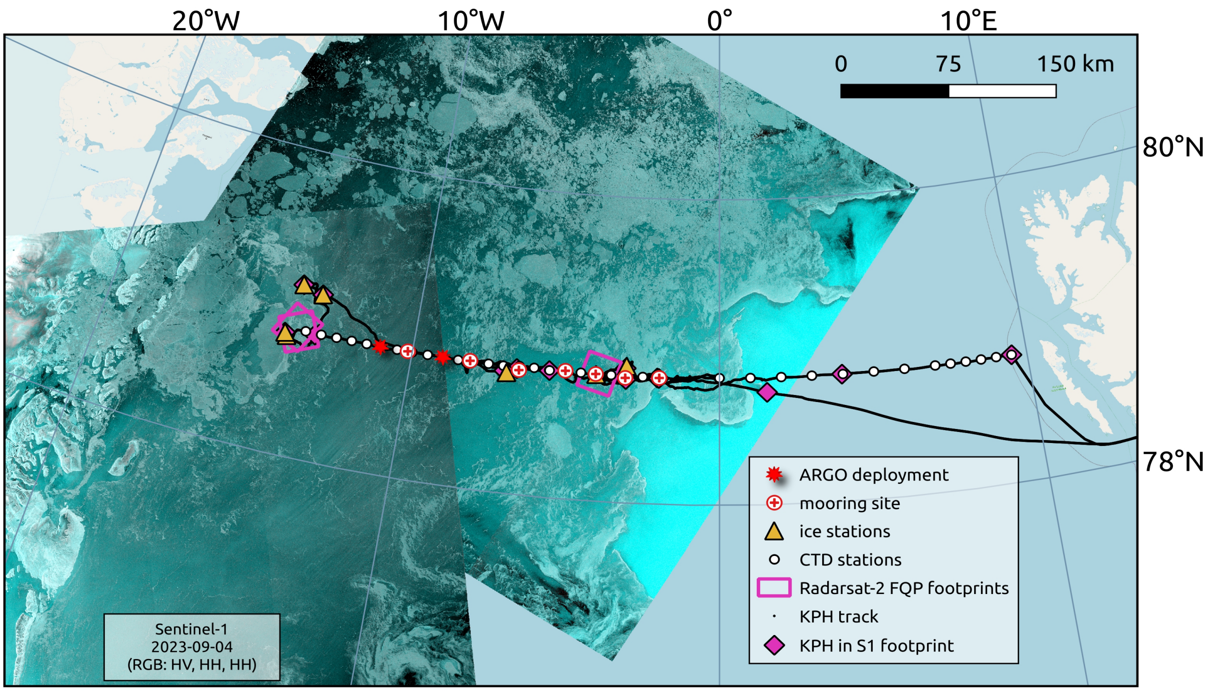
Fram Strait Cruise Report

FS2023 - Cruise ID 2023007015

30 August - 13 September 2023

Longyearbyen - Longyearbyen



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1. Cruise Overview

The objective of the annual cruise of the Norwegian Polar Institute to Fram Strait is to service the Arctic Outflow Observatory in the western Fram Strait. The purpose of this observing system is to monitor the properties of the Arctic freshwater, sea ice, and returning Atlantic water, as well as the state of ocean acidification, CDOM and nutrients in the East Greenland Current.

The main priority was to recover and redeploy seven NPI moorings across the East Greenland Current at 78°50' N. Unfortunately, two moorings on the shelf (F20 and F17) were lost. Those two and F13, F12, F11 were in the water for two years (since 2021), while F10 and F14 were serviced in 2022. In addition, we carried out the main CTD/LADCP section including extensive water sampling for various tracers across the whole Fram Strait along the 78°50'N line. The main CTD section extended to 14°W where we met land-fast ice.

While we move westward on the CTD and mooring section, sea ice physics work was carried out across the East Greenland Current and Greenland shelf to collect in-situ observations and measurements of sea ice and snow properties for validation of CIRFA remote sensing products. Three cruise days were provided by CIRFA for this purpose (contact T. Eltoft (CIRFA, UiT)). The work included in-situ work (ice thickness measurements and coring) on some selected drifting sea ice floes in the EGC and on land-fast ice stations on the Belgica Bank nearby 14°W,79°N. Iceberg and sea ice observations were done from the vessel as well. Prioritization and timing of moorings, CTDs and sea ice stations will be guided by sea ice images (Sentinel-1 wide swath). CIRFA set up near real-time transfer of satellite imagery and classification results to the ship to support navigation and decision making for route planning during the cruise. These observations help to validate and improve the classification products.

In addition, two ARGO float deployments were carried out by DTU (led by C. Stedmon (DTU Aqua)) on the shelf with the aim to profile the water column for a year or more, and which are parked near the bottom after each profile or if there is ice.

2. Participants

Organisation

Chief scientist
1 Laura de Steur

Sea ice NPI:
2 Dima Divine (co-chief scientist)
3 Martine Nyhagen (polar bear protection and safety)

Sea ice CIRFA:
4 Johannes Lohse (CIRFA lead, postdoc)
5 Henrik Fisser (PhD student)

CTD DTU-Aqua:
6 Colin Stedmon (CTD lead + ARGO floats)
7 Camila Serra Pompei (Postdoc)
8 Bodil Berendt Toftegård (Msc student)
9 Caroline Gjelstrup (PhD student)

CTD ETH Zurich:
10 Marcel Scheiwiller (PhD student)
11 Aline Schneuwly (MSc student)

CTD Univ. Edinburg
12 Marta Santos Garcia (PhD student)

Moored instrument data NPI:
13 Hege-Beate Fredriksen (postdoc)

Technical support:
14 Kristen Fossan (NPI, mooring lead)
15 Jan Are Jakobsen (NPI, moorings and sea ice)
16 Thomas Haug Johnsen (NPI, internship)

Outreach:
17 Trine Lise Sviggum Helgerud (NPI)

3. Sailing log

Note: all times in local shipboard time unless UTC is specified. Times are approximate, not exact.

Wed 30.08.23	Departure from LYR at 15:00 local time. Most loading was already done the day before since we could have the dock today. Started steaming to 1°W for first CTD where there will be sea ice.
Thu 31.08.23	First CTD at 1°W at 13:30 local time. Steam to F10 at 2°W. Quite a lot of ice, so we go at ~5 to 6 kn. At F10 too much and heavy ice floes so too risky to release F10. Likewise for CTD at 2°W, too much for CTD over the side. Do not want to risk contaminated sensors in the moonpool so we go to 2.5°W to try a CTD there. CTD at 3°W late night
Fri 01.09.23	Recover F11 in morning. CTDs at 3.5°W, 4°W. Too much ice to recover F12 in afternoon. Wait and try sea ice station first. Ice station 4 pax for 2 hrs with use of small boat, aborted due to fog. Instead F12 recovery, on deck by 21:30. CTDs at night until we get to F12
Sat 02.09.23	Recover F12 and F13. CTDs in between as well as at 6.5°W. Put on the SUNA nitrate sensor on CTD at 6°W station (it can only go down to 500 m) and profile with that for the rest of the shelf. Aim to get F14 but too much ice to recover. Continue with CTDs at 7, 7.5 and 8°W at night, be at F14 again early Sunday morning.
Sun 03.09.23	Recovery of F14 at 8:15 am in between ice floes, lots of large floes nearby, need to time it well, and very foggy. On deck by 9:15. Steam to F17 after 9:15. On F17 site at 11:30, no sea ice, very foggy. Drive over it but no sign on EK80. No response from the release. Tried pinging several times, also 3 km, 5.5 km and 8 km south of the original mooring site. No signal. We continue to CTD at 8.5°W stopping one more time to ping and check. No reply; **F17 lost** Onward with CTDs at 8.5°W, 9°W, followed by ARGO deployment from Colin Stedmon (DTU) at the same location. CTD at 9.5°W. Mooring F20 site at 19:45. No contact with release, tried about 5 locations around it, and 2 south of it. No contact, nor any visual on the EK80 at or near the site; **F20 lost**. Demonstrates the big loss after not having serviced these each year, i.e. two 2-year long data gaps on the shelf instead of 1 year. Continue the evening/night with CTDs between 10°W and 14°W until we reach land-fast ice in the morning.
Mon 04.09.23	In the morning still going westward with CTDs until about lunch time. It was going slower at night than expected, due to sea ice and bad visibility and rain. Start work on land-fast ice with use of basket after lunch. Lots of broken up, not as 'fast' as expected from sat images. Second ARGO float deployed at ~11 W. One CTD at the end of the ice station (70 m), at about 14°W as the 'end of the section' point. During the night, move to the north ~79°N ~ 14°W and continue with sea ice work all day Tuesday.
Tue 05.09.23	Work on land-fast ice all day about 79°N, 14°W, north of the section.
Wed 06.09.23	Ice work between 9-11 at about 79°N, 13.25°W Steam to 10°W, 78°50'N Deploy F20 10°W (~16:00) in extremely nice and calm weather, no sea ice. Mirror flat Deploy F17 8°W (~20:00) in good and calm weather, quite a lot of sea ice (so takes longer to get there) but hardly any drift so easy to deploy on DP. Done by 22:22 local time. Steam to F14 site

Thu 07.09.23	Sea ice station nearby F14 site. Spool on wire for F14 in order to deploy after lunch. Deployed F14 (14:00, after some delay with the crane). CTD to 500 m with SUNA at 5.5°W and prepare for F13. Deployed F13 successfully (at about 21:00 after some finetuning due to ice and water depth). CTDs to 500 m with SUNA at 5°W, 4°W while steaming eastward to F10 mooring site to try to recover it Friday morning, given good ice conditions there seen on satellite images.
Fri 08.09.23	Arrival at F10 site around 7:00. Inspect drift and ice situation. Need to release it quick in an open water area before it gets covered again. Released at 8:15 local time and on deck at 9:15. Take 500 m deep CTD at 2°W and 3°W while steaming back west to F12 site. Take off the SUNA after that. Quite a lot of ice so steaming takes longer (going at 4 to 6 knots) so no time for sea ice station in between, instead position nearby F12, inspect sea ice conditions and drift. Start deploying F12 at 17:55 local time, done by 18:10. Smooth and easy. Spool on wire for F11. Steam northward during night to be well north of F11 the next day taking into account drift of about 1 knot.
Sat 09.09.23	Sea ice station starting at about 5 nm north of F11 site, while drifting south. Inspect sea ice conditions and drift north of F11, start upstream about 1.5 hr / 1.5 nm. Start deploying of F11 after lunch at about 13:00. Finalized much later in the evening about 19:00 due to having to find out where it was after it got stuck in an ice floe and was dragged along (whole mooring including anchor hanging under a ridge after the top kevlar of the top release broke). After breaking the ice floe it sank after all but it was unclear where it ended up exactly. Several locations for pinging the release and fine tuning speed of sound for the deck unit (from 1500 to 1469) allowed to spot it (anchor and 1500 m group) on the EK60, however, likely too deep, or rather, too short kevlar for the top to be closer to the surface) Spool on kevlar for F10 in the evening. Steam east to do the 0° CTD at night. Quite a lot of ice so steaming goes slower than expected.
Sun 10.09.23	Deep CTD at 0° at about 02:30 local time. Steam back to 2°W. CTD at F10 site at 07:30 local time. Preparations on deck and last instrument programming for F10. Start deployment F10 about 13:05, reposition slightly for drift and speed, to be on the site (with 0.9 knots and straight southward drift) after 1hr 15 mins. Ice from north pushing us while we are in a large lead. Excellent deployment done at 14:37 local time (with IceCAT). After that, start CTD section eastward from 1°E to continue the section until Svalbard.
Mon 11.09.23	We continue the CTDs all day along the 78°50'N section. While steaming to the east on section and doing CTDs eastward, there is an encounter with Russian vessel Yantar at about 11:45 local time. They turn to follow us, and keep doing so all day and night until 05:05 the next day. They are between 350 m to 700 m distance from us and monitor all we do. They stop along side starboard or aft starboard when we stop on a station. There is contact with them on radio by the Captain, and IMR and NPI are both informed. A Norwegian coastguard vessel is nearby and following the Yantar. We proceed our work as normal and ask the Yantar to keep a safe distance of at least 500 m. We

	continue with CTDs overnight.
Tue 12.09.23	We finish the CTD section at ~10:30. Russian vessel Yantar left us at about 05:05 in the morning. Steaming to Longyearbyen (~12 hrs). Arrival at about 20:00.
Wed 13.09.23	Finalize packing, cleaning and offloading

4. Mooring operations during FS2023

Two out of 7 Fram Strait Arctic Outflow Observatory moorings were lost. We do not know when. There was no sign of any release on the sea floor and searching in a radius of 8 km did not give any response of the releases. Since the formal Fram Strait cruise was cancelled in 2022 and only F10 and F14 were serviced by Silver Arctic in 2022, the loss of F20 and F17 on the shelf implies a data gap of two years for F17 and three years for F20 with respect to current measurements since we did not have sufficient spare ADCPs to redeploy on F20.

F10, F11, F12, F13 and F14 were recovered in good shape. All 7 moorings including a 'slim' version of F20 were redeployed. The moorings F20, F17 and F10 are equipped with IceCATs to obtain salinity and temperature data as close as possible to the surface, with a target depth of ~25m. F10 at ~2°W is funded through the NorEMSO project, a NFR infrastructure project. Sunburst SAMI instruments for pH and pCO2 were deployed on F10, which did not work last time. We added a SUNA nitrate sensor to F17, borrowed from Are Olsen at UiB.

