Supplementary Material

Table S1. Deployment methods, duration, station location and description of a drifting sediment trap deployed in the western Weddell Sea (February 2024).

Sampling Station	Deployment method	Deployment date	Deployment duration (decimal hours)	Deployment Location (Decimal Latitude, Longitude)	Deployment Location description	Ice description	Mixed Layer depth (m)	Water column depth (m) on deployment	PICCOLO sampling station name
S1	Tethered to ship	04/02/2024	11.4	-58.23477, -64.58536	Shelf	Icebergs present	12	498	SS4
S2	Free-drifting	07/02/2024	18.1	-48.50012, -64.53655	Off-shelf	Open water	25	3988	T1
S5	Free-drifting	29/02/2024	22.4	-56.58060, -64.67640	Shelf	Icebergs present	11	343	Superstation
S3	Free-drifting	16/02/2024	12.1	-55.02203, -64.58017	Shelf	Sea ice, high coverage	36	422	Mooring
S4	Free-drifting	27/02/2024	20.5	-57.71208, -65.38404	Shelf	Sea ice, High coverage	13	421	Floe 8

Supplementary Methods: *Microplankton community abundance*

Sample Collection and Preservation
At stations S1, S2, S3, and S5, fresh seawater samples were collected from 200 m to the surface using a Sea-Bird SBE 9plus CTD system equipped with a 24bottle rosette of 20 L Niskin bottles during predawn casts. Subsamples (250 mL) from 55, 14, 1% surface irradiance levels were preserved with 5 mL acid Lugol's solution in glass amber bottles and stored at 4 °C until return to Plymouth Marine Laboratory, Plymouth, UK. S4, the nearest microplankton samples (both temporally and spatially) were collected from an ice floe (named Floe 8) with water collected using niskins lowered to four depths (1 m, 5 m, 20 m and 30 m) through a pre-drilled hole in the ice. Subsamples were then preserved as above.

Preparation, Imaging and classification
In the laboratory, samples were allowed to settle under gravity, after which the top 200 mL was gently removed, leaving the lower 50 mL containing concentrated microplankton for processing. Prior to imaging, samples were mixed thoroughly and screened through a 100 µm mesh to remove large particles and prevent flow cell obstruction. Concentrated, screened samples were analysed using a FlowCam IV (Yokogawa Fluid Imaging Technologies) with a 10× objective lens and a 100 µm deep flow cell. The imaging configuration targeted particles with an equivalent spherical diameter (ESD) of 10–100 µm, and imaging was performed in Auto-Image mode.-Image mode.

Images were processed using VisualSpreadsheet (v4.19.3). Particles were classified to genus where possible, or assigned to broader taxonomic categories including *Phaeocystis* colonies, large nanoflagellates, dinoflagellates, pennate or centric diatoms, and ciliates. Ice associated phytoplankton taxa (commonly *Fragilariopsis*, *Entomoneis*, *Nitzschia*, *Cylindrotheca* and large single centric diatoms) were subsequently compared with total protist abundance to evaluate their contribution to community structure. These taxa are considered ice associated because they are well documented components of Antarctic sea ice and under ice communities, adapted to the low light, variable salinity conditions of brine channels and the ice–water interface (e.g. Otte et al., 2023).-associated phytoplankton taxa (commonly -associated because they are well-documented components of Antarctic sea-ice and under-ice communities, adapted to the low-light, variable-salinity conditions of brine channels and the ice–water interface (e.g. Otte et al., 2023).

Otte, A., Winder, J. C., Deng, L., Schmutz, J., Jenkins, J., Grigoriev, I. V., Hopes, A., & Mock, T. (2023). The diatom Fragilariopsis cylindrus: A model alga to understand cold-adapted life. Journal of Phycology, 59, 301–306. https://doi.org/10.1111/ jpy.1332

Table S2. Results of Spearmans rank correlation comparing hydrological conditions (salinity, chlorophyll, temperature and mixed layer depth) against the POC flux. POC flux (mg C m^{-2} day^{-1}) was the response variable throughout with 13 degrees of freedom present throughout. Significant correlations are marked with an asterisk.

