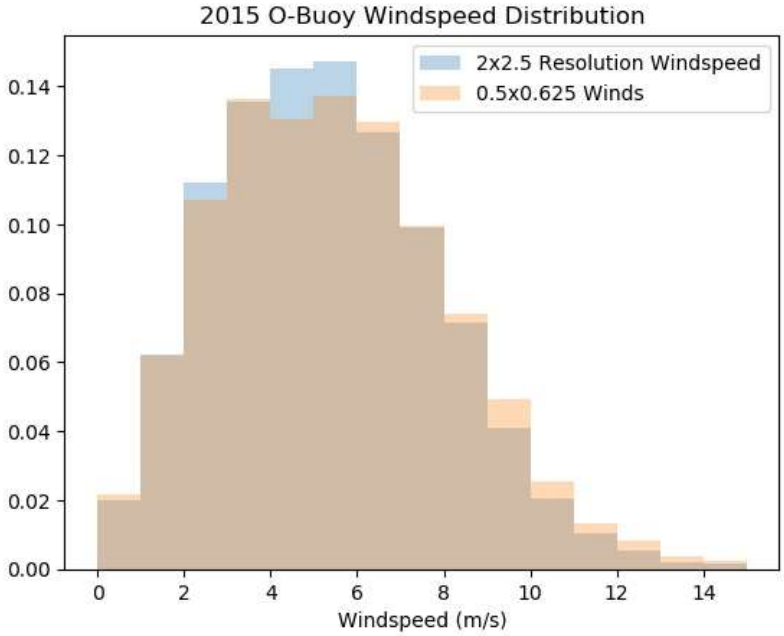
1. Supplement

Supplemental Equations

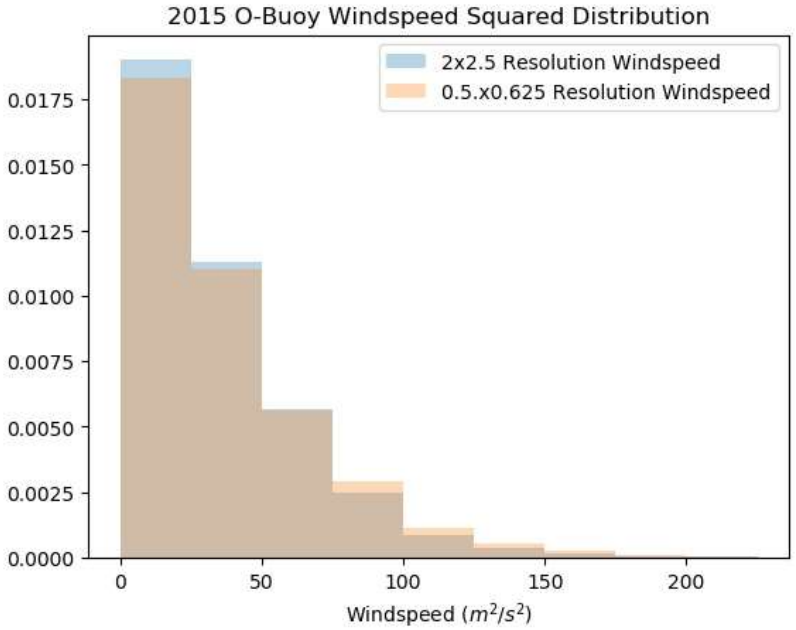
$$\mathbf{A_c} = \mathbf{W^* A_f W} \quad \text{(S1)}$$

A_c is the coarse averaging kernel, A_f is the fine averaging kernel, W is the interpolation matrix which samples the coarse grid profile vector on the fine grid, and W* is the transformation matrix (Payne et al., 2009).



