

Supplement of Atmos. Chem. Phys., 17, 7311–7332, 2017
<https://doi.org/10.5194/acp-17-7311-2017-supplement>
© Author(s) 2017. This work is distributed under
the Creative Commons Attribution 3.0 License.



Supplement of

Aerosol indirect effects on the nighttime Arctic Ocean surface from thin, predominantly liquid clouds

Lauren M. Zamora et al.

Correspondence to: Lauren M. Zamora (lauren.m.zamora@nasa.gov)

The copyright of individual parts of the supplement might differ from the CC BY 3.0 License.

Supplementary Notes on MOONLiT cloud selection criteria:

If the MOONLiT criteria were changed to include a) clouds with bases that were 200 m instead of 1 km above the surface, b) clouds above a separate ice cloud, or c) clouds below other non-opaque cloud layers (icy or otherwise), the MOONLiT cloud sample size would respectively have increased by 107 (121), 16 (28), and 303 (617)% over sea ice (open ocean). Any other differences between the MOONLiT cloud subset and the ONLi cloud subset was due to cases where uncertain aerosol CAD scores (<70) existed somewhere above or beneath cloud layer of interest. These clouds were allowed in the ONLi cloud subset, but not in the MOONLiT cloud subset.

Table S1. Median (interquartile range) and sample number (n) of Arctic Ocean ONLi cloud properties over sea ice, separated by altitude bins as classified by the criteria in Table 1 and by radar reflectivity above and below detection limit (DL, -29 dBZ). Red (grey) color indicates significant (not significant) differences compared to clean background clouds, as determined at 95% confidence using a permutation test.

Attribute	Reflectivity	Clean, < 1.1 km	n	All clouds, < 1.1 km	n	Aerosol-impacted ^a , < 1.1 km	n
<i>Base T (°C)</i>	> DL	-16.9 (-19.8 to -13.7)	1063	-18.4 (-21.7 to -14.8)	4809	-18.2 (-22.0 to -13.7)	133
	< DL	-14.5 (-16.7 to -10.0)	135	-17.5 (-20.6 to -13.3)	1030	-19.0 (-20.4 to -9.1)	41
	All	-16.5 (-19.6 to -13.0)	1265	-18.2 (-21.4 to -14.5)	6126	-18.1 (-21.4 to -14.5)	180
<i>Top T (°C)</i>	> DL	-19.1 (-22.0 to -16.2)	1063	-20.1 (-23.0 to -16.8)	4809	-20.6 (-23.1 to -16.0)	133
	< DL	-15.3 (-18.3 to -11.0)	135	-18.4 (-20.9 to -14.6)	1030	-19.6 (-21.6 to -13.0)	41
	All	-18.7 (-21.7 to -15.3)	1265	-19.7 (-22.7 to -16.4)	6126	-19.8 (-22.4 to -15.7)	180
<i>Altitude, base (km)</i>	> DL	0.76 (0.58-0.94)	1063	0.76 (0.58-0.94)	4809	0.82 (0.64-1.00)	133
	< DL	0.76 (0.67-0.94)	135	0.82 (0.70-0.94)	1030	0.88 (0.70-1.00)	41
	All	0.76 (0.58-0.94)	1265	0.76 (0.64-0.94)	6126	0.88 (0.64-1.00)	180
<i>Thickness (km)</i>	> DL	0.72 (0.60-1.08)	1063	0.72 (0.60-0.90)	4809	0.66 (0.54-0.90)	133
	< DL	0.60 (0.48-0.72)	135	0.54 (0.48-0.72)	1030	0.60 (0.54-0.66)	41
	All	0.72 (0.60-1.02)	1265	0.66 (0.54-0.84)	6126	0.66 (0.54-0.84)	180
<i>COD</i>	> DL	1.79 (0.96-2.58)	823	1.15 (0.68-1.96)	4277	1.05 (0.65-1.63)	127
	< DL	1.07 (0.33-1.80)	111	0.79 (0.45-1.29)	978	0.70 (0.37-1.18)	40
	All	1.63 (0.85-2.54)	994	1.05 (0.61-1.80)	5521	0.96 (0.52-1.55)	172
<i>Multi-layer clouds</i>	> DL	67%	1063	74%	4809	84%	133
	< DL	71%	135	77%	1030	85%	41
	All	68%	1265	75%	6126	85%	180
<i>BC at base (ng m⁻³)</i>	> DL	15 (9-20)	1063	27 (13-55)	4809	56 (40-90)	133
	< DL	13 (8-20)	135	24 (11-48)	1030	43 (36-62)	41
	All	14 (9-20)	1265	26 (13-54)	6126	53 (38-86)	180
<i>% < CloudSat DL^b</i>	All	15%	651	22%	3328	30%	111
<i>% Mixed-phase^b</i>	> DL	90%	501	87%	2355	86%	70
<i>% precipitating^{b,c}</i>	> DL	17%	621	12%	2695	14%	78
<i>r_e (μm)^b</i>	> DL	10.0 (9.2-11.0)	503	9.9 (9.1-10.9)	2286	10.4 (9.3-11.3)	71
<i>Reflectivity (dBZ)^b</i>	> DL	-21.4 (-24.7 to -18.2)	553	-22.0 (-25.5 to -18.5)	2593	-20.3 (-24.5 to -16.5)	78

