Cruise HE 519
with RV Heincke

Trondheim, N – Bremerhaven, D
September 19th – October 21st 2018

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Name and address of scientist in charge:

Dr. Felix C. Mark

fmark@awi.de

Integrative Ecophysiology
Alfred-Wegener-Institut
Helmholtzzentrum für Polar- und Meeresforschung
Am Handelshafen 12
D-27570 Bremerhaven, Germany

1. Summary

The main objectives of this cruise were to elucidate whether climate change (mainly ocean acidification and warming, OAW) affects interacting species differently due to divergent physiological optima and ranges, expressed in thermal tolerance windows and associated performance capacities and phenologies of specific life stages. To determine the degree of the ongoing 'Atlantification' of the waters around (Western) Svalbard, we took sediment samples to analyse the benthic epi- and meiofauna. Further, we intended to obtain specimens of both Polar cod (*B. saida*) and Atlantic cod (*G. morhua*) in the Atlantic and polar waters around Svalbard, which were used in experiments on board and back at the Alfred Wegener Institute.

We left port in Trondheim in the morning of September 21st, heading North towards Svalbard. Due to severe storms in the Norwegian Sea, we had to travel close to the Norwegian shoreline and eventually seek shelter inside Vestfjorden/Lofoten Islands until September 25th. A second attempt to reach Bjørnøya (Bear Island) on September 26th failed again due to weather, this time weathering off in Fugløysund/Troms (see figure 1 for cruise track).
Around noon of September 28th, we finally reached the first scientific station at Bjørnøya (HE519_1), where we deployed a CTD and two short bottom trawls (mainly Atlantic cod, *Gadus morhua*, and haddock, *Melanogrammus aeglefinus*) and continued to the Southern tip of Svalbard to reach Hornsund in the morning of September 29th.
The first station at Svalbard was carried out in Hornsund (HE519_2), where a CTD and a multicorer was deployed, to sample the water column and first 30cm of sediment. Following this, we ran several juvenile fish trawls with fish lift at different depths from surface waters to close to the bottom, specifically aiming for flocks of juvenile fish under the surface, at the thermocline and above ground (water layers of interest derived from CTD and EK80 profiles). This daily sampling protocol was repeated at all other stations unless stated otherwise.

In Hornsund, the whole water body including bottom waters were around 3°C and well mixed by the rough weather. The dominant fish species throughout the water column was Atlantic cod (*Gadus morhua*) and bottom waters only contained few polar cod (*Boreogadus saida*). During the following night, we steamed to North West Svalbard to sample a station north of Moffen Island (HE519_3) on September 30th. Due to deteriorating weather conditions, the fisheries protocol had to be reduced to angling of 50 Atlantic cod for population genetic studies. The overall weather situation forbade to go further east and the stations planned for Rijpfjorden and Hinlopenstreet had to be cancelled.
The day after, we sampled Raudfjorden (HE519_4, 5, 6), which was under Atlantic influence at this time of the year (juv. Atlantic cod, haddock and herring, *Clupea harengus*, only few remaining polar cod). On October 2nd, we had to seek shelter in the Krossfjorden/Kongsfjorden system, the stations envisaged for Yermak plateau and the Hausgarten-transect had to be cancelled. Krossfjorden (HE519_7) did not show any specific stratification of its water column, yet at its northern tip the deep bottom waters were still relatively cold (0.8°C) and we found several Polar cod there. Due to its western exposure, Kongsfjorden (HE_519_8, 9, 10) was very well mixed with bottom temperatures >2°C and was clearly dominated by Atlantic cod over the whole of its west-east trajectory. In the afternoon of October 4th, we called at Ny Ålesund to load frozen samples and expedition material of the AWIPEV summer campaign and transport them to AWI in Bremerhaven.
The next morning saw us stopping over shortly at Longyearbyen for a medical appointment of a crew member, followed by a short multicorer station in Isfjorden (HE519_11) on the way to Billefjorden the same day.

Figure 1: Cruise track of HE 519.
1 - Trondheim, port of embarkation.
2 - Bremerhaven, port of disembarkation.

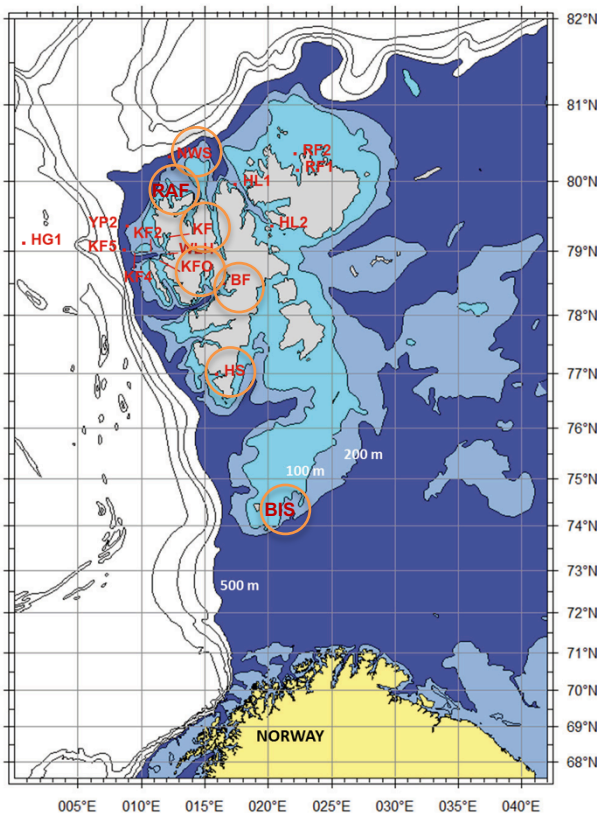
The last stations of the cruise were carried out in Billefjorden (HE519_12, 13) on October 5th and 6th. Due to its geographical position and relative shallow sill (30-40m), the water body was clearly structured into warmer surface waters (3-5°C) and the very cold bottom waters (-1,4°C), which were populated by Polar cod as the only fish species on the bottom. The surface waters contained flocks of young Atlantic cod and swarms of herring.

In the evening of October 6th, the scientific program of cruise HE519 ended and we sailed back to Longyearbyen to bid three members of the scientific crew farewell on the morning of October 7th. The weather forecast once more did not look promising so we left Svalbard three days earlier than planned to sail home as close to shore as possible. After several delays due to seeking shelter under land along the Norwegian coast, we arrived in Bremerhaven 10 days later in the early morning of October 16th.

Thus ended a challenging research cruise, with relatively meagre results due to the extremely bad weather. Nonetheless, we were able to carry out about 50% of the planned station work, took a great amount of sediment cores and biological samples. In only nine days of station work, 2 bottom trawls, 9 multicorer placements, 11 CTD profiles and 16 pelagic fish trawls with fish lift could be realised. We brought more than 250 juvenile Polar cod back to the home institute in Bremerhaven alive.

2. Sampling sites

In the following, the individual sampling sites are presented, together with some preliminary catch statistics for the fishery stations. We intended to revisit as many stations of the previous cruises HE408 (16.8.-15.9.2013; RIS ID 6332, Jnr 13/4976) and HE451.1 (11.-29.9.2015, RIS ID 10209, Jnr 15/4013) as possible.



1. **BIS**: Bjørnøya (CTD, fishery)
2. **HS**: Hornsund (CTD, fishery, box corer)
3. **NWS**: North West Svalbard (CTD, fishery, box corer)
4. **RAF**: Raudfjorden (CTD, fishery, box corer)
5. **KF**: Krossfjorden (CTD, fishery, box corer)
6. **WLH**: Western Kongsfjorden (CTD, fishery, box corer)
7. **KFO: Kongsfjorden** (CTD, fishery, box corer)
8. **KFI**: Eastern Kongsfjorden (CTD, fishery, box corer)
9. **ISF**: Isfjorden (CTD, box corer)
10. **BIF**: Billefjorden (CTD, fishery, box corer)

Figure 2: map of the stations of HE 451

3. Fishery stations:

For the detection of fish schools, a Simrad EK60 hydro-acoustic system was applied. To effectively catch small and juvenile fish and surface them alive, we used a so-called fish-lift (Holst&MDonald, 2000, figure 3) connected to the juvenile fish trawl. Trawl times never exceeded 15 minutes for each haul.

Figure 3: Fish-lift attached to the juvenile fish trawl of RV Heincke (photography: F. Mark).

In the following, we provide size distribution frequencies of the main species of relevant hauls.

Bear Island (BIS, #001) 28.09.2018
Bottom Trawl (benthic)
Mainly Atlantic cod and haddock of different year classes and some 30 rays (*A. radiata*, returned alive to ocean).

Hornsund (HOS, #002) 29.09.2018
Juvenile Fish Trawl (pelagic)
Exclusively Polar cod at bottom of fjord (150-220m). Larger animals than in Sept. 2015. Some larger individual Atlantic cod in midwater, 0-YC Polar cod close to surface.

North West Svalbard (NWS, #003) 30.09.2018
Catch dominated by adult Atlantic cod (*G. morhua*) and a few juvenile (*M. aeglefinus*)

Raudfjorden (RAF, #004, 005, 006) 01.10.2018
Mostly 0-YC and 1-YC Polar cod (*B. saida*) and a few Atlantic cod.
Some juvenile haddock (60-110mm), herring (50-145mm) and daubed shanny (*L. maculatus*).

Krossfjorden (KRF, #007) 02.10.2018
Next to no Polar cod, only a few Atlantic cod in midwater.

Kongsfjorden (HE_519_8, 9, 10) 03.10.2018
Some Polar cod (0-YC) in inner fjord, flocks of Atlantic cod throughout all water layers. Daubed shanny, herring and capelin in surface waters.

Isfjorden (HE519_11) 05.10.2018
No fishing, just CTD and multi corer.

Billefjorden (HE519_12, 13) 05.-06.10.2018
Shanny, herring and 0-YC haddock in surface waters as well as 0-YC Polar cod. Clear thermocline between 40-60m.
Multi YC of Atlantic cod in surface and midwater layers above thermocline. Almost exclusively Polar cod in bottom waters below thermocline (0-, 1-, 2-YC), some liparids (40-60mm).

ALL Stations:

4. Seafloor Sampling

To address the depositional and biogeochemical processes in the sediments, samples for geochemical analyses were taken off the southern and west coast of Svalbard. Cores were taken for TOC content and its porosity, content of pollutants and nutrients as well as tracer elements. This was done at 7 different locations inside different fjords (Hornsund, Raudfjorden, Krossfjorden, Isfjorden and Billefjorden, Table 1, Figure 4) and 1 offshore (Moffenbank). Sediments were obtained with a Multicorer (MUC; Fig. 5A) to collect approximately the upper 40 cm of the seafloor sediments (Fig. 5B). From each station 2 sediment cores were sliced in 1 cm segments for TOC and radiocarbon analysis. Pore-water extraction was done at 3 cores for e.g. profiles of nutrients in the sediment. At 6 stations one core each was taken and frozen directly at -20°C for subsequent analysis of pollutants. At 6 stations surface sediment and bottom water was taken for elemental tracer analysis. At the northernmost coring 500 g of one core were taken for temperature measurements.

