DBO Hydrography from recent July programs

Sir Wilfrid Laurier : July 2016 to 2019

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Fisheries and Oceans Canada

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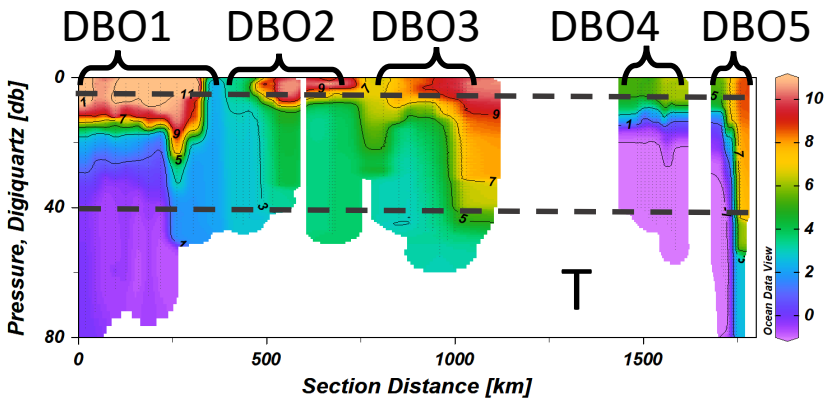
Summary

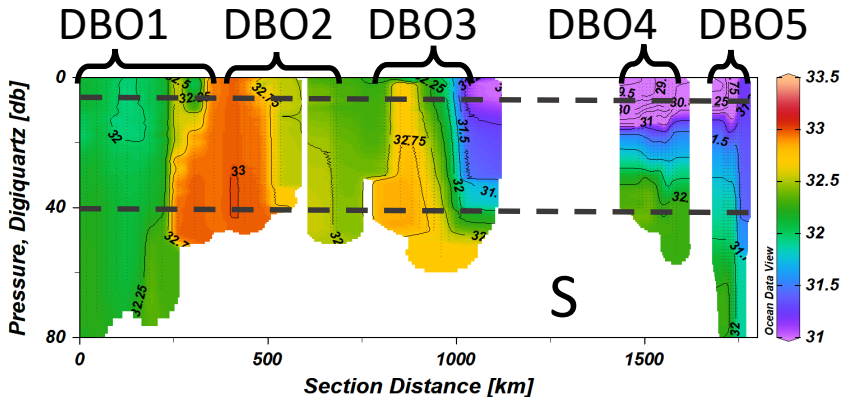
The Sir Wilfrid Laurier July time series shows 2019 continues to warm, and increase in salinity in the N. Bering Shelf and Bering Straight region. Their counterbalanced effect on density means the density range stays about the same.

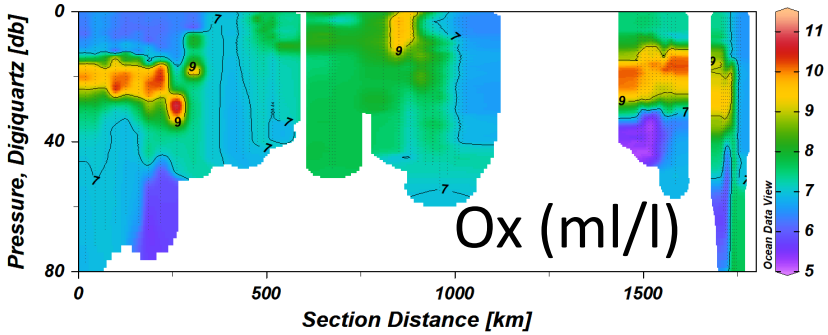
Nutrient spatial distribution remained the same, but in 2019 the local maximums had even higher concentrations than the previous 3 years.

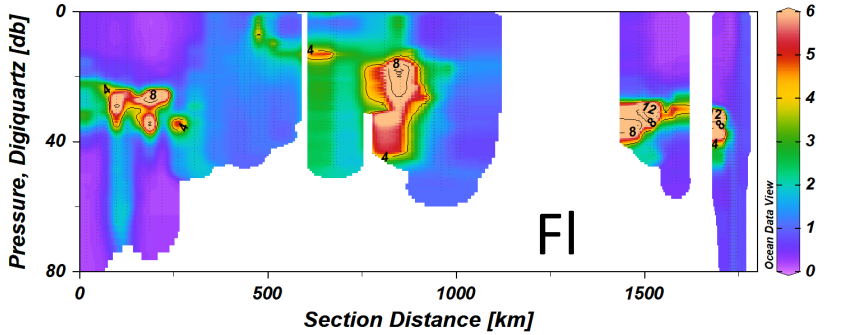
A method for improving CTD oxygen accuracy when no water samples are available is being investigated. The method will use multiple sensors and frequent in-house 2-point calibrations.

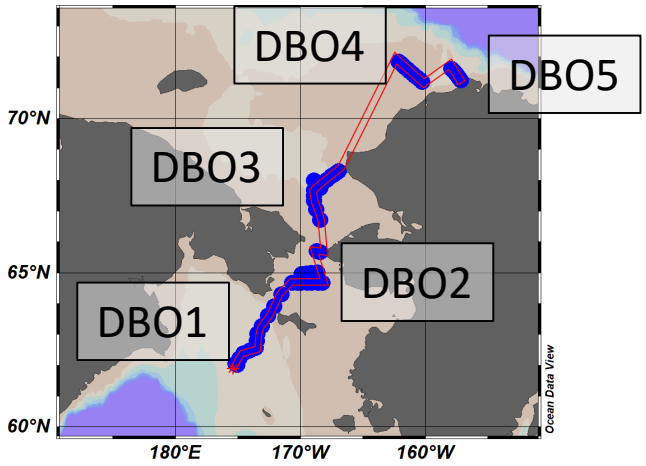
CTD Measurements: 2019

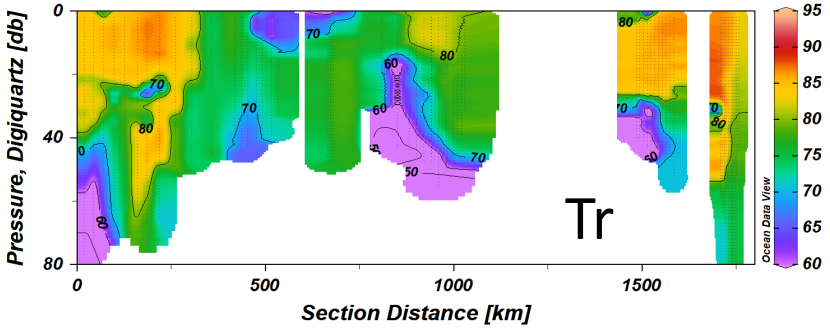




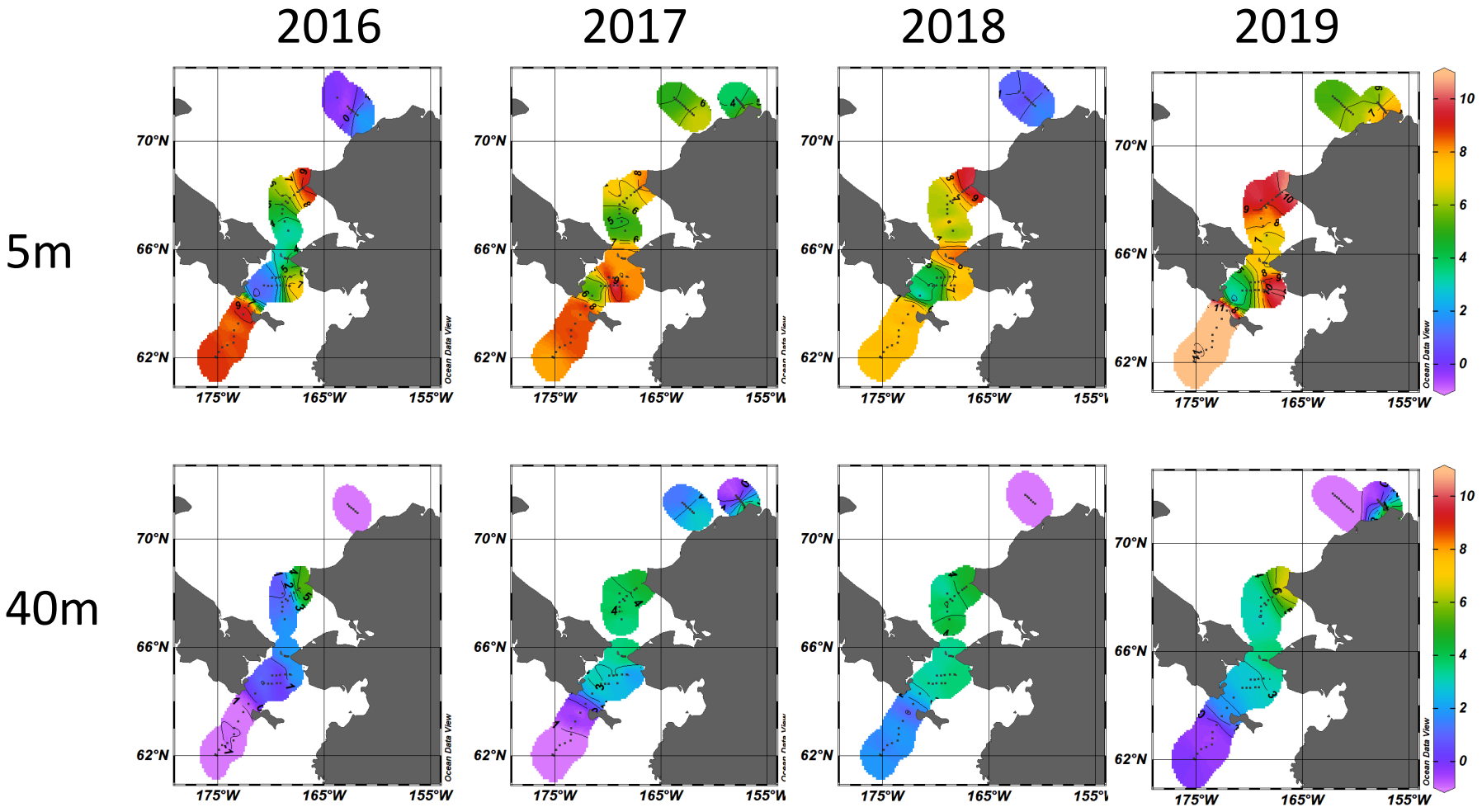








Temperature



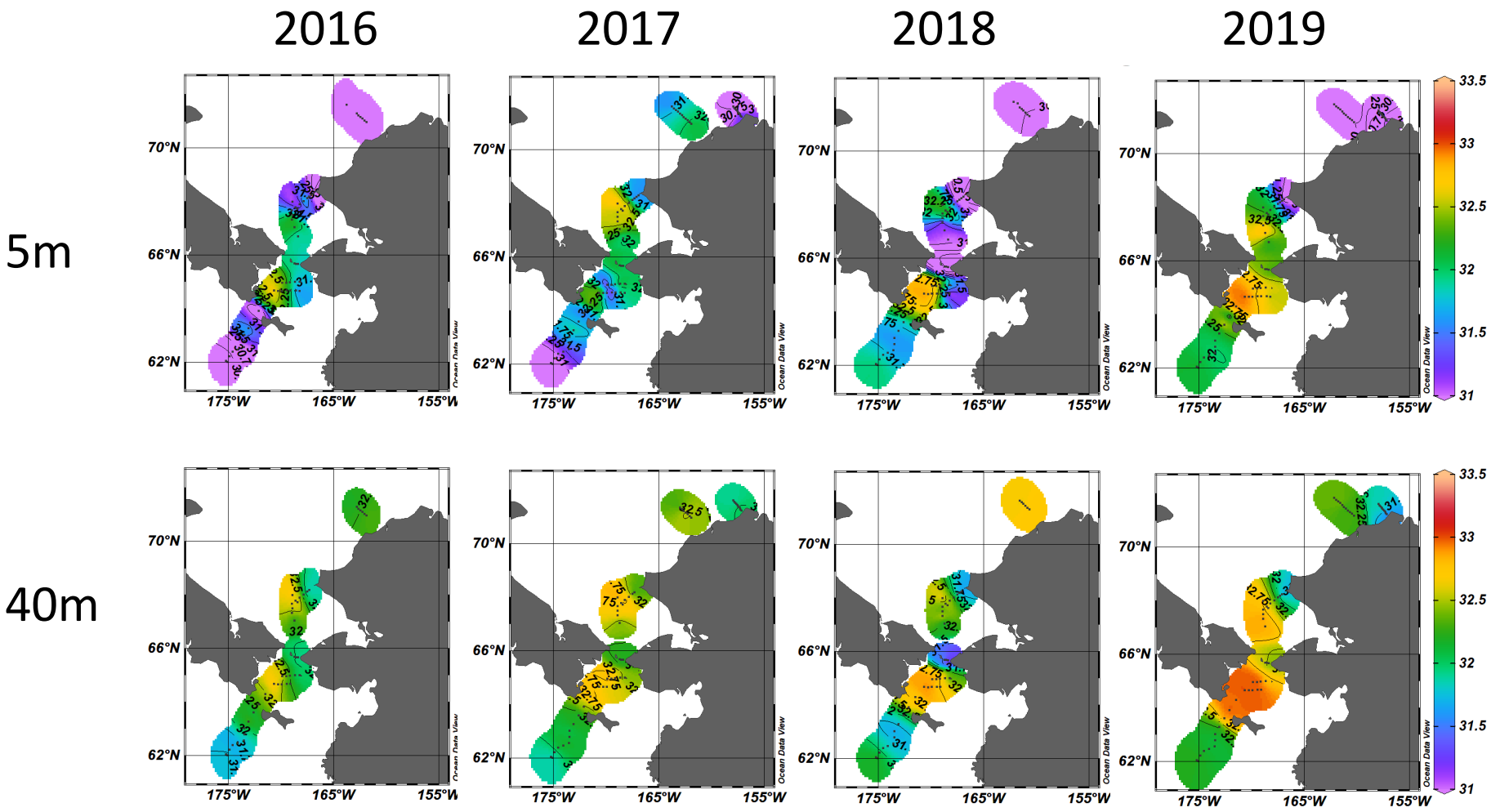
Warming at surface and at depth on Bering Shelf, Strait area and S. Chukchi Shelf.

2019 is ~2 to 3 warmer than 2016 in these areas.

Cold pool south of St Lawrence Island in 2018 and 2019 does not get below -1C

2017 unusually warm in N Chukchi Shelf at depth.

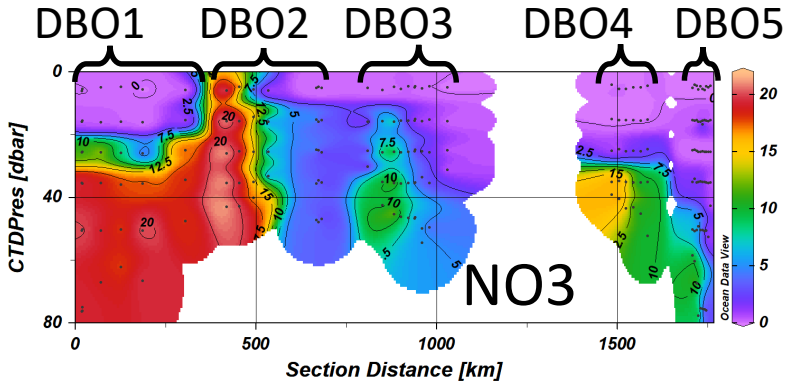
Salinity

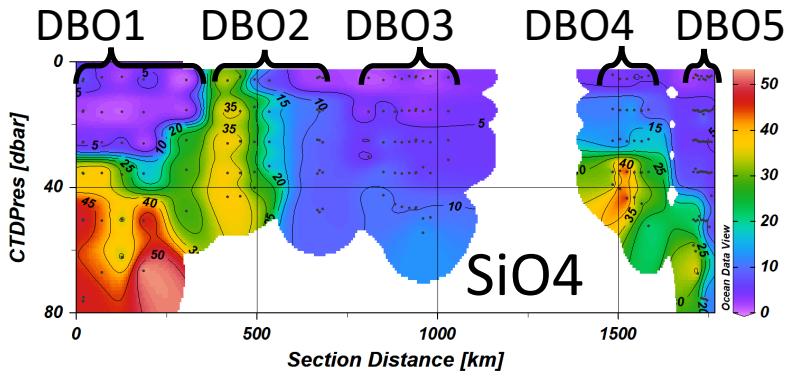


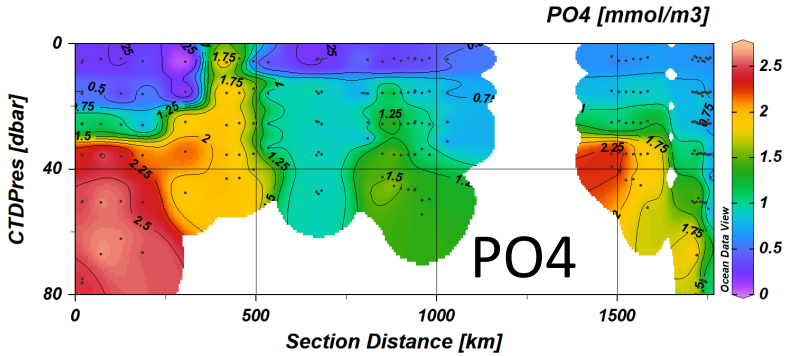
Salinity is increasing surface and at depth on Bering Shelf, Strait area.

