



Laboratoire d'Océanographie Physique et Spatiale

UMR6523 – CNRS-IFREMER-IRD-UBO

<http://www.umr-lops.fr>

Cruise Report : ARcticGO 2022

Ship : “Le Commandant Charcot” (Ponant)

23 July 2022 to 7 August 2022

ref: 03.06.2022, 23.07.2022-07.08.2022, Jnr. 22/7880

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1. Abstract

The 15-days cruise (23 July to 7 August 2022) purpose was to deploy autonomous platforms and perform expandable measurements in the Eurasian Arctic Basin from the touristic icebreaker of opportunity “Le Commandant Charcot” which is run by the French Ponant Company, operating between Svalbard and the North Pole.

More specifically, the ARcticGO 2022 cruise, supported by french funding program LEFE- GMMC INSU and Argo France, aimed at:

- deploying under-ice autonomous profiling Argo floats that measure hydrological profiles over the water column in the framework of the International Argo program (<https://argo.ucsd.edu/>);
- deploying surface drifters measuring hydrological properties in the Marginal Ice Zone in the framework of the Global Drifter Program <https://www.aoml.noaa.gov/phod/gdp/>;
- carrying out XBT/XCTD and CTD hydrological measurements of the water column along the transect ~34°E between 80°N-90°N.

This scientific program involves several scientists from LOPS (UMR6523, Brest, France), and is done in collaboration with scientists from the Norwegian Argo program.

2. Context

The ArcticGo project is funded by the French LEFE GMMC INSU/CNRS program for 3 years over 2021-2023.

The Arctic region is experiencing some of the most rapid transformations on the planet in response to the on-going climate change. In response to the changes that have affected the atmosphere and the cryosphere in the Arctic Basin, changes in the ocean are also logically expected, although it remains challenging to detect a clear emerging signal from the observations thus far.

The purpose of the research is to deploy autonomous profiling floats in the framework of the international Argo program in the Eurasian Basin, in order to collect hydrological profiles (temperature, salinity, pressure and oxygen) over the water column (typically 2000 m depth). As the Eurasian Basin is seasonally ice-covered and hardly accessible without an icebreaker, the data coverage in the region is very sparse, preventing the monitoring of the Eurasian Arctic ocean physical change. To circumvent this constraint, the deployed floats are equipped with ice capacity allowing sea ice detection when profiling under ice. The data are then transmitted when the floats have drifted away and reached an ice-free region. This is an opportunity to monitor the evolution of heat and salt, as well as dissolved oxygen content in the Eurasian Basin, and to contribute to the reinforcement of the Argo network within the Arctic Ocean.

During the season when the cruise takes place (summer), sea ice is melting and strong freshwater fluxes are released at the surface of the ocean in the Marginal Ice Zone (MIZ). These processes have a strong impact on the upper ocean stratification and air-sea heat flux exchanges. To complement the observation of the water column, surface drifters buoys have been deployed in the MIZ to collect sea surface temperature and salinity data and surface current drift measurements. Monitoring the process driving the evolution of the MIZ during the seasonal sea ice retreat is particularly relevant in the context of the ongoing Arctic sea ice decline. The ARcticGO experiment has been conducted during summer 2022, and will be repeated during summer 2023 to monitor year-to-year variability of the melting processes in the MIZ.

3. Embarking Team

In the context of a cruise of opportunity the embarking team is restrained to only 2 scientists who are responsible for deploying the autonomous platforms and performing the CTD/XBT casts with the help of “Le Commandant Charcot” crew.

Table 1 : Embarking scientists and affiliation

Scientist	Affiliation	Country
Camille Lique	LOPS, Ifremer	France
Nicolas Kolodziejczyk	LOPS, UBO	France

4. Campaign plan

The ARcticGO 2022 cruise was operated along a radial between Svalbard (embarking at Longyearbyn, Svalbard) and North Pole (Eurasian Arctic Basin 77°N – 90°N / 0°E – 35° E). See Figure 1 for previsual campaign plan. The summary of deployment is as follow

- deploying 5 under-ice autonomous profiling Argo floats, at the North Pole (2) and in the MIZ (~83°15'N-34°E, 3), that measure hydrological profiles over the water column in the framework of the International Argo program (<https://argo.ucsd.edu/>);
- deploying surface drifters in the MIZ (~83°15'N-34°E, 3) measuring hydrological properties in the Marginal Ice Zone in the framework of Global Drifter Program (<https://www.aoml.noaa.gov/phod/gdp/>);
- performing XBT/XCTD and CTD hydrological measurements of the water column along the transect ~34°E between 80°N-90°N .

The planning of the scientific operations achived during the cruise is given Table 2:

Table 2: Planning of the ARcticGO 2022 cruise

Day	Date	Operations	Remarks
1	23/07/2022	Embarking and departure 7:00 p.m. LT	Longyearbyen, Svalbard
2	24/07/2022	Transit, beginning of scientific operation, XBT/XCTD launch	
3	25/07/2022	Station , CTD cast (1), Argo (1), Drifter (2), XBT/XCTD	MIZ
4	26/07/2022	Transit, XBT/XCTD	
5	27/07/2022	Transit & station, XBT/XCTD, CTD	
6	28/07/2022	Station, Argo (1), XBT/XCTD, CTD	North Pole
7	29/07/2022	Station, Argo (1), XBT/XCTD, CTD	North Pole
8	30/07/2022	Transit	
9	31/07/2022	Transit	
10	01/08/2022	Station, Argo (2), Drifter (3), CTD	MIZ
11	02/08/2022	Transit, end of scientific operation	
12	03/08/2022	Transit	
13	04/08/2022	Transit	

14	05/08/2022	Transit	
15	06/08/2022	Transit	
16	07/08/2022	Arrival, disembarking ~7:00 a.m. LT	Longyearbyen, Svalbard

