the Nansen LEGACY

Joint Cruise 2-2 2021

Cruise Report

The Nansen Legacy Report Series 30/2022

Joint cruise 2-2 2021

Cruise 2021710

R/V Kronprins Haakon
Tromsø-Longyearbyen
Aug 24 – Sep 25, 2021

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To be cited as: Agneta Fransson, Bodil Bluhm, Marti Arumi, Karen Assmann, Amalie Marie Bårnås Gravelle, Marius Bratrein, Kenneth Buvik, Melissa Chierichi, Tomsz Cisielski, Anca Cristea, van Khuong Dihn, Wenche Eikrem, Nadjejda Espinel, Jessie Gardner, Christine Gawinski, Zoe Koenig, Øyvind Lundesgaard, Miriam Marquardt, Iliana-Vasiliki Ntinou, Griselda Ortiz, Magne Palmesen, Bonnie Raffel, Nicolas Sanchez, Birte Katarina Schuppe, Arunima Sen, Even Sletteng Garvang, Adam Steer, Camilla Svensen, Anna Vader, Selina Våge, Anette Wold and Amanda Ziegler (2022). Joint cruise 2-2 2021: Cruise report. *The Nansen Legacy Report Series*, 30/2022. DOI: https://doi.org/10.7557/nlrs.6413

ISSN 2703-7525
Publisher: Septentrio Academic Publishing, Tromsø, Norway

Summary

The below fact box summarizes briefly the core coverage of the JC2-2 cruise by area and sample type.

Fact box: Summary of general cruise information and gear deployments during JC2-2. (Note P1 CTD location is excluded).

Category	Specific gear/fact	Information
Start-end date		24 Aug - 26 Sep
Start-end sampling		28 Aug - 22 Sep
		81.46-87.51°N
Bounding box		31.34°E-21.53°W
Distance traveled TOS-LYR		2330 nm
Water depth during sampling		2817-4290
P stations (ca. 48 h - 72 h)		5
NLEG stations (ca. 3 h)		12
Activities logged		236
Hours Polar Bear Guarding		ca. 350
Time in air	Helicopter flights	7 (4 proper), 6 h 20 min
	Drone flights	8
Ice work	Full station (phys, chem, bio)	4
	Physics only	2
	Days with ice work	17
	Ice cores	148
Water/microbe sampling / measurements	CTD with rosette (moon pool)	44
	Distance CTD wire	160 km
	Watersampling bucket surface	4
	Microstructure Sensor casts	82
	Secchi disc	7
	GO-FLO casts	12
	Water volume sampled	5000 L
Plankton sampling (94)	Phytoplankton net 10 μm	17
	Bongo 64 μm	17
	Bongo 180 μm	22
	WP II 64 μm	1
	WP 3 1000 μm	4
	MIK	13
	Multinett Midi 64 μm	10
	Multinett mammoth 180 μm	6
	Multinett Midi 180 μm	4
Vertical flux sampling (15)	Sediment trap to 500 m	5
	Sediment trap under ice	5
	Sediment trap gel	5
Seafloor sampling	Box Core casts	22
Fish sampling	Harstad trawl (modified for ice)	8
	Krill trawl 1723	4
	Polar cod trap	2

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1. Cruise goals

The main scientific goal of the Nansen Legacy JC2-2 cruise was to extend the project's research activities from the northern Barents Sea shelf into the central Arctic Ocean. Specifically, JC2-2 addressed objectives of the research foci RF1, RF2 and RF3 by jointly collecting interdisciplinary samples and data at five process (P) and in-between NLEG stations extending northward from the previously northernmost station P7. We had a special focus on sea ice and the upper ocean as well as connectivity to the mid and deep water column and underlying sediments in early autumn. In addition, JC2-2 explored the role of transport of elements and organisms from the Siberian shelves through the Transpolar Drift in the Amundsen Basin. Experiments were an important part of the cruise and were designed to measure and quantify relevant processes and their rates. The overarching project objectives are summarized in the project proposal and implementation plan. This cruise was also a Norwegian contribution to the international Synoptic Arctic Survey (SAS) and took place at the same time as the Swedish icebreaker Oden was on their SAS expedition in the nearby region between Northeast Greenland and the North Pole.

To achieve our science objectives we collected samples and data to contrast the conditions in the deep Nansen Basin (P7, P8) and in the Amundsen Basin (P10, P11) as well as over the separating Gakkel Ridge (P9) with the earlier Nansen Legacy cruises (Q1-Q4, JC1-2, JC2-1) in the northern Barents Sea (P1-P6). To ensure this connectivity we began at process station P7 as our southernmost station.

Our operational goal was to follow the routines established on earlier Nansen Legacy cruises and to continue to improve collaboration, interdisciplinary research and efficient and safe operations. We followed sampling procedures summarized in protocol version 9.

2. Study area and overview of station plan and sampling

The station plan covered a transect of 2330 km extending from the Nansen Basin NE of the Svalbard slope in the south to the northern side of the Amundsen Basin just south of the Lomonosov Ridge in the north. The geographic bounding box spanned 81.46-87.51°N and 31.34°E-21.53°W and covered a depth range of ca. 2800-4800 m with sampling covering 2817-4290 m. Sampling was conducted between 28 Aug-22 Sep; from 24-27 Aug we were in transit from Tromsø to P7, and between 22-25 Sept from NLEG41 to Longyearbyen.

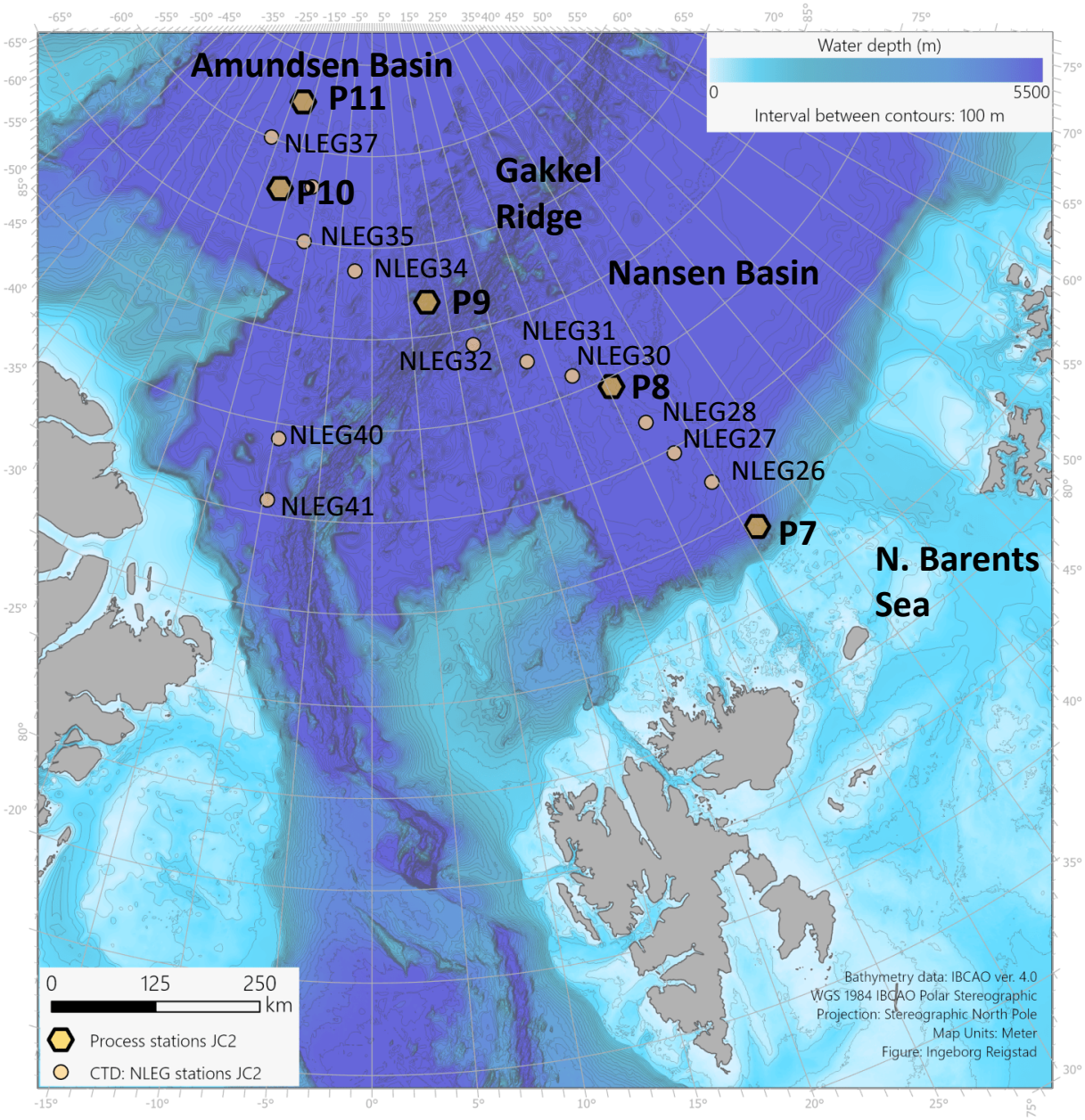


Figure 2-1: Map of study area with process (P) and non-process (NLEG) stations.

The station strategy is based on 5 long P stations that ran for up to 72 h with the full program and 12 shorter (~3 h) NLEG stations with shallower (1500 m) CTDs and water sampling in between P stations (Table 2-1 and Figure 2-1). The distance between

stations was approx. 27-35 nm. During P stations we were parked at an ice floe during the day when we conducted work on sea ice and simultaneously deployed gear either through the moon pool or off the aft deck using the A-frame. During the evenings we left the floe to deploy gear over the side of the ship in open water through the night. During early mornings we returned to our 'parking position' before starting up ice work again. NLEG stations were conducted in leads with either open water or in thin new ice. Trawling was primarily associated with P stations and conducted in nearby leads. A total of ca. 6 hours of helicopter operations distributed over four successful flights complemented sea ice station work when weather conditions allowed.

Table 2-1: Station summary of JC2-2 locations and activities. Station locations are at start/end of first/last gear (not including trawl stations and helicopter flights). Detailed locations for every gear are in Appendix 2.

Station	Date start 2021 UTC	Date end 2021 UTC	Start lat. dec.deg N	Start long. dec. deg E(+)/W(-)	End lat. dec.deg N	End long. dec. deg E(+)/W(-)	Bottom depth (m)	Bottom depth (m)	Region	Program
Transit	24-Aug	28-Aug							Norwegian coast, Barents Sea	Departure from Tromsø and transit to study area
P1	26-Aug	26-Aug	75,9999	31,2213			324		Barents Sea	Attempted glider deployment with CTD at P1
P7/ NLEG25	28-Aug	30-Aug	81,8027	30,8846	81,8096	30,8561	3056	3087	Nansen Basin	Full water column and seafloor station, ca. 48 h
NLEG26	30-Aug	31-Aug	82,4703	29,5359	82,4773	29,4342	3661	3669	Nansen Basin	Upper water column, ca. 3 h
NLEG27	31-Aug	31-Aug	82,9469	27,9103	82,9486	27,7239	3924	3929	Nansen Basin	Upper water column, ca. 3 h, Oden cross-over
NLEG28	31-Aug	31-Aug	83,3821	26,8780	83,3768	26,7109	3983	3983	Nansen Basin	Upper water column, ca. 3 h
P8/ NLEG29	01-Sep	03-Sep	83,8994	25,4114	83,8375	26,1442	4002	4018	Nansen Basin	Full water column, seafloor and ice station, ca. 72 h
NLEG30	04-Sep	04-Sep	84,1782	22,0896	84,1747	22,1440	4013	4014	Nansen Basin	Upper water column, ca. 3 h
NLEG31	05-Sep	05-Sep	84,4960	17,9159	84,5059	18,0049	4014	4013	Nansen Basin	Upper water column, ca. 3 h
NLEG32	05-Sep	05-Sep	84,8254	12,3426	84,8373	12,4203	3719	3642	Gakkel Ridge	Upper water column, ca. 3 h
P9/ NLEG33	06-Sep	08-Sep	85,3707	7,4551	85,5082	4,6302	3573	3563	Gakkel Ridge	Full water column, seafloor and ice station, ca. 72 h
NLEG34	09-Sep	09-Sep	85,7470	-2,5438	85,7472	-2,6794	4166	4160	Gakkel Ridge	Upper water column, ca. 3 h
NLEG35	10-Sep	10-Sep	86,0051	-10,6921	85,9955	-10,7823	4172	4172	Amundsen Basin	Upper water column, ca. 3 h
P10/ NLEG36	11-Sep	13-Sep	86,5052	-16,7077	86,4163	-16,4282	4235	4252	Amundsen Basin	Full water column, seafloor and ice station, ca. 72 h
NLEG37	14-Sep	14-Sep	87,0041	-21,5252	87,0065	-21,3153	4285	4284	Amundsen Basin	Upper water column, ca. 3 h
P11/ NLEG38	15-Sep	18-Sep	87,5009	-17,3716	87,4848	-17,6742	4290	4281	Amundsen Basin	Full water column, seafloor and ice station, ca. 72 h
NLEG39	19-Sep	19-Sep	86,6043	-11,1007	86,6103	-11,0150	4246	4246	Amundsen Basin	Trawls and CTD w/o water
NLEG40	21-Sep	21-Sep	83,8515	-9,5361	83,8381	-9,6387	3568	3545	East Greenland	Upper water column, ca. 3 h
NLEG41	22-Sep	22-Sep	83,1549	-9,6042	83,1399	-9,6377	2817	2904	East Greenland	Upper water column, ca. 3 h
Transit	22-Sep	24-Sep							Fram Strait	Arrival LYR

3. Cruise participants

The JC2-2 science team consisted of a total of 35 participants distributed across RF1, RF2 and RF3 (Table 3-1) in addition to safety and helicopter staff. Researchers comprised physical oceanographers, chemical and biological oceanographers and marine ecologists, grouped into teams 'ocean-ice physics', 'chemistry', 'lower trophic levels/microbes', 'zooplankton' and 'benthos/sediment'.

Table 3-1: Overview of JC2-2 participants with affiliation and roles during the cruise. Team leads are in italics print.

#	Group/Team	Tasks	Last name	First name	RF-RA	Email	Institute
1	Lead	Chief scientist	Fransson	Agneta		agneta.fransson@npolar.no	NPI
2	Lead	co-Chief scientist	Bluhm	Bodil		bodil.bluhm@uit.no	UIT
3	Safety	Safety officer	Hellerud	Eirik		eirik.hellerud@npolar.no	NPI
4	Safety	Bear guard / safety	Lennert	Kunuk		kunuk.lennert@uit.no	UiT
5	Tech support	Helicopter, ice work support	Bratrein	Marius		marius.bratrein@npolar.no	NPI
6	*Ocean-ice*	*phys oce, lead*	*Koenig*	*Zoe*	*RF1*	*zoe.koenig@uib.no*	*NPI/UiB*
7	Ocean-ice	phys oce, lead	Assmann	Karen	RF1	karen.assmann@imr.no	IMR
8	Ocean-ice	sea ice physics	Steer	Adam	RF1	adam.steer@npolar.no	NPI
9	Ocean-ice	sea ice phys, ice obs, remote sensing	Cristea	Anca	RF1	anca.cristea@npolar.no	NPI
10	Ocean-ice	phys oce, lead	Lundesgaard	Øyvind	RF1	oyvind.lundesgaard@npolar.no	NPI
11	*Chem*	*carbon chem, d18O, nutrients (ice, water)*	*Chierici*	*Melissa*	*RF2*	*melissa.chierici@hi.no*	*IMR*
12	Chem	carbon chem, d18O, nutrients (ice, water)	Raffel	Bonnie	RF2	bonnie.ra@icloud.com	NPI
13	Chem	trace metals, Hg, DOM	Sanchez	Nicolas	RF2	nicolas.sanchez@ntnu.no	NTNU
14	Chem	pelagic forams, pteropods, OA	Ortiz	Griselda	RF2	griselda.a.ortiz@uit.no	UiT
15	Chem	trace metals, Hg, DOM	Ciesielski	Tomasz	RF2	tomasz.m.ciesielski@ntnu.no	NTNU
16	*LTL microbes*	*metatranscriptomics metabarcoding, protists ice water*	*Vader*	*Anna*	*RF3*	*anna.vader@unis.no*	*UNIS*
17	LTL microbes	sea ice bio, filtration, water & ice budgets	Marquardt	Miriam	RF3	miriam.marquardt@uit.no	UIT
18	LTL microbes	primary production, PvsI (ice, water)	Arumi	Marti	RF3	marti.a.arumi@uit.no	UiT
19	LTL microbes	metabarcoding, microalgae	Sletteng Garvang	Even	RF3	evengar@student.ibv.uio.no	UiO
20	LTL microbes	metabarcoding, microalgae	Eikrem	Wenche	RF3	wenche.eikrem@niva.no	NIVA
21	LTL microbes	vertical flux, sediment traps	Gardner	Jessie	RF3	jessie.gardner@uit.no	UiT

22	LTL microbes	bact-vir div-prod, grazer experiments	Ntinou	Iliana-Vasiliki	RF3	iliana.ntinou@student.uib.no	UiB
23	LTL microbes	bact-vir div-prod, grazer experiments	Våge	Selina	RF3	Selina.Vage@uib.no	UiB
24	*Zooplankton*	*Zoopl. 180/64 um multi-net*	*Svensen*	*Camilla*	*RF3*	*camilla.svensen@uit.no*	*UiT*
25	Zooplankton	multistress-exp., copepod long-term exp.	Van Dinh	Khuong	RF2	van.k.dinh@ibv.uio.no	UiO
26	Zooplankton	multistress-exp., copepod long-term exp.	Bårnås Gravelle	Amalie Marie	RF2	amgravel@student.ibv.uio.no	UiO
27	Zooplankton	Zoopl. 180/64 um multi-net, experiments	Wold	Anette	RF3	anette.wold@npolar.no	NPI
28	Zooplankon	Zoopl. experiments	Gawinski	Christine	RF3	christine.gawinski@uit.no	UiT
29	Zooplankton	OA experiments zoopl.	Espinel	Nadjejda	RF2	nadjejda.espinel@npolar.no	NPI
30	*Benthos*	*core respirations sediment, sediment parameters*	*Sen*	*Arunima*	*RF3*	*arunima.sen@nord.no*	*UNIS*
31	Benthos	benthic food web, meiofauna sampling	Ziegler	Amanda	RF3	amanda.f.ziegler@uit.no	UiT
32	Benthos	Pelagic fish, sediment sampling	Schuppe	Birte Katarina	RF3	birte.katarina.schuppe@hi.no	IMR
33	Benthos	sediment sampling, palaeo	Lockwood-Ireland	Christine	RF3	Christine.lockwood.ireland@uit.no	UiT
34	Heli team	Pilot	Palmesen	Magne	Heli	magne.palmesen@airlift.no	Airlift
35	Heli team	Technician	Buvik	Kenneth	Heli	kenneth.buvik@airlift.no	Airlift

4. Activity reports RF1 Physical Drivers

Task 4-1 Measure and analyze fluxes of sea ice, water masses, momentum and heat

4.1. Hydrography – CTD measurements

Zoe Koenig (NPI/UiB), Karen Assmann (IMR), Øyvind Lundesgaard (NPI)

The hydrographic work was carried out using a CTD-water sampling package from SeaBird Inc., acquiring data during both down and upcast. The package consisted of a SBE 911plus CTD (underwater unit SBE9plus SN 141612, deck unit SBE11 SN 1121) with sensors listed below in Table 4-1. The Benthos altimeter (200 kHz) allowed profiling close to the bottom. The CTD was equipped with a 24 position SBE 32 Carousel (SN 1222). The rosette was fitted with 24 10-litre bottles for collecting water samples for salinity calibration and for biological and biogeochemical sampling as specified in other parts of this report.

On all stations, the CTD package was lowered through the moonpool. In our preliminary plots we have therefore discarded the top 15 m of the casts, since temperature and salinity profiles show clear signs of being disturbed by the presence of the moonpool and the ship's hull. In total 44 CTD casts were taken, recorded in files sta0464 to sta0050, at 18 separate stations. Casts at NLEG stations covered the upper 1500 m. Multiple casts were performed at process (P) stations to different depths to accommodate the volumes needed for biological and biogeochemical water sampling. At all stations, water samples for salinity calibration were collected at the deepest sampling level. Additional samples for salinity calibration covering the entire cast depth sampled were taken at 11 stations. Station positions are shown in Table 1 and Figure 1. During a CTD cast, the CTD package was lowered into the water for a 1-minute soak before lowering to the bottom. All CTD sensors worked well throughout the cruise. Offset between primary and secondary T and S sensors were in an acceptable range.

Table 4-1. Sensor details installed on the CTD rosette.

Sensor	SN	Calibration/Service date
Temperature	4535	20.02.2020
Conductivity	4386	28.02.2020
Pressure	141612	19.12.2017
Temperature, 2	4306	28.01.2020
Conductivity, 2	2799	28.01.2020
Oxygen, SBE 43	3774	28.02.2020
Altimeter, Benthos PSA-916	73084	24.12.2017
Fluorometer, Wet Labs ECO-AFL	6506	18.09.2020
Transmissiometer, Wet Labs C-Star	2003 DR	01.10.2019
Fluorometer, Wet Labs ECO CDOM	4885	15.08.2019
PAR/Irradiance, Biospherical/Licor	70736	29.10.2018
SPAR, Biospherical/Licor	20568	27.11.2017
RDI WH300 L-ADCP, downward	24474	
RDI WH300 L-ADCP, upward	24472	

Data processing - SBEDataProcessing-Win32, standard Seabird Electronics software for Windows (version 7.26.7.114), is used for post-processing of the CTD data. Only data from downcasts are used to avoid turbulence caused by rosette package on the upcast. Raw data (pressure, temperature and conductivity from dual sensors) are converted to physical units using calibration files modified for air pressure and conductivity slope factor (DATCNV). Outliers, differing more than 2 and 20 standard deviations for the first and second pass, respectively, from the mean of 100 scan windows are flagged and excluded from analysis (WILDEDIT). WILDEDIT flags only the bad data points of each parameter and does not flag the entire scan. The thermal mass effects in the conductivity cell are corrected for (CELLTM, with parameters alpha = 0.03 and 1/beta = 7.0). Pressure is low-pass filtered with a time constant of 0.15 s. Following the SBE recommendation, the conductivity or temperature signals were low-pass filtered. Auxiliary sensors (oxygen, CDOM, flC, Trans) were filtered using a time constant of 0.03 s. Scans when the CTD package moved less than the set minimum fall rate of 0.25 m s^{-1} are flagged to remove pressure reversals due to ship heave (LOOPEDIT). Data are then averaged (BINAVG) into 1-dbar vertical bins and 1-s temporal bins (the latter is for the LADCP data processing). In the final (converted and bin-averaged) data files, temperature is saved using the ITS-90 scale, and salinity on the practical salinity scale (PSS-78). Pressure, temperature, and salinity data are accurate to ±0.5 dbar, $\pm 2\times10^{-3}$ °C, and $\pm 3\times10^{-3}$, respectively.
Conductivity correction from salinity bottle samples – A total of 44 salinity bottle samples from the lowest Niskin and an additional 84 samples from 11 station profiles will be analyzed at IMR with a Guildline Portasal 8410 salinometer. The final version of the CTD data set will include salinities adjusted by the offsets from this analysis.

Preliminary results

Preliminary temperature and salinity sections between P7 and P11 show an Atlantic Water (AW) core that cools northwards as the section leaves the inflowing Svalbard Branch at its southern end (Figure 4-1). A slight AW warming and thickening at P11 may be due to the recirculation of the AW along the Lomonossov Ridge. The AW layer with potential temperatures exceeding 0°C occupies a depth range from roughly 80-150 m to 800 m over most of the section. The Arctic Intermediate Water (AIW) layer below extends to a depth of 1600 – 1800 m using the density surface of $\sigma_{0.5}$ = 30.44 kg m^{-3} to distinguish it from the deep waters that fill the abyss of the Nansen and Amundsen Basins.

North of NLEG27, a layer of cold Polar Surface Water (PSW) with temperatures below -1.5°C occupies the top 80-100 m of the water column (Figures 4-1, 4-2). This layer and the especially the surface freshen as the section crosses the Gakkel Ridge at P9. For these stations the surface mixed layer was generally at the surface freezing point temperature.

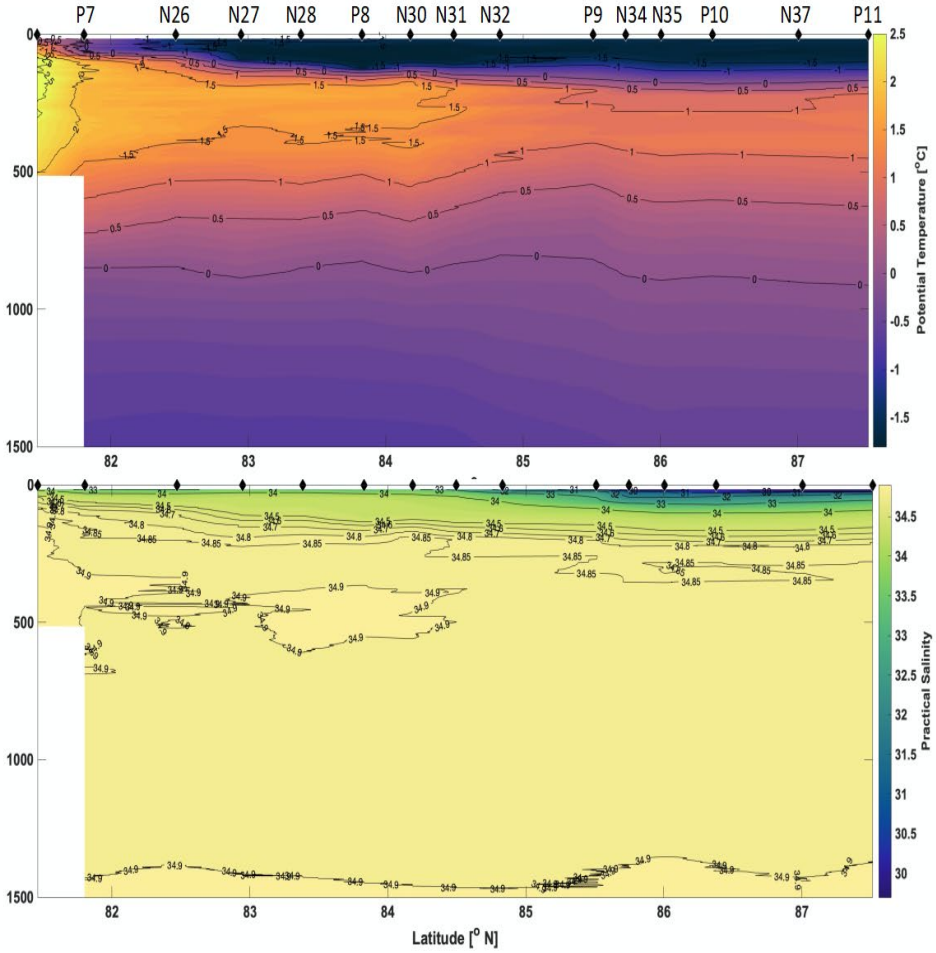


Fig. 4-1. Potential temperature (top) and practical salinity (bottom) in the top 1500 m for the main section from the shelf break north of Svalbard to the northwestern Amundsen Basin. The top 15 m were excluded due to the influence of the moonpool. A CTD cast south of P7 performed to obtain water for sediment traps was included to illustrate the location of the main AW core on the upper continental slope.

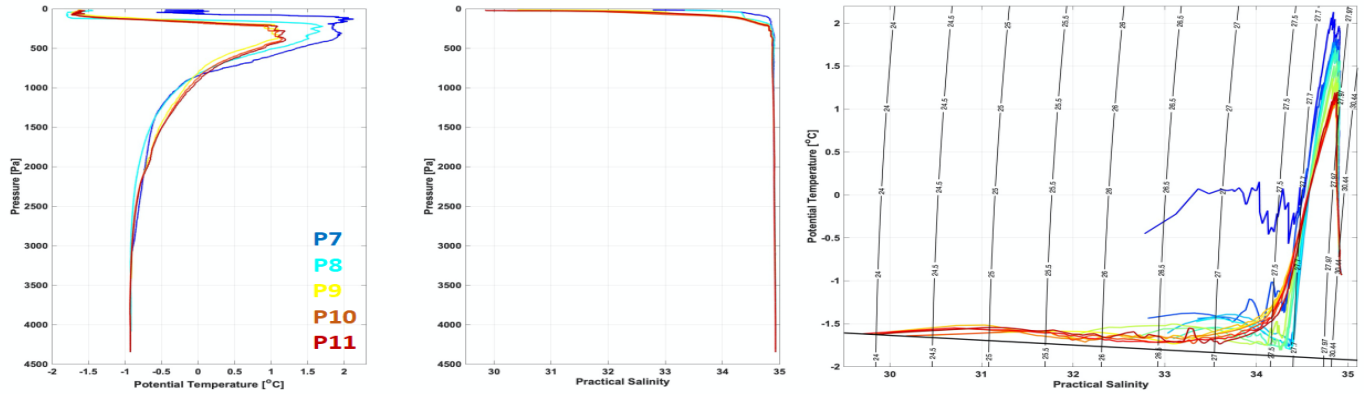


Fig. 4-2: Potential temperature (left) and salinity (centre) profiles for the five P stations. Stations are colour-coded as marked in the left panel. TS-diagram for both P and NLEG stations. NLEG stations in the Nansen Basin up to P9 are shown green and turquoise, those in the Amundsen Basin after P9 are shown in orange and red.

4.2 Underway measurements

Zoe Koenig (NPI/UiB), Karen Assmann (IMR), Øyvind Lundesgaard (NPI)

Weather Station

Weather data were collected continuously by the ship. In addition to these data, weather balloons were launched twice a day during the entire cruise. This frequency was increased to 4 per day on the second day of the ice station to get a better resolution of the high atmosphere / possible temperature inversions.

Thermosalinograph

Thermosalinograph data were collected all along the cruise.

4.3 Current Profiling

Zoe Koenig (NPI/UiB), Karen Assmann (IMR), Øyvind Lundesgaard (NPI)

Lowered-ADCP (LADCP)

Two LADCP-profilers (RD Instruments) were mounted on the CTD rosette to obtain vertical profiles of horizontal currents. The ADCPs are 6000-m rated, 300 kHz Sentinel Workhorses. The units received power from an external battery canister with a housing identical to that of the instruments. All three units are installed on the rosette in a balanced distribution to ensure minimum tilt. Each ADCP has the L-ADCP option installed (firmware v16.3). The ADCPs were configured to sample in master and slave mode to ensure synchronization. The master ADCP pointed downward (SN 24474) and the slave ADCP pointed upward (SN 24472). The compass of each instrument was last calibrated in Tromsø, in their respective orientation in 2018. The resulting compass errors were less than 4°. Because the batteries are in an external canister, we expect the compass calibration to be valid.

In total 31 profiles of LADCP were taken. Communication with the instruments, start & stop of data acquisition and data download were done using the BBTalk software. PC time (UTC) was transferred to each instrument before each cast. The vertical bin size (and pulse length) was set to 8 m for each ADCP. The altimeter worked reliably and no sign of degradation of LADCP data quality was observed.

The LADCP data are processed using the LDEO software version IX-13 based on Visbeck (2002). For each master/slave profile data, synchronized time series of CTD and navigation is used. The NMEA GPS stream is automatically stored in the CTD *.hex files with each scan and are post-processed as 1-s bin averages, same as the ADCP ping rate. LADCP-relevant processing of the CTD data included the identical steps in the SBE-Data Processing software. Additionally, 2-minute time averaged profiles from the 150 kHz SADCP are included for constraint on the inversion of the LADCP data. The SADCP data are obtained from processing of single ping data using CODAS, but before a vigorous editing. The magnetic declination is obtained from https://www.ngdc.noaa.gov/geomag/calculators/ magcalc.shtml, using the WMM (2019-2024) model, at the day and position of the profile.

Shipboard-ADCP (SADCP)
Two ship-mounted RDI Ocean Surveyour ADCPs (38 kHz and 150 kHz) measured ocean currents during the cruise. Both were installed in “Arctic chamber” windows flush with the ship hull (an additional pair of ADCPs mounted in the drop keel was not used during the cruise). Both ADCPs were configured with a bin size of 8 m, and operated in narrowband mode. Blanking distances were 16 m for the 38 kHz and 8 m for the 150 kHz.

ADCP and navigational data were collected by the ship’s VMDAS acquisition system. For preliminary post-processing, single-ping data were converted to UHDAS CODAS format (*currents.soest.hawaii.edu*), water-track calibrated (very small adjustments), manually and automatically edited using UHDAS, and exported to netcdf files available in the *Ocean_Physics* folder of the cruise directory.

Parameters used for preliminary processing of the 150 kHz ADCP include:

Transducer angle: 46.42 degrees
Transducer depth: 10 m (rounded from the 9.66 m of the 2017 Parker Survey report)
Starboard offset xducer_dx: +1 m
Forward offset xducer_dx: +30 m
Ensemble length 300 m
Maximum depth for bottom search: 400 m.
Position feed / heading feed / heading correction: N1R / N2R / N3R

Parameters used for preliminary processing of the 38 kHz ADCP:

Transducer angle: 46.88 degrees
Transducer depth: 10 m
Starboard offset xducer_dx: +1 m
Forward offset xducer_dx: +27 m
Ensemble length 300 m
Maximum depth for bottom search: 400 m.
Position feed / heading feed / heading correction: N1R / N2R / N3R

The manual editing approach was conservative, generally rejecting suspicious data altogether. This included most data collected when travelling in heavy ice, and near-surface bins from parts of the transit through the Barents Sea. Some suspicious data

were left in two particular instances where it was unclear whether the observed currents were artifacts of problematic data or actual ocean signals:

- 08/30 (could show a transit through an anticyclonic eddy north of the Barents Sea slope).
- 22/09 (could show transit through a current system on the way south towards the Fram Strait).

The effective depth reach of the 150 kHz after editing was typically from 26 to 250-300 m in sea ice in the Eurasian Basin, and to >350 m in the Barents Sea. The range of the 38 kHz was ~40 m to >700 m initially, but was reduced to ~120 m to ~600 m in heavy ice (after 09.01).

Occasional gaps exist in the record. On 25.08., there was a period where the 38 kHz did not receive sync signals and therefore did not sample for a period of 4 hours. There was also a later crash in the logging of 38 kHz data, resulting in a data gap from 5/9 18:10 to 6/9 02:58. The processed 150 kHz record also has a number of minor gaps. These may be a result of issues during CODAS processing, or gaps in the navigational feed, but since they comprise a small part of the record, the origins of these gaps have not been investigated further.

Task T1-2 Process studies to investigate the atmospheric, oceanographic, radiative and other physical controls on sea ice and stratification

4.4 Microstructure Profiling

Zoe Koenig (NPI/UiB), Karen Assmann (IMR), Øyvind Lundesgaard (NPI)

Microstructure profiling during the cruise was performed using a Microstructure Sensor Profiler (MSS) by Sea&Sun Technology, Germany. Ocean microstructure measurements were made using two MSS90L profilers (SN 046 and SN054), 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. In addition to these sensors, SN054 was equipped with a chlorophyll a sensor. The shear probes used were SN067 (sensitivity 4.58e-04, SHE1) and SN068 (sensitivity 4.83e-4, SHE2) for SN053 and SN019 (sensitivity 5.13e-4, SHE1) and SN032 (sensitivity 6.551e-4, SHE2) for SN046. The same sensors were used throughout the cruise and 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 ship-board data acquisition system. The first 9 casts were performed using MSS053 and the next one with MSS046 as MSS053 failed after cast 9. MSS053 was used with 5 ring weights. MSS046 was used with 5 ring weights first, and we decreased this number to only 4 in the Amundsen Basin (after cast 59) as in this basin 5 ring weights resulted in a fall speed of more than 0.8 m s^{-1}.

In total 82 casts were attempted (Table 4-2), of whom 58 from the sea ice and 24 from the ship. MSS data reported here are from the processing conducted during the cruise. However, substantial editing and salinity offset correction were performed and the data can be considered ready for analysis. Two different setups of the MSS were implemented, depending on if it was operated from the ship or from the sea ice (Figure 4-3).

Table 4-2 Overview of MSS casts during JC2-2

MSS cast number	Station
1-3	P7
4-5	NLEG26
6-7	NLEG27
8-9	NLEG28
10-21	P8
22-23	NLEG30
24-25	NLEG31
26	NLEG32
27-45	P9
46-47	NLEG34
48-49	NLEG35
50-59	P10
60	NLEG37
61	NLEG38
62-78	P11
79-80	NLEG40
81-82	NLEG41

Profiling from the ship

The deployment of the MSS from the ship was done from the starboard side, from the "small" CTD room. A motor-driven winch was mounted on several pallets 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. One to two casts were performed at each NLEG station down to about 350 m depth. Because of the keel of the ship, the upper 12 m of each cast were excluded from dissipation estimates. Once in the water, we routinely waited up to two minutes until the measured salinity stabilized. The connector to the profiler had to be terminated in the middle of the cruise.

Figure 4-3: Set up of the MSS on board (left, photo: Bodil Bluhm, UiT) and on ice (right, photo: Eirik Hellerud, NPI)

Profiling during ice station

The MSS was operated from the sea ice during every ice station. The MSS was deployed from the ice edge near the lead sampling site, in open water or thin ice (P8-P9-P10), and under about 30 cm of sea ice at P11. At P10, we deployed the MSS one from a water hole close to the ship due to bad visibility. The lead sampling and MSS site were located at least 300 m away from the ship, ensuring sampling of undisturbed waters. A manual winch was set up by the hole. A pop-up tent was installed at P11 over the hole to protect the electronics (data acquisition unit, a laptop and motor power supply) as it was snowing. We tried to collect profiles every day of the ice station, and at different time of the day to cover the inertial variabilities. At P8, equipment had to be left on ice because of a bear visit. The instrument was recovered 8h later while it was -8 outside. The sensors were not damaged.

The MSS temperature data will be compared against the thermosalinograph and the ship CTD data.

Data processing

Processing of the MSS data was performed using routines developed at the University of Bergen and reported in detail elsewhere. Full-scan (1024 Hz) data from all channels of the MSS profiler are edited for transmission errors and spikes, and then averaged to 256 Hz to reduce noise. Time series are converted into vertical wavenumber space using a smooth fall-speed profile. The fall speed is derived from the time derivative of the (2-Hz low passed) pressure record. The dissipation rate of turbulent kinetic energy per unit turbulent kinetic energy per unit mass, ε, is estimated from the isotropic relation $\varepsilon = 7.5\nu\langle u_z^2 \rangle$, where ν is the viscosity of seawater (approximated as a function of temperature) u_z is the shear of the horizontal velocity resolved at cm-scales. Shear wavenumber spectra are calculated using half overlapping 256-point (about 0.7 m) Hanning windows. The shear variance is obtained by integrating the shear wavenumber spectrum between 2 cpm and an upper cutoff number depending on the Kolmogorov wavenumber. The upper cutoff is determined by iteration and is set to maximum 30 cpm (a limitation of the probe size) or 14 cpm when 2-14 cpm integrated $\varepsilon < 2 \times 10^{-8}$ W kg^{-1}. This range is not affected by the narrowband noise peaks. A small correction is applied for the unresolved variance assuming the Nasmyth's form. A further check is employed by comparing dissipation values from both probes, and anomalous data were discarded prior to averaging at 1 m resolution. The noise level measured in quiet regions is about $\sim 10^{-9}$ W kg^{-1}.

CTD data from the precision sensors are low-passed at 10 Hz. Conductivity and temperature records are aligned by advancing one record over the other in -100 to 100 scan range, with unit increments, and obtaining the best advance giving the minimum salinity spiking (result is typically 35 to 50 scans). CTD data are then averaged at 10-cm intervals prior to calculate salinity. Finally, the 10-cm vertical averaged salinity and density profiles are despiked (detecting only large spikes). An overview of preliminary data is shown in Figure 4-4.

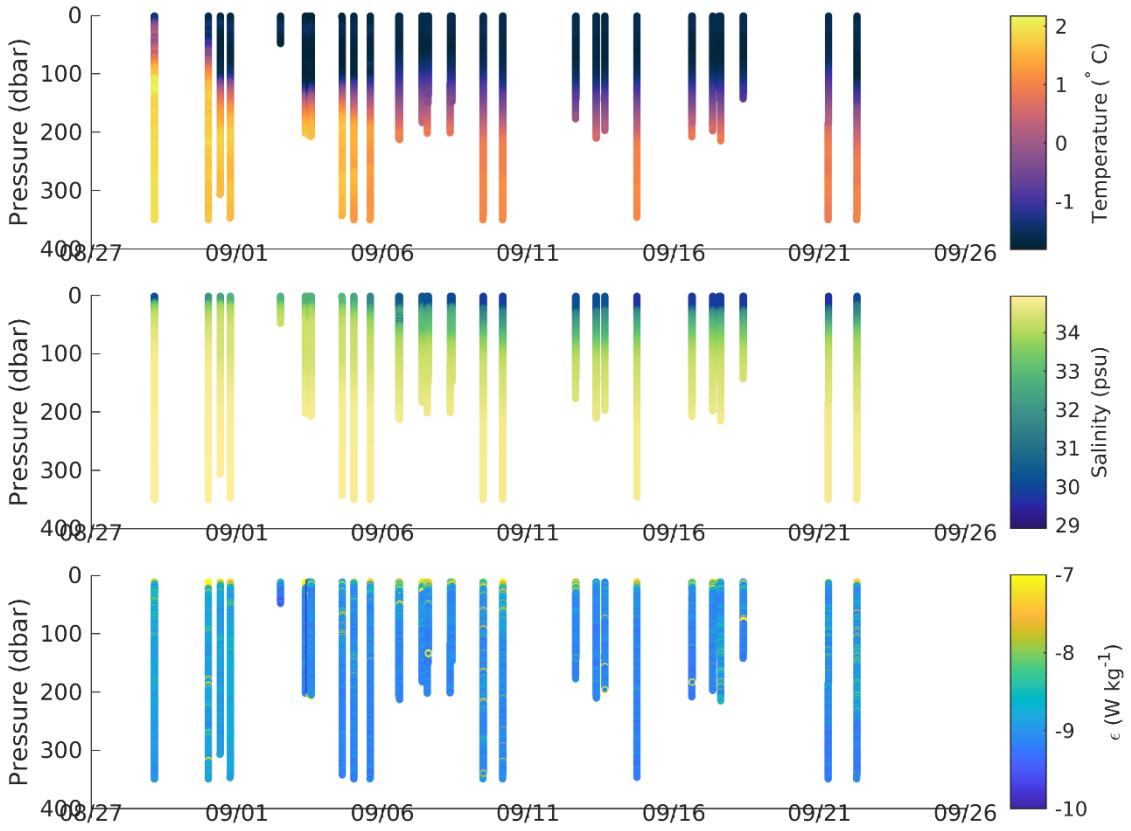


Figure 4-4 Overview of the MSS data collected during JC2-2

4.5 Sea-Ice based Lead Study

Zoe Koenig (NPI/UiB), Karen Assmann (IMR), Øyvind Lundesgaard (NPI)

We conducted process studies focussed on open and re-freezing leads at the process stations P8 – P11 from the sea ice. These process studies employed hydrographic moorings and ADCPs deployed through holes in the sea ice, masts to measure atmospheric fluxes and CTD casts from a kayak and through thin ice areas to document the upper ocean changes that occur during the early autumn freeze up. A summary of deployment times during each of the ice stations is found in Table 4-3.

Table 4-3 Summary of deployments of equipment during lead sampling.

P8		Day 1 AM 01/09/2021	Day 1 PM 01/09/2021	Day 2 AM 02/09/2021	Day 2 PM 02/09/2021	Day 3 AM 03/09/2021	Day 3 PM 03/09/2021
Mooring 1	Near lead 50 m long						
Mooring 2	Far from lead on floe, 20 m long						
RDI 300 kHz	With mooring 1 & atmos mast 1					All recovered at the end of day 2 due to lead closing.	
Signature 1000							
Atmos. Mast 1	With Mooring 1 and RDI 300						
Atmos. Mast 2	Other side of lead						
Fishing Rod CTD							

P9		Day 1 AM 06/09/2021	Day 1 PM 06/09/2021	Day 2 AM 07/09/2021	Day 2 PM 07/09/2021	Day 3 AM 08/09/2021	Day 3 PM 08/09/2021
Mooring 1	Near lead 50 m long						
Mooring 2	Far from lead on floe, 20 m long						
RDI 300 kHz	With mooring 1 & atmos mast SEB1						
Signature 1000	Between mooring 1 & 2						
Atmos. Mast SEB1	With Mooring 1 and RDI 300						
Atmos. Mast SEB2		Not deployed due to lead geometry and heavy ridging on the far side of the lead.					
Fishing Rod CTD							

P10		Day 1 AM 06/09/2021	Day 1 PM 06/09/2021	Day 2 AM 07/09/2021	Day 2 PM 07/09/2021	Day 3 AM 08/09/2021	Day 3 PM 08/09/2021
Mooring 1	Near lead 50 m long						
Mooring 2	Far from lead on floe, 20 m long						
RDI 300 kHz	With mooring 1 & atmos mast SEB1						
Signature 1000	Between mooring 1 & 2						
Atmos. Mast SEB1	With Mooring 1 and RDI 300						
Atmos. Mast SEB2							
Fishing Rod CTD							

P11		Day 1 AM 16/09/2021	Day 1 PM 16/09/2021	Day 2 AM 17/09/2021	Day 2 PM 17/09/2021	Day 3 AM 18/09/2021	Day 3 PM 18/09/2021
Mooring 1	Near thin ice area, 100 m long						
Mooring 2	In thin ice area, 20 m long						
RDI 300 kHz	With mooring 1 & atmos mast SEB1						
Signature 1000	Between mooring 1 & 2, in thin ice						
Atmos. Mast SEB1	With Mooring 1 and RDI 300						
Atmos. Mast SEB2							
Fishing Rod CTD							

Hydrographic Moorings

RBR Concerto (Conductivity/Temperature/Pressure) and RBR Solo (Temperature) sensors were mounted on two separate mooring lines extending from holes in the ice. At all stations, one mooring was placed near a lead on the floe in which the ship was parked. This *primary* mooring had RBR sensors between 2 m and 50 m depth[1], and was further extended to 95 m depth at P10 and P11 (details in Table 4-4). A *secondary,* shallower mooring with sensors between 2 m and 20 m was also deployed some distance away. During P8, P9, and P10, the secondary mooring was located on the same floe as the primary mooring, but inward on the floe and away from the lead at a distance of approximately 100 m. At P11, the secondary mooring was placed in a refreezing lead at the edge of thin new ice. At station P11, two additional Concertos were also mounted in the upper 10 m of the shallow mooring.

All moored RBRs were set to sample at 1 Hz, and data was retrieved using RBR's *Ruskin* software. Instruments were laboratory calibrated pre-cruise in spring 2021. The manufacturer-specified initial accuracy of the RBR sensor measurements are ±0.002 C for temperature and is ±0.003 mS/cm. Preliminary analysis suggests that for some Concerto sensors, there may be an initial period of a few hours during which the conductivity value equilibrates. A direct comparison generally yielded good agreement between the ship CTD and the RBR Concerto which was mounted on the rosette during a calibration cast on 21.09.21.

[1] Nominal depths – more accurate depths will be estimated from the Concerto pressure records.

Table 4-4: Nominal depth of RBR sensors on JC2-2 ice station primary (a) and secondary (b) moorings. Instrument serial numbers in parentheses.

***Primary* RBR moorings**

	Concerto	**Solo**
P8	**2** m (*60600*), **5** m (*60591*), **10** m (*60592*), **20** m (*201407*), **50** m (201402)	**15** m (*102486*), **30** m (*102488*), **40** m (*102475*)
P9	**2** m (*201414*), **5** m (*201402*), **10** m (*60592*), **20** m (*201407*), **50** m (*60591*)	**15** m (*102486*), **30** m (*102488*), **40** m (*102475*)
P10	**2** m (*201414*), **5** m (*201402*), **10** m (*60592*), **20** m (*201407*), **50** m (*60591*), **95** m (*201403*)	**15** m (*102486*), **30** m (*102488*), **40** m (*102475*), **60** m (*102487*), **73** m (*102492*), **86** m (*102477*)
P11	**2** m (*201414*), **5** m (*201402*), **10** m (*60592*), **20** m (*201407*), **50** m (*60591*), **95** m (*201403*)	**15** m (*102486*), **30** m (*102488*), **40** m (*102475*), **60** m (*102487*), **73** m (*102492*), **86** m (*102477*)

***Secondary* RBR moorings**

	Concerto	**Solo**
P8	2 m (*201401*), 5 m (*201413*), 10 m (*201403*), 20 m (*201405*)	15 m (*102476*)
P9	2 m (*201401*), 5 m (*201413*), 10 m (*60600*), 20 m (*201405*)	15 m (*102476*)
P10	2 m (*201401*), 5 m (*201413*), 10 m (*60600*), 20 m (*201405*)	15 m (*102476*)
P11	~1 m (*201412*), 2 m (*201401*), ~3 m (*201411*), 5 m (*201413*), 10 m (*60600*), 20 m (*201405*)	15 m (*102476*)

Moored ADCPs

RDI Workhorse 300 kHz

An ADCP 300kHz from RDI (S/N: 24485) was deployed under the sea ice at each ice station (P9 to P11), at about 20-50m away from the sea ice edge (Figure 4-5). The ADCP was always in close vicinity to a mooring line and to the weather mast. The 3rd beam of the ADCP was facing the lead at each station. The mooring was composed of a wooden beam over a hole. From this wooden beam 2 chains were attached to each side of the ADCP frame prevent the latter one from spinning. The ADCP sampled the upper 50m on average the upper 50m of the water column.

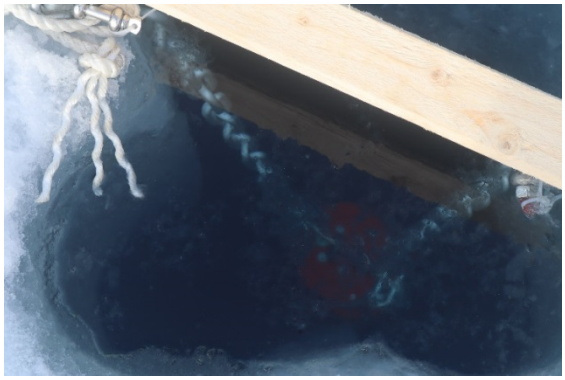


Figure 4-5 Setup of the ADCP 300 on ice

Nortek Signature 1000

At P9, P10 and P11, a Signature Nortek S1000 was deployed just below the sea ice. The ADCP was linked to the surface via a wooden beam. The setup was so that the ADCP could not spin. The x-axis of the ADCP was always pointing towards the lead/open water. At P9 the ADCP was deployed close to the weather mast, at P10 close to the far mooring and at P11 it was deployed under thin ice (about 20 cm thick).

Atmospheric Flux Masts

The ocean observations in and near the leads and thin ice areas were supplemented by atmospheric observations to investigate the surface energy balance, compute fluxes and link changes in the sea ice-ocean system to atmospheric fluxes. Two 2-m masts (Figure 4-6) were loaned from the Geophysical Institute, University of Bergen for this purpose. They were each equipped with a radiometer to measure up- and downward shortwave and longwave radiation, a sonic anemometer to measure turbulent surface fluxes, a LiCor Open Path gas analyser to measure CO2 and water vapour fluxes and temperature and relative humidity sensors. The standard setup of mast SEB1 is shown in Fig. 4-6 for reference and specifications of the instruments are listed at the end of this section.

Mast SEB1 was deployed at the ship side of the lead at each station from P8 to P11. It was generally positioned around 15-20 m from the lead or thin ice and grouped together with the near hydrographic mooring and RDI 300kHz Workhorse ADCP. The sites were around 300 m from the ship and upwind of it at the time of deployment. The sonic anemometer was pointed into the direction of the wind and the radiometer placed on the south side of the mast. Mast SEB 2 was only deployed at P8 on the far side of the lead. At P9 it was not deployed due to strongly ridged sea ice on the far side of the lead. At P10 SEB1 was deployed next to a narrow recently refrozen lead and at P11 next a large area of newly formed sea ice that were too narrow or too wide, respectively to warrant deployment of SEB2.

Atmos. Mast SEB-1 (Ship side of lead):
Campbell Scientific CSAT3 sonic anemometer (u,v,w,Ts)
Li-Cor Li 7500 open path gas analyser
Kipp & Zonen CNR-4 four-component radiation sensor (LWU, LWD, SWU, SWD)
Campbell Scientific ASPTC thermocouple temperature sensor + Rotronic HC2-S relative humidity sensor Campbell Scientific
CR3000 data logger 2m-mast (tripod, mast, attachment parts, booms, guy-wires, ice nails)
Mains power supply (up to 500m cable) + 12 V Battery
GPS + AIS

Atmos. Mast SEB-2 (remote lead side):
Campbell Scientific CSAT3 sonic anemometer (u,v,w,Ts)
Li-Cor Li 7500 open path gas analyser
Kipp & Zonen CNR-1 four-component radiation sensor (LWU, LWD, SWU, SWD)
Campbell Scientific ASPTC thermocouple temperature sensor + PT100 temperature + Rotronic HC2-S relative humidity sensor Campbell Scientific
CR5000 data logger 2m-mast (tripod, mast, attachment parts, booms, guy-wires, ice nails)
12 V Battery
GPS + AIS

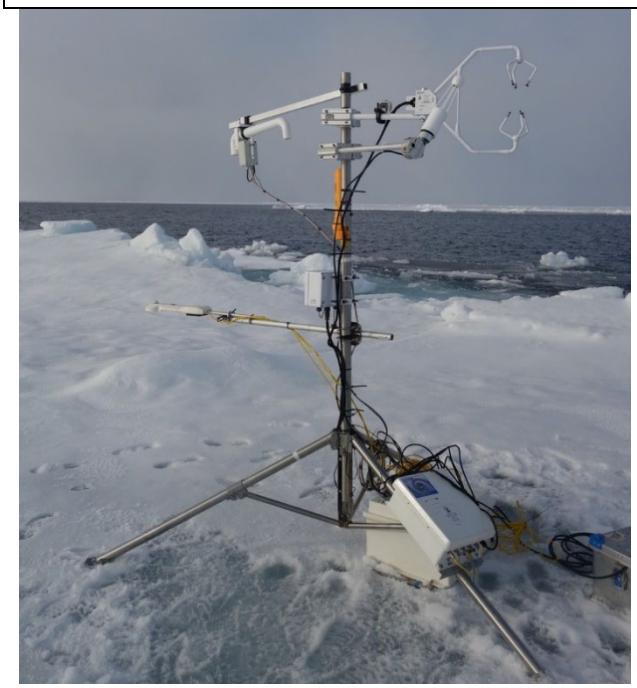


Fig. 4-6 Lead studies: left - Atmospheric Mast/Surface Energy station SEB1 after deployment at P8. To the left of the mast is the temperature/relative humidity sensor at the top and the radiometer about halfway up the mast. To the right at the top of the mast are the sonic anemometer and LiCor. Photo Z. Koenig. Right: Catamaran sampling. Photo: C. Lockwood-Ireland

Catamaran lead sampling

A dual kayak catamaran setup was used to gain access to the lead waters (Figure 4-6). The setup consisted of two ocean kayaks mounted together with a wooden frame including a working platform between the kayaks. This platform was used to collect fishing rod CTD profiles in the lead, and to sample thin ice and upper waters for other research groups. In addition, two RBR Concerto CTDs were suspended from the catamaran, both sampling at 2 Hz. These instruments were suspended on a line, with the upper instrument (S/N 201412) within the top 0.5 m of the water column, and the lower instrument (S/N 201411) one meter below.

