Fram Strait Cruise Report

09 September – 19 September 2022; Ver. 01, 10/27/2022

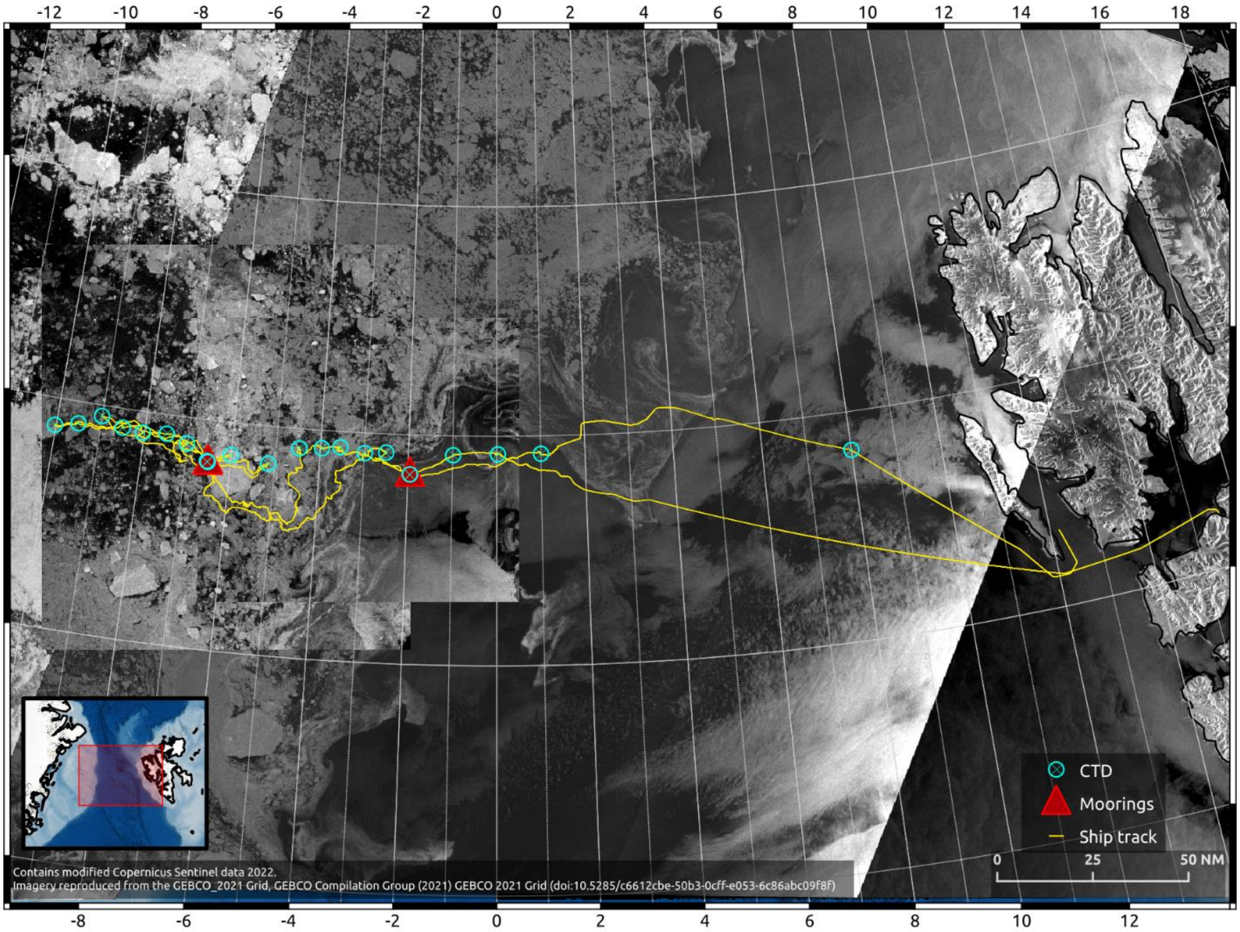

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Table of Contents

1. Cruise Overview

The objective of the annual cruise of the Norwegian Polar Institute to Fram Strait is to service parts of the Fram Strait Arctic Outflow Observatory (FSAOO) consisting of 7 ocean moorings and to conduct the CTD section across 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 cargo ship Silver Arctic was used for this year's operation and another objective was to test and optimize the containerized science deck arrangement and operations in sea ice cover waters with this vessel for future scientific work. Therefore, some time was also spent on training the ship's crew and practicing with the setup on board. During the ten-day cruise, three oceanographic moorings were recovered (F10 in the deep ocean and F14, F14B (a test mooring) on the East Greenland shelf), of which two (F10, F14) were redeployed. F17 and F20 were planned to be serviced but there was too little time. 22 CTD profiles (thereof 11 in waters deeper than 1000 m) and 1085 water samples were obtained with focus on western Fram Strait and the East Greenland shelf.

Day-to-day route planning was done in close communication with the captain, who actively used the sea ice images provided by the science team for navigation in ice-covered waters. The ice conditions during FS2022 were representative of a "normal" September (representative for 2010-2020) with drifting of heavier pack ice in the EGC and more open, but still some drift ice on the East Greenland continental shelf. Navigation in the sea ice was possible but needed to be more opportunistic than what would be possible with a stronger ship like KPH, because of the limited ice-breaking strength (weak engine power) of Silver Arctic. Together with the smaller science team (only 6 berths available) and shorter cruise duration, these were the main factors limiting the amount of work that could be carried out during the cruise, as compared to general a full Fram Strait Arctic Outflow Observatory cruise services 7 moorings, takes between 45-80 CTDs, carries out sea ice work (5 to 10 sea ice stations), and in recent years, whale research with 5 pax and helicopter.**Overall recommendations**
(1) Being able to bring one or two additional science team members to sustain two fully staffed shifts would greatly improve the work capacity on board. The science deck arrangement (winch container, flat-rack, workshop- and lab containers) functioned well as expected. After familiarization with the operations, the science team and the ship's crew worked well together to carry out the planned tasks safely and efficiently. Room for improvement was identified in relation to the following aspects and with more details given further below: (2) future use of a customized A-frame for CTD-work, instead of the ship's main crane that is more complicated/ less safe and requires crane driver availability around the clock; (3) installation of a gangway or staircase to access the science deck from the secondary crane platform, instead of climbing vertical leaders that are less safe to use in ice conditions or when the ship is moving due to waves or when breaking through sea ice, and (4) minimizing the use of or improving the opening of the small cargo hatch (consider installing a hinge system) for accessing the workspace under deck. The current procedure of lifting away the hatch with the main crane is complicated, time-consuming, and requires absolutely calm conditions at sea. All instrument deployments were carried out via the starboard side; depending on the prevailing wind- and ocean current direction, deployment via the port side may be considered with respect to positioning the ship against the drift, while rearranging the container layout will create other challenges.

2. Participants

Six berths were available on Silver Arctic for the following science team members.

1. Tore Hattermann (NPI cruise leader, mooring- & science deck work coordination)
2. Kristen Fossan (NPI, mooring & CTD engineer, cruise deputy leader)
3. Jan Are Jakobsen (NPI, mooring & science deck engineer)
4. Yannick Kern (NPI, CTD & ice map coordination)
5. Fletcher Thompson (DTU Aqua, CTD-winch work and sampling)
6. Marcel Scheiwiller (ETH, Zurich, CTD-winch work and sampling)

Due to the small team size, participants were taking part in different operations, in addition to their main responsibilities. During some periods of the cruise, a six-hour shift routine with two teams of 3 people was adopted to carry out CTD work independent of the time of the day. During transit in the ice and the mooring operations, all science team members were working daytime hours. This mode of operation allows efficient use of science time with a small group but cannot be sustained for a long time without sufficient resting periods.

3. Sailing log

Tuesday 06.09.2022	Loading and unpacking of science containers, visit of the science team members for familiarization on MS Silver Arctic, in Breivika, Tromsø.
Wednesday 07.09.2022	J.A. Jakobsen boarding. Departure from Tromsø at 06:00 am, all day steaming toward Longyearbyen. Use the day for science deck preparations & carpentering work.
Thursday 08.09.2022	All day steaming toward Longyearbyen. Use the day for science deck preparations & carpentering work.
Friday 09.09.2022	Ship arrival in Longyearbyen 08:00 local time (LT), boarding of the rest of the science team members - loading of science equipment and cargo to Tromsø. - Testing of winches, wire angle, lifting of anker & CTD from ship to on pier. - Leaving port at 14:30 LT steaming toward fist CTD station (0° E). Start track logging on NP-PC on bridge. - Fire & safety briefing, including entering the lifeboat and protocol for rifle handling for polar bear protection in case of evacuation - Set up CTD computer & lab, labelling sampling bottles. Note that CTD needs to be reconfigured before LADCP can be mounted; splitter cable for second O2 sensor is missing, continue for now without LADCP and with one O2 sensor only. - Waves picking up with 18 m/s wind at 22:00 LT.

