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Supplement of

Enhancement of the North Atlantic CO_2 sink by Arctic Waters

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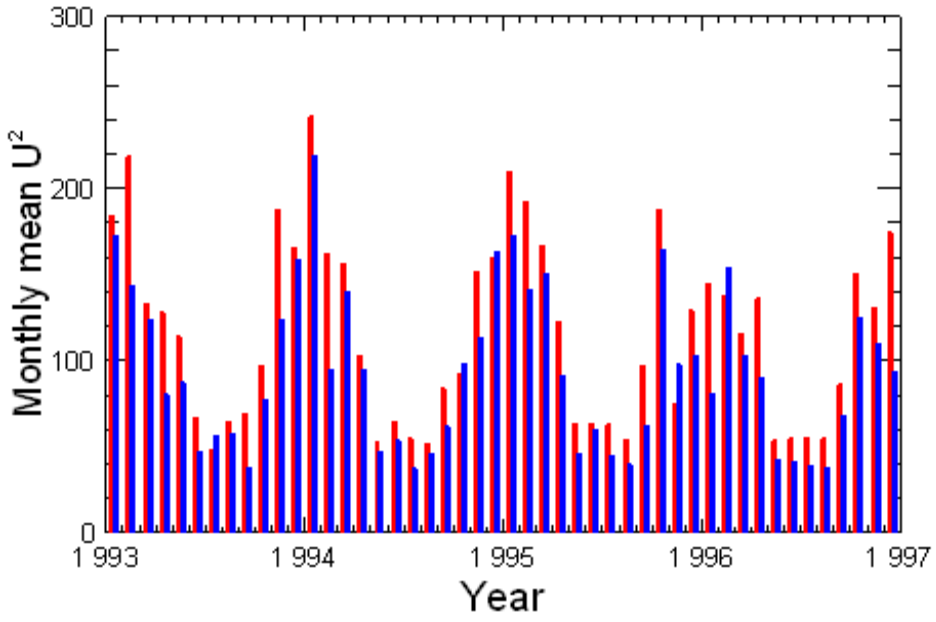

Figure S1. Montlhy means of squared CCMP-2 daily winds, U m^2/s^2. Irminger Sea region (red) and the Iceland Sea region (blue).