Continued on next page...

Attribute	Reflectivity	Clean, ≥ 1.1 km	n	All clouds, ≥ 1.1 km	n	Aerosol-impacted ^a , ≥ 1.1 km	n
<i>Base T (°C)</i>	> DL	-19.2 (-22.1 to -16.5)	4741	-19.5 (-22.4 to -16.5)	14695	-19.5 (23.3 to -15.2)	667
	< DL	-19.2 (-23.0 to -15.7)	762	-18.7 (-21.9 to -15.6)	3564	-18.4 (-22.2 to -15.3)	350
	All	-19.2 (-22.2 to -16.4)	5710	-19.3 (-22.4 to -16.3)	19014	-18.9 (-22.8 to -15.1)	1081
<i>Top T (°C)</i>	> DL	-24.7 (-28.4 to -21.5)	4741	-24.4 (-28.0 to -20.8)	14695	-23.9 (-27.7 to -19.6)	667
	< DL	-22.3 (-26.5 to -19.0)	762	-21.8 (-25.1 to -18.6)	3564	-21.7 (-24.8 to -18.7)	350
	All	-24.3 (-28.2 to -21.0)	5710	-23.8 (-27.5 to -20.1)	19014	-22.8 (-27.0 to -19.0)	1081
<i>Altitude, base (km)</i>	> DL	1.96 (1.54-2.50)	4741	1.84 (1.48-2.44)	14695	1.96 (1.54-2.56)	667
	< DL	2.26 (1.78-2.98)	762	2.02 (1.54-2.68)	3564	2.20 (1.54-2.68)	350
	All	1.96 (1.54-2.56)	5710	1.90 (1.48-2.50)	19014	2.02 (1.54-2.62)	1081
<i>Thickness (km)</i>	> DL	1.08 (0.66-1.32)	4741	0.84 (0.60-1.20)	14695	0.72 (0.60-0.96)	667
	< DL	0.60 (0.48-0.72)	762	0.60 (0.48-0.66)	3564	0.54 (0.48-0.66)	350
	All	0.96 (0.66-1.26)	5710	0.72 (0.60-1.14)	19014	0.66 (0.54-0.84)	1081
<i>COD</i>	> DL	1.04 (0.61-1.63)	3337	0.95 (0.58-1.54)	11957	0.82 (0.51-1.54)	645
	< DL	0.52 (0.30-1.02)	705	0.58 (0.35-1.01)	3394	0.52 (0.33-0.84)	347
	All	0.95 (0.53-1.55)	4201	0.85 (0.50-1.43)	16012	0.70 (0.41-1.08)	1055
<i>Multi-layer clouds</i>	> DL	77%	4741	80%	14695	92%	667
	< DL	87%	762	88%	3564	96%	350
	All	79%	5710	82%	19014	94%	1081
<i>BC at base (ng m⁻³)</i>	> DL	15 (10-21)	4741	26 (14-53)	14695	60 (43-94)	667
	< DL	16 (11-21)	762	25 (14-48)	3564	56 (39-95)	350
	All	15 (10-21)	5710	25 (14-52)	19014	59 (41-94)	1081
<i>% < CloudSat DL^b</i>	All	14%	5543	21%	18513	37%	1052
<i>% Mixed-phase^b</i>	> DL	96%	4294	94%	13343	92%	611
<i>% precipitating^{b,c}</i>	> DL	18%	5295	13%	15430	11%	659
<i>r_e (μm)^b</i>	> DL	10.3 (9.4-11.3)	4414	10.1 (9.2-11.1)	13128	9.8 (9.0-10.6)	579
<i>Reflectivity (dBZ)^b</i>	> DL	-20.3 (-24.3 to -16.5)	4741	-21.5 (-25.2 to -17.4)	4741	-22.9 (-26.4 to -19.3)	667

^aAerosol-impacted, as determined in the third column of Table 1.