ARcticGO 2022

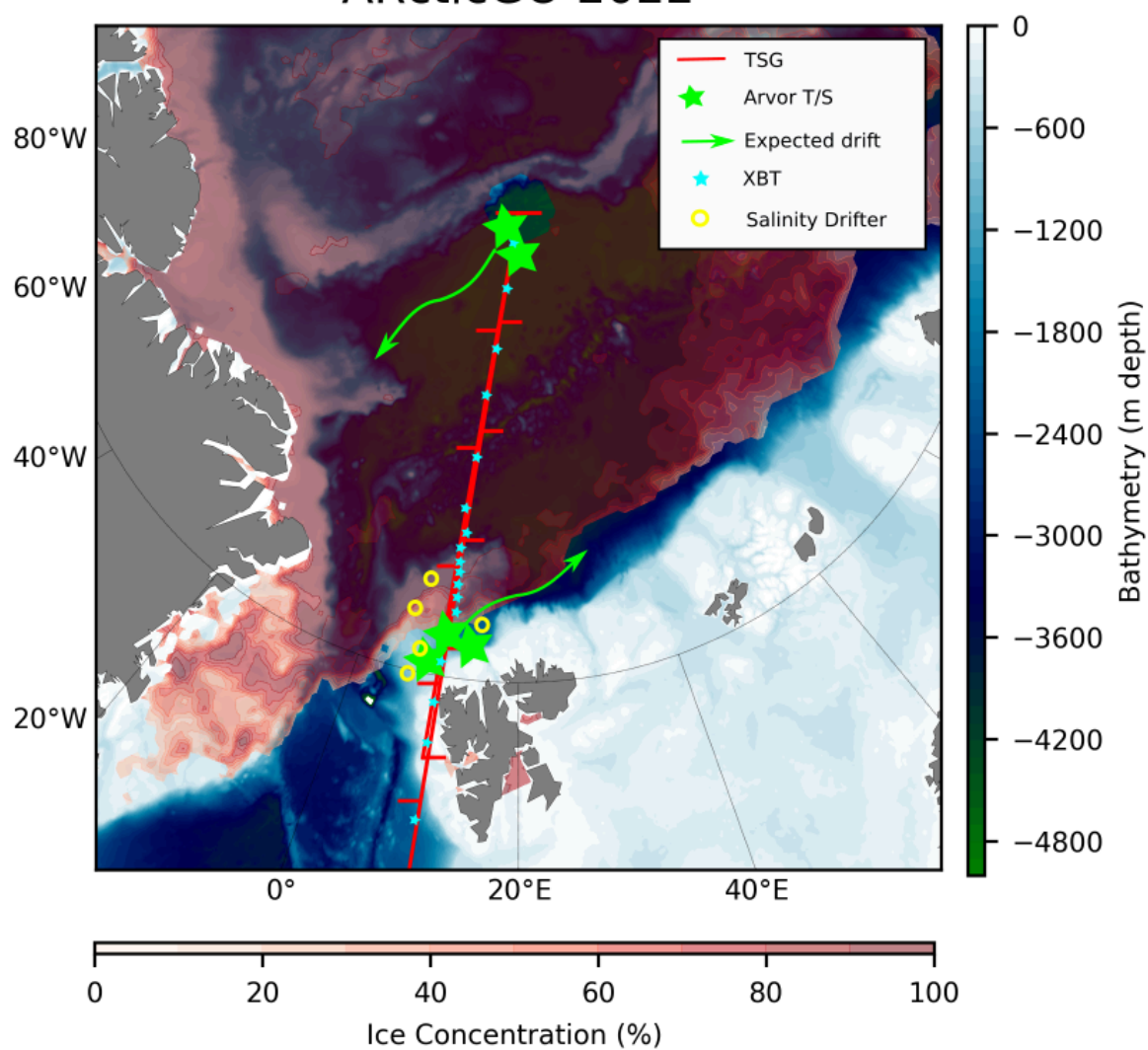


Figure 1: Summary of the deployments planned during the cruise ARcticGO 2022 actual track between Svalbard and the North Pole is plotted in Figure 8. Each symbol indicates a different instrument. The blue/green shading indicates bathymetry, while the red shading shows the extreme sea ice low extent for September 2012.

5. Details of the operations

a. Argo deployment

5 Argo profiling floats have been deployed along a transect between Svalbard and the North Pole. 2 floats have been deployed at the North Pole and 3 floats in the MIZ around 82°15'N (Fig. 1 & Table 2). The profiling floats are NKE ARVOR T/S collecting profiles of temperature, salinity and pressure between 0-2000 m every 10 days and between 0-200 m every day. The floats are equipped with an Ice Sensing Algorithm. The data are collected in the framework of Argo France program (<https://www.argo-france.fr/en>), which is a contribution to the international Argo program and freely distributed for fundamental research and operational oceanography : <https://argo.ucsd.edu/>. The float positions are instantaneously notified through : <https://www.ocean-ops.org/board?t=argo>.

Table 2 : Deployment position and set up of the Argo floats during ARcticGO2022.

Serial Number	WMO*	Type	Time (UTC)	Latitude	Longitude	CTD cast	Remarks
AI2600-21FR013	6903145	NKE Arvor Ice	25/07/2022 01h10	82 15.007N	33 52.903E	CTD cast1 800 m depth	MIZ
AI2600-21FR014	6903146	NKE Arvor Ice	28/07/2022 17h39	89°58'12.69"N	43°45'25.57"W	CTD cast3 800 m depth (x2+niskin at 800 m)	North Pole
AI2600-21FR015	6903147	NKE Arvor Ice	28/07/2022 17h39	89°58'12.69"N	43°45'25.57"W	CTD cast3 800 m depth (x2+niskin at 800 m)	North Pole
AI2600-21FR012	6903144	NKE Arvor Ice	01/08/2022 20h33	82 15.055N	34 57.410E	CTD cast6 800 m depth	MIZ
AI2600-21FR011	6903143	NKE Arvor Ice	01/08/2022 20h51	82 14.234N	34 55.581E	CTD cast6 800 m depth	MIZ

*Click on the WMO number to access detailed information on the floats technical and scientific data, and visualize data and trajectory plot from : <https://fleetmonitoring.euro-argo.eu/>

b. Surface Drifter deployment

5 surface drifters have been deployed in the MIZ north of Svalbard (~82°15'E). These drifters are NKE SVP BSC SC40 drifters measuring the surface temperature, salinity and atmospheric pressure. They are equipped with a drogue at 15 m depth to drift with the actual surface currents. The geolocalization by GPS provides us with their trajectories to estimate surface currents. The data are gathered in the framework of the Global Drifter Program and are freely distributed for fundamental research, operational oceanography and weather forecast: <https://www.aoml.noaa.gov/phod/gdp/>. Table 3 shows the list of SVP drifter deployed during ARcticGO 2022. SVP Drifters trajectories since the deployments are shown on map in Figure 2. The temperature, salinity, surface current velocity and Sea Surface Atmospheric Pressure time series for each drifter are shown in Fig. 3 to 7.

Table 3: Deployment position and set up of the SVP drifting buoys during ARcticGO2022

drifter	WMO	SN	IEMI	Time (UTC)	Latitude	Longitude	Remarks
1	6301843	SC40 Y21 N0021	300534060019420	25/07/2022 01h10	82 15.007N	33 52.903E	MIZ
2	6301844	SC40 Y21 N0020	300534060015500	25/07/2022 01h10	82 15.007N	33 52.903E	MIZ
3	6301846	SC40 Y22 N0001	300534062477410	01/08/2022 20h33	82 15.055N	34 57.410E	MIZ
4	6301847	SC40 Y22 N0002	300534062471340	01/08/2022 20h44	82 14.483N	34 57.805E	MIZ
5	6301845	SC40 Y21 N0019	300534060016500	01/08/2022 20h51	82 14.234N	34 55.581E	MIZ