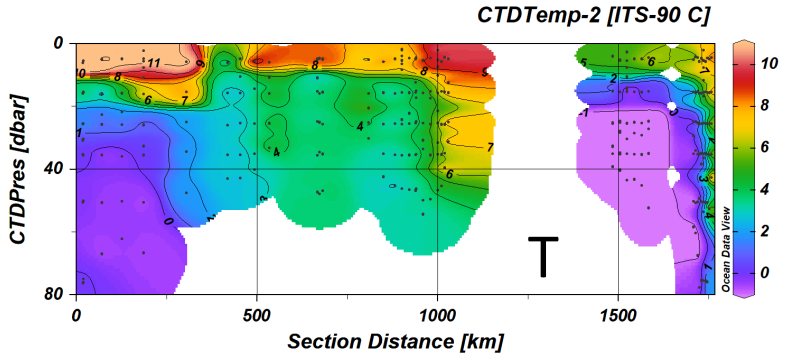
- 2019 is 0.5 to 1.75 PSU saltier than 2016 in most of these areas
- 2019 western Bering St region is over 33 PSU and 3C (unusually salty, warm)
- 2017 has saltier surface in N Chukchi Shelf - less sea ice melt?

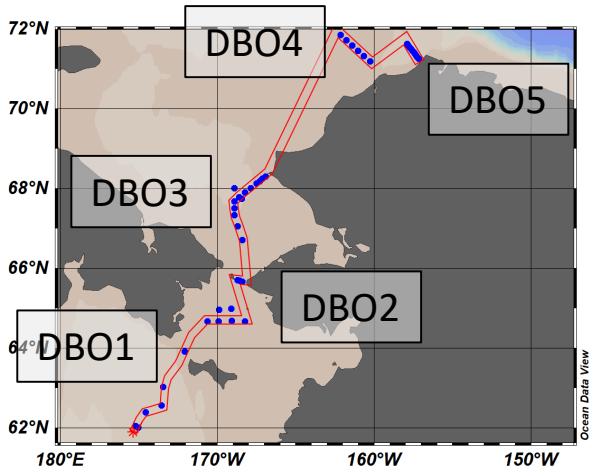
Nutrients: 2019

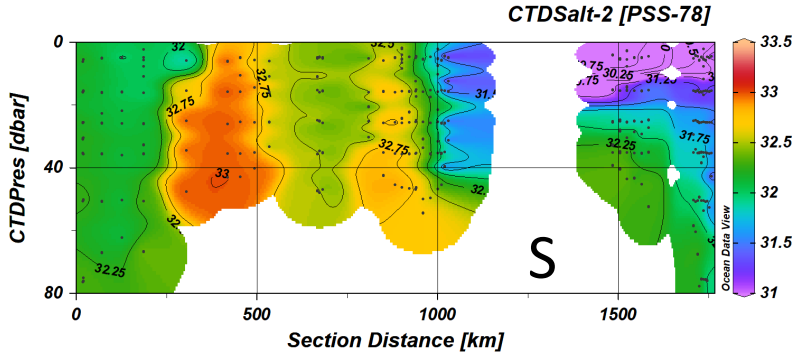






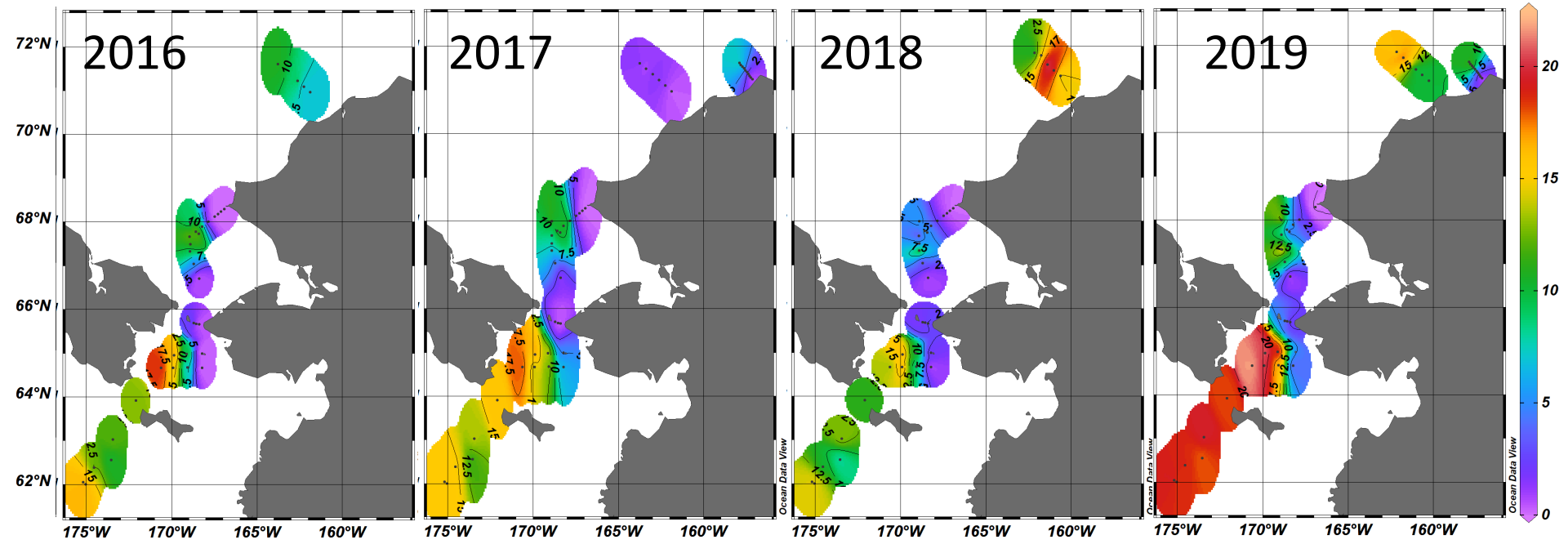




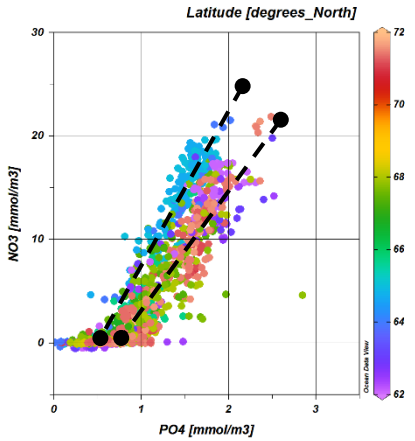


Nutrients

NO3 from bottom sample:

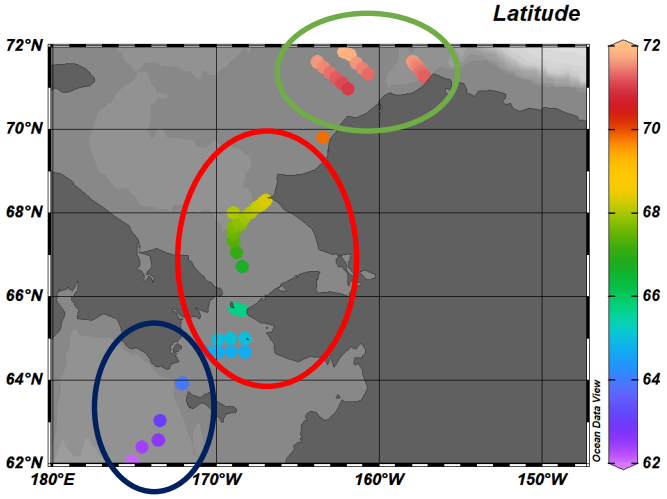


- All years: Similar spatial distribution
- 2019: Higher concentration of N, S, P particularly in deep Bering Slope/Shelf waters and in the Anadyr/Shelf water

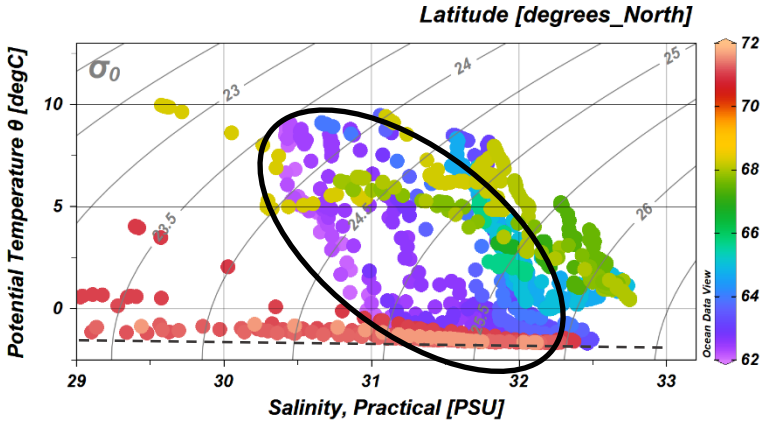


Thank You!

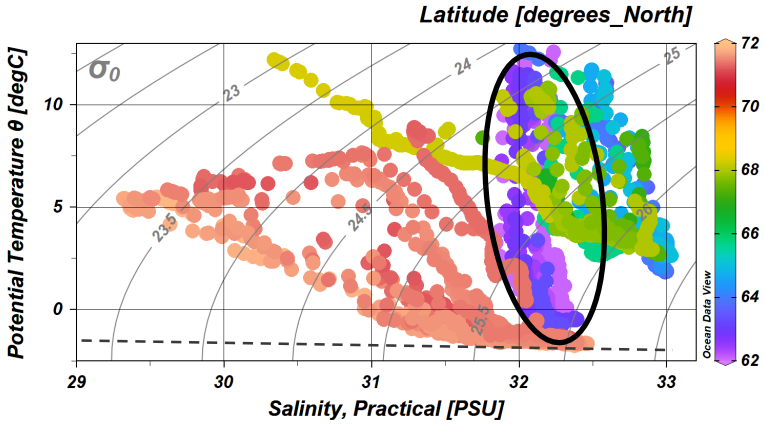
Temperature v. Salinity



2016

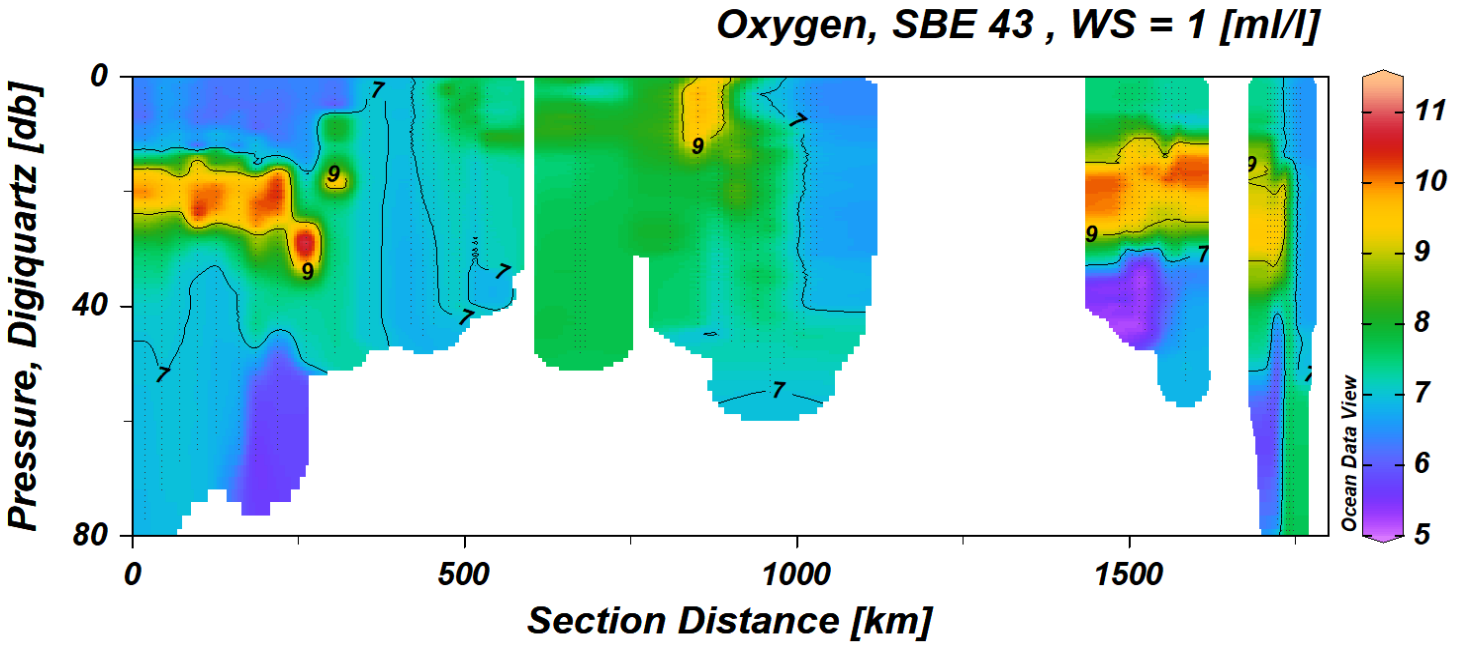


2019



Warmer and saltier,
but density range stays
mostly the same.

Oxygen



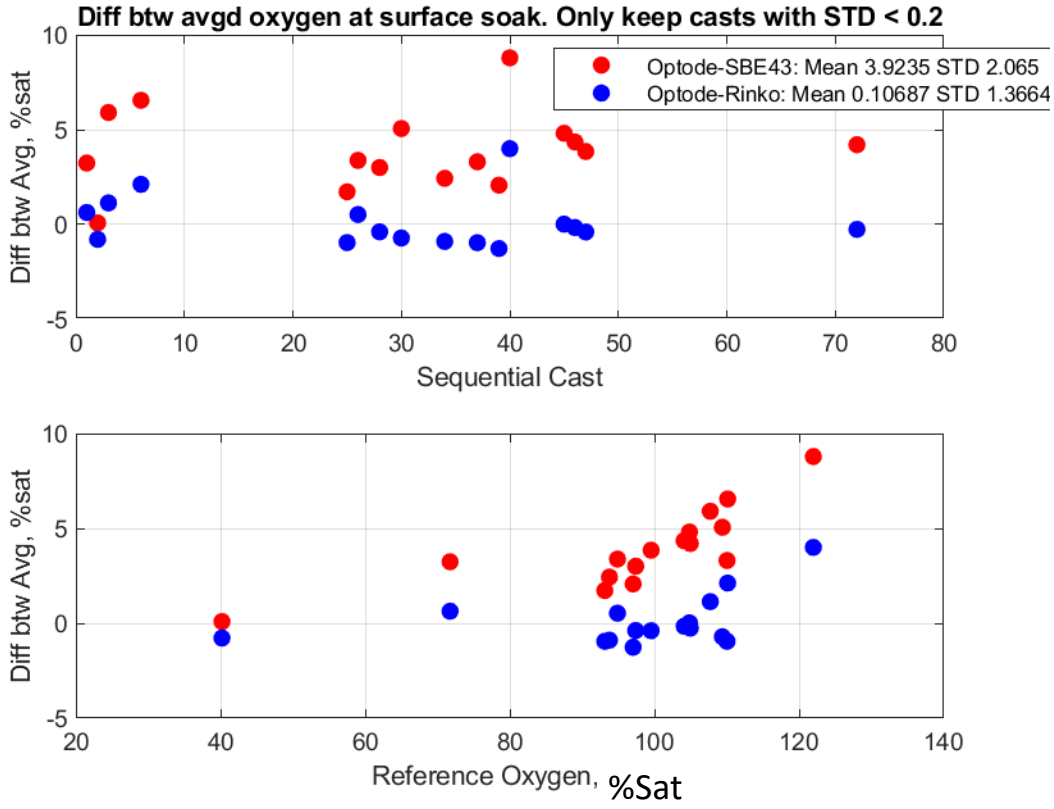
Physical – renewal through surface mixing, convection with ice formation

Biological – phytoplankton add, microbes, zooplankton and animals use

CTD has oxygen sensors, but we've been able to analyze water samples the past few years to calibrate the sensors…but do we have to?