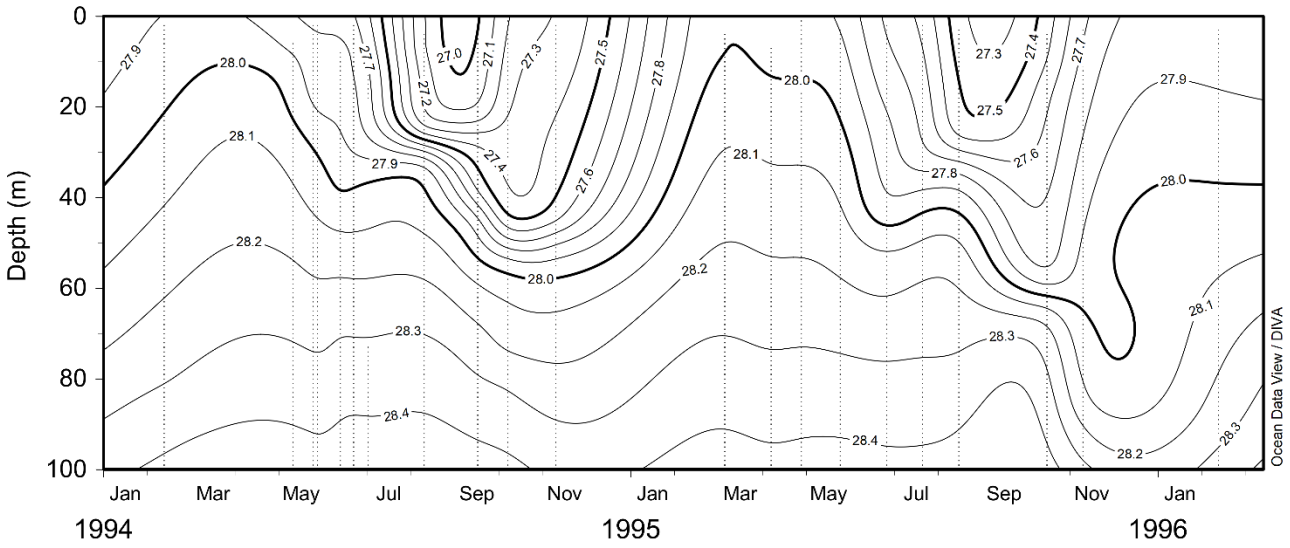

Figure S2. Development of surface layer density in the Iceland Sea from January 1994 to February 1996. Contour lines for density (sigma theta, kg m^{-3}) are shown for combined CTD data from stations Ice 4 and LNA 6, Table S1. Vertical dotted lines denote the CTD profiles. The density difference between surface and 30 m depth in late May is 0.136 in 1994 and 0.223 in 1995 and weaker stratification was generally observed in 1995 for the phytoplankton growth period.

