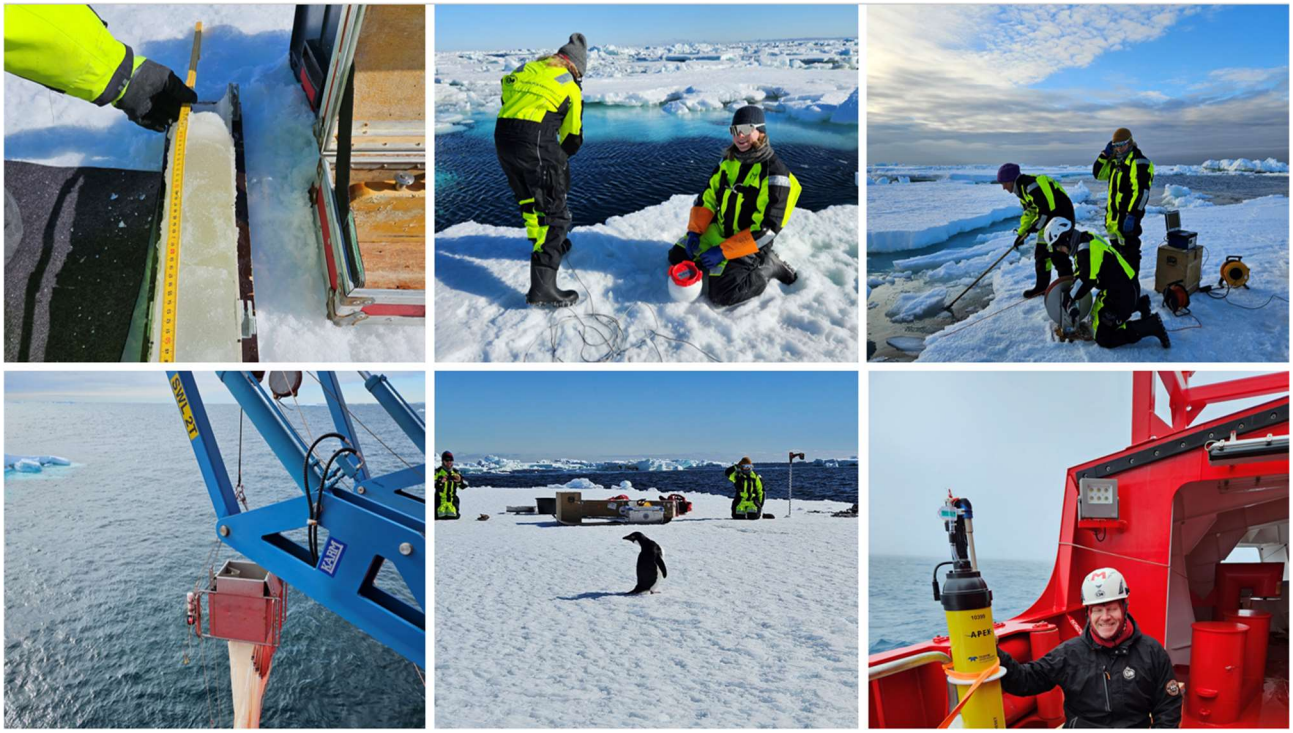
Troll Transect 2024

Cruise report

05 Jan. 2024 – 9 Feb. 2024



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Alle var enige at det var en fin tur! Ganske flatt hav…

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1. Cruise Objectives

The objective of the Norwegian Polar Institute (NPI) Transekttokt 2024 (TT24) was to collect essential scientific data contributing to our understanding of the principal physical, biogeochemical and biological drivers in the King Haakon VII Sea and adjacent sea. This data will enhance our knowledge, emphasizing the region's significance in the Southern Ocean.

In compliance with the general plan ("NPI Troll Transekt rammeplan") the cruise contributed to regular observations, this year with focus on studying sea ice in Kong Haakon VII Sea. The rationale behind this research cruise was that the breaking and melting of sea ice floes in summer in the Southern Ocean likely support the rich Southern Ocean food web, which attracts the iconic migratory baleen whales to their summer feeding grounds. The share of sea ice primary productivity to this great feeding event is probably changing, and possibly under-estimated as the general belief is that sea ice derived organic matter is mainly used in the springtime. However, our recent field experience and new sea ice data from other parts of the Southern Ocean show that sea-ice microhabitats like infiltration layers in summer sea ice as well as fall algal blooms might be important new contributors to the Southern Ocean ecosystem and biogeochemical cycles.

In addition, cryosphere-ocean interactions play a crucial role in shaping unique and very productive sea-ice microhabitats. In close proximity to ice shelves, abundant frazil ice or platelets are frequently observed among the ice floes, floating between the sea ice leads. These platelets likely aggregate under the landfast sea ice and create a productive iron-rich environment beneath the sea ice that fully unleashes its productive potential in the Austral summertime.

In this context, the Transekttokt 2024 main objective focused on the contribution of sea ice micro-habitats such as the infiltration layers and the consolidated platelets to the Southern Ocean ecosystem. In addition, the role of ocean-ice turbulent nutrient fluxes was assessed with the use of micro-structure profiles. Distribution of zooplankton organisms and stable isotopes values from sampled zooplankton, phytoplankton and ice algae will allow us to understand how much the Southern Ocean ecosystem relies on sea ice-derived primary productivity. The results from this Transekttokt will be useful to answer objectives from I-CRYME, iC3, WOBEC and BREATHE, all of which contribute to our research in the Southern Ocean.

- Objective 1: study sea ice physics, biology, biogeochemistry, and primary production. Study the contribution of sea ice microhabitats and cryosphere-ocean interactions to the overall SO primary production and ecosystems.
- Objective 2: study the role of under-ice turbulence role on ocean-ice nutrient exchanges.
- Objective 3: study zooplankton distribution and food web linkages.
- Objective 4: bridge observations of marine mammals, marine birds, and sea ice (ASPECT database)
- Objective 5: retrieve echosounder data through the transect (EK80).
- Objective 6: observe, register, and describe the ice shelf edge ecosystem as the basis for planned vulnerability assessments in the context of future increased unloading activity (part of the EIA process for New Troll Station).
- Objective 7: deploy opportunistically three BGC-Argo floats (AWI, BSH).
- Objective 8: retrieve opportunistically sediment cores at the unloading bay and further offshore.

Even though this year presented a strong challenge with a strongly negative sea ice anomaly throughout 2023 (see Figure 1.1) and very low sea ice concentration in the Kong Haakon VII Sea in January 2024, all objectives were achieved with success, except the opportunistic retrieval of sediment cores due to difficulties in operating the gravity corer.

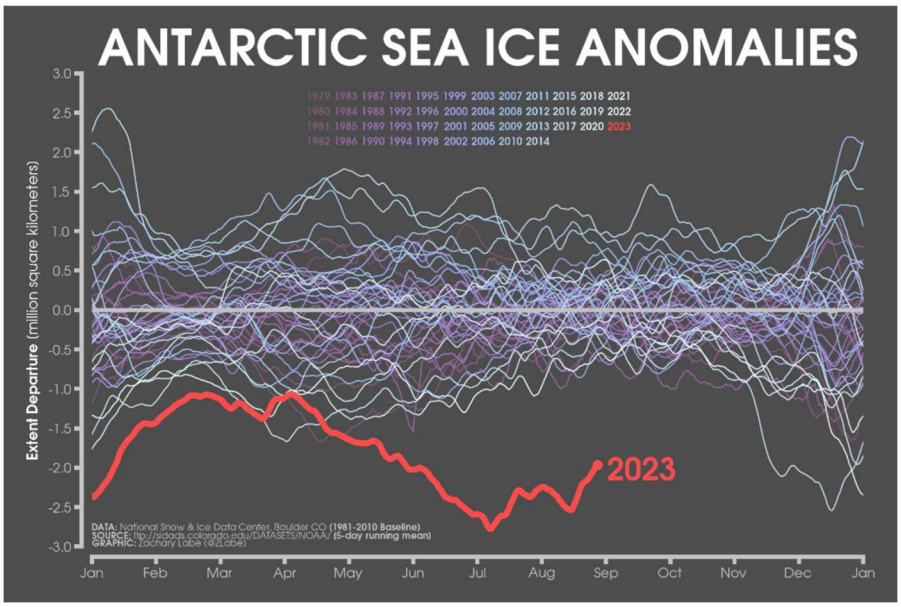


Figure 1.1: Sea ice concentration anomalies in the Southern Ocean highlighting the strong negative sea ice anomaly throughout 2023.

2. Cruise participants, NPI science team

Seven berths were available on Silver Arctic for the following designated science team members:

- Sebastien Moreau (NPI, sea ice and pelagic biology and biogeochemistry)
- Anette Wold (NPI, zooplankton dynamics)
- Marius Bratrein (NPI, sensors, and winches)
- Megan Lenss (NPI, sea ice and pelagic biology and biogeochemistry)
- Zoe Koenig (UiT, links sea ice biogeochemistry to under-ice turbulent nutrient fluxes)
- Johanne Hus (UTAS, under-ice turbulent nutrient fluxes)
- Laura Dalman (UTAS, sea ice primary productivity and photophysiology)

Due to the small team size, participants took part in different operations, in addition to their main responsibilities.

2.1 Departure and arrival

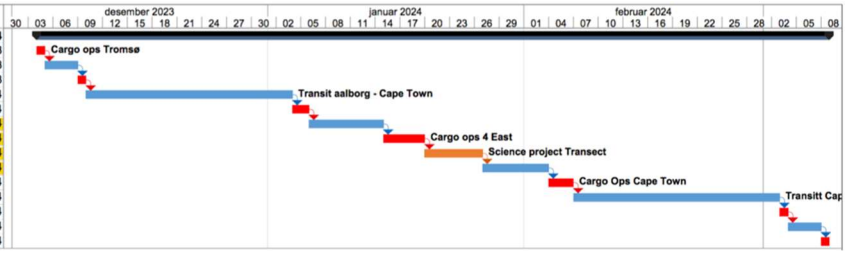
- Science team members boarded and disembarked the vessel in Cape Town, South Africa.
- The departure from Cape Town was on 5th of January 2024.
- The arrival to Cape Town was on 9th of February 2024.

3. Cruise Outline and planning

The planned sailing schedule of the Transekttokt 2024 is shown in Table 4.1.

Table 4.1: Sailing schedule of the Transekttokt 2024.