Table 1: Overview of sampling locations (MUCs).

Muc labeling	Region	Longitude	Latitude	Waterdepth	Date	Work program					
						Sediment	Porewater	Surface temp	Pollutants	Elemental tracer	Comments
1	Hornsund	76°58.93	15°98.92	200	29.09.2018	x					
2	Moffenbank	80°14.45	13°16.66	62	30.09.2018						rocky surface
3	Raudfjorden	79°48.37	12°0084	210	01.10.2018	x	x	x	x	x incl. PW	
4	Krossfjorden	79°08.10	11°40.55	320	02.10.2018	x			x	x	
5	Kongsfjorden 1	78°54.84	12°9.34	112	03.10.2018	x	x		x	x incl. PW	
6	Kongsfjorden 2	78°59.11	11°41.47	313	04.10.2018	x	x		x	x	
7	Isfjorden	78°24.94	15°58.84	185	05.10.2018	x			x	x	
8	Billefjorden	78°36.18	12°31,41	153	05.10.2018	x			x	x	

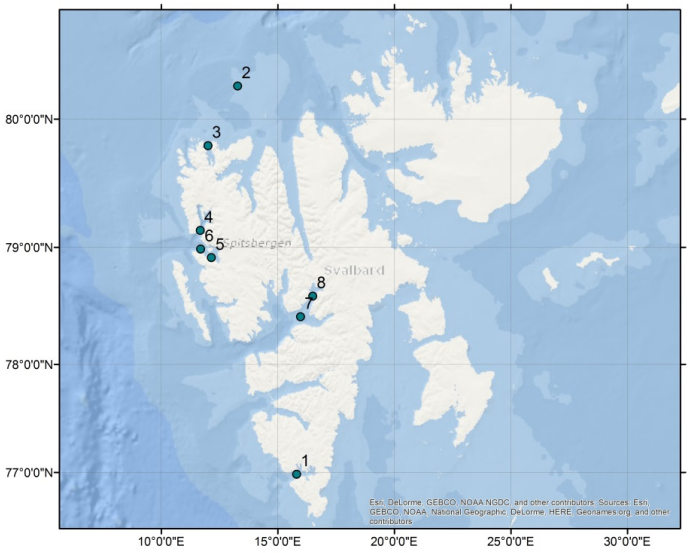


Figure 4: Overview of sampling locations (MUCs).

Figure 5: MUC in operation (A), retrieved sediment cores (B), slicing the cores for subsequent sediment analysis (C).

Pore Water and Element Sampling
Immediately after retrieval, one MUC sediment core was transported into a controlled temperature (CT) room cooled to 4 °C. Pore-water was extracted from sediments directly with Rhizons (Rhizon CSS: length 3 cm, pore diameter 0.2 µm; Rhizosphere Research Products, Wageningen, Netherlands) inserted though pre-drilled holes in the MUC liners and connected to a syringe on which a small under-pressure was applied. For three MUC stations samples were collected at 1 cm intervals for the entire core length. Aliquots of pore-water were collected for cations (2 mL), DIC (2 mL), nutrients (2 mL), and total alkalinity (0.5 mL).

Sediment Sampling
At all stations two MUC sediment cores were taken und cut into 1 cm sections for the entire core length. The samples were stored in petri dishes and frozen at -20°C for further analysis like porosity, TOC content as well as radiocarbon age of the organic material to determine depositional processes.

Elemental sampling
Pore water, sediment and bottom water (water directly above the sediment) were taken for the analysis of elemental tracer (Mg, Mn, Sr, Ba, Li and Ca). Pore water samples were extracted with Rhizons and bottom water was taken with an acid-washed syringe. 2 ml of each sample were transferred into acid-washed tubes. 40 µl of HNO_3 (65%) were added to each sample.
The first 1-2 cm of a MUC sediment core were taken as sediment sample and stored in small Nalgene bottles for further analysis. All samples are stored at 4°C for a later analysis.

5. Underway MIMS measurements

Background
One of the major questions of polar biogeochemical research is, whether the Arctic basin as a whole is a net phototrophic system or a net heterotrophic system. The basin is influenced by water masses from the Barents Sea and the North Atlantic, carrying large amounts of 'pre-formed' microalgal and animal biomass. However, it also exhibits regional primary production and consumption, creating 'original Arctic' input into the food webs. The magnitude of these biogeochemical fluxes and processes is uncertain.
During the MOSAiC drift study 2019/20, these open questions will be addressed. Among other things, concentrations of dissolved O_2, Ar and CO_2 will be assessed with membrane-inlet mass spectrometry (MIMS) to determine net community production of transected water masses. Data will be combined with hydrological data (water mass identification), chemical data (nutrient fluxes) and live-recorded biological data (^{14}C-based net primary production, transfer to first-order consumers) to allow an extrapolation to the whole arctic basin.
We expect large seasonal variations, the system starting in winter as net heterotrophic, becoming net phototrophic over the course of the growing season, and turning heterotrophic again towards the end of the season. We expect that sea-ice conditions, light regimes, and nutrient fluxes strongly modulate this pattern and the subsequent biogeochemical functioning of the ecosystem in terms of food web input, particle flux and carbon sequestration.

MIMS development and testing
Over the past 4 years, an extended mobile MIMS system has been developed in the section *Marine Biogeosciences* of AWI that can be deployed onboard research vessels to measure the concentrations of dissolved gases in the ship´s seawater supply. It has been previously tested on Polarstern cruise PS99a, and significant additions and enhancements have been implemented since. Among those were an intake system to measure discrete bottle samples, e.g. derived from CTD casts to the deep ocean.
On HE519 (21.9.-16.10.2018), the MIMS underwent a thorough field testing in harsh sea conditions during which the new additions were tested and remaining bugs were fixed. Finally, we recorded a continuous 7-day O_2/Ar dataset to exemplarily derive net community production.

Achievements during HE519
- The newly installed pump- and valve-control for measuring discrete samples was electronically implemented, tested and bug-fixed.
- The LabView graphical user interface was partially reprogrammed to lower the processor load on the computer hardware, to smoothen operation and to assure reliability and user friendliness

- A needle-valve flow regulator was built in, so that the equilibrator unit could be flushed with flowing air to avoid steam up.
- Protocols and SOPs were established that guide non-expert users through critical operation steps and can later serve as a manual during MOSAiC.
- The vacuum tubing system, the turbo pump and pressure sensors were successfully tested under harsh field conditions (including ship vibration and movement as well as operating temperatures of 5±2°C), and routines were implemented into the user interface to manually re-calibrate sensor readings.
- Valve settings that regulate the permeability between the gradually increasing vacuum areas in the mass spectrometer were optimized and harmonized with the settings of the pulse-tube cooler to maximize signal heights and minimize data noise.
- An exemplary dataset of continuous O_2/Ar and CO_2 data was recorded for internal use (quality checks, staff training)

6. Preliminary results

This cruise revisited many of the station of HE408 (2013) and HE451.1 (2015), albeit after (and during) a severe early autumn storm (after a very hot summer over Northern Europe). Due to the weather conditions, we were only able to carry out about 50% of the planned stationwork.

The autumn storms caused thorough mixing of most westerly open fjord systems of Svalbard, which clearly influenced species composition throughout the water column. Thus, we found very few Polar cod in bottom waters but also, for example, no 0-YC redfish in the surface water layers on the Western coast of Spitsbergen. Only the protected inland fjords (e.g. Billefjorden) still had cold winter water pockets at the bottom (<0°C), documented by lower oxygen contents. While we found adult Polar cod to be restricted to cold bottom waters in the fjords that ranged from -1.3 to 2.0°C in temperature, in bottom waters of higher temperature (ca. 2.5-3.0°C) and in midwater, 0-year classes and juveniles of the Polar cod and Atlantic cod appeared to share the habitat in a few cases. This has also been observed in Greenland waters by Christiansen and colleagues (Christiansen *et al.*, 2016). This will undoubtedly have a further impact on Polar cod recruitment around Svalbard, given the size difference between the predatory juvenile Atlantic cod (>10cm) and the small 0-year class Polar cod (about 5-6cm).

About 250 specimens of juvenile Polar cod were successfully transported to Bremerhaven using the capacities on board and a custom-made fish transport container that was equipped with aquaria systems. In Bremerhaven, the fish are being used in experimental incubations to test their response towards ocean acidification, warming and hypoxia within the framework of the HGF research programmes POF III and POF IV.

The full catch statistics and CTD data will be published and made available via PANGAEA (see links below). First results of the seafloor sampling are expected to be published in 2020/21, and will then also be available via PANGAEA.

7. Appendix A

Literature cited:

Christiansen, J.S., Bonsdorff, E., Byrkjedal, I., Fevolden, S.-E., Karamushko, O.V., Lynghammar, A. *et al.* (2016). Novel biodiversity baselines outpace models of fish distribution in Arctic waters. *The Science of Nature*, 103, 1-6.

Holst, JC; McDonald, A (2000) FISH-LIFT: a device for sampling live fish with trawls. *Fisheries Research* 48: 87-91

List of participants

Name	Institute
Mark, Felix Christopher, PhD, Chief Scientist	Alfred Wegener Institute
Polleichtner, Christian Uwe	Umweltbundesamt Berlin
Åsheim, Eirik Ryvoll	NTNU Trondheim
Andreassen, Anna Haukedal	NTNU Trondheim
Kempf, Sarah	Universität Bremen
Spotowitz, Lisa	Alfred Wegener Institute
Thoben, Femke	Universität Kiel
Rokitta, Sebastian Dominik, PhD	Alfred Wegener Institute
Rost, Björn Christian, PhD	Alfred Wegener Institute
Gentz, Thorben, PhD	Alfred Wegener Institute
Richter, Klaus-Uwe	Alfred Wegener Institute

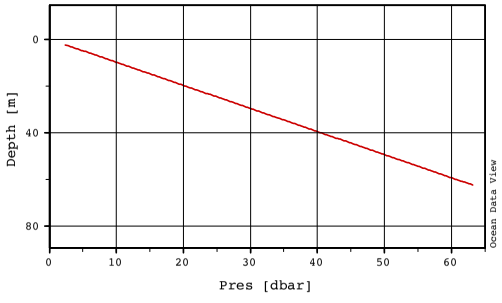
Station list

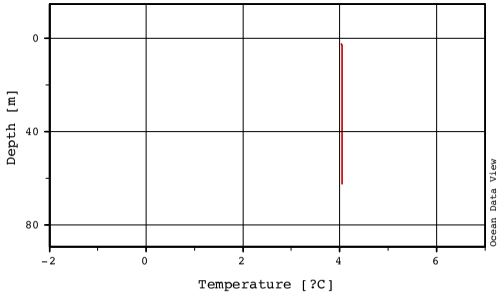
The CTD traces can be found in Appendix B, track data of cruise HE 519 can be accessed on the PANGAEA database under: https://doi.org/10.1594/PANGAEA.896258, as well as continuous thermosalinograph (https://doi.pangaea.de/10.1594/PANGAEA.897222) and physical oceanography/CTD raw data (https://doi.org/10.1594/PANGAEA.896218).