Saturday 10.09.2022	Approaching first, open ice, ship moving very slowly at 06:00 LT, weather calm - Continue CTD & bio lab rigging - Moving some more boxes - Tore mainly on bridge with Alfred solving internet trouble and getting sea ice images. Others working on deck - Develop CTD checklist based on TrollTransect & Paul's notes in cruise plan - Arriving at 0° E station around lunch; toolbox meeting with all crew on CTD ops including familiarization with NPI risk assessment. - 1st CTD cast: shallow (50 m) cast for water sampling exercise (on deck outside), then full cast, sampling inside - Done with CTD & water sampling for dinner; steaming to next station without much ice - Agree to split into shifts (08:00-02:00: Kristen, Fletcher, Tore & 02:00-08:00: Yannick, Jan, Marcel) when continuous CTD work starts - Ship on station (1° W) after dinner; second CTD lasting until about midnight - Steaming with low speed to F10 during the night, all science team sleeps at night
Sunday 11.09.2022	Wx calm, light snow, some fog (<2 km visibility), light wind, nearly no ice flows - On position, but no sign of F10 on EK80 around 07:00 LT; spiralling outward with approx. 0.15 NM offset - After 700 radius, try to locate mooring with acoustic release: Contact at 3 locations, triangulation suggests that mooring is roughly at deployment position - Release mooring ~08:00 UTC, see surface buoys within a minute, - Toolbox meeting on bridge for recovery procedure. - get fresh water on deck and open cargo hatch first to get stuff down - Bottom float spotted ~40 min after release, move closer, Tore stays on bridge until mooring is connected, then all on deck for recovery. - Recover mooring until 12:30 LT - Move wet gear and other mooring instruments into cargo hull - Start CTD (2° W), at bottom around lunch / shift change; split up group - Get new sea ice images: ice on the way to 3°W, trying to go into the ice carefully, approaching denser pack at 19:00 LT - On station (3° W) around 19:30 LT, CTD work until 22:00 LT, sampling until 23:00 LT - Sea ice image suggests circumnavigating dense pack in EGC southbound - Alfred tries to go into the pack ice toward 4W on slightly southerly route until getting stuck at 00:30 LT, good ice breaking & navigation until then. Fog and around -4 °C. - Reverting and circumnavigating along alternative waypoints toward F14

Monday 12.09.2022	- Not much progress toward F14 during rest of night; revert all back to daytime operations - Kristen & Jan Are start working on fixing the CTD/ mounting the LADCP - Sunny, sailing in leads toward F14B, spooling off wire from F10 after lunch; prepare/ practice LADCP work; Develop checklist based on TrollTransect & Laura's notes. - Arrive at F14/F14B after dinner; see both on EK80, take up F14B in last daylight - Group meeting in deck's mess to decide further progression. F14 will not be ready for deployment before the 15th, which will tie us to the shelf area until then. - Go to 7° W for night-time CTD, reshuffle groups so that mooring-people get enough sleep after Kristen & Jan had a full daytime work: Tore, Kristen & Jan stay up to finish 7° W CTD, then steaming to 9° W and waking up Yannick, Fletcher & Marcel, who also do 8° W CTD (on station there at 8:00 LT, 13.09.)
Tuesday 13.09.2022	- Jan & Tore stayed up late (03:50 LC 12th 09.). Kristen got up for breakfast, starting the mooring preps. - Completing CTD work at 8° W around breakfast - Heading back to F14, arriving at 15:00 LT, encountering heavier, rafted ice that has drifted southward over the mooring position during the night - Trying to drift over F14 with the ice edge, take calibration CTD, abort waiting and go through open water to 6° W instead. - Return to F14, which was ice free by then, recover the mooring and start moving toward 5° W after dinner. Slowly circumnavigating consolidated floes in fog, break through into another lead, continue with <100m visibility for CTD at 00:0 LT at 78° 50´ N, 5° 10´ W. - 02:00 LT CTD processing finished, steaming westward back toward F14. - All sleep during the night and revert to daytime operations
Wednesda y 14.09.2022	- 07:30 LT arriving at 7° 30´ W for CTD, continue westward and finish 8° 30´ W CTD at 11:30 LT - Based on latest Sentinel image, decide to approach 9° 30´ W (arrival 13:30 LT) & 10° W (arrival 15:30 LT) - Return to F14, Jan Are & Kristen continue moorings preps - Approaching F14 during the evening, wait with distance to larger ice floes nearby
Thursday 15.09.2022	- Move close to F14 deployment position in the morning - Icing during the night. Hammering handrails & put salt on deck, prepare F14 deployment - Deployment CTD before 11:00 LT, toolbox meeting at 11:30 - Mooring deployed at 14:00 - Retreat from shelf area southbound toward F10 - Spooling Kevlar and other preps. For F10 deployment in the afternoon

Friday 16.09.2022	- Approaching 4° 30´ W after breakfast, need to restart CTD due to nilas, start proper profile around 12:30 LT - Kristen & Jan Are continue preparations for F10 deployment - Yannick works with downloading data from the F14 and F10 instruments - Approaching 4° W station after lunch, CTD work - Finishing 3° 30´ W before dinner - Going slowly through the sea ice toward 2° 30´ W
Saturday 17.09.2022	- 01:00 LT on 2° 30´ W CTD station; profiling and sampling until 03:30 LT (Jan, Tore Yannick & Marcel) - Arrival at F10 deployment site at 2° W around 08:00 LT, 6/10 ice cover, light wind from NNE - CTD cast with deep water samples, discuss ship position in wind and ocean current angle (Yannick, Marcel, Fletcher) - Toolbox meeting in deck mess - 11:30 – 13:00 LT mooring deployment (Jan, Kristen, Tore) - Steaming eastward - 19:00 LT on station for 1° E CTD, 4/10 ice cover - Sampling completed around 23:00 LT - revert everybody back to daytime work for clean-up, processing, reporting - Steaming toward 8° E CTD station, northward circumnavigating ice, getting free around 3° E
Sunday 18.09.2022	- 07:00 LT on 8° W CTD station - Steaming toward Longyearbyen - Science team busy with dismounting and storing the equipment on the science deck, preparing sample shipments and writing the cruise report. - In the afternoon, using good weather to stop at Pyntepoolen, Prins Karls Forlandet.
Monday 19.09.2022	Arrival in LYR around midnight. Breakfast, packing, cleaning and offloading. Disembarking of the science team, except Jan Are, who follows ship to Tromsø
Tuesday 08.09.2020	Si
Wednesday 09.09.2020	

4. Mooring operations during FS2022

According to the cruise plan, up to 4 out of 7 moorings of the AOO should be serviced (F10, F14, F17, F20) and one test mooring should be recovered (F14B). Service of F10 and F14 and recovery of F14B was carried out successfully. F17 and F20 were not recovered, because there was not enough time to prepare for their re-deployment on the East Greenland shelf during the ten-day cruise.

4.1 Moorings recovered during FS2022

Mooring	Position	Depth (m)	Date and time (UTC)	Instrument	Serial #	Instrument depth (m)
F10-17	N 78° 49.637' W 01° 57.080'	2665 m **)pH/pCO2 sensors: P0261/S2CA01*	Deployed: 17 Aug 2021 16:03 UTC Recovered: 11 Sep 2022 08:30 UTC	**SBE37-IM weak link** ADCP Data logger AQD **SAMI pH+pCO₂*** **RBR CTD+ODO** AQD **RBR CTD+** **SBE37** AQD AR861	**23250** 24899 NPI005 15910 (665) **227 / 261** **207317** 15888 (666) **207318** **23266** 15877 (667) 506	**25** 48 50 **51** **52** **54** 221 **223** **2634** 2639 2641
F14-23	N 78° 48.848' W 06° 30.127'	270	Deployed: 14 Aug 2021 14:05 UTC Recovered: 13 Sep 2022 17:00 UTC	**IPS** **SBE37** ADCP **SBE37** **SBE37** **SBE56** **SBE56** **SBE37** Nortek AQD AR861	**51138** **7058** 17461 **7054** **9853** **10330** **10331** **7057** 16603 568	**48** **56** 60 **112** **150** **203** **228** **257** 260 267
F14B-1	N 78° 48.995' W 06° 29.704'	273	Deployed: 6 May 2022 07:22 UTC Recovered 12. Sep 2022 21:00 UTC	**Nortek Signature** **SBE37** AR861	**103518** **12234** 409	**63** **67** 267

Table 2: *Moorings that were recovered during FS2022.*

Notes:

The AOO moorings F10 and F14 were recovered in good shape and with the IceCAT still in place on F10. The additional pilot mooring F14B targeted for Nortek ice profiler testing was also recovered in good shape. All SBE37, RBR, IPS and the Nortek ice profiler that were recovered were still logging upon recovery. The moorings F10 and F14 were deployed in the same positions., however, the pH and pCO2 sensors on F10 could be re-deployed due to lack of programming cable and unknown levels of calibration fluids inside the instrument. The tentative recovery of a mooring in Billefjorden, Svalbard, at the end of the cruise was not necessary, because the mooring could be recovered during the period of FS2022 by another vessel.

