

# Supplemental Material

## Snowpack Measurements Suggest Role for Multi-year Sea Ice Regions in Arctic Atmospheric Bromine and Chlorine Chemistry

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Table S 1: Sample pH, location, snowpack depth, sampling depth, and sea ice type.

Sample_ID	Date	pH	pH Stdev	Latitude	Longitude	FYI/MYI	Snow Depth (cm)	Sample Depth (cm)
UW-07 1-3cm	5/7/2013	5.38	0.09	83.42	84.44	MYI	7	0
UW-07 2-5cm	5/7/2013	5.28	0.10	83.42	84.44	MYI	7	2
UW-05 4-7cm	5/3/2013	5.78	0.06	85.98	45.37	MYI	10	4
UW-05 1-3cm	5/3/2013	5.95	0.07	85.98	45.37	MYI	10	0
UW-06 2-5cm	5/3/2013	6.61	0.27	85.63	54.37	MYI	35	2
UW-06 3-7cm	5/3/2013	6.17	0.06	85.63	54.37	MYI	35	4
UW-14 1-3cm	5/15/2013	5.69	0.03	85.51	32.11	MYI	65	0
UW-01 Top Layer	4/30/2013	5.52	0.04	83.09	95.14	MYI	12	0
UW-06 1-3cm	5/3/2013	5.96	0.18	85.63	54.37	MYI	35	0
UW-11 2-5cm	5/13/2013	5.68	0.12	84.49	24.78	MYI	9	2
UW-11 1-3cm	5/13/2013	5.39	0.08	84.49	24.78	MYI	9	0
UW-05 2-5cm	5/3/2013	5.10	0.09	85.98	45.37	MYI	10	2
UW-14 2-5cm	5/15/2013	5.44	0.09	85.51	32.11	MYI	65	2
UW-14 4-7cm	5/15/2013	5.24	0.12	85.51	32.11	MYI	65	4
UW-07 4-7cm	5/7/2013	6.11	0.13	83.42	84.44	MYI	7	4
UW-10 1-3cm	5/11/2013	6.64	0.04	83.01	55.02	MYI	6.5	0
UW-03 1-3cm	5/2/2013	5.83	0.07	85.13	45.06	MYI	12.5	0
UW-11 4-7cm	5/13/2013	6.20	0.08	84.49	24.78	MYI	9	4
UW-15 1-3cm	5/15/2013	5.24	0.04	86.35	29.08	FYI	9	0
Camden Bay #5	2/24/2014	6.10	0.09	70.33	-145.71	FYI	8	0
Camden Bay #4	2/24/2014	4.97	0.05	70.40	-145.38	FYI	8	0
Peard Bay #1	2/26/2014	5.06	0.07	71.62	-157.18	MYI		0
Peard Bay #2	2/26/2014	4.83	0.04	71.62	-157.18	MYI		0
Peard Bay #3	2/26/2014	5.09	0.02	70.20	-148.45	MYI		0
Camden Bay #3	2/27/2014	4.78	0.07	70.36	-145.56	FYI	8	0
Camden Bay #1	2/24/2014	5.67	0.11	70.32	-145.85	FYI	8	0
Camden Bay #2	2/24/2014	5.03	0.06	70.33	-145.71	FYI	8	0
MYI #6 5-10cm	2/26/2014	5.54	0.10	71.80	-157.08	FYI	15	0
Site B (Harrison Bay)	2/25/2014	5.04	0.05	70.70	-149.42	FYI	27	0
Site A (Harrison Bay)	2/25/2014	4.89	0.10	70.62	-149.82	FYI	10.5	0
MYI 10-15cm	2/26/2014	5.62	0.05	71.80	-157.08	FYI	15	0
Site C	2/25/2014	4.84	0.11	70.84	-149.37	FYI	7.5	0
Barneo SS 4/18/13 13:43	4/18/2013			84.96	-169.84	FYI	15	0
Barneo SS 4/5/13 14:00	4/5/2013			89.56	-145.75	FYI	15	0
Barneo SS 4/5/13 14:13	4/5/2013			89.56	-145.75	FYI	15	0
Barneo 4/5/13 14:13	4/5/2013			89.56	-145.75	FYI	15	0
Barneo SS 4/18/14 14:30 (b)	4/18/2014	4.95	0.01	85.94	89.90	FYI	15	0
Barneo SS 4/17/13 16:25 (n)	4/17/2013			81.01	179.65	FYI	15	0
Barneo 4/14/13 10:33	4/14/2013			84.96	89.37	FYI	15	0
Barneo 4/18/14 14:30 Surface	4/18/2013	5.71	0.07	89.99	-1.49	FYI	15	0
Barneo 4/18/14 14:30 15cm	4/18/2014	5.38	0.07	89.99	-1.49	FYI	15	15
Barneo 4/21/14 12cm	4/21/2014	5.38	0.04	88.06	14.24	FYI	37	12