The catamaran setup was tested at P8, but proved difficult to use due to newly formed ice in the lead. Instead, fishing rod CTD casts and sample collection were conducted with the use of a single kayak, which could navigate the thin ice more easily. At P9, multiple transects were conducted with the catamaran setup, and several CTD profiles and other measurements were conducted in the middle of the lead while parking the catamaran in thin ice which extended approximately halfway across the lead. The catamaran setup was not used at P10 or P11.

GPS

Geographical coordinates were obtained from Garmin 64s GPS units. GPSs mounted at each of the weather masts were powered by external batteries and sampled at 1 minute intervals. An additional hand-carried unit sampling at 1 second intervals was used to obtain coordinates of moorings and CTD profiles, and positions relative to the primary weather mast was obtained using the *pycurrents.navcalc* Python module.

The GPS unit on the primary mast during station P11 (S/N 25-050 155) had trouble obtaining a GPS fix, and the record from this unit during the first station day is incomplete and rather noisy. After day 2, the unit was replaced, and the record from the following period is complete and appears well-behaved.

Fishing Rod CTD

An RBR Concerto (S/N 201410) was attached to a fishing rod to obtain upper ocean temperature and salinity profiles during the sea ice stations to supplement records from the moored instruments. The instrument was set up to sample continuously at 2 Hz during the casts. Casts were performed through mooring holes, thin ice areas and from the kayak catamaran and are summarised in Table 4-5 below.

RBR Concerto (S/N 201410) was attached to the ship-board CTD during CTD cast 506 on 21 September 2021 for calibration. We aimed to take CTD casts through each mooring hole at deployment and recovery. Casts were made from either a single kayak at P8 or the kayak catamaran at P9 where there was open water or sea ice thin enough to use them.

Table 4-5 Summary of fishing rod CTD casts conducted from leads.

NLEG27 Mini-ice station

Date	Time	GPS Position	Max. Pressure	Notes
31/08/2021	07:37		55 dbar	Test site, coring hole
	07:45		60 dbar	Test site, coring hole
	08:01		75 dbar	Test site, coring hole

P8

Date	Time	GPS Position	Max. Pressure	Notes
01/09/2021	08:35:00		170 dbar	Near mooring
	11:31:00		110 dbar	Far mooring
02/09/2021	09:09:00		90 dbar	Kayak (centre of lead)
	11:36:00	83.8367N, 25.0263E	85 dbar	Kayak (far edge of lead)
	11:48:00	83.8362N, 25.0375E	85 dbar	Kayak (centre of lead)
	11:58:00	83.8359N, 25.0470E	85 dbar	Kayak (close edge of lead)

P9

Date	Time	GPS Position	Max. Pressure	Notes
06/09/2021	09:15		130 dbar	Near mooring
	11:33		130 dbar	Far mooring
	12:26	85.4008N, 7.5107E	60 dbar	Kayak (centre of lead)
	13:31	85.4044N, 7.5430E	48 dbar	Kayak (centre of lead)
	14:12	85.4061N, 7.5552E	55 dbar	Kayak (centre of lead)
07/09/2021	08:18	85.5101N, 7.1210E	75 dbar	Kayak (centre of lead)
	11:55	85.5343N, 7.0584E	75 dbar	Kayak (centre of lead)
	13:36	85.5379N, 7.0405E	65 dbar	Kayak (centre of lead)
08/09/2021	07:20	85.5504N, 5.8454E	85 dbar	Kayak (close edge of lead)
	11:50		120 dbar	Far mooring
	12:06		115 dbar	Near mooring

P10

Date	Time	GPS Position	Max. Pressure	Notes
11/09/2021	08:54		116 dbar	Near mooring
	11:51	86.4775N, -16.6289E	102 dbar	Far mooring

P11

Date	Time	GPS Position	Max. Pressure	Notes
16/09/2021	12:24:00		96 dbar	Thin ice mooring
	12:39:00		130 dbar	Mooring at mast
17/09/2021	08:08:00		132 dbar	Near thin ice mooring
	12:43:00		113 dbar	MSS hole
18/09/2021	13:32:00		107 dbar	RDI 300 ADCP hole

4.6 Autonomous platforms

Zoe Koenig (NPI/UiB), Karen Assmann (IMR), Øyvind Lundesgaard (NPI)

IAOOS platform

An autonomous IAOOS platform (Ice Atmosphere Ocean Observing System) was deployed at P10 (Figure 4-7). The platform is equipped with:

- a tethered argo float from NKE profiling twice a day on a 350m long wired
- an ice mass balance from SAMS composed of a 5m thermistor string going through the air, the sea ice and the upper ocean.
- a temperature sensor
- an iridium mast

Deployment was done on the main ice floe, on ice of about 1.20 m thick, in a level part of the floe and about 250 m away from the ship. The IMB was deployed on bare ice

after removal of the snow and the slush created by the drilling of the hole to deploy the profiler.

Figure 4-7 Deployment of the IAOOS platform (photos: Eirik Hellerud)

Ice Mass Balance

An ice Mass Balance (IMB) from the Scottish Association of Marine Science was deployed at P11, on the floe where the sediment trap was installed, about 700m-1km away from the main floe and separated from it by a large lead (Figure 4-8). The IMB thermistor had to be fixed because of damage. The upper 24 sensors had to be removed.

Level ice, more than 30m from nearest ridge or vertical structure was chosen. Ice thickness in the two measured holes were 149cm and 156cm. Snow thickness was between 5-30cm as observed during the walk from the ship to the buoy site, deepest snow was in refrozen cracks and melt ponds. Snow thickness measured in the drill holes was 13cm, and 11cm. No cores were taken on the SIMBA floe. The general area consisted of solid, thick (1-1.5m) ice, sometimes thicker, many refrozen melt ponds and leads, with a snow on top (5-20cm). The ice seemed fairly dry/hard for the first 70-80 cm, the lower parts were slushy. Large (2-3m vertically) ridges were in the general areal, but also large (100-500m diameter) areas of "normal" ice (non-ridged). A "test hole" was drilled and measure before and after snow-removal to get an accurate measure of freeboard.It was hard to read freeboard in the hole for the thermistor string because of the snow on top of the ice. A thermistor hole was drilled 1m away from the "test hole" in undisturbed snow.

Test hole:
Bottom of ice <----> top of snow: 156 cm
Bottom of ice <----> top of ice: 143 cm
Bottom of ice <----> water line: 124 cm

Thermistor hole:
Bottom of ice <----> top of snow: 160 cm
Bottom of ice <----> top of ice: 149 cm

The pelicase was put on top of red floatation "donut" which was attached to 3 wood (48x48) stakes in the ice with large metal links and rope to allow for buoy to slide up and down 30-40cm in case of melt ponds etc. The pelicase was tied to a float.

Figure 4-8 Deployment of the Ice Mass Balance site at P11 (photos: Marius Bratrein)

4.7 Sea ice physical properties summary

Adam Steer (NPI), Anca Cristea (NPI)

The sea ice physics program on the Nansen Legacy JC2-2 /Polhavet cruise in 2021 made observations at 6 locations from the Nansen basin to the Amundsen basin, alongside ASSIST shipborne ice observations while in transit through ice-covered waters. These were aimed at addressing tasks T1.1-1.2, and T1-2.2 – investigating the regional and local scale structure and variability of sea.

At each station the Nansen Legacy standard protocol for ice coring and basic snow description was completed. At P8, P9, P10 and P11 long transects with the GEM2 multi frequency electromagnetic induction sounder and Magnaprobe snow depth probe were conducted (Figure 4-9) . Drone flights were undertaken with the aim of capturing local topography at high resolution, filling in gaps between the coarse GEM2 + Magnaprobe grids. At P9, P10 and P11 ‘mini ridge’ studies were undertaken, collecting GEM2, Magnaprobe and snow observations across small ridges.

Each P station observed a progression from open melt ponds to increasingly refrozen ice, although in general there was not a progression in thickness.

Ice coring

The Nansen Legacy coring program was carried out at all P stations, NLEG27 and at an opportunistic point between NLEG40 and NLEG41 (NLEG40.5). This followed the Nansen Legacy sampling protocol V9, with the chemistry team collecting temperature profiles at all P stations.

GEM2 snow and ice thickness soundings

An electromagnetic sounding instrument (Geophex GEM-2) was towed on a Fjellpulken transporter sled by foot or ski to obtain measurements of total snow and ice thickness at each P station. Transect patterns aimed to 'paint in' an ice floe as much as possible given time and personnel constraints, although some stations only permitted long, straight lines.

Each long transect line aimed to capture the variability present on the floe, so patterns are not necessarily straight lines or regular polygons, but more 'where should we walk to represent everything we see here'. Line crossings were also a design feature, aiming to cross-check each line against the other with at least one common reference point. This was not always possible, but done when conditions permitted.

A small strategy change was made on JC2-2, by towing two sleds as we walked – the second containing a few 2" auger flights, a drill, shovel, ice thickness gauge and drone. This gave us some flexibility to sample ice directly if we found an interesting place, or take advantage of shorter periods of visibility to make drone flights. On P9 and P11 we made short drill hole transects of 5 holes roughly 5 meters apart, by walking back along the GEM2 track. This way we have some in field validation of the GEM2 data. We did not fly the drone while on transect, because the idea of getting small visibility windows did not work out. While towing a little extra gear is more work, we felt it was a valuable strategy and should be considered on future trips.

Figure 4-9 Snow and ice thickness soundings using a Magnaprobe and Geophex GEM-2 instrument, respectively. Photo: C. Lockwood-Ireland.

The GEM2 ski was calibrated once at each station using a ladder calibration, measuring lines as we raised the instrument up a wooden ladder from step to step.

On JC2-2 we had persistent technical issues with the GEM2 instrument disconnecting from the controller. This will be investigated in Tromsø. Preliminary data are not available yet because of instrument issues.

Finally, a new GEM2 (GEM2-632) was calibrated alongside the GEM2-531 at P10 and P11, with a short repeat transect made with both instruments at P10. This process should identify any offsets between the two instruments.

Snow depth observations using Magnaprobe

Along the same track as EM surveys, snow depth observations were made using a Snowhydro Magnaprobe (NPI-1). On JC2-2 the magnaprobe also had persistent issues with the sliding disk becoming stuck, and an auto-logging problem possibly related to a short circuit in the cable connecting the probe to the backpack. Preliminary data are unreliable and will need intensive cleaning.

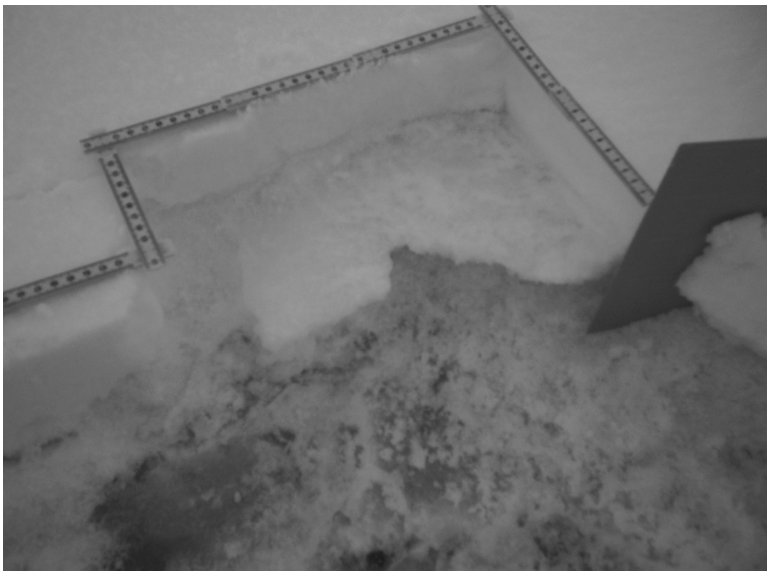
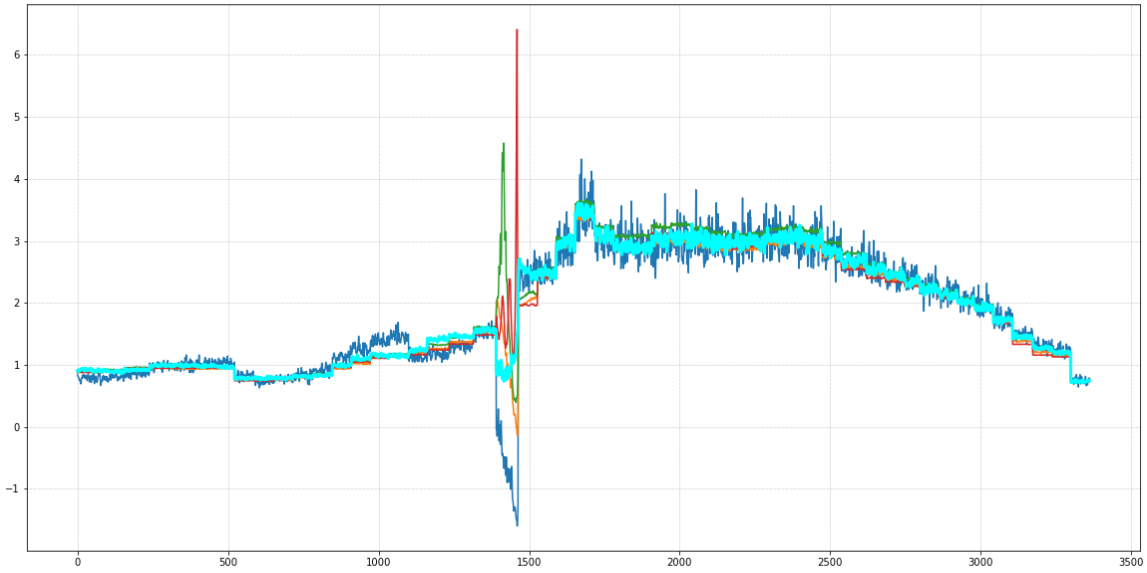


Figure 4-10 Example of a snow pit studied at P10.

Snow observations

At NLEG27, P8, P9, P10 and P11, analytical snowpits (Figure 4-10) were made on the main coring site. Depth, temperature profile, structure, density and salinity were measured.

A small near-infrared camera was used to capture snowpit walls on P10, these images will be assessed for useability for snow grain size analysis



Ridge transects

Sea ice ridge transects were taken at P10 and P11 by the two sea ice physics team members as well as a number of volunteers from the other teams. This involved GEM2 + magnaprobe surveys at 1m spacing. Due to some time restrictions, only one ridge was sampled at each station. Drill hole observations, attempting to gain a view of ridge internal structure, were also made along these transects. A sample GEM2 multi frequency plot of distance from the instrument to seawater is given below. Note that this ridge transect did not seem to show much internal structure, it seemed quite consolidated.

Aerial imagery using a small drone

Drone flights for sea ice mapping were made at every station, a preliminary map from P8 is given below. From these images we aim to examine local melt pond size and distribution, ridge fraction, and eventually topographic feature analysis from the terrain underlying these maps. The strategy of recalibrating the aircraft before flight developed on Q1 went well, with no out-of-control flight issues.

ASSIST observations

A three hourly schedule was set up for ASSIST ship-based sea ice observations using the RF1 team and volunteers from the ships complement. Due to other work demands, some scheduled slots lack observations. At ice stations, no observations were made.

Figure 4-11 Ridge transect showing number of measurements across the ridge on the x-axis and height of the ridge in meters on the y-axis.

High resolution radar imagery

Radarsat-2 Fine-Quad mode SAR scenes (30x30km , with ~5m horizontal resolution) were ordered for P8, P9, P10 and P11. Unfortunately, the two P9 scenes were ordered at the wrong location because the station location was changed after the scenes had been ordered. The orders are centered on the geographical coordinates of the stations and do in the cases of P8, P10 and P11 cover the sampled ice floes (e.g. Figure 4-12). The scene acquired at P8 covers approximately the same sea ice covered by the previous day's HEM flight. See below for an overview of the ship track and image coverage at P8.

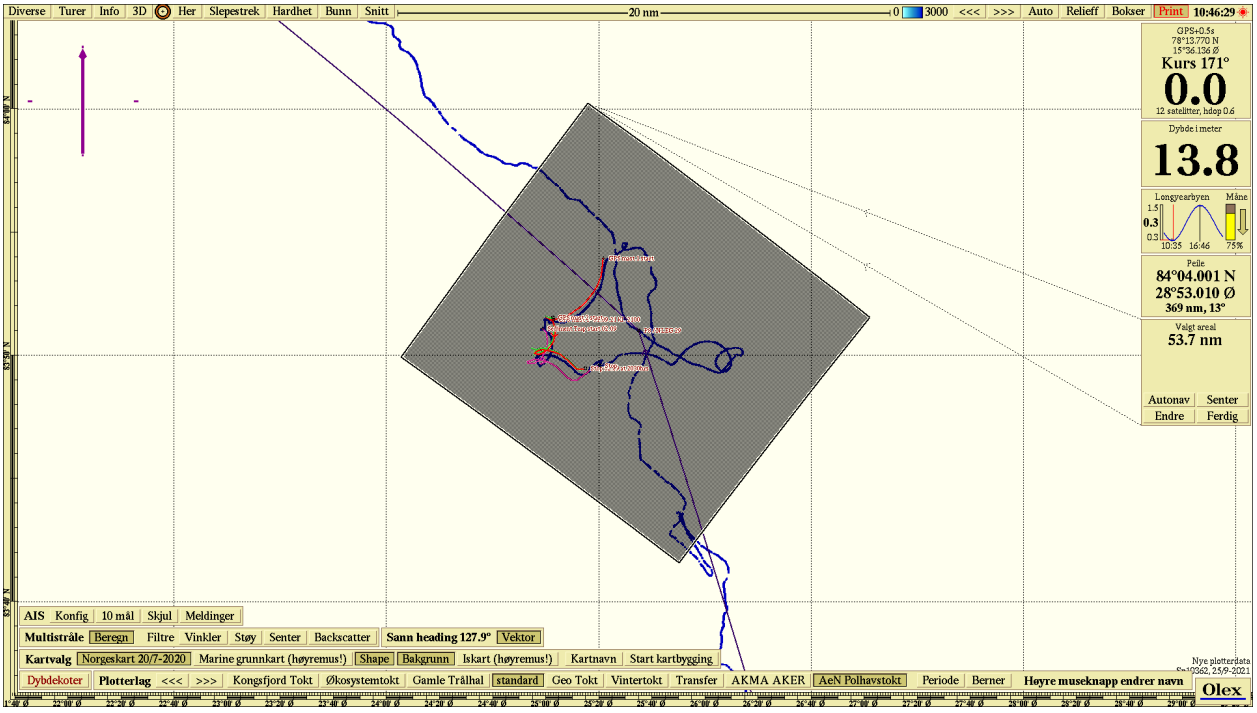


Figure 4-12 Example of radarsat bounding box ordered to match in situ sampling.

Field management and safety

The sea ice physics team could not operate as independently as desired. The physics team needs to move around in a relatively lightweight fashion while the IMR regulation of needing to wear regatta suits led to becoming soaked with sweat particularly on transects. Most stations on JC2-2 were conducted on solid, 1m+ sea ice with melt ponds refrozen enough to walk safely over. An exception was P8, which had freshly refrozen ponds. Here, it should be noted that the sea ice transect team proactively elected to use viking survival suits. At all other sites, on the main ice floe there was no risk of falling into the sea. Use of snow machines was appreciated, however setting any precedent of heavy snow machine reliance is a little concerning. We suggest that in future there should be consideration made to more specialised 'far site' operations on sea ice, with more training (minimum NPI rifle course and standard first aid, ideally wilderness first aid/first responder, additional training for interaction with wildlife) available for people whose work takes them some distance from the ship. Another idea might be the use of amphibious pulks for equipment towing on transects, if there is concern about ship separation. This also relates back to the choice of field wear – long separations from the ship are much better handled if we are not left wet through by inflexible clothing choices. It would also be great to review IMR guidelines for operations on sea ice – since we now have 3 cruises with teams venturing far from the

ship, and some experience from those to consider. Overall we do not want to be loaded with even more gear – we think that just like operating in the mountains, there is a line to walk where we can stay safe for the time required (hours to a full day) with a minimalist set of required equipment.

Helicopter flights and ice thickness measurements
Marius Bratrein (NPI), Magne Palmesen (Airlift), Kenneth (Airlift)

A total of 7 flights were conducted of which two were canceled shortly after take-off due to fog. Approximately 8:30 hrs of flying time covered 845 km of flight tracks.

Weather conditions were challenging. Cold air temperature combined with a lot of moisture in the air generated freezing conditions quite often. Fog would often appear out of nowhere due to small temperature changes. During one flight, an 8°C degree temperature inversion was observed between measurement altitude (15m, -10°C) and calibration altitude (120m, -2°C). An instrument measuring electromagnetic signals, a so-called EM Bird, was attached to the helicopter for ice thickness measurements on a larger/broader scale (Figure 4-13).

Figure 4-13 Helicopter operations (left) using an EM bird (right) for sea ice thickness measurements. Photos: Bodil Bluhm (UiT).

5. Activity reports RF2 Human Impact

5.1 T2-1-1 Current variability and drivers of ocean acidification, and Arctic Ocean CO_2 uptake

Onboard: Melissa Chierici (IMR), Bonnie Raffel (NPI) and Agneta Fransson (NPI)
On-land Team: Elizabeth Jones (IMR), Helene H Lødemel (IMR), Claire Mourgues (IMR), Ylva Ericson (NPI).

Summary and objectives

Our focus was to investigate carbonate and nutrient chemistry for the study of ocean acidification and inorganic carbon cycle in the surface water, water column and sea ice environment (snow, brine, melt ponds) in the Arctic Basins. The Nansen and Amundsen basins are both influenced by anthropogenic CO_2 in the upper 1000 m and one of the objectives was to investigate progressing anthropogenic CO_2 and ocean acidification. Another aim was to study the influence of the transported carbon in the Transpolar Drift in the upper water column in these basins and relate to observations in the Fram Strait. We also sampled sea ice, melt ponds and under ice water for studies of sea ice biogeochemistry focusing on ikaite ($CaCO_3$ formation), air-ice-water CO_2 exchange and main drivers of variability in inorganic carbon and nutrients. Samples collected for analysis of the oxygen isotopic ratio will be used to estimate the amount and type of freshwater in the sea ice and water column. Different types of ice were collected such as MYI, recently formed ice, thin ice and FYI. For studies of diurnal variability below the ice cover we deployed sensors for pCO_2 (Hydro-C, Contros), dissolved oxygen (SBE-37-ODO, Microcat with S,T,P and DO). We sampled the water column from the all stations from Niskin bottles on CTD-Rosette (24 bottles) at all P and NLEG stations (including P1), and sea ice (ice cores) from all P stations. In addition to CTD the frame carried sensors for dissolved oxygen, CDOM, chlorophyll fluorescence, PAR and transmissivity. The samples were analysed within 48 hours (usually within 24-hours) onboard for the determination of the carbonate chemistry (total alkalinity (AT), total inorganic carbon (DIC), pH and dissolved oxygen (DO using Winkler). In addition, we sampled nutrients and oxygen isotopes ($\delta^{18}O$) for post-cruise analyses on all samples. At selected depths (~6 depths) and stations we sampled CDOM post-cruise analyses (Mats Granskog, NPI, RF1).

<u>Water column sampling and methods</u>

A total of 18 casts for analyses of carbonate chemistry (onboard) and nutrients and $\delta^{18}O$ for storage and post-cruise analysis. Sampling was performed and analysis followed the protocol described in *Nansen Legacy Sampling Protocol version 9, chapter 8.2 and Dickson et al., 2007.* The samples for carbonate chemistry were sampled first or directly after dissolved oxygen (DO) samples were analysed within 24-hours, and DO within 12 hours in most cases.

Standard depths were (in m): Bottom-10, 3500, 3000, 2500, 2000, 1750, 1500, 1250, 1000, 750, 500, 300, 200, 150, 120, 90, 60, 50, 40, 30, 15 (moon pool was used thus 15 m was upper limit). CDOM was sampled at the deepest and at 90, 60, 50, chl max, 20, 15 m, at NL41 also at 120 m. We will use data from the CDOM sensor to investigate the CDOM signal and potential influence of terrestrial organic matter transported in TPD (Øyvind Lundesgaard (NPI, RF1, initiated analysis).

DO was analysed using Winkler titration for water samples at 8 stations (NL26, NL27, NL28, NL30, NL34, P8, P9, P11, total of 142 analyses). Samples for inorganic nutrients (nitrate, phosphate, silicic acid) were preserved with chloroform and stored cool and dark for post-cruise analyses at IMR in Bergen. Also, the samples for $\delta^{18}O$ was stored and analysed post-cruise. The nutrient and $\delta^{18}O$ sampling also followed version 9 of the protocol.

Sea ice sampling and methods

At five sea ice stations (P7, P8, P9, P10 and P11), sea ice cores (6+backup cores), melt ponds (12), snow (7 samples) and 10 thin ice samples from lead, water in hole (0.5m, 2m, 5m, 10m) and lead water (uiw, 2, 5, 10, 15m) were collected (Table 1). Water samples taken on the ice was taken from a Niskin bottle (wih) and a Limnos sampler (lead). Temperature was measured in the ice core and in the sample bottles on site immediately after sampling. Ice cores were sliced into 10-cm pieces from the sea-ice top (snow-air interface to the ice-seawater interface) and melted in airtight bags and analysed for salinity, AT, DIC, and pH on board. Samples for $\delta^{18}O$ and nutrients were preserved and stored cool and dark as for seawater samples. At all stations snow and ice thickness, freeboard, temperatures in air, snow and sea-ice were measured. A total of 9 sea ice cores were sampled with lengths ranging from 97 cm to 183 cm likely spanning second year ice, as well as multi-year ice, based on salinity and temperature profiles. Sea ice sampling followed the protocol described in Version 9.

Analytical methods (Described in NL Protocol, Dickson et al., 2007)

DIC: gas extraction of acidified seawater with photometric detection and coulometric titration (VINDTA).
AT: Potentiometric titration in open cell using 0.05 N hydrochloric acid (Metrohm system)
pH: spectrophotometric measurement using 2 mM m-cresol purple indicator dye (Cary Diode Array)
DO: Winkler followed by amperometric titration (Metrohm system, Karl Fischer titration)

More than 1000 seawater (water column and under ice water) were sampled and about 1350 analyses were performed (including analyses of sea ice melt). Table 5-1 summarizes the sampled sea ice cores and Figures 1 to 4 show preliminary data from sea ice and water column.

Table 5-1: Sea ice station overview for the sea ice chemistry studies.

Station	Sample Type	Ice thickness [cm]	Freeboard [cm]	Snow thickness [cm]
P8	Chemical core	97	8	3,4,3
P8	Backup/Temperature core	97	8	3,4,4
P8	Chemical core II (from Adam Steer)	173	22	3.5,4,5
P8	3 Meltponds, 1 Snow sample,1 thin ice sample, 4 under ice water samples, 2 under ice water samples from lead			
P9	Chemical core	183	23	4.5,6,7
P9	Backup/Temperature core	183	14	4
P9	3 Meltponds, 1 snow sample, 4 under ice water samples, 4 under ice water samples from lead, 1 thin ice sample from lead, 1 pancake ice sample from MSS hole			
P10	Chemical core	108	13	9,10,10.5
P10	Backup/Temperature core	99	9	13.5,13,15
P10	3 Meltponds, 3 snow samples, 4 under ice water samples, 2 thin ice samples from lead			
P11	Chemical core	147	20	6.5,6,6
P11	Backup/Temperature core	144	20	7,8.5,6
P11	3 Meltponds, 2 snow samples, 4 under ice water samples, 5 under ice water samples from lead, 3 thin ice samples from lead, 2 short ice cores from lead (19cm)			

Underway surface water measurements: Surface water oxygen, CO_2 and air-sea CO_2 exchange

The underway instrumentation for autonomous high-frequency surface water measurements of partial pressure of CO_2, pCO_2, (General Oceanics) and dissolved oxygen (DO) (Aanderaa sensor) was maintained after a short repair and ran well in open water. In ice covered waters the underway seawater system is pumped from the Drop Keel "moonpool" basin, meaning that the water exchange is not as efficient, and the temperature is higher than in the general seawater intake used in open water. Thus, we are unsure about the quality of the pCO_2 and O_2 measurements in ice covered waters. We sampled the same water and performed analysis onboard for quality checks and consistency control. After cruise pCO_2 And O_2 calculations requires corrections using a combination of files from the TSG (sea temp 2 is faulty), files from the drop keel "senkekjøls-filer", and the surface seawater temperature from the meteorology files. On the 23rd September, at about 81°N, 2°W, we entered into open water again and the seawater intake was changed back to the 4 m seawater intake system, thus normal data calculation routines for surface pCO_2 can be followed after this.

Under ice pCO_2 and DO measurements on P stations

Two deployments of pCO2 and DO (+S,T,P) were performed, both at approximately 1 meter below the sea ice bottom at about 3 m depth (Figure 5-1). The first one took place at P9 (only pCO2 sensor) for ~24-hours between 7 September (14:00 UTC) 8 September (11:40 UTC) below the ice at in the sediment trap hole after that one was retrieved on the 2nd ice day. The second deployment (pCO_2 and Microcat) was performed for nearly 48-hours under the ice near the lead site at P10 between 11 (1700 UTC) to 13 September (12:00 UTC) (Figure 5-2).

Figure 5-1. The retrieval of the pCO_2 and DO sensors from the lead site on the 13th September (to the right on the sled). Bonnie Raffel was performing the retrieval with Marius Bratrein (also photographer).

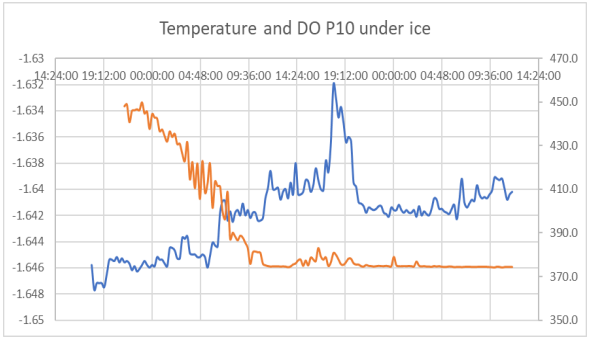


Figure 5-2. Preliminary data from under the ice showing the temperature (°C, blue line, left axis) and dissolved oxygen concentration (µmol/kg, orange line, right axis) from the 11 to 13th September, near the lead site (about 300 m away from the ship).

Carbonate chemistry in experiments for ocean acidification effect studies

Carbonate chemistry measurements were also performed samples taken from experiments aiming to investigate ocean acidification effects on *Calanus* and *Foraminifera* jointly with Nadjejda and Griselda (RF2 T2.1.3, T2.1.4, T2.2). These experiments are described in detail in a separate chapter.

Total Dissolved Inorganic carbon for primary production (PP) incubation measurements

Samples were collected on shallow CTDs for DIC to give information to PP measurements (incubations) performed by Marti (RF3).

Preliminary results

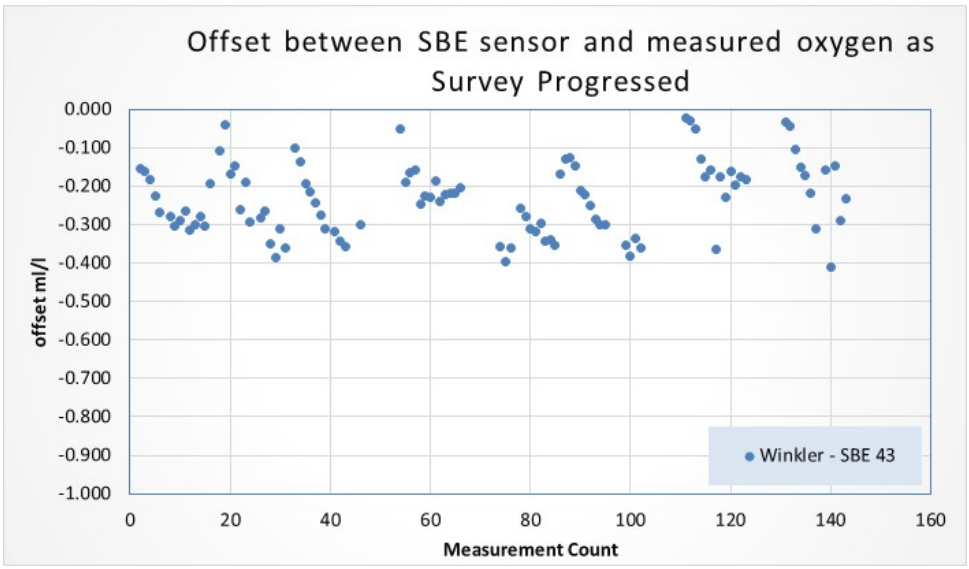
Comparison between Dissolved oxygen concentrations between measured by Winkler titrations and the CTD-O2 sensor (SBE) including drift check

On 8 stations (total of 142 analysis) we sampled the same depths as for ATDICpH and analysed DO using Metrohm Ti- system with platinum electrode for Winkler titration (amperometric titration). Values were compared with the values from the oxygen sensor on the CTD and we performed a drift check according to the Seabird the

following: *From Sea-Bird: The main term of interest for correcting fouling drift is the Soc term in the SBE 43 sensor calibration equation:*

$$Oxygen(ml / l) = Soc * (V + Voffset) * \varphi$$

The results from this calculation show that the drift is about -2.0%, thus there is no need for drift correction, and the progress of the offset between sensor and Winkler is seen below (Figure 5-3)



	Last Cal SN3774 28 feb 2020, instale march 2021	
Report	143	Total number of dissolved oxygen samples measured for validation
	0.9802	Mean of the Correction Ratio (Winkler / SBE 43)
	0.5797	Previous*Soc* for SBE43 SN 3255 (from .btl file)
	0.5682	New*Soc* = Previous*Soc**(Winkler / SBE 43)
Report	-2.0 %	% drift from original Soc calibration
		% drift from your survey's first day's Correction Ratio to its last
Report	4348	Greatest depth water samples were collected for DO validation
	Drift outside ±15%. Apply correction. Remove sensor.	
	Drift outside ±10%. Apply correction. Order/get a new sensor on board and repla	
	Drift outside ±5% but inside ±10%. Apply correction.	
	Drift within ±5%. No correction needed.	
From Sea-Bird: The main term of interest for correcting fouling drift is the *Soc* term in the SBE 43 sensor calibration equation: *Oxygen(ml / l) = Soc * (V + Voffset) * φ*		
***Soc* is the linear slope scaling coefifficent**		
Since *Oxygen (ml/l)* and the *Soc* are proportional to each other in the above equation, when a drift exceeds 5%, we can simply multiple the SBE43 Oxygen (ml/l) sensor data by the Correction Ratio determined from the Winkler titrations.		
"Note that the SBE 43 drifts in slope, not offset. This means that applying a simple offset to DO data in a given range of values (e.g., 5-6 ml/L) will give incorrect results in a different range (e.g., 4-5 ml/L)."		

Figure 5-3. Offset between the SBE sensor and the Winkler oxygen concentration as the survey progressed (left), and the results of the Drift calculation (right). Drift within ±5% requires no correction or other action.

Moreover, the mean difference between the Winkler titration and the CTD-O_2 sensor was about -0.2 ml/L (-0.16±0.17 ml/L) this corresponds to about -7 µmol/kg. Triplicate analysis of deep water showed that the precision of the Winkler analysis was about ±0.02 ml/L or lower. That precision required a first shake at sampling, and another shake after 30 minutes and analysis within 6 hrs after sampling. Generally, the CTD-O_2 sensor showed higher concentrations than the Winkler titrated DO. However, at depth (>2000 m) it was the opposite, with Winkler giving higher values than the sensor of about 0.14 ml/L±0.02 ml/L.

Salinity and temperature in sea ice cores

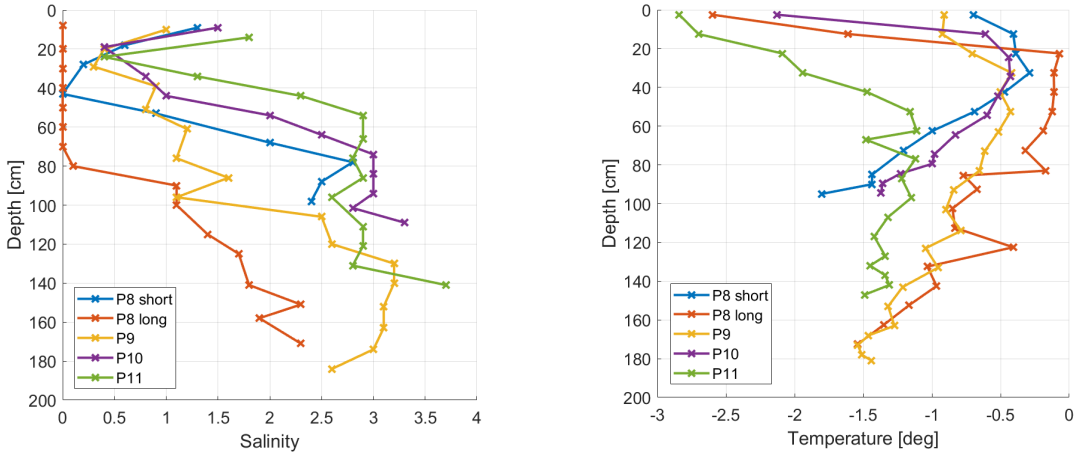
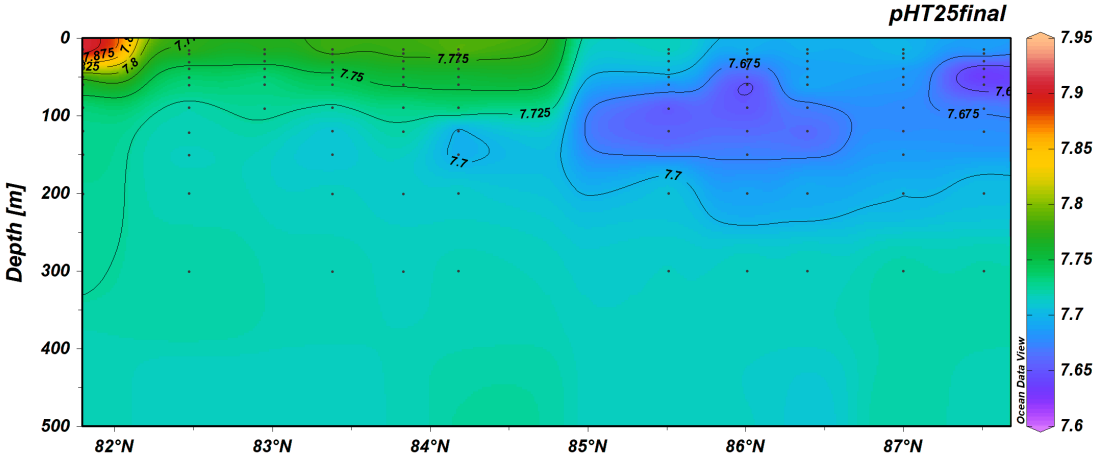


Figure 5-4. Vertical profiles in the sea ice cores of salinity (left) and temperature (right).

Water column pH (at 25 °C) and DO along the transect

The pH variability in the top 500 meters clearly shows lower pH north of P9 (85.5N), after the Gakkel Ridge in the Amundsen Basin relative to the Nansen Basin (Figure 5-5 top). *NB: The pH values are preliminary and given at measured temperature thus lower than the actual pH at in situ conditions*. The DO shows lower concentrations throughout the upper 500 m relative to Nansen Basin (Fig 1. bottom panel), particularly between 200 and 500 m, where DO was less than 310 µmol/kg



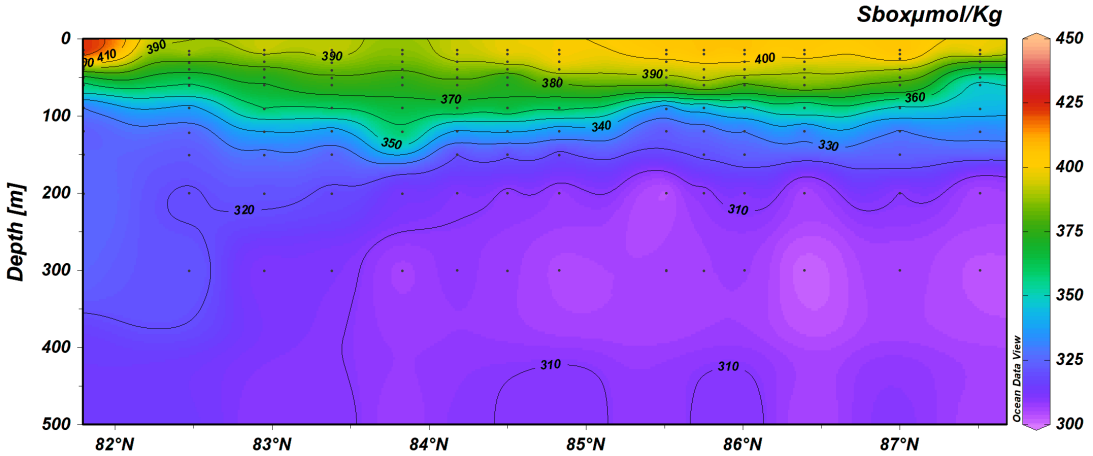


Figure 5-5. Section from P7 to P11 on pH (total scale at 25 C°, top panel) and Dissolved oxygen (from SBE-37 DO sensor, bottom).

5.2 T2-1.2 Ocean acidification effects on the mobility of particulate and dissolved organic carbon (POC, DOC), essential trace elements (micronutrients) and heavy metals

Nicolas Sanchez & Tomasz Ciesielski (NTNU) team onboard
Stephen Kohler, Maria Digernes, Laura Kul, Mathew Adams and Murat Ardelan

Objective

The purpose of for this cruise was to extend the spatial coverage to the artic basin (Nansen and Amundsen) in order to compare the variables affecting the distribution of trace elements within the arctic basin versus to shelf seas during the seasonal cruises on the northern Barents Sea. This task is to understand the impact of ocean acidification and other variables on the biogeochemistry (cycling and mobility) of dissolved organic carbon (DOC) and trace elements in the water column of the Northern Barents Sea and surrounding waters. To best explore this topic, a complete survey of trace elements and heavy metals needs to be sampled along the entire transect and at various depths under clean sampling and handling conditions. In addition, the conditions and characteristics in the Arctic basin gives the opportunity to study other variables more relevant compared to the shelf seas. This is the case for study processes of micronutrient limitation or co-limitation together with macronutrients and the distribution of rare earth elements and its relation to hydrothermal vents in the oceanic ridges.

Trace elements (micronutrients)

A total of 230 samples (including replicates) for dissolved (filtration through 0.45+0.2 μm) and total acid leachable trace elements (focus on Mn, Fe, Co, Ni, Cu, Zn, and Al), were successfully sampled at all process stations (P7-P11) and selected NLEGs (27,31,34,37) at eight depths (10, 20, 40, 90, 120, 200, 300 and 500) with GO FLO bottles with clean sampling and handling techniques (Figure 5-6 left). Replicate samples were collected at certain stations.

Experiment on potential Fe-NO_3 co-limitation in the Nansen Basin
(cooperation with RF3: Natalie Summers and Geir Johnsen)

From the perspective of inputs and sources of micronutrients, the Nansen basin is among the basins with the lowest concentrations of trace elements such as iron in the upper water column. Future scenarios of climate change ponder the question what the role of trace elements in primary productivity in future ice-free waters will be. Indirect evidence has been presented for the possible limitation that low Fe concentration can cause to late summer blooms in the Nansen basin. Given the above scenario, an experiment was designed to test the effects of the addition of the micronutrient iron and the macronutrient NO3. At P7 and P8 (Nansen Basin) water (25L) from the Chlorophyl max was collected using clean sampling techniques. The experiments consisted of three treatments (only Fe addition (0.2 nM), only NO3(2.5 µM) addition and Fe and NO3 addition) in 1 L PC acid-washed bottles (in triplicate). Incubations were short term (24-30 hrs) on-deck (200 L acrylic tank) with running water and mesh for light attenuation (30% of incident light). Samples were analyzed using photo biology techniques (Phyto-PAM) in order to detect short-term physiological changes (Electron transfer rate; ETR) affecting the photosynthetic processes, hence expecting to detect any potential stress relief product of the nutrient addition.

Figure 5-6 Water sampling for trace elements and toxic metals

Preliminary results from Chlorophyll values showed a higher phytoplankton abundance at P7 compared to P8. However, the physiological state revealed in the experiments, showed that both communities in P7 and P8 may have been poor and in post-bloom state at this late stage of the summer. The addition of Fe versus controls (no addition) seems to reflect no significance difference in the attributes (ETR) measured. Further post processing of the data must be carried.

Toxic metals (Hg)
Separately, samples for both total mercury (n=68) and methylmercury (n=68) were collected at all process stations only, at eight sampling depths up to 500m with GO FLO bottles using clean sampling and handling techniques. In addition, for Hg which is not so prone to sampling contamination, at the same stations, samples for total mercury and methylmercury were also collected from six deeper depths (1000, 1500 ,2000, 2500, 3000 and 4000) from the CTD rosette with Niskin bottles to complete the water column profile.

Rare Earth Elements (REE)

Complementary to the task and to the study of marine biogeochemistry of trace elements in the Northern Barents Sea and Arctic basin, sampling was conducted to analyze REE in the water column, sediments (below) and marine biota.
Water samples (1 L) for rare earth elements (REE), Sc and Y analysis were collected following the same stations and equipment used for Hg. The samples were collected via GO-FLO at depths 8 depths (10, 20, 40, 90, 120, 200, 300, 500 m) and Niskin bottles (at 1000, 1500, 2000, 2500, 3000, 4000). The samples from the GO-FLO system were filtered in the in-house made clean laboratory and preserved in PE bottles with HCl (1 mL of UP 6 M acid). The deep-water samples were filtered directly from the Niskin bottles, transported to the clean laboratory and acidified with HCl.
At the same stations sample surface sediments surface sediments (3 replicates/ station) were collected using box-corer for Hg and REE analysis. In addition, macro-zooplankton (approx. 70 samples) for REE was sampled at P stations using MIK net and Krilltrål 1723, sorted into taxonomic groups and frozen for further analysis (Figure 5-6 right). Water samples will follow similar techniques for preconcentration and analysis as trace element but requiring larger volumes and. Sample analysis for sediments and marine biota need further protocol development but ultimately will analyzed by mass spectrometry.

Dissolved organic matter (DOM) characterization
No sampling for DOM was conducted during this cruise.

Sea ice cores (Trace elements)
Greater focus was applied on this cruise for ice work in determining trace element concentration in the sea ice. Ice cores were collected (n=15) for trace elements at all P-ice stations (P8, P9, P10 and P11). 3 to 4 ice cores were collected per station (packed in sleeves), to be processed on board. Cores were cut in sections (9 -13) between 10 to 15 cm length, to then be shaved with a titanium knife under a flow laminar air chamber to remove potential contamination on the surface. Cores were melted at room temperature in sealed acid-washed containers and samples were collected for total acid leachable, dissolved and particulate trace elements.
1 ice core per station (except P9) was collected for complementary analysis and kept frozen onboard. The cores will be transported frozen back to NTNU for further processing.

Sediment sampling
In addition to the water column sampling, the benthic sampling was complementary as per other cruises. At all process stations (P7-P11), samples (n=16) of surface sediments were collected by the benthos group (UiT – Nord) for trace element analyzes of Hg and REE.

5.3 T2-1.3 Effects of ocean acidification on Arctic planktonic crustaceans

Nadjejda Espinel-Velasco (NPI) and Haakon Hop (PI, NPI)

The main goal of the experiment carried out on board was to investigate the metabolic responses of living copepods to stressors of anthropogenic origin (in this case ocean acidification) through a series of respiration experiments. Planktonic live specimens were collected with a bongonet (180 µm) from P9 and P10 for experimental use on board. *Calanus* spp. and C. *hyperboreus* females were selected from the net haul for the measurements (Table 5-2).

The oxygen uptake of the copepods when exposed to ocean acidification was measured by means of the Loligo® multiwell system. The selected copepods were individually placed in 1700 µL wells in the plates which were subsequently placed on the readers. Two plates were used simultaneously for the measurements at in-situ temperature (one control and one with the treatments). Each experiment consisted on exposing the organisms to a gradual decrease of seawater pH at the in-situ temperature (0°C). The pH decrease of 0.3 units pH was carried out every 12h for the smaller *Calanus* females and every 4-5 hours for the *C. hyperboreus*, while continuously measuring the oxygen uptake. The experiment consisted of 4 or 5 steps. At the end of the experiment, the individual copepods were photographed (for body size and lipid sac measurements), snap-frozen and stored at -80°C for further analyses.

Table 5-2 Overview of copepod sample collected during JC2-2 for ocean acidiication experiments.

Station	Life Stage	No. of individuals
P9	Female *C. hyperboreus*	40
P9	Female *Calanus spp.*	40
P10	Female *C. hyperboreus*	40
P10	Female *Calanus spp.*	40

5.4 T2-1-4 Ocean acidification effects on planktonic calcifiers and biological pump efficiency

Griselda Anglada-Ortiz (UiT), PIs: Tine L. Rasmussen (UiT), Melissa Chierici (IMR), Agneta Fransson (NPI)

The abundance of the main planktic marine calcifiers (foraminifera, pteropods and coccolithophores) and their contribution to the carbon pump are studied from 64 µm multinet samples (foraminifera and pteropods) and niskin bottles (coccolithophores) and will be related to the water chemistry from the sampling area. In addition, the presence of these calcifiers in ice cores is studied and the abundances will be compared to the ones from the multinet. Moreover, the preservation state of these calcifiers on the sediments will be studied from subcores taken from the box core.

A total number of **355** samples have been retrieved on the P stations along the transect to study these marine calcifiers following the protocol from the Nansen Legacy v9 (overview in Table 5-3). On one hand, **25** samples have been collected using the 64 µm multinet on all P stations at the standard depths: 0–20 m, 20–50 m, 50–100 m, 100–200 m and 200–500 m. All samples have been washed through a cascade of sieves obtaining four size fractions (>500 µm, 250–500 µm, 100–250 µm, 63–100 µm) from each sample (total number of multinet samples= 100). Once on deck, **300** pteropod and foraminiferal specimens (from all size fractions) have been individually picked from the upper 100 m and (individually) frozen at - 80° C for protein extraction analysis. The rest of the samples have been analysed for pteropods and foraminifera (abundance and species distribution), stored on plastic bags, and preserved at - 20° C. On the other hand, **30** samples coming from the P stations and different depths (90 m, 60 m, 50 m, chl max, 20 m and 10 m) have been collected from the niskin bottles. A total volume of 8 L were sampled and filtered through a 0.45 µm Acetate cellulose membrane (volume=3 L; depths 10, 20, 50, 60 and 90 m) and 0.4 µm Polycarbonate membrane (volume=5 L; depths 10, 20 and 50 m). Once the samples have been filtered, the filters have been rinsed with distilled water buffered with ammonia (5 ‰) and oven dried at 60° C.

One ice core from each P ice-station (P8, P9, P10 and P11) have been collected and sliced every 10 cm. A total number of **56** subsamples have been retrieved during the cruise and preserved frozen at -20° C.

Eight subcores to study the surface sediment have been collected from the box cores. Each of these subcores have been sliced every centimetre. The upper 3 cm have been preserved in ethanol and ethanol + rose of Bengal, while the samples below 3 cm, have been frozen at -20 C.

Table 5-3. Overview of the samples collected during JC 2-2 2021.

	Coccolithophores (niskin)	Foraminifera and pteropods (multinet)	Forams ice core
P7	10, 20, (chlmax), 50, 60 and 90 m	0-20, 20-50, 50-100, 100-200, 200-500	
P8	15, 20, (chl max), 50, 60 and 90 m	0-20, 20-50, 50-100, 100-200, 200-500	125 cm long - Sliced every 10 cm
P9	15, 20, (chl max), 50, 60 and 90 m	0-20, 20-50, 50-100, 100-200, 200-500	180 cm long - Sliced every 10 cm
P10	15, 20, (chl max), 50, 60 and 90 m	0-20, 20-50, 50-100, 100-200, 200-500	109 cm long - Sliced every 10 cm
P11	15, 20, (chl max), 50, 60 and 90 m	0-20, 20-50, 50-100, 100-200, 200-500	153 cm long - Sliced every 10 cm

Griselda Anglada-Ortiz (UiT), Nadjejda Espinel-Velasco (NPI), Melissa Chierici (IMR, PI), Agneta Fransson (NPI, PI), Tine L. Rasmussen (UiT, PI), and Haakon Hop (NPI, PI).

An experiment was conducted to investigate effects of ocean acidification on calcifying plankton. Specifically, the main goal of this experiment was to study the combined effect of ocean acidification and warming on planktic foraminifera. Organisms were collected at P10 with a Bongo net (64 µm) from the upper 100m. The sample was washed through a cascade of sieves to obtain the size fraction 100-250 µm and a total of 120 organisms were picked. The experiment consisted of five different pH treatments (Δ ~ 0.3 pH units), two temperature scenarios (0 ° C and 3 ° C) and four replicates per treatment (Figure 5-7). Three specimens were placed into each well and were kept in the selected treatment for 24 hours. After 24 hours the specimens were picked, photographed and packed for further analyses (weight, SEM, state of the shell) on land. Moreover, water samples were collected from each treatment and analysed for water chemistry parameters by Melissa Chierici (IMR).

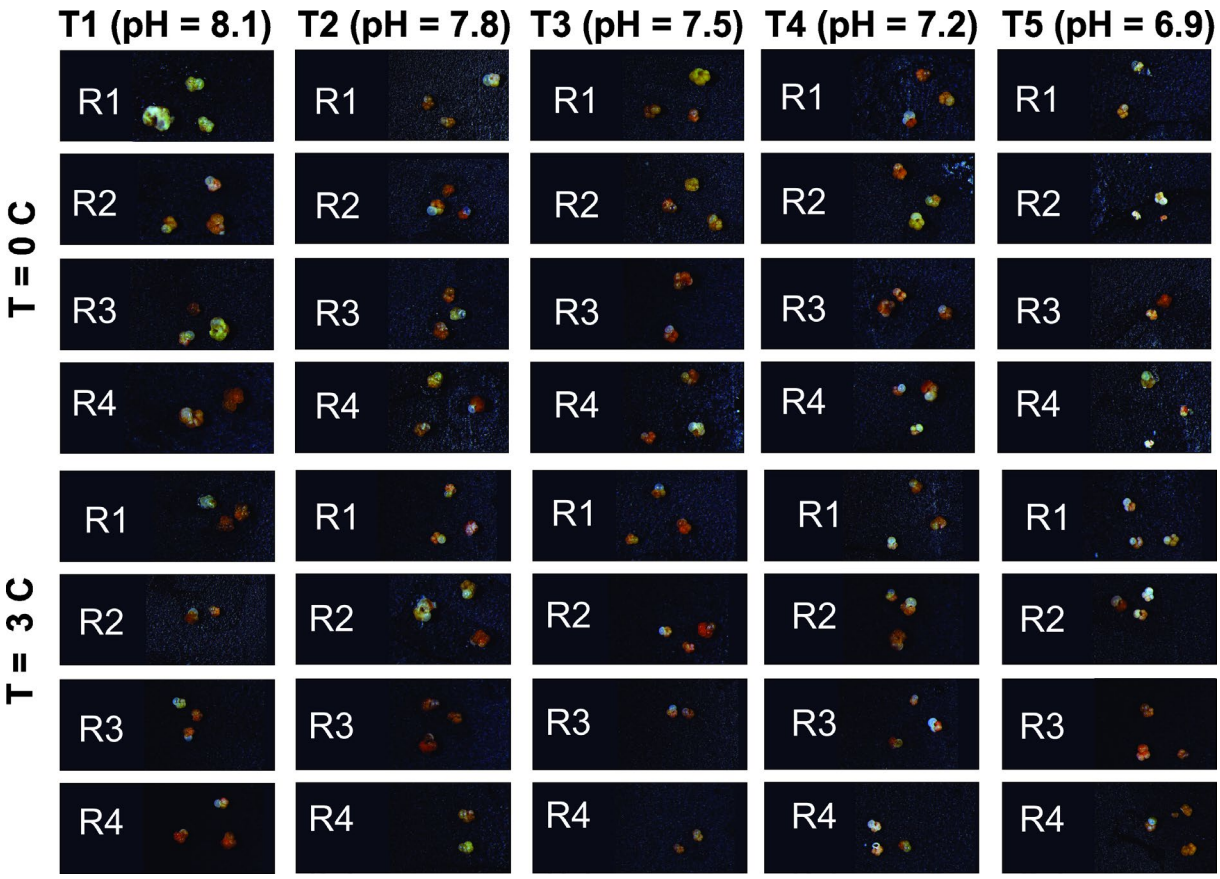


Figure 5-7 Experimental set-up for investigaing effects of temperature and pH on planktonic forams.