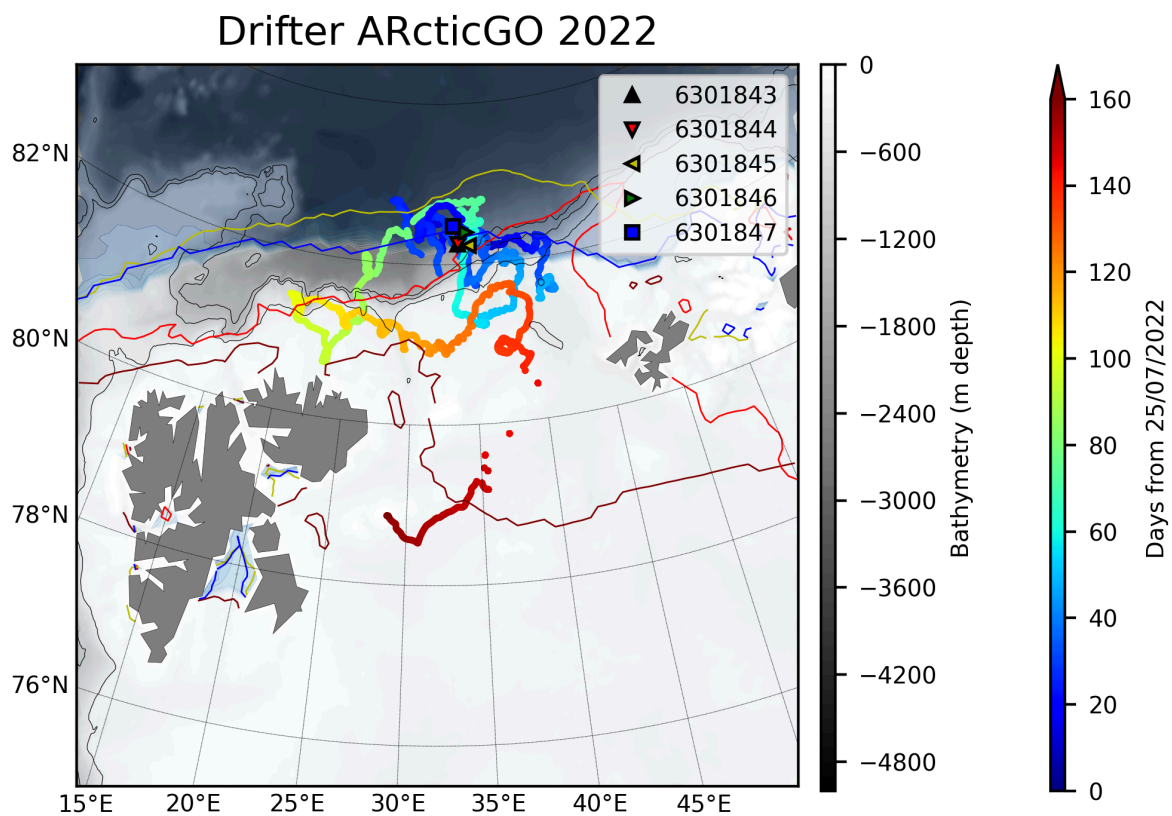


Figure 2: Trajectories (thick curves with color shading : day since 25 July 2022) of the 5 drifters 6301843-7 deployed in the MIZ during the Arcticgo2022 cruise north of Svalbard. Thin colored contours are the ice edge on 07/25/2022 (blue); 10/01/2022 (yellow); 12/01/2022 (red); and 12/31/2023 (brown).

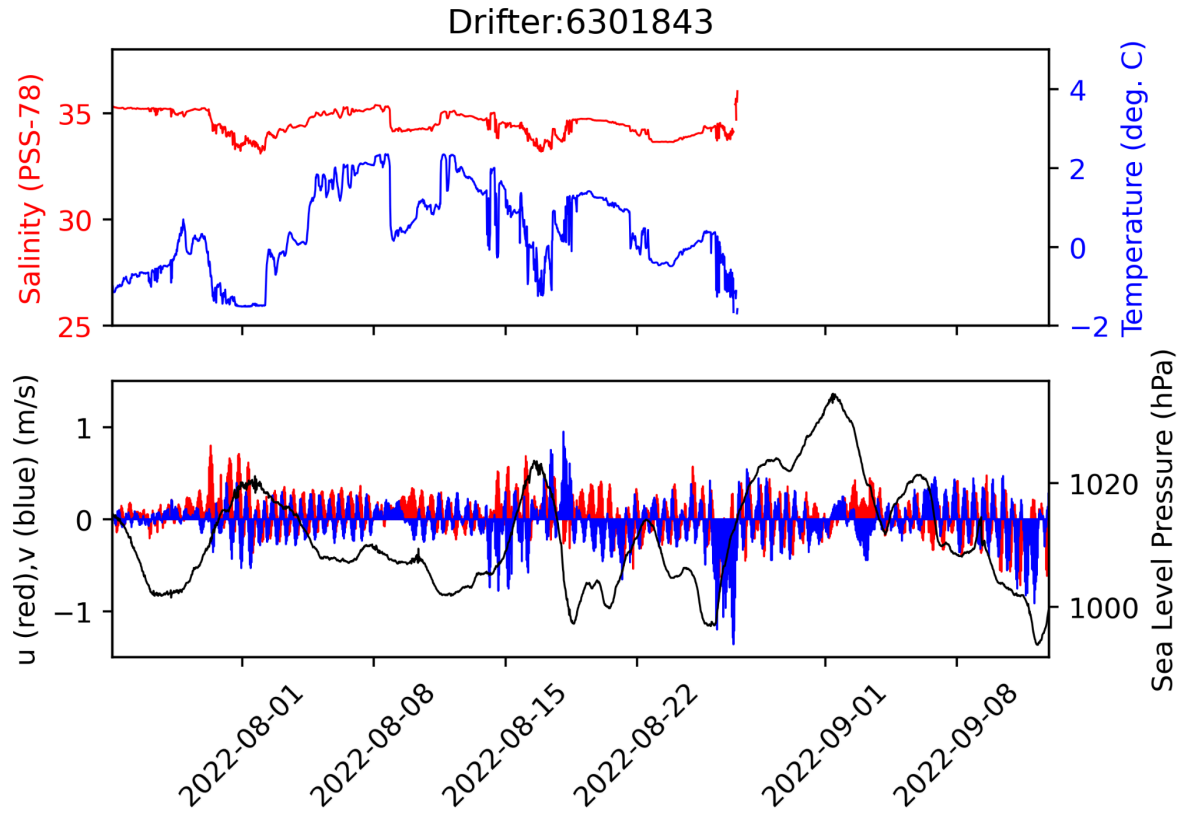


Figure 3 : Timeseries of temperature (blue, upper panel, in °C) , salinity (red, lower panel, in pss), surface (~15 m depth) zonal velocity (red, lower panel, in m/s), surface meridional velocity (blue, lower panel, in m/s), and Sea Level Atmospheric Pressure (black, lower panel, in hPa) along the drifter 6301843.

