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*Supplement of*

## **Forcing for varying boundary layer stability across Antarctica**

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1 **Supplemental Information**

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Table S1: Number of BMUs, mean downwelling longwave radiation ( $W m^{-2}$ ) and mean 20 m wind speed ( $m s^{-1}$ ) (from left to right, separated by a forward slash (/) in each column) for each regime annually and seasonally at South Pole. Rows that list the basic near-surface stability regimes are shown with gray shading. Regimes with less than 10 observations annually or seasonally are listed in italics and red text. A triple dash (“---”) indicates this regime is not observed annually or seasonally.

South Pole					
Regime	Annual	Summer	Fall	Winter	Spring
<b>NN</b>	66 / 174 / 4.5	64 / 173 / 4.5	<i>1 / 204 / 2.4</i>	---	<i>1 / 200 / 3.6</i>
<b>NN-WSA</b>	85 / 172 / 5.5	78 / 171 / 5.4	<i>3 / 184 / 4.2</i>	---	<i>4 / 176 / 8.8</i>
<b>NN-MSA</b>	177 / 160 / 6.2	150 / 159 / 5.8	<i>3 / 159 / 9.4</i>	<i>1 / --- / 9.8</i>	23 / 164 / 8.6
<b>NN-SSA</b>	275 / 156 / 7.2	122 / 158 / 5.1	22 / 167 / 8.3	42 / 144 / 9.5	89 / 155 / 8.9
<b>VSM-WSA</b>	100 / 163 / 4.3	99 / 163 / 4.3	---	---	<i>1 / --- / 10.2</i>
<b>VSM-MSA</b>	388 / 144 / 4.5	362 / 145 / 4.4	<i>5 / 186 / 4.2</i>	---	21 / 130 / 6.5
<b>VSM-SSA</b>	955 / 136 / 6.5	262 / 147 / 5.0	194 / 142 / 6.2	194 / 125 / 7.8	305 / 130 / 7.2
<b>WS</b>	23 / 144 / 6.2	17 / 133 / 5.7	<i>1 / 168 / 2.6</i>	<i>1 / 106 / 10.2</i>	<i>4 / 187 / 8.3</i>
<b>WS-MSA</b>	62 / 140 / 7.7	36 / 133 / 6.7	<i>5 / 146 / 8.7</i>	<i>5 / 154 / 11.0</i>	16 / 145 / 8.8
<b>WS-SSA</b>	208 / 138 / 9.3	32 / 136 / 6.6	29 / 128 / 9.5	70 / 142 / 9.7	77 / 137 / 10.0
<b>MS</b>	363 / 135 / 4.4	278 / 137 / 3.9	17 / 138 / 6.0	<i>3 / 123 / 9.6</i>	65 / 129 / 5.8
<b>MS-SSA</b>	751 / 125 / 6.2	235 / 131 / 4.8	171 / 132 / 6.2	67 / 125 / 8.7	278 / 117 / 6.8
<b>MS-VSSA</b>	517 / 112 / 8.0	<i>1 / 126 / 5.4</i>	152 / 121 / 7.3	177 / 108 / 8.5	187 / 108 / 8.1
<b>MS-ESSA</b>	236 / 98 / 8.5	---	49 / 104 / 7.5	128 / 98 / 8.9	59 / 96 / 8.6
<b>SS</b>	1157 / 117 / 5.1	192 / 128 / 3.7	419 / 119 / 5.2	126 / 115 / 7.1	420 / 110 / 5.1
<b>SS-VSSA</b>	1032 / 101 / 6.8	<i>1 / --- / 3.8</i>	322 / 107 / 6.2	377 / 97 / 7.3	332 / 101 / 6.9
<b>SS-ESSA</b>	409 / 92 / 7.5	---	96 / 96 / 7.0	230 / 89 / 7.7	83 / 94 / 7.7
<b>VSS</b>	1076 / 98 / 5.4	<i>6 / 129 / 5.5</i>	354 / 104 / 4.7	398 / 90 / 6.1	318 / 100 / 5.2
<b>VSS-ESSA</b>	274 / 92 / 6.5	---	68 / 95 / 6.1	151 / 90 / 6.6	55 / 95 / 6.5
<b>ESS</b>	433 / 91 / 5.2	---	104 / 95 / 4.9	241 / 88 / 5.3	88 / 93 / 5.0

8 *Table S2: Number of BMUs, mean downwelling longwave radiation ( $W m^{-2}$ ) and mean 20 m wind speed*  
9 *( $m s^{-1}$ ) (from left to right, separated by a forward slash (/) in each column) for each regime annually and*  
10 *seasonally at Dome C. Rows that list the basic near-surface stability regimes are shown with gray*  
11 *shading. Regimes with less than 10 observations annually or seasonally are listed in italics and red text. A*  
12 *triple dash (“---”) indicates this regime is not observed annually or seasonally.*

