Supplement of

Marine Carbohydrates in Arctic Aerosol Particles and Fog – Diversity of Oceanic Sources and Atmospheric Transformations

Sebastian Zeppenfeld et al.

Correspondence to: Hartmut Herrmann (herrmann@tropos.de)

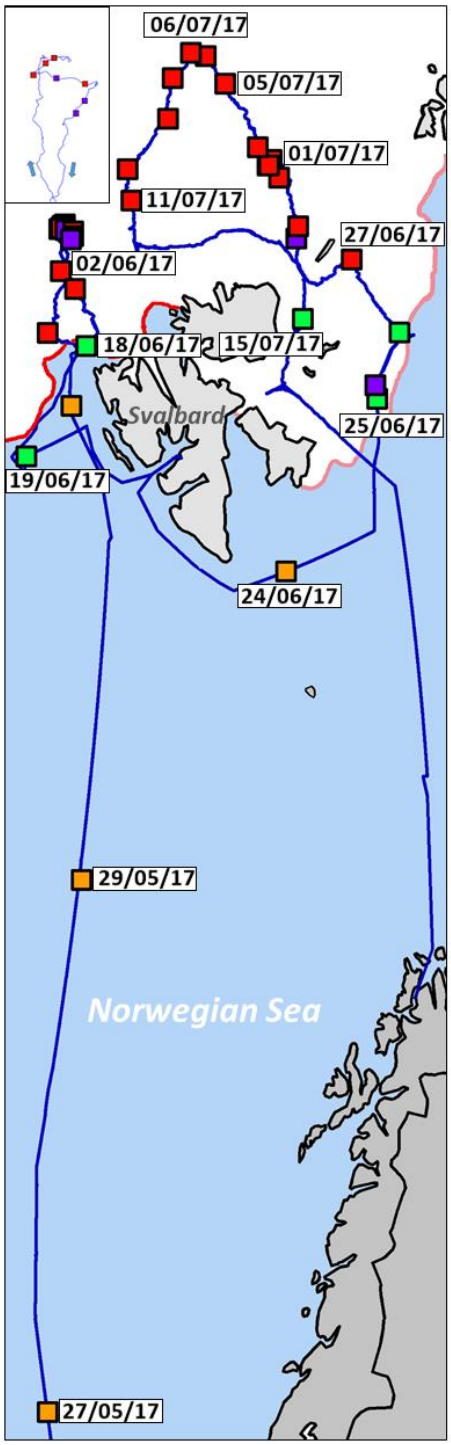

Figure SI 1. Cruise track during PS106 (blue) with a closer zoom for the ice floe camp period (5—14 June 2017). Squares represent surface water sampling events (orange: ice-free ocean; red: open leads and polynyas within the pack ice; purple: melt ponds; green: MIZ) The red lines represent the ice edges on 07 June 2017 (west of Svalbard) and 07 July 2017 (east of Svalbard).

Table SI 1. Detailed information about size-resolved aerosol particle sampling during PS106 campaign.