Can we measure accurate oxygen using CTD sensors only?

Seabird 43 is traditional sensor, but data are typically 0.2ml/l low.



Sensors

SBE43 – pumped flow, medium speed, can be stable

Optode – optical, slow response, high stability

Rinko – optical, fast response, low stability

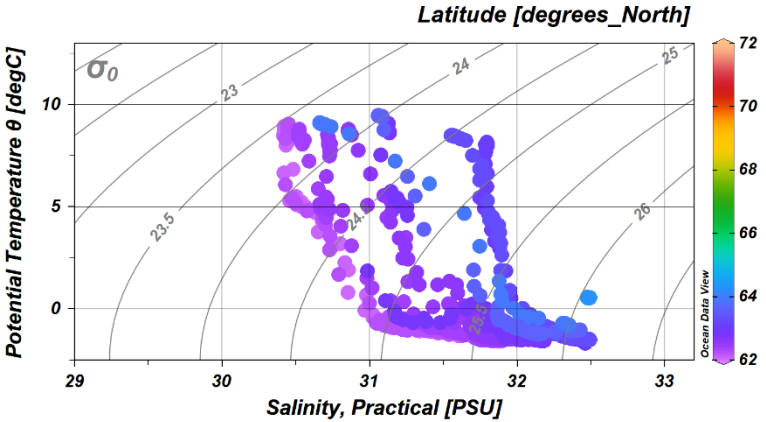
Assumption is that Optode is stable through the cruise.

Using the 3 minute surface CTD soak, calibrate other sensors to the optode data.

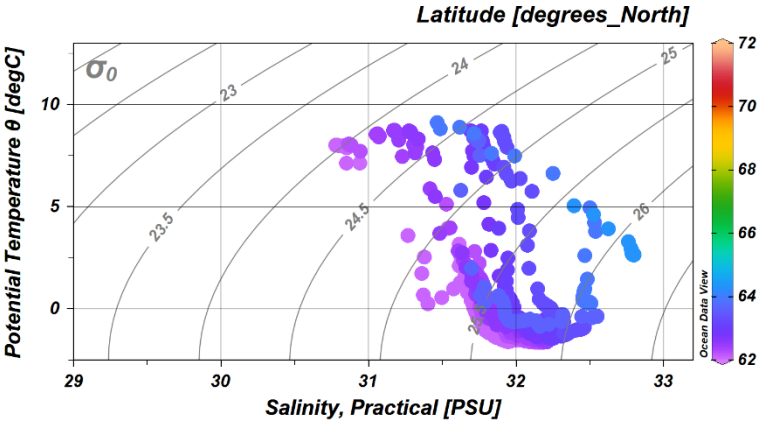
Results: No obvious drift or shift, but SBE43's STD is high (~twice expected STD for fit of bottles)

Bering Shelf (DBO1)

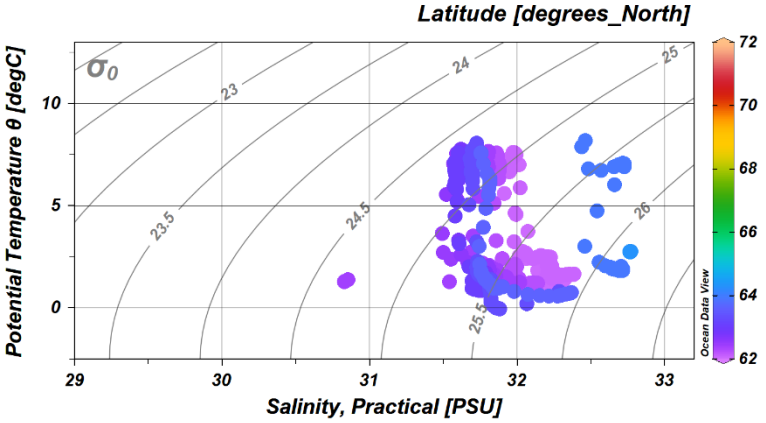
2016



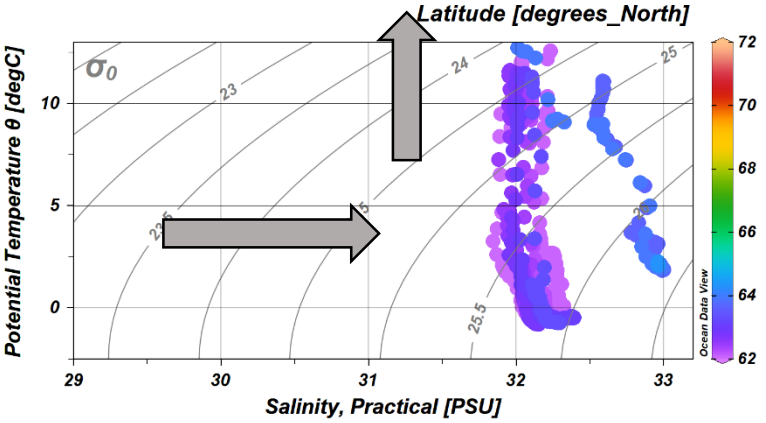
2017



2018



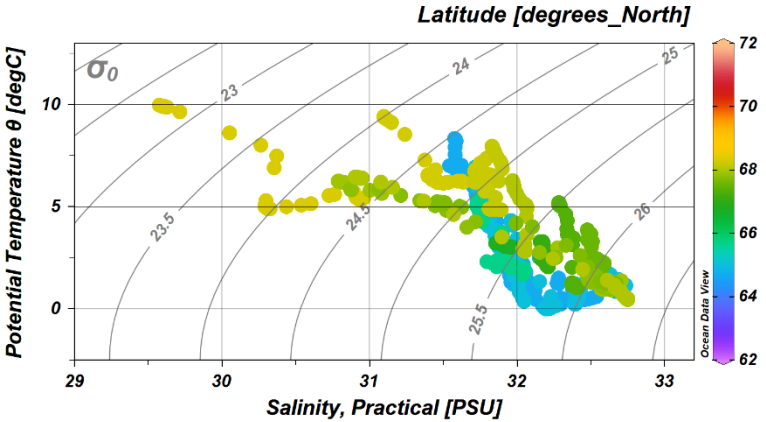
2019



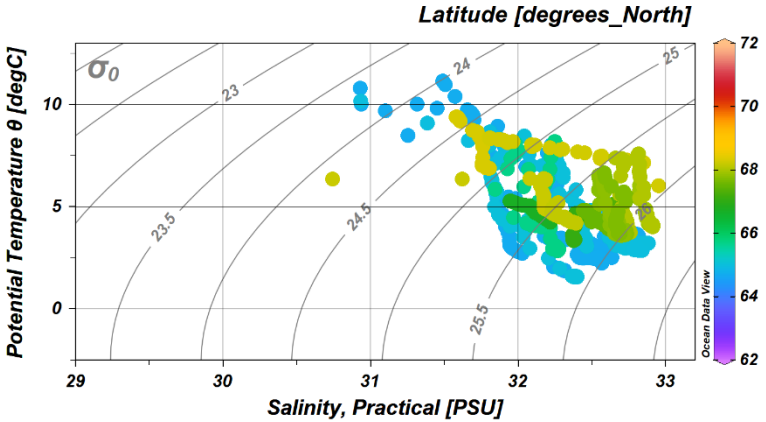
Bottom water stays salty (32.5PSU) and cold,
but the rest is getting saltier and warmer.

Bering Strait (DBO2 and 3)

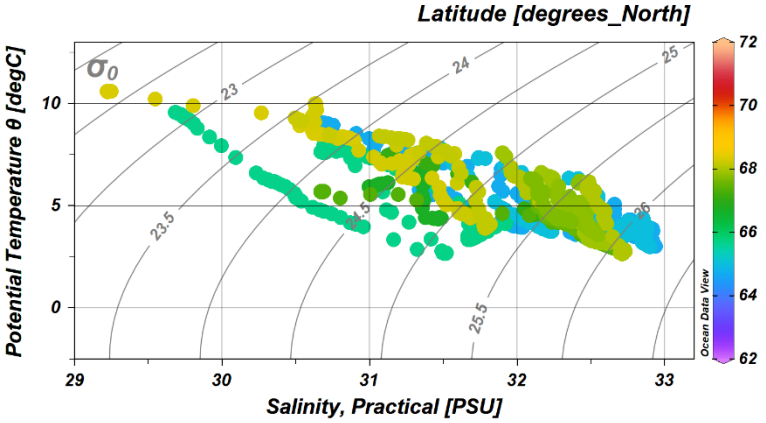
2016



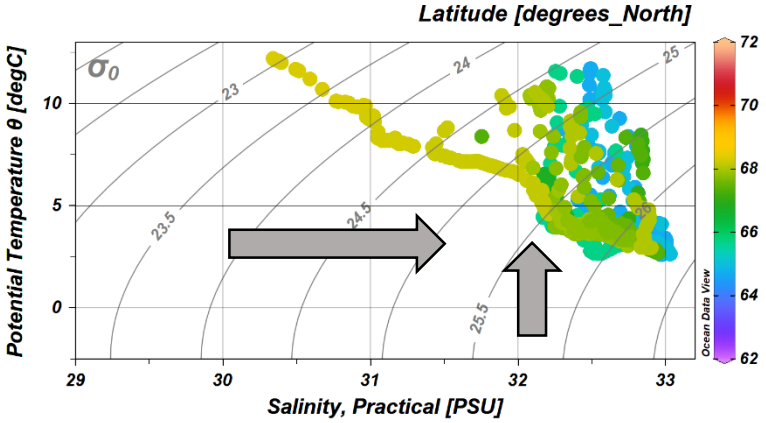
2017



2018



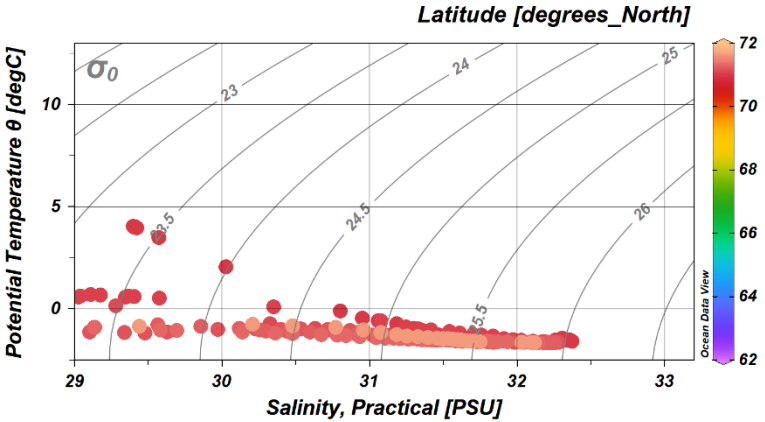
2019



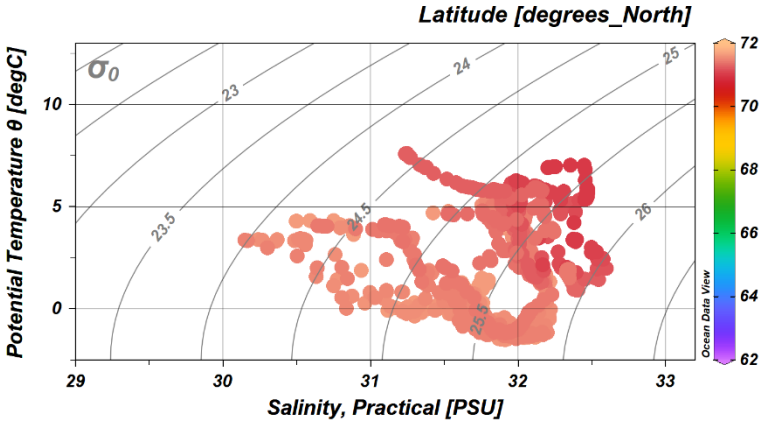
Bottom layer is
Getting warmer (from 0 to 3C)
Getting saltier (from 32.7 to 33.1).

Chukchi Shelf (DBO4 and 5)

2016

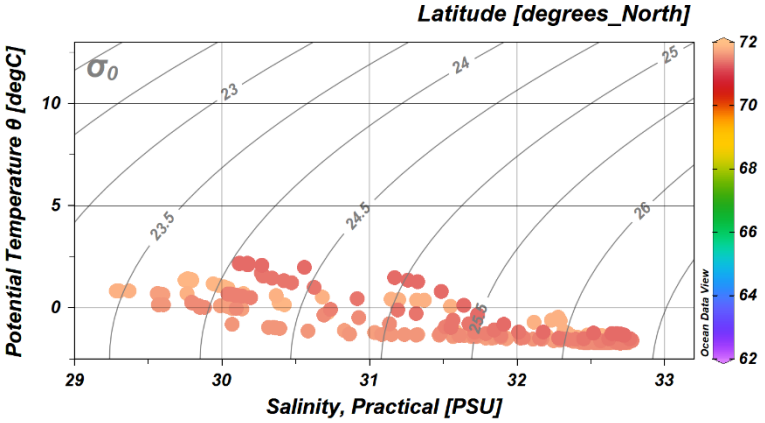


2017

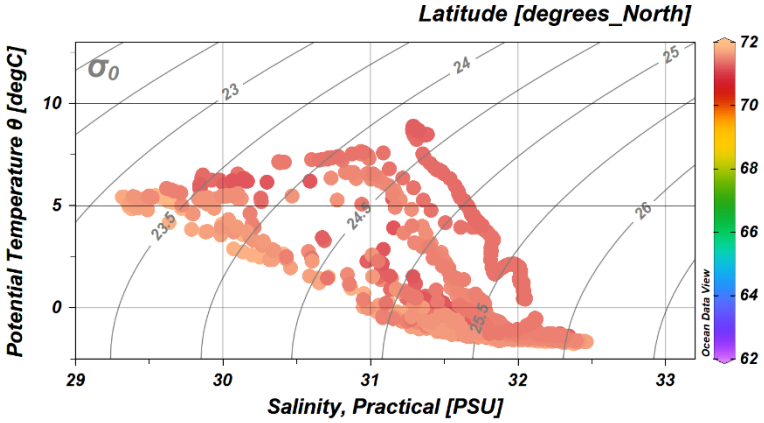


Add freezing temperature line to plots

2018



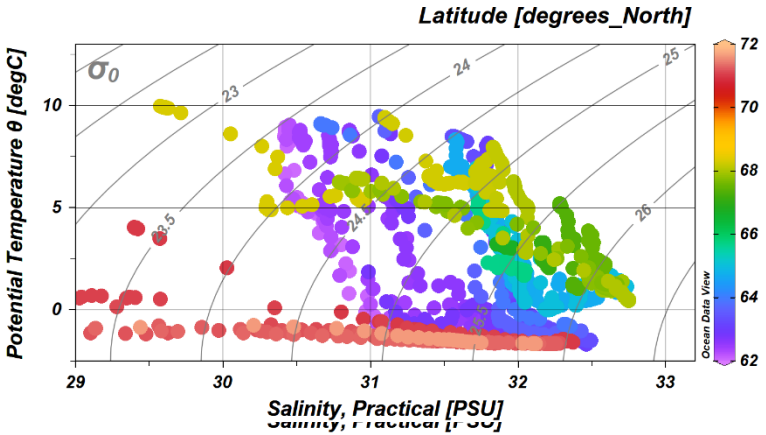
2019



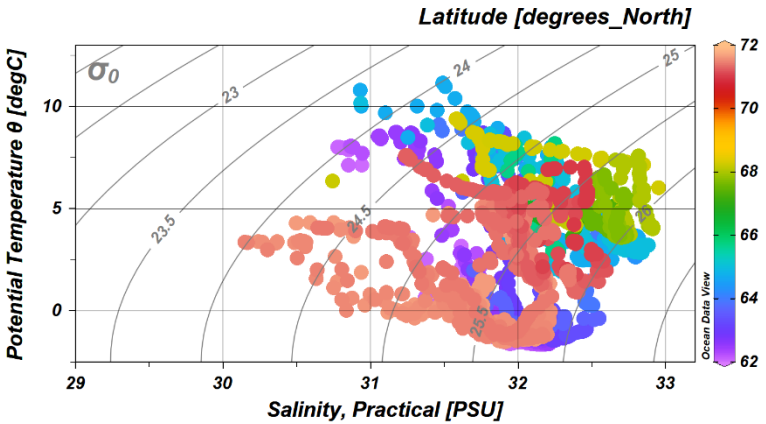
Variable. 2016 and 2018 had sea-ice (prevented sampling of DBO5 Barrow Canyon) with colder waters top to bottom.