^bFor clouds with bases >750 m asl

^cPrecipitating clouds were included in this metric only.

Table S2. Median (interquartile range) of Arctic Ocean ONLi cloud properties over open ocean, separated by altitude bins as classified by the criteria in Table 1. Red (grey) color indicates significant (not significant) differences compared to clean background clouds, as determined at 95% confidence using a permutation test.

Attribute	Reflectivity	Clean, < 1.1 km	n	All clouds, < 1.1 km	n	Aerosol-impacted ^a , < 1.1 km	n
<i>Base T (°C)</i>	> DL	-6.1 (-9.7 to -2.0)	722	-5.6 (-9.3 to -1.0)	2592	-7.6 (-11.6 to -4.8)	47
	< DL	-4.2 (-7.0 to 0.9)	247	-3.6 (-6.4 to 0.6)	1100	-4.5 (-6.2 to -0.9)	27
	All	-5.4 (-8.8 to -1.0)	1047	-4.9 (-8.3 to -0.2)	3975	-6.4 (-9.2 to -3.5)	77
<i>Top T (°C)</i>	> DL	-10.6 (-15.5 to -6.2)	722	-10.5 (-15.1 to -5.3)	2592	-13.7 (-21.6 to -9.8)	47
	< DL	-7.2 (-10.0 to -1.1)	247	-6.9 (-10.0 to -2.0)	1100	-6.9 (-9.1 to -2.2)	27
	All	-9.4 (-13.5 to -4.0)	1047	-8.8 (-13.0 to -3.7)	3975	-11.3 (-16.1 to -6.9)	77
<i>Altitude, base (km)</i>	> DL	0.70 (0.58-0.88)	722	0.70 (0.58-0.88)	2592	0.82 (0.67-1.00)	47
	< DL	0.82 (0.70-1.00)	247	0.82 (0.70-1.00)	1100	0.88 (0.79-1.00)	27
	All	0.76 (0.58-0.94)	1047	0.76 (0.58-0.94)	3975	0.88 (0.70-1.00)	77
<i>Thickness (km)</i>	> DL	0.72 (0.54-0.96)	722	0.75 (0.60-1.02)	2592	0.90 (0.66-1.38)	47
	< DL	0.60 (0.36-0.72)	247	0.60 (0.48-0.72)	1100	0.60 (0.42-0.72)	27
	All	0.66 (0.42-0.84)	1047	0.66 (0.54-1.14)	3975	0.72 (0.54-1.14)	77
<i>COD</i>	> DL	1.13 (0.15-2.52)	612	1.24 (0.37-2.25)	2302	1.01 (0.61-1.53)	45
	< DL	0.52 (0.09-2.01)	210	1.08 (0.26-1.96)	1001	1.08 (0.25-1.93)	25
	All	0.91 (0.11-2.47)	898	1.13 (0.27-2.08)	3569	1.01 (0.35-1.66)	114
<i>Multi-layer clouds</i>	> DL	78%	722	79%	2592	77%	47
	< DL	83%	247	83%	1100	85%	27
	All	80%	1047	80%	3975	79%	77
<i>BC at base (ng m⁻³)</i>	> DL	11 (7-18)	722	16 (8-34)	2592	51 (39-93)	47
	< DL	12 (7-19)	247	16 (8-33)	1100	73 (43-109)	27
	All	11 (7-18)	1047	16 (8-34)	3975	63 (39-109)	77
<i>% < CloudSat DL^b</i>	All	38%	538	42%	2171	42%	55
<i>% Mixed-phase^b</i>	> DL	62%	287	60%	1052	67%	24
<i>% precipitating^{b,c}</i>	> DL	11%	325	13%	1224	22%	27
<i>r_e (μm)^b</i>	> DL	10.3 (9.3-11.6)	237	10.2 (9.2-11.6)	924	10.2 (9.8-11.9)	22
<i>Reflectivity (dBZ)^b</i>	> DL	-22.3 (-26.3 to -17.4)	336	-22.5 (-26.3 to -17.4)	1265	-21.6 (-27.5 to -17.0)	32

Continued on next page...