Start sampling[a]	Stop sampling[a]	Location	Residence time of air masses 12 h before sampling[b]				Wind speed ($m\ s^{-1}$)[c]	Air temperature (°C)[c]	Relative humidity (%)[c]	Percentage frequency of occurrence of fog[c,d] (%)	$Na^+_{aer,PM10}$ ($ng\ m^{-3}$)[e]	$CCHO_{aer,PM10}$ ($ng\ m^{-3}$)[e]	$\frac{Na^+_{aer,PM10}}{CCHO_{aer,PM10}}$
			Ice-free (%)	MIZ (%)	Pack ice (%)	Land (%)							
24/05/17 20:49	26/05/17 16:34	North Sea	100	0	0	0	7.0±2.4	10.5±0.4	97±3	14.9	463	4.42	9.6E-03
26/05/17 19:34	29/05/17 11:33	Norwegian Sea	100	0	0	0	9.1±2.3	5.4±3.3	83±18	35.0	765	3.15	4.1E-03
29/05/17 12:46	01/06/17 08:28	Greenland Sea/ Fram Strait	50	9	29	13	9.9±3.8	-0.1±3.7	77±15	0.0	651	1.60	2.5E-03
01/06/17 09:35	04/06/17 08:06	Fram Strait/ Arctic Ocean (west and northwest of Svalbard)	3	20	76	0	7.2±3.0	-2.7±1.1	94±4	11.2	108	3.22	3.0E-02
04/06/17 10:57	07/06/17 08:08		0	1	99	0	5.2±2.1	-3.1±0.8	93±4	2.4	37	0.71	1.9E-02
07/06/17 09:39	10/06/17 08:29		0	1	99	0	4.5±1.6	-3.1±2.9	95±3	2.1	79	3.35	4.2E-02
10/06/17 09:25	13/06/17 11:23		0	0	100	0	6.2±3.0	-0.6±0.8	98±5	32.8	27	4.66	1.7E-01
13/06/17 12:36	16/06/17 08:18		0	0	100	0	4.3±1.5	-1.3±0.7	95±3	8.8	12	1.03	8.6E-02
16/06/17 09:13	19/06/17 09:03		2	42	56	0	4.0±1.3	-1.2±1.1	89±5	0.4	40	2.19	5.4E-02
19/06/17 10:00	25/06/17 09:30	Greenland Sea/Barents Sea	47	20	11	23	5.5±2.5	1.8±1.9	87±8	0.8	230	0.66	2.8E-03
25/06/17 11:40	28/06/17 09:20	Barents Sea/ Arctic Ocean (north and northeast of Svalbard)	11	35	54	0	6.2±2.5	-0.6±0.5	89±5	0.0	89	1.19	1.3E-02
28/06/17 10:20	04/07/17 08:55		2	5	93	1	6.0±1.7	-1.8±1.5	94±4	4.6	40	0.50	1.3E-02
04/07/17 10:25	07/07/17 08:45		0	0	100	0	5.9±1.3	-1.5±0.9	98±2	11.5	39	1.04	2.7E-02
07/07/17 09:50	13/07/17 09:00		0	9	87	4	6.9±2.1	-0.4±0.8	98±2	22.5	29	2.83	9.8E-02
13/07/17 10:05	16/07/17 10:35		10	42	40	8	7.7±3.5	0.5±1.1	95±6	8.0	269	3.14	1.2E-02

[a] date/time format: dd/mm/yy hh:mm (UTC); [b] residence time of air masses over certain Earth surfaces were calculated based on back-trajectories and sea-ice maps using R; [c] meteorological data (mean ± standard deviation over sampling time) calculated from the quality controlled data archived in the PANGAEA network (Schmithüsen, 2018, 2019); [d] here, fog occurrence was defined based on two operational meteorological thresholds: visibility≤1500 m & relative humidity ≥98%; [e] values as the sum of all five Berner stages, size-resolved information are available on PANGAEA.

Table SI 2. Fog sampling during the PS106 campaign and average meteorological conditions at the sampling site calculated from the quality controlled data archived in the PANGAEA network (Schmithüsen, 2018, 2019); n.d.=not determined.