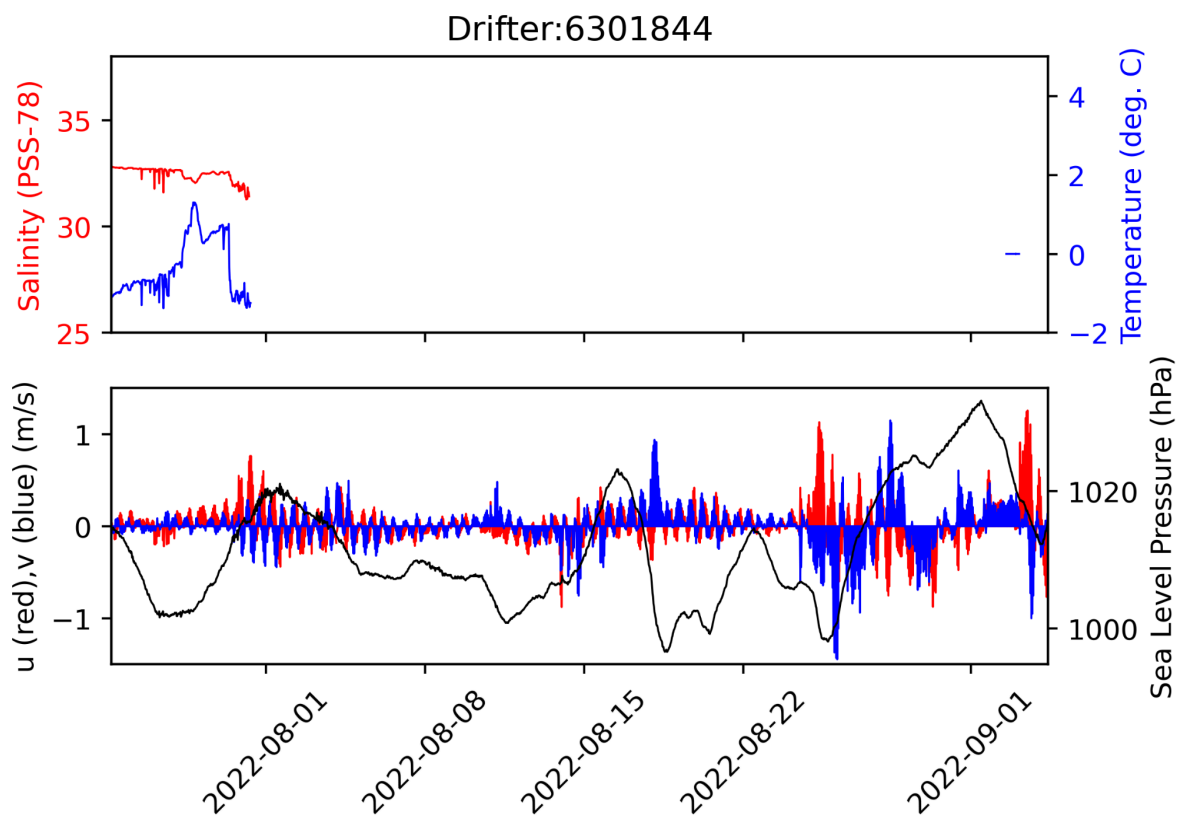


Figure 4: Same as Figure 2, but for drifter 6301844.

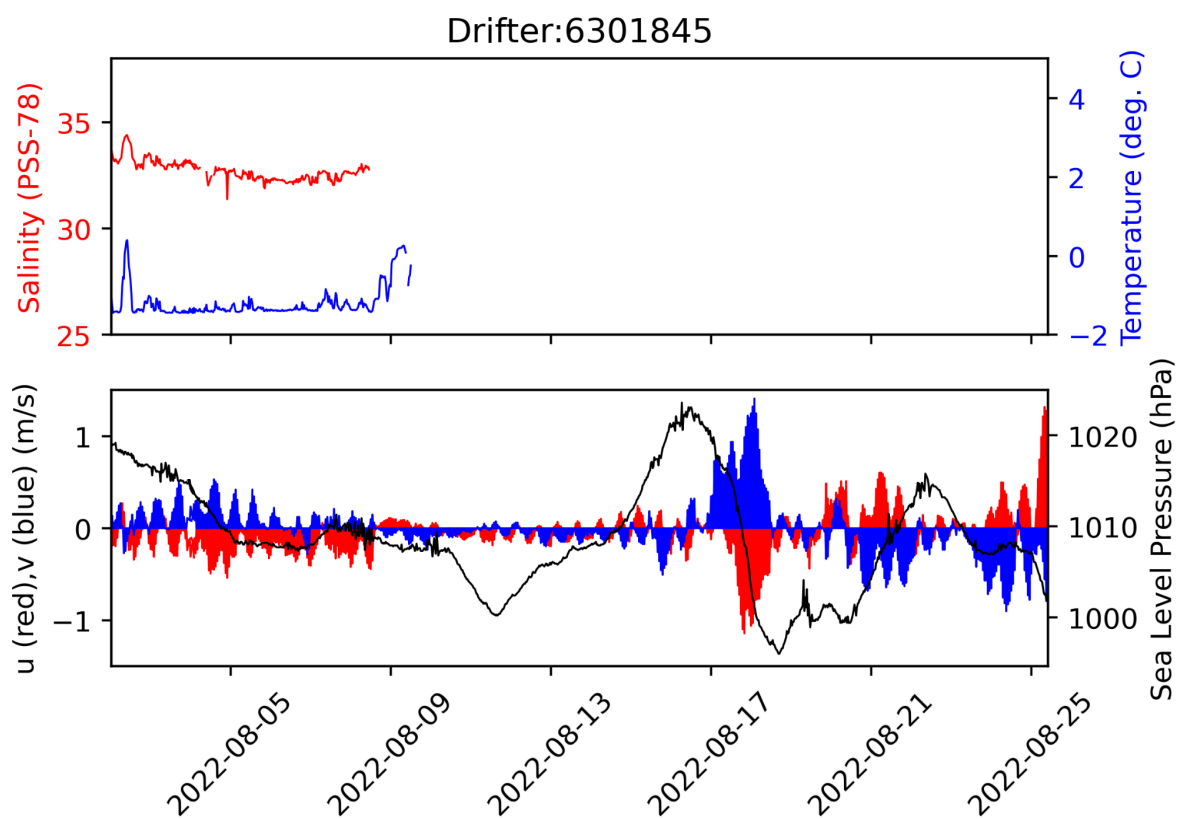


Figure 5: Same as Figure 2, but for drifter 6301845.