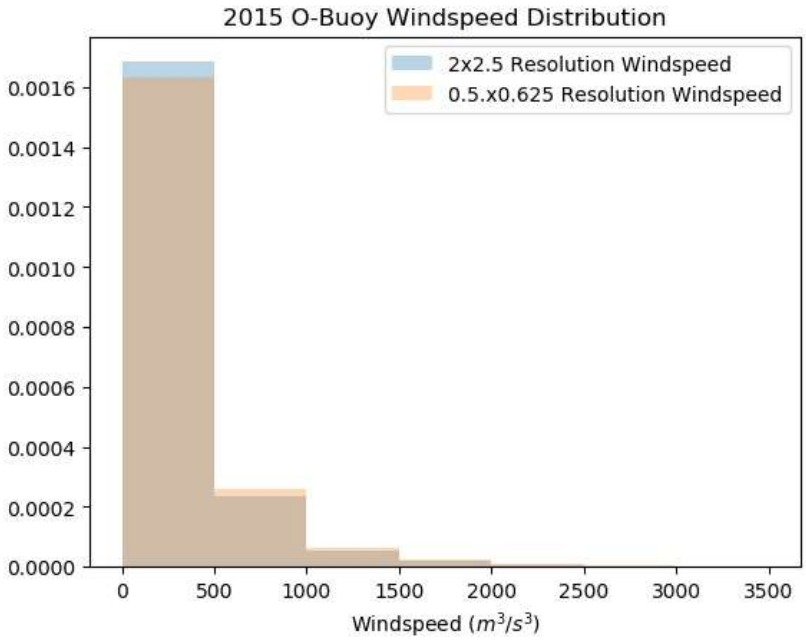
Supplemental Figure S1: Windspeed histogram

Distribution of windspeed along O-Buoy paths, plotted by bins of 1 m/s. Windspeed is in units in m/s, while Y-axis shows fraction of all windspeeds along O-Buoy paths in each bin.



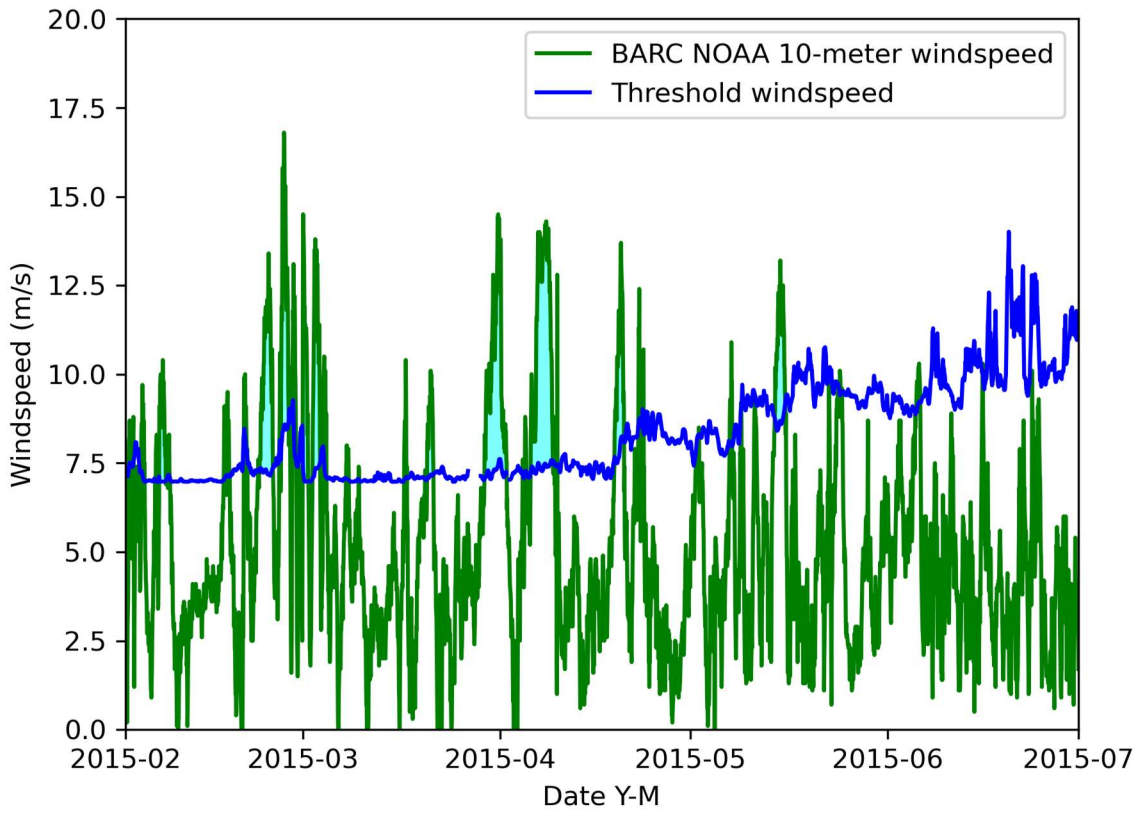
Supplemental Figure S2: Windspeed squared histogram