Start sampling[a]	Stop sampling[a]	Location	Time with fog events[b] (min)	Average wind speed during fog events ($m\ s^{-1}$)	Average air temperature during fog events (°C)	pH	$Na^+_{fog,liquid}$ ($mg\ L^{-1}$)	$Na^+_{fog,atmos}$ ($ng\ m^{-3}$)	$CCHO_{fog,liquid}$ ($\mu g\ L^{-1}$)	$CCHO_{fog,atmos}$ ($ng\ m^{-3}$)	$dFCHO_{fog,liquid}$ ($\mu g\ L^{-1}$)
26/05/17 04:33	26/05/17 12:27	North Sea	140	4.1	9.9	n.d.	91	61183	1976	1331.0	1539.4
26/05/17 18:48	27/05/17 12:26	Norwegian Sea	1030	7.9	9.1	5.72	61	n.d	456	n.d	416.6
27/05/17 12:46	27/05/17 20:39		240	8.2	9.1	5.74	23	22985	129	128.0	59.5
27/05/17 20:56	28/05/17 06:15		110	8.4	7.8	6.23	13	2823	153	32.9	104.9
01/06/17 13:15	02/06/17 16:37	Fram Strait/Arctic Ocean (west and northwest of Svalbard)	480	8.1	-1.1	6.41	903	150343	283	47.1	98.3
10/06/17 20:30	13/06/17 09:58		1410	3.9	-0.4	5.85	80	3723	186	8.7	104.3
23/06/17 10:00	25/06/17 10:10	Greenland Sea	30	4.4	-1.0	n.d.	448	72589	1542	250.1	233.5
25/06/17 10:30	29/06/17 10:34	Barents Sea/Arctic Ocean (north and northeast of Svalbard	190	2.9	0.0	n.d.	393	n.d	726	n.d	93.9
29/06/17 10:45	01/07/17 10:25		190	5.6	-0.2	n.d.	374	73568	21818	4293.4	270.5
01/07/17 10:38	06/07/17 10:30		210	6.7	-1.5	n.d.	98	3902	467	18.7	40.4
06/07/17 10:45	07/07/17 11:10		280	5.6	-1.2	n.d.	90	7410	495	40.9	26.2
07/07/17 11:25	08/07/17 11:15		980	3.8	-0.4	6.44	30	377	322	4.1	488.0
08/07/17 11:30	08/07/17 22:20		240	6.8	-0.5	6.53	13	120	392	3.7	260.8
08/07/17 22:40	09/07/17 16:35		30	9.2	-2.9	n.d.	2.7	n.d.	363	n.d.	208.2
09/07/17 17:00	10/07/17 11:00		330	8.1	-0.6	6.75	5.1	185	81	3.0	84.1
10/07/17 11:15	11/07/17 11:00		250	9.0	0.0	6.26	19	1164	336	20.1	61.3

11/07/17 11:15	14/07/17 10:25	Barents Sea/Arctic Ocean (north and northeast of Svalbard	200	7.3	-0.5	6.08	5.1	392	66	5.1	19.5
14/07/17 10:38	15/07/17 10:45		10	13.5	-0.1	6.12	7.6	2196	67	19.3	13.6
15/07/17 10:52	16/07/17 10:20		230	4.4	-0.2	6.14	18	3213	64	11.5	11.1
16/07/17 10:30	16/07/17 22:15		100	7.1	1.2	6.18	1.7	n.d	18	n.d	2.7
16/07/17 22:30	17/07/17 10:20		220	9.8	1.6	6.02	59	n.d	103	n.d	23.3
17/07/17 10:30	17/07/17 14:00		210	8.5	1.4	5.68	101	n.d	321	n.d	170.8

[a] date/time format: dd/mm/yy hh:mm (UTC). [b] here, fog occurrence was defined based on two operational meteorological thresholds: visibility≤1500 m & relative humidity ≥98%.