Dome C					
Regime	Annual	Summer	Fall	Winter	Spring
<b>NN</b>	<i>9 / 140 / 4.3</i>	<i>9 / 140 / 4.3</i>	---	---	---
<b>NN-WSA</b>	21 / 146 / 3.5	21 / 146 / 3.5	---	---	---
<b>NN-MSA</b>	33 / 141 / 4.7	33 / 141 / 4.7	---	---	---
<b>NN-SSA</b>	24 / 152 / 5.3	21 / 152 / 4.9	<i>2 / 162 / 7.3</i>	<i>1 / --- / 10.2</i>	---
<b>VSM-WSA</b>	82 / 123 / 3.3	81 / 123 / 3.2	<i>1 / --- / 4.4</i>	---	---
<b>VSM-MSA</b>	267 / 119 / 3.4	219 / 123 / 3.4	23 / 109 / 3.6	<i>3 / 84 / 4.0</i>	22 / 95 / 3.1
<b>VSM-SSA</b>	102 / 126 / 5.3	46 / 131 / 3.3	28 / 112 / 6.5	<i>4 / 178 / 15.8</i>	24 / 123 / 6.2
<b>WS</b>	52 / 127 / 4.5	50 / 127 / 4.3	---	---	<i>2 / 134 / 8.8</i>
<b>WS-MSA</b>	78 / 130 / 5.9	68 / 128 / 5.5	<i>3 / 135 / 7.2</i>	<i>1 / --- / 12.7</i>	<i>6 / 142 / 8.8</i>
<b>WS-SSA</b>	23 / 125 / 7.3	13 / 132 / 4.8	<i>3 / 98 / 10.2</i>	<i>4 / 118 / 12.1</i>	<i>3 / 123 / 8.7</i>
<b>MS</b>	364 / 118 / 5.5	246 / 122 / 5.3	44 / 116 / 5.3	12 / 132 / 9.0	62 / 104 / 5.8
<b>MS-SSA</b>	241 / 114 / 6.6	38 / 123 / 5.8	86 / 115 / 6.0	12 / 130 / 8.4	105 / 110 / 7.3
<b>MS-VSSA</b>	53 / 105 / 9.8	---	20 / 113 / 8.0	15 / 101 / 11.7	18 / 100 / 10.2
<b>MS-ESSA</b>	<i>8 / 99 / 12.0</i>	---	<i>2 / 84 / 10.3</i>	<i>5 / 111 / 12.8</i>	<i>1 / 106 / 11.1</i>
<b>SS</b>	1450 / 97 / 5.1	53 / 120 / 4.8	473 / 102 / 4.8	545 / 90 / 5.1	379 / 96 / 5.5
<b>SS-VSSA</b>	223 / 94 / 8.2	<i>4 / 132 / 7.0</i>	69 / 93 / 7.5	58 / 99 / 9.5	92 / 91 / 7.9
<b>SS-ESSA</b>	90 / 80 / 10.1	---	20 / 78 / 8.6	43 / 83 / 11.2	27 / 78 / 9.5
<b>VSS</b>	997 / 88 / 6.2	11 / 124 / 4.6	284 / 94 / 5.9	454 / 83 / 6.2	248 / 89 / 6.5
<b>VSS-ESSA</b>	120 / 82 / 8.8	---	29 / 84 / 8.0	64 / 82 / 9.8	27 / 81 / 7.4
<b>ESS</b>	910 / 79 / 7.7	<i>1 / 156 / 5.5</i>	219 / 83 / 7.3	522 / 76 / 8.0	168 / 81 / 7.3

13 *Table S3: Number of BMUs, mean downwelling longwave radiation ( $W m^{-2}$ ) and mean 20 m wind speed*  
 14 *( $m s^{-1}$ ) (from left to right, separated by a forward slash (/) in each column) for each regime annually and*  
 15 *seasonally at McMurdo. Rows that list the basic near-surface stability regimes are shown with gray*  
 16 *shading. Regimes with less than 10 observations annually or seasonally are listed in italics and red text. A*  
 17 *triple dash (“---”) indicates this regime is not observed annually or seasonally.*