Distribution of windspeed squared along O-Buoy paths, plotted by bins of 25 m^2/s^2. Windspeed is in units in m/s, while Y-axis shows number of observations in each bin.



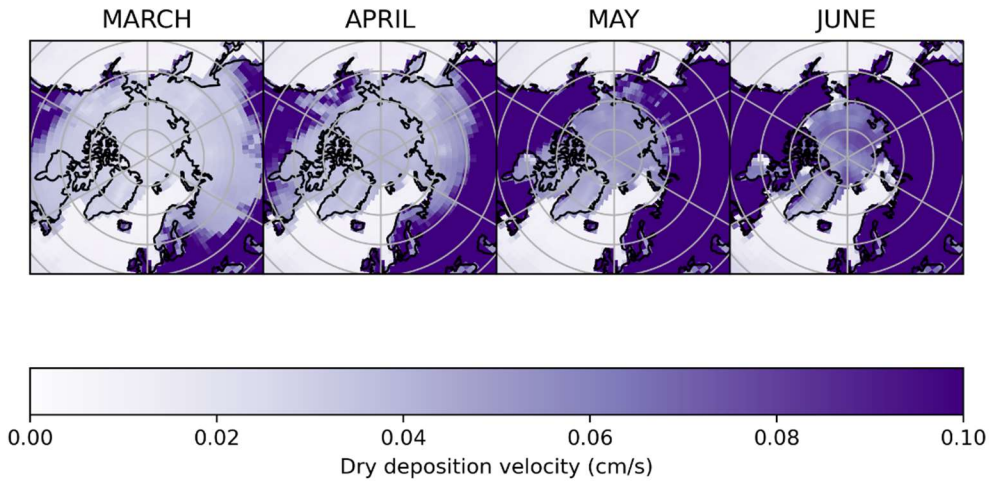
Supplemental Figure S3: Windspeed cubed histogram

Distribution of windspeed cubed along O-Buoy paths, plotted by bins of 500 m^2/s^2. Windspeed is in units in m/s, while Y-axis shows number of observations in each bin.



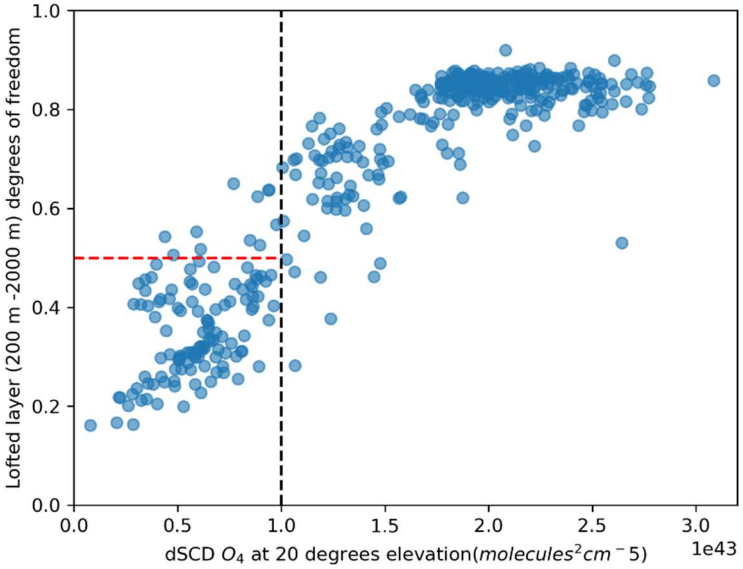
Supplemental Figure S4: Utqiaġvik ten-meter windspeeds

Hourly ten-meter windspeeds measured at Barrow Arctic Research Center (BARC) in green (NOAA, 2018), with threshold windspeed calculated from BARC ten-meter temperature using Equation 1 in blue. Periods with the potential for blowing snow SSA production highlighted in cyan.