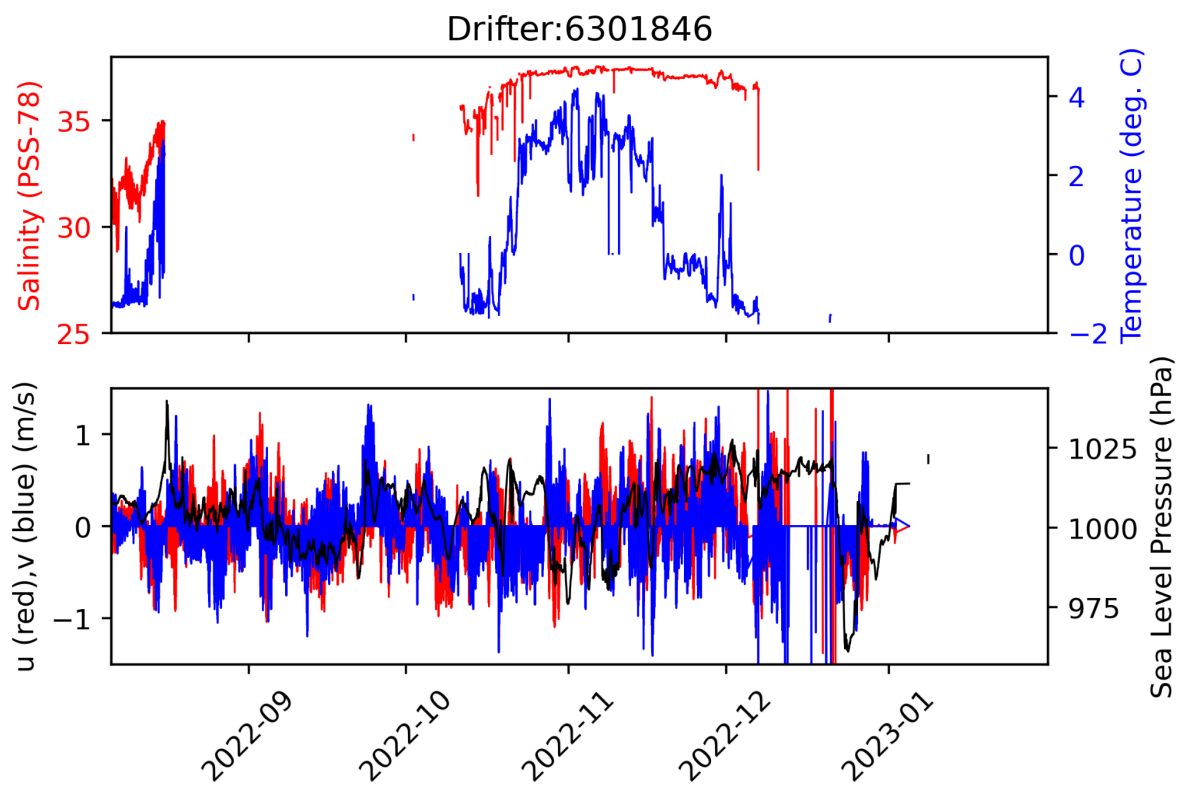


Figure 6: Same as Figure 2, but for drifter 6301846.

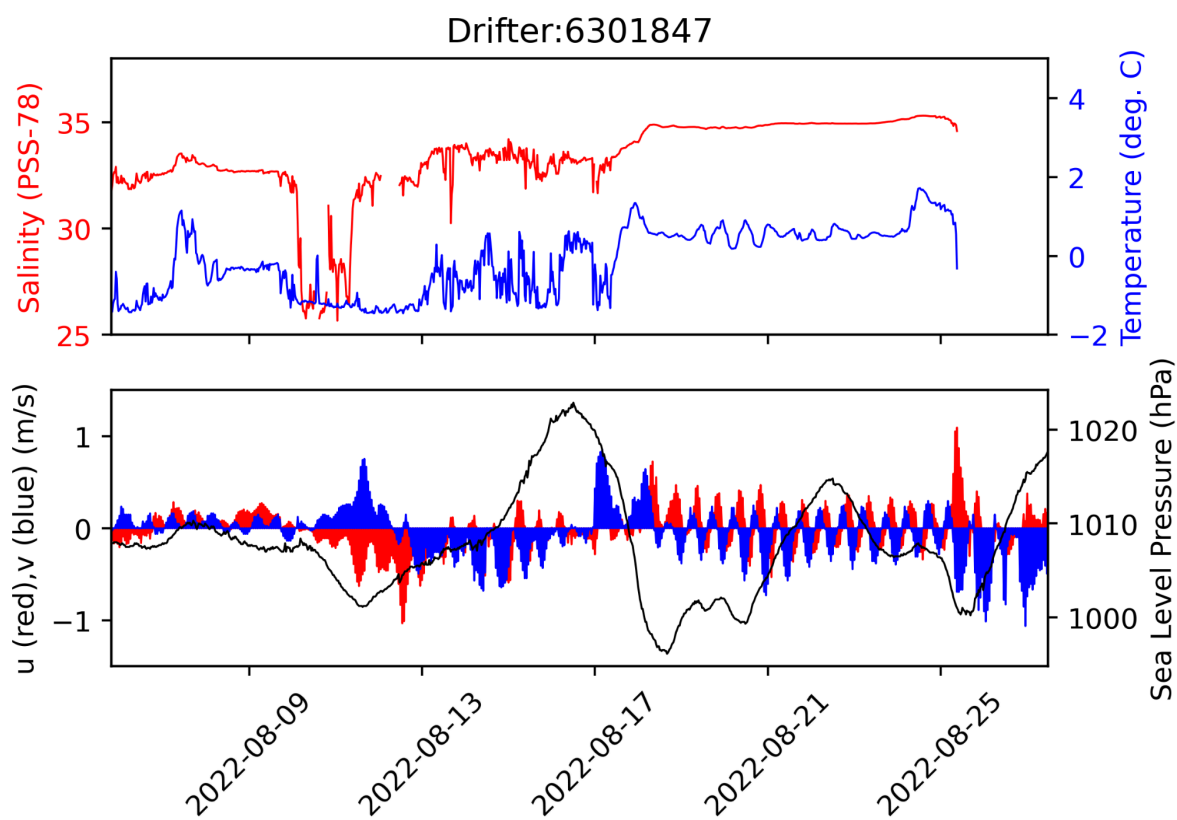


Figure 7: Same as Figure 2, but for drifter 6301847.

c. CTD stations

Along with the Argo floats and drifters deployments, 6 CTD stations as well as XBT/XCTD casts have been carried out for the calibration of the CTD sensors of the autonomous platforms. An RBR Concerto3 750 m CTD inductive sensor has been deployed over the upper water column (800 m depth) and provide temperature, salinity and pressure measurements. After calibration and validation, the profiles will be freely distributed by the French Coriolis Data Center for fundamental research purposes and operational oceanography (<http://www.coriolis.eu.org/>). Below is the list of the CTD stations (Table 4) along with temperature and salinity plots of CTD positions (Fig. 8) and profiles casts (Fig. 9) during the ARcticGO 2022.