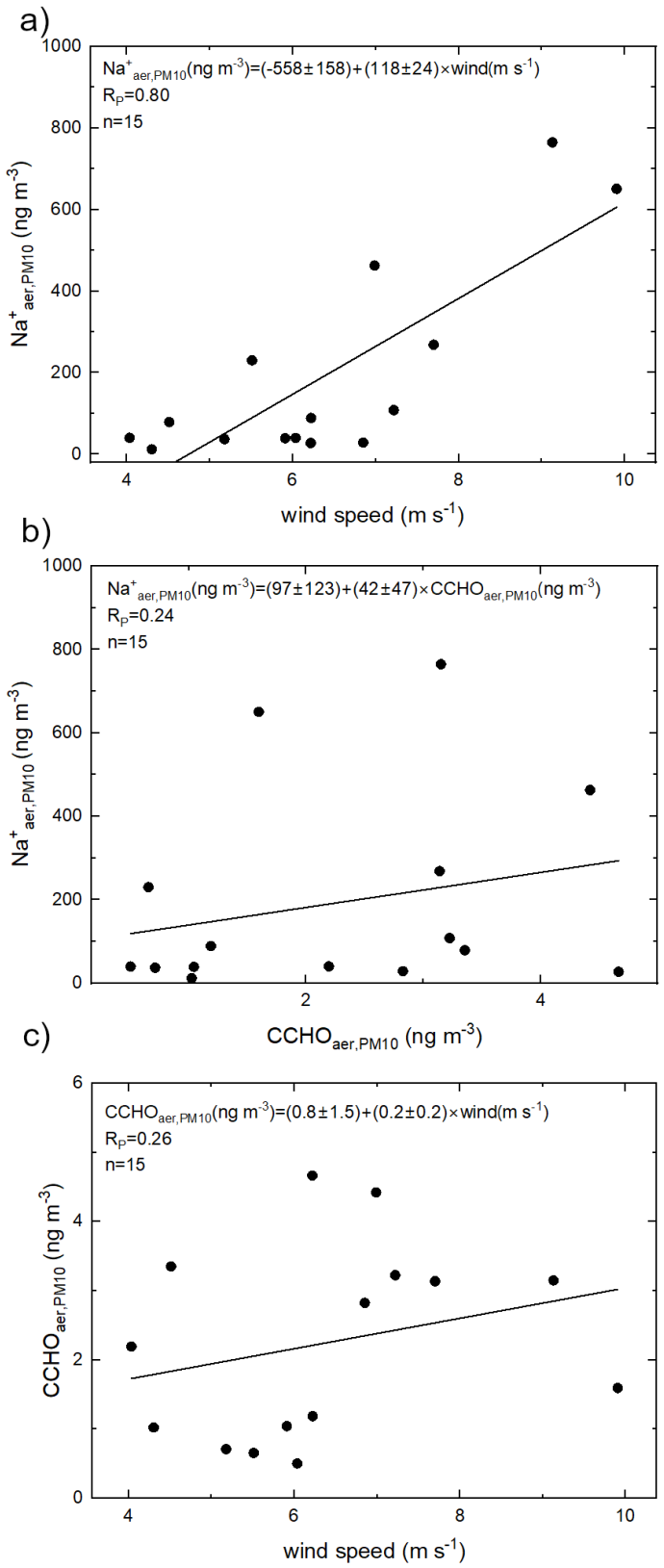

Figure SI 2. Correlations between a) $Na^{+}_{aer,PM10}$ and the averaged wind speed, b) $Na^{+}_{aer,PM10}$ and $CCHO_{aer,PM10}$, c) $CCHO_{aer,PM10}$ and averaged wind speed.