5.5 T2-2.2 Effect of multiple stressors on sub-lethal physiological and ecological responses in Arctic zooplankton – effects of ocean acidification and pyrene exposure

Nadjejda Espinel-Velasco (NPI), Khuong V. Dinh (UiO), Amalie Marie Bårnås Gravelle (UiO), Katrine Borgå (PI, UiO) and Haakon Hop (PI, NPI).

The main goal of the experiment carried out on board was to empirically investigate the physiological responses of living copepods to multiple stressors of anthropogenic origin (in this case ocean acidification and volatile compounds – pyrene).

Planktonic live specimens were collected with a bongonet (180 µm) from P7 for experimental use on board. *Calanus* spp. copepodites IV (n=288) were selected from the net hauls for this experiment. Living specimens were distributed equally among 250ml borosilicate bottles (6 individuals per bottles) and exposed to 8 different treatments consisting of a combination of two levels of *p*CO2 (ambient air and high *p*CO2) and four levels of contaminants (no pyrene, low, medium and high). Each treatment was replicated three times. The duration of the exposure did not surpass 7 days.

The following endpoints were used in order to assess the physiological responses of the *Calanus* copepodites IV to the exposure to the different treatments: mortality/survival, metabolic rates (measured through respiration at day 0 and day 7),

gene expression and metabolite production (assessed through metabolomics). Mortality and survival were checked every two days through a visual inspection. Metabolic rates of the copepodites were assessed through respiration assays at T_0 and T_{end}. For this, we used the Oxodish© multiwell plates from PreSens placed on top of SDRs (Sensor Dish Reader). Individual copepodites were introduced in each well and then respiration was measured for about 12hours. After this, each copepodite was individually photographed, snap frozen in liquid nitrogen and frozen at -80°C for further analyses (i.e. gene expression and metabolomics). Moreover, water samples from the start and the end of the experiment were taken and analysed for the different water chemistry parameters by Melissa Chierici (IMR).

6. Activity reports RF3 The Living Barents Sea

6.1 T3-1.1&2.1 Mesozooplankton taxonomy, abundance, biomass and genomics

Camilla Svensen (UiT) & Anette Wold (NPI)

Purpose

The main objective was to describe the mesozooplankton taxonomic composition, abundance and biomass along the transect going from P7 to P11. We expect to see a gradient in the presence of Atlantic and Arctic species.

The data obtained during this cruise (JC2-2) will be compared with the data collected from the standard transect during the seasonal cruises, Q1-4 and JC2-1.

Description of work

We sampled with a Multinet Mammoth (HydroBios, Figure 6-1) with the following specifications: 9 nets, opening: 1.0 m^2, net length: 550 cm), Multinet Midi (HydroBios, 5 nets, opening: 0.25m^2, net length: 250 cm) and Bongonets (HydroBios, opening: 2 x 0.2827m^2, net lengths: 250 cm) (Tables 6-1, 6-2). For all nets, except the Mammoth net, we have been using both 180 µm and 64 µm mesh nets in order to cover all size groups. We refer to the samples from the two mesh sizes as “mesozooplankton” and “small mesozooplankton” respectively.

The Multinet Midi samples for taxonomy and abundance were sampled at 5 standard depth intervals: bottom-2000 m, 2000-600 m, 600-200 m, 200-50 m, 50-0 m. The deepest sampling was 4200-3000 m. All samples for taxonomy and abundance were preserved in 4 % formaldehyde free from acid. The Multinet Mammoth was equipped with 180 µm mesh size, and the maximum operation depth was 3000m. Standard depths were 3000-2500 m, 2500-2000m, 2000-1500m, 1500-1000m, 1000-600m, 600-200m, 200-50m, 50-20m, 20-0m. At P7 the bottom depth was about 3100m and the Mammoth was used for taxonomy and abundance instead of the Multinet Midi. At the deeper P8, P9, P10 and P11, the Mammoth was used in addition to the Multinet Midi and for other purposes; 1) obtain abundance of *Paraeuchaeta* sp. females with and without eggs (estimated from live material), 2) collection of *Paraeuchaeta* sp. for experiments, 3) collection of *Calanus hyperboreus* and *Paraeuchaeta* sp. (*mainly P. glacialis*) females for fatty acid analyses 4) photography of live organisms and 5) depth-specific samples for genetical analyses. All specimens removed from the total sample were recorded, and the remaining samples were preserved in 96% Ethanol for the genetic analyses.

Problems with the Mammoth: net #4 (1500-1000m) was more or less empty at all the stations except at P7. At P11 we did a test by shifting the depths so that the 1500-1000 interval was sampled by net #3, and net #4 sampled 1000-2000m. Net #4 was still empty. We think this could have been caused by a slight displacement of the “motor pin” that causes the nets to open and close. This was adjusted, but we did not have the possibility to test if this fixed the problem. Also, several holes were discovered in net #9 but this was mended before packed down.

The Bongonets were used to take sample for taxonomy, metabarcoding, biomass and fatty acid from 1000-0m (Table 6-2). Each of the two Bongonets were split in two, net one was used for metabarcoding and taxonomy with ½ of the sample for each. Net two was used for biomass and fatty acid analyses. The biomass samples were transferred to pre-weighted tinfoil cups, dried at 60 °C for a minimum of 24 h and weighted onboard. Genetic samples for metabarcoding were preserved in ice cold 96 % ethanol. Taxonomy samples were preserved in 4 % buffered formaldehyde. The taxonomy samples will be used to support the metabarcoding samples. Fatty acid samples were stored in -80 °C

Figure 6-1 Multinet mammoth, sampling capacity 9 depths and area of opening 1 m^2. Photo: Christine Gawinski.

Table 6-1: Overview of mesozooplankton sampling conducted during JC2-2

Gear	Purpose	Station	Number samples
Multinet midi 180 µm	Mesozooplankton taxonomy	P8, P9, P10, P11	20
Multinet mammoth 180 µm	Mesozooplankton taxonomy	P7 P11	17
Multinet midi 64 µm	Small mesozooplankton taxonomy	P7, P8, P9, P10, P11	25
Bongonet 180 µm	Mesozooplankton biomass	P7, P8, P9, P10, P11	5
	Mesozooplankton taxonomy (alive/dead)	P7, P8, P9, P10, P11	5
	Mesozooplankton metabarcoding	P7, P8, P9, P10, P11	5
	Mesozooplankton fatty acid (community)	P7, P8, P9, P10, P11	5
Bongonet 64 µm	Small mesozooplankton biomass	P7, P8, P9, P10, P11	5
	Small mesozooplankton metabarcoding	P7, P8, P9, P10, P11	5
	Small mesozooplankton tax. (alive/dead)	P7, P8, P9, P10, P11	5
	Small mesozooplankton fatty	P7, P8, P9, P10, P11	5
Multinet Mammoth 180 µm	Metabarcoding / genetics of single organisms (in addition live animals, copepod fatty acid samples)	P8, P9, P10, P11	36

Table 6-2: Overview of sampling depths, and hauling speed for different zooplankton nets

Gear	Sampling depth	Hauling speed (m/s)	
		lowering	heaving
Multinet midi 180 µm	Bottom-2000-600-200-50-0m	0.7	0.5
Multinet midi 64 µm	Bottom-2000-600-200-50-0m	0.7	0.3
Multinet mammoth 180 µm	3000-2500-2000-1500-1000-600-200-50-20-0m	0.7	0.5
Bongonet 180 µm	1000-0m	0.5	0.5
Bongonet 64 µm	1000-0m	0.5	0.3
MIK 1500 µm	1000-0m	0.3*	1.5

*If lowering to fast the net-bucket might flip into the net since the ring is much heavier than the bucket even when added weight to the bucket. The net bucket should be improved in order to attach heavier weights.

Brief observations of the mesozooplankton community from multinet sampling

The upper 50 m were dominated by *Calanus glacialis*, *C. hyperboreus*, *Oithona similis* and *Metridia* sp.

50-600 m: Relatively high diversity of zooplankton. *C. hyperboreus* was in general abundant but mostly in the upper 200 m. Ostracods, possibly *Boroecia* sp., was highly abundant at all stations. Of the smaller copepods, *Oithona similis*, *Triconia* sp. and other smaller (unidentified) species were abundant. Common amphipods were *Themisto abyssorum* and *T. libellula*, *Cyclocaris guelelmi* and *Eusirius holmi*.

2000-600 m: Very diverse community with high abundance of small jellyfish. The species *Atolla* sp. and *Botrynema* sp. were the most abundant species, although

several other species such as *Mertensia ovum*, *Beröe Cucumis*, *Aglantha digitale* and some unknown species were also observed. Several large-sized Arctic copepods were found, the most dominant were *Paraeuchaeta glacialis*,
P. barbata, *Chiridius* sp., *Heterohabdus* sp., *Scaphocalanus magnus*, *Gaetanus brevispines*/*tenispinus* and *Bradyidius similis* (Fig. 2).

Below 2000 m: Few large copepods were observed, but small (smaller than 500 µm) cyclopoid and harpacticoid copepods were relatively abundant. At the northernmost stations *Oikopleura* sp. were abundant in the deepest sample but less frequently observed shallower. Interestingly, nauplii and younger copepodite stages were observed in the deepest samples.

Figure 6-1: Arctic giants - abundant copepod species observed. From left to right: Bradyidius similis (possibly), Scaphocalanus magnus, Gaetanus brevispinus and Paraeuchaeta glacialis (and a small Oithona sp. in the upper left corner). Photo: Camilla Svensen

6.2 T3-4.2 Trophic ecology of zooplankton: Fatty acids of selected zooplankton

Anette Wold (NPI) & Camilla Svensen (UiT)

Purpose

A limited amount of zooplankton samples were collected for analyses of fatty acids (FA) (Table 6-3). Targeted zooplankton species were the large herbivorous *Calanus hyperboreus* and carnivorous *Paraeuchaeta* sp., as well as some other dominating species. For *C. hyperboreus* and *Paraeuchaeta* sp., we aimed to collect individuals below 1000 m but most *C. hyperboreus* were found in the upper 200 m depth. Fatty acids will be used as a measure of food quality for the planktonic grazer communities and will be linked to on board grazing experiment.

Description of work

Zooplankton samples were collected using MIK net 1500 µm and multinet Mammoth (180 µm mesh size) at stations P7, P8, P9, P10 and P11. The MIK sampled 1000-0 m and the Mammoth allowed depth-specific sampling from 3000-0 m. Fatty acids will be analysed by Doreen Kohlbach, NPI and Sigrun Jonasdottir at DTU-Aqua, Denmark (only *C. hyperboreus* and *Paraeuchaeta* sp.).

Table 6-3. Overview of fatty acid samples collected during JC2-2. Samples were collected both with MIK net and multinet mammoth.

Gear Type	Station	Depth	Taxon
MIK-net 1500 µm, Multinet Mammoth 180 µm	P7	1000-0m/ 3000-0m	*C.hyperboreus, Paraeuchaeta glacialis*, *Themisto libellula, T. abyssorum, Amphipoda* indet.
MIK-net 1500 µm, Multinet Mammoth 180 µm	P8	1000-0m/ 3000-0m	*C. glacialis, C. hyperboreus, Paraeuchaeta* spp., *Cyclocaris guilelmi*, Hymenodora glacialis, *Themisto abyssorum*
MIK-net 1500 µm, Multinet Mammoth 180 µm	P9	1000-0m/ 3000-0m	*Calanus glacialis, C. hyperboreus, Paraeuchaeta sp.*
MIK-net 1500 µm, Multinet Mammoth 180 µm	P10	1000-0m/ 3000-0m	*Calanus glacialis, C. hyperboreus, Paraeuchaeta sp.*
MIK-net 1500 µm, Multinet Mammoth 180 µm	P11	1000-0m/ 3000-0m	*Calanus hyperboreus, Paraeuchaeta sp.*

6.3 T3-2.2. Measure how current environmental settings drive the phenology of primary and secondary production

Christine Gawinski (UiT), Camilla Svensen (UiT)

The goal of this task is to characterize how current environmental settings drive the seasonality of copepod production. To meet this goal mesozooplankton productivity was determined experimentally for selected key-species through egg-production/egg-hatching incubations in different seasons, representing species with contrasting life-history traits and reproductive strategies in open and ice-covered waters. Assuming that female copepods allocate their ingested carbon into egg production rather than into growth, the specific egg production rate can be used as an estimate of the production of the population. The data collected during the Arctic Basin cruise will be used to supplement the seasonal dataset on copepod production. Egg hatching experiments of *Oithona similis* were conducted at P7, for two temperatures (0˚C, 4˚C).

Biology of the predatory copepods *Paraeuchaeta* spp.

Calanoid copepods of the genus Paraeuchaeta are among the most common species inhabiting epi-, meso- and bathy-pelagic waters in the Arctic. Here, four different species, namely *P. glacialis*, *P. norvegica*, *P. barbata*, and *P. polaris*, sympatrically co-occur. Each species is generally restricted to a certain depth range, with *P. glacialis* and *P. norvegica* occuring from the surface to 500 m depth, *P. barbata* from 500 – 1500 m depth and *P. polaris* at depths below 1000 m. All Paraeuchaeta species produce egg sacs that are carried attached to the genital opening until the offspring hatch. However, there are strong differences concerning species-specific reproductive strategies. The epi- and mesopelagic species, *P. glacialis* and *P. norvegica* produce large numbers of relatively small eggs, while the bathypelagic species *P. barbata* and *P. polaris* rely on small numbers of large, energy-rich eggs. *Paraeuchaeta spp.* are tactile predators and feed on small copepods, such as *Paracalanus, Pseudocalanus, Microcalanus* and young *Calanus spp.* stages, as well as fish larvae.

The purpose of the present study was to describe the regional and vertical distribution and abundance of *Paraeuchaeta* spp. in the Nansen Basin, over the Gakkel Ridge and in the Amundsen Basin. To assess the ecological role of *Paraeuchaeta* spp. and to evaluate their impact on the carbon and energy flux within the high European Arctic, the carbon demand of different species and stages was evaluated by performing feeding experiments and respirometry. In addition, egg production experiments were conducted. Potential carbon demand will be compared to primary and secondary production, as well as mesozooplankton standing stock and vertical fluxes of organic material, to investigate *Paraeuchaeta* spp.'s impact on the carbon cycle in the deep Arctic Ocean.

Experimental protocol

Animal collection

Experimental *Paraeuchaeta* spp. were collected with vertical hauls of the MIK net (1500 µm) from 1000 – 0 m at all process stations, to cover depth ranges of all four Paraeuchaeta species. Prey animals were collected with Bongo net 64 um, from 1000 – 0 m. Experimental animals were sorted into 2 l beaker with FSW right after catch and stored in the incubator. Potential prey samples were diluted with sea water and transported into a cold room until further processing.

Data on abundance and depth distribution of *Paraeuchaeta* spp. and their potential prey will be obtained from the standard Mesozooplankton taxonomic composition, abundance, and biomass hauls, that were performed with the Multinet 64 µm and 180 µm along the transect going from ice covered Arctic water (P7) into the Amundsen Basin (P11).

Feeding experiments

Ingestion rates of the four different *Paraeuchaeta* species were determined during feeding experiments according to Auel 1999, who modified the protocol of Yen (1982, 1983, 1985). Earlier studies showed daily feeding rates of *Pareuchaeta norvegica* between 0.25 – 2.3 prey organisms per predator and day, equivalent to an average carbon ingestion of 0.15 ± 0.12 mg C d^{-1} or a mean turnover of 6.7% of body mass per day. Predation rates of 0.5 – 1 ind. prey d^{-1} in *P. glacialis* females resulted in an individual daily carbon ingestion of 0.12 ± 0.06 mg C d^{-1} (Auel 1999). To evaluate feeding rate in response to prey concentrations, experiments were set up with a range of different prey concentrations (Table 6-4).

Table 6-4 Experimental set-up for feeding experiments with the predatory copepod Paraeuchaeta. Prey and prey concentrations are given.

Prey organism	concentration (individuals l^{-1})
Oithona similis CV, AF	0, 5, 10, 20, 40, (20 control)
Oithona similis CV, AF	5, 10, 20, 40, 60, (20 control)
Calanus glacialis AF	2, 4, 6, 8, 20 (8 control)
Small calanoids < 1 mm	2, 4, 6, 8, 20 (8 control)

Prey organisms were sorted and stored in Falcon tubes with 50 ml of GF/F FSW until addition to the experimental bottles. Experimental bottles were filled with 950 ml of FSW, the content of the Falcon tubes with prey and one *Paraeuchaeta spp.* were added. Experiments were run in three replicates per treatment for a duration of 24 hours in darkness at in-situ temperature. After termination of the experiment, the content of the experimental bottles was poured over a 20 um filter that was attached to a bottle with open bottom. The filter was removed from the bottle and rinsed with FSW several times into a 10 cm petri dish. Predators were removed and photographed. Remaining prey individuals and faecal pellets were counted. Pellets were photographed and stored in a small petri dish until the end of the cruise, to collect as many pellets for CHN analysis as possible. Predators were frozen at -80˚C.

Respirometry

Respiration rates were measured on a Logilo micro plate system placed in incubators at in-situ water temperature. The plates have 24 wells filled with 1700 ul of GF/F filtered seawater that has been aerated with air stones for approximately 1 hour at in-situ temperature. Experimental animals were handled in the cold room, disturbed as little as possible and were not exposed to strong light. Copepods were added to 20 wells, while 4 wells were left with experimental water only, to measure background respiration. Incubations were started using 5 second measuring intervals and were run for 2 – 5 hours depending on the oxygen consumption. If oxygen drops below 60%, we cannot trust the measurements anymore since they then may be oxygen limited.

Egg hatching experiments

Egg hatching experiments followed the protocol in Chapter 9.3.3. “Experimental protocol for copepod egg incubations to determine secondary production and grazing experiment” of the Nansen Legacy Sampling Protocol Version 9 and were conducted at P7 to P9 (Table 6-5).

Table 6-5 List of samples collected during Arctic Basin Cruise AeN2021710

Egg incubation experiments				
Station	Temperature (˚C)	Species	Number of individuals	Comment
P7	0	*Oithona similis*	30	
P7	4	*Oithona similis*	30	
P7-P9	0	*Paraeuchaeta spp.*	15 + 9	loose egg sacs + females with eggs

Bongo net samples for female:egg ratio			
Station	Net size (µm)	Fixative	Comment
P7	64	Formaldehyde	1 net, 1000-0m
P8	64	Formaldehyde	1 net, 1000-0m
P9	64	Formaldehyde	1 net, 1000-0m
P10	64	Formaldehyde	1 net, 1000-0m
P11	64	Formaldehyde	1 net, 1000-0m

Feeding experiments		
Prey organism	Concentrations	Stations
Oithona similis CV, AF	0, 5, 10, 20, 40, (20 control)	P7
Oithona similis CV, AF	5, 10, 20, 40, 60, (20 control)	2 experiments at P8
Calanus glacialis AF	2, 4, 6, 8, 20 (8 control)	P9
Small calanoids < 1 mm	2, 4, 6, 8, 20 (8 control)	P10

Respirometry			
Number of individuals	Station	Temperature (˚C)	Plate size (ul)
20	P7	0	1700
20	P7	0	2500
80	P8	0	1700
25	P10	0	1700
20	P11	0	1700

CHN samples				
Species	type	Number of individuals	Station	comment
Oithona similis	females	300	P7-9	100 individuals filtered on pre-combusted GF/Fs
Oithona similis	nauplii	351	P7-9	351 individuals filtered on pre-combusted GF/Fs
Calanus hyperboreus	females	30	P7	Frozen individually in cryo tubes
Paraeuchaeta spp.	females, young stages, females with eggs	from feeding experiments /respirometry	P7-P11	
FA, SI samples				
Species	station	Number of individuals	replicates	comment
Oithona similis	P7	50	3	FA
Oithona similis	P7	50	3	SI

***Oithona similis* nauplii experiment**	
0, 3, 5 ˚C	T0, T8 respiration, Photos of stage development

6.4 T3-3.1 Characterize biological communities in sympagic, pelagic and benthic realms: Macrozooplankton abundance, biomass & species composition

Espen Bagøien (IMR) and Anette Wold (NPI)

Objective

The aim of the sampling is to provide information about the abundance, biomass, and genetic composition of the macrozooplankton community in the Arctic Ocean

Description of sampling

Macrozooplankton was sampled with vertical hauls of the MIK net (1500 µm) from 1000 m to the surface at all process stations. Gelatinous zooplankton were isolated from the sample and two subsamples were taken for (1) metabarcoding stored in ethanol at -20 degrees C, and (2) for later taxonomic identification of species, stored at room temperature in 4% buffered formaldehyde.

Gelatinous zooplankton were picked out from MIK net at all stations Individuals in good conditions were photographed, weighted and stored individually with ice cold 96 % ethanol.

The samples mainly consisted of larges specimen of copepods such as *Calanus hyperboreus* and *Paraeuchaeta* sp. and gelatinous zooplankton with *Atolla* sp. and *Botrynema* sp. being the most dominant (Table 6-6). The samples also included amphipods such as *Themisto libelulla*, *Themisto abyssorum* and *Cyclocaris guilelmi* as well as some *Thysanoessa* sp. and the shrimp *Hymenodora glacialis*.

Table 6-6. Overview of gelatinous zooplankton samples sampled from the MIK net, Multinets and Bongo nets.

Station	Depth	Taxon
P7	1000-0m	*Aglantha digitale*; *Beroe* sp.; *Botrynema brucei* / *ellionorae*; *Mertensia ovum*
P8	2000-0m	*Aglantha digitale; Atolla* sp.; *Botrynema brucei / ellionorae; Mertensia ovum*
P9	1000-0m	*Atolla* sp.; *Botrynema brucei / ellionorae*
P10	1000-0m	*Aglantha digitale*; *Atolla* sp.; *Botrynema brucei* / *ellionorae*; *Beroe cucumis*
P11	3000-0m	*Aglantha digitale*; *Atolla* sp.; *Botrynema brucei* / *ellionorae*; *Mertensia ovum*

6.5 T3-1 and T3-4 Microbes: biodiversity, abundance, biomass, distribution and activity and cryo-pelagic-benthic coupling

Onboard team Anna Vader (team lead; UNIS), Martí Amargant Arumí & Miriam Marquardt & Jessie Gardner (all UiT), Wenche Eikrem & Even Sletteng Garvang (both UiO), Iliana Vasiliki Ntinou & Selina Våge (UiB)

The activities contribute to **tasks T3-1 "characterize biological communities in sympagic, pelagic and benthic realms" and T3-4 "characterize lower trophic levels food web structure", and link to T3-2 "investigate the timing of critical biological processes" and T3-3 "characterize the total annual production".**

Focus on JC2-2 has specifically been to investigate biological differences between contrasting oceanographic conditions within and between the Nansen and Amundsen basins and across the Gakkel Ridge. This gradient was sampled using CTD casts with sampling rosette, aiming to sample both surface freshwater influenced water and water from deeper ocean currents. In line with this, the standard sampling depths on JC2-2 have been 15 m and chlorophyll a maximum (usually 30 m) in the surface layer, 300 m in the core of the Atlantic Water, 1500 m in the Arctic Intermediate Water, and 2500 m and bottom in the Deep Water. As all CTD casts were run through the moonpool with disturbances from the ship observed down to approximately 12 m depth, 15 m was used as the shallowest sampling depth from the ship CTD. The effect of sea ice origin and properties on biological communities and activities was investigated by sea ice sampling. The sampling included sea ice coring, collection of water from melt ponds and under ice, and sampling of thin ice from refrozen leads.

Samples for microbial (viruses, prokaryotes and protists) community composition, abundance and activity were collected from all five process stations (P7, P8, P9, P10 and P11, Table 6-7). A reduced sampling effort was conducted at all eleven NLEG stations (NLEG26 through NLEG 41). Pelagic samples were collected at all stations, while ice samples were procured at stations P8, P9, P10 and P11. Samples for metatranscriptomics were obtained from 15 m depth at local solar noon. Sampling at the process stations also included phytoplankton net hauls. Chl *a* and live protist samples were analysed on board, while all other samples were preserved or frozen for later analyses.

Onboard experiments included grazer exclusion experiments at stations P7 and P9. These were prepared by gentle reverse filtration of water collected from the chl *a* maximum (27 and 30 m respectively) to retain organisms of different size fractions (<0.8 µm; <3 µm; <90 µm) and were incubated each for eight days at *in situ* temperature and light. Subsamples for abundance and diversity analyses were collected at different frequencies throughout the incubation period.

Sampling at process stations also included the deployment of both pelagic and under-ice **sediment traps** to assess sympagic-benthic-pelagic coupling (T3-4.4, see details below).

Several **functional aspects** of pelagic and sympagic primary producers were studied. At stations P7, P8, P9, P10 and P11, water was sampled from the standard depths 15, 20, 30, 40, 60, 90 m and spiked with radioactively labeled carbon in order to determine the carbon fixation rate (i.e. the primary production rate) of phototrophic organisms.

Additionally, water from 15 m and chlorophyll a maximum depth was spiked with stable isotopes of Carbon (13C) and Nitrogen (15N) to estimate the F-ratio (which fraction of the primary production is new production). This water was incubated in situ for 24 hours, attached to the sediment trap mooring. In parallel, water from chlorophyll a maximum (or surface in its absence) was sampled to study the photosynthetic response of the community to light intensity (P vs I curves). At the ice-covered stations P8, P9, P10 and P11, the bottom 3cm of 4 ice cores were sampled and pooled for similar incubations: under-ice primary production and nitrogen uptake in situ, and P vs I curves on board. In addition, one ice core was collected. The brine from the bottom 10 cm was analyzed with a spectroradiometer, to assess the absorption spectra of ice algal pigments. At stations P8, P9 and P10, water was sampled from one meltpond and the surface at the centre of a lead. At the same stations, P vs I incubations were carried out on board. At stations P9 and P10, net primary production and nitrogen uptake incubations were deployed in situ at the lead site. At station P10, a net primary production and nitrogen uptake incubation was conducted in a meltpond.

Additionally, three **ice cores** (0-30 cm) were sampled at P8, P9, P10 and P11 for investigation of sea ice meiofauna (sympagic meiofauna) abundance and biodiversity. All ice core sections were investigated on board, prior to fixation for genetic barcoding and abundance counts. Ice meiofauna was found especially at P8, P9 and P11, with taxa such as harpacticoid copepods, rotifers and a few specimens of the red flatworm Acoela. At P11 three additional cores of 20 cm thick young ice were examined.

Finally, a secchi disc and coloured glass filters was used at stations NLEG30, NLEG32, NLEG34, NLEG37, NLEG40 and NLEG41 to assess light penetration of different wavelengths in the watercolumn.

Parameters sampled on JC2-2:

Biodiversity

- Genetic identification of community composition of protists and prokaryotes (Metabarcoding)
- Genetic identification of (free) virus diversity (Virus diversity)
- Qualitative analyses of protists >10 µm from net hauls (Net)
- Qualitative analyses of small protists by tangential flow filtration for cultures and electron microscopy (Vivaflow)
- Qualitative and quantitative analysis of protists including coccolithophores by scanning electron microscopy (SEM)
- Algal diversity by culturing (Cultures)
- Abundance and diversity of ice meiofauna by genetic barcoding and microscopy counts (Ice meiofauna)

Abundance and biomass

- Algal biomass (total and >10 µm chlorophyll a concentration Chl *a*)
- Abundance of bacteria, virus, pico and nano-plankton by flow cytometry (FCM)
- Quantitative analyses of protists from water samples by light microscopy (Microscopy)
- Particulate organic carbon and nitrogen (POC/PON)
- Elemental composition of seston (XRF, particulate C:N:Si:Ca:P:Mg:S:K:Fe)(XRF)

Activity

- Genetic identification of protist activities (Metatranscriptome)
- Bacterial production
- Primary production
- Nitrogen uptake by primary producers (Nitrogen uptake)
- Primary producer's response to light intensity (P vs I curve)

Table 6-7 Overview of microbial samples taken during JC2-2 from Niskin bottles and sea ice cores. SEM is scanning electron microscopy, FCM is flow cytometry, P vs I is photosynthesis versus irradiance, POC-PON is particulate organic carbon and nitrogen, XRF is X-ray fluorescence. xx under cultures denotes that several types of cultures were made. x and X under SEM denote that samples were taken by UiB or UiO respectively, with xX meaning both.

Stn	Depth (m)	Metabarcoding	Virus diversity	Vivaflow	SEM	Cultures	Chl *a*	FCM	Microscopy	POC/PON	XRF	Metatranscriptome	Bacterial production	Primary production	Nitrogen uptake	P vs I curve	Ice meiofauna
P1																	
	0						x		x								
	10						x		x								
	20						x		x								
P7																	
	0	x		x	xX	xx	x	x	x	x	x		X				
	15	x			xX		x	x		x	x	x	X	x	x		
	20						x	x		x	x		X	x			
	30						x	x	x	x	x		X				
	36=chl *a* max	x	x		xX		x	x	x	x	x		X	x	x	x	
	40						x	x		x	x		X	x			
	50						x	x		x	x		X				
	60						x	x	x	x	x		X	x			
	90						x	x	x	x	x		X	x			
	120				x		x	x		x	x		X				
	150							x			x		X				
	200	x			X			x		x	x		X				
	500							x		x	x		X				
	1000		x		x			x		x	x		X				
	1500				x			x		x	x		X				
	2000				x			x		x	x		X				
	2500				x			x		x	x		X				
	bottom	x	x		xX		x	x		x	x		X				
	0-50 net					x			x								
P8																	
	15	x		x	xX	x	x	x	x	x	x	x	X	x	x		
	20						x	x		x	x		X	x			
	30	x	x		X		x	x	x	x	x		X	x	x	x	
	40						x	x		x	x		X	x			
	50						x	x		x	x		X				
	60						x	x	x	x	x		x	x			

	90						x	x	x	x	x		x	x			
	120				x		x	x		x	x		x				
	200						x	x		x	x		x				
	300	x			X		x	x		x	x		x				
	1000				x		x	x		x	x		x				
	1500	x			X			x		x	x		x				
	2000				x			x		x	x		x				
	2500	x			X			x		x	x		x				
	3000		x		x			x		x	x		x				
	3500									x							
	bottom	x	x		xX		x	x		x	x		x				
	0-50 net					x			x								
P9																	
	15	x			X	x	x	x	x	x	x	x	x	x	x	x	
	20						x	x		x	x		x	x			
	30	x	x	x	xX		x	x	x	x	x		x	x	x		
	40						x	x		x	x		x	x			
	50						x	x		x	x		x				
	60						x	x	x	x	x		x	x			
	90						x	x	x	x	x		x	x			
	120				x		x	x		x	x		x				
	150							x			x		x				
	200				x		x	x		x	x		x				
	300	x			xX					x	x						
	500				x			x		x			x				
	1000		x					x		x	x		x				
	1500	x			xX			x		x	x		x				
	2000				x			x		x	x		x				
	2500	x			X					x							
	3000				x			x		x	x		x				
	bottom	x	x		xX		x	x		x	x		x				
	0-50 net					x			x								
P10																	
	15	x		x	xX		x	x	x	x	x	x	x	x	x	x	
	20						x	x	x	x	x		x	x			
	30		x				x	x	x	x	x		x				
	40						x	x		x	x		x	x			
	50						x	x		x	x		x				
	60						x	x	x	x	x		x	x			
	90						x	x	x	x	x		x	x			
	120				x		x	x		x	x		x				
	200				x		x	x		x	x		x				
	300	x			xX		x			x	x						
	500				x			x		x	x		x				
	1000						x	x		x			x				
	1500	x			X			x		x	x		x				
	2000				x			x		x	x		x				
	2500	x			X					x							
	3000		x		x			x		x	x		x				
	3500									x							
	bottom	x	x		xX		x	x		x	x		x				
	0-50 net								x								
P11																	
	15	x			X		x	x	x	x	x	x	x	x	x	x	
	20						x	x		x	x		x	x			
	30	x	x	x	xX	x	x	x	x	x	x		x				
	40						x	x		x	x		x	x			
	50						x	x		x	x		x				

	60						x	x	x	x	x		x	x			
	90						x	x	x	x	x		x	x			
	120				x		x	x		x	x		x				
	200	x					x	x		x	x		x				
	300				xX		x	x		x	x		x				
	500							x		x	x		x				
	1000						x	x		x			x				
	1500	x			xX						x						
	2000				x			x		x	x		x				
	2500	x			X					x							
	3000		x		X			x		x	x		x				
	3500									x							
	bottom	x	x		xX		x	x		x	x		x				
	0-50 net								x								
NLEG stations 26 through 41																	
	15	x			X		x	x		x			x				
	20							x					x				
	30	x			X		x	x		x			x				
	40							x					x				
	50							x					x				
	60							x					x				
	90							x					x				
	120							x									
	200							x									
	300	x			X		x	x		x							
	1000							x									
	1500	x			X		x	x		x							
Additional NLEG samples																	
NLEG27	melt pond			x		x											
NLEG27	0			x		x	x										
NLEG37	15					x											
NLEG37	new ice/slush				x		x	x		x			x				
NLEG37	0/slush				x		x	x		x			x				
NLEG40	0						x										
NLEG41	0			x		x	x										
P8ice																	
	0-3	x					x	x	x	x			x	x	x	x	x
	3-10	x					x	x	x	x			x				x
	10-20	x					x	x	x	x			x				x
	20-30	x					x	x	x	x			x				x
	30-50	x					x	x		x			x				
	50-70	x					x	x		x			x				
	70-90	x					x	x		x			x				
	0-10		x		x	xx			x		x						
	UIW 0.5	x		x	xX	x	x	x		x	x		x				
	UIW 2						x	x					x				
	UIW 5						x	x					x				
	UIW 10				x		x	x			x		x				
	Meltpond1	x		x	xX	x	x	x	x	x	x		x				
	Meltpond2	x		x	xX	x	x	x	x	x	x		x	x	x	x	
	Meltpond3	x		x	xX	x	x	x	x	x	x		x				
	0-5 net					x			x								
P9ice																	
	0-3	x					x	x	x	x			x	x	x	x	x
	3-10	x					x	x	x	x			x				x
	10-20	x		x			x	x	x	x			x				x
	20-30	x					x	x	x	x			x				x
	30-50	x					x	x		x			x				

	50-70	x					x	x		x			x				
	70-90	x					x	x		x			x				
	90-110	x					x	x		x			x				
	110-140	x					x	x		x			x				
	140-174	x					x	x		x			x				
	0-10		x	x	x				x		x						
	colored ice								x								
	nilas ice	x		x	x		x	x		x			x				
	pancake ice	x		x	x		x	x		x			x				
	lead 0 m						x	x					x	x	x	x	
	UIW 0.5	x		x	X	xx	x	x		x	x		x				
	UIW 2						x	x					x				
	UIW 5						x	x					x				
	UIW 10						x	x					x				
	Meltpond1	x			X		x	x	x	x	x		x				
	Meltpond2	x			X	x	x	x	x	x	x		x			x	
	Meltpond3	x		x	X	x	x	x	x	x	x		x				
	0-5 net								x								
P10ice																	
	0-3	x					x	x	x	x			x	x	x	x	x
	3-10	x					x	x	x	x			x				x
	10-20	x		x			x	x	x	x			x				x
	20-30	x					x	x	x	x			x				x
	30-50	x					x	x		x			x				
	50-70	x					x	x		x			x				
	70-90	x					x	x		x			x				
	90-98	x					x	x		x			x				
	0-10		x	x	x				x		x						
	10-20					x											
	nilas ice	x		x	x	x	x	x	x	x	x		x				
	UIW 0.5	x		x	xX	x	x	x		x	x		x				
	UIW 2						x	x					x				
	UIW 5						x	x					x				
	UIW 10						x	x					x				
	Meltpond1	x			xX		x	x	x	x			x				
	Meltpond2	x		x	xX	x	x	x	x	x			x				
	Meltpond3	x			xX		x	x	x	x			x	x	x	x	
	0-5 net								x								
P11ice																	
	0-3	x					x	x	x	x			x	x	x	x	x
	3-10	x					x	x	x	x			x				x
	10-20	x					x	x	x	x			x				x
	20-30	x					x	x	x	x			x				x
	30-50	x					x	x		x			x				
	50-70	x					x	x		x			x				
	70-90	x					x	x		x			x				
	90-110	x					x	x		x			x				
	110-130	x					x	x		x			x				
	130-150	x					x	x		x			x				
	150-top	x					x	x		x			x				
	0-10		x		x						x						
	0-20			x		x											
	20 cm young ice	x		x			x	x	x	x	x		x				x
	15 cm young ice	x		x			x	x		x	x		x				
	4 cm nilas ice	x					x	x		x			x				
	UIW 0.5	x		x	xX	xx	x	x		x	x		x				
	UIW 2						x	x					x				
	UIW 5						x	x					x				

	UIW 10						x	x					x				
	Meltpond1	x			xX		x	x	x	x	x		x				
	Meltpond2	x		x	xX	x	x	x	x	x	x		x				
	Meltpond3	x			xX		x	x	x	x	x		x				
	0-5 net								x								

Sea ice work

Sea ice samples for biology were collected at stations P8ice, P9ice, P10ice and P11ice. Sea ice thickness at the four stations was 83-102 cm, 156-183 cm, 86-121 cm and 132-159 cm, respectively.

Samples included ice-cores and water from under the ice (several depths, sampled through a hole in the ice). In addition, a handheld phytoplankton net was used to collect samples from under ice (5-0 m depth). CTD profiles were obtained from under the ice using a handheld RBR CTD equipped with fluorescence and light sensors. At each station water from three meltponds was sampled by drilling a hole in the ice covering the pond and subsequently pumping out water.

Figure 6-2: Sea ice and water sampling. Top left: Sampling water from a frozen meltpond using auger and a handpump. Photo: Anna Vader. Top right: Coring and sectioning of light sensitive ice-cores for sampling of biological parameters. Photo: Even Sletteng Garvang. Bottom left: Drying of containers for ice-core sections under "clean" conditions in the Kronprins Haakon auditorium. Photo: Miriam Marquardt.Bottom right: Water sampling from niskin bottles. Photo: Bodil Bluhm

Table 6-8: Overview of all ice-cores collected (number denotes number of ice cores sampled for each parameter). Bio bulk cores were cut into sections before pooling the same section from all bio bulk cores. The melted pooled sections were divided into sub-samples for metabarcoding, flow cytometry, chlorophyll a, POC/PON, bacterial production and stable isotopes (latter only from 0-3 cm and 3-10 cm sections). See table 1 for an overview of which biological parameters were sampled at each ice station.

	P8_ice	P9_ice	P10_ice	P11_ice
Ice-cores				
Chemistry 1	1	1	1	1
Chemistry 2	1	1	1	1
Physic (salinity)	1	1	1	1
Physic (stratigraphy)	1	1	1	1
Physic (density – 7 cm kovacs)	1	1	1	1
Physic (Archive)	1	1	1	1
P versus I	2	2	2	2
Primary production	2	2	2	2
Bio bulk	5	5	5	5
Phytoplankton experiment	1	1	1	1
Ice-algae taxonomy	1	1	1	1
Meiofauna/algae	3	3	3	3
SEM	1	1	1	1
XRF	3	3	3	3
Virus	3	3	3	3

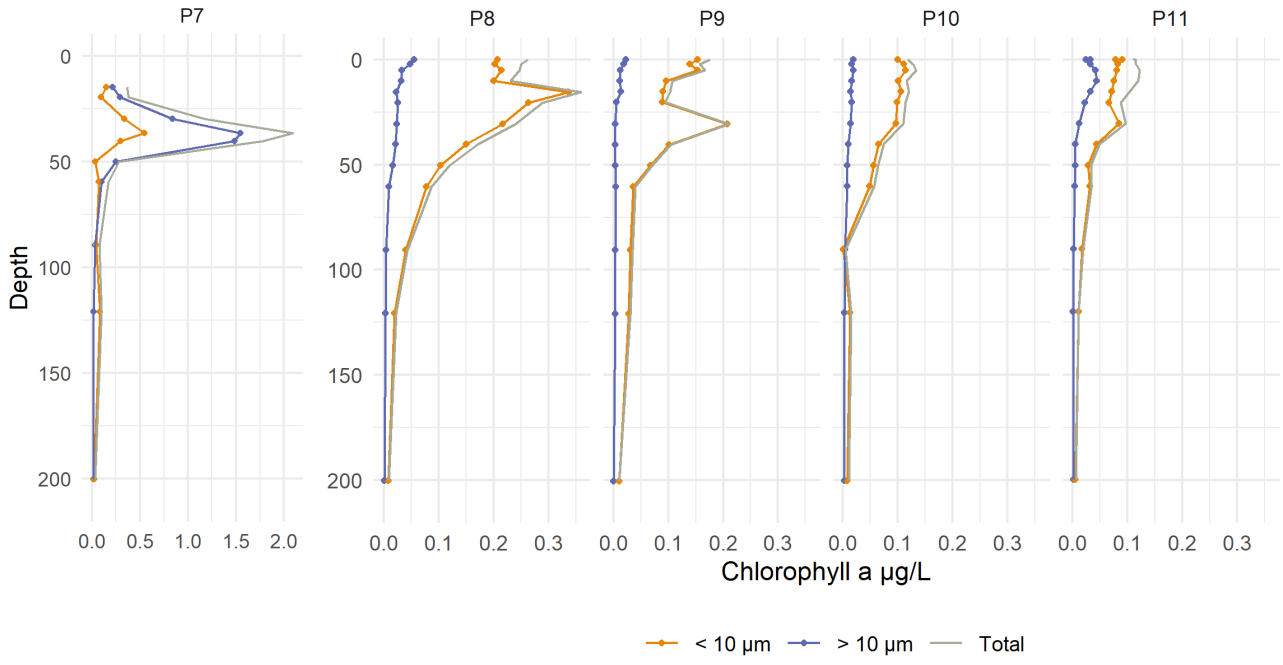
Nutrients/sal (bio)	1	1	1	1
Trace metals	4	3	4	4
Foraminifera	1	1	1	1

Some very preliminary results from JC2-2

The only parameter measured on board was algae biomass. Chlorophyll concentrations in the water column were generally low throughout the cruise with values decreasing along the transect (Figure 6-3). An exception was the southernmost station P7, where a pronounced peak in chlorophyll concentration was observed at 35 m depth with maximum values of 2.1 µg/L. P7 was also the only station where large (>10 µm) cells dominated the pelagic algae biomass. At all other stations pico and nano-plankton (<10 µm) made up the bulk of the photosynthetic cell biomass.

Algae biomass in the ice varied greatly between the four ice stations. Maximum chlorophyll concentrations were found in the 0-3 cm or 3-10 cm sections and varied from 0.4 to 3.9 µg/L, with the higher values found in the thicker ice at stations P9 and P11. Ice algae biomass was generally dominated by larger cells, although small cells were abundant in the lower sections at P11.

During the cruise a total of twelve melt ponds were sampled. Algae biomass in melt ponds ranged from very low to low (0.03-0.19 µg/L).



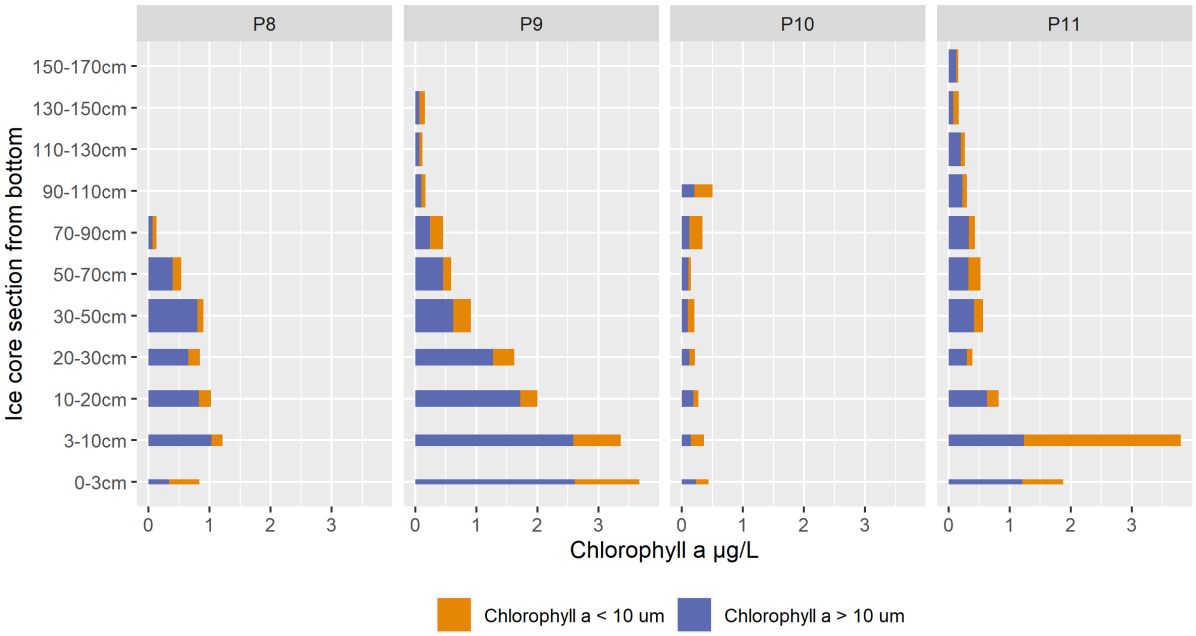


Figure 6-3 Algal biomass, measured as chlorophyll a concentration, in the watercolumn (top) and in sea ice (bottom). Note different scale on x-axis on the plot from P7. The pelagic plots from P8-P11 were made by combining values from samples taken under the ice (0-10 m) and from the ship CTD (15 m-bottom). NB: preliminary unpublished data.

On board light microscopy of collected samples showed that at the ice edge station P7 the protist community was characterized by high diversity and abundance. Large diatom species dominated the society, with large dinoflagellates and *Phaeocystis pouchetii* also abundant. Moving into the ice the water column protist community changed. Smaller organisms and heterotrophic species became more prominent while larger diatom species became scarcer. The protist community in the ice cores was dominated by pennate diatoms, but dinoflagellates and in particular heterotrophic species were also abundant. In the «other» group green flagellates, cryptomonads, chrysophytes and haptophytes were frequent. A *Melosira*-assemblage associated with sea ice was found at station P9.

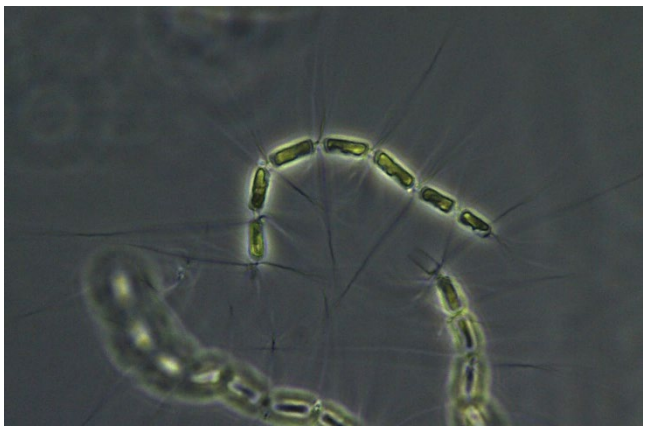


Figure 6-4: The diatom Chaetoceros gelidus is typical of the Arctic Ocean. Photo: Wencke Eikrem

6.6 T3-4.4 Sympagic-pelagic-benthic coupling

Jessie Gardner (UiT)

To assess the vertical flux at the P-stations along the cruise transect short-term sediment traps (KC-Denmark) were deployed (Table 6-9). Three configurations of traps were used; pelagic, under-ice and gel traps (Figure 6-5).

Pelagic sediment traps were deployed at P7, P8, P9, P10 and P11, with 4 cups attached at 8 depths (30, 40, 60, 90, 120, 200, 300 and 500 m) between 23 hours and 10 minutes and 27 hours and 50 minutes. Prior to the deployment, the cylinders were filled with pre-filtered deep water (500 m, filtered through a Sartorius filtration system) from the NLEG station before the corresponding station to make sure that the water within the cylinders had a higher density than at the sampling depths. Extra salt was added to the 500 m and 300 m to ensure a higher density. An anchor of 40 kg was fixed to the bottom of the mooring to keep it upright in the water column. To keep the traps neutrally buoyant in the water, floatation was attached at 5 m depth, and a surface buoy was kept at the top of the rig to ensure neutral buoyancy. A flagged pole equipped with an AIS beacon was used to mark the location of the mooring and to relocate its position for recovery. A small buoy with a long rope was attached to the pole for the recovery of the mooring. A chain was added as a connection between the flagpole and the top part of the mooring. Additional buoys accounting for the weight of the chain were attached to the flagpole-end of the chain. At P7 the trap was free floating, while at P8, P9, P10 and P11 the mooring was attached to an ice floe, where the chain was secured with two metal poles that were hammered into the ice (Figures 6-5, 6-6). After recovery, the traps from each depth were pooled into one canister and processed within 8 hours afterwards.

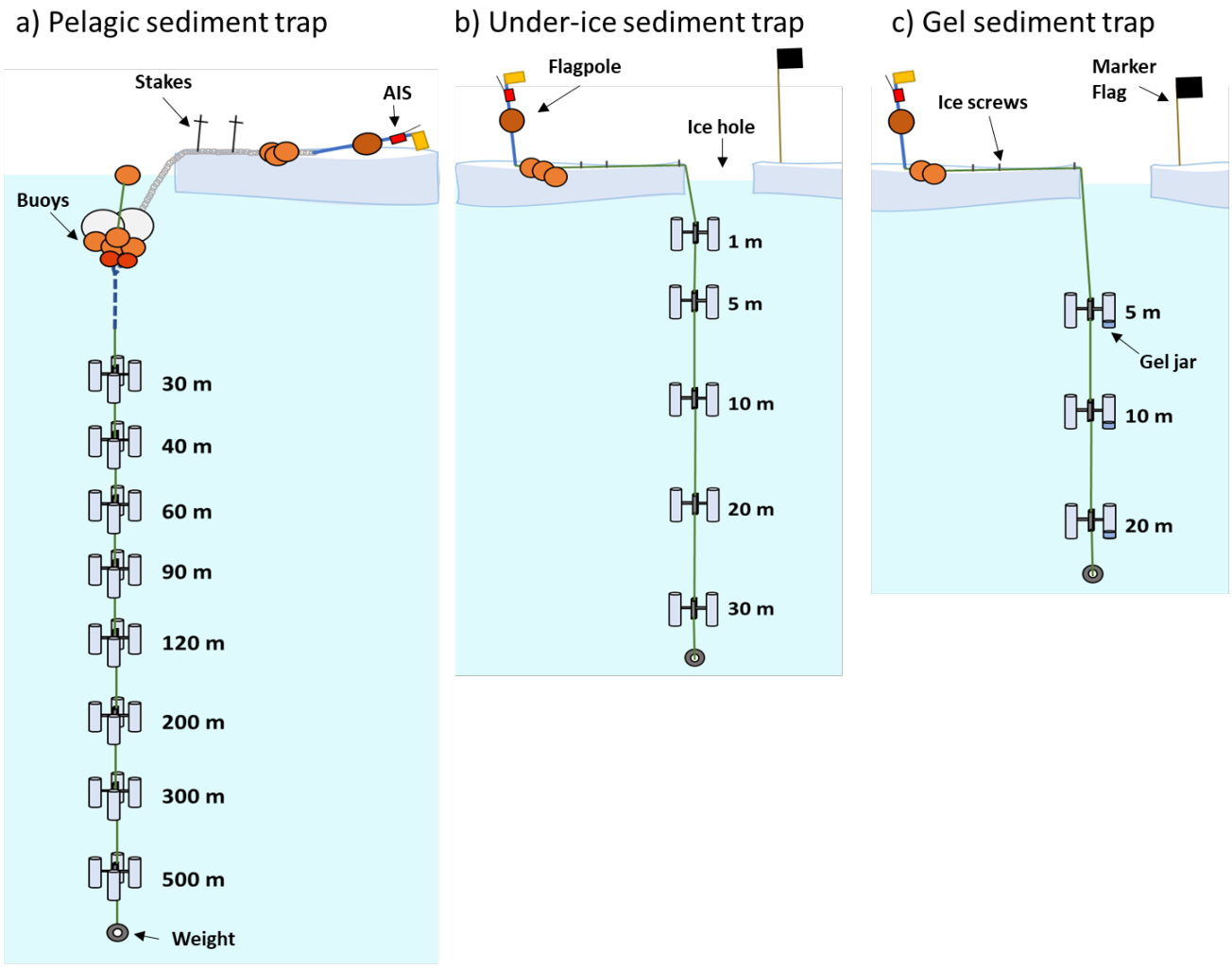


Figure 6-5. Schematic of the three configurations of sediment trap moorings deployed during JC2-2 between 28/08/21 and 16/09/21.

Under-ice sediment traps were deployed at P8-P11 through the ice hole within 20 m of the coring site (Figure 6-5 and 6-6). The same hole was used to collect under-ice water and for hand-held CTD deployments. The hole was created using a 20" ice auger, ice saws and slush removal equipment. Sediment traps with 2 cups attached were deployed at 1, 5, 10 and 20 m at P8-P11 and an extra trap was added at 30 m at P10 and P11. Deployments were for between 23 hours and 10 minutes and 25 hours 45 minutes. Prior to the deployment, the cylinders were filled with pre-filtered deep water (500 m, filtered through a Sartorius filtration system) from the NLEG station before the corresponding station to make sure that the water within the cylinders had a higher density than at the sampling depths. An anchor of 5 kg was fixed to the bottom of the mooring to keep it upright in the water column. Traps were fixed to the ice using 3 ice screws and attached to buoys and a flagged pole equipped with an AIS beacon in case relocation was required should the ice break up. The deployment spot was also marked with a flag on a bamboo stick. On retrieval both cups at each depth were pooled into a canister and processed within 4 hours.

