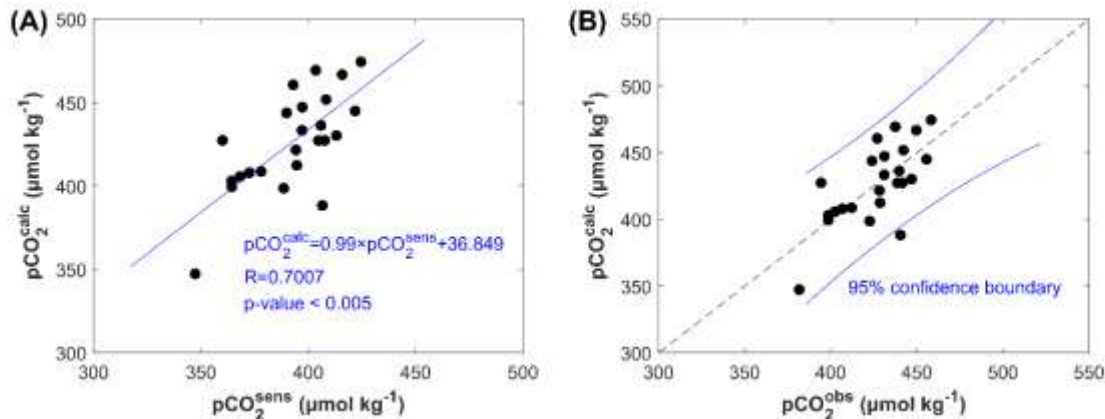
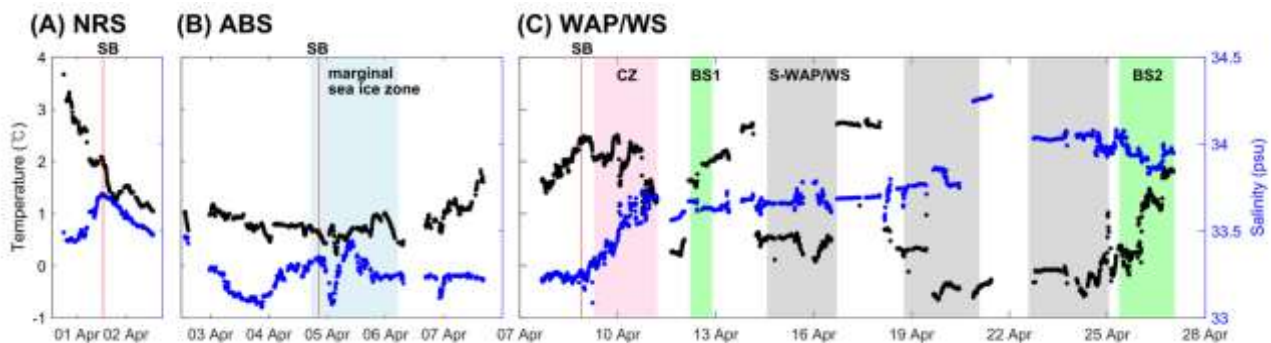


Supplementary Material

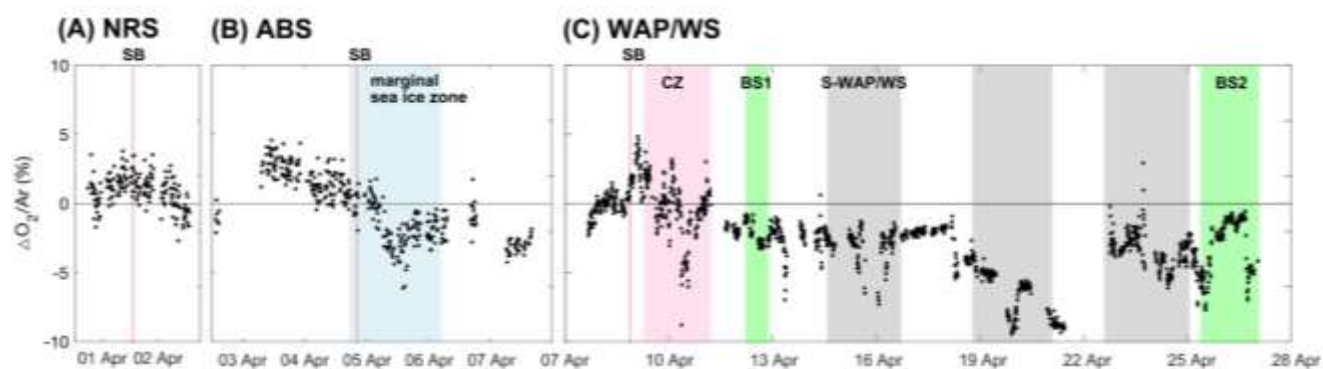
1. Supplementary Figures



Supplementary Figure 1. (A) Results of the linear regression between a carbon dioxide sensor (CONTROS HydroC CO_2 ; $p\text{CO}_2^{\text{sens}}$) and calculated $p\text{CO}_2$ from bottle TA and DIC data ($p\text{CO}_2^{\text{calc}}$). (B) Result of 95% confidence boundary between $p\text{CO}_2^{\text{calc}}$ and calibrated data ($p\text{CO}_2^{\text{obs}}$).