ID	Activity	Varighet	Start	Slutt
1	**Cruise plan Silver Arctic 2023-24**	**96 dager**	**ma 04.12.23**	**fr 08.03.24**
2	Cargo ops Tromsø	1 dag	ma 04.12.23	ma 04.12.23
3	Tranitt Tromsø - Aalborg	4 dager	ti 05.12.23	fr 08.12.23
4	Cargo ops Aalborg	1 dag	lø 09.12.23	lø 09.12.23
5	Transit aalborg - Cape Town	25 dager	sø 10.12.23	on 03.01.24
6	Cargo ops Cape Town	2 dager	to 04.01.24	fr 05.01.24
7	Transit Cape Town-4E/ part of Transect	9 dager	lø 06.01.24	sø 14.01.24
8	Cargo ops 4 East	5 dager	ma 15.01.24	fr 19.01.24
9	Science project Transect	7 dager	lø 20.01.24	fr 26.01.24
10	Transit Cape Town	8 dager	lø 27.01.24	lø 03.02.24
11	Cargo Ops Cape Town	3 dager	sø 04.02.24	ti 06.02.24
12	Transitt Cape Town-Aalborg	25 dager	on 07.02.24	lø 02.03.24
13	Offloading Aalborg	1 dag	sø 03.03.24	sø 03.03.24
14	Transitt aalborg - Tromsø	4 dager	ma 04.03.24	to 07.03.24
15	Offloading - Tromsø	1 dag	fr 08.03.24	fr 08.03.24



- A simple-access containerized science deck was set up during cargo operations in Tromsø.
- Further practical preparations (e.g. equipment set-up and installation of laboratories) were completed during the southbound transit from Cape Town to the study region. Opportunistic work happened on the Southbound transect and consisted of the deployment of 2 BGC-Argo floats.
- Work while the ship was moored at the unloading site was not possible due to the difficult unloading conditions this year. The captain stayed in surveillance mode when the ship could not be moored, monitoring the sea ice and iceberg situation at the shelf to be able to proceed with the unloading as soon as the opportunity came. In the meantime, researchers on board carried out an ecosystem assessment at the shelf edge, planning for the increased unloading activity at the shelf that will happen in combination with the building of the new Troll Station in the coming years (see the appended ecosystem assessment led by Megan Lenss). Towards the end of the unloading operation, on January 20th, containers from the Fimbulisen fieldwork were loaded onboard and researchers could access the MSS and Gravity Corer. Researchers tested the MSS in preparation for the following science days and tried several attempts at retrieving sediment cores from Trianglebukta. The LADCP was recalibrated on the shelf on January 22nd. The cargo operations at the unloading location ended at 5:00 during the night of January 26th. In the afternoon, around 16:00, the final containerized science deck was set up and science could begin.
- The main part of the scientific work of the Transekttokt was completed after the unloading work, starting on the afternoon of January 26th. A total of 5 main stations were carried out along the DML continental shelf (see stations maps in Figure 4.1 and 4.2) and consisted of sea ice stations (N = 4), Multinet deployments (N = 5), CTD deployments (N = 4) and MSS casts (several per station from both the ship and the sea ice). Due to a strong weather system coming, scientific activities were stopped at 15:00 in the afternoon of January 30th, for a total of 4 full science days.
- During the return, the 3rd BGC Argo float was deployed Northeast of Maud Rise at 18:00 on February 1st.

Table 4.2: Station list of the Transekttokt 2024 science program.

Station	Date	Latitude decimal	Lat (dd)	Lat (min)	Longitude decimal	Lon (dg)	Lon (min)	Float BGC Argo	Sea ice station	Multinet	MSS	CTD	Sediment corer	Comment
Cape Town	05.01.2024	-33.92	33°	54.95'	18.25	018°	15.00'							Transit South
A	13.01.2024	-62.08	62°	05.03'	11.63	011°	37.53'	x						Float #1 + Concerto
B	14.01.2024	-66.79	66°	47.25'	7.031	007°	01.87'	x						Float #2 + Concerto
Unloading operation		-70.12	70°	07.20'	4.10	004°	06.00'				x		x	Unloading Bay
1	26.01.2024	-70.11	70°	06.40'	4.26	004°	15.70'		x	x				Science stations
2	27.01.2024	-69.96	69°	57.87'	5.50	005°	29.93'		x	x	x	x		Science stations
3	28.01.2024	-69.91	69°	54.72'	6.76	006°	45.48'		x	x	x	x		Science stations
4	29.01.2024	-69.71	69°	42.86'	10.18	010°	10.59'		x	x	x	x		Science stations
5	30.01.2024	-69.85	69°	51.20'	9.38	009°	22.90'			x		x		Science stations
C	01.01.2024	-63.79	63°	47.15'	5.30	005°	18.20'	x						Float #3 + Concerto
Cape Town	09.02.2024	-33.92	33°	54.95'	18.25	018°	15.00'							Transit North

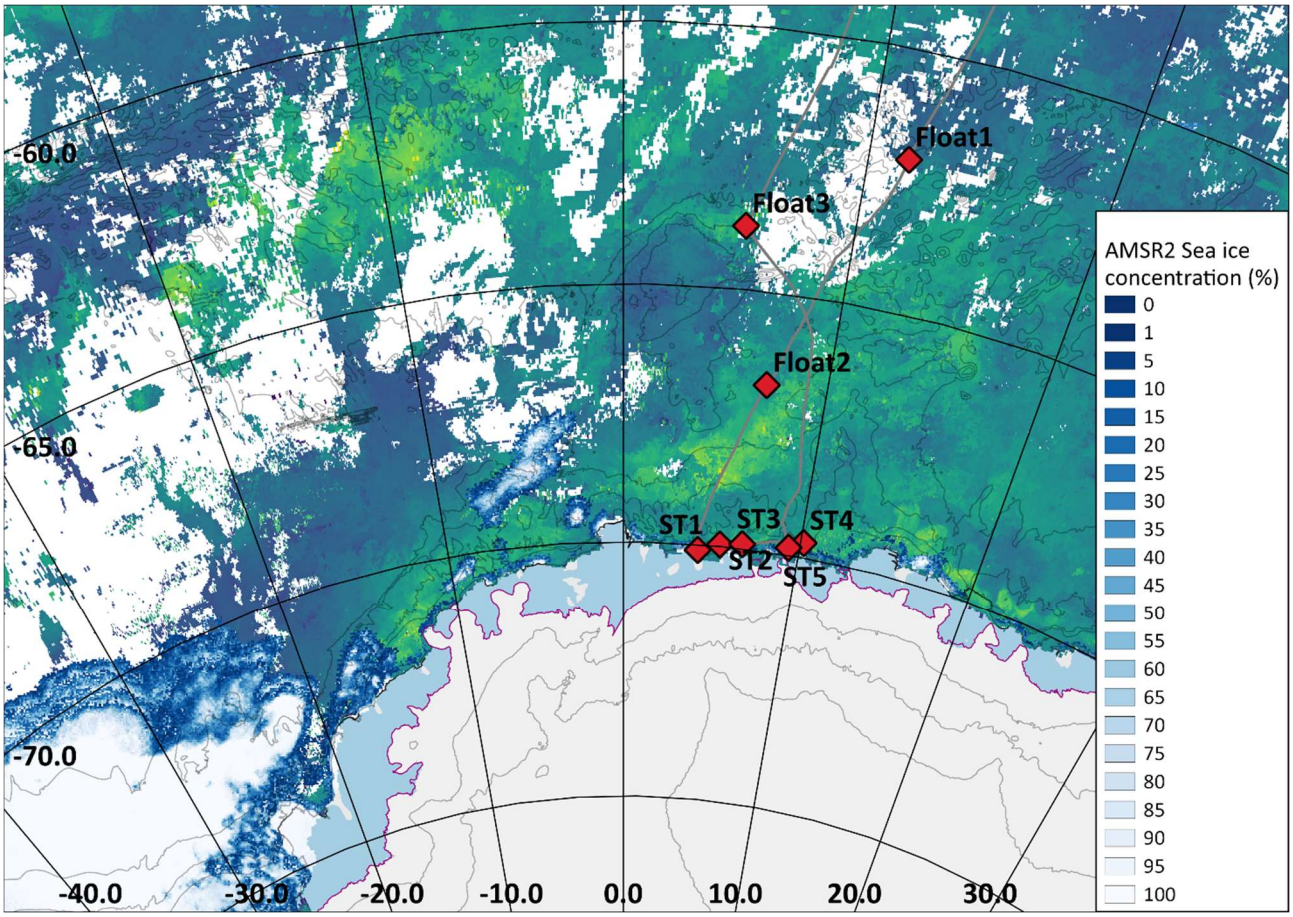


Figure 4.1: map of the scientific main stations from TT24 (red diamonds), including the deployment of BGC Argo floats in the open ocean of the Kong Haakon VII Sea, and cruise track (grey line). The satellite derived Chlorophyll-a concentration (Sentinel 3A-B) from 27 November 2023 to 29 January 2024 is indicated in blue-to-green shades. The stacked sea ice concentration (AMSR2, University of Bremen, Germany) from 26 to 30 January (i.e., during the science days) is indicated in blue shades.

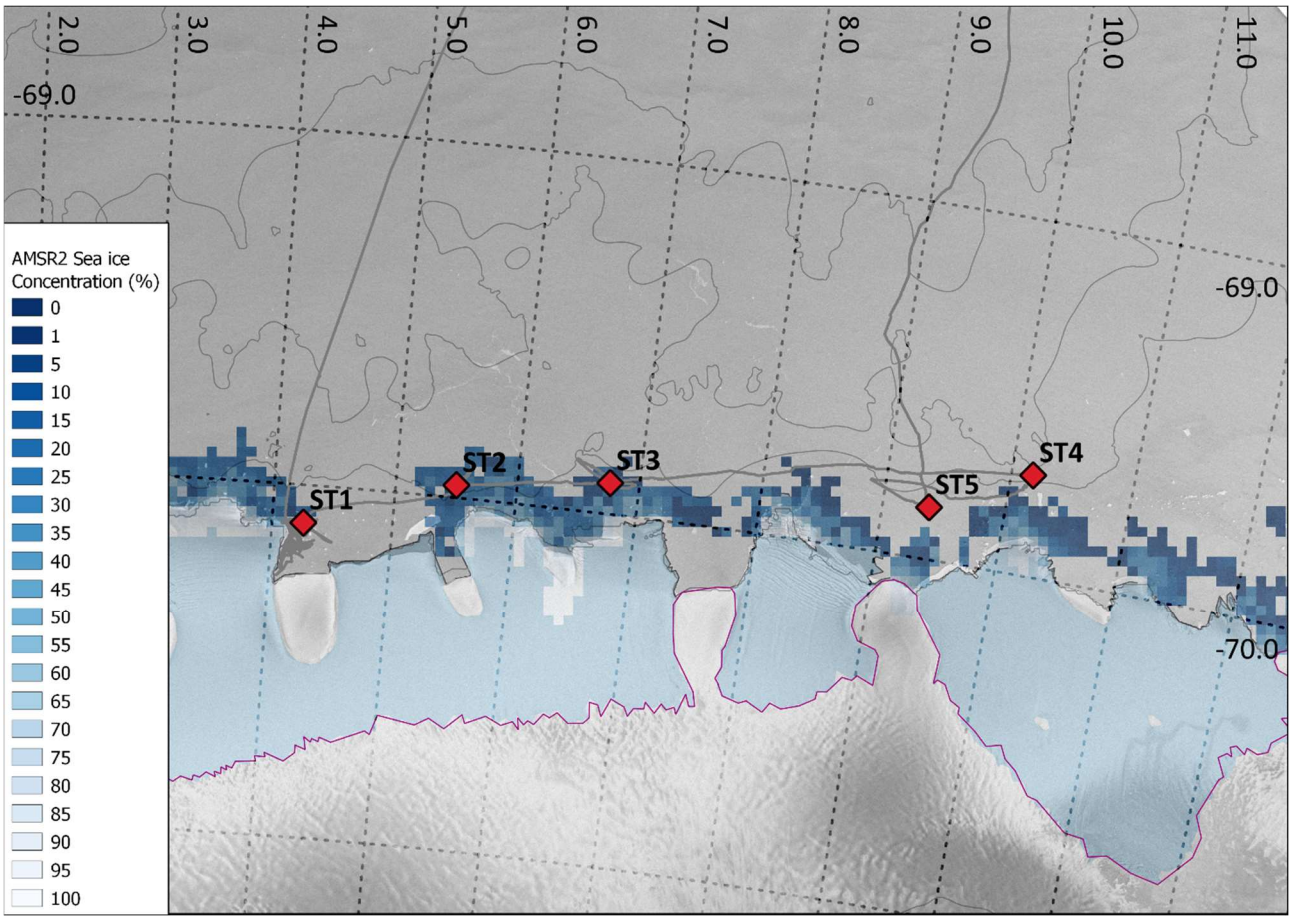


Figure 4.2: map of the TT24 scientific main stations (red diamonds) and cruise track (grey line) along the Dronning Maud Land continental shelves, bordering the ice shelves and within the remaining pack sea ice zone. A sentinel SAR image from the Kong Haakon VII Sea indicates the overall low sea ice concentration on 30 January 2024. The stacked sea ice concentration (AMSR2, University of Bremen, Germany) from 26 to 30 January (i.e., during the science days) is indicated in blue shades.