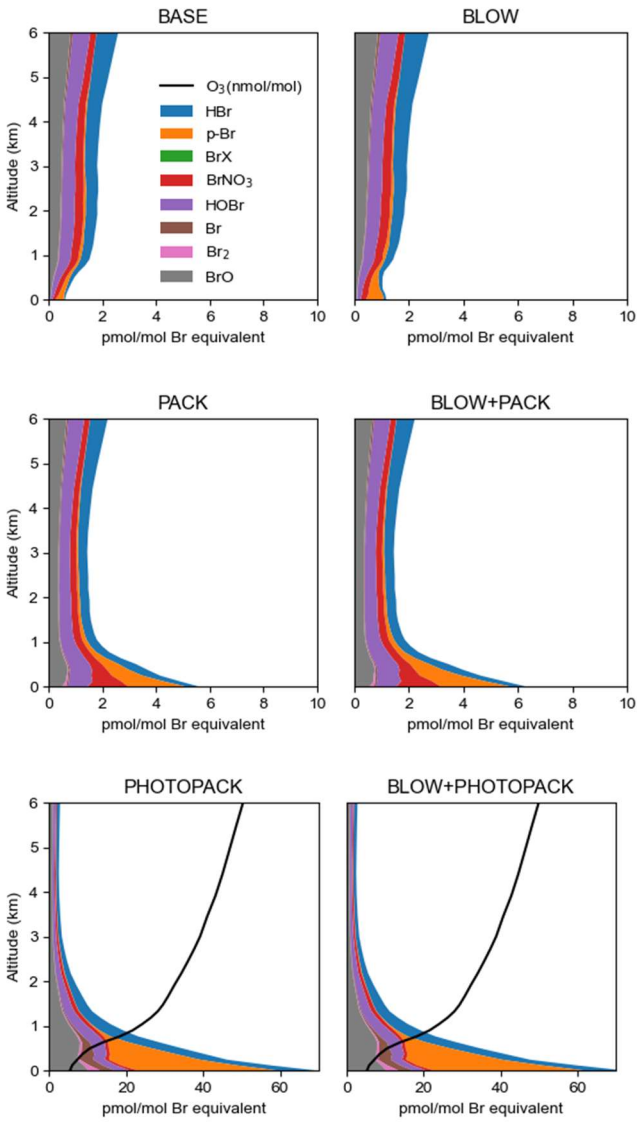
Supplemental Figure S5: Ozone dry deposition velocities by month, as simulated by GEOS-Chem

The dry deposition velocity of ozone in GEOS-Chem from 50 º N to 90 º N region in cm/s at 2° latitude x 2.5° longitude spatial resolution.