*Figure 6-6. Deployed pelagic sediment traps under thin ice conditions found at P7 (**a**) and off the side an ice floe at P8-P11 (**b**). In addition, at P8-P11 under-ice and gel sediment traps were deployed through an ice hole (**c**). Traps were deployed between 28/08/21 and 16/09/21 on the JC2-2 AeN Nansen Legacy cruise. Photos: Jessie Gardner.*

Gel traps were deployed in parallel to the under-ice sediment traps through an additional ice hole 20 m from the coring site and 20 m from the under-ice sediment traps at stations P8-P11 (Table 6-9). Gel traps were prepared prior to deployment according to the Nansen Legacy sampling protocol version 9, section 14.6.6. The hole was also created using a 20” ice auger, ice saws and slush removal equipment. Gel traps with 2 cups attached were deployed at 5, 10 and 20m. Deployment time of 6 hours and 15 minutes to 16 hours and 55 minutes was chosen to prevent an overload of particles in the gel traps. After recovery, the gel traps were stored dark and cold for 4-6 h to allow particles to sink into the gel. The overstanding water in the trap cylinder was then gently siphoned out with a silicone hose and a 3 mL plastic pipette, but the last millimeter of water was left on the gel to prevent unintentional removal of particles. Gel jars were photographed and then frozen (−20°C) for later photography and image analysis ashore.

Table 6-9 Overview of sediment trap stations during AeN SSQ3 with deployment and recovery time, and the total time of deployment.

Station	Trap type	Deployment time (UTC)	Recovery time (UTC)	Total time of deployment	Deployment conditions	Deployment depths (m)
P7	Pelagic	28_08_21 15:48:56	29_08_21 19:38:57	27 hours and 50 minutes	In thin ice conditions	30, 40, 60, 90, 120, 200, 300 and 500
P8	Pelagic	01_09_21 21:59:10	02_09_21 21:40:12	23 hours and 41 minutes	Attached to an ice floe	30, 40, 60, 90, 120, 200, 300 and 500
	Under-Ice	01_09_21 12:20:00	02_09_21 11:30:00	23 hours and 10 minutes	Through Ice hole	1, 5, 10 and 20
	Gel	01_09_21 11:30:00	01_09_21 17:45:00	6 hours and 15 minutes	Through Ice hole	5, 10 and 20
P9	Pelagic	06_09_21 19:38:38	07_09_21 19:49:11	24 hours and 11 minutes	Attached to an ice floe	30, 40, 60, 90, 120, 200, 300 and 500
	Under-Ice	06_09_21 15:00:00	07_09_21 15:00:00	24 hours	Through Ice hole	1, 5, 10 and 20
	Gel	06_09_21 15:00:00	07_09_21 07:30:00	16 hours and 10 minutes	Through Ice hole	5, 10 and 20
P10	Pelagic	11_09_21 21:03:07	12_09_21 20:35:35	23 hours and 22 minutes	Attached to an ice floe	30, 40, 60, 90, 120, 200, 300 and 500
	Under-Ice	11_09_21 13:30:00	12_09_21 15:15:00	25 hours and 45 minutes	Through Ice hole	1, 5, 10, 20 and 30
	Gel	11_09_21 13:40:00	12_09_21 06:45:00	16 hours and 55 minutes	Through Ice hole	5, 10 and 20
P11	Pelagic	16_09_21 18:54:02	17_09_21 19:55:44	25 hours and 1 minute	Attached to an ice floe	30, 40, 60, 90, 120, 200, 300 and 500
	Under-Ice	16_09_21 13:30:00	17_09_21 15:15:00	25 hours 45 minutes	Through Ice hole	1, 5, 10, 20 and 30
	Gel	16_09_21 16:00:00	17_09_21 08:50:00	16 hours and 50 minutes	Through Ice hole	5, 10 and 20

Sampling largely followed the Nansen Legacy sampling protocol version 9, chapter 8. Upon recovery of the sediment traps, the cylinder content of each depth was pooled and partitioned. From each depth, water was filtered for triplicate POC/PON analyses on pre-combusted GF/F filters and for size fractionated algal pigments (total chl a (in triplicates on GF/F filters) and Chl a >10µm; on polycarbonate filters) and water samples were taken for microscopic counts of fecal pellets and phytoplankton communities. Filters for algal pigments were immediately extracted in methanol at 4°C and measured with a fluorometer on board ideally after 12-24 h. Faecal pellets were preserved in a hexamine-buffered 4% Formaldehyde solution and phytoplankton communities in GA-Lugol. Triplicate samples were filtered for stable isotopes (pre-combusted GF/F) and stored at -80°C, particulate biogenic silica (bSi; on 0,8 µm polycarbonate filters), HPLC (GF/F) IP25 (GF/F), nutrients (40 ml sterile-filtered over 0.22 µm GF/F filters into Falcon tubes), protist DNA and particle-associated bacterial DNA analyses (approx. 500 ml was filtered through sterivex filters or through 10 µm polycarbonate filters, respectively). DNA, IP25, HPLC and stable isotopes samples

were stored at -80°C. POC/PON, nutrients and BSi were stored at -20°C. Field blanks for POC/PON analyses were taken at all stations and stored at -20°C. For additional control of the pre-filtered water that was used for the deployments, samples for POC/PON, nutrients and chl a were taken from the pre-filtered water and processed as described above, usually after the recovery of the sediment traps.

6.7 T3-4.1 Trophic interactions of small invertebrates

Anna Vader and Snorre Flo (UNIS-UiT)

Purpose

Abundant large and deep-water copepods were sampled for the currently running "copepod diet project". The collected samples will be available for PhD student Snorre Flo. All samples are fixed in ethanol, kept cool (-20°C) and brought back to the lab at UNIS for dietary metabarcoding analysis. At UNIS, a number of each study species are picked, DNA is extracted from whole-body individuals, and further preparations are made for deep sequencing of the 18S small subunit (SSU) rRNA gene. Deep sequencing raw data are further processed in a bioinformatics pipeline to remove unwanted sequences (e.g. the sequence of the study-species itself, and symbionts), and with the help of an experimental control group (starved copepods).

Description of work

Individual copepods of selected carnivorous deep-water copepods were collected from the multinet or MIK net at P10 and P11 (Table 6-10). The copepods were transferred with forceps to ice-cold ethanol and kept cold (-20) until transported to UNIS for analyses.

Sample overview

Table 6-10 List of zooplankton samples. All samples were fixed with ice-cold ethanol (96%, -20°C) and put immediately in the freezer (-20°C).

Samples	P7	P8	P9	P10	P11
Paraeuchaeta sp. 3000-2000 m				x	x
Paraeuchaeta sp. 2000-2500 m					x
Paraeuchaeta sp. 100-0 m					x
Paraeuchaeta sp. 500-0 m					x
Paraeuchaeta sp., various depths. Kept in FSW for > 1 week		x	x	x	

6.8 T3-1 Characterize biological communities, and T3-4.3 Trophic links to fish: Fish and macrozooplancton sampling from trawl hauls

Birte Schuppe (IMR), Elena Eriksen (IMR), Espen Bagøien (IMR)

Objective

During the JC2-2 cruise the purpose was to map the pelagic fish and macrozooplancton taxonomic composition, abundance and biomass along the transect from P7 to P11. The equipment used to collect the samples included the pelagic Harstad trawl, which was fitted to trawl in icy conditions, and a krill trawl.

Description of work

In total, 12 trawl hauls were conducted, 8 of them with Harstad trawl and 4 of them with Krill trawl at a maximum depth of 450 m and for a maximum time of 30 minutes (Table 6-11). Two trawl hauls were conducted at each station, representing different depth layers of the strongest acoustic signal. The decision of the depth to be trawled was made by using the EK80, showing acoustic signals mostly between 300 – 450 m and fewer signals in the upper 50 m. The cod ends of the trawls were mesh sizes of 8 mm for the Harstad and Krill trawl, respectively. The following table gives and overview of the trawl hauls. For the first time in the Nansen Legacy and IMR history, trawls were conducted so far north, from latitude 83 - 87 °N.

Table 6-11. Overview of pelagic trawling activities conducted during JC-2

Gear	Purpose	Station, latitude	Max. Depth sampled
Harstad trawl	Fish and Macrozooplancton abundance, taxonomy, and biomass.	P7 81,8608	50m, 450m
Harstad trawl	Fish and Macrozooplancton abundance, taxonomy, and biomass.	P8 83,7185	150m, 450m
Harstad trawl(first), Krill trawl (second)	Fish and Macrozooplancton abundance, taxonomy, and biomass.	P9 84,9571	548m, 537m (strongest acoustic signal)
Harstad trawl(first), Krill trawl (second)	Fish and Macrozooplancton abundance, taxonomy, and biomass.	P10 85,5209	210m, 347m (strongest acoustic signal)
Harstad trawl(first), Krill trawl (second)	Fish and Macrozooplancton abundance, taxonomy, and biomass.	P11 87,4595	483m, 482m (strongest acoustic signal)
Harstad trawl(first), Krill trawl (second)	Fish and Macrozooplancton abundance, taxonomy, and biomass.	NLEG39 86,6043	460m, 414m (strongest acoustic signal)

Sample processing included measuring the total catch weight, sorting and identifying the catch to the lowest taxonomic level possible of fish and macrozooplankton, and measuring the weight and abundance of each taxonomic group. For jellies, weight and the bell diameter were measured. For the fish species, sample weight, individual weight and length were measured, and a fin clip was collected and preserved in EtOH for genetic analyses. The fish and some macrozooplankton samples were stored in -20°C

freezer. The sorted macrozooplankton were weighed by groups at the lowest taxonomic level possible and then fixed in formaldehyde for detailed taxonomic identification in future. Pictures of the catch and the sorted groups were also taken for reference.

Preliminary results

In general, the acoustics on the EK80 showed very low signals. In total, 7 fish were caught (at P7, P8 and NLEG39), 5 of them were identified as Northern Lanternfish (family Myctophidae), one polar cod (*Boreogadus saida*) (Figure 6-7) and one juvenile halibut. The macrozooplankton diversity caught in each trawl haul included Arctic species like *Hymenodora glacials*, *Themisto* spp., several species of *Calanus*, *Eusirus* and *Cyclocaris guilelni*. The biomass of macrozooplankton caught with the Krill trawl was much higher than the biomass caught by Harstad trawl.

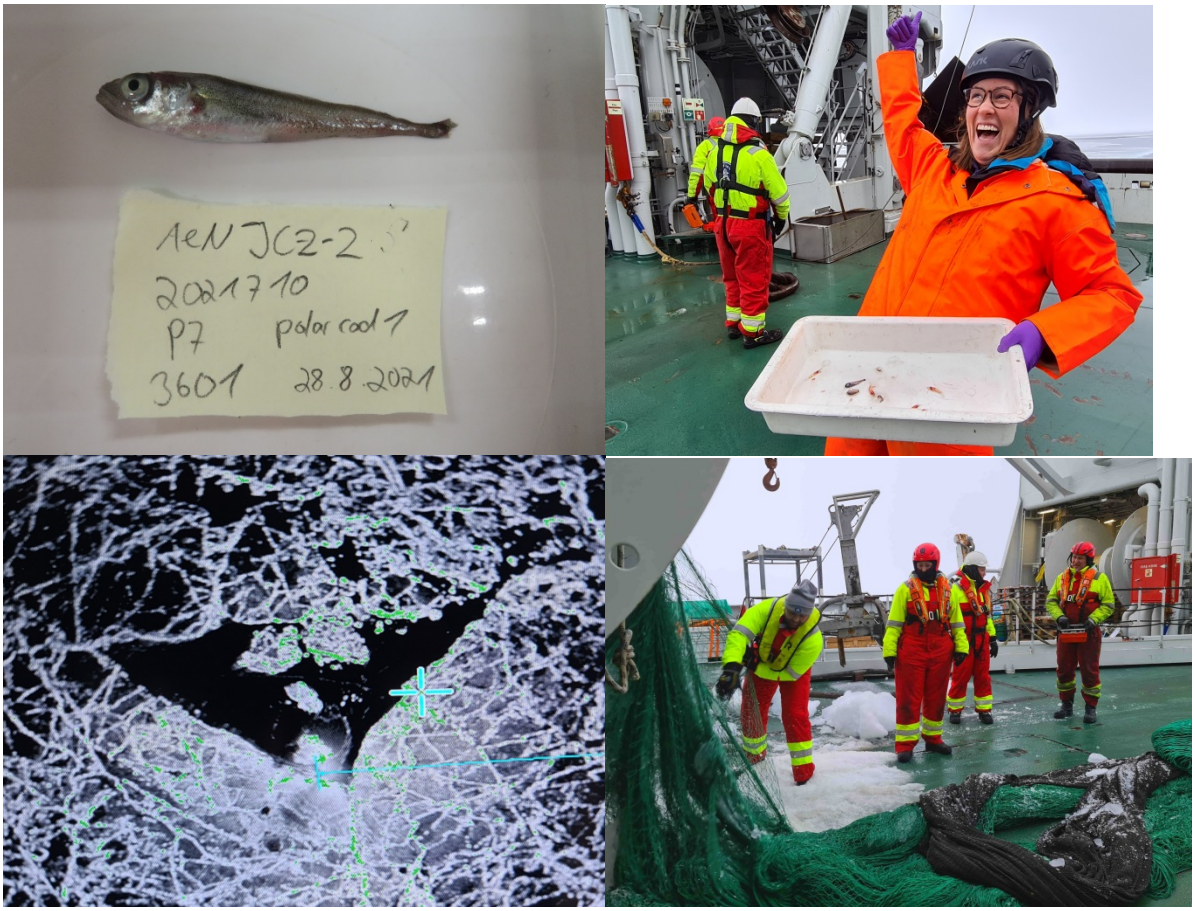


Figure 6-7 Fish-related activites. Polar cod at P7 (top left, photo by Birte Schuppe), the rare fish catch (top right, photo Bodil Bluhm), lead used for trawl operations in sea ice cover (bottom, photos Bodil Bluhm).

6.9 T3-1-1 Benthic biodiversity, T3-1.2, and T3-4.4 Sympagic-pelagic-benthic coupling, and RF1 T1-3 Biological proxies

Field team Arunima Sen (UNIS), Amanda Ziegler (UiT/IMR), Birte Schuppe (IMR) and Christine Lockwood-Ireland (UiT/UNIS), Bodil Bluhm (UiT)

Aims

The aims of the group were to:

1. ***T3-1-1: Characterize and quantify biota of the Arctic Basins*** by sampling sediment communities for biodiversity and abundance/biomass assessments; specifically microbes (PI Lise Øverås, UiB), benthic foraminifera (PIs Elisabeth Alve, and Silvia Hess UiO), multicellular meiofauna (PI Bodil Bluhm) and macro-infauna (PIs Paul Renaud, APN and Bodil Bluhm, UiT).
2. ***T3-1-1: Characterize biota of the Arctic Basins*** by collecting voucher material of benthic macro- and megafauna to be archived at the UiT Museum for a legacy of physical material of the project (PIs Bodil Bluhm, Andreas Altenburger UiT)
3. ***T3-1-2: Relate environmental conditions to biological communities*** by sampling for sediment properties (grain size and porewater chemistry), indicators of food availability (total organic carbon and nitrogen, sediment pigment amount) and food sources ($\delta^{13}C/\delta^{15}N$, pigment composition) (PIs Elisabeth Alve and Silvia Hess, UiO and Paul Renauld, Akvaplan-niva)
4. ***T3-4-4: Sympagic-pelagic-benthic coupling*** by sampling representative benthic invertebrate taxa for stable carbon and nitrogen stable isotope analysis (PIs Bodil Bluhm, UiT and Lis Jørgensen, IMR)
5. ***T3-4-4: Sympagic-pelagic-benthic coupling*** by conducting sediment community respiration incubation experiments onboard (PI Paul Renaud, APN). Experimental treatments include ambient temperature (T1), ambient temperature with 30mg of added algae (T2), ambient temperature +2°C (T3), and ambient temperature +2°C with 30mg of added algae (T4). Unlike the AeN seasonal cruises, added algae was not isotopically enriched except at P11.
6. ***T3-4-4: Sympagic-pelagic-benthic coupling*** by sampling sediment for IP_{25} analysis and biogenic silica as indicators of ice algal food available to the sediment communities (PI Marit Reigstad).
7. ***T3-4-4: Trophic ecology of benthos*** by sampling benthic meiofauna for molecular characterization of diets of small benthic invertebrates (PI Anna Vader, UNIS and Bodil Bluhm UiT).
8. ***RF1 T1-3: To help to interpret changes in sea-ice distribution, paleoproductivity, and related environmental conditions during the past 2 kyrs*** by using results gained by living benthic foraminiferal assemblages and associated parameter analyses of surface and sub-surface sediments (PIs Elisabeth Alve, Silvia Hess, UiO and Tine L. Rasmussen, UiT)
9. ***RF2 - T2-1.2 Ocean acidification effects on the mobility of particulate and dissolved organic carbon (POC, DOC), essential trace elements (micro nutrients) and heavy metals and rare earth elements*** by sampling sediment sub-samples for trace element analysis by sequential sediment extraction (PI Murat Ardelan and Tomasz Ciesielski, NTNU).

Sampling sites and strategy

Sampling largely followed the Nansen Legacy sampling protocol version 9 (with the difference that sieving for animals was done over a 250 µm sieve as opposed to 500 µm due to the reduced body size of deep-sea animals). At all P stations, 3 successful box cores were collected from which sediment properties, respiration sub-cores and macrofauna for isotope analyses were collected. In addition, 23 sediment sub-cores for paleo studies were taken either from the same box cores or from an additional cast when time permitted (Table 2). The sedimentology and foraminiferal content of the paleo sub-cores will be investigated and used in paleo-studies to reconstruct the past environment and oceanography of the central Arctic Ocean.

Station P7

The first box core cast yielded a very disturbed surface. Therefore, this box core sediment was used exclusively for collecting organisms for stable isotope analyses via sieving. The next three box cores yielded better surfaces and were thoroughly sampled for all required sediment parameters (sediment properties and respiration sub-cores) as well as for paleo studies (Figure 6-8, Tables 6-11, 6-12).

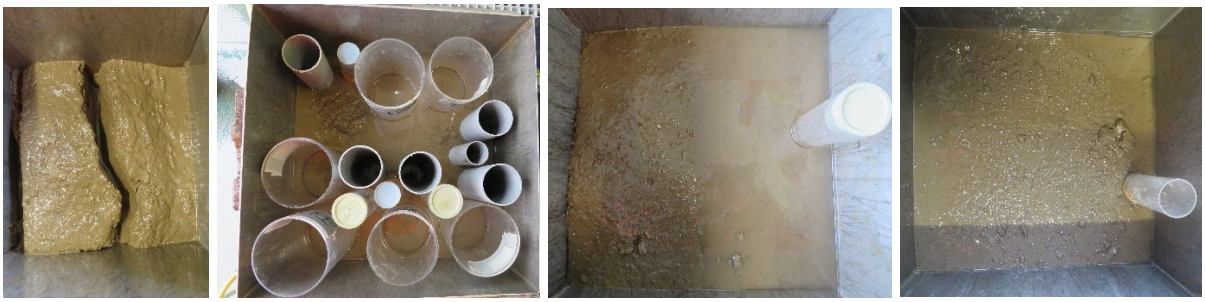


Figure 6-8 Box cores 1-4 (in order from left to right) from P7.

The sediment was primarily composed of homogenous, brown clay/silt with the presence of some large (>2 cm) clasts. The box cores from P7 had less fauna than on seasonal cruises and lacked conspicuous fauna (e.g. *Spiochaetopteris typicus*, Siboglinids, maldanids, etc). Instead, sipunculans, sponges, annelids and some crustaceans (tanaids and cumaceans) were present. *Pirgo* sp. and large red foraminifera were present in high abundances similar to on seasonal cruises.

Station P8

A single box core was taken for paleo studies on the 2nd night at the P8 station. On the third night at the station, three box cores were taken which were sampled for all required parameters (Figure 6-9).

Figure 6-9 Box cores from P8. From left to right: box core paleo, box core 1, box core 2, box core 3.

Texturally the sediment was comprised of homogenous, brown very fine sandy silt with abundant *N. pachyderma* (foraminifera) in the top 2 cm with clay below. The sediment in the base of the box core was compact, very-fine sandy silt.

No macrofauna was found in any of the box cores. Based on this, it was decided to sieve a subset of the incubation cores over a 63µm sieve. Accordingly, 1 nematode was retrieved from 63um sieved incubation cores. The sediment was dominated by foraminifera including benthic (several types) and planktic (*N. pachyderma*) rather than by *Pirgo* sp. and red foraminifera like at P8. Some of the planktic forams were alive, but most were opaque white indicating they were dead/fossil remnants. Additionally, a lot of sponge spicules were present; these were both large (0.5cm) and small (1mm or less), but all of similar shape. In addition, many radiolarian tests, ostracod shells and fine sand grains were present.

Station P9

Four successful box cores were recovered at this station allowing for collection of paleo sub-cores as well as porewater and methane samples (Figure 6-10, Table 6-11). Sediment surfaces of all replicate cores were well preserved and had clear surface water. The third replicate box core also had many bivalve shells (dead) and serpulid tubes on the surface as well as markings that could have been from epifauna burrowing.

Figure 6-10 Four replicate box cores from the P9 station.

The sediment was composed of homogenous, brown very fine-fine sandy silt in the top 7 cm. A prominent 0.7 cm-thick light greyish brown, medium sand layer was observed between 7-7.7 cm with sharp upper and lower contacts. Below this, the sediments were fine sandy silt with a gradual transition to brown, very fine-fine sandy silt with increasing matrix towards the base of the core.

After sieving, sediment was dominated by foraminifera, again mostly *N. pachyderma* and some benthic species, as well as a lot of fine sand, sponge spicules, and some volcanic rock pieces (Figure 6-11). There were more live planktic forams than at previous stations which appeared more translucent and filled with light orange/brown cytoplasm compared to previous stations. Very few macrofauna were found including 2 tanaids and 1 sponge (Hexactinellida). After sieving on 63um there were still no nematodes present in incubation cores.

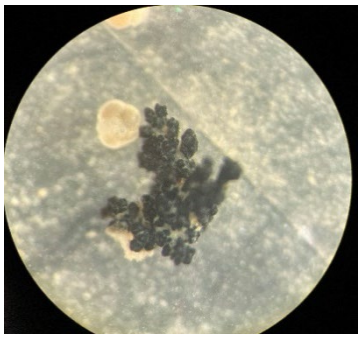


Figure 6-11 Pieces of what appeared to be volcanic rock retrieved from the box cores at P9. Note also the foram in the image

Station P10

Five replicate box cores were collected at P10 (Figure 6-12 to 6-14). The first cast yielded a core that was not ideal, yet we utilized this sample for paleo studies. The second core had a more intact surface, so it was sampled for all of the required parameters. The third cast failed yielding a very disturbed core so only the surface 5cm was sieved for isotope analyses. The fourth core had a very sloped surface and cracks, so we used the small area of undisturbed surface for some required parameters (Table 1). Finally, the fifth cast yielded a core that was similar in quality to the fourth core but with more surface intact, thus we sampled this core similarly to the fourth (Table 1). In total, 16 respiration sub-cores were collected for an experiment with 4 treatments each with 4 replicates. Images below correspond to BC paleo, and 1-3. Missing image for box core cast 3. Porewater samples were not taken from this station since water was seen running out of the box cores upon retrieval.

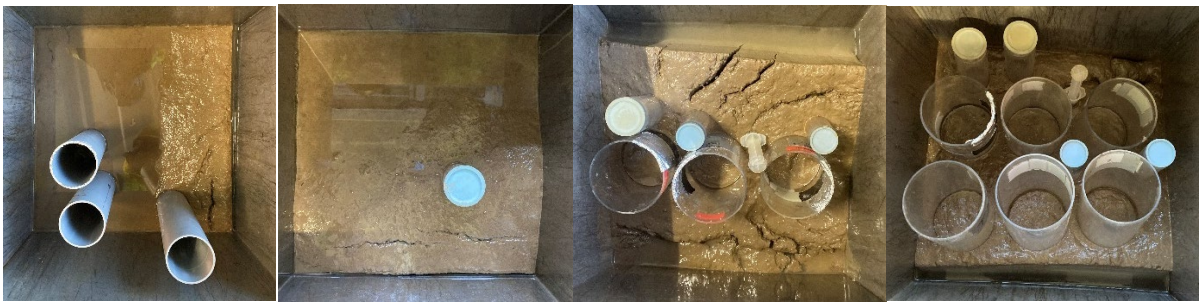


Figure 6-12 Four of the five replicate box cores taken at P10 (excluding failed cast 3).

Texturally the sediments were comprised of brown clay-silt in the top ~13 cm of the box core. A prominent layer of clasts (~0.5 cm-thick) was observed in at least box cores 1 and 2 (figure below). The clasts were shiny black, sub-angular (<0.5 cm) and easily crushed, leaving a coal-like/oily residue on the fingers. All box core replicates had a layer of dense, fine sand with no water content approximately 20 cm below the surface, that was about 2 cm thick and a second layer present at the bottom of the core, which likely contributed to the difficulty coring at this station.

Figure 6-13 Prominent layer of black clasts observed on the outside of the box core 1 at P10.

A 11 cm-thick section was removed from the base of box core 1 and the sediment sequence was logged (figure below).

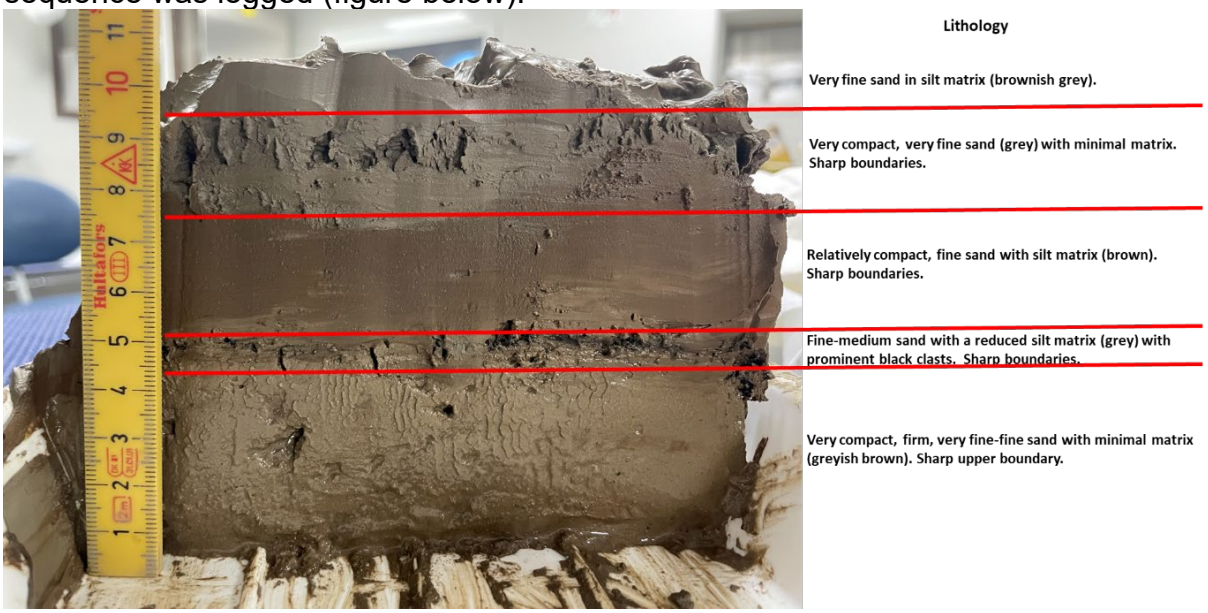


Figure 6-14 Preliminary lithological log of the sedimentary sequence recovered from the base of box core 1 at P10.

After sieving, we found that the sediment was dominated by foraminifera, again *N. pachyderma* and few benthic species. Fewer living planktic forams were present than at P9 and there were still a lot of sponge spicules and fine sand grains.

Station P11

Five replicate box cores were collected at P11 (Figure 6-15). The first core was very disturbed so we only sampled for isotopes, metals, and meiofaunal diets. The second core was similar, but to maximize sampling we collected 3 respiration sub-cores and most of the required sediment parameters (Table 6-11). The third core was similarly sloped, thus we targeted the small area of undisturbed sediment surface. The fourth box core came to the surface tangled in the cable, but surprisingly the surface of the sediment was undisturbed. We sampled all sediment parameters from this box core. Finally, the fifth box core cast yielded an intact core with minimal disturbance so the remaining respiration sub-cores and required sediment parameters were all sampled. A total of 12 respiration cores were collected across all 5 box cores for an experiment with 4 treatments of 3 replicates each. Porewater samples were not taken from this station since water was seen running out of the box cores upon retrieval.

Figure 6-15 All five box cores taken at P11 in the Amundsen Basin.

The sediment was composed of brown clay/silt in the surface. A prominent 2.5-3 cm-thick very compact layer of grey, very fine sand with minimal silt matrix was observed at ~3 cm and another similar layer towards the base of the core. Large (3-5 cm), thin (2 mm), greyish black, plate-like clasts were observed in the base of the box core.
After sieving we found that the sediment was dominated by foraminifera but very little material remained after sieving. We found few polychaetes and 1mollusc (possibly of the family Thyasiridae) from all 5 box cores. No meiofauna (i.e. nematodes) were found in the incubation cores even after sieving on 63um sieve. Lots of fine sand still present though much less than other stations.

Table 6-11: Overview of stations sampled for each of the different activities. Numbers in parentheses indicate number of sediment layers.

Sample Type	Task	PI/Responsible	Institution	P7	P8	P9	P10	P11
Sediment microbes biodiv	T3-1-1	L. Øvreås	UiB	3 (6)	3 (6)	3 (6)	3 (6)	3 (6)
Meiofauna biodiv/abun	T3-1-1	E. Alve/S. Hess/T. Freitag	UiO	3 (6)	3 (6)	3 (6)	3 (6)	3 (6)
Macrofauna biodiv/abun	T3-1-1	B. Bluhm/P. Renaud	UiT/APN	3	4	4	5	5
Macrofana ($\delta^{13}C/\delta 1^{5}N$)	T3-4-4	A. Ziegler/Lis L. Jørgensen/B. Bluhm	UiT/IMR	3	4	4	5	5
Grain size, TOC/TN, $\delta^{13}C/\delta^{15}N$	T3-1-2	E. Alve	UiO	3 (6)	3 (6)	3 (6)	3 (6)	3 (6)
Sediment Chl / phaeopigments	T3-1-2	P. Renaud	APN	3 (8)	3 (8)	3 (8)	3 (8)	2 (8), 1 (4)
Sediment pigment compositon	T3-1-2	P. Renaud	APN	2 (1)	3 (1)	3 (1)	1 (1)	3 (1)
Incubation experiments	T3-4-4	P. Renaud/A. Sen	APN/UNIS	20	20	20	16	12
Nutrients pre-incubations	T3-4-4	P. Renaud/A. Sen	APN/UNIS	20	20	20	16	12
Nutrients post-incubations	T3-4-4	P. Renaud/A. Sen	APN/UNIS	20	20	20	16	12
Sediment IP_{25}	T3-4-4	M. Reigstad/Y. Bodur	UiT	2 (1)	3 (1)	1 (1)	1 (1)	3 (1)
Meiofauna molecular diet	T3-4-4	S. Flo/A. Vader/B.Bluhm	UNIS	2	3	3	2	3
Trace metals/REE	RF2	M. Adelan/T. Cieleiski	NTNU	2	3	4	3	3
Biogenic silica	T3-4-4	Y. Bodur/ M. Reigstad	UiT	2 (2)	3 (2)	3 (2)	1 (2)	3 (2)
Porewater chemistry	T3-1-2	Tine L. Rasmussen	UiT	2 (6)	1 (8), 1 (7)	2 (6)	-	-

Methane/headspace	T3-1-2	Tine L. Rasmussen	UiT	1 (3)	1 (5)	1 (4)	-	-

Table 6-12: Paleo subcores taken during the JC2-2 cruise.

Station	Box core	Subcore name	Core length (m)	Storage
P7	BC1	NL-KH21-710-P7-BC1-A	0.28	Cold (4 °C)
P7	BC1	NL-KH21-710-P7-BC1-B	0.25	Cold (4 °C)
P7	BC1	NL-KH21-710-P7-BC1-C	0.25	Cold (4 °C)
P7	BC1	NL-KH21-710-P7-BC1-D	0.24	Frozen (-20 °C)
P7	BC1	NL-KH21-710-P7-BC2-E	0.18	Frozen (-20 °C)
P8	BCpalaeo	NL-KH21-710-P8-BCpalaeo-A	0.22	Cold (4 °C)
P8	BCpalaeo	NL-KH21-710-P8-BCpalaeo-B	0.22	Cold (4 °C)
P8	BCpalaeo	NL-KH21-710-P8-BCpalaeo-C	0.21	Frozen (-20 °C)
P8	BCpalaeo	NL-KH21-710-P8-BCpalaeo-D	0.23	Cold (4 °C)
P8	BCpalaeo	NL-KH21-710-P8-BCpalaeo-E	0.21	Frozen (-20 °C)
P9	BCpalaeo	NL-KH21-710-P9-BCpalaeo-A	0.23	Cold (4 °C)
P9	BCpalaeo	NL-KH21-710-P9-BCpalaeo-B	0.21	Cold (4 °C)
P9	BCpalaeo	NL-KH21-710-P9-BCpalaeo-C	0.21	Cold (4 °C)
P9	BCpalaeo	NL-KH21-710-P9-BCpalaeo-D	0.21	Frozen (-20 °C)
P9	BCpalaeo	NL-KH21-710-P9-BCpalaeo-E	0.21	Frozen (-20 °C)
P10	BCpalaeo	NL-KH21-710-P10-BCpalaeo-A	0.17	Frozen (-20 °C)
P10	BCpalaeo	NL-KH21-710-P10-BCpalaeo-B	0.19	Cold (4 °C)
P10	BCpalaeo	NL-KH21-710-P10-BCpalaeo-C	0.19	Frozen (-20 °C)
P10	BCpalaeo	NL-KH21-710-P10-BCpalaeo-D	0.18	Frozen (-20 °C)
P10	BCpalaeo	NL-KH21-710-P10-BCpalaeo-E	0.20	Cold (4 °C)
P10	BC1	NL-KH21-710-P10-BC1-F	0.21	Cold (4 °C)
P11	BC2	NL-KH21-710-P11-BC2-A	0.20	Cold (4 °C)
P11	BC3	NL-KH21-710-P11-BC3-B	0.14	Cold (4 °C)

7. Safety implementations for JC2-2 sea-ice work

Eirik Hellerud (NPI), Kunuk Lennert (UiT)

Figure 7-1. Polar bear visit at ice station P9. Photo: Kay Jørgensen.

Establishing the ice stations: Toolbox meeting

Upon establishing the ice stations, a toolbox meeting was held with KPH Bridge, Cruise leaders, Safety Officers & Team Leaders for the various science groups planning to work on sea ice. Depending on the conditions of the day as viewed from the bridge, regarding factors directly/indirectly affecting the safety at play, such as visibility, polar bears, cold/wind, remoteness, SAR cover – the plan of the day and the overall structure of the ice-floe was set. Scientists were given the opportunity to explain plans for the coming days, come with suggestions for their work, and map it all out on a Whiteboard sheet. This provided an overview and set a common understanding for the workstations. In addition, the toolbox meeting gave backing for what safety equipment to wear and bring along in the individual groups. As cruise leaders and polar bear watches on bridge worked on shift, the drafted whiteboard *"plan of the day"* also helped to increase situational awareness in-between work shifts. A bullet point for future operations with KPH is to acquire a fixed whiteboard and/or flipover to be permanently placed on bridge.

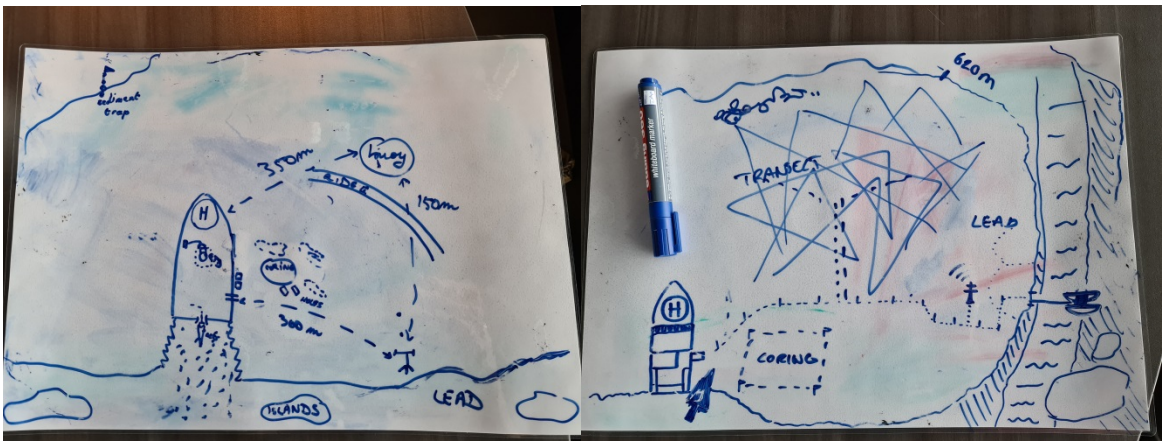


Figure 7-2 Examples of Plan of the day for sea ice sampling on a makeshift whiteboard. Photos: Bodil Bluhm.

Assessing the ice floe & setting up workstations

SAFETY EIRIK HELLERUD		
Comms/gear	ID	Comment
VHF	MAR 06	2 Extra batteries
Inreach	NP LYB 06	In suit
Iridium	+8816 2141 6390	In backpack
Signalpistol	1	25 flares
Ruger	NP 30 (791-76384)	10 rounds
AIS	Yes	On belt
First Aid	1 kit	Lommeapotek
PLB	LC2325	On belt
Binoculars	8x40	On suit
Ice belt	Yes	Throwing rope, ice spikes

SAFETY KUNUK LENNART		
Comms/gear	ID	Comment
VHF	MAR 06	2 Extra batteries
Inreach	None	None
Iridium	+8816 4141 0726	In backpack
Signalpistol	1	25 flares
Ruger	NP 33 (791-76380)	10 rounds
AIS	Yes	On belt
First Aid	1 kit	Lommeapotek
PLB	LC2316	On belt
Binoculars	8x40	On suit
Ice belt	Yes	Throwing rope, ice spikes

Figure 7-3 Safety equipment carried by safety officers on JC2-2

When a potential ice floe was chosen, safety officers would access the ice by crane or gangway and inspect the overall thickness and quality of the ice. For operations with snowmobiles, NPI procedures are set at minimum 30 cm thickness (10 cm on foot). Upon checking the ice with a drill and Kovacs 2-inch ice auger, we could verify the thickness to be over the required thickness for all ice stations on this cruise. Once the ice was assessed to be safe, a further check for cracks was conducted

particularly in the vicinity of the gangway. Crew would then be given a green light to unload the snowmobiles and gear from KPH onto the ice.

ICE GROUP 01: LEAD SAMPLING (Karen, Øyvind, Zoe)		
Comms/gear	ID	Comment
VHF	MAR 06	Karen, Øyvind, Zoe
Inreach	NP LYB 05	Øyvind
Iridium	+8816 2141 6392	In emergency bag 01
Signalpistol	Signalpistol x3	Karen, Øyvind, Zoe
Ruger	NP 35 (791-98278)	10 rounds
AIS	Yes x3	Karen, Øyvind, Zoe
First Aid	1 kit	Lommeapotek
Emergency bag	01	Food, tent etc.
PLB	LC2317	In emergency bag 01
Ice belt	Yes x3	Throwing rope, ice spikes

ICE GROUP 02: Adam, Anca		
Comms/gear	ID	
VHF	MAR 06	Adam, Anca
Inreach	NP Longyear 04	Adam
Iridium	+8816 4141 0999	Backpack
Signalpistol	Signalpistol	Adam, Anca
Ruger	NP 13 (791-73729)	10 rounds
AIS	Yes	On belt
First Aid	1 kit	Lommeapotek
PLB	LC2486	On belt
Icebelt	Yes, x2	Throwing rope, ice spikes

ICE GROUP 03: CORING SITES NEAR KPH		
Teams	Team Leads	Other members
Hole & Water team	Jessie	Even, Nadiedja
Coring #1	Miriam	Marti, Even, Anna
Coring #2	Anette	Bonnie, Nicolas
Coring #3	Adam	Anca
VHF on Team Leads/ Ice-belts accessible for all		
ICE GROUP 03: CORING SITE POLAR BEAR GUARD		
Comms/Gear	ID	Comment
VHF	MAR 06	1
Ruger	NP 17 (791-76397)	10 rounds
Signalpistol	1	15 flares
Binoculars	8x40	On suit
Teams	Team Leads	Other members
Hole & Water team	Jessie	Even, Nadiedja
Coring #1	Miriam	Marti, Even, Anna
Coring #2	Anette	Bonnie, Nicolas
Coring #3	Adam	Anca
VHF & Flaregun on Team Leads/ Ice-belts accessible for all		

Figure 7-4 Safety equipment supplied to the three ice teams that often worked in parallel during JC2-2.

Based on the information from the toolbox meeting, snowmobile routes would be established towards workstations further away from the ship. These trails were marked with bamboo sticks and checked with the ice drill continuously. If the overall impression of the ice floe was good, a peripheral track occasionally was set to further the overview. The routes provided easy going logistics on the ice, a good overview of the entire ice floe condition, and acted as evacuation routes back to the ship - if necessary. The two snowmobiles with sleds proved to be a very useful Safety-tool for us during this cruise. As an example, personnel on sea ice had to be transported back to the ship by snowmobile, when a Polar Bear visited our ice station at P9. Also, when visibility varies throughout the day, having a Snowmobile nearby gave comfort in knowing that we easily and quickly could return to KPH. In the event of an ice-floe breakup this would of course change, thus the need to issue emergency bags for groups working on separate ice-floes or far away from the ship (IMR/NPI procedure).

Visibility & Temperature management

Visibility dictates the work range from ship which is decided in the toolbox meeting at the beginning of the day, and this should be flexible. This means that the scientists who works

further away from ship should have an alternative plan on the “Whiteboard, plan of the day” in case visibility improves during the day. This should eliminate confusion on the bridge, if scientists expand their working area during the day and between crew and responsible shifts - just by saying on the radio that they are using the alternative route plan due to improvement of visibility. Communication over VHF in these situations are key, in order to agree both on bridge and on the ice, about where to draw the line. To ease the job for polar bear overwatch on the bridge, an improvement point for could be to issue markers on the ice with a 100 m spacing (e.g. flags). Distance could easily be set with a rangefinder. That way there would be no doubt as to the extent of visibility, and the actual range could easily be communicated.

Figure 7-5 Safety equipment used during JC2-2 and for the most part supplied by the Norwegian Polar Institute.

Temperatures on the JC2-2 cruise ranged between -1 and -9 °C. In combination with wind however, windchill could at times make it an effort to stay warm during stationary work such as polar bear guarding, ice coring or winch-operations. On certain scientific sampling where work had to be performed near a lead or on thinner ice, the Viking Survival suits were worn. For work on stable ice near KPH, Regatta suits were worn (per IMR/NPI Procedure). Though the Viking suit is waterproof, it is also colder to wear. The steel shoe tip has a particular cold-effect on the feet, and overshoes were needed to stay warm. As to the safety on ice, Regatta suits are warmer and easier to regulate temperature with. A choice between the two should therefore include an assessment of the factors above. Another challenge for some of the scientific work, is overheating when preparing for the day, resulting in a wet base layer and then the following potential of getting cold when the work becomes more stationary. Normal winter clothing could in these cases be considered worn in combination with a lifejacket on upcoming cruises, to ease ventilation. (Note any change in mandatory work clothes would need to be implemented with IMR-NPI decision makers).

Overwatch, personnel and equipment management

In order to keep track of personnel and equipment on the ice, checking personnel in and out via VHF to the bridge by the gangway was routine. An overview of all names was listed on a whiteboard, combined with magnets indicating **"ON ICE"** or **"ON SHIP".** The wording is important, to avoid miscommunication over VHF. In addition, the list of the distributed safety gear gave an overview of who-has-what, in the event of VHF loss etc;

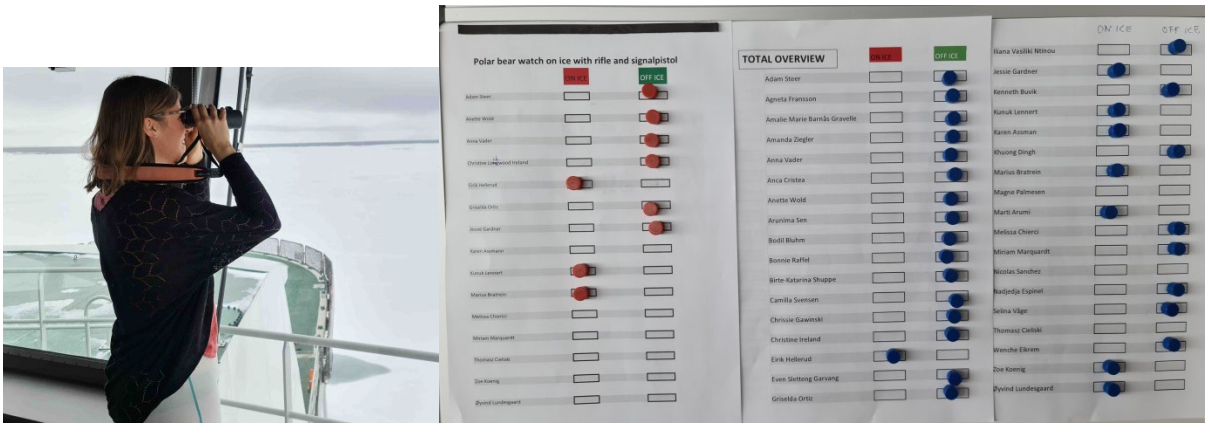


Figure 7-6 During work on ice the work areas and beyond were monitored by three on-bridge polar bear watches covering different sectors of the area, as well as one on-ice bear watch per ice team. Persons on ice were listed as working on ice and those carrying guns were marked as such continuously during ice work. Photos: Bodil Bluhm.

Polar bear watch on the bridge is a must have for this type of fieldwork. It however interferes with the lab-work for the scientists assigned to lookout in-between their work.

8. Outreach

Outreach activities conducted during JC2-2 included 13 blogs sent to forskning.no and sciencenorway.no on a variety of research topics investigated during the expedition (Table 8-1; full texts are in Appendix 3). Blogs were authored primarily by cruise participants, but in several cases also by other Nansen Legacy researchers leading or associated with a particular task.

Table 8-1: Titles and authors (with affiliations) of blogs associated with JC2-2, in the sequence posted on sciencenorway.no and forskning.no

Title	Author(s)
Three good reasons to visit the Arctic Basin in 2021	Marit Reigstad (UiT), Agneta Fransson (NPI), Bodil Bluhm (UiT)
Into the deep unknown central Arctic Basin	Agneta Fransson (NPI), Bodil Bluhm (UiT)
Where food is delivered only once a year	Amanda Ziegler (UiT, IMR)
Will the future ocean be greener?	Rolf Gradinger (UiT), Wenche Eikrem (NIVA), Marti Amargant Arumi (UiT), Phillip Assmy (NPI)
Cracks in the cooking pot lid	Øyvind Lundesgaard (NPI), Melissa Chierici (IMR), Agneta Fransson (NPI)
Polhavet – utilgjenglig, ukjent og i endring	Camilla Svensen (UiT), Anna Vader (UNIS)
The Central Arctic Ocean, no longer the once forgotten no man's land	Bodil Bluhm (UiT), Tomasz Ciesielski (NTNU)
The Arctic Ocean blender system	Zoe Koenig (NPI, UiB), Melissa Chierici (IMR), Øyvind Lundesgaard (NPI)
The tiniest do the heavy lifting	Selina Våge (UiB)
The Transpolar Drift current	Melissa Chierici (IMR), Agneta Fransson (NPI), Mats Granskog (NPI)
Ephemeral landscapes	Adam Steer (NPI)
Hardcore science	Arunima Sen (UNIS)

Figure 8-1 Outreach activity with Svalbard Folkehøyskole onboard RV Kronprins Haakon, conducted by M. Marquardt, A. Ziegler and I. Ntiniou.

In addition we keep a running story map at (https://storymaps.arcgis.com/stories/3e2d0f059df746be8b37bf130e089ddc) where brief daily text pieces were placed at the current location of the vessel along with one or several images (Appendix 3). This story map was followed by 50-250 readers daily with a total of over 3500 over the course of the cruise

.

Social media messages were regularly posted at various venues such as Instagram and twitter. At the end of the cruise, a tour was offered to a Svalbard Folkehøyskole class by vessel crew and select science team members. After the cruise, life interviews were given by the chief scientists in NRK's Helsemorgen https://tv.nrk.no/serie/helgemorgen-tv/202110/DNRR62007621/avspiller.

9. Sample logging and data archival

Over 220 research activities conducted during JC2-2 were logged using the cruise logger system on Kronprins Haakon and read into an activity log (Appendix 2). This log adds parent UUIDs to each gear deployment or activity to the time stamps from the cruise logger. Separate standardized activity logs were generated for each type of parameter for which the UUIDs were generated with the UUDI generator accessible on the vessel's internal network at http://10.3.65.20/ following Protocol V9 sections 2.1 and 2.2. These logs will be forwarded to the Nansen Legacy portal at SIOS (https://sios-svalbard.org/reports/aen_multi?startdate=2018-08-01&enddate=2021-02-12&&&%20) where they are searchable by parameter, cruise, gear type, station etc..

Data streams from continuous onboard measurements were transferred to IMR's data system following standard procedures.

10. Lab use

All of Kronprins Haakon's laboratories, cool rooms and freezer rooms were used essentially at full capacity during JC2-2 (Table 10-1, Figure 10-1). Most labs were used

as intended by their design, with the exception of the fish lab that was instead used as physical oceanography lab, and the catch room that was shared between catch processing and maintenance of sea ice equipment.

Figure 10-1 Examples of labs use: Filtraton lab (top left), dry lab (top right), chilled lab (bottom left), education lab (bottom right). Photos Bodil Bluhm.

Table 10-1: Use of laboratories including cold rooms onboard Kronprins Haakon during JC2-2. For last names of users see participant table.