Attribute	Reflectivity	Clean, 1.1-3.2 km	n	All clouds, 1.1-3.2 km	n	Aerosol-impacted ^a , 1.1-3.2 km	n
<i>Base T (°C)</i>	> DL	-11.4 (-16.8 to -7.3)	1511	-11.1 (-16.0 to -7.1)	5293	-12.5 (-16.8 to -8.2)	305
	< DL	-6.4 (-12.4 to -1.2)	803	-6.4 (-12.8 to -1.9)	3601	-9.1 (-15.3 to -4.6)	240
	All	-9.5 (-15.5 to -4.7)	2439	-9.0 (-14.9 to -4.4)	9417	-11.2 (-15.9 to -6.2)	581
<i>Top T (°C)</i>	> DL	-18.2 (-23.8 to -12.3)	1511	-16.3 (-22.3 to -12.0)	5293	-18.7 (-23.7 to -13.5)	305
	< DL	-9.4 (-16.4 to -4.9)	803	-9.6 (-16.6 to -4.9)	3601	-12.0 (-19.4 to -8.0)	240
	All	-14.6 (-21.8 to -9.8)	2439	-13.6 (-20.2 to -8.0)	9417	-15.9 (-21.5 to -9.8)	581
<i>Altitude, base (km)</i>	> DL	2.26 (1.66-2.80)	1511	2.14 (1.54-2.68)	5293	2.20 (1.60-2.74)	305
	< DL	2.02 (1.54-2.62)	803	1.96 (1.48-2.62)	3601	2.08 (1.54-2.58)	240
	All	2.14 (1.60-2.74)	2439	2.02 (1.54-2.56)	9417	2.08 (1.54-2.68)	581
<i>Thickness (km)</i>	> DL	0.84 (0.60-1.38)	1511	0.72 (0.60-1.14)	5293	0.72 (0.60-1.14)	305
	< DL	0.60 (0.42-0.72)	803	0.60 (0.48-0.72)	3601	0.60 (0.48-0.72)	240
	All	0.66 (0.54-0.84)	2439	0.66 (0.54-0.90)	9417	0.66 (0.54-0.84)	581
<i>COD</i>	> DL	0.92 (0.44-1.62)	1342	0.93 (0.47-1.53)	4913	0.85 (0.47-1.31)	288
	< DL	0.57 (0.22-1.26)	738	0.65 (0.28-1.22)	3414	0.67 (0.35-1.14)	237
	All	0.76 (0.30-1.48)	2198	0.79 (0.36-1.402)	8831	0.75 (0.37-1.22)	560
<i>Multi-layer clouds</i>	> DL	89%	1511	89%	5293	95%	305
	< DL	91%	803	92%	3601	96%	240
	All	90%	2439	91%	9417	96%	581
<i>BC at base (ng m⁻³)</i>	> DL	13 (8-19)	1511	19 (10-44)	5293	65 (46-102)	305
	< DL	12 (7-18)	803	18 (10-45)	3601	67 (45-114)	240
	All	13 (8-19)	2439	19 (10-45)	9417	66 (45-107)	581
<i>% < CloudSat DL^b</i>	All	38%	2423	43%	9353	47%	574
<i>% Mixed-phase^b</i>	> DL	81%	1240	78%	4281	78%	269
<i>% precipitating^{b,c}</i>	> DL	7%	1350	7%	4610	5%	287
<i>r_e (μm)^b</i>	> DL	10.1 (9.2-11.3)	1168	10.1 (9.1-11.3)	4058	9.7 (9.0-10.9)	225
<i>Reflectivity (dBZ)^b</i>	> DL	-21.3 (-25.6 to -16.4)	1510	-22.1 (-26.2 to -16.8)	5285	-23.5 (-26.6 to -19.0)	305

Continued on next page...