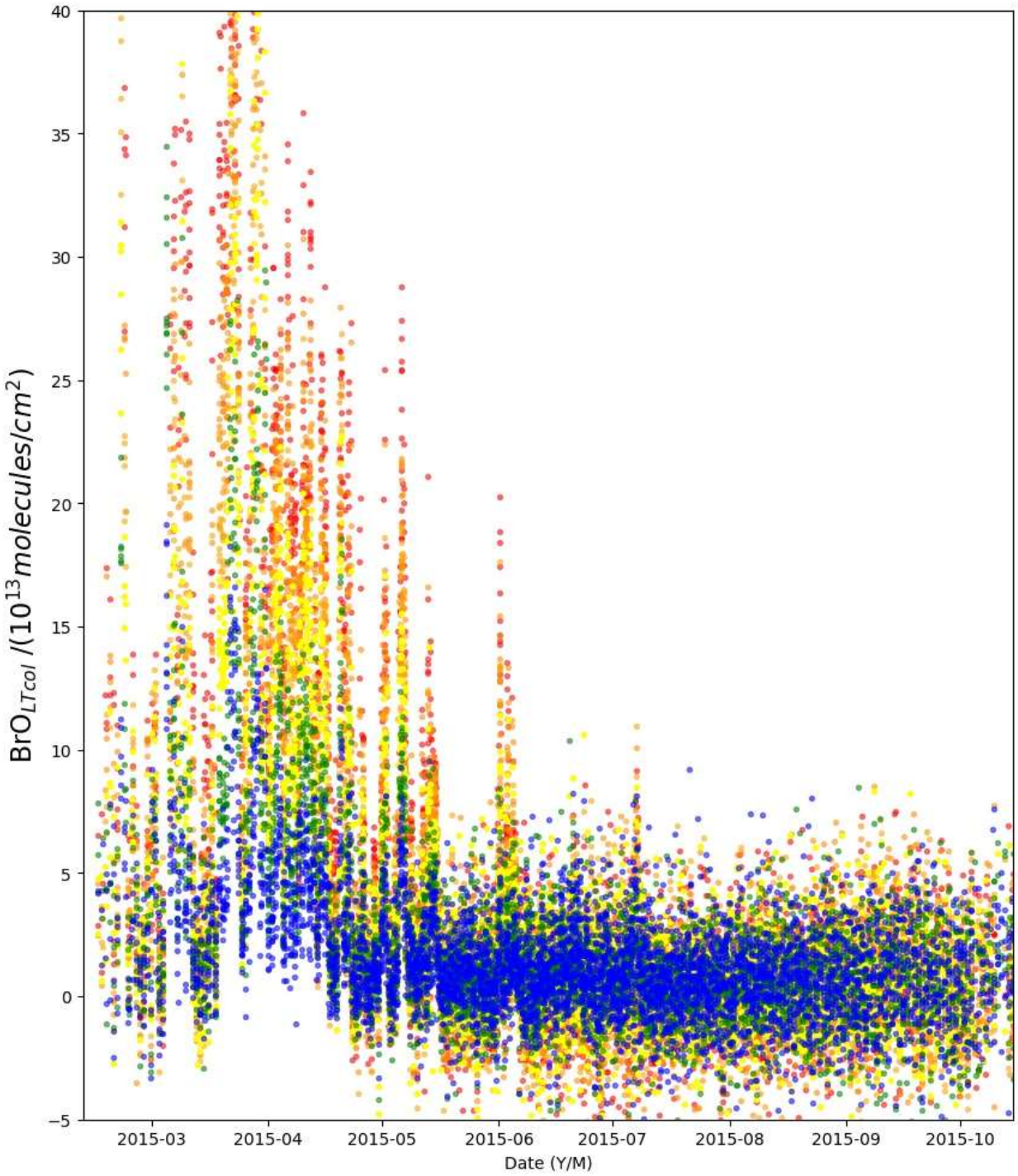
Supplemental Figure S6: Clear sky screen

Degrees of freedom in the lofted later from 200 to 2000 m plotted versus slant column density of the O_4 collisional dimer at 20º elevation. The clear sky threshold at 0.5 degrees of freedom is shown by the dashed red line, with the BrO_{LTcol} screen threshold at 10^{43} molecules^{2}cm^{-5} dSCD O_4 shown by dashed black line.