Table 4: List of CTD stations during ARcticGO2022

Station	Time (UTC)	Latitude	Longitude	Remarks
1	25/07/22 01:26	82 15.007N	33 52.903E	deployment of Argo 6903145 (MIZ)
2	27/07/22 10:28	87 27.390N	50 38.606E	XCTD 20
3	28/07/22 15:57	89 59'12.69"N	43 45'25.57"W	2 casts RBR : SN:207998, SN:210196, cast niskin 800 m ; sample: 14
4	29/07/22 12:41	89 50'18.35"N	33 50'46.53"W	2 casts RBR : SN:207998, SN:210196, cast niskin 800 m ; sample 15
5	01/08/22 20:33	82 15.055N	34 57.410E	3 casts 20 m depth: deployment of Argo+drifter : 82 15.055N 34 57.410E / 82 14.483N 34 57.805E / 82 14.234N 34 55.581E
6	01/08/22 21:08	82 14'12.78"N	34 57'29.69"E	Deployment of Argo 6903143-44 (MIZ)

ARcticGO 2022

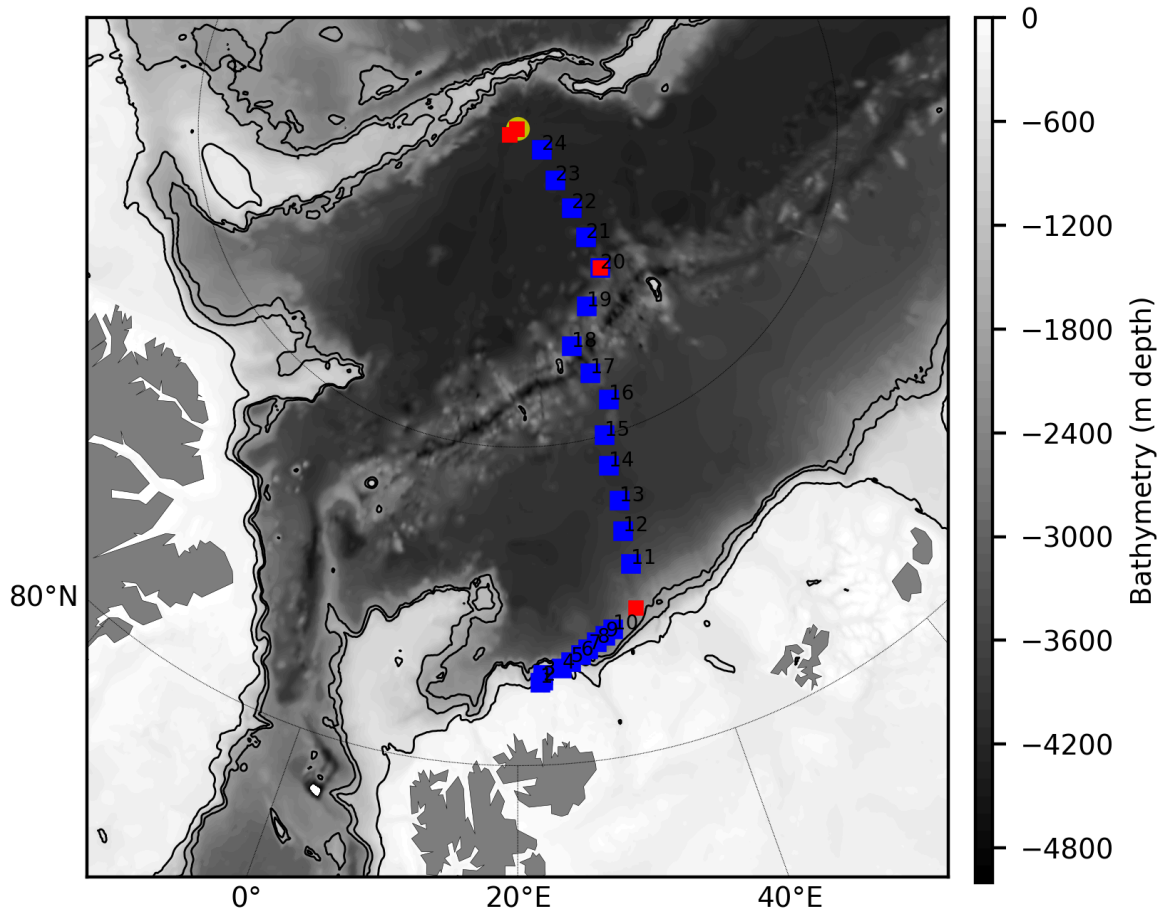


Figure 8: Position of XBT/XCTD launch (blue square) and CTD stations (red square) during the ARcticGO 2022 cruise (23 July-7 August 2022). Yellow circle is the location of the North Pole.

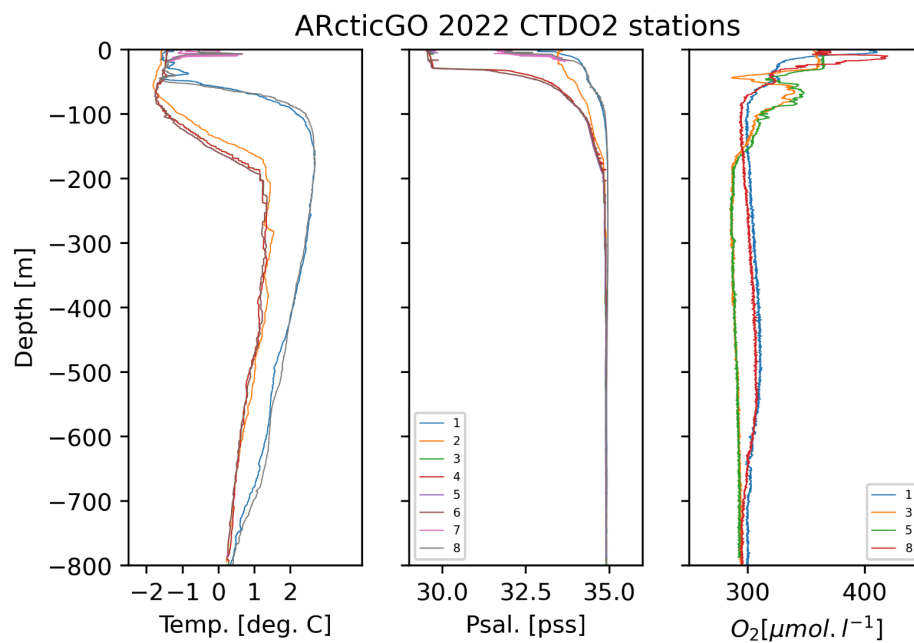


Figure 9: Temperature (in °C, left panel), Salinity (in pss, middle panel) and Dissolved Oxygen concentration (in $\mu\text{mol/l}$, right panel) from CTDO2 station carried out during ARcticGO2022 cruises (See Fig. 1). Station number corresponds to the stations listed in Table 3.

d. XBT launch

XBTs Lockheed-Martin Sippican T7 are one-shot-probs measuring profile of temperature of the upper 700m depth of the water column (https://www.lockheedmartin.com/content/dam/lockheed-martin/rms/documents/oceanographic-instrumentation/20050054_XBT_XSV_reader_page.pdf); and XCTD Lockheed-Martin Sippican XCTD-1N (<https://www.lockheedmartin.com/content/dam/lockheed-martin/rms/documents/oceanographic-instrumentation/Lockheed%20Martin%20XCTD%20Profiling%20System%20Data%20Sheet.pdf>). They have been launched during the transit of ship without stopping ship. After calibration and validation, the data will be freely distributed by the French Coriolis Data Center for fundamental research purposes and operational oceanography (<http://www.coriolis.eu.org/>). The position of XBT/XCTD launch are reported in Table 5 and in map Fig. 8. The XBT/XCTD temperature and salinity profiles are shown in Fig. 10, and along the section from Svalbard to North Pole in Fig. 11 and 12.