4. Sea ice work

The Transekttokt 2024 had the following objectives related to sea ice:

- Objective 1: Sea ice stations including sea ice physics, biology, biogeochemistry, and primary production. Study the contributions of sea ice microhabitats and cryosphere-ocean interactions to the overall SO primary production and ecosystems.

- Objective 2: Study the under-ice turbulence role on ocean-ice nutrient exchanges.

- Objective 3: Study trophic interactions between ice algae, phytoplankton, and zooplankton.

A total of 4 sea ice stations were studied during the Transekttokt 2024 (Table 5.1). Sea ice stations lasted 3-4h and consisted of ice coring (6-9 different sea ice cores), the cutting and storing of ice cores, the deployment of nets and oceanographic instruments with sensors underneath the sea ice. The sea ice work was organized in different groups: deployment of Blue Eye drone (all), sea ice transects (all), ice coring (Megan, Laura, Sebastien), sensor deployment, MSS and nets (Zoe, Johanne and Anette). A description of the various activities is described in Figure 5.1 and detailed below.

Table 5.1 Sea ice stations during the Transekttokt 2024

Station	Date	Latitude	Longitude	Thickness (m)	Coring	Under ice water	Nets	MSS	ADCP	Suna
1	26.01.2024	-70.44	4.58	1.33	Phys+bio+back-ups	x	x	x	x	x
2	27.01.2024	-69.96	5.64	1.55	Phys+bio+back-ups	x	x	x	x	x
3	28.01.2024	-69.88	6.59	2.66	Phys+bio	x	x	x		x
4	29.01.2024	-70.25	10.29	1.61		x	x	x		

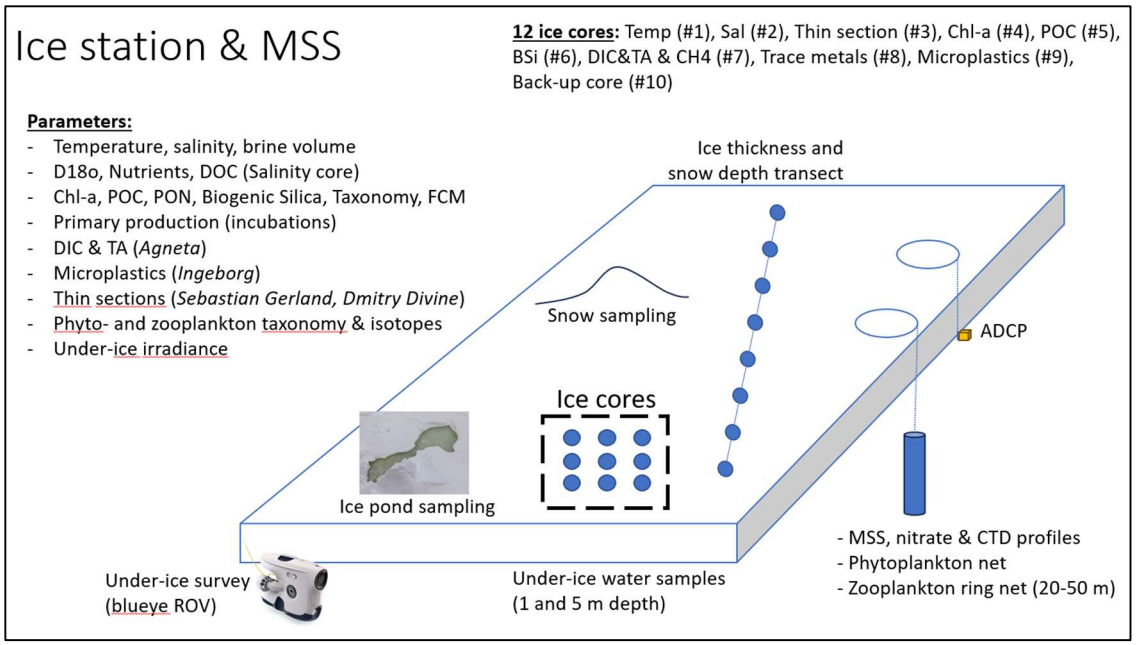


Figure 5.1.: description of sea ice activities, ice cores taken, and parameters studied.

a. **Environmental parameters:** Date and UTC time; Start Station Time; End Station Time; Latitude, Longitude; Water depth; Water Temperature; Air Temperature; Weather; Visibility; Barometer; Wind; Remarks; Who was present.

b. **Blue eye drone deployment to characterize the sea ice floe.**

The blue eye drone was deployed from the side of the floe to observe its physical and biological underneath features. Due to high swell in all sea ice stations, the blue eye drone was only deployed at the first sea ice station.

c. **Ice and snow thickness transect across the ice sea floe.**

A transect to measure ice thickness was carried out across the floe. The platelet ice layer thickness under the sea ice would have been measured if present. Unfortunately, presumably due to the low sea ice concentration this year, no platelets were observed under the studied ice floes and platelets were only observed on rare occasions from the ship's deck or on the echosounder. It is worth noting that some MSS profiles were carried out when platelets were observed drifting at depth under the ship (see section 8. Turbulence measurements: microstructure profiling).

d. **Physical ice cores:** Temperature core (becomes back-up texture core) + salinity core + a third ice core to bring back for thin sections and granulometry.

When a core was retrieved, it was first measured and noted down.

(1) Temperature core. sea ice temperature profiles were measured on one recovered ice core within a few minutes from core extraction. The ice core was collected using a 9 cm diameter Kovacs ice core and measurements were made using a thermistor probe Testo-720 from holes drilled into the ice core at 5 cm spacing, starting from the top at 2.5 cm, then 7.5 cm, 12.5 cm, 17.5 cm, etc. Ice depth and temperature were noted on the notebook.

(2) Salinity core. The salinity ice core was collected using a 9 cm diameter Kovacs ice core and sectioned on site at 10-cm vertical resolution. Ice core sections were then melted undiluted at room temperature in the dark. The bulk salinity of each melted sample was measured using a conductivity meter Cond 3110 SET3 S/N 11400491. Salinity is reported on the practical salinity scale (dimensionless). Samples for inorganic nutrients, the ratio of stable oxygen isotopes, and dissolved organic carbon (DOC) were taken from the same melted samples. Latex gloves were worn when handling and cutting the ice core.

Oxygen isotope ratios ($\delta^{18}O$). The parameter $\delta^{18}O$ describes the ratio of ^{18}O to ^{16}O isotopes in the H_2O molecules and is used as a tracer for water which has at some point evaporated. Samples were collected in 60 mL scintillation vials and stored at +4 °C for further analysis on shore.

Inorganic nutrients. The parameter inorganic nutrients refers to the sum of nitrate, nitrate, phosphate, and silicate. A sub-sample from each of the 10 cm sections of the ice core for inorganic parameters was filtered through a pre-combusted 25 mm Whatman GF/F using a syringe and a 25 mm Swinnex filter holder. Samples were stored at -20 °C and will be further analyzed ashore at UiT – The Arctic University of Norway.

Dissolved organic carbon (DOC). The parameter DOC provides information on microbial activity and biogeochemical cycling within the sea ice. A sub-sample from each of the 10 cm sections of the ice core for inorganic parameters was filtered through a pre-combusted 25 mm Whatman G/F using a syringe and a 25 mm Swinnex filter holder into acid washed vials. The DOC vials were also pre-combusted, and the sample was acidified with 100 µL of 2N HCl prior to storage at +4 °C for later analysis at UiT – The Arctic University of Norway.

(3) Thin section and density core. Texture (thin sections) will be obtained by processing the ice in the -20C freezer laboratory ashore at NPI.

Overall, 3 physics cores were retrieved and 2 brought back (1 temperature and 1 thin section and density).

e. **Biological and BGC ice cores:** These cores were taken for the analysis of Chl-a, POC:PON, BSi, Si isotopes, taxonomy, algae incubations, flow cytometry, DIC:TA, and Trace metals. In addition, we brought back-up cores for the analyses of microplastics.

(4, 5, 6) Chl-a, POC, BSi, Si isotopes, taxonomy, incubations, and flow cytometry cores (x3 cores):

Ice cores were collected using a 9 cm diameter Kovacs ice corer; hence, several cores are melted together in large cooler jugs for biological analyses. For biological cores, we started cutting from both the top and the bottom with 10 cm sections. Overall, 6 sections will be taken from each core to study the BGC variables.

Pooled ice sections were melted into filtered seawater at room temperature in cooler jugs and constantly monitored. This was done in the dark and the jugs were swirled regularly to ensure homogenous, low temperature. We used interface water so that the salinity and nutrients are comparable to what the bottom-ice cells would be experiencing. The seawater was retrieved with 20 liters jugged directly on the edge of the ice floe, filtered on 0.2 um filters and kept in the dark for no more than 48h. This 48h window was to avoid bacterial growth. We then added a known volume of filtered seawater (3:1 water to ice volume). For 1 ice section, the total volume with ice is about 635.8 ml per core x 3 = 1.9L FSW. For 3 ice sections, the total volume with ice and FSW is about 7.5L = 1920 ml x 3 (=5.8L) FSW + 1920 ml of ice.

Figure 5.2: ice core with ice algal biomass in the bottom retrieved at sea ice Station 3.

After melting the samples, we first measured the total volume of melted sample, took a salinity reading with the salinity probe and made sure melting buckets were well mixed. Before doing any filtration, we measured exact volume to be filtered with measuring cylinder for each parameter. The various methods used for sampling and laboratory analyses can be obtained from Megan Lenss (megan.lenss@npolar.no), Laura Dalman (laura.dalman@utas.edu.au), Karley Campbell (karley.l.campbell@uit.no), and Sebastien Moreau (sebastien.moreau@npolar.no), and are described briefly below.

Flow cytometry. The parameter Flow cytometry provides information on the abundance and size distribution of microorganisms. 4.5 mL of sub-sample from the pooled ice sample was fixed with 90 µL of 25% glutaraldehyde for approx. 1 hour at room temperature before flash freezing at -80°C. Samples will be further analyzed ashore.

Ice algae taxonomy. Samples for sea ice algae taxonomy are taken to understand the community composition of ice alga. 90 mL of sub-sample from the pooled ice sample was fixed with 0.5 mL of 25% glutaraldehyde and

5 mL of 20% hexamine-buffered formaldehyde and stored at +4 °C. Once ashore, fixed samples will be shipped to IOPAN (Sopot, Poland) for further identification and analysis by microscopy.

