16.601	20.717	25.468	36.758	30.666	27.038
10 mm	10.583	13.149	10.079	13.885	17.041	20.914	26.603	18.261
15 mm	7.559	10.680	8.374	10.986	11.971	18.162	17.936	11.899
20 mm	6.032	9.923	7.489	9.787	7.752	11.166	12.301	9.469
25 mm	4.971	8.996	9.894	8.117	5.614	6.902	8.237	7.205

  

Sample 5					Mean
Total Mass	192.89 g				186.36 g
Snow Mass	80.51 g				73.98 g
Volume	1.45 x10 <sup>-4</sup> m <sup>3</sup>				1.45 x10 <sup>-4</sup> m <sup>3</sup>
Density	554.40 kg m <sup>-3</sup>				509.46 kg m <sup>-3</sup>
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	26.408	29.449	26.032	28.587	24.311
10 mm	16.870	16.057	17.306	14.554	14.747
15 mm	11.402	14.573	15.641	11.987	11.585
20 mm	8.491	10.217	9.828	8.745	9.019
25 mm	4.279	5.353	6.174	6.520	7.096

**Table S16.** Raw light intensity measurements through granular water ice Samples 1 – 5, of grain size range 1.18 - 2.00 mm.

Grain Size 1.00 – 1.18 mm								
Sample 1					Sample 2			
Total Mass	188.04 g				147.68 g			
Snow Mass	75.66 g				56.00 g			
Volume	1.45 x10 <sup>-4</sup> m <sup>3</sup>				1.16 x10 <sup>-4</sup> m <sup>3</sup>			
Density	521.00 kg m <sup>-3</sup>				482.03 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	20.042	19.760	21.046	22.675	19.338	22.939	20.810	21.842
10 mm	13.946	15.201	14.759	15.081	14.027	14.036	16.470	13.789
15 mm	8.733	8.816	7.954	11.609	9.847	15.404	12.625	9.376
20 mm	6.555	9.132	10.006	10.075	7.380	8.643	9.515	9.816
25 mm	5.271	4.375	5.530	8.356	-	-	-	-

  

Sample 3					Sample 4			
Total Mass	144.46 g				152.03 g			
Snow Mass	52.78 g				60.35 g			
Volume	1.16 x10 <sup>-4</sup> m <sup>3</sup>				1.16 x10 <sup>-4</sup> m <sup>3</sup>			
Density	454.31 kg m <sup>-3</sup>				519.47 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	16.086	14.879	15.090	15.267	19.282	23.841	20.546	21.567
10 mm	8.634	9.737	8.679	9.962	11.994	16.789	16.645	12.524
15 mm	5.569	7.208	6.639	4.760	7.563	12.242	14.889	8.487
20 mm	4.671	6.650	5.177	6.652	5.608	9.054	9.576	7.089
25 mm	-	-	-	-	-	-	-	-

  

Sample 5					Mean
Total Mass	151.67 g				156.78 g
Snow Mass	59.99 g				60.96 g
Volume	1.16 x10 <sup>-4</sup> m <sup>3</sup>				1.22 x10 <sup>-4</sup> m <sup>3</sup>
Density	516.37 kg m <sup>-3</sup>				498.64 kg m <sup>-3</sup>
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	19.023	19.949	20.104	19.430	19.676
10 mm	11.602	14.435	12.366	10.670	13.067
15 mm	7.607	8.516	10.028	7.259	9.257
20 mm	5.525	5.804	7.721	5.214	7.493
25 mm	-	-	-	-	5.883

**Table S17.** Raw light intensity measurements through granular water ice Samples 1 – 5, of grain size range 1.00 – 1.18 mm.

Grain Size 0.85 – 1.00 mm								
Sample 1					Sample 2			
Total Mass	148.44 g				142.70 g			
Snow Mass	56.76 g				51.02 g			
Volume	$1.16 \times 10^{-4} \text{ m}^3$				$1.16 \times 10^{-4} \text{ m}^3$			
Density	488.57 kg m <sup>-3</sup>				439.16 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	22.264	30.363	21.460	20.810	18.737	19.950	23.288	22.593
10 mm	11.508	19.672	15.375	12.623	11.028	14.850	13.513	12.769
15 mm	8.864	10.670	15.893	9.516	6.869	7.015	9.011	9.072
20 mm	7.732	10.230	12.153	8.587	5.924	7.966	9.505	7.519

  

Sample 3					Sample 4			
Total Mass	142.35 g				146.26 g			
Snow Mass	50.67 g				54.58 g			
Volume	$1.16 \times 10^{-4} \text{ m}^3$				$1.16 \times 10^{-4} \text{ m}^3$			
Density	436.15 kg m <sup>-3</sup>				469.80 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	12.246	11.950	12.181	13.340	21.107	23.598	23.888	23.579
10 mm	6.443	5.896	7.925	6.997	11.709	13.662	19.509	15.254
15 mm	3.920	4.361	4.932	5.273	12.093	15.319	13.633	10.752
20 mm	3.238	2.431	3.663	4.984	5.666	9.837	8.142	5.804