4.1 Moorings recovered during FS2023

Mooring	Position	Depth (m)	Date and time (UTC)	Instrument	Serial #	Instrument depth (m)
F10-18	N 78° 49.636' W 01° 57.077'	2651 m	Deployed: 17 Sep 2022 10:50 UTC Recovered: 8 Sep 2023 06:15 UTC *Top float of weak link on EK80 at 25 m depth*	**SBE37-IM weak link** ADCP Data logger Nortek AQD **RBR CTD+ODO** **RBR CTD+** **SBE37** Nortek AQD **SBE37** Nortek AQD AR861	**22259 (wrong in last year's report)** 16831 15910 ****207317** ****207318** **20789** 15888 **22261** 15877 2879	**26** 44 46 49 **52** **220** **220** 223 **2636** 2640 2642
F11-23	Drop of top: N 78° 49.109' W 03° 03.087' ***Note:*** *1.2kt drift upon deploying!* ***Anchor position likely further north,*** *250m group on EK80 seen at 78° 49.350'N*	2474 m	Deployed: 16 Aug 2021 12:42 UTC Recovered: 1 Sep 2023 06:27 UTC *16/8/21 changed out 50 m kevlar with 40m to*	**IPS5** **SBE37** ADCP **SBE37** **SBE37** RCM9 **SBE37** RCM11 **SBE37** RCM Seaguard AR861	**51062** **3492** 17462 **10294** **3996** 1049 **7061** 538 **8821** 834 499	**44** **46** 50 **150** **273** 276 **1526** 1529 **2439** 2442 2444

	03° 02.840'W (±0.3 nm north!) YES		*get top lower than in 2020*			
F12-23	N 78°48.968' W 04° 00.730' ***Note** 1/9/23: corrected error in earlier versions with lat 49.968 which should be 48.968'N*	1848 m (EK80 depth about 17 m too much?)	Deployed: 15 Aug 2021 19:43 UTC Recovered: 1 Sep 2023 17:57 UTC	**IPS5** **SBE37** ADCP **SBE37** **SBE37** RCM9 **SBE37** RCM11 **SBE37** RCM Seaguard AR861	**51167** **14099** 20021 **13252** **3994** 836 **13505** 556 **8226** 345 500	**52** **54** 65 **150** **275** 279 **1476** 1480 **1817** 1820 1822
F13-23	N 78° 50.333' W 04° 59.927'	1018 m	Deployed: 14 Aug 2021 20:01 UTC Recovered: 2 Sep 2023 06:25 UTC	**IPS** ADCP **SBE16** AURAL **SBE37** **SBE37** RCM9 **SBE37** RCM Seaguard AR861	**51140** 18070 **7253** N/A **7060** **3995** 1326 **13504** 883 743	**50** 56 **58** 72 **147** **245** 248 **996** 1000 1002
F14-24	N 78° 48.844' W 06° 29.788'	277	Deployed: 15 Sep 2022 11:57 UTC Recovered: 3 Sep 2023 06:40 UTC *Top float on EK80 at 59 m depth in 2022*	**IPS** **SBE37** ADCP Nortek AQD **SBE37** **SBE56** **SBE56** **SBE37** Nortek AQD AR861	**51138** **14097** 24518 16603 13253 10330 10331 3992 16764 409	**58** **60** 64 **66** **108** **211** **236** **261** 264 266
F17-18 **LOST**	N 78° 50.139' W 08° 06.233'	230	Deployed: 13 Aug 2021 21:00 UTC 3 Sep 2023: LOST. No contact, no signs on EK80	**SBE37-IM weak link** Data logger **SBE16** ADCP ext. battery **SBE16** **SBE56** **SBE56** **SBE37** RCM9 AR661	**23259** NPI004 **7212** 24385 **7339** **3942** **3943** **14098** 1325 501	**30** 52 **54** 107 **108** **170** **196** **216** 218 220
F20-2 **LOST**	N 78° 50.100' W 10° 08.813'	326	Deployed: 13 Aug 2021 14:09 UTC 3 Sep 2023: LOST. No contact, no signs on	**SBE37-IM weak link** Data logger **SBE37** ADCP ext. battery **SBE37** **SBE37** RCM7	**20128** NPI003 **9852** 727 **7059** **7055** 9694	**30** 54 **56** 106 **109** **313** 316

			EK80	AR661	**410**	318

Table 2: *Moorings recovered during FS2023.*
Note: F11, F12, F13, F17, and F20 had been out for 2 years since Aug 2021, while F10 and F14 were serviced in Sep 2022.
***RBRs on F10 should not have been redeployed in 2022. Error on previous cruise. This implied now we had to redeploy one SBE37 here without calibration.*

Notes of moored instruments deployed in 2021:

- Five ACDP calibrations were carried out in May in Tromsø, two ADCPs recovered on F20 and F17 on the cruise will get external battery pack, however, still a calibration on ice needed for these two with the external battery ==> OK (12/08/2021)

- NOTE: One large ADCPs (SN 18070, F13-23) was not disconnected after calibration and showed very low voltage on the ship: Kristen changed to new batteries and so this one needed to be recalibrated on land-fast ice again before deployment in '21 ==> OK (12/08/2021)

Notes of moored instruments recovered in 2023:

- Whole moorings F17 and F20 were lost after having been out for two years; no contact with none of the releases and no sign of it on the EK80. Several attempts to contact to release from various sites and distances but no success, also followed and tried to find it on a line up to 8 km south of the mooring site. No success. Both IceCATs lost.

- IPS: All IPSs had worked well as far as we can see from the data files:
    F14: one year data Sept 2022 - Sept 2023
    F13: two years data Aug 2021 - Sept 2023
    F12: two years data Aug 2021 - Sept 2023
    F11: one year data Sept 2022 - Sept 2023, sampling frequency 2 sec.

- ADCP:
    F14: one year data Sept 2022 - Sept 2023 but sampling only every other hour.
    F13: two years data
    F12: two years data
    F11: two years data
    F10: one year data

- F10:
    - IceCAT with Data Logger was recovered. Had data for whole year from ~28 dbar depth.
    - Both RBRs were redeployed in 2022 from Silver Arctic after having been in water for one year. Unclear why. Specially given there was an SBE37 placed also at 220 m next to the second RBR+. The RBR+ at 220 m one did not work at all, the 56 m RBR+ODO only worked until Feb. 2023.
    - F10-16 was financed by the NorEMSO project / NFR infrastructure.

4.2 Moorings deployed during FS2023

Mooring	Position	Depth (m)	Date and time (UTC)	Instrument	Serial #	Instrument depth (m)
F10-19	N 78° 49.628' W 01° 57.074'	2668 m	Deployed: 10 Sep 2023 12:37 UTC Strong drift about 0.9 kn south, anchor likely north of drop position.	**SBE37-IM weak link**	**22260**	**27**
				ADCP	24899	52
				Data logger	NPI005	53
				SAMI pH+pCO_2*	**227/261**	**57**
				RBR CTD+ODO	**205002**	**58**
				SBE56	**12966**	**125**
				SBE56	**12967**	**175**
				AQD	15877	220
				SBE37**	**20789****	**221**
				AQD	16603	760
				SBE37	**23266**	**2634**
				AQD	16764	2639
				AR861	2425	2641
F11-24	N 78° 48.601' W 03° 04.708' ** Approximate NOTE: drama deployment. See below; mooring ended up further south than planned. To be corrected again in 2024.	2474 m ** 1500 m group and anchor seen on the EK80 after searching and tracking; triangulation corrected for sound speed.	Deployed: 9 Sep 2023 14:23 UTC Duration ~1 hr + 20 min? Duration 6 hrs due to messing up last 10 mins.	**IPS5**	**51062**	**54**
				SBE37	**3490**	**56**
				ADCP	24830	60
				SBE37	**12233**	**150**
				SBE56	**12959**	**175**
				SBE56	**12965**	**200**
				SBE37	**4702**	**244**
				RCM Seaguard	1846	247
				SBE37	**3552**	1496
				RCM11	494	1499
				SBE37	**8227**	**2409**
				RCM8	10071	2413
				AR861	287	2416
F12-24	N 78° 49.121' W 04° 01.341'	1833 m	Deployed: 8 Sep 2023 17:03 UTC Duration 1 hr + 13 min	**IPS5**	**51167**	**52**
				SBE37	3489	**54**
				ADCP	16876	65
				SBE37	**14100**	**150**
				SBE56	**12963**	**175**
				SBE56	**12968**	**200**
				SBE37	**4837**	**264**
				RCM Seaguard	884	267
				SBE37	**3554**	**1471**
				RCM11	235	1474
				SBE37	**8822**	**1814**
				RCM11	228	1817
				AR861	128	1825
F13-24	N 78° 50.435' W 05° 00.433'	1027 m	Deployed: 7 Sep 2023 19:45 UTC Duration ±1 hr	**IPS**	**51064**	**50**
				SBE37	**7056**	**52**
				ADCP	18151	56
				AURAL	304	78
				SBE37	**12234**	**152**
				SBE56	**12960**	**175**
				SBE56	**12961**	**200**
				SBE37	**3993**	**253**
				RCM9	1327	257
				SBE37	**3551**	**1007**
				RCM11	561	1011
				AR861	053	1013

F14-25	N 78° 48.864' W 06° 30.192'	274	Deployed: 7 Sep 2023 12:36 UTC Duration32 min	**IPS** **SBE37** ADCP **SBE37** **SBE37** **SBE56** **SBE56** **SBE37** RCM9 AR861	**51138** **7058** 17461 **7054** **9853** **12964** **12958** **7057** 1046 568	**50** **52** 56 **112** **150** **175** **200** **257** 260 267
F17-19	N 78°50.196' W 08° 04.754'	227	Deployed: 6 Sep 2023 20:22 UTC Duration 28 min	**SBE37-IM weak link** Data logger **SUNA Nitrate (Are Olsen, UiB)** **RBR CTD+CDOM** Nortek Sig 250 **RBR CTD+CDOM** **SBE56** **SBE56** **SBE37** RCM8 AR661	**23250** NPI002 **NTR 1126** **204799** 103528 **204800** **10331** **10330** **9650** 12733 2426	**32** 52 **54** **56** 107 **108** **175** **200** **216** 218 220
F20-3	N 78° 50.100' W 10° 08.815'	330	Deployed: 6 Sep 2023 15:22 UTC Duration 32 min	**SBE37-IM weak link** Data logger **SBE37** **SBE37** RCM7 **SBE37** AR661	**22258** #20 **9651** **12232** 7718 **10295** 291	**28** 56 **56** **106** 109 **313** 318

Table 2: *Moorings deployed during FS2023.*

* pH/pCO2: P0261/S2CA01 * SBE37 20789 re-cycled after 2022-'23 - not serviced

Moored instrument related preparations:

- Five ACDP calibrations were carried out, see table below.

- SUNA nitrate sensor (SN 1126) from Are Olsen (UiB) was added to F17. Placed in a frame from NP, using two clamps (SBE9 cage, SUNA V2, 2.5" DIA MOUNT CLAMP, product nr. 236440) from Arild Sundfjord. TO DO: replace when we return!!!

- Consider to buy an extra top frame (normal type) for the float of the Nortek Signature 250 so that it can be in-line in case one does not measure ice draft/drift. Now we used one that is not in-line for ice draft purposes, but there was stuff to be mounted above it still, not great, a ships based fix with kevlar.

Notes on deployment of F11-24:

Start deploying of F11 after lunch at about 1 pm. Finalized in the evening about 19:00 due to having to find out where it was after it got stuck in an ice floe and was dragged along (whole mooring including anchor hanging under a ridge after the top kevlar of the top release broke): After breaking the ice floe, the mooring sank after all but it was unclear where it ended up exactly. Several locations for pinging the release and fine-tuning speed of sound for the deck unit (from 1500 to 1469 m/s) allowed to spot it (anchor and 1500 m group) on the EK60, however, likely too deep, or rather, too short kevlar for the top to be closer to the surface...)

NOTE: the drawings between 2 versions of F11 need to be fine-tuned, need to be the same lengths, not different versions.

NOTE: F11 ended up way too far south now because of problems with deployment, and should not be there. To be corrected in 2024.

ADCP calibrations FS2023:

5 ADCPs calibrated in Tromsø (2 June 2023):

SN 17461 (2°), 16876 (1.6°), 18151 (1.0°) calibrated at Holt, Tromsø. All good!

SN 24830 did not get an error less than 13.1° after 3 different attempts and after a battery rotation. We made a look up table using the rotating table to do post-calibration after recovery in 2024.

SN 24899 did not get an error less than 10° after 2 different attempts. We made a look up table using the rotating table to do post-calibration after recovery in 2024.

Deployment plan:

F20 @ 100m	**F17** @ 100m	**F14**	**F13**	**F12**	**F11**	**F10**
727 with external battery lost	23485 with external battery lost	Calibrated in Tromsø (2/6/23)	Calibrated in Tromsø (2/6/23)	Calibrated in Tromsø (2/6/23)	Calibrated in Tromsø (2/6/23)	Calibrated in Tromsø (2/6/23)
RCM7	Nortek Signature 250 - no compass calibration	Error after cal: 2°	Error 1.0°	Error after cal: 10°	Error after cal: 13.1°	Error after cal: 1.6°
Lithium	Lithium	Lithium	Alkaline	Lithium	Lithium	Lithium
N/A	Ice track + draft	BTM track	BTM track	BTM track	BTM track	ICE track
N/A	SN 103528	SN 17461	SN 18151	SN 24899	SN 24830	SN 16876

Updated: 7 Sep 2023

Lost:
Both ADCPs (SN 727 and 23485) with external battery cases on F20 and F17 resp. were lost since the whole moorings were gone. These ADCPs need a one time calibration either on land fast ice, or land, or with crane and rotating in air.

Triangulation to get position to the release:
By measuring the distance from the ship on multiple locations to the acoustic release on bottom, we can use pythagoras to determine distances along the surface to the mooring position. If we measure close to a mooring that is located in deep ocean, small errors in measured distances can give large errors in the distance calculated along the surface.

Errors in measured distance (hypothenuse in the triangle) to be aware of:
An older instrument for release was used during this cruise, where the speed of sound in water cannot be adjusted. Normally the speed of sound is then set to 1500 m/s, while the echosounder on the ship was set to 1469 m/s. By correcting the measured distance by the factor 1469/1500 (about 2% reduction) we got a much better estimate of the location where mooring F11 was dropped.

Corrections in the depth estimate:
The acoustic release that we ping is located 10 m above the sea bottom, and the hydrophone is about 15 m below surface when making measurements, so we can subtract a total of 25 m from the depth estimate when using it for triangulation.

5. CTD Measurements

5.1 General Approach

The CTD used was an SBE911+ unit. The T, S and O_2 ducts was flushed with Triton-X and freshwater between stations, which was blown out by mouth just before deployment, to avoid problems with icing. At the beginning of stations, the CTD was lowered to 10 dbar to soak until the pump started and sensors stabilised. The CTD was then brought up to the surface for start of the profile, and lowered to 10 m above the seabed as determined using the altimeter. Data acquisition was generally initiated just before deployment with the CTD on deck and allowed to run until the CTD was back on deck at the end of the cast.

During FS2023, the CTD was always lowered over the side of the ship in the conventional way, the moon pool was not used. Niskin bottles were closed using the bottle fire command within the Sea-Bird acquisition software so that a .bl file was created for each cast when bottles were fired. NMEA time and position information was fed to the acquisition computer and added to each scan line of the data files. Cast positions and starting times were also automatically added to the header of all data files.