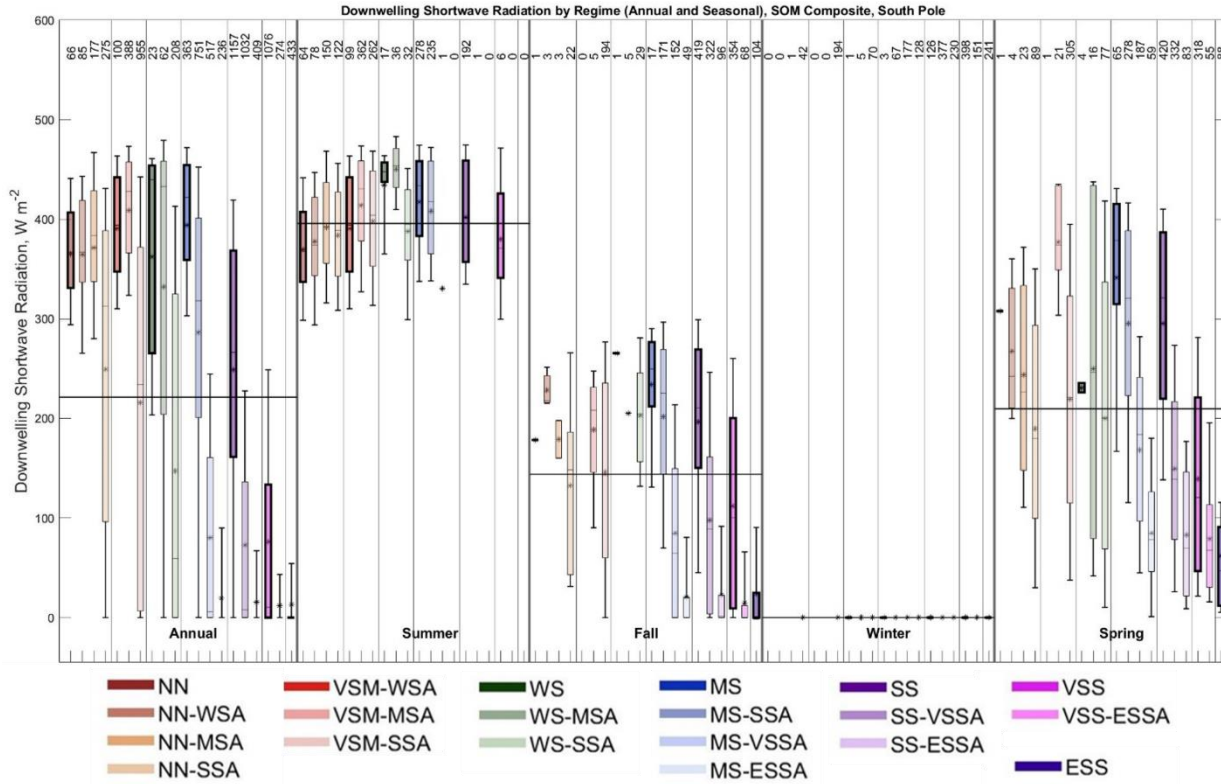
<b>McMurdo</b>					
<b>Regime</b>	<b>Annual</b>	<b>Summer</b>	<b>Fall</b>	<b>Winter</b>	<b>Spring</b>
<b>NN</b>	28 / 232 / 5.2	15 / 244 / 5.4	<i>6 / 222 / 3.1</i>	<i>1 / 243 / 11.7</i>	<i>6 / 212 / 5.8</i>
<b>NN-WSA</b>	70 / 220 / 4.8	30 / 238 / 5.0	18 / 210 / 3.9	<i>7 / 211 / 6.9</i>	15 / 204 / 4.5
<b>NN-MSA</b>	72 / 208 / 5.6	31 / 236 / 5.0	13 / 200 / 6.5	12 / 184 / 6.9	16 / 188 / 4.9
<b>NN-SSA</b>	43 / 187 / 6.4	<i>9 / 229 / 7.8</i>	<i>8 / 192 / 9.7</i>	14 / 157 / 5.8	12 / 188 / 3.9
<b>VSM-WSA</b>	75 / 205 / 2.8	35 / 227 / 2.4	20 / 191 / 3.0	<i>7 / 165 / 3.2</i>	13 / 200 / 3.1
<b>VSM-MSA</b>	148 / 188 / 4.3	43 / 223 / 4.0	37 / 187 / 4.6	35 / 161 / 4.4	33 / 184 / 4.1
<b>VSM-SSA</b>	103 / 181 / 5.1	12 / 224 / 5.2	30 / 189 / 7.1	34 / 168 / 4.3	27 / 172 / 4.0
<b>WS</b>	10 / 197 / 5.3	<i>1 / 276 / 5.4</i>	<i>1 / 250 / 16.0</i>	<i>5 / 181 / 4.5</i>	<i>3 / 179 / 3.1</i>
<b>WS-MSA</b>	11 / 205 / 6.8	<i>1 / 266 / 10.4</i>	<i>2 / 209 / 8.0</i>	<i>6 / 200 / 6.7</i>	<i>2 / 189 / 4.0</i>
<b>WS-SSA</b>	<i>9 / 144 / 7.0</i>	---	<i>2 / 123 / 9.3</i>	<i>4 / 147 / 6.0</i>	<i>3 / 155 / 6.8</i>
<b>MS</b>	85 / 173 / 2.5	10 / 235 / 2.3	16 / 190 / 2.8	36 / 148 / 1.9	23 / 172 / 3.3
<b>MS-SSA</b>	44 / 165 / 3.3	<i>3 / 255 / 3.9</i>	<i>8 / 176 / 4.9</i>	25 / 157 / 2.6	<i>8 / 158 / 3.4</i>
<b>MS-VSSA</b>	<i>4 / 158 / 5.5</i>	<i>1 / 198 / 7.6</i>	---	<i>3 / 144 / 4.9</i>	---
<b>MS-ESSA</b>	---	---	---	---	---
<b>SS</b>	67 / 161 / 3.0	<i>1 / 227 / 3.6</i>	18 / 175 / 5.3	31 / 149 / 2.0	17 / 164 / 2.4
<b>SS-VSSA</b>	<i>7 / 147 / 3.8</i>	---	<i>1 / 212 / 7.7</i>	<i>6 / 136 / 3.1</i>	---
<b>SS-ESSA</b>	<i>1 / 139 / 0.2</i>	---	---	<i>1 / 139 / 0.2</i>	---
<b>VSS</b>	<i>9 / 139 / 2.4</i>	---	---	<i>6 / 145 / 1.7</i>	<i>3 / 128 / 3.7</i>
<b>VSS-ESSA</b>	---	---	---	---	---
<b>ESS</b>	---	---	---	---	---

18 *Table S4: Number of BMUs, mean downwelling longwave radiation ( $W m^{-2}$ ) and mean 20 m wind speed*  
 19 *( $m s^{-1}$ ) (from left to right, separated by a forward slash (/) in each column) for each regime annually and*  
 20 *seasonally at Neumayer. Rows that list the basic near-surface stability regimes are shown with gray*  
 21 *shading. Regimes with less than 10 observations annually or seasonally are listed in italics and red text. A*  
 22 *triple dash (“---”) indicates this regime is not observed annually or seasonally.*