Chlorophyll-a (Chl *a*). The parameter Chl *a* is a proxy for algal biomass in sea ice. A measured volume of sub-sample from the pooled ice sample was filtered under low vacuum pressure (approx. 30 kPa) onto 25 mm Whatmann glass fiber filters. Filters were placed in 5 mL of methanol for extraction. Immediately following an 18–24 hour extraction period, samples were analyzed onboard using a Turner Trilogy Fluorometer.

Particulate organic carbon/particulate organic nitrogen (POC/PON). The parameter POC/PON is a proxy for organic biomass in sea ice. A measured volume of sub-sample from the pooled ice sample was filtered under low vacuum pressure (approx. 30 kPa) onto pre-combusted Whatmann glass fiber filters. Filters were dried at 60 °C for approx. 24 hours and packed for further analysis ashore at VUB – Vreji Universitet Brussels (Brussels, Belgium).

Biogenic silica (BSi). The parameter BSi can provide information on diatom productivity and nutrient cycling within the sea ice. 1 L of sub-sample from the pooled ice sample was filtered under low vacuum pressure (approx. 30 kPa) onto 47 mm polycarbonate filters. Filters were dried at 60 °C for approx. 24 hours and packed for further analysis ashore at Brest University (Brest, France).

Dissolved silica (DSi). The parameter DSi can provide information on nutrient available for diatoms, sea ice formation and melting, and biological activity within the sea ice. 250 mL of sub-sample from the pooled ice sample was filtered under low vacuum pressure (approx. 30 kPa) onto 47 mm polycarbonate filters. The filtered seawater produced was stored in brown plastic bottles at +4 °C and packed for further analysis ashore at Brest University (Brest, France).

(7) DIC-TA and CH4 core.

(8) Trace metals core.

(9) Microplastics core.

Overall, we took all ice cores for station 1 and 2 while we could only take the physics and biological ice cores for Station 3, where sea ice was close to 3 meters thick, and no cores for station 4 due to a large backlog of laboratory work on the ship. The sea ice was relatively warm summer sea ice with signs of snow ice formation in the upper parts of the ice. The less thick (< 1.55 m) sea ice stations 1 and 2 presented low overall algal biomass (Figure 5.3). The thicker (2.65 m) sea ice station 3 had high algal biomass located in the bottom 40 cm (up to 175 µg Chl-*a* l^{-1}; Figure 5.2 and 5.3 and Table 5.2). After the storm on January 31st, we lost the melted salinity cups from Station 3. Hence, on February 1st, onboard the ship, we cut the physics back up core from Station 3 to obtain salinity, nutrients, d18O and DOC samples.

f. Under-ice water samples: (Nutrients, delta18O, Chl-a, POC, BSi, FCM and taxonomy).

Under ice seawater (interface, 5m and 10 meters below the sea ice) was obtained with a dedicated Hydrobios sampling bottle (borrowed from P. Assmy, NPI). The samples seawater was run in the lab for inorganic nutrients, delta18O, Chl-a, POC, BSi, FCM and taxonomy following the methods described for the seawater samples retrieved with the CTD-rosette (see section 7.CTD measurement and water sampling).

g. Phytoplankton and zooplankton nets

Samples for taxonomic analyses of phytoplankton species were collected at stations 1, 2, 3 and 4 using a hand-towed phytoplankton net with 20 µm mesh size. The net was lowered to 25 m depth and slowly towed upwards through the water column. 90 mL of sample was fixed with 2 mL of strontium chloride ($SrCl_2$) and 20% hexamine-buffered formaldehyde for a final solution concentration of 10%. Samples were stored at +4 °C and will be shipped to IOPAN (Sopot, Poland) for analysis via microscopy once ashore.

In addition, samples for taxonomic analysis of zooplankton species were collected at stations 1, 2, 3 and 4 using a hand-towed zooplankton WP2 ring net (Hydro-Bios Kiel, opening: 0.25 m^2, net length: 370 cm, mesh size: 180 µm). The net was lowered to 50 m depth and slowly towed upwards through the water column. Two separate hauls with WP2 net were taken at each ice floe, one net for taxonomic composition, abundance, and biomass,

and one for stable isotope samples. The method used for sampling and laboratory analyses can be obtained from Anette Wold (anette.wold@npolar.no) and are described in detail in section 7. Zooplankton nets.

Figure 5.3: Sea ice Chlorophyll a (mg m^{-3}), Temperature (°C) and Salinity (psu; unitless) by depth at each sea ice station with biological sampling.

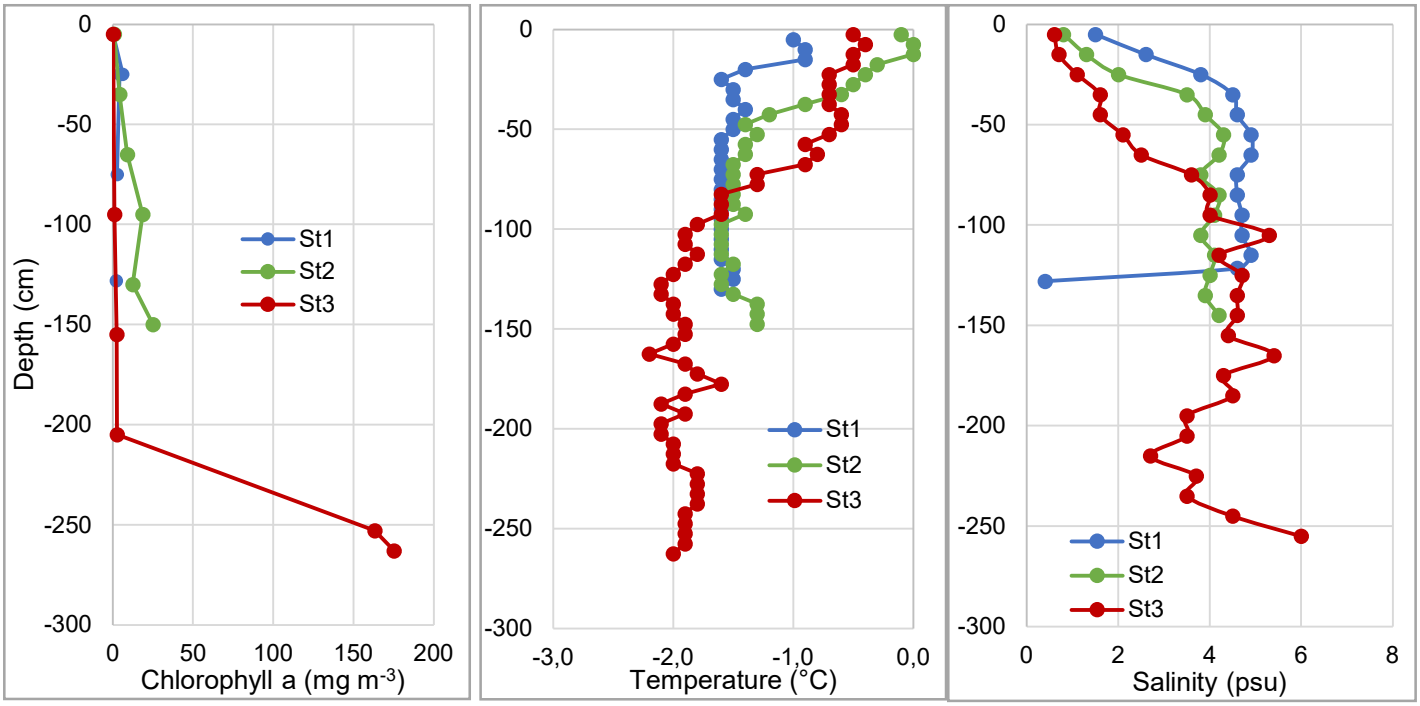


Table 5.2: Physical and biological parameters of ice stations with biological sampling.

Site	Date	Ice thickness (m)	Snow depth (m)	Free board (m)	Albedo	Under-ice light ((µmol s^{-1} m^{-2})	Chlorophyll-*a* (mg m^{-2}; depth integrated)	NCP incubation
St1	Jan. 26, 2024	1.33	0.00	0.10	0.74	37.89	1.55	-
St2	Jan. 27, 2024	1.55	0.00	0.13	0.77	60.02	7.04	X
St3	Jan. 28, 2024	2.66	0.03	0.36	0.80	5.28	34.5	-

h. Upper and under ice light field

Data on photosynthetically active radiation (PAR) were collected as measurements using Li-COR sensors and data logger (curtesy of K. Campbell, UiT) at sea ice stations 1, 2 and 3 (Table 5.2). Sensors were deployed beneath the sea ice (i.e. below the ocean-ice interface) via a mechanical L-arm, or above the air-ice interface for albedo measurements. Instantaneous measurements were completed immediately prior to ice sample collection at undisturbed coring locations except for station 3. At station 3, albedo and under-ice measurements were taken immediately following core collection at an undisturbed parallel site to where cores were collected. Though the sea ice here was increasingly thicker, an under-ice measurement was still attempted despite having the L-arm in full extension below the sea ice as with prior stations. The methods used for deploying light sensors can be obtained from Laura Dalman (laura.dalman@utas.edu.au) and Karley Campbell (karley.l.campbell@uit.no).

i. Under-ice nutrient and turbulent fluxes (nitrate sensors, ADCP and MSS)

To measure the role of under ice turbulence in ocean-sea ice nutrient fluxes, at each sea ice station, we deployed an ADCP and made profiles with the SUNA nitrate sensor and the MSS from the side of the sea ice floe.

First, a Signature 500 ADCP (SN100809) was deployed on the side of the sea ice floe at the first two ice stations. The ADCP was mounted downward looking in a metal frame, hanging from two chains approximately 30 cm beneath the sea ice bottom. The instrument was configured to measure in XYX coordinates. The ADCP was configured with a concurrent plan measuring average currents in 0.5 m bins for one minute every second minute and burst sampling with 5 beams as maximum sampling rate (600 samples, 2Hz) every 5 minutes. Deployment file: TT2024_ice.deploy.

Then one or several MSS profiles were done from the floe side and from 100 to 300 meters away from the ship to avoid interference with the ship's thrusters. See Section 9 for more details on MSS deployment during Transekttokt 2024.

Finally, we performed one mid-depth profile with the SUNA nitrate sensor. A SUNA nitrate sensor (SN 2096) was mounted on a frame with a Concerto RBR CTD (SN 204991, with Chl-a and PAR sensors) and an external battery pack. The SUNA was configured for continuous sampling of 20 light frames and 1 dark frame. The CTD sampled every second. This setup was mounted on a Kevlar rope and used in a profiling setup from the sea ice down to 50 m. Profiles were collected at the edge of the sea ice floes 1, 2 and 3. The methods used for deploying the ADCP, MSS and SUNA can be obtained from Zoe Koenig (zoe.c.koenig@uit.no) and Johanne Hus (johanne.jhus@gmail.com).

j. Sample platelets (if present): unfortunately, we observed no platelets near the ice floes during the sea ice stations.

k. Snow sampling (if present). During the Transekttokt 2024, the sea ice floes we had our stations on were not covered by snow. Other sea ice floes showed heavy snow cover, but we did not get the chance to operate on them due to operational constraints.

l. GPS trajectories

Trajectories of the ice floes were recorded using a hand-held GARMIN GPS placed in a pelicase on the sea ice. Position was recorded every 10 seconds.