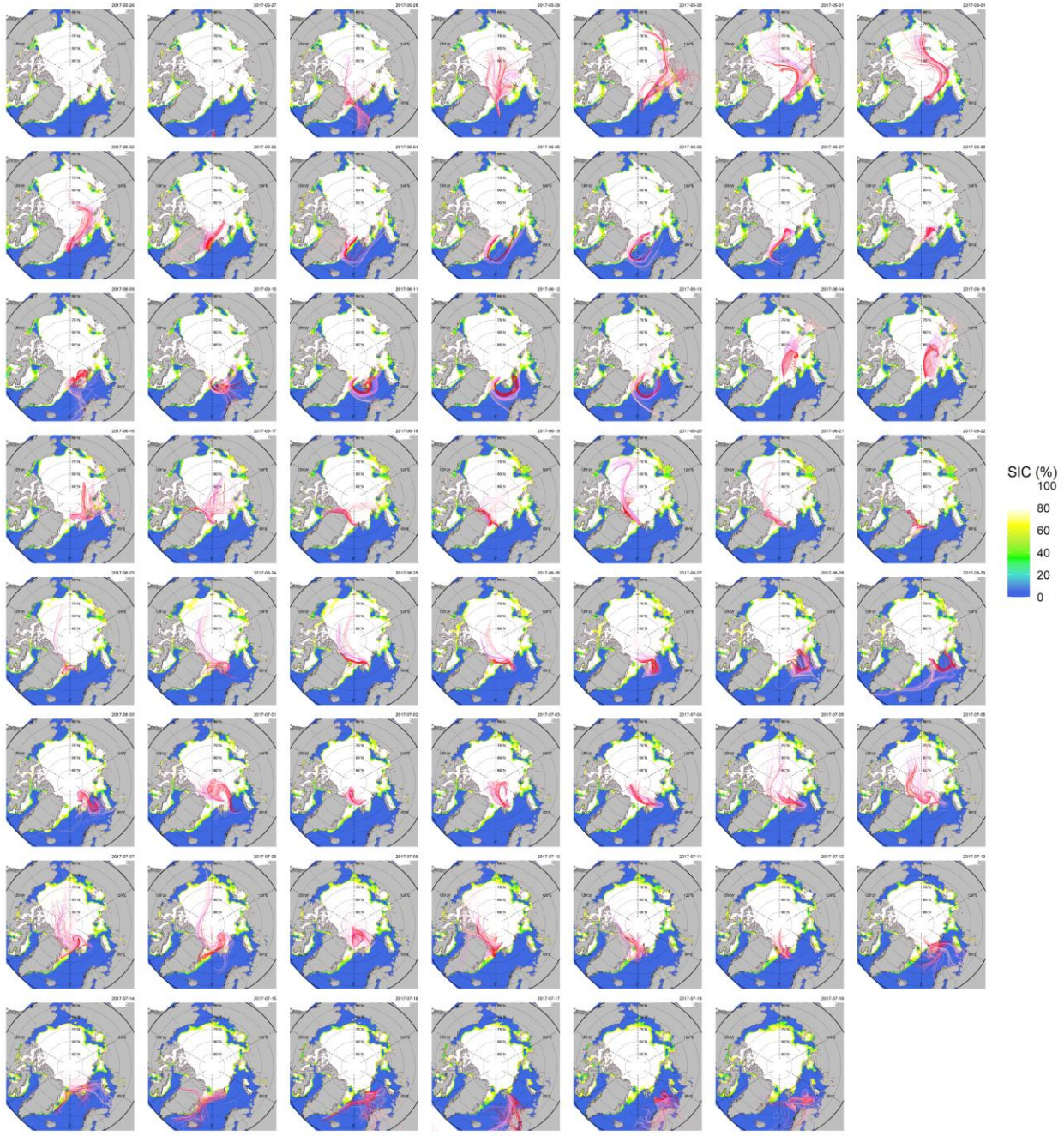

Figure SI 3. Daily sea ice maps for PS106 showing sea ice concentrations (SIC) and 120 h back-trajectories on an hourly basis at three arrival heights (red: 50 m, purple: 250 m and pink: 1000 m). A high-resolution animation can be viewed at the following link: https://doi.org/10.5446/62589.

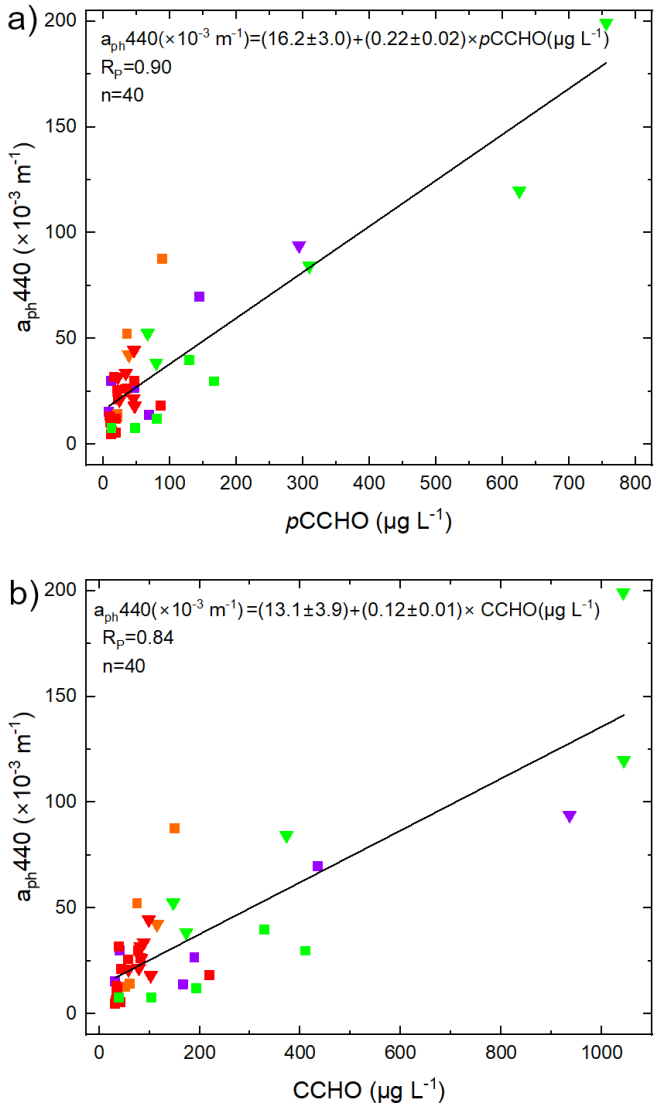

Figure SI 4. Correlation plots of $a_{ph}440$ derived from PAB spectra against a) *p*CCHO and b) CCHO. Triangles: SML, squares: bulk. Green: marginal ice zone (MIZ), purple: melt ponds, orange: ice-free ocean, red: open leads/polynyas in the pack ice.