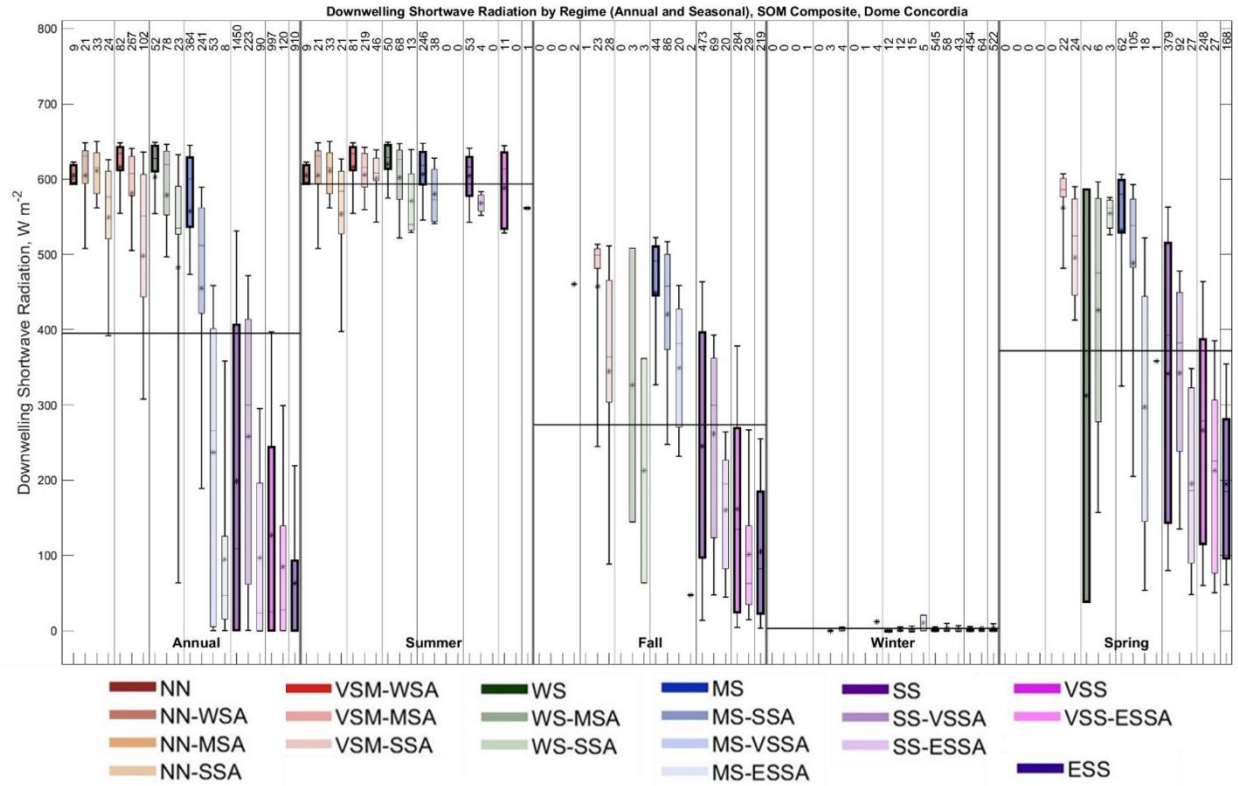
Neumayer					
Regime	Annual	Summer	Fall	Winter	Spring
<b>NN</b>	53 / 261 / 8.9	28 / 263 / 7.4	<i>2 / 261 / 6.0</i>	<i>4 / 235 / 9.4</i>	19 / 264 / 11.3
<b>NN-WSA</b>	147 / 263 / 11.1	82 / 271 / 10.9	17 / 260 / 10.0	15 / 227 / 10.5	33 / 261 / 12.8
<b>NN-MSA</b>	136 / 248 / 12.6	43 / 257 / 10.0	26 / 247 / 12.6	18 / 227 / 13.9	49 / 247 / 14.5
<b>NN-SSA</b>	38 / 232 / 14.0	<i>4 / 270 / 11.5</i>	<i>9 / 245 / 15.2</i>	13 / 223 / 15.7	12 / 222 / 12.3
<b>VSM-WSA</b>	93 / 245 / 4.3	57 / 254 / 4.2	18 / 246 / 2.8	<i>7 / 205 / 6.9</i>	11 / 219 / 5.8
<b>VSM-MSA</b>	115 / 227 / 6.7	32 / 241 / 5.3	25 / 239 / 6.4	22 / 207 / 7.9	36 / 218 / 7.5
<b>VSM-SSA</b>	62 / 213 / 7.8	19 / 220 / 4.4	<i>9 / 230 / 9.3</i>	15 / 208 / 9.1	19 / 200 / 9.7
<b>WS</b>	43 / 224 / 7.9	10 / 255 / 8.7	<i>7 / 213 / 6.2</i>	10 / 204 / 7.3	16 / 223 / 8.5
<b>WS-MSA</b>	46 / 223 / 9.6	10 / 236 / 8.8	<i>7 / 243 / 10.2</i>	23 / 215 / 9.8	<i>6 / 206 / 9.4</i>
<b>WS-SSA</b>	14 / 223 / 11.4	<i>2 / 266 / 9.6</i>	<i>3 / 256 / 15.4</i>	<i>8 / 198 / 10.7</i>	<i>1 / 240 / 7.9</i>
<b>MS</b>	179 / 201 / 5.2	43 / 231 / 4.3	38 / 219 / 4.9	56 / 169 / 6.2	42 / 195 / 5.2
<b>MS-SSA</b>	72 / 181 / 5.7	<i>7 / 221 / 4.4</i>	14 / 203 / 4.7	35 / 169 / 6.2	16 / 172 / 6.1
<b>MS-VSSA</b>	---	---	---	---	---
<b>MS-ESSA</b>	---	---	---	---	---
<b>SS</b>	199 / 179 / 5.0	21 / 222 / 5.3	41 / 203 / 3.7	99 / 160 / 5.2	38 / 180 / 5.4
<b>SS-VSSA</b>	<i>3 / 183 / 5.7</i>	---	---	<i>3 / 183 / 5.7</i>	---
<b>SS-ESSA</b>	---	---	---	---	---
<b>VSS</b>	19 / 162 / 6.0	---	<i>6 / 182 / 4.7</i>	10 / 159 / 6.7	<i>3 / 132 / 6.2</i>
<b>VSS-ESSA</b>	---	---	---	---	---
<b>ESS</b>	<i>1 / 150 / 11.5</i>	---	---	<i>1 / 150 / 11.5</i>	---