5. Net Community production: Incubations experiments

Incubations were completed on the meltwater of three sea ice core sections (bottom 10 cm) and completed directly on water collected from the CTD casts at the respective chlorophyll maxima depth. Ice cores were melted in darkness with the addition of 0.2 μm filtered seawater (collected at the ice-ocean interface) for approximately 24-48 h. The filtered seawater was added at a ratio of three parts water to one-part ice. Total volume and volume of seawater were recorded for all cores to correct subsequent measurements for dilution.

Table 6.1: Net community production (NCP) incubations conducted at sampling sites.

Site	Date	Sample type	NCP Incubation
St1	01/26/2024	Bottom-ice	-
		Chl max	-
St2	01/27/2024	Bottom ice	X
		Chl max	X
St3	01/28/2024	Bottom-ice	-
		Chl max	X

Eight Wheaton glass bottles (7 clear and one black) were incubated in temperature-controlled chamber, held at -0.6°C. The temperature for the chamber was determined by in situ temperatures at the ice-ocean interface. The chamber permitted incubation of samples over a range of light intensities that were measured using Walz 4-pie microsensor, from which a photosynthesis-irradiance curve could be constructed. The NCP of pooled ice samples and chlorophyll maxima was determined using oxygen optodes. Samples were transferred to glass bottles via peristaltic pump and incubated in a temperature-controlled photosynthesis-irradiance chamber. Each bottle was equipped with a Pyroscience robust O_2 optode that logged data at one-second intervals. Incubations were run for approximately 24h. Some production measurements had to be terminated before 24h incubation time due to inclement weather (Station 2 bottom-ice and Station 3 CTD chlorophyll max) while the incubation for Station 2 CTD chlorophyll max ran for 24h. These NCP measurements can also be used to calculate an estimate for Gross Primary Production (GPP). The methods used for

measuring net community production can be obtained from Laura Dalman (laura.dalman@utas.edu.au) and Karley Campbell (karley.l.campbell@uit.no).

6. Zooplankton nets

The main objective of the work was to collect samples to study the mesozooplankton community in terms of taxonomic composition, abundance, and biomass (zooplankton community study). In addition, we aimed to collect larger mesozooplankton for stable isotope analysis of trophic level interactions in the pelagic ecosystem.

Figure 6.1: Multinet deployed from A-frame during TT24.

Sampling methods

Depth stratified samples were taken with Multiple Plankton Sampler MultiNet type Midi (Hydro-Bios Kiel, 5 nets, opening: 0.25 m^2, net length: 250 cm, mesh size: 180 µm) from the ship (Fig. 1). The MultiNet was hauled with a speed of 0.5 m s^{-1}. The depth sampled at the different stations is shown in Table 1. A Concerto SN 060589 was used as CTD on the multinet when depths were shallower than 900 m. The method used for sampling and laboratory analyses can be obtained through Anette Wold (anette.wold@npolar.no) and is described in detail below.

Zooplankton community samples

All zooplankton community samples were processed immediately upon retrieval of the nets. The zooplankton was concentrated on 180 µm sieves, gently flushed with filtered seawater, and transferred into 125 mL plastic bottles, preserved in 4% acid-free formaldehyde for later taxonomical identification in the laboratory at Plankton Ecology Laboratory at the Institute of Oceanology (IO PAN) in Sopot, Poland.

Table 7.1: Overview of all zooplankton community samples collected with Multinet and WP2 net and Stable isotope samples collected with a WP2 net.

Station	Latitude (S)	Longitude (E)	Bottom depth	Gear	Depth layers
Meszooplankton community					
St1	70.0797	4.3140	373 m	WP2	50-0 m
				Multinet 180 um	350-200-100-50-20-0 m
St2	69.9646	5.4987	930 m	Multinet 180 um	900-500-100-50-20-0 m
				WP2	50-0 m
St3	69.9120	6.7580	332 m	Multinet 180 um	300-200-100-50-20-0 m
				WP2	50-0 m
St4	69.7174	9.8477	1578 m	Multinet 180 um	1200-500-100-50-20-0 m
				WP2	50-0 m
St5	69.7173	10.1643	210 m	Multinet 180 um	180-150-100-50-20-0 m
Stable Isotope					
St2	69.9622	5.6351		WP2	50-0 m
St3	69.8758	6.5897		WP2	50-0 m
St4	70.2533	10.2927		WP2	50-0 m

Short description of the zooplankton community samples.

The brief description of the samples is solely based on a cursory examination on a lightboard, and a few sub-samples scrutinized under the stereomicroscope. Acantharians were a prominent component of the zooplankton samples causing aggregates together with sinking out phytoplankton/ice algae.

Station 1: There were no distinct differences between the depth layers and the samples were dominated by small copepods, benthic larvae, Acantharians as well as small *Mertensia* sp. and *Beroe* sp.

Station 2: The two deepest layers (900-500 m and 500-100 m) were dominated by benthic larvae, Acantharians and small copepods, whereas the shallower layers (100-50 m, 50-20 m, and 20-0 m) also exhibited a relatively large abundance of gelatinous species, such as the unknown Cnidaria (Figure 7.2), as well as small *Mertensia* sp. and *Beroe* sp.

Additionally, there was a notable presence of small *Euphasia superba* and the pteropod *Limacina helicina* in both the surface MultiNet sample and the WP2 net from the ice floe.

Station 3: No notes or pictures was taken at station 3.

Station 4: We did not sample to the bottom since it was uncertain how long wire we had (approx. 1500 m) and how deep we could track the MultiNet on the EK80, therefore the deepest layer was from 1200 m. In the deepest layer 1200-500 m there were some carnivorous copepods as well as smaller copepods as well as foraminifera. The intermediate depth layers (500-100 m and 100-50 m) had high abundance of Foraminifera. It also showed a high concentration of aggregated material consisting of a mix of phytoplankton/ice algae and Acantharians. The surface samples (50-20 m & 20-0 m) contained less foraminifera but there were still some present.

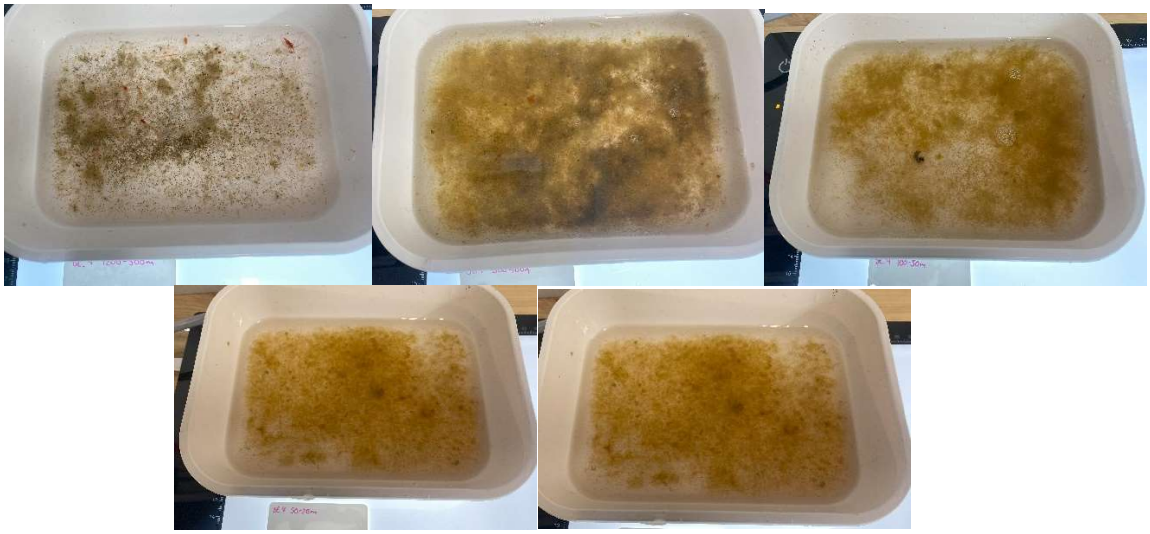


Fig. 7.1: MultiNet zooplankton samples from station 4 for the following depth layers; 1200-500 m, 500-100 m, 100-50 m, 50-20 m, and 20-0 m

Station 5: This station was sampled at a shallow location (bottom depth 210 m) while we were sheltering from strong winds behind an iceberg. There were no distinct differences between the depth layers and relatively low biomass.

Stable isotope samples

Samples for stable isotope analysis were collected from stations 2, 3, and 4 using the WP2 net in the upper 50 m of the water column on the side of the ice floe. The samples were kept in in situ water in a cooler until sorting using a lightboard and stereomicroscope onboard the ship. Large specimens were sorted to the highest taxa, while for the smaller copepods, it wasn't possible to obtain large enough samples for specific species; therefore, a bulk sample was taken after removing larger specimens and aggregated material from the sample. Table 7.2 shows the species collected for stable isotope analysis with WP2 net from 50-0 m from the edge of ice floe at stations 1, 2 & 3.

Table 7.2: Overview of stable isotope samples

Station	Species	Size	Ind. per sample	Repli-cates
St2	Cnidaria indet.	10-15 mm	20	3
	Euphausia superba	15-20 mm	4	3
	Limacina helicina	2-3 mm	4	2
	Limacina helicina	3-6 mm	2	2
	Mertensia sp.	40 mm	1	1
	Mertensia sp.	1-10 mm	4	1
	Beroe sp.	40 mm	4	1
	Beroe sp.	5-10 mm	4	1
	Clione limacina	10 mm	1	1
	Copepoda		bulk sample	3

St3	Copepoda		bulk sample	3
	Limacina helicina	5-10 mm	2	1
	Beroe sp.	3-5 mm	6	1
	Mertensia sp.	3-5 mm	8	1
St4	*Limacina helicina*	7 mm	1	1
	Mertensia sp.	5 mm	1	1
	Calanus propinquus	CV	1	1

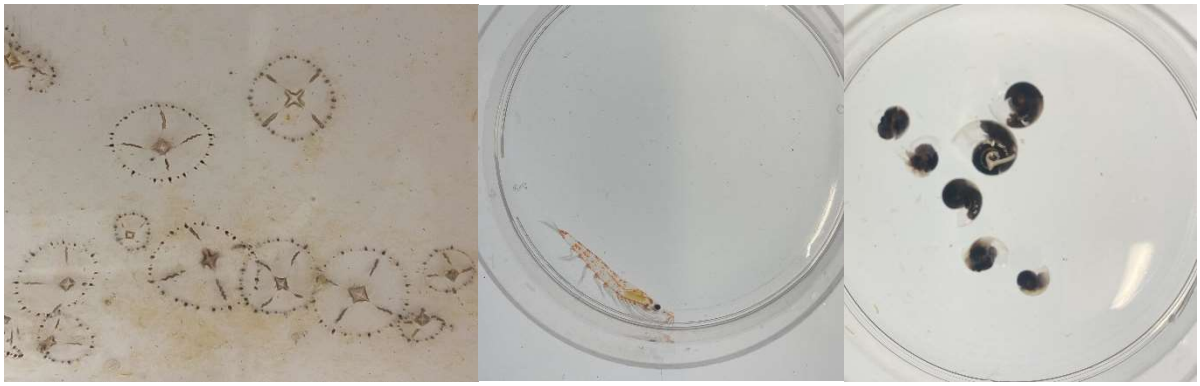


Figure 7.2: Some of the species sorted out for stable isotope analysis in order from left to right; cnidaria indet., Euphasia superba, Limacina helicina

7. Turbulence measurements: microstructure profiling

During the Transekttokt 2024, one of the primary goals was to conduct microstructure turbulence measurements using the MicroStructure Sonde (MSS). We aimed to compare turbulent mixing in as many diverse sea ice regimes as possible: open ocean, marginal ice zone, pack ice, frazil ice, proximity to the ice shelf or icebergs, and before and after changing weather conditions. The sampling plan was designed to be flexible, allowing for adaptation based on field conditions, particularly in response to rapidly changing ice and weather conditions.