Attribute	Reflectivity	Clean, > 3.2 km	n	All clouds, > 3.2 km	n	Aerosol-impacted ^a , >3.2 km	n
<i>Base T (°C)</i>	> DL	-18.1 (-21.5 to -13.6)	1448	-17.8 (-21.3 to -13.1)	3454	-18.4 (-22.0 to -13.2)	135
	< DL	-17.9 (-21.5 to -13.4)	498	-17.2 (-21.3 to -12.8)	1505	-17.3 (-21.3 to -12.8)	79
	All	-18.0 (-21.4 to -13.5)	2001	-17.6 (-21.3 to -12.9)	5107	-18.0 (-22.6 to -13.0)	221
<i>Top T (°C)</i>	> DL	-25.2 (-28.9 to -21.0)	1448	-24.3 (-28.3 to -19.9)	3454	-22.9 (-27.0 to -18.8)	135
	< DL	-22.5 (-26.6 to -18.2)	498	-21.6 (-25.6 to -17.2)	1505	-21.1 (-26.5 to -15.3)	79
	All	-23.9 (-28.2 to -20.0)	2001	-23.3 (-27.5 to -18.7)	5107	-22.6 (-26.7 to -18.2)	221
<i>Altitude, base (km)</i>	> DL	4.00 (3.52-4.66)	1448	3.94 (3.52-4.60)	3454	3.70 (3.40-4.06)	135
	< DL	4.12 (3.64-4.84)	498	4.06 (3.58-4.66)	1505	3.76 (3.46-4.33)	79
	All	4.00 (3.52-4.72)	2001	4.00 (3.52-4.60)	5107	3.70 (3.46-4.18)	221
<i>Thickness (km)</i>	> DL	0.90 (0.66-1.32)	1448	0.84 (0.66-1.20)	3454	0.72 (0.60-0.84)	135
	< DL	0.66 (0.54-0.78)	498	0.60 (0.54-0.72)	1505	0.60 (0.54-0.66)	79
	All	0.78 (0.60-1.20)	2001	0.72 (0.60-1.08)	5107	0.66 (0.54-0.78)	221
<i>COD</i>	> DL	0.72 (0.41-1.14)	1332	0.72 (0.43-1.12)	3259	0.71 (0.48-1.02)	130
	< DL	0.41 (0.27-0.73)	479	0.47 (0.30-0.79)	1470	0.41 (0.32-0.70)	77
	All	0.63 (0.43-1.03)	1856	0.63 (0.36-1.02)	4865	0.62 (0.37-0.89)	214
<i>Multi-layer clouds</i>	> DL	96%	1448	95%	3454	97%	135
	< DL	98%	498	96%	1505	99%	79
	All	97%	2001	95%	5107	98%	221
<i>BC at base (ng m⁻³)</i>	> DL	15 (10-21)	1448	18 (11-29)	3454	49 (35-76)	135
	< DL	15 (9-21)	498	18 (11-29)	1505	38 (32-65)	79
	All	15 (10-21)	2001	18 (11-29)	5107	42 (34-73)	221
<i>% < CloudSat DL^b</i>	All	27%	1989	32%	5088	39%	221
<i>% Mixed-phase^b</i>	> DL	90%	1151	88%	2727	88%	112
<i>% precipitating^{b,c}</i>	> DL	6%	1235	5%	2894	8%	119
<i>r_c (μm)^b</i>	> DL	9.9 (9.1-10.9)	1116	9.8 (9.1-10.8)	2669	9.5 (9.0-10.5)	108
<i>Reflectivity (dBZ)^b</i>	> DL	-22.3 (-26.0 to -17.9)	1448	-23.0 (-26.4 to -18.5)	3453	-24.2 (-26.8 to -20.9)	135

^aAerosol-impacted, as determined in the third column of Table 1.

^bFor clouds with bases >750 m asl

^cPrecipitating clouds were included in this metric only.

Table S3: Median (interquartile range) of Arctic Ocean MOONLiT cloud properties as classified by the criteria in Table 1, separated by reflectivity above and below detection limit (DL, -29 dBZ) and surface regime. Red (grey) color indicates significant (not significant) differences compared to clean background clouds, as determined at 95% confidence using a permutation test. Blue indicates that significance was lost^c with altitude binning (relevant only to the open ocean cases).