5.2 CTD Package Configuration

Channel	Sensor	Serial Number	Last Calibration
Frequency 0	Temperature 1	5127	30-Mar-2023
Frequency 1	Conductivity 1	2694	30-Mar-2023
Frequency 2	Pressure	141612	19-Dec-2017
Frequency 3	Temperature 2	6028	27-Apr-2023
Frequency_4	Conductivity 2	2045	30-Mar-2023
A/D Voltage 0	SBE43 Oxygen 1	3785	29-Nov-22
A/D Voltage 1	Altimeter	73084	24-Dec-2017
A/D Voltage 2	Chl a Fluorometer	FLRTD-6506	18-Sep-2020
A/D Voltage 3	(FREE)		
A/D Voltage 4	Transmissometer	CST-2003 DR	01-Oct-2019
A/D Voltage 5	CDOM Fluorometer	FLCRTD-4531**	12-May-2023
A/D Voltage 6	SBE43 Oxygen 2*	1259**	09-Aug-2022
A/D Voltage 7	(FREE)		
SPAR Voltage	SPAR Biosph/Licor	20568	27-Nov-2017

*Table 5.1: CTD package configuration during FS2023. ** NPIs sensors.*

5.3 CTD Section

The main east-west CTD section along the Fram Strait mooring array line at 78º50'N was carried out, which is repeated annually, Figure 5.1. There was quite a lot of ice in the EGC and again on the shelf where land-fast ice extended to about 14°W, implying the western end of the section. Types and number of samples collected during the cruise are summarized in Table 5.2.

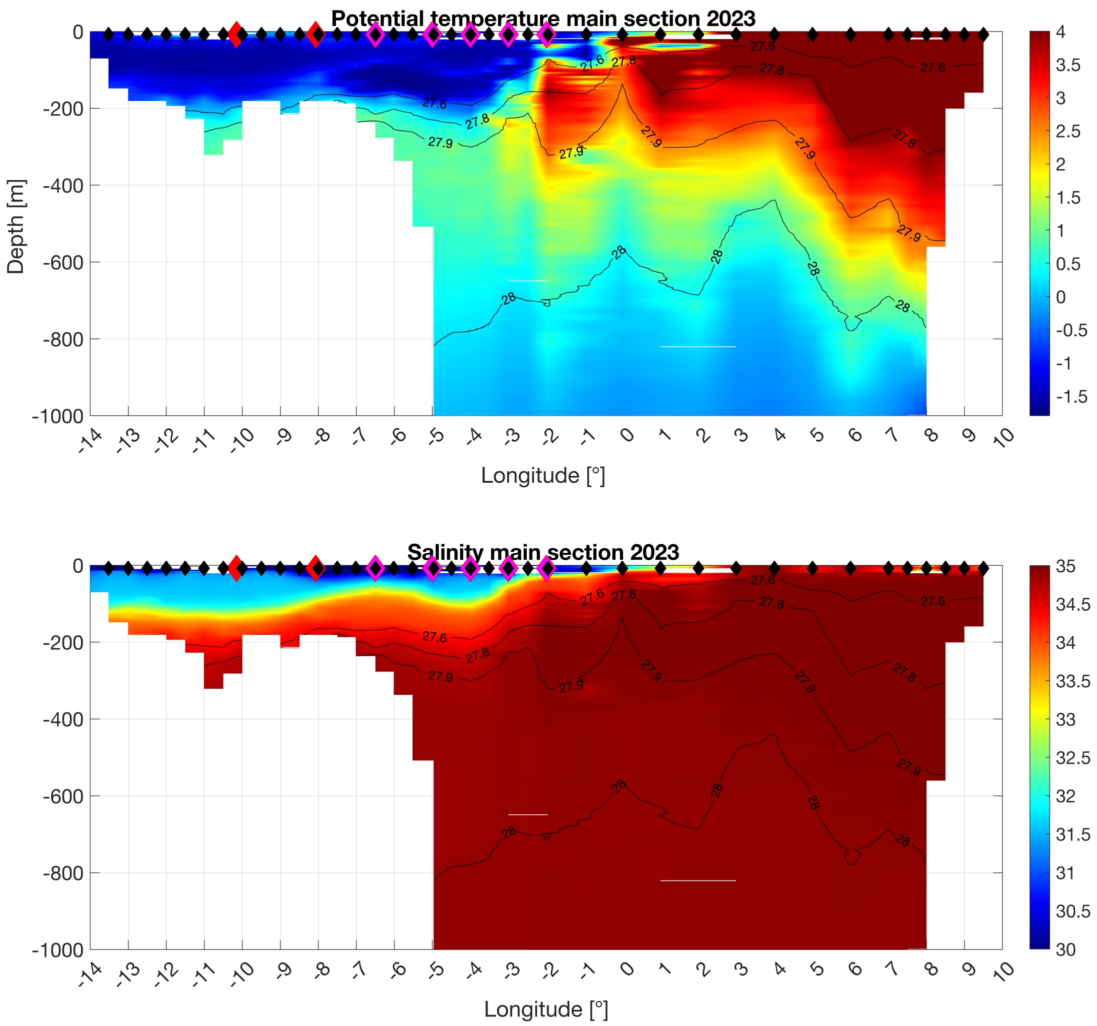


Figure 5.1: Main CTD section across the Fram Strait at 78°50'N showing the upper 1000 m only. Black diamonds mark the CTD positions, the magenta/red diamonds mark mooring sites. Measurements are from the primary temperature (top panel) and primary salinity (bottom panel) sensors.

5.4 Validation of CTD salinity measurements

A. Nikolopoulos (NPI. post-cruise)

Water samples for laboratory salinity measurement were collected along the main Fram Strait section at the standard depths where tracer samples were collected: 1, 5, 15, 25, 50, 75, 100, 150, 200, 250 and 400 dbar, plus one sample from the bottom of the water column. Where time and rosette capacity allowed additional deep-water samples were collected.

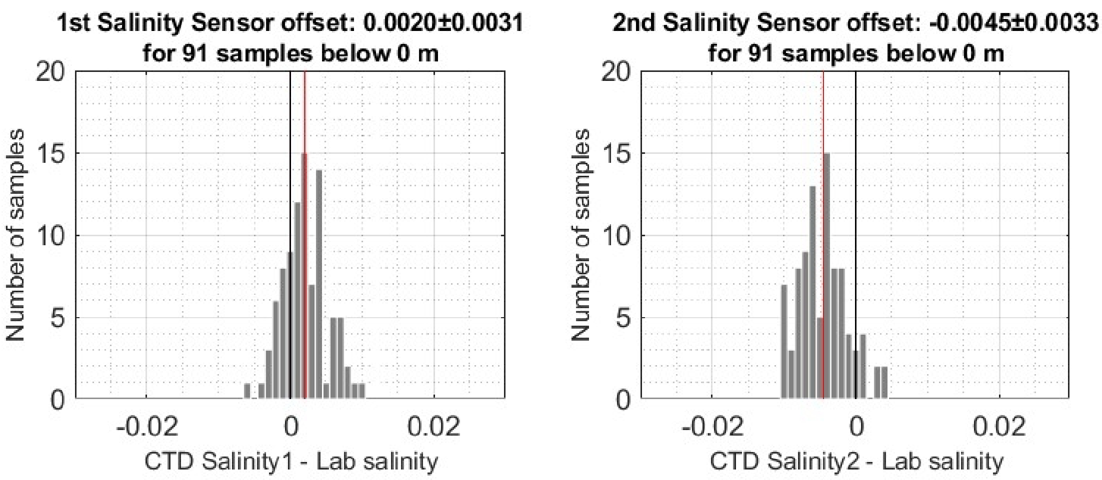
All the temperature and salinity sensors performed well during the cruise. Throughout the cruise,

for bins/depths subject to a gradient less than 0.002 °C or S/m, the mean difference between sensor group 1 and sensor group 2 was:
Temperature -0.00041 °C (400 m-bottom) and -0.00049 °C (1000m-bottom)
Conductivity 0.00040 S/m (400 m-bottom) and 0.00043 S/m (1000m-bottom)

The salinity samples could not be analysed on board since the Guildline Portasal portable salinometer from NPI (SN 74176) was not performing well at the end of the cruise prior to FS2023. The salinometer was sent back to the UK from Longyearbyen for service and a salinometer from UNIS was borrowed instead (R. Skogseth, F. Nilsen). this did, however, not work well either. The thermistors in the bath did not line up and gave completely different temperatures. The problem remained and could not be fixed on board. Salinity samples were taken on all whole degree stations and shipped back to Tromsø for on-land analysis post-cruise.

The laboratory analysis was eventually carried out at NPI in February 2024, when the salinometer initially brought on the FS2023 (Guildline Portasal; SN 74176) was repaired and functioning again. The samples were analyzed based on salinity with help of standardization after every 24 measurements using IAPSO P-series standard seawater. The salinometer maintained a stable bath temperature and provided stable readings throughout the analysis period (21-24 February 2024).

Comparison of the CTD-salinity measurements vs. the laboratory salinity measurements was limited to samples where the absolute difference between the sensor and lab values was less than 0.01. The offset was calculated to 0.002±0.003 practical salinity units for the primary sensor group of the CTD system and -0.005±0.003 practical salinity units for the secondary sensor group (see Figure 5.2). These results were valid both when accounting all water samples through the entire water column (that is, below 0 m depth), and when only using samples below 400 m depth where salinity is less variable (as well as for the 11 samples below 1000 m depth, not shown).
While the variability (standard deviation) was very similar for both sensors, the offset itself was rather different between them (0.002 vs -0.005, respectively). Based on the smaller offset, and hence a better-balanced distribution (i.e. centred around zero offset), we only recommend the use of the primary salinity sensor values onward. As both the offset and the associated standard deviation are smaller than the expected accuracies of the laboratory salinometer (±0.003 psu) as well as the CTD salinity sensor (±0.003 psu), there is no need to further correct the salinity values before use.



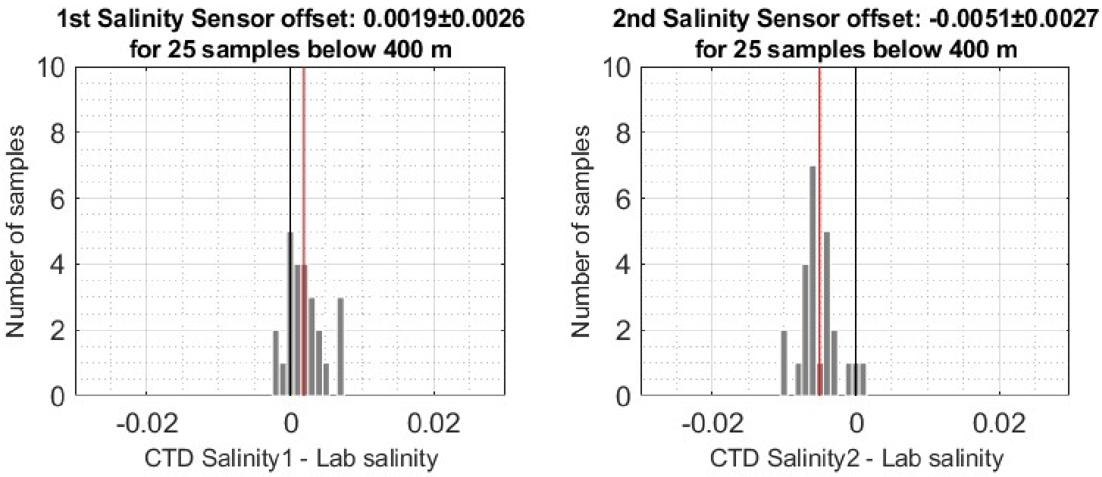


Figure 5.2: Histograms showing the difference between the CTD sensor salinity and in situ sampled (laboratory) salinity for the primary CTD sensor group (left hand panels) and secondary sensor group. The comparison was made for two different depth intervals: samples from the entire water column (upper panels) and samples restricted to below 400 m (lower panels).

Water sampling

Water sampling was performed on 34 stations along the Fram Strait transect. Samples were taken with Niskin bottles attached to the Rosette system (24 bottles total, 8 liter each) at selected sampling depths. The number of samples per profile ranged between 8 and 17, depending on the local bathymetry. See Table 5.3 for an overview of all samples from all stations.

CDOM/DOC/Nutrient sampling carried out according to plan between 14°W and 9.5°E along the 78°50' N parallel. CDOM and DOC samples taken at standard carbon stations and depths, and the Chl-a maximum. Nutrient, alkalinity/DIC, salinity and ʃ^{18}O-H_2O samples taken standard tracer stations and depths, and the Chl-a maximum.

CDOM samples were measured on board (spectral fluorescence and absorption). DOC and nutrient samples will be measured on return to DTU. Samples for ^{137}Cs and ^{233}U were also shipped to DTU for analysis by Dr. Jixin Qiao.

Parameter	# samples	Responsible
Salinity	312 total (297 ocean)	NPI
ʃ^{18}O-H_2O	401	NPI
Alkalinity & DIC	238	NPI/IMR
Inorganic nutrients	401	DTU
CDOM and DOC	282	DTU
Stable isotopes of nitrate	377	Edin. Uni.
^{233}U	90	DTU
^{137}Cs	109	DTU
POC	35	Edin. Uni
^{129}I & ^{236}U	120	ETH
^{14}C-DIC	119	ETH

Table 5.2: parameters and number of samples take from the CTD rosette.

Station	S	CDOM + DOC	D18O + Nutrients	AT-CT	129I + 236U	233U	Cs	POM	14C	N Iso-topes
222	12	12	12	11	8	-	5	1	8	12
223	12	1	12	-	-	6	-	1	-	12
224	12	12	12	11	8	-	5	1	8	12
225	12	1	12	-	-	6	-	1	-	12
226	12	12	12	11	9	-	6	1	8	12
227	12	1	12	-	-	6	-	1	-	12
228	12	12	12	11	8	-	6	1	8	12
229	12	1	12	-	-	6	-	1	-	12
230	11	11	11	10	7	-	6	1	7	11
231	10	1	10	-	-	6	-	1	-	10
232	10	10	10	9	6	-	6	1	6	10
233	9	9	9	8	-	6	6	1	-	9
234	9	9	9	8	5	-	6	1	5	9
235	-	1	10	-	-	6	-	1	-	10
236	10	10	10	9	6	-	6	1	6	10
237	-	1	9	-	-	6	-	1	-	9
238	11	11	11	10	6	-	5	1	6	11
239	-	1	11	-	-	6	-	1	-	11
240	11	11	11	10	7	-	6	1	7	11
241	-	1	10	-	-	7	-	1	-	10
242	8	8	8	7	4	-	4	1	4	8
243	-	1	9	-	-	6	-	1	-	9
244	9	9	9	8	6	-	5	1	6	9
245	-	1	8	-	-	5	-	1	-	8
246	5	5	5	5	3	-	3	1	-	5
248	-	-	-	-	4	-	-	-	-	-
252	12	12	12	11	8	-	6	1	8	12
253	12	12	12	11	8	-	6	1	8	12
254	12	12	12	11	8	-	6	1	8	12
255	12	12	12	11	8	-	-	1	8	12
256	12	12	12	11	-	6	6	1	-	12
257	12	12	12	11	-	-	-	1	-	12
258	11	12	12	11	-	6	6	1	-	12
259	11	12	12	11	-	-	-	1	-	12
260	-	12	12	11	-	6	4	1	-	12
262	4	12	12	11	8	-	-	1	7	12
264	-	10	10	-	-	-	-	1	-	-

Table 5.3 Number of each type of water sample collected at each CTD station.