T v. S

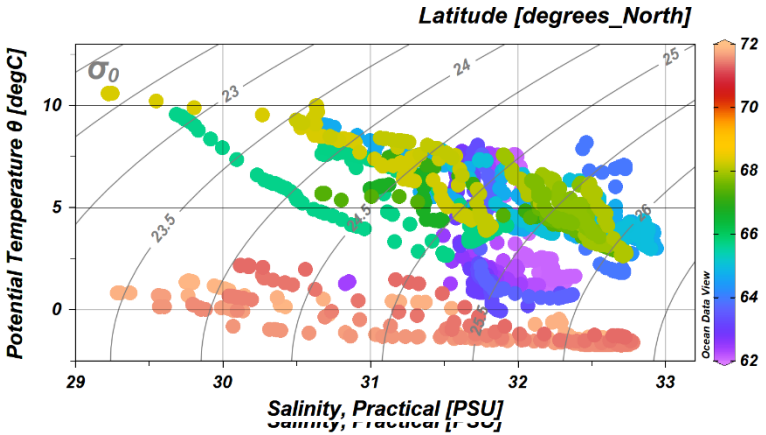
2016



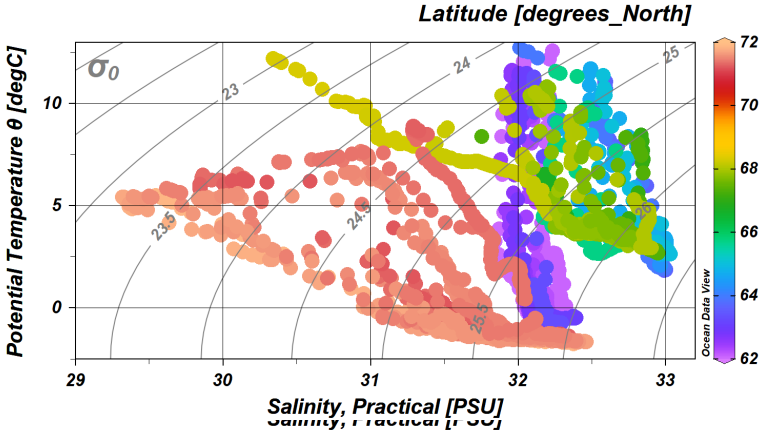
2017



2018

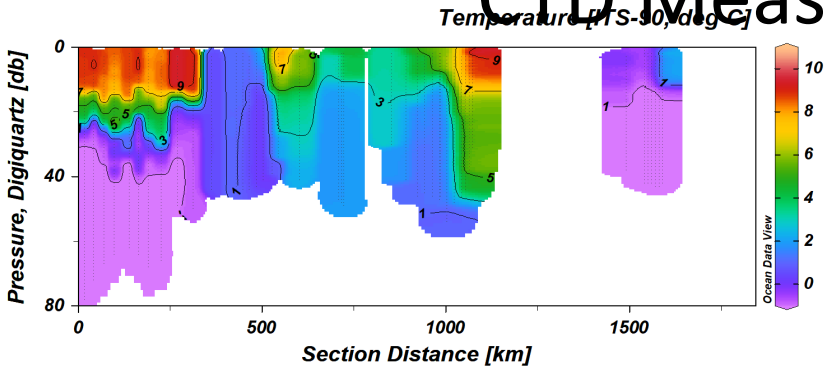


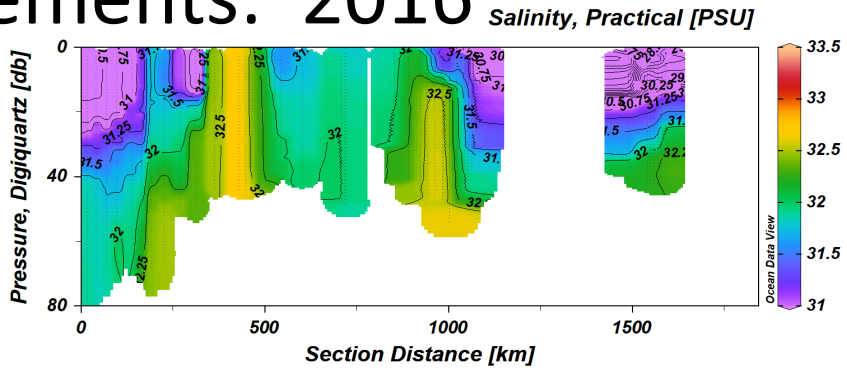
2019

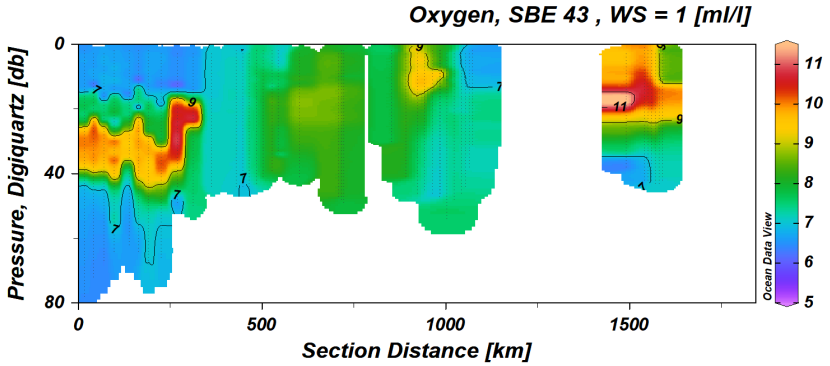


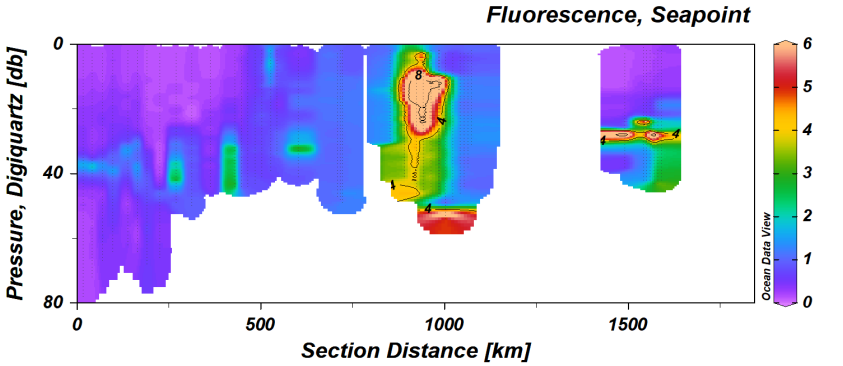
- Bering Shelf (Purple):

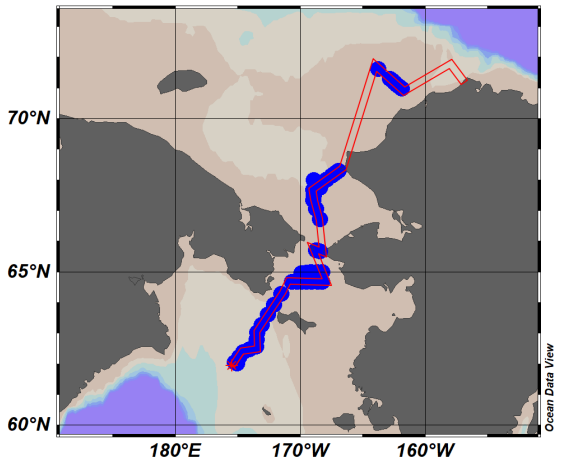
CTD Measurements: 2016

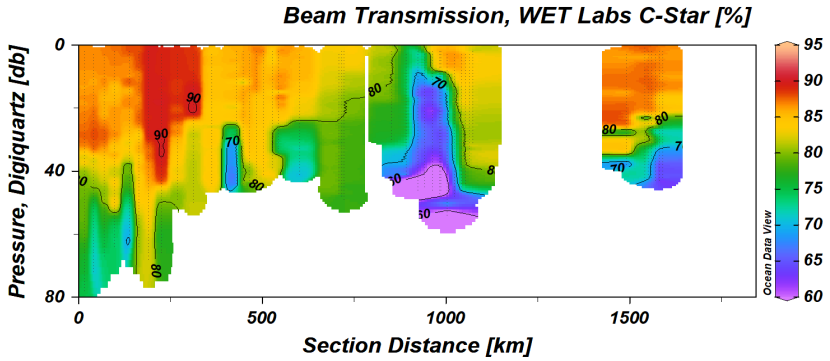












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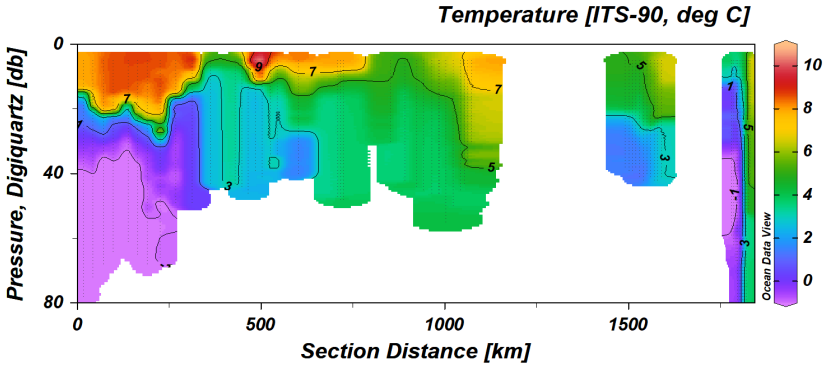
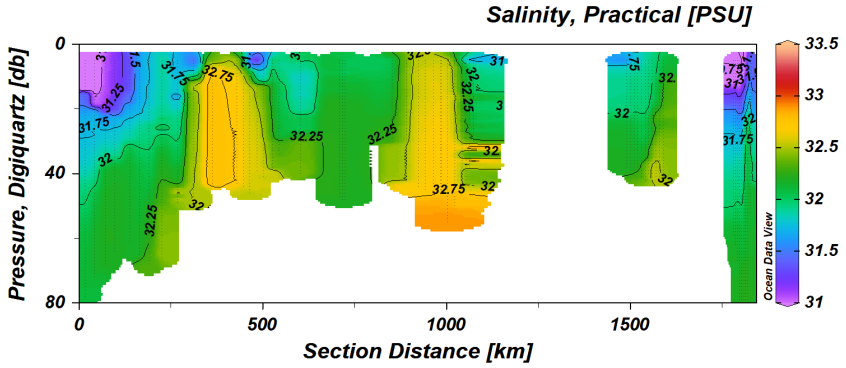
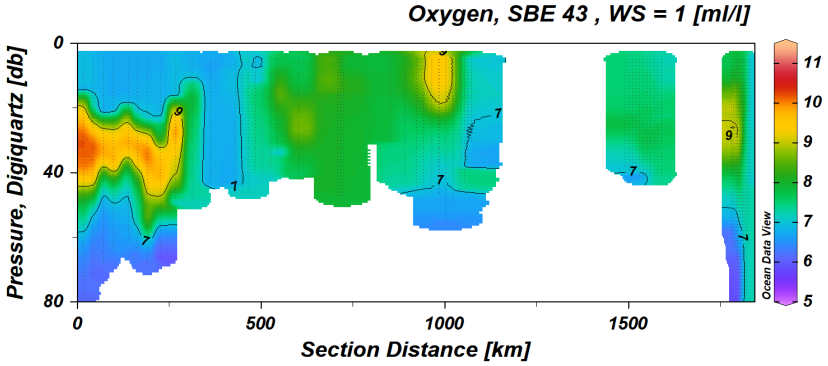
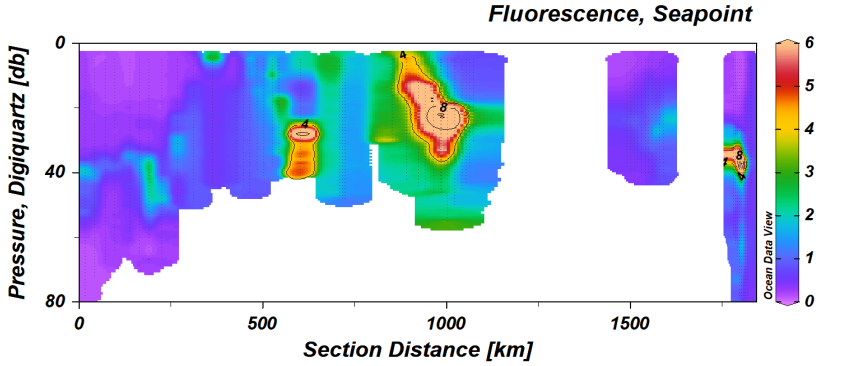
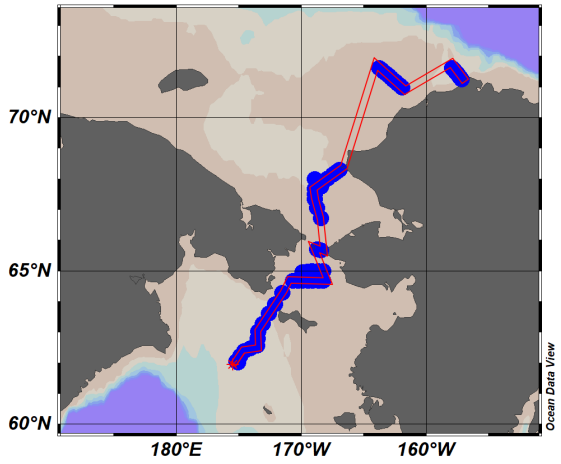
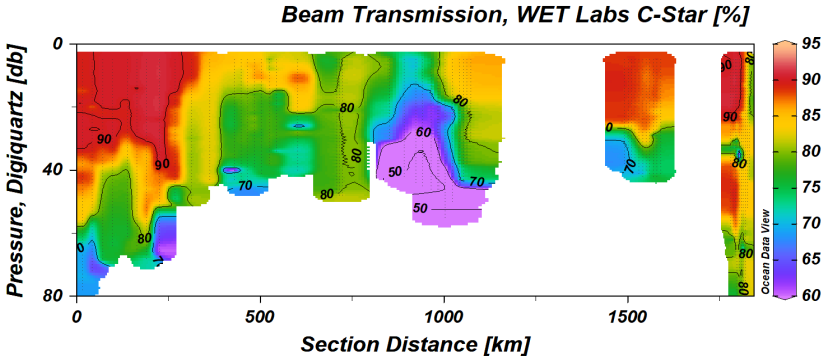