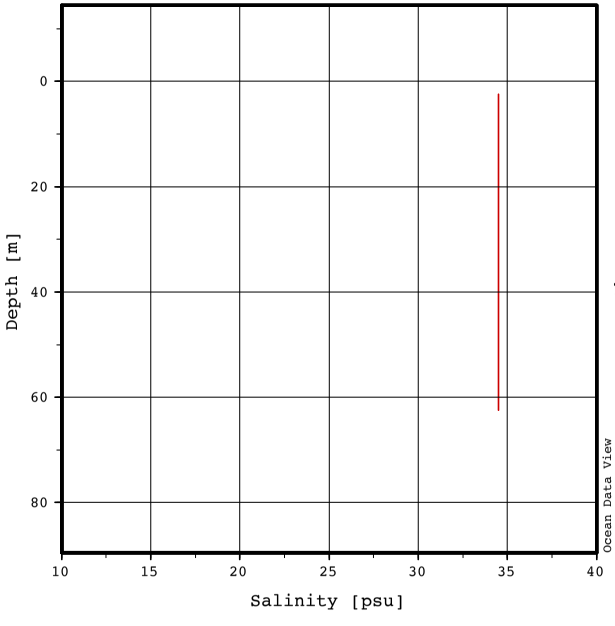
Station	Timestamp	Station name	ID	Device	Latitude	Longitude	Depth (m)
HE519_1-1	28.09.18 08:19	Bear Island	BIS	CTD	74° 26,235' N	019° 34,969' E	61,4
HE519_1-2	28.09.18 10:13	Bear Island	BIS	Bottom Trawl	74° 27,186' N	019° 34,054' E	57,4
HE519_1-3	28.09.18 10:58	Bear Island	BIS	Bottom Trawl	74° 29,607' N	019° 30,859' E	51,8
HE519_2-2	29.09.18 06:18	Hornsund	HOS	CTD	76° 58,918' N	015° 49,022' E	203,1
HE519_2-3	29.09.18 07:10	Hornsund	HOS	Multi Corer	76° 58,957' N	015° 49,194' E	201,7
HE519_2-4	29.09.18 08:08	Hornsund	HOS	Young Fish Trawl	76° 59,187' N	015° 47,955' E	208,9
HE519_2-5	29.09.18 10:46	Hornsund	HOS	Young Fish Trawl	76° 58,907' N	015° 44,679' E	233,1
HE519_2-6	29.09.18 13:32	Hornsund	HOS	Young Fish Trawl	76° 58,918' N	015° 45,119' E	231,6
HE519_3-1	30.09.18 14:20	North Svalbard II	NSB II	CTD	80° 14,503' N	013° 16,759' E	60,9
HE519_3-2	30.09.18 14:38	North Svalbard II	NSB II	Multi Corer	80° 14,446' N	013° 16,647' E	61,7
HE519_3-3	30.09.18 14:47	North Svalbard II	NSB II	Multi Corer	80° 14,492' N	013° 16,674' E	60,9
HE519_4-1	01.10.18 06:56	Raudfjorden I	RAF I	CTD	79° 48,420' N	012° 00,397' E	219,7
HE519_4-2	01.10.18 07:20	Raudfjorden I	RAF I	Multi Corer	79° 48,482' N	011° 59,980' E	218,7
HE519_4-3	01.10.18 08:14	Raudfjorden I	RAF I	Young Fish Trawl	79° 47,747' N	012° 02,969' E	188,5
HE519_5-1	01.10.18 10:56	Raudfjorden II	RAF II	Young Fish Trawl	79° 44,468' N	012° 00,750' E	135,1
HE519_6-1	01.10.18 12:27	Raudfjorden I	RAF I	Young Fish Trawl	79° 48,233' N	012° 01,522' E	210,4
HE519_7-1	02.10.18 12:54	Krossfjorden	KRF	Young Fish Trawl	79° 09,675' N	011° 43,870' E	361,7
HE519_7-2	02.10.18 14:37	Krossfjorden	KRF	CTD	79° 08,164' N	011° 40,516' E	317,5
HE519_7-3	02.10.18 15:02	Krossfjorden	KRF	Multi Corer	79° 08,093' N	011° 40,543' E	319,9
HE519_8-1	03.10.18 06:26	Kongsfjorden East	KFE	CTD	78° 54,488' N	012° 12,441' E	88,5
HE519_8-2	03.10.18 06:48	Kongsfjorden East	KFE	CTD	78° 54,844' N	012° 09,376' E	111,1
HE519_8-3	03.10.18 06:59	Kongsfjorden East	KFE	Multi Corer	78° 54,875' N	012° 09,447' E	104,4

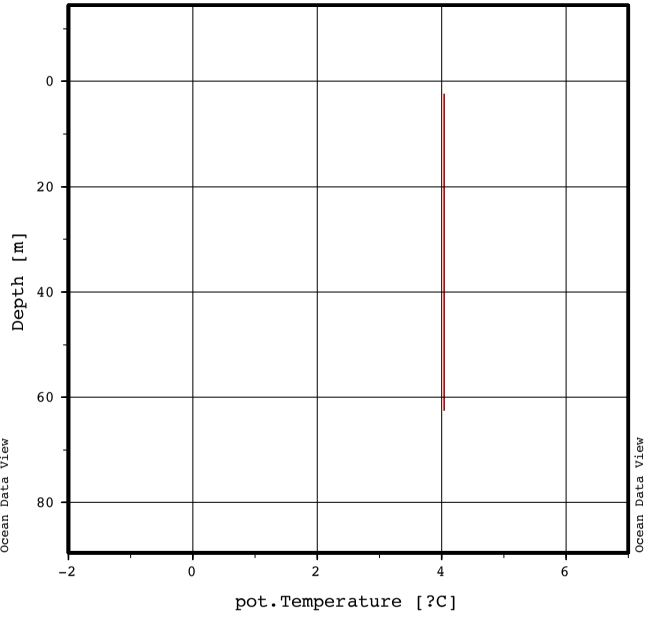
HE519_8-4	03.10.18 07:51	Kongsfjorden East	KFE	Young Fish Trawl	78° 55,083' N	012° 08,087' E	123,1
HE519_8-5	03.10.18 08:55	Kongsfjorden East	KFE	Young Fish Trawl	78° 56,083' N	012° 01,291' E	288,6
HE519_8-5-a	03.10.18 10:30	Kongsfjorden East	KFE	Sci. Angling	78° 55,309' N	012° 06,660' E	125
HE519_8-6	03.10.18 12:11	Kongsfjorden East	KFE	Young Fish Trawl	78° 56,462' N	011° 58,552' E	309
HE519_9-1	04.10.18 06:44	Kongsfjorden East	KFE	Young Fish Trawl	78° 56,514' N	011° 59,773' E	300,7
HE519_10-1	04.10.18 09:29	Kongsfjorden West	KFW	CTD	78° 59,098' N	011° 41,372' E	314,2
HE519_10-2	04.10.18 10:08	Kongsfjorden West	KFW	Multi Corer	78° 59,178' N	011° 41,334' E	312,3
HE519_11-1	05.10.18 11:56	Isfjorden	ISF	CTD	78° 24,969' N	015° 58,505' E	186,7
HE519_11-2	05.10.18 12:12	Isfjorden	ISF	Multi Corer	78° 24,944' N	015° 58,608' E	186,6
HE519_12-1	05.10.18 14:02	Billefjorden	BIF	Young Fish Trawl	78° 35,005' N	016° 28,743' E	160,5
HE519_12-2	05.10.18 16:20	Billefjorden	BIF	CTD	78° 35,596' N	016° 30,059' E	163,1
HE519_13-1	06.10.18 06:28	Billefjorden	BIF	Young Fish Trawl	78° 33,558' N	016° 25,080' E	126,4
HE519_13-2	06.10.18 07:31	Billefjorden	BIF	Young Fish Trawl	78° 34,845' N	016° 28,574' E	159,3
HE519_13-3	06.10.18 09:28	Billefjorden	BIF	Multi Corer	78° 36,227' N	016° 31,736' E	154,4
HE519_13-4	06.10.18 09:30	Billefjorden	BIF	Multi Corer	78° 36,248' N	016° 31,814' E	154,1
HE519_13-5	06.10.18 10:59	Billefjorden	BIF	Young Fish Trawl	78° 39,567' N	016° 42,391' E	195,4
HE519_13-6	06.10.18 13:05	Billefjorden	BIF	Young Fish Trawl	78° 39,320' N	016° 40,468' E	189
HE519_13-7	06.10.18 15:04	Billefjorden	BIF	CTD	78° 35,299' N	016° 29,901' E	159,7