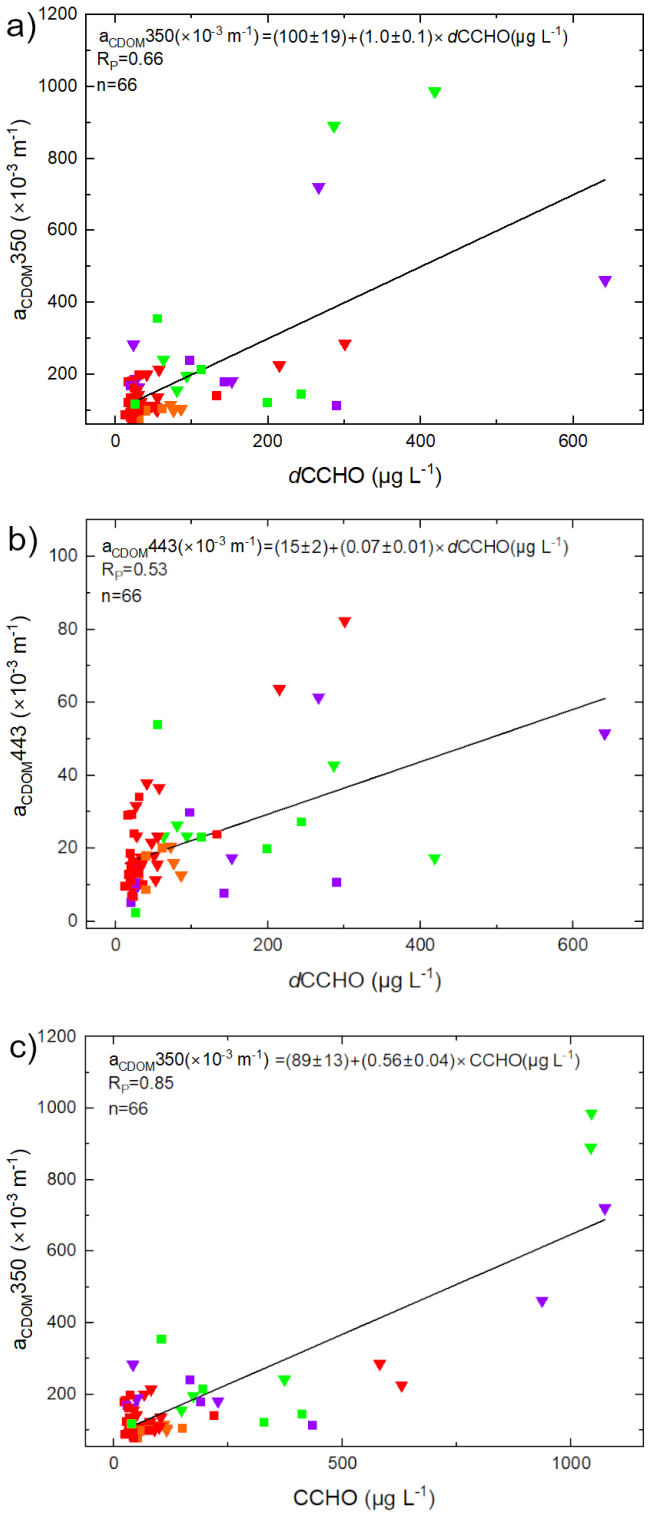

Figure SI 5. Correlation plots of a) $a_{CDOM}350$ against *d*CCHO, b) $a_{CDOM}443$ against *d*CCHO and c) $a_{CDOM}350$ against CCHO. Triangles: SML, squares: bulk. Green: marginal ice zone (MIZ), purple: melt ponds, orange: ice-free ocean, red: open leads/polynyas in the pack ice.