Table 5: List of XBT/XCTD launch during Arcticgo2022

Launch	Time (UTC)	Latitude	Longitude	Depth	data file	Probs type
1	24/07/22 15:48	81 17.921N	22 20.007E	700	XBT T-7 20220724121202	T7
2	24/07/22 16:10	81 19.787N	22 40.104E	700	XBT T-7 20220724122835	T7
3	24/07/22 16:57	81 25.050N	22 41.810E	700	XBT T-7 20220724145312	T7
4	24/07/22 17:35	81 30.046N	24 41.367E	760	XBT T-7 20220724153554	T7
5	24/07/22 18:21	81 35.193N	25 44.047E	1000	XCTD-01 TSK 20220724162113	XCTD-1N
6	24/07/22 19:09	81 40.679N	26 49.575E	760	XBT T-7 20220724170904	T7
7	24/07/22 19:46	81 45.280N	27 44.655E	1000	XCTD-01 TSK 20220724174634	XCTD-1N
8	24/07/22 21:25	81 50.575N	28 43.902E	700	XBT T-7 20220724192459	T7
9	24/07/22 22:08	81 55.305N	29 46.919E	1000	XCTD-01 TSK 20220724200749	XCTD-1N
10	24/07/22 22:49	82 00.038N	30 47.958E	700	XBT T-7 20220724204702	T7
11	25/07/22 09:37	82 56.657N	34 33.220E	700	XBT T-7 20220725073132	T7
12	25/07/22 14:01	83 28.314N	34 42.791E	1000	XCTD-01 TSK 20220725115944	XCTD-1N
13	25/07/22 18:25	83 56.808N	35 16.415E	700	XBT T-7 20220725161929	T7
14	25/07/22 23:16	84 31.168N	35 04.395E	700	XBT T-7 20220725212151	T7
15	26/07/22 03:25	84 59.949N	35 44.332E	1000	XCTD-01 TSK 20220726011655	XCTD-1N

16	26/07/22 08:46	85 30.936N	38 29.151E	700	XBT T-7 20220726064120	T7
17	26/07/22 13:28	85 59.804N	36 37.406E	1000	XCTD-01 TSK 20220726112256	XCTD-1N
18	26/07/22 19:05	86 23.674N	33 57.216E	700	XBT T-7 20220726150213	T7
19	27/07/22 00:23	87 0.678N	41 6.768E	700	XBT T-7 20220726221829	T7
20	27/07/22 09:34	87 27.522N	50 32.568E	1000	XCTD-01 TSK 20220727072906	XCTD-1N
21	27/07/22 14:18	87 59.112N	51 54.114E	700	XBT T-7 20220727121416	T7
22	27/07/22 20:29	88 29.477N	54 18.610E	1000	XCTD-01 TSK 20220727184421	XCTD-1N
23	28/07/22 01:43	88 59.964N	55 48.966E	700	XBT T-7 20220727234303	T7
24	28/07/22 06:15	89 29.732N	69 06.031E	1000	XCTD-01 TSK 20220728040623	XCTD-1N

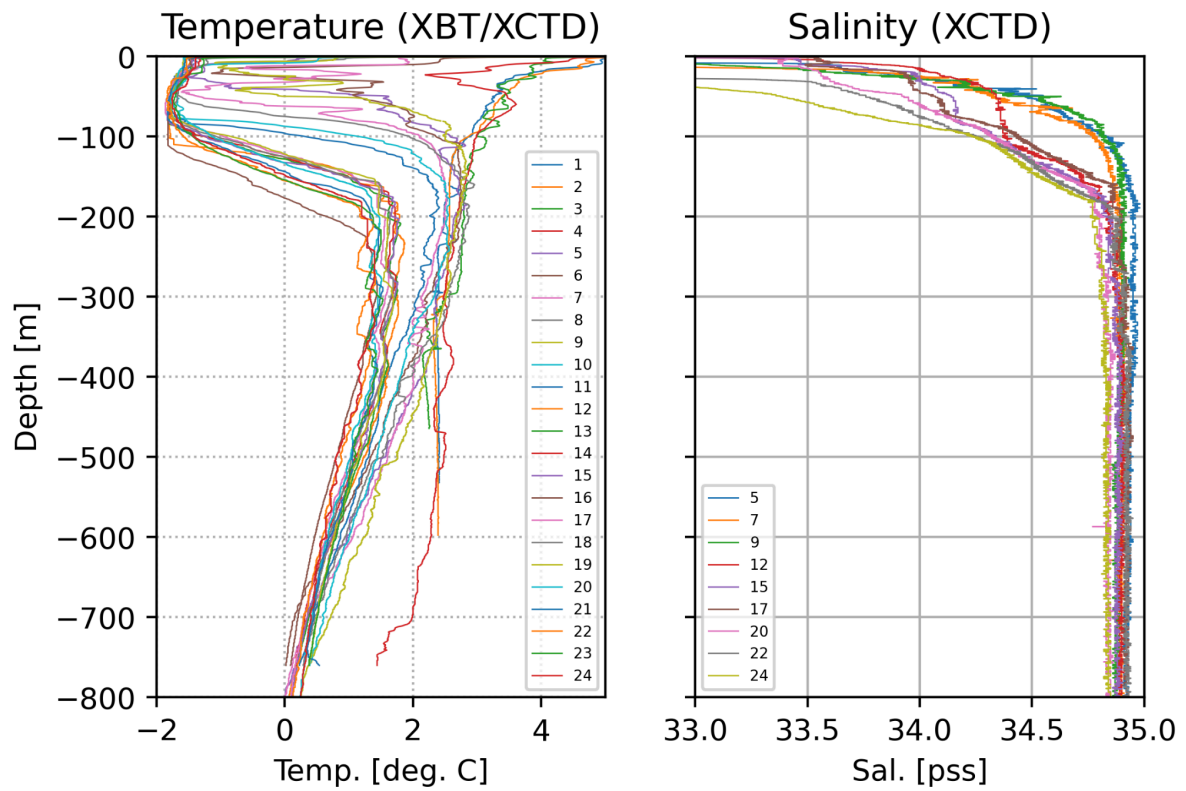


Figure 10: Temperature (left panel) and salinity (right panel) as function of depth from XBT/CTD profiles carried out during ARcticGO 2022 between Svalbard and North Pole (see Fig. 1). The profile number corresponds to the launch number in Table 4.