Appendix B – CTD traces of stations

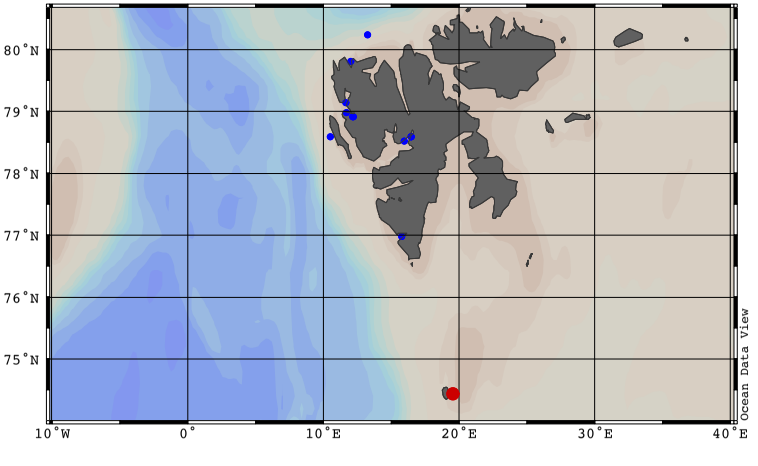


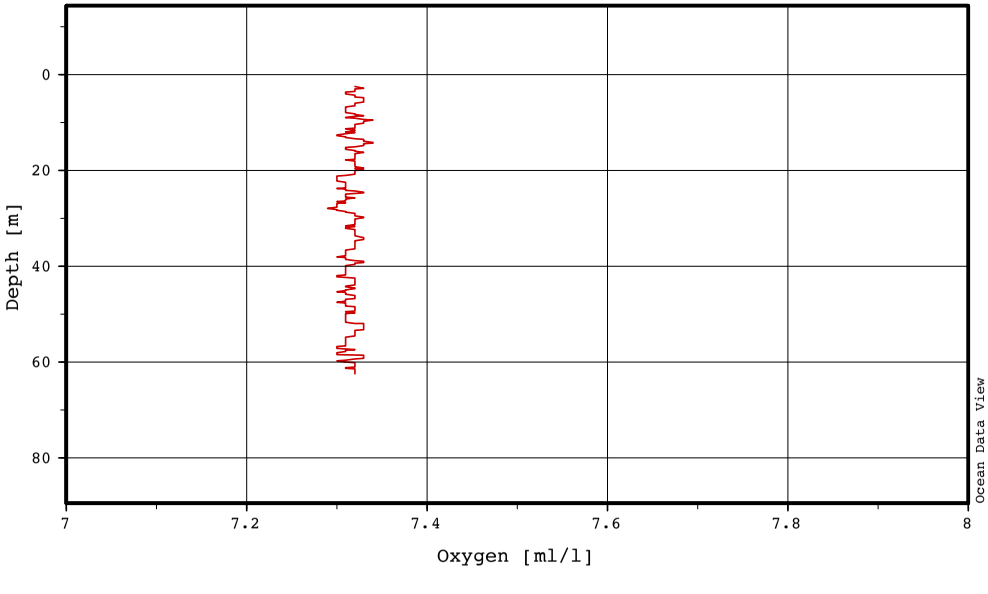


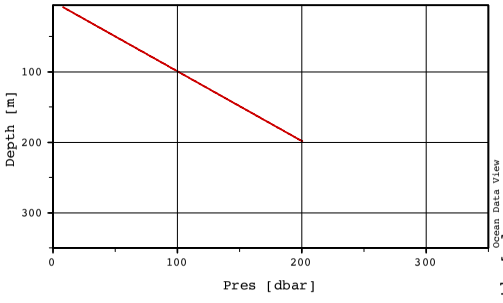


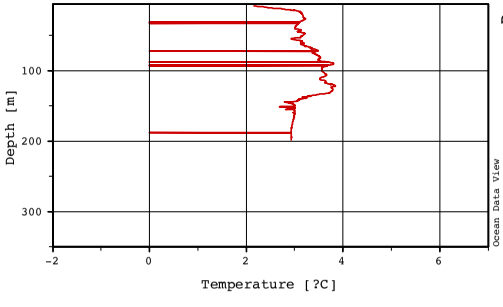


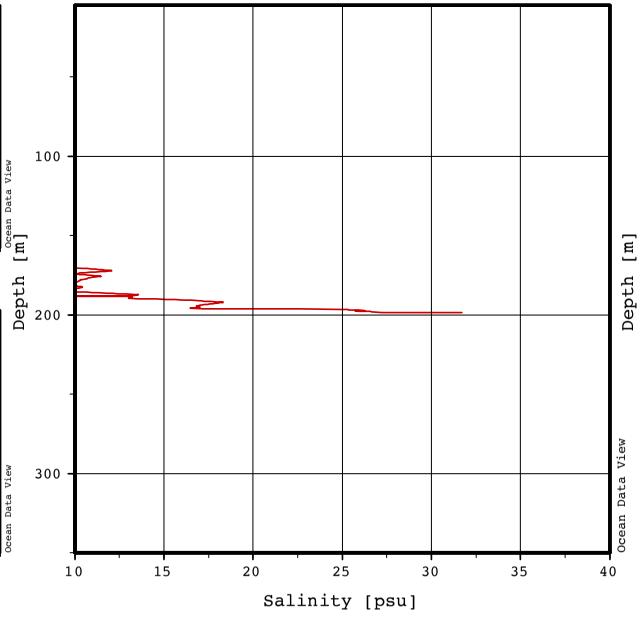
HE519 #001 Bjørnøya

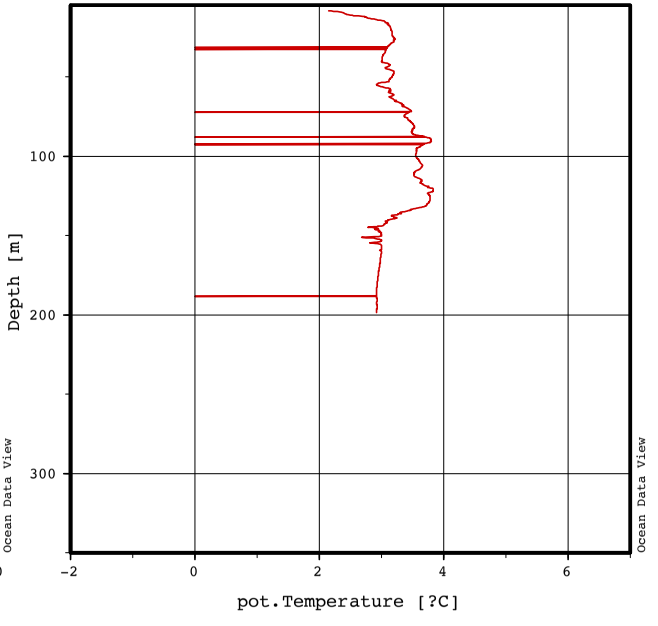




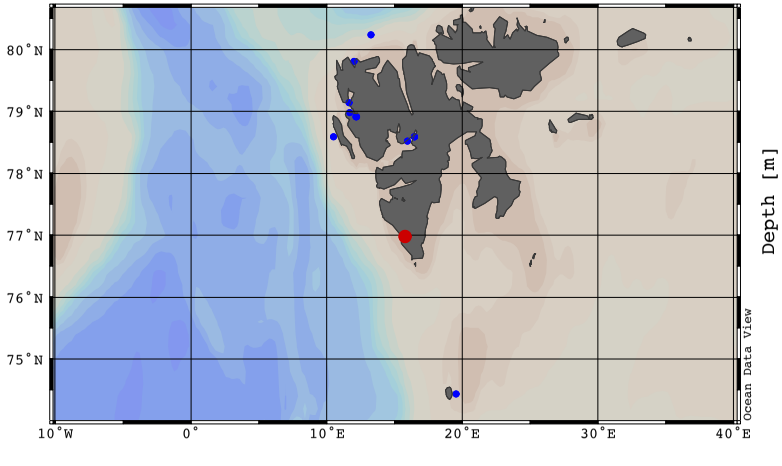


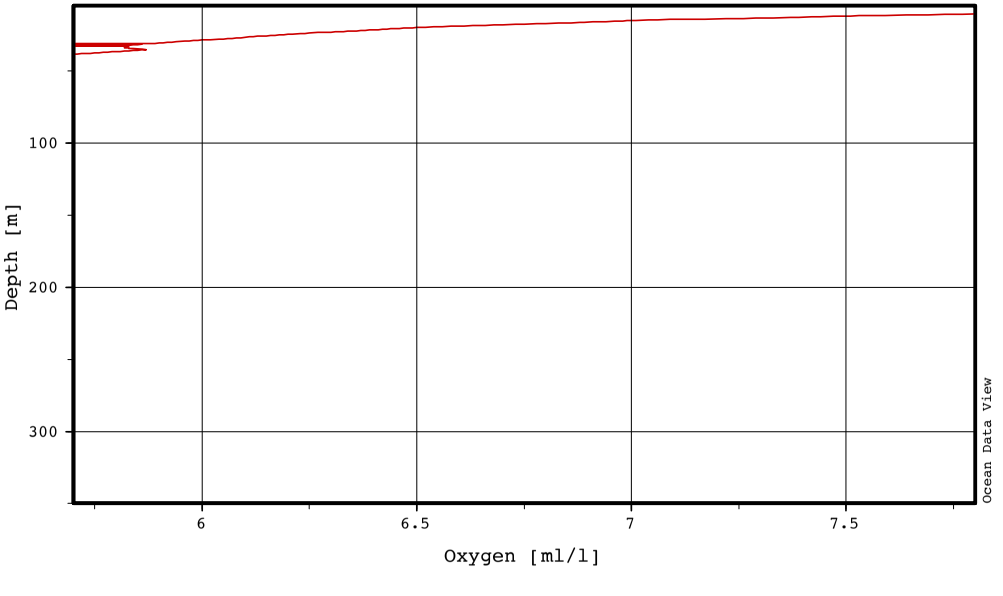


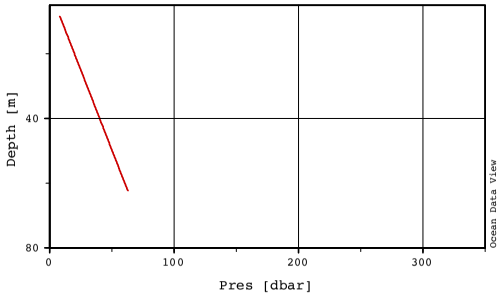


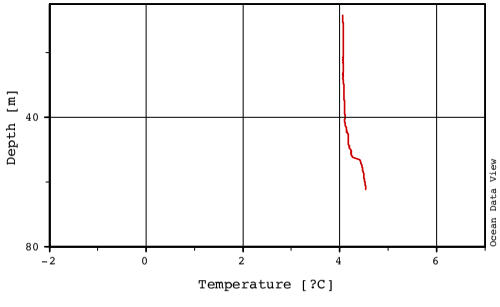


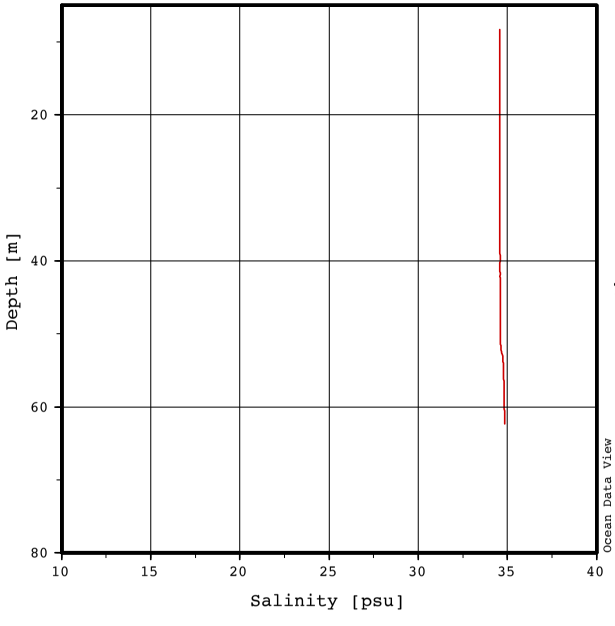
HE519 #002 Hornsund

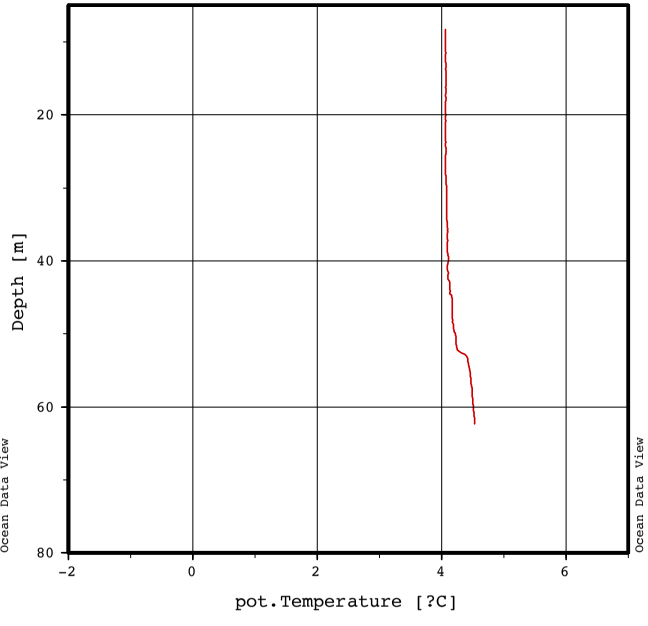




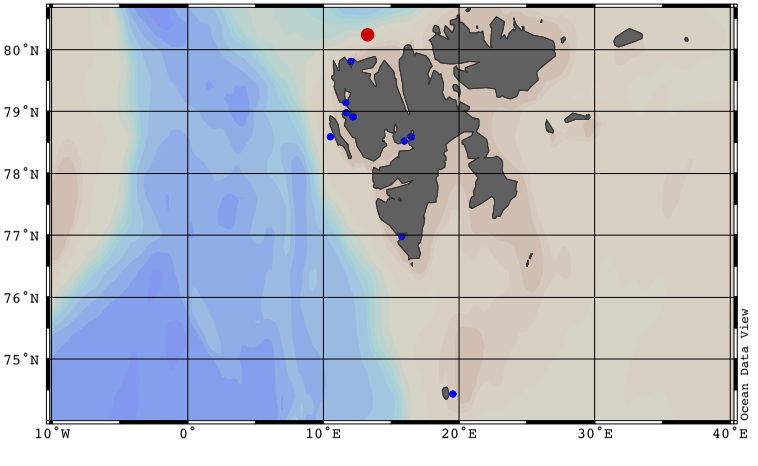