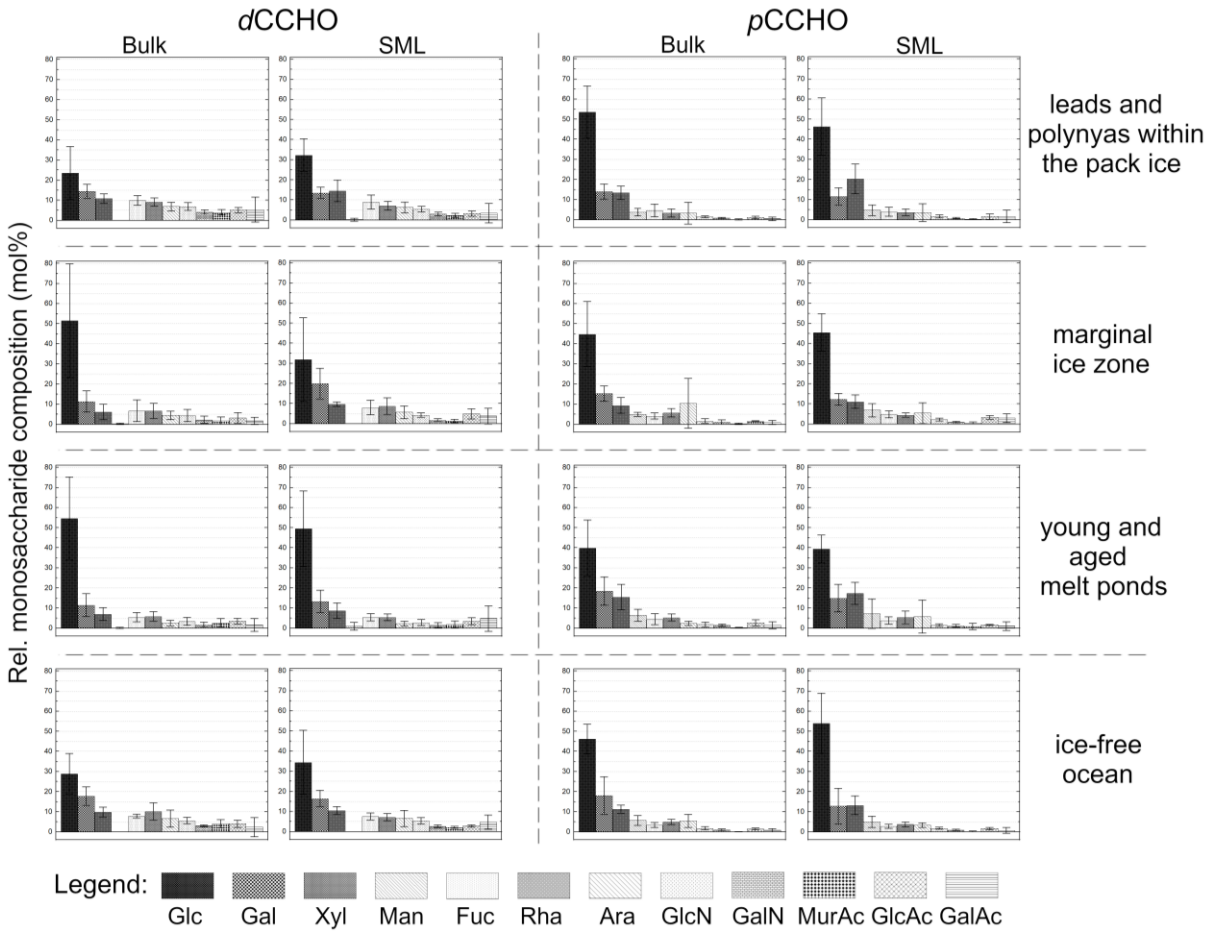

Figure SI 6. Relative monosaccharide composition of dissolved (*d*CCHO) and particulate combined carbohydrates (*p*CCHO) after acid hydrolysis in bulk and SML samples from the leads and polynyas within the pack ice, the MIZ, the ice-free ocean and young and aged melt ponds. The bar charts show the averages and standard deviations of the relative contributions.