

Supplemental Table 1. Median (interquartile range) of Arctic marine cloud properties over the 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 | Z _m | Background, < 2.6 | n | All, < 2.6 | n | Aero, < 2.6 | n |
|---------------------------------------|----------------|------------------------|-----|------------------------|------|------------------------|-----|
| <i>Base T (°C)</i> | > DL | -14.6 (-19.5 to -9.0) | 109 | -11.7 (-16.4 to -7.6) | 822 | -9.9 (-15.0 to -7.3) | 71 |
| | < DL | -6.9 (-13.5 to -1.3) | 64 | -5.8 (-10.8 to -1.6) | 555 | -4.6 (-13.1 to -0.4) | 49 |
| | All | -10.7 (-18.0 to -4.7) | 177 | -8.9 (14.9 to -4.6) | 1460 | -8.6 (-14.7 to -3.6) | 129 |
| <i>Top T (°C)</i> | > DL | -21.0 (-26.1 to -13.8) | 109 | -17.4 (-22.9 to -12.6) | 822 | -15.6 (-22.1 to -11.7) | 71 |
| | < DL | -9.1 (-16.5 to -5.4) | 64 | -9.4 (-14.7 to -4.6) | 555 | -9.0 (-17.1 to -2.8) | 49 |
| | All | -17.1 (-23.8 to -8.9) | 177 | -14.0 (-20.5 to -8.5) | 1460 | -13.6 (-20.1 to -6.2) | 129 |
| <i>Altitude, base (km)</i> | > DL | 2.0 (1.7-2.3) | 109 | 1.8 (1.4-2.1) | 822 | 1.8 (1.4-2.1) | 71 |
| | < DL | 2.0 (1.8-1.2) | 64 | 1.8 (1.4-2.1) | 555 | 1.7 (1.4-2.1) | 49 |
| | All | 2.0 (1.7-2.2) | 177 | 1.8 (1.4-2.1) | 1460 | 1.8 (1.4-2.2) | 129 |
| <i>Thickness (km)</i> | > DL | 1.1 (0.7-1.4) | 109 | 0.8 (0.7-1.3) | 822 | 0.7 (0.7-1.1) | 71 |
| | < DL | 0.5 (0.4-0.7) | 64 | 0.6 (0.5-0.8) | 555 | 0.7 (0.5-0.8) | 49 |
| | All | 0.7 (0.-1.3) | 177 | 0.7 (0.5-1.0) | 1460 | 0.7 (0.5-1.0) | 129 |
| <i>COD</i> | > DL | 1.2 (0.7-1.8) | 89 | 1.2 (0.7-1.9) | 668 | 0.8 (0.4-1.4) | 60 |
| | < DL | 0.4 (0.1-1.1) | 58 | 0.8 (0.2-1.5) | 453 | 0.8 (0.3-1.6) | 44 |
| | All | 0.9 (0.3-1.6) | 151 | 1.0 (0.4-1.7) | 1181 | 0.8 (0.4-1.5) | 112 |
| <i>Multi-layer clouds</i> | > DL | 56% | 109 | 57% | 822 | 76% | 71 |
| | < DL | 81% | 64 | 72% | 555 | 82% | 49 |
| | All | 65% | 177 | 64% | 1460 | 79% | 129 |
| <i>BC at base (ng m⁻³)</i> | > DL | 16 (9-20) | 109 | 22 (12-48) | 822 | 69 (44-96) | 71 |
| | < DL | 11 (8-18) | 64 | 19 (10-49) | 555 | 54 (41-100) | 49 |
| | All | 14 (8-19) | 177 | 21 (11-49) | 1460 | 63 (44-97) | 129 |
| <i>% Mixed-phase</i> | > DL | 67% | 3 | 92% | 12 | 100% | 1 |
| <i>% precipitating^b</i> | > DL | 16% | 122 | 10% | 817 | 3% | 67 |
| <i>r_e (μm)</i> | > DL | 10.2 (9.6-11.3) | 84 | 10.4 (9.4-11.5) | 572 | 10.4 (9.0-11.5) | 45 |
| <i>Reflectivity (dBZ)</i> | > DL | -22.3 (-25.8 to -17.8) | 107 | -21.2 (-25.9 to -15.8) | 818 | -23.4 (-27.7 to -15.7) | 71 |