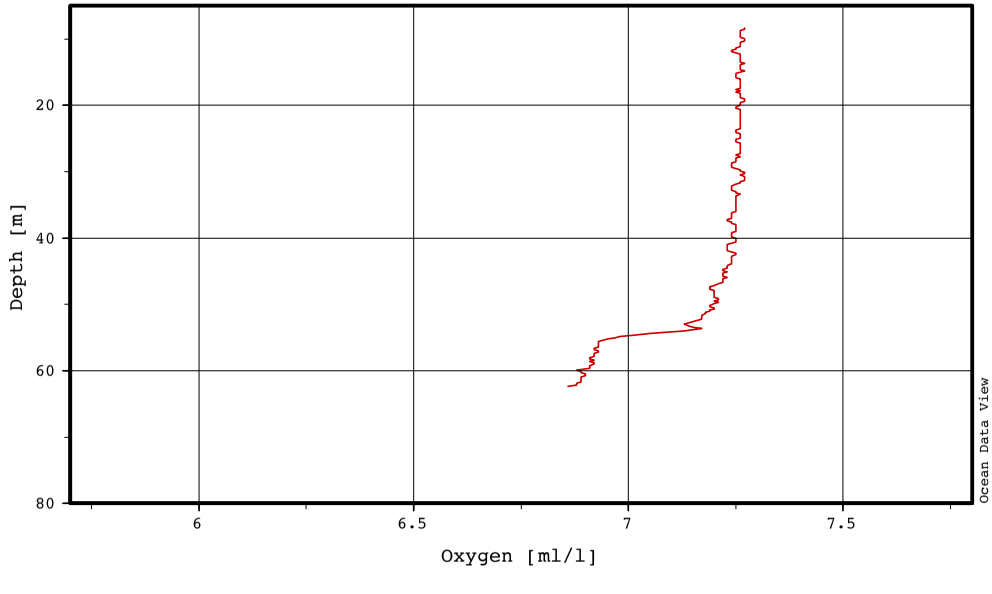


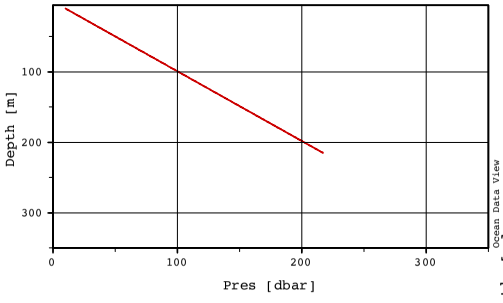




HE519 #003 North West Svalbard



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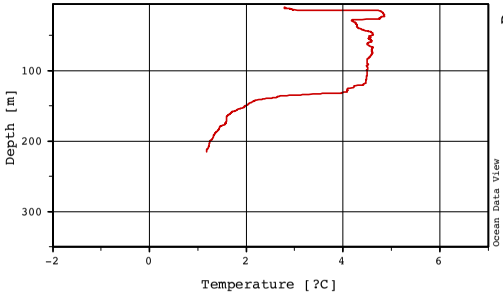
100
200
300
0
100
200
300
Pres [dbar]
Ocean Data View


Depth [m]
100
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300
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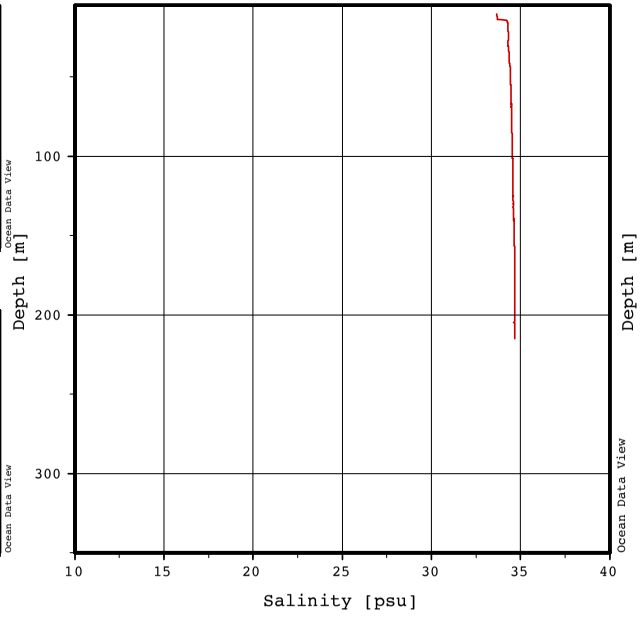
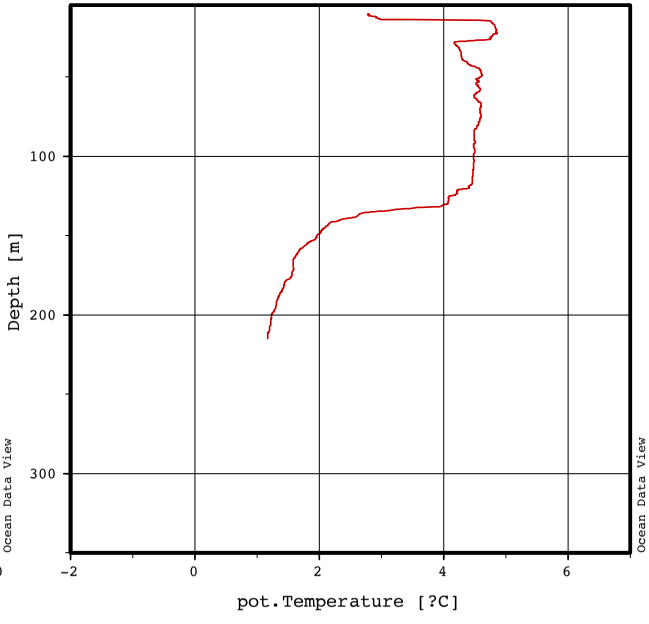
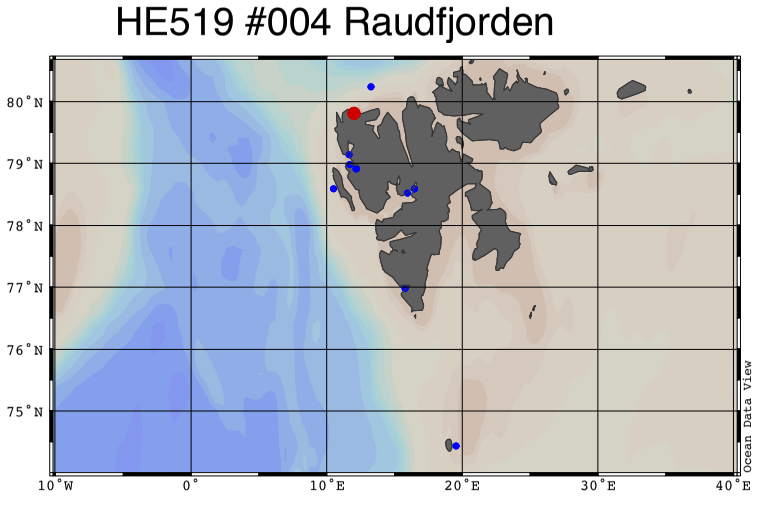
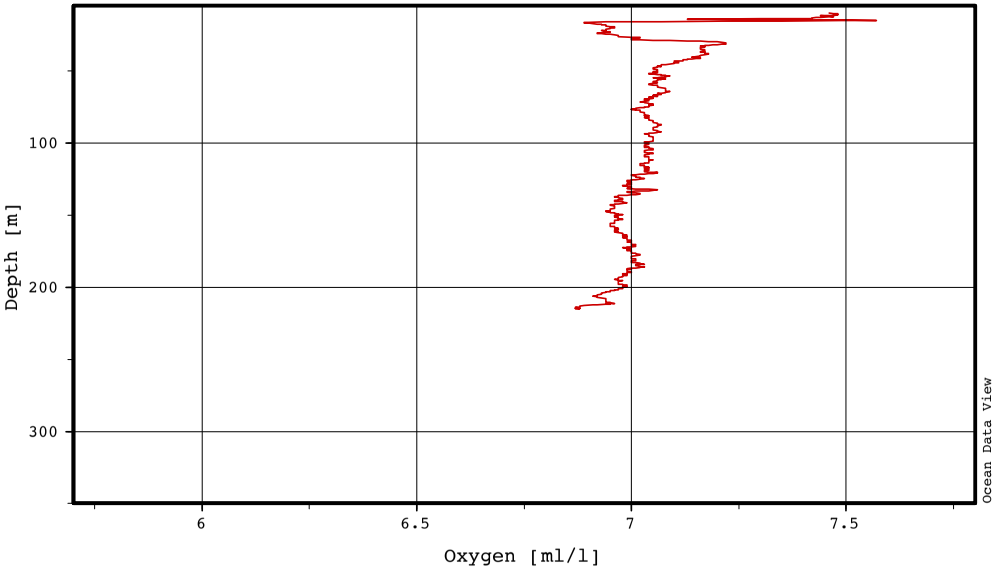
0
2
4
6
Temperature [?C]
Ocean Data View