Lab no.	Name of laboratory	Use during JC2-2	Lab users
102	Clean seawater sample room	Seawater intake room & TSG, pCO_2 underway instrumentation	Melissa, Agneta
301	Chilled lab	Mesozooplankton experiments, trace metal experiment	Chrissie G, Nadjejda, Nicolas
302	Dry lab common (Chem. lab)	Analyses of AT, DIC, pH, dissolved oxygen, microscope calcifiers, ice processing	Melissa, Bonnie, Griselda (OA)
303	Wet lab common, (Zoopl. lab) Thermax 1+2	Meso- and macrozooplankton, filtration (viruses, bacteria, XRF)	Camilla, Anette, Amalia, Selina, Iliana
307	Radioisotope lab	Primary (PP) and bacterial production (PB)	Marti (PP), Selina (BP)
308/309	Wet lab biology (fish lab)	ocean physics	Zoe, Karen, Øyvind
310	Catch sample room	Trawl processing, rinsing & storage of sea ice equipment (ice stations)	Birte (trawl) All ice teams
311	Toxicology lab	Trace metal clean lab	Nicolas, Tomasz
312	Cooler room (inside fish lab)	OA & pollutants exp.	Khuong, Nadjejda
313	Freezer room converted to cold room (accessible from fish lab)	Experiments, cultures	Marti, Wenche
314	Cold room (by benthos lab)	Benthos exp. (Temp +2°C)	Arunima, Amanda, Christine LI, Birte
315	Cold room (by benthos lab)	Benthos exp. (Temp. in situ), storage samples (<4°C)	Arunima, Amanda Christine LI, Birte
316	Filtration lab	Filtration (metabarcoding, metatranscriptomics, coccolithophores, vivaflow)	Even, Wenche, Anna
317	Education lab	Label printer, microscope, fluorometer, sample labeling & logging, common use	Wenche (microscope) Anna (fluorometer) Label printer, Miriam CTD logs, others
319	Wet Lab Geology/Benthos	Benthos	Arunima, Amanda, Christine L, Birte
320	Microbiology lab	Filtrations (Chl a, POC/PON, FA/SI/HBI, and more)	Miriam, Marti, Jessie
322	Ice Lab	Storage of phys/chem ice cores	Adam, Anca, Melissa et al.
323	Cold room (Greenland)	ice core melting (°C), zooplankton sample temporary storage, storage filtered seawater	LTL & zoop. teams
325	Freezer ice samples	For biological frozen samples	Primarily biologists
503	Dive room	Ice physics	Adam, Anca
AUD	Auditorium	Meetings; drying ice containers	All; ice bio group
701 (deck 9)	Observation Central	Common, ice observation support	Everyone
Incubators			
Thermax1	303 Wet lab	Zooplankton, OA experiment	Nadjejda
Thermax2	303 Wet lab	Zooplankton	Zooplankton groups
Thermax3	Hangar	Zooplankton egg production exp.	Chrissie G
Thermax4	Hangar	Zooplankton exp. OA	Nadjejda
Thermax5	Hangar	Microbial food web exp.	Illiana, Selina

Lab cont.	Deck main	Sea ice physics	Adam, Marius

Appendix 1: Data sets with parameter list for JC2-2 and responsible researchers

Who		Sample info			Analyses				Relevance to Nansen Legacy Implementation plan		Data				
Cruise participant	PI	Sample type	Intended method	Parameter	Analysis protocol	Dataset	Where will analyses be done	When are analyses planned for	RF	Task/Subtask	Sharing within project	Publishing data	Ask for embargo of data?	If yes, why?	Comments
KHP instrumentation	Helge Sagen (IMR)					Acoustic data surveying fish and zooplankton, logged continuously					2022, NIRD	2022	No		EK80
KHP instrumentation	Øystein Godøy (MET)					Air and sea temperature (8 m depth), air pressure, wind speed and direction, relative humidity and solar radiation logged continuously					post cruise on NIRD	2021	No		Weather station
KHP instrumentation	Helge Sagen (IMR)					Temperature, salinity, density and fluorescence at 4m, logged continuously					post cruise on NIRD	2021	No		Thermosalinograph
KHP instrumentation	Helge Sagen (IMR)					Currents in the upper ~500 m logged continuously					post cruise on NIRD	2021	No		ADCP 150 kHz
KHP instrumentation	Agneta Fransson (NPI)					pCO2 measured from the underway system, 4 m intake during the open water part of the cruise					post cruise on NIRD	2022	Yes	COS project, public after substantial QC, restricted for use by PD	pCO2 underway
KHP instrumentation	Helge Sagen (IMR)					Temperature, salinity, density fluorescence, oxygen profiles from NLEG stations					post cruise on NIRD	2021	No		CTD
KHP instrumentation	Helge Sagen (IMR)					Atmospheric pressure, temperature and humidity profiles					post cruise on NIRD	2021	No		Radiosondes

Who		Sample info		Analyses					Relevance to Nansen Legacy implementation plan		Data				
Cruise participant JC 2-2	NL PI	Sample type	Intended method	Parameter	Section in NL protocol V9	Dataset	Where will analyses be done	Planned analysed	RF	Task/Subtask	Sharing within project	Publishing data	Ask for embargo of data?	If yes, why?	Comments
	Sebastian Gerland, Maximilian Semmling (DLR, Germany)	only data	GNSS-R	Sea ice surface characteristics		Sea-ice permittivity derived from GNSS reflection profiles; sea ice concentration around the ship	DLR/GFZ (Germany)	2021	RF1; RA-C	T1-2.2, T1-1.2	2022	2023	yes		
	Sebastian Gerland, Rudolf Krakauer (DWD, Germany)	only data	Radiosondes	Air temp., pressure, moisture, wind		Altitude profile of air temp., pressure, moisture, wind during the cruise period	DWD	2021	RF1	T1-2.3, T1-2.2, T1-1.2	2022	2023			
Adam Steer, Anca Cristea	Sebastian Gerland, Arild Sundfjord	geolocated imagery of sea ice captured by remotely piloted	Parrot ANAFI USA	ice and snow topoography		small scale orthophotos and elevation models of sea ice	NPI	2021-2022	RF1	T1.1-1.2, T1-2.2	2021	2022-2023	yes	Post doc project	
Adam Steer, Anca Cristea	Sebastian Gerland, Arild Sundfjord	Electromagnetic induction soundings of snow + ice thickness	GEM2 electromagnetic induction sounder	ice and snow thickness		geolocated ice and snow combined thickness	NPI	2021-2022	RF1	T1.1-1.2, T1-2.2	2021	2022-2023	yes	Post doc project	
Adam Steer, Anca Cristea	Sebastian Gerland, Arild Sundfjord	Snow probe surveys of snow depth	Magnaprobe GPS snow probe	Snow depth		Geolocated snow depths	NPI	2021-2022	RF1	T1.1-1.2, T1-2.2	2021	2022-2023	yes	Post doc project	
Adam Steer, Anca Cristea	Sebastian Gerland, Arild Sundfjord	sea ice cores	ice sampling using Kovacs corer	Physical characteristics of sea ice		Physical charactersistics of sea ice in the northern Barents Sea from in situ observations	NPI	2021	RF1	T1.1-1.2, T1-2.2	2022	2022-2023	yes	Post doc project	
Adam Steer, Anca Cristea	Dmitry Divine, Sebastian Gerland	Sea ice observations	Sea ice observations/pictures from the bridge follow ASSIST protocol	Sea ice coverage, Sea ice age and type, Snow cover	6.3	Sea ice observations	NPI	2021-2022	RF1	T1.1-1.2, T1-2.2	2021	2022-2023	yes	Post doc project	
Adam Steer, Anca Cristea	Sebastian Gerland, Arild Sundfjord	Precise GNSS observations of ice station drift and rotation	Leica Viva GPS receiver x 3	ice drift and rotation		Precise ice drift, rotation and surface elevation parameters for correcting drift in airborne datasets	NPI	2021-2023	RF1	T1.1-1.2, T1-2.2	2021	2022-2023	yes	Post doc project	
Agneta Fransson, Melissa Chierici	Agneta Fransson, Melissa Chierici	Water	Underway system	CO2, pH, fluorescence, fDOM, oxygen			NPI	2022	RF2	T2.1	2022	2023			
Amanda Ziegler, Bodil Bluhm	Bodil Bluhm, Lis Jørgensen	d13C / d15N organisms (mostly benthic)	IRMS coupled to C/N analyser	d13C, d15N	10.3.13	Carbon and nitrogen stable isotope composition	UiO	2021-2023	RF3	T3-3.4	2022-2023	2023	possibly	Post doc project	
Amanda Ziegler, Bodil Bluhm	Bodil Bluhm, Lis Jørgensen	Water POM, sea ice POM	IRMS coupled to C/N analyser	d13C-d15N pPOM, iPOM	14.7.1, 9.1.5	IRMS	UiO		RF3	T3-3.4	2022-2023	2023	possibly	Post doc project	
Amanda Ziegler	Bodil Bluhm, Lis Jørgensen	zooplankton stable isotopes	IRMS coupled to C/N analyser	d13C; d14N	13,2	Stable isotopes of main zooplankton taxa	UiO	2021-2023	RF3	T3-3.4	2022-2023	2023	possibly	Post doc project	
Anette Wold, Camilla Svensen	Anette Wold, Janne Søreide; Camilla Svensen	Mesozooplankton & small mesozooplankton t taxonomy & abundance	Morphological identification	ind/m3 & mg dry mass/m3 using species-specific dry mass values from published sources	chapter 9.2.1	Mesozooplankton & small mesozooplankton abundance (ind/m3), biomass (mg dry mass/m3) and species composition (species list)	IOPAN	2022	RF3	T3-1.1 & 2.1	2022	2023	Yes	PhD project	
Anette Wold, Camilla Svensen	Janne Søreide; Kim Præbel	Mesozooplankton community	Metabarcoding (Biomass; Fatty acid; Taxonomy)	COI sequences	chapter 9.2.1	Barcoding Biodiversity	UiT, Kim Præbel(barcoding); IOPAN (taxonomy)	2020-2022	RF4	T3-1.1 & 2.1 T3-2.1 & 2.3	2021-2022	2021-2022	yes	master student	The Bongonet sample taken for Metabarcoding was splitt in two 1/2 for Metabarcoding & 1/2 for taxonomy in order to validate calculation of the relative proportion of the different taxa from metabarcoding analyses. The other Bongonet was split in biomass and fatty acid acid
Anette Wold, Camilla Svensen	Espen Bagøien, Post Doc	Macrozooplankton	Sorting and morphological identification, metabarcoding	taxonomic composition, biomass	9.2.2	Key organims, e.g. Euphausiids and amphipods, Map spatial distribution, taxonomic compostion and biomass indices, temporal and spatial variation in	IMR	2019-2021	RF3	T3-1.1; T3-2.1	2021	2020-2022	No		
Anette Wold, Camilla Svensen	Anette Wold; Janne Søreide; Camilla Svensen (in collabaoration with Sanna Majaneva, NTNU)	Gelatinous zooplankton	Genetic analyses, counts, size measurmnts	species list; ind/m3; ml/m3	9.2.1.5	Gelatinous zooplankton abundance (ind/m3), volume & species composition (species list)	Counts, weight and length measurements done onboard; species identification NTNU (Sanna Majaneva)	2021	RF3	T3-1.1 & 2.1 T3-2.1 & 2.2	2021-2022	2021-2022	Yes	master student	
Camilla Svensen	Camilla Svensen	fatty acids of Calanus hyperboreus & Paraeuchaeta sp.	Analysis of relative proportions of lipid classes by HPLC and individual fatty acids	Relative amount of fatty acid	9.2.1.	Copepod fatty acid composition and content	DTU-Aqua, Denmark in collaboration with Sigrun	2022	RF3	T3.1, T3.2	2022-2023	2022-2023	yes	PhD project	
Camilla Svensen, Anette Wohld	Anna Vader/Bodil Bluhm/Camilla Svensen/Kim Præbel	mesozooplankton diet	plankton sample for DNA analysis of diet of arctic carnivore copepods	Zooplankton diet/prey diversity		Linking copepod predators and prey, possibly also zooplankton genetic identification	UNIS/UiT	2022	RF3	T4-4.1	2022	2023	yes	PhD project	
Camilla Svensen, Anette Wold	Doreen Kohlbach	Fatty acids of select zooplankton	Analysis of relative proportions of lipid classes by HPLC and individual fatty acids by GC, and fatty acid-specific stable isotopes by GC-c-MS	Relative proportions of neutral and polar lipid classes and fatty acids, and carbon stable isotope compositions of	9.2.1.3	Fatty acids of main zooplankton taxa	AWI (collaboration w/ Martin Graeve) University la Rouchelle	2022	RF3	T3-1.3	2022-2023	2022-2023	Yes	Post doc project	Will be used for future RCTIC Ocean projects and as a comparison to data from Barent Sea
Anna Vader	Anna Vader; Tove M. Gabrielsen	Microbial diversity (DNA and RNA) in water and ice	rRNA	Protist diversity	7.17	Microbial eukaryote diversity along the JC2-2 transect based on rRNA metabarcoding	UNIS	2021-2023	RF3	T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2023	2023	Yes, possibly	Post doc project	
Anna Vader	Anna Vader; Tove M. Gabrielsen	Microbial activity (RNA) in water and ice	mRNA	Protist activity		Metatranscriptomics and quantification of gene expression of select genes along the JC2-2 transect	UNIS	2021-2023	RF3	T3-2.2	2023	2023	Yes, possibly	Post doc project	
Anna Vader, Miriam Marquardt	Anna Vader	Chlorophyll a in water and ice	Fluorometric analysis	Chl a total and > 10um biomass	7.13	Chl a total and > 10um biomass	Onboard KPH	During cruise	RF3	T3-1.1		2022	No		
Anna Vader, Wenche Eikrem, Even Sletteng	Anna Vader; Bente Edvardsen	Protist diversity (DNA and RNA) in water and ice	metabarcoding using rDNA	Protist diversity		Protist diversity, proportional abundance, dynamics and distribution along the JC2-2 transect	UNIS; UiO	2021-2023	RF3	T3.1.1, T3.1.2, T3.2.1	2023	2023	No	PhD-project	
Anna Vader, Wenche Eikrem, Even Sletteng	Anna Vader/Lise Øvreås	Bacterial diversity (DNA and RNA) in water and ice	metabarcoding using rDNA and rDNA	Bacterial diversity		Bacterial diversity, proportional abundance, dynamics and distribution along the JC2-2 transect	UNIS; UiB	2021-2023	RF3	T3.1.1, T3.1.2, T3.2.1	2023	2023	No		
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Paul Renaud	Sediment pigments	HPLC	mg pigment type / m2		sediment pigments HPLC	Plymouth Marine Laboratory	2019-2020	RF3, CAO	T3-1.2	2021-2022	2021-2022	no	no embargo	
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Anna Vader/Bodil Bluhm/Camilla Svensen/Kim Præbel	Sediment meiofauna ethanol	Benthos sample from box core for DNA analysis of benthic diets and prey based on DNA	Benthos diet/prey diversity	10.3.14	Diversity of zoobenthos prey, possibly also genetic identification of benthic species	UNIS; UiT	2022	RF3	T4-4.2	2022	2022	Yes, possibly	PhD project	
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte	Elisabeth Alve	Sediment samples	Laser Diffraction Particle Size Analyzer	sediment grain size fractions	10.3.3	sediment grain size fractions	UiO	2019-2022	RF1; RF3	RF1, RF3 T3-1.2	2021	2022-2023	Yes, possibly	PhD project	
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Elisabeth Alve (Forams), Bodil Bluhm/ Andreas Altenburger (metazoans)	Meiofauna abundance in sediment	Sorting and morphological identification	number of individuals/ cm2	10.3.5	Foraminifera abundance, diversity and composition; metazoan meiofauna abundance, diversity and composition	UiO (Foraminifera), UiT (metazoan meiofauna)	2019-2022	RF1; RF3	T3-1.1	2021	2022-2023	Yes, possibly	PhD project	
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Lise Øvreås	Bacterial diversity in sediment	Metabarcoding	taxonomic composition, abundance and distribution	10.3.4	Microbial prokaryote diversity in sediment across season based on metabarcoding	UiB	2021-2022	RF3	T3-1.1, T3-1.2, T3-1.3, T3-4.1	2022	2023	No		
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Paul Renaud	Sediment pigment	Fluorometric analysis	mg Chl a / m2, mg phaeopigment / m2	10.3.2	Sediment pigments	APN	2019-2021	RF3	T3-1.2	2021	2021-2023	No		
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Paul Renaud	Nutrient concentrations in incubations	nutrient analyzer	Macronutrient concentrations in bottom water before and after incubation		Macronutrient concentrations in bottom water before and after incubation	APN	2019-2020	RF3	T3-3.4	2021-2023	2021-2023	no	no embargo	
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte	Paul Renaud	Sediment community incubations	Sediment community oxygen uptake experiments	oxygen uptake mmol / h	10.3.8	oxygen uptake	onboard	2019-2020	RF3	T3-4.3	2020-2021	2022-2023	no	no embargo	

Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Bodil Bluhm, Paul Renaud	Macrofauna diversity and abundance	Sorting and morphological identification	number of (taxon) / cm2, diversity indexes, community analysis	10.3.9	Macrofauna abundance, diversity and composition; metazoan macrofauna abundance, diversisty and composition, community analysis	Nord/IOPAN	2019-2020	RF3	T3-1.1, T3-1.3	2021-2023	2021-2023	Yes, possibly	PhD project	
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Elisabeth Alve	Sediment samples	combustion in muffle furnace	sediment total organic carbon (TOC, %)	10.3.3	sediment total organic carbon (TOC, %)	UK lab	2019-2022	RF1; RF3	RF1, RF3 T3-1.2	2020	2021-2022	Yes, possibly	PhD project	
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Elisabeth Alve	Sediment samples	combustion in muffle furnace	sediment total nitrogen (TN, %)	10.3.3	sediment total nitrogen (TN, %)	UK lab	2019-2022	RF1; RF3	RF1, RF3 T3-1.2	2020	2021-2022	Yes, possibly	PhD project	
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Elisabeth Alve	Sediment organic matter	IRMS	d13C (per mil), d15N (per mil)	10.3.3	d13C (per mil), d15N (per mil)	UK lab	2019-2022	RF1; RF3	RF1, RF3 T3-1.2	2020	2021-2022	Yes, possibly	PhD project	
Jessie Gardner, Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte Schuppe	Marit Reigstad, Jessie Gardner	Sediment samples	IP25	IP25	8	IP25	UK	2021-23	RF3		2022	2022-23	yes	Post doc project	
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte	Tine L. Rasmussen	Sediment for porewater chemistry		Porewater	10.3.11	sulfate, methane, DIC isotopes	Sweden	2022-2023	RF1, RF3	RF1, RF3	2022	2022-2023	no		
Arunima Sen, Amanda Ziegler, Christine Lockwood-Ireland, Birte	Reigstad, Bodur	Sediment biogenic silica		Biogenic silica in sediment	10.3.6				RF3			2023			
Asgeir Steinsland	Randi Ingvaldsen, Elena Eriksen	Acoustic signal	Acoustic data analysis	Target strength and identity		Target strength and identity	IMR	2021-2022	RF3	RF3, T3-3.2, T3-3.4	2022	2022			
Birte Schuppe	Randi Ingvaldsen, Elena Eriksen	Fish, macrozooplankton	Taxononomic identification	Taxonomic composition	11.6	Fish body size and weight, diet	IMR	2021-2022	RF3	RF3, T3-3.2, T3-3.4	2022	2022			
Christine Gawinski	Camilla Svensen	Productivity of Oithona similis	Egg hatching experiment	egg production rate, weight specific egg production rate	9.3.3.	spatial and temporal variability of copepod secondary production, specific egg production rate as an estimate	UiT	2019 - 2022	RF3	T3-2.2	2021	2021-22	yes	PhD project	
Christine Gawinski	Camilla Svensen	Productivity of Paraeuchaeta sp.	Egg hatching experiments	egg production rate, weight specific egg production rate	9.3.3.	spatial and temporal variability of copepod secondary production, specific egg production rate as an estimate for copepod production	UiT	2019 - 2022	RF3	T3-2.2	2022	2022-2023	yes	PhD project	
Christine Gawinski	Camilla Svensen	small mesozooplankton	Secondary production	Female:egg ratio, taxonomy and abundance of nauplii	9.3.3.	spatial and temporal variability of copepod secondary production, female:egg ratio as an estimate for copepod production, copepod reproduction	UiT	2019 - 2022	RF3	T3-2.2	2022	2022-2023	yes	PhD project	
Christine Gawinski	Camilla Svensen	Grazing experiment of Paraeuchaeta sp.	Paraeuchaeta sp. Feedding rates on various copepod species	Grazing rates	Protocol developed during this cruise, will be added to Version 10	Functional response of Paraeuchaeta feeding on different prey types and concentrations	UiT	2021	RF3	T3-4.1	2021-2022	2021-2022	yes	PhD project	
Christine Gawinski	Anna Vader	Paraeuchaeta individuals	identification of prey by metabarcoding	prey diversity	9.2.1.	Diversity and relative abundances of prey	UNIS; UiT	2022	RF3	T3-4.2	2022	2022	yes	PhD project	
Christine Lockwood-Ireland	Tine L. Rasmussen	Palaeocores	Box core	Palae forams			UiT		RF1			2024		PhD project	
Griselda Anglada-Ortiz	Tine L. Rasmussen	Plankton sample	Absolute abundance and carbonate contribution from pteropods and foraminifera	#/m3 and mg CaCO3/m3		Relative and absolute abundance of marine calcifiers on the water column and their contribution to the carbonate pump	CAGE-UiT (Tromsø)	2021	RF2	T2-1.4	2021	2021-2022	yes	PhD project	
Griselda Anglada-Ortiz	Tine L. Rasmussen	Water sample	Absolute abundance and carbonate contribution from coccolithophores	#/m3 and mg CaCO3/m3		Relative and absolute abundance of marine calcifiers on the water column and their contribution to the carbonate pump	CAGE-UiT (Tromsø)	2021	RF2	T2-1.4	2021	2021-2022	yes	PhD project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	Chlorophyll a	fractionated algal pigments, filtered through GF/F filters from sediment trap samples	Chl a total	8	Chlorophyll a	Onboard KPH	During cruise	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	Chlorophyll a >10µm	fractionated algal pigments, filtered through Polycarbonate filters from sediment trap samples	Chl a >10µm	8	Chlorophyll a >10µm	Onboard KPH	During cruise	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	POC/PON	CN analyses from sediment trap samples	µg/L	8	POC/PON	UiT	2021-23	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	stable isotopes	from sediment trap samples	d13C; d14N	8	stable isotopes	UiO	2021-23	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	water column pigments	HPLC from sediment trap samples	mg pigment type / m2	8	HPLC	UK	2021-23	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	sea ice algae proxy	IP25 from sediment trap	mg pigment type / m2	8	IP25	UK	2021-23	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	phytoplankton communities	from sediment trap samples	community composition and counts	8	phytoplankton communities	UiT	2021-23	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	fecal pellets	from sediment trap samples	fecal pellet types and counts	8	fecal pellets	UiT	2021-23	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	particulate biogenic Silica	biogenic silica from sediment trap and boxcore	biogenic silica	8	bSi	UiT	2021-23	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	Metatranscriptomics	DNA/RNA from sediment trap samples	biological diversity & activity on particles		Metatranscriptomics	UiT/UNIS	2021-23	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Jessie Gardner	Marit Reigstad, Jessie Gardner	Gel trap material	Under-ice gel trap	Particle morphometrics and characteristics	8	Particle morphometrics and characteristics	University of Bremen	2021-23	RF3	T3-2.2; 4.4	2022	2022-23	yes	Post doc project	
Karen Assmann, Zoe Koenig, Øyvind Lundesgaard	Arild Sundfjord	Data only		Temperature					RF1		2022	2023			
Karen Assmann, Zoe Koenig, Øyvind Lundesgaard	Arild Sundfjord	Water		Salinity					RF1		2022	2023			
Marius Bratrein, Anca Cristea	Sebastian Gerland, Arild Sundfjord	Regional scale helicopter borne electromagnetic induction	EM-bird	ice and snow thickness		Ice and snow combined thickness along the flight track	NPI	2021-2023	RF1	T1.1-1.2, T1-2.2	2021	2021	No		
Martí Amargant-Arumí	Rolf Gradinger	Radioactively labelled algae on	Primary production in situ incubations	Primary production rate (14C uptake)	7.25	Vertical profiles of primary production across latitude	UiT	2019-2020	RF3	T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2020	2021-2022	Yes	PhD-project	
Martí Amargant-Arumí	Rolf Gradinger	Radioactively labelled algae on	Light intensity vs. Photosynthesis curves	Primary production rate (14C uptake)	7.26	Primary production response to various light	UiT	2019-2020	RF3	T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2020	2021-2022	Yes	PhD-project	
Martí Amargant-Arumí	Rolf Gradinger	Isotopically labelled algae on GF/F filters	Nitrogen uptake in situ incubations	d13C, d15N	7.25	Ratios of Carbon and Nitrogen stable isotopes before and after incubations, F-ratios of primary production	UiO	2019-2020	RF3	T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2020	2021-2022	Yes	PhD-project	
Melissa Chierici, Bonnie Raffel,	Melissa Chierici, Agneta Fransson	Water samples from the CTD-	Winkler titration	dissolved oxygen (DO)		Dissolved oxygen	IMR/NPI	2021	RF2	T2-1.1	2021	2022	No		
Melissa Chierici, Bonnie Raffel, Agneta Fransson	Melissa Chierici, Agneta Fransson	Water samples from the CTD-Rosette, sea ice, snow, brine, under-	spectrophotometric with m-cresol purple as indicator dye	pH	7.2.3	pH	onboard	2021	RF2	T2-1.1	2021	2023	No		
Melissa Chierici, Bonnie Raffel, Agneta Fransson	Melissa Chierici, Agneta Fransson	Water samples from the CTD, and sea ice cores, snow, under-ice	Gasextraction of acidified seawater followed by photometric detection and coulometric titration	dissolved inorganic carbon (DIC)	7.2.1	dissolved inorganic carbon, µmol/kg	onboard	2021	RF2	T2-1.1	2021	2023	No		

Melissa Chierici, Bonnie Raffel, Agneta Fransson	Melissa Chierici, Agneta Fransson	Water samples from the CTD, and sea ice cores, snow, under-ice	Potentiometric titration in open cell with hydrochloric acid	total alkalinity (AT)	7.2.2	total alkalinity, µmol/kg	onboard	2021	RF2	T2-1.1	2021	2023	No		
Melissa Chierici, Bonnie Raffel, Agneta Fransson	Melissa Chierici, Agneta Fransson	Water samples from the CTD, and sea ice cores, snow, under-ice	Autoanalyzer	nutrients (NO2, NO3, PO4, Si)	7.12	nutrients, µM	IMR Bergen	2021	RF2	T2-1.1	2021	2022	No		
Melissa Chierici, Bonnie Raffel, Agneta Fransson	Melissa Chierici, Agneta Fransson	Water samples from the CTD, and sea ice cores, snow, under-ice	isotopic oxygen ratio (d18O), mass spectrometer	d18O	7.3	d18O, promille	NPI	2022	RF2	T2-1.1	2022	2023	No		
Melissa Chierici, Bonnie Raffel, Agneta Fransson	Mats Granskog, Børge Hamre	Water samples from the CTD-Rosette niskin bottles, and under	spectrophotometric absorbance	CDOM	7.8.1	CDOM, m-1 (possibly FDOM, Raman Units)	NPI/UiB, , collab with IOPAN/DTU-Aqua	2022	RF1	T1-2.4	2022	2023	Yes	PD	uncertain when capacity to analyse
Miriam Marquardt	Marit Reigstad, Gunnar Bratbak	POC/PON water and ice	CN analyses	µg/L	14.7.1, 7.4	POC/PON	UiT/UiB	2020-2023	RF3		2020-2023	2022-2023	yes	PhD project	
Miriam Marquardt	Miriam Marquardt, Rolf Gradinger, Bodil Bluhm	Ice meiofauna abundance/taxonomy	Microscopy	Ind/m3; ml/m3	14.7.5	Ice meiofauna abundance/taxonomy	UiT	2020-2023	RF3		2020-2023	2022	Yes, possibly		
Melissa Chierici, Bonnie Raffel, Agneta Fransson	Melissa Chierici, Bonnie Raffel, Agneta Fransson	Nutrients from sea ice cores	Nutrient analyzer	µg/L	7.12	Nutrients	IMR	2020-2023	RF3		2020-2023	2023	No		
Nadjejda Espinel-Velasco	Geir Wing Gabrielsen, Haakon Hop	Frozen adult copepods (-80)	Metabolomics + Lipid analyses	measures of metabolites and lipid content in ug/individual	9.3.4	Physiological responses of lower trophic levels of arctic ecosystems, when exposed to stressors of	NPI	2022-2023	RF2	T2-1.3	2021	2021-2022	yes	Postdoc	
Nicolas Sanchez, Tomasz Cieliski	Murat V. Ardelan	Total trace elements and dissolved trace elements water and ice	Preconcentration via SeaFAST and ICP-MS	Concentration of elements in nM	7.7	Total and dissolved trace elements transect profile	NTNU	2022	RF2	T2-2.2	2023	2023	yes	PostDoc	
Nicolas Sanchez, Tomasz Cieliski	Murat V. Ardelan	Total mercury and methylmercury water	Cold vapor atomic fluorescence spectrometry (CVAFS) for THg and MeHg, or GC-SF-IR-ICPMS	THg, MeHg in pM	7.7	Total mercury and methylmercury transect profile	NTNU / MiO	2022	RF2	T2-2.2	2023	2023	yes	PhD project	Samples status questionable due to wrong storage during shippment to
Nicolas Sanchez, Tomasz Cieliski	Murat V. Ardelan	Sediment samples	Hg determination, DMA-80 and REE elements,	THg in ng/g, Trace element	7.7	Distribution of trace elements in sediments	NTNU	2022	RF2	T2-2.2	2022	2023	yes	PhD project	
Selina Våge, Iliana Ntinou	Gunnar Bratbak, Aud Larsen	Microbial abundance in ice and	Flow cytometry	Planktonic cell per ml	7.19	Abundance tables	UiB	2022	RF3	T3.1.1, T3.1.2, T3.2.1	2022	2023	No		
Selina Våge, Iliana Ntinou	Gunnar Bratbak, Oliver Müller, Lasse Mørk Olsen	Grazer exclusion experiment	Bacterial production, Flow Cytometry, microbial diversity, nutrient analysis, microzooplankton	Bacterial production, Flow Cytometry, microbial diversity, nutrient analysis,		Dynamics of lower trophic level food web structure	UiB	2022	RF3	T3-4.1	2022	2023	yes	Postdoc project	
Selina Våge, Iliana Ntinou	Gunnar Bratbak	Bacterial activity (Radioactively labelled bacteria) in ice and water	Bacterial production of carbon biomass	Bacterial production rate ([2,3,4-3H] leucine) in µgC L-1-d-1	14.7.1, 7.20	Bacterial production rate	UiB	2022	RF3	T3-2.3/T3-3.1/	2022	2023	No		
Selina Våge, Iliana Ntinou	Gunnar Bratbak	SEM filter ice and water	Scanning electron microscoppy (SEM)	Qualitative analysis of small plankton		Plankton diversity, dynamics and distribution	UiB	2022	RF3	T3.1.1, T3.1.2, T3.2.1	2022	2023	No		
Selina Våge, Iliana Ntinou	Gunnar Bratbak, Jorun K. Egge, Tatiana Tsagaraki	XRF filter ice and water	X-Ray Fluorescence (XRF)	Concentration of total particulate elements in µM	7.11	Concentration of total particulate O, P, Na, Mg, Si, S, Ca, Mn, Fe, Zn (µM)	UiB	2022	RF3	T3.1.1, T3.1.2, T3.2.1	2022	2023	No		
Selina Våge, Iliana Ntinou	Gunnar Bratbak, Ruth-Anne Sandaa	Virus diversity ice and water	Recover viruses from natural waters via iron	Virus diversity	14.7.1, 7.19	Virus diversity across season based on metabarcoding	UiB	2022	RF3	T3.1.1, T3.1.2, T3.2.1	2022	2023	No		
Tomasz Cieliski	Murat Ardelan	Zooplankton	Elemental analyzer	Rare earth elements	Not included		NTNU		N/A			2023			
Khuong Van Dinh	Katrine Borgå, Ketil Hylland	Alive copepods	Exposure experiments to oil compounds	Life history traits	9.3.5	Survival, body size, development, egg reproduction	UiO	2021-2022	RF2	T2-2.2	2021	2021-2023	yes	Postdoc	
Wenche Eikrem, Even Sletteng	Philipp Assmy, Bente Edvardsen	Fixed water samples from Niskin bottles 6 depths and ice stations	Utermöhl cell counts under the microscope	Cell abundances of protists > 10 µm	7,15	Phytoplankton/protist abundance	IOPAS	2021-2022	RF3	T3.1.1	2022	2023	No		
Wenche Eikrem, Even Sletteng	Bente Edvardsen, Philipp Assmy	Fixed phytoplankton sample 50-	Light and electron microscopy	Protist diversity > 10 µm	7,16	Species lists and micrographs	UiO and IOPAS	2021-2022	RF3	T3.1.1	2022	2023	Need to ask	PhD-project	
Wenche Eikrem, Even Sletteng	Bente Edvardsen	Coccolithophores on PC filters	Scanning electron microscoppy (SEM)	taxonomic composition, abundance and distribution		Coccolithophore diversity, dynamics and distribution	UiO	2021-2022	RF3	T3.1.1, T3.1.2, T3.2.1	2021-2022	2021-2022	Need to ask PI	PhD-project	
Wenche Eikrem, Even Sletteng	Bente Edvardsen	Microalgae	VivaFlow	Electron microscopy, protist diversity	7.14	Protist diversity	UiO	2022-2023	RF3	T3.1.1	2023	2023	No		
Wenche Eikrem, Even Sletteng	Bente Edvardsen	Microalgae	VivaFlow	Cultures	7,14	Protist culturer	UiO	2022-2023	RF3	T3.1.1	2023	2023	No		
Zoe Koenig, Karen Assmann, Øyvind Lundesgaard	Arild Sundfjord	Water		Density					RF1			2022-2023	yes	Post doc project	
Zoe Koenig, Karen Assmann, Øyvind Lundesgaard	Arild Sundfjord	Data only		Turbulence					RF1			2022-2023	yes	Post doc project	
Zoe Koenig, Karen Assmann, Øyvind Lundesgaard	Joachim Reuder	Data only		Atmospheric/weather data					RF1			2022-2023	yes	Post doc project	
Øyvind Lundesgaard, Karen Assmann, Zoe Koenig	Arild Sundfjord	Data only		Current velocity					RF1			2022-2023	yes	Post doc project	
Griselda Anglada-Ortiz	Tine L. Rasmussen	Foraminifera from Bongo	OA experiment onboard	Survival, shell size, status		SEM, size measurements, mortality rate	UiT	2022	RF2			2023		PhD-project	

Appendix 2: Full station activity list

Event ID	Description	Gear Type	Date	Time (UTC)	Station Name	Latitude	Longitude	Bottom Depth (m)	Local Station ID	Sample Depth (m)	Maximum depth(m)	Minimum depth (m)	Start Date	End Date	End Time	End Latitude	End Longitude	Event Remarks	Sampling protocol	Recorded By	Principal investigator (PI)	PI email	PI institution
eventID	description	gearType	eventDate	eventTime	stationName	decimalLatitu	decimalLongit	bottomD	statID	sampleD	maximur	minimu	start_date	end_date	end_time	endDecimalLati	endDecimalLong	eventRemarks	samplingProtocol	recordedBy	pi_name	pi_email	pi_institution
56cea700-068a-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	26/08/21	16:26:17	P1 (NLEG01)	75,9999	31,2213	323,54	464		323	0	26/08/21	26/08/21	17:06:27	75,9999	31,2213	CTD glider	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
5a8eb660-07b5-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	28/08/21	4:06:43	P7 (NLEG25/NPAL16)a	81,4641	31,0667	523,62	465		500	0	28/08/21	28/08/21	4:42:42	81,4641	31,0667	CTD465 sed trap water	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
9f4982f0-07db-11ec-afc5-a3f13bbd5a61	Harstad Trål Pelagisk	Harstad trawl	28/08/21	8:40:39	P7 (NLEG25/NPAL16)b	81,8608	30,1546	3158,3	69		50	0	28/08/21	28/08/21	9:10:34	81,8867	30,1174	50 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
4fbe9230-07e4-11ec-afc5-a3f13bbd5a61	Harstad Trål Pelagisk	Harstad trawl	28/08/21	9:42:51	P7 (NLEG25/NPAL16)b	81,8832	30,2100	3153,2	70		450	0	28/08/21	28/08/21	10:13:10	81,8643	30,3338	450 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
3984b370-07f6-11ec-afc5-a3f13bbd5a61	WP 3 1000My	WP3 1000 um	28/08/21	11:51:05	P7 (NLEG25/NPAL16)	81,8027	30,8846	3055,6	363		400	0	28/08/21	28/08/21	12:21:22	81,8026	30,8843	400m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
0d7a5e90-07f8-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	28/08/21	12:04:10	P7 (NLEG25/NPAL16)	81,8026	30,8843	3055,6	466		90	0	28/08/21	28/08/21	12:40:58	81,8026	30,8843	CTD466 epx	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
5cf3e7f0-08a4-11ec-afc5-a3f13bbd5a61	watersampling with bucket from surface	Bucket	28/08/21	12:39:38	P7 (NLEG25/NPAL16)	81,8026	30,8843	3055,9	470	0			28/08/21	28/08/21	12:42:38	81,8026	30,8843	surface	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
2d6692a0-07fd-11ec-afc5-a3f13bbd5a61	WP 3 1000My	WP3 1000 um	28/08/21	12:40:51	P7 (NLEG25/NPAL16)	81,8026	30,8843	3055,5	364		400	0	28/08/21	28/08/21	13:10:45	81,8026	30,8843	400m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
e211f560-0801-11ec-afc5-a3f13bbd5a61	WP 3 1000My	WP3 1000 um	28/08/21	13:14:32	P7 (NLEG25/NPAL16)	81,8026	30,8843	3055,8	365		400	0	28/08/21	28/08/21	13:43:06	81,8026	30,8843	400m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
de428490-0806-11ec-afc5-a3f13bbd5a61	WP 3 1000My	WP3 1000 um	28/08/21	13:50:13	P7 (NLEG25/NPAL16)	81,8026	30,8843	3055,9	366		400	0	28/08/21	28/08/21	14:21:53	81,8026	30,8843	400m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
e82eb3c0-080b-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	28/08/21	14:26:17	P7 (NLEG25/NPAL16)	81,8026	30,8843	3055,9	367		70	0	28/08/21	28/08/21	14:38:25	81,8026	30,8843	70m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
a63b9840-081d-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	28/08/21	16:33:18	P7 (NLEG25/NPAL16)	81,8028	30,8763	3056,8	368		1000	0	28/08/21	28/08/21	18:01:37	81,8031	30,8775	1000m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
2f59e840-082b-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	28/08/21	18:10:11	P7 (NLEG25/NPAL16)	81,8031	30,8774	3056,8	369		1000	0	28/08/21	28/08/21	19:17:56	81,8035	30,8780	1000 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
60a9a6f0-0836-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	28/08/21	19:30:18	P7 (NLEG25/NPAL16)	81,8035	30,8780	3057	370		1000	0	28/08/21	28/08/21	21:01:02	81,8035	30,8825	1000 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
550c1f70-084b-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	28/08/21	22:00:18	P7 (NLEG25/NPAL16)	81,8033	30,8836	3056,5	127		500	0	28/08/21	28/08/21	23:30:45	81,8032	30,8837	500 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
86e8a2e0-0858-11ec-afc5-a3f13bbd5a61	Multinett midi 64	Multinet 64 um	28/08/21	23:34:46	P7 (NLEG25/NPAL16)	81,8032	30,8837	3056,5	371		500	0	28/08/21	29/08/21	0:21:08	81,8032	30,8837	500m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
7b0b3490-085f-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	29/08/21	0:24:32	P7 (NLEG25/NPAL16)	81,8032	30,8837	3058,2	467		3056	0	29/08/21	29/08/21	3:45:21	81,8047	30,9118	CTD467 std deep	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
5bd2e430-087b-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	29/08/21	3:44:06	P7 (NLEG25/NPAL16)	81,8047	30,9107	3057,8	128		350	0	29/08/21	29/08/21	4:01:11	81,8051	30,9243	Annen stasjon (S-S)	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
1cabe990-08a4-11ec-afc5-a3f13bbd5a61	watersampling with bucket from surface	Bucket	29/08/21	3:47:49	P7 (NLEG25/NPAL16)	81,8048	30,9139	3058,1	470	0			29/08/21	29/08/21	3:48:50	81,8048	30,9148	surface	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
e01a0aa0-087d-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	29/08/21	4:02:07	P7 (NLEG25/NPAL16)	81,8051	30,9250	3056,2	129		350	0	29/08/21	29/08/21	4:31:14	81,8061	30,9497	Annen stasjon (S-S)	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
5fa52840-0883-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	29/08/21	4:41:28	P7 (NLEG25/NPAL16)	81,8059	30,9595	3053,6	468		500	0	29/08/21	29/08/21	5:04:36	81,8052	30,9820	CTD468 std shallow	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
702801c0-0887-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	29/08/21	5:10:34	P7 (NLEG25/NPAL16)	81,8050	30,9880	3051,7	372		50	0	29/08/21	29/08/21	5:28:42	81,8041	31,0065	50m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
5acf3200-088a-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	29/08/21	5:31:26	P7 (NLEG25/NPAL16)	81,8040	31,0095	3050,6	373		50	0	29/08/21	29/08/21	5:43:57	81,8032	31,0221	50m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
31428750-088c-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	29/08/21	5:44:36	P7 (NLEG25/NPAL16)	81,8032	31,0227	3067,3	469		3067	0	29/08/21	29/08/21	8:32:20	81,8031	31,1425	CTD469 other	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
76331240-08a4-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	29/08/21	8:38:19	P7 (NLEG25/NPAL16)	81,8032	31,1468	3054	374		400	0	29/08/21	29/08/21	9:09:19	81,8035	31,1657	400 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
88855f20-08a9-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	29/08/21	9:14:37	P7 (NLEG25/NPAL16)	81,8035	31,1685	3050,6	375		50	0	29/08/21	29/08/21	9:26:34	81,8037	31,1737	50 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
47f97290-08ac-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	29/08/21	9:34:18	P7 (NLEG25/NPAL16)	81,8038	31,1758	3048,9	470		3049	0	29/08/21	29/08/21	9:58:43	81,8050	31,1853	CTD470 noon	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
04de6f50-08b2-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	29/08/21	10:15:22	P7 (NLEG25/NPAL16)	81,8059	31,1953	3049,5	130		40	0	29/08/21	29/08/21	10:50:38	81,8083	31,2089	Annen stasjon (S-S)	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
73cfa1e0-0817-11ec-afc5-a3f13bbd5a61	Sediment trap	Sediment trap (short term)	28/08/21	15:48:56	P7 (NLEG25/NPAL16)	81,8026	30,8838	3056,4	126	3000			28/08/21	29/08/21	19:38:57	81,8088	31,3678	Annen stasjon (S-S)	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
31aa1ec0-08b8-11ec-afc5-a3f13bbd5a61	Multinett midi 64	Multinet 64 um	29/08/21	10:59:34	P7 (NLEG25/NPAL16)	81,8088	31,2123	3045,8	376		3000	0	29/08/21	29/08/21	14:54:12	81,8292	31,2780	3000m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
adcaa910-08dc-11ec-afc5-a3f13bbd5a61	Multinett mammoth 180	Multinet 180 um	29/08/21	15:20:44	P7 (NLEG25/NPAL16)	81,8310	31,2862	3039,7	377		3000	0	29/08/21	29/08/21	18:47:46	81,8438	31,3241	3000m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
3f6fba40-09ff-11ec-afc5-a3f13bbd5a61	watersampling with bucket from surface	Bucket	29/08/21	3:47:50	P7 (NLEG25/NPAL16)	81,8048	30,9139	3058,1	132	0			29/08/21	29/08/21	3:48:51	81,8048	30,9148	Annen stasjon (S-S)	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
d7db2c20-090e-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	29/08/21	21:19:50	P7 (NLEG25/NPAL16)	81,8198	31,3236	3035,5	378		1000	0	29/08/21	29/08/21	22:28:31	81,8340	31,3151	1000 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
ad58e7c0-0919-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	29/08/21	22:37:23	P7 (NLEG25/NPAL16)	81,8362	31,3188	3042,2	379		500	0	29/08/21	29/08/21	23:11:50	81,8436	31,3238	500m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
541bd8b0-091f-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	29/08/21	23:17:50	P7 (NLEG25/NPAL16)	81,8450	31,3246	3052,4	380		200	0	29/08/21	29/08/21	23:34:34	81,8489	31,3304	200m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
b0c8fcb0-0923-11ec-afc5-a3f13bbd5a61	Box Core	Box core	29/08/21	23:49:04	P7 (NLEG25/NPAL16)	81,8523	31,3374	3035,2	126	3035			29/08/21	30/08/21	3:00:50	81,8760	31,3748	Failed	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
946c8270-0947-11ec-afc5-a3f13bbd5a61	Box Core	Box core	30/08/21	4:05:58	P7 (NLEG25/NPAL16)	81,8102	30,8550	3087	127	3087			30/08/21	30/08/21	7:38:25	81,8097	30,8574	3087m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
397619e0-0969-11ec-afc5-a3f13bbd5a61	Box Core	Box core	30/08/21	8:06:48	P7 (NLEG25/NPAL16)	81,8097	30,8574	3087,1	128	3087			30/08/21	30/08/21	11:24:18	81,8096	30,8564	3087m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
90dde530-098e-11ec-afc5-a3f13bbd5a61	Box Core	Box core	30/08/21	12:34:06	P7 (NLEG25/NPAL16)	81,8096	30,8561	3086,9	129	3087			30/08/21	30/08/21	15:15:02	81,8096	30,8561	3097m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
2ed40060-09e1-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	30/08/21	22:25:30	NLEG26	82,4703	29,5359	3660,9	471		1500	0	30/08/21	31/08/21	0:12:18	82,4770	29,4401	CTD471	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
2d56bbf0-09f1-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	31/08/21	0:19:59	NLEG26	82,4773	29,4342	3668,8	131		350	0	31/08/21	31/08/21	0:51:22	82,4806	29,4134	Annen stasjon (S-S)	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
06f38e30-0a27-11ec-afc5-a3f13bbd5a61	ICE station		31/08/21	6:45:28	NLEG27 Ice	82,9469	27,9103	3923,7	132				31/08/21	31/08/21	8:38:50	82,9469	27,8160	phys only, replaces P7 due to lack of ice at P7 (no sa	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
357dfd40-0a30-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	31/08/21	7:51:11	NLEG27	82,9470	27,8570	3923,9	472		1500	0	31/08/21	31/08/21	9:31:31	82,9468	27,7691	CTD472	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
7b5c33a0-0a34-11ec-afc5-a3f13bbd5a61	Drone	Drone	31/08/21	8:21:47	NLEG27	82,9469	27,8310	3923,6	133				31/08/21	31/08/21	8:27:33	82,9469	27,8259	from ice	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
9b190430-0a42-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	31/08/21	10:02:53	NLEG27	82,9495	27,7866	3926,2	134		350	0	31/08/21	31/08/21	10:33:04	82,9493	27,7440	Annen stasjon (S-S)	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
21ed4150-0a49-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	31/08/21	10:49:36	NLEG27	82,9486	27,7239	3929,1	135		500	0	31/08/21	31/08/21	12:03:39	82,9480	27,6588	Annen stasjon (S-S)	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
0be1f100-0a79-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	31/08/21	16:32:35	NLEG28	83,3821	26,8780	3982,6	473		1500	0	31/08/21	31/08/21	18:09:28	83,3789	26,7758	CTD473 NLEG 1500 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
db359f70-0a87-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	31/08/21	18:18:36	NLEG28	83,3794	26,7669	3983,1	136		350	0	31/08/21	31/08/21	18:47:21	83,3781	26,7384	350 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
c0eca210-0a8e-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	31/08/21	19:07:58	NLEG28	83,3768	26,7109	3983,3	474		1500	0	31/08/21	31/08/21	19:43:25	83,3749	26,6723	CTD474 NLEG 1500 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
21172a00-0ab4-11ec-afc5-a3f13bbd5a61	Harstad Trål Pelagisk	Harstad trawl	31/08/21	23:35:31	P8 (NLEG29)a	83,7185	25,8665	4000	71		150	0	31/08/21	01/09/21	0:05:50	83,6979	25,9775	150m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
421c7260-0abd-11ec-afc5-a3f13bbd5a61	Harstad Trål Pelagisk	Harstad trawl	01/09/21	0:40:52	P8 (NLEG29)a	83,6937	25,9677	3999,9	72		450	0	01/09/21	01/09/21	1:02:56	83,7064	25,8523	450m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
18ea9dd0-0aff-11ec-afc5-a3f13bbd5a61	Multinett midi 64	Multinet 64 um	01/09/21	8:32:09	P8 (NLEG29)a	83,8973	25,3808	4002	381		3950	0	01/09/21	01/09/21	13:40:46	83,8741	25,3166	Bottom 4000 m, had to reconnect	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
4ebd6080-0af2-11ec-afc5-a3f13bbd5a61	ICE station		01/09/21	7:00:36	P8 (NLEG29) Ice	83,8994	25,4114	4001,9	137				01/09/21	01/09/21	20:17:13	83,8574	24,9987	P8 Day one	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
39421a30-0b2d-11ec-afc5-a3f13bbd5a61	Multinett Midi 180um	Multinet 180 um	01/09/21	14:02:20	P8 (NLEG29)	83,8717	25,3026	4001,8	382		3950	0	01/09/21	01/09/21	17:43:46	83,8555	25,1147	bottom	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
6acf4a80-0b4d-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	01/09/21	17:52:47	P8 (NLEG29)	83,8559	25,0860	4001,8	475		90	0	01/09/21	01/09/21	18:52:09	83,8554	25,0246	exp CTD	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
35a84310-0b58-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	01/09/21	19:10:03	P8 (NLEG29)	83,8575	25,0227	4001,9	383		1000	0	01/09/21	01/09/21	20:42:10	83,8575	24,9946	1000 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
8f09dc30-0b75-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	01/09/21	22:40:08	P8 (NLEG29)	83,8487	25,0162	4001,8	384		100	0	01/09/21	01/09/21	22:48:47	83,8485	25,0182	100m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
1a02af00-0b77-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	01/09/21	22:51:11	P8 (NLEG29)	83,8485	25,0188	4001,8	385		100	0	01/09/21	01/09/21	22:58:45	83,8483	25,0206	100m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
9349ef80-0b78-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	01/09/21	23:01:44	P8 (NLEG29)	83,8482	25,0213	4001,8	386		100	0	01/09/21	01/09/21	23:09:33	83,8479	25,0232	100m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
b30fa540-0b7c-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	01/09/21	23:31:15	P8 (NLEG29)	83,8471	25,0283	4001,8	139		30	0	01/09/21	01/09/21	23:56:38	83,8459	25,0333	Annen stasjon (S-S)	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
d6088240-0b6f-11ec-afc5-a3f13bbd5a61	Sediment trap	Sediment trap (short term)	01/09/21	21:59:10	P8 (NLEG29)	83,8512	24,9789	4001,8	138	500			01/09/21	02/09/21	21:40:12	83,8269	25,3600	P8 500 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
937929f0-0b85-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	02/09/21	0:34:47	P8 (NLEG29)	83,8436	25,0386	4001,8	387		1000	0	02/09/21	02/09/21	1:42:49	83,8391	25,0394	1000m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
faf3e700-0b8f-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	02/09/21	1:49:16	P8 (NLEG29)	83,8387	25,0388	4001,7	388		1000	0	02/09/21	02/09/21	3:19:03	83,8327	25,0227	1000m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
9a337f80-0b9d-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	02/09/21	3:26:47	P8 (NLEG29)	83,8322	25,0202	4001,6	389		1000	0	02/09/21	02/09/21	4:34:47	83,8285	24,9912	1000m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
4c743c20-0ba8-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	02/09/21	4:43:21	P8 (NLEG29)	83,8281	24,9870	4001,7	390		50	0	02/09/21	02/09/21	4:54:27	83,8276	24,9815	50m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
3632fda0-0baa-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	02/09/21	4:57:02	P8 (NLEG29)	83,8275	24,9802	4001,7	391		50	0	02/09/21	02/09/21	5:08:50	83,8271	24,9743	50m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
43ca3ad0-0bac-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	02/09/21	5:11:44	P8 (NLEG29)	83,8270	24,9729	4001,7	392		50	0	02/09/21	02/09/21	5:21:08	83,8267	24,9682	50m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
147b9060-0bae-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	02/09/21	5:24:44	P8 (NLEG29)	83,8266	24,9664	4001,7	393		50	0	02/09/21	02/09/21	5:32:43	83,8264	24,9626	50m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
53628910-0bb7-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	02/09/21	6:30:55	P8 (NLEG29)	83,8306	24,9637	4001,8	476		500	0	02/09/21	02/09/21	7:14:56	83,8307	24,9488	CTD476 std shallow	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
dfd729a0-0bbc-11ec-afc5-a3f13bbd5a61	Helicopter flight	Helicopter flight	02/09/21	7:10:38	P8 (NLEG29)	83,8306	24,9500	4001,8	140				02/09/21	02/09/21	8:18:45	83,8315	24,9403	Flight 1	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
e4d9dec0-0bc1-11ec-afc5-a3f13bbd5a61	Multinett midi 64	Multinet 64 um	02/09/21	7:46:34	P8 (NLEG29)	83,8310	24,9423	4001,9	394		500	0	02/09/21	02/09/21	8:46:37	83,8321	24,9426	bottom	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
7f6f7b60-0bc8-11ec-afc5-a3f13bbd5a61	Drone	Drone	02/09/21	8:33:50	P8 (NLEG29)	83,8318	24,9410	4001,9	141				02/09/21	02/09/21	9:35:06	83,8329	24,9565	P8 Drone from Iceflow	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
0269eba0-0bcd-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	02/09/21	9:06:08	P8 (NLEG29)	83,8324	24,9466	4001,8	477		4088	0	02/09/21	02/09/21	13:10:03	83,8292	25,1148	CTD477 std deep	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
e06ec630-0bf2-11ec-afc5-a3f13bbd5a61	Helicopter flight	Helicopter flight	02/09/21	13:37:12	P8 (NLEG29)	83,8277	25,1336	4001,5	142				02/09/21	02/09/21	15:02:18	83,8229	25,1813	Flight 2	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
f0174210-0bf2-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	02/09/21	13:37:38	P8 (NLEG29)	83,8277	25,1339	4001,5	395		1000	0	02/09/21	02/09/21	14:46:05	83,8238	25,1736	1000 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
96268120-0bfd-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	02/09/21	14:53:52	P8 (NLEG29)	83,8233	25,1773	4020,2	478		4088	0	02/09/21	02/09/21	18:39:29	83,8219	25,2641	CTD478 other	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
a25f5fa0-0c27-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	02/09/21	19:54:51	P8 (NLEG29)	83,8264	25,2942	4020	143		500	0	02/09/21	02/09/21	20:59:58	83,8304	25,3526	500 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
70a689a0-0c42-11ec-afc5-a3f13bbd5a61	Box Core	Box core	02/09/21	23:06:44	P8 (NLEG29)	83,8345	25,5142	4019,7	130	4020			02/09/21	03/09/21	2:42:05	83,8302	25,7382	Palaeo, food web	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
ed9d9140-0c7b-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	03/09/21	5:58:15	P8 (NLEG29)	83,8285	25,8137	4019,3	479		4086	0	03/09/21	03/09/21	9:46:22	83,8412	25,9455	CTD479 noon, bottom	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
e6d89d70-0c9c-11ec-afc5-a3f13bbd5a61	Multinett mammoth 180	Multinet 180 um	03/09/21	9:54:17	P8 (NLEG29)	83,8415	25,9526	4019	396		3000	0	03/09/21	03/09/21	12:53:29	83,8393	26,1107	3000 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
eaab8db0-0cb8-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	03/09/21	13:14:49	P8 (NLEG29)	83,8379	26,1247	4018,9	397		1000	0	03/09/21	03/09/21	14:25:49	83,8323	26,1572	1000 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
0be1a2b0-0cc5-11ec-afc5-a3f13bbd5a61	Box Core	Box core	03/09/21	14:41:39	P8 (NLEG29)	83,8310	26,1610	4017,9	131	4018			03/09/21	03/09/21	19:04:18	83,8247	26,0828	All else 1	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
43e064f0-0ceb-11ec-afc5-a3f13bbd5a61	Box Core	Box core	03/09/21	19:15:14	P8 (NLEG29)	83,8252	26,0792	4017,9	132	4018			03/09/21	03/09/21	23:18:37	83,8371	26,1347		Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
6b806590-0d0f-11ec-afc5-a3f13bbd5a61	Box Core	Box core	03/09/21	23:34:02	P8 (NLEG29)	83,8375	26,1442	4017,7	133	4018			03/09/21	04/09/21	3:50:36	83,8333	26,2314	1500 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI
e7859580-0d7c-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	04/09/21	12:37:45	NLEG30	84,1782	22,0896	4013,2	480		1500	0	04/09/21	04/09/21	14:19:29	84,1756	22,1395	CTD480 NLEG 1500 m	Nansen Legacy Versio	Agneta Franss	Agneta Fransson	agneta.fra	NPI