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| Attribute | Z _m | Background, 2.6-4.1 | n | All, 2.6-4.1 | n | Aero, 2.6-4.1 | n |
|---------------------------------------|----------------|------------------------|-----|------------------------|-----|------------------------|----|
| <i>Base T (°C)</i> | > DL | -15.9 (-19.1 to -10.4) | 173 | -15.8 (-19.4 to -10.4) | 622 | -19.4 (-22.3 to -14.8) | 37 |
| | < DL | -16.3 (-20.5 to -8.6) | 68 | -15.6 (-19.9 to -8.6) | 317 | -16.3 (-19.7 to -13.8) | 32 |
| | All | -16.0 (-19.3 to -10.0) | 251 | -15.8 (-19.5 to -9.9) | 976 | -17.9 (-21.2 to -14.3) | 69 |
| <i>Top T (°C)</i> | > DL | -24.8 (-28.5 to -19.6) | 173 | -23.4 (-28.0 to -17.5) | 622 | -25.1 (-29.3 to -20.0) | 37 |
| | < DL | -19.5 (-24.2 to -11.8) | 68 | -19.4 (-24.2 to -11.8) | 317 | -19.4 (-24.1 to -11.6) | 32 |
| | All | -23.2 (-27.3 to -17.6) | 251 | -21.9 (-26.6 to -16.0) | 976 | -23.1 (-27.2 to -18.2) | 69 |
| <i>Altitude, base (km)</i> | > DL | 3.3 (3.0-3.6) | 173 | 3.2 (2.9-3.6) | 622 | 3.2 (2.9-3.6) | 37 |
| | < DL | 3.4 (3.0-3.7) | 68 | 3.3 (2.9-3.6) | 317 | 3.0 (2.8-3.5) | 32 |
| | All | 3.4 (3.0-3.6) | 251 | 3.2 (2.9-3.6) | 976 | 3.1 (2.8-3.5) | 69 |
| <i>Thickness (km)</i> | > DL | 1.3 (0.8-1.7) | 173 | 1.0 (0.7-1.6) | 622 | 0.8 (0.7-1.1) | 37 |
| | < DL | 0.5 (0.4-0.7) | 68 | 0.6 (0.5-0.8) | 317 | 0.6 (0.5-0.7) | 32 |
| | All | 0.8 (0.6-1.5) | 251 | 0.8 (0.6-1.3) | 976 | 0.7 (0.6-0.9) | 69 |
| <i>COD</i> | > DL | 0.9 (0.4-1.5) | 137 | 0.8 (0.5-1.4) | 507 | 0.7 (0.4-1.0) | 34 |
| | < DL | 0.3 (0.2-0.6) | 60 | 0.5 (0.3-0.8) | 254 | 0.5 (0.4-1.0) | 23 |
| | All | 0.7 (0.3-1.3) | 206 | 0.7 (0.3-1.2) | 790 | 0.6 (0.4-1.0) | 57 |
| <i>Multi-layer clouds</i> | > DL | 79% | 173 | 80% | 622 | 95% | 37 |
| | < DL | 96% | 68 | 87% | 317 | 100% | 32 |
| | All | 84% | 251 | 83% | 976 | 97% | 69 |
| <i>BC at base (ng m⁻³)</i> | > DL | 16 (11-23) | 173 | 20 (11-38) | 622 | 62 (43-103) | 37 |
| | < DL | 13 (7-16) | 68 | 19 (11-38) | 317 | 62 (42-83) | 32 |
| | All | 15 (10-21) | 251 | 19 (11-37) | 976 | 63 (42-97) | 69 |
| <i>% Mixed-phase</i> | > DL | 92% | 62 | 84% | 184 | 64% | 11 |
| <i>% precipitating^b</i> | > DL | 5% | 171 | 8% | 593 | 5% | 37 |
| <i>r_e (μm)</i> | > DL | 10.3 (9.5-11.4) | 144 | 10.4 (9.5-11.4) | 447 | 9.7 (9.4-10.5) | 26 |
| <i>Reflectivity (dBZ)</i> | > DL | -20.4 (-25.0 to -16.6) | 173 | -21.0 (-25.2 to -16.3) | 622 | -23.7 (-25.6 to -19.0) | 37 |