Explanatory variable	**Correlation coefficient (Rho)**	***P* value**
Chlorophyll Max	0.71	0.003*
Depth of chorophyll max	-0.64	0.009*
Temperature maximum	-0.34	0.218
Temperature minimum	0.51	0.051
Salinity maximum	-0.71	0.003*
Salinity minimum	0.37	0.173
Mixed layer depth	-0.14	0.614

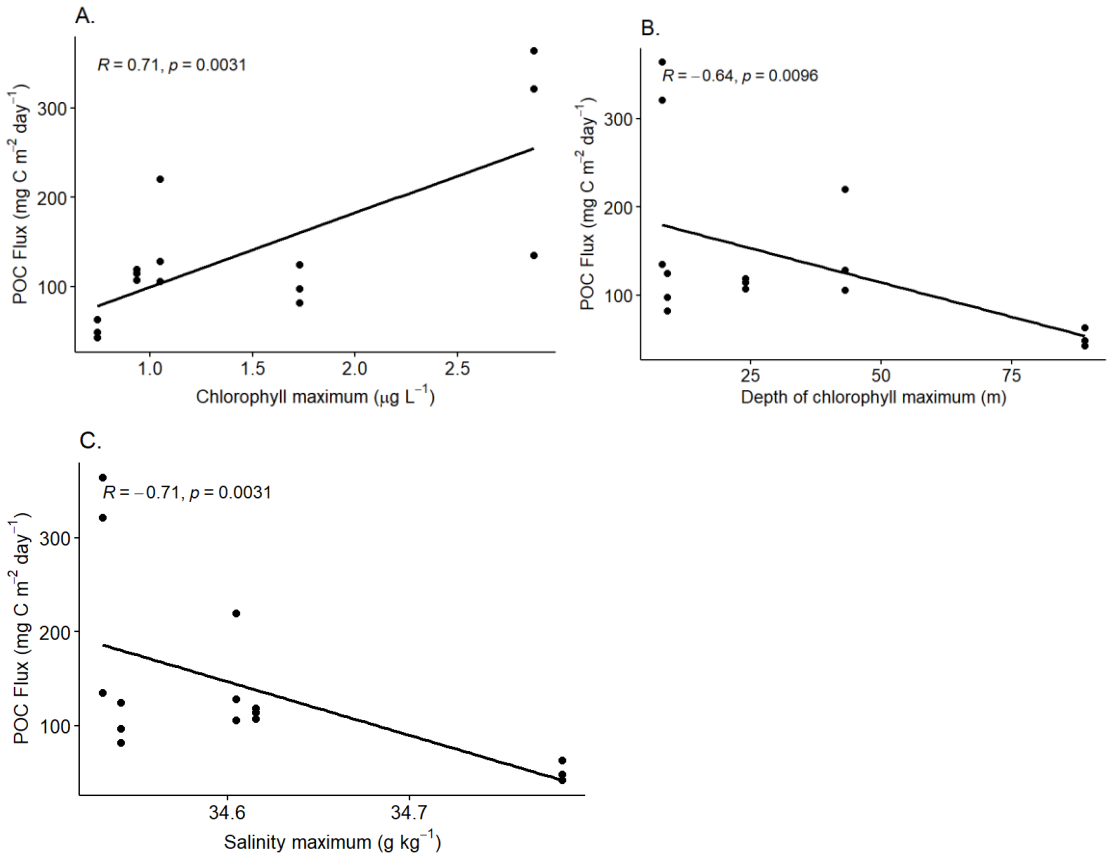

Figure S1. Significant correlations between hydrological conditions as measured by a proximal CTD with the POC flux. Correlations were determined using spearman's rank correlation

coefficient, a full list of conditions compared against POC flux is available in supplementary table 2. POC flux was measured at three depths (50, 100, and 150 m) in the western Weddell Sea during February 2024.

Table S3. Mean volume, estimate carbon content and percent contribution of faecal pellets to the POC flux in the western Weddell Sea (February, 2024)

Sampling station	Depth (m)	Faecal pellet shape	mean faecal pellet volume (mm m^2 day^{-1})	Estimated organic carbon content (mg m^2 day^{-1})	Percent faecal pellet contribution to total particulate organic carbon flux (%)
S1	50	cylinder	927.52	74.20	54.96
S1	100	cylinder	2138.29	171.06	53.23
S1	150	cylinder	1755.65	140.45	38.57
S1	100	oval	0.69	0.03	0.01
S1	150	oval	16.45	0.66	0.18
S1	50	round	8.51	0.30	0.22
S1	100	round	24.66	0.86	0.27
S1	150	round	29.35	1.03	0.28
S2	50	cylinder	136.96	10.96	17.40
S2	100	cylinder	322.70	25.82	60.80
S2	150	cylinder	193.48	15.48	31.98
S2	100	oval	11.26	0.45	1.06
S2	100	round	0.31	0.01	0.03
S3	50	cylinder	1078.16	86.25	39.21
S3	100	cylinder	1121.47	89.72	69.86
S3	150	cylinder	410.95	32.88	31.03
S3	50	oval	23.51	0.94	0.43
S3	100	oval	28.39	1.14	0.88
S3	150	oval	15.15	0.61	0.57
S3	50	round	32.41	1.13	0.52
S3	100	round	23.37	0.82	0.64
S3	150	round	1.95	0.07	0.06
S4	50	cylinder	381.00	30.48	25.63
S4	100	cylinder	738.15	59.05	55.03
S4	150	cylinder	486.43	38.91	34.02
S4	50	oval	5.59	0.22	0.19
S4	100	oval	9.45	0.38	0.35
S4	150	oval	12.50	0.50	0.44
S4	100	round	4.01	0.14	0.13
S4	150	round	18.85	0.66	0.58
S5	50	cylinder	486.57	38.93	47.54
S5	100	cylinder	788.97	63.12	50.66
S5	150	cylinder	1203.43	96.27	99.04
S5	100	oval	1.19	0.05	0.04