405106f0-0d8b-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	04/09/21	14:20:27	NLEG30	84,1756	22,1396	4013,6	144		350	0	04/09/21	04/09/21	14:52:16	84,1747	22,1439	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
f92d9040-0d8f-11ec-afc5-a3f13bbd5a61	Secchi disc	Secchi disk	04/09/21	14:54:15	NLEG30	84,1747	22,1440	4013,7	145		50	0	04/09/21	04/09/21	15:01:38	84,1745	22,1439	350 m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
adc0e740-0dcd-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	04/09/21	22:15:58	NLEG31	84,4960	17,9159	4013,6	481		1500	0	04/09/21	04/09/21	23:59:02	84,5044	17,9832	1500 m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
d067ea00-0ddc-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	05/09/21	0:04:18	NLEG31	84,5045	17,9843	4013,2	146		350	0	05/09/21	05/09/21	0:32:18	84,5059	18,0041	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
e22ba7f0-0de0-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	05/09/21	0:33:26	NLEG31	84,5059	18,0049	4013,1	147		500	0	05/09/21	05/09/21	1:45:53	84,5075	18,0489	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
9c627830-0e34-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	05/09/21	10:32:47	NLEG32	84,8236	12,3368	3712,8	482		500	0	05/09/21	05/09/21	11:08:57	84,8276	12,3514	CTD water for sediment trap 500 m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
cf5af3f0-0e36-11ec-afc5-a3f13bbd5a61	Secchi disk	Secchi disk	05/09/21	10:48:31	NLEG32	84,8254	12,3426	3718,5	148		50	0	05/09/21	05/09/21	11:03:18	84,8270	12,3488	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
33b9ab50-0e3e-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	05/09/21	11:41:26	NLEG32	84,8307	12,3677	3712,8	483		1500	0	05/09/21	05/09/21	13:21:31	84,8369	12,4208	1500 m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
1c3356c0-0e4d-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	05/09/21	13:28:09	NLEG32	84,8373	12,4203	3642,4	149		350	0	05/09/21	05/09/21	13:56:40	84,8382	12,4324	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
401f8f70-0e77-11ec-afc5-a3f13bbd5a61	Harstad Trål Pelagisk	Harstad trawl	05/09/21	18:29:48	P9 (NLEG33)a	84,9571	9,4165	3513,6	73		450	0	05/09/21	05/09/21	18:59:49	84,9606	9,5867	450m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
10ac8bc0-0e87-11ec-afc5-a3f13bbd5a61	Krilltrål 1723	Harstad trawl	05/09/21	20:23:00	P9 (NLEG33)a	84,9675	9,5135	3418,4	74		450	0	05/09/21	05/09/21	20:53:01	84,9671	9,3449	450m, same track back		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
a7ca73e0-0ee7-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	06/09/21	7:54:26	P9 (NLEG33)	85,3707	7,4551	3573	484		3677	0	06/09/21	06/09/21	11:31:28	85,3925	7,4597	noon CTD bottom		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
61127f80-0f08-11ec-afc5-a3f13bbd5a61	Multinett mammoth 180	Multinet 180 um	06/09/21	11:48:40	P9 (NLEG33)	85,3938	7,4699	3611,9	398		3000	0	06/09/21	06/09/21	14:59:06	85,4031	7,5425	3000 m genetics		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
c3bbc0e0-0f1e-11ec-afc5-a3f13bbd5a61	Drone	Drone	06/09/21	14:28:55	P9 (NLEG33)	85,4021	7,5422	3651,5	151				06/09/21	06/09/21	14:50:55	85,4029	7,5430	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
b7f2a870-0f26-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	06/09/21	15:25:51	P9 (NLEG33)	85,4041	7,5381	3690,9	485		90	0	06/09/21	06/09/21	15:45:20	85,4049	7,5322	CTD experiments		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
644a0e90-0f2e-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	06/09/21	16:20:47	P9 (NLEG33)	85,4068	7,6532	3645,4	399		50	0	06/09/21	06/09/21	16:36:31	85,4079	7,6424	50m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
2077d0a0-0f31-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	06/09/21	16:40:21	P9 (NLEG33)	85,4081	7,6399	3661,9	400		50	0	06/09/21	06/09/21	16:52:13	85,4088	7,6352	50m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
f451dd70-0f32-11ec-afc5-a3f13bbd5a61	WP2 56 um	WP2 56 um	06/09/21	16:53:26	P9 (NLEG33)	85,4089	7,6338	3665,1	401		50	0	06/09/21	06/09/21	17:02:02	85,4094	7,6290	50m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
adda1770-0f34-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	06/09/21	17:05:47	P9 (NLEG33)	85,4097	7,6264	3715,3	402		1000	0	06/09/21	06/09/21	18:38:15	85,4182	7,5553	1000m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
081da5c0-0f4a-11ec-afc5-a3f13bbd5a61	Sediment trap	Sediment trap (short term)	06/09/21	19:38:38	P9 (NLEG33)	85,4244	7,5342	3619	152	500			06/09/21	07/09/21	19:49:11	85,5427	6,7161	500m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
385a46c0-0f55-11ec-afc5-a3f13bbd5a61	Multinett Midi 180um	Multinet 180 um	06/09/21	20:58:43	P9 (NLEG33)	85,4367	7,3476	4079,6	403		3600	0	06/09/21	07/09/21	0:45:45	85,4659	7,4251	bottom		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
5dec5650-0f76-11ec-afc5-a3f13bbd5a61	Multinett midi 64	Multinet 64 um	07/09/21	0:56:00	P9 (NLEG33)	85,4669	7,4288	3949,6	404		3600	0	07/09/21	07/09/21	5:53:45	85,4880	7,2675	bottom		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
062a78f0-0fa5-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	07/09/21	6:29:59	P9 (NLEG33)	85,4919	7,2224	3605,6	486		500	0	07/09/21	07/09/21	7:15:54	85,4974	7,1682	CTD standard shallow		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
aac2c4e0-0fae-11ec-afc5-a3f13bbd5a61	Multinett midi 64	Multinet 64 um	07/09/21	7:39:01	P9 (NLEG33)	85,5005	7,1431	3763,5	405		500	0	07/09/21	07/09/21	8:29:33	85,5072	7,0980	500m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
853c5c00-0fb7-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	07/09/21	8:42:23	P9 (NLEG33)	85,5090	7,0891	3520,5	487		3415	0	07/09/21	07/09/21	12:44:57	85,5322	7,0427	CTD standard deep		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
8fba9230-0fe1-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	07/09/21	13:43:19	P9 (NLEG33)	85,5335	7,0248	3031,2	488		3031	0	07/09/21	07/09/21	16:23:50	85,5344	6,8609	CTD other		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
4cb5dea0-0ffe-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	07/09/21	17:09:02	P9 (NLEG33)	85,5361	6,9647	3131,8	153		500	0	07/09/21	07/09/21	18:11:06	85,5385	6,8671	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
5a42eb30-1017-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	07/09/21	20:08:23	P9 (NLEG33)	85,5460	6,7165	3608,8	406		100	0	07/09/21	07/09/21	20:16:37	85,5466	6,7083	100m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
91b77930-1019-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	07/09/21	20:24:15	P9 (NLEG33)	85,5471	6,7000	3590,6	407		100	0	07/09/21	07/09/21	20:34:39	85,5478	6,6889	100m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
100dc7b0-101c-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	07/09/21	20:42:06	P9 (NLEG33)	85,5482	6,6652	3353,3	408		100	0	07/09/21	07/09/21	20:55:07	85,5489	6,6503	100m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
ea3e4c10-101d-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	07/09/21	20:55:21	P9 (NLEG33)	85,5489	6,6501	3340,9	409		100	0	07/09/21	07/09/21	21:04:28	85,5495	6,6420	100m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
220fee30-1020-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	07/09/21	21:11:14	P9 (NLEG33)	85,5499	6,6364	3301	410		1000	0	07/09/21	07/09/21	22:21:25	85,5535	6,5912	1000m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
8b61b530-102a-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	07/09/21	22:25:45	P9 (NLEG33)	85,5537	6,5891	3262,4	411		100	0	07/09/21	07/09/21	22:34:16	85,5540	6,5854	100		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
24f4f9d0-102d-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	07/09/21	22:44:22	P9 (NLEG33)	85,5543	6,5811	3302,1	412		1000	0	07/09/21	08/09/21	0:15:42	85,5552	6,5472	1000		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
f3342a50-0ee3-11ec-afc5-a3f13bbd5a61	ICE station		06/09/21	7:27:54	P9 (NLEG33) Ice	85,3684	7,4765	3605	150				06/09/21	08/09/21	13:32:30	85,5443	5,5027	P9		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
533fbc40-1040-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	08/09/21	1:01:40	P9 (NLEG33)	85,5533	6,3541	3408,5	413		1000	0	08/09/21	08/09/21	2:09:49	85,5509	6,3059	1000		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
93e9d6d0-104b-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	08/09/21	2:22:13	P9 (NLEG33)	85,5504	6,2947	3426,8	414		1000	0	08/09/21	08/09/21	3:39:42	85,5473	6,2034	1000m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
fb350d80-1057-11ec-afc5-a3f13bbd5a61	Box Core	Box core	08/09/21	3:51:00	P9 (NLEG33)	85,5469	6,1870	3623,9	134	3624			08/09/21	08/09/21	8:25:03	85,5483	5,7488		3623,94	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
072e7300-1077-11ec-afc5-a3f13bbd5a61	Drone	Drone	08/09/21	7:33:15	P9 (NLEG33)	85,5466	5,8168	3620,2	154				08/09/21	08/09/21	8:35:28	85,5487	5,7371	from Iceflow		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
947f45f0-1080-11ec-afc5-a3f13bbd5a61	Box Core	Box core	08/09/21	8:41:37	P9 (NLEG33)	85,5489	5,7304	3386,8	135	3387			08/09/21	08/09/21	12:38:32	85,5477	5,5557		3386,805	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
209f2610-10a2-11ec-afc5-a3f13bbd5a61	Box Core	Box core	08/09/21	12:41:46	P9 (NLEG33)	85,5476	5,5531	3431,7	136	3432			08/09/21	08/09/21	15:59:21	85,5326	5,2834		3431,71	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
90e5c120-10a4-11ec-afc5-a3f13bbd5a61	Drone	Drone	08/09/21	12:59:13	P9 (NLEG33)	85,5465	5,5378	3391,2	155				08/09/21	08/09/21	13:12:49	85,5457	5,5243	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
50fc3040-10c1-11ec-afc5-a3f13bbd5a61	Box Core	Box core	08/09/21	16:25:02	P9 (NLEG33)	85,5308	5,2367	3494,6	137	3495			08/09/21	08/09/21	19:59:54	85,5221	4,8625			Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
11bd4b60-10eb-11ec-afc5-a3f13bbd5a61	Harstad Trål Pelagisk	Harstad trawl	08/09/21	21:23:54	P9 (NLEG33)	85,5209	4,9863	3554	75		200	0	08/09/21	08/09/21	21:59:26	85,5101	4,6471	200-100-50 m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
335d6240-10f6-11ec-afc5-a3f13bbd5a61	Krilltrål 1723	Harstad trawl	08/09/21	22:43:35	P9 (NLEG33)	85,5082	4,6302	3563,3	76		200	0	08/09/21	08/09/21	23:13:41	85,5131	4,8364	200-100-50 m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
65415260-1148-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	09/09/21	8:31:58	NLEG34	85,7470	-2,5438	4165,6	489		1500	0	09/09/21	09/09/21	10:25:17	85,7490	-2,6368	NLEG 1500 m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
4f856820-1158-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	09/09/21	10:25:53	NLEG34	85,7490	-2,6371	4164,6	156		350	0	09/09/21	09/09/21	10:59:22	85,7492	-2,6515	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
1f485eb0-115d-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	09/09/21	11:00:20	NLEG34	85,7492	-2,6521	4163,9	157		500	0	09/09/21	09/09/21	12:19:04	85,7473	-2,6786	500		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
49dbb810-1168-11ec-afc5-a3f13bbd5a61	Secchi disk	Secchi disk	09/09/21	12:20:15	NLEG34	85,7472	-2,6794	4159,8	158		50	0	09/09/21	09/09/21	12:34:55	85,7451	-2,6912	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
a3c2dfd0-11d0-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	10/09/21	0:47:14	NLEG35	86,0051	-10,6921	4172	490		1500	0	10/09/21	10/09/21	2:35:28	85,9987	-10,7497	NLEG 1500 m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
bec0dde0-11e0-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	10/09/21	2:42:31	NLEG35	85,9976	-10,7518	4171,8	159		350	0	10/09/21	10/09/21	3:14:04	85,9955	-10,7822	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
2dca7a30-11e5-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	10/09/21	3:14:16	NLEG35	85,9955	-10,7823	4171,9	491		500	0	10/09/21	10/09/21	3:51:46	85,9930	-10,8169	CTD water for sediment trap 500 m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
1e740ef0-1232-11ec-afc5-a3f13bbd5a61	Helicopter flight	Helicopter flight	10/09/21	12:25:01	transit to P10	86,1506	-14,1536	4202,9	160				10/09/21	10/09/21	12:43:39	86,1591	-14,1572	Flight 3		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
67525200-124e-11ec-afc5-a3f13bbd5a61	Helicopter flight	Helicopter flight	10/09/21	15:25:29	transit to P10	86,2244	-14,9972	4215,6	161				10/09/21	10/09/21	16:47:26	86,2611	-15,1034	Flight 4		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
2dc7b8d0-129a-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	11/09/21	0:49:54	P10 (NLEG36)	86,5052	-16,7077	4235,4	415		1000	0	11/09/21	11/09/21	2:22:50	86,4966	-16,6922	1000m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
626a1d90-12a8-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	11/09/21	2:31:36	P10 (NLEG36)	86,4957	-16,6927	4234,8	416		1000	0	11/09/21	11/09/21	3:41:12	86,4887	-16,7044	1000m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
02cffde0-12c7-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	11/09/21	6:10:50	P10 (NLEG36)	86,4973	-16,7338	4234,8	417		1000	0	11/09/21	11/09/21	7:24:49	86,4933	-16,7594	1000 m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
514a0a20-12da-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	11/09/21	8:29:02	P10 (NLEG36)	86,4903	-16,7649	4233,9	492		4332	0	11/09/21	11/09/21	12:21:40	86,4756	-16,6530	CTD noon		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
706c2580-12e1-11ec-afc5-a3f13bbd5a61	Drone	Drone	11/09/21	9:20:00	P10 (NLEG36)	86,4879	-16,7551	4234,4	163				11/09/21	11/09/21	9:36:10	86,4871	-16,7498	P10		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
542affa0-12fe-11ec-afc5-a3f13bbd5a61	Multinett Midi 180um	Multinet 180 um	11/09/21	12:44:48	P10 (NLEG36)	86,4736	-16,6379	4252,2	418		4100	0	11/09/21	11/09/21	16:45:10	86,4495	-16,5853	bottom		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
beec5d60-1322-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	11/09/21	17:07:29	P10 (NLEG36)	86,4476	-16,5906	4250,2	493		90	0	11/09/21	11/09/21	17:24:45	86,4461	-16,5953	CTD experiments		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
b781e420-132a-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	11/09/21	18:04:33	P10 (NLEG36)	86,4351	-16,5884	4248,1	419		1000	0	11/09/21	11/09/21	19:34:02	86,4292	-16,6115	1000m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
9e4526a0-1331-11ec-afc5-a3f13bbd5a61	Film av CTD	CTD	11/09/21	18:15:57	P10 (NLEG36)	86,4343	-16,5915	4248,5	164				11/09/21	11/09/21	18:53:59	86,4316	-16,6031	Filming av CTD sonde til 40m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
fb6804f0-1337-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	11/09/21	19:39:30	P10 (NLEG36)	86,4289	-16,6124	4247,6	420		50	0	11/09/21	11/09/21	19:51:57	86,4282	-16,6141	50m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
5ecc0570-133b-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	11/09/21	19:53:46	P10 (NLEG36)	86,4281	-16,6143	4247,5	421		50	0	11/09/21	11/09/21	20:05:36	86,4274	-16,6154	50m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
19747c80-133d-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	11/09/21	20:08:08	P10 (NLEG36)	86,4273	-16,6156	4247,4	422		50	0	11/09/21	11/09/21	20:19:59	86,4267	-16,6162	50m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
dcc62c60-134c-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	11/09/21	22:08:58	P10 (NLEG36)	86,4205	-16,6095	4246,7	423		100	0	11/09/21	11/09/21	22:18:53	86,4199	-16,6068	100m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
f80a8aa0-134e-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	11/09/21	22:24:03	P10 (NLEG36)	86,4196	-16,6051	4246,6	424		150	0	11/09/21	11/09/21	22:35:28	86,4189	-16,6014	150m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
aa454d70-1351-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	11/09/21	22:43:21	P10 (NLEG36)	86,4185	-16,5988	4246,5	425		100	0	11/09/21	11/09/21	22:51:20	86,4180	-16,5958			Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
3c6ef240-1353-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	11/09/21	22:54:36	P10 (NLEG36)	86,4177	-16,5946	4246,5	426		100	0	11/09/21	11/09/21	23:02:25	86,4172	-16,5918			Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
73e750d0-1355-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	11/09/21	23:10:28	P10 (NLEG36)	86,4167	-16,5888	4246,3	166		500	0	11/09/21	12/09/21	0:23:22	86,4111	-16,5617	Annen stasjon (S-S)		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
b417dc50-1365-11ec-afc5-a3f13bbd5a61	Multinett midi 64	Multinet 64 um	12/09/21	1:06:48	P10 (NLEG36)	86,4160	-16,5591	4245,8	427		500	0	12/09/21	12/09/21	6:41:26	86,3939	-16,6638	500 m foram		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
20824340-1397-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	12/09/21	7:00:35	P10 (NLEG36)	86,3934	-16,6742	4244,4	494		500	0	12/09/21	12/09/21	7:50:45	86,3924	-16,6957	CTD std shallow		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
bd393c70-13a1-11ec-afc5-a3f13bbd5a61	Multinett midi 64	Multinet 64 um	12/09/21	8:16:33	P10 (NLEG36)	86,3920	-16,7026	4244,1	428		4100	0	12/09/21	12/09/21	9:00:34	86,3914	-16,7093	500m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
762a9400-13ab-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	12/09/21	9:26:08	P10 (NLEG36)	86,3910	-16,7112	4243,9	495		4322	0	12/09/21	12/09/21	13:24:03	86,3834	-16,6631	CTD std deep		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
5a7d6200-13ce-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	12/09/21	13:35:54	P10 (NLEG36)	86,3828	-16,6616	4243,8	429		1000	0	12/09/21	12/09/21	14:48:53	86,3789	-16,6616	1000m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
a9b48780-1343-11ec-afc5-a3f13bbd5a61	Sediment trap	Sediment trap (short term)	11/09/21	21:03:07	P10 (NLEG36)	86,4218	-16,6372	4244,6	165	500			11/09/21	12/09/21	20:35:35	86,3624	-16,8135	500m		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
cffcc410-13da-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	12/09/21	15:05:05	P10 (NLEG36)	86,3781	-16,6641	4245,4	496		4322	0	12/09/21	12/09/21	18:54:45	86,3721	-16,7617	CTD other		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI

49bb8fa0-140a-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	12/09/21	20:44:56	P10 (NLEG36)	86,3623	-16,8154	4242,7	430		100	0	12/09/21	12/09/21	20:55:13	86,3626	-16,8159	100m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
68fd3330-140c-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	12/09/21	21:00:08	P10 (NLEG36)	86,3627	-16,8163	4242,8	431		100	0	12/09/21	12/09/21	21:10:29	86,3628	-16,8167	100m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
b70839b0-140e-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	12/09/21	21:16:37	P10 (NLEG36)	86,3629	-16,8169	4242,9	432		100	0	12/09/21	12/09/21	21:27:39	86,3630	-16,8165	100m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
ec0b2ea0-1414-11ec-afc5-a3f13bbd5a61	Multinett mammoth 180	Multinet 180 um	12/09/21	22:01:03	P10 (NLEG36)	86,3741	-16,7917	4245,7	433		3000	0	12/09/21	13/09/21	1:02:12	86,3736	-16,7147	3000m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
130f4190-1432-11ec-afc5-a3f13bbd5a61	Box Core	Box core	13/09/21	1:29:44	P10 (NLEG36)	86,3732	-16,7018	4246,9	138	4247			13/09/21	13/09/21	6:13:37	86,3734	-16,6764		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
fbfe62e0-12c6-11ec-afc5-a3f13bbd5a61	ICE station		11/09/21	6:10:38	P10 (NLEG36) Ice	86,4973	-16,7337	4246,3	162				11/09/21	13/09/21	17:39:30	86,3992	-16,4321	P10	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
cdb8e9f0-145b-11ec-afc5-a3f13bbd5a61	Box Core	Box core	13/09/21	6:28:27	P10 (NLEG36)	86,3739	-16,6770	4246,9	139	4247			13/09/21	13/09/21	11:23:03	86,3872	-16,5622		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
19c05ba0-1487-11ec-afc5-a3f13bbd5a61	Box Core	Box core	13/09/21	11:38:23	P10 (NLEG36)	86,3878	-16,5508	4247,6	140	4248			13/09/21	13/09/21	15:51:16	86,3941	-16,4273		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
936f9070-14ae-11ec-afc5-a3f13bbd5a61	Box Core	Box core	13/09/21	16:20:57	P10 (NLEG36)	86,3951	-16,4257	4248,5	141	4249			13/09/21	13/09/21	20:22:34	86,4138	-16,4352		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
e5512c80-14d3-11ec-afc5-a3f13bbd5a61	Box Core	Box core	13/09/21	20:48:06	P10 (NLEG36)	86,4163	-16,4282	4252,1	142	4252			13/09/21	14/09/21	0:10:08	86,4330	-16,3218		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
9642b4f0-156f-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	14/09/21	15:22:35	NLEG37	87,0041	-21,5252	4284,6	497		1500	0	14/09/21	14/09/21	17:07:31	87,0042	-21,3948	CTD NLEG	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
d94f0e00-1570-11ec-afc5-a3f13bbd5a61	Secchi disk	Secchi disk	14/09/21	15:31:37	NLEG37	87,0056	-21,5163	4284,6	167		50	0	14/09/21	14/09/21	16:01:25	87,0052	-21,4684	Annen stasjon (S-S), unsuccessful	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
435848b0-157c-11ec-afc5-a3f13bbd5a61	Helicopter flight	Helicopter flight	14/09/21	16:53:19	NLEG37	87,0044	-21,4090	4284,6	168				14/09/21	14/09/21	17:01:39	87,0043	-21,4004	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
db8ce7b0-157e-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	14/09/21	17:11:54	NLEG37	87,0042	-21,3907	4284,5	169		350	0	14/09/21	14/09/21	17:42:46	87,0042	-21,3700	Annen stasjon (S-S) 500 m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
e19f1b90-1584-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	14/09/21	17:55:01	NLEG37	87,0043	-21,3628	4284,5	170		500	0	14/09/21	14/09/21	19:03:53	87,0064	-21,3162	Annen stasjon (S-S) 350 m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
2e6e9800-158b-11ec-afc5-a3f13bbd5a61	watersampling with bucket from surface	Bucket	14/09/21	18:19:07	NLEG37	87,0048	-21,3475	4284,4	171	0			14/09/21	14/09/21	18:40:12	87,0056	-21,3323	Ice and Water take by bucket from 3rd Deck level	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
c54f9870-158e-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	14/09/21	19:05:48	NLEG37	87,0065	-21,3153	4284,5	498		500	0	14/09/21	14/09/21	19:42:06	87,0076	-21,2888	500 m water for sediment trap	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
59d2a910-15fd-11ec-afc5-a3f13bbd5a61	Harstad Trål Pelagisk	Harstad trawl	15/09/21	8:17:22	P11 (NLEG38)a	87,4566	-17,4113	4283,7	77		480	0	15/09/21	15/09/21	8:50:42	87,4715	-17,9234		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
4356bc70-1608-11ec-afc5-a3f13bbd5a61	Krilltrål 1723	Harstad trawl	15/09/21	9:35:29	P11 (NLEG38)a	87,4595	-17,3968	4285,3	78		480	0	15/09/21	15/09/21	10:06:40	87,4671	-17,7112		Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
3f5e2ce0-161a-11ec-afc5-a3f13bbd5a61	Multinett mammoth 180	Multinet 180 um	15/09/21	11:44:13	P11 (NLEG38)	87,5009	-17,3716	4289,6	434		3000	0	15/09/21	15/09/21	14:40:44	87,4966	-17,2522	3000m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
a8fedb60-161d-11ec-afc5-a3f13bbd5a61	Drone	Drone	15/09/21	12:08:39	P11 (NLEG38)	87,5007	-17,3501	4289	172				15/09/21	15/09/21	13:21:22	87,4993	-17,2906	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
2035bb00-1636-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	15/09/21	15:03:47	P11 (NLEG38)	87,4929	-17,3419	4287,7	435		50	0	15/09/21	15/09/21	15:13:39	87,4926	-17,3397	50m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
e2d5e110-1638-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	15/09/21	15:23:32	P11 (NLEG38)	87,4921	-17,3400	4288	436		50	0	15/09/21	15/09/21	15:29:50	87,4917	-17,3413	50m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
c8a6e310-1639-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	15/09/21	15:29:58	P11 (NLEG38)	87,4917	-17,3413	4288	437		50	0	15/09/21	15/09/21	15:38:21	87,4917	-17,3390	50m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
b5caaf40-1640-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	15/09/21	16:19:33	P11 (NLEG38)	87,4899	-17,3490	4289	499		50	0	15/09/21	15/09/21	20:09:44	87,4901	-17,4841	CTD other, to bottom	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
c4499c40-1661-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	15/09/21	20:16:10	P11 (NLEG38)	87,4903	-17,4882	4287,9	438		1000	0	15/09/21	15/09/21	21:46:19	87,4928	-17,5260	1000m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
6b3ec720-166f-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	15/09/21	21:53:54	P11 (NLEG38)	87,4930	-17,5275	4286,9	439		100	0	15/09/21	15/09/21	22:04:54	87,4933	-17,5292	100m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
c06ff140-1671-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	15/09/21	22:10:36	P11 (NLEG38)	87,4934	-17,5299	4286,9	440		100	0	15/09/21	15/09/21	22:18:58	87,4935	-17,5307	100m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
d1b6c8f0-1673-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	15/09/21	22:25:24	P11 (NLEG38)	87,4936	-17,5313	4286,8	441		100	0	15/09/21	15/09/21	22:33:58	87,4938	-17,5318	100m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
ca0199d0-1675-11ec-afc5-a3f13bbd5a61	Bongo 180um	Bongonet 180 um	15/09/21	22:39:30	P11 (NLEG38)	87,4938	-17,5320	4286,8	442		1000	0	15/09/21	16/09/21	0:08:44	87,4938	-17,5231	1000m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
6dbc0c10-1683-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	16/09/21	0:17:08	P11 (NLEG38)	87,4936	-17,5216	4287,3	443		1000	0	16/09/21	16/09/21	1:46:20	87,4908	-17,5140	1000m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
04620180-1696-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	16/09/21	2:30:12	P11 (NLEG38)	87,4918	-17,4266	4288,5	444		500	0	16/09/21	16/09/21	3:39:53	87,4884	-17,4494	500m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
66be9ff0-16a0-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	16/09/21	3:44:32	P11 (NLEG38)	87,4882	-17,4516	4288	445		500	0	16/09/21	16/09/21	4:53:36	87,4852	-17,4952	500m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
bb64b200-16ab-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	16/09/21	5:05:38	P11 (NLEG38)	87,4851	-17,5004	4287,7	446		500	0	16/09/21	16/09/21	6:18:58	87,4841	-17,5602	500m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
5e6355b0-16b6-11ec-afc5-a3f13bbd5a61	MIK	MIK-net 1500 um	16/09/21	6:21:47	P11 (NLEG38)	87,4841	-17,5626	4286,6	447		1000	0	16/09/21	16/09/21	6:58:47	87,4846	-17,5963	500mtr extra	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
58df6800-16c4-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	16/09/21	8:01:50	P11 (NLEG38)	87,4867	-17,6474	4284,8	500		4362	0	16/09/21	16/09/21	12:01:03	87,4981	-17,6060	CTD noon bottom	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
30de8a70-16e7-11ec-afc5-a3f13bbd5a61	Multinett Midi 180um	Multinet 180 um	16/09/21	12:11:15	P11 (NLEG38)	87,4984	-17,5977	4286,4	448		4100	0	16/09/21	16/09/21	16:16:36	87,4990	-17,5164	bottom	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
23d7ef50-16f7-11ec-afc5-a3f13bbd5a61	Birtes polartorskfelle	Polar cod trap	16/09/21	12:55:26	P11 (NLEG38)	87,4993	-17,5639	4280,5	174	0			16/09/21	17/09/21	11:35:42	87,5101	-18,2496	P11	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
1a19d630-170c-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	16/09/21	16:35:29	P11 (NLEG38)	87,4980	-17,6165	4284,4	501		90	0	16/09/21	16/09/21	17:00:58	87,4983	-17,6335	CTD experiments	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
31aafe30-1713-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	16/09/21	17:26:15	P11 (NLEG38)	87,4988	-17,6532	4283,6	175		500	0	16/09/21	16/09/21	18:31:18	87,5010	-17,7106	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
1aaeb5a0-172c-11ec-afc5-a3f13bbd5a61	Multinett midi 64	Multinet 64 um	16/09/21	20:24:34	P11 (NLEG38)	87,5078	-17,7212	4280,9	449		4100	0	16/09/21	17/09/21	1:31:49	87,5169	-17,8054	BOTTOM	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
ba0f1360-1777-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	17/09/21	5:25:53	P11 (NLEG38)	87,5127	-18,0169	4275,9	502		500	0	17/09/21	17/09/21	6:16:46	87,5125	-18,0760	CTD st shallow	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
f65b2070-1781-11ec-afc5-a3f13bbd5a61	Multinett midi 64	Multinet 64 um	17/09/21	6:39:09	P11 (NLEG38)	87,5124	-18,1024	4274,2	450		500	0	17/09/21	17/09/21	7:24:41	87,5123	-18,1529	500m foram	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
118ee340-178c-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	17/09/21	7:51:30	P11 (NLEG38)	87,5123	-18,1795	4270,6	503		4348	0	17/09/21	17/09/21	11:49:02	87,5098	-18,2480	CTD st deep	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
751358f0-171f-11ec-afc5-a3f13bbd5a61	Sediment trap	Sediment trap (short term)	16/09/21	18:54:02	P11 (NLEG38)	87,5029	-17,7521	4272,6	176	500			16/09/21	17/09/21	19:55:44	87,4919	-18,2522	500m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
233bc560-17b2-11ec-afc5-a3f13bbd5a61	Multinett mammoth 180	Multinet 180 um	17/09/21	12:24:00	P11 (NLEG38)	87,5087	-18,2433	4271,5	451		3000	0	17/09/21	17/09/21	15:19:29	87,5004	-18,2329	3000m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
9895d510-17d2-11ec-afc5-a3f13bbd5a61	GO-FLO	GO-FLO	17/09/21	16:16:21	P11 (NLEG38)	87,4961	-18,3204	4269,6	178		30		17/09/21	17/09/21	16:55:06	87,4945	-18,3276	Annen stasjon (S-S), chl max	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
db8e8cd0-17d8-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	17/09/21	17:01:11	P11 (NLEG38)	87,4943	-18,3284	4269,5	452		100	0	17/09/21	17/09/21	17:16:03	87,4937	-18,3303	100m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
f7880a40-17da-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	17/09/21	17:16:16	P11 (NLEG38)	87,4937	-18,3303	4269,4	453		100	0	17/09/21	17/09/21	17:33:13	87,4932	-18,3326	100m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
5ce9a4f0-17dd-11ec-afc5-a3f13bbd5a61	Bongo 64um	Bongonet 64 um	17/09/21	17:33:26	P11 (NLEG38)	87,4931	-18,3327	4269,3	454		100	0	17/09/21	17/09/21	17:55:13	87,4925	-18,3356	100m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
dc69fe10-17eb-11ec-afc5-a3f13bbd5a61	Drone	Drone	17/09/21	19:17:12	P11 (NLEG38)	87,4922	-18,3674	4269,1	179				17/09/21	17/09/21	19:27:43	87,4919	-18,3680	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
e3c9ae50-16e5-11ec-afc5-a3f13bbd5a61	ICE station	Ice corer	16/09/21	6:30:57	P11 (NLEG38)	87,4842	-17,5704	4280,6	173				16/09/21	18/09/21	17:15:23	87,4833	-18,0164	P11	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
cb5b9720-17cb-11ec-afc5-a3f13bbd5a61	Birtes polartorskfelle	Polar cod trap	17/09/21	11:40:40	P11 (NLEG38)	87,5100	-18,2490	4277,6	177	0			17/09/21	18/09/21	14:24:05	87,4842	-17,7195	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
8cda80d0-17f1-11ec-afc5-a3f13bbd5a61	Box Core	Box core	17/09/21	19:57:56	P11 (NLEG38)	87,4919	-18,2518	4273,7	143	4274			17/09/21	17/09/21	23:45:25	87,4909	-18,1024	bottom	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
35076990-1819-11ec-afc5-a3f13bbd5a61	Box Core	Box core	18/09/21	0:41:48	P11 (NLEG38)	87,4900	-18,0397	4279,4	144	4279			18/09/21	18/09/21	4:12:28	87,4837	-17,8102	bottom	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
52ab4000-1839-11ec-afc5-a3f13bbd5a61	Box Core	Box core	18/09/21	4:31:42	P11 (NLEG38)	87,4831	-17,7992	4281,7	145	4282			18/09/21	18/09/21	8:29:43	87,4820	-17,7283	bottom	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
fa51fb10-185b-11ec-afc5-a3f13bbd5a61	Box Core	Box core	18/09/21	8:39:46	P11 (NLEG38)	87,4821	-17,7250	4283,9	146	4284			18/09/21	18/09/21	12:18:02	87,4850	-17,6550	bottom	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
41793e50-1883-11ec-afc5-a3f13bbd5a61	Box Core	Box core	18/09/21	13:20:56	P11 (NLEG38)	87,4848	-17,6742	4281,2	147	4281			18/09/21	18/09/21	17:16:13	87,4833	-18,0183	bottom	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
a1e20980-1931-11ec-afc5-a3f13bbd5a61	Harstad Trål Pelagisk	Harstad trawl	19/09/21	10:09:10	NLEG39	86,6043	-11,1007	4246,3	79		450	0	19/09/21	19/09/21	10:39:16	86,6269	-11,2258	NLEG39	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
c1895da0-193c-11ec-afc5-a3f13bbd5a61	Krilltrål 1723	Harstad trawl	19/09/21	11:28:48	NLEG39	86,6281	-11,1897	4247,2	80		450	0	19/09/21	19/09/21	11:59:11	86,6132	-11,0724	NLEG39	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
b6b59720-1943-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	19/09/21	12:18:36	NLEG39	86,6103	-11,0150	4246,2	504		500	0	19/09/21	19/09/21	12:51:51	86,6113	-10,9809	NLEG39, 500 m, w/o water to support trawl	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
62d1d210-1a95-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	21/09/21	4:35:45	NLEG40	83,8515	-9,5361	3567,9	505		1500	0	21/09/21	21/09/21	6:18:57	83,8453	-9,6090	NLEG40 1500 m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
51161de0-1aa6-11ec-afc5-a3f13bbd5a61	Secchi disk	Secchi disk	21/09/21	6:36:57	NLEG40	83,8441	-9,6162	3567	180		50	0	21/09/21	21/09/21	6:42:25	83,8437	-9,6184	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
d5f76170-1aa8-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	21/09/21	6:54:59	NLEG40	83,8429	-9,6231	3563,5	181		350	0	21/09/21	21/09/21	7:15:58	83,8414	-9,6299	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
21a4d370-1aac-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	21/09/21	7:18:34	NLEG40	83,8412	-9,6305	3555,7	506		500	0	21/09/21	21/09/21	7:52:50	83,8385	-9,6379	NLEG40 500m calibration on ice CTD	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
860b3de0-1ab1-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	21/09/21	7:57:10	NLEG40	83,8381	-9,6387	3545,5	455		50	0	21/09/21	21/09/21	8:06:04	83,8374	-9,6403	50M	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
965bad00-1ac6-11ec-afc5-a3f13bbd5a61	Helicopter flight	EM-bird	21/09/21	10:27:57	transit to NLEG41	83,8478	-8,8604	3459,3	182				21/09/21	21/09/21	12:27:29	83,8641	-8,1778	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
37938350-1ae5-11ec-afc5-a3f13bbd5a61	ICE station	Ice corer	21/09/21	14:07:12	transit to NLEG41	83,8578	-8,2376	3470,7	183				21/09/21	21/09/21	16:24:44	83,8520	-8,3136	Seilbåt stasjon	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
329af270-1b03-11ec-afc5-a3f13bbd5a61	Helicopter flight	EM-bird	21/09/21	17:25:49	transit to NLEG41	83,8496	-8,3421	3457,9	184				21/09/21	21/09/21	18:20:00	83,8583	-8,5769	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
fb589dc0-1b5d-11ec-afc5-a3f13bbd5a61	CTD med vannhenter gjennom moonpool	CTD w/bottles	22/09/21	4:31:40	NLEG41	83,1549	-9,6042	2817,4	507		1500	0	22/09/21	22/09/21	6:16:57	83,1451	-9,6322	NLEG 1500m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
78af0aa0-1b6f-11ec-afc5-a3f13bbd5a61	Secchi disk	Secchi disk	22/09/21	6:36:52	NLEG41	83,1429	-9,6350	2875,4	186		50	0	22/09/21	22/09/21	6:46:37	83,1417	-9,6362	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
6a7c7b00-1b71-11ec-afc5-a3f13bbd5a61	Secchi disk	Secchi disk	22/09/21	6:50:47	NLEG41	83,1411	-9,6366	2896,6	187		50	0	22/09/21	22/09/21	6:59:26	83,1400	-9,6377	Annen stasjon (S-S)	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
a7e97780-1b72-11ec-afc5-a3f13bbd5a61	phytoplankton net 10um	Phytoplankton net 10 um	22/09/21	6:59:40	NLEG41	83,1399	-9,6377	2904	456		50	0	22/09/21	22/09/21	7:07:41	83,1388	-9,6384	50m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI
dca05910-1d09-11ec-afc5-a3f13bbd5a61	MSS station	Vertical microstructure profiler	22/09/21	7:10:33	NLEG41	83,1384	-9,6391	2904	188		350	0	22/09/21	22/09/21	7:40:36	83,1276	-9,6780	350 m	Nansen Legacy Versio Agneta Franss Agneta Fransson	agneta.fra NPI

Appendix 3: Blogs and story map associated with JC2-2

Three good reasons to visit the Arctic Basin in 2021 (sciencenorway.no)

Marit Reigstad, Agneta Fransson, Bodil Bluhm

Work on the ice 125 years ago Photo: Fridtjof Nansen (1861-1930) Owner: National Library of Norway

125 years since the return of Nansen's Fram expedition

Exactly 125 years after the research vessel Fram with Fridtjof Nansen as scientific leader returned from its drift across the Arctic Basin, the Nansen Legacy revisits the region with Norway's new research icebreaker Kronprins Haakon. This anniversary is the first of several good reasons why it is timely to revisit and extend our exploration of the Arctic Basin right now.

When Fridtjof Nansen's expedition was completed in August 1896, his team had discovered the deep Arctic Basin. Since it was previously assumed that the central Arctic Ocean was shallow like the surrounding shelves, the great depths of >3000 m took them by surprise. They also brought proof of the Transpolar Drift, an ocean current crossing the Arctic Basin, as well as on how ocean currents from lower latitudes enter and impact the Arctic Ocean.

The changing Arctic urges better understanding

Presently, the Arctic Basin is changing in many ways as a result of rising global temperatures. That is the second good reason to pay more attention to the Arctic Basin. There are limited amounts of physical, chemical and biological data and especially time series from the central Arctic region. The declining sea ice cover, however, is well documented, as is the regional freshwater accumulation in the Beaufort Gyre, a circular surface current over the Amerasian part of

the Arctic Basin. Also an increasing similarity to the North Atlantic in the Eurasian sector is taking place including the northward expansion of Atlantic species. The recent ice-drift projects Norwegian Young sea ICE cruise 2015 (N-ICE 2015) and Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC 2019/2020) have provided valuable data on the seasonality of both the physical-chemical environment and biological dynamics over periods of 6-12 months. Still we lack understanding of how the system functions and changes on regional levels, but also on how different regions are interconnected on a Pan-Arctic scale. This gap requires a follow up to the baseline studies carried out during the N-ICE and MOSAiC.

The Nansen Legacy project, Norway´s joint Arctic marine science effort, has since 2018 investigated the seasonally ice-covered and rapidly changing northern Barents Sea. We cover both seasonal and interannual variability along a climatic gradient across the Barents Sea shelf, shelf-break and adjacent deep Arctic Basin. This year, honoring Nansen's return with the Fram 125 years ago, we zoom out and extend the climate gradient across the entire Nansen Basin, the Gakkel Ridge and into the Amundsen Basin in the central Arctic Ocean. The motivation is to better understand to what degree changes observed on the shelf and in the inflowing Atlantic Water propagate into the Arctic Basin. Moreover, the deeper parts of the basin, which are filled with older water, are not well investigated. Our investigation is interdisciplinary so that we can grasp the complex interactions involved in changing climate and ecosystem responses. Our study targets processes and interactions across the atmosphere, sea ice, ocean and seafloor.

Synoptic observations: connect Arctic knowledge to a 'whole'
A third good reason to visit the Arctic Basin this year is the international joint research initiative, the Synoptic Arctic Survey (SAS). The SAS aims to conduct comparable ocean measurements at almost the same time in the different Arctic regions. This approach will enable a large-scale picture of the status and change of the Arctic carbon cycle and marine ecosystems including relevant physical drivers. The Arctic regions are interconnected, but it is not yet well understood how changes propagate from one region to another. With every nation providing puzzle pieces from their region, the understanding of the whole Arctic Ocean can be improved. The Nansen Legacy expedition with RV Kronprins Haakon contributes to the SAS from the Norwegian side with an extended transect from the Barents Sea shelf break to the Amundsen Basin. At almost the same time the Swedish icebreaker Oden and the Canadian Louis St. Laurent each take the same type of measurements in other slices of the Arctic Ocean. Previous cruises in SAS have been performed in 2020 by the Japanese RV Mirai and the Korean RV Aaron.

The Synoptic Arctic Survey coincides with the start of the United Nations Decade of Ocean Sciences for sustainable Development (in short: Ocean Decade). The Ocean Decade also includes the Arctic as a target region due to the major changes seen here over the past few decades. An important step for the scientific investigation of the changing Arctic Ocean is an international agreement to prevent unregulated fisheries in the Central Arctic Ocean for the coming 15 years. The agreement entered into force this summer, and gives scientists time to generate knowledge for the management of the regions fisheries.

Hence, 125 years after the Fram expedition returned from the Central Arctic Ocean with the discovery of the deep Arctic Basin, there is an urgent need to update and extend our understanding of how climate changes impact the Arctic. This year major steps are taken in the right direction.

Into the deep unknown central Arctic Basin (sciencenorway.no)

By cruise leaders JC2-2: Agneta Fransson (NPI) og Bodil Bluhm (UiT)

35 researchers on their way to the deep unknown Foto: Elin Vinje Jenssen (NPI)

Our scientific crew of 35 people for the Nansen Legacy cruise JC2-2-Arctic Basin will spend five weeks onboard the Norwegian icebreaker and research vessel Kronprins Haakon, with departure on Thursday 24th August 2021. Cruise leaders are Agneta Fransson (NPI) and Bodil Bluhm (UiT).

The scientist are here done with 10 days of isolation and testing for covid-19. Now it is safe to embark RV Kronprins Haakon Photo: Christine Gawinski (UiT)

The main goal for our scientific mission is to explore the poorly known ice-covered central Arctic Basin, with the 4000 m deep Nansen and Amundsen basins north of Svalbard, and the Gakkel Ridge that separates them, where we have few previous physical, chemical and biological data. The Arctic Ocean is changing due to climate change, warming, freshening, melting of ice and decreasing ice extent and thickness as well as expansion of Atlantic marine organisms northwards into the Arctic Ocean. We have limited knowledge on the effects of these changes on the Arctic ecosystem and atmosphere-ice-ocean system on a regional level and how different regions are connected on a pan-Arctic scale. Since this cruise is a Norwegian contribution to the international initiative 'Synoptic Arctic Survey' where several nations conduct similar measurements at the same time, we will contribute to gaining knowledge on a pan-Arctic scale.

From the bus and directly onboard the ship. Photo: Christine Gawinski (UiT)

For this cruise, we have a special focus on sea ice and upper ocean work as well as connectivity to the mid and deep water column and underlying sediments in early autumn. In addition, we will explore the role of transport of elements and organisms from the Siberian shelves through the Transpolar Drift (a prominent surface current crossing the Arctic Basins), and for that we will enter the Amundsen Basin. Onboard and in situ experiments are an important part of the cruise and are designed to measure and quantify processes and rates such as production and respiration, and sinking of food particles to the seafloor.

Embarking RV Kronprins Haakon. Safe voyage and may the data catch be big .Photo: Christine Gawinski (UiT)

We have five scientific teams; physical oceanography and sea ice physics, ocean and ice chemistry, lower trophic levels, zooplankton and pelagic fish, and benthos and sediment work. There will be lots of activities, we will for example take water and plankton samples, conduct ice work, sample leads in the ice, bring up seafloor from 4000 m to the surface, etc… We will jointly collect interdisciplinary samples and data at five long process stations and about a dozen shorter stations, extending northward from the previously northernmost station in the northern Barents Sea to about 86 degrees north. This is about how far explorer and researcher Fritdjof Nansen got during his famous Fram expedition from which he returned 125 years ago - we are excited to follow his foot steps.

Where food is delivered only once a year (sciencenorway.no)
Amanda Ziegler (UiT)

Imagine living at a place where food is available for only a few short weeks each year. What sounds impossible is reality for hundreds of different animal species thousands of meters beneath the ocean surface.

Sorting the catch of a bottom trawl Christian Morel/christianmorel.net/The Nansen Legacy

Sea cucumbers, brittle stars, clams and worms are among the animal groups inhabiting the bottom of our oceans. Sunlight does no reach the seafloor much below 100 m, leaving the majority of these benthic animals not only subjected to complete darkness, but also without local production of fresh plant-based food. Consequently, they feed on what is falling from above, like remains of phytoplankton and zooplankton (and their excrements) and other small organisms inhabiting the sunlit surface ocean. Life at the seafloor could be easy if the delivery of food was not such a rare event.

Living in the Arctic makes food deliveries rare events
In polar oceans like the Barents Sea and Arctic Ocean, sunlight is only present for part of the year, limiting plant-growth to a brief period. The amount of food sinking to the seafloor dramatically increases in the spring and summer when phytoplankton and sea ice algae grow. In the shallow (<350 m) Barents Sea, the entire year's stock of food for the benthic animals may arrive in only a few short weeks during the very short Arctic summer. In the deep (1000-4000 m) Arctic Ocean, there is a longer lag between phytoplankton growth at the surface and the arrival of the food at the seafloor, as it takes time for dead phytoplankton and other remains to sink through thousands of meters of water. During this long journey, the phytoplankton remains are exposed to microbes and zooplankton,

leaving the animals at the deep-sea seafloor with significantly less food of poorer quality than their counterparts in shallow seas. During winter, there is virtually no phytoplankton available that could sink to the seabed all across the Arctic. So how do benthic animals survive the winter? What do they eat? What sounds like straightforward questions is all but simple to answer.

Many places in the Arctic the seafloor consist of soft sediments. The animals living in the sediment are sampled with a box corer – a large and heavy metal box without bottom that is pushed deep into the sediment. Upon retrieval, scientists carefully wash the sediment collecting small worms and mussels. These are identified for species and analyzed for their isotope composition. Photo: Christian Morel/christianmorel.net/The Nansen Legacy

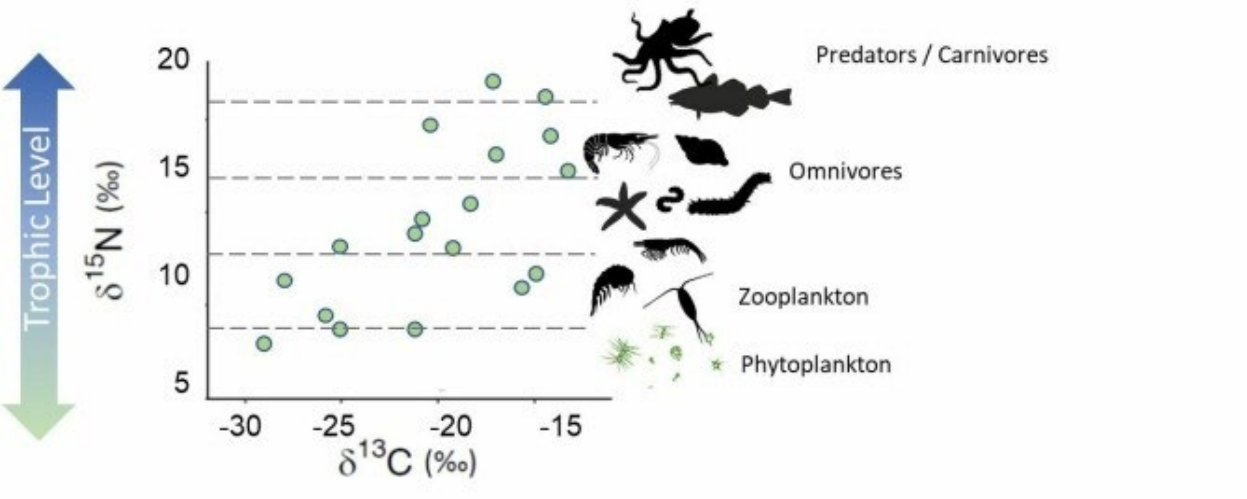
Catching animals you cannot see

To find out what benthic animals eat and how they survive in the Arctic demands first of all getting a hold of them. Living far beyond the depths of scuba divers, we use trawls and corers to collect the animals for our investigations. The trawl is dragged behind a ship and collects large (>1 cm) animals living on and near the seabed, while the box core collects a cube of undisturbed mud from the seafloor. To get the small animals out of the mud, we pass the mud through a sieve. It is exciting to collect animals from the seafloor because you cannot see what you are going to collect! It is not until after we have sieved the box core sample and sort the trawl that we are able to see the full diversity of the seafloor community. After sorting the samples, we do our best to identify the animals. In the deep Arctic Ocean this is particularly difficult because the region is so under-sampled that few are familiar with the fauna. It is likely that we will find species that have never been seen before.

How to detect what an animal has eaten

Having collected and identified the animals, we still need to find out what they ate. Historically, ecologists analyzed an organism's stomach contents to determine what they ate. However, this can only be done for large animals that are easily caught (e.g. fish). To determine the diets of small animals like those we find in the benthos, we use chemical tracers called stable isotopes. Stable isotopes are found in all organisms, but their composition differs between organisms and depends on what animals eat. They are thus suited to detect what an animal has ingested, and is what we use in our quest to understanding the nutrition of Arctic benthic animals.

Fact box: Stable isotopes



Isotopes of the same earth element contain different numbers of neutrons around the atom. An isotope with an additional neutron has a heavier mass than one with one less neutron. The heavy isotopes occur naturally alongside the "normal" elements. Food web ecologists use typically stable isotopes of carbon and nitrogen since these elements are involved in nearly all important organic molecules (such as proteins) and reactions. When carbon or nitrogen is consumed by an organism, it is used in different chemical reactions for metabolism, growth, reproduction, etc. Because isotopes vary in atomic mass, they undergo reactions at different rates and it is easier to use the "lighter" isotopes in reactions. This causes the products resulting from these reactions to contain different amounts of "light" and "heavy" isotopes. This difference is called fractionation, and the degree of fractionation generally increases as carbon and nitrogen are transferred through the food web. This provides ecologists with a way to measure the trophic position of any animal (illustrated in below figure) and to compare what different animals are eating.

The closer to trophic level 0 (phytoplankton) an organism feeds the more similar their isotopic composition will be to that of phytoplankton. As nitrogen is transferred through the food web, it becomes more enriched in the heavy isotope (15N), here indicated by an increase in the δ15N value (e.g. it will appear higher on the plot above). Therefore, we can for example tell the difference between a predatory organism that feeds on other animals (and will have high 15N) compared to grazers or suspension feeders that consume phytoplankton particles (low 15N) such as some zooplankton or barnacles and sponges, respectively.

What do we expect to find?

We have no results quite yet, but we do have an idea (hypothesis) of what we may find. Within the Barents Sea, we expect there to be differences in organism diets as we travel northward because there is a strong gradient of primary producer biomass in the Barents Sea. There is also a greater contribution of sea ice algae in the north. Because sea ice algae grow in the sea ice brine channel system (a maze of small interconnected tubes) with limited access to carbon dioxide, they have a distinct isotopic signature compared to phytoplankton in the water column. Therefore, we can tell from the isotopic composition of benthic organisms whether they seasonally consume sea ice algae that sink to the seafloor from the surface. We expect seafloor organisms to consume more sea ice algae in the northern Barents Sea particularly during spring when they are abundant. We also hypothesize that benthic organisms feeding on detritus (dead organic particles) in the deep Arctic Ocean will not show strong seasonal changes in isotopic composition because they consume mostly “old food” that has been mixed into the sediment.

Sorting the catch of a bottom trawl according to species takes time but is the only way to get an understanding of how these animals survive the harsh Arctic conditions and how climatic changes may affect them. Photo: Christian Morel/christianmorel.net/The Nansen Legacy

Heading to the unknown Central Arctic Ocean

While writing these lines, the Norwegian research icebreaker ‘Kronprins Haakon’ is breaking through the sea ice in the Nansen Basin and onwards to the Amundsen Basin of the Central Arctic Ocean – a region we know far less about than the Barents Sea. The longer ice cover of thicker sea ice in this region makes it difficult to access and sample. Deep-sea regions around the globe remain under-sampled because the sheer depth of the site also makes collecting samples difficult, time-consuming and expensive. The

research cruise is a unique opportunity to collect samples from one of the world's least-explored oceans and we hope that our samples will help us to fill significant gaps in knowledge about the Central Arctic Ocean benthos.

Climatic changes also affect animals at the seafloor

It is important that we understand the food web, even at the seabed, because the Arctic is facing significant changes brought on by climate change. As the cover of sea ice declines, surface ocean dynamics change which directly alters the amount of phytoplankton and sea ice that is exported to the seafloor and therefore the amount of food for the benthic community. Furthermore, reduced sea ice in the Arctic Ocean will also allow for the northward expansion of fisheries, shipping, and other exploitative activities that may impact the seafloor. The more we understand about how the seafloor in the Central Arctic Ocean functions now, the better we will understand its vulnerabilities to these kinds of stressors in the future.

Will the future Arctic Ocean become greener? (sciencenorway.no)

Rolf Gradinger (UiT) , Wenche Eikrem (NIVA), Marti Amargant (UiT) & Philipp Assmy (NPI)

On land grass and other plants provide ecosystems with food and play an essential role in binding CO2 from the atmosphere. Microscopically small plants called algae fulfill this role in the world's oceans. As plants on land, these tiny algae depend on nutrients and sunlight for growth. Rising global temperatures have led to sea ice melt in polar seas, allowing more light to reach the algae in the seawater. Still researchers are unsure if sea ice melt will give a greener Arctic Ocean, supporting more marine life and increased fisheries.

Living in water and sea ice

Arctic marine microalgae (Figure 1) occur in two greatly different habitats. In addition to the water column microalgae (phytoplankton), sea ice provides an important habitat in the brine filled gaps between the ice crystals, contributing up to half of the total primary production to the Arctic system. Their combined production of organic substances fuels the entire ecosystem, from bacteria, herbivorous zooplankton to deep sea animals, seals, whales, and the polar bear.

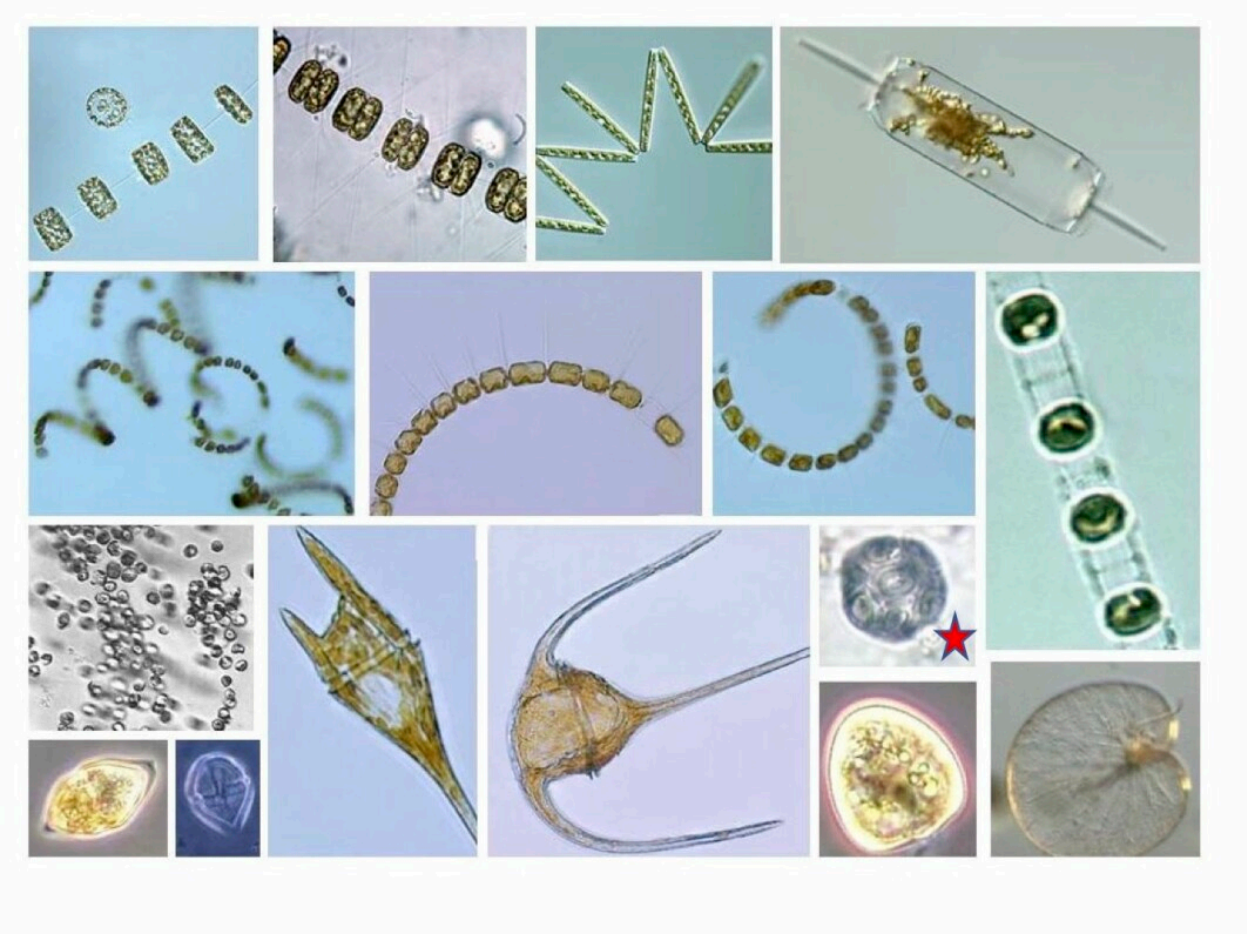


Figure 1: Arctic marine microalgae Photo: Philipp Assmy, NPI; Marina Montresor, Stazione Zoologica Anton Dohrn; and PLANKTON_NET (https://planktonnet.awi.de)

Arctic Seas are both desserts and lush pastures.
Algal production in Arctic Seas ranges from the very low productive central Arctic Ocean to the extremely productive shallow Chukchi and Barents Seas. The Arctic Ocean harbors a patchwork of different sub-systems which all have their unique environment. These environments have changed dramatically over the last decades. Indeed, the Arctic Seas are no longer remote near-natural systems. They are highly disturbed by increasing temperatures, decreasing salinities, loss of sea ice, ocean acidification, pollution, and stronger inflow from sub-Arctic Seas – all impacting the ecosystem. It is such changes that need to be measured, understood, and modelled to make useful predictions about the future of Arctic marine systems, including future potential fish catches.

