BERING STRAIT NORSEMAN II 2019 MOORING CRUISE REPORT

Research Vessel Norseman II, Norseman Maritime Charters

Nome-Nome, 5th September to 15th September 2019

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Jim Johnson, Max Showalter, Katy Christensen and Kim Gottschalk (the 2019 Science Team)

Funding from NSF Arctic Observing Network Program PLR-1758565

(Updated: March2020 with postcruise calibrations for test tank and in water CTD casts)

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Top left: *Research vessel Norseman II during Nome on-load [Credit: Woodgate].* ***Bottom left:*** *Bering Strait 2019 Science Team [Credit: Christensen]. Bottom right: Looking south at the Diomede Islands at the end of the 2019 cruise [Credit: Woodgate].*

As part of the Bering Strait project funded by NSF-AON (Arctic Observing Network), in September 2019 a team of five US scientists undertook a ~ 11 day cruise in the Bering Strait and southern Chukchi Sea region on the US vessel Norseman II, operated by Norseman Maritime Charters.

The primary goals of the expedition were:

1) recovery of 3 moorings carrying physical oceanographic (Woodgate and Peralta-Ferrriz) and whale acoustic (Stafford) instrumentation. These moorings were deployed in the Bering Strait region in 2018 from the Norseman II. The funding for the physical oceanographic components of these moorings comes from NSF-AON.

2) deployment of 3 moorings in the Bering Strait region, carrying physical oceanographic (Woodgate and Peralta-Ferriz) and whale acoustic (Stafford) instrumentation. The funding for the physical oceanographic components of these moorings comes from NSF-AON.

3) accompanying CTD sections (without water sampling).

4) collection of accompanying ship's underway data (surface water properties, ADCP, meteorological data).

The cruise loaded and offloaded in Nome, Alaska.

<u>Key Statistics:</u> 3 moorings recovered, 3 moorings deployed, 438 CTD casts on 22 CTD lines

SCIENCE BACKGROUND

The ~50m deep, ~ 85km wide Bering Strait is the only oceanic gateway between the Pacific and the Arctic oceans.

The oceanic fluxes of volume, heat, freshwater, nutrients and plankton through the Bering Strait are critical to the water properties of the Chukchi [*Woodgate et al.*, 2005a]; act as a trigger of sea-ice melt in the western Arctic [*Woodgate et al.*, 2010]; provide a subsurface source of heat to the Arctic in winter, possibly thinning sea-ice over about half of the Arctic Ocean [*Shimada et al.*, 2006; *Woodgate et al.*, 2010]; are ~ 1/3rd of the freshwater input to the Arctic [*Aagaard and Carmack*, 1989; *Woodgate and Aagaard*, 2005]; and are a major source of nutrients for ecosystems in the Arctic Ocean and the Canadian Archipelago [*Walsh et al.*, 1989]. In modeling studies, changes in the Bering Strait throughflow also influence the Atlantic Meridional Overturning Circulation [*Wadley and Bigg*, 2002] and thus world climate [*De Boer and Nof*, 2004].

Quantification of these fluxes (which all vary significantly seasonally and interannually) is critical to understanding the physics, chemistry and ecosystems of the Chukchi Sea and western Arctic, including sea-ice retreat timing and patterns, and possibly sea-ice thickness. The Bering Strait oceanic heat flux has been found to be the best predictor of Chukchi sea ice retreat [*Serreze et al.*, 2016]. Understanding the processes setting these fluxes is vital to prediction of future change in this region, in the Arctic, and beyond. The Bering Strait is the only Arctic gateway where observations currently show significant interannual change [*Østerhus et al.*, 2019].

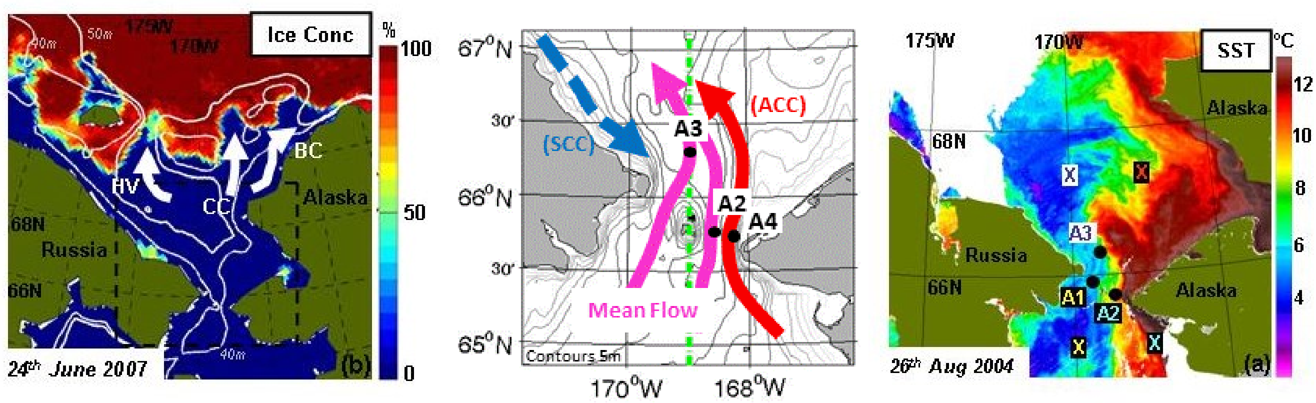

Figure 1: (Left) *Chukchi Sea ice concentration (AMSR-E) with schematic topography. White arrows mark three main water pathways melting back the ice edge [Woodgate et al., 2010].*
(Middle) *Detail of the Bering Strait, with schematic flows and mooring locations (black dots – A2, A3, A4). The main northward flow passes through both channels (magenta arrows). Topography diverts the western channel flow eastward near site A3. The warm, fresh Alaskan Coastal Current (ACC) (red arrow) is present seasonally in the east. The cold, fresh Siberian Coastal Current (SCC) (blue dashed arrow) is present in some years seasonally in the west. Green dashed line at 168º58.7'W marks the US-Russian EEZ (Exclusive Economic Zone) boundary. Note all moorings are in the US EEZ. Depth contours are from IBCAO [Jakobsson et al., 2000]. The Diomede Islands are in the center of the strait, shown here as small black dots on the green dashed line marking the US-Russian boundary.*
(Right) *Sea Surface Temperature (SST) MODIS/Aqua level 1 image from 26th August 2004 (courtesy of Ocean Color Data Processing Archive, NASA/Goddard Space Flight Center). White areas indicate clouds. Note the dominance of the warm ACC along the Alaskan Coast, and the suggestion of a cold SCC-like current along the Russian coast [Woodgate et al., 2006].*

Since 1990, year-round moorings have been maintained almost continually year-round in the Bering Strait region, supported by typically annual servicing and hydrographic cruises [*Woodgate et al.*, 2015; *Woodgate*, 2018]. These data have allowed us to quantify seasonal and interannual change [*Woodgate et al.*, 2005b; *Woodgate et al.*, 2006; *Woodgate et al.*, 2010; *Woodgate et al.*, 2012; *Woodgate*, 2018], and assess the strong contribution of the Alaskan Coastal Current (ACC) to the fluxes through the strait [*Woodgate and Aagaard*, 2005; *Woodgate*, 2018]. These data also show that the Bering Strait throughflow increased ~50% from 2001 (~0.7Sv) to 2011 (~1.1Sv), driving heat and freshwater flux increases [*Woodgate et al.*, 2012], with more recent fluxes also being high (e.g., 2014, 1.2Sv, [*Woodgate*, 2018], see Figure 2).

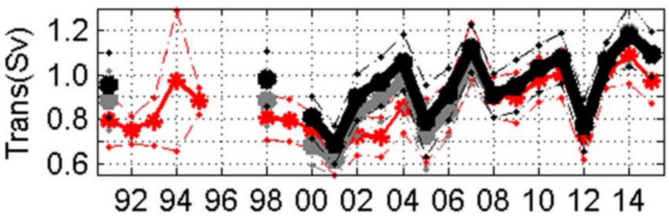

Figure 2, from Figure 3 of [Woodgate, 2018]*: Annual mean (x-axis, time in years) of Bering Strait mooring data from 1991 to 2015, showing transport for the whole strait, as estimated from A2 (red) or A3 (uncorrected data - grey; corrected data - black).*

Analysis [*Woodgate*, 2018] indicates this long term trend is driven by large scale changes between the Pacific and the Arctic Oceans, with no significant trends in the winds in the strait. Thus, remote data (winds, SST) prove insufficient for quantifying long-term variability, indicating interannual change can still only be assessed by in situ year-round measurements [*Woodgate et al.*, 2012]. The work to be accomplished on this cruise will extend this mooring time-series to mid-2020, as part of a new NSF project to continue the year-round observations until summer 2022.

In addition, this cruise aims to provide a high resolution survey of the water properties of the strait and southern Chukchi Sea in late-summer (September), a season where few truly high resolution surveys have ever been performed. A particular goal is to quantify the heat and salt content of the waters, which have been unusually warm and fresh in the last 2 years (see Figure 3).

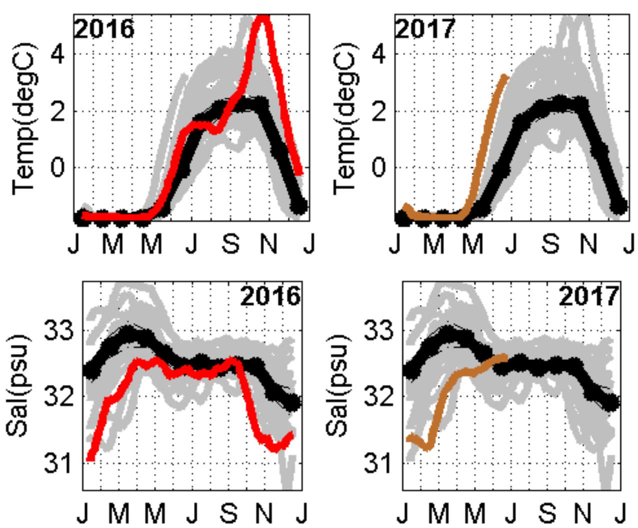

Figure 3: *30-day smoothed estimates from A3 mooring data for near-bottom temperature* ***(top)*** *and near-bottom salinity* ***(bottom)****, for 2016* ***(left column)*** *and 2017* ***(right column)****, showing labeled year in color, climatology [Woodgate et al., 2005b] in black, and all prior years of mooring data (1990-present) in grey. X-axis is labeled with month (J=January, M=March, M=May, J=July, S=September, N=November, J=January). For details of calculations, see [Woodgate, 2018]. Note the particularly warm summers and fresh winters in these years.*

In addition to physical oceanographic goals, our work also supports long term marine mammal acoustic monitoring in the Strait (PI: Stafford) and biogeochemical studies [*Woodgate et al.*, 2015].

International links: Maintaining the time-series measurements in Bering is important to several national and international programs, e.g., the Arctic Observing Network (AON), started as part of the International Polar Year (IPY) effort in 2007; various NSF, ONR and NPRB projects and missions in the region. For several years, the work was part of the RUSALCA (Russian-US Long Term Census of the Arctic). Some of the CTD lines are part of the international Distributed Biological Observatory (DBO) effort. The mooring work also supports regional studies in the area, by providing key boundary conditions for the Chukchi Shelf/Beaufort Sea region (a current focus on ONR Arctic programs); a measure of integrated change in the Bering Sea, and an indicator of the role of Pacific Waters in the Arctic Ocean.

2019 CRUISE SUMMARY:

Our 2019 cruise, being in September, was later in the season than in previous years, and we expected more stormy weather. We were fortunate that our exact timing and cruise track allowed us mostly to avoid the worst of the storms. The Port of Nome, which is mostly unprotected from the south, was closed for stormy weather for the day before and day after our on-load, with other ships diverting to Port Clarence, and waves breaking over the port wall. However, a clever tie-up plan (using an anchor to hold the ship away from the port wall) allowed us to on-load safely during a temporary lessening of the seas, and depart on schedule on Thursday 5th September 2019. Without this, we would likely have had to wait several days in Nome to commence the cruise. As detailed below, mooring operations were accomplished in the next two days of the cruise, and our subsequent CTD survey managed to avoid the worst of the storms. Only twice were CTD operations suspended due to high seas. Thus, this year has accomplished a remarkably rich survey of the southeastern Chukchi Sea and Bering Strait in late summer, a previously rarely sampled time of the year.

On the morning of the scheduled on-load, Thursday 5th September 2019, significant seas from the south looked likely to preclude any attempt to load. However, mid morning, some slight change of direction of the seas, allowed the Norseman2 to enter the port and, by staging off both the port moorings and a laid forward/port anchor, the ship was able to onload, while ship's crew acquired provisions on shore (courtesy of Alaska Airlines Air Cargo, who had mistakenly given the food shipment for the ship to a visiting cruise vessel). We sailed ~ 2pm local time, and immediately undertook safety orientation and ship's drills. The wind and the seas made it necessary to "tack" to the strait, and during this transit, the CTD equipment was set up, test casts performed, and preparations made for mooring recoveries (including setting up of the on-deck calibration tank). Weather delayed our arrival at the strait until early the next morning, Friday 6th September 2019.

Limited daylight at this time of year provided sufficient light for mooring operations only between ~ 830am and ~10pm. We choose to start at mooring site A2 as it has less tendency for morning fog and weaker currents should dragging be necessary. As detailed below, moorings A2 and A4 were both recovered by dragging on Friday 6th Sept 2019. Fog (and impending darkness) prevented us trying to recover A3 on the Friday also, but on Sat 7th Sept 2019, mooring A3 was recovered (without dragging), and all 3 moorings were redeployed. The running of CTD sections started immediately after mooring deployments and continued throughout the rest of the cruise, other than when hindered by high seas.

CTD work was ended at 1am on the early morning of Sunday 15th September, and we turned for Nome. High opposing winds, seas and tidal currents slowed our transit to Nome, but we finally docked around 2:30pm, and the offload was complete by ~ 4pm, and the science team left the ship ~ 5pm. The ship left Nome that evening, and the science team flew back to Anchorage that night, and onto Seattle on Monday 16th September.

On this 2019 cruise, a fortunate combination of circumstances allowed us to complete 438 CTD casts on a total of 22 CTD lines, including several repeat lines. The repeat lines are extremely informative as to the changing position of the Alaskan Coastal Current under different wind conditions. This year, the high resolution surveys just north of the Diomede islands captured several full depth (or almost full depth) eddy-like features in detail, allowing for a much better study of the mixing of the flow by the Diomede Islands. Note that many sections this year were taken under southward wind conditions.

For full station coverage, see map and listings below. Preliminary results are given in the various sections.

Summary of CTD lines.

BS *(Bering Strait)* (US portion) – the main Bering Strait line, run at the start and at nearly the end of the cruise. This line has been occupied by past Bering Strait mooring cruises. US portion only run here. This line was previously ~ 2nm resolution. On both runnings of this section, we used the more recent station spacing of ~1nm to better resolve the structure in the strait. Previous runnings of this line have included two stations (BS23 and BS24) which fall south of the main line near Prince of Wales, extending the line along (rather than across) isobaths. BS23 and BS24 were only taken during the first running of this line.

DLS and DLN *(Diomede Line)* (previously one line DL) – two consecutive lines running north from the Diomede Islands to A3, the southern portion DLS (stations DL1-12) at 1nm spacing, the northern portion DLN (stations DL13-A3) was previously run at 2.5nm spacing, but on this cruise a station spacing of 1.25nm was used. Run both at the start and end of the cruise, in the first running the southern portion (DL1-12) was run in conjunction with lines DLa and DLb (order of running DLS, DLa, DLb, DLN). These lines study the hypothesized eddying and mixing region north of the islands.

DLa and DLb – two other high resolution lines (1nm resolution), mapping the eddying/mixing region, parallel to DLS, allowing for a 2-dimensional mapping of the region. These lines were run at the start of the cruise.

AL *(A3 Line)* (US portion) – another previously-run line (previously run at ~ 1.7nm resolution, run this cruise twice at 0.85nm resolution), just north of the Strait, running from the Russian coast, through the mooring site A3, to where the main channel of the strait shallows on the eastern (US) side. US portion only run here, and extended by 6.6nm to map the transition to shallower water.

AS – a line sampled only once before (2011) (although sometimes run for underway data), running from the eastern end of AL back towards the western end of the CS line, taken at variously 4nm or 2nm spacing (closer stations over steeper topography).

CS *(Cape Serdtse)* (US portion) – another cross strait line (~ 3.9nm resolution), run here from the US-Russian convention line (~168° 58.7'W) to Point Hope (US), but originally starting at Cape Serdtse-Kamen, in Russian waters. Also repeated during the cruise, second running adding stations to make station spacing ~1.9nm.

NPH *(North Point Hope)* (US waters) - a line run once before in 2016, crossing from north of Point Hope to the WNW, at 1.25nm spacing near the coast, and 2.5nm spacing after NPH5, to chart the Alaskan Coastal Current transformation on its route along the Alaskan Coast. Extended in 2019 to the Convention Line, and run twice.

CD *(Cape Dyer)* (US waters) - a line new in 2016, taken also in 2017, running west-east towards the Alaskan Coast, midway between Point Hope and Cape Lisburne, set just south of some apparent topographic irregularities, also to chart the Alaskan Coastal Current transformation on its route along the Alaskan Coast. Extended in 2019 to the Convention Line, and run twice.

LIS *(Cape Lisburne)* (US waters) – from Cape Lisburne towards the WNW, a previous RUSALCA line, run by us also in 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018 and close to the CP line occupied in previous Bering Strait cruises in 2003 and 2004 (station spacing ~ 3.6nm). Note that due to the Quintillion cable, station Lis 9 is replaced by 2 new neighboring stations, Lis 8.5 and 9.5 . Run once during the 2019 cruise.

Re-run of CD, NPH, CS and AL lines

NNBS *(North North Bering Strait)* – a new line run only twice before (2015, 2017) west-east across the eastern strait, south of A3 and north of NBS, run at ~ 1.8nm resolution, to better map the Alaskan Coastal Current north of the Strait proper.

NBS *(North Bering Strait)* – an east-west cross-strait line ~ 8nm north of the Bering Strait line, run in previous years, with ~ 1.7nm resolution.

MBS *(Mid Bering Strait)* – an east-west cross-strait line ~ 10nm north of the Bering Strait line, run in previous years, with ~ 1.7nm resolution, with higher resolution near the coast. Run in part from the east until bad weather prevented CTD operations. Returned to ~ 14hrs later (after the DL lines) and run again in full.

Re-run of the DLN and DLS lines, following by rerunning of the MBS and BS lines

SBSn – a previous line new in 2014, run only in 2014, 2015 and 2017 and then often only in part, just south of the strait, crossing the Alaskan Coastal Current before it enters the strait proper (previously run at 2.2nm resolution, run this year at 1.1nm resolution). Note the alignment of the section has been changed to start at BS22, not BS24, with new line name SBSn signifying slightly different line position and spacing driven by operational issues. (Positions for a new complete line SBSnn, better matching SBS, are given in the Appendix.)

Summary of ADCP/Underway data lines

The ship's ADCP recorded for the duration of the cruise, and between lines steams were often positioned to give more useful underway information. The following were targeted underway surveys:

Between mooring work: - a zigzag line crossing the ACC north of A3 and returning to A3 by the morning.

During bad weather at end of cruise: - completion of MBS line (slightly north of original line, once bad weather prevented further CTD casts), followed by zigzagging across the eddy zone north of the Diomede Islands, from MBS1 to A3.

See maps for details of these lines.

Prior lines not taken on this cruise:

CCL *(Chukchi Convention Line)* (US waters) – a line running down the convention line from the end of the LIS line towards the Diomedes (also run in 2003, 2004, 2011, 2012, 2013, 2014, 2015, 2016, 2017 and 2018), typically incorporating a rerun of the high resolution DL line at the southern end, run variously at 10nm (typical) or 5nm (rarely) resolution.

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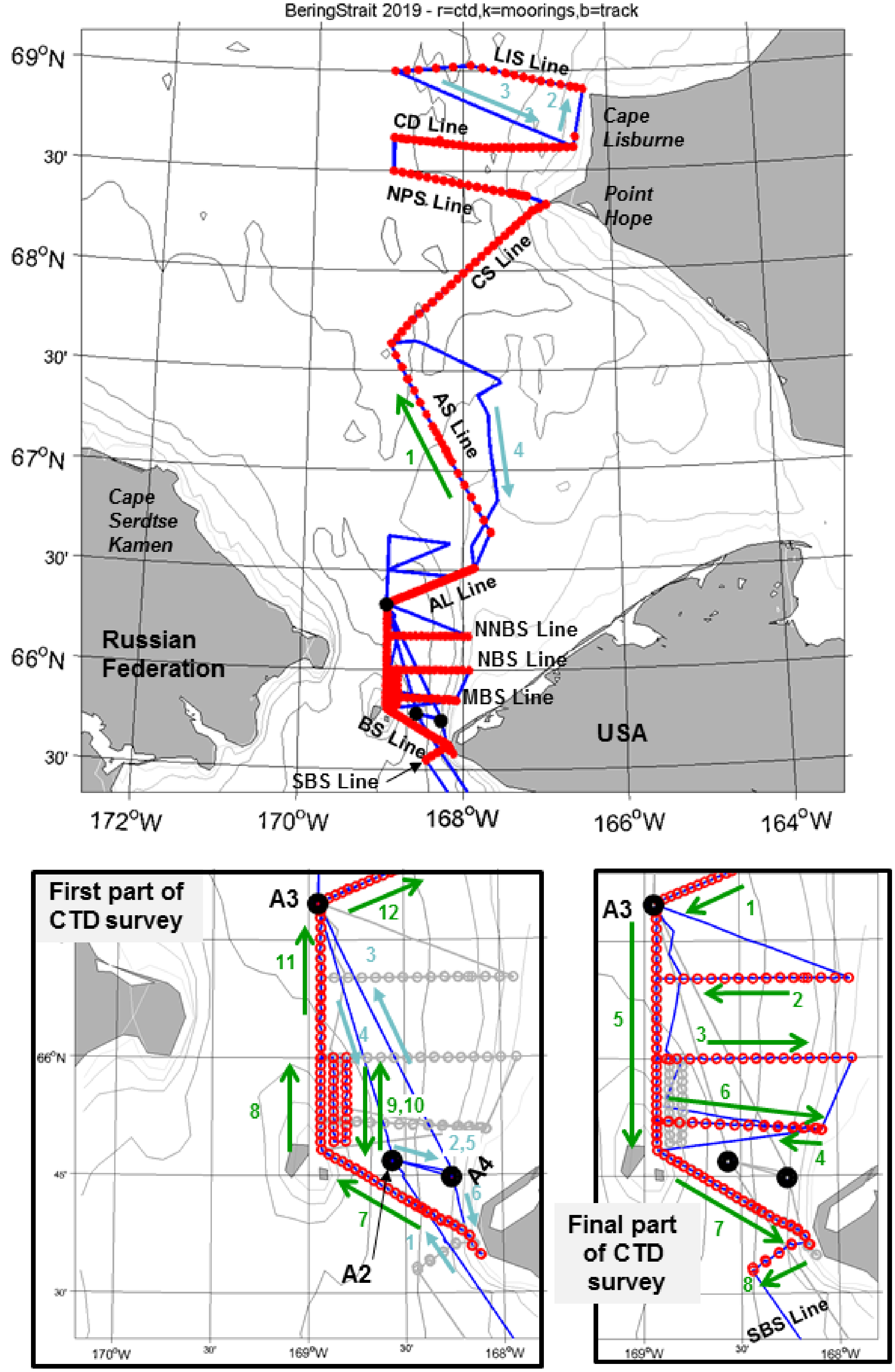
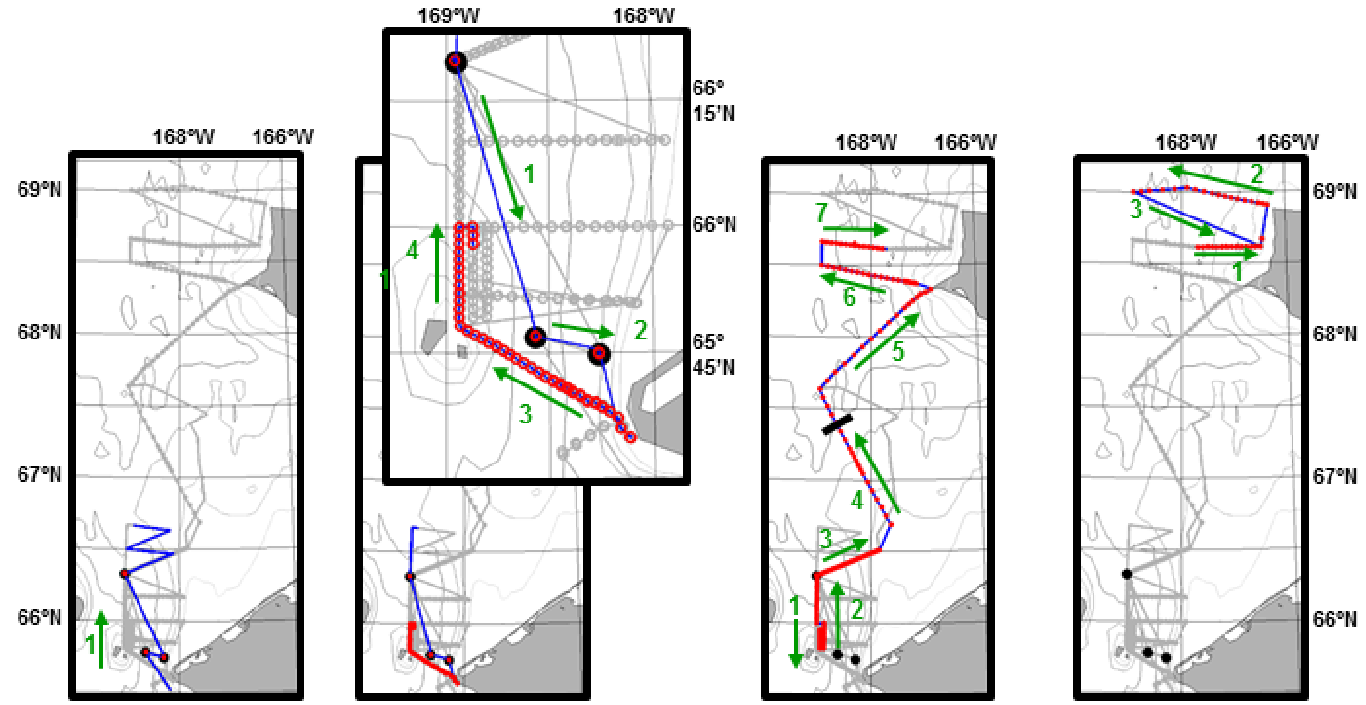
BERING STRAIT 2019 MOORING CRUISE MAP: *Ship-track, blue. Mooring sites, black. CTD stations, red. Consecutively numbered arrows indicate direction of travel (on this figure, green marking CTDing lines, cyan marking transit). Depth contours every 10m from the International Bathymetric Chart of the Arctic Ocean (IBCAO) [Jakobsson et al., 2000]. Lower panels give detail of strait region at the start (left) and end (right) of the cruise. (See next page for daily detail.)*





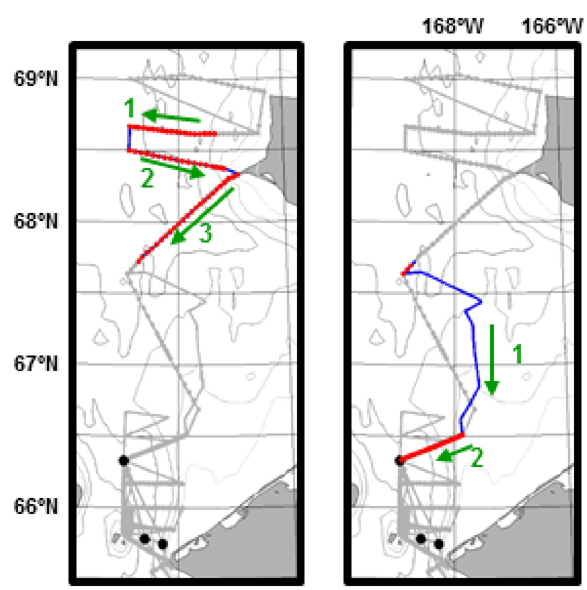
Day 1 *(local time)*
0500 6th Sep 2019
- 0500 7th Sep 2019

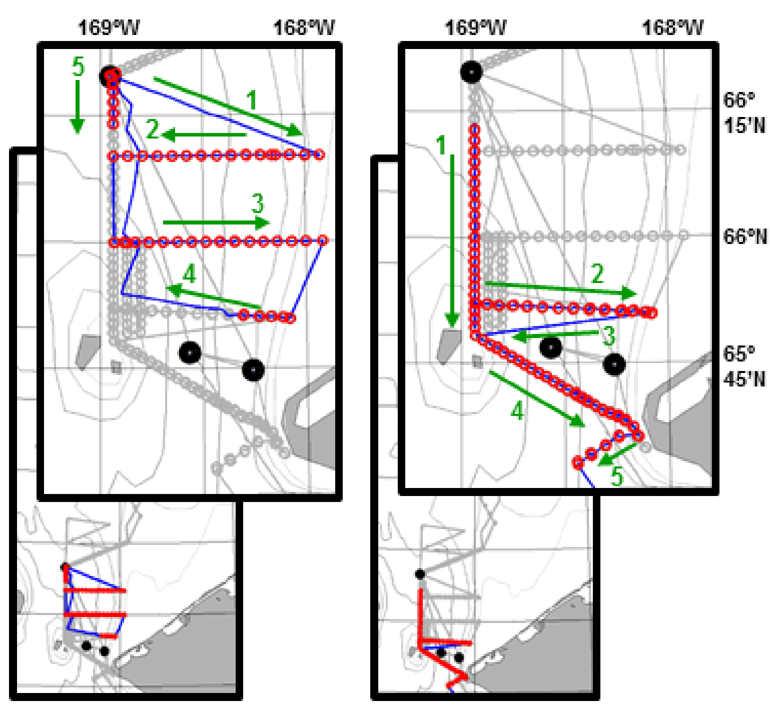
Day 2 *(local time)*
0500 7th Sep 2019
- 0500 8th Sep 2019

Day 3&4 *(local time)*
0500 8th Sep 2019
- 0500 10th Sep 2019

Day 5 *(local time)*
0500 10th Sep 2019
- 0500 11th Sep 2019

Bering Strait 2019
Mooring Cruise
Norseman II





Day 6 *(local time)*
0500 11th Sep 2019
- 0500 12th Sep 2019

Day 7 *(local time)*
0500 12th Sep 2019
- 0500 13th Sep 2019

Day 8 *(local time)*
0500 13th Sep 2019
- 0500 14th Sep 2019

Day 9 *(local time)*
0500 14th Sep 2019
- 0500 15th Sep 2019

BERING STRAIT 2019 SCIENCE PARTICIPANTS

1.	Rebecca Woodgate (F)	UW	*Chief Scientist and UW PI*
2.	Jim Johnson (M)	UW	*UW lead Technician*
3.	Max Showalter (M)	UW	*UW bio grad student (Moorings and CTD)*
4.	Katy Christensen (F)	UW	*UW phys grad student (Moorings and CTD)*
5.	Kim Gottschalk (F)	UW	*UW phys grad student (Moorings and CTD)*

UW – University of Washington, US

Cabin Allocations:
main deck: C4-Johnson
lower deck: C5-Showalter; C7-Christensen & Gottschalk; C8-Woodgate

BERING STRAIT 2019 NORSEMAN II CREW

1.	Jake Meek (M)	NMC	*Captain*
2.	Jim Wells (M)	NMC	*Boson*
3.	Mike Bain (M)	NMC	*Engineer*
4.	Luke Johnston (M)	NMC	*AB*
5.	Andrew Wilson (M)	NMC	*Mate*
6.	Nolan Nantz (M)	NMC	*OS*
7.	Zac Buss (M)	NMC	*OS / Cook*
8.	Harry Burnet(M)	NMC	*AB / Head Cook*