23 *Table S5: Nu Number of BMUs, mean downwelling longwave radiation ( $W m^{-2}$ ) and mean 20 m wind*  
 24 *speed ( $m s^{-1}$ ) (from left to right, separated by a forward slash (/) in each column) for each regime*  
 25 *annually and seasonally at Syowa. Rows that list the basic near-surface stability regimes are shown with*  
 26 *gray shading. Regimes with less than 10 observations annually or seasonally are listed in italics and red*  
 27 *text. A triple dash (“---”) indicates this regime is not observed annually or seasonally.*

Syowa					
Regime	Annual	Summer	Fall	Winter	Spring
<b>NN</b>	152 / 236 / 7.2	39 / 245 / 5.3	38 / 245 / 7.2	32 / 236 / 11.6	43 / 220 / 5.5
<b>NN-WSA</b>	891 / 234 / 6.2	270 / 239 / 5.2	253 / 247 / 6.4	109 / 227 / 8.8	259 / 219 / 6.1
<b>NN-MSA</b>	317 / 220 / 5.7	78 / 223 / 4.0	83 / 238 / 7.2	68 / 210 / 6.3	88 / 208 / 5.4
<b>NN-SSA</b>	24 / 214 / 4.1	<i>7 / 243 / 4.9</i>	<i>5 / 188 / 3.7</i>	<i>5 / 221 / 3.9</i>	<i>7 / 195 / 3.8</i>
<b>VSM-WSA</b>	1015 / 226 / 5.4	270 / 239 / 4.6	291 / 239 / 5.8	194 / 208 / 6.3	260 / 212 / 5.2
<b>VSM-MSA</b>	883 / 205 / 5.1	157 / 226 / 4.7	224 / 228 / 5.5	309 / 182 / 4.8	193 / 196 / 5.3
<b>VSM-SSA</b>	110 / 196 / 5.2	15 / 245 / 3.2	18 / 213 / 6.8	50 / 180 / 5.1	27 / 187 / 5.3
<b>WS</b>	730 / 234 / 9.7	118 / 253 / 8.3	200 / 248 / 9.7	239 / 222 / 10.5	173 / 222 / 9.5
<b>WS-MSA</b>	216 / 204 / 6.7	15 / 240 / 6.9	62 / 225 / 8.1	94 / 186 / 6.4	45 / 202 / 5.4
<b>WS-SSA</b>	18 / 191 / 6.5	---	<i>4 / 213 / 5.1</i>	<i>6 / 179 / 8.2</i>	<i>8 / 190 / 5.9</i>
<b>MS</b>	1460 / 192 / 6.5	172 / 227 / 6.9	295 / 214 / 7.4	640 / 178 / 6.4	353 / 184 / 6.2
<b>MS-SSA</b>	133 / 182 / 4.6	<i>7 / 218 / 5.1</i>	25 / 207 / 5.4	62 / 171 / 4.1	39 / 178 / 4.7
<b>MS-VSSA</b>	<i>3 / 154 / 1.1</i>	---	---	<i>2 / --- / 1.2</i>	<i>1 / 165 / 1.0</i>
<b>MS-ESSA</b>	---	---	---	---	---
<b>SS</b>	404 / 176 / 5.4	21 / 223 / 8.3	64 / 199 / 5.5	232 / 168 / 5.1	87 / 169 / 5.5
<b>SS-VSSA</b>	<i>7 / 167 / 2.2</i>	---	<i>1 / 196 / 2.1</i>	<i>5 / 156 / 1.5</i>	<i>1 / 193 / 5.6</i>
<b>SS-ESSA</b>	---	---	---	---	---
<b>VSS</b>	26 / 154 / 4.4	---	<i>3 / 183 / 8.1</i>	14 / 150 / 4.4	<i>9 / 150 / 3.1</i>
<b>VSS-ESSA</b>	---	---	---	---	---
<b>ESS</b>	<i>1 / 156 / 7.2</i>	---	---	<i>1 / 156 / 7.2</i>	---