Attribute	Zm	Sea ice						Open ocean					
		Clean background	n	All clouds	n	Aerosol-impacted ^a	n	Background	n	All	n	Aerosol-impacted ^a	n
<i>Base T (°C)</i>	> DL	-19.4 (-22.2 to -17.0)	1349	-19.9 (-22.6 to -17.4)	4462	-20.1 (-23.5 to -17.7)	197	-16.6 (-19.7 to -10.4)	368	-14.4 (-19.1 to -9.4)	1731	-14.1 (-19.4 to -8.8)	125
	< DL	-21.7 (-24.7 to -18.2)	196	-19.8 (-23.1 to -16.6)	987	-18.7 (-22.8 to -16.0)	101	-14.7 (-19.5 to -7.6)	183	-10.2 (-17.9 to -4.7)	1046	-13.0 (-17.0 to -3.7)	89
	All	-19.6 (-22.5 to -17.2)	1604	-19.9 (-22.7 to -17.3)	5691	-19.8 (-23.3 to -17.1)	314	-16.1 (-19.7 to -9.6)	571	-13.4 (-18.5 to -7.5)	2919	-13.2 (-17.9 to -7.0)	223
<i>Top T (°C)</i>	> DL	-26.1 (-29.0 to -22.9)	1349	-25.9 (-28.6 to -22.5)	4462	-25.3 (-28.9 to -22.0)	197	-24.4 (-28.2 to -19.0)	368	-21.2 (-26.5 to -15.3)	1731	-19.8 (-25.6 to -14.3)	125
	< DL	-25.1 (-28.9 to -21.5)	196	-23.0 (-26.7 to -19.8)	987	-22.2 (-25.5 to -19.0)	101	-18.6 (-24.0 to -10.7)	183	-14.5 (-22.0 to -8.1)	1046	-15.9 (-21.1 to -7.6)	89
	All	-26.0 (-29.0 to -22.8)	1604	-25.4 (-28.4 to -21.9)	5691	-24.2 (-28.4 to -20.2)	314	-22.5 (-27.1 to -15.5)	571	-19.1 (-24.9 to -11.8)	2919	-18.0 (-23.5 to -11.5)	223
<i>Altitude, base (km)</i>	> DL	1.84 (1.60-2.32)	1349	1.78 (1.54-2.26)	4462	1.84 (1.48-2.50)	197	3.28 (2.38-4.06)	368	2.68 (1.84-3.64)	1731	2.44 (1.72-3.40)	125
	< DL	2.50 (1.90-3.30)	196	2.08 (1.60-2.74)	987	2.20 (1.72-2.92)	101	3.28 (2.14-4.21)	183	2.50 (1.78-3.58)	1046	2.50 (1.72-2.98)	89
	All	1.90 (1.60-2.50)	1604	1.84 (1.54-2.38)	5691	1.99 (1.54-2.62)	314	3.28 (2.29-4.09)	571	2.56 (1.78-3.58)	2919	2.38 (1.69-3.31)	223
<i>Thickness (km)</i>	> DL	1.20 (1.02-1.44)	1349	1.08 (0.72-1.32)	4462	0.78 (0.60-1.02)	197	1.14 (0.72-1.62)	368	0.84 (0.66-1.38)	1731	0.72 (0.66-1.08)	125
	< DL	0.60 (0.48-0.72)	205	0.60 (0.48-0.72)	987	0.54 (0.48-0.66)	101	0.6 (0.4-0.7)	183	0.6 (0.5-0.7)	1049	0.6 (0.5-0.7)	89
	All	1.20 (0.78-1.38)	1604	0.90 (0.60-1.26)	5691	0.66 (0.54-0.90)	314	0.78 (0.60-1.32)	571	0.72 (0.54-1.08)	2919	0.66 (0.54-0.90)	223
<i>COD</i>	> DL	1.03 (0.64-1.50)	813	1.01 (0.61-1.57)	3279	0.80 (0.53-1.34)	191	0.80 (0.43-1.39)	302	0.89 (0.50-1.54)	1554	0.70 (0.38-1.14)	116
	< DL	0.40 (0.26-0.66)	186	0.56 (0.32-0.99)	939	0.46 (0.28-0.83)	100	0.30 (0.13-0.64)	181	0.51 (0.23-1.06)	1009	0.54 (0.29-1.11)	88
	All	0.92 (0.51-1.45)	1041	0.89 (0.51-1.47)	4427	0.72 (0.40-1.16)	307	0.61 (0.24-1.16)	503	0.73 (0.31-1.37)	2701	0.66 (0.33-1.11)	213
<i>Multi-layer clouds</i>	> DL	39%	1349	41%	4462	69%	197	76%	368	71%	1731	83%	125
	< DL	62%	196	56%	987	86%	101	92%	183	80%	1046	90%	89
	All	42%	1604	44%	5691	75%	314	81%	571	75%	2919	86%	223
<i>BC at base (ng m⁻³)</i>	> DL	15 (11-22)	1349	27 (14-53)	4462	56 (42-82)	197	15 (11-21)	368	20 (11-38)	1731	62 (40-94)	125
	< DL	15 (11-20)	196	22 (13-42)	987	45 (38-80)	101	13 (8-19)	183	19 (11-38)	1046	57 (40-94)	89
	All	15 (11-22)	1604	26 (14-51)	5691	54 (39-81)	314	14 (10-20)	571	19 (11-38)	2919	61 (40-94)	223
<i>% < CloudSat DL</i>	All	13%	1557	19%	5538	36%	306	35%	568	41%	2913	44%	223
<i>% Mixed-phase</i>	> DL	100%	63	97%	146	100%	8	93%	138	88%	412	72%	18
<i>% precipitating^b</i>	> DL	20%	1571	14%	4811	8%	196	10%	383	8%	1675	4%	114
<i>r_e (μm)</i>	> DL	10.5 (9.7-11.4)	1178	10.3 (9.5-11.3)	3809	10.0 (9.4-11.1)	152	10.2 (9.4-11.2)	284	10.3 (9.4-11.4)	1211	10.0 (9.0-11.0)	78
<i>Reflectivity (dBZ)</i>	> DL	-19.6 (-23.6 to -17.3)	1349	-20.8 (-24.5 to -16.9)	4462	-22.2 (-25.6 to -18.8)	197	-21.8 (-25.8 to -17.3)	368	-21.4 (-25.9 to -16.6)	1729	-23.4 (-26.8 to -16.9)	204