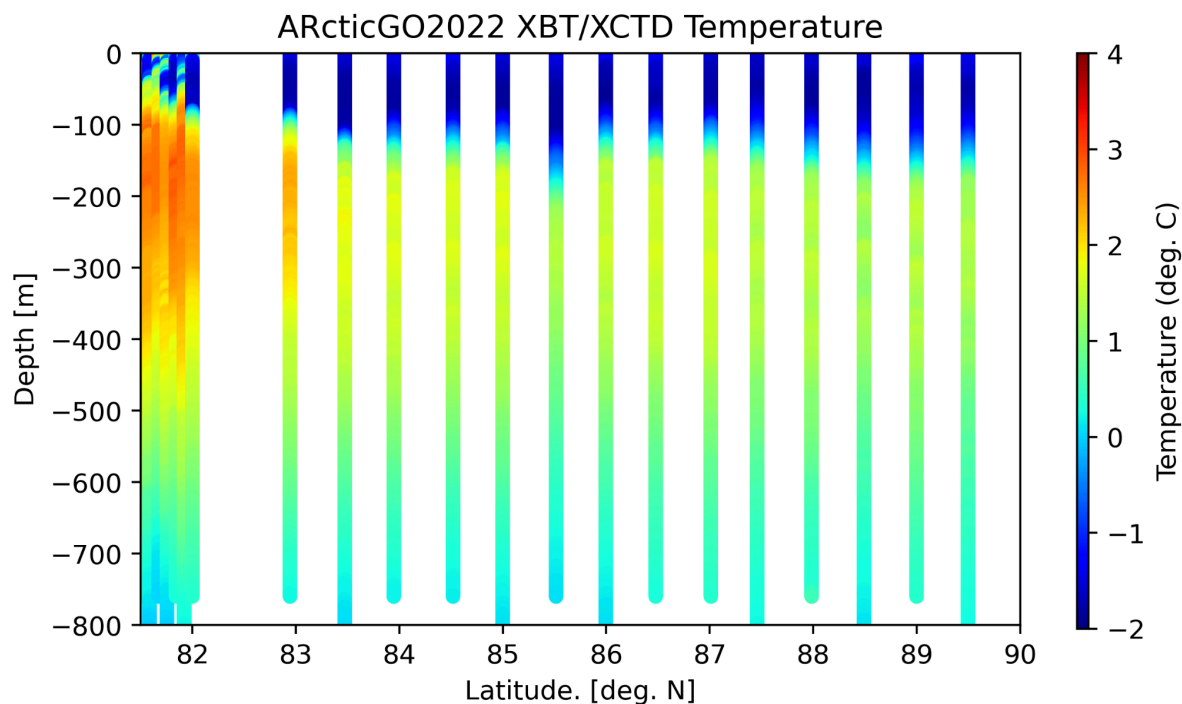


Figure 11: Latitude-depth temperature section between 81-90°N and between 20-40°E (see Fig. 1) from XBT/XCTD profiles carried out during ARcticGO 2022.

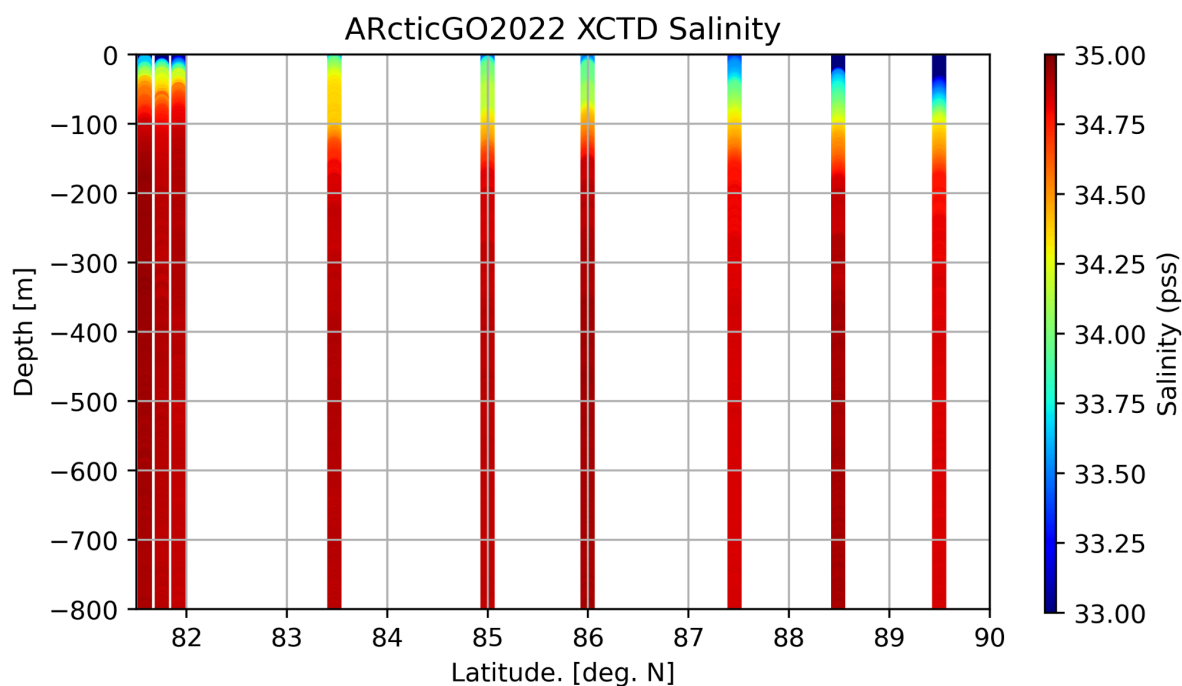


Figure 12: Latitude-depth salinity section between 81-90°N and between 20-40°E (see Fig. 1) from XCTD profiles carried out during ARcticGO 2022.

e. Underway TSG measurement

The vessel “Le Commandant Charcot” is equipped with a Seabird SBE45 and SBE38 sensors (<https://www.seabird.com/sbe45-microtsg-thermosalinograph/product?id=54627900541>) measure conductivity [mS/cm] and temperature [°C]. The additional parameters of salinity [PSU] and sound velocity [m/s] are calculated internally and are also stored in the vessel's data management system. The data are collected for fundamental research and operational oceanography. Water samples are collected for validation and SBE45 conductivity cell drift correction. After post processing and validation, the data are archived on French National Services of Sea Surface Salinity and freely displayed and distributed at <http://www.legos.obs-mip.fr/observations/sss/>.

6. ZEE operation

ARcticGo 2022 cruise has been performed in July-August 2022 (23/07-7/08) on “Le Commandant Charcot” between Longyearbyen and the North Pole. Argo floats, XBT/XCTD, SVP-BSC drifters, CTDs have been deployed within the Norwegian/Svalbard ZEE in the Marginal Ice Zone with clearance: **ref. 22/7880**.