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| Attribute | Z _m | Background, > 4.1 | n | All, > 4.1 | n | Aero, > 4.1 | n |
|---------------------------------------|----------------|------------------------|-----|------------------------|-----|------------------------|----|
| <i>Base T (°C)</i> | > DL | -18.9 (-24.2 to -14.9) | 88 | -18.5 (-22.3 to -15.0) | 290 | -14.5 (-22.3 to -13.1) | 17 |
| | < DL | -19.3 (-22.7 to -16.8) | 52 | -19.4 (-23.3 to -16.1) | 177 | -17.4 (-22.2 to -13.4) | 8 |
| | All | -19.1 (-24.1 to -15.3) | 143 | -18.9 (-22.7 to -15.3) | 483 | -14.9 (-22.3 to -13.1) | 25 |
| <i>Top T (°C)</i> | > DL | -26.9 (-29.7 to -21.7) | 88 | -26.1 (-29.4 to -21.5) | 290 | -22.8 (-26.1 to -17.0) | 17 |
| | < DL | -19.1 (-24.1 to -11.6) | 52 | -19.1 (-24.3 to -15.8) | 177 | -24.0 (-28.9 to -20.1) | 8 |
| | All | -26.1 (-29.7 to -21.5) | 143 | -24.7 (-29.0 to -21.0) | 483 | -21.9 (-26.1 to -16.6) | 25 |
| <i>Altitude, base (km)</i> | > DL | 4.6 (4.3-5.0) | 88 | 4.7 (4.4-5.1) | 290 | 4.3 (4.2-4.8) | 17 |
| | < DL | 4.6 (4.3-5.2) | 52 | 4.7 (4.4-5.1) | 177 | 4.4 (4.3-4.5) | 8 |
| | All | 4.6 (4.4-5.1) | 143 | 4.7 (4.4-5.1) | 483 | 4.3 (4.2-4.5) | 25 |
| <i>Thickness (km)</i> | > DL | 1.0 (0.7-1.4) | 88 | 0.8 (0.7-1.4) | 290 | 0.7 (0.6-0.9) | 17 |
| | < DL | 0.6 (0.5-0.7) | 52 | 0.6 (0.5-0.7) | 177 | 0.5 (0.3-0.5) | 8 |
| | All | 0.7 (0.6-1.2) | 143 | 0.7 (0.5-1.1) | 483 | 0.6 (0.5-0.7) | 25 |
| <i>COD</i> | > DL | 0.6 (0.4-1.0) | 75 | 0.7 (0.5-1.1) | 240 | 0.6 (0.5-0.8) | 10 |
| | < DL | 0.3 (0.2-0.5) | 45 | 0.3 (0.2-0.6) | 140 | 0.3 (0.2-0.4) | 6 |
| | All | 0.5 (0.3-1.7) | 122 | 0.6 (0.3-0.9) | 391 | 0.5 (0.3-0.6) | 16 |
| <i>Multi-layer clouds</i> | > DL | 92% | 88 | 91% | 290 | 88% | 17 |
| | < DL | 100% | 52 | 90% | 177 | 100% | 8 |
| | All | 95% | 143 | 91% | 483 | 92% | 25 |
| <i>BC at base (ng m⁻³)</i> | > DL | 13 (11-20) | 88 | 16 (11-26) | 290 | 37 (32-65) | 17 |
| | < DL | 14 (11-23) | 52 | 18 (11-26) | 177 | 38 (31-58) | 8 |
| | All | 14 (11-21) | 143 | 16 (11-26) | 483 | 37 (32-65) | 25 |
| <i>% Mixed-phase</i> | > DL | 96% | 73 | 92% | 216 | 83% | 6 |
| <i>% precipitating^b</i> | > DL | 11% | 90 | 5% | 265 | 0% | 10 |
| <i>r_e (μm)</i> | > DL | 9.6 (9.2-10.4) | 56 | 9.8 (9.2-10.7) | 192 | 9.6 (9.3-10.2) | 7 |
| <i>Reflectivity (dBZ)</i> | > DL | -23.9 (-27.0 to -19.7) | 88 | -23.4 (-26.7 to -19.3) | 289 | -21.5 (-25.9 to -18.7) | 17 |