Instrument notes, failures/early stop:

- ADCP (SN 24899) on F10 stopped in June 2022 with an empty battery. The FS2021 cruise report mentions the following about this instrument:
  "New SN 24899 did not get an error less than 15° after 3 different attempts with different battery or with different orientation. Kristen will make a new battery from demagnetized cells and we try again on 19.5. New attempts 19+20 May (Holt and Fram Centre after discusion with Loic@ RDI): final error 4.1°"
- Both SAMI instruments at F10 could not be read out until back in Tromsø. The communication failed and upon opening them in the lab at NPI, the batteries had been severely leaking. Both had severe high pressure in the canister and it was dangerous to open them. The pH instrument indicated flooding and battery leakage/damage, while the pCO2 instrument only showed battery leakage/damage. It is unclear if they have worked at all (if there are data) and when the battery turned bad. They will be sent to Sunburst in autumn for inspection and service. The instruments were newly purchased with new batteries installed by Sunburst in 2021, a couple of months prior to deployment.

Mooring depths based on recovery of instruments:

1. F10 top IceCAT was at ~ 27 m
2. F14 top Microcat was at ~ 57 m
3. F14B top Microcat was at ~ 65 m

4.2 Moorings deployed during FS2022

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 Top float of weak link recorded on echosounder 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	22258 16831 15910 207317 207318 20789 15888 22261 15877 2879	**26** 44 46 49 **52** **220** **220** 223 **2636** 2640

F14-24	N 78° 48.837' W 06° 29.966'	277	Deployed: 14 Sep 2022 12:15 UTC Top float recorded on echosounder at 59 m depth	**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

Table: *Moorings deployed during FS2022*

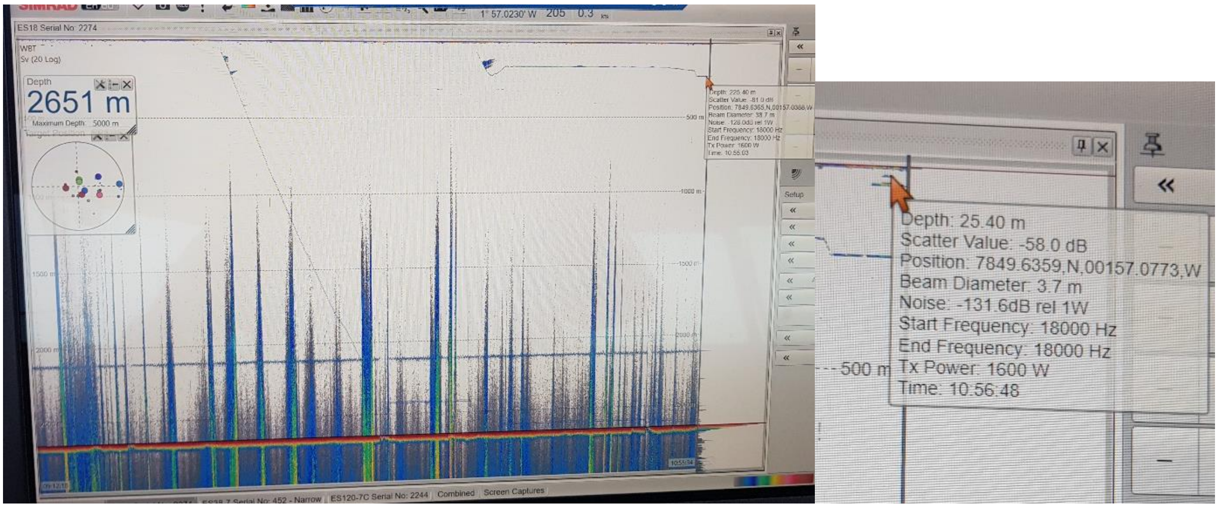


Figure 4.1: Echogram from F10 deployment, showing the descent of the buoyancy spheres, its position at deployment time and the depth of the top-float of the weak link at approximately 25 m depth.

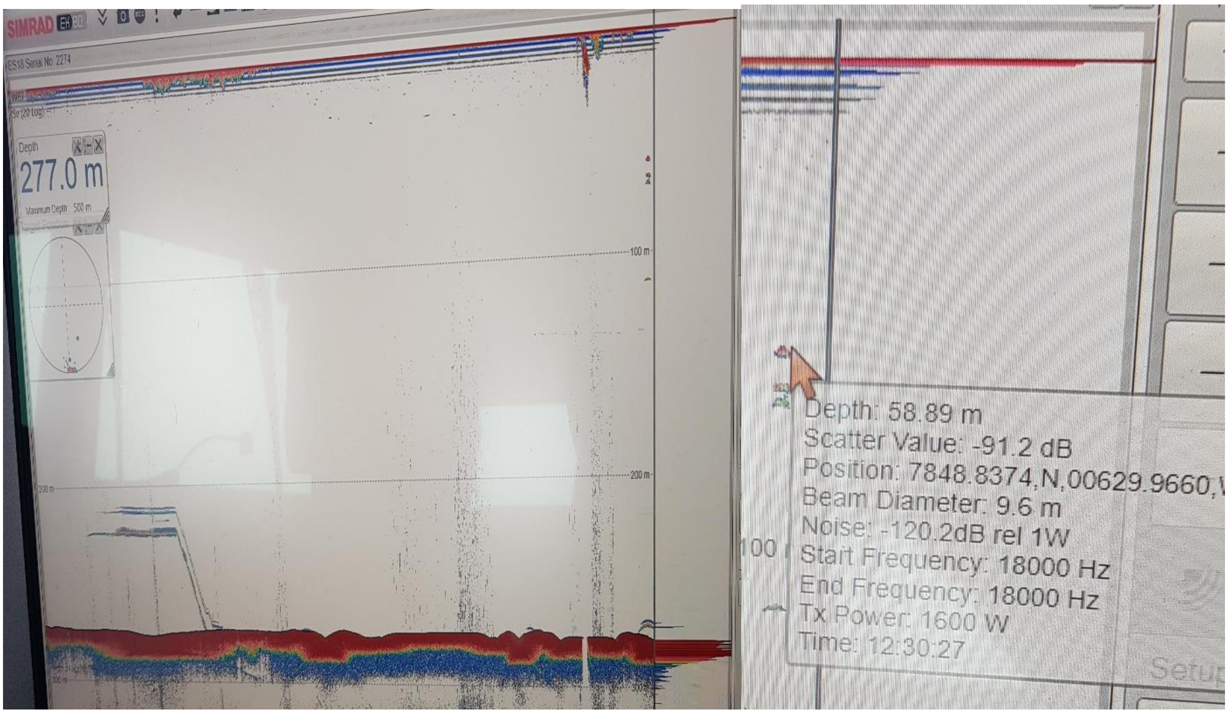


Figure 4.2: Echogram from F14 deployment, showing the descent of the buoyancy spheres, its position at

deployment time and the depth of the top-float at approximately 59 m depth.

Notes:

- IceCAT deployed on F10-17 had 1800 s sample interval. For the instrument on F10-18 Jan Are set the sample interval back to earlier 900 s, believing that the batteries last for two years with that. Note that datalogger is set to requesting latest sample once per hour, i.e. it is usually leaping over 3 samples (but always getting a sample taken close to the logger request time, which is good if logger and instrument clocks are drifting. For future cruises, however, the SBE37 should be programmed with the same logging interval as the datalogger.
- Due to the notes on struggle with kevlar lengths, mooring lengths, target depths of upper instruments and target bottom depths for F10-16 and F10-17, the length of the weak link was adjusted after touching the seafloor once (there was very little drift during the deployment). The top of the weak link from F10-18 was visible on the EK80 at 25m depth after deployment.

4.3 ADCP calibrations FS2022

- Two ACDP calibrations (F10 and F14) were carried out in May 2022 in Tromsø
- A fresh battery was installed in the LADCP, which was not calibrated prior to its use on the CTD rosette, which is not ideal.

5. CTD Measurements

CTD work and water sampling was carried out, following the cruise plan and focussing on the main CTD section in eastern Fram Strait (Figure 5.1). The highest priority was given to full-degree stations in western Fram Strait (0E to 10 W), and as a second priority filling in half-degree stations as well as additional stations in central and eastern Fram Strait. The western part of the East Greenland shelf was not visited due to time constraints and sea ice conditions. The aim was to complete the section within the band N 78º 45’ to N 78º 55’. This band is 10 nm and within 5 minutes longitude of target positions. The criteria were met for all stations, except for the station at W 5º, which was taken 5 nm further west from the target corridor due to ice conditions.