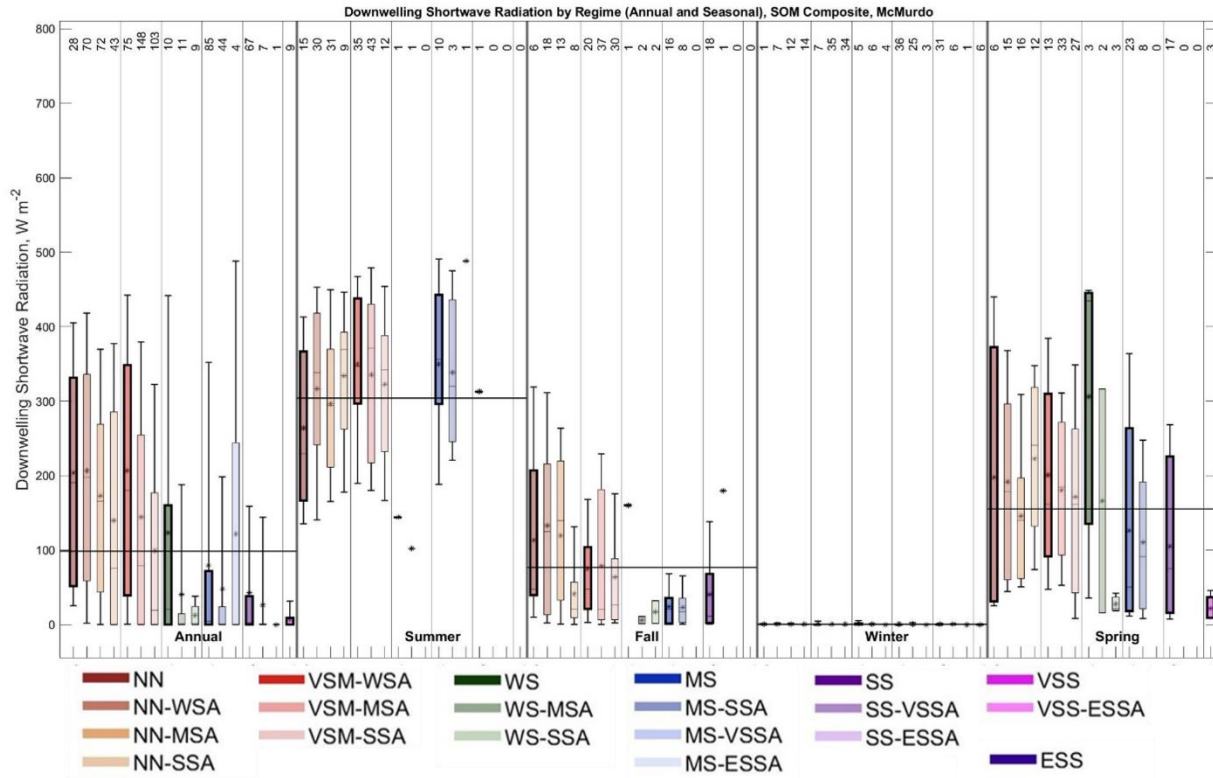


28 Figure S1: Distribution downwelling shortwave radiation observed for each regime at South Pole annually (left  
 29 panel) and seasonally (right four panels – summer, fall, winter, and spring). Box plots show median downwelling  
 30 shortwave radiation (horizontal line), 25th and 75th percentiles (edges of boxes), mean downwelling shortwave  
 31 radiation (center black star), and 10<sup>th</sup> and 90<sup>th</sup> percentiles (whiskers) for each stability regime for annual and  
 32 seasonal periods. The thin vertical black lines in the figure separate the stability groupings in each panel (annual or  
 33 seasonal). The numbers at the top indicate the number of radiosonde profiles in each regime.

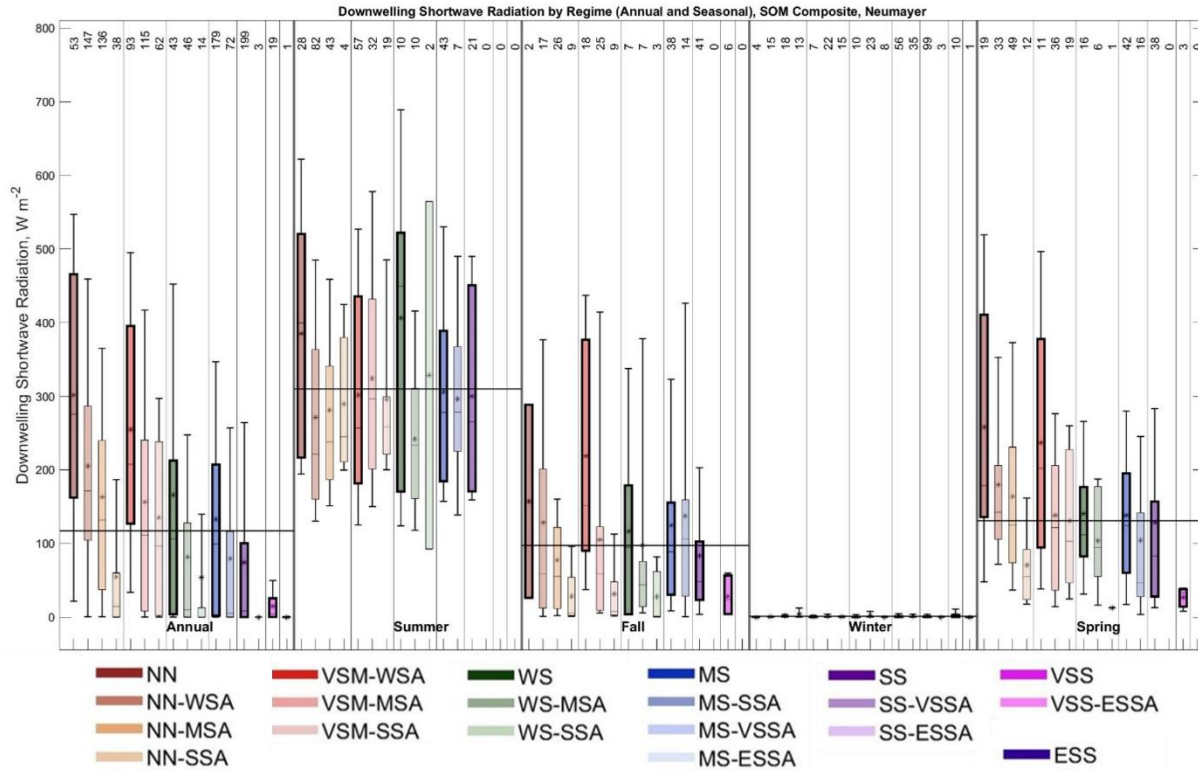


34 *Figure S2: Distribution downwelling shortwave radiation observed for each regime at Dome C annually (left panel)*  
 35 *and seasonally (right four panels – summer, fall, winter, and spring). Box plots show median downwelling shortwave*  
 36 *radiation (horizontal line), 25th and 75th percentiles (edges of boxes), mean downwelling shortwave radiation*  
 37 *(center black star), and 10th and 90th percentiles (whiskers) for each stability regime for annual and seasonal*  
 38 *periods. The thin vertical black lines in the figure separate the stability groupings in each panel (annual or*  
 39 *seasonal). The numbers at the top indicate the number of radiosonde profiles in each regime.*