NMC – Norseman Maritime Charters, http://www.norsemanmaritime.com/index

Ship contract arranged by:

CPS Polar Field Services, partner of CH2MHILL Polar Services
Anna Schemper, anna@polarfield.com

BERING STRAIT 2019 CRUISE SCHEDULE (Times: Alaskan Daylight Time (GMT-8), 24hr format)
(Wind directions are wind source (same as ship met data .. so S Wind = wind from South)

Fall 2018	*Preliminary arrangement of charter of Norseman II by CPS for NSF for the Bering Strait mooring work*
April 23rd 2019	*UW visits N2 in Seattle, to test CTD cable*
End of June 2019	*Shipment of container of UW equipment to Nome*
Sunday 1st Sept 2019	*UW science team (Rebecca, Jim, Max, Katy, Kim) arrive Nome*
Monday 2nd Sept 2019 *(Blustery but mostly dry)*	*UW Instrument preparation (extract and start instruments in room in Aurora Inn, return all gear to container)*
Tuesday 3rd Sept 2019 *(Stormy, S wind)*	*UW Instrument preparation (build ISCATs, ADCPs)* *Restuff container*
Wednesday 4th Sept 2019 *(Strong S wind)*	*Scott Hameister of NMC arrives, chasing of food shipment lost by Alaska Air Cargo. Discuss onload plans for poor weather*

Thurs 5th Sept 2019 *(JD248)* *(Stormy, S wind)*	Ship arrives from Port Clarence, comes into dock to see if workable Ties up with extra anchor to hold off dock ~ 1000 On slinging of gear finished ~ 1100 Science team down to ship Leave ~ 1400 Safety briefings. Set up underway, CTD, and test tank ~1600 CTD test cast Discussion of CTD and mooring operations with captain and crew Tack northward towards strait
Fri 6th Sept 2019 *(JD249)* *(Clear, light winds)* *(Foggy by afternoon)*	Arrive on site at A2-18 ~0730 and still too dark to work 0823 A2-18 pre-recovery CTD 0843 Start **A2-18 mooring recovery** drift, Recovered mooring by dragging (sighted 0938) All on deck by 0944 Steam to A4-18 1104 A4-18 pre-recovery CTD 1115 Start **A4-18 mooring recovery** drift Recovered mooring on 3rd dragging attempt (sighted 1256,1258) All on deck by 1327 Steam to A3-18, cleaning up some of the recovered instruments 1720 A3-18 pre-recovery CTD Too foggy to recover, instead survey in mooring position ~1930 Run ADCP and underway sections through the night
Sat 7th Sept 2019 *(JD250)* *(Clear, light winds)*	~0800 on site A3-18, but still too dark 0830 Start **A3-18 mooring recovery** drift, all on deck by 0841 Prep A3-19 deployment 1120 Start **A3-19 deployment**, anchor dropped 1137 1149 A3-19 post-deployment CTD Prep A2-19 (and A4-19) during steam (put cleaning aside for now)

	1619 Start **A2-19 deployment**, anchor dropped 1629 1635 A2-19 post-deployment CTD 1752Start **A4-19 deployment,** anchor dropped 1803 1810 A4-19 post-deployment CTD Transit to BS24 1958 Start **BS line** at high resolution, running to west

Sun 8th Sept 2019 *(JD251)*
(Light winds only)
	0101 Finish BS line at BS11, steam to DL1
	0145 Start **DLS line**, running north
	    0407 End DLS line at DL12, steam to DLa12
	0421 Start **DLa line**, running south
	    0704 End DLa line at DLa1, steam to DLb1
	0718 Start **DLb line**, running north
	    0931 End DLb line at DLb12, steam to DL12
	0956 Start **DLN line**, running north
	    1345 End DLN line at A3, continue AL line
	1354 Start **AL line**, running north east
	Clean up recovered moorings on upper deck while CTDing
	    2000 Finish AL line at AL27.5, steam to AS1
	2117 Start **AS line**, running northwest

Mon 9th Sept 2019 *(JD252)*
(Mostly light S winds)
	0644 Finish AS line at AS19, steam to CS10
	0712 Start **CS line**, running northeast
	    1557 Finish CS line at CS19, steam to NPH1
	    (crossed paths here with at least one sail drone)
	1634 Start **extended NPH line**, running to west
	    2309 Finish NPH line at CCL19, steam to CCL20
	Troubleshoot strange hex data in CTD files

Tues 10th Sept 2019 *(JD253)*
(Light winds only)
	0018 Start **extended CD line**, running to east
	    0926 Finish CD line at CD1, steam to LIS1, doing test cast
	1134 Start **LIS line**, running west
	    1934 End LIS line at CCL22, Steam to CD1

Wed 11th Sept 2019 *(JD254)*
(Winds and seas building, winds from East)
	0223 Start **CD line**, running west
	    1057 Finish CD line at CCL20, Steam to CCL19
	    1209 Start **NPH line** running east,
	    1923 Finish NPH line at NPH1, Steam to CS19
	2026 Start **CS line** running southwest
	    in increasingly bad weather

Thurs12th Sept 2019 *(JD255)* *(Storm from N)*	0612 Finish CS line at CS10, Jog into seas to wait out storm ~2000 Seas abate sufficient to steam to next point, AL27.5 2304 Start **AL line**, running southwest

Fri 13th Sept 2019 *(JD256)*
(Still windy, N wind, brief lull but high seas still in strait)
	0513 Finish AL line at A3, Steam to NNBS8
	0838 Start **NNBS line**, running west
	    1302 Finish NNBS line at NNBS1, Steam to NBS1
	1417 Start **NBS line**, running east
	    1857 Finish NBS line at NBS9, Steam to MBS8
	2008 Start **MBS line** at MBS8, running west
	    2122 Abort MBS line due to high seas
	    Steam underway sections along
	    - rest of MSB line (just north thereof)

	- northwards through the DLa,DLb grid to A3
Sat 14th Sept 2019 *(JD257)*	0341 Start **DLN+DLS line**, running south
(Still windy, mostly N wind	1038 Finish DLS line at DL1, Steam to MBSn1
turning briefly)	1057 Start **MBS line**, running east
	1447 Finish MBS line at MBSn8, Steam to BS11
	1735 Start **BS line**, running east
	2331 Finish BS line at BS22, Steam south, but make little headway in face of strong current and seas, so divert west, and re-align SBS line so start as BS22 notBS24
	2351 Start **SBS line** running south west
Sun 15th Sept 2019 *(JD258)*	0123 Finish SBS line at SBSn5, Turn for Nome
(Still windy, but sheltered	making only ~ 7knots against wind and current
in Nome as N wind)	**1430 Dock in Nome**,
	1600 Offload complete, Clean up science party
	1700 Science party leaves ship for airport
	Evening - Science party flies to Anchorage

Monday 20th Sept 2019 *Rest of Science party returns to Seattle.*

<u>Bering Strait 2019 Mooring cruise TOTALS</u>

10 days at sea (away from Nome)	1400 5th Sept – 1430 15th Sept 2019
10.25 days on ship (including on/offload)	1000 5th Sept – 1700 15th Sept 2019

Moorings recovered/ deployed:	3/3
CTD casts:	438 (including 2 test casts)

SCIENCE COMPONENTS OF CRUISE

The cruise comprised of the following science components:

- Mooring operations – 3 mooring recoveries, 3 mooring deployments (UW moorings)

- CTD operations - 438 casts on 22 lines (UW instrumentation, measuring temperature, conductivity, oxygen, fluorescence, and turbidity with pressure)

- Underway sampling – ship-based equipment of 300kHz hull-mounted ADCP; SBE21 underway Temperature-Salinity recorder, an SBE38 temperature sensor, and some meteorological data (air temperature, pressure, humidity, wind direction and wind speed).

- Moored Marine Mammal Observations (acoustic instruments on the moorings)
All recovered moorings and the deployed A3 mooring carried Marine Mammal Acoustic Recorders from Kate Stafford, UW.

MOORING OPERATIONS (Woodgate, Johnson, assisted by others)

Background: The moorings serviced on this cruise are part of a multi-year time-series (started in 1990) of measurements of the flow through the Bering Strait. This flow acts as a drain for the Bering Sea shelf, dominates the Chukchi Sea, influences the Arctic Ocean, and can be traced across the Arctic Ocean to the Fram Strait and beyond. The long-term monitoring of the inflow into the Arctic Ocean via the Bering Strait is important for understanding climatic change both locally and in the Arctic. Data from 2001 to 2011 suggest that heat and freshwater fluxes are increasing through the strait [*Woodgate et al.*, 2006; *Woodgate et al.*, 2010; *Woodgate et al.*, 2012; *Woodgate et al.*, 2015; *Woodgate*, 2018], with 2012 being a year of low flow, but 2013 to 2016 returning to higher flow conditions [*Woodgate*, 2015; *Woodgate et al.*, 2015; *Woodgate*, 2018]. The data recovered this cruise will indicate if 2018 shows further increase or a return to older conditions. An overview of the Bering Strait mooring work (including data access) is available at http://psc.apl.washington.edu/BeringStrait.html. Data are also permanently archived at the National Oceanographic Data Center, recently renamed the National Centers for Environmental Information (https://www.nodc.noaa.gov/).

A map of mooring stations is given above. Three UW moorings were recovered on this cruise. These moorings (all in US waters – A2-18, A4-18, A3-18) were deployed from the Norseman II in August 2018, with mooring funding from NSF-AON (PI: Woodgate and Peralta-Ferriz, *PLR1758565*).

Three UW moorings (A3-19, A2-19, A4-19) were deployed on this 2019 Norseman II cruise under funding from the same NSF-AON grant. All these deployments were replacements of recovered moorings at sites occupied since at least 2001 (A4) or 1990 (A2 and A3). Analysis of past data suggests data from these three moorings are sufficient to give reasonable estimates of the physical fluxes of volume, heat and freshwater through the strait, as well as a useful measure of the spread of water properties (temperature and salinity) in the whole strait [*Woodgate et al.*, 2015].

All moorings (recovered and deployed) carried upward-looking ADCPs (measuring water velocity in 2m bins up to the surface, ice motion, and medium quality ice-thickness); lower-level temperature-salinity sensors; and iscats (upper level temperature-salinity-pressure sensors in a trawl resistant housing designed to survive impact by ice keels). The three recovered moorings carried marine mammal acoustic recorders, and acoustic recorders were deployed on the new A3-19 mooring also. This A3-19 mooring also carried the first prototype "Miscat", a multiple instrument version of the iscat, designed to allow instruments to be lost sequentially from nearer the surface. For a full instrument listing, see the table below.

This coverage should allow us to assess year-round stratification in and fluxes through the strait, including the contribution of the Alaskan Coastal Current, a warm, fresh current present seasonally in the eastern channel, and known to be a major part of the heat and freshwater fluxes [*Woodgate and Aagaard*, 2005; *Woodgate et al.*, 2006; *Woodgate et al.*, 2015; *Woodgate*, 2018]. The ADCPs (which give an estimate of ice thickness and ice motion) allow the quantification of the movement of ice through the strait [*Travers*, 2012]. The marine mammal recording time-series measurements should advance our understanding of the biological systems in the region.

Calibration Casts: Biofouling of instrumentation has been an on-going problem in the Bering Strait. Prior to each mooring recovery, a CTD cast was taken to allow for *in situ* comparison with mooring data. Similarly, CTD casts were taken at each mooring site immediately after deployment. These post-deployment casts will allow us to assess how effective this process is for pre-recovery calibration. Since the strait changes rapidly, and CTD casts are by necessity some 200m away from the mooring and may be as long as 1hr separated in time from the mooring reading, it is inevitable that there will be differences between the water measured by the cast and that measured by the mooring. **Action item: On recovery, check the post deployment casts to see how reliable the comparison is.**
This year (as in 2017 and 2018), an on-deck calibration tank was also used for recovered instruments. This is discussed below.

2019 Recoveries and Deployments: Mooring operations were unusually difficult this year

For recoveries, the ship positioned ~ 200m away from the mooring so as to drift towards the mooring site. Ranging was done from the port mid corner of the aft deck of the ship, with the hydrophone connecting to the deck box inside at the aft end of the port laboratory. **Action item: Re check position as regards to ship's propellers.** Without exception, acoustic ranges agreed to within 50m of the expected mooring position. Once the ship had drifted over the mooring and the acoustic ranges had increased to >70m, the mooring was released**.** This procedure was followed to prevent the mooring being released too close (or underneath) the ship since in previous years the moorings have taken up to 15min to release. **Action item: Be sure to distinguish between slant and horizontal range during soundings.** As site A3 is ~0.6nm from the Russian border, prior to ranging on A3, the Norseman II's small boat was prepared for launching, to cover the eventuality that if the mooring had to be dragged, the mooring would surface and drift towards Russian waters before the ship was able to recover it. **Action item: Continue to prepare for small boat operations at site A3.**

On all moorings, we use double releases, with springs to assist the mooring release. For the all moorings, our routine was to communicate and range with one release and then attempt to release the other release (to test both instruments). Although on all moorings, releases communicated clearly, only on A3-18 was this successful in bringing the mooring to the surface.

On A2-18, release #16898 repeatedly replied slow (i.e. not released) to the release command. The other release, #32831, did confirm release, but the mooring did not surface. Dragging operations were instigated and the mooring was sighted part way through the first attempt. On recovery only release #32831 had opened. Release #16898 was still locked. Some small mussels had grown on the biofouling paint, possibly holding the release shut.

On A4-18, the same problems were found. Release #16897 replied slow (i.e., not released) to the release command, and the mooring did not surface. Release #32833 replied confirming release, but the mooring still did not surface. Release #16897 did confirm release after being enabled, but still the mooring remained at the sea floor. Again, dragging operations were instigated. The first two trawls yielded no results. Part way through the third attempt however the iscat was sighted, and a couple of minutes afterwards, the rest of the mooring was sighted. Once the trawl wire was recovered, the ship then recovered the iscat and finally the rest of the mooring. Here, there was extensive growth of small barnacles and also some small mussels which were jamming the mechanism on release #16897 (which had turned but the hook was trapped by the biofouling.

Action Items:

- Investigate internal spring on 16898.

- Investigate better biofouling paint. Ensure all releases are newly painted each year.

- Continue to use external springs

In all cases, once the mooring was on the surface, the ship repositioned, bringing the mooring tightly down the starboard side of the ship. One boat hook and a pole with a quick releasing hook attached to a line were used to catch the mooring, typically on a pear link fastened to the chain between the float and the ADCP or on eyes welded to the float surface. The line from the hook was then passed back to through the stern A-frame, and tied with a "cats paw" knot to a hook from the A-frame. This portion of the mooring was then elevated, allowing the second A-frame hook to be attached lower down the mooring chain, and tag lines to be attached if necessary. The iscat, if present, was recovered by hand at a convenient point in this operation, prior to recovery of most of the mooring. (This year, iscats were recovered on A2-18 and A4-18.) Then the entire mooring was then elevated, using both hooks from the aft A-frame, and recovered onto deck. Recovery work was done by a deck team of 4 crew of the Norseman II – one on the A-frame controls, three on deck with on overhead safety lines ("dog runs") down each side of the deck (one of these working forward of the deck on tag lines), assisted by UW personnel further forward on the aft deck. Once on deck, the moorings were photographed to record biofouling and other issues. **Action items: Be sure to add pear-link to the chain between float and ADCP. Prepare loops of line for threading through chain/shackles to provide a lifting point. High A-frame or crane very helpful for recovery. Also helpful to review mooring movies at start of cruise.**

The A-frame of the Norseman II is atypically high (~ 26ft less block attachments). While this is extremely useful in fair weather, it allows for swinging of the load in rougher seas. **Action item: Continue to use tag line options for recovery in rougher weather.**

Good visibility (at least ~1nm) is required for mooring recoveries since the mooring may delay releasing due to biofouling, or the mooring may require dragging, as in previous years. Given the proximity of A3 to the US-Russian border, small boat operations may also be necessary during a dragging operation to prevent the surfaced mooring drifting out of US waters. Fog and lack of daylight hindered mooring recovery at site A3 by late afternoon, but cleared up the following morning. **Action item: Continue to include weather days in the cruise plan; plan also for small boat operations (including sending a battery powered release unit), considering especially if small boat operations could be used in fog. Assess causes of foggy conditions, in order to predict best strategy for finding workable visibility.**

Biofouling was heavy in the recoveries this year, especially at A2 and A4. However, despite the moorings being in the water for more than a year (deployed in August), growth was comparable (A4) or slightly less (A2 and A3) than the 2018 recoveries.. Bryozoan growth was limited - instead mussels and barnacles were plentiful. A separate report below gives more details. Unusually, this year the releases had significant biofouling on the release mechanisms despite the biofouling paint. Also, salinity cells were significantly blocked, usually with small mussels. Summary of biofouling on salinity cells:

- ***A2-18 SBE*** - muddy, and with some byrzoans but hole still visible
- ***A2-18 ISCAT*** - one end completely blocked by small mussels, other end half blocked
- ***A4-18 SBE*** - byrzoans, but hole basically clear
- ***A4-18 ISCAT*** - some small barnacles, but cell mostly clear
- ***A3-18 SBE*** - cell clear

In contrast to 2016, when significant damage (hypothesized ice damage) was found on the moorings, in 2019 there was no clear evidence of mechanical damage to the mooring frames. However, the iscat on A3 was severed above the upper block (thus the wire rope and coupler were recovered), and the anode on the A2SBE was bent, possibly when the steel float fell near to it during deployment.

Mooring deployments were done through the aft A-frame, using the A-frame hooks for lifting. The height of the Norseman II A-frame was extremely advantageous for these deployments. Lacking such an A-frame, alternative ships might consider lifting the mooring with the crane, rather than the A-frame. The mooring was assembled completely within the A-frame. The ship positioned to steam slowly (~1 to 2knots) into the wind/current, starting between 500m and 600m from the mooring site. **Action item: This distance (greater distance in strong current) works well.** At the start of the deployment, the iscat was deployed by hand and allowed to stream behind the boat, which steams at ~ 2knots, fast enough to maintain headway and to trail the mooring behind the ship, but not so fast as to damage the equipment being towed or pull equipment off the deck. **Action item: Feed the iscat tether unwound to the person spooling it off the deck.** The first pick (from one of the hooks of the aft A-frame) was positioned below the ADCP, except in the case of A4, where the first pick was below the top float. The second pick (from the other hook of the aft A-frame) was lower down on the mooring allowing all the mooring except the anchor to come off the deck during the lift. Then, the A-frame boomed out to lower these instruments into the water. Tag lines were used to control the instruments in the air. **Action item: use deck cleats to fair tag lines. Be sure to position the lift point on the float so it does not cause the float to roll off.** The first pick was released by a mechanical quick release, which was then repositioned to lift the anchor. (Previous years have shown that if the first pick was insufficiently high, the releases would still be on deck when the first package was in the water. The releases would then slip off the deck inelegantly. It was found that a higher lift of the instruments, and using both hooks of the A-frame, allowed the releases also to be lifted from the deck and then hang nicely behind the ship once the ADCP was placed in the water.) The anchor was lifted into the water just prior to arriving at the site. Positioning of this final pick very close to the anchor prevents the releases being pulled back over the lip of the ship when the anchor is lifted. **Action item: Make final pick as close as possible to the anchor.** When the ship arrived on site, the anchor was dropped using the mechanical quick release. Positions were taken from a hand-held GPS on the upper aft deck, some 5m from the drop point of the mooring. **Action item: Continue to bring own GPS unit. Note that due to mooring fall back, actual mooring position may be ~ 10m from this position in the opposite direction to the steaming direction during recovery.** This information is noted on the mooring diagrams.

A team of 4-5 crew did the deployments, with one person on the A-frame, 3 on the "dog runs' assisting the instruments up into the air, and other members of the crew/science team assisting with tending the tag lines during lifting.

Action items: design pick points into the moorings for recover; continue to put 2 rings on the anchors for tag lines. Consider using chain, not line for the moorings (saves on splicing and gives extra pick points); Compute the best pick point, such that the releases are lifted free of the deck, rather than slipped over the edge.

Deployment Instrumentation issues: Most instrumentation was started in Nome or aboard ship in the days prior to sailing. This work was accomplished in one reasonably long day. All instrumentation was started successfully, although the following start-up issues were encountered:

ADCPs: ADCP #19413 reported it had no memory card on first connection. The ADCP head was removed and the card (which was present) was taken out and reinserted, and the ADCP subsequently started properly. However, it was used as the spare for the cruise and not deployed. **Action item: Check compass calibration in Seattle. Be sure to fully seat memory cards.**

SBEs: SBE16 #1700 reported in its status message that it was in "Calibrate Mode". Manuals contained no information on this, but message to Seabird finally brought the recommendation to send command *cn to take the SBE16 out of calibration mode. This worked.

ISCATs and MISCAT: One SBE37 came from Seabird with an unusual ID number, and this had to reset (with *ID=02). Tests were run with the MISCAT system, suggesting (a) if the logger time interval is not a multiple of the microcat time interval strange behavior can occur; (b) communication issues if the couplers on the SBE37s were too close together.

Iscat housings and ADCP frames were assembled using a group of 5 people in Nome (2 teams). This year, releases were also deckchecked in Nome to save time at sea. **Action item: Deck check releases in Nome using battery deck set.** This preparation, and restuffing the container, took us one day. This gave us one extra day before the cruise, but this extra day should be kept, as it allows for unforeseen issues, for example, requests for early loading as in previous years. **Action item: Ensure when container is set up for working at Northland, its doors are set to provide protection from weather from the south.**

Recovered Data and Instrumentation issues: Data recovery on the moorings was generally good, although with some challenges, as detailed below:

- ISCAT SBE37IMS AND LOGGERS: Of the 3 iscats deployed on the recovered moorings:
- from **A2-18**, the top SBE37 sensor was recovered (although the cell was very blocked with mussels) and both the SBE37 and the logger ran until recovery.
- from **A4-18**, the top SBE37 sensor was recovered (the cell was mostly clear) and both the SBE37 and the logger ran until recovery
- from **A3-18**, the top SBE37 had been lost above the stopper just below the iscat housing (i.e., the wire rope and coupler were recovered), but the logger was still running on recovery and indicated the SBE37 was lost on the 31st May 2019. **Action item: Check for sea ice.**

All loggers and SBE37s downloaded without incident, with using the newer SBE software cutting the download time to much less than the previous several hours and resolving the skipping record problems of last year. Preliminary results are plotted below.

- *ADCPs:* Of the 3 ADCPs deployed on the recovered moorings:
- from **A2-18**, ADCP #13758 was still recording on recovery and gave a complete good record.
- from **A4-18**, ADCP #10926 was still recording on recovery and gave a complete good record.

- from **A3-18**, ADCP #2332 was also still recording on recovery and gave a complete record, however at the time the iscat was lost (end of May), the distribution of flow direction of the ADCP changed to only show ~ southward flow. This is inconsistent with the other mooring and all prior data. We suspect some error in the compass (or possible the presence of something magnetic, such as the coupler) in close proximity to the ADCP, but further tests are necessary. **Action item: investigate 2332; do on shore checks of all compasses on good ADCPs.** Preliminary results are plotted below.

- SBEs: A SBE16 was recovered from each mooring. None of these instruments were pumped. Of the 3 seacats deployed on the recovered moorings:
- from **A2-18**, SBE16 #0008 was not logging data on recovery and had completely lost its clock time and data pointers. Downloading the memory showed 70 good records were recorded from when the instrument was started in Nome last year, the last good record being 1300 local (2100GMT) on the 10th August 2018. Last year's cruise onloaded on the 10th August (ending at ~ 1100), and sailed around 1300. Thus the instrument stared recording junk data sometime just after loading. This instrument had a reset switch problem on its previous deployment (2012-2013) and Seabird had replaced the board. **Action item: Investigate at Seabird, but likely retire this instrument. Check all SBE16s are running prior to deployment.**
- from **A4-18**, SBE16 #0005, deployed in a vaned frame, was still recording on recovery and returned a full record, including time in the test tank. The cell was mostly clear on recovery.
- from **A3-18,** SBE16 #1224, deployed on the side of the ADCP frame, had a clear cell on recovery, and returned a full record from the mooring deployment, but stopped recording data after 1 record in the test tank. Although the instrument status was reported as "logging data" when connection was made after the time in the test tank, this was not the case. Also, three consecutive "DS" commands returned clock times that were going backwards in time. **Action item: Investigate at Seabird.**

Preliminary results are plotted below.

Post recovery tank calibrations: As an addition calibration test, uncleaned post-recovery SBE instruments were placed, for various periods between 6th Sept 2019 (1024local, 1824GMT) and 8th Sept 2019 (~0848local, 1648GMT) in a large-plastic bin filled with salt water in conjunction with two recently calibrated SBE instruments:
- SBE19 #924, borrowed from the APL equipment pool and last calibrated in Jan/Feb 2018
- SB37IM #20937, brought as a mooring spare and last calibrated in June 2019.

The intent was to ascertain to what extent cleaning after recovery changes the readings on the SBE instruments. The preliminary test with this system was in 2016, and had significant limitations, likely relating to the instruments being horizontal, trapping air bubbles or biofouling, or coming out of the water on the rolling ship, or possibly due to interactions between instruments. This year, as in 2017 and 2018, the tank was designed to a) allow all instruments to be vertical and b) to include a pump to circulate water within the tank.

Once instruments were recovered from the moorings, they were placed in the tank for various periods of several hours. Since recovered instrumentation is recording either hourly (SBE16s) or every 5min (SBE37), this allows a good comparison with the calibration CTD, set at 5 second data, and the SBE37 recording every 5min. As the tank was not big enough for all instrumentation at one time, instruments were swapped in and out.

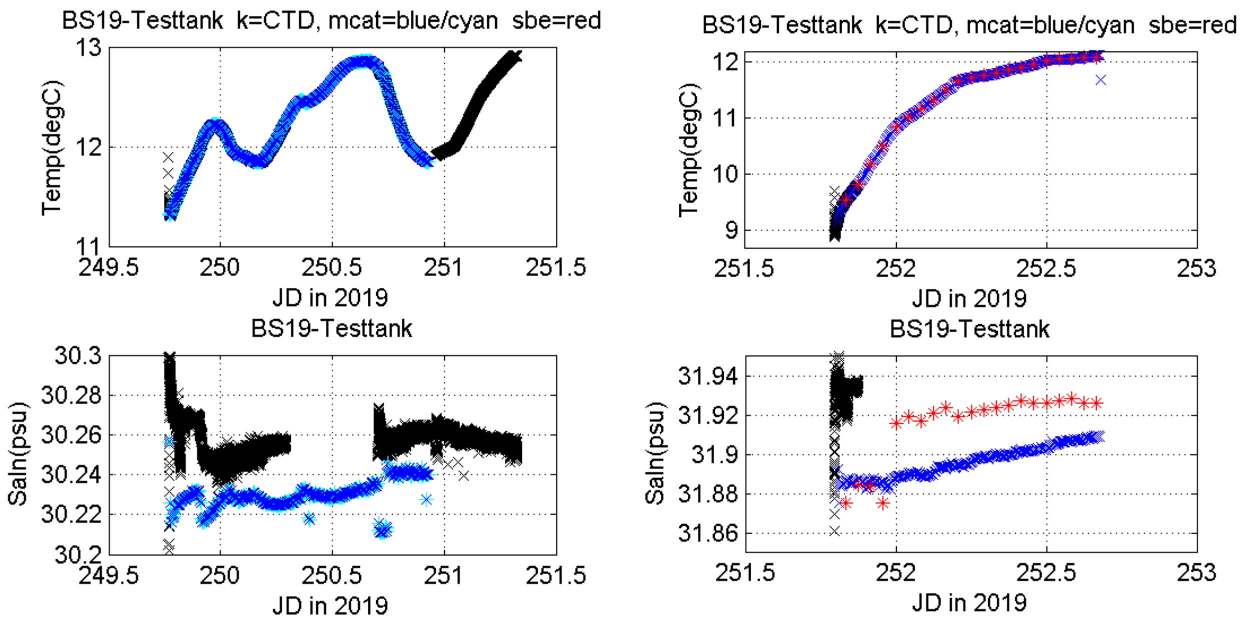
The first test run showed a significant difference between the instruments being used as the reference, CTD#924 and SBE#20937, so the test was rerun introducing a third calibration instrument, viz:
- SBE16 #1225, brought as a mooring spare and last calibrated in Sept 2009.

The water in the tank was changed for this second run, and also the mooring instruments had been cleaned for transit. This latter point means we can compare our test tank results better to results of the manufacturer's calibration, and have an immediate estimate of the impact of cleaning.

Some problems were also found with a) the CTD turning off in the tank (likely the switch being knocked as other instruments were moved in the tank; b) noise in the CTD (possibly from bubbles in the CTD system if not entirely upright); c) the CTD at 5s sampling ran only for 28.5hrs, and thus stopped recording as some point due to low battery.

Action item: Keep CTD upright. Do test before and after cleaning. Use both mooring spares. Track CTD time (only ~ 28hrs per battery set). Check CTD pump is working.

First, we ask how well do the references agree? This plot shows the references (CTD=black; SBE37=blue/cyan; SBE16=red) for the two soaks (left and right) for temperature (top) and salinity (right).

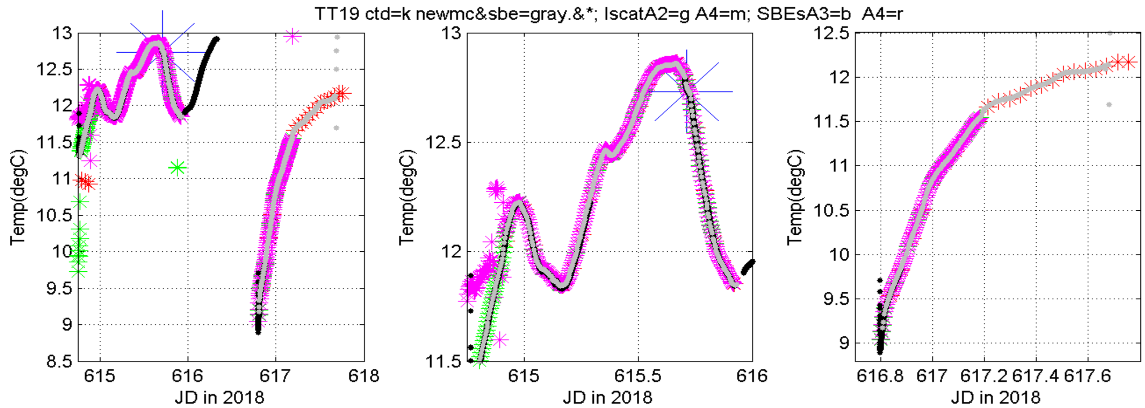


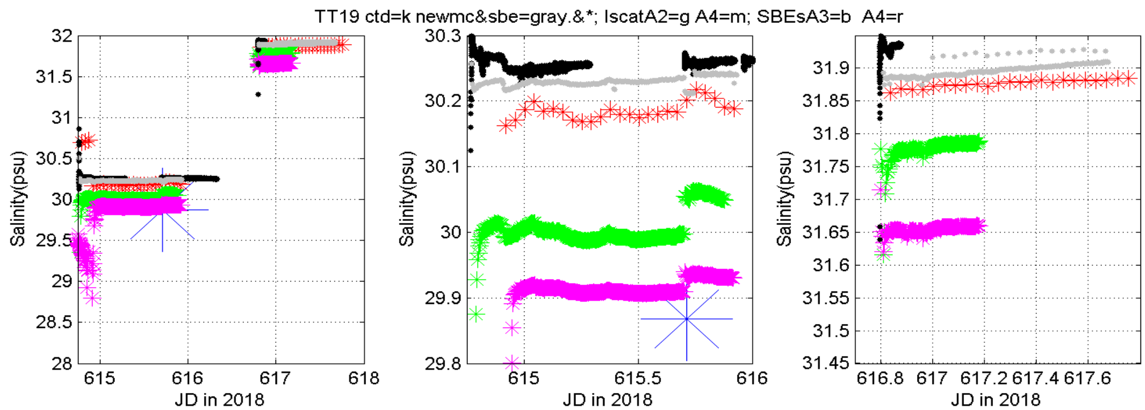
Although these look significantly off in salinity, this is actually within the manufacturer's specifications (see table, ~0.05psu).
Results with the test tank are summarized in the following table, final rows to be updated when postcals are available.