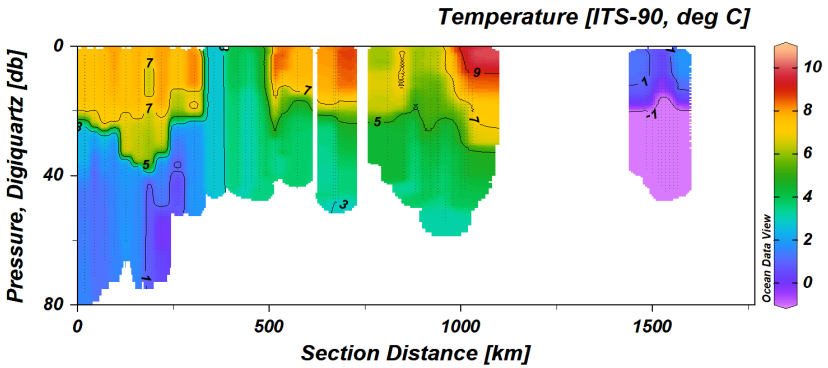


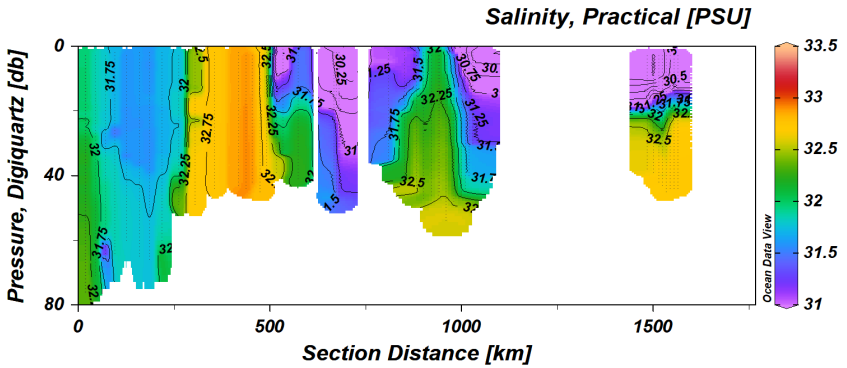


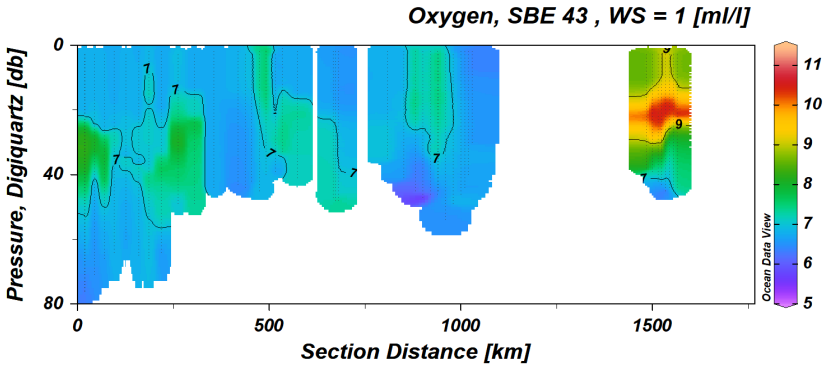


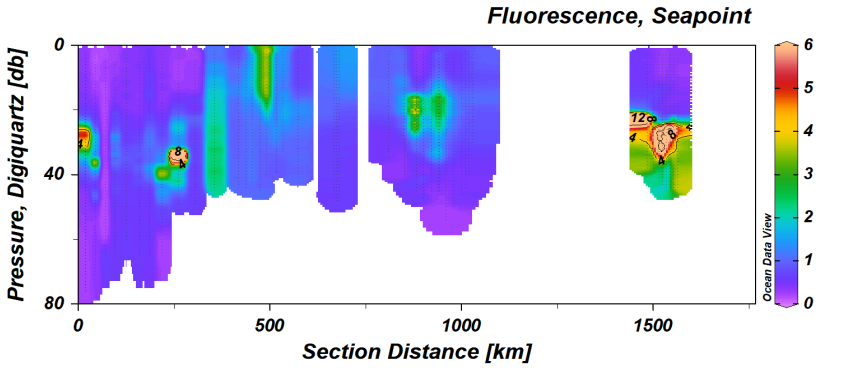


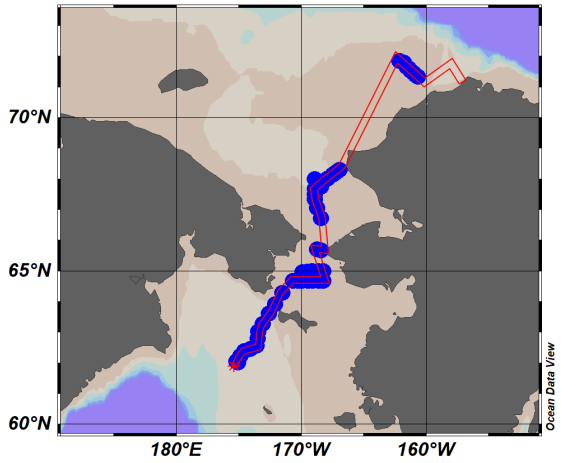
CTD Measurements: 2018

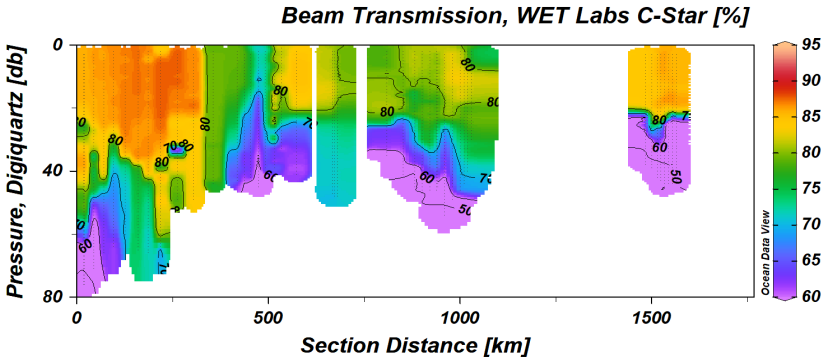




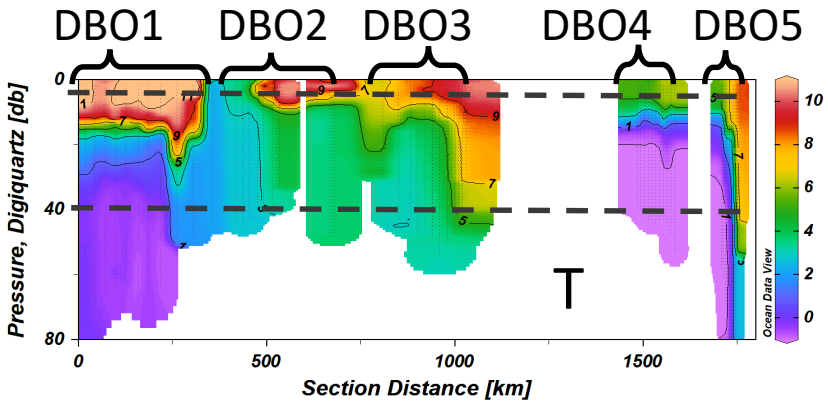


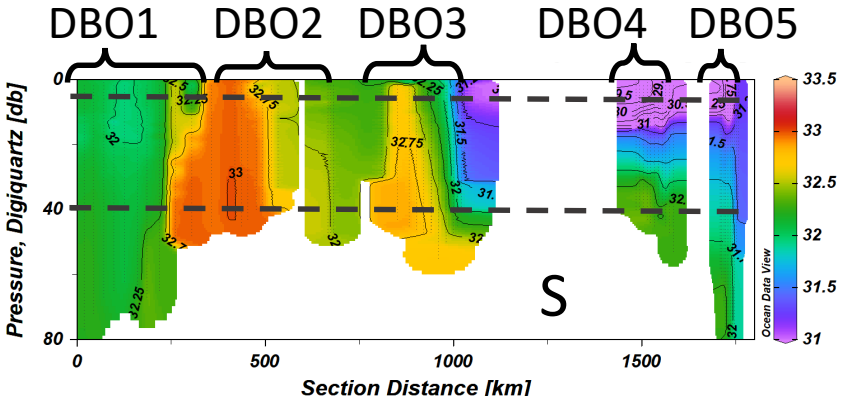


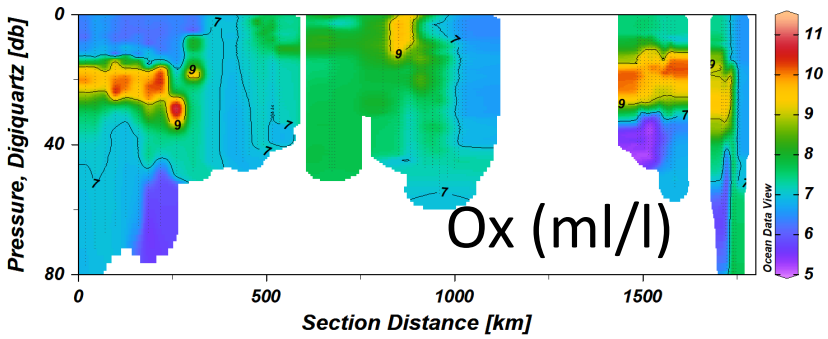


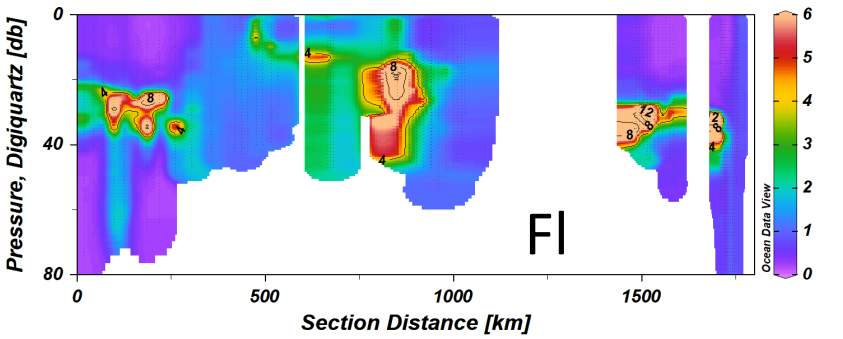


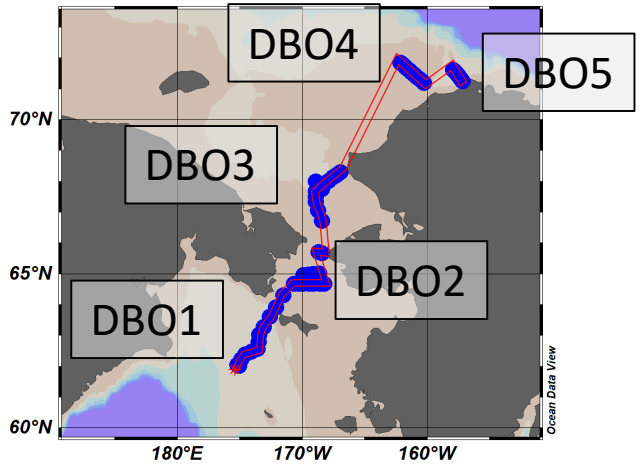
CTD Measurements: 2019

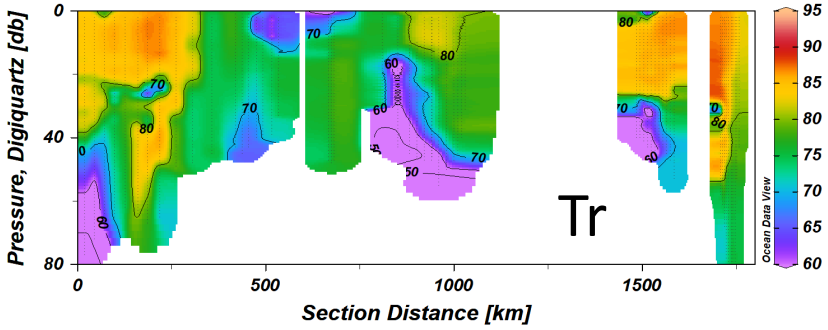




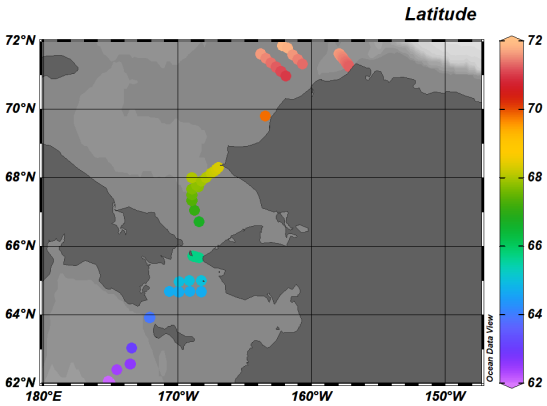


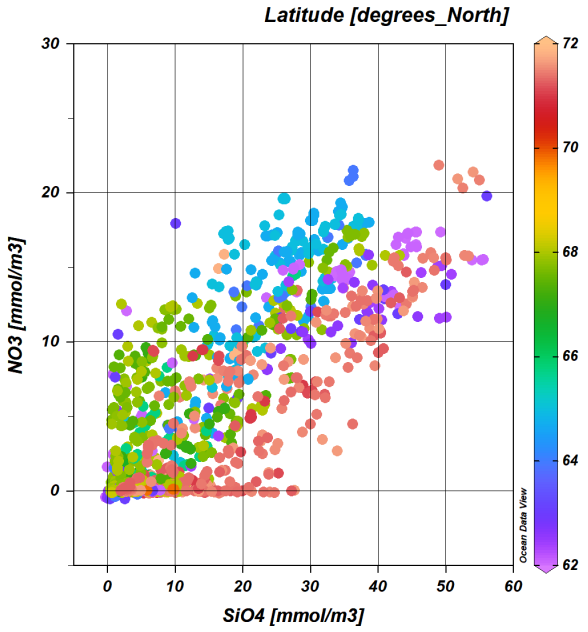


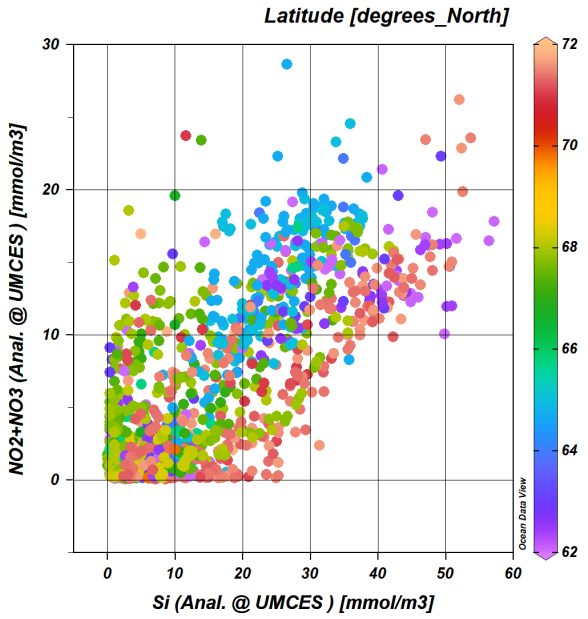


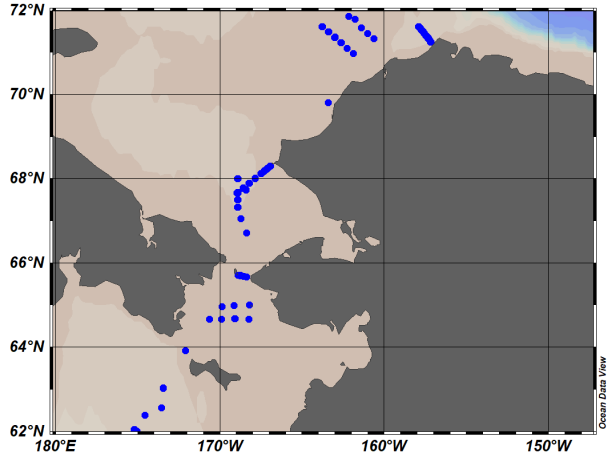


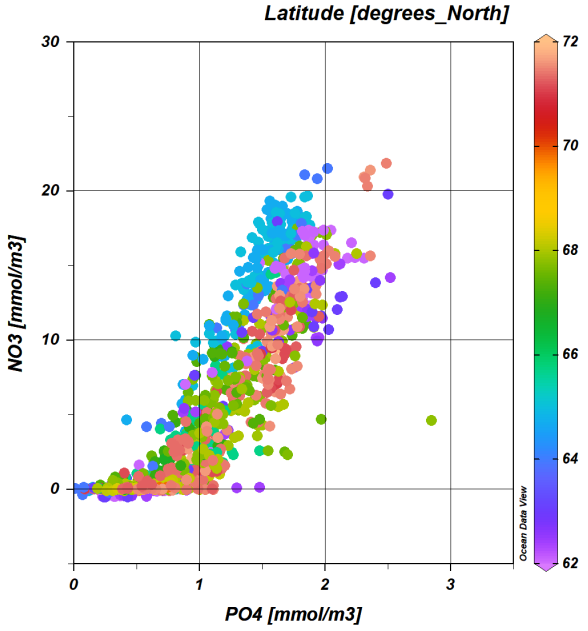
Nutrients

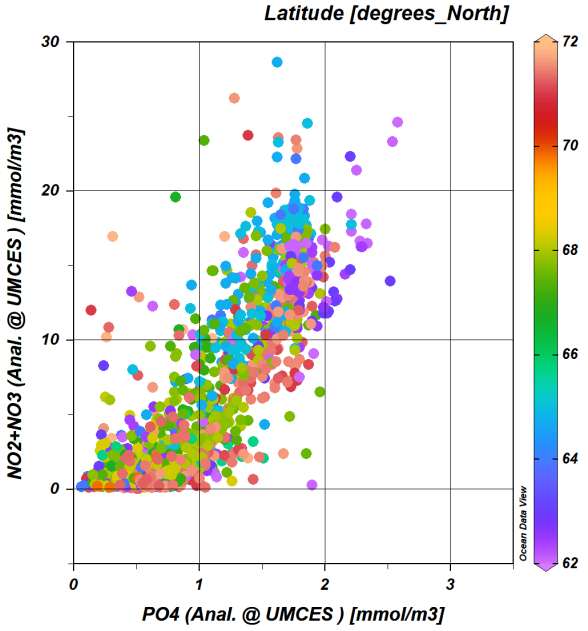

Latitude
72°N
70°N
68°N
66°N
64°N
62°N
180°E
170°W
160°W
150°W
72
70
68
66
64
62
Ocean Data View