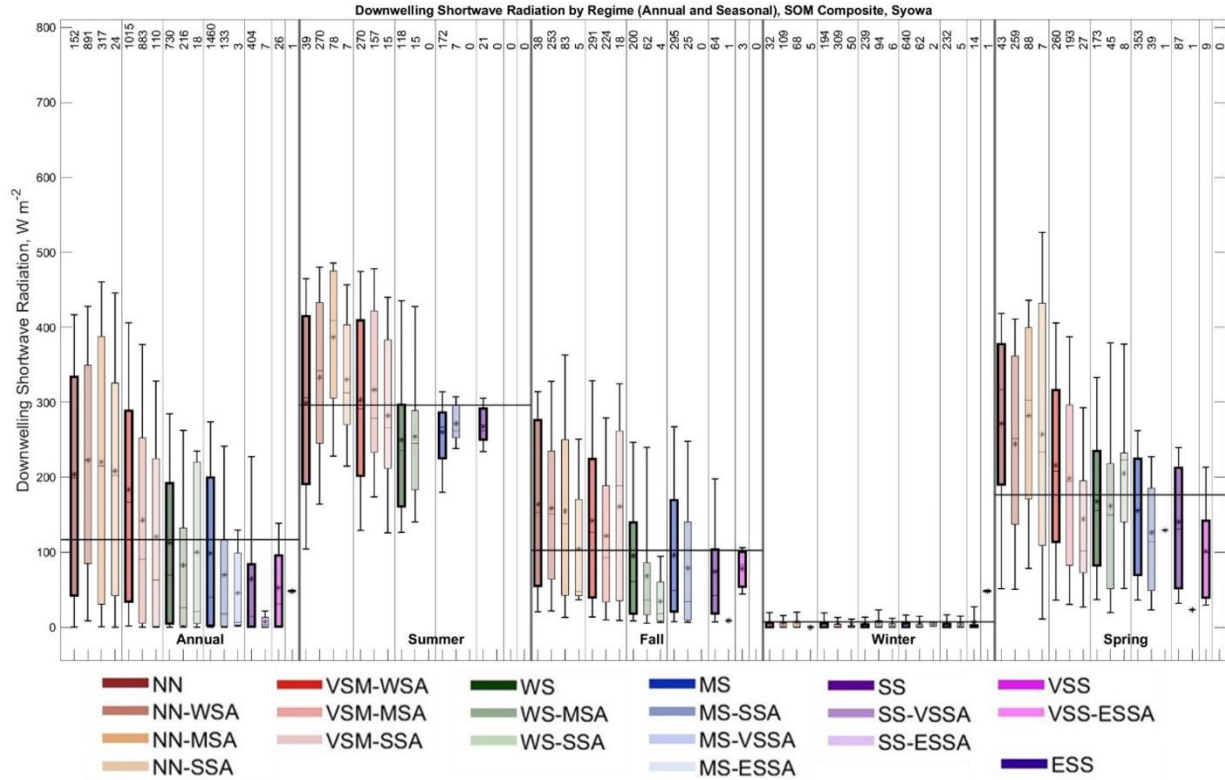




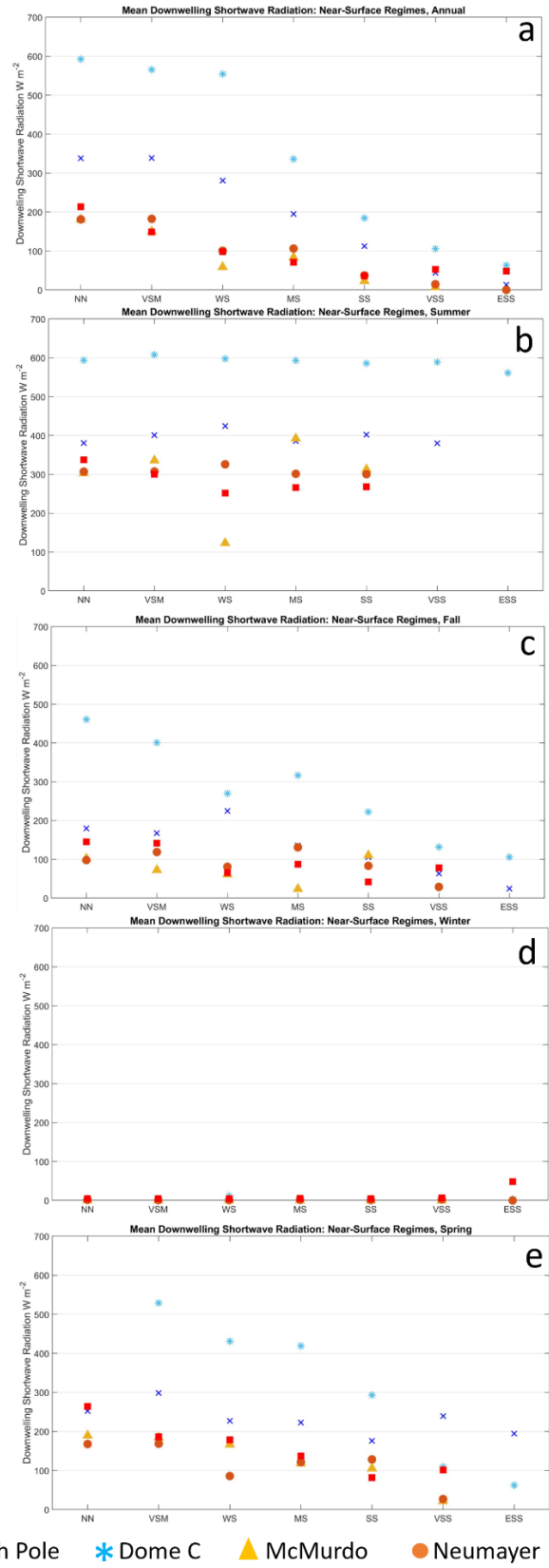
40 *Figure S3: Distribution downwelling shortwave radiation observed for each regime at McMurdo annually (left*  
 41 *panel) and seasonally (right four panels – summer, fall, winter, and spring). Box plots show median downwelling*  
 42 *shortwave radiation (horizontal line), 25th and 75th percentiles (edges of boxes), mean downwelling shortwave*  
 43 *radiation (center black star), and 10th and 90th percentiles (whiskers) for each stability regime for annual and*  
 44 *seasonal periods. The thin vertical black lines in the figure separate the stability groupings in each panel (annual or*  
 45 *seasonal). The numbers at the top indicate the number of radiosonde profiles in each regime.*