Iodine-129, Uranium-236 and Carbon-14

Marcel Scheiwiller (ETH Zurich)

The physical and tracer oceanography group at ETH Zürich studies the circulation pathways into and out from the Arctic Ocean and looks into new tools to constrain the freshwater fluxes to the Subpolar North Atlantic. In particular, Iodine-129 (I-129) and Uranium-236 (U-236), two artificial radionuclides that originate from the nuclear reprocessing plants at Sellafield (UK) and La Hague (France) are used. These man-made tracers, once discharged into the Irish Sea and English channel, respectively, travel northward with the Norwegian Coastal Current and enter the Arctic Ocean through the Fram Strait and the Barents Sea Opening. Every year, water samples in repeated stations across the Fram Strait are collected. On this cruise, 120 samples for I-129 and U-236 were collected in 3L containers. Later on, they will be subsampled to measure both tracers from the same container. The sampling for these two tracers is mainly focused on the outflowing part in the western Fram Strait, plus one station at 8°E to catch the inflow to the Arctic Ocean as part of the West Spitsbergen Current. The sampling concentrates on the upper layers with depths of 5, 25, 50, 100, 150, 200, 250 and 400 meters.

Carbon-14 (C-14) samples were collected in 120 ml glass bottles along with the I-129 and U-236. The sampling of C-14 followed the same structure as for I-129 and U-236 in terms of stations and depths. The C-14 samples were poisoned on board with $HgCl_2$. After the cruise all samples were sent to Zürich where they are processed and measured in the lab. Results are used to understand pathways of Atlantic waters flowing in and out the Arctic Ocean, estimate its mixing and timescales of water circulation, as well as the fraction of fresher water exiting the Arctic Ocean.

N isotopes

Marta Santos Garcia (Univ. Edinburgh)

A total of 377 seawater samples from the Fram Strait 2023 programme were obtained for stable isotope analysis of N and O of dissolved nitrate. Sampling was carried out according to plan between 12°W and 10°E along the 78°N 50’ parallel. Samples were taken at standard tracer stations and depths, and the chl-a maximum. 37 samples of particulate organic matter were collected at the chl-a max of each station, following on-board filtering, for stable isotope measurements of organic nitrogen. Stable isotope analyses will be employed along with concentration parameters to understand the role of various N cycling processes in determining N availability. Results will help understanding how nutrient limitation is changing in the Fram Strait.

Stable isotope analysis of nitrate will be carried out in the Wolfson’s Mass Spectrometry Laboratory at the School of GeoSciences, University of Edinburgh, as part of the PhD project of Marta Santos Garcia. The dataset collected will be interpreted in the context of a wide range of oceanographic and biogeochemical data collected during the cruise. Data synthesis and quantification will be achieved by constructing inverse and forward models describing Arctic N budget.

Table 5.3 lists the core water samples collected at each CTD station. During the cruise a paper log sheet was completed at each CTD station listing the depths at which bottles were fired and the samples taken from each bottle. Times, depths and positions manually recorded on log sheets are indented as a backup in the case of a problem with the data acquisition, not a replacement for electronically logged time and position data. There were no problems with time or position data during the cruise.

SUNA profiles from CTD casts

This year, we attached the SUNA nitrate sensor (SN 2096, A. Sundfjord (NPI)) on the CTD for profiles down to 500 m (max. depth rating). This was started when heading west onto the shelf at 6°W, and we did some more profiles returning east over deep water but just down to 500 m.

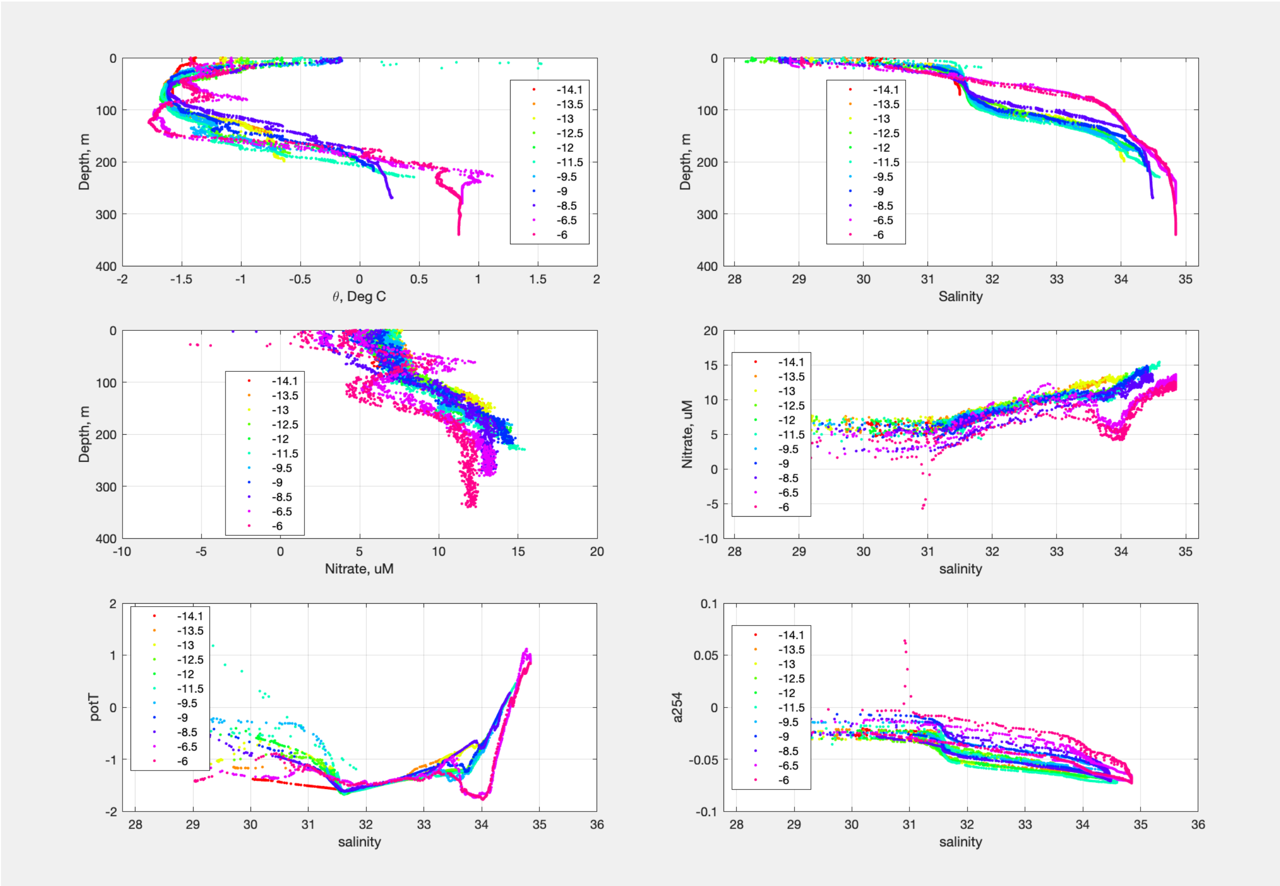


Figure 5.3 Preliminary display of the nitrate data from the SUNA together with CTD values. Figure courtesy: C. Stedmon (DTU).

6. VMADCP and LADCP measurements

During the cruise, both hull-mounted Vessel Mounted Acoustic Doppler Current Profilers (VMADCP) (38 kHz and 150 kHz) were used on the main transect across the Fram Strait to provide continuous measurements of ocean velocity. This meant it was turned on when leaving Longyearbyen and stopped when reaching Isfjorden on Svalbard.

Lowered Acoustic Doppler Current Profiler (LADCP) data were collected at all CTD stations. The set up consisted of a double-head LADCP system (one downward looking (master) and one upward looking (slave) ADCP) with external battery case on the large, 24-bottle CTD rosette. The data were processed using the LDEO processing package (Version IX.7 – IX.10) and detided with the barotropic tidal model (TMD2.03/DATA/Model_tpxo6.2). The two script files (Master.txt and Slave.txt) to program and start the LADCPs are given in Appendix C at the end of this report.

7. Sea ice work

The sea ice work on Fram Strait 2023 cruise was conducted by Dmitry V. Divine (NPI), Johannes Lohse and Henrik Fischer (UIT-CIRFA) with support from other members of the science crew who conducted bridge bear watch during the work on sea ice.

Sea ice cover in Fram Strait this time of the year at the transect latitude was more extensive than observed in previous year, with open to close drift ice (0.3-0.8) in the core of the EGC between 0 to 8°W, and more open drift ice towards the edge of fast ice that was at about 13.5°W during the KPH operation in the area.

Altogether the sea ice group conducted seven sea ice stations (see Table 1) that include four ice stations on drift ice and three on fast ice. A substantial fraction of sea ice observed outside fast ice area during the cruise was a thick second-year/multiyear ice, often ridged and deformed with well-elaborated melt ponds that started to refreeze. Ice thickness from visual observations and direct measurements varied within 1.5 m – 2.5 m thick. Thinner, around 1 - 1.8 m thick preferentially first-year ice was mainly found in the core of the EGC, closer to the ice edge. Ice floes had very variable sizes from medium (100-500 m) size floes often present west of 2°W to smaller floes (20 m-60 m) east of 2°W. Detailed regular observations of ice conditions were conducted during the cruise in the framework of ASSIST IceWatch observations (see below) and additional observations during the Sentinel-1, RCM and RS-2 radar satellites acquisitions.

The fast ice area next to Greenland on Belgica bank was situated within approximately 13.3- 15.5°W and 78.51- 79.30°N. Fast ice was found to be heavily ponded with melt ponds largely melted through (see also Figure IS3). The edge of fast was dynamic and in a state of continuous break up during the cruise, in response to changing winds.

Ice observations from the bridge (ASSIST)

Regular sea ice observations using ASSIST protocol (see https://cryo.met.no/en/icewatch) were made by members of sea ice team while RV KPH was in the ice-covered waters.

Sea ice conditions were observed on average every three hours, except for the nighttime between midnight and 7:00, from the observation deck of RV KPH. The observations were skipped during sea ice stations, though corrections to ASSIST observations were introduced based on direct measurements made on ice stations. Various sea ice parameters including sea ice types, floe sizes, snow cover, ridges etc. were recorded along with ship data (position, speed, and heading) and meteorological data (air and water temperature, air pressure, wind speed and direction, and humidity). Digital photos were taken with each observation (3 photos, looking out towards portside, bow, and starboard, respectively). In total 73 observations were made during the cruise while RV KPH was in the ice zone.

Preliminary results below (see Figure 7.1) show changes in observed sea ice concentrations along the cruise track. Observations will be uploaded to Icewatch ASSIST portal after the cruise and used, e.g. to support the improvement of automatized algorithms for interpretation of satellite based radar imagery.

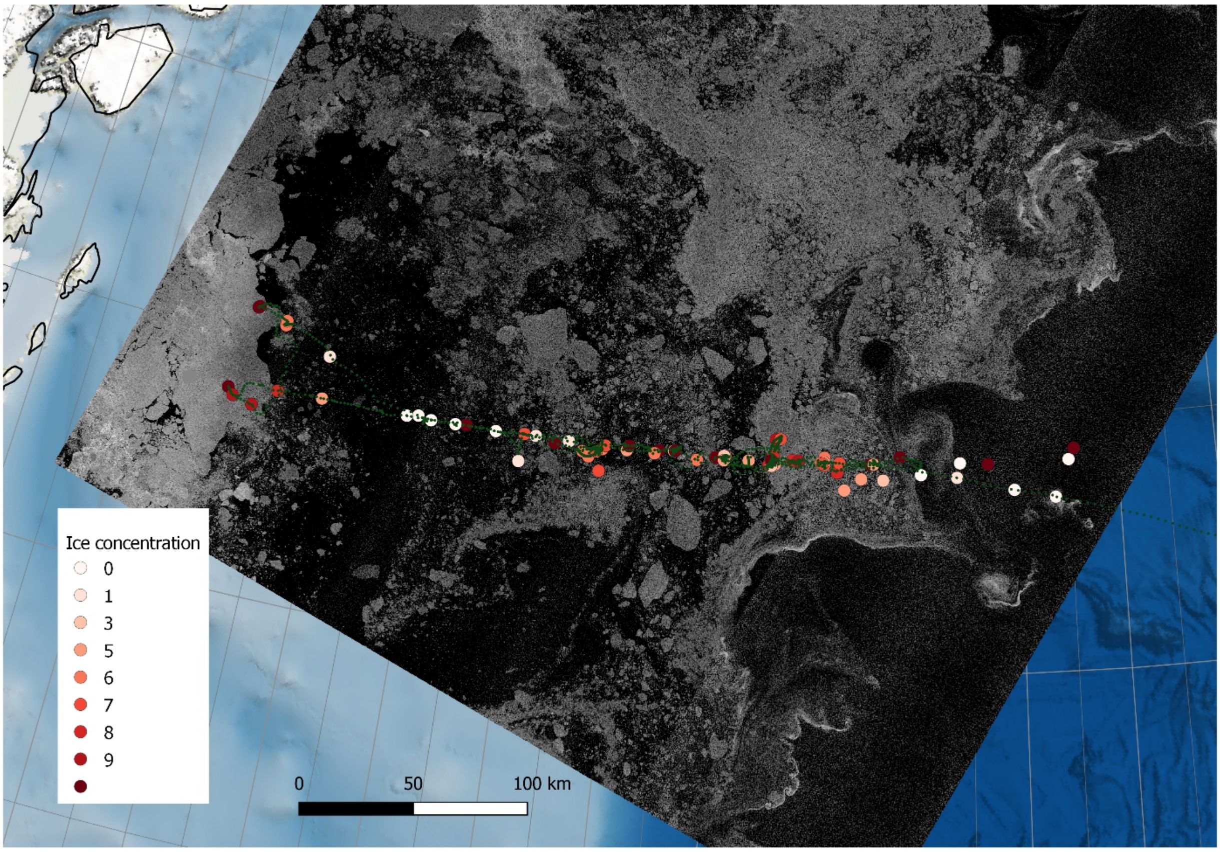


Figure 7.1: Sea ice concentrations as observed along the FS2023 cruise track from the bridge based IceWatch ASSIST observations.