It should not come as a surprise that the ongoing changes in the Arctic system have also already substantially changed the characteristics of algal production. Ice as an important habitat is disappearing at an alarming rate, and more and more of the algal production is contributed by phytoplankton, changing amount and quality of the algal biomass. Seasonality of algal growth has changed with phytoplankton blooms now observed under sea ice and intense blooms found also in fall and not only spring, which had not been observed 20 years ago. But how do these changes affect the Barents Sea ecosystem, and how do they link to changes in different parts of the Arctic? Our observational knowledge is still poor, and scientists do argue for both increasing, decreasing or constant primary production in the future Barents Sea – it is the balance of light, availability of plant nutrients, algal species, and growth as well as grazing and sinking as loss terms that determine the outcome and assumptions used in the different models. We do not know, which of the predictions correctly reflect the status of the future Barents Sea, as we deal with enormous uncertainties based on limited knowledge and the simplified model systems we have to use.

Small organisms, big research effort
Research aimed at this difficult challenge is at the core of the Norwegian Nansen Legacy project. To tackle questions ranging from identifying the current inventories of microalgal species, determining their growth physiology, understanding the seasonality and fate of algal production and adjust ecosystem models to better predict the future of the Barents Sea marine food web requires teamwork by researchers and early career scientists from many Norwegian universities and institutions. This is a daunting task as we need to consider hundreds, if not thousands of different algal species, enormous seasonal and regional variability, and limited accessibility to the study area due to its remoteness. Some of these species are unknown, and Nansen Legacy scientists have already discovered species new to science (Figure 2). Observations of algal abundance from space can help, as the presence or absence of microalgae can change the color of the ocean (Figure 3). However, such observations are limited as they are obscured by the Arctic ice cover and frequent clouds and the long polar night. Therefore, going into the Arctic is for many of our research aspects still an absolute requirement. Alternatives like autonomous gliders or moored instrumentation can help with some measurements but cannot provide the complete inventory of information we need to understand the ecology of Arctic

microalgae, specifically as many processes do occur within the sea ice connected to the Arctic food web.

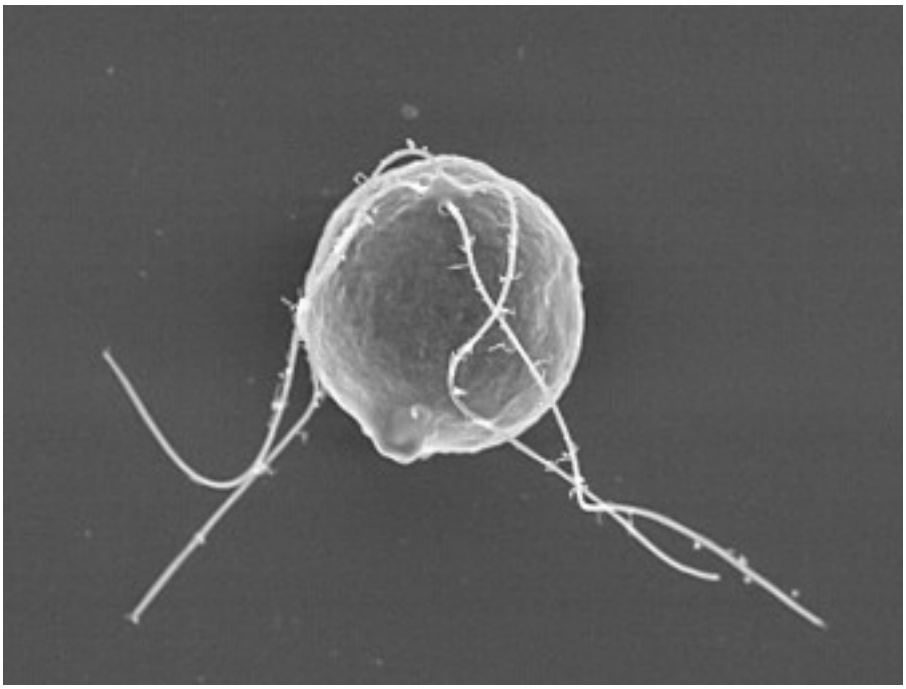


Figure 2: Some of these species are unknown, and Nansen Legacy scientists have already discovered species new to science. A new species of the green algae Carteria was collected from a melt pond on top of sea ice during a Nansen Legacy expedition. Photo: Luka Supraha, UiO

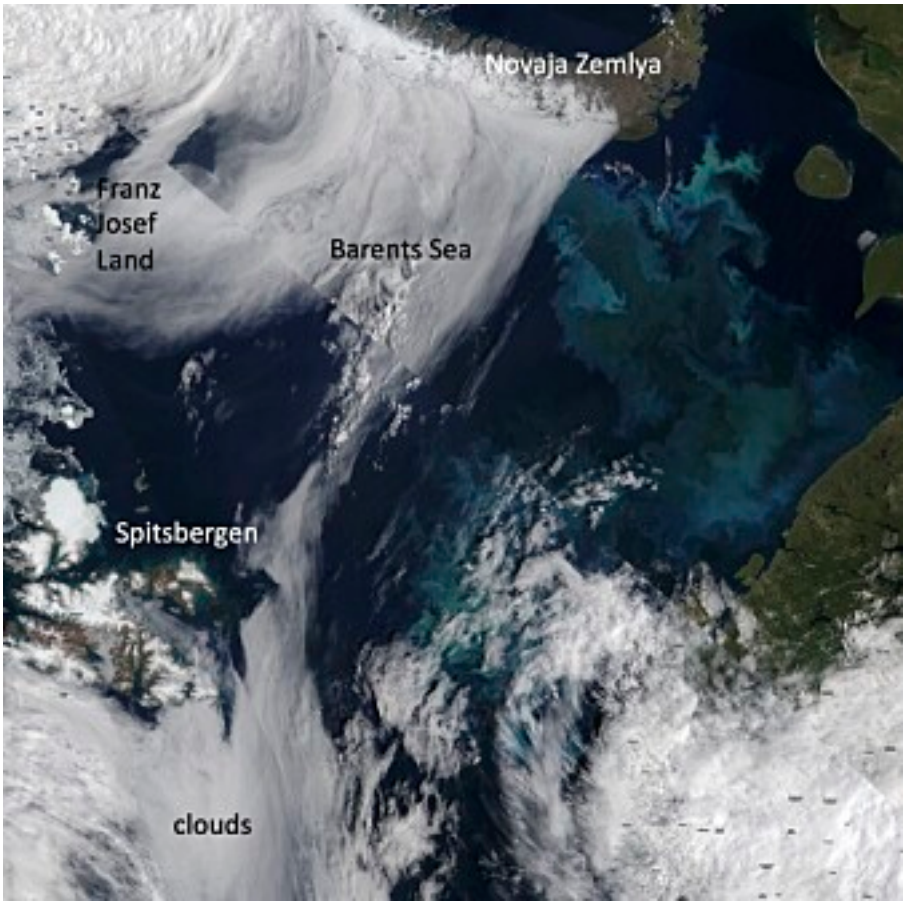


Figure 3: Algae can be observed from space as their presence or absence can change the color of the ocean. Satellite picture of a massive bloom of tiny algae called coccolithophores in the Barents Sea. Photo: NASA https://worldview.earthdata.nasa.gov).

Studies in the Barents Sea alone will not allow us to address this question. Arctic Seas are interconnected through transport of plant nutrients, species, water and sea ice and changes in one area can impact what happens hundreds of kilometers away. Therefore, a Nansen Legacy expedition on board research vessel Kronprins Haakon is currently sailing from the shallow Barents Sea shelf into the deep Arctic Basin, crossing different Arctic regions with strong and weak Atlantic influence, high and low nutrient concentrations, and high and low sea ice coverage (see first cruise blogs). Along these gradients of environmental settings, all relevant physical, chemical, and biological variables will be assessed to not only measure the rate of algal production, but also understand why such a rate is observed and why a certain species community is found.

Seven million microalgae in one liter of Arctic seawater

Microalgal composition is investigated directly onboard and has already revealed insights into the current status (Figure 4). We now know that the massive algal bloom, that the research vessel Kronprins Haakon has passed on its transit through the southern Barents Sea and that had changed the color of the ocean to its milky blue appearance (Figure 3), has been caused by a massive bloom of small flagellates with tiny carbonate plates on the cell surface called coccolithophores (see microalgal image marked with red star in

Figure 1). Our current estimate is that there were ca. 7 million of these small flagellates in a single liter of seawater. These coccolithophores are known to be sensitive to ocean acidification and can have a strong impact on the marine carbon cycling. Understanding their summer occurrence and contribution to the food web is therefore important.

Figure 4: Microalgal composition is investigated onboard Kronprins Haakon by Wenche Eikrem (front) and Anna Vader (background) Photo: Bodil Bluhm, UiT

The productivity of the algae in sea ice and water will be studied using the addition of tiny amounts of the radioactive carbon isotope 14C as algal carbon source into the water (Figure 5). Algae will incorporate the 14C into their organic matrix and after short incubations of a few hours, the rate of incorporation and therefore algal productivity can be assessed. Furthermore, data relevant for model improvement (for example the response of algal growth to different light intensities) will be determined at all stations during this expedition.

Figure 5: The productivity of the algae in sea ice and water will be studied using the addition of tiny amounts of the radioactive carbon isotope 14C. Marti Amargant, ready to deploy an in-situ primary production incubation. Photo: Christian Morel/christianmorel.net/The Nansen Legacy

These data will fill critical knowledge gaps for the Barents Sea and deep Arctic Ocean, not only on algal production but also for the entire food web and carbon cycle.
Nansen Legacy scientists do not work isolated but link their work within international research networks like MOSAiC (https://mosaic-expedition.org/) or SAS (https://synopticarcticsurvey.w.uib.no/science-plan/). The gained knowledge will directly be used in the Nansen Legacy and international modelling efforts, increasing the accuracy of the model output and our ability to better predict the future Arctic Ocean and sustainably manage its valuable marine resources.

Cracks in the cooking pot lid (sciencenorway.no)

Øyvind Lundesgaard (NPI), Melissa Chierici (IMR), Agneta Fransson (NPI)

The point of putting a lid on a cooking pot is to prevent the transfer of heat and moisture between the boiling contents and the air above. When you remove the lid from a boiling pot, heat and water vapour flow upward into the air, along with chemical compounds filling your kitchen with the (hopefully) promising smells of an upcoming meal.

In a way, the sea ice that covers much of the Arctic Ocean acts like a giant cooking pot lid, extending over millions of square kilometers. It limits exchange between the upper ocean and the lower atmosphere, allowing the ocean to retain heat and moisture while keeping the air cold and dry. This is important - the fact that the sea surface is separated from the air over much of the Arctic Ocean has many implications for the climate on top of the globe and, because of the many connections between different regions, for the climate of the Earth as a whole.

(Cooking pot lid not to scale)

We have broken many kitchen utensils in our culinary careers, but never a cooking pot lid - apparently, they are constructed to be pretty sturdy. Sea ice, on the other hand, melts and freezes due to high or low temperatures (referred to as thermodynamic forcing), and moves, smashes together, and breaks up due to winds and currents pushing it around (referred to as mechanical forcing). When sea ice breaks up due to mechanical forces, it tends to do so in a way similar to when a mirror or a windshield breaks: it forms long cracks. Such cracks in sea ice are known as *leads;* a lead might be tens to hundred of metres across but extend as much as hundreds of kilometres across parts of the Arctic Ocean. Any captain of an icebreaking ship is familiar with leads, as they can provide paths of open water (or thin, newly formed ice) through the thicker sea ice pack around the leads.

Since leads are relatively narrow, they account for only a small areal fraction within the sea ice cover of the Arctic Ocean. Their small scale makes them challenging to observe from space, and difficult to include in computer models. Yet, studies suggest that in fact about half of the heat transfer between the ocean and the air in the ice-covered ocean occurs through leads, and in winter, the moisture that enters the air over leads can contribute to air masses rising many kilometres upward into the atmosphere, generating clouds and affecting the local weather.

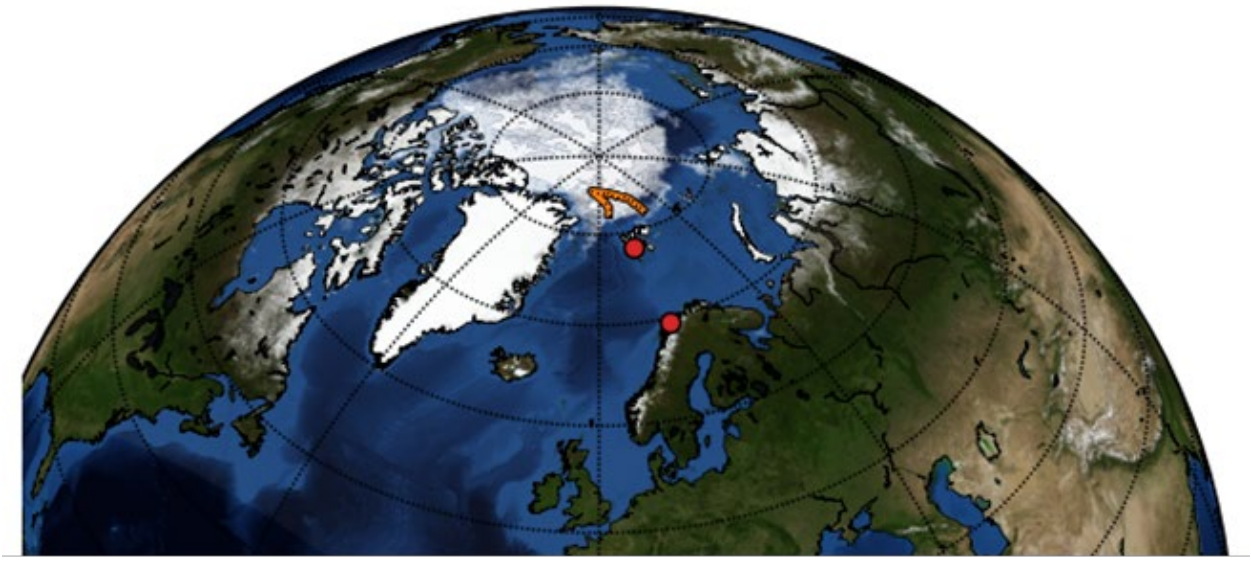
Sea ice lead. Note the research ship on the near side! (Photo: Nick Cobbing)

Exchange of heat and moisture is not the only process that happens in leads. Since the ocean is open to the atmosphere, the surface water can be cooled by the air until new ice begins to form, and leads can therefore act as “sea ice factories” during autumn and winter. Storms can also affect the ocean surface in open leads and churn and mix up the waters in the usually calm upper ocean.

The lack of a sea ice barrier also means that gases can be transferred more efficiently between the air and the atmosphere. Elsewhere in the ocean, there is a continuous exchange of gases at the air-ocean boundary: For example, the ocean contains enormous amounts of dissolved inorganic carbon (including carbondioxid, CO_2), and the uptake and release at the sea surface in various parts of the world has a huge impact on the amount of CO_2 in the atmosphere. In general, the Arctic Ocean is undersaturated in CO_2, meaning that it could take up more CO_2 from the air, but the sea ice cooking pot lid partly restricts this exchange. In leads, the opening in the ice acts as a window to the atmosphere where the gas exchange can happen more freely, impacting both the chemical composition of the water below and the CO_2 content of the atmosphere above. Also, sea ice formation in leads releases brine (very salty water), which is rich in CO_2 due to chemical processes within the sea ice as ice forms. The brine is dense and heavy, so it sinks, bringing CO_2 from the air and surface water down to deeper parts of the ocean. This process is likely important for the Arctic Ocean’s role in the global CO_2 uptake.

Alas, every analogy has its limits, and the Arctic sea ice cover differs from cooking pot lids in one critical way: the latter are typically more accessible. Despite the many interesting and important processes going on in sea ice leads, researchers rarely have the opportunity to study them directly. There are many remaining questions left, and on the ongoing Nansen Legacy cruise to the central Arctic Ocean we are hoping to answer some of them. With us on the R/V Kronprins Haakon we have a number of different

scientific instruments that allow us to study lead processes, including the exchange between the air and the sea, the composition and chemistry of the ocean, and the penetration of water from leads in below the sea ice. Hopefully, we will step off the ship in Svalbard at the end of September carrying new data that will help us understand more about the Arctic Ocean's role in the global climate system - something to think about back home while waiting for the potatoes to boil.



Map of the planned stations on the ongoing Nansen Legacy cruise to the central Arctic Ocean, showing sea ice concentration on 18.08.2021 from EUMETSAT Oceans and Sea Ice (AMSR-2). The cruise will depart from Tromsø, Norway and return to Longyearbyen, Norway.

Polhavet – utilgjengelig, ukjent og i endring (forskning.no)

Camilla Svensen (UiT) & Anna Vader (UNIS)

Småkryp fra 2000 m Foto: Christine Gawinski

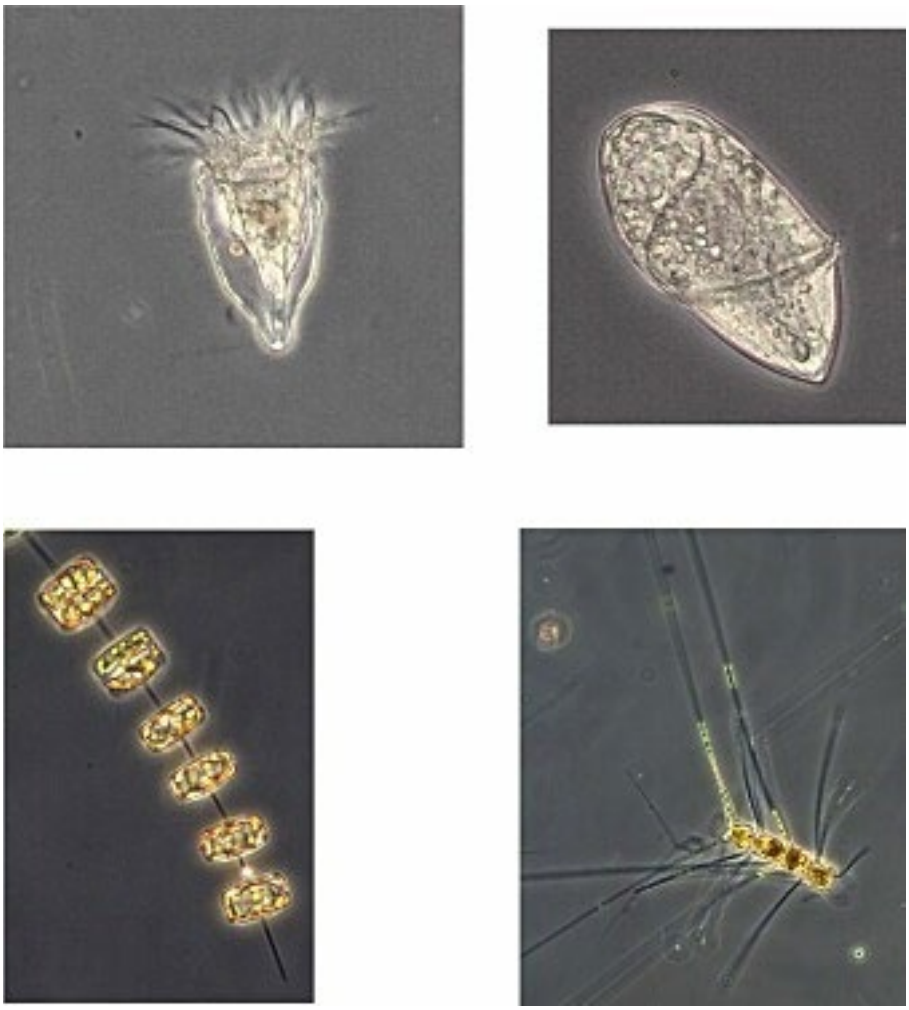
Vi står i fare for at Polhavet endrer seg raskere enn vi klarer å innhente ny kunnskap.

Tenk deg et sted nesten uten sesongvariasjoner og hvor solstrålene aldri når. Hver eneste dag er stummende mørk og bitende kald, uansett hvilken dato kalenderen viser. Vi snakker om dyphavet. Omtrent halvparten av jordoverflaten består av hav dypere enn 3000 m og dyphavsbunn er faktisk et av de vanligste habitatene på jorda. Mye vanligere enn landjorda der vi holder til. Lenge ble dyphavet oppfattet som ødemark hvor forholdene var for ekstreme for levende organismer, og derfor ikke interessante å undersøke.

Dette synet ble endret etter at Challenger-ekspedisjonene i 1872 og 1876 viste at det var liv i dyphavet og at de spesielle forholdene hadde forårsaket unike organismer. Nå vet vi at dyphav kjennetegnes av høy biodiversitet, lav biomasse og lav produksjon. Det betyr at mange ulike organismer lever i dypet, men at de ikke blir veldig tallrike fordi de vokser sakte - tilpasset et liv med lite mat og lave temperaturer.

Man må anta at dyrene som lever i dyphavet er konstant sultne. De lever langt fra matfatet, og hovedmenyen er rester etter alger som har sunket sakte fra overflaten og ned til flere tusen meters dyp. I tropene er det lite sesongvariasjon i mattilgangen - men dess lengre bort fra ekvator en beveger seg, dess større blir forskjellen mellom den lyse sommeren og den mørke vinteren, en forskjell som forplanter seg ned i dyphavet. Mer alger og detritus synker ned til havbunnen på våren og sommeren fordi algene vokser hurtig og blir tallrike i havoverflaten når det er både lys og næring.

Det vanligste habitatet i Polhavet er dyphav, det vil si vannmasser og havbunn som befinner seg dypere enn dit sollyset når - altså under ca. 200 m. Dyphavet i Arktis utgjør et enormt habitat. Man finner både flere tusen meter dype bassenger som Nansenbassenget og Amundsenbassenget, og undersjøiske fjellkjeder som Gakkelryggen og Lomonosovryggen.
Polhavets dyphav er ikke bare ekstreme habitater. Området er også vanskelig tilgjengelig fordi det ligger langt mot nord og er dekket av sjøis. Polhavet er derfor kostbart og tidkrevende å studere, og helt utilgjengelig uten et isbrytende fartøy. Det er følgelig mye vi ikke vet. Hvilke organismer lever der i dag, hvilke endringer har skjedd over tid, og hvordan vil denne ukjente verdenen påvirkes av menneskelige aktiviteter?



Mikroskopisk liv finnes i mange former og størrelser. Noen er alger, mens andre er konsumenter som spiser alger eller hverandre. Artssammensetning og antall av mikroorganismer i is og overflatevann er avgjørende for mengden mat som til slutt vil synke ned i dypet. Bildene er fra dette toktet. Øverst fra venstre:ciliate og dinoflagellate fureflagellat gyrodinium. Nederst fra venstre: Diatom kiselalge Thalassiosira og Diatom kiselalge Chaetoceros. Foto: Wenche Eikrem

Vi er 35 forskere på tokt i regi av forskningsprosjektet Arven etter Nansen. Ett av målene er å undersøke biodiversiteten i et av de få områdene som fremdeles er dekket av sjøis

hele året. Isfysikere, kjemikere, oseanografer og biologer jobber sammen for å undersøke ulike aspekter av habitatet Polhavet. Biologene undersøker diversiteten av mikroorganismer, plankton og bunndyr. Algenes vekstrater i og under sjøisen og i vannet måles, og koblingen mellom overflaten og dypet studeres ved å måle hvor mye av algene som synker ned til bunndyrene flere tusen meter under overflaten. Vi ser på fangsten i luper og mikroskop og beundrer hoppekreps, amphipoder, maneter og andre skapninger som lever i dette for oss ugjestmilde miljøet. Eksperimenter ombord undersøker hvordan de vil klare seg dersom det blir varmere eller havet forsures. Og vi tar prøver for DNA analyser, som ofte er eneste brukbare metode for å skille mikroorganismene fra hverandre. Flere spennende nye alge-arter er allerede oppdaget i løpet av Arven etter Nansen prosjektet, og vi regner med å finne flere på dette toktet. I tillegg kartlegges vannets, sjøisens og havbunnens fysiske og kjemiske egenskaper. Alt henger sammen, og ved å studere de samme prosessene på tvers av Polhavet, og fra overflaten og helt ned til bunnen av de store polbassengene, vil vi få en bedre forståelse av hvordan miljøet påvirker biodiversiteten og næringskjeden i et unikt habitat.

Deep sea paraeuchaeta with eggs Foto: Christine Gawinski

Om bord i isbryteren Kronprins Haakon gnager vi oss sakte gjennom et hvitt landskap. Vi følger råker, passerer skruis og observerer variasjoner i is-tykkelse og farge. Sjøisen kan virke uendelig massiv i sin utbredelse, men det er langt fra sannheten. Ingen andre steder på jorda skjer klimaendringene like raskt som nettopp her. Utbredelsen av sjøisen minker hurtig, og den gamle isen som er et viktig habitat for mikroskopiske alger og dyr som rundormer, flatormer og hoppekreps, blir stadig sjeldnere. Disse endringene vil ikke bare ha store konsekvenser for de som lever i og på havoverflaten, men også påvirke økosystemene i dyphavet.
Vi står i fare for at Polhavet endrer seg raskere enn vi klarer å innhente ny kunnskap. Selv om Polhavet ligger langt mot nord, vil det som skjer her påvirke resten av jordkloden. Derfor er det greit å kjenne på utålmodigheten mens man venter på at måleinstrumenter, sediment-grabber og håver skal ta turen hele veien ned til 5000 meter - og opp igjen. For vi har faktisk ikke uendelig med tid.

The Central Arctic Ocean: No longer the once forgotten no man's land (sciencenorway.no)

Bodil Bluhm (UiT) & Tomasz Ciesielski (NTNU)

Trawling at 85 d N Photo: Bodil Bluhm

Large trawlers are pulling tons of fish out of the deep Central Arctic Ocean. Our cell phones are powered with rare earth elements from the seafloor underneath the North Pole. The ice-free Arctic allows much shorter delivery time of shipped goods from the Atlantic to the Pacific. Coast guard ships dot the vast Arctic coastline and fleets of submarines survey the chilly waters. Will these scenarios soon be a reality? To some extent some of them already are.

The Central Arctic Basin has long rested in Sleeping Beauty peace, with only the occasional polar explorer or research vessel briefly joining the cold-adapted life forms for which this area is home. As the icy white lid has continually decreased over the past 40+ years the deep basin has been woken up. Less sea ice allows easier access for vessels, from tourist vessels visiting the North Pole to those following commercial interests. Hence, the interest in claiming, clarifying and defending national territories has increased. At the

same time concerns about potential threats and risks have arisen - threats to the ecosystem and the climate services this region provides to all of us.
This situation has resulted in a flurry of activities over the past years. Multiple seafloor mapping programs are delineating continental shelves and rises that define territories per the UN Law of the Seas. Shipping yards are building icebreaker and other vessel capacity. For example, as we speak a new French ice breaker cruise ship is at the North Pole. Oil, gas and metal resources are being mapped, and National strategies on the use and management of the Arctic region are being developed and territorial borders debated. Arctic nations jointly and individually discuss the potential for expanding fisheries further and further north.
In what may be a race against time international actors are no less busy compiling and generating knowledge pre-(possible) exploitation. An agreement on banning commercial fishing in the high seas of the Central Arctic Ocean for the time being was recently signed. (Note: We have caught exactly one polar cod so far; the lone seal in our last lead probably found a handful more.) The Working Group for Integrated Ecosystem Assessment of the Central Arctic Ocean prepares status-of-knowledge reports to inform management agencies and governments. Arctic Council groups and NGOs publish assessments on the status and increase of shipping activities and noise, and risks of (potential) future industrial activities for pollution of the ecosystem. The few available long-term observatories track ocean warming, ice melt, and more direct human footprints. For example, the HAUSGARTEN observatory in deep Fram Strait, the doorstep to the deep central Arctic basins, finds that litter has been increasing even at great depths in this remote area.
Even the ignorant or oblivious (should) now recognize how strongly connected the Arctic is to our lower latitudes. This connectivity applies to ocean currents and ecosystem as much as it applies to politics, policies and commerce. No longer is the Central Arctic Ocean the quiet and forgotten place it seems to be as we investigate it onboard the Norwegian icebreaker Kronprins Haakon this very moment.

The Arctic Ocean blender system (sciencenorway.no)
Zoe König (NPI), Melissa Chierici (IMR) & Øyvind Lundesgaard (NPI)

MSS profiling during one of the ice station Photo: Eirik Hellerud

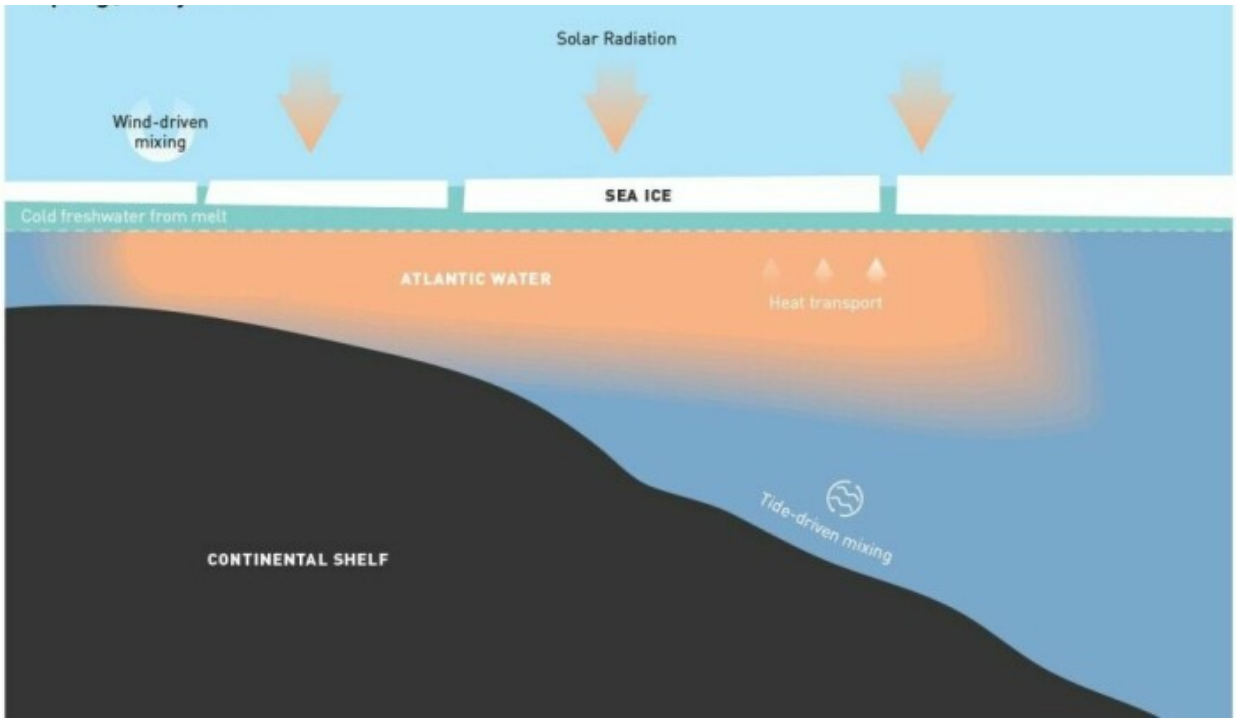
The Arctic Ocean is composed of different layers organized on the vertical, and these layers have different temperature and salinity properties. A cold and fresh surface layer caps a warm and salty layer of Atlantic Water. The heat contained at depth (about 300m) in the warm and salty Atlantic Water could melt the entire Arctic sea ice cover if it reached the surface. It does not happen because the cold surface layer caps this Atlantic layer quite well and keeps it at depth. However, in some regions, such as north of Svalbard, sea ice melts in summer even though it is -30 outside. How is that possible?

It is because some exchanges are possible between the water masses. That's what we call the mixing of the ocean, like what we can have in a bathtub when we mix warm and cold water by hand to get a homogeneous temperature.

How does that happen in the ocean?
It is of course not a hand mixing the ocean, but other factors. The two main factors are the wind with its storms, but also the tide can mix the ocean. There are two main types of mixing in the Arctic; vertical mixing which can bring the heat of the Atlantic Water towards the surface in the Arctic, and horizontal mixing with eddies which brings warm Atlantic Water from along the slope into the middle of the Arctic Ocean. In addition to transporting heat upwards, vertical mixing contributes greatly to transport gases such as oxygen and carbon dioxide (CO_2) in two ways, bringing CO_2 from the surface ocean to the deeper layers, as well as bringing up water rich in CO_2 to the surface ocean.

In the Arctic, the sea ice tends to block the influence of the wind on the ocean, which is why the Arctic is known as the 'quiet' ocean. Sea ice is declining due to climate change, leading to increased open water and leads (fractures between two pieces of sea ice). But with climate change, there is less and less sea ice and then more and more open water and leads, so, we can expect that the storms will mix the ocean more and more, and hence could bring more and more heat towards the sea ice... and increase the gas exchange between ocean and air. But at the same time, with more melting of sea ice, this cold and fresh layer on top of the Atlantic layer becomes thicker, which reduces the mixing between the warm Atlantic layer and the surface.

So what will win? The sea ice melt or the wind?
This is something that we as researchers are still looking into! We use a lot of different tools, such as models where we impose a lot of sea ice melt or a lot of wind, or observations.



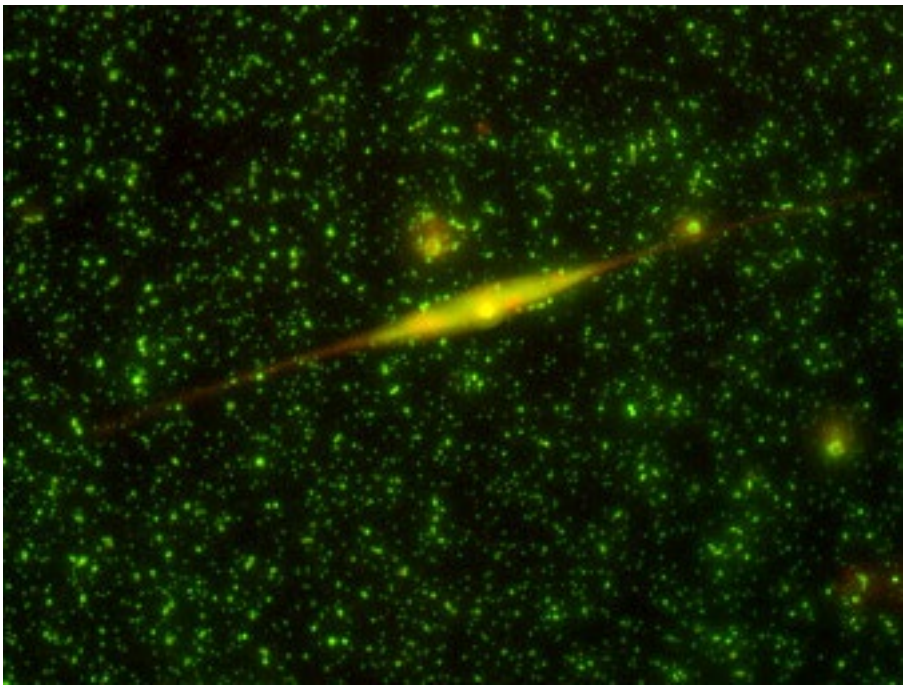
Simplified schematic of the mixing in the Arctic Ocean. Declining sea ice is making the Arctic warmer

During this cruise in the Arctic Ocean, we will look into the mixing of the ocean by using an MSS profiler (Microstructure profiler). This instrument measures small (a few centimetres) vertical variations of the temperature, salinity and current speed of the ocean, which gives us an estimate of the vertical mixing of the ocean. To understand more on the role of sea ice and winds on gas exchange and transport, we will measure oxygen and CO2 from sensors beneath the ice. With all the measurements, we hope to better understand how the Arctic Ocean works and how the Arctic Ocean blender system evolves with the climate change!

The tiniest do the heavy lifting (sciencenorway.no)
Selina Våge (UIB)

– Who are they and what do microbes do in the Arctic Ocean?

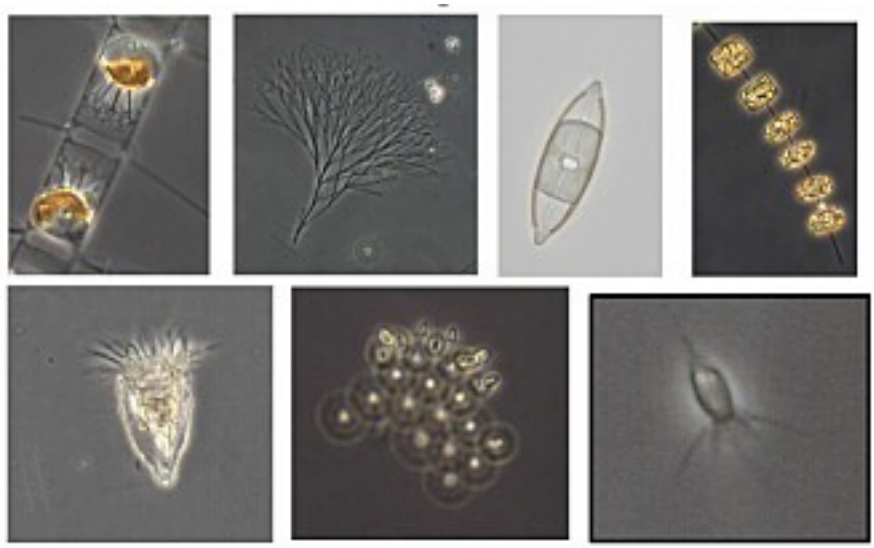
A microbe? That's an organism whose body is made of a single cell. Some microbes like bacteria are cells that look completely different from our own body cells, whereas others are built just like our own cells are. The biodiversity in microbes is staggering. Almost all of the genetic diversity we find on Earth is encoded in microbes and their appearance can be as different as worms and elephants! Microbes are everywhere. If you could miraculously remove all other organisms on Earth and at the same time make the microbes become visible with your naked eye, you would still see the contours and whereabouts of all the plants and animals and landscape around them! In the ocean alone, there are a million times more microbes than stars in the entire universe!



Seawater seen under the microscope with 1000 times magnification – bright blobs are bacteria and the tiny dots are viruses. There are roughly one billion bacteria and ten times more viruses in 1 liter of seawater. Photo: Gunnar Bratbak

In the central Arctic Ocean, where we are right now, microbes definitely steal the show of life - only few other organisms thrive in this harsh environment. Studying the microbes living here is thus an important part of our mission. In the course of our cruise we have found them free-floating in the water column or attached to sea ice, living either inside brine channels or growing as mats underneath the ice. As we moved northward, larger waterborne microbes became less abundant, but the sea ice community is still hanging in there!
Some microbes (most of which have cells that look similar to our own) can convert carbon gas into biomass, producing oxygen as a by-product, just like trees do on land (they are

called “photosynthetic”), whereas other microbes need to eat (parts of) other organisms to get organic carbon building blocks for their bodies. We have everything to thank for the photosynthetic microorganisms in the ocean! They were the ones turning Earth’s atmosphere into an oxygen rich medium that we can breathe some 2.8 to 2.45 billion years ago! Marine microorganisms still produce roughly half of the oxygen we all breathe today.



Phytoplankton (top row) are beautiful photosynthetic microorganisms that produce oxygen and organic carbon from CO2 and water. They are strong competitors of bacteria for limiting nutrients. So-called heterotrophic flagellates and ciliates (bottom row) are ferocious microbial predators of bacteria. Photos taken on board by Wencke Eikrem (NIVA) using a light microscope.Photo: Wenche Eikrem

Bacteria versus Virus

Most bacteria in the Arctic Ocean cannot produce oxygen. Their sheer abundance is mind-blowing however; imagine you were brave enough to take a bath in the Arctic ocean (we are currently measuring freezing temperature of -1.8 °Celsius in the surface water) - then a single droplet of sea water running down your cheek would harbor a million bacteria!

Even more impressive, there are about 10 million viruses in that drop of water! Fortunately, most marine viruses mean no harm to us – it’s the bacteria that have to worry! When bacteria get infected by viruses they explode and turn into food for other microorganisms. In an environment where vertical mixing of the water column is limited due to strong density gradients, just like here in the central Arctic Ocean, this “recycling” of organisms near the surface is critical for life to persist since supply of new nutrients from deeper waters is very limited. Bacteria also disintegrate other dead microbes, slowing down their sinking and thus further helping to retain essential nutrients near the surface.

Bacterial and viral abundances are mind-blowing - in each of these small tubes there are about two million bacteria and 20 million viruses. We study their activity by giving them radio-actively labeled food (aminoacids) that we can trace when the bacteria have taken it up. Photo: Selina Våge

Bacteria have a tough life

Not only are bacteria under constant viral attack, they are also hunted by ferocious and extremely efficient predatory microbes. Besides, they have to share the little nutrients we find in the Arctic Ocean with their beautiful “cousins”, the phytoplankton (photosynthetic microorganisms). Under optimal growth conditions, these phytoplankton can monopolize limiting nutrients, creating a short-cut through the microbial food web with reduced recycling that bacteria and viruses stand for, resulting in an efficient transfer of energy from the bottom of the food web to animals like shrimp and fish. Events like that are the reason why Norway could rise as a nation from fisheries. Although regularly occurring in sub-polar regions like the Barents Sea or Norwegian Sea, such optimal growth events are rarely found in the central Arctic Ocean. Understanding how this might change in the future is one of our research goals.

Scientists on board studying abundance, activity and elemental composition of microorganisms from seawater samples. If you want to become an observational marine microbiologist, get ready for some filtration fun. Photos: Bodil Bluhm & Selina Våge

As you see, microbes show many different faces, linking ocean chemistry to harvestable resources, and we have not even started to talk about the fascinating evolutionary games they play! Rapid co-evolution between bacteria and viruses can tell us a whole lot about the development of infectious diseases like the Covid-19 for instance... I would be happy to talk more about this on our next cruise!

The Transpolar Drift current (sciencenorway.no)
Melissa Chieric (IMR)i, Agneta Fransson & Mats Granskog (NPI)

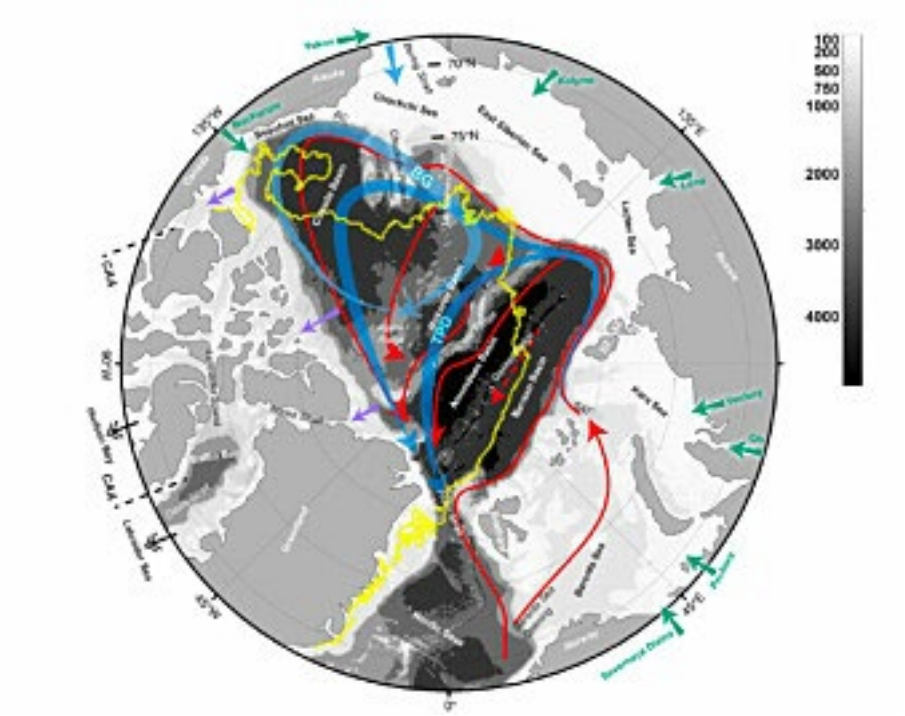
RV Kronprins Haakon is breaking ice with sediments in the Transpolar drift current Photo: Agneta Fransson, NPI

The largest Arctic river - transports materials into the central Arctic Ocean from Siberian Shelf across the North Pole

We passed latitude 87°N in the central Arctic Ocean onboard the RV Kronprins Haakon, not far from the Lomonosov Ridge and only 300 km from the North Pole, hoping to find traces of Siberian Shelf and river water in the Transpolar Drift current. We are sailing against the current, going northward from the Nansen Basin, north of Svalbard into the Amundsen Basin in the search for this specific water or sea ice transported in this current.

Seawater sampling from CTD-Niskin-rosettePhoto: Agneta Fransson, NPI

The Transpolar Drift (TPD) is a surface current that crosses the North Pole and central Arctic Ocean from Siberia to ends up in the Arctic outflow in the East Greenland Current in the western Fram Strait. It was this current that Nansen himself used to traverse across the Arctic Ocean with Fram frozen into the ice, and Nansen in fact showed that this current existed. It is like a large river that carriers surface waters and sea ice with larger concentrations of greenhouse gases such as carbon dioxide (CO2) and methane, and trace metals, organic carbon, sediments, and organisms, originating from land, rivers, coastal erosion and melting permafrost all the way from Siberia. Sea ice is formed on the shallow shelves, where it can incorporate sediments, carbon and organisms when formed. The trapped inorganic and organic carbon in the ice and water are further transported in the TPD, to later end up in the Fram Strait Arctic outflow water where it melts on the western side near the North-East Greenland, releasing carbon accumulated on the shallow Siberian shelves. Parts of the carbon are conveyed into this surface current which finally ends up further south in the North Atlantic, influencing the world oceans.



Map of current Solomon et al. (2021)

The presence of the TPD in surface waters can be traced using chemical tracers, such as colored dissolved organic carbon (CDOM), salinity, oxygen stable isotopic ratio, nutrients, inorganic carbon, and ocean acidification state which is a measure of ocean acidity; described commonly by pH, CO2, alkalinity (basicity), and calcium carbonate saturation state. We expect higher CDOM signals of terrestrial organic matter derived from river input when reaching the TPD in the Amundsen Basin than in the Nansen Basin, with lower pH, higher CO2, fresher water, and effects on the alkalinity. Indications from previous observations in the Fram Strait time series on inorganic carbon show that pH and calcium carbonate saturation are decreasing and CO2 increasing, with fresher water in the top 50 meters. This is a large contrast to the salty Atlantic waters that enter the Arctic Ocean in Nansen Basin.
We are eager finding the TPD water going north. Passing the Gakkel Ridge at 85°N, 07°E, there were no signs of the Siberian shelf water in the CDOM signal. Entering the deep Amundsen Basin, slightly elevated CDOM and CO2 signals were observed, which was intensified moving further northwest. Finally, in the Amundsen Basin clear indications of chemical tracers of TPD water were found, with the origin from Siberia.

Sailing northwest into the Amundsen Basin and central Arctic Ocean Photo: Agenta Fransson, NPI

In the Nansen Legacy project (Arven etter Nansen), we trace the chemical components to find out where is the TPD located and how much of this water and sea ice are transported in this current and observed downstream in the Arctic outflow water in the Fram Strait.

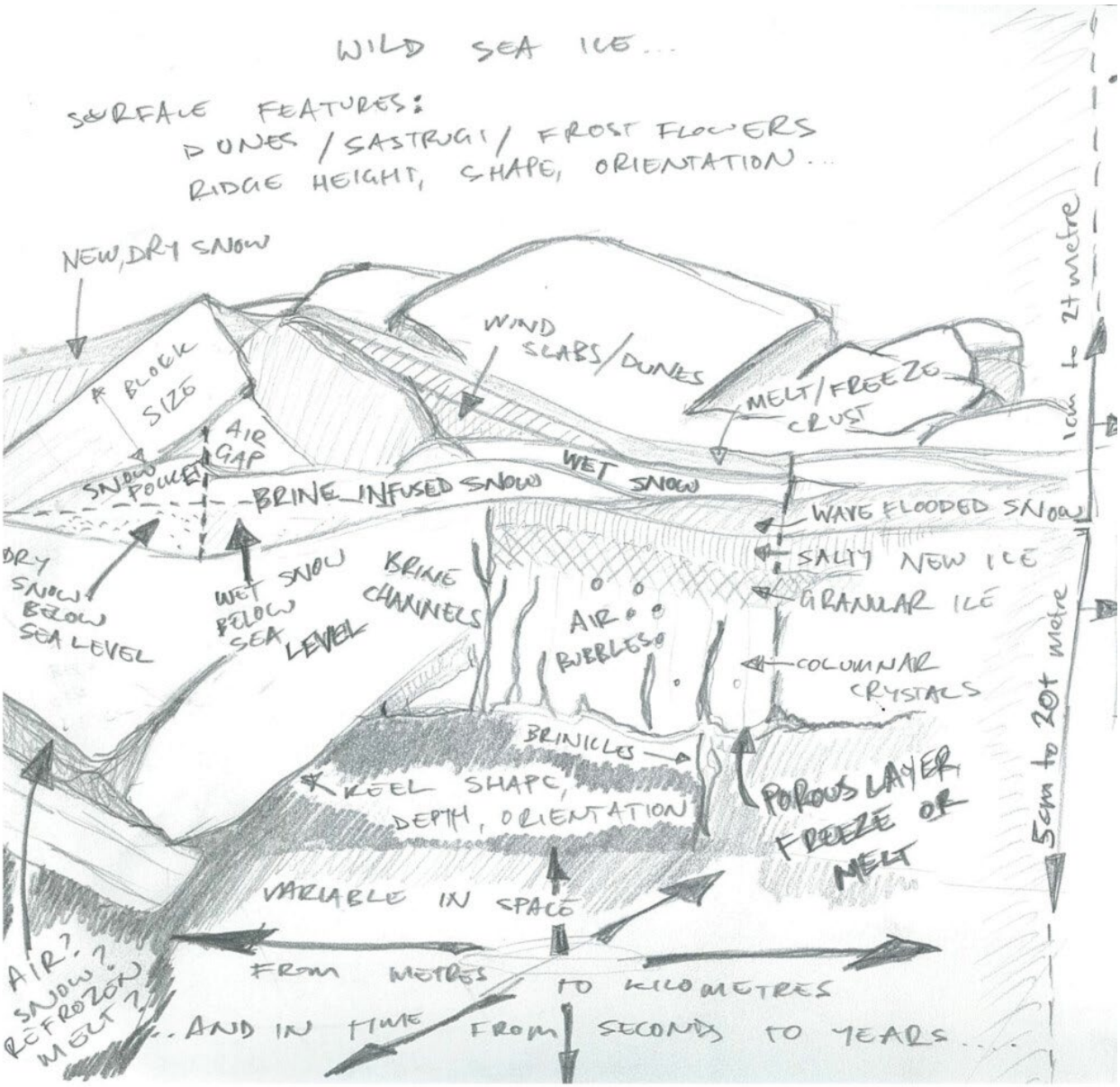
There was a green moss found in one of the sediment samples picked up from the sea floor at 4000m depth in the Amundsen Basin. We wonder if this green moss is coming from the Siberian tundra, flushed out with a river to the ocean shelf, incorporated into sea ice or transported with sinking surface water to the bottom, and then later picked up by the box corer by scientists onboard RV Kronprins Haakon, during the Arctic Basin cruise in 2021?

Ephemeral landscapes (sciencenorway.no)
Adam Steer (NPI)

Ice ridges (Photo: Adam Steer, NPI)

Have you ever watched the colors of the sunset over the sea – then suddenly the beautiful moment is gone, and darkness surrounds you. Arctic sea ice is like that - a temporary and beautiful landscape constantly presenting moments that are suddenly gone, if you dare to blink.

Sea ice is a lot of things. It gets made when the upper ocean becomes cooled enough (around -1.8 C for regular seawater) to freeze. In the right conditions, eventually vast regions of ocean become covered by highly dynamic layer of ice. This thin layer affects how heat, light, momentum and gases are exchanged between the vast ocean and vast atmosphere – impacting the local environment of things which live here, and the earth system as a dynamic whole.



Seaice is made of many parts Photo: Adam Steer, NPI

...but it doesn't stop there. Sea ice is itself a complex composite assembled from different types of ice at different stages of growth and decay; air gaps, water, slushy ice filling in voids; snow in complex layers of its own; and finally the living component – everything which makes sea ice its home, and the biological material they produce and leave behind. The diagram below shows only a simplified view

Ephemeral
Have you ever watched the colors of the sunset over the sea – then suddenly the beautiful moment is gone, and darkness surrounds you. Arctic sea ice is like that - a temporary and beautiful landscape constantly presenting moments that are suddenly gone, if you dare to blink.