What	**CTD** *Black*	**SBE** *Gray*		**A2SBE** **No data**	**A2ISC** *green*	**A3SBE** *Blue ** *1pt only*	**A3ISC**	**A4SBE** *red*	**A4ISC** *magenta*
SN	**924**	**1225**		**0008**	**8964**	**1224**	**LOST**	**0005**	**20128**
	pumped	**New**		**Deployed**	**Deployed**	**Deployed**	**Deployed**	**Deployed**	**Deployed**
TAcc	0.01°C			0.01°C	0.002°C		0.002°C		0.002°C
CAcc	0.001S/m			0.001S/m	0.0003S/m		0.0003S/m		0.0003S/m
SAcc	0.05psu	0.05psu		0.05psu	0.008psu	0.05psu	0.008psu	0.05psu	0.008psu
PreCal	**Feb2018**	**Sep2009**		**Sep2013**	**Nov2017**	**Aug2016**	**Apr2016**	**Nov2017**	**Jun2018**
First soak	+0.02psu				-0.22psu -0.20psu	-0.35psu		-0.05psu	-0.32psu -0.30psu
Second Soak	+0.05psu	<0.02psu			-0.12 psu			-0.01psu -0.02psu	-0.23psu
PostCal					**TBD**	**TBD**		**TBD**	**TBD**
First soak									
Second Soak									

From this we conclude, agreement in the references to 0.05psu is the best that can be expected.

Next, here are the plots for the mooring instruments, data converted using the pre-deployment calibrations. Now references are in black (CTD) or Gray (SBE37 and 16), with colors as per the table of results below. Post cals to be added later.





Here we learn:

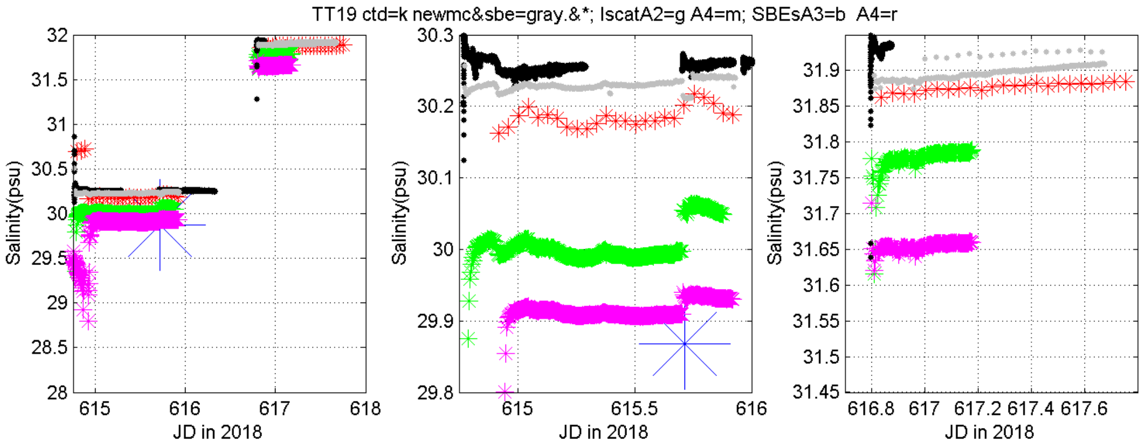
- SBE37 #20937 (spare) is probably the best reference, as it has the highest accuracy and the most recent calibration
- CTD19 #924 and the spare SBE16 #1225 agree with the SBE37 to within manufacturer's specifications, which could give differences of up to ~ 0.05psu
- Of the 4 recovered instruments we can test:
  - A2ISC is 0.2psu off pre washing, and 0.1psu off after washing
  - A4SBE - is within specs, being 0.05psu off pre washing and 0.02psu off after washing
  - A4ISC is 0.3psu off pre washing, and 0.2psu off after washing
  - A3SNE is 0.3psu off pre washing, post washing data not available.

. **Action item: - return to this once SBEs have been post-cruise calibrated. Revisit test methodology in Seattle to improve reliability. Note that washing can change calibration by 0.1psu.**

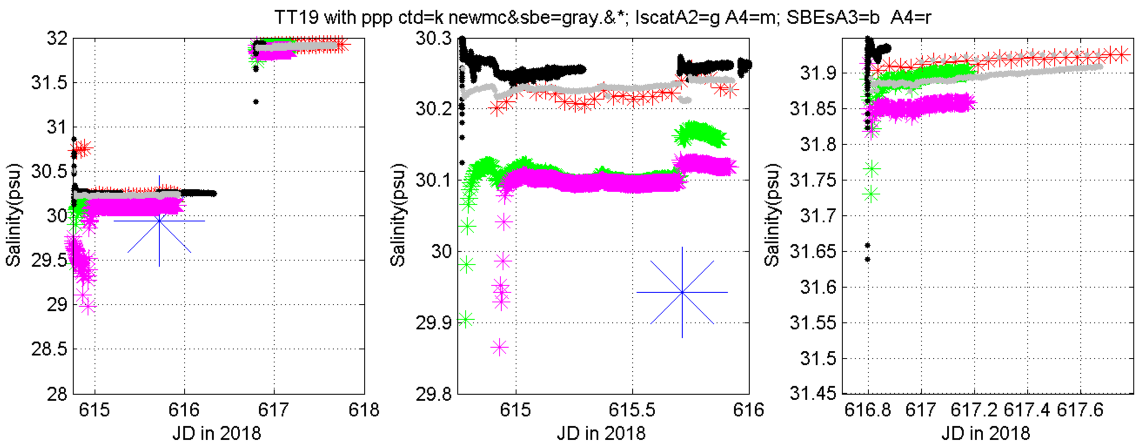
Action item: Once all SBEs have been post-cruise calibrated, also do:
- comparison to CTD casts
- comparison to instruments on same moorings

March 2020: Update testtank results with post cruise calibrations:

Precal testtank salinity results



Postcal testtank salinity results



What	CTD *Black*	SBE *Gray*		A2SBE No data	A2ISC *green*	A3SBE *Blue ** *1pt only*	A3ISC	A4SBE *red*	A4ISC *magenta*
SN	**924**	**1225**		**0008**	**8964**	**1224**	**LOST**	**0005**	**20128**
	pumped	**New**		**Deployed**	**Deployed**	**Deployed**	**Deployed**	**Deployed**	**Deployed**
TAcc	0.01°C			0.01°C	0.002°C		0.002°C		0.002°C
CAcc	0.001S/m			0.001S/m	0.0003S/m		0.0003S/m		0.0003S/m
SAcc	0.05psu	0.05psu		0.05psu	0.008psu	0.05psu	0.008psu	0.05psu	0.008psu
PreCal	**Feb2018**	**Sep2009**		**Sep2013**	**Nov2017**	**Aug2016**	**Apr2016**	**Nov2017**	**Jun2018**
First soak	+0.02psu				-0.22psu -0.20psu	-0.35psu		-0.05psu	-0.32psu -0.30psu
Second Soak	+0.05psu	<0.02psu			-0.12 psu			-0.01psu -0.02psu	-0.23psu
PostCal					**Feb2020**	**Feb2020**		**Feb2020**	**Feb2020**
First soak					-0.13psu -0.07psu	-0.3psu, but only one point		0 to -0.02psu	-0.13psu -0.11psu
Second Soak					0psu +0.01psu			+0.02psu	-0.04psu
Results from In Water CTD Cast (see next section)									
					-0.03psu	-0.3psu	unreliable	-0.1psu	unreliable

Conclude from Test tank:

1) How accurate is the tank test .. here we see jumps of 0.05psu just by rearranging things in the tank. In the lab in APL, we find differences between tests of 0.026psu. **Decide field test tank error ~ 0.05psu**

2) How much does cleaning affect the results ...
... in pre and postcals, cleaning (difference between first and second soak) changed results by ~0.08psu
Decide manufacturer post cruise calibrated data may still be reading ~ 0.08psu too fresh.

3) After applying postcals, and cleaning the instruments - **all agree to within manufacturer's SBE16 specs**, greatest difference at A4ISC (0.04psu too fresh). However, this was an SE37 and thus should have been considerably more accurate.

4) Thus, can **use postcal first soak as a good approximation for the in-the-water error** due to fouling at the end of the deployment, i.e., (all with uncertainties order 0.05psu)

<u>**FINAL POSTCAL CONCLUSIONS from TESTTANK**</u>

A2-SBE no data	**A2-Iscat may be be 0.07 to 0.13psu too fresh**
A3-SBE not enough information **	A3-Iscat was not recovered
A4-SBE may be 0 to 0.02psu too fresh	**A4-Iscat may be 0.11 to 0.13psu too fresh**.

See also CTD comparisons.

** An alternative conclusion is that A3-SBE is possibly 0.3psu too fresh by the end of the deployment. However, A3-SBE only recorded one data point in tank. This may not be a reliable estimate of the offset.
Note that higher time resolution SBE37 took 7-8 readings (recording every 5min, so ~ 40min) to come to tank salinity. When were SBEs recording compared to time into tank?

A3-SBE 1224	record at=xx08	out of water=1639	into tank=1654	time to 1st tank record= 14min
A4-SBE 0005	record at=xx06	out of water=2127	into tank=2143	time to 1st tank record=23min

After 15min in tank, A2iscat still 0.1-0.2psu fresher than steady value, and A4 iscat is 0.7psu fresher
After 25min in tank, A2iscat still 0.05psu fresher than steady value, and A4 iscat is 0.6psu fresher
So one record is not sufficient to do a post tank calibration.

In-water Calibration casts.

Instrument	CTD Cast	Distance to CTD	Moor-CTD ΔT (°C)	Moor-CTD ΔS (psu)	Comments
DEPLOYMENT					
SBE-A218	2018-008	No Data			
SBE-A318	2018-007 2018-090	~350m ~1500m	0.014 0.009	-0.013 -0.010	Agrees within cals, even though T structure evident and S temporal trend. Agrees within cals, even though T and S temporal trends.
SBE-A418	2018-009	~600m	-0.056	0.034	Does not agree within cals, likely due to either spatial or temporal trends
ISCAT-A218	2018-008	~350m	0.016	0.028	In sharp vertical gradients, unreliable
ISCAT-A318	2018-007 2018-090	~350m ~1500m	-1.554 0.620	0.058 -0.097	In sharp vertical gradients, unreliable In sharp vertical gradients, unreliable
ISCAT-A418	2018-009	~600m	-2.198	1.613	In sharp vertical gradients, unreliable
RECOVERY					
SBE-A218	2019-002	No Data			
SBE-A318	2019-004	~300m	0.054	-0.306	In well mixed layer, but large temporal change in T and S.T spans CTD, but S does not. Suggestive moored S is 0.3psu too fresh, but not proven.
SBE-A418	2019-003	~300m	-0.006	-0.141	As above, but with S offset of 0.1psu
ISCAT-A218	2019-002	~350m	-0.083	-0.036	As above, but with S offset of 0.03psu
ISCAT-A318	2019-004	Not recovered			
ISCAT-A418	2019-003	~300m	-0.013	-0.224	In sharp vertical gradients, unreliable

Table above and plots below show comparison of in situ mooring data to CTD casts taken near the mooring site just after deployment (2018 CTD data) and before recovery (2019 CTD data). There are fundamental challenges to using this to recalibrate data, since to avoid snagging the mooring, CTD must be performed some distance from the mooring, and the CTD and the mooring recording may be separated by up to half the sampling interval in time.

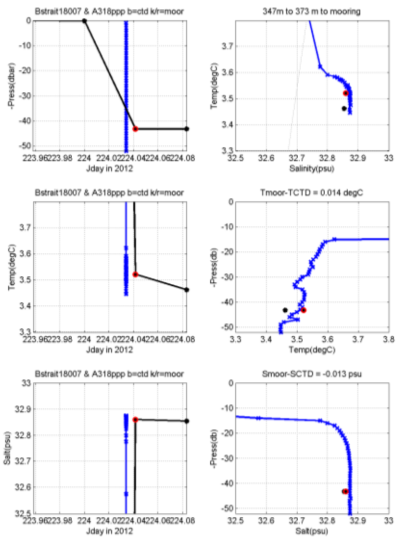
In particular, we note:
- **comparisons with iscat data are frequently unreliable** due to gradients in the upper water column.
- temporal change from moorings may indicate reliability of test
- recovery casts are supportive of the sensors reading too fresh, but this is not conclusive.

Interestingly, note also that even in the deployment casts (where we expect the calibration to be good), there is significant disagreement between the TS diagrams of the cast and of the instruments. This is indicative of water transformation processes and may merit further investigation, but also shows the fundamental limitations of this approach.

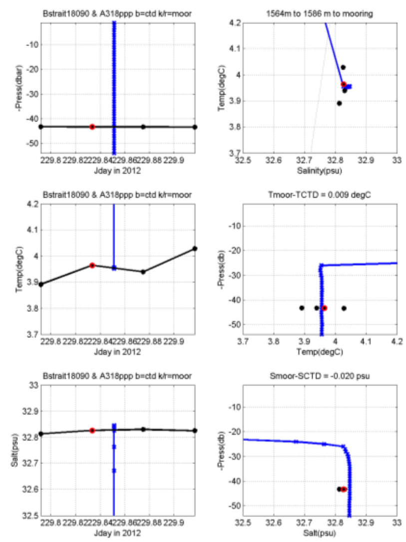
From these results, we conclude **these casts may give some support to the tank tests, but alone are not reliable enough to be conclusive**. In particular in this year, these results may yield some indication that A3sbe is too fresh, but as other CTD cast comparisons suggest larger discrepancies than the tank tests, this is more of a qualitative, than a quantitative measure.

DEPLOYMENTS (i.e., BStrait 2018 CTD data) (No data SBE - A2-18

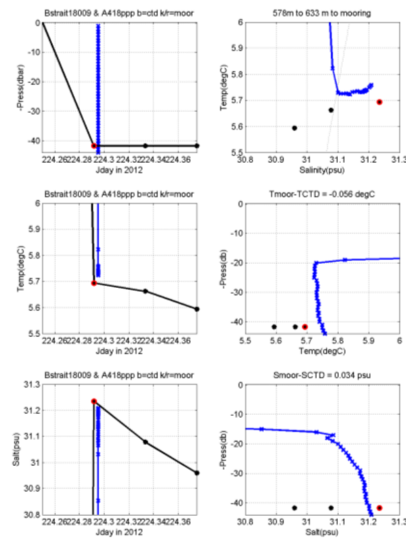
A3-18 (cal cast)



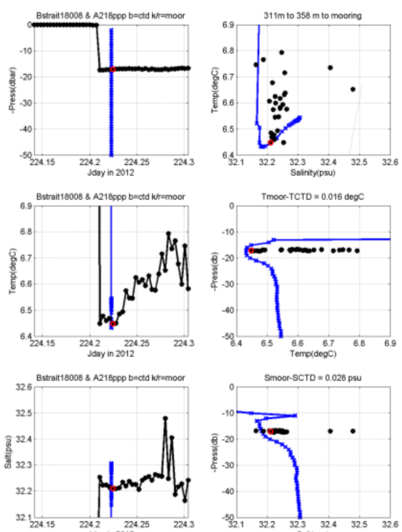
A3-18 (second cast)



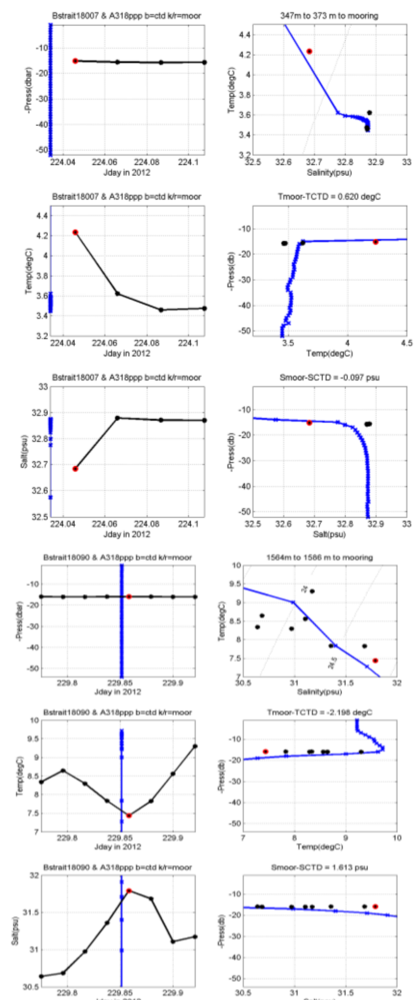
A4-18



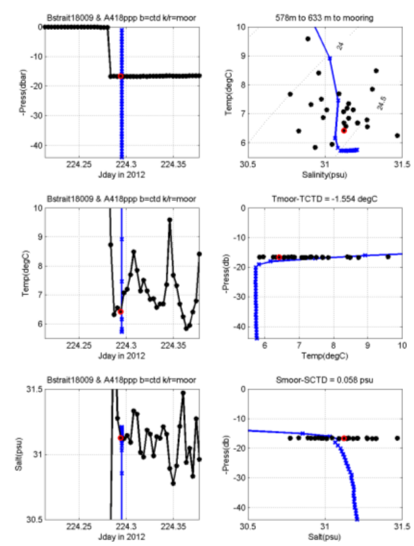
- **ISCAT- A2-18**



A3-18

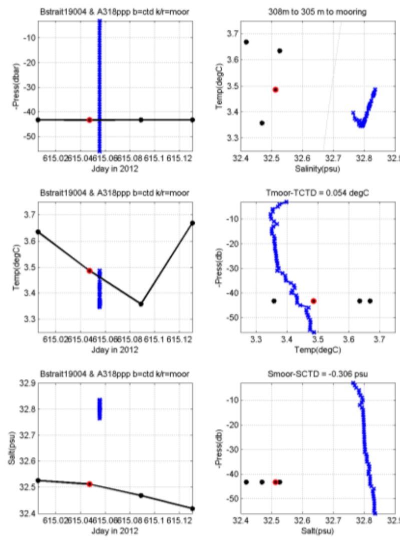


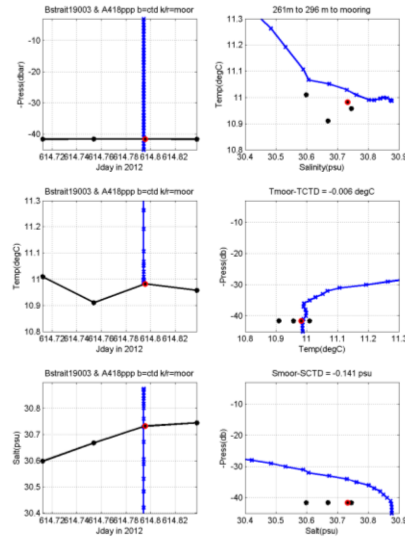
A4-18



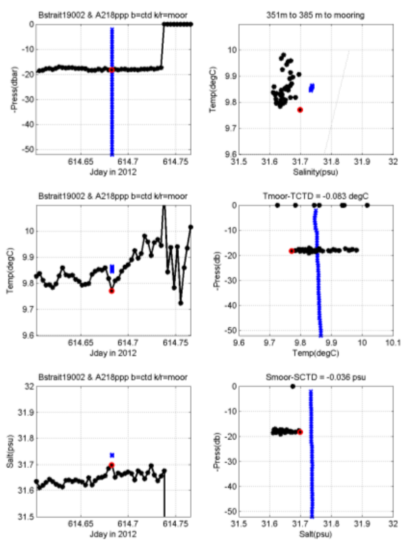
RECOVERIES (i.e., BStrait 2019 CTD data)

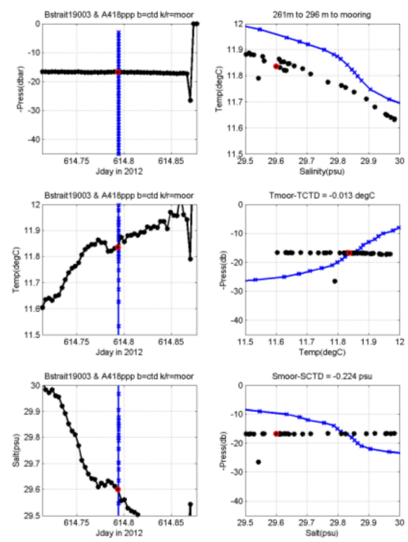
- **SBE- A2-18 (No data)** **A3-18** **A4-18**





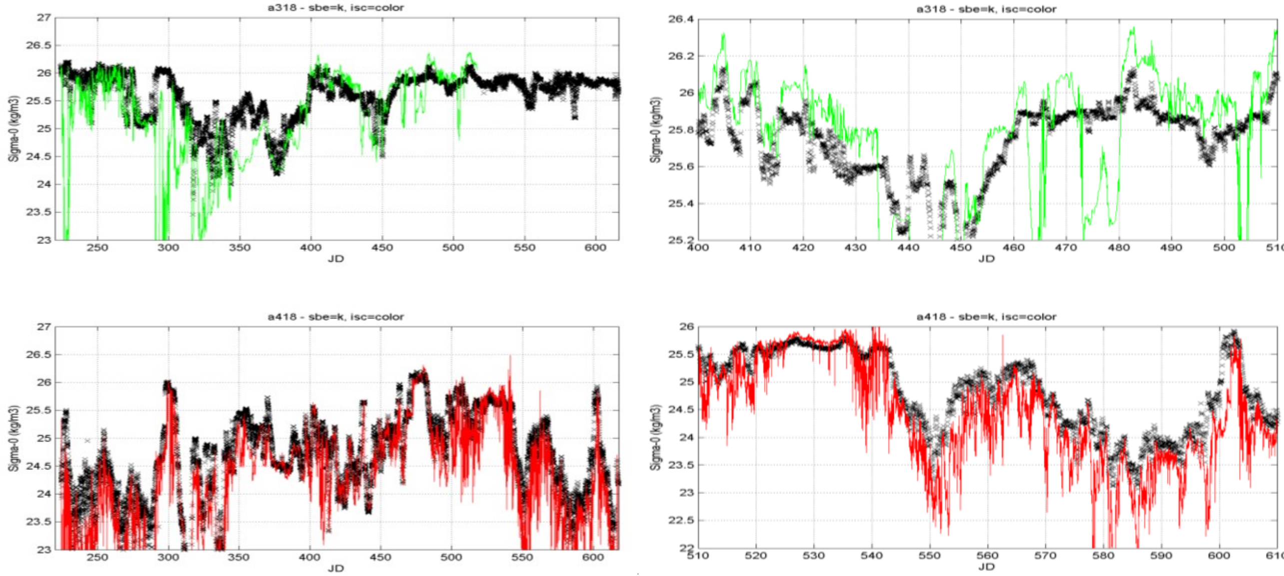
- **ISCAT- A2-18** **A3-18 (not recovered)** **A4-18**





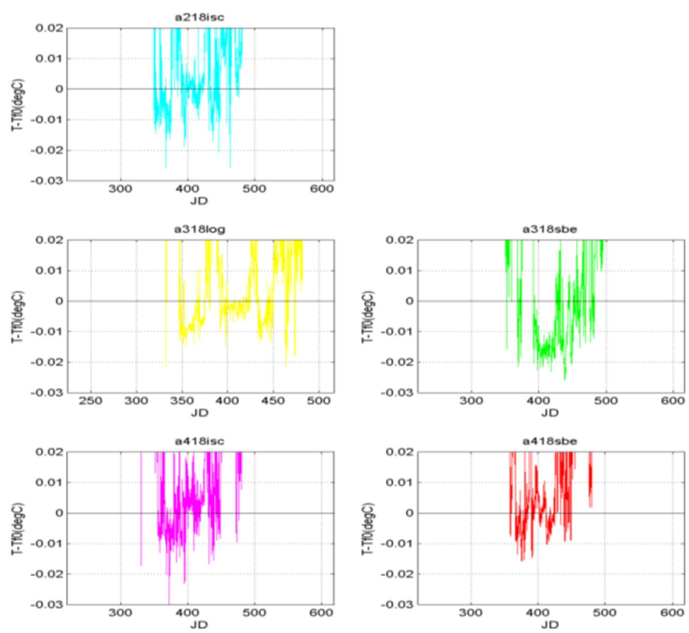
Comparison between ISCAT and SBE densities:

No A2 SBE, so can only compare A3 (green, top) and A4 (red, bottom).



A3 - Iscat is ~0.2kg/m3 denser than SBE. This suggests **A3-SBE is ~ 0.2psu too fresh** (or iscat is 0.2psu too salty). **A4 -** There is a period (JD515 toJD535 when Iscat is ~0.1kg/m3 denser than SBE, suggesting **A4-SBE is ~ 0.1psu too fresh** (or iscat is 0.1psu too salty), but mostly towards the end of the record, A4-iscat is less dense as expected. This difference is ~ 0.1kg/m3, and consistent also with **A4- iscat being ~ 0.1psu too fresh.**

Comparison of winter temperatures to surface freezing point:



Often winter temperatures are found to be ~ 0.01deg C cooler than the surface freezing point. Temperatures that deviate more from the surface freezing point may be indicative of a salinity error. A 0.1psu error yields a 0.005deg C temperature difference.

From these comparisons we conclude:

A2iscat - ok in winter

A3iscat - ok in winter
A3SBE - perhaps 0.1psu too fresh in winter

A4iscat - ok in winter
A4SBE - ok in winter.

Summary of salinity offsets in moorings:

Test	A2-sbe	A2-iscat	A3-sbe	A3-iscat	A4-sbe	A4-iscat
	NO DATA			**LOST**		
Tank Test		0.1psu fresh	Possibly fresh		Up to 0.02psu fresh	0.1psu fresh
CTD cast		0.03 psu fresh	0.3psu fresh		0.1psu fresh	unreliable
Density in mooring		NA	0.2psu fresh	*OR 0.2psu salty***	*0.1psu salty***	OR 0.1psu fresh
Tfreeze in winter		Ok	0.1 psu fresh	Ok	Ok	Ok
CONCLUDE		**Up to 0.1psu fresh**	**Up to 0.2psu fresh**	**Ok**	**OK**	**Up to 0.1psu fresh**

****** The most likely salinity problems in the strait are biofouling or cell scouring, both of which cause the data to be erroneously fresh. Thus, we suspect density inversions are always due to an instrument reading fresh, rather than an instrument reading salty.

Other Recovered/Deployed Instrumentation: Other instruments on the moorings were recovered/deployed for other groups. These instruments are:

Recovery: ***Aural Marine Mammal Acoustic*** sensor on A3 was deployed by Kate Stafford, (UW). This instruments was cleaned but not opened. Its data return will be investigated in Seattle.

Deployment: ***Marine Mammal Acoustic*** only 1 sensor (placed on A3) was deployed this year. This instrument is deployed for Kate Stafford, UW. Note this instrument was missing a dummy plug and thus the dummy plug from the recovered instrument was used for this new deployment.

Details of mooring positions and instrumentation are given below, along with schematics of the moorings, photos of the mooring fouling, and preliminary plots of the data as available.

BERING STRAIT 2019 MOORING POSITIONS AND INSTRUMENTATION

ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2018 Mooring Recoveries				
A2-18	65 46.872	168 34.081	55	ISCAT, ADCP, SBE16
A4-18	65 44.764	168 15.765	48	ISCAT, ADCP, SBE16
A3-18	66 19.623	168 57.079	57	ISCAT, ADCP with SBE16, MMR

ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2019 Mooring Deployments				
A2-19	65 46.855	168 34.070	56	ISCAT, ADCP, SBE16
A4-19	65 44.748	168 15.765	48	ISCAT, ADCP, SBE16
A3-19	66 19.604	168 57.046	57	MISCAT, ADCP with SBE16, MMR

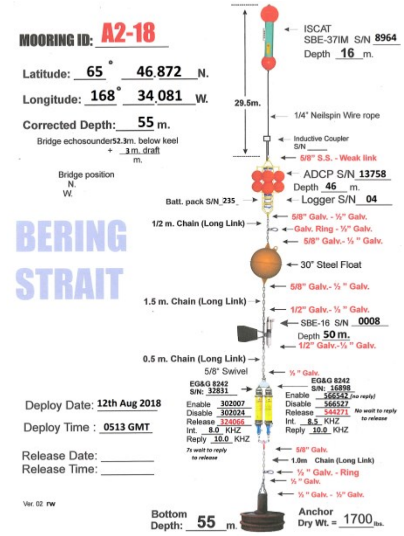
ADCP = RDI Acoustic Doppler Current Profiler
ISCAT = near-surface Seabird TS sensor in trawl resistant housing, with near-bottom data logger
MISCAT = ISCAT with two near-surface sensors (one at ~ 8m, one at ~ 16m)
SBE16 = Seabird CTD recorder, SBE37 = Seabird CTD recorder
MMR=Marine Mammal Recorder (new=new APL version)

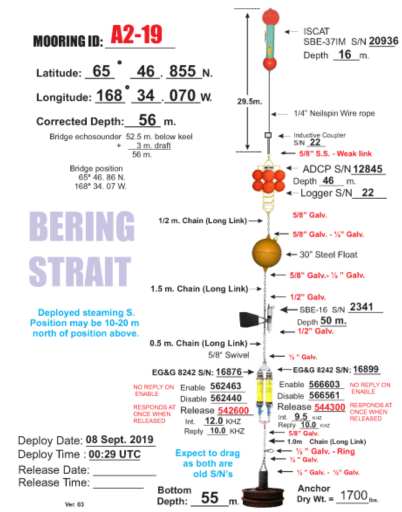
For 2018 deployments, water depths are assuming a ship's draft of 2-3m.
For 2019 deployments, water depths are assuming a ship's draft of 3m.