Sea ice stations and on-ice activities
Table 7.1 presents the list of ice stations conducted during the cruise with a general overview of the on-ice activities. Locations of ice stations are also shown in Figure 7.6. All collected data are found in the respective Ice Stations folder for Sea ice data for the cruise.

***Table 7.1**: List of ice stations made during the FS2023 cruise.*

Date	#	time start (UTC)	lat (start)	lon (start)	Activities
01.09.2023	IST1	14:55	N 78.830	W 4° 0’	Ice coring for physics
04.09.2023	IST2	12:25	N 7 8° 46.62’	W14° 5.48’	Fast Ice South: Ice coring for physics and tracers
04.09.2023	IST3	16:59	N 78°47.718’	W 14°9.723’	Fast Ice South: Ice coring for physics
05.09.2023	IST4	07:45	N 79.126°	W 13.950°	Fast Ice North: Ice coring for physics and tracers; melt ponds; drone survey; GEM-2 survey; icebergs mapping.
06.09.2023	IST5	07:33	N 79.090°	W 13.256°	Ice coring for physics and tracers; drone survey;
07.09.2023	IST6	06:49	N 78.789°	W 6.89°	Ice coring physics and tracers; melt ponds;
09.09.2023	IST7	06:49	N 78.896°	W 3.024°	Ice coring physics and tracers; melt ponds; Ice thickness transect

Sea ice coring

On all sea ice stations, except for IST2, we collected a complete set of ice cores for the analysis of the physical properties of sea ice. It includes ice core samples recovered for salinity and temperature analysis, ice density, chemical analyses as well as an archive storage including later analysis of the microstructure.

At each coring event during ice station work, a dedicated ice core was collected to obtain the ice salinity profile using a 9 cm diameter Kovacs ice corer. Recovered cores were sectioned on site at 5-cm to 10-cm vertical resolution. Onboard, bulk salinity of melted sections were measured using a conductivity meter Cond 3110 SET3. Salinity is reported on the practical salinity scale (dimensionless).

At each coring event during ice station work, sea ice temperature profiles were also measured on one recovered ice cover within a few minutes from core extraction. The measurements were made using a thermistor probe Testo-720 in holes drilled at 10 cm spacing.

Additional cores for tracers studies were collected as bulk ice samples during stations S2 and S4-S7, one to three ice cores per station depending on time limitations. In total, 15 tracers cores at 7 ice stations.

Measured salinity and temperature profiles of sea ice cores recovered on Ice stations IST1, IST2, IST4 and IST7 are shown in Figure 7.2. Analysis of salinity profiles together with assessments of ice surface morphology made in situ indicate that ice floes of ice station IST1 and IST7 are more likely to be FYI, while IST2 and IST4 ice floes of fast ice are representative of the older ice types (SYI/MYI).

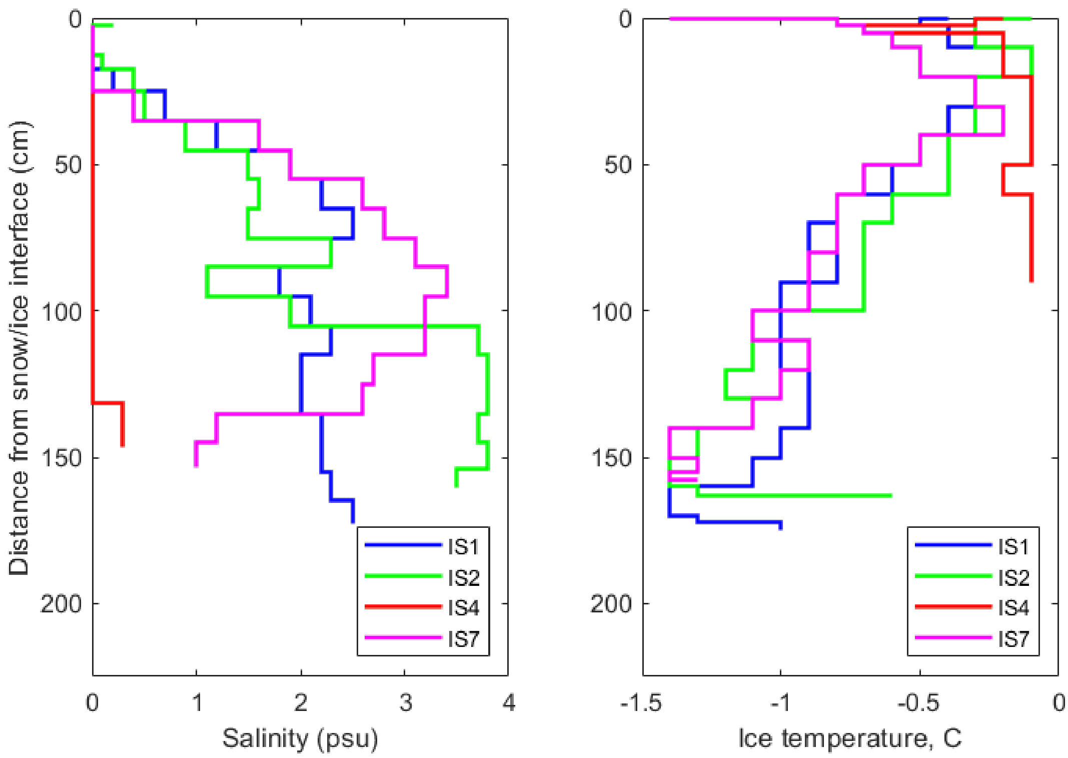


Figure 7.2: Salinity (left) and temperature (right) profiles in the ice measured from ice cores recovered on ice station IS1, IS2, IS4 and IS7.

Sea ice thickness surveys conducted by direct drillings and GEM-2 surveys

On Station IST4 on the Fast Ice North, sea ice thickness of the floe was additionally surveyed indirectly using the electromagnetic instrument sensor (GEM-2 by Geophex Ltd) towed on a small sled. The instrument includes a real-time data processing unit including a GPS receiver which communicates with a pocket PC that operates the sensor and records the EM and GPS data streams. Due to safety limitations, namely elongated and partly melted-through ponds in the area that makes their crossing with the instrument unsafe, the survey was limited to only two 70 meter-long lines nearly parallel to the melt pond. After the survey the transect measurements were also complemented by a sensor calibration, where the GEM-2 was placed at known heights above the sea ice surface using a wooden ladder on top of level ice with a known thickness determined by 5 drill holes. Preliminary result shown in Figure 7.3 suggests ice thickness to vary within 1.6-1.8 m on average along the transect lines with ice around two older ridges being up to 5 m thick.

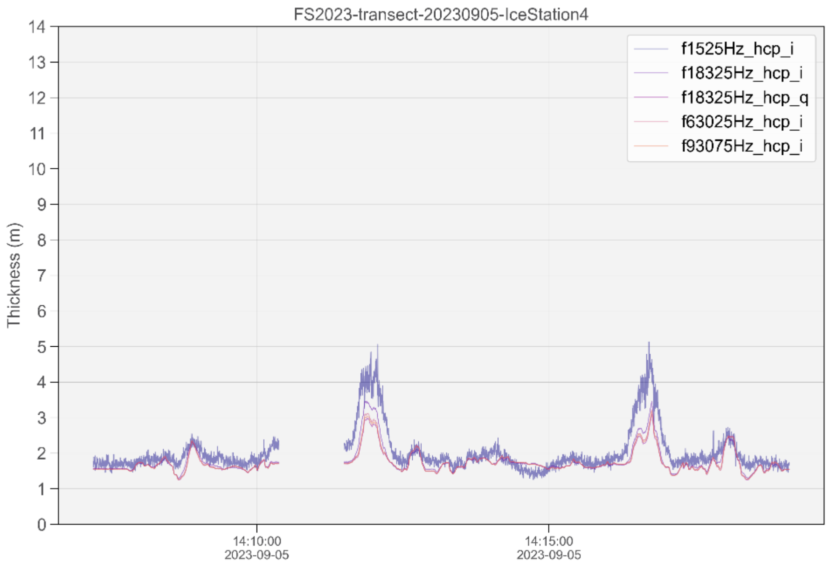


Figure 7.3: Preliminary results of ice thickness along the GEM-2 transect conducted on ice station IS4.

On Station 7 we also conducted measurements of ice thickness along a 70 meter-long transect using direct drillings. The transect consisted of 14 drill holes with a nearly equal spacing of 5 m in both level ice and refrozen melt ponds.

Small drone work

On ice stations IST4 and IST5, weather conditions were favourable enough for flying a small drone over the ice station floes. The drone flights provided high quality downward looking images of the study area with a coverage large enough (more than few hundreds m^2) that makes the acquired imagery useful to further support the interpretation of satellite radar images. It includes an accurate estimate of melt pond fraction and their stage of development as well as representativeness of the coring site for the local area around the vessel.

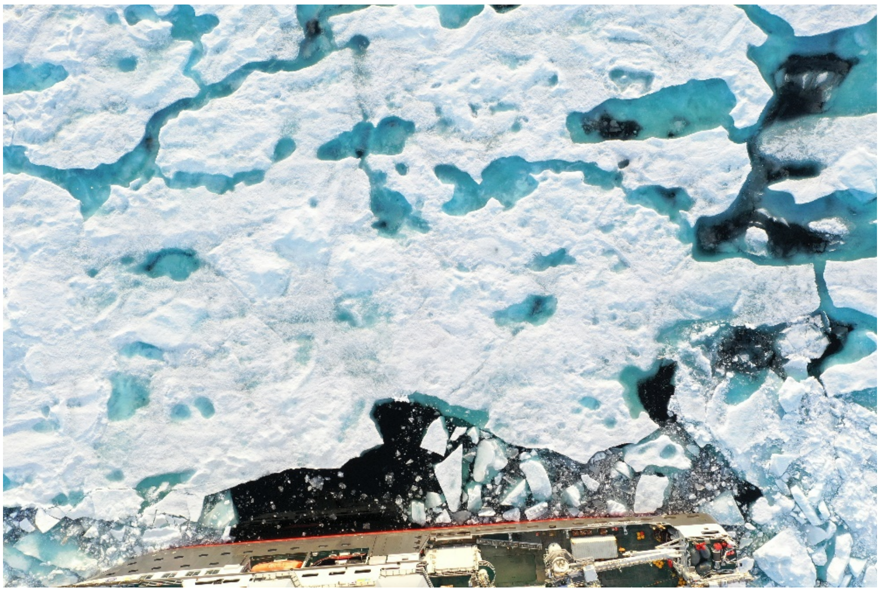


Figure 7.4: Photo of ice station IST4 taken from the elevation of about 120 m; one of the sequence of images collected during the overflight of ice station area.

The imagery collected during these two overflights will be processed/stitched together later. The derived orthophotos of the area will be subject to further analysis for melt pond fraction.

Iceberg observations

Icebergs in the Fram Strait originate from marine-terminating glaciers at the Greenlandic east shore. The iceberg observation program pursued an inventory of icebergs sighted along the oceanographic transect, and in the land-fast sea ice on the Greenlandic shelf. The observations were opportunistic and therefore do not depict the full picture of all icebergs encountered on the cruise.

With every registered iceberg, its coordinates, the ship coordinates, the time and further descriptions were noted. Photographs were taken, and the ship-based ice radar imagery was archived with the observation. In total, 34 individual icebergs were registered. There was an occasional overlap with satellite remote sensing acquisitions by Sentinel-1, Radarsat-2, and by the Radarsat Constellation Mission, which is noted in the iceberg inventory.

Most icebergs were observed on the Greenlandic shelf and particularly during the two fast ice stations. These icebergs are usually land-fast, which simplifies their reconnaissance in remote sensing imagery. However, we observed icebergs at 2.9°W and 3.5°W in the central Fram Strait on this cruise, which is about 400 km away from the Greenland coast. Figure 7.5 shows an example of iceberg identification and registration procedure from visual observations and ships ice radar imagery made during ice station IST4 on fast ice north on 05.09.2023.

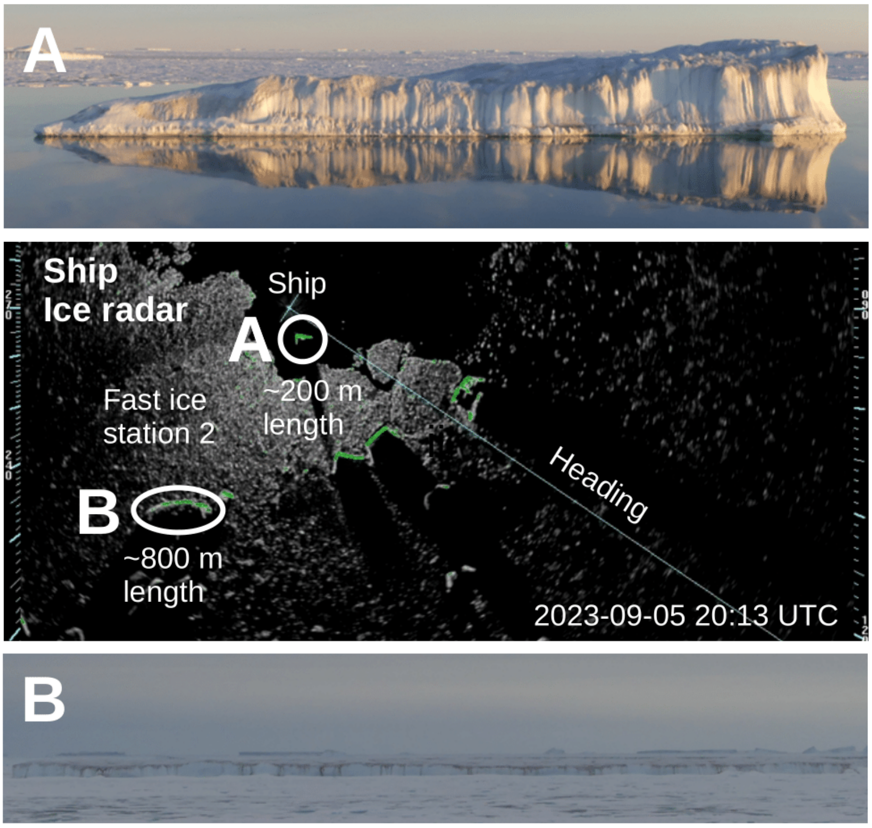


Figure 7.5: Ice radar image acquired by Kronprins Haakon and iceberg photos taken during the iceberg observations at ice station IS4 on fast ice north on 05.09.2023. The iceberg length estimates were obtained from the ice radar image, which has a total width of 10 km.