S5	50	round	7.99	0.28	0.34
S5	100	round	3.03	0.11	0.09
S5	150	round	6.53	0.23	0.24

Table S4. Results of Kruskal Wallace test to determine if individual cylindrical faecal pellet volume changed across sampling depth (50 100 and 150 m) across five drifting sediment trap deployments in the Weddell Sea (February 2024). Significant differences are indicated with an asterisk.

Sampling station	Chi Square	Degrees of Freedom	Total no. of faecal pellets in test	P value
S1	27.21	2	227	< 0.001*
S2	4.23	2	45	0.120
S3	4.55	2	349	0.103
S4	0.52	2	199	0.773
S5	14.35	2	310	<0.001*

Table S5. Krill egg flux, estimated organic carbon content and contribution to total POC flux. Carbon conversion assumes each egg contains 16.7 ug carbon per egg (Ikeda, 1985) and an average hatching success of 68.4% was applied (Harrington and Ikeda, 1986).

Station	Depth	Krill egg flux (No. Eggs m^{-2} day^{-1})	Estimated organic carbon content of Krill eggs (mg C m^{-2} day^{-1})	Percent contribution of eggs to total particulate organic carbon flux (not hatching success applied) (%)	Percent contribution of eggs to total particulate organic carbon flux (with a 68.4% hatching success) (%)
S1	100	3990	68.53	21.3	6.7
S1	150	1958	33.63	9.2	2.9
S3	50	2059	35.36	16.1	5.1

Table S6. Total number of ice associated algae as compared to the total number of protists from the closest (temporally and spatially) water samples relative to the drifting sediment trap deployments.

Sampling station	Sample collection method	Depth (m)	Surface Irradiance level (%)	Total ice associated algae (cells/L)	Percent ice associated algae compared to total protists (%)	Mean percent abundance of Ice algae (as compared to total protists (per station) (%)

S1	CTD Niskin	7	55	6640	2.22	7.7
		22	14	3972	6.17	
		52	1	4419	14.73	
S2	CTD Niskin	11	55	11617	26.38	26.4
		36	14	23848	38.62	
		84	1	5014	14.07	
S3	CTD Niskin	5	55	6653	8.34	17.0
		15	14	5671	11.73	
		35	1	16274	31.04	
S4	Through Ice Niskin	1	NA	19100	11.15	11.5
		5	NA	13920	9.39	
		20	NA	21230	15.43	
		30	NA	13850	9.93	
S5	CTD Niskin	8	55	6922	4.36	17.7
		25	14	14355	40.28	
		55	1	1296	8.41	

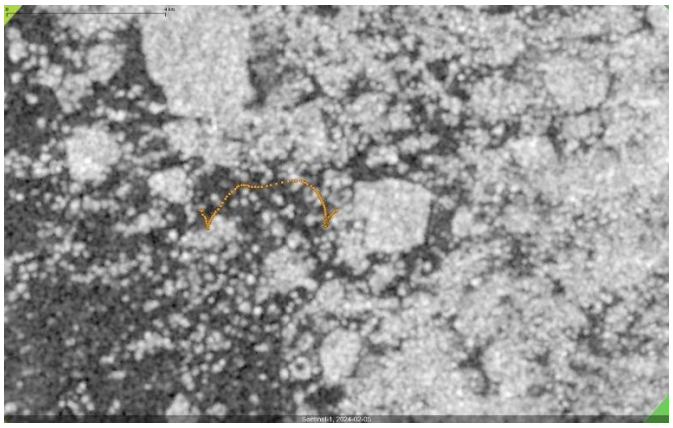

Figure S2. Satellite imagery with overlayed track data for the drifting sediment trap at station S2 two days prior to deployment (Weddell Sea, 5th February 2024). Images produced by Mapping and Geographic Information Centre, British Antarctic Survey, 2025.