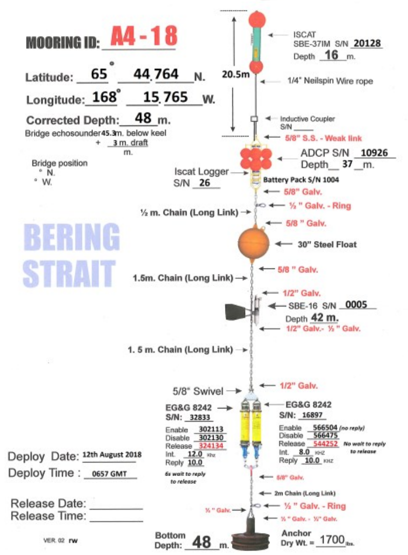
BERING STRAIT 2019 SCHEMATICS OF MOORING RECOVERIES AND DEPLOYMENTS

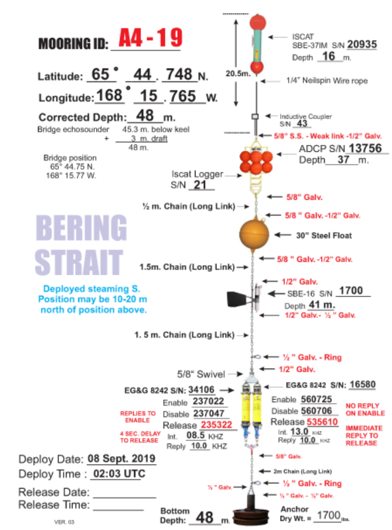
RECOVERED | **DEPLOYED**

= in the eastern channel of the Bering Strait

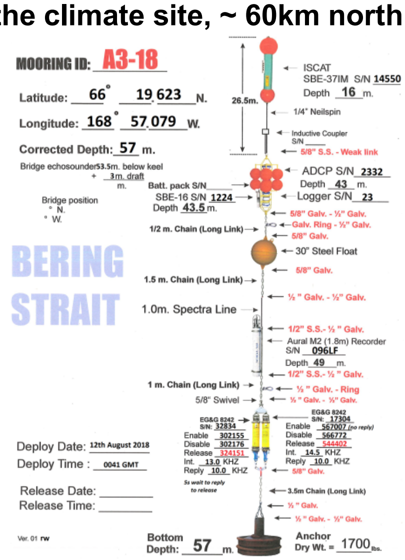


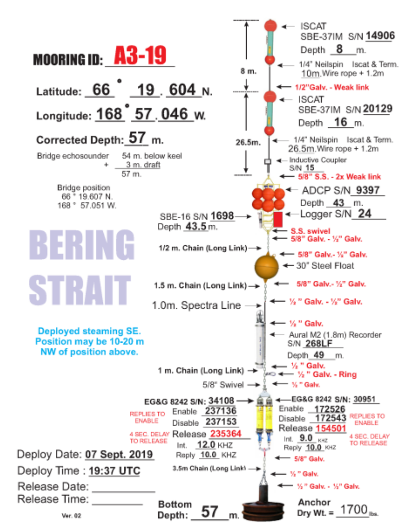






= at the climate site, ~ 60km north of the Strait





BERING STRAIT 2019 RECOVERY PHOTOS

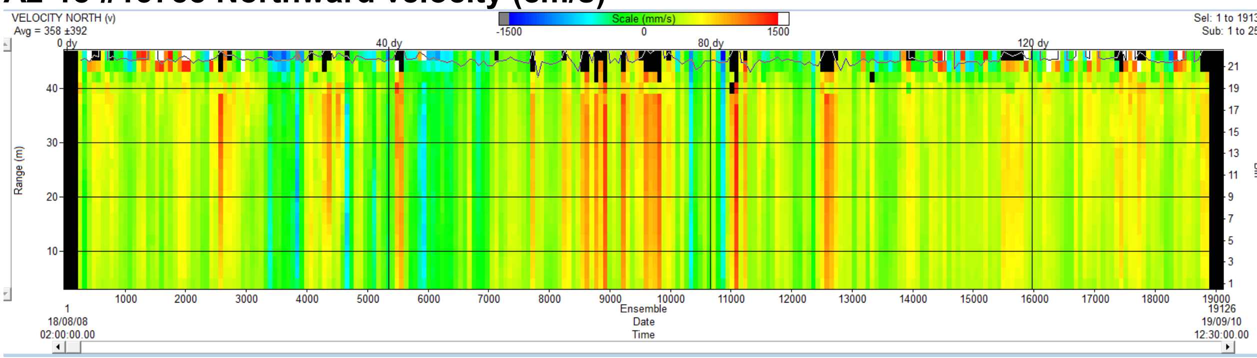
BERING STRAIT 2019 RECOVERY PHOTOS (continued)

BERING STRAIT 2019 PRELIMINARY ADCP RESULTS

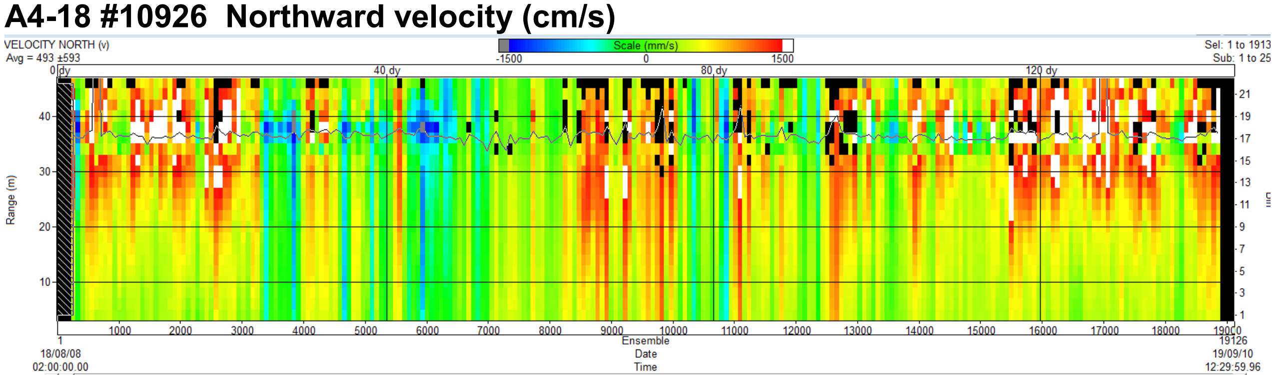
Preliminary plots of northward velocity, and velocity magnitude from the three recovered ADCPS are given below. Note that from ~ mid May 2019, A3 is recording southward flow while A2 and A4 are recording northward flow. Speeds are however very comparable between the moorings. Post recovery checks of compasses while at sea revealed no obvious compass issues. Note that change of direction occurs at the time the iscat was lost, and subsequent to this time, the distribution of directions at A3 is not consistent with all previous data. Post cruise experimentation suggests the tether from the severed iscat may have fallen near the ADCP compass head and, being magnetic, this would skew all the ADCP directions. Thus, direction data from A3 after 0925, 31st May 2019 is erroneous, but analysis suggests velocity heading may be recreated from A2 directions if offset by ~ 37deg.

NORTHWARD VELOCITY from ADCPs.

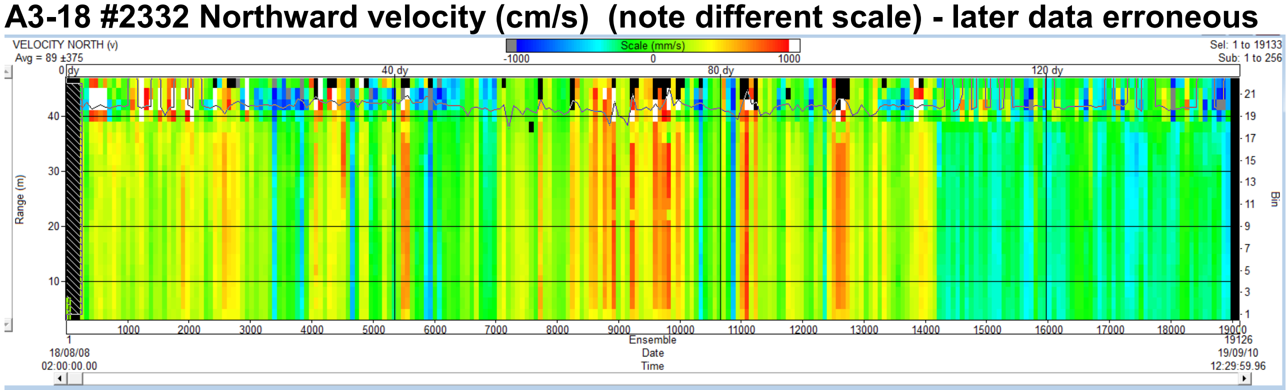
A2-18 #13758 Northward velocity (cm/s)



A4-18 #10926 Northward velocity (cm/s)

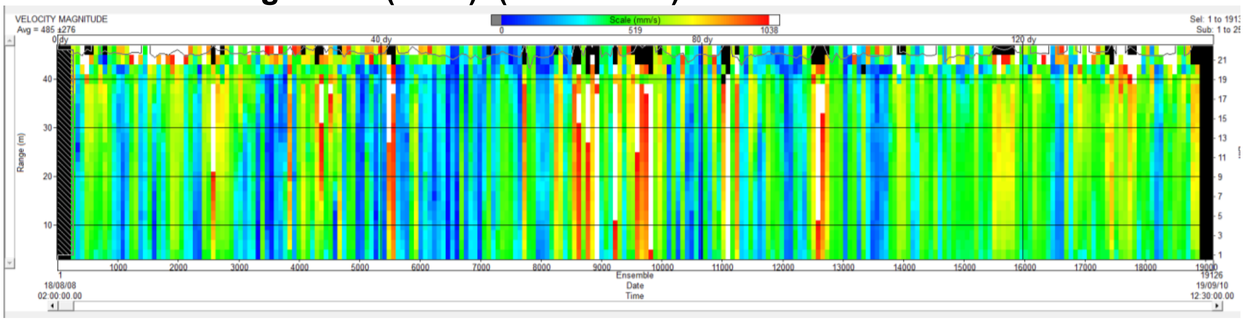


A3-18 #2332 Northward velocity (cm/s) (note different scale) - later data erroneous

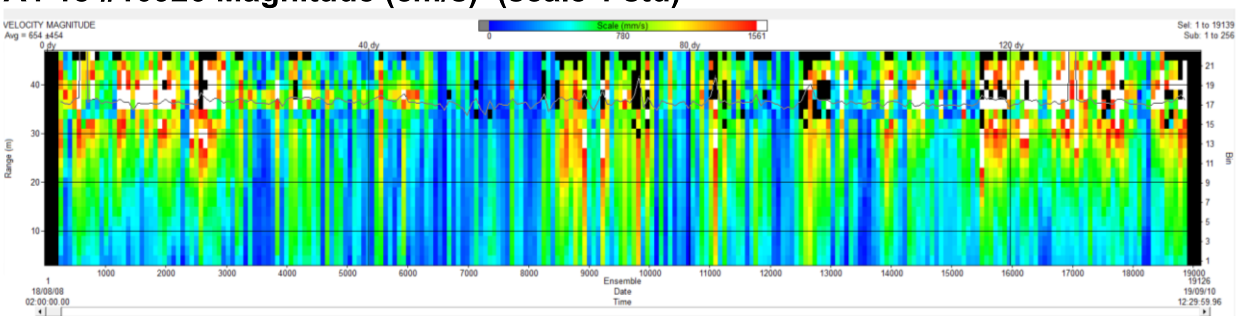


SPEED from ADCPs.

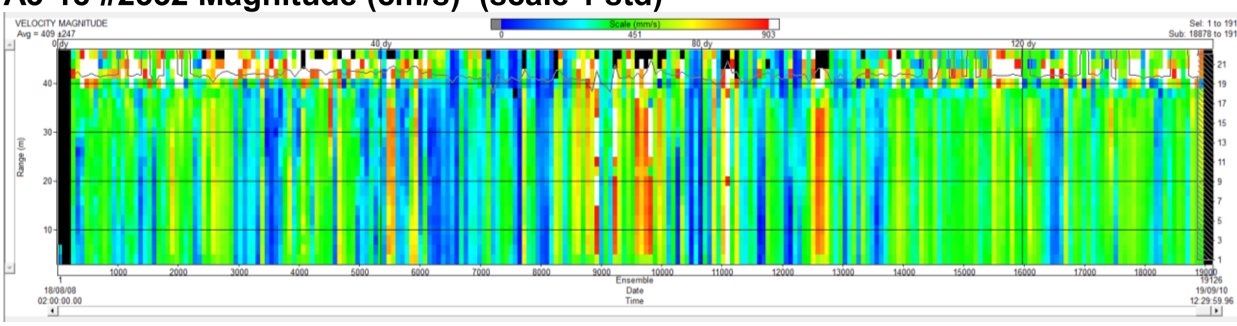
A2-18 #13758 Magnitude (cm/s) (scale 1 std)



A4-18 #10926 Magnitude (cm/s) (scale 1 std)

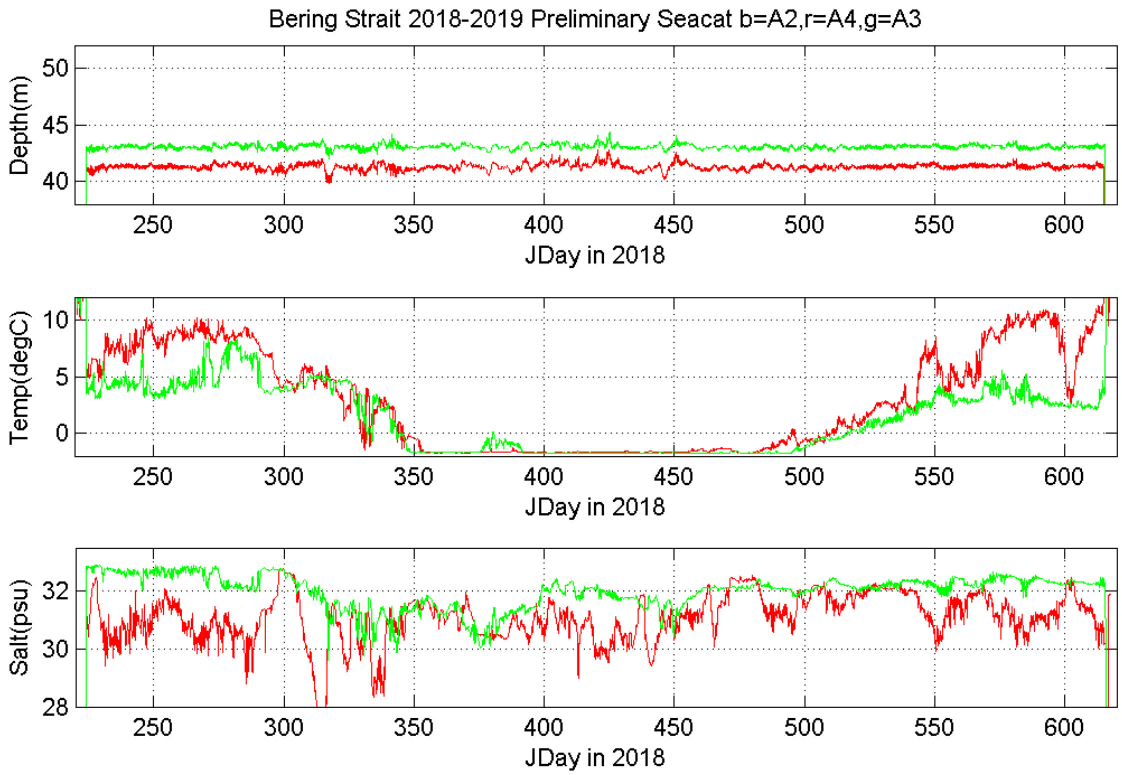


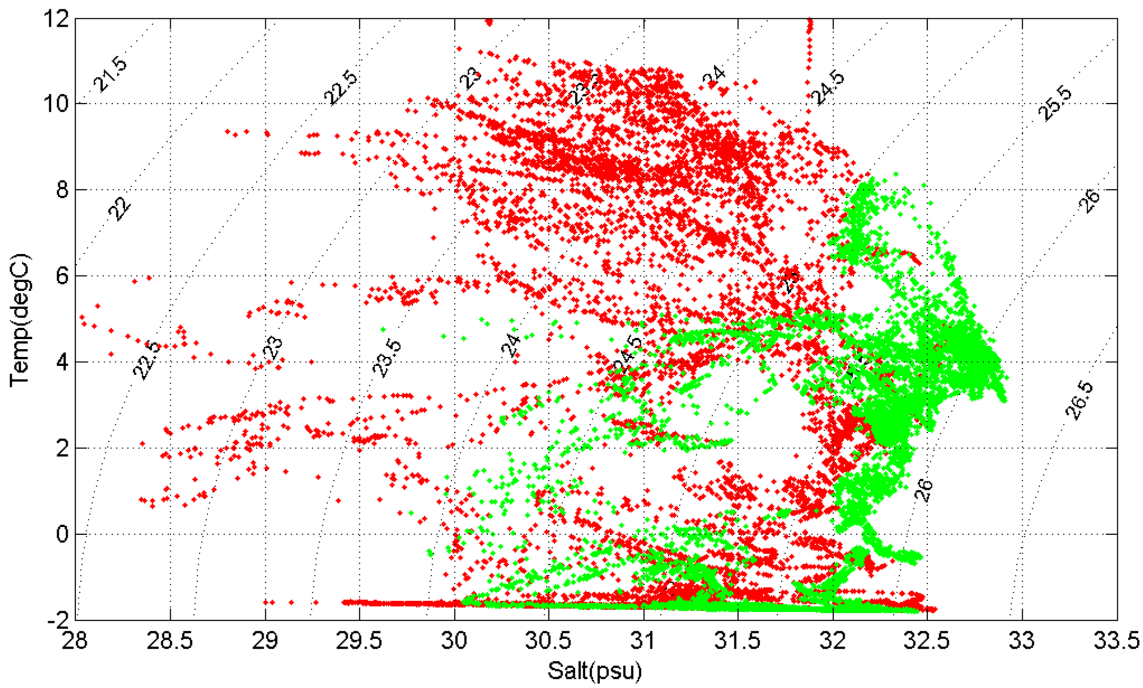
A3-18 #2332 Magnitude (cm/s) (scale 1 std)



BERING STRAIT 2019 SBE PRELIMINARY RESULTS

– all lower level TS Sensors *(Note no data from A2)*
A3 temperatures are warmer in summer 2018 than in 2017 and 2019.
A4 temperature in 2019 is warmer than in 2018, which is also warmer than 2017
Summer 2018 is also remarkably fresh compared to 2017

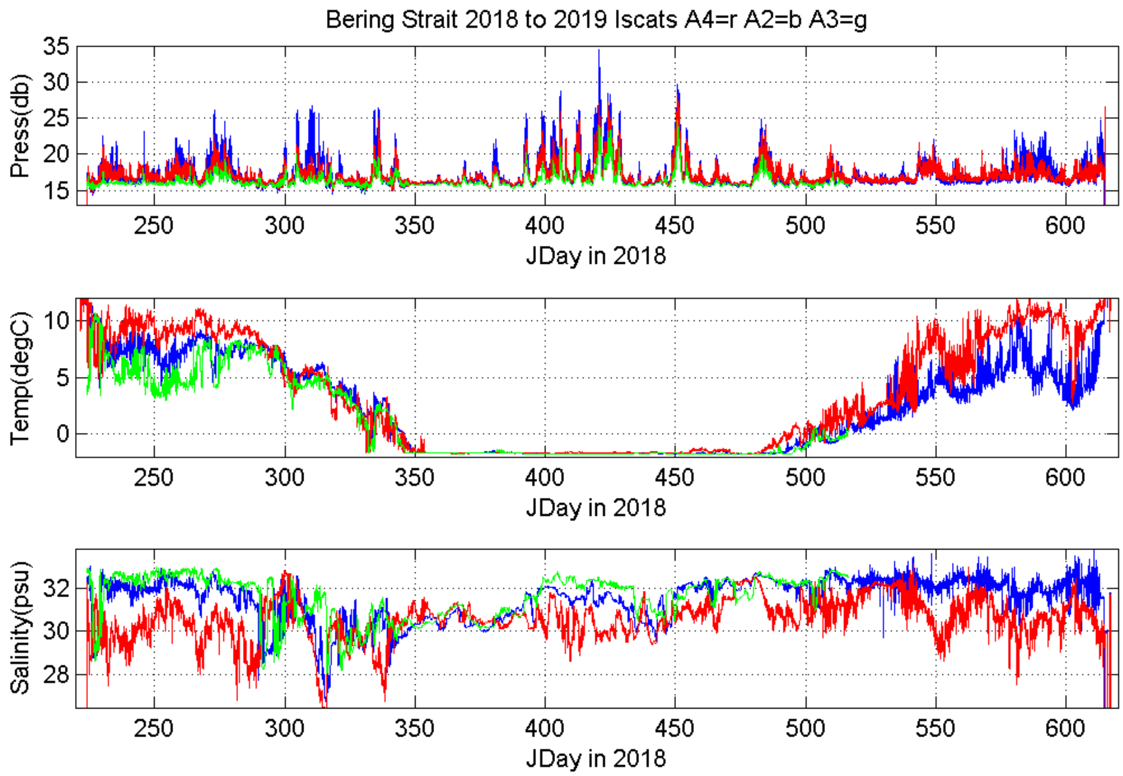


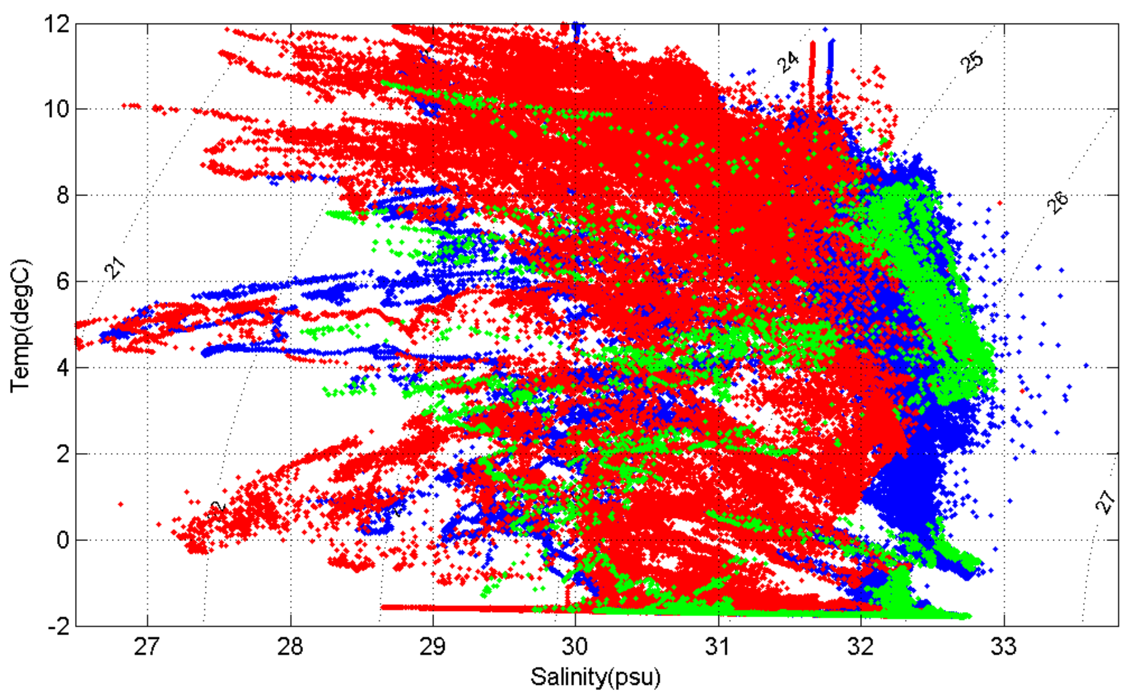


BERING STRAIT 2019 PRELIMINARY ISCAT RESULTS

– all upper level TS Sensors

Generally warmer in summers and fresher at all times than in previous years (note salinity corrections, still to be performed, may be as large as 0.3psu). Beware of significant fouling of A2Iscat (blue).

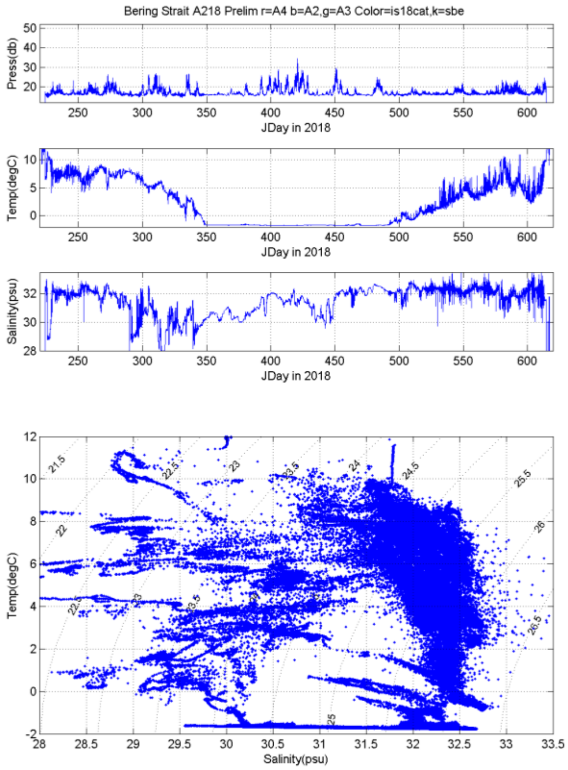




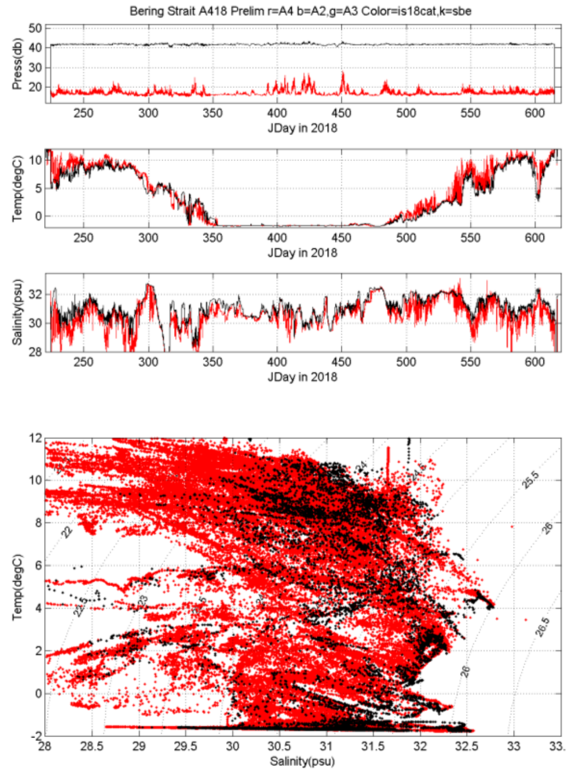
BERING STRAIT 2019 PRELIMINARY ISCAT AND SBE RESULTS (per mooring)

Note very clear separation of fall and spring in salinity at A2 and A3. Beware of significant fouling of A2-Iscat (blue)

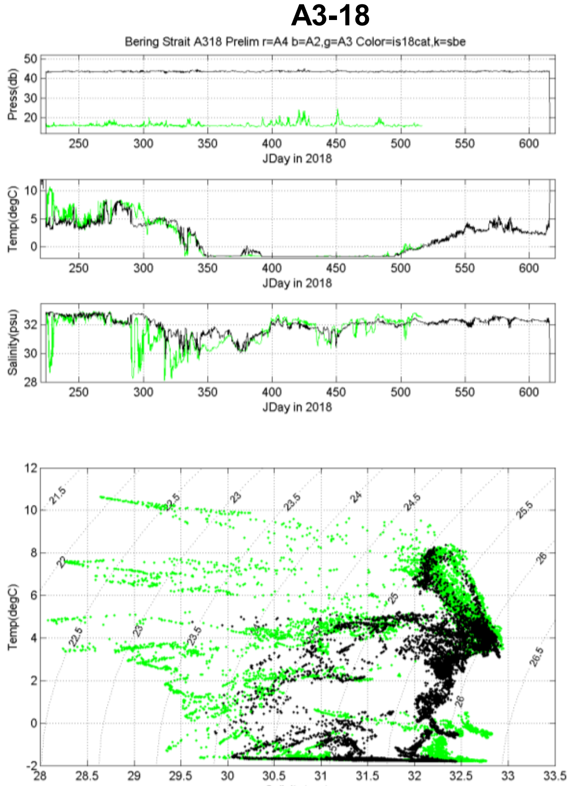
A2-18



A4-18



A3-18



CTD OPERATIONS (Woodgate, Johnson, Showalter, Christensen, Gottschalk)

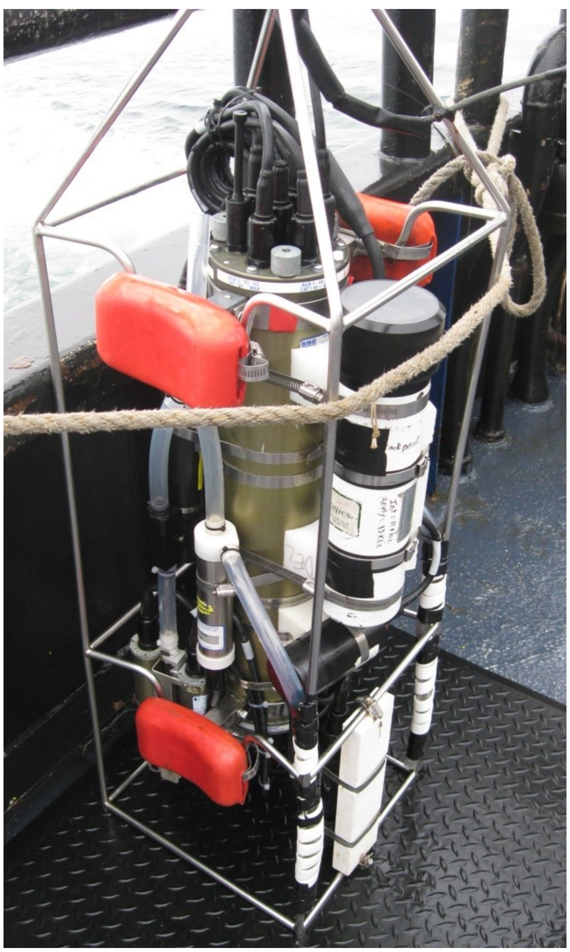
As in previous years, in 2019 the moorings were supported by annual CTD sections. This year (as per 2014, 2015, 2016, 2017 and 2018) these sections were run without taking any bottle samples.

The CTD rosette system used on this cruise was loaned from APL-UW and, was the same set up as in 2016, 2017 and 2018 (the same set up as in 2014/2015,with the exception of the transponder). The full package consisted of:

one SBE9+ with pressure sensor
(SN26451 – calibration 17th June 2019)
two SBE3 temperature sensors
(T1 = SN0843 – calibration 15th Feb 2018)
(T2 = SN0844 – calibration 15th Feb 2018)
two SBE4 conductivity sensors
(S1 = SN0484 – calibration 23rd Feb 2018)
(S2 = SN0485 – calibration 13th Feb 2018)
two SBE43 oxygen sensors
(Ox1 = SN1753 – calibration 27th Feb 2018, new membrane & electrolyte)
(Ox2 = SN1754 – calibration 14th Feb 2018)
one Wetlabs FLNTURT fluorescence/turbidity sensor (SN1622 – calibration 11th March 2010)
one Benthos Altimeter (SN50485, repaired spring 2015)
two Seabird pumps (believed to be SN50340, SN55236, but not confirmed)
one EG&G transponder (D-CAT SN31892, Interrogate: 11.0kHz, Reply: 13.5kHz)

The temperature, conductivity and oxygen probes were paired as last year, viz:

	Temperature	**Conductivity**	**Oxygen**	**Pump**
Primary	#843	#484	#1753	SN NA
Secondary	#844	#485	#1754	SN NA



with a y-like connection system, whereby the exit vent of the loop was at the same depth as the intake as per recommendation from the manufacturer. The top of the Y contained a slow leak valve (the vent plug) to keep the system sea-water primed on removal from the water. Tests in Seattle in 2014 showed air in the system was expunged after ~ 45s of emersion in water.

All instruments were housed in one frame (see left), weighted with diving weights to ensure a close-to-vertical cast, as per 2014**.**

The CTD was connected to a conducting wire winch on the ship. This winch (Rapp Hydema NW, SOW 160 5000m capacity, with 3 conductor 0.322"diameter wire), was new on the Norseman II in 2014. Chris Siani, APL, assisted with wiring and CTD tests of this system while the ship was in Seattle in April 2014. In 2019, in port tests in spring showed the termination existing on the ship (done by Russ Hopcroft likely in 2017) still to be functional. The winch was connected to an SBE11 deckbox, which in turn was linked via serial ports and USB-serial connectors to a dedicated PC, running the software package Seasave v7. Data were recorded in standard hexadecimal SBE format, incorporating NMEA GPS input from the Norseman II aft A-frame. **Action Item: Check the ship is carrying a spare GPS antenna.**

An event log (copied attached at the end of this report) was maintained on the CTD computer, including comments on data quality and other issues. The log, the data files, and a screen dump of the end-of-cast Seasave image were copied to a thumb drive as a backup after each cast.