Remote sensing work

Data availability

Remote sensing data from multiple sensors were acquired during the cruise. Besides freely available Sentinel-1 and Sentinel-2 imagery, these data include three high-resolution fine-quad-pol (FQP) Radarsat-2 images ordered by NPI, as well as multiple images from the Radarsat Constellation Mission (RCM), that were acquired in collaboration with *Environment and Climate Change Canada*. The precise number of available RCM scenes is unknown at the time of writing this report, but orders were placed for daily coverage of the fast ice edge between August 29th and September 13th for VV-HH low resolution (SC100M) and VV-HH high resolution (SC16M) modes. Furthermore, L-band SAR data (ALOS-2) of the area may be available through UiT the ESA-JAXA agreement. For possible use of the RCM or ALOS-2 data, UiT should be contacted. The three Radarsat-2 scenes were ordered for acquisition on the 04.09, 05.09 and 08.09. For at least one scene on 04.09, the KPH was within the acquisition frame while on ice station IST3 fast ice south.

Data transfer to KPH during the cruise

Before the cruise, a processing chain for download, processing, and transfer of Sentinel-1 images to KPH was set up on UiT servers. The workflow automatically downloaded all S1 scenes intersecting with an area of interest as soon as they were available. HH and HV channels were extracted from the images and geocoded to polar stereographic projection (EPSG:3996) at a set of distinct pixel spacings. The fast internet connection on board KPH also enabled to log onto the UiT servers (SSH login using a VPN connection) and adjust the workflow during the cruise. The data transfer to KPH was performed using *rsync* to avoid multiple downloads and to facilitate easy continuation of downloads in case of interrupted internet connection.
The time from image acquisition until the data at 200m pixel spacing was available on KPH was

usually around two hours, and less than 70 minutes in the fastest case.
Regular maps and fine-resolution updates of the sea ice situation were produced on board and were provided to the cruise leader and the bridge. The timely data availability greatly improved planning of sea ice work as well as decision making for the other scientific goals of the cruise.

Sea ice observations for validation of sea ice retrieval algorithms from Sentinel-1
For 14 Sentinel-1 scenes, KPH was located within the image footprint at the time of acquisition (Table 7.2). For each of these occasions, special sea ice observations were performed that were dedicated to the interpretation of the SAR imagery as well as the validation of sea ice retrieval algorithms developed at CIRFA. These observations were made independently of and in addition to the standard IceWatch/Assist sea ice observations. They include:

- 360-degree photographs form the observation deck before, during, and after image acquisitions
- time laps photographs and videos from a GoPro camera mounted on the observation deck or the crow's nest
- drone imagery when possible (only at fast ice stations)
- detailed notes of large-scale sea ice features that should be visible in the SAR data
- detailed notes of small-scale sea ice and open water features that may not be resolved on the pixel level of the Sentinel-1 EW GRDM product, but will still affect the overall backscatter

***Table 7.2**: List of Sentinel-1 images with KPH in the foot during the FS2023 cruise.*

Timestamp	KPH position (lon/lat)	Image ID
2023-08-31 06:56	1.5292 78.7357	S1A_EW_GRDM_1SDH_20230831T065628_20230831T065732_050116_0607F0_6A18
2023-09-01 07:37	-3.0323 78.8082	S1A_EW_GRDM_1SDH_20230901T073728_20230901T073828_050131_06087A_297F
2023-09-02 08:18	-5.5156 78.8309	S1A_EW_GRDM_1SDH_20230902T081844_20230902T081944_050146_06090B_65CA
2023-09-03 07:22	-6.5699 78.8226	S1A_EW_GRDM_1SDH_20230903T072203_20230903T072303_050160_060975_7EB4
2023-09-04 08:02	-13.2052 78.8212	S1A_EW_GRDM_1SDH_20230904T080221_20230904T080321_050175_0609EB_A455
2023-09-04 17:48	-14.1637 78.7952	S1A_EW_GRDM_1SDH_20230904T174852_20230904T174952_050181_060A30_CB92
2023-09-05 08:44	-13.9486 79.1258	S1A_EW_GRDM_1SDH_20230905T084327_20230905T084431_050190_060A77_2EA5
2023-09-06 07:45	-13.2503 79.0896	S1A_EW_GRDM_1SDH_20230906T074549_20230906T074649_050204_060AE7_5947
2023-09-07 08:26	-6.9679 78.8000	S1A_EW_GRDM_1SDH_20230907T082634_20230907T082738_050219_060B6D_22F9
2023-09-08 07:29	-2.0132 78.8268	S1A_EW_GRDM_1SDH_20230908T072923_20230908T073027_050233_060BE3_4A98
2023-09-09 08:10	-3.0491 78.8812	S1A_EW_GRDM_1SDH_20230909T081032_20230909T081137_050248_060C71_1ACF
2023-09-10 07:12	-1.9638 78.8240	S1A_EW_GRDM_1SDH_20230910T071257_20230910T071401_050262_060CE5_E0E3
2023-09-11 07:54	3.9680 78.8323	S1A_EW_GRDM_1SDH_20230911T075404_20230911T075508_050277_060D67_09B6
2023-09-12 06:56	9.5000 78.8335	S1A_EW_GRDM_1SDH_20230912T065628_20230912T065732_050291_060DE9_6B85

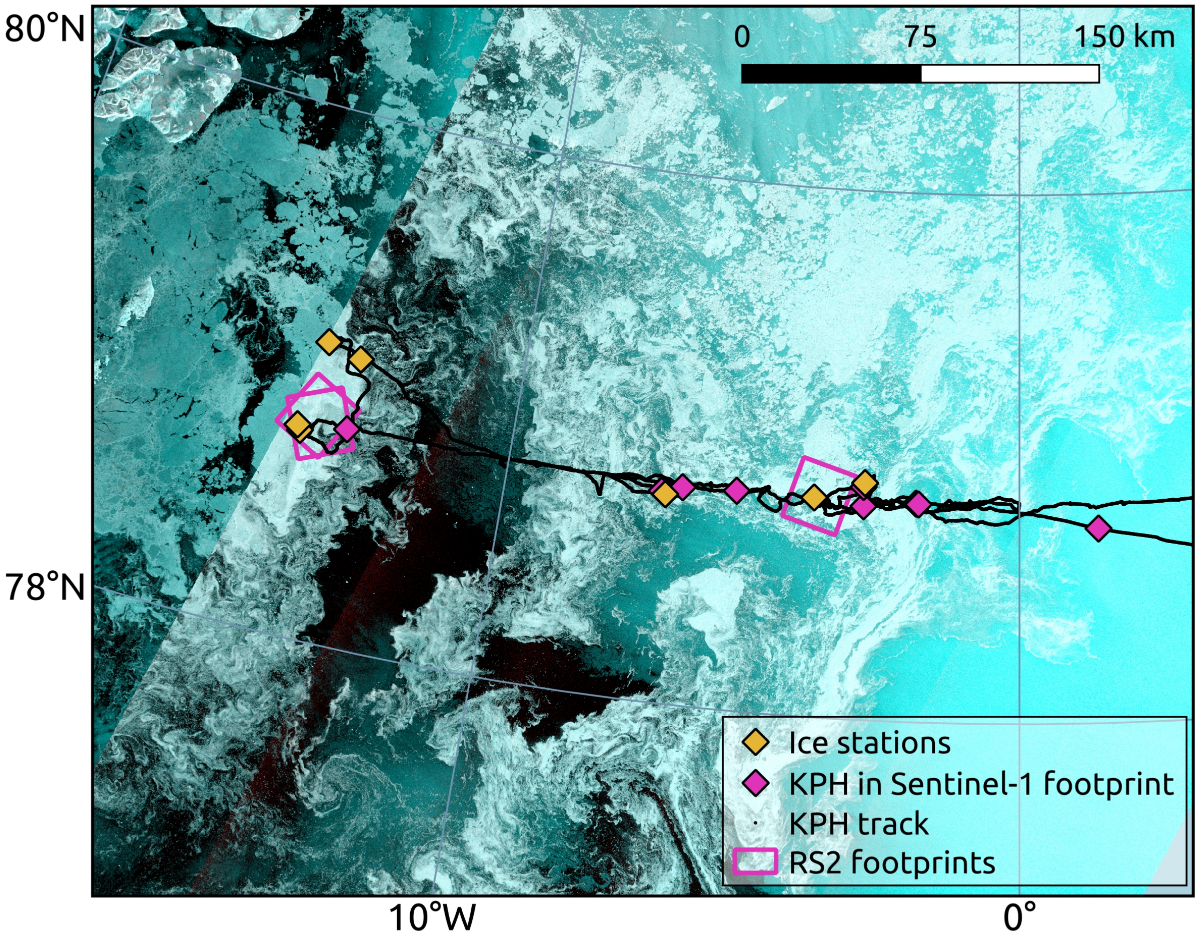


Figure 7.6: Overview map showing the locations of all seven ice stations, footprints of the Radarsat-2 FQP images, and the locations of KPH at the times the ship was within a Sentinel-1 footprint. Background Sentinel-1 images are from 5th and 6th of September 2023 and show representative sea ice conditions during the cruise.

8. ARGO deployment

C. Stedmon (DTU)

Two ARGO floats from DTU were deployed on the East Greenland Shelf as planned:

WMO #	1902659	3902564
Date/Time (UTC)	03/09/2023 15.25	04/09/2023 00.40
Latitude	78 50.056 N	78 49.978 N
Longitude	008 59.916 W	11 3.085 W
Depth on station	223	335
Float make/model	NKE CTS5 PROVOR, CTD-DO-FLBBCD	NKE CTS5 PROVOR, CTD-DO-FLBBCD

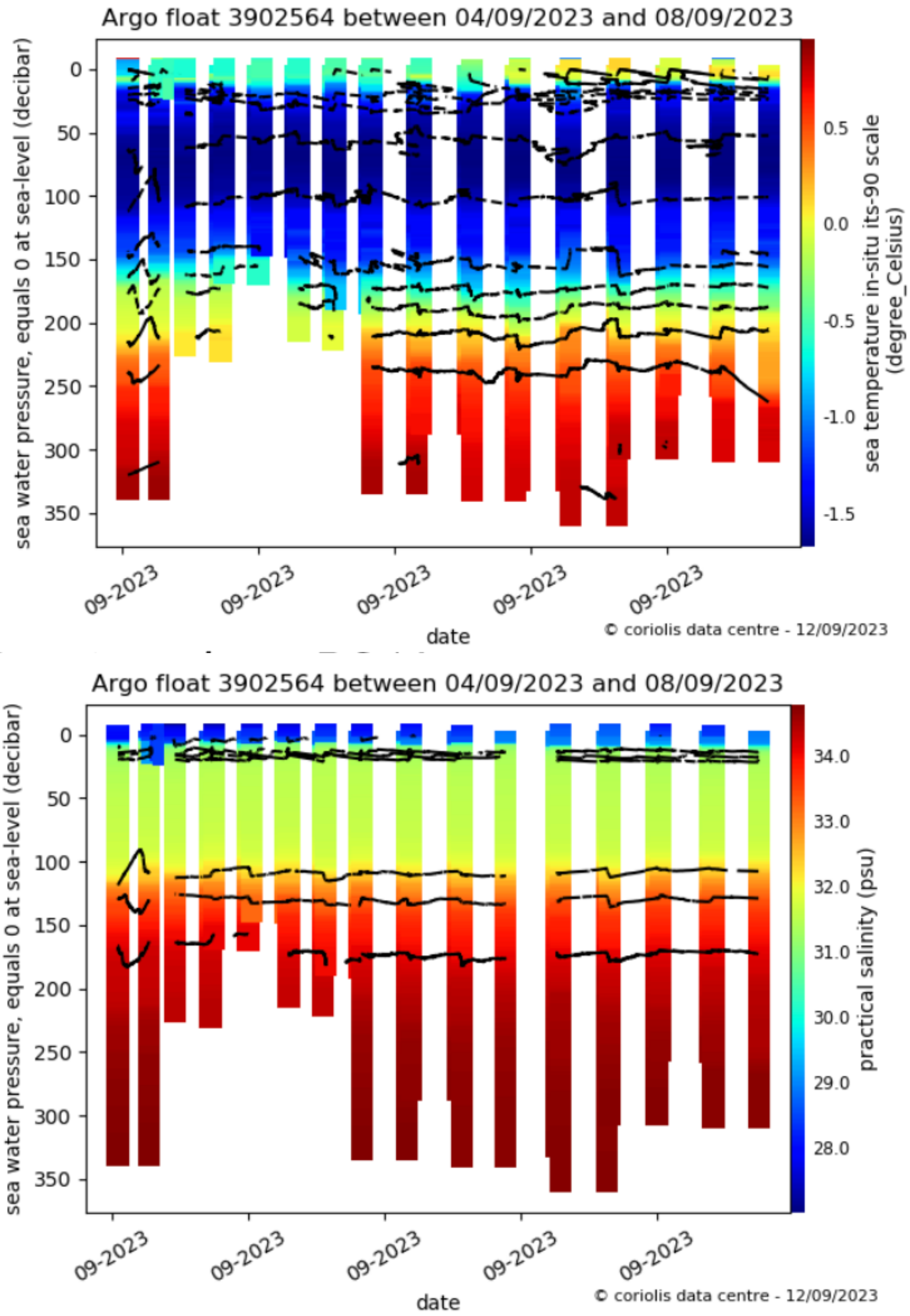
Initial deployment was with rapid profiles, then switched to longer periods of parking on seafloor.

Float 1902659: First 6 profiles were very shallow. The float had difficulties penetrating mixed layer. Parameters changed and then two profiles (one down and one up) made it deeper (~160m). Float then likely encountered ice and waiting to surface.

Float 3902564: Similar issue for initial profiles but parameters then changed and successful parking on seafloor attained.

Float data is public and progress can be monitored here:
https://fleetmonitoring.euro-argo.eu/float/1902659
https://fleetmonitoring.euro-argo.eu/float/3902564

Figure 8: Examples of temperature and salinity data from initial profiles after deployment.