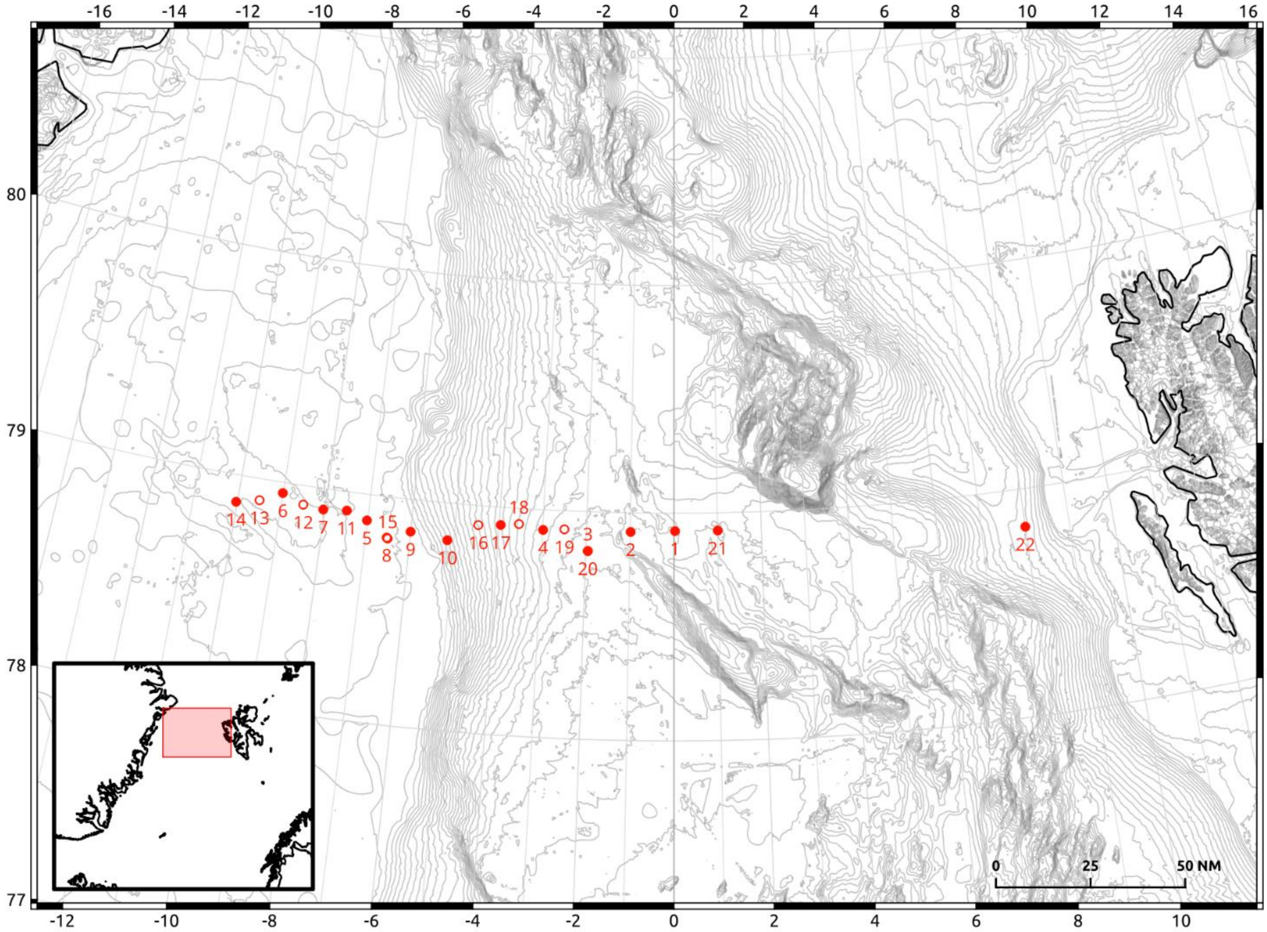


Figure 5.1. CTD stations completed during FS2022. Where two stations occur at the same location, the number of the second station is offset for readability. Full circles represent stations with full water sample plan, empty circles represent Nuts, O2 and salt samples only.

Station	Depth [m]	Latitude [N]		Longitude [E]	
		[deg]	[min]	[deg]	[min]
1	2497	78	55,29	0	1,51
2	2658	78	54,97	0	59,32
3	2704	78	49,67	-1	57,23
4	2490	78	54,7	-2	59,42
5	244	78	53,15	-7	0,97
6	265	78	57,19	-9	0,46
7	174	78	54,48	-8	2,19
8	264	78	49,26	-6	31,46
9	346	78	51,5	-5	59,97
10	877	78	50,21	-5	8,97
11	183	78	55,05	-7	29,92
12	240	78	54,99	-8	30,28
13	217	78	54,34	-9	30,49
14	226	78	52,89	-10	1,67
15	266	78	49,03	-6	30,1
16	1611	78	54,86	-4	28,56
17	2008	78	55,33	-3	57,87
18	2245	78	55,88	-3	32,98
19	2600	78	55,12	-2	30,3
20	2704	78	49,66	-1	57,13
21	2541	78	55,34	1	0,18
22	1013	78	49,97	8	0

Table 5.1. Station list with maximum depth.

5.1 General Approach

The CTD used was an SBE911+ unit with 12 bottle rosette. The T, S and O_2 ducts were neither flushed with Triton-X nor freshwater between stations. Sometimes, an alcohol-seawater mixture was injected by using a syringe to reduce the risk of freezing of the sensors during cold conditions. The sampling procedure from the cruise plan was adopted following a step-by-step checklist (Appendix D). Water samples were taken according to the updated sampling plan and filled out pre-fabricated logsheets on each station. Sometimes, the pump on the CTD would not start for several minutes because of low values on one of the conductivity sensors. Sometimes, the package was then lowered 40-50 m before the pump started, as is noted in the logsheets.

5.2 CTD Package Configuration

Channel	Sensor	Serial Number	Last Calibration
Frequency	Temperature 1	2400	26.04.2022
Frequency	Conductivity 1	3447	05.05.2022
Frequency	Pressure	0972	20.02.2014
Frequency	Temperature 2	4052	24.05.2022
Frequency	Conductivity 2	3234	05.05.2022
A/D Voltage 0	CDOM1 Fluorometer	1930	-
A/D Voltage 1	Free		
A/D Voltage 2	CDOM2 Fluorometer	4531	-
A/D Voltage 3	Free		
A/D Voltage 4	SBE43 Oxygen	3841	28.06.2022
A/D Voltage 5	Free		
A/D Voltage 6	Altimeter	48701	01.08.2010

Table 5.1: CTD package configuration during FS2022.