Depth [m]
100
200
300
10
15
20
25
30
35
40
Salinity [psu]
Ocean Data View


Depth [m]
100
200
300
-2
0
2
4
6
pot.Temperature [?C]
Ocean Data View


HE519 #004 Raudfjorden
80°N
79°N
78°N
77°N
76°N
75°N
10°W
0°
10°E
20°E
30°E
40°E
Ocean Data View


Depth [m]
100
200
300
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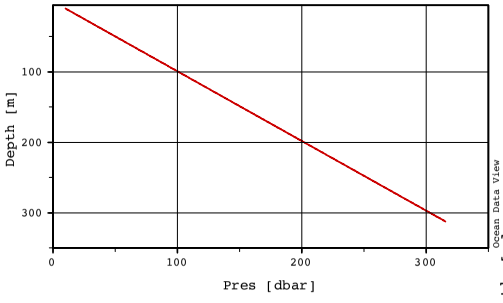
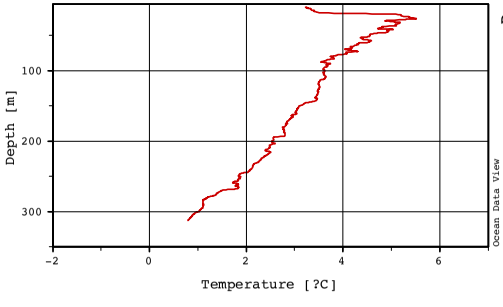
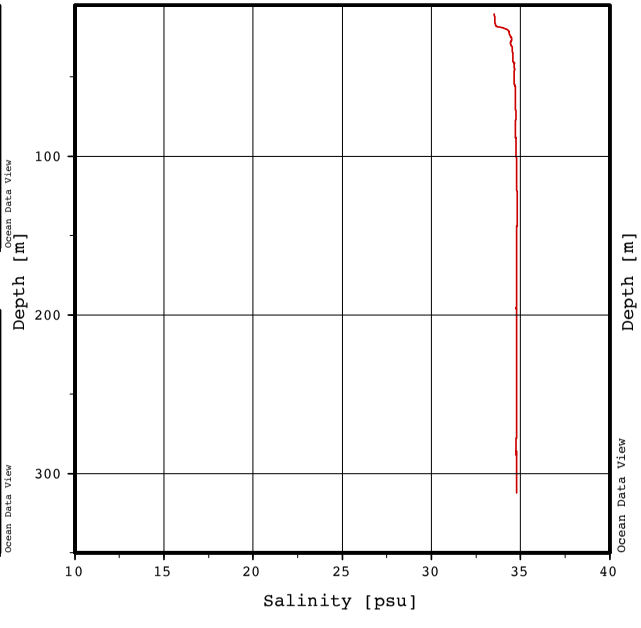
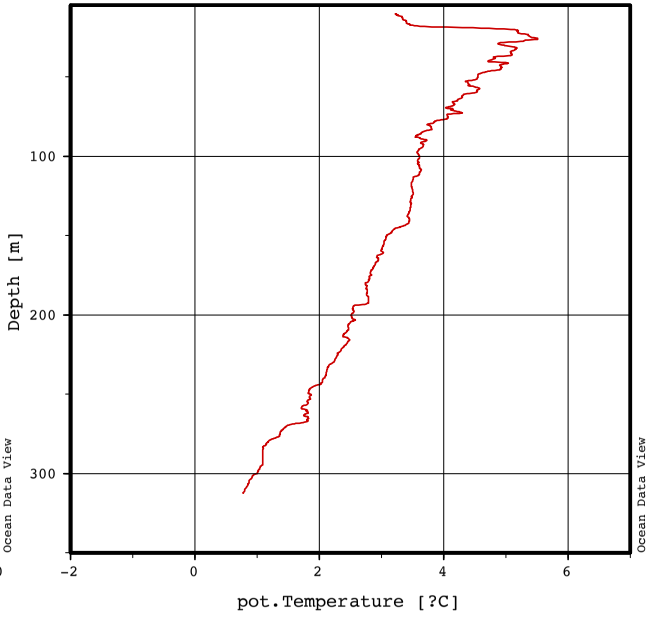
6.5
7
7.5
Oxygen [ml/l]
Ocean Data View