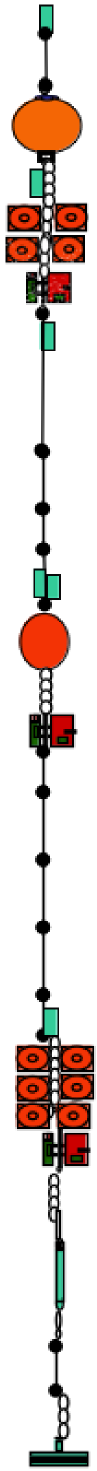
9. Outreach

The NPI communication department participated to highlight the time series in the Fram Strait, and the new articles published in 2023. The new findings are of value to the media, so we are providing video + photos to the NRK's climate journalists, aiming for a TV reportage on NRK Dagsrevyen, an article on NRK.no, in addition on the DR1, the Danish public broadcasting.

NPIs social media channels were updated during the cruise, also shared in channels of UiT CIRFA, ETH Zurich and DTU Aqua. A longer video about the Fram Strait work and news articles on npolar.no/forskning.no will be produced ashore. Videos and photos will be archived in NPI's official archives for future internal, external and media coverage.

Appendix A: Diagrams of moorings recovered

Rigg F10-18 78 49,636N
Satt ut 17/9-2022 , kl 10:52 001 57,077W

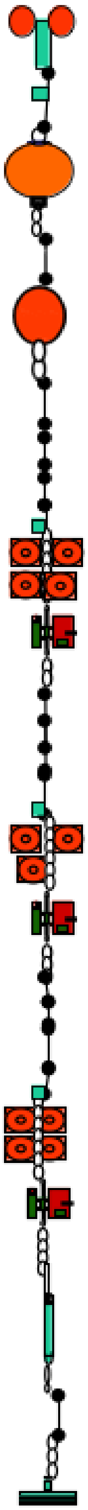


		Dyp:	Fra bunn:	Ned i vann:
SBE37IM	SNR. 22258	26	2624	10:50
18 m Vaier				
ADCP 300	SNR: 16831	44	2606	10:50
DATALOGGER	SNR.	46	2604	10:50
4 glasskuler				
3 m Kjetting Galv.				
AQUADOPP	SNR. 15910	49	2601	10:50
RBR ODO	SNR. 207317	52	2598	10:50
100 (102) m Kevlar				
40 m Kevlar				
20 (17)m Kevlar				
10 m Kevlar				
RBR Concerto	SNR. 207318	220	2430	10:20
SBE37	SNR. 20789	220	2430	10:20
Plastkule 40'' Oransje				
Svivel				
1 m Kjetting Galv.				
AQUADOPP	SNR. 15888	223	2427	10:20
0,5 m Kjetting Galv. Med svivel.				
4 x 500 (497,498,498,498) m Kevlar				
208 m Kevlar				
100 m Kevlar				
100 m Kevlar				
10 m Kevlar	Justert opp 30 m fra forrige gang			
SBE37	SNR. 22261	2636	14	09:41
6 Glasskuler				
3 m Kjetting Galv.				
AQUADOPP	SNR. 15877	2640	10	09:41
Svivel				
AR861	SNR. 2879			
3,5 m Kevlar				
2 m Kjetting				
ANKER 1150/(950) kg		2650	0	

Rigg F11-23

Satt ut 16/8-21 kl 12:42 UTC — 78 49,109N(*) / 003 03,087W

* NOTE: Anchor likely 250m further north: large drift!

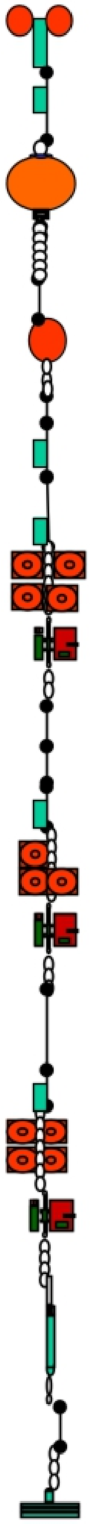


		Dyp:	Fra bunn:	Ut:
IPS	SNR. 51062	44	2409	12:45
SBE37	SNR. 3492	46	2407	12:45
5 m Kevlar				
ADCP300	SNR: 17462	50	2403	12:45
0,5 m Kjetting galvanisert				
10 m Kevlar				
Stålkule (gul)		72	2381	
Svivel				
1 m Kjetting galvanisert				
100 m Kevlar				
SBE37	SNR. 10294	150	2180	11:59
40 m Kevlar	11:597			
50 m Kevlar				
SBE37	SNR. 3996	273	2180	11:55
4 Glasskuler (2 gule og 2 oransje)				
2 m Kjetting galvanisert				
RCM9	SNR.1049	276	2177	11:55
0,5 m Kjetting galv				
200(199) m Kevlar				
500(519) m Kevlar				
500(511) m Kevlar				
20 m Kevlar				
10 m Kevlar Kanskje bort				
SBE37	SNR. 7061	1526	927	11:30
3 Glasskuler (gule)				
2 m Kjetting galvanisert				
RCM11	SNR.538	1529	924	11:30
0,5 m Kjetting galv				
500(511) m Kevlar				
200 m Kevlar				
200 m Kevlar				
SBE37	SNR. 8821	2439	14	11:07
4 Glasskuler (gule)				
2 m Kjetting galvanisert				
RCM Seaguard	SNR.834	2442	11	11:07
0,5 m Kjetting rustfri				
Svivel				
AR861	SNR. 499			
5 m Kevlar				
3 m Kjetting galvanisert				
ANKER	1230/(980) kg	2453(2474)	0	

Rigg F12-23

Satt ut 15/8-21 kl 19:43UTC

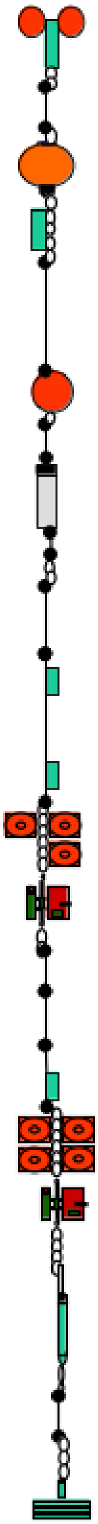
78 48,968N
004 00,730W



		Dyp:	Fra bunn:	Ut:
IPS	SNR. 51167	55	1775	17:22
SBE37	SNR.14099	57	1773	17:22
5 m Kevlar				
ADCP300	SNR: 20021	61	1769	17:22
0,5 m Kjetting galvanisert				
0,5 m Kjetting galv				
10 m Kevlar				
Skumkule 37	Oransje	74	1756	
0,5 m Kjetting galvanisert				
0,5 m Kjetting galv				
SBE37	SNR.13252	150	1680	17:10
200(199) m Kevlar				
SBE37	SNR.3994	275	1554	17:10
3 Glasskuler				
2 m Kjetting galvanisert				
RCM9	SNR. 836	279	1551	17:10
0,5 m Kjetting galv				
500(498) m Kevlar				
500(497) m Kevlar				
200(205) m Kevlar				
SBE37	SNR.13505	1476	354	16:53
3 Glasskuler				
2 m Kjetting galvanisert				
RCM11	SNR.556	1480	350	16:53
0,5 m Kjetting galv				
200(207) m Kevlar				
100(101) m Kevlar				
20 m Kevlar				
SBE37	SNR. 8226	1817	13	16:42
4 Glasskuler				
2 m Kjetting galvanisert				
Seaguard	SNR.345	1820	10	16:42
0,5 m Kjetting rustfri				
Svivel				
AR861	SNR. 500			
5 m Kevlar				
2 m Kjetting galvanisert				
ANKER	1190/(960) kg	1830 (1848)	0	

Rigg F13-21

Satt ut 14/8-21 Kl 20:01 UTC — 78° 50.333N, 04° 59.927W

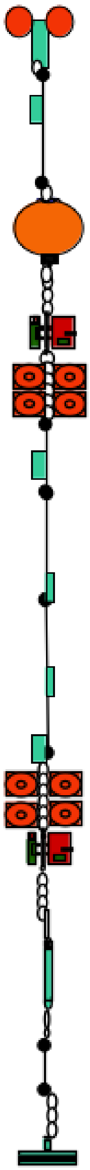


		Dyp:	Fra bunn:	Ned i vann:
IPS5	SNR. 51140	50	960	18:00
5 m Kevlar				
ADCP300	SNR: 18070	56	954	18:00
1,5 m Kjetting galv				
SEACAT SBE16	SNR. 7253	59	951	18:00
0,5 m Kjetting galv.				
10 m Kevlar				
Stålkule 37		69	941	
2 m Kevlar				
Hvallydopptaker	SNR. 304	72	938	
2 m Kevlar				
0,5 m Kjetting galv.				
20 m Kevlar				
Merke for instrument		95		
50 m Kevlar				
SBE37	SNR. 7060	147	863	17:41
100 m Kevlar				
SBE37	SNR. 3995	245	765	17:36
3 Glasskuler				
2 m Kjetting galv.				
RCM9	SNR.1326	248	762	17:36
0,5 m Kjetting galv				
500(499) m Kevlar				
100 m Kevlar				
100 m Kevlar				
50 m Kevlar				
SBE37	SNR. 13504	996	14	17:07
4 Glasskuler				
2 m Kjetting galv.				
SEAGUARD	SNR. 883	1000	10	17:07
0,5 m Kjetting rustfri				
Svivel				
AR861	SNR. 743			
5 m Kevlar				
2 m Kjetting galvanisert				
ANKER	1100/(880) kg	1010(1018)	0	

Rigg F14-24 78 48,844N

Satt ut 15/9-2022 , kl 11:57 006 29,788W

Tatt opp Aug 20



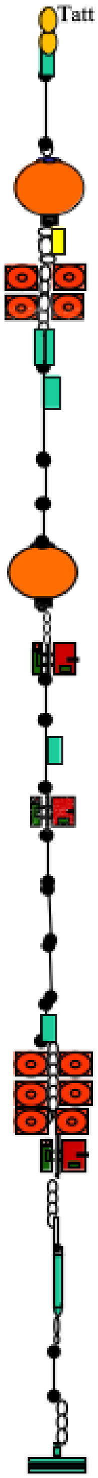
			Dyp:	Fra bunn:	Ned i vann:
IPS	SNR. 51138		58	215	11:14
SBE37	SNR: 14097		60	213	11:14
5 m Kevlar					
ADCP 300	SNR: 24518		64	209	11:14
0,5 m Kjetting Galv.					
AQUADOPP	SNR: 16603		66	207	11:14
4 Glasskuler					
2 m Kjetting Galv.					
40 m Kevlar					
SBE37	SNR: 13253		108	165	10:58
100 (103) m Kevlar					
SBE56	SNR.10330	(25 m over 56)	211	62	10:53
SBE56	SNR.10331	(25 m over 37)	236	37	10:50
50 (51) m Kevlar					
SBE37	SNR.3992		261	12	10:48
4 Glasskuler					
2 m Kjetting Galv.					
Aquadopp	SNR. 16764		264	9	10:48
Svivel					
AR861	SNR. 409				
3,5 m Kevlar					
2,5 m Kjetting					
ANKER 920/(740) kg			273	0	

Appendix B: Diagrams of moorings deployed

Rigg F10-19 78 49,628N

Satt ut 10.09.23 kl 12:37 001 57,074W

Tatt

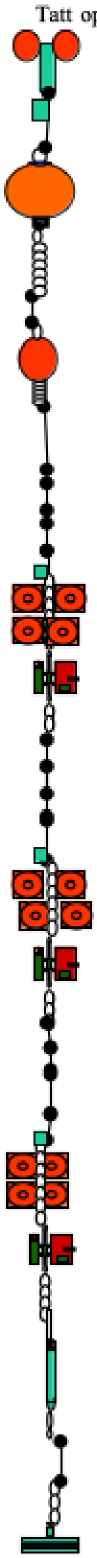


		Dyp:	Fra bunn:	Ned i vann:
SBE37IM	SNR. 22260	24	2626	12:37
ADCP 300	SNR: 24899	52	2598	12:32
Batteribeholder DL-NPI005		53	2597	12:32
SAMI CO2/pH	SNR. 227/261	57	2593	12:32
RBR ODO	SNR. 205002	58	2592	12:32
100 (102) m Kevlar				
SBE56	SNR. 12966	125	16	12:24
SBE56	SNR. 12967	175	16	12:20
40 + 20 m Kevlar				
Plastkule 40'' Med svivel.				
1 m Kjetting Galv.				
AQUADOPP	SNR. 15877	221	2419	12:10
0,5 m Kjetting Syrefast				
0,5 m Kjetting Galv.				
SBE37	SNR. 20789	250	2417	12:08
AQUADOPP	SNR. 16603	760	2594	11:58
4 x 500 (538,40,21,198,198,516,506) m Kevlar				
200(204) m Kevlar				
100 (101 m Kevlar				
40 + 20 m Kevlar				
(totalt i midten 2322)				
SBE37	SNR. 23266	2634	16	11:21
6 Glasskuler				
3 m Kjetting Galv.				
Aquadopp	SNR. 16764	2639	11	11:21
Svivel				
AR861	SNR. 2425			
5 m Kevlar				
3 m Kjetting				
ANKER 1140/(1000) kg		2650 (2668)	0	

Rigg F11-24

Satt ut 09.09.2023 kl 14:23 78 48,601N 003 04,708W

Tatt opp

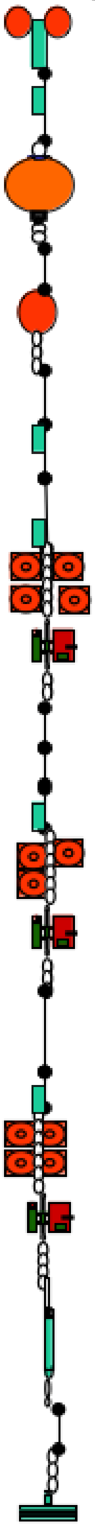


		Dyp:	Fra bunn:	Ut:
IPS	SNR. 51062	54	2369	12:22
SBE37	SNR. 3490	56	2367	12:22
5 m Kevlar				
ADCP300	SNR: 24830	60	2363	12:22
2 Glasskuler				
1 m Kjetting galvanisert				
5 m Kevlar				
Stålkule 37 McLane		69	2354	
0,5 m Kjetting galvanisert				
SBE37	SNR. 12233	150	2179	12:08
100 m Kevlar				
SBE56	SNR. 12959	175	2179	12:06
50 m Kevlar				
SBE56	SNR. 12965	200	2179	12:04
20 + 5 m Kevlar				
SBE37	SNR. 4702	244	2179	12:02
4 Glasskuler (gule)				
2 m Kjetting galvanisert				
Seaguard	SNR.1846	247	2176	12:02
0,5 m Kjetting galv				
200(208) m Kevlar				
500(498) m Kevlar				
500(502) m Kevlar				
40 (41) m Kevlar				
SBE37	SNR. 3552	1496	927	11:34
4 Glasskuler				
2 m Kjetting galvanisert				
RCM11	SNR.494	1499	924	11:34
0,5 m Kjetting galv				
500 m Kevlar				
200 (201)m Kevlar				
200 (209)m Kevlar				
SBE37	SNR. 8227	2409	14	11:10
4 Glasskuler (gule)				
2 m Kjetting galvanisert				
RCM8	SNR.10071	2413	10	11:10
0,5 m Kjetting rustfri				
Svivel				
AR861	SNR. 287			
3,5 m Kevlar				
2 m Kjetting galvanisert				
ANKER 1153/(980) kg		2423(Ekko 2474)	0	