^aAerosol-impacted, as determined in the third column of Table 1.

^bPrecipitating clouds were included in this metric only.

Table S4. Median (interquartile range) and sample number (n) of Arctic Ocean ONLi cloud properties over open ocean, separated by altitude bins as classified by the criteria in Table 1 and by radar reflectivity above and below detection limit (DL, -29 dBZ). Red (grey) color indicates significant (not significant) differences compared to clean background clouds, as determined at 95% confidence using a permutation test.

Attribute	Reflectivity	Clean, 1.1-3.2 km	n	All clouds, 1.1-3.2 km	n	Aerosol-impacted ^a , 1.1-3.2 km	n
<i>Base T (°C)</i>	> DL	-15.3 (-19.1 to -9.5)	176	-12.5 (-17.1 to -8.2)	1113	-11.8 (-16.6 to -8.0)	89
	< DL	-8.3 (-14.3 to -2.9)	89	-7.0 (-13.6 to -2.3)	687	-10.4 (-15.9 to -2.7)	67
	All	-12.8 (-18.0 to -6.4)	275	-10.2 (-16.0 to -5.5)	1909	-11.0 (-16.0 to -4.6)	165
<i>Top T (°C)</i>	> DL	-22.3 (-26.5 to -15.5)	176	-18.8 (-24.7 to -13.5)	1113	-18.9 (-24.7 to -13.5)	89
	< DL	-11.6 (-17.8 to -6.6)	89	-10.6 (-17.5 to -5.7)	687	-12.4 (-18.5 to -4.4)	67
	All	-18.9 (-25.6 to -11.4)	275	-15.6 (-22.1 to -9.5)	1909	-16.2 (-22.1 to -9.0)	165
<i>Altitude, base (km)</i>	> DL	2.35 (1.90-2.92)	176	2.08 (1.54-2.62)	1113	2.02 (1.48-2.50)	89
	< DL	2.14 (1.84-2.68)	89	1.96 (1.48-2.50)	687	2.02 (1.57-2.68)	67
	All	2.26 (1.90-2.86)	275	2.02 (1.54-2.56)	1909	2.02 (1.54-2.56)	165
<i>Thickness (km)</i>	> DL	1.20 (0.72-1.62)	176	0.84 (0.66-1.38)	1113	0.78 (0.66-1.20)	89
	< DL	0.54 (0.42-0.72)	89	0.60 (0.48-0.75)	687	0.60 (0.51-0.78)	67
	All	0.78 (0.60-1.35)	275	0.72 (0.54-1.08)	1909	0.66 (0.60-1.02)	165
<i>COD</i>	> DL	1.04 (0.65-1.63)	144	1.08 (0.57-1.74)	994	0.78 (0.37-1.37)	82
	< DL	0.35 (0.12-0.90)	89	0.63 (0.24-1.28)	687	0.80 (0.37-1.45)	67
	All	0.82 (0.29-1.46)	275	0.86 (0.29-1.46)	1909	0.86 (0.36-1.37)	165
<i>Multi-layer clouds</i>	> DL	64%	176	63%	1113	79%	89
	< DL	84%	89	76%	687	87%	67
	All	71%	275	68%	1909	82%	165
<i>BC at base (ng m⁻³)</i>	> DL	16 (10-20)	176	22 (12-50)	1113	66 (46-101)	89
	< DL	11 (7-16)	89	19 (10-49)	687	58 (44-98)	67
	All	14 (9-19)	275	21 (11-50)	1909	63 (45-100)	165
<i>% < CloudSat DL</i>	All	35%	272	42%	1904	46%	165
<i>% Mixed-phase</i>	> DL	85%	13	89%	63	100%	2
<i>% precipitating^b</i>	> DL	12%	193	10%	1103	11%	87
<i>r_e (μm)</i>	> DL	10.3 (9.6-11.3)	148	10.3 (9.4-11.4)	831	10.1 (9.0-11.2)	60
<i>Reflectivity (dBZ)</i>	> DL	-21.2 (-25.3 to -16.8)	176	-20.9 (-25.5 to -15.9)	1111	-22.1 (-27.4 to -16.1)	89