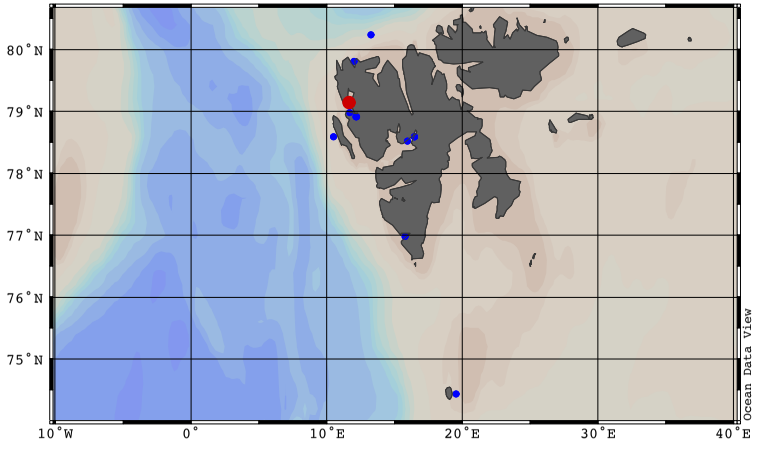


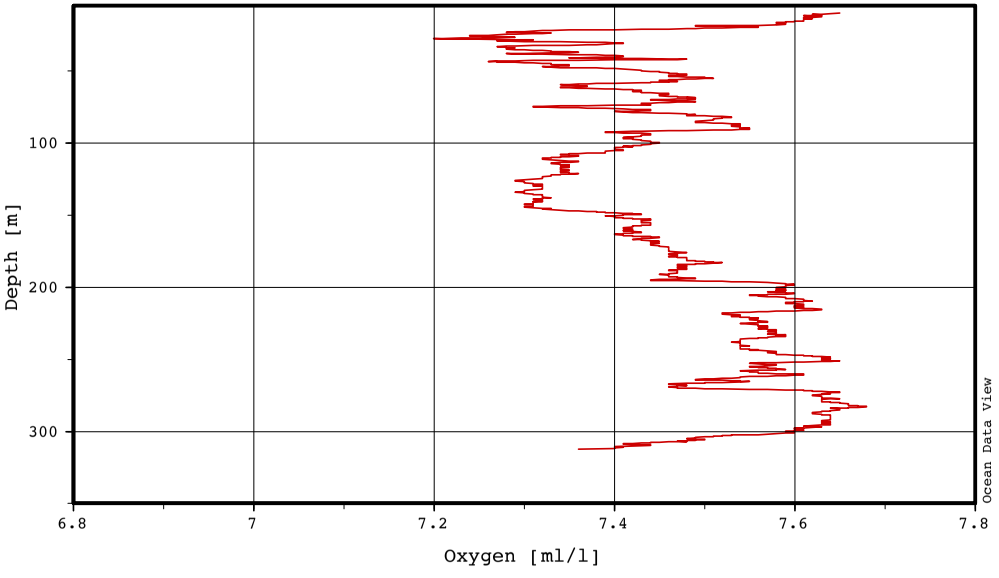


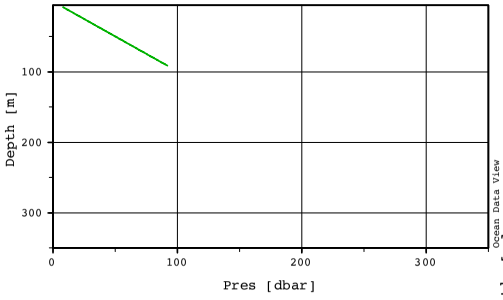


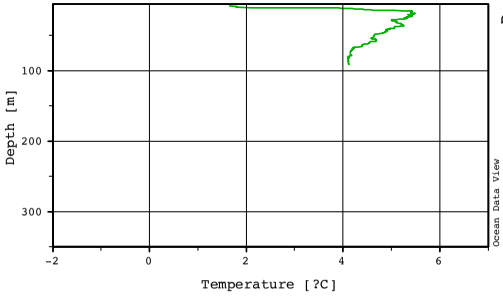


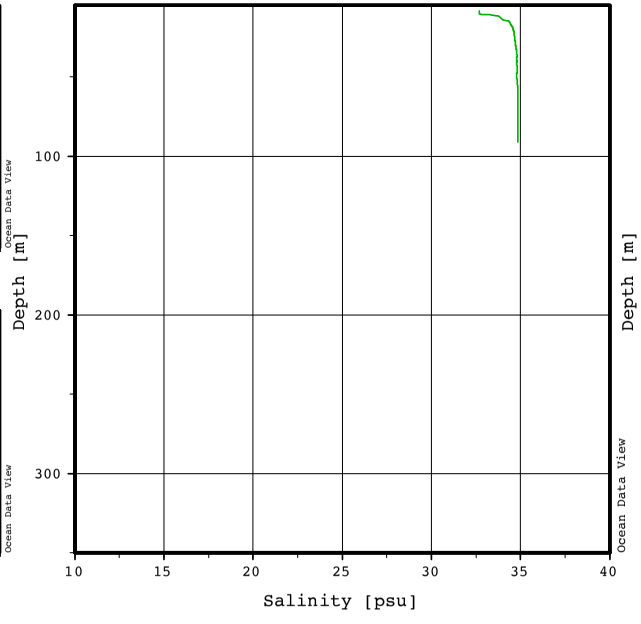
HE519 #007 Krossfjorden

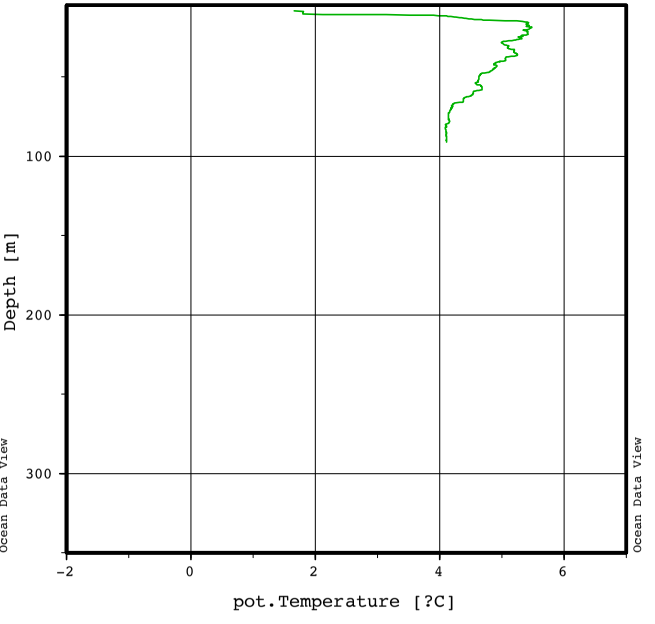




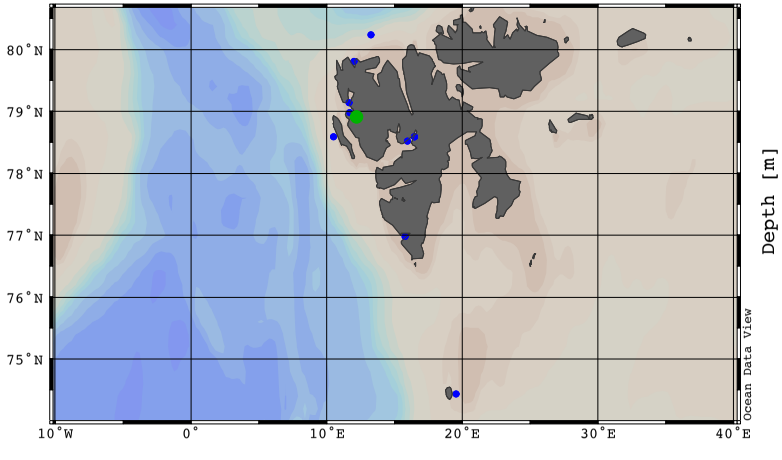


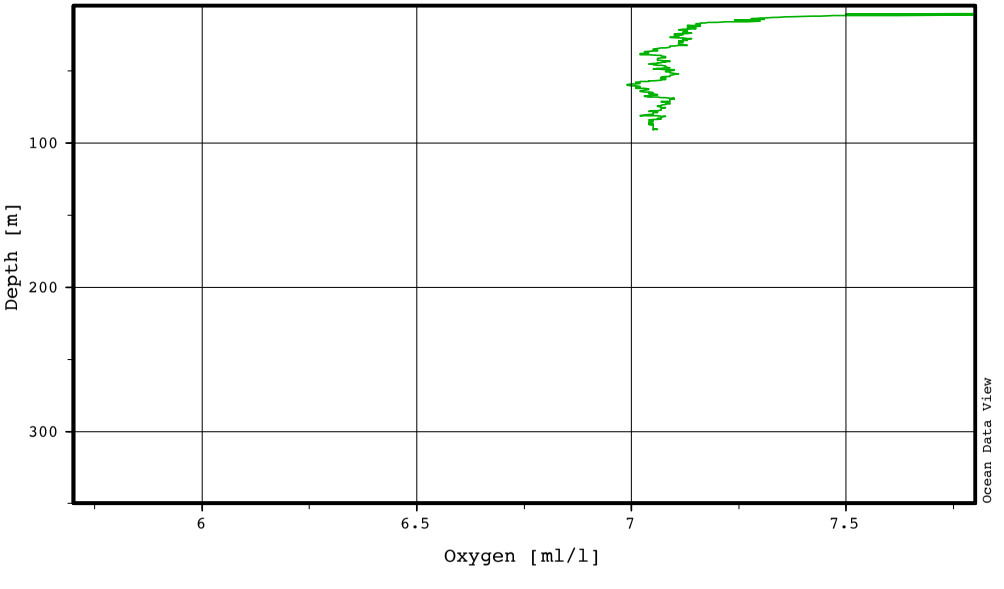


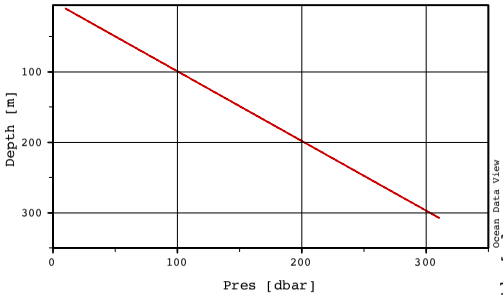


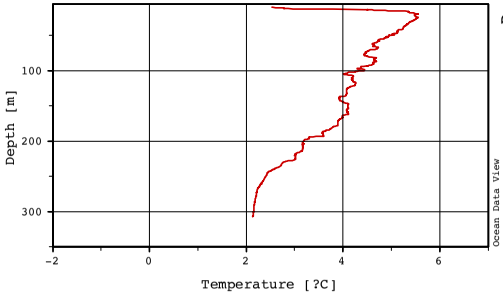


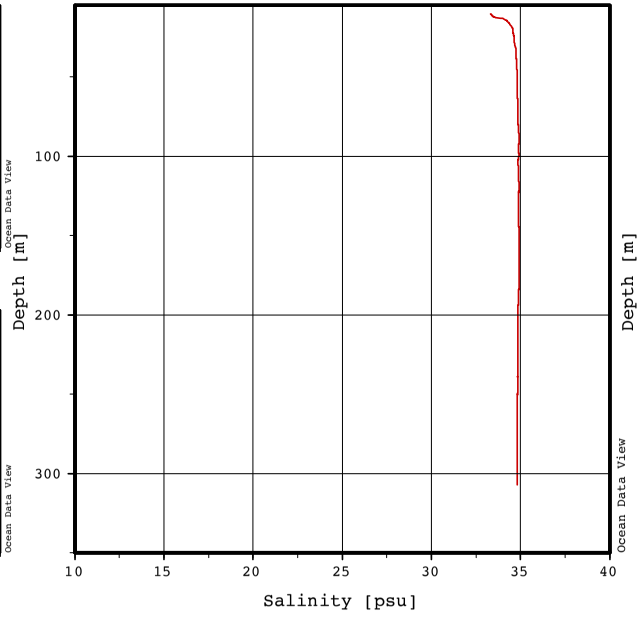
HE519 #008 Kongsfjorden East

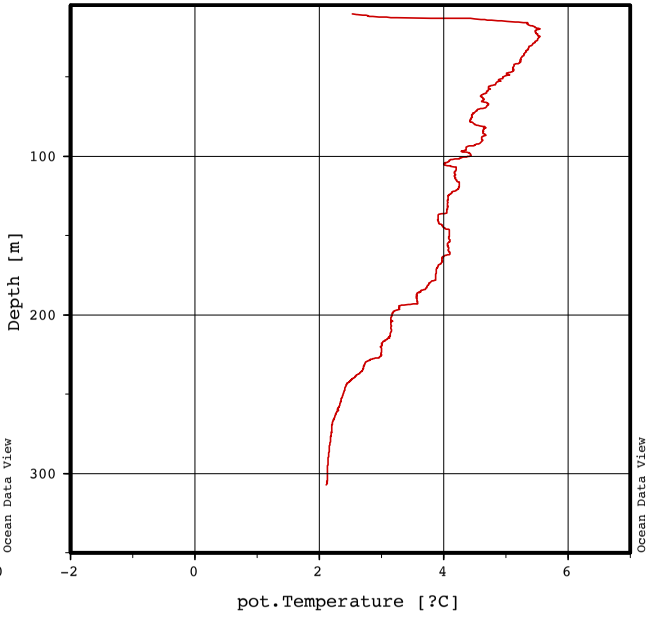