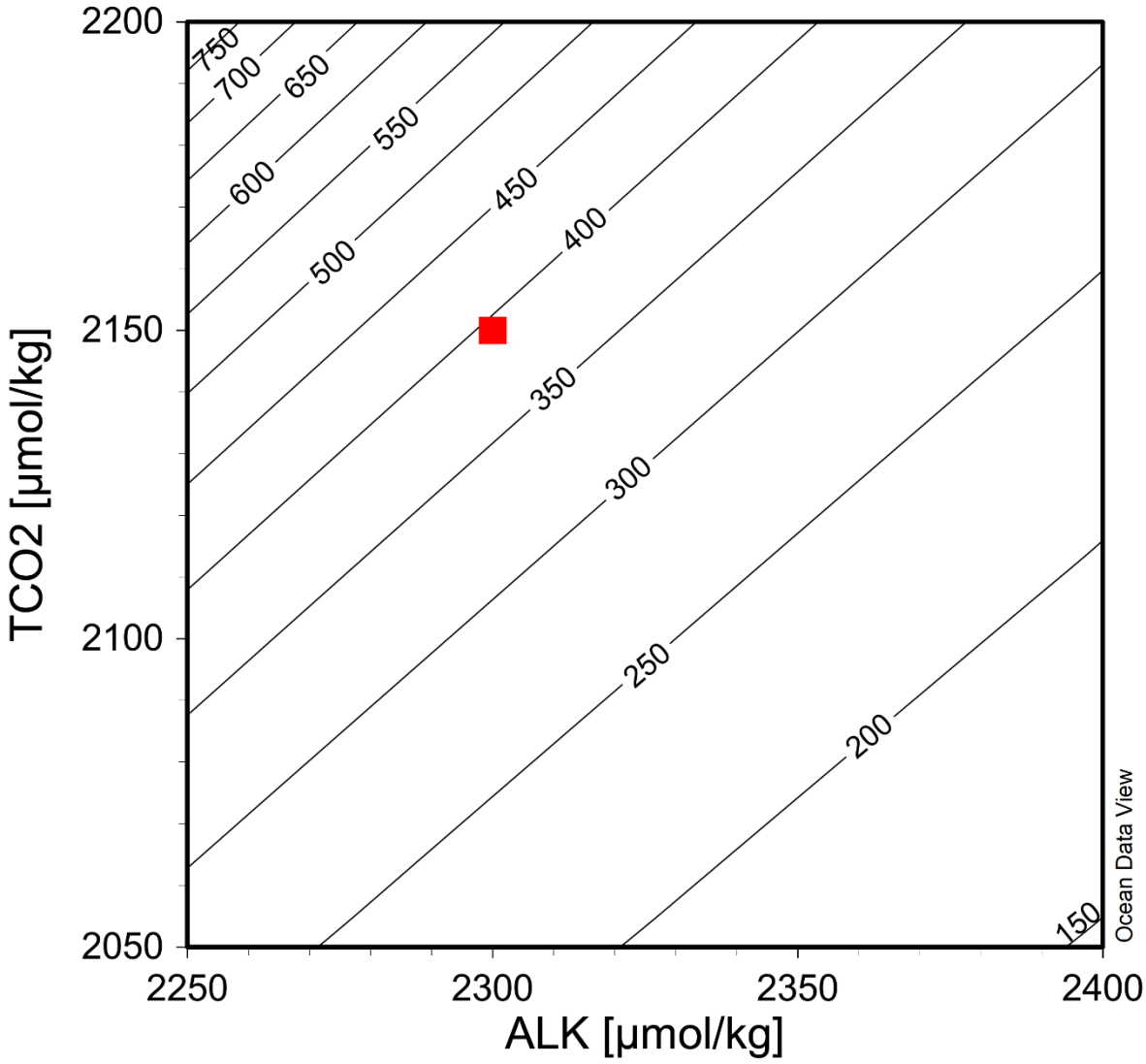

Figure S3. Thermodynamic relations of alkalinity, total inorganic carbon and the equilibrium pCO_2 in seawater (µatm) plotted for S=35 and t=5°C. The red square represents Atlantic Water which reaches the Nordic Seas and has TCO2/Alk=0.935. The slopes, $\Delta TCO_2 / \Delta Alk$, of the pCO_2 contours in the vicinity of the square have a value of ~0.85 which describes the relative proportions of alkalinity and TCO2 additions to maintain unchanged pCO_2. Figure drawn using the Ocean Data View program (Schlitzer, 2018).

Estimated influence of alkalinity input on seawater *p*CO_2.

Estimate 1. Alkalinity added with river runoff.

Estimated river runoff to the Arctic Ocean is 4.2 x 10^3 km^3 yr^{-1} or 0.133 x 10^6 m^3 s^{-1} (Carmack et al., 2016). Taking the average alkalinity, 1048 µmol kg^{-1}, for river flow to the Arctic Ocean (Cooper et

al., 2008), then the river derived alkalinity transported by ocean currents towards the North Atlantic, would be: 0.133×10^6 (m^3 s^{-1}) x 3.15×10^7 (s yr^{-1}) x 1048×10^{-3} (mol m^{-3})= 4.4×10^{12} mol yr^{-1}.

Estimate 2. Effects of excess alkalinity in Polar Water.

The Polar Water volume transport by the East Greenland Current is estimated 3.9 Sv (Våge et al., 2013). Nondal et al. (2009) give two equations (Eq 6 and Eq 7) for linear salinity-alkalinity relationships for Atlantic and Polar Waters:

Atlantic Water: $TA = 49.35 \times S + 582.00$ for $S>34.5$ Eq 6

Polar Water: $TA = 15.29 \times S + 1751.73$ for $S<34.5$ Eq 7

For the mean salinity S=33.0 for the EGC Polar Water and using equations 6 and 7 in Nondal et al (2009), the Polar Water mean alkalinity is 2256 µmol kg^{-1} which is 46 µmol kg^{-1} greater alkalinity than that of the North Atlantic Water calculated at the same salinity (Nondal et al., 2009).

Thus, the excess alkalinity transported southward to the North Atlantic by the EGC is:

3.9×10^6 (m^3 s^{-1}) x 3.15×10^7 (s yr^{-1}) x 46×10^{-3} (mol m^{-3})= 5.7×10^{12} mol yr^{-1}. Such excess alkalinity would lower the pCO_2 of Atlantic Water by 88 µatm and increase the pH by 0.10. Using 0.85 for the $\Delta TCO_2/\Delta Alk$ changes at a constant pCO_2 (Fig. S3), we obtain the contribution of the excess East Greenland Current alkalinity to the uptake of CO_2 from the atmosphere as: 4.8×10^{12} mol CO_2 yr^{-1}, or 0.058 Pg-C yr^{-1}.