Table S 2: Sample ion concentrations ( $\mu\text{M}$ ) and uncertainties for  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{K}^+$ ,  $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{Br}^-$ , and  $\text{NO}_3^-$ . BDL stands for below detection limit.

Sample_ID	Na <sup>+</sup>	Na Er	Mg <sup>2+</sup>	Mg <sup>2+</sup> Er	Ca <sup>2+</sup>	Ca <sup>2+</sup> Er	K <sup>+</sup>	K <sup>+</sup> Er	Cl <sup>-</sup>	Cl <sup>-</sup> Err	SO <sub>4</sub> <sup>2-</sup>	SO <sub>4</sub> <sup>2-</sup> Er	Br <sup>-</sup>	Br <sup>-</sup> Er	NO <sub>3</sub> <sup>-</sup>	NO <sub>3</sub> <sup>-</sup> Er
UW-07 1-3cm	66.01	5.01	4.01	0.31	3.42	0.58	2.53	0.23	98.21	9.15	8.65	1.55	0.54	0.08	4.39	0.43
UW-07 2-5cm	74.92	7.07	5.89	1.71	2.90	0.57	2.85	0.19	146.79	3.06	9.74	0.49	0.42	0.03	4.79	0.15
UW-05 4-7cm	151.87	4.87	19.05	1.16	4.66	0.08	5.01	0.29	282.49	13.35	23.33	0.79	1.01	0.04	6.35	0.37
UW-05 1-3cm	52.26	6.79	BDL	BDL	1.04	0.41	1.59	0.31	66.59	1.46	9.59	0.91	0.54	0.01	4.96	0.05
UW-06 2-5cm	8.55	2.57	BDL	BDL	0.22	0.06	0.12	0.16	7.81	0.68	0.53	0.17	0.86	0.01	1.81	0.01
UW-06 3-7cm	24.84	3.57	BDL	BDL	0.64	0.11	1.00	0.10	39.94	1.77	2.73	1.33	0.18	0.01	3.89	0.25
UW-14 1-3cm	140.70	4.53	14.13	0.14	4.53	0.09	4.45	0.15	266.26	0.54	13.92	1.71	0.19	0.01	7.94	0.08
UW-01 Top Layer	166.57	4.43	32.59	0.56	24.64	1.04	7.38	0.07	395.58	5.87	7.02	0.80	0.19	0.06	2.53	0.07
UW-06 1-3cm	10.50	4.10	BDL	BDL	0.49	0.47	0.24	0.04	14.34	0.33	4.07	0.24	0.32	0.05	3.44	0.19
UW-11 2-5cm	124.40	5.70	14.77	1.08	3.22	0.17	4.32	0.18	251.49	2.08	8.89	0.64	0.13	0.03	2.74	0.08
UW-11 1-3cm	199.84	4.91	26.03	0.56	7.06	0.29	6.62	0.17	396.09	3.50	19.53	1.74	0.28	0.00	4.03	0.08
UW-05 2-5cm	102.90	5.54	8.96	0.95	1.91	0.14	2.90	0.12	169.59	1.96	16.54	0.69	0.78	0.02	6.76	0.27
UW-14 2-5cm	122.02	1.41	13.51	0.48	3.28	0.07	3.82	0.03	238.55	0.78	8.61	0.34	0.16	0.01	7.53	0.09
UW-14 4-7cm	120.19	4.02	13.01	0.51	3.20	0.29	3.69	0.11	230.18	0.67	11.29	0.43	0.15	0.01	7.21	0.03
UW-07 4-7cm	11724.41	2428.39	2338.11	395.58	522.27	37.88	606.59	113.37	27061.14	835.26	2048.74	154.42	99.27	4.56	87.89	11.43
UW-10 1-3cm	1826.55	255.57	BDL	BDL	21.34	5.72	61.47	19.94	2183.18	164.12	427.67	43.20	5.32	0.95	41.23	5.18
UW-03 1-3cm	7501.68	495.90	BDL	BDL	94.22	13.74	231.81	18.66	11718.37	636.28	514.02	104.93	26.93	3.49	50.23	8.00
UW-11 4-7cm	19341.61	469.59	1273.23	47.75	318.81	23.49	574.41	15.33	21760.30	56.66	7407.98	8.88	5.97	1.88	26.18	3.78