  

Sample 5					Mean
Total Mass	149.45 g				145.84 g
Snow Mass	57.77 g				54.16 g
Volume	$1.16 \times 10^{-4} \text{ m}^3$				$1.16 \times 10^{-4} \text{ m}^3$
Density	497.26 kg m <sup>-3</sup>				466.19 kg m <sup>-3</sup>
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	18.571	20.816	23.549	20.081	20.085
10 mm	11.296	14.650	15.455	13.271	12.421
15 mm	7.044	10.097	11.361	8.018	9.200
20 mm	7.369	8.505	9.624	5.971	7.086

**Table S18.** Raw light intensity measurements through granular water ice Samples 1 – 5, of grain size range 0.85 – 1.00 mm.

Grain Size 0.71 – 0.85 mm								
Sample 1					Sample 2			
Total Mass	142.70 g				142.79 g			
Snow Mass	51.02 g				51.11 g			
Volume	1.16 x10 <sup>-4</sup> m <sup>3</sup>				1.16 x10 <sup>-4</sup> m <sup>3</sup>			
Density	439.16 kg m <sup>-3</sup>				439.94 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	17.659	19.596	23.213	18.875	18.469	15.543	17.392	20.740
10 mm	8.194	14.588	11.486	13.443	9.082	15.901	11.260	10.362
15 mm	6.105	8.207	10.474	8.293	6.612	8.355	7.836	6.258
20 mm	5.445	7.881	8.679	8.066	4.862	7.929	8.117	6.525

  

Sample 3					Sample 4			
Total Mass	139.38 g				140.95 g			
Snow Mass	47.70 g				49.27 g			
Volume	1.16 x10 <sup>-4</sup> m <sup>3</sup>				1.16 x10 <sup>-4</sup> m <sup>3</sup>			
Density	410.58 kg m <sup>-3</sup>				424.10 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	16.977	14.687	15.198	17.637	15.607	14.904	17.566	16.378
10 mm	8.348	10.332	8.693	10.138	10.303	11.038	8.427	12.523
15 mm	5.159	5.931	5.446	7.498	7.221	11.027	9.211	10.823
20 mm	3.960	3.625	4.821	5.613	3.789	5.537	8.020	5.037

  

Sample 5					Mean
Total Mass	142.45 g				141.65 g
Snow Mass	50.77 g				49.97 g
Volume	1.16 x10 <sup>-4</sup> m <sup>3</sup>				1.16 x10 <sup>-4</sup> m <sup>3</sup>
Density	437.01 kg m <sup>-3</sup>				430.16 kg m <sup>-3</sup>
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	15.615	19.476	19.842	19.306	17.528
10 mm	8.848	15.186	14.548	11.261	10.882
15 mm	5.868	9.376	11.034	7.423	7.779
20 mm	5.309	10.385	8.807	6.528	6.119

**Table S19.** Raw light intensity measurements through granular water ice Samples 1 – 5, of grain size range 0.71 – 0.85 mm.

Grain Size 0.60 – 0.71 mm								
Sample 1					Sample 2			
Total Mass	140.37 g				108.03 g			
Snow Mass	48.69 g				37.32 g			
Volume	$1.16 \times 10^{-4} \text{ m}^3$				$8.71 \times 10^{-5} \text{ m}^3$			
Density	$419.11 \text{ kg m}^{-3}$				$428.32 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	10.782	9.968	10.105	12.456	11.357	11.161	10.795	12.426
10 mm	5.932	5.859	5.204	7.025	5.637	5.558	5.642	6.023
15 mm	3.529	4.073	3.826	4.979	2.604	3.339	3.680	4.457
20 mm	2.749	4.750	2.515	4.442	-	-	-	-

  

Sample 3					Sample 4			
Total Mass	112.86 g				117.06 g			
Snow Mass	42.15 g				46.35 g			
Volume	$8.71 \times 10^{-5} \text{ m}^3$				$8.71 \times 10^{-5} \text{ m}^3$			
Density	$483.75 \text{ kg m}^{-3}$				$531.95 \text{ kg m}^{-3}$			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	16.140	13.497	15.942	16.978	14.423	13.208	15.575	15.751
10 mm	5.637	5.558	5.642	6.023	7.300	9.576	10.017	10.520
15 mm	3.612	3.059	2.810	4.477	4.425	7.309	8.116	8.908
20 mm	-	-	-	-	-	-	-	-

  