Latitude [degrees_North]
NO3 [mmol/m3]
SiO4 [mmol/m3]
0
10
20
30
40
50
60
72
70
68
66
64
62
Ocean Data View

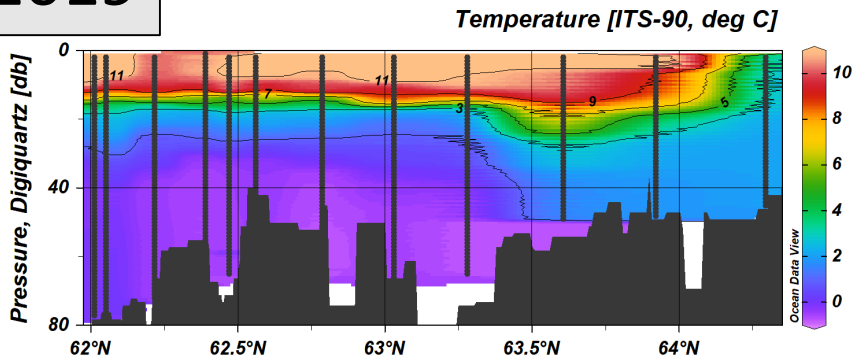

Latitude [degrees_North]
NO2+NO3 (Anal. @ UMCES) [mmol/m3]
Si (Anal. @ UMCES) [mmol/m3]
0
10
20
30
40
50
60
72
70
68
66
64
62
Ocean Data View

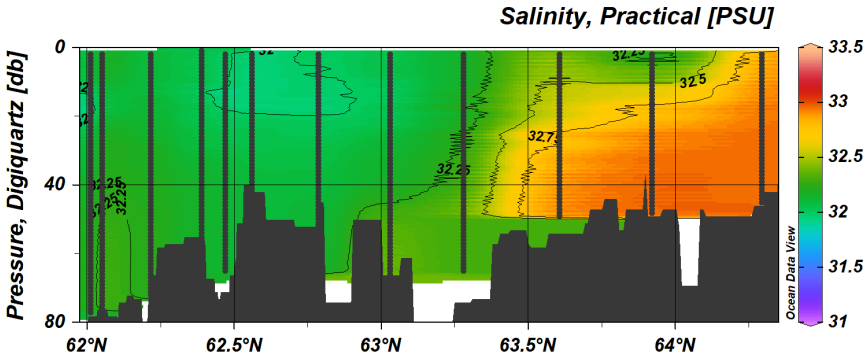

72°N
70°N
68°N
66°N
64°N
62°N
180°E
170°W
160°W
150°W
Ocean Data View

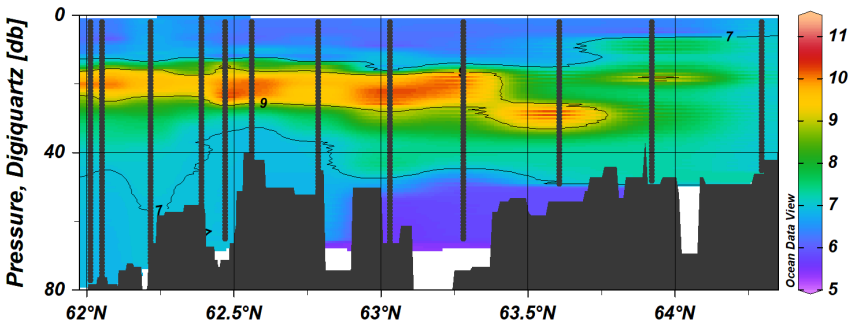

Latitude [degrees_North]
NO3 [mmol/m3]
PO4 [mmol/m3]
0
1
2
3
10
20
30
72
70
68
66
64
62
Ocean Data View

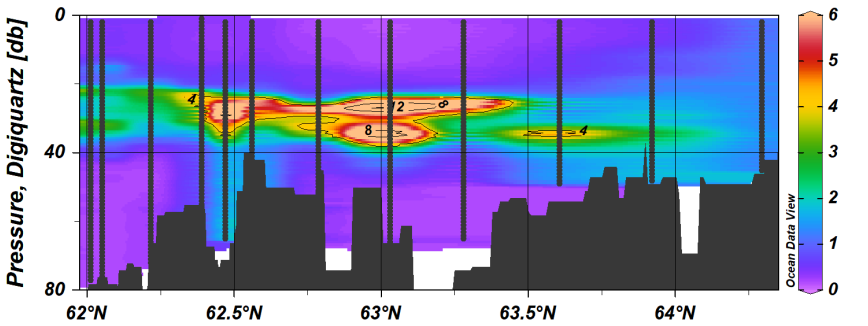

Latitude [degrees_North]
NO2+NO3 (Anal. @ UMCES) [mmol/m3]
PO4 (Anal. @ UMCES) [mmol/m3]
0
1
2
3
10
20
30
72
70
68
66
64
62
Ocean Data View

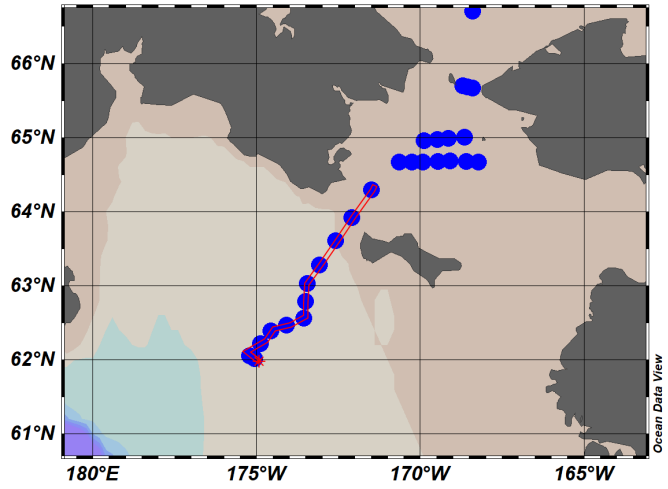
2019

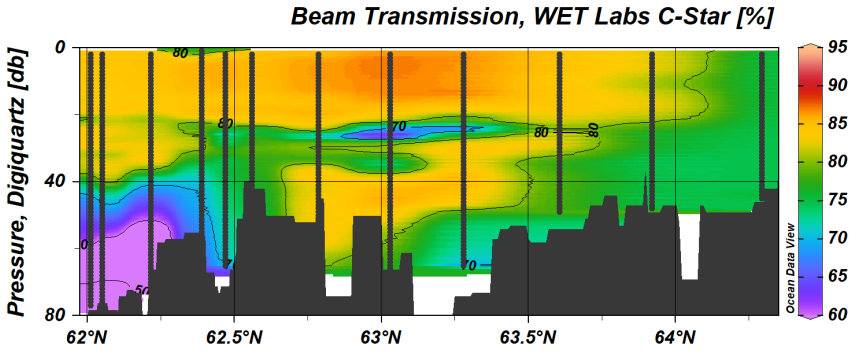

Temperature [ITS-90, deg C]
Pressure, Digiquartz [db]
0
40
80
62°N
62.5°N
63°N
63.5°N
64°N
10
8
6
4
2
0
Ocean Data View


Salinity, Practical [PSU]
Pressure, Digiquartz [db]
0
40
80
62°N
62.5°N
63°N
63.5°N
64°N
33.5
33
32.5
32
31.5
31
Ocean Data View

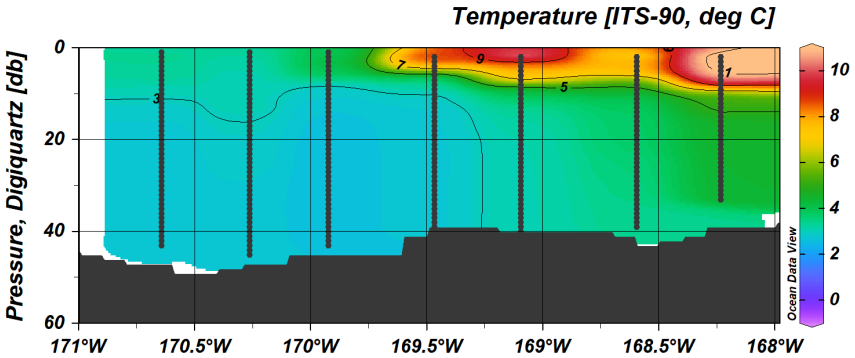

Oxygen, SBE 43 , WS = 1 [ml/l]
Pressure, Digiquartz [db]
0
40
80
62°N
62.5°N
63°N
63.5°N
64°N
11
10
9
8
7
6
5
Ocean Data View

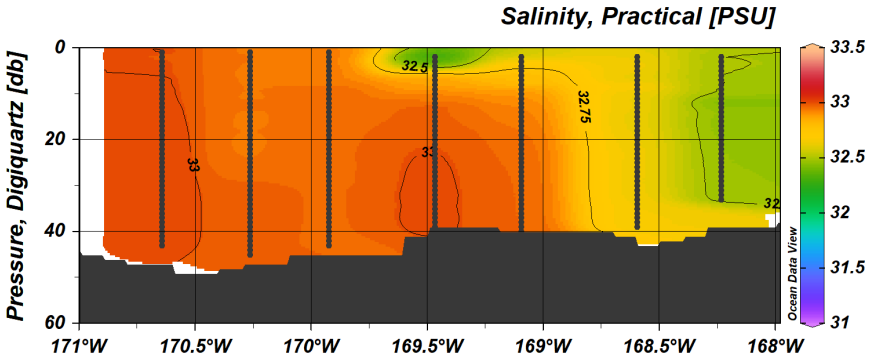

Fluorescence, Seapoint
Pressure, Digiquartz [db]
0
40
80
62°N
62.5°N
63°N
63.5°N
64°N
6
5
4
3
2
1
0
Ocean Data View

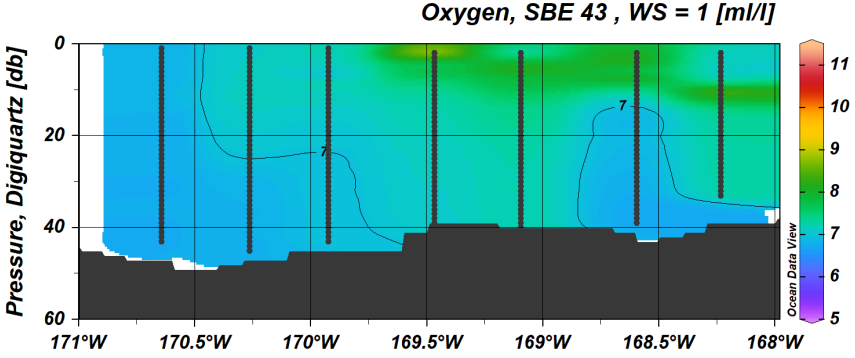

66°N
65°N
64°N
63°N
62°N
61°N
180°E
175°W
170°W
165°W
Ocean Data View

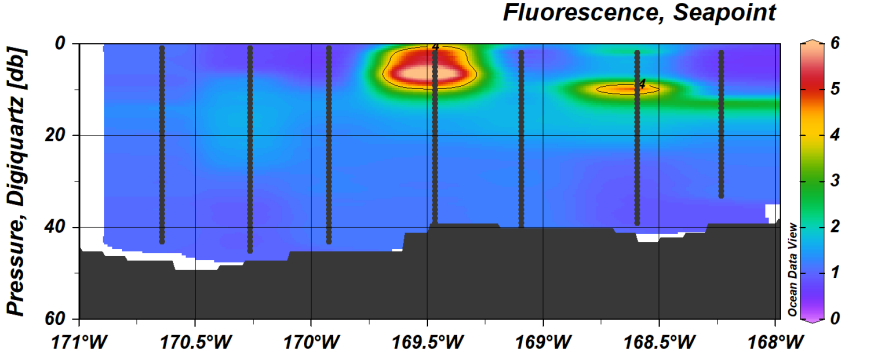

Beam Transmission, WET Labs C-Star [%]
Pressure, Digiquartz [db]
0
40
80
62°N
62.5°N
63°N
63.5°N
64°N
95
90
85
80
75
70
65
60
Ocean Data View

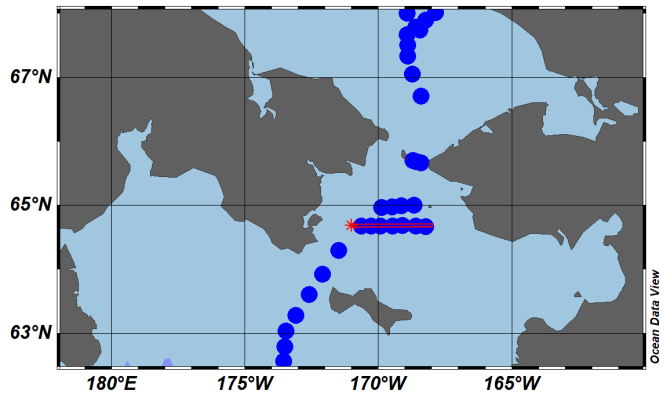
2019

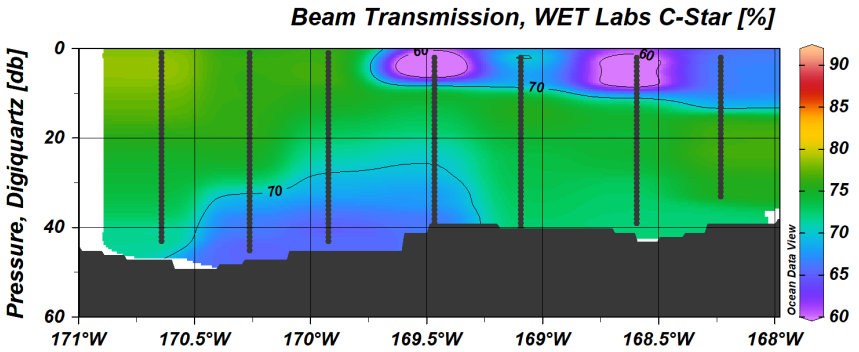

Temperature [ITS-90, deg C]
Pressure, Digiquartz [db]
0
20
40
60
171°W
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
10
8
6
4
2
0
Ocean Data View


Salinity, Practical [PSU]
Pressure, Digiquartz [db]
0
20
40
60
171°W
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
33.5
33
32.5
32
31.5
31
Ocean Data View

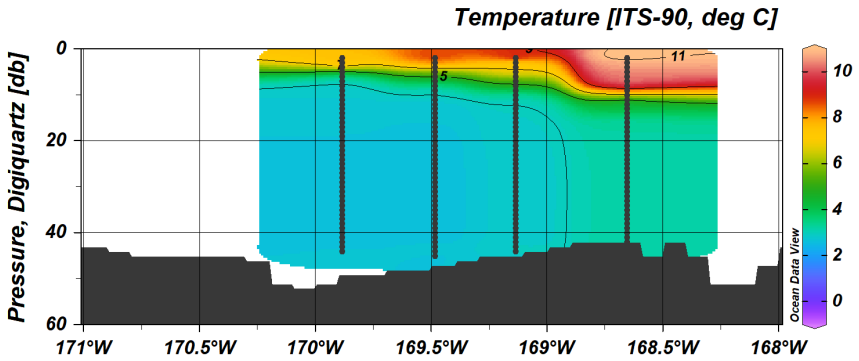

Oxygen, SBE 43 , WS = 1 [ml/l]
Pressure, Digiquartz [db]
0
20
40
60
171°W
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
11
10
9
8
7
6
5
Ocean Data View