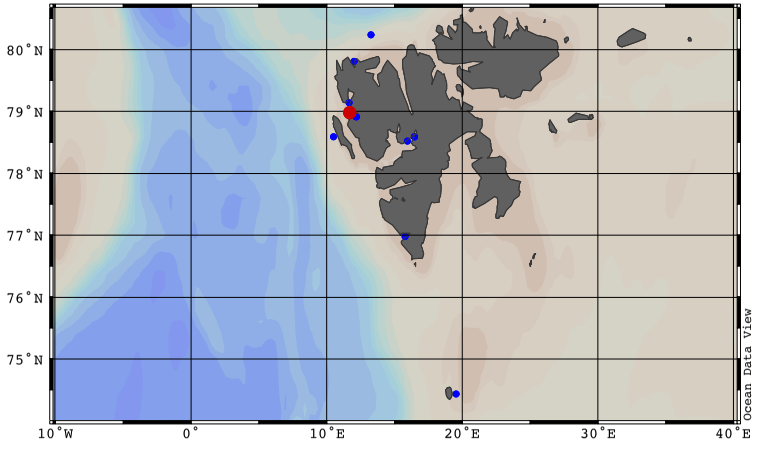


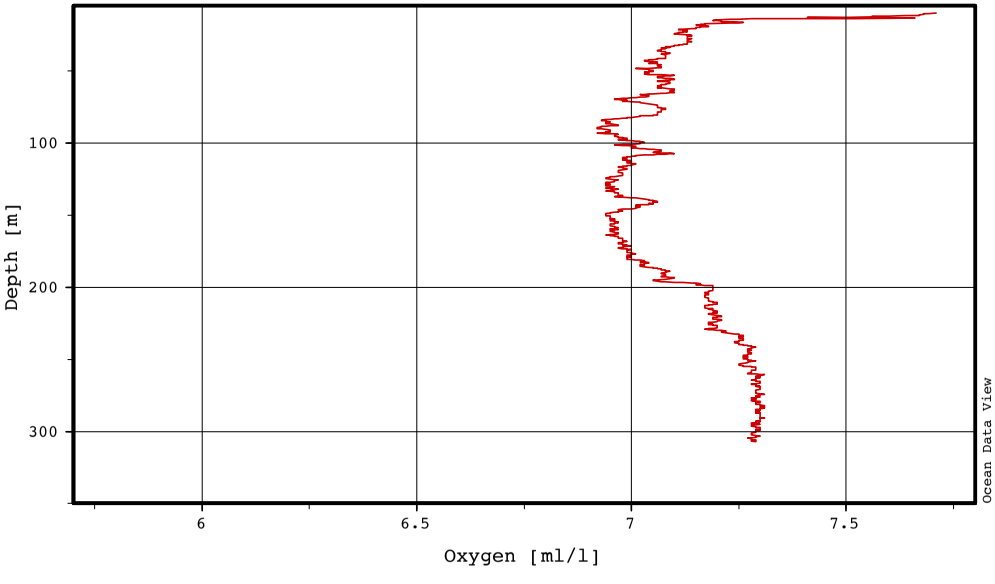


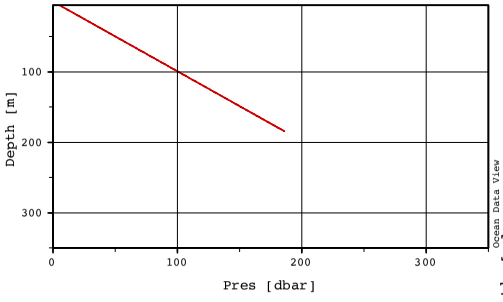


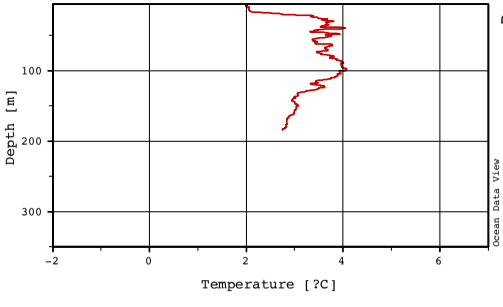


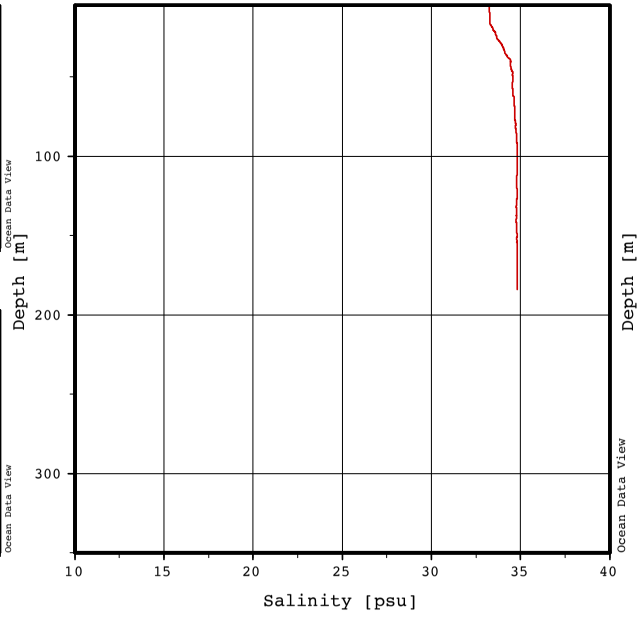
HE519 #010 Kongsfjorden West

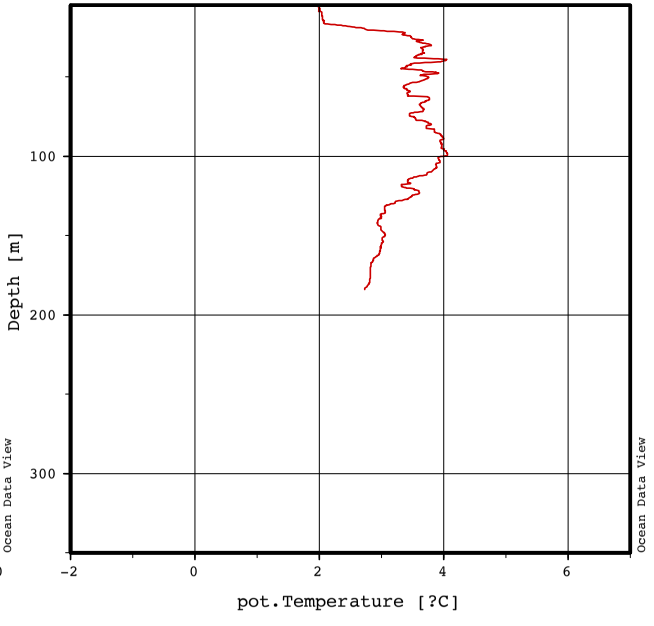




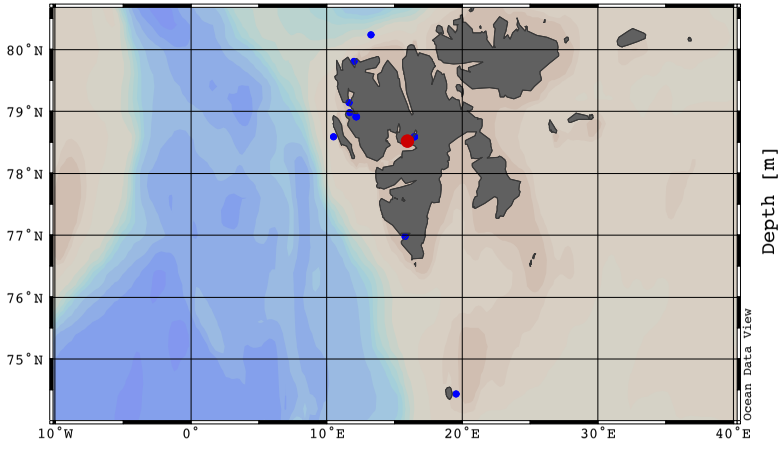


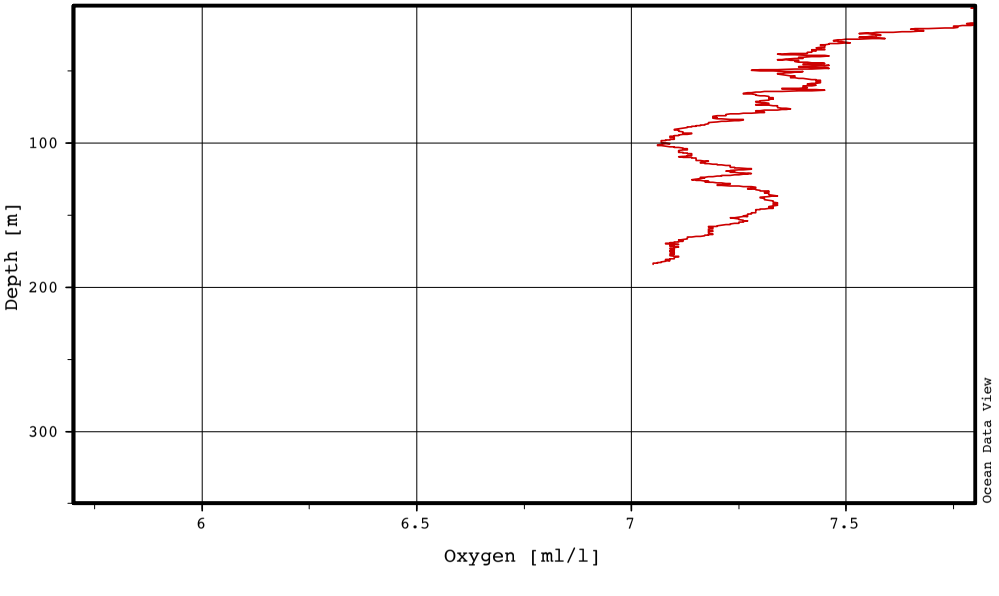


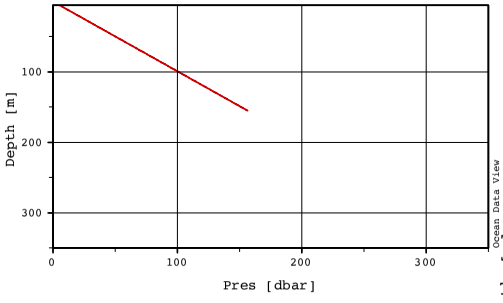


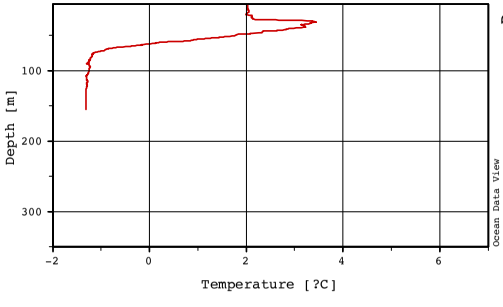


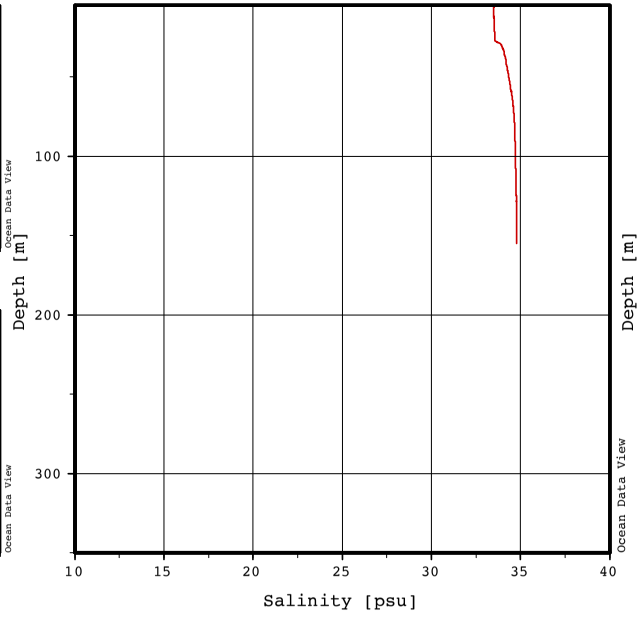
HE519 #011 Isfjorden

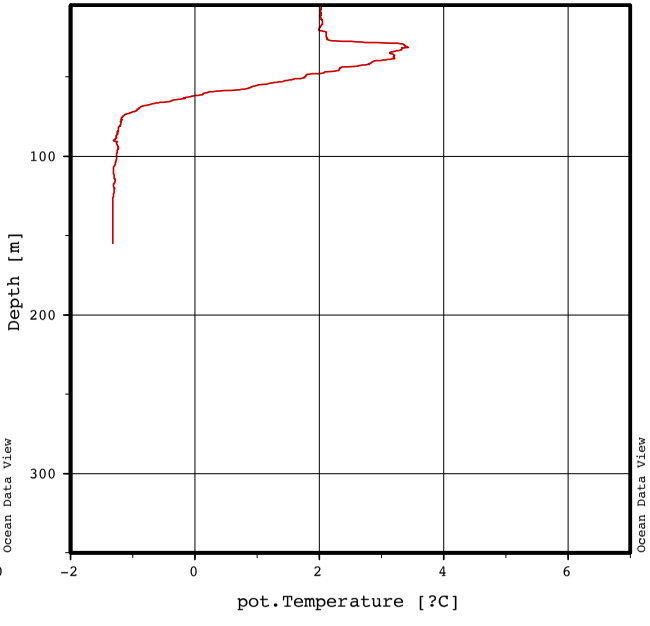












HE519 #013 Billefjorden