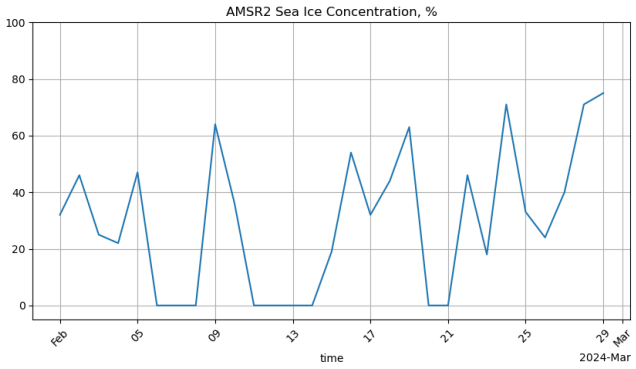

Figure S3. AMSR2 Sea Ice concentration data for the S2 deployment station in the Weddell Sea throughout February 2024

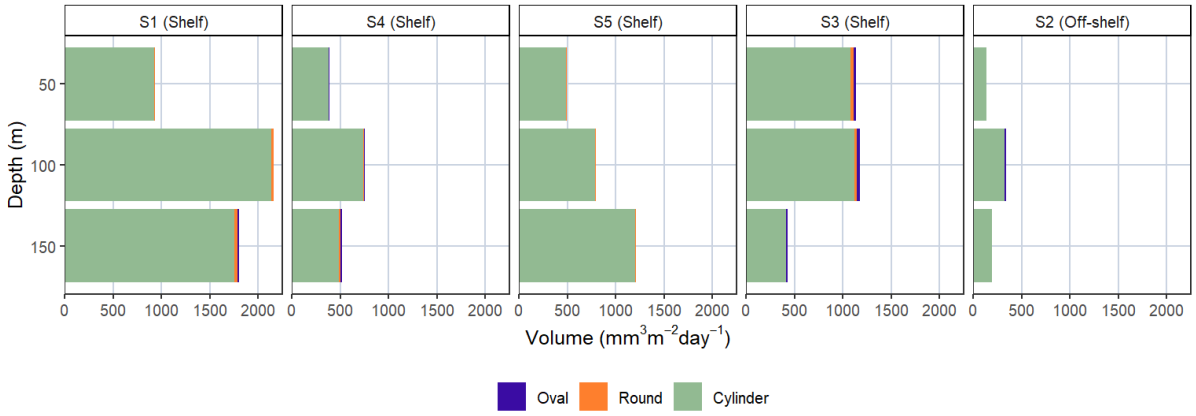

Figure S4. Volume flux of all faecal pellets identified in a drifting sediment trap deployed in the Weddell Sea (February 2024). Throughout, stations are numbered by sampling order, but the panel is arranged in a gradient from on shelf to off-shelf (left to right).

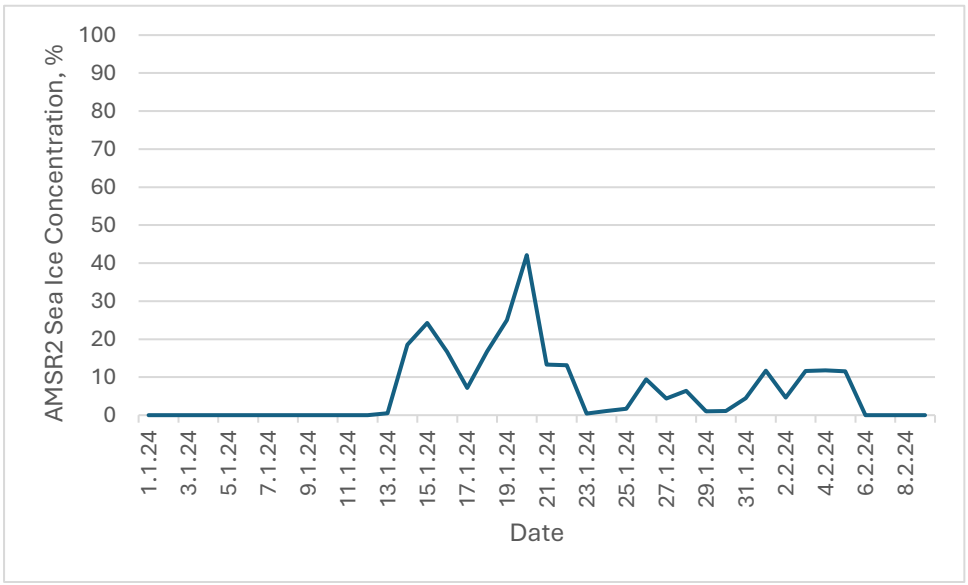

Figure S5. AMSR2 Sea Ice concentration data for the S5 deployment station in the Weddell Sea throughout from 24th January – 24th February 2024.