5.4 Temperature and Salinity Sensor Cross-Validation

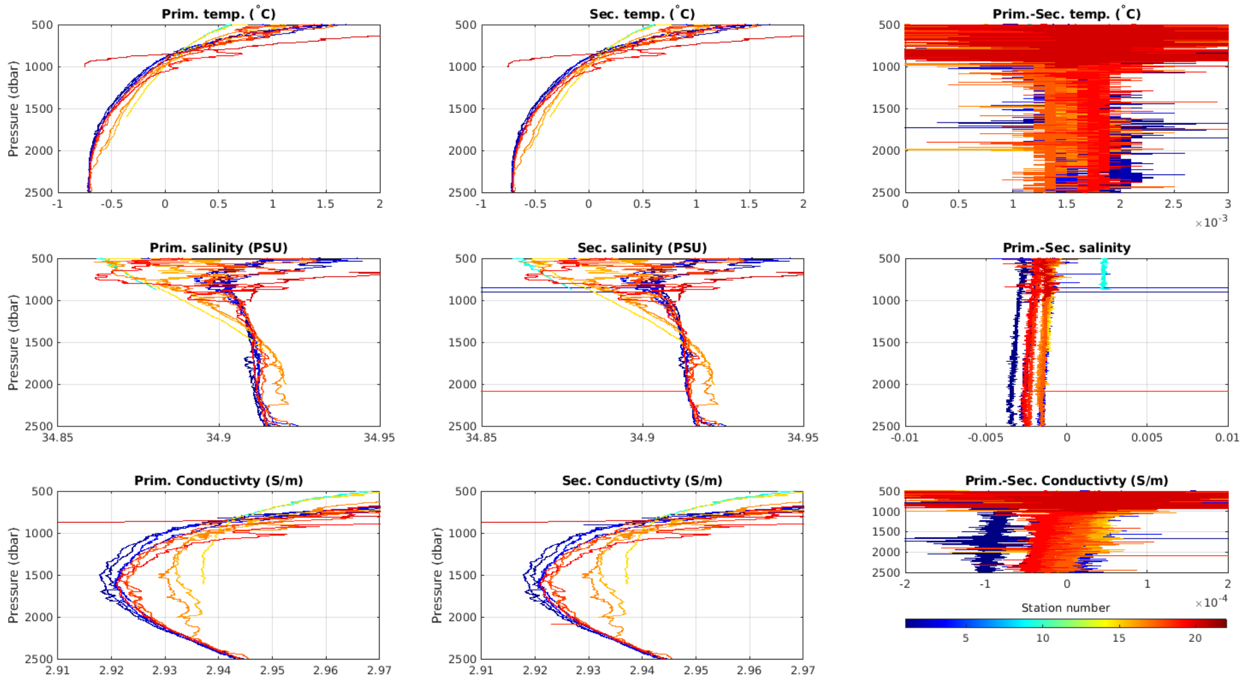


*Figure 5.2: Profiles of temperature, salinity and conductivity of from the primary (left column) and secondary (center column), as well as their differences (right panel). Colors indicate the station number of individual profiles. The temperature sensors showed a constant difference of ~1.5*10^-3 degC, the conductivity sensors initially showed a maximum difference of ~ -1*10^-4 S/m, which decreased and slightly increased again over the course of the cruise. The combination of these effects resulted in a slightly drifting negative difference between the salinity values obtained from the primary and secondary line.*

6. Biogeochemical Program

Table 6.2 lists sample types that were collected from Niskin bottles. No analysis was carried out on board. All samples were preserved for further analysis ashore.

Sample type	**Description**
Laboratory Salinity	Used to validate and (if necessary) calibrate conductivity sensors on the CTD. Required to obtain representative salinity values for Niskin bottles closed in steep salinity gradients, where CTD salinity values are unsuitable.
Dissolved Inorganic Carbon (DIC) & Total Alkalinity (A_T)	Used to investigate the carbonate system, including estimation of carbon fluxes and monitoring of the ocean acidification state.
Nitrate, Nitrite, Phosphate, Silicate & Dissolved Organic Carbon (DOC)	Nutrients: Used to investigate nutrient cycling in Arctic Ocean and to trace Pacific Water DOC: Used to investigate the carbonate system, including estimation of carbon fluxes. NB: Measured from nutrient bottle samples.
Stable Oxygen Isotopes ($\delta^{18}O$)	Used to separate sea ice meltwater from river input & precipitation. Combined with CDOM and/or total alkalinity measurements $\delta^{18}O$ is also be used to identify freshwater from precipitation.

^{129}I	Used to trace Atlantic-derived water masses circulating in the Arctic Ocean basin. Also used to study the fate of anthropogenic radionuclides released by fuel reprocessing.

Table 6.2 – Parameters measured from water samples collected during FS2022

6.1 Samples collected from the water column

Table 6.3 lists the water samples collected at each CTD station. A total number of 1085 samples was collected. 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.

Western Fram Strait water sampling plan FS2022

Type											
	GREENLAND	ICE	ICE	ICE	ICE	ICE	ICE	ICE	ICE	ICE	ICE
		(near F20)				(near F17)			(near F14)		(near F13)
	Station #	14	13	6	12	7	11	5	8, 15	9	10
	Longitude	10° W	9° 30' W	9° W	8° 30' W	8° W	7° 30' W	7° W	6° 30' W	6° W	5° W
	Latitude	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N
	Approx targ. depth	290		222		188	185	247	276	346	1024
	8 dbar	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I
	15 dbar	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N,OC,TA
	25 dbar	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I
	50 dbar	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I
	75 dbar	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N,OC,TA
	100 dbar	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I
	150 dbar	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I
	200 dbar	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	(Seabed)	(Seabed)	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I
	250 dbar	S,O,N,OC,TA,I	(Seabed)	(Seabed)	(Seabed)	(Seabed)	(Seabed)	(Seabed)	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I
	400 dbar	(Seabed)	(Seabed)	(Seabed)	(Seabed)	(Seabed)	(Seabed)	(Seabed)	(Seabed)	(Seabed)	S,O,N,OC,TA,I
	Bottom	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA,	S,O,N,OC,TA
	Comments							CDOM filter possibly not well enough flushed at bottle 1-3			
	1018										
Type	Totals										
Salinity	216	10	9	9	9	8	8	9	20	10	11
d18O	216	10	9	9	9	8	8	9	20	10	11
Nutrients	216	10	9	9	9	8	8	9	20	10	11
CDOM	145	10		9		8	8	9	0	10	11
ATCT	145	10		9		8	8	9	0	10	11
129I	80	6		6		5	0	6	0	7	8

Type											
	GREENLAND	ICE	ICE	ICE	ICE	ICE	ICE	ICE	ICE	WATER	WATER
			(near F12)		(near F11)		(near F10)				
	Station #	16	17	18	4	19	3, 20	2	1	21	22
	Longitude	4° 30' W	4° W	3° 30' W	3° W	2° 30' W	2° W	1° W	0°	1° E	8° E
	Latitude	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N	78° 55' N
	Approx targ. depth	1490	1902	2283	2515	2631	2706	2558	2630	2474	1021
	8 dbar	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA, I	S,O,N,OC,TA,I
	15 dbar	S,O,N	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA
	25 dbar	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA
	50 dbar	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA
	75 dbar	S,O,N	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA
	100 dbar	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA
	150 dbar	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA
	200 dbar	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA
	250 dbar	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA
	400 dbar	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA,I	S,O,N,OC,TA	S,O,N,OC,TA
	Bottom	S,O,N	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA	S,O,N,OC,TA
	Comments				additional samples at 1000 m, no LADCP		additional samples at 1000 m, no LADCP	additional samples at 1000 m, no LADCP	12th bottle with bottom water used to filter CDOM filter, no LADCP	bottle depths according to deep sampling plan, all parameters taken	bottle depths according to deep sampling plan, all parameters taken
	1018										
Type	Totals										
Salinity	216	11	11	11	12	11	12	12	11	11	11
d18O	216	11	11	11	12	11	12	12	11	11	11
Nutrients	216	11	11	11	12	11	12	12	11	11	11
CDOM	145	0	11	0	12	0	12	12	11	11	11
ATCT	145	0	11	0	12	0	12	12	11	11	11
129I	80	0	8	0	8	0	8	8	8	1	1

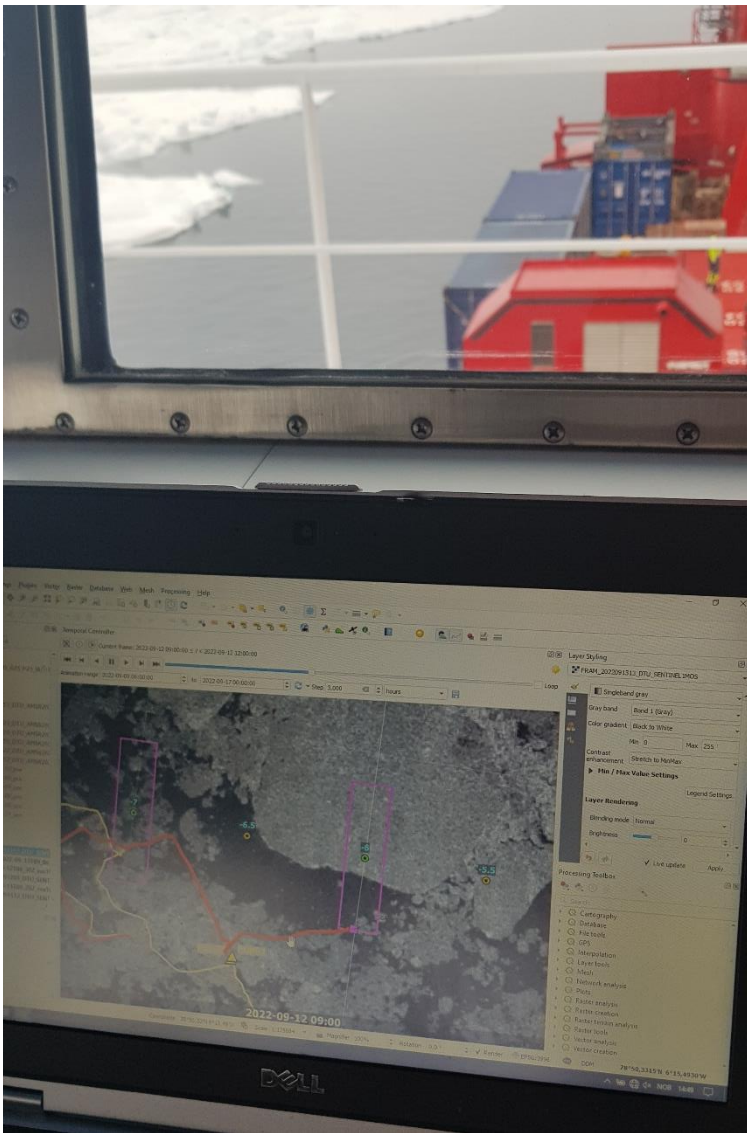
Table 6.3 Number of each type of water sample collected at each CTD station.