MSS configuration: Ocean microstructure measurements were made using two MSS90L profiler (SN 053 and SN 046), a loosely-tethered free-fall instrument equipped with two airfoil probes aligned parallel to each other, a fast tip thermistor (FP07), an acceleration sensor and conventional CTD sensors for precision measurements. The shear probes used were SN033 (sensitivity 4.86e-04, SHE2) and SN032 (sensitivity 4.40e-4, SHE1) on MSS046 and SN116 (sensitivity 3.32e-04, SHE1) and SN149 (sensitivity 3.17e-4, SHE2) on MSS053. MSS053 was used from the ship while MSS046 was run on the sea ice mainly. For MSS053, 4 weight rings were used. However, for MSS46, 2 weight rings were removed before cast 8, and only 2 were used for the rest of the cruise. The sensors point downward when the instrument profiles vertically, and all sample at 1024 Hz. The instrument is ballasted for a typical fall speed of 0.6-0.7 m s-1 and is decoupled from operation induced tension by paying out cable at sufficient speed to keep it slack. Data are transmitted in real time to a shipboard data acquisition system. In total 28 casts were done. The profiler is equipped with a sensor protection guard at the leading end. Two different setups of the MSS were implemented, depending on if it was operated from the ship or from the sea ice. The methods used for deploying the MSS can be obtained from Zoe Koenig (zoe.c.koenig@uit.no) and Johanne Hus (johanne.jhus@gmail.com).

Profiling from the ship: The deployment of the MSS from the ship was done from the portside, by the evacuation door. A motor-driven winch was mounted on a pole strapped to the railing of the ship and an arm was used to extend the cable from the winch to outside. The profiler was lowered in the water and brought back on board by pulling on the data cable transmission by hand. Two to three casts were performed at each station. Because of the keel of the ship, the upper 10 m of each cast were excluded from dissipation estimates. We first ran a winch with a 350 m cable. After cast 13, the winch stopped working (the reason was unknown) and we had to swap winches and spool. The cable on this winch was about 250 m long and needed retermination after one cast. With this winch we ran without the extending arm but no noticeable damage to the cable was observed.

Profiling during ice stations: The MSS was operated from the sea ice during the ice stations. We deployed the MSS from the side of the sea ice floe. The floe was ideally located approximately 100-150 m away from the ship, ensuring sampling

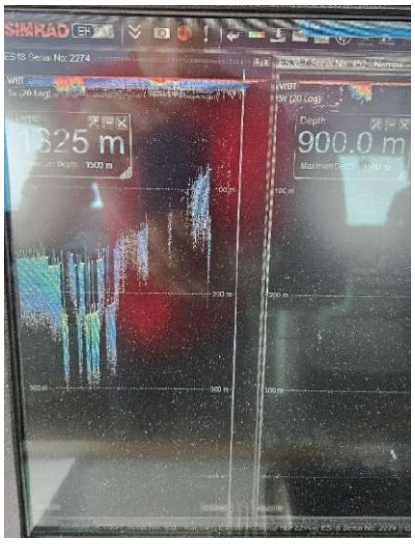
of undisturbed waters. A manual winch was set up by the edge, and one set of ideally 3 casts was performed at each station. See Table 8.1 for a total overview of the casts.

Table 8.1: List of MSS Stations.

Date	MSS cast	CTD cast	LAT	LON	TIME (UTC)	Eco depth	Start depth	stop depth	Environmental conditions	Comments
26/01/2024	1		70.18049	4.27098	9:09	267	1	250	open water	from ship, drifting, MSS46, 4 metal rings, 4 flotations
26/01/2024	2		70.18024	4.16803	9:20	273	1	255	open water	from ship, drifting, MSS46, 4 metal rings, 4 flotations
26/01/2024	3		70.18009	4.28281	9:30	280	1	244	open water	from ship, drifting, MSS46, 4 metal rings, 4 floatation
26/01/2024	4		70.10976	4.25602	18:50	291	1	180	sea ice flow, ice drifting by, 6-7 m/s wind, ice thickness 1.33m	from sea ice, ship 50m away, MSS46, 3 metal rings, 4 flotations
27/01/2024	5	1	69.97	5.51333	7:36	850	1	263	open water with some flows around, platelet ice seen on eco around 15-35m	from ship, drifting, MSS53, 4 metal rings, 4 flotations
27/01/2024	6	1	69.97	5.51333	7:50	850	1	250	open water with some flows around, platelet ice seen on eco around 15-35m	from ship, drifting, MSS53, 4 metal rings, 4 floatation
27/01/2024	7	1	69.97	5.51333	8:03	850	1	234	open water with some flows around, platelet ice seen on eco around 15-35m	from ship, drifting, MSS53, 4 metal rings, 4 flotations
27/01/2024	8	1	69.95	5.551	13:35	1200	2	180	sea ice flow, ice drifting by, wind 8 m/s	from sea ice, ship close, thrusters on, MSS46, ice flow rotating, 2 metal ring, 4 flotations
27/01/2024	9	1	69.95	5.551	13:50	1200	2	180	sea ice flow, ice drifting by, wind 8 m/s	from sea ice, ship 200m away, ice flow rotating, MSS46, 2 metal rings, 4 flotations
27/01/2024	10	1	69.95	5.551		1200	2		sea ice flow, ice drifting by, wind 8 m/s	Johanne testing the winch, MSS46, data can't be used, 2 metal rings, 4 flotations
27/01/2024	11	1	69.95	5.551	14:15	1200	2	55	sea ice flow, ice drifting by, wind 8 m/s	upper layer, stopped winch at 50 m, ship 300 m away, MSS46, 2 metal rings, 4 flotations
27/01/2024	12	1	69.965	5.595	21:07	900	1	269	open water, waves 1m	from the ship, ship drifted a lot, MSS53, 4 metal rings, 4 flotations
27/01/2024	13	1	69.965	5.595	21:25	900	1	289	open water, waves 1m	from the ship, ship drifted a lot, MSS53, 4 metal rings, 4 flotations
28/01/2024	14	2	69.874	6.61557	12:29	538	1	268	open water	from the ship, close to sea ice station, MSS53, 4 metal rings, 4 flotations
28/01/2024	15	2	69.87	6.58167	14:25	532	1	204	big ice flow 2.69m thick, open water on MSS side, sea drifting mostly on opposite side, wind 4 m/s	from sea ice, ship 300.-500m away, MSS46, 2 metal rings, 4 flotations
28/01/2024	16	2	69.87	6.58167	14:41	532	1	210	big ice flow 2.69 m thick, open water on MSS side, sea drifting mostly on opposite side, wind 4 m/s	from sea ice, ship 300.-500m away, MSS46, 2 metal rings, 4 flotations
28/01/2024	17	2	69.87	6.58167	14:51	532	1	205	big ice flow 2.69 m thick, open water on MSS side, sea drifting mostly on opposite side, wind 4 m/s	from sea ice, ship 300.-500m away, MSS46, 2 metal rings, 4 flotations
29/01/2024	18	3.4	69.7147	10.71917	8:14	1600	2	150	open water, 5m/s wind, platelet ice observed on eco	MSS53, from ship, hashtags at 150 - 172 m, stopped the cast, 4 metal rings, 4 flotations

29/01/2024	19	3.4	69.7147	10.71917	8:26	1600	1	210	open water, 5m/s wind, platelet ice observed on eco	MSS53, from ship, 4 metal rings, 4 flotations
29/01/2024	20	3.4	69.7147	10.71917	8:44	1600	1	226	open water, 5m/s wind, platelet ice observed on eco	MSS53, from ship, 4 metal rings, 4 flotations
29/01/2024	21	3.4	69.716667	10.15	12:16	1546	3	203	open water, sea ice flow around, wind 5m/s	MSS53, hashtags at 200 then stopped the cast, from ship, 4 metal rings, 4 flotations
29/01/2024	22	3.4	69.716667	10.133333	12:39	1454	2	100	open water, sea ice flow around, wind 5m/s	MSS53, hashtags at 100m then stopped the cast, from the ship, 4 metal rings, 4 flotations
29/01/2024	23	3.4	69.716667	10.133333	12:25	1454	1	203	open water, sea ice flow around, wind 5m/s	MSS53, from the ship, problems with deck unit, cast cut, 4 metal rings, 4 flotations
29/01/2024	24	3.4	69.716667	10.133333	12:56	1454	1	200	open water, sea ice flow around, wind 5m/s	MSS53, from the ship, problems with deck unit, cast cut, 4 metal rings, 4 flotations
29/01/2024	25	3.4	69.74072	10.15154	18:28	1616	1	51	ice surrounding the flow, wind 8m/s, 1.65 m ice thickness, air temp -0.2 deg	MSS46, from sea ice, ship 200m away, 2 metal rings, 4 flotations
29/01/2024	26	3.4	69.74072	10.15154	18:31	1616	2	185	ice surrounding the flow, wind 8m/s, 1.65 m ice thickness, air temp -0.2 deg	MSS46, from sea ice, ship 200m away, 2 metal rings, 4 flotations
29/01/2024	27	3.4	69.76	10.111667	20:28	559	0	211	open water, sea ice flow around, wind 8.8m/s	MSS53, from ship, 4 metal rings, 4 flotations
29/01/2024	28	3.4	69.76	10.111667	20:44	559	1	198	open water, sea ice flow around, wind 8.8m/s	MSS53, from ship, 4 metal rings, 4 flotations

Figure 8.1: MSS deployment from sea ice at sea ice Station 4 on January 29, 2024 (left). Platelet ice crystals observed under the ship with EK80 on January 29, 2024, and during which MSS profiles were carried out (right).



8. CTD Measurements and water sampling

Ship based CTD profiling work and water sampling was carried out accompanying sea ice, zooplankton and MSS at stations 2, 3, 4, and 5. A SBE911+ sensor package (2 x temp, 2x conductivity, oxygen, fluorescence, backscattering) with 12-bottles water sampler rosette on 8 mm steel wire with an electrical winch in the winch container was used. One of the bottles on the water sampler was replaced with a single-head (down) LADCP that is controlled via a separate laptop. To avoid problems with icing the T, S and O2 ducts were not flushed between stations – an extended surface soak was specified to account for this. At the beginning of stations, the CTD was lowered to 20 dbar and allowed to soak for 2 minutes after the pump started. After the soak was complete and sensors stabilized the CTD was brought to the surface and then lowered. Data acquisition was initiated just before deployment with the CTD on deck and allowed to run until

the CTD was back on deck at the end of the cast. Niskin bottles were closed using the fire bottle command within the Sea-Bird acquisition software so that a bottle file (.bl) was created for each CTD cast. NMEA GPS time and position information was fed to the acquisition computer and added to each scan line of the data files. Cast starting times were automatically added to the header of all data files. During the cruise a paper log sheet was completed for each CTD cast listing the depths at which bottles were fired and the sample numbers of water samples taken from each bottle. The list of sensors is included at the end of this report as Appendix A. In addition, scanned images of the log sheets can be requested to Megan Lenss (megan.lenss@npolar.no) and Sebastien Moreau (sebastien.moreau@npolar.no).