The CTD console was set on the port side of the interior lab. The package was deployed through the aft A-frame using a special block supplied by the ship. Although a Pentagon ULT unit had been mounted inside by the CTD console for lowering and raising the CTD, in practice, the winch driving was done by a crew member on deck, directed by the CTD operator using radio commands. This was deemed more efficient given the shortness of the casts (50m or less).

In 2019 the crew operated the winch operated from a remote console on the deck by the A-frame, although, as in previous years, winch speed was an issue. The lowering late we seek is ~30 or 40m/min. There is no readout of winch speed at the remote console and winch drivers had to estimate speed either from the sound of the winch or from feedback from the scientist in the lab. **Action item: Be sure to calibrate in winch speed early in the cruise, preferably with some scale on the winch so the speed is consistent between operators. Update ship's winch so as to provide a speed readout by the remote console. Also, train CTD driver to check winch speed on read-out beside CTD console.**

The A-frame was set slightly outboard and not repositioned during the cast - the package was lifted to the height of the aft rail of the ship by the winch, and swung inboard by hand. For the casts done during mooring operations, the CTD was hand-carried forward after each cast to the port-forward corner of the aft-deck, to clear the aft-deck for mooring work. Once all the mooring work was complete, the CTD package was kept at the rail.

Once mooring work was complete, CTD operations were run 24hrs, using a team (per watch) of 1 science team member driving the CTD, and 2-3 personnel on deck - one (ship's crew) driving the winch, and one or two ship's crew/scientists recovering the instrument. This cruise, the science team provided 1 person for deck for 12 hrs a day in good weather and for an extra 12hrs in bad weather, since in bad weather, it was deemed necessary to always have two persons catching the CTD as it came aboard.

The efficiency of the crew made for very speedy CTD operations, and combined with the fast winch speed, resulted in commendably fast times for running lines. Since the CTD system required ~ 1min in the water to allow for the pumps to turn on (initiated by a manual command sent by the CTD driver), the CTD was generally put over the side and down to ~ 7m before the ship had come to a complete stop. Experience allowed the crew to time this such that, by the end of the 1min soak, the ship had come to a sufficient stop. Once the ship was stopped, the CTD pump was on and data were reliable, the CTD package was returned to ~ 1m depth (just below surface) and then was lowered to the sea floor, target depth ~ 3m above bottom, see discussion below. Only a brief (1-2 s) pause was taken at the bottom before the CTD was returned to the surface, and then recovered. If the cast was successful, the ship would start to move away just as the package was being recovered. Note on these stations, taken without any bottles, it was not necessary for the cast to be entirely vertical.

Prior to each cast the turbidity sensor was cleaned by rinsing with soapy water and freshwater and wiping. **Action Item: Bring syringe with better fit for flushing the CTD cell.**

Ship's draft was estimated at 2m, and this should be taken into account in viewing the data. Also given that sea states were often significant and the altimeter on the CTD rarely functioned, some casts stop 5m-6m above the bottom.

Overall, CTD data this year are exceedingly clean, although the following issues were encountered:

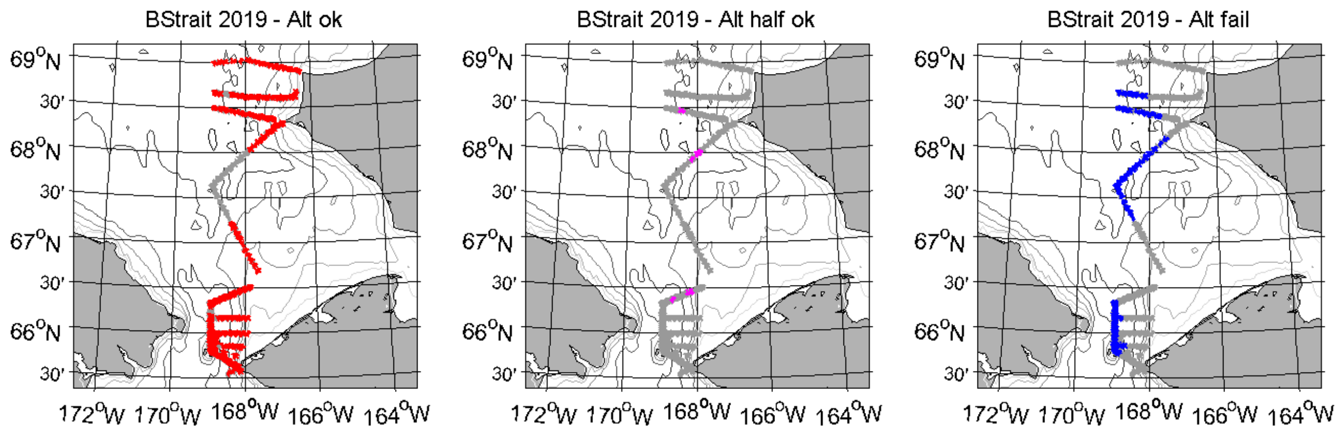
1) For casts up to and including 206. The raw .hdr and .hex files written by the CTD cast contained many spurious lines of hex data, which interrupted the header file and in some cases caused the .hex file to be unloadable with SeaSave, and various Seabird software packages to complain about scan length errors. It was found early on that editing out these extra data by hand allowed the files to be readable and convertable again. After extensive investigation and emailing with Seabird, it was discovered this problem was not due to any problem with the wiring/termination etc., but instead due to the CTD fish being left in Autorun mode. In this state, the fish starts sending data immediately it receives power and this input was being logged into the relevant files. This status could be confirmed by a line in the .hdr file (buried under the spurious text) which said "autorun on power up is enabled".

To fix this (as per information sent from Seabird), it was necessary to communicate directly with the fish, via the following steps:

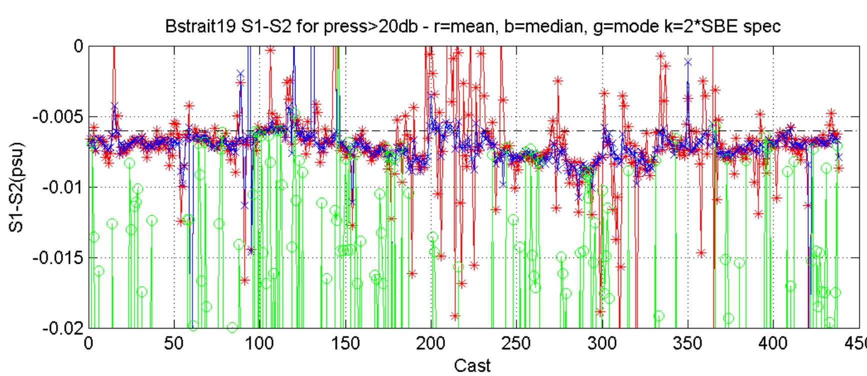
- Run Seaterm (not SeatermV2)
- Click configure in the menu bar and select SBE11 Interface (19200, 8, none)
- press the reset switch on front panel. View settings. (If the unit outputs samples, type stop to stop it)
- send command autorun=n
- turn power off then back on again. Verify deck unit does not start outputting hext data
- send command ds and check that autorun is disabled.

This was successful in rectifying the problem. For the 206 casts already completed, the problematic lines were edited out by hand.

2) Altimeter. In previous years, it was found that the altimeter only performed well intermittently, and the pattern of success and failure appeared to be strongly correlated with water temperature. This year, being later in the season, the waters were generally warmer and indeed we found a much greater success with the altimeter see Figure. However, a reluctance to trust a previously intermittent instrument meant most casts were still driven using the ship's echosounder depth. **On viewing sections, recall bottom 3+m may be unsampled. Actin Item: Next year, reconsider bottom depth decisions in light of warmer waters.**

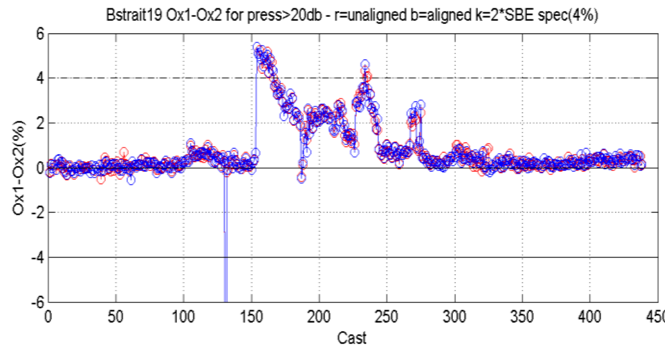


3) Vent plug blocking. As in previous years, the blocking of the vent plug due to impurities in the water was a continual concern. We instigated a cast-by-cast check that the tubes were draining once the CTD was recovered and if either was slow, the plugs would be cleaned with wire. **Action item: Continue this check in other years.** High vigilance to this issue this year resulted in fewer problems with the data, but data should still be checked for this problem.



4) Offset between Salinity sensors. Prior years found an offset in salinity between the two sensors on the CTD. This year, a similar offset was observed (with S1 reading fresher as in prior years). The CTD should be accurate to 0.003psu, and thus discrepancies of < 0.006psu (marked as dashed line on plot) are within specifications. When the difference between sensors became large, suspecting some biofouling of the cells, we used a syringe to flush both cells with freshwater, and this was found to return to difference to ~ 0.006psu. However, this is as the limit of the manufacturer's specifications and suggests recalibration is in order. Since we expect with biofouling the sensor to drift fresh, these results suggest S1 is drifting fresher with time and that S2 may be the more reliable record. **Action item: Flush cells with freshwater on deck at start of cruise and at regular intervals. Return system to Seabird for calibration when possible.**

5) Offset between Oxygen sensors. Prior years have found a significant (~2% of saturation) error in Oxygen readings between the two sensors, This year's processing suggests this may have been due to using an old calibration file in the final step of the CTD calibration. This conversion error has been corrected here, and Ox1 and Ox2 now show very good agreement. Note that the agreement between sensors does not change when the data is aligned. The larger discrepancy between sensors for the middle part of the cruise is as yet unexplained, but may relate to the larger fluorescence signals found around the same period. **Action item: Investigate Ox data differences. Check prior years' data.**



6) Other cast issues:
- cast 245 was retaken due to sensor discrepancy and thus need not be processed.
- cast 246 was "yoyo-ed" to overcome blocked vent plug issues without recovering and recasting the CTD in the erroneous belief the software could process the first profile as an extra long soak. However, this is not the case, and a better practice would be to stop and restart the cast (although this would require an extra 1minute soak).
- cast 400 has an interesting bolus of water
- casts near coast on line CD show intriguing layering

<u>NOTES ON BERING STRAIT 2019 CTD PROCESSING</u>
Rebecca Woodgate (based on 2017 processing)

Start with files from SeaSave for each cast, i.e.,
Bstrait19nnn.hex and Bstrait19nnn.hdr

===0) All files up to and including 206 have spurious hex in the header and hex files.
Put data copied from CTD into directory:
C:\Norseman2_19\CTD\2019CruiseData\orig\untouched
Copy them then up a directory and discard the test files.
Edit HDR files to get the extra hex out. When this is done for all casts up to 206 inclusive, can just copy up.

Casts (31) which did NOT need HDR editing were:
8, 17, 19,
21,22,25,26,28,29,37,
41,48,54,58,
72,73,75,78,85,89,
95,98,
110,111,
125,129,
154,
184,
190, 204, 205
All others for numbers of 206 and below have been edited.

Then run through 9 steps (8 of them with SBEDataProcessing program from Seabird).

=== 1) First make up a file to be used for quick plotting. This contains all variables, but is not corrected in any way.
IN SBEDATA PROCESSING, RUN: DATA CONVERSION
(PSA file for this = DatCnvBStrait2019_allvars.psa)
Inputs are: BStrait19nnn.hex and BStrait19nnn.hdr
*In FILE SETUP
-- CHECK box on match instrument to configuration file
-- Choose input file (should be .HEX) and directory
-- Name append .rw1
-- Choose output directory
*In DATA SETUP
-- Convert data from:UP and downcast *(Last year we just did down as we were firing no bottles. Here we do both, noting that upcasts may differ because of water being swept up with the CTD.)*
-- Create file types: data (.CNV) only
...—Merge Header file
-- Select output variables... for 2019 we use
-- 1) Pressure, Digiquartz (db)
-- 2) Temperature (ITS-90, degC)

-- 3) Temperature,2 (ITS-90, degC)
-- 4) Conductivity (S/m)
-- 5) Conductivity, 2 (S/m)
-- 6) Oxygen raw, SBE 43 (Volts)
-- 7) Oxygen, SBE 43 (saturation)
-- 8) Oxygen raw, SBE 43, 2(Volts)
-- 9) Oxygen, SBE 43, 2(saturation)
-- 10) Fluorescence WET Labs WET star (mg/m^3)
-- 11) Upoly 0, FLNTURT
12) Scan Count % This was done in 2018, but not recorded in the write up
-- 13) Salinity, Practical (PSU)
-- 14) Salinity, Practical, 2 (PSU)
-- 15) Time, NMEA (seconds)
-- 16) Latitude (deg)
-- 17) Longitude (deg)
-- 18) Altimeter (m)
-- 19) Pump Status
-- Source for start time in output .cnv header: Select NMEA time
*In MISCELLANEOUS
-- Keep all defaults. Note the Oxygen is Window size (2s), Apply Tau Correction, Apply Hysteresis.
THIS GIVES files called: BStrait19nnn.rw1.cnv

In 2019, this refused to run the following files, but ran ok after the following actions
27 - removed first line of hex
61 - removed first line of hex
76 - removed first line of hex
122 - removed first line of hex
165 - removed first line of hex
166 - removed first line of hex
179 - removed first line of hex
186 - removed first line of hex

Also issues with "required header *END* line not found in
61 - took out all spurious lines before end of header in hex
165 - took out all spurious lines before end of header in hex

=== 2) Do first basic quality control by plotting everything in Matlab
Matlab master code = **testplotsBStrait2018RW.m** which calls subroutine **CTDQCpump.m**
Inputs are: BStrait18nnn.rw1.cnv
Checks here include:
--- that the pump comes on
--- that the altimeter is working
--- that T1=T2, S1=S2 and Ox1=Ox2
--- preliminary identification of spikes and other issues.
Results recorded by cast in master CTD log file **BStrait2018_CTDissuesbycast.xls**

******* 2019 issues:*
This flags the following casts for a closer look: 17, 22, 54, 88, 97, 142, 192:
17, 24, 54: first record is a large spike. For these, edit out bad data at the start of the file in orig and rerun. Rest of data mostly same but changes oxygen values ever so slightly. (92.292% to 92.297%)

88 has a salinity spike
97 has a salinity spike
142 has a large salinity spike
192 ha a large salinity spike

=== 3) Now work through the 7 steps of SBEDataConversion. Start by applying the calibrations to get the converted files, but this time excluding all the derived variables.
IN SBEDATA PROCESSING, RUN: DATA CONVERSION
(PSA file for this = DatCnvBStrait2019_CTDforprocess.psa)
Inputs are: BStrait19nnn.hex and BStrait19nnn.hdr

*In FILE SETUP
-- CHECK box on match instrument to configuration file
-- Choose input file (should be .HEX) and directory
-- Name append NONE
-- Choose output directory
*In DATA SETUP
-- Convert data from:UP and downcast *(Last year as here, we do both, noting that upcasts may differ because of water being swept up with the CTD.)*
-- Create file types: data (.CNV) only
...—Merge Header file
-- Select output variables... for 2018 we use
-- 1) Pressure, Digiquartz (db)
-- 2) Temperature (ITS-90, degC)
-- 3) Temperature,2 (ITS-90, degC)
-- 4) Conductivity (S/m)
-- 5) Conductivity, 2 (S/m)
-- 6) Oxygen raw, SBE 43 (Volts)
-- 7) Oxygen raw, SBE 43, 2(Volts)
-- 8) Fluorescence WET Labs WET star (mg/m^3)
-- 9) Upoly 0, FLNTURT
-- 10) Scan Count
-- 11) Time, NMEA (seconds)
-- 12) Latitude (deg)
-- 13) Longitude (deg)
-- 14) Altimeter (m)
-- 15) Pump Status
-- Source for start time in output .cnv header: Select NMEA time
*In MISCELLANEOUS
-- Keep all defaults. Note the Oxygen is Window size (2s), Apply Tau Correction, Apply Hysteresis.

THIS GIVES files called: BStrait19nnn.cnv

=== 4) Second step of SBEDataProcessing. Apply a time filtering to the data.

This step allows us to time-filter (i.e., smooth) the data. Routine allows us to select two filters, A and B. In 2014, we used A = 0.5 sec and B=0.15 sec, but in 2015 this appeared to remove too much variability. Manual for the SBE9plus suggests to not filter Temperature and Conductivity, but to filter pressure at 0.15s. So set A=0, and B=0.15 and then only filter pressure *(this is now the same as 2015, but different to 2014).*

Note these filters should be applied to the raw data (e.g., Ox voltage, Conductivities), not the derived data (e.g., salinity, oxygen saturation, etc).

IN SBEDATA PROCESSING, RUN: FILTER

(PSA file for this = FilterBStrait2019_CTDforprocess.psa)

Inputs are: BStrait19nnn.cnv

*In DATA SETUP

-- Lowpass filter A(sec): 0.0 *(was 0.5 in 2014, but this seemed too smooth in 2015, so used 0, as here)*

-- Lowpass filter B(sec): 0.15 *(This is as per the manual for SBE9plus)*

--> SPECIFY FILTERS

-- Pressure: Lowpass filter B

-- Temperature: None

-- Temperature, 2: None

-- Conductivity: None

-- Conductivity,2: None

-- Oxygen raw: None

-- Oxygen raw,2: None

-- All others: None

*In FILE SETUP

-- Name append = A00B15 *... this indicates data was filtered (Note: makes only small changes to the data)*

THIS GIVES files called: BStrait19nnnA00B15.cnv

=== 5) Third step of SBEDataProcessing. Align the timeseries in time.

This step is to compensate for the delay between the water passing the various sensors in the pumped pathway. For the SBE9plus, the manuals suggest that

- the temperature advance relative to pressure =0
- that the salinity advance relative to pressure is 0.073s, but this advance is set in the SBE11plus by factory settings, and thus for this program we use conductivity advance =0. ***Action item: Check this is what is set in the SBE11 plus.***
- that the oxygen advance should be between +2and +5. This should be done on the Oxygen voltage.

IN SBEDATA PROCESSING, RUN: ALIGN

(PSA file for this = AlignCTDBStrait2019_CTDforprocessOx2.psa)

Inputs are: BStrait19nnnA00B15.cnv

*In DATA SETUP

--> Enter Advance values

-- Oxygen: 2 *(as recommended in SBE9+ manual (2 to 5), and tests suggest in 2014 and 2015)*

-- All others: 0

*In FILE SETUP

-- Append added = AdvOx5

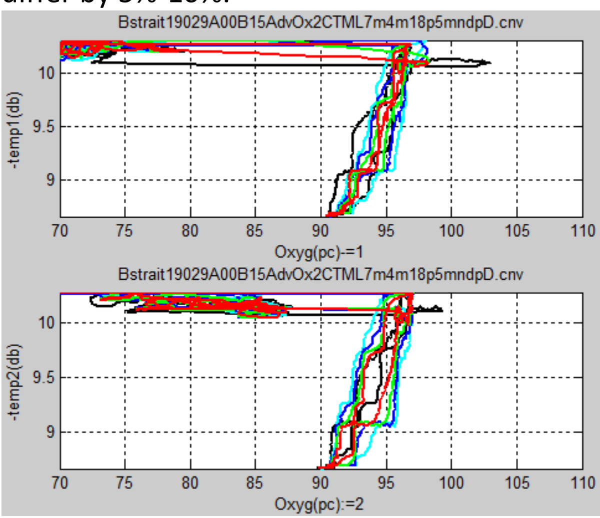
THIS GIVES files called: BStrait19nnnA00B15AdvOx2.cnv

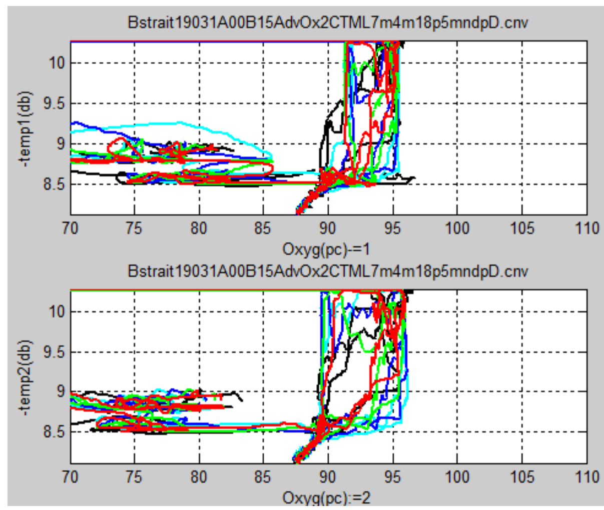
So, of these, it is suggested we investigate the various oxygen options. This we run this step with various values for the oxygen advance (2-5) and, by plotting oxygen against temperature, see which advance value gives the most consistent reading comparing the up and down casts.
R=2,g=3,b=4,c=5

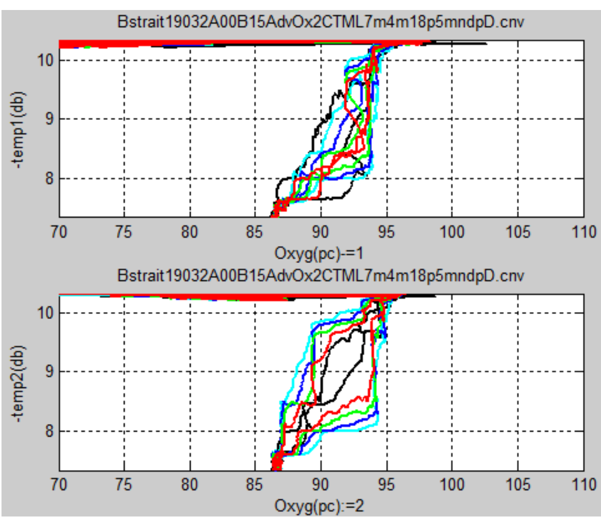
Previous years have segregated casts into which colors are good.   Here we look at casts 29-39 only

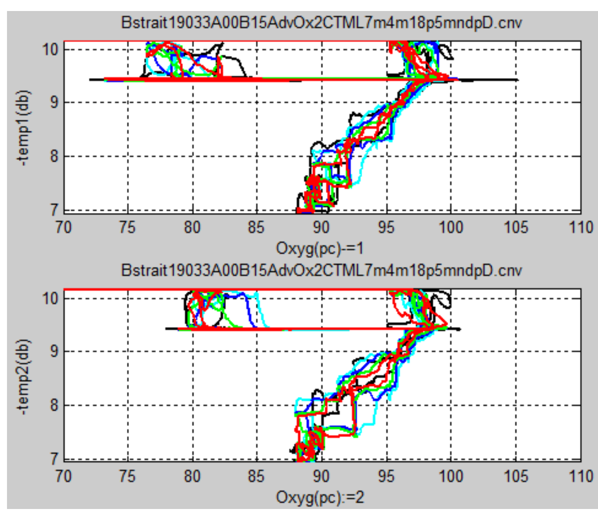
Black (0)	**Red (2)**	**Green(3)**	**Blue (4)**	**Cyan (5)**	**Unclear**
32,35, 36, 37	29,32,33,34, 35, 36, 37, 38, 39				30, 31

By this tally, Red (2) has the best fit most often, although black(0) is better for some casts. Previous years have used (2). We continue to use 2 here, though examples show that up and down casts by differ by 5%-10%.









Finally conclude:
- at this stage will use Ox1, as it shows less spread than Ox2.
- alignment is generally best for both as +2.
- recognize that up and down casts may differ by 5%-10% .

=== 6) Fourth step of SBEDataProcessing. Correct for thermal mass of the cell

This is a standard SBE correction to compensate for thermal mass of the cell. Assumes the pump is at 3000 rpm. ***Action Item: Check this.*** Then manual suggests for SBE9+ Alpha=0.03, 1/beta=7.

IN SBEDATA PROCESSING, RUN: CELL THERMAL MASS
(PSA file for this = CellTMBStrait2019_CTDforprocess.psa)
Inputs are: BStrait19nnnA00B15AdvOx2.cnv

*In DATA SETUP (correct both Primary and Secondary values)
-- Thermal anomaly amplitude [alpha]: 0.03 *(suggested for SBE9+)*
-- Thermal anomaly time constant [1/beta]: 7 *(suggested for SBE9+)*
*In FILE SETUP
-- Append added = CTM

THIS GIVES files called: BStrait19nnnA00B15AdvOx2CTM.cnv

== 7) Fifth step of SBEDataProcessing. Remove pressure loops from the casts.

This step is to take out pressure looping, stalls in lowering, and the surface soak. To run this, you must have filtered the pressure first (as we did above). This does not remove any data, it just marks looped data with a bad data flag of -99e-26.

In 2015, we instigated a 5m depth for the initial surface soak, returning after that soak to the surface to start the downcast. Thus the used values were L5m2m6m (soak, min, max) and were used including deck pressure, and that seemed to work well with this routine. Prior years just used a 2m soak depth and that might be less successful with this routine.

In 2016 the soak was about 4m .. checks show this works with this routine and these settings.

In 2017, soak is about 7m, but sometimes much deeper. Previous settings (L5m2m6m) did not work well with this data set. After investigation, we learn the following:

- likely best not to include the deck pressure as offset - our system is never on while in air, and thus this will just introduce a non-intuitive offset.
- the max must be deeper than the deepest soak, yet shallower than the maximum depth of the shallowest cast. In 2017, the shallowest casts were (Cast1 and 2, tests, and thus not considered; 113(19.6m), 114(19.6m), 115(19.5m), 117(18.7m). Our deepest soaks were cast 20(18.25m), cast 31(16m). Thus, we set max to be 18.5m
- the min must be deep enough to separate the going-in-the-water oscillations from the soak. 2m and 3m were found to be too shallow in 2017, but by inspection 4m works well.

Finally settings for 2017 were thus: 7m soak, min 4m, max 18.5m. (Note if you specify max and min, the program is not supposed to use soak depth at all.)

In2018 these settings gave a good result and were used without further testing.

In 2019 we again adopted these settings. The only problematic casts are:
5 (an test cast) and 245 (an aborted cast)
And 246 .. which was “yoyo-ed” because of initial discrepancies in the data.
In preliminary processing, copy the original hex file to 246full, and take a trimmed version through the processing instead

IN SBEDATA PROCESSING, RUN: LOOP EDIT
(PSA file for this = LoopEditBStrait2019_CTDforprocess.psa)
Inputs are: BStrait19nnnA00B15AdvOx2CTM.cnv
Must run filter on pressure first. Flag surface soak with -9.99e-26 ..

*In DATA SETUP
-- Minimum ctd velocity (m/s) = 0.25
--> Check box Remove Surface soak
-- Surface soak depth (m) = 7
-- Minimum soak depth (m) = 4
-- Maximum soak depth (m) = 18.5
--> UNCheck box Use deck pressure as pressure offset
--> Check box Exclude scans marked bad
*In FILE SETUP
-- Append added = L7m4m18p5mndp

THIS GIVES files called: BStrait19nnnA00B15AdvOx2CTM L7m4m18p5mndp.cnv

=== 8) Sixth step of SBEDataProcessing. Derive the parameters you want.

This step takes the raw data and calculates derived parameters, such as salinity, density, oxygen values, etc.

IN SBEDATA PROCESSING, RUN: DERIVE
(PSA file for this = DeriveCTDBStrait2019_CTDforprocess.psa)
Inputs are: BStrait19nnnA00B15AdvOx2CTML7m4m18p5mndp.cnv

-- CHECK box on match instrument to configuration file (Prior notes says to check this box, however, in 2016 this crashed if the box was checked, so instead uncheck the box, **BUT MUST MAKE SURE IS USING A 2019 CALIBRATION FILE**). If ever change sensors during cruise, will have to do something different here. Check these files to make sure the .con files are consistent.

*In DATA SETUP
--> Select derived variables... add:
-- Salinity (psu)
-- Salinity,2 (psu)
-- Salinity difference
-- Sigma theta (kg/m3)
-- Sigma theta,2 (kg/m3)
-- Sigma theta difference
-- Oxygen, SBE 43 (ml/l)
-- Oxygen, SBE 43 (saturation)
-- Oxygen, SBE 43, 2 (ml/l)
-- Oxygen, SBE 43, 2 (saturation)
*In FILE SETUP
-- Append added = D

THIS GIVES files called: BStrait19nnnA00B15AdvOx2CTM L7m4m18p5mndp D.cnv

Could stop here, and use these files, but to be more useful want to have Bin averages and despike, and the combination of the two of those processes. So, first look at the despiking options. SBEDataProcessing includes a file called "Wild Edit", but the manual describes that as "not the faint of heart" and says much trial and error is necessary to get good results. Thus, instead use something more automatic, Window Filter.

=== 9) Twelfth step of SBEDataProcessing. Use Window Filter to despike.

This is an attempt at automatic despiking. If just try so smooth over a spike, you will flatten it, but the bad data will still remain. Here we make one basic attempt, as outlined in the manual. This takes a window of data points, and for each window, replaces the central (?) point with the median of all the points. In some way thus, this is smoothing over the data points, but one that neglects extreme values. Their example suggests 17 points, and we have used that. Sampling rate is 24Hz. Drop rate is ~ 1m/s. So this is roughly equivalent to smoothing at 0.7 sec, or 70cm.

IN SBEDATA PROCESSING, RUN: WINDOW FILTER

(PSA file for this = W_FilterCTDBStrait2019_CTDforprocess_MF17.psa)

Inputs are: BStrait19nnnA00B15AdvOx2CTM L7m4m18p5mndp D.cnv

*In DATA SETUP

--> Select Exclude scans marked bad

--> Specify Window Filters:

Type: Median Parameters: 17

For variables: Temp1, Temp2, Cond1, Cond2, Oxraw1, Oxraw2, Fluorescence, Upoly (Turbidity/Transmissivity), Latitude, Longitude, Salinity1, Salinity2, Density1, Density2, Ox1ml/l, Ox1%, Ox2ml/l, Ox2%

-- Append added = MF17

THIS GIVES files called: BStrait19nnnA00B15AdvOx2CTM L7m4m18p5mndpDMF18.cnv

=== 10) Seventh step of SBEDataProcessing. Bin average all the data.

All data files prior to this have been the 24Hz data up and down casts. Here we separate out the downcasts only, exclude the data marked bad by loop edit, and create 1m bin averages. We chose here to create a surface sample, however often the number of scans in that sample is small and in any case surface stirring by the ship must also be considered.

IN SBEDATA PROCESSING, RUN: BIN AVERAGE

(PSA file for this = BinAvgBStrait2019_CTDforprocess.psa)

Inputs are: BStrait19nnnA00B15AdvOx2CTM L7m4m18p5mndp.cnv &
BStrait19nnnA00B15AdvOx2CTM L7m4m18p5mndpDMF17.cnv

*In DATA SETUP

-- Bin type = Pressure

-- Bin size = 1

--> Select Exclude scans marked bad

→ Select include number of scans per bin

-- Scans to skip over = 0

-- Cast to process = **Downcast**

-> Include surface bin 0,1,0

*In FILE SETUP

-- Append added = BADCS010

THIS GIVES files called: BStrait19nnnA00B15AdvOx2CTM L7m4m18p5mndpDBADCS010.cnv &
BStrait19nnnA00B15AdvOx2CTM L7m4m18p5mndp DMF17BADCS010.cnv

In 2019 this marks the end of the CTD pre processing.