Table S1. Locations and depths of stations repeated in the Irminger and Iceland Seas.

Station no	Latitude° N	Longitude° W	Station depth, m
Irm 1	63.835	31.200	2682
Irm 2	63.958	30.393	2500
Irm 3	64.072	29.585	2009
Irm 4	64.213	28.775	1518
Irm 5	64.333	27.950	1000
Ice 1	67.666	18.333	405
Ice 2	67.850	17.500	1100
Ice 3	68.167	16.167	1350
Ice 4	68.417	14.833	1470
LNA 3	67.250	13.567	1540
LNA 4	67.500	13.267	1725
LNA 6	68.000	12.667	1875

Table S2 Irminger Sea cruises and dates for discrete pCO_2 samples

No	Cruise number	Expocode	Dates
1	B2-1993	46BS19930223	23 02 1993
2	A4-1993	46FR19930313	13 03 1993 -14 03 1993
3	B5-1993	46BS19930414	14 04 1993-15 04 1993
4	A8-1993	46FR19930514	14 05 1993-15 05 1993
5	A10-1993	46FR19930526	26 05 1993
6	B7-1993	46BS19930602	02 06 1993-03 06 1993
7	B8-1993	46BS19930623	23 06 1993
8	B9-1993	46BS19930707	07 07 1993-08 07 1993
9	A13-1993	46FR19930728	28 07 1993-29 07 1993
10	B10-1993	46BS19930825	25 08 1993-26 08 1993
11	B11-1993	46BS19930909	09 09 1993
12	B13-1993	46BS19931005	05 10 1993
13	B14-1993	46BS19931019	19 10 1993-20 10 1993
14	B15-1993	46BS19931114	14 11 1993
15	B1-1994	46BS19940106	06 01 1994 -07 01 1994

Table S3 Iceland Sea cruises and dates for discrete pCO_2 samples

No	Cruise number	Expocode	Dates
1	B3-1994	46BS19940211	11 02 1994-12 02 1994
2	SO1-1994	46SR19940318	18 03 1994
3	SO2-1994	46SR19940417	17 04 1994-18 04 1994
4	SO3-1994	46SR19940512	12 05 1994-13 05 1994
5	B8-1994	46BS19940525	25 05 1994-26 05 1994
6	SO4-1994	46SR19940614	14 06 1994-15 06 1994
7	A10-1994	46FR19940623	23 06 1994-24 06 1994
8	A10-1994	26FR19940623	03 07 1994
9	JH08-94	58JH19940811	11 08 1994
10	B14-1994	46BS19940916	16 09 1994-17 09 1994
11	B16-1994	46BS19941008	08 10 1994
12	B17-1994	46BS19941110	10 11 1994
13	B3-1995	46BS19950306	06 03 1995-08 03 1995
14	B5-1995	46BS19950408	08 04 1995-09 04 1995
15	B6-1995	46BS19950429	29 04 1995-30 04 1995
16	B7-1995	46BS19950525	25 05 1995-26 05 1995
17	A9-1995	46FR19950627	27 06 1995
18	B11-1995	46BS19950721	21 07 1995-22 07 1995
19	A11-1995	46FR19950815	15 08 1995-16 08 1995
20	B16-1995	46BS19951015	15 10 1995-16 10 1995
21	B17-1995	46BS19951110	10 11 1995
22	B3-1996	46BS19950212	12 02 1996

Table S4 Cruises with Underway pCO_2 measurements 2006-2007

	Cruise number	Expocode	Dates
1	B4-2006	46BS20060514	14 05 2006-31 05 2006
2	B6-2006	46BS20060710	10 07 2006-03 08 2006
3	A11-2006	46FR20061107	07 11 2006-01 12 2006
4	B3-2007	46BS20070206	06 02 2007-19 02 2007
5	B6-2007	46BS20070412	12 04 2007-26 04 2007
6	B8-2007	46BS20070514	14 05 2007-27 05 2007

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