One LADCP-profiler (RD Instrument) was mounted on the 12 bottle CTD rosette to obtain vertical profiles of horizontal currents. The ADCPs are 6000-m rated, 300 kHz Sentinel Workhorses. The ADCP has the LADCP option installed. The ADCP pointed downward. The compass of the instrument was calibrated on 22 January 2024 on the Fimbulisen ice shelf during the unloading. The resulting compass errors were less than 1.5°. In total 4 profiles of LADCP were taken. The vertical bin size (and pulse length) was set to 8 m for each ADCP. Single ping data were recorded in beam coordinates, with blank distance set to zero.

A SUNA nitrate sensor (SN 2096) was mounted on a frame with a Concerto RBR CTD (SN 204991) and an external battery pack. The SUNA was configured for continuous sampling of 20 light frames and 1 dark frame. The CTD sampled every second. The SUNA was mounted on the CTD (cast 2, 3 and 5) when the CTD was profiling shallower than 500 m depth (Table 9.1).

Table 9.1: List of CTD stations

Time (UTC)	CTD cast	Lat deg	LAT min	LON deg	LON min	Eco depth	SUNA	LADCP	Comments
19:19	1	69	57.98	5	29.51	884		L001	small swell, LADCP with its cap
19:29	2	69	54.72	6	45.48	333	A0000050.CSV	L002	calm, no strong wind
14:09	3	69	43.05	10	09.86	1561	A0000051.CSV		calibration cast with CONCERTO and SUNA
14:42	4	69	43.04	10	09.86	1561		L004	
10:48	5	69	51.31	9	23.01	210	A0000052.CSV	L005	SUNA with tape, so no data

Water sampling for tracers from the CTD-rosette Niskin bottles was carried out for the following parameters:

Salinity. Laboratory salinity measurements are used to validate and calibrate conductivity sensors on the CTD. Salinity samples were collected from selected depths on all casts. 250 mL glass sample bottles were filled directly from Niskin bottles and stored at room temperature for analysis ashore at NPI in Tromsø.

Dissolved inorganic carbon (DIC). The parameter DIC describes the sum of dissolved carbon dioxide, carbonic acid, and biocarbonate- and carbonate- ions in seawater and used to investigate carbonate chemistry and processes associated with ocean acidification. Samples were collected for the full water column at each CTD deployment and taken first from the CTD-rosette. Samples were spiked with 50 µL saturated mercury chloride ($HgCl_2$) and stored in dark conditions at room temperature for analysis ashore at the Institute of Marine Research (IMR) in Tromsø.

Oxygen isotope ratios ($\delta^{18}O$). The parameter $\delta^{18}O$ describes the ratio of ^{18}O to ^{16}O isotopes in the H_2O molecules and is used as a tracer for water which has at some point evaporated. Samples were collected in 60 mL scintillation vials for the full water column at each CTD deployment and stored at +4 °C for further analysis on shore VUB – Vreji Universitet Brussels (Brussels, Belgium). Additional under ice seawater samples were collected at stations 1, 2, 3, and 4.

Inorganic nutrients. The parameter inorganic nutrients is the sum of nitrate, nitrate, phosphate, and silicate. Samples were collected for the full water column at each CTD deployment by filtering through a pre-combusted 25 mm Whatman GF/F using a syringe and a 25 mm Swinnex filter holder. Samples were thereafter stored at -20 °C for further analysis ashore at UiT – The Arctic University of Norway. Additional under ice seawater samples were collected at stations 1, 2, 3, and 4.

Phytoplankton taxonomy. Samples for phytoplankton taxonomy are taken to understand the community composition of phytoplankton. Samples from 6 standard depths in addition to the depth of the Chl *a* maximum were collected at each CTD deployment. 190 mL of sample was fixed with 0.8 mL of 25% glutaraldehyde and 10 mL of 20% hexamine-buffered formaldehyde and stored at +4 °C. Once ashore, fixed samples will be shipped to IOPAN (Sopot, Poland) for further identification and analysis by microscopy. Additional under ice seawater samples were collected at stations 1, 2, 3, and 4.

Flow cytometry. The parameter Flow cytometry provides information on the abundance and size distribution of micro-organisms. Samples from 6 standard depths in addition to the depth of the Chl *a* maximum were collected at each CTD cast. 4.5 mL of sub-sample from the pooled ice sample was fixed with 90 µL of 25% glutaraldehyde for approx. 1 hour at room temperature before flash freezing at -80°C. Samples will be further analyzed ashore. Additional under ice seawater samples were collected at stations 1, 2, 3, and 4.

Chlorophyll-a (Chl *a*). The parameter Chl *a* is a proxy for algal biomass in sea ice. Samples from 6 standard depths in addition to the depth of the Chl *a* maximum were collected at each CTD cast. Samples were filtered under low vacuum pressure (approx. 30 kPa) onto 25 mm Whatmann glass fiber filters and extracted in 5 mL of methanol. Samples were analyzed onboard using a Turner Trilogy Fluorometer immediately following an 18–24 hour extraction period. Additional under ice seawater samples were collected at stations 1, 2, 3, and 4.

Particulate organic carbon/particulate organic nitrogen (POC/PON). The parameter POC/PON is a proxy for organic biomass in sea ice. Samples from 6 standard depths in addition to the depth of the Chl *a* maximum were collected at each CTD cast. Samples were filtered under low vacuum pressure (approx. 30 kPa) onto pre-combusted Whatmann glass fiber filters. Filters were then dried at 60 °C for approx. 24 hours and packed for further analysis ashore at VUB – Vreji Universitet Brussels (Brussels, Belgium). Additional under ice seawater samples were collected at stations 1, 2, 3, and 4.

The various methods used for sampling and laboratory analyses can be obtained through Sebastien Moreau (sebastien.moreau@npolar.no), Megan Lenss (megan.lenss@npolar.no), Zoe Koenig (zoe.c.koenig@uit.no), and Agneta Fransson (Agneta.Fransson@npolar.no).

Figure 9.1: Upper 200 meters CTD profiles for temperature (C), salinity, dissolved oxygen (ml L^{-1}), uncalibrated Chlorophyll-a concentration (mg m^{-3}) and beam attenuation (m^{-1}). High biomass was observed at the 5 CTD stations carried out in combination with the multinet and sea ice stations. Signs of export of phytoplankton biomass is obvious at all stations, which also corresponded to high particulate biomass observed in the zooplankton nets. In addition, mid-depth export spikes are observed at Station 5 where winds were increasing quickly and possibly already mixing the water column while the ship was sheltering in the lee side of grounded icebergs. Clear signs of non-photochemical quenching can be observed near the surface in all Chlorophyll-a profiles.

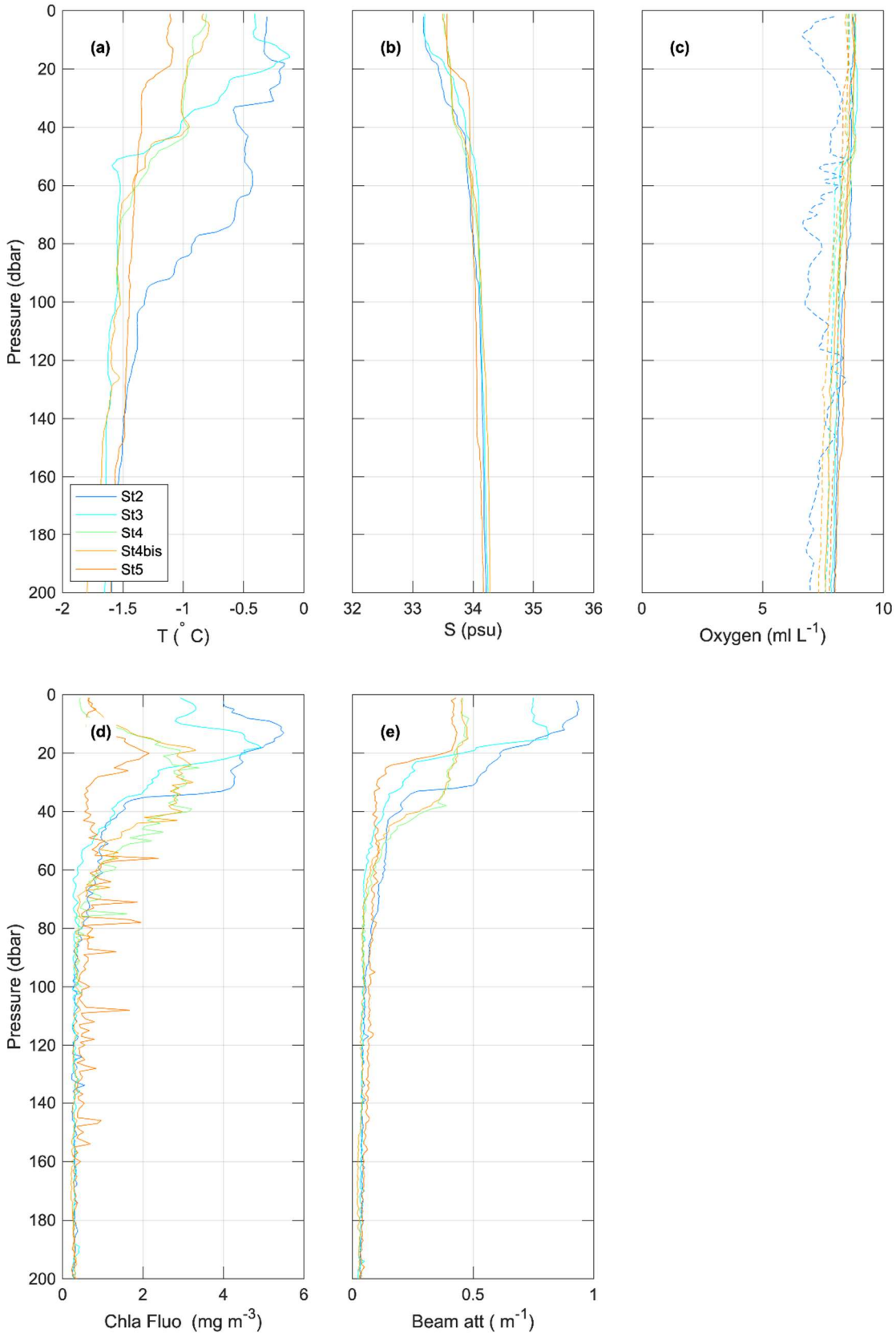
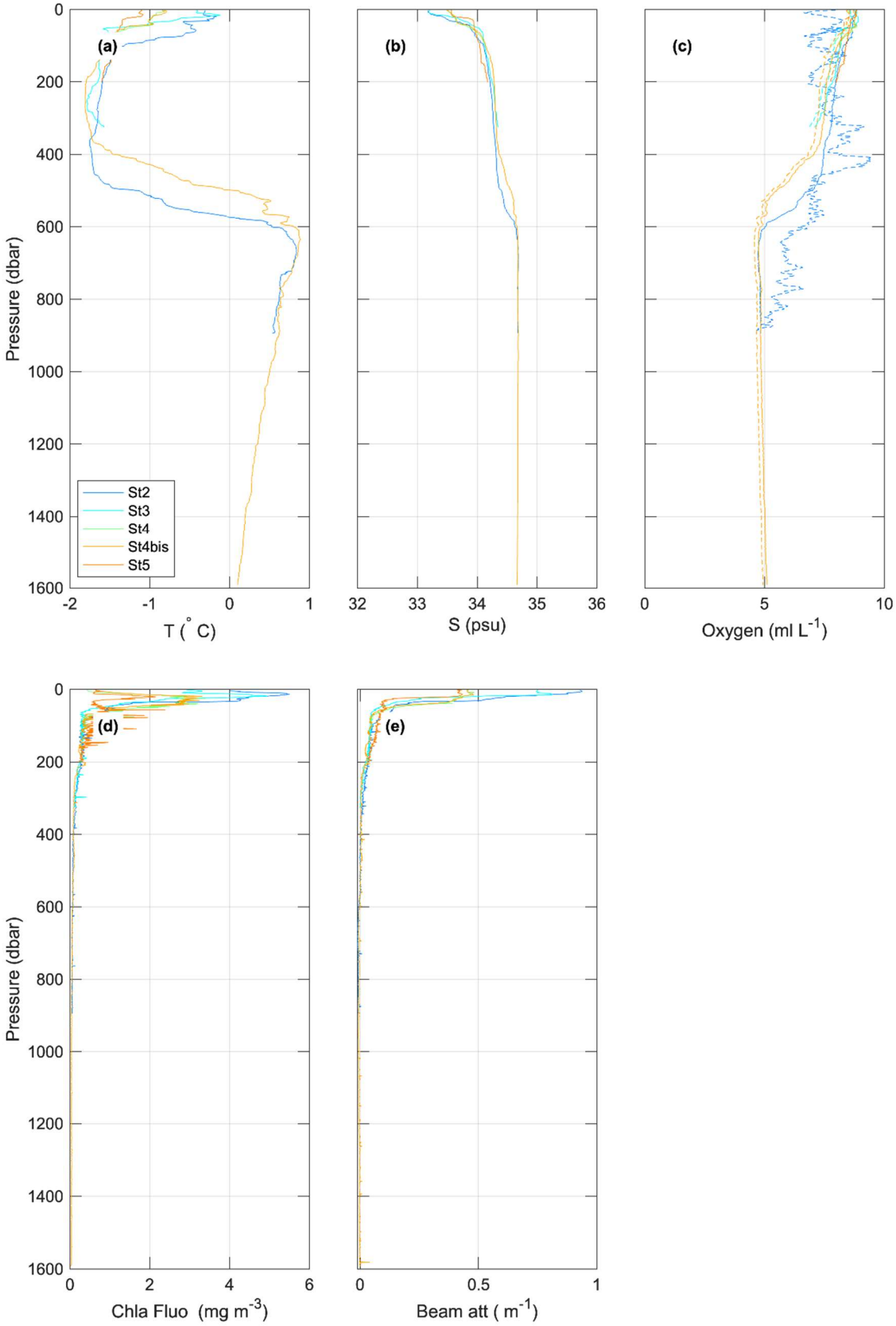