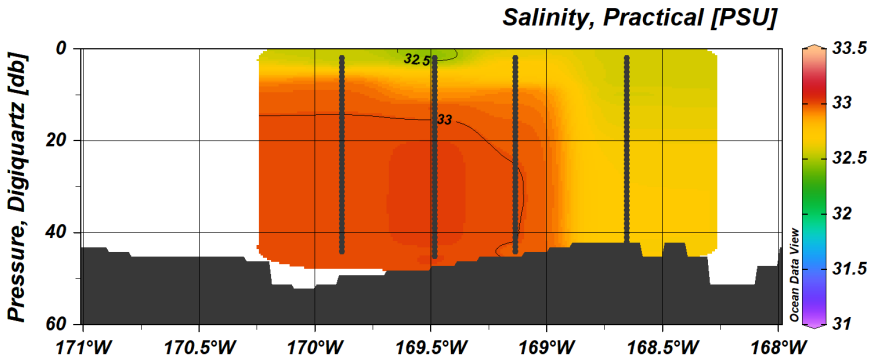

Fluorescence, Seapoint
Pressure, Digiquartz [db]
0
20
40
60
171°W
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
6
5
4
3
2
1
0
Ocean Data View

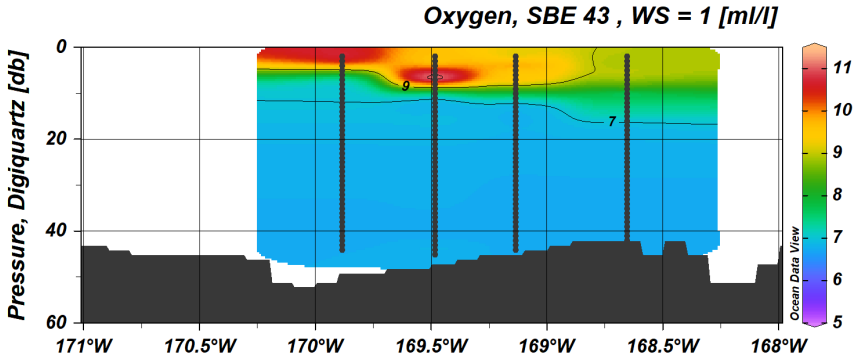

67°N
65°N
63°N
180°E
175°W
170°W
165°W
Ocean Data View

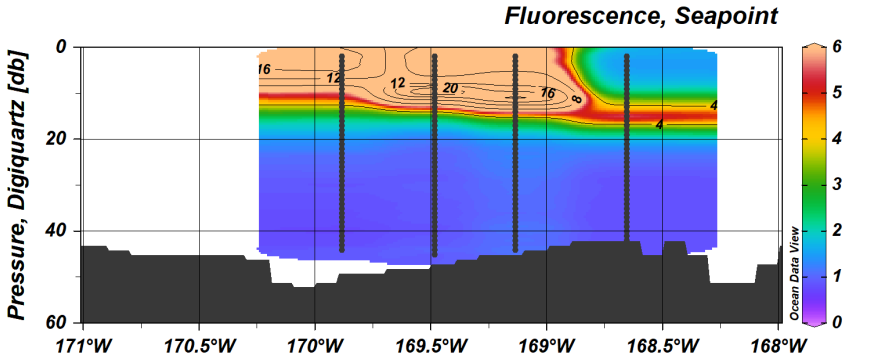

Beam Transmission, WET Labs C-Star [%]
Pressure, Digiquartz [db]
0
20
40
60
171°W
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
90
85
80
75
70
65
60
Ocean Data View

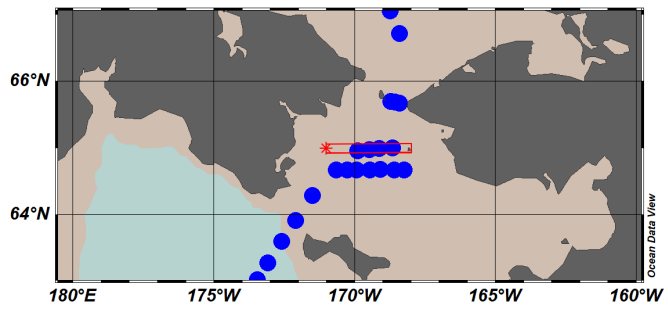
2019

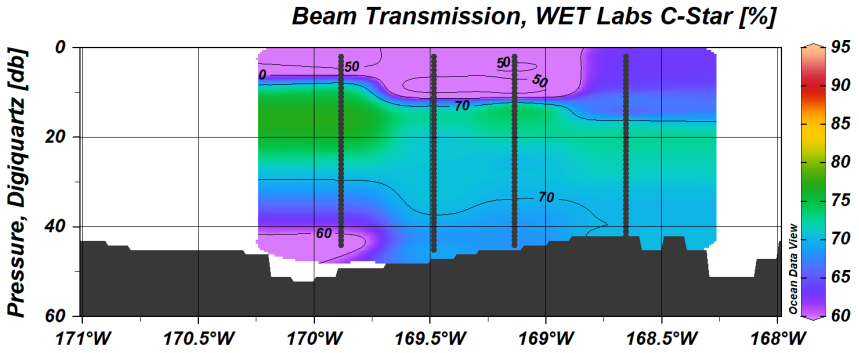

Temperature [ITS-90, deg C]
Pressure, Digiquartz [db]
0
20
40
60
171°W
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
11
5
10
8
6
4
2
0
Ocean Data View


Salinity, Practical [PSU]
Pressure, Digiquartz [db]
0
20
40
60
171°W
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
32.5
33
33.5
33
32.5
32
31.5
31
Ocean Data View

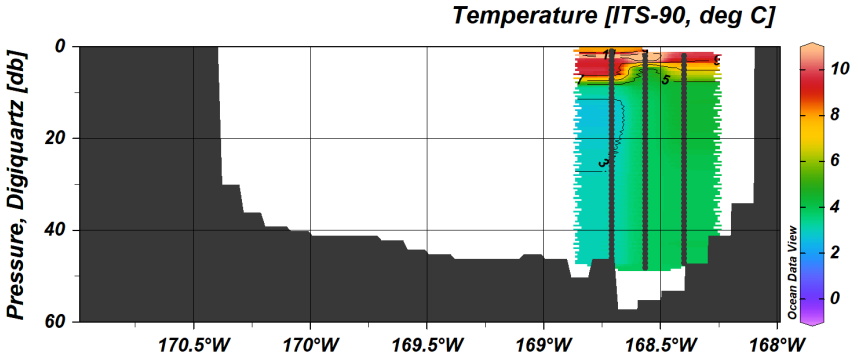

Oxygen, SBE 43 , WS = 1 [ml/l]
Pressure, Digiquartz [db]
0
20
40
60
171°W
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
9
7
11
10
9
8
7
6
5
Ocean Data View

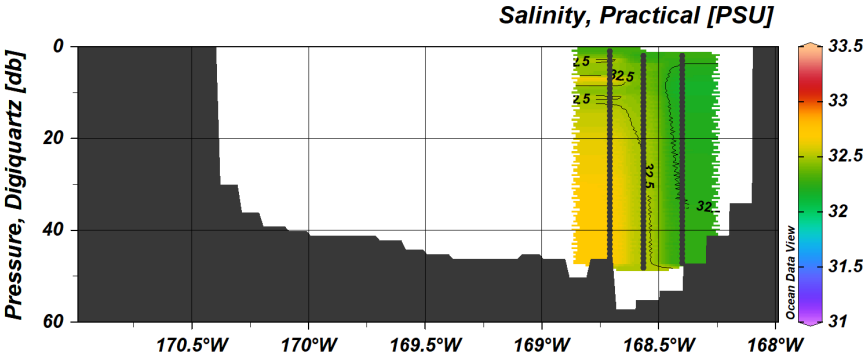

Fluorescence, Seapoint
Pressure, Digiquartz [db]
0
20
40
60
171°W
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
16
12
12
20
16
8
4
4
6
5
4
3
2
1
0
Ocean Data View

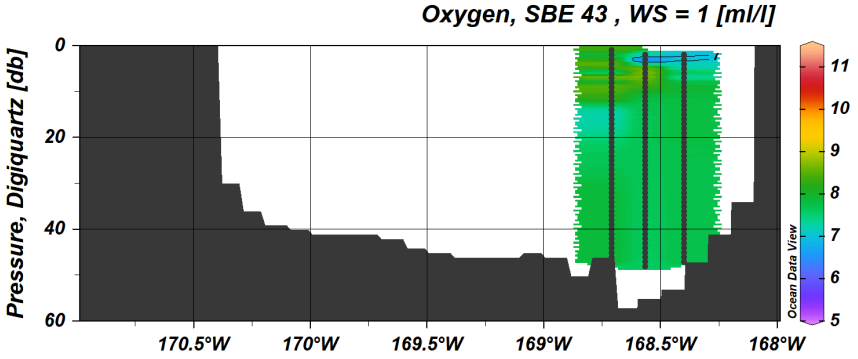

66°N
64°N
180°E
175°W
170°W
165°W
160°W
Ocean Data View

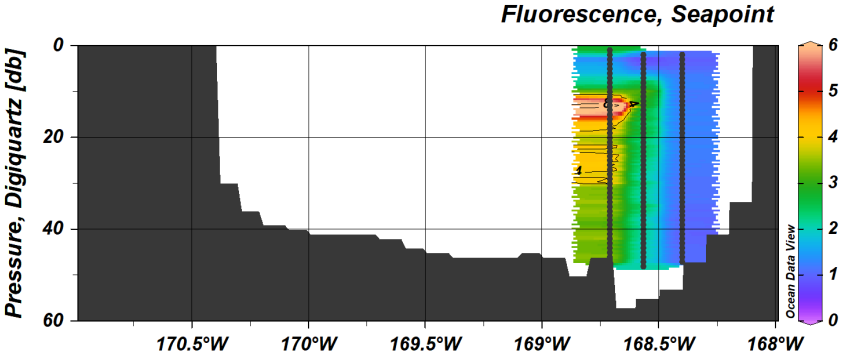

Beam Transmission, WET Labs C-Star [%]
Pressure, Digiquartz [db]
0
20
40
60
171°W
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
0
50
50
50
70
70
60
95
90
85
80
75
70
65
60
Ocean Data View

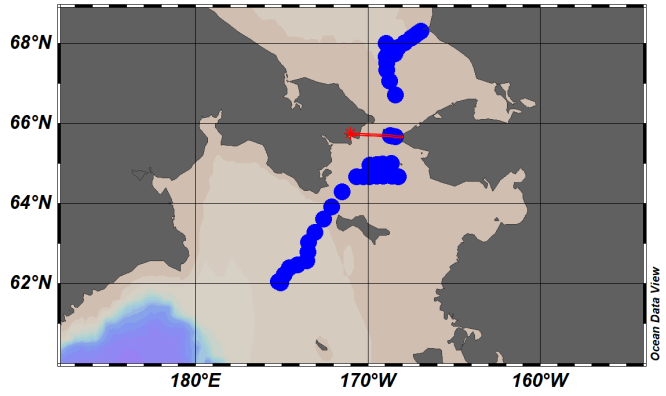
2019

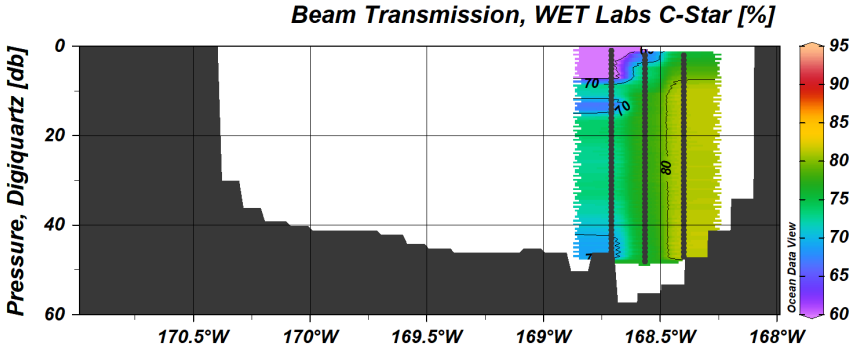

Temperature [ITS-90, deg C]
Pressure, Digiquartz [db]
0
20
40
60
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
10
8
6
4
2
0
Ocean Data View


Salinity, Practical [PSU]
Pressure, Digiquartz [db]
0
20
40
60
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
33.5
33
32.5
32
31.5
31
Ocean Data View

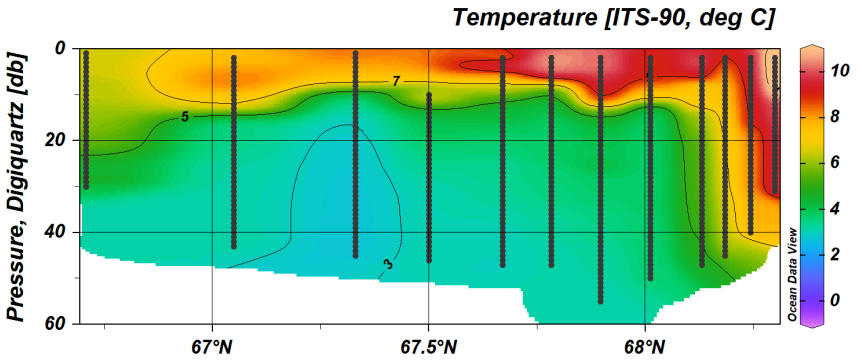

Oxygen, SBE 43 , WS = 1 [ml/l]
Pressure, Digiquartz [db]
0
20
40
60
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
11
10
9
8
7
6
5
Ocean Data View

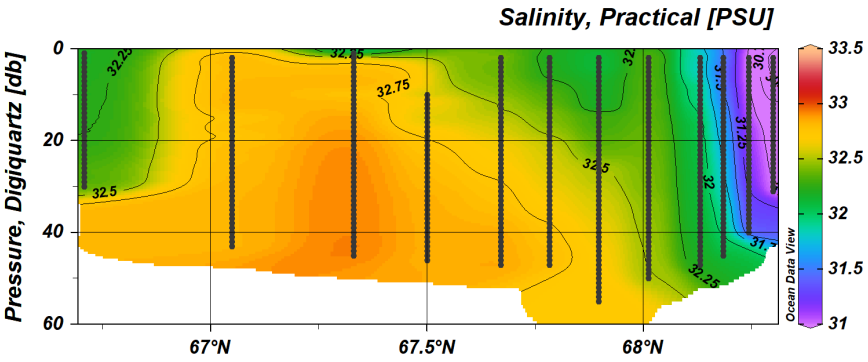

Fluorescence, Seapoint
Pressure, Digiquartz [db]
0
20
40
60
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
6
5
4
3
2
1
0
Ocean Data View

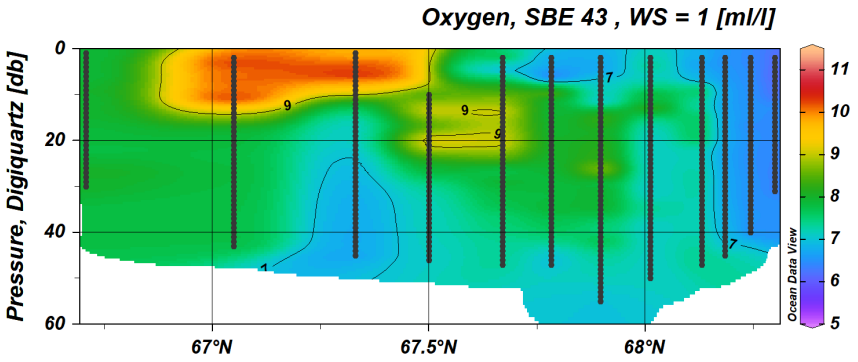

68°N
66°N
64°N
62°N
180°E
170°W
160°W
Ocean Data View

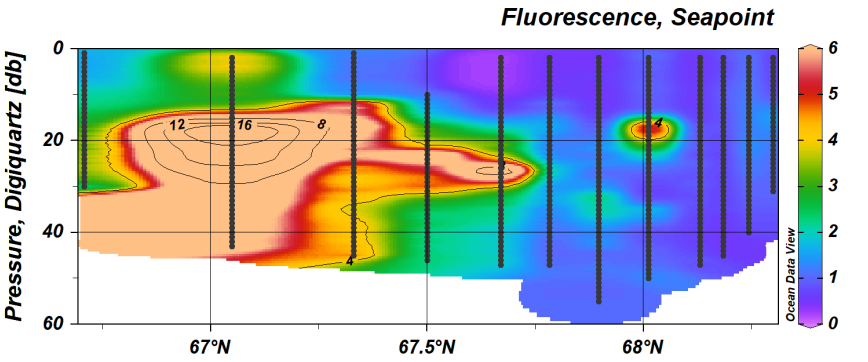

Beam Transmission, WET Labs C-Star [%]
Pressure, Digiquartz [db]
0
20
40
60
170.5°W
170°W
169.5°W
169°W
168.5°W
168°W
95
90
85
80
75
70
65
60
Ocean Data View