BERING STRAIT 2019 CTD OPERATION NOTES from end of cruise + Deck responsibilities

0. Coming onto station
   - pre fill Event Log (Excel file)
   - In Seasave
     - `Real time data, Start, Begin archiving data immediately`
     - `Select Output Data File Name`: Bstrait17nnn.hex, *** NOTE NAME 17, not 2017
     - `Start`
   - fill in header
     - Ship: Norseman 2, Station name (e.g., BS24), Operator
     - then WAIT
   - **Driver to Deck:** "**clean wetlabs sensor**"
   - **Deck to Driver:** "**sensor cleaned**"
   - **Driver to Deck:** "**Is transponder in?**"
   - **Deck to Driver:** "**Transponder in**"
1. On station confirmed from bridge "**on station**",
   - **Driver to deck**, "**Ready to Deploy**"
   CTD in the water (**Deck to Driver**: "**CTD in water and at 5m**") (**Driver: double click radio**)
   - Power on CTD Deck Unit, check get readout of "10" (0110)
   - `OK` on SeaSave header, wait until SeaSave gray windows close
   - `Real-time Control, Pump on` (to turn pump on manually)
   - Fill out rest of Event log (Excel file) for deployment (including time).
   - Driver to deck, "**Please report wave height, air visibility, water visibility**"
   - WAIT until –"11", "Pump on", Data ok (incl S and position), check #'s agree
   - check target depth ~ water depth under keel
   - **Driver to Deck**: "**return to surface and go down to xxx meters**" (GET SURFACE WIRE OUT)
   - **Deck to Driver**: "**Going down**"
   - Check lower speed (want 30/40 m/min) on winch readout
3. CTD lowers
   - watch pressure
   - **Driver to Deck**: "**3 2 1 stop**" for target depth
   - **Deck to Driver**: "**CTD stopped**" (GET BOTTOM WIRE OUT)
   - wait ~2sec
   - **Driver to Deck**: "**Come to surface**" AND CHECK CTD COMES UP
4. CTD comes up ** COMPARE SENSOR PAIRS - decide if data good enough to leave station
   When at surface (**Deck to Driver: "At surface"**) (**Driver: double click radio**)
   - `real time control – Pump off`
   - `real time data – STOP`
   - Power off CTD Deck Unit
   - **Driver to deck**: "**Recover CTD and proceed to next station**"
   - OR IF may have to recast .. add "**We have CTD issues, do not leave after this cast**"
   - fill in Event Log for up cast (including time), while
   - **Deck to Driver** "**CTD recovered, Pipes are/not draining**", and default is ship leaves for next station.
5. THEN
   - screen dump to paint (Alt-print screen, Cntrl V, save as BStrait17nnn.png); F12 (save as);
   - QUIT paint.
   - Copy the 4 files (.hex, .hdr, .xmlcon, .png) to USB Backup file directory

(Start event log for next cast)

If leaves CTD for long time, check "transponder is out"

<u>Deck responsibilities every cast:</u>
- checking sensor cleaned and transponder in
- checking depth of surface soak
- watch wire (out aft is ok, under ship is not, far to side near ship not)
- keep winch operator focused
- count CTD as it goes down, listen for 3 2 1 stop and make sure winch stops

- At Bottom, make sure winch comes UP (e.g., watch wheel)
- Watch for tape on way up,

- Observe and report surface issues (e.g., broke surface, ask for repeat soak if out of water for more than 4 sec)
- report - clarity of water (max range at which you can see CTD in m)
    - fog
    - wave height if exciting
- report if pipes are draining once CTD is on deck.
- report if jelly fish remains on salinity cells

- make sure secure on deck.
- every 50 casts, check all CTD bolts

BERING STRAIT 2019 CTD LINES

A total of 22 CTD lines were run on the cruise.

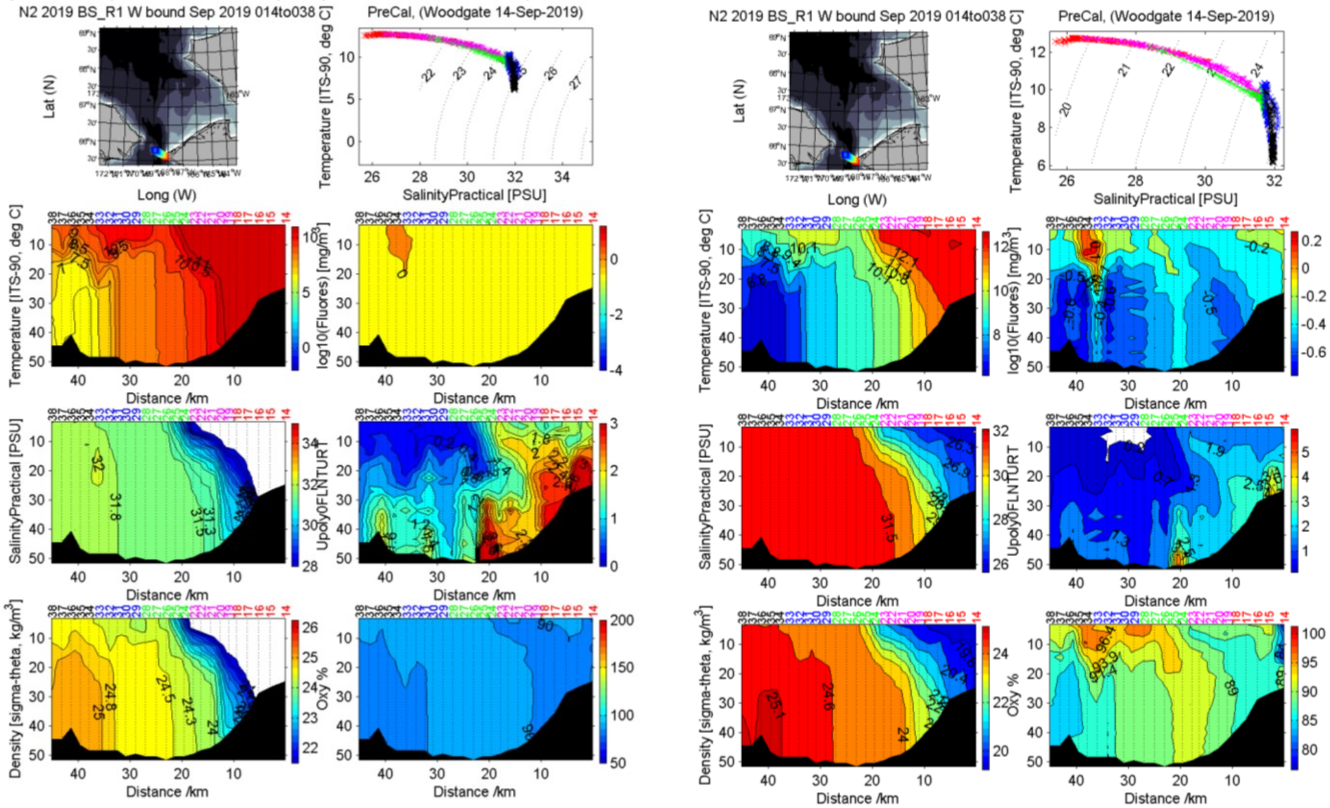
Preliminary sections were plotted using code from An Nguyen from the preliminary processed data, which uses pre-cruise calibrations, and the quality control procedures outlined above to give 1m bin averages for plotting.

The plots below give all 22 sections on the same scales (left) and on a scale for that section (right), presented in order of data acquisition. Note that:
- this uses the S1 and Ox1 data,
- typically stops 2 to 3+ m above the bottom.

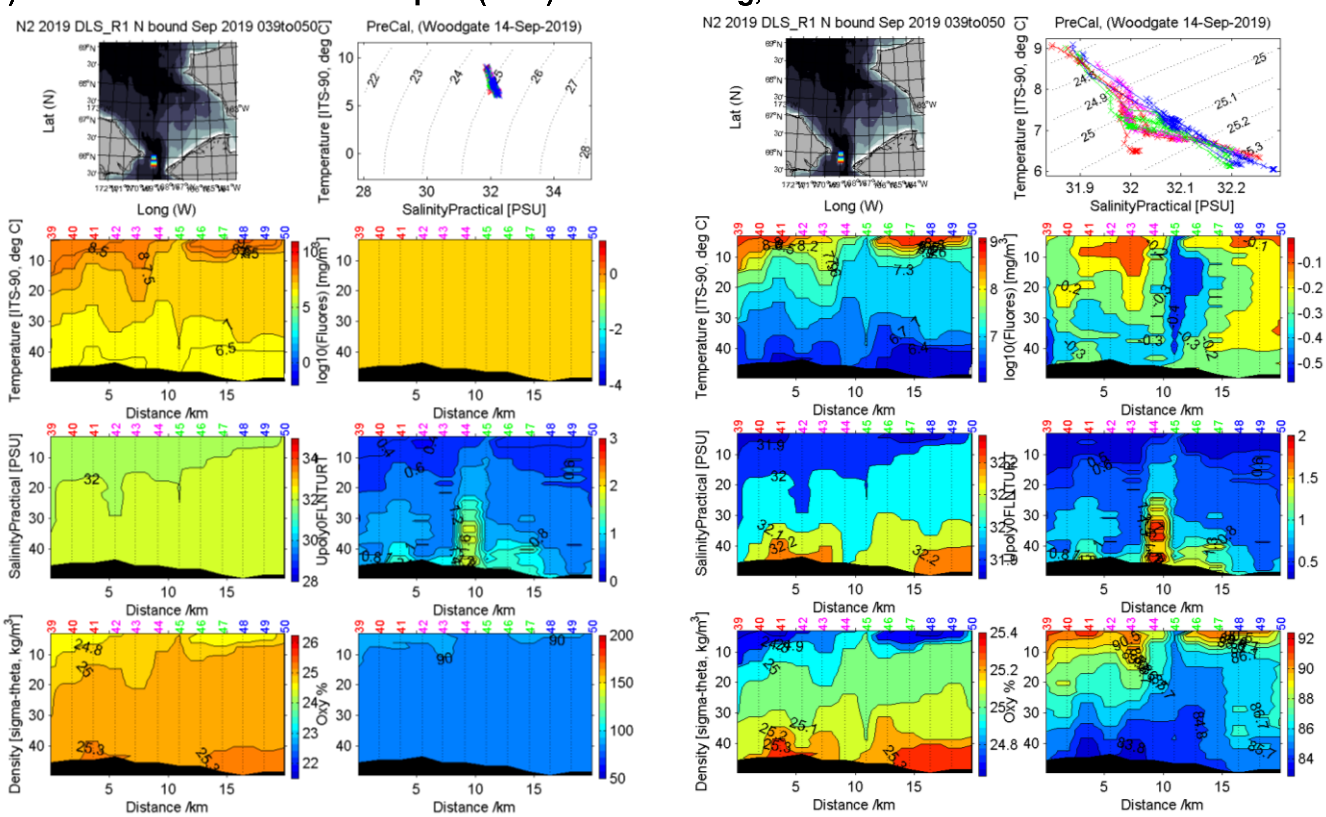
Several repeat sections were run on the cruise (see naming below). Also, for comparison with the partial running of MBS (aborted due to weather), the MBS repeat running is plotted twice - once with all stations, and once showing just the repeated stations.

For full positions and times see event log and data file headers.

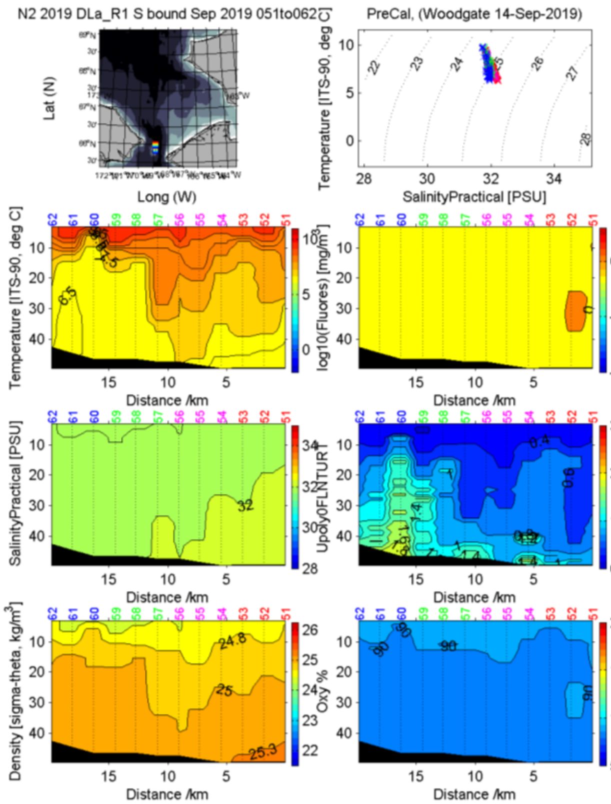
1) Bering Strait line (BS) – first running, Westward

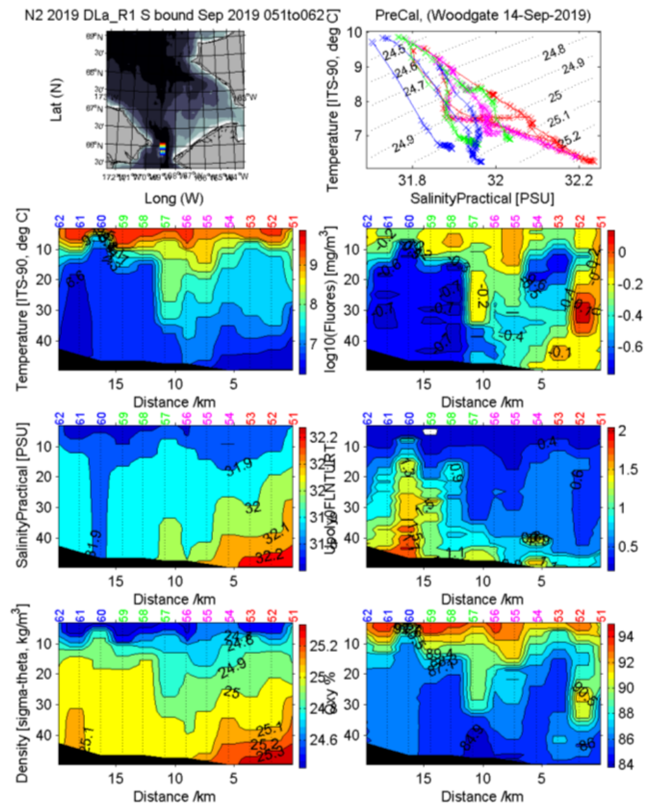


2) Diomede Islands line south part (DLS) - first running, Northward

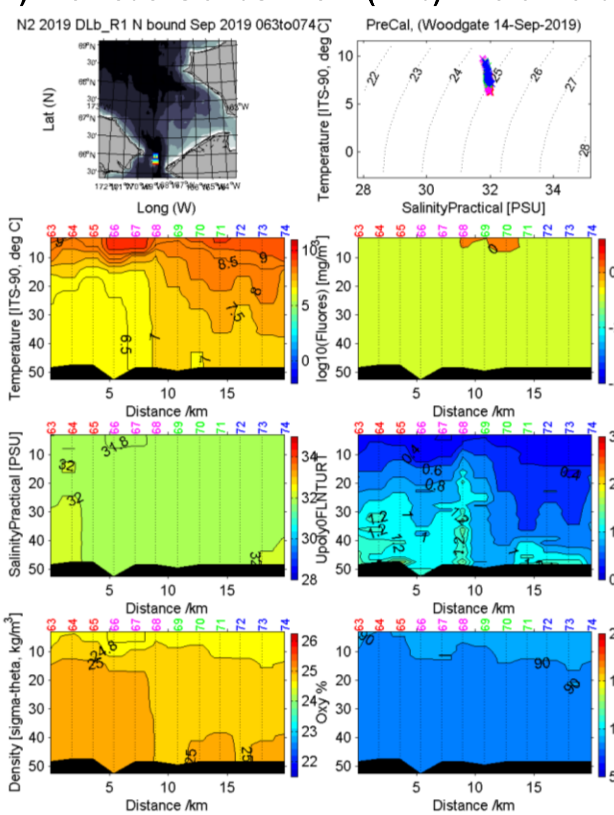


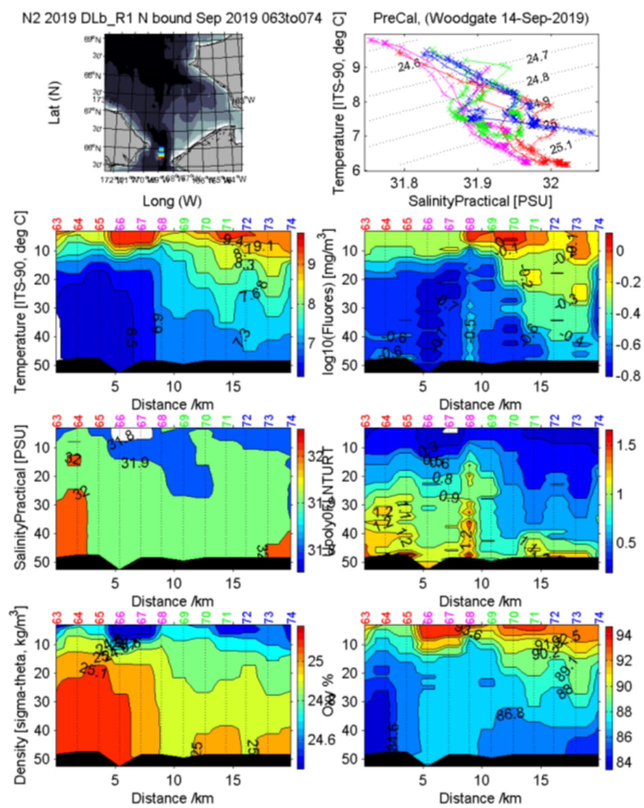
3) Diomede Islands line A (DLa) - Southward



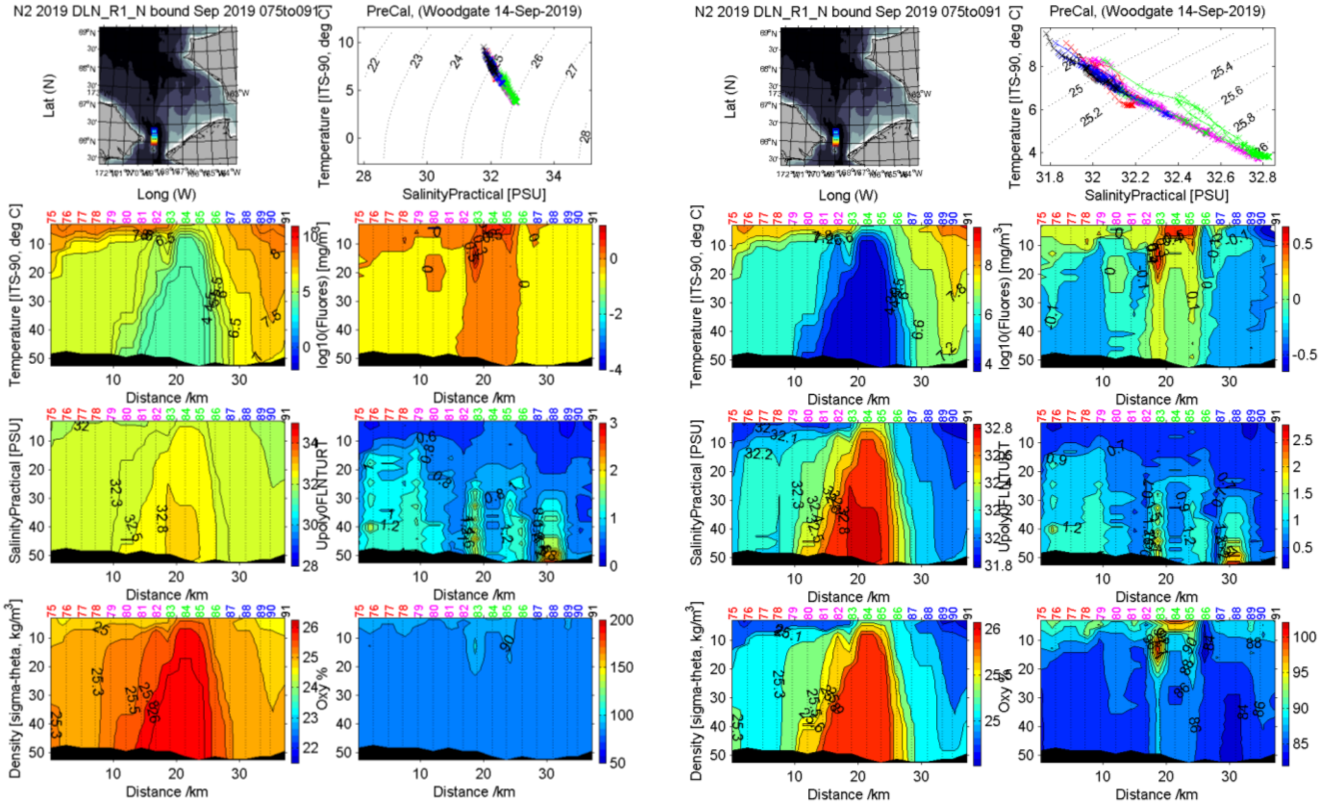


4) Diomede Islands line B (DLb) - Northward

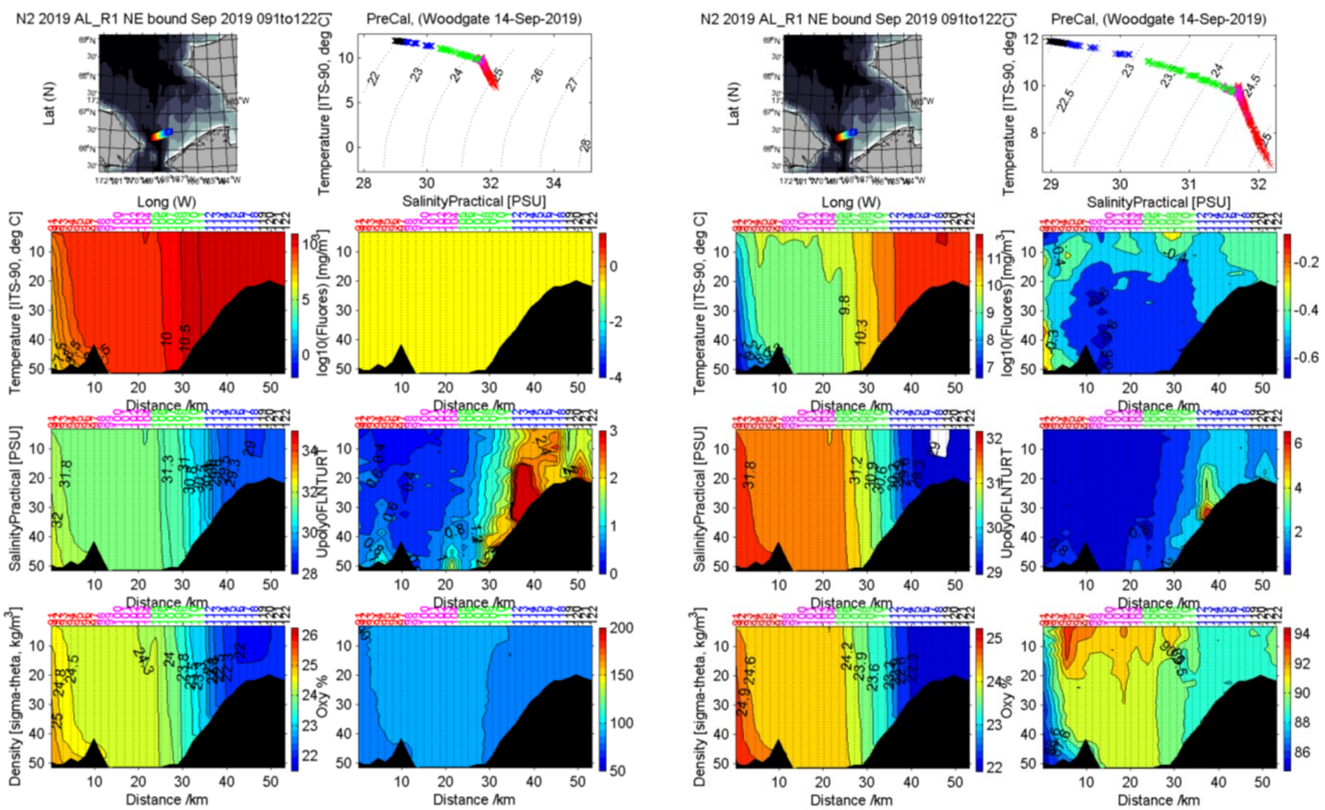




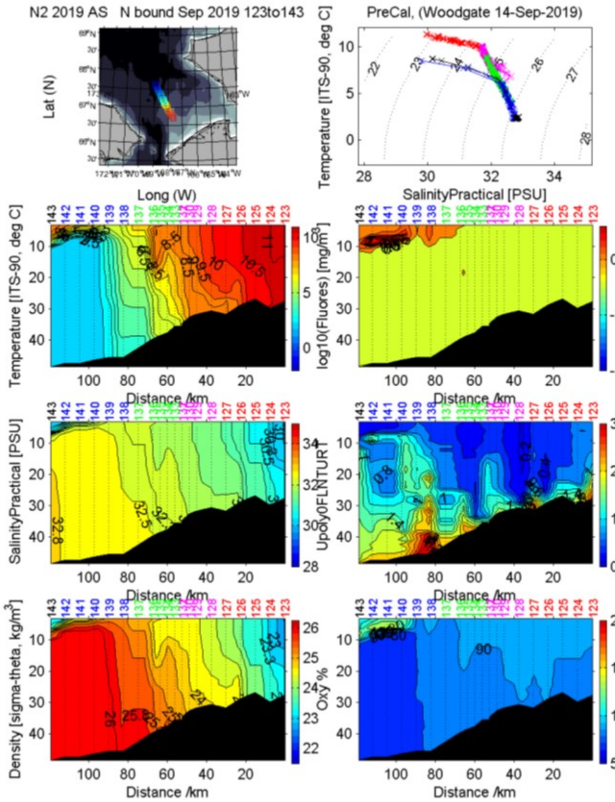
5) Diomede Islands line north part (DLN) - first running, Northward

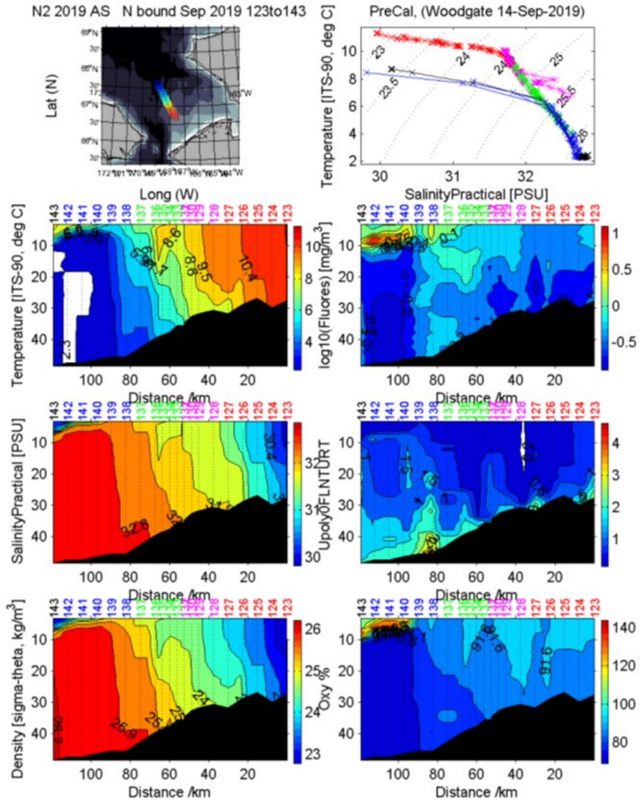


6) A3 line (AL) - first running, Northeastward

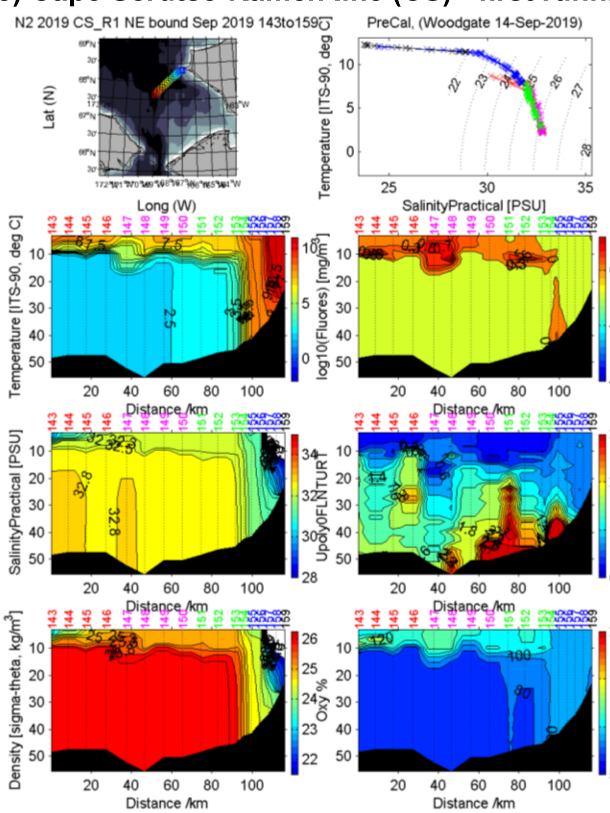


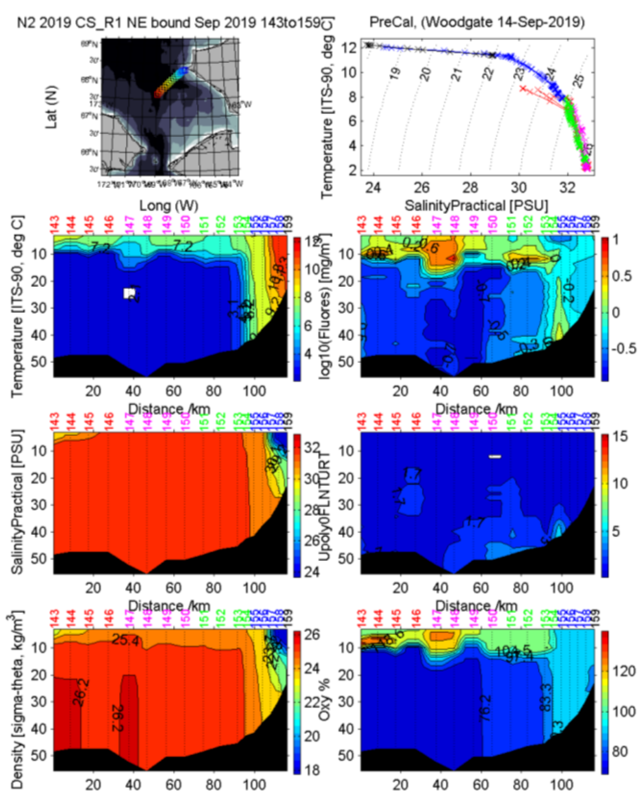
7) AS Shelf line (AS) - Northwestward



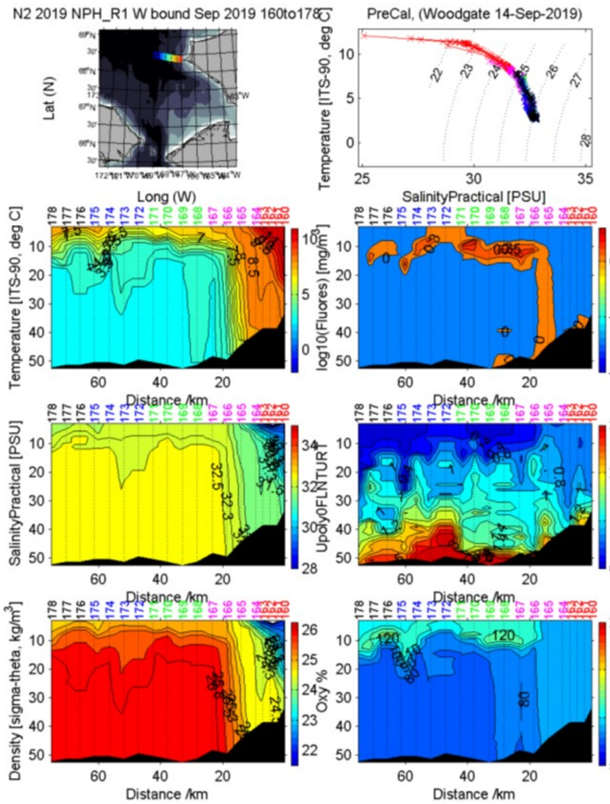


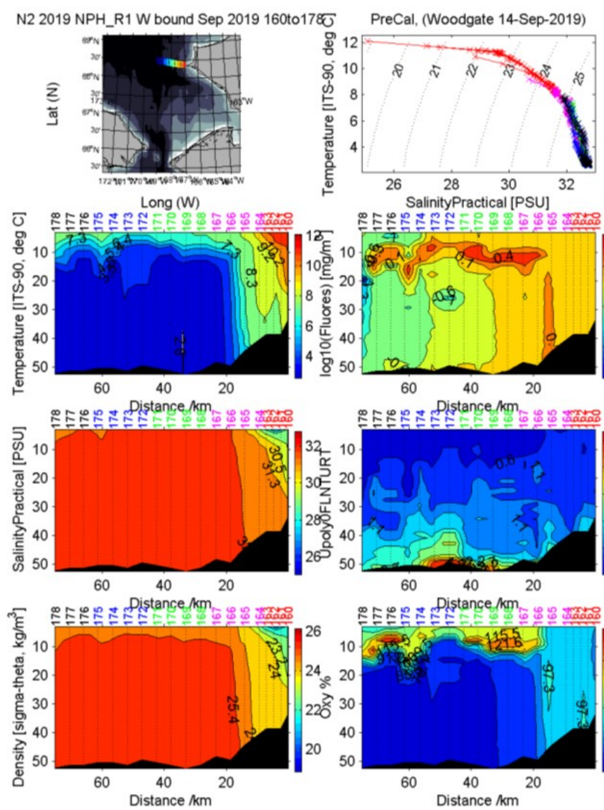
8) Cape Serdtse-Kamen line (CS) - first running, Northeastward