Supplementary Figure 2. Temperature (black) and salinity (blue) distribution in (A) the north of Ross Sea (NRS), (B) the Amundsen-Bellinghshausen Sea (ABS), and (C) the Western Antarctic Peninsula with the Weddell Sea (WAP/WS). The blue shading in (B) and pink shading in (C) indicate the result in the marginal sea ice zone and Confluence Zone (CZ), respectively. The green shadings in (C) shows the observations taken twice at different time periods in the Bransfield Strait. And the gray shadings in (C) represent the result in the south of WAP/WS (S-WAP/WS). Finally, the red vertical lines indicate the Southern boundary of the Antarctic Circumpolar Current (SB).



Supplementary Figure 3. Distribution of the difference between the O_2/Ar ($\Delta O_2/Ar$) values of the sample and air-saturated water in (A) the north of Ross Sea (NRS), (B) the Amundsen-Bellinghshausen Sea (ABS), and (C) the Western Antarctic Peninsula with the Weddell Sea (WAP/WS). Negative and positive values indicate the release and removal of carbon as a result of biological activities, respectively. The shadings, lines, and abbreviations are the same as those in Supplementary Figure 2.

2. Supplementary Tables

Table S1. Results of the latitude (Lat) and longitude (Lon), pressure (Pres.) sea surface temperature (SST), nitrate (NO_3^-), total alkalinity (TA), dissolved inorganic carbon (DIC), underway $p\text{CO}_2$, thermal $p\text{CO}_2$ ($p\text{CO}_2^{\text{th}}$), non-thermal $p\text{CO}_2$ ($p\text{CO}_2^{\text{nt}}$), and air–sea CO_2 flux data of the SOCCOM floats.

Float NO.	Date	Location (Lat, Lon)	Pres. (dbar)	SSS (psu)	SST (°C)	NO_3^- ($\mu\text{mol kg}^{-1}$)	TA	DIC	$p\text{CO}_2$	$p\text{CO}_2^{\text{th}}$ (μatm)	$p\text{CO}_2^{\text{nt}}$	air–sea CO_2 flux ($\text{mmol m}^{-2} \text{d}^{-1}$)
5904184	06-Apr	62.1°S, 145.0°W	4.96	33.96	0.68	–	2296	2184	411	411	395	2.1
	17-Apr	62.1°S, 145.2°W	8.85	33.96	0.44	–	2296	2185	409	414	391	1.5
	27-Apr	62.2°S, 145.1°W	7.65	33.94	0.27	–	2295	2186	412	420	388	2.4
5904185	02-Apr	63.2°S, 83.2°W	7.02	33.85	2.85	–	2282	2158	411	375	433	2.1
	13-Apr	63.2°S, 83.4°W	7.49	33.84	2.72	–	2282	2157	406	373	430	0.6
	23-Apr	62.8°S, 83.9°W	7.67	33.89	2.27	–	2285	2161	402	376	422	–0.6
5905075	03-Apr	68.1°S, 99.7°W	7.00	33.70	–0.74	25.80	2277	2158	359	382	372	–13.7
	13-Apr	68.8°S, 97.6°W	7.38	33.71	–1.05	26.35	2280	2164	362	390	367	–12.8
	23-Apr	69.0°S, 100.1°W	4.28	33.74	–1.47	26.59	2282	2170	367	402	360	–11.3
5905099	04-Apr	60.5°S, 161.5°W	7.43	33.93	2.65	27.64	2288	2165	413	380	429	2.7
	14-Apr	60.7°S, 160.8°W	7.37	33.95	2.39	28.25	2290	2171	421	392	424	5.0
	24-Apr	60.8°S, 160.1°W	8.37	33.94	2.20	27.90	2291	2172	417	391	421	3.9
5905635	08-Apr	67.2°S, 173.9°W	4.80	34.08	–0.94	27.47	2308	2186	358	384	369	–13.9
	18-Apr	67.3°S, 174.1°W	6.54	34.08	–1.07	27.84	2308	2197	386	416	367	–5.5
	28-Apr	67.5°S, 173.7°W	5.58	34.04	–1.30	27.63	2305	2196	386	420	363	–5.5