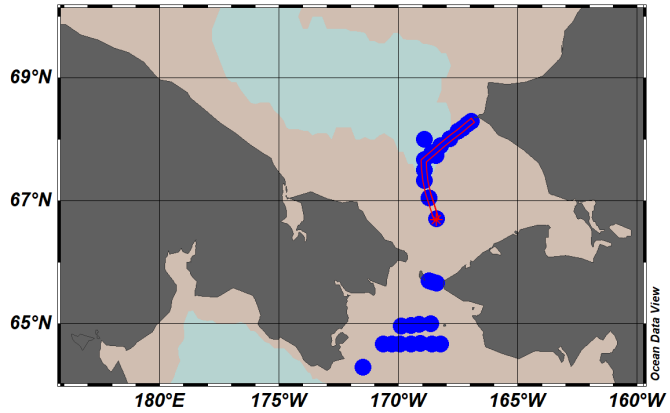
2019

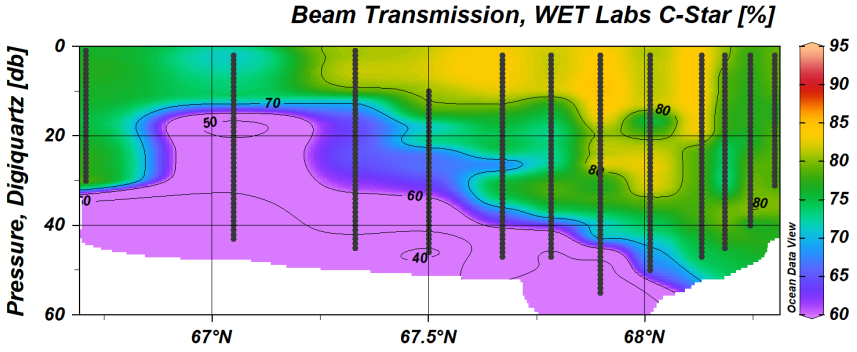

Temperature [ITS-90, deg C]
Pressure, Digiquartz [db]
0
20
40
60
67°N
67.5°N
68°N
10
8
6
4
2
0
Ocean Data View


Salinity, Practical [PSU]
Pressure, Digiquartz [db]
0
20
40
60
67°N
67.5°N
68°N
33.5
33
32.5
32
31.5
31
Ocean Data View

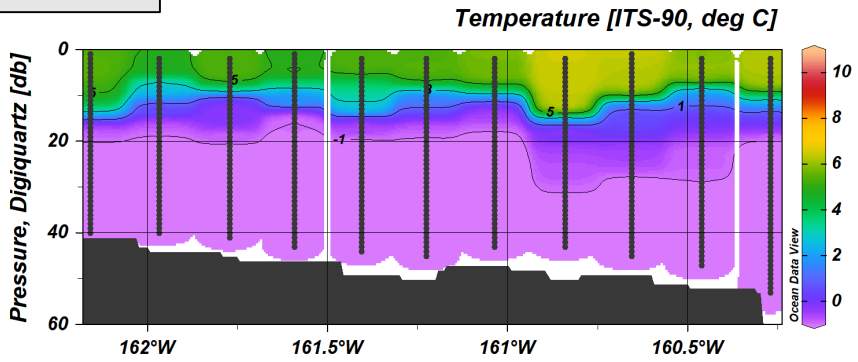

Oxygen, SBE 43 , WS = 1 [ml/l]
Pressure, Digiquartz [db]
0
20
40
60
67°N
67.5°N
68°N
11
10
9
8
7
6
5
Ocean Data View

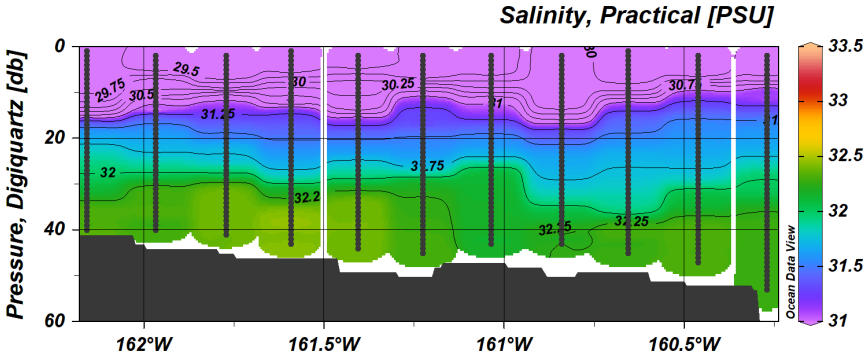

Fluorescence, Seapoint
Pressure, Digiquartz [db]
0
20
40
60
67°N
67.5°N
68°N
6
5
4
3
2
1
0
Ocean Data View

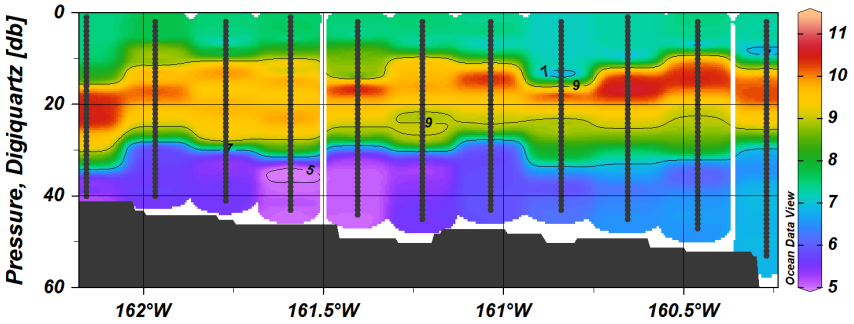

69°N
67°N
65°N
180°E
175°W
170°W
165°W
160°W
Ocean Data View

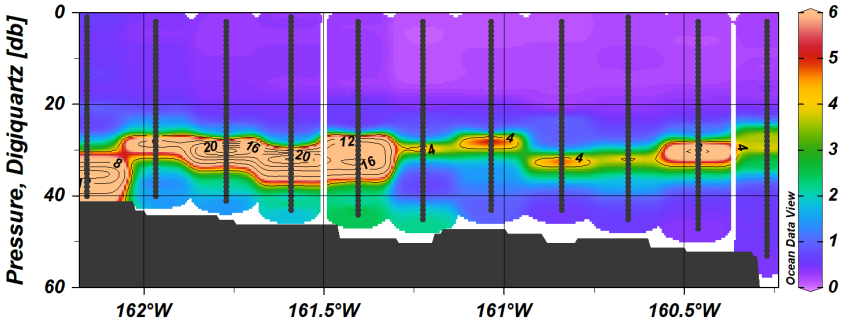

Beam Transmission, WET Labs C-Star [%]
Pressure, Digiquartz [db]
0
20
40
60
67°N
67.5°N
68°N
95
90
85
80
75
70
65
60
Ocean Data View

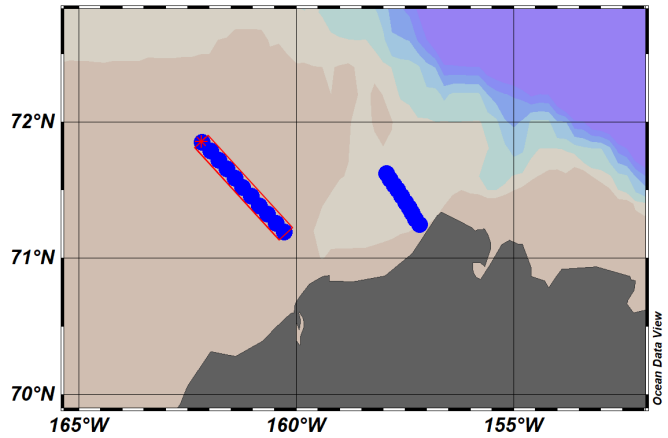
2019

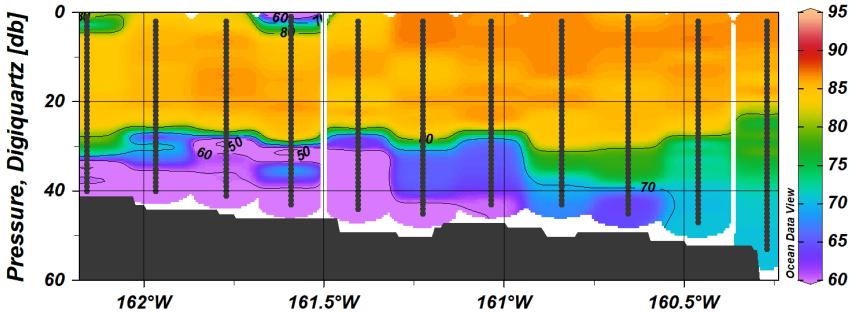

Temperature [ITS-90, deg C]
Pressure, Digiquartz [db]
0
20
40
60
162°W
161.5°W
161°W
160.5°W
10
8
6
4
2
0
Ocean Data View


Salinity, Practical [PSU]
Pressure, Digiquartz [db]
0
20
40
60
162°W
161.5°W
161°W
160.5°W
33.5
33
32.5
32
31.5
31
Ocean Data View

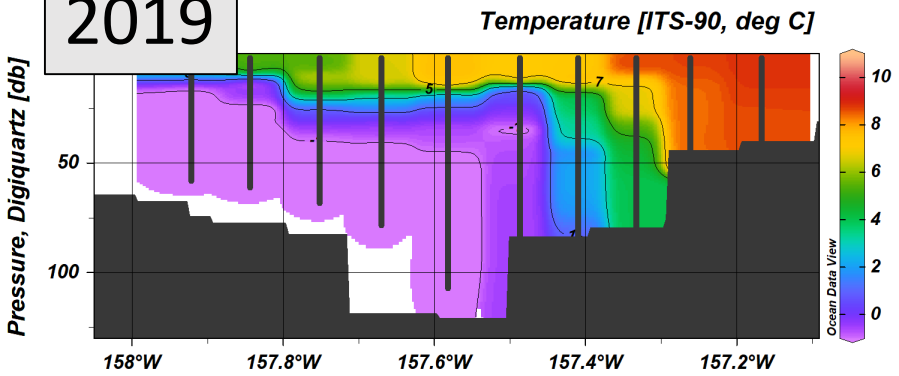

Oxygen, SBE 43 , WS = 1 [ml/l]
Pressure, Digiquartz [db]
0
20
40
60
162°W
161.5°W
161°W
160.5°W
11
10
9
8
7
6
5
Ocean Data View

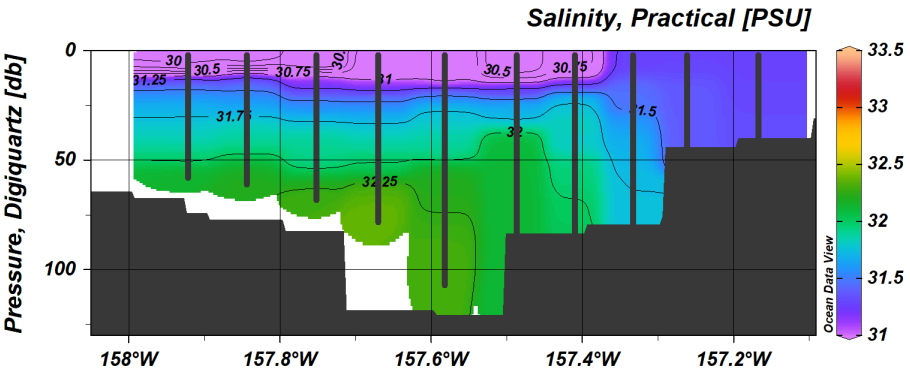

Fluorescence, Seapoint
Pressure, Digiquartz [db]
0
20
40
60
162°W
161.5°W
161°W
160.5°W
6
5
4
3
2
1
0
Ocean Data View

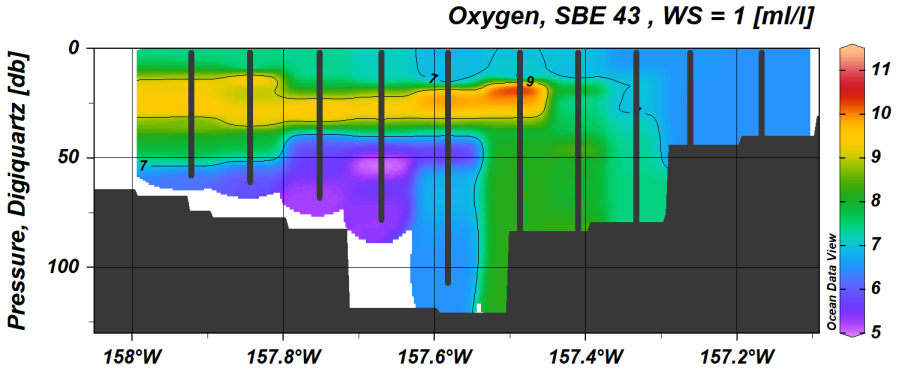

72°N
71°N
70°N
165°W
160°W
155°W
Ocean Data View

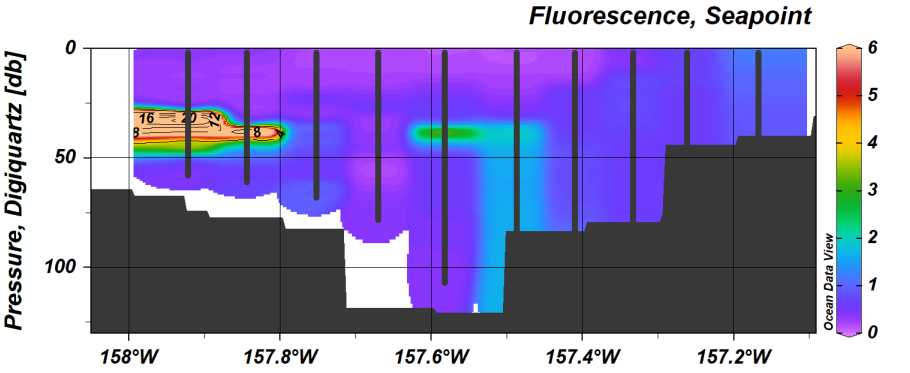

Beam Transmission, WET Labs C-Star [%]
Pressure, Digiquartz [db]
0
20
40
60
162°W
161.5°W
161°W
160.5°W
95
90
85
80
75
70
65
60
Ocean Data View

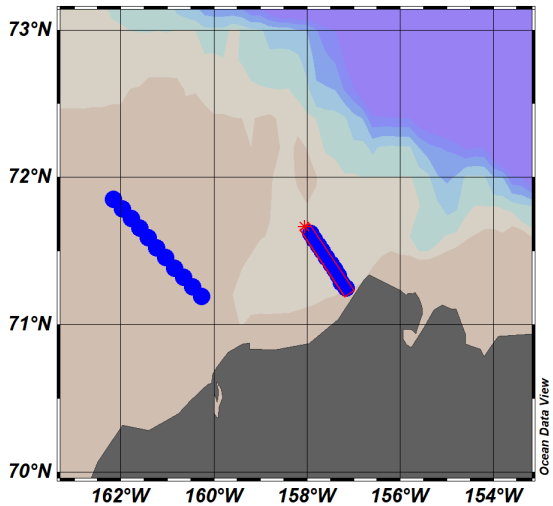
2019

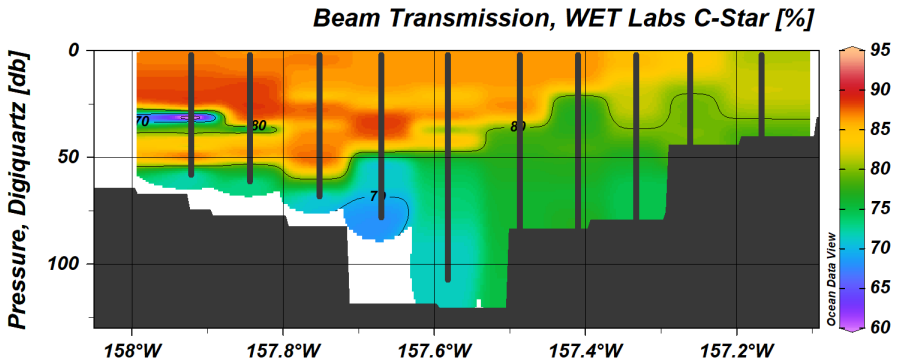












Bottom bat
5.4: 110m
5.5: 120m
5.6: 110m