Sample 5					Mean
Total Mass	111.75 g				118.01 g
Snow Mass	41.04 g				43.11 g
Volume	$8.71 \times 10^{-5} \text{ m}^3$				$9.29 \times 10^{-5} \text{ m}^3$
Density	$471.01 \text{ kg m}^{-3}$				$466.83 \text{ kg m}^{-3}$
Ice Depth	Light Intensity (mV)				
	1	2	3	4	Mean
5 mm	15.713	14.420	14.619	14.261	13.479
10 mm	7.372	10.058	11.671	8.338	7.230
15 mm	6.074	6.963	10.309	5.276	5.091
20 mm	-	-	-	-	3.614

**Table S20.** Raw light intensity measurements through granular water ice Samples 1 – 5, of grain size range 0.60 – 0.71 mm.

Grain Size 0.50 – 0.60 mm								
Sample 1					Sample 2			
Total Mass	112.08 g				110.21 g			
Snow Mass	41.37 g				39.50 g			
Volume	$8.71 \times 10^{-5} \text{ m}^3$				$8.71 \times 10^{-5} \text{ m}^3$			
Density	474.80 kg m <sup>-3</sup>				453.33 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	11.994	10.460	11.322	12.649	11.983	11.577	11.457	12.654
10 mm	5.934	8.083	7.980	7.942	6.484	7.967	6.825	7.353
15 mm	3.378	3.381	3.408	5.071	3.090	3.984	3.847	4.915
Sample 3					Sample 4			
Total Mass	112.64 g				104.18 g			
Snow Mass	41.93 g				33.47 g			
Volume	$8.71 \times 10^{-5} \text{ m}^3$				$8.71 \times 10^{-5} \text{ m}^3$			
Density	481.22 kg m <sup>-3</sup>				384.13 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	12.630	10.792	11.710	12.796	12.099	11.636	10.278	13.638
10 mm	5.287	8.050	6.881	7.476	5.589	6.408	7.407	8.512
15 mm	3.519	2.718	3.625	4.838	3.278	3.107	5.694	4.895
Sample 5					Mean			
Total Mass	102.67 g				108.36 g			
Snow Mass	31.96 g				37.65 g			
Volume	$8.71 \times 10^{-5} \text{ m}^3$				$8.71 \times 10^{-5} \text{ m}^3$			
Density	366.80 kg m <sup>-3</sup>				432.06 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	Mean			
5 mm	10.497	14.303	12.409	11.081	11.898			
10 mm	5.765	6.009	8.471	6.728	7.058			
15 mm	2.946	3.482	6.203	4.618	4.000			

**Table S21.** Raw light intensity measurements through granular water ice Samples 1 – 5, of grain size range 0.50 – 0.60 mm.

Grain Size 0.355 – 0.500 mm								
Sample 1					Sample 2			
Total Mass	106.95 g				107.91 g			
Snow Mass	36.24 g				37.20 g			
Volume	$8.71 \times 10^{-5} \text{ m}^3$				$8.71 \times 10^{-5} \text{ m}^3$			
Density	415.92 kg m <sup>-3</sup>				426.94 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	12.292	9.740	11.963	14.467	12.275	11.098	11.456	12.218
10 mm	5.732	5.814	5.853	6.737	4.880	5.258	5.755	6.243
15 mm	3.730	3.206	2.131	4.262	2.517	3.046	3.286	3.020
Sample 3					Sample 4			
Total Mass	110.87 g				103.06 g			
Snow Mass	40.16 g				32.35 g			
Volume	$8.71 \times 10^{-5} \text{ m}^3$				$8.71 \times 10^{-5} \text{ m}^3$			
Density	460.91 kg m <sup>-3</sup>				371.28			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	1	2	3	4
5 mm	9.866	9.863	13.659	11.430	11.874	16.981	18.446	10.339
10 mm	4.198	5.024	6.717	8.090	5.466	9.374	8.819	6.250
15 mm	2.502	2.411	3.438	5.273	2.050	5.793	4.487	3.988
Sample 5					Mean			
Total Mass	103.90 g				106.54 g			
Snow Mass	33.19 g				35.83 g			
Volume	$8.71 \times 10^{-5} \text{ m}^3$				$8.71 \times 10^{-5} \text{ m}^3$			
Density	380.92 kg m <sup>-3</sup>				411.19 kg m <sup>-3</sup>			
Ice Depth	Light Intensity (mV)							
	1	2	3	4	Mean			
5 mm	13.104	17.888	13.817	11.731	12.725			
10 mm	6.143	8.374	7.908	6.839	6.474			
15 mm	3.083	4.441	6.701	3.528	3.645			

**Table S22.** Raw light intensity measurements through granular water ice Samples 1 – 5, of grain size range 0.355 – 0.500 mm.