7. LADCP measurements

Lowered Acoustic Doppler Current Profiler (LADCP) data were collected at all CTD stations starting from station 5. The set up consisted of a single-head LADCP system (one downward looking master) with internal battery and a flotation element for balance mounted on the 12-bottle CTD rosette. The CTD-sensor package was originally mounted such that there was no space for the LADCP (the main unit/ modem facing the wrong direction within the non-symmetric mounting bracket). The sensor package was disassembled during transit to the East Greenland shelf and re-mounted, so that the LADCP could be fitted, taking up the space of one bottle. The LADCP was activated and deactivated and data was downloaded on each station, following the checklist (Appendix E) that was developed based on the TrollTransect 20/21 checklist, inputs from L. de Steur, and further testing during the cruise. The script files to program and start the LADCP are given in (Appendix F). Note that LADCP and CTD profiles are synchronized through their timestamps. Hence the offset of the LADCP clock (usually set through the LADCP computer) from UTC should be minimized. In our case, setting the LADCP clock needed to be done via a separate computer (only once at the start, instead of at every station), because we had no permission to change the time on the LADCP computer. The CTD data are recorded with UTC time stamps directly from the GPS that is connected to the CTD computer.

Figure 7.1: Pictures of the LADCP and buoyancy mounted correctly on the "labelled" side of the rosette and the two-lined sensor package sticking far out on the "unlabelled" side to maximize space.

8. Ice charts and mapping tools



Prioritizing and timing of mooring operations and CTDs were guided by georeferenced sea ice images and weather forecasts retrieved via the ship's Iridium internet connection from (1) a customized FTP site provided by the technical university of Danmark (Sentinel & AMSR2, POC Roberto Saldo, saldo@dtu.dk) and (2) using the NPI-developed "vixed" mailer service (Sentinel & EMSF).

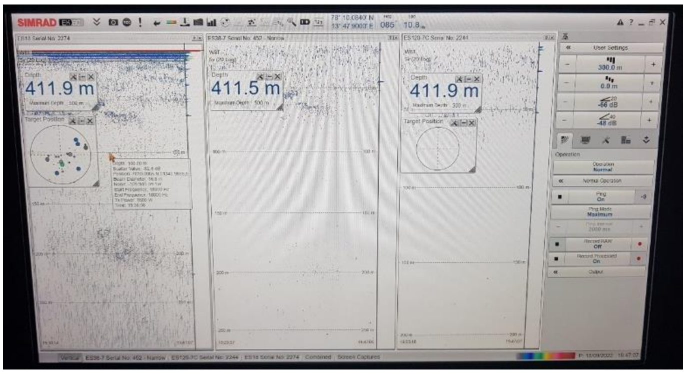
Sea ice images and weather information were displayed together with other relevant mapping information, such as station location, bathymetry, and the ship's real-time position on an NPI-owned navigation computer that was permanently installed on the bridge, using QGIS. That computer was receiving the ship's NMEA feed, recording the cruise track via a serial connection that was installed for that purpose.

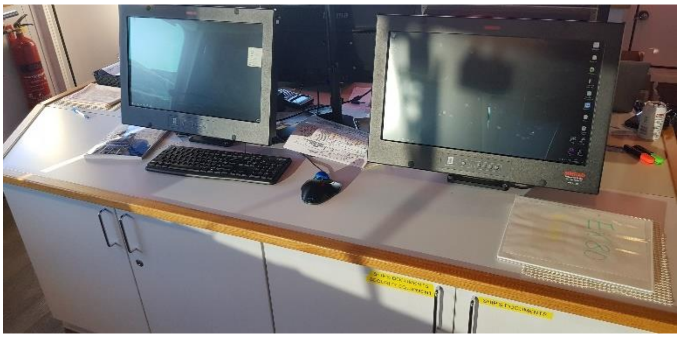
Potential visual sea ice observations following the IceWatch/ASSIST protocol were not carried out, because of the limited capacity of the science team and the lack of software for efficient logging.

The NPI navigation computer conveniently located on the bridge for displaying sea ice maps in QGIS together with the ship's real time position. Position data were obtained and logged as cruise track via an RS232 NMEA feed from the ship's GPS that was installed for that purpose before the departure.

9. EK80 three-channel Echosounder

A one-day introduction to the three-channel echosounder was given on board of Silver Arctic in Tromsø by Simrad/ Kongsberg, attended by three members of the science team and some of the ship's crew. During the cruise, the 18 kHz channel was successfully used to measure the bottom depth during the mooring- and CTD work, as well as for locating the moorings and checking water depths of the instruments in the water column.





Above: The EK80 is accessible through a computer with two screens in the wheelhouse via a remote desktop solution that connects to the main instrument computer in the server rack (left) behind in a closet nearby. For data download, an external harddrive was directly connected to the main instrument computer.

10. Science deck arrangement

The main crane was used for both CTD profiling (left) and mooring operations (right, recovery of F14B). For the latter, this is an optimal solution with a lot of flexibility and large lifting height of the crane to lift several meter long instrument groups over the side of the ship during few, concentrated operations. For frequent CTD work the use of a dedicated A-frame that can be operated by the science team is recommended. This would speed up the process, eliminate the requirement of a dedicated crane driver for CTD work at any time of the day, and reduce risk of damage/ injury with a lower lifting height and more controlled movement of the instrument when the CTD lifted over the side of the ship, in particular in wavy conditions.

View on the science deck (upper), with mooring equipment lined up prior to deployment of F14. The container layout provides a sheltered working area and works well for the CTD and mooring operations. View of the vessel laying against the edge of a larger ice floe (lower) during the deployment of F14

Left: Lifting of the top float group of F10 with the main crane over the side of the ship from the flat-rack platform. The seal wire of the weak-link is laid out along the side of the ship with people manually managing the instrument and float atop during the deployment.

Lower: Lifting of the F10 anker over the side of the flat-rack by use of the main crane and NPI-winch container.

View into the heated CTD control-room area (upper) that is located on the port side next to the winch container. The container doubles as a dry workshop space that can be used for storing, mounting and programming instruments or other equipment.

View into the heated CTD lab container (left), while setting up the LADCP computer. The CTD is standing behind the camera and here, water sampling took place and empty sampling bottles, the logsheets etc. were stored.

Watch out for objects that may fall onto people operating down in the

Stowaway of the hatch

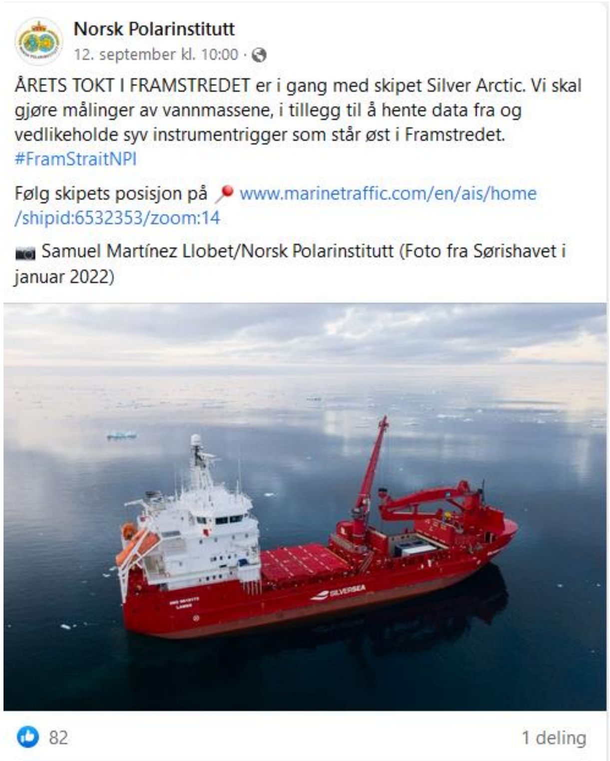
Upper: View into the forward cargo hull (lower) that can be accessed walking through two doors and via a smaller cargo hatch from the main deck. The area offers plenty space for sheltered instrument maintenance, but it needs several days to warm up (heating needs to be turned on in time) and is exposed to a lot of noise.