UW-15 1-3cm	192.77	2.69	32.33	0.53	6.79	0.08	7.65	0.25	388.09	1.35	31.26	0.43	1.35	0.19	6.70	0.29
Camden Bay #5	164.52	0.94	17.88	0.42	4.38	0.18	5.14	0.02	310.97	1.39	14.95	1.79	0.80	0.01	1.33	0.09
Camden Bay #4	172.00	8.60	26.75	0.61	5.09	0.19	6.75	0.40	350.19	16.55	11.60	2.08	0.48	0.04	6.48	0.54
Peard Bay #1	69.08	2.88	8.77	0.26	2.11	0.05	2.39	0.20	147.20	1.12	4.62	0.48	0.44	0.01	8.53	2.24
Peard Bay #2	197.48	0.67	22.46	0.33	3.94	0.19	6.85	0.09	390.86	1.36	8.33	0.53	0.60	0.01	2.30	0.06
Peard Bay #3	132.16	1.89	22.44	0.59	3.60	0.27	6.14	0.13	293.88	1.29	5.29	0.58	0.19	0.01	5.52	3.20
Camden Bay #3	238.22	54.75	26.04	5.70	4.58	0.64	7.26	1.46	526.67	1.58	7.14	0.32	0.66	0.01	4.45	0.09
Camden Bay #1	216.89	2.42	27.87	0.02	4.40	0.11	7.15	0.07	423.06	0.44	18.13	0.43	0.95	0.01	0.49	0.06
Camden Bay #2	322.47	3.58	45.69	0.57	7.49	0.14	11.56	0.05	685.28	2.70	5.91	0.66	1.61	0.01	4.35	3.11
MYI #6 5-10cm	27.12	4.52	2.40	0.42	1.02	0.19	0.97	0.17	49.75	3.37	3.87	1.96	0.12	0.03	8.06	10.81
Site B (Harrison Bay)	166.22	2.16	18.07	0.21	3.32	0.28	5.15	0.08	331.91	2.54	6.35	4.43	0.23	0.01	9.98	14.09
Site A (Harrison Bay)	218.65	1.60	29.38	0.28	4.28	0.08	7.66	0.23	455.89	0.13	5.49	1.26	0.32	0.03	3.90	3.51
MYI 10-15cm	17.75	5.05	1.42	0.29	1.10	0.42	0.57	0.04	32.90	1.08	1.60	0.57	0.12	0.02	1.16	0.10
Site C	112.54	4.89	8.74	0.82	2.18	0.22	3.44	0.19	133.60	2.02	1.31	0.22	0.32	0.02	0.80	0.40
Barneo SS 4/18/13 13:43 Mark	169.49	4.07	19.06	0.48	4.28	0.38	18.86	0.27	354.32	22.43	10.17	1.93	0.27	0.03	4.96	0.52
Barneo SS 4/5/13 14:00	90.29	0.82	11.92	0.93	3.26	0.11	21.69	1.13	225.52	6.18	9.11	0.73	0.32	0.01	3.26	0.09
Barneo SS 4/5/13 14:13	24.98	7.21	3.31	0.04	2.65	0.84	23.76	2.05	95.46	2.63	5.49	1.22	0.27	0.00	4.65	0.18
Barneo 4/5/13 14:13	165.18	14.09	16.91	1.47	3.30	0.45	4.56	0.51	301.77	7.71	13.14	0.66	0.56	0.01	0.84	0.09
Barneo SS 4/18/14 14:30 (b)	53.83	9.89	BDL	BDL	0.25	0.06	16.77	4.17	55.27	1.70	2.02	0.32	0.29	0.01	1.05	0.03
Barneo SS 4/17/13 16:25 (n)	407.63	20.58	40.65	4.80	10.02	1.54	28.23	2.57	498.56	53.86	10.83	1.64	0.75	0.07	1.69	0.27
Barneo 4/14/13 10:33	224.51	5.90	24.06	1.36	7.62	0.42	8.66	0.31	292.01	2.08	6.26	0.67	0.79	0.07	3.31	0.90
Barneo 4/18/14 14:30 Surface	351.86	6.27	43.92	0.14	0.56	0.97	0.72	0.26	379.86	4.17	55.08	0.18	1.65	0.25	3.08	0.92
Barneo 4/18/14 14:30 15cm	172.25	29.56	23.79	4.20	1.72	0.46	7.81	0.17	366.32	22.88	7.68	0.59	0.47	0.03	4.06	0.12
Barneo 4/21/14 12cm	391.14	3.53	54.89	1.47	4.72	0.54	5.64	0.25	809.90	9.20	10.16	0.31	1.35	0.14	3.32	0.26