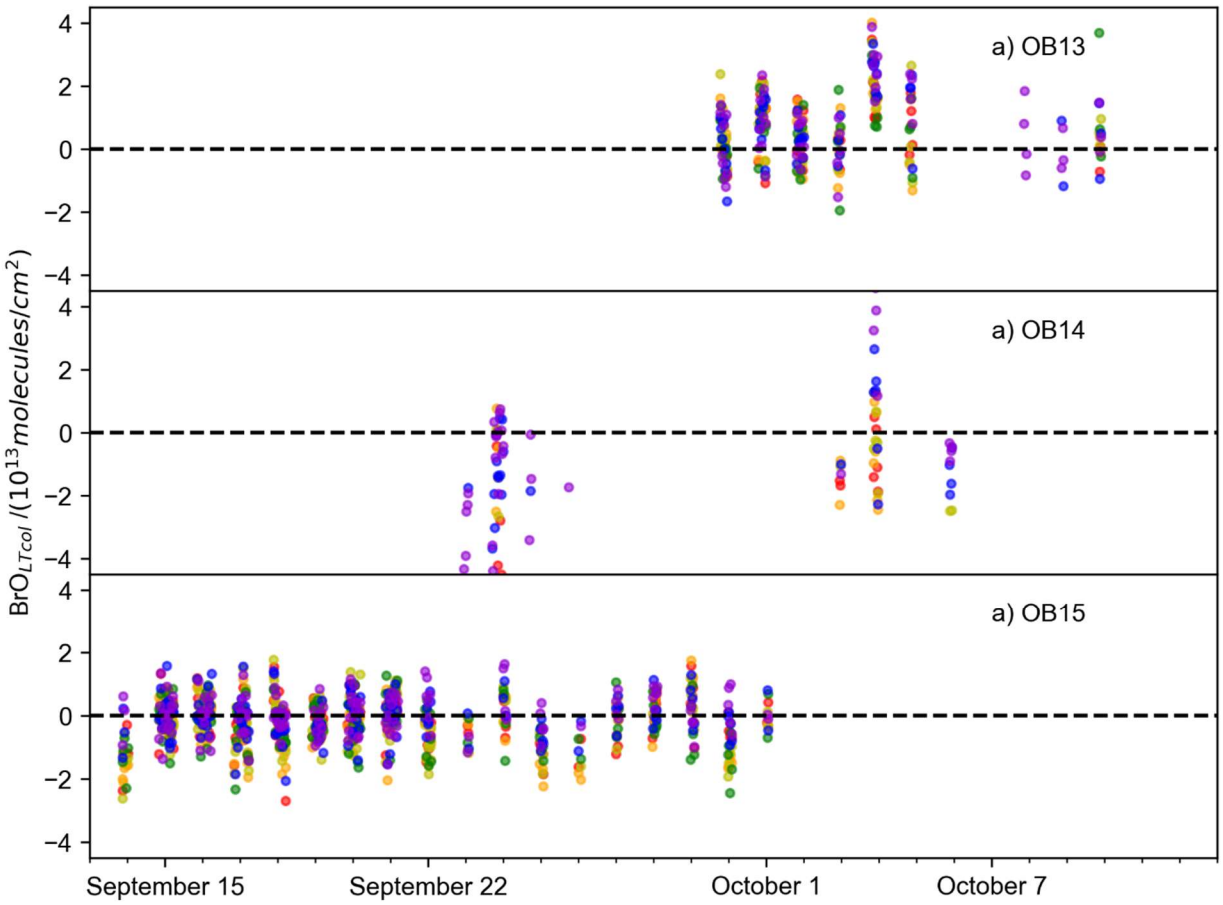
Supplemental Figure S7: Simulated vertical profiles of Br_y and p-Br^- at Utqiaġvik in May 2015.

Mixing ratios of Br equivalent (true Br_2 mixing ratios are half of plotted Br ratios) are shown for daytime (solar elevation > 5°). The simulations are named in the panel titles. Ozone is plotted in black as nmol/mol for PHOTOPACK and BLOW+PHOTOPACK runs.