Left: View down into the forward cargo hull while instruments are being brought on deck with the main crane. The removable hatch has been lifted onto a rack on the port side in front of the science deck (orange oval). This operation provides access to convenient working space, but it requires very calm seas and takes some time during which the main crane is not available for other work. Moving equipment in and out this way should be grouped for efficiency and probably completed before leaving the ice. Alternatively future improvements could include a hinge-system to open the hatch.

Originally, the science deck was only accessible via vertical leaders (left) from the main gangway. Those were considered impractical when moving items around (e.g. water samples) and climbing those leaders is less save when the ship is moving due to waves or when impacting the sea ice. During the cruise, the leaders were closed and instead, improvised staircases were installed from the aft crane platform (center) that is safely accessible via a staircase and onto the science deck (right). Ideally, this structures will be made more permanent/ robust in the future, or even better, the reeling of the crane platform can be (temporarily) opened to install a flat gangway onto the science deck.

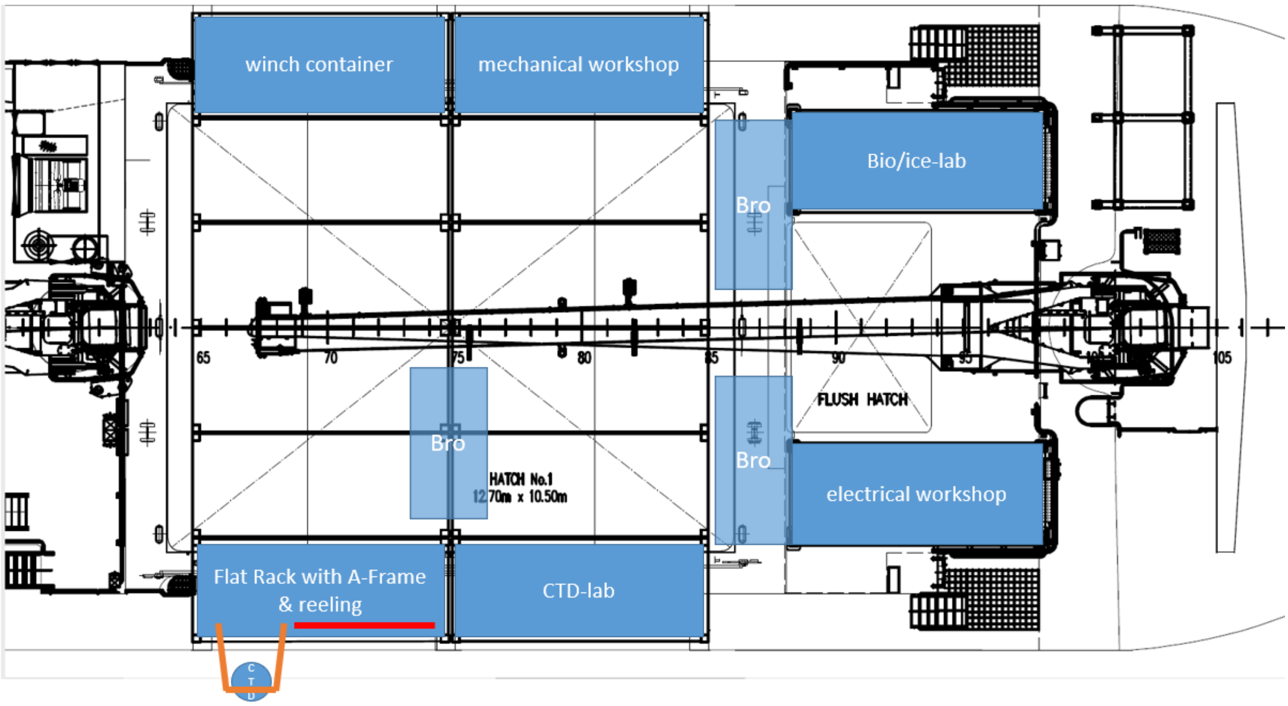
11. Communication and outreach

The fjrodshipping IT safety policy does not allow external individuals to use any of the ship's bridge computers. Hence, for future cruises, it would be preferred to bring a separate NPI computer that can be connected via ethernet to the iridium internet connection (VSAT is broadcasted via Wifi on board).



Thanks to e pre-prepared plan from the info department and support from the Oceans and sea ice section, we reported on the oceanseaicenpi Twitter/ Instagram and NPI general facebook accounts.

Appendix A: Diagrams of the planned science deck layout

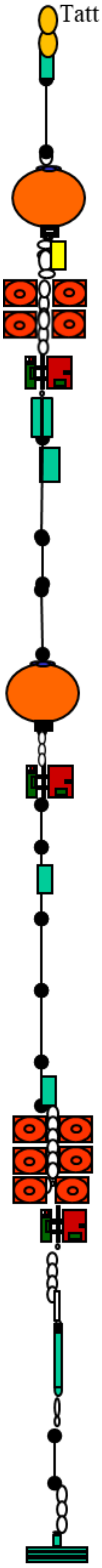


Appendix B: Diagrams of moorings recovered

Rigg F10-17

Satt ut 17/8-21 , kl 18:03 — 78 49,637N

Tatt opp 11/9-22, kl 07:45 — 001 57,080W

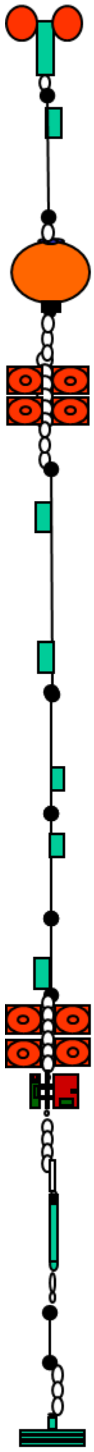


		Dyp:	Fra bunn:	Ned i vann:
SBE37IM	SNR. 23250	24	2626	18:02
ADCP 300	SNR: 24899	52	2598	18:00
Batteribeholder DL-NPI005		53	2597	18:00
AQUADOPP	SNR. 665	56	2594	18:00
SAMI CO2/pH	SNR. 227/261	57	2593	18:00
RBR ODO	SNR. 207317	58	2592	18:00
100 (102) m Kevlar				
40 m Kevlar				
20 m Kevlar				
Plastkule 40'' Med svivel. 1 m Kjetting Galv.				
AQUADOPP	SNR. 15888	221	2419	15:10
0,5 m Kjetting Syrefast 0,5 m Kjetting Galv.				
RBR Concerto	SNR. 207318	223	2417	15:10
4 x 500 (538,40,21,198,198,516,506) m Kevlar				
200(204) m Kevlar 100 (101 m Kevlar 60 m Kevlar				
(totalt i midten 2322)				
SBE37	SNR. 23266	2634	16	14:17
6 Glasskuler 3 m Kjetting Galv.				
Nortek	SNR. 15877	2639	11	14:17
Svivel				
AR861	SNR. 506			
5 m Kevlar				
3 m Kjetting				
ANKER 1200/(1000) kg		2650 (2665)	0	

Rigg F14-23

Satt ut 14/8-21 , kl 12:05
Tatt opp 13/9-22 kl 17:00

78 48,848N
006 30,127W

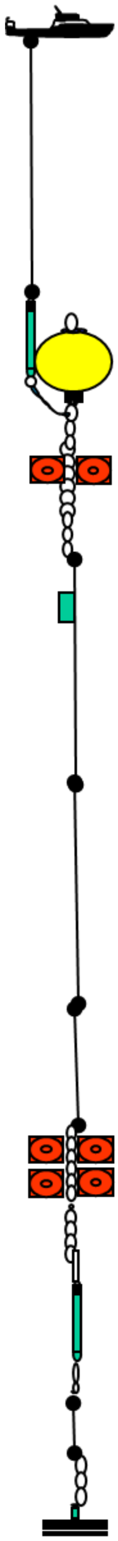


		Dyp:	Fra bunn:	Ned i vann:
IPS	SNR. 51138	48	222	12:05
SBE37	SNR: 7058	60	210	12:05
5 m Kevlar				
ADCP 300	SNR: 17461	65	205	11:53
1 m Kjetting Galv. 4 Glasskuler 2 m Kjetting galv.				
0,5 m Kjetting Galv.				
SBE37	SNR. 7054	112	158	11:49
100 m Kevlar				
SBE37	SNR. 9853	150	120	11:45
50 m Kevlar				
SBE56	SNR: 10330	203	67	
SBE56	SNR: 10331	228	42	
40 m Kevlar				
SBE37	SNR.7057	257	13	10:53
4 Glasskuler				
2 m Kjetting Galv.				
Aquadopp	SNR. 16603	260	10	10:53
Svivel				
AR861	SNR. 568			
3,5 m Kevlar				
2,5 m Kjetting				
ANKER 900/(740) kg		270 (270)	0	