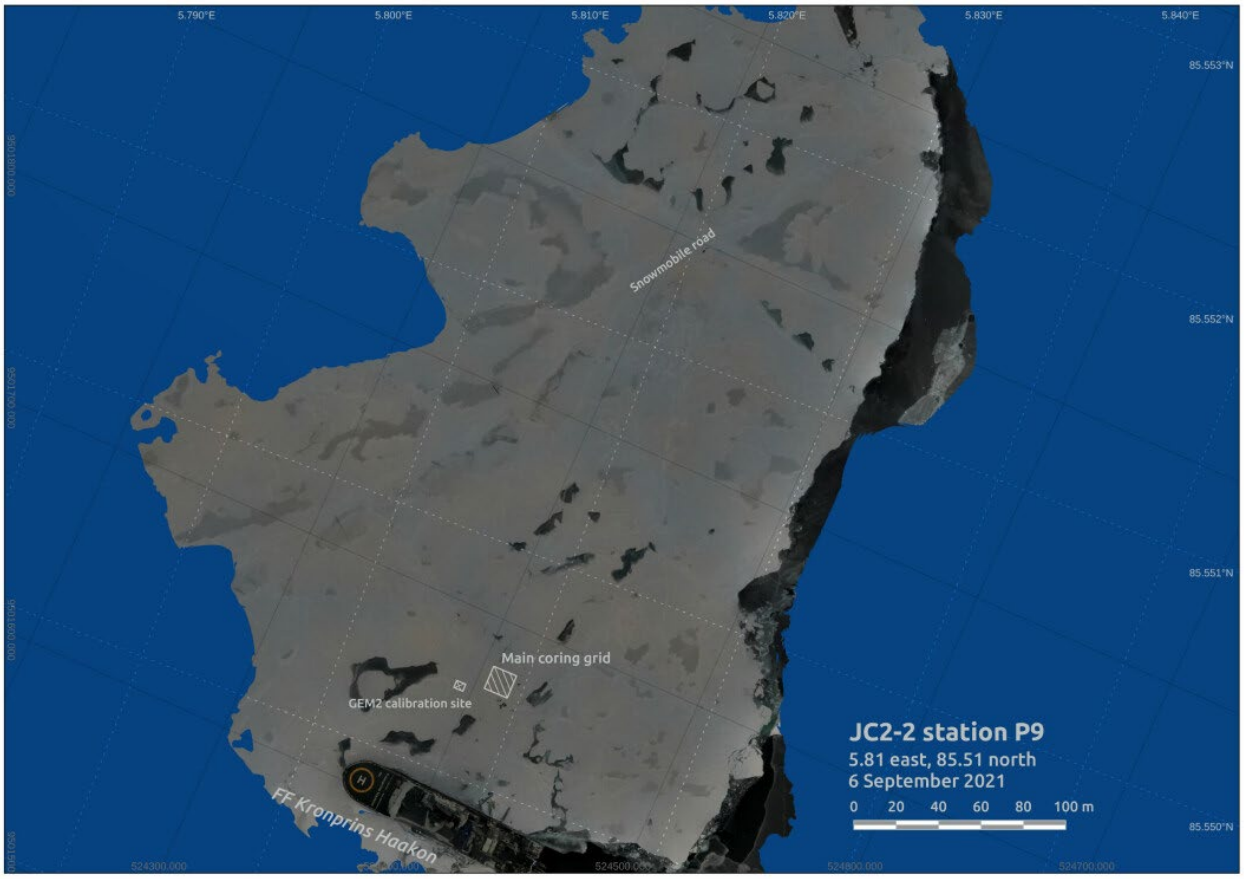
Understanding how it looks – its shapes, how big or small things are, how they are assembled together – is like the microbiology of sea ice. To use ourselves as a metaphor, we can observe 'body' or 'organ' or even sometimes 'cell' size components of the sea ice system using remote sensing, usually satellites equipped with cameras (using light or radar) and altimeters (lasers and radars). In order to interpret those as well as possible, we need to go deeper – into the ice. What proteins are expressed? What's going on between synapses? How do the structural parts look and what are they made of? How do these small components affect the larger scale system?
Here in the Arctic ocean aboard RV Kronprins Haakon we bring a range of approaches to this task. We are coordinating high resolution radar imagery from space, instrumented helicopter flights, smaller scale drone missions, person-towed instruments to measure fine scale sea ice properties, all the way to ice corers, drills and measuring tapes.

Adam Steer and Anca Cristea measuring snow depth with an automated probe, and ice thickness with a sled towed electromagnetic sounding ski. Photo: Christine Lockwood-Ireland

It is a lot – and difficult to find the mix of weather, light and wildlife encounters (polar bears, but then, we work in their house) to get a complete set of measurements, so we triage our approach and work from the basics up. The bare minimum we need to investigate the physical properties of sea ice which is also intensively sampled for things which live in it, is a few ice cores at the same place. From those we can discover whether the ice grew in calm or turbulent conditions by what kinds of ice crystals are present, whether it is still growing, and describe its physical properties generally.

This, however, is a single point in space and time. Broadening our scope, we use electromagnetic induction surveying tools, a simple semi-automated snow probe and a lot of walking or skiing to collect hundreds or thousands more observations about the snow and ice thickness on the ice floe we are sampling, From this we can say something about whether the point sample we took can be generalised across an ice floe. We also aim to cover enough area to be, seen from space' using near coincident radar imagers.
...and we still have gaps. We attempt to fill these with small drones, mapping the site with hundreds of overlapping images and then using computer vision and photogrammetry techniques to reconstruct the immediate area of our point sample.

3D model of sea ice and FF Kronprins Haakon, generated from drone imagery Photo: Adam Steer, NPI



Geographically-corrected site map generated from drone photography Adam Steer, NPI

Using modern geospatial tools we can assemble these data in ways that were extremely difficult even a decade ago. We will overlay very high resolution drone maps over satellite pictures, align walking tracks with towed instruments with both of those, and then add information about the state of ice at point sampling sites. In this way we can build a multi-scale picture of how sea ice looks, what makes it up, at a range of scales relevant to people taking samples on the ground as well as satellite imagery analysts working remotely. In turn this level of detail can give a framework for asking questions like ‘why does a thing live here in the sea ice but not there, just a few metres away?’

Our tiny icy planet Photo: Adam Steer, NPI

Sea ice is an ephemeral landscape, incredibly diverse and variable at scales from centimetres to hundreds of kilometres. When we take a snapshot of what is out here, when we walk around towing our tools of the trade to measure its properties, we are often the only humans who will ever see the places we have explored – a privilege which is granted to few on this planet of ours.

How we approach this place, and communicate about our experiences, often has more impact than the numbers and equations and dry facts we extract. It changes us forever, and that is multiplied when we relay our story to others. So it is also our task to bring back with us the sense of wonder we feel when we encounter, experience, immerse ourselves in these ephemeral landscapes. How does the arctic sea ice affect us, and our internal world, is just as valid a question as ’how thick is the ice?’.

Hardcore science (sciencenorway.no)
Arunima Sen (UNIS)

The box core team in action Photo: Birte Schuppe

On the JC2-2 cruise we are visiting the deep basins of the Arctic Ocean. The goal of my team is to conduct experiments with animals from the bottom of those basins, which means keeping deep, Arctic animals alive. If deep-sea diving is an extreme sport, then this is definitely extreme science.

Seriously, keeping animals alive that live in pitch dark, at below freezing temperatures and under crushing pressure isn't trivial. So here is a little hardcore science guide.
Right at the start there is a challenge; reaching and retrieving seafloor animals in the first place. We are lucky enough to have a world renowned ship capable of decimating sea ice thick enough to land a jumbo jet on, but reaching the bottom of the ocean is another matter. Our target locations are 4000 m below us. Recreational divers only go down to 30

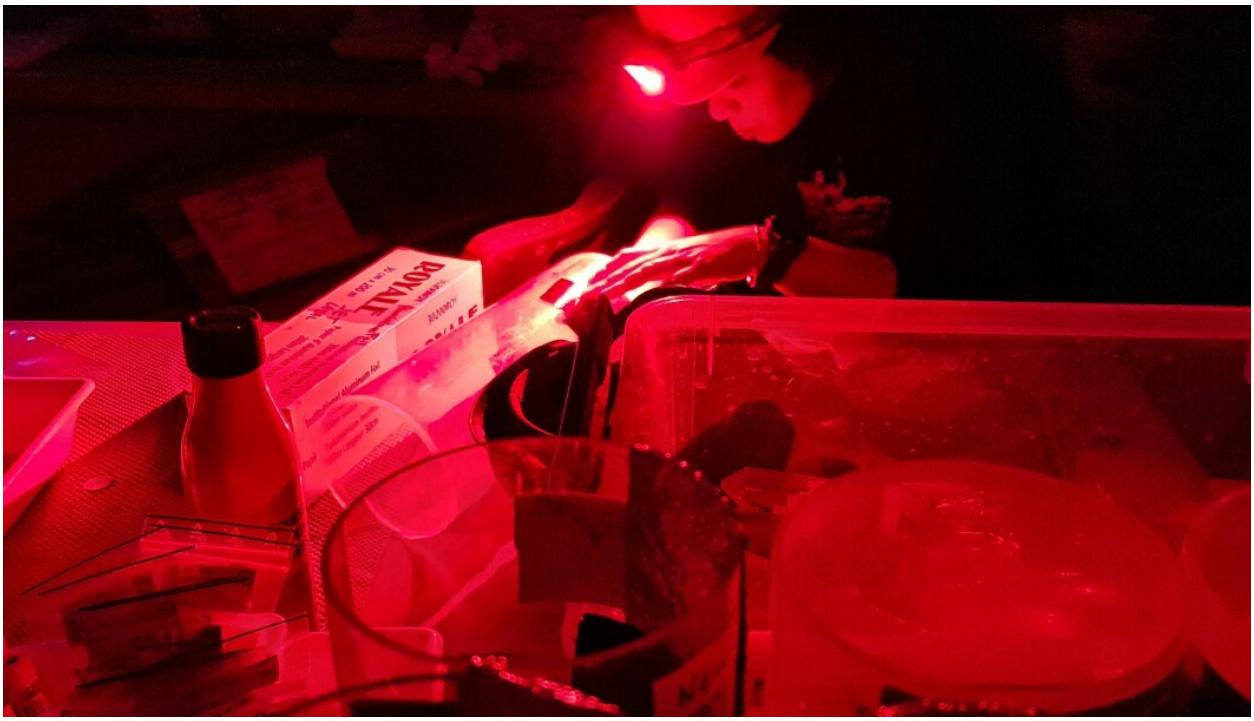
m. That's like climbing a tall tree when you need to climb to the summits of the Alps. We don't have fancy robots at our disposal on this cruise, so instead we put our faith in a heavy metal box.
From the ship, with a winch and some very strong wire, we lower a box core, that, as the name implies, literally boxes up a piece of the seafloor which we then reel in. It might look clunky, but it is a time tested piece of equipment invaluable for anyone studying the seafloor. It doesn't depend on complicated machinery or circuitry, but rather makes use of natural forces, like gravity, to sink into the seabed. Nonetheless, blindly lowering a box kilometers beneath the ship brings out superstition and even prayers into our very scientific agenda. Here is a video showing it in action:

NTNU Oceans

A piece of the seafloor brought up in the box core with numerous sub cores for different types of samples. Photo: Birte Schuppe

Once we have a chunk of the seafloor and all its inhabitants on board with us, the next challenge is keeping the animals alive. There is no light at 4000 m depth. We don't want to blind the ones that aren't blind to begin with, or influence their behavior by shining a torch on them. So we keep them in the dark. That means when we check up on them or

take any measurements, we can't use light either. But unlike my cat, I am pretty inept at slinking around in the dark, so the solution is using red light.



Working in red light. Photo: Bodil Bluhm

Red light doesn't travel very far in general, and even less so in water (the reason why many deep sea creatures are famously red). Plus red light has the lowest energy on the visible spectrum, in other words, it is dim and the least disruptive. That's why everyone on board has very strict instructions to enter our experimental rooms with red light only.
Other than dark, another characteristic feature of the seafloor is that it is cold. On the Arctic seafloor, we actually reach negative temperatures (the reason the whole Arctic seafloor isn't one giant block of ice is because saltwater freezes at lower temperatures than 0°C). And that is one limitation in our setup; we keep our rooms very cold, but we can't get down to subzero temperatures.
Of course there are walk-in freezers on board, but those are considerably colder, plus our electronics and other gear would be severely compromised at freezing temperatures. Furthermore, our labs have taps and pipes with both fresh and saltwater and just like our pipes at home, they can freeze. Unless we want to bring the wrath of the entire crew upon us, destroying the ship's plumbing system is out of the question. Science can have some very ordinary, everyday limitations! What this means is that we, and our deepwater guinea pigs have to make do with a balmy 0 degrees Celsius.

Regular sized foam cups (back) and cups shrunken from being sent to the bottom of the ocean (front). Photo: Arunima Sen, UNIS

And finally, there's the pressure. For every 10 m you go down in the ocean, pressure increases by 1 atmosphere (how much pressure we feel sea level). That means, these animals, at 4000 m depth are experiencing pressure 400 times more than what we feel on land. You can see this squeeze in action in foam cups we sent down.

The box core team in action. Photo: Birte Schuppe

And the reverse is true as well, the infamous, supremely ugly blobfish is a classic example of how pressure can mess up a deep-sea animal (including its appearance). So you might think the answer lies in pressure chambers. But here is a quirky physics factoid: it is only air that gets compressed, not water. Fish, which have air filled sacs (called swim bladders) cannot be brought up alive from depths because the air in their air sacs decompresses and expands, exploding their guts on the way up. But the sediment dwelling animals we study don't have air within their bodies. And so they don't distort as a result of decompression and turn into hideous blobs. Sure, they might not be as happy and as active as if they were under pressure as in their native habitat, and we do keep that caveat in mind when interpreting our results. If you step into our cold, dark rooms (with red light!), you will see live and all things considered, fairly healthy deep-sea animals.

StoryMap – Into the heart of the Arctic

Into the heart of the Arctic

Join 35 researchers on their scientific journey to the Central Arctic Ocean

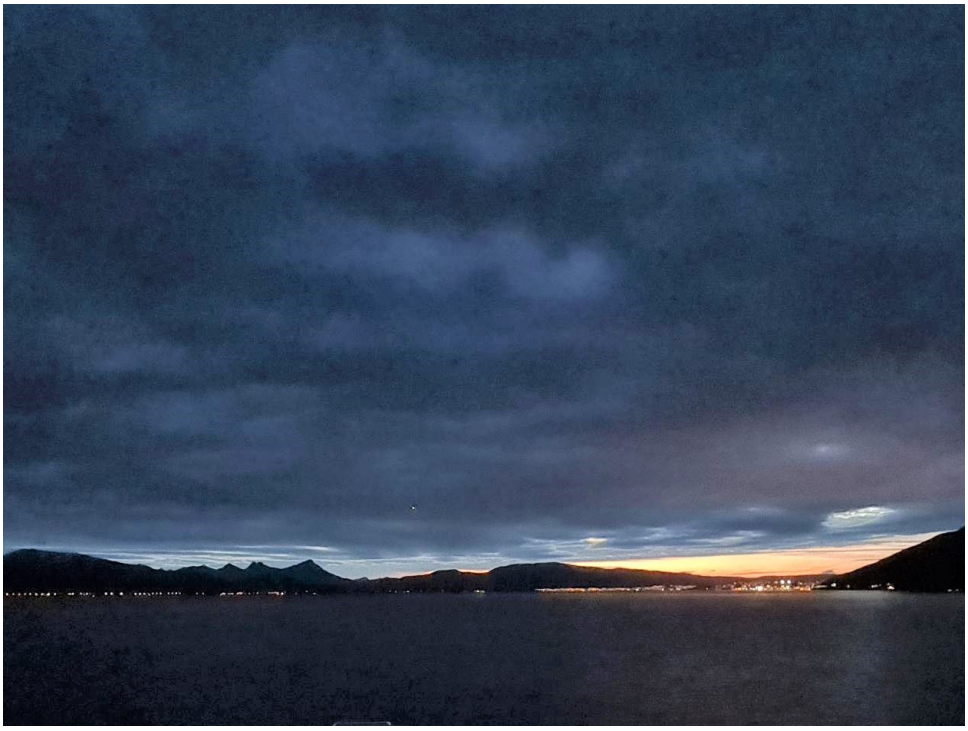
September 27, 2021

The Arctic is warming faster than other regions of the world, leading to profound changes and loss of Arctic habitats. Relatively li
known about the Central Arctic Ocean, as ship operations in this remote and ice-covered sea are costly and logistically demandin

During August and September 2021, thirtyfive scientists are heading deep into the Nansen and Amundsen basins of the Arctic Oc
an endavour to investigate how warming and ice-melt affect the arctic food web and interplay between ocean, sea ice and atmos

The expedition is part of the Norwegian Nansen Legacy project, and an contribution to the international Synoptic Arctic Survey.

Finally heading north!



Tromsø, Aug 24. Day 1.

After months of planning, ten days of quarantine, and two COVID-19 tests, we are finally ready to leave Tromsø port onboard RV research icebreaker. The ship will be our home and workspace for the coming five weeks, leading us into the very heart of the Ar

Read more about the expedition

Scientists never travel light

Aug 25. Day 2.

A scientific expedition to the Central Arctic Ocean is like a mission to the moon - everything you need, you need to bring along. I snowmobiles, four over-sea containers, and 12 tons of scientific equipment.

Consequently, we have been unpacking fanatically since we left Tromsø yesterday. Every little piece has to be in place before we northern Barents Sea.

The picture shows Anette Wold and Camilla Svensen setting up a large fin-meshed net, which we will use to catch small crustace

Why study the Arctic Ocean now?

Like a pair of new shoes

Aug 26. Day 3.

We have loads of new gear with us. Like a pair of new shoes, the new equipment needs testing before we reach our first sampling

Today, we tested a brand new wire. Sounds weird? Well, wires are an extremely important part of our scientific equipment! They contain electronic cables that allow us to communicate with measuring sensors deep down in the ocean. A damaged cable not or equipment, but may also prohibit us from getting measurements.

During the cruise, we will use a Teflon wire on one of our main workhorses - the CTD rosette. The rosette is a carousel with 24 b depths, important to all biologists, chemists and physical oceanographers onboard.

The ‘CTD’ itself is a sensor package that measures conductivity (that we translate into salinity), temperature and depth. Addition microalgae and traces of river water in the water.

Today's test result? Wire and CTD worked fine, and we are ready to go to our first true sampling station!

First ice in sight!!

Aug 27. Day 4.

Lucky us, we got beautiful views of Kvitøya, a small island on the eastern side of the Svalbard Archipelago, covered by glacial ice.

Chunks of this freshwater ice drift around the island, mixed with a few little pieces of sea ice. Some seabirds, a lonely seal and a f
life.

Everyone got an introduction to (...our few newbies) or reminder of (... the seasoned sea ice teams) safety around working on sea

Now we are looking forward to getting started with our sampling!

A day of full action and a lonely polar cod

Aug 28. Day 5.

We have reached our southernmost station, yet have crossed 80degrees North!

From a 3000 m water column of Arctic Ocean we retrieved our very first lonely polar cod, a handful of squid and midwater fish, a comb jellies and krill. What do they eat and who eats them? We are here to find out.

Plastics and trace metals

Aug 29. Day 6.

Plastics are what we try to avoid in today's world. In this one case, however, researchers from NTNU must package their special-
while carrying them to and from their sampling wire. This is to avoid contact with metal - a difficult task when working on a huge

Here they have sampled water from specific depths down to 500m and measure trace metal content in the lab. The lab looks like
and Tomasz Cieliski work in full body suits that look like medical stuff conducting COVID-19 test.

Read interview with Nicolas

Muddy business

Aug 29. Day 6.

While all those working with seawater and organisms living in the water column have it nice and clean, benthologists (biologists i often have it muddy. However, how exciting to bring up a big clump of ocean seafloor from 3000 meters depth!

How we do that? We lower a big open metal box down to the seafloor, where it is pressed into the soft sediment. A closing mech the sediment can carefully be winched up onto the ship.

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On deck, the sediment samples are washed and sieved in order to recover the animals living within the sediment.

The sediment that is brought up to the surface has a thin layer of organic carbon at the top, consisting of sinking particles from th within the sediments. Deep-sea organisms live in these sediments, where they respire and thereby contribute to the chemical co

We are here to understand how animals on and in the sediment manage to survive in this extremely food-poor environment.

Read more about our benthos work

What a wealth of samples!

Aug 29. Evening day 6.

We have now spent 48 hours at our first sampling station - two days in which the boat's winches have not been standing still. Da deployed into the sea to measure water temperature, salinity, alkalinity, nutrients concentrations, and current speed, to only me

Sampling gears, like trawls and nets, corers and water samplers retrieved various samples from ocean viruses to fish. Upon retrie hours of water filtration, sorting of organisms, or chemically analyzes.

Now we are on our way northwards again, eager for a new round of sampling even deeper in the Arctic Ocean!

Meeting the Arctic icon

Aug 30. Day 7.

The polar bear is undoubtedly the most charismatic Arctic animal for the general public. Seeing the first wild polar bear ever in y were glued to the windows or out on deck when this large Arctic predator with black skin and nose appeared out of the fog. Fres ahead of time. Fortunately we had no one working on the sea ice at the time. When we do work on the sea ice, several bear guar high bridge of the vessel and from the ice itself. This time we could all just enjoy the moment.

Finally out on the ice, or at least almost

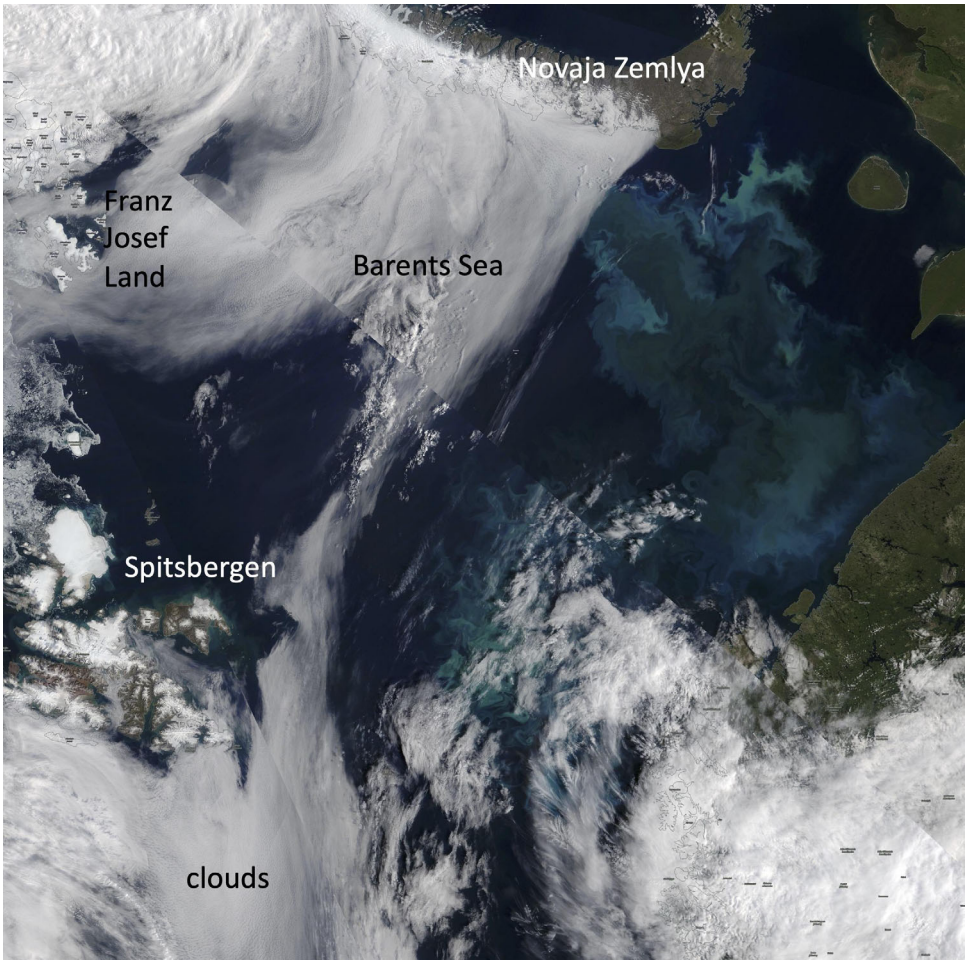
Sep 1. Day 9.

We have now come well into the Nansen Basin of the Central Arctic Ocean. The sea ice around us is getting more solid, and the getting off the ship. However, for now the ice is still too thin and fragile to work safely on it. Therefore, the first sea ice survey wa polar bear guard from a basket attached to the ships crane.

Despite the restricted workspace, the team came back with sea ice cores for ice texture, salinity, and temperature measurements ranged between 50 to 120 centimeters.

More extensive sea ice work will be conducted throughout the coming weeks.

Seven million in a liter



Sep 1. Day 9.

The sunlit surface layers of the ocean are home to trillions of tiny algae, too small to be seen by bare eye. However, sometimes th by changing the color of the sea.

On our way northwards, we sailed through beautiful turquois water for more than a day. The responsible for the color: the cocco 0.005 millimeters in size. How such a tiny creature can color the ocean? The answer is twofold: 1) It was not one but seven millio carries tiny whitish shields of calcium carbonate. These shields scatter sunlight and lead to a change in ocean color.

The bloom we encountered covered a large area and can be seen on satellite images (look for the turquois flow marks beneath th

As we approached the ice edge, *Emiliania* disappeared and the water became inhabited by other single-celled algae: large diaton and the haptophyte *Phaeocystis*.

Now deeper into the ice, the large diatoms have disappeared and dinoflagellates together with other tiny microalgae have becon

Will the Arctic Ocean get green?

Working as trapper out in the Arctic Ocean

Sep 1. Day 9.

We trap mice that we do not want in the house, and read in Jack London books how trappers go after foxes, wolves and wolverir
What's to trap far out here in the Arctic Ocean?

Well, imagine sitting at the bottom of the 4000 meters deep Arctic Ocean at almost 84 degrees North (which is where we now ar
The only food comes from the surface ocean where fresh microscopic algae grow. When these or their zooplankton grazers die th
worms and clams, once they have made their way through 4000 m of water. This may take days (for large and heavy particles) to

What sinks where and when, if it is junk food or has juicy veggie quality, and how long it takes to sink, we can measure with a sec
Plexiglas cylinders put into metal frames and tied to a rope at various depths. A few buoys keep the trap afloat and a geo-locator
our vessel during its daylong trip.

What comes up in the cylinders looks like just a little bit of fluff (or even seems to show just clear water), but it actually contains
time from now.

So out here, trappers do not catch mice, foxes, or wolves. They simply catch fluff slowly sinking from the ocean surface to the sea

Sep 2. Day 10.

We are working in a harsh environment. That influences the fassion out here: On the sea ice and out on deck we wear full body s leads a survival suit suitable for physical work is what we wear.

Ahead of cruises we regularly train how to put the survival suits, how to swim and rescue someone in it. In the picture we practic ice flow with ice pics.

Away from open water and on deck we wear a flotation suit that would also keep us afloat were we to fall into the water. Helmet body protection on deck where much heavy gear and wires under tension are operated.

Parked for 72 hours

Sep 3. Day 11.

Our research platform RV Kronprins Haakon is now parked at an ice floe for 72 hours, where we carry out intense sampling and r meltponds, and in the lead.

The ice floe is divided into several sampling locations:

a) main ice coring site close to the ship, where more than 35 ice cores are collected for biology, chemistry and physics

b) the open lead sampling site, where physics measurements on the water column such as salinity, temperature, and turbulence, in an undisturbed environment, a few hundred meters from the ship.

We are flying!

Sep 4. Day 12.

Perfect weather at 83 degrees north today, and we are finally up in the air!

Below the helicopter hangs an important sensor, called the EM-bird. This torpedo-like looking instrument sends out and receives conductivity of the material below it (air, sea ice and seawater) affects the signals the EM-bird receives.

From the received electro-magnetic signals, together with data from a laser altimeter, the thickness of the sea ice can be calculat

Consequently, helicopter flights with the EM-bird give us a lot of detailed information about the sea ice in a much larger area tha the ship.

Water shortage

Sep 5. Day 13.

Even though we have 4000 m of water under us and a whole ocean around us, we carefully budget the water sample needs to th couple of buckets over the side are not enough for all the analyses we are doing.

Several times in a row we send 24 ten-liter bottles to pre-determined depths and press a button that sends a signal through the c
lid. Then that water from 3500 m is trapped in the bottle, and brought up on board. This can be done at every depth of interest t

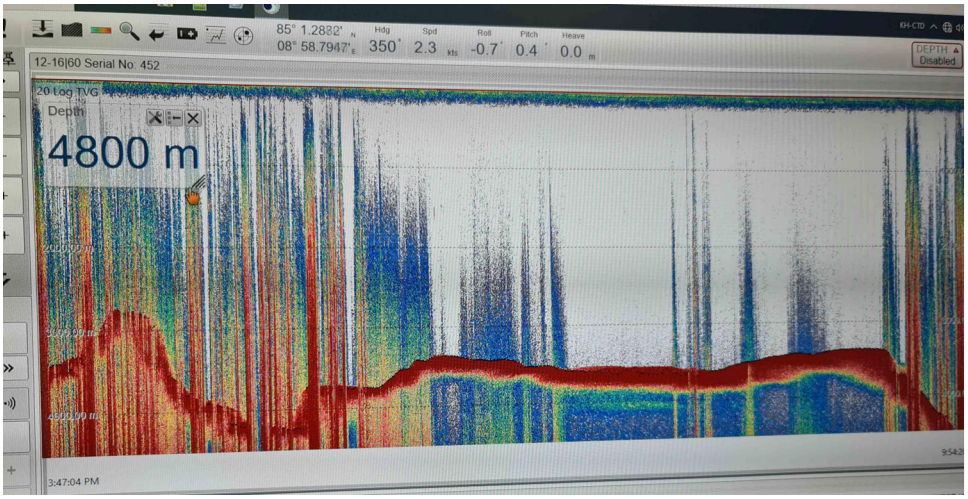
The only problem: Getting water from 4000 m depth takes 3 to 4 hours! That is why seawater water is precious on a research ves

What happens to all that water? We measure how much oxygen, microalgal pigments and total carbon mass (means the living st
how much nutrients are available for algae to take up for their growth, what the composition of viruses, bacteria and small algae
contribute to food production for those that eat them.

Hard to believe that 24 liters keeps a dozen people busy in the shipboard labs for hours (and even more back on land afterwards

Read more about life in seawater

Mountain hike at sea



Sep 6. Day 14.

The bottom bathymetry of Central Arctic Ocean is far from being formed like a simple pool. It consists of several deep basins that

Since we left the shallow waters of the Barents Sea, we have been crossing the Nansen Basin, which deepest point is 4665 meters
which is a mid-oceanic ridge stretching 1800 kilometers between Siberia and Greenland. The Gakkel Ridge separates the Nansen
plan to explore after a 72-hour station here at the Gakkel Ridge.

Crossing the Gakkel Ridge was quite a mountain hike with ever-changing water depth. The deepest spot we crossed was 4800 m
We spent some time looking for a reasonably flat plateau so our equipment that goes to or near bottom would not all of a sudden
set and sampling can start.

Ice is nice

Sep 6. Day 14.

It is always a fantastic experience to leave the ship and walk out onto the frozen sea. Working on the ice is all but easy. Beside sa survival/floation suits) and frozen toes and fingers, working on the ice is physically demanding. Many tens of ice core have to be equipment to be towed over the ice.

Our ice cores look like huge lollipops with freshwater taste at the top where the snow is, and salt flavor at the bottom where the This layer is where "home" is for most organisms.

We also go through the effort of drilling holes into the ice to take water samples from directly under the ice. This is the layer we disturbance cause by the ship's propellers and thrusters.

Read more about life in sea ice

White visitors

Sep 7. Day 15.

Polar bears are curious animals and can smell the ship or food (what about fried bacon and fried egg?) on miles of distance. Whe days in a row, polar bears tend to come and check us out.

It is therefore we have dedicated polar bear guards with flare guns and rifles on the ice next to the working scientists. In addition constantly watching out for polar bears. From the bridge, one has a good overview of the surroundings. Should a polar bear appr from up here, leaving us time to evacuate people from the ice.

It is worse for our equipment that not always makes it back on board in time. Quite some buoys and tripods have turned into pol

Home, sweet home

Sep 8. Day 16.

We have been stationed at 85 degrees north for the last 72 hours, working heavily out on the ice. After a half day or so we start c

We sampled it during the day, with the ship "docked" onto the ice floe. At night, we left our "parking garage" to be able to deplo the early next morning, we were parked back at our home floe.

We used "our" ice floe like a house with different rooms: the coring site, the lead site, the safe snow scooter path marked with ba ice and snow thickness measurements.

Staying at a place for three days allows not only for good science but also for experiencing the beauty and wonder of this frozen l leaving a short window of sun at 3 am in the morning. We observed the lead freeze over and the open water area for "our" seal g

After three days and a last snow machine tour to pick up after us, we are now leaving our floe, in transit to the next ice station at

Moving off the map in wiggling lines

Sep 9. Day 17. 85°49.9'N, 04°30.44'W

It turns out that we have moved off the map - at least the one of this storymap, which turns out to ignore the world north of 85 d

That means that our position shown on this map is no longer correct. We are now at

85°49.9'N, 04°30.44'W

We have been steaming ever since we left our last ice station. Our cruise track looks like we had a broken ruler when we drew th

It is immensely fuel (and time) intensive to break our way through the sea ice. For that reason any icebreaker captain and officer
of open water between the floes, as much as possible.

Now in the autumn these leads freeze up, but the thin ice is much easier to break than 1-3 m thick ice. Those lead systems obvio
our "wiggles".

00:00 / 00:21

The sound of RV Kronprins Haakon going betwen the ice floes.

Another reason for a seemingly erratic line is that we drift with the ice when we are on station, because we are "parked" to a drif
direction and speed, we add more or less angles to our transect line.

During the last ice station we had winds of 7-12 meters per second from the southeast and later east, so we "sailed" northwest ar

Despite all detours, drifts and wiggling, and the ice around us getting heavier, we are confident to reach our next planed station a

Read more about leads

Passing Nansen's footsteps

Sep 10. Day 18. 86°14'N

Hundred and twenty eight years ago, the Norwegian polar explorer and researcher, Fridtjof Nansen, set sail with his research ves
then unknown Central Arctic Ocean.

In an attempt to reach the North Pole, Fridtjof Nansen and Hjalmar Johansen left the ship in March 1895. Due to southward ice d
the North Pole. They had to turn around at 86°14'N.

Today - 126 years later - we passed this position. This time not on a quest for the North Pole, but in the endeavor to map parts of

We hope that the cruise leaders (Agneta Fransson and Bodil Bluhm) this time will stay onboard, and not leave on skis for the Nor

Read more

A big cheer to our vessel and crew!

Sep 11. Day 19. 86°25.8'N, 16°36.6'W.

It really is about time for a big applause to our captain and his officers on the bridge (wheelhouse) of RV Kronprins Haakon! On r
icebreaking skills (and the vessel's capabilities) as much as on this one in the vessel's life time so far.

The past two days felt reminiscent of "the old days" where ice was thick across much of the Arctic. Where we now are is not far a
Last Ice Area" where thick multi-year sea ice still persists.

A big cheer to the bridge team!

Take a virtual tour on the ship

Le ballon rouge

Sep 12. Day 20. 86°23'N, 16°25'W.

A big red balloon is filled with helium gas by the crew on RV Kronprins Haakon and released to the atmosphere four times a day stations, and two times a day (every 12 hours) on other days.

The balloon rises rapidly in the air, and in a few seconds, only a small red dot is observed far away in the sky.

The balloon carries a radiosonde that measures air pressure and temperature to heights up to 20-30hPa. This corresponds to abo

The data are used by the Deutscher Wetterdienst (Germany) in models for weather forecasts. The increased frequency of data ol improve the model.

Needless to say, that weather balloon data from 86°N, 16°W are a rare treat for meteorologists!

When stress multiplies

Sep 13. Day 21. 86°23'N, 16°25'W.

The atmosphere on board is all but stressful despite long workdays and sampling 24/7. However, the white world around us – so subjected to several stresses. Sea ice retreat, increasing water temperatures, human-induced pollutants, new species, and an acic interested in understanding how Arctic organisms react to these stressors.

Several post-docs and PhD students onboard conduct experiments to investigate the effects of more acidic seawater on plankton organisms called foraminiferans.

They also add in additional stressors that can act at the same time, including increased water temperature and contamination thr

These experiments will give us first insights in how Arctic animals can cope with stress that multiplies.

Read more about some experiments

Buzzing activity inside and outside

Sep 14. Day 22. 86°43'N, 22°09'W.

We have left our last 72-hours station and are now heading for our northernmost station at 87 degrees north, 30 degrees west. Tl there is no guarantee for getting that far north- and westover.

While the ship is steaming, the many labs on our vessel are buzzing with activities! Here you see early career researchers workin

The smallest living things we work with are viruses and bacteria - organism groups that are extremely abundant anywhere in the Since they are mostly too small to be identified by microscopes, they get filtered on tiny-mesh filters and get sequenced. Their ge what “work” they do in the ocean (and by the way, these ones do not make you sick).

In comparison, copepod crustaceans are giants that can be studied under stereomicroscopes as you see on the other two images. copepods are probably the most abundant group in the oceans. They can be picked out for identification or experiments using pi without light to reduce the stress they experience.

Three stars to the kitchen

Sep 14. Day 22. 86°43'N, 22°09'W.

Food is important - especially in the Arctic when working long days physically out in the cold.

Imagine preparing three meals a day plus coffee with cake and midnight snacks for 56 people over 5 weeks with no store anywhe requires some planning!

Our hotel team of only four makes us feel like we are a luxury hotel every day. Vegetarians, pescetarians, vegans, omnivores ... w and so do the four hard workers, day after day.

A great thanks to the kitchen team!

Work hard, play hard

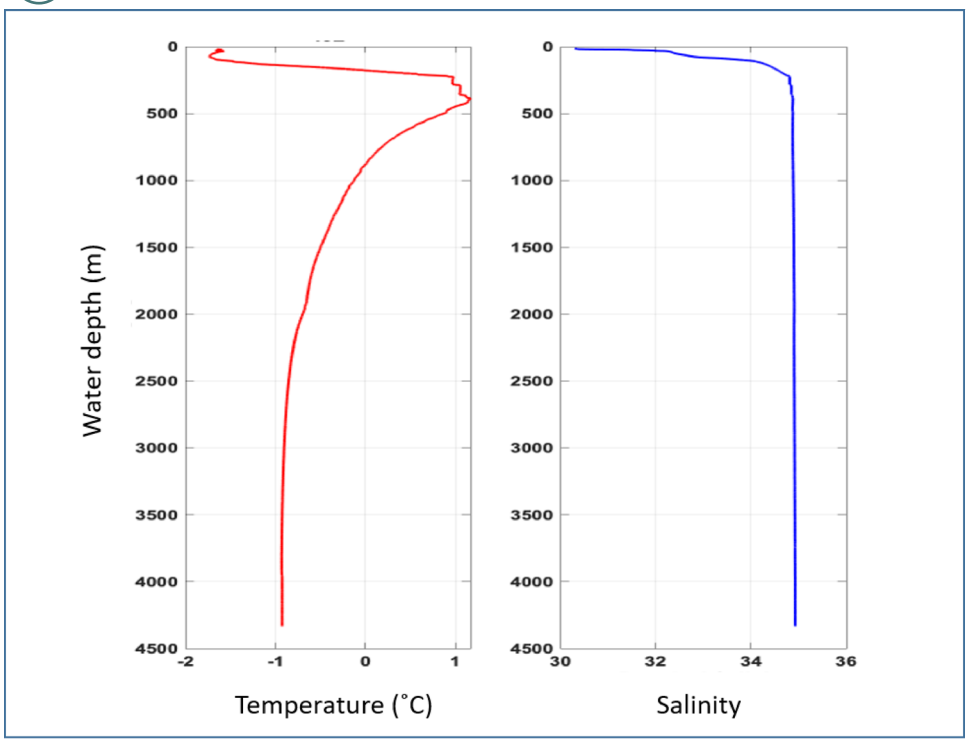
Sep 15. Day 23. Transition to 87°N, 17°W.

Ship time is expensive, and no one would consider taking the weekends off while onboard. We work a lot, but we do have very fu

Wednesday nights are bingo nights, and participation is higher than any university teacher could dream of in a student lecture.

There are also many knitters working on beautiful sweaters during off-time, coffee breaks with cake in the dining area (we have a
on the observation deck high up at the 9th floor, and much sweat in the gym. We can even go "shopping" for toothpaste, chocola
our hearts desire?

The Arctic Ocean cocktail



Sep 15. Day 23. Transition to 87°N, 17°W.

Have you ever made a cocktail where the different drinks formed nice layers above each other? If so, you have seen the world's c
between your cocktail glass and the ocean: The Ocean's layers consists of seawater of different temperatures and salinities.

In the Nansen Basin - in the beginning of the cruise in August - the surface water (surface to 25 meters depth) temperature was a
this layer, water of Atlantic origin was laying at 200 to 400 meters depth. This water mass was warmer than the surface water (2°
34.5). The higher salt content makes this water mass heavier than the water in the surface, and gives it therefore an intermediate
cocktail glass.

On our journey northward - passing the Gakkel Ridge and reaching the Amundsen Basin - the surface waters became close to fre
(salinity around 30). Here, the signal of the Atlantic layer was weaker than in the Nansen Basin.

In the greater depths of the central Arctic Ocean, the salinity and temperature are hardly changing at all (straight lines on the figu
cocktail layers to find here. However, the waters down here can be several hundreds of years old, and that is pretty cool to think

Here we go again

Sep 16. Day 24. 87°30'N, 17°20'W.

We have reached our last 72-hour ice station, and are eager to get started.

At a main station like this one, we use an impressive variety of different gear types: plankton nets in all shapes and sizes, water b
a pelagic fish trawl, and instruments that measure water properties.

While the researchers bring most gear, it is the vessel crew that hooks it up to one of the many different wires that are rolled up
gear into the water.

For these deployments, the crew skillfully operates the cranes and winches, consider the different wire speeds and ways the gear
the winches at the desired depths. They also know how to fix just about everything and work 24/7 (in shifts obviously).

Hooray to the ship's deck crews!

Finally found: The Transpolar Drift

Sep 16. Day 24. 87°30'N, 17°20'W.

The Transpolar Drift is a surface current that crosses the North Pole and central Arctic Ocean from Siberia to end up in the Arctic the western Fram Strait.

This current is like a large river that transports surface waters and sea ice with larger concentrations of greenhouse gases such as carbon, sediments, and organisms originating from land, rivers, coastal erosion and melting permafrost all the way from Siberia.

We are interested to find out how the transported material affects the water flowing out of the Arctic, and if climatic changes affe transported material.

In the Nansen Basin we did not find any traces of Transpolar Drift water. But here, about 300 km from the North Pole, in the Amu derived water was finally successfull! Detection of special chemical compounds in the seawater and sea ice clearly indicate that w

Still we were surprised when the benthos team found moss in the seafloor sediment from 4000 meters depth! Could it reallt been way from the Siberian tundra and rivers, ending up in the sediments in the Amundsen Basin?

Find out more

Aliens from the deep

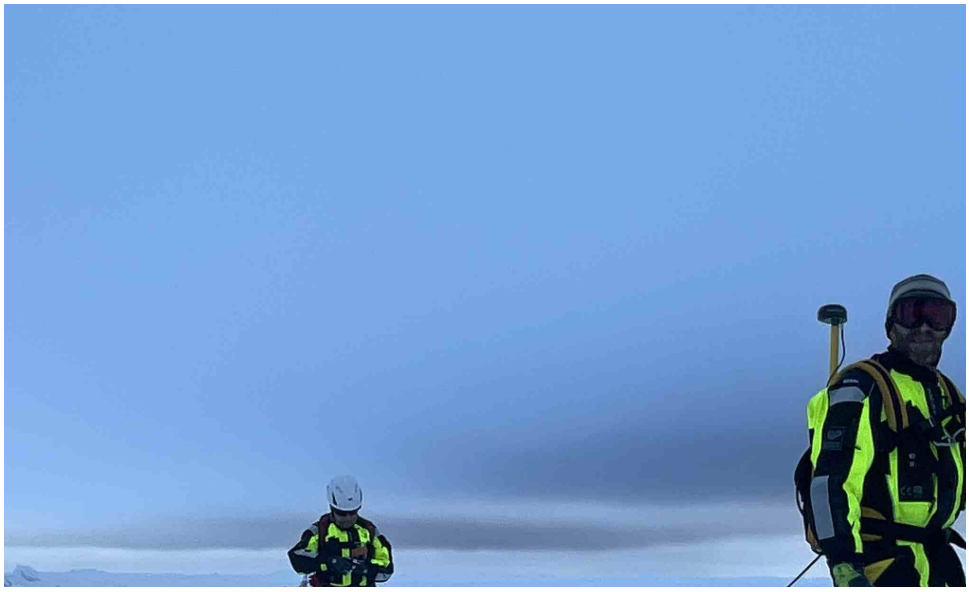
Sep 17. Day 25. 87°30'N, 17°27'W.

The deep-sea differs from our coastal waters and shelf seas in many ways. For the most part we find very different animals in the Amundsen Basin.

Animal densities are much lower than on the shelves, that means the number of individuals per liter of water or square meter of higher, meaning per 100 individuals you would find more different species in the deeper water column and at the seafloor than ir

The pictures give a flavor of our treasures in the Arctic deep sea fauna.

How thick is sea ice?



Sep 17. Day 25. 87°30'N, 17°27'W.

It depends is the answer.

Most first-year ice (that is ice that does not persist through the summer melt) grows no thicker than around 1 to 1.5 meters. Reall several summer melts can be 3-5 meters thick, and sea ice in ridges where floes crash into each other may be several times that. I contained in glaciers or in the Greenland Ice sheet that extend over hundreds and thousands of meters, respectively.

To measure sea ice thickness we take ice cores - but the area we cover with those is very small. On the picture above, two in our instrument that can measure ice thickness over transects of several kilometers zickzacking acros our floes.

On an even larger scale, we take out a similar instrument as is strapped to the sled and fly it around with a helicopter to cover do

Through a combination of these field measurements and satellite based me asurements and integrative models we know roughly the Arctic.

Such measurements made over time have made us aware that ice thickness has been decreasing all over the Arctic over the past

The quiet ocean

Sep 18. Day 26. 87°30'N, 17°27'W.

Arctic Ocean is considered as a "quiet ocean", where no drastic changes in salinity, temperature and mixing occur in the surface

When the ice cover cracks or an open lead is formed, the wind can stir and mix the ocean water so that underlying water can be water transported deeper down.

In this process, heat from below can be brought up to the surface and melt the overlaying sea ice, and nutrients and greenhouse below up to surface, or other way around.

In undisturbed water, away from the ship, we use an instrument (MSS microstructure profiler) that measures the vertical variatio temperature, salinity and current speed of the upper 350 meters of the water column, to estimate the mixing of the ocean.

Read more about ocean mixing

300 kilomters from the North Pole

Sep 18. Day 26. 87°31'N, 18°W.

Today we reached the northernmost position of our expedition at 87°31'N and 18°W - only 300 km away from the North Pole.

The last 72-hours ice station in the Amundsen Basin, in the central Arctic Ocean, and the main cruise plan have now successfully

Along the journet, we performed a large amount of CTD measurements, water sampling, plankton nets, box corers, trawls, filtrati snow measurements, lead sampling measurements, lab work, sample analyses, and a lot more.All this could not be possible witho safety responsible!

We are now going south and plan a few shorter stations on the way back home. The cruise and storymap will continue for about Longyearbyen.

We are not alone

Sep 19. Day 27. 86°10'N, 5°3'W.

Did Nansen and his team on the Fram feel lonely out here in the central Arctic Ocean?

We don't really. Of course we have not seen another vessel or other people than our team of 54 since late August, but we know t the central Arctic Ocean at this time.

Their and our efforts are part of the international Synoptic Arctic Survey that aims to produce a snapshot of the status of the Arct biology across the entire Arctic Basin.

For example, the Swedish icebreaker Oden is finishing their expedition across the Amundsen and Nansen Basins, North Pole and Canadian Joint Ocean Ice Study group is working in the Canada Basin on the Amerasian side right now, the Chinese icebreaker X operate on various Arctic shelf seas.

Scientific collaboration within and across the Arctic states and way beyond is a common feature of today's research landscape inc over a dozen nations.

Synoptic Arctic Survey

The hidden world of our icebreaker

Sep 20. Day 28. 84°28'N, 7°2'W.

Why is an icebreaker strong enough to break ice? How do we make our drinking water? What about all our waste? What if an en
or a fire breaks out?

Today, the lead machinist took us on a tour into the part of the vessel we scientists rarely get to see or appreciate. We walked th
tanks, pumps, cables, electronics, noise, engines, tools and more, and learned about the high tech world of modern icebreaker de

Incredible that a small team of four keeps this entire vessel running smoothly day in, day out, making our research possible!

Office work at sea

Sep 22. Day 30. 83°8'N, 9°38'W.

Even at sea there we have computer work to do, especially now on our return trip. For every sample taken we record where, whe
given sample was taken, regardless of whether it was a liter of seawater, a worm from the seafloor sediments, a jellyfish from a pl

This information gets linked to a unique QR code (similar to the barcode on each supermarket item) that we generate onboard a
proof special labels that we stick on each sample bottle, tube, vial or bag. Each code gets scanned and the QR code appears in ou

In the end, every drop of water taken and analyzed for, say microalgal biomass, can be tracked back to a specific site, instrument

After the cruise these logs get uploaded to the Nansen Legacy portal of the SIOS website, a place where anyone can search for th

Sounds like a lot of effort? It is, but through this process we ensure that every data point is traceable, can be linked to other samp respective person one might want to get in touch with), and that we openly document how tax money is used.

In addition, the good old traditional notebook is still a useful tool...

Last time

Sep 23. Day 31. 81°41'N, 1°49'W.

After almost five weeks in the Arctic ice pack, we are soon out in open water, sailing along the East Greenland current.

The last short sampling station has been carried out. Here, the last CTD (salinity, temperature, depth) profile, last seawater samp phytoplankton net were taken. For the last time water was filtered and analyzed in the ship's laboratories.

Further analyses of ocean chemistry, DNA genetics, chlorophyll, phytoplankton and microbes will be conducted back on shore.

Finishing up

Sep 23. Day 31. 81°33'N, 1°20'W.

While we steadily move through the last ice floes on our way southeast, we take stock of what we have accomplished.

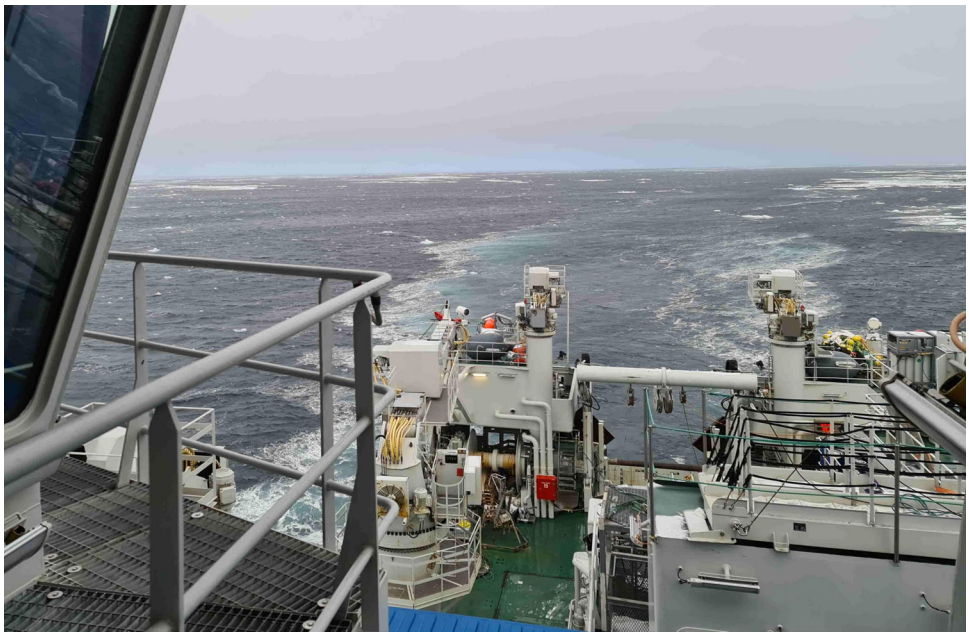
The sediment group has just ended the last respiration incubation designed to find out how much the seafloor organisms "breath energy they used and indirectly how much food was available.

The team uses a box full of the sticky fine-grained mud from the deep ocean and take out sediment cores (here the largest diame taken from our water sampler, close the cores with airtight caps, and attach oxygen sensors that then measure the decline in oxy

Afterwards the sediment gets sieved to quantify the fauna that actually was in it and was "breathing". Very few "large" (few milli Arctic deep sea, meaning the share of bacterial oxygen use is high, whereas in shallower water larger organisms contribute more recycling of organic matter.

Think about your compost out by the garden - without bacteria in it, the earthworms alone would not make the beautiful soil you

Saying goodbye to the ice



Sep 23. Day 31.

The transition from open water to sea ice and sea ice to open water is always a milestone on Arctic cruises.

When leaving the sea ice going south there tends to be a wee bit of "Wehmut" mixed into the joy of returning to family and frien

The transition area between ice and open ocean, the so-called marginal ice zone, varies in its location across the year and by regi zone where the sea ice can be more or less compacted depending on the prevailing winds in the last days or hours.

Regardless of where this zone is it is wise to have gear packed and strapped before leaving the "safe" ice where wave movement enough we are greeted by rather big seas and howling wind once the great blue surface covers 100% of the ocean surface again.

Back on land

Sep 24. Day 32.

What a fantastic sight to see Svalbard's mountains raising at the horizons, and fulmars, dolphins and whales are welcoming us.

After five weeks onboard 'Kronprins Haakon' in the Arctic Basin cruise, we are finally in port in Longyearbyen, bringing lots of sa

The cruise leaders Agneta and Bodil thank the ship's crew, scientific crew and safety team for a successful cruise!

By Bodil Bluhm, Agneta Fransson, Lena Seuthe

with pictures by Adam Steer, Agneta Fransson, Amanda Ziegler, Anette Wold, Bodil Bluhm, Camilla Svensen, Christine Lockwood-Ireland, Christian Morel/christianmorel.net, Elin Vinje Jenssen, Fredrik Broms/northernlightsphotography.no, Hallgeir Johansen, Kay Jørgensen, Miriam Marquardt, Wenche Videos and sound by Christian Morel/christianmorel.net. Satellite image: NASA https://worldview.earthdata.nasa.gov.

The Nansen Legacy in numbers

6 years

The Nansen Legacy is a six-year project, running from 2018 to 2023.

1 400 000 km² of sea

The Nansen Legacy investigates the physical and biological environment of the northern Barents Sea and adjacent Arctic Ocean.

>10 fields

The Nansen Legacy includes scientists from the fields of biology, chemistry, climate research, ecosystem modelling, ecotoxicology, geology, ice physics, meteorology, observational technology, and physical oceanography.

>350 days at sea

The Nansen Legacy will conduct 15 scientific cruises and spend more than 350 days in the northern Barents Sea and adjacent Arctic Ocean between 2018 and 2022. Most of these cruises are conducted on the new Norwegian research icebreaker RV *Kronprins Haakon*.

280 people

There are about 230 researchers working with the Nansen Legacy, of which 73 are early career scientists. In addition, 50 persons are involved as technicians, project coordinators, communication advisers and board members.

10 institutions

The Nansen Legacy unites the complimentary scientific expertise of ten Norwegian institutions dedicated to Arctic research.

Universitas Oslo Sis MDCCCXI
Universitas Bergensis
The Arctic University of Norway UIT
Institute of Marine Research
Norwegian Polar Institute
Norwegian Meteorological Institute
UNIS The University Centre in Svalbard
NTNU
NERSC
Akvaplan niva

50/50 financing

The Nansen Legacy has a total budget of 740 million NOK. Half the budget comes from the consortiums' own funding, while the other half is provided by the Research Council of Norway and the Ministry of Education and Research.

Norwegian Ministry of Education and Research

With funding from The Research Council of Norway

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Photo cover: Kay Jørgensen