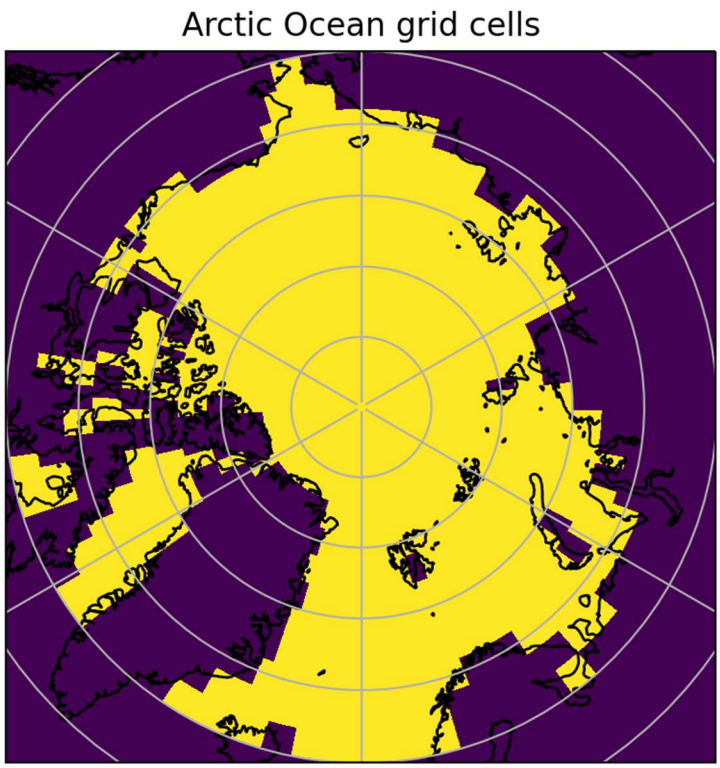
Supplemental Figure S8: Utqiaġvik 2015 differential slant column densities

Differential slant column densities of BrO at the Barrow Arctic Research Center from February to October 2015. View angel is denoted by color: 1° is red, 2° is orange, 5° is yellow, 10° is green, and 20° is blue.



Supplemental Figure S9: O-Buoy Fall 2015 differential slant column densities

Differential slant column densities of BrO at each buoy from September 13-October 13. View angle is denoted by color: 1° is red, 2° is orange, 3° is yellow, 5° is green, 10° is blue, and 20° is violet.



Supplemental Figure S10: Arctic Ocean grid cells in GEOS-Chem

Shows the area over which the burdens and rates in Tables S1, S2 and S3 were calculated. Yellow coloring indicates a grid cell north of 66˚ N latitude with greater than 50% fractional ocean coverage as determined by MERRA-2 ocean fields.

Supplemental Table S1: Arctic Tropospheric Reactions Rates by Model Run

Rates for each of the reactions listed in Figure 1 organized by GEOS-Chem run. All units are listed as millions of moles per hour across the region shown in Supplemental Figure S10. R in equation R2 refers to any organic molecule. Y in equation 1 represents NO, Cl, or H. X in equation HR6a represents either Br or Cl. PHOTOPACK and BLOW+PHOTOPACK are excluded as they severely overpredict BrO as seen in Figures 4 and 5.