Rigg F12-24

Satt ut 08.09.2023 kl 17:03 — 78 49,121N, 004 01.341W

Tatt opp

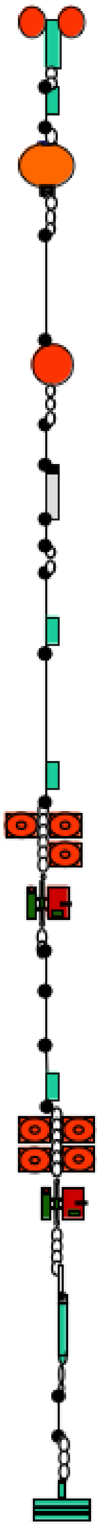


		Dyp:	Fra bunn:	Ut:
IPS	SNR. 51167	50	1778	16:52
SBE37	SNR.3489	52	1776	16:52
5 m Kevlar				
ADCP300	SNR: 16876	56	1772	16:52
0,5m Kjetting galvanisert				
5 m Kevlar				
Stålkule 37 Gul		62	1766	
0,5 m Kjetting galvanisert				
(SBE37)	SNR.	114	1714	07:54
SBE37	SNR. 14100	150	1714	16:38
SBE56	SNR. 12963	175	1714	16:36
SBE56	SNR. 12968	200	1714	16:34
200 m Kevlar				
SBE37	SNR.4837	264	1564	16:30
4 Glasskuler				
2 m Kjetting galvanisert				
SEAGUARD	SNR. 884	267	1561	16:30
0,5 m Kjetting galv				
498 m Kevlar				
501 m Kevlar				
200m Kevlar				
SBE37	SNR.3554	1471	357	16:03
3 Glasskuler				
2 m Kjetting galvanisert				
RCM11	SNR.235	1474	354	16:03
0,5 m Kjetting galv				
199 m Kevlar				
99 m Kevlar				
40 +10 m Kevlar				
SBE37	SNR. 8822	1814	14	15:48
4 Glasskuler				
2 m Kjetting galvanisert				
RCM11	SNR.228	1817	11	15:48
0,5 m Kjetting rustfri				
Svivel				
AR861	SNR. 182			
5 m Kevlar				
2 m Kjetting galvanisert				
ANKER	1130/(950) kg	1828 (Ekko1833)	0	

Rigg F13-24

Satt ut 07.09. 2023 , kl 19:45 — 78 50.435N, 005 00.433W

Tatt opp

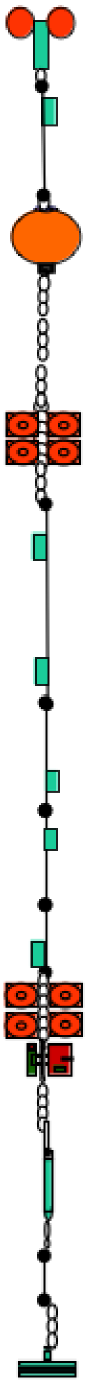


		Dyp:	Fra bunn:	Ned i vann:
IPS5	SNR. 51064	53	967	19:01
SBE37	SNR: 7056	55	965	19:01
5 m Kevlar				
ADCP300	SNR: 18151	59	961	19:01
1,5 m Kjetting galv				
5 m Kevlar				
Plastkule 37 Oransje		66	954	
1,5 m Kjetting galv.				
2 m Kevlar				
Hvallydopptaker M3	SNR. 248	71	949	18:53
2 m Kevlar				
0,5 m Kjetting galv.				
50 + 20 m Kevlar				
SBE37	SNR. 12234	144	876	17:43
SBE56	SNR. 12960	175	845	18:41
SBE56	SNR. 12961	198	822	18:39
100 (103) m Kevlar				
SBE37	SNR.3993	251	769	18:36
3 Glasskuler				
2 m Kjetting galv.				
RCM9	SNR.1327	255	765	18:36
0,5 m Kjetting galv				
500 m Kevlar K				
200 m Kevlar				
50 m Kevlar				
SBE37	SNR.3551	1005	15	18:10
4 Glasskuler				
2 m Kjetting galv.				
RCM11	SNR. 561	1009	11	18:10
0,5 m Kjetting rustfri				
Svivel				
AR861	SNR. 053			
5 m Kevlar				
2 m Kjetting galvanisert				
ANKER	1044/(900) kg	1020 (Ekko 1027)	0	

Rigg F14-25

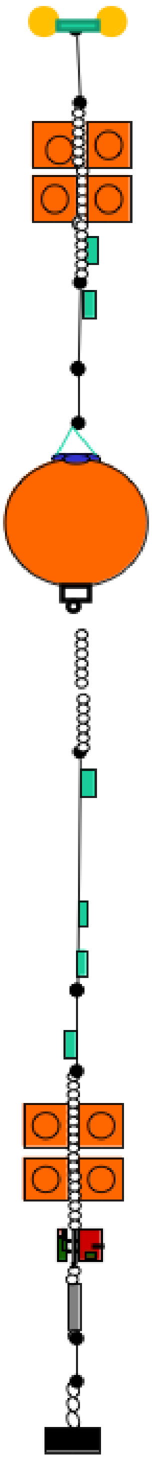
Satt ut 07.09.2023 kl 12:36

78 48,864N
006 30,192W



		Dyp:	Fra bunn:	Ned i vann:
IPS	SNR. 51138	47	222	12:05
SBE37	SNR: 7058	49	210	12:05
5 m Kevlar				
ADCP 300	SNR: 17461	53	205	11:53
Svivel 1 m Kjetting Galv.				
4 Glasskuler 2 m Kjetting galv.				
0,5 m Kjetting Galv.				
SBE37	SNR. 7054	108	158	11:49
100(104) m Kevlar				
SBE37	SNR. 9853	146	120	11:45
50 (52) m Kevlar				
SBE56	SNR: 12964	171	67	
SBE56	SNR: 12958	196	42	
40(41) m Kevlar				
SBE37	SNR.7057	253	13	12:06
4 Glasskuler 2 m Kjetting Galv.				
RCM 9	SNR. 1046	257	10	12:06
Svivel				
AR861	SNR. 568			
3,5 m Kevlar				
2,5 m Kjetting				
ANKER 834/(750) kg		266 (274)	0	

Rigg F17-19 78 50. 196 N
Satt ut 06.09.2023 , kl 20:22 008 04.754W



		Dyp:	Fra bunn:	Ut:
SBE37	SNR. 22250	30	196	20:22
25 m Kevlar				
Weak link o/u				
3 m Kjetting galv.				
4 Glasskuler				
SUNA	SNR.1126	56	172	20:20
0,5 m Kjetting galv.				
RBR CDOM	SNR.204799	56	172	20:20
40 m Kevlar				
10 m Kevlar				
SIG 250	SNR.103518	107	121	20:12
Svivel				
1,5 m Kjetting galv.				
RBR CDOM	SNR.204800	109	119	20:12
0,5 m Kjetting galv.				
100 (102) m Kevlar				
SBE56	SNR. 10331	175	32	20:00
SBE56	SNR. 10330	200	32	19:58
5 m Kevlar				
SBE37SMP	SNR. 9650	216	12	19:55
2 m Kjetting galv.				
4 GLASSKULER		217	11	
RCM8	SNR. 12733	219	9	19:55
AR861Li	SNR. 2426			
3 m Kevlar.				
2 m Kjetting galv.				
ANKER	735/(650)kg	228 (Ekko 227)	0	

Rigg F20-3

Satt ut 06.09.2023 , kl 15:23 — 78 50.100 N, 010 08.815W

Tatt opp

		Dyp:	Fra bunn:	Ut:
ICECat	SNR. 22258	28	298	15:21
25 m Wire				
Weak link				
3 m Kjetting galv.				
4 Glasskuler				
ICECAT modem				
SBE37	SNR. 9651	56	270	15:21
51 m Kevlar				
2 GLASSKULER		314	12	
RCM	SNR.7718	106	220	15:07
1 m Kjetting galv.				
SBE37	SNR. 12232	109	217	14:52
(Merke på ca 50 m og to lengre ned)				
206 m Kevlar				
SBE37	SNR. 10295	310	10	14:52
2 GLASSKULER		314	12	
2 m Kjetting galv.				
AR661	SNR. 291			
5 m Kevlar.				
2 m Kjetting galv.				
ANKER	715/(620)kg	326(Ekko 330)	0	

Appendix C: LADCP script files

Master.txt:

; Append command to the log file

$LC:\KH2023007015\Logfiles\Mladcp_log.txt

$P
****

$P ************** LADCP Master. Looking down (firmware v16.3) *************

$P ************* Master and Slave will ping at the same time ***************

$P ************ staggered single-ping ensembles every 0.8/1.2 s *************

$P
****

; Send ADCP a BREAK

$B

; Wait for command prompt (sent after each command)

$W62

; Display real time clock setting

tt?

$W62

; Set to factory defaults

CR1

$W62

; use WM15 for firmware 16.3

; activates LADCP mode (BT from WT pings)

WM15

$W62

; Rename data file prior to new CTD station and use CTD station nr

RN M0222_

; Flow control (Record data internally):

; - automatic ensemble cycling (next ens when ready)

; - automatic ping cycling (ping when ready)

; - binary data output

; - disable serial output

; - enable data recorder

CF11101

$W62

; coordinate transformation:

```
; - radial beam coordinates (2 bits)
; - use pitch/roll (not used for beam coords?)
; - no 3-beam solutions
; - no bin mapping
EX00100
$W62
; Sensor source:
; - manual speed of sound (EC)
; - manual depth of transducer (ED = 0 [dm])
; - measured heading (EH)
; - measured pitch (EP)
; - measured roll (ER)
; - manual salinity (ES = 35 [psu])
; - measured temperature (ET)
EZ0011101
$W62
;
; - configure staggered ping-cycle
```

```
; ensembles per burst
TC2
$W62
; pings per ensemble
WP1
$W62
; time per burst
TB 00:00:01.20
$W62
; time per ensemble
TE 00:00:00.80
$W62
; time between pings
TP 00:00.00
$W62
;
; - configure no. of bins, length, blank
```

```
; number of bins

WN015

$W62

; bin length [cm]

WS0800

$W62

; blank after transmit [cm]

WF0000

$W62

; ambiguity velocity [cm]

WV250

$W62

; amplitude and correlation thresholds for bottom detection

LZ30,220

$W62

; Set ADCP to narrow bandwidth and extend range by 10%

LW1

$W62
```

;

; SET AS MASTER ADCP

SM1

$W62

;+ TRANSMITS SYNCHRONIZING PULSE BEFORE EACH ENSEMBLE

SA011

$W62

; WAIT .55 s after sending sync pulse

SW05500

$W62

; SYNCHRONIZING PULSE SENT ON EVERY PING

SI0

$W62

; keep params as user defaults (across power failures)

CK

$W62

; echo configuration

T?

$W62

W?

$W62

; start Pinging

CS

; Delay 3 seconds

$D3

$p
****

$P Please disconnect the ADCP from the computer.

$P
****

; Close the log file

$L

Slave.txt:

```
; Append command to the log file

$LC:\KH2023007015\Logfiles\Sladcp_log.txt

$P **************************************************************************

$P ************** LADCP SLAVE. Looking UP (firmware v16.30) *************

$P ************* Master and Slave will ping at the same time ***************

$P ************ staggered single-ping ensembles every 0.8/1.2 s ************

$P **************************************************************************

; Send ADCP a BREAK

$B

; Wait for the command prompt BBTalk needs this before each command

$W62

; Display real time clock setting

tt?

$W62

; Set to factory defaults
```

CR1

$W62

; use WM15 for firmware 16.3

; activates LADCP mode (BT from WT pings)

WM15

$W62

; Rename data file prior to new CTD station and use CTD station nr

RN S0222_

$W62

; Flow control (Record data internally):

; - automatic ensemble cycling (next ens when ready)

; - automatic ping cycling (ping when ready)

; - binary data output

; - disable serial output

; - enable data recorder

CF11101

$W62

; coordinate transformation:

; - radial beam coordinates (2 bits)

; - use pitch/roll (not used for beam coords?)

; - no 3-beam solutions

; - no bin mapping

EX00100

$W62

; Sensor source:

; - manual speed of sound (EC)

; - manual depth of transducer (ED = 0 [dm])

; - measured heading (EH)

; - measured pitch (EP)

; - measured roll (ER)

; - manual salinity (ES = 35 [psu])

; - measured temperature (ET)

EZ0011101

$W62

; - configure staggered ping-cycle

; ensembles per burst

TC2

$W62

; pings per ensemble

WP1

$W62

; time per burst

TB 00:00:01.20

$W62

; time per ensemble

TE 00:00:00.80

$W62

; time between pings

TP 00:00.00

$W62

;

; - configure no. of bins, length, blank

; number of bins

WN015

$W62

; bin length [cm]

WS0800

$W62

; blank after transmit [cm]

WF0000

$W62

; ambiguity velocity [cm]

WV250

$W62

; amplitude and correlation thresholds for bottom detection

LZ30,220

$W62

; Set ADCP to narrow bandwidth and extend range by 10%

LW1

$W62

;

; SET AS SLAVE ADCP

SM2

$W62

; TRANSMITS SYNCHRONIZING PULSE BEFORE EACH ENSEMBLE

SA011

$W62

; don't sleep

SS0

$W62

; WAIT UP TO 300 SECONDS FOR SYNCHRONIZING PULSE

ST0300

$W62

; keep params as user defaults (across power failures)

CK

$W62

; echo configuration

T?

$W62

W?

$W62

; start Pinging

CS

; Delay 3 seconds

$D3

$p

****

$P Please disconnect the ADCP from the computer.

$P
****

; Close the log file

$L