Figure 9.2: Upper 1600 meters CTD profiles for temperature (C), salinity, dissolved oxygen (ml L^{-1}), uncalibrated Chlorophyll-a concentration (mg m^{-3}) and beam attenuation (m^{-1}).



9. BGC-Argo floats deployments

During the Transekttokt 2024, we deployed opportunistically three BGC-Argo floats from Teledyne Marine System (USA). The floats were purchased by the German Federal Office for maritime shipping and hydrography (BSH). The floats are APEX BGC profiling floats which are equipped with the following sensors: sbe41cp CTD; Aanderra optode, Wet Labs flbbcd; and Satlantic Irradiance sensors. The floats' life expectancy is of 4-5 years. The floats will drift throughout the Weddell Gyre and possess ice-avoiding algorithm that allow them to function in sea ice dense areas.

Since the deployment cables were not present in the BGC Argo floats when they were delivered in Cape Town, a self-test was performed on the ship 24h to 2h before deployment. Once the self-test was completed and verified on the servers by contacts (Meike Martins, meike.martins@bsh.de) at German Federal Office for maritime shipping and hydrography (BSH), the floats were deployed from the side of the ship. The floats were deployed at 1) 62.08°S, 11.63°E (January 13th); 2) 66.79°S, 7.031°E (January 14th); and 3) 63.79°S, 5.30°E (February 1st).

Following the BGC Argo floats deployments, 1 to 2 CTD casts were done with a Concerto SN204991 (with Chl-a and PAR sensors down to 100 m) and a Concerto SN 060589 (down to 200-300m).

Figure 10.1: BGC Argo float deployment from Silver Arctic on February 1, 2024.

10. Bridge Observations: Birds, Marine Mammals

During the Transekttokt 2024, we recorded birds and marine mammals from the bridge following the protocol from the DML2019 Ecosystem cruise on board RV Kronprins Haakon and the previous Transekttokt 2021, 2022 and 2023. This was done during the Southbound and Northbound transects 2 to 3h per day by 2 or 3 dedicated researchers. At all times, one or two observers were identifying birds and mammals, and a person was logging the data. The following protocol was used:

- At the beginning of a session, time, latitude, longitude, and weather were recorded.
- Observers observed without binoculars most of the time, straight ahead as animals appear on the course of the ship.
- After a sighting, the sighting was recorded. The events were recorded on a computer with species, numbers, time (UTC), latitude and longitude.
- We then quickly used cameras and binoculars to identify the species.
- Observations were taken on a 0 to 90 degrees angle. Observations outside of this quadrant were recorded as incidentals. Observations made when the ship stopped were also recorded as incidentals.
- Birds' sightings were only recorded if within 300 m of the ship.

- Marine mammals' and birds' observations were made at all times while, every hour, a snapshot of followers (any animals located at the back of the ship) was recorded for 180 degrees around the stern of the vessel out to 300m.

Figure 11.1: pictures of marine mammals and birds observed during the Transekttokt 2024.

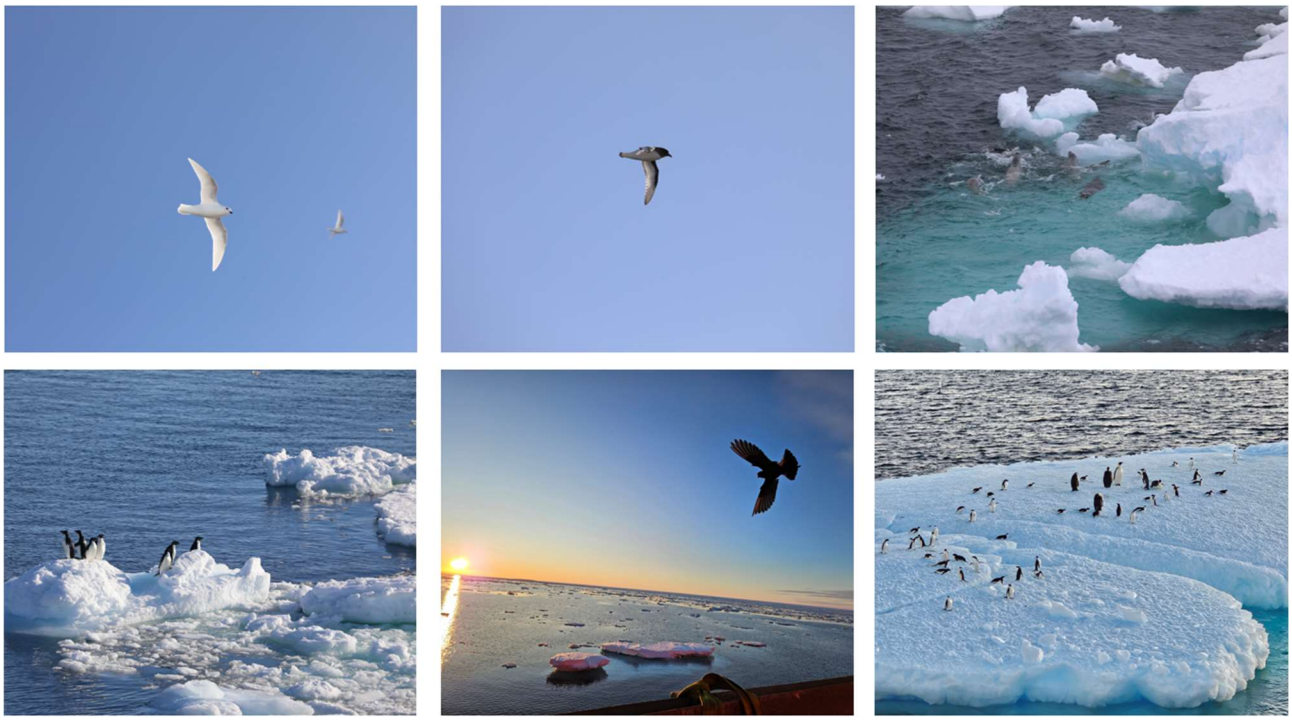


Figure 11.2: pictures of marine mammals and birds observed during the Transekttokt 2024.

11. Bridge Observations: Sea Ice

During the Transekttokt 2024, we also retrieved bridge observations of the sea ice concentration following the ASPECT protocol (using the IceBox program). During the Transekttokt 2024, sea ice concentrations from the bridge were

mainly retrieved during the unloading operation at Trianglebukta. The Aspect data will be transferred to Petra Heil (Australian Antarctic Division, AAD) who collects all Southern Ocean ASPECT sea-ice data.

12. Ship's Observations: Echo-sounder

During the Transekttokt 2024, we retrieved information on pelagic organisms, including Antarctic krill, with the ship's echosounder. The data are stored on an external hard drive and will be analyzed by Ole Arve Misund (ole.arve.misund@npolar.no) in collaboration with IMR. The EK80 data may also be used to analyze turbulence in the ocean.

Appendix A : CTD sensors (see with Marius Bratrein for further information).

SBE911 Plus	**TT24 Cruise**	**15-01-2024 Setup**	
Channel	**Sensor**	**Serial Number**	**Last Calibration**
Frequency	SBE 03 - Temp 1	5299	18-AUG-23
Frequency	SBE 04 - Cond 1	3525	31-AUG-23
Frequency	Pressure	0972	29-SEP-23
Frequency	SBE 03 - Temp 2	2400	26-APR-2022
Frequency	SBE 04 - Cond 2	3742	17-AUG-23
Aux 1 - A/D Volt ch 0	WET-Labs Chl-A	1547	4-JAN-16
Aux 1 - A/D Volt ch 1	-	-	-
Aux 2 - A/D Volt ch 2	C-STAR Transmissiometer	CST-1306DR	20-JUL-22
Aux 2 - A/D Volt ch 3	-	-	-
Aux 3 - A/D Volt ch 4	SBE 43 DO - 1	3481	27-SEP-23
Aux 3 - A/D Volt ch 5	SBE 43 DO - 2	1740	08-SEP-23
Aux 4 - A/D Volt ch 6	Altimeter - PSA 916	48701	01-AUG-2010
Aux 4 - A/D Volt ch 7	-	-	-