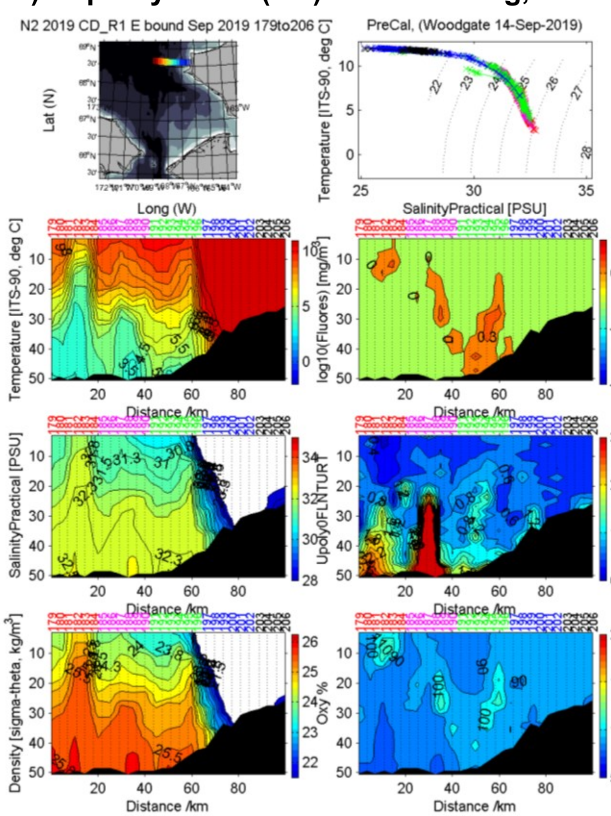


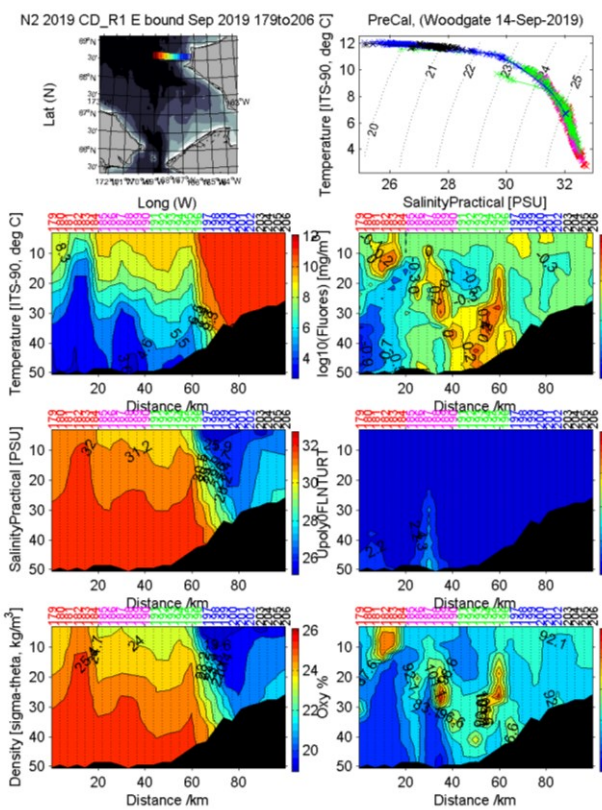
9) North Point Hope line (NPH) - first running, Northwestward



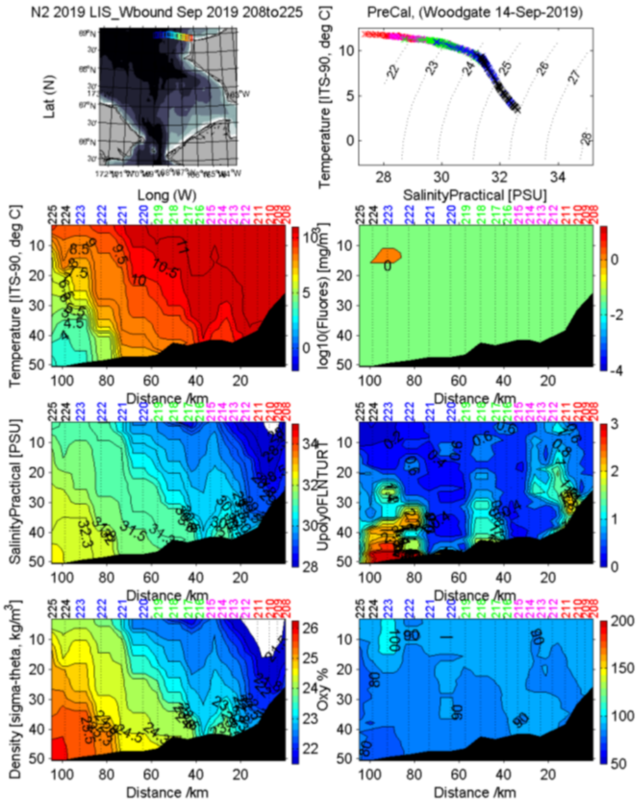


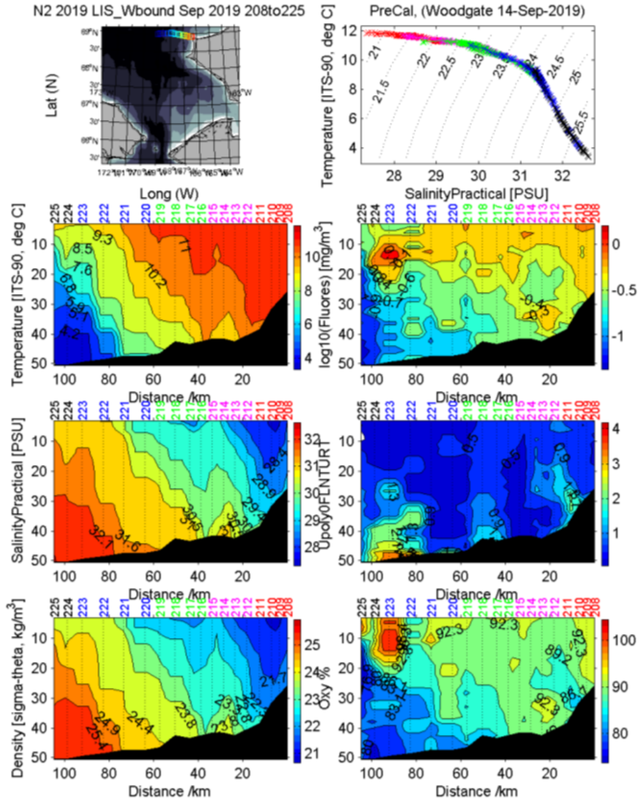
10) Cape Dyer line (CD) - first running, Eastward



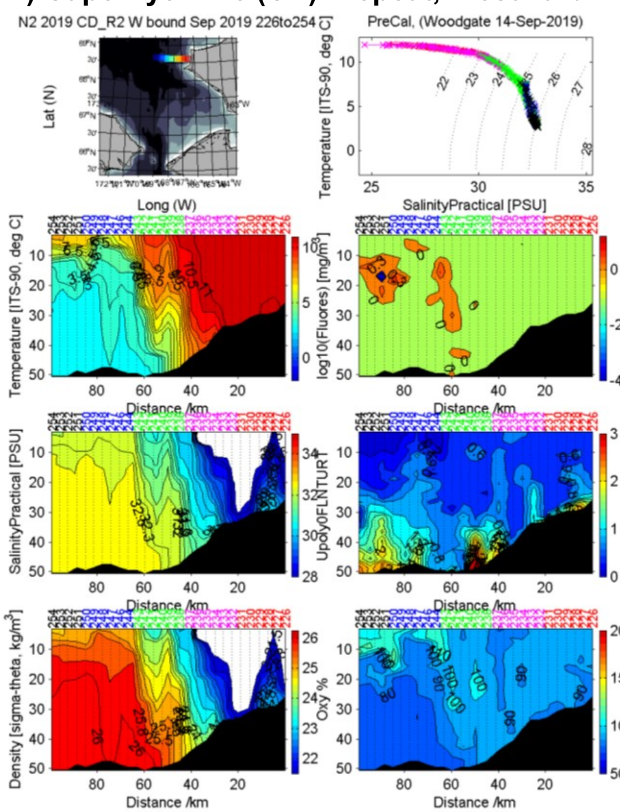


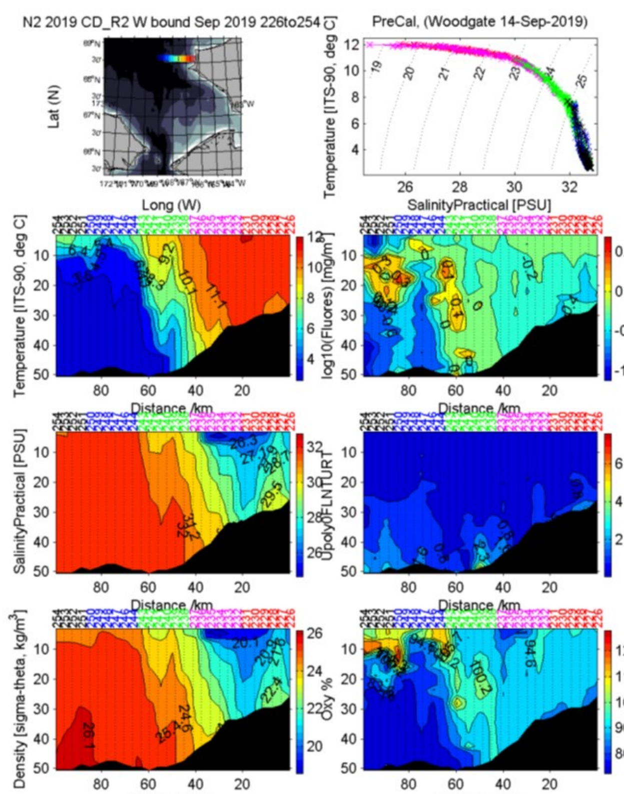
11) Cape Lisburne line (LIS) - Westward



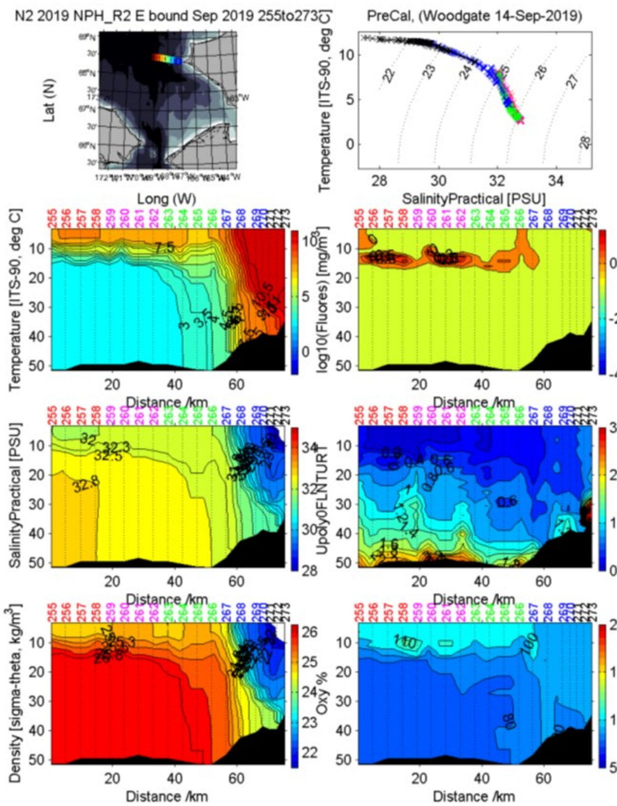


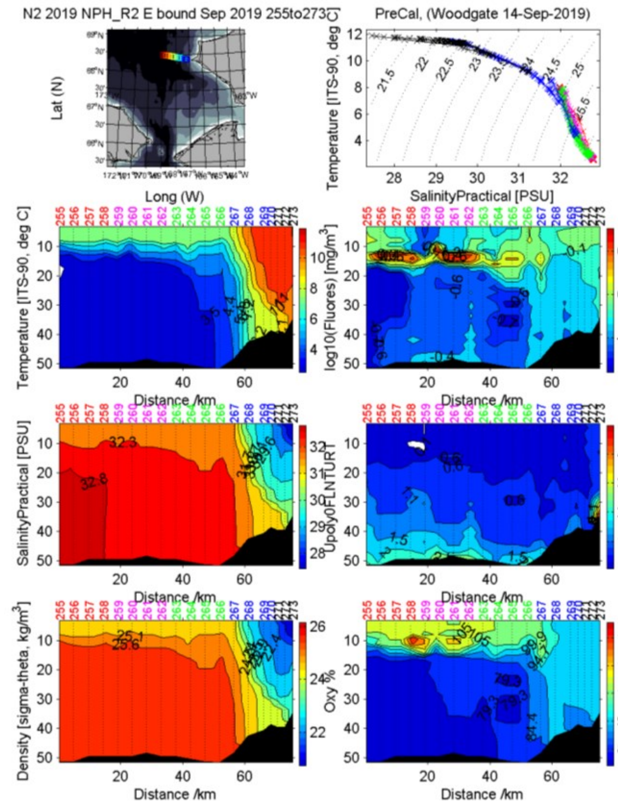
12) Cape Dyer line (CD) - repeat, Westward



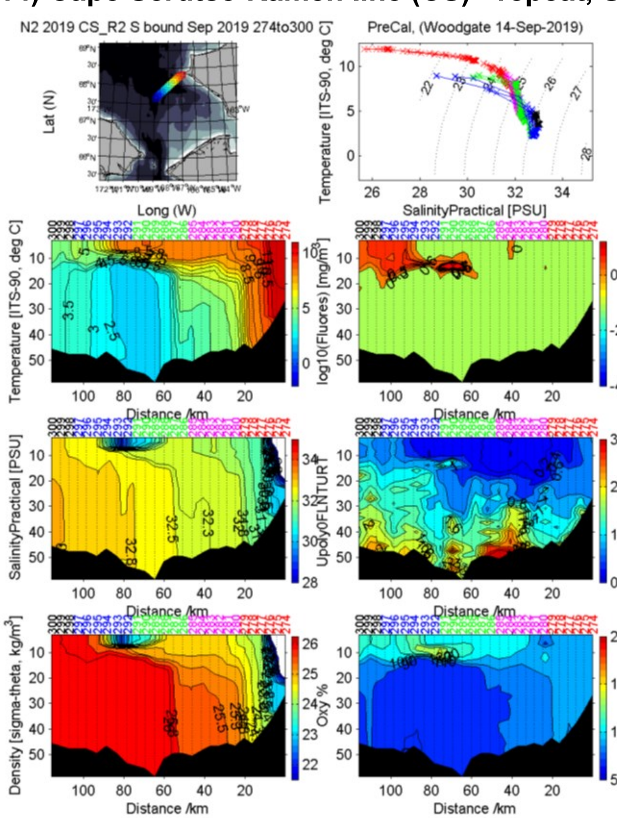


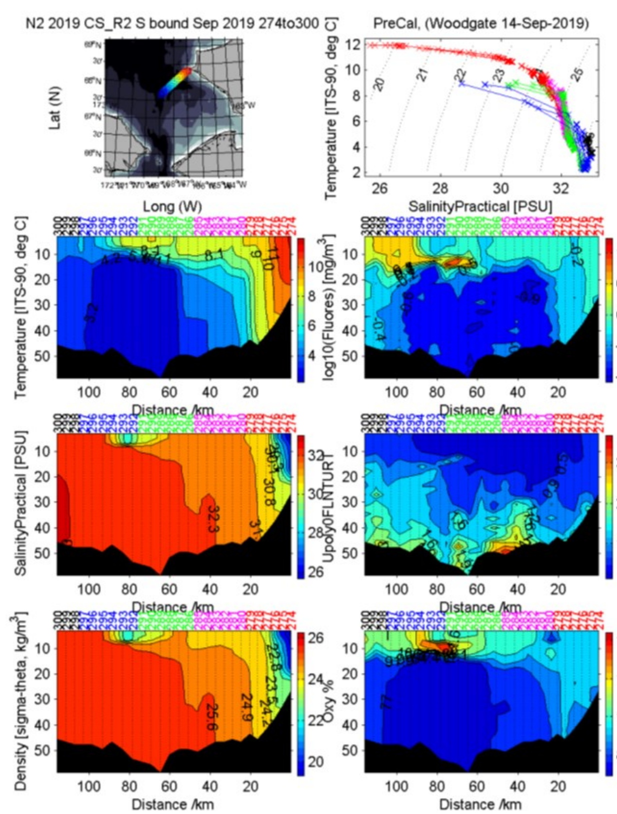
13) North Point Hope line (NPH) - repeat, Eastward



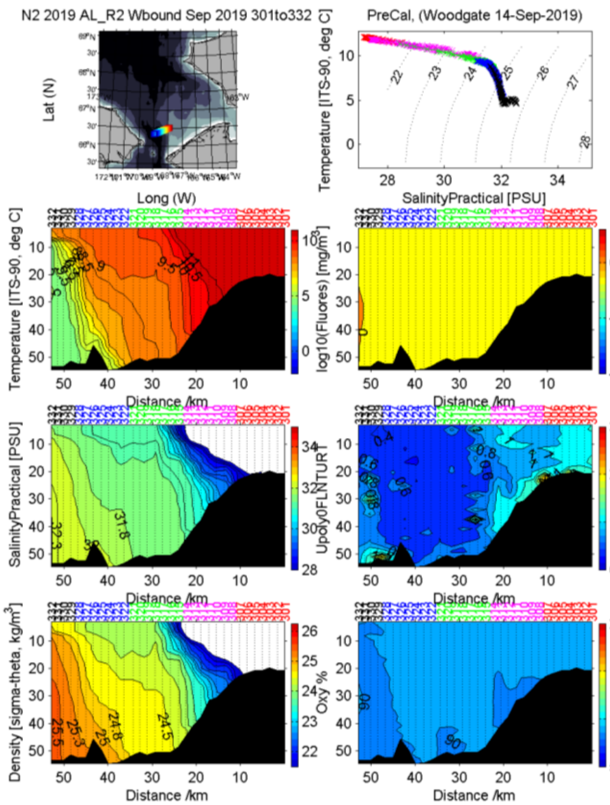


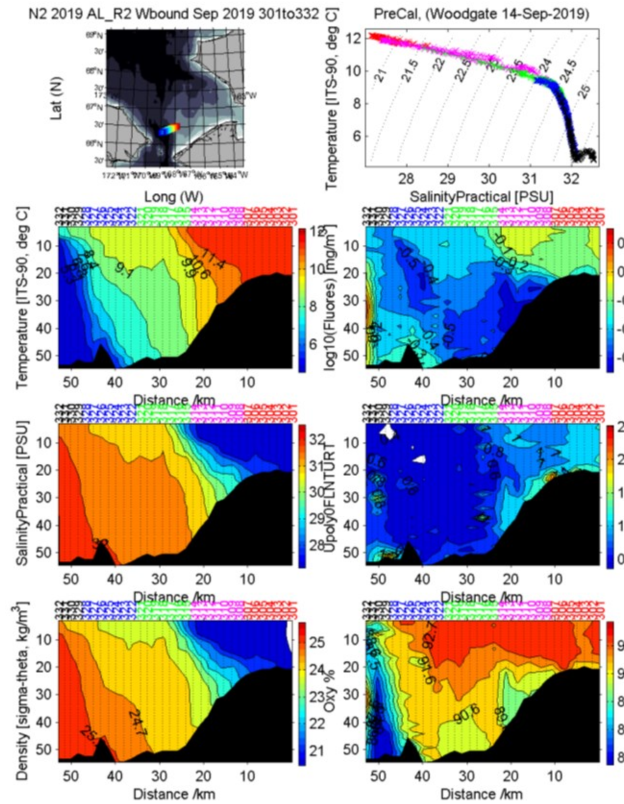
14) Cape Serdtse-Kamen line (CS) - repeat, Southwestward



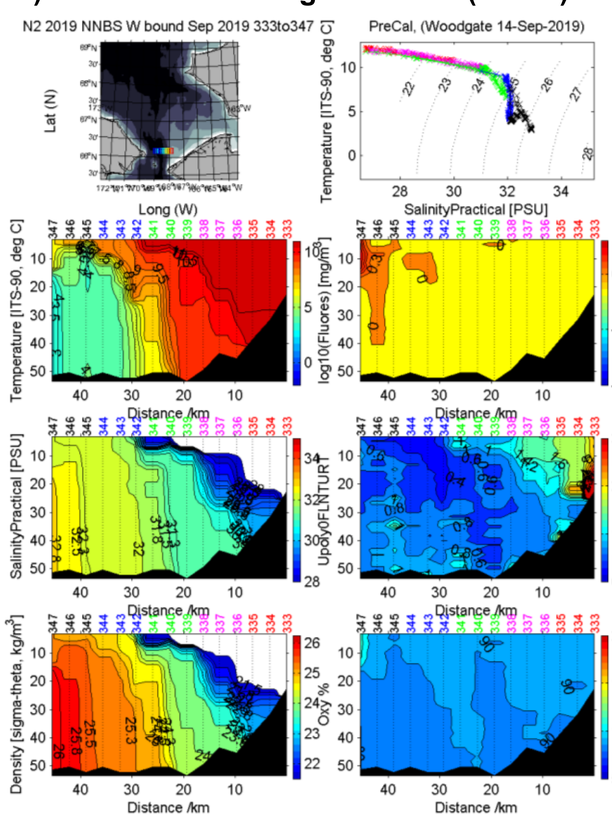


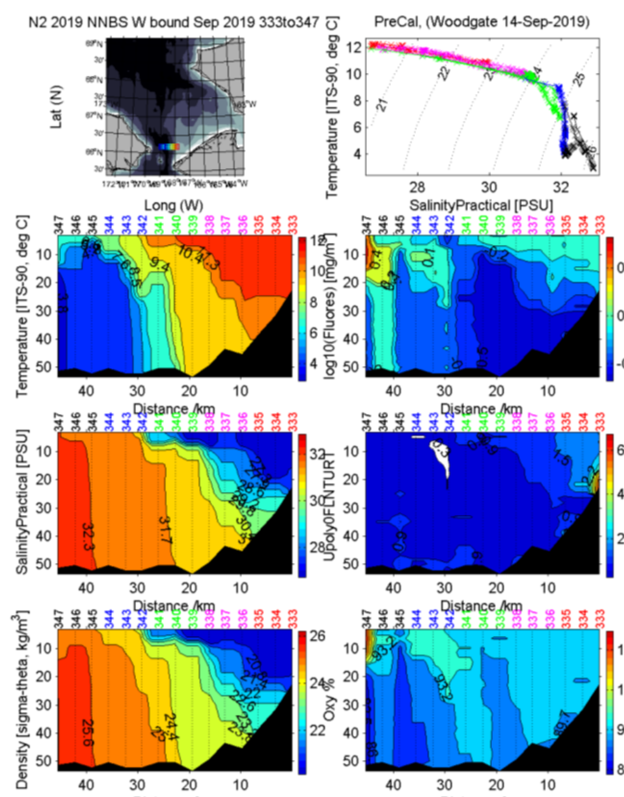
15) A3 line (AL) - repeat, Southwestward



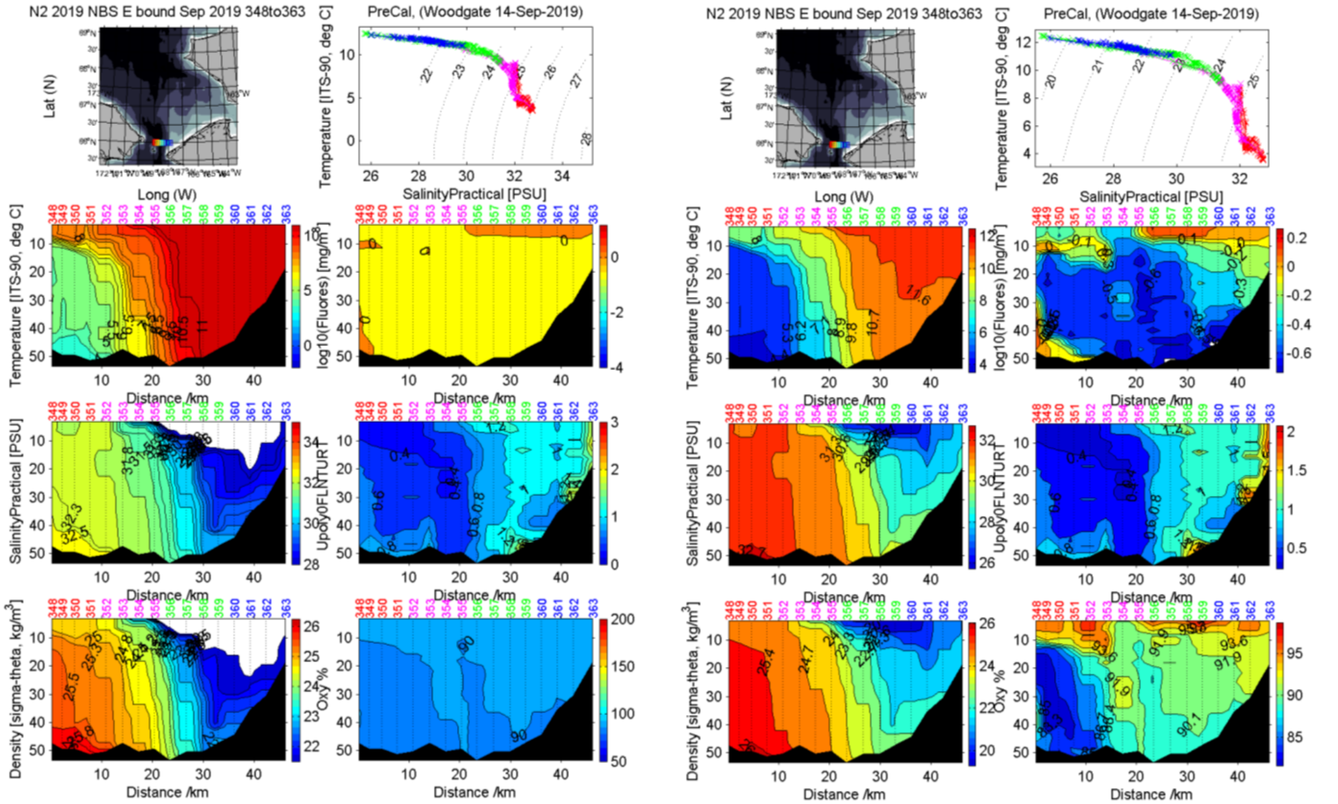


16) North North Bering Strait line (NNBS) - Westward

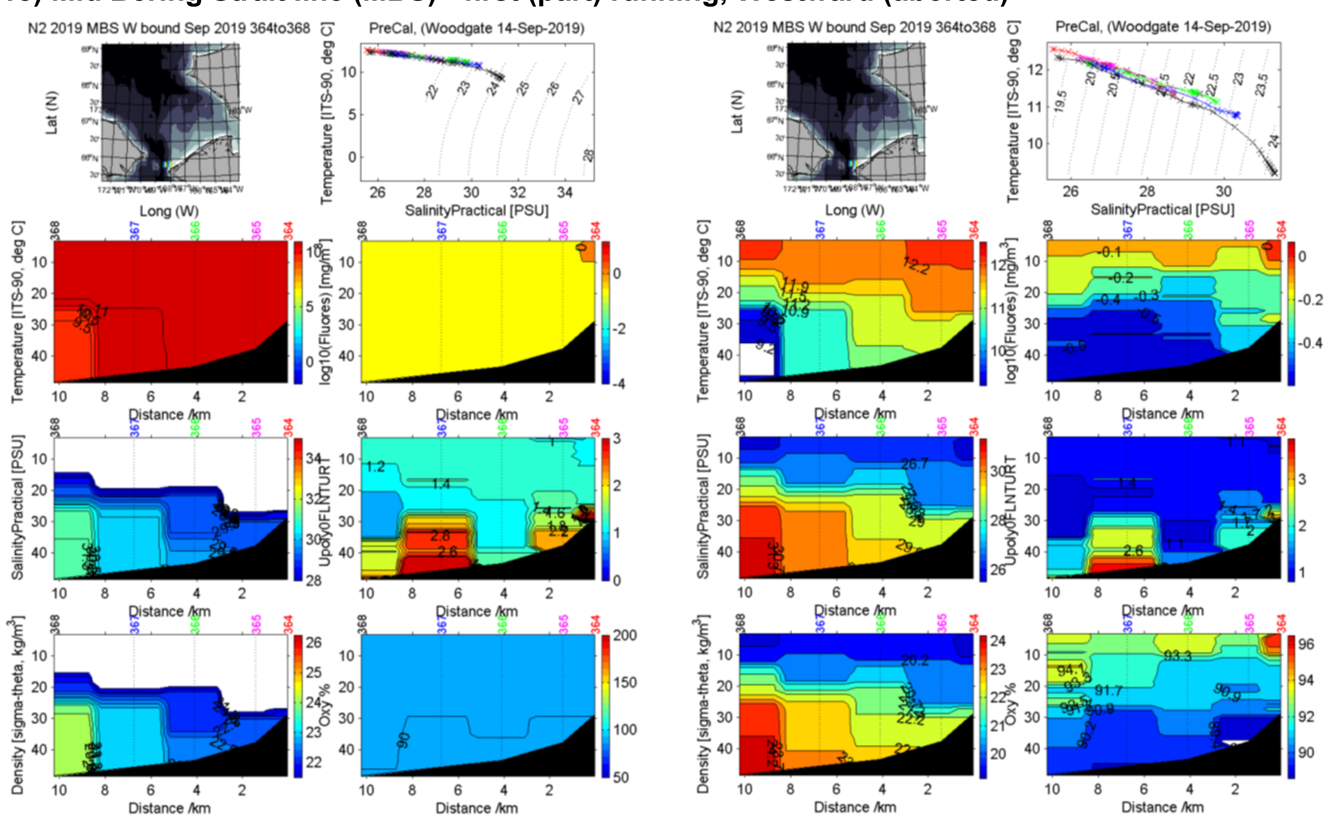




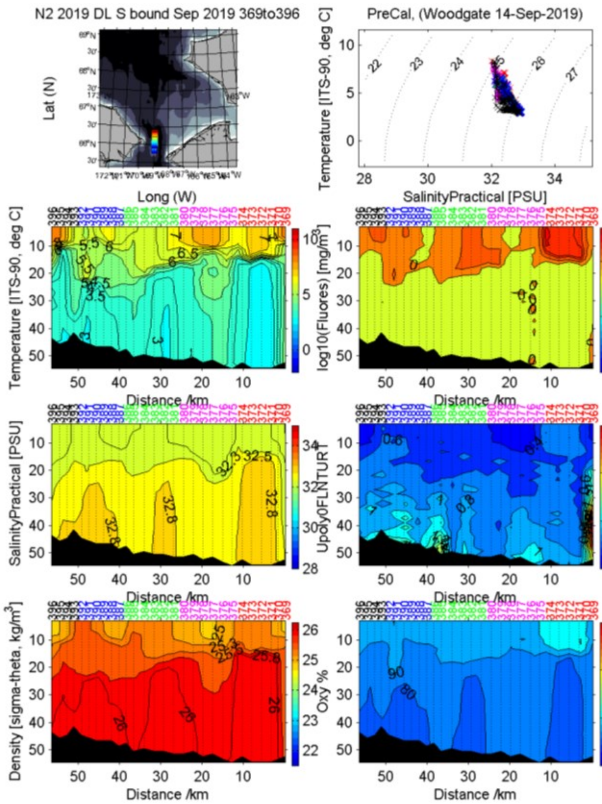
17) North Bering Strait line (NBS) - Eastward