46 Figure S4: Distribution downwelling shortwave radiation observed for each regime at Neumayer annually (left  
 47 panel) and seasonally (right four panels – summer, fall, winter, and spring). Box plots show median downwelling  
 48 shortwave radiation (horizontal line), 25th and 75th percentiles (edges of boxes), mean downwelling shortwave  
 49 radiation (center black star), and 10th and 90th percentiles (whiskers) for each stability regime for annual and  
 50 seasonal periods. The thin vertical black lines in the figure separate the stability groupings in each panel (annual or  
 51 seasonal). The numbers at the top indicate the number of radiosonde profiles in each regime.

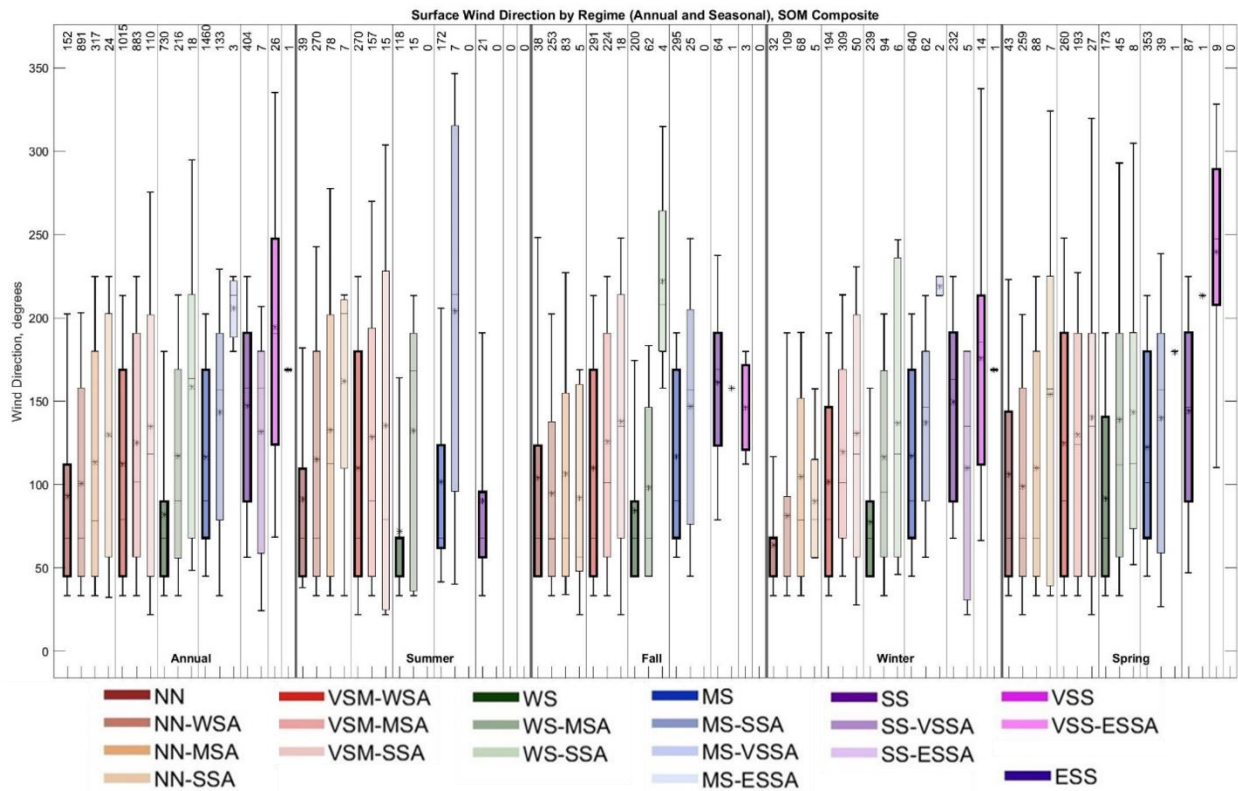


52 *Figure S5: Distribution downwelling shortwave radiation observed for each regime at Syowa annually (left panel)*  
 53 *and seasonally (right four panels – summer, fall, winter, and spring). Box plots show median downwelling shortwave*  
 54 *radiation (horizontal line), 25th and 75th percentiles (edges of boxes), mean downwelling shortwave*  
 55 *radiation (center black star), and 10th and 90th percentiles (whiskers) for each stability regime for annual and seasonal*  
 56 *periods. The thin vertical black lines in the figure separate the stability groupings in each panel (annual or*  
 57 *seasonal). The numbers at the top indicate the number of radiosonde profiles in each regime.*



X South Pole \* Dome C ▲ McMurdo ● Neumayer ■ Syowa

Figure S6: Summary of the mean downwelling shortwave radiation for the near-surface stability regimes at all five sites annually (a) and seasonally: summer, fall, winter, and spring (b through e).



58 *Figure S7: Distribution of surface wind direction observed for each regime at Syowa annually (left panel) and*  
 59 *seasonally (right four panels – summer, fall, winter, and spring). Box plots show median wind direction (horizontal*  
 60 *line), 25th and 75th percentiles (edges of boxes), mean wind direction (center black star), and 10th and 90th*  
 61 *percentiles (whiskers) for each stability regime for annual and seasonal periods. The thin vertical black lines in the*  
 62 *figure separate the stability groupings in each panel (annual or seasonal). The numbers at the top indicate the*  
 63 *number of radiosonde profiles in each regime.*