	BASE	BLOW	PACK	BLOW+PACK	Reaction Equation
R1	17.57	17.77	27.7	28.4	$BrO + YO \rightarrow Br + O_2$
R2	236.28	261.75	435.74	472.14	$Br + O_3 \rightarrow BrO + O_2$
R3	0.7	0.84	1.38	1.54	$Br + RH \rightarrow HBr$, $Br + HO_2 \rightarrow HBr$
R4	0.01	0.01	0.02	0.02	$HBr + OH \rightarrow Br + H_2O$
R5	9.41	9.47	14.41	14.01	$BrO + HO_2 \rightarrow HOBr$
R6	1.63	2.4	12.78	16.16	$BrO + BrO \rightarrow Br_2 + O_2$
R7	0.03	0.06	0.04	0.06	$BrO + ClO \rightarrow BrCl + O_2$
R8	2.8	2.94	5.69	5.86	$BrO + NO_2 \rightarrow BrNO_3$
R9	0	0	0	0	$Br_2 + OH \rightarrow Br + HOBr$
R10	0.15	0.17	1.39	1.64	$Br + BrNO_3 \rightarrow Br_2 + NO_3$
R11	0.18	0.18	0.55	0.7	$Br + NO_2 \rightarrow BrNO_2$
HR1a	0.04	0.03	0.15	0.1	$HOBr + HBr \rightarrow Br_2 + H_2O$
HR1b	0.79	0.95	1.47	1.68	$HOBr + p\text{-}Br^- \rightarrow Br_2 + OH^-$
HR2	0.17	0.21	0.38	0.38	$HOBr+H_2O+HSO_3^- \rightarrow H_2SO_4+HBr+OH^-$
HR3	0.25	0.29	0.43	0.44	$BrNO_3 + H_2O \rightarrow HNO_3 + HOBr$
HR4a	0	0	0	0	$HBr + O_3 \rightarrow HOBr + O_2$
HR4b	0.07	0.09	0.14	0.15	$p\text{-}Br^-+O_3+H_2O \rightarrow HOBr+O_2+OH^-$
HR5	0	0	0	0	$BrNO_3 + HCl \rightarrow BrCl + HNO_3$
HR6a	0	0	0	0	$HOX + HX \rightarrow BrCl+H_2O$
HR6b	0.29	0.54	0.37	0.68	$HOBr + p\text{-}Cl^- \rightarrow BrCl + OH^-$
HR7a	0	0	0	0	$HBr + ClNO_x \rightarrow BrCl + HNO_x$
HR7b	0	0	0	0	$p\text{-}Br^-+ClNO_x+H_2O \rightarrow BrCl+HNO_x+OH^-$
HR8	0	0	0	0	$p\text{-}Br^- + IO_x > IBr + O_x$
P1	1.38	1.76	6.04	7.24	$Br_2 + h\nu \rightarrow 2Br$
P2	203.54	227.07	362.89	392.04	$BrO + h\nu \rightarrow Br + O$
P3	8.45	8.11	12.6	11.75	$HOBr + h\nu \rightarrow OH+Br$
P4	0.36	0.37	0.57	0.56	$BrNO_3 + h\nu \rightarrow BrO + NO_2$
P5	2.04	2.1	3.24	3.17	$BrNO_3 + h\nu \rightarrow Br + NO_3$
P6	0.18	0.18	0.55	0.7	$BrNO_2 + h\nu \rightarrow Br+NO_2$
P7	0.35	0.63	0.45	0.76	$BrCl + h\nu \rightarrow Br + Cl$
P8	0	0	0	0	$BrI + h\nu \rightarrow Br + I$

Supplemental Table S2: Arctic Tropospheric Burdens by Model Run

Average tropospheric burdens during March April and May 2015 organized by GEOS-Chem Run. All units are listed as millions of moles across the region shown in Supplemental Figure S10. PHOTOPACK and BLOW+PHOTOPACK are excluded as they severely overpredict BrO as seen in Figures 4 and 5.

	BASE	BLOW	PACK	BLOW+PACK	BLOW+PACK interaction
Br_2	0.49	0.67	1.72	2.07	0.17
BrO	3.15	3.75	6.57	7.31	0.14
Br	0.16	0.17	0.41	0.57	0.15
HOBr	1.89	1.53	2.89	2.37	-0.16
$BrNO_3$	2.91	3.05	4.57	4.55	-0.16
$BrNO_2$	0.03	0.03	0.09	0.13	0.04
BrCl	0.54	0.7	0.72	0.86	-0.02
IBr	0	0	0	0	0
HBr	0.69	0.63	1.21	1.13	-0.02
p-Br^-	0.37	0.52	0.8	0.96	0.01

Supplemental Table S3: Arctic Emissions and Deposition by Model Run

Average emission and deposition of selected species during March April and May 2015 organized by GEOS-Chem Run. All units are listed as millions of moles per hour across the region shown in Supplemental Figure S10. PHOTOPACK and BLOW+PHOTOPACK are excluded as they severely overpredict BrO as seen in Figures 4 and 5.

	BASE	BLOW	PACK	BLOW+PACK
Dry Dep Br2	0.01	0.01	0.01	0.01
Dry Dep BrNO3	0.27	0.30	0.37	0.39
Dry Dep HOBr	0.19	0.20	0.20	0.20
Dry Dep BrCl	0.00	0.00	0.00	0.00
Dry Dep IBr	0.00	0.00	0.00	0.00
Dry p-Br^-	2.10	2.16	2.37	2.19
Emission PACK Br_2	0.00	0.00	184.77	179.07
Emission SSA p-Br^-	10.09	10.50	10.71	10.50
Wet Dep p-Br^-	5.11	5.76	5.48	5.34