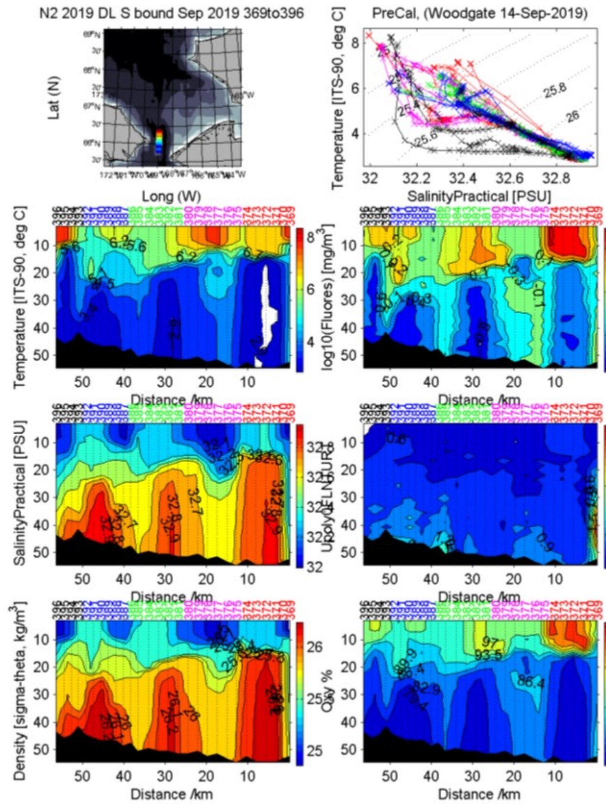


18) Mid Bering Strait line (MBS) - first (part) running, Westward (aborted)

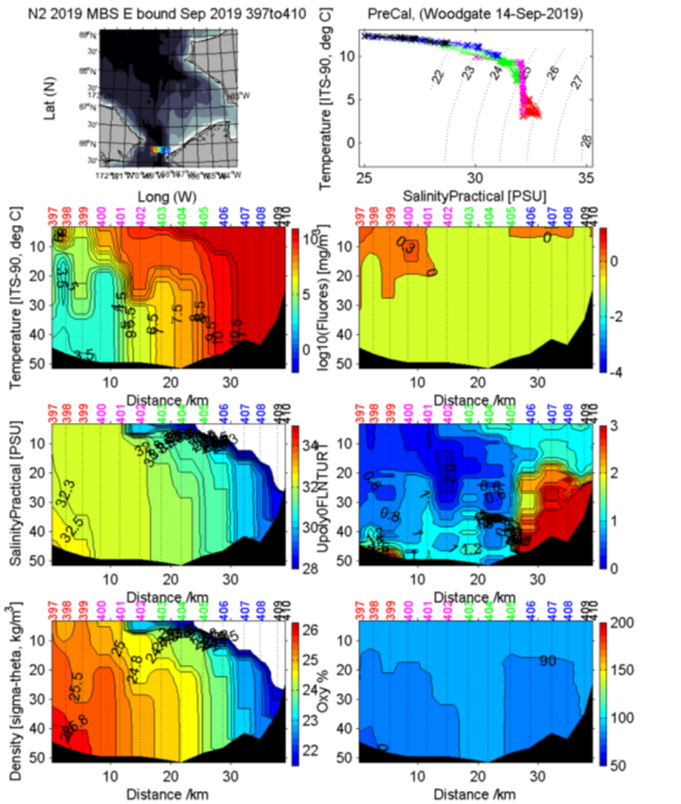


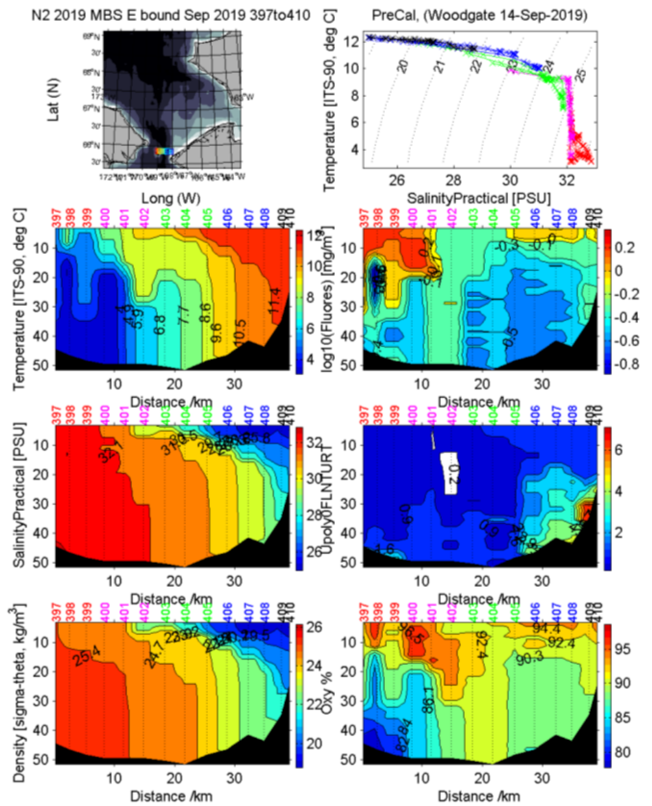
19) Diomede Islands line North and South (DL) - repeat, Southbound



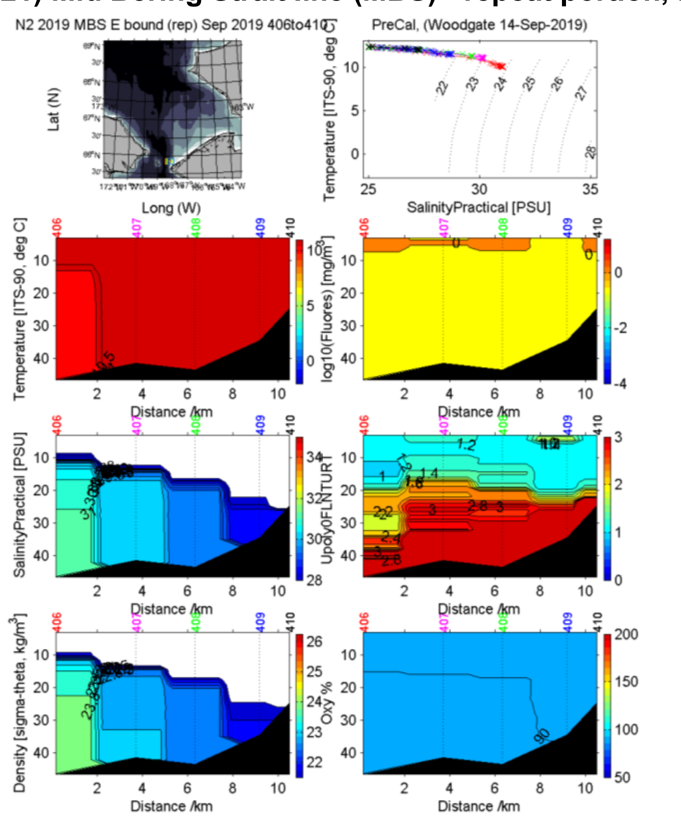


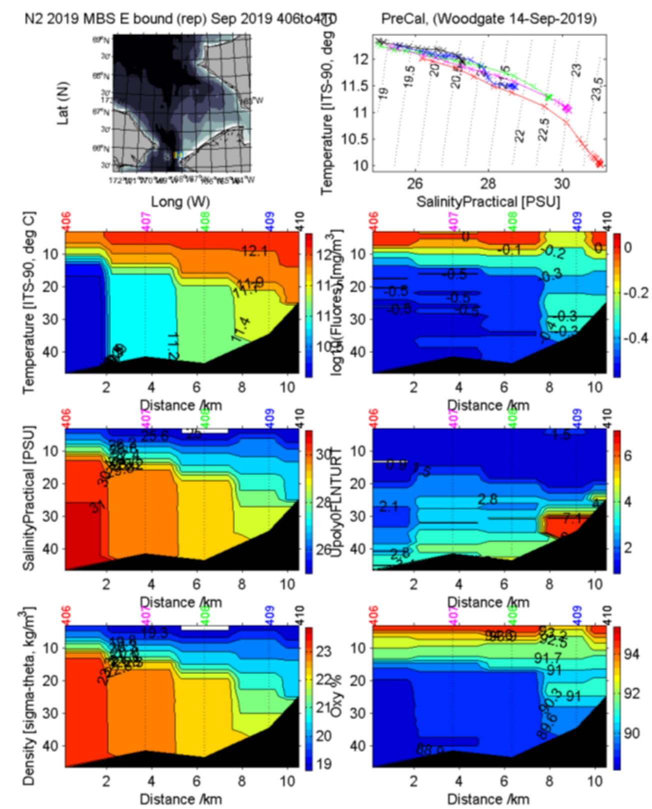
20) Mid Bering Strait line (MBS) - first complete, Eastbound



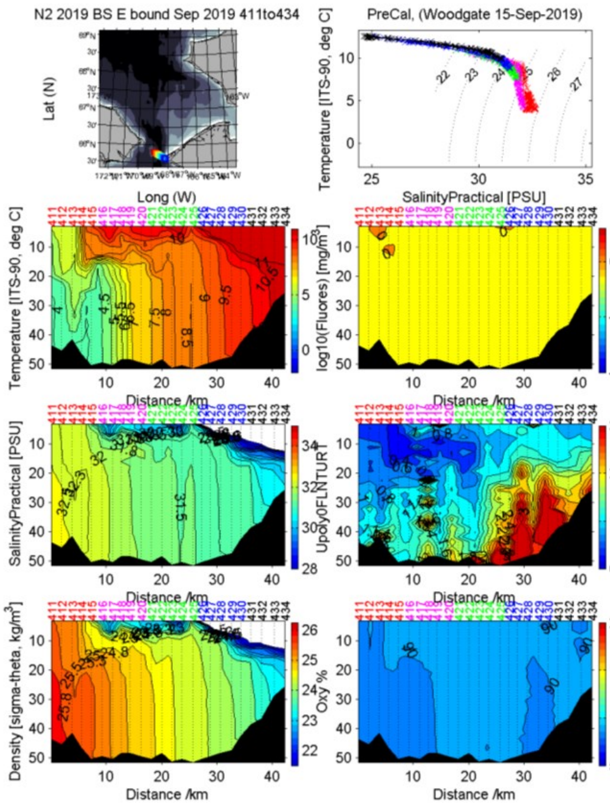


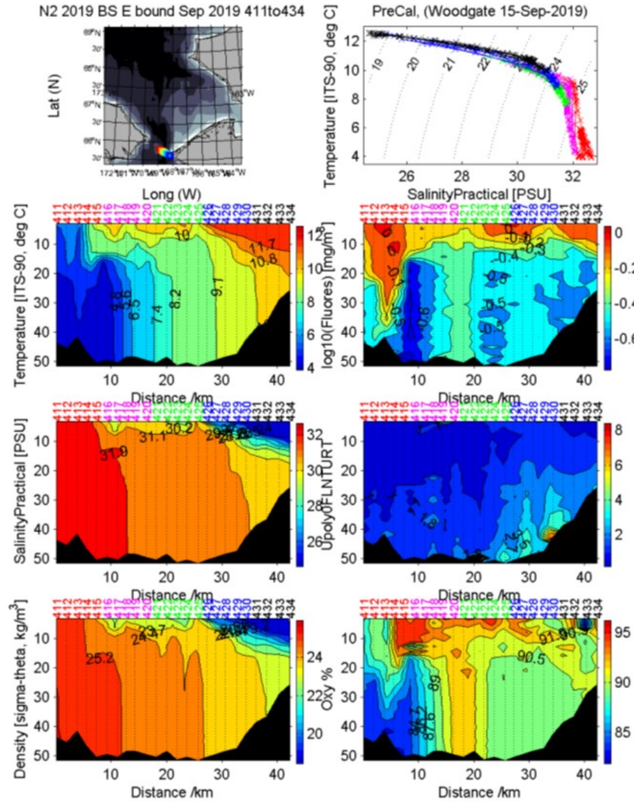
21) Mid Bering Strait line (MBS) - repeat portion, Eastbound



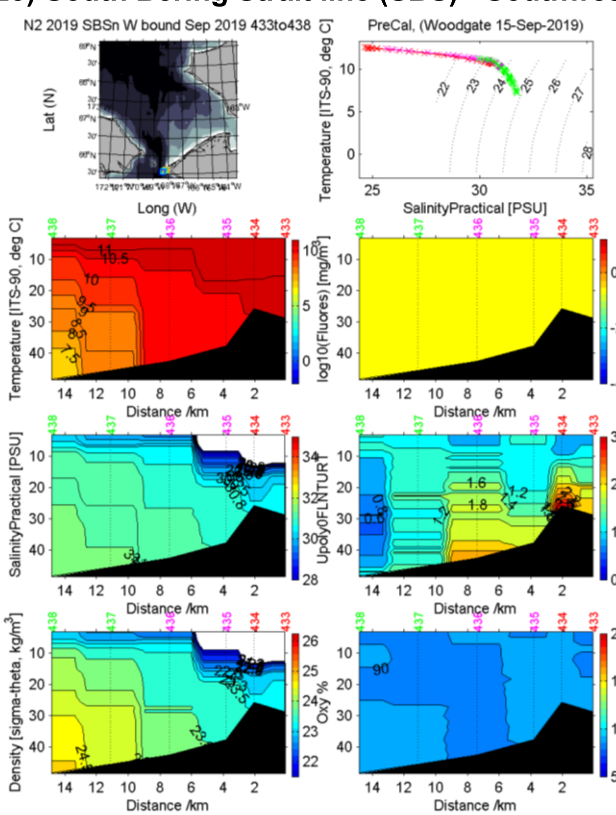


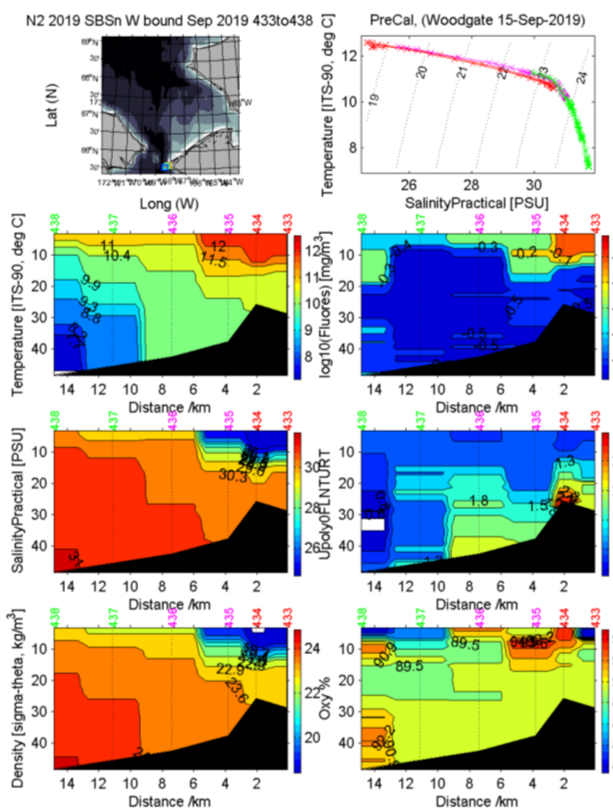
22) Bering Strait line (BS) - repeat, Eastbound





23) South Bering Strait line (SBS) - Southwestward





BERING STRAIT 2019 BIOFOULING REPORT (Max Showalter)
Identification of main Biofouling Organisms (Adapted from 2015 report)

Introduction

As the Bering Strait witnesses increased heat flux from the Pacific Ocean into the Chukchi [*Woodgate et al., 2006]*, marine organisms must adapt with one of three outcomes: decreased competitive advantage, increased competitive advantage, or no change in competitive advantage. Each of these responses may cause system-wide reverberations, both locally and globally. Indeed, ecosystems within the Chukchi and Bering Sea are complex and demonstrate high levels primary productivity that feed multiple heterotrophic levels [*Saukshaug, 2004; Hill and Cota, 2005]*. Because of the dynamic and extreme nature of the Arctic, these ecosystems may only display themselves for observation or sampling on short time scales throughout the year.

The Bering Strait moorings provide us an opportunity to directly observe the ecosystem change at annual intervals within this region. Identification and cataloging of major fouling organisms accumulated on the mooring surfaces provide year-round sampling of multiple levels of the native ecosystem to accompany direct physical observations of the *in situ* environment. These biofouling communities provide an easily sampled biological context to physical observations of the changing Arctic, thereby providing insight to the broader organismal response to climate change in high latitudes.

Detailed within this report are descriptions of critical species of the fouling communities found on the three moorings recovered on the Bering Strait mooring cruise, 5th Sept to 15th Sept, 2019. Photographic documentation and tentative identification accompany the descriptions.

Science Background

Biofouling, biological colonization of an artificial surface, represents an ever-present nuisance to aquatic infrastructure, especially marine. The presence of micro- and macrofauna on man-made surfaces can increase drag and subsequent fuel costs, cause material corrosion and discoloration, and decrease general performance and lifespan of ships, pipes and cables, structures, or instruments in the ocean [*Callow and Callow, 2002; Railkin, 2003]*.

Canonical theory of fouling communities predicts a primary succession of micro and macro-fouling. Immediately after placement of a surface into seawater, organic materials adhering to the surface via Van der Waals forces. Copiotrophic bacteria swim toward this now nutrient rich surface and begin colonizing within the first two hours [*Railkin, 2003*]. As the coptiotrophs consume nutrients, oligotrophic bacteria begin to outcompete and outgrow the first colonizers. Planktonic diatoms land on the surface, contributing to microbial fouling. This process takes place over a period of two to three weeks.

Following micro-fouling, macro-fouling occurs in two stages. The first stage sees quickly growing bryozoans, hydroids, anemones, and polychaetes colonize the surface within 1 to 2 years of its submersion. Slow-growing invertebrates then begin settling on the surface in the second stage of macro-fouling [*Railkin, 2003]*.

Species richness on biofouled surfaces varies highly, in accordance with the *Theory of Island Biogeography*, which highlights the dominance of immigration and extinction within an insular ecosystem [*Railkin, 2003; Wilson and MacArthur, 1967]*. So, while knowledge of succession can predict state of biofouling, other predictions, like extent or specific composition of the fouling community, remain elusive or inaccurate. For example, relative biomass of fouling communities decreases in higher latitudes as compared to warmer waters, but as highlighted below, relative biofouling can shift from heavy to light in as little as twenty nautical miles.

Vertical distribution and surface properties also affect fouling communities upon the same principle of immigration and extinction. Photosynthesizing diatoms active within high PAR regions of the water column have a higher likelihood of colonizing shallow surfaces as compared to deeper surfaces, whereas larval invertebrates often exhibit sensitivities to light, gravity, or current [*Crisp, 1984*]. Similarly, within high latitude environments most fouling occurs in warmer temperatures(April – September, in the Northern Hemisphere) and under high nutrient conditions, leading to seasonality of fouling extent and patterns (Lehaitre and Compère, 2008). The variability makes it difficult to back-estimate nuanced nutrient, salinity, or temperature regimes from biofouling patterns alone, except to suggest relative temperature or nutrients compared to previous years.

Summary and Analysis of Biofouling Patterns

For each of the three moorings recovered, biofouling analysis consisted of a broad visual inspection, photographic documentation, and selective sampling of dominant species for later identification, areal extent analysis performed in *ImageJ*. Samples were collected from instruments deployed typically between depths of ~ 37-52m, i.e., 3 and 14m above bottom in water depths of 48-57m. ISCATs were however deployed nearer the surface (~16m depth, see mooring diagrams in the main report). Sampling did not take into account vertical distribution or surface-type differentiation on the mooring. Moorings were photographed for later identification of biofouling organisms.

The moorings exhibited similar patterns of speciation, and, in contrast to previous years, similar patterns of biofouling extent. In most previous years, mooring A4-18 has demonstrated the highest levels of biofouling, which corresponds to the region of highest current (see cruise reports 2010 - 2016). This supports the accepted theory that biofilming and fouling increase under high flow [*Railkin, 2003*]. However, recent recoveries also showed extensive biofouling on A2 (2016, 2017, 2018) and A3 (2018) which matched or seemed to exceed the amount of fouling on A4. A similar trend was continued in 2019, where all moorings showed similar levels of biofouling with A4 slightly more fouled as indicated by areal extent analysis.

As in previous years, the ADCP floats showed extensive barnacle communities on their dorsal surfaces, with moderate algal and bryozoan colonies. Barnacle communities also fouled the ADCP proper and battery, with moderate algal fouling. Extensive barnacles, algae, and bryozoans encrusted the dorsal surface of the 30" steel float, with moderate to minimal on the ventral surface. Recovered ISCATs demonstrated minimal relative fouling by barnacles, but moderate fouling by algal and bacterial filming. Low levels of macrofouling may be related to the presence of antifouling paint on the ISCAT housing, as well as tributyltin oxide poison within the conductivity cell of the instrument.

Also present on the instrumentation package across (excluding the acoustic release and in dense barnacle fields) were ascidians (sea squirts) and nudibranchs (sea slugs) attached in numbers higher than previous years. Small mussels were also observed on the mooring as in previous years, but seen for the first time on the acoustic release. Additionally fouling was observed on the mechanisms painted with anti-fouling paint and may have partially inhibited release.

Primary resources for identification include the *Organisation for Economonic Cooperation and Development's Catalogue of Main Marine Fouling Organisms* and the World Register of Marine Species.

Major Fouling Species Identification

Barnacle communities were largely homogenous across the entirety of the moorings. These acorn barnacles ranged in size from roughly 0.5cm to 2cm in diameter, and roughly 0.5cm to 2cm in length. Samples showed 6 plates, with rostral overlap of the two adjacent plates. Scuta and terga formed a closed, rhomboidal center with oblique angling of radii. Putative identification implicates *Balanus crenatus* as the major species associated with the mooring. *B. crenatus* is known to reside in the North Pacific, preferring strong currents and exhibiting fast growth. Morphology, range, and description suggest the collected samples were *B. crenatus* [*OECD, 1963; WoRMs, 2015*].

Bryozoa collected from each of the three moorings match closely with descriptions of the genus *Bugula,* an arboreal-type bryozoan of branches emanating from a single stock. *Bugula* is thought to be globally distributed, in part due to its nature as an invasive species [*OECD, 1963; WoRMs, 2015*].

Hydroids removed from the surfaces likely belong with the genus *Halecium*, a cosmopolitan, dendritic polyp of similar morphology to the collected samples. Accurate identification of hydroids requires magnification of hydranths, and would benefit from observation near *in situ* (in seawater) [*OECD, 1963; WoRMs, 2015*].

Several nudibranchs (sea slugs) were isolated from the moorings, largely nearly identical morphology, and also observed in 2015. A fleshy body of muted, dark salmon color with white spots and small, light cerata symmetrically lining the back characterized the specimens. Samples likely belong to the family *Dendronotidae* based on morphology. Genus or species level classification was not achieved.

Several tunicates (sea squirts) of nearly identical morphology were recovered from the moorings. Based on morphology and distribution, the specimens have been identified as likely belonging to the genus *Corella*, and putatively the species *inflata. Corella inflata* has been previously recovered from the Bering Strait [*OECD, 1963; WoRMs, 2015*]. These tunicates were similarly seen in 2015.

At least one sea anemone was recovered with mooring A3-18, as well as one worm and several sea stars. Identification of these species may be considered by an experienced macro-biologist [*OECD, 1963; WoRMs, 2015*].

Comparison of biofouling patterns and species distribution across cruises was inhibited due to inconsistent sampling and low-resolution photography. For a quantitative analysis of fouling (as suggested in the following section), standardized photographs are recommended.

Fouling Extent by Image Analysis

In an attempt to quantitively analyze the biofouling of the moorings, characterization of fouling extent by image analysis was attempted. To do so, images were taken of a flat surface of the mooring (the vane) and uploaded in ImageJ (Reuden, 2017). Using ImageJ, the extent of biofouling as a percentage of the total image area was approximated. Surfaces which were largely fouled by barnacles were selected to control for biological variability that would confuse the image analysis program.

Protocol:

1. Load image into ImageJ
    a. Aim to capture images of fantails on flat surface, with whole fan tail in image so size can be properly aligned to pixel value.
    b. Sub-sample fantail to get manageable chunk
2. Image → adjust→ brightness/contrast
3. Image → adjust → color thresholds (bring forward individual elements in white by adjusting parameters, ensure dark background is toggled.
4. Analyze → Analyze Particles
    a. Adjust parameters to be image appropriate (size and circularity of targeted object)
5. Report areal extent as percentage of image

Results:

Images of moorings A2 and A4 were used to explore this method of analyzing areal extent of biofouling using ImageJ, focusing on the fantails and the acoustic releases as relatively flat, extensive surfaces which were easily imaged and analyzed (Fig 1). As previously mentioned, surfaces were analyzed for the percent of area covered by barnacles, and these surfaces were chosen because barnacles were the overwhelming majority of the fouling organisms.

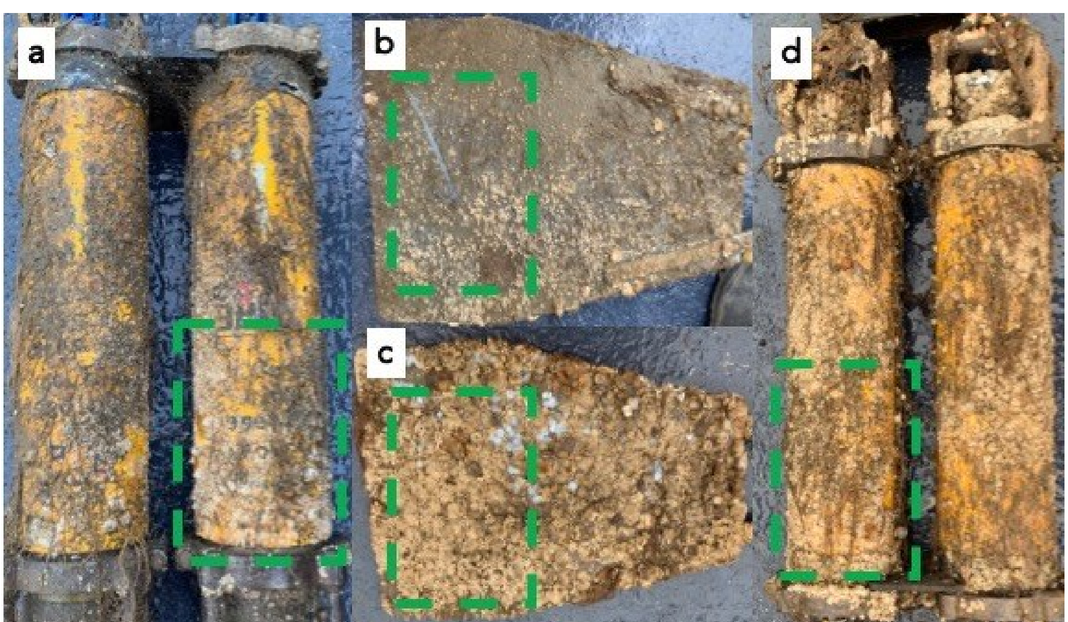


***Figure 1:** Images selected for the ImageJ analysis from A2 (a, releases and b, vane) and A4 (c, vane and d, releases). The green boxes show the subsampled region.*

A2-18 showed less biofouling by areal extent on both the vane (10.02%) and release (16.7%) than A4-18 (41.07% on the vane, 19.98% on the release) (Figs. 2 and 3). This correlates to previously observed patterns in which A4 had the highest observable biofouling of the three moorings.

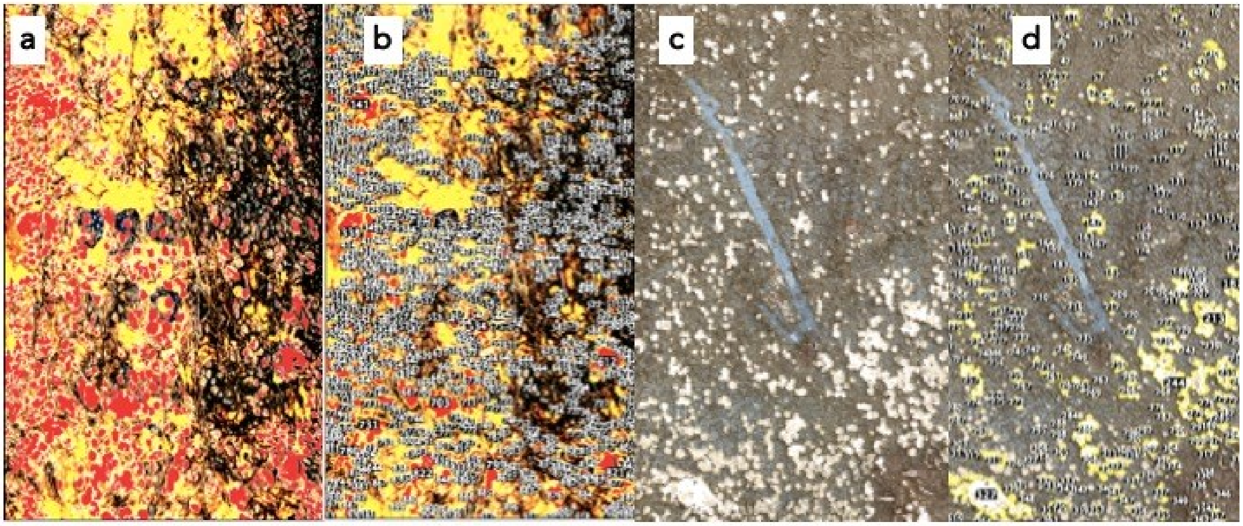


Figure 2: *Selected particles on mooring A2 on the releases (red, a) and vane (c, white) and those same particles counted on the releases (b) and vane (d).*