Continued on next page...

Attribute	Reflectivity	Clean, > 3.2 km	n	All clouds, > 3.2 1.1 km	n	Aerosol-impacted ^a , >3.2 km	n
<i>Base T (°C)</i>	> DL	-17.6 (-21.5 to -11.7)	192	-17.6 (-21.1 to -12.6)	617	-18.8 (-24.0 to -13.4)	36
	< DL	-18.6 (-22.2 to -15.2)	94	-18.4 (-22.0 to -14.3)	358	-17.4 (-21.8 to -14.3)	22
	All	-18.2 (-21.8 to -12.4)	296	-18.0 (-21.4 to -13.0)	1008	-18.1 (-22.7 to -13.2)	58
<i>Top T (°C)</i>	> DL	-25.7 (-29.4 to -21.2)	192	-24.6 (-28.8 to -20.5)	617	-23.8 (-29.1 to -18.7)	36
	< DL	-22.8 (-26.7 to -19.0)	94	-22.8 (-26.7 to -17.8)	358	-21.0 (-25.6 to -10.8)	22
	All	-24.5 (-28.6 to -20.4)	296	-23.8 (-28.2 to -19.4)	1008	-22.8 (-27.0 to -17.5)	58
<i>Altitude, base (km)</i>	> DL	4.00 (3.52-4.54)	192	4.06 (3.52-4.60)	617	4.06 (3.64-4.26)	36
	< DL	4.15 (3.64-4.76)	94	4.06 (3.58-4.60)	358	3.76 (3.46-4.26)	22
	All	4.06 (3.58-4.60)	296	4.06 (3.58-4.66)	1008	3.97 (3.52-4.29)	58
<i>Thickness (km)</i>	> DL	1.08 (0.72-1.62)	192	0.90 (0.66-1.44)	617	0.69 (0.60-0.91)	36
	< DL	0.60 (0.48-0.72)	94	0.60 (0.48-0.72)	358	0.54 (0.49-0.60)	22
	All	0.78 (0.60-1.32)	296	0.72 (0.54-1.14)	1008	0.60 (0.54-0.84)	58
<i>COD</i>	> DL	0.62 (0.30-1.12)	158	0.70 (0.38-1.17)	559	0.62 (0.43-0.86)	34
	< DL	0.29 (0.14-0.57)	94	0.37 (0.22-0.68)	354	0.33 (0.24-0.47)	22
	All	0.50 (0.23-0.83)	262	0.56 (0.26-0.99)	946	0.48 (0.25-0.73)	56
<i>Multi-layer clouds</i>	> DL	86%	192	85%	617	94%	36
	< DL	99%	94	87%	358	100%	22
	All	91%	296	86%	1008	97%	58
<i>BC at base (ng m⁻³)</i>	> DL	14 (11-22)	192	17 (11-28)	617	43 (35-86)	36
	< DL	14 (9-20)	94	18 (11-29)	358	42 (36-65)	22
	All	14 (11-21)	296	17 (11-28)	1008	43 (35-74)	58
<i>% < CloudSat DL</i>	All	35%	296	39%	1007	38%	58
<i>% Mixed-phase</i>	> DL	94%	125	88%	349	69%	16
<i>% precipitating^b</i>	> DL	7%	190	6%	571	4%	27
<i>r_e (μm)</i>	> DL	10.0 (9.2-11.0)	141	10.1 (9.2-11.1)	421	9.6 (9.0-10.6)	20
<i>Reflectivity (dBZ)</i>	> DL	-22.4 (-26.1 to -17.9)	192	-22.4 (-26.5 to -17.9)	617	-24.6 (-26.1 to -19.9)	36

^aAerosol-impacted, as determined in the third column of Table 1.

^bPrecipitating clouds were included in this metric only.