Rigg F14B-1

Satt ut: 6 mai 2022 kl 09:22 UTC
Tatt opp 13/9-22 kl 21:00

78° 48.995N
06° 29.704W



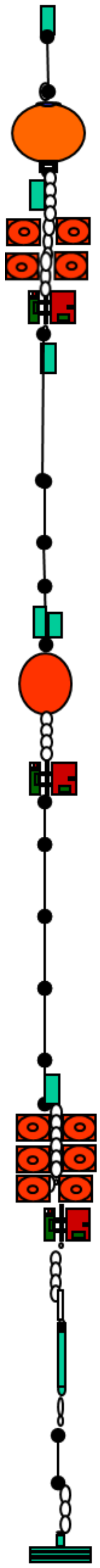
		Dyp:	Fra bunn:	Ned i vann:
100 m tykk rød Kevlar til utsetting				
AR861 Arm 0897 Release 0855	SNR. 1220			
Signature 250 + float	SNR: 103518	63	227	
1 m Kjetting Galv. 2 Glasskuler 2 m Kjetting galv.				
0,5 m Kjetting Galv.				
SBE37	SNR. 12234	67	202	
100 m Kevlar				
52 m Kevlar				
40 m Kevlar				
4 Glasskuler 2 m Kjetting Galv.				
Svivel				
AR861	SNR. 409			
3,5 m Kevlar				
2,5 m Kjetting				
ANKER 630/(500) kg		270 (273)	0	

Appendix C: Diagrams of moorings deployed

Rigg F10-18

Satt ut 17/9-2022, kl 10:52

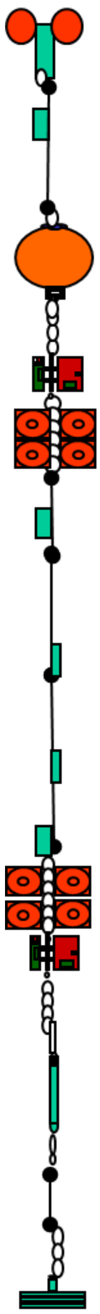
78 49,636N
001 57,077W



		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 F14-24
Satt ut 15/9-2022, kl 11:57
Tatt opp Aug 20

78 48,844N
006 29,788W



			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 D: CTD computer checklist

SBE9 CTD Station Checklist

History: Last edited September 2022 based on TrollTransect 2020 updated on based on Silver Arctic Fram Strait 2022 cruise plan with inputs from J. Lauber, P. Dodd, Y. Kern & T. Hattermann

Start-up

- Fill out station number, echodepth, date & time on logsheet
- Start SeaSave software & switch on deck unit
- In the menu, click "Real-Time Data" and "Start"
- Change filename, counting stations using 3 numbers i.e., 001.hex, 002.hex etc. Each cast is a new station; use same file number for LADCP
- Click "Start"; enter information; click "Ok" to start data recording
- Check if GPS data are recorded in the NMEA window (restart PC without GPS if mouse goes crazy) and note position on log sheet
- Put CTD into water for surface soak at 20 m
- Check that the pump started (deck unit switching from 10 to 11), then
- Wait for 2 min (use a timer), then check that double sensor differences (salinity 1 – salinity 2, etc.) are normal before starting the profiling

During the Cast

- Raise package, slowly approaching "surface depth" (1-2 dbar); immediately lower to 25 m with speed of 0.5 m/s, then increase to 1 m/s; in waves, 0.8-1.2m/s ok, if speed exceeds 1.2 m/s, slow down
- 50 - 100 m above the bottom, slow down to 0.5 m/s and monitor the altimeter, bottom alarm & pressure reading carefully
- Stop 10 m above bottom, log pressure & altimeter reading, fire first bottle, wait 2 seconds and begin to raise the CTD immediately with a constant speed around 1-1.5 m/s.
- Use "bottle fire control" in seasave software, stop for 2 s before firing each bottle and wait 2 s before continuing; deactivate/ click "outside" the fire window reduce risk of false firing.
- If closing a bottle at 1 m, do so without stopping.

After

- Bring CTD on deck
- Stop acquisition by clicking "Real-Time Data" and "Stop"
- Switch off deck unit
- Right click on the data window and select "Save picture as…" and save 001.jpeg, 002.jpeg etc.
- Backup new hex-file and jpeg on external hard drive or USB
- Bring paper log sheet to CTD for bottle sampling

Appendix E: LADCP checklist

LADCP Station Checklist

History: Last edited September 2022 based on TrollTransect 2020 updated on based on Silver Arctic Fram Strait 2022 cruise plan with inputs from J. Lauber, L. de Steur, Y. Kern & T. Hattermann

Before

- Connect LADCP to PC (know your COM-port, care about the pins)
- Rename the log- and raw filename in the script file according to the current station, e.g. change *[cruise_dir]/LADCP/Script File/single_beam.txt* **RN L001_** to **RN L002_**
- Start BBtalk software (Version 3.09, 3.01 behaves differently)
- Select "Workhorse" and the correct COM-port, click "Next"
- Set Baud Rate to 9600, Parity to None, Stop Bits to 1, Flow Control to None, click "Next"
- Tick "Error Checking For Script Files", "Send CK On Baud Rate Change (CB Command)" and "Wait For Prompt in Script File". Click "Finish".
- Connect to instrument by clicking the blue "B" in the menu
- ~~Click "Transfer" and "PC time to ADCP"~~ (could not adjust time on pc)
- Click "File" and "Send script file" and select single_beam.txt. Press "OK".
- Wait for script to run through (last command is "CS", see binary output)
- Check that ADCP is pinging (you can hear it!)
- Disconnect cable from LADCP and put dummy plug on (!!!)
- Take cap off (!!!)
- Put device into water

After

- Remove dummy plug and connect cable to LADCP
- Connect to instrument by clicking the blue "B" in the menu
- Type "cb811" in command window and push "Enter" to increase the baud rate for the download.
- Click "File" and "Recover recorder"
- Select for the Directory where the files should be downloaded. Click "OK"
- Select the latest data file (end of list) and click "Ok"
- In the popping up window, click "Disable window output"
- Move mouse out of window to not accidentally abort the download
- Wait until download is finished (~15 min),
- Type "cb411" in command window and push "Enter" to decrease the baud rate to talk to the instrument.
- Put LADCP to sleep by typing "cz" in command window and push Enter
- Secure new 000-file on hard drive
- Put cap on

Appendix F: Script files for Master programming and starting

; Append command to the log file
$LC:\KH2019702\LADCP\ladcp_log.txt   !! EDIT PATH for log file
$P
CR1
WM15
;   !!! PRIOR TO EACH CAST MAKE SURE TO RENAME THE FILE NAME BELOW (L001_) TO MATCH EXACTLY THE CTD STATION NR, ie 001 is CTD station 1, 002 is CTD station 2, etc !!!:
RN L001_
LZ030,220
CF11101
EA0
EB0
ED0
ES35
EX00111
EZ1111101
WB1
WD111100000

; blank after transmit [cm]
WF0176

; number of bins
WN015

; pings per ensemble
WP1

; bin length [cm]
WS0800

; ambiguity velocity [cm]
WV250

; SET AS MASTER ADCP
SM1

; TRANSMITS SYNCHRONIZING PULSE BEFORE EACH ENSEMBLE
SA001

; SYNCHRONIZING PULSE SENT ON EVERY PING
SI0

; WAIT .55 s after sending sync pulse
SW05500

; ensembles per burst
TC2

; time per burst

```
TB00:00:01.20

; time per ensemble
TE00:00:00.80

; time between pings
TP00:00.00
CK
; start Pinging
CS
; Delay 3 seconds
$D3
$p ****************************************************************************
$P Please disconnect the ADCP from the computer.
$P ****************************************************************************
; Close the log file
$L
;
;Instrument        = Workhorse Sentinel
;Frequency         = 307200
;Water Profile     = YES
;Bottom Track      = NO
;High Res. Modes   = NO
;High Rate Pinging = NO
;Shallow Bottom Mode= NO
;Wave Gauge        = NO
;Lowered ADCP      = YES
;Ice Track         = NO
;Surface Track     = NO
;Beam angle        = 20
;Temperature       = 5.00
;Deployment hours  = 12.00
;Battery packs     = 1
;Automatic TP      = YES
;Memory size [MB]  = 256
;Saved Screen      = 1
;
;Consequences generated by PlanADCP version 2.06:
;First cell range  = 10.11 m
;Last cell range   = 114.11 m
;Max range         = 116.10 m
;Standard deviation = 1.73 cm/s
;Ensemble size     = 521 bytes
;Storage required  = 21.46 MB (22507200 bytes)
;Power usage       = 43.18 Wh
;Battery usage     < 0.1
;
; WARNINGS AND CAUTIONS:
; WM15 feature has to be installed has to be installed in Workhorse to use selected option.
; Advanced settings have been changed.
```