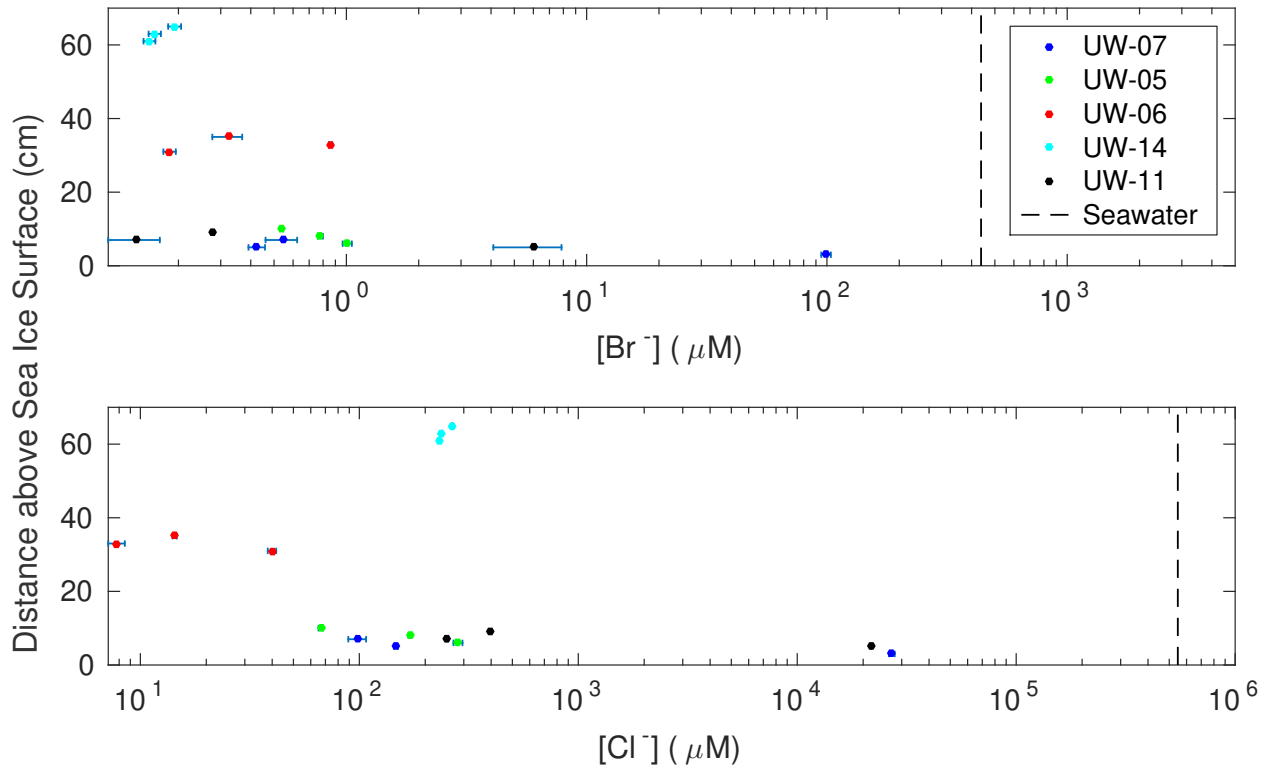


Figure S 1: Profiles of bromide and chloride within the snowpack at 5 sites. The seawater ratio (Millero et al., 2008) is plotted for reference.

## References

Millero FJ, Feistel R, Wright DG, McDougall TJ. 2008. The composition of Standard Seawater and the definition of the Reference-Composition Salinity Scale. *Deep-Sea Research Part I: Oceanographic Research Papers* **55**(1): 50–72. ISSN 09670637. doi:10.1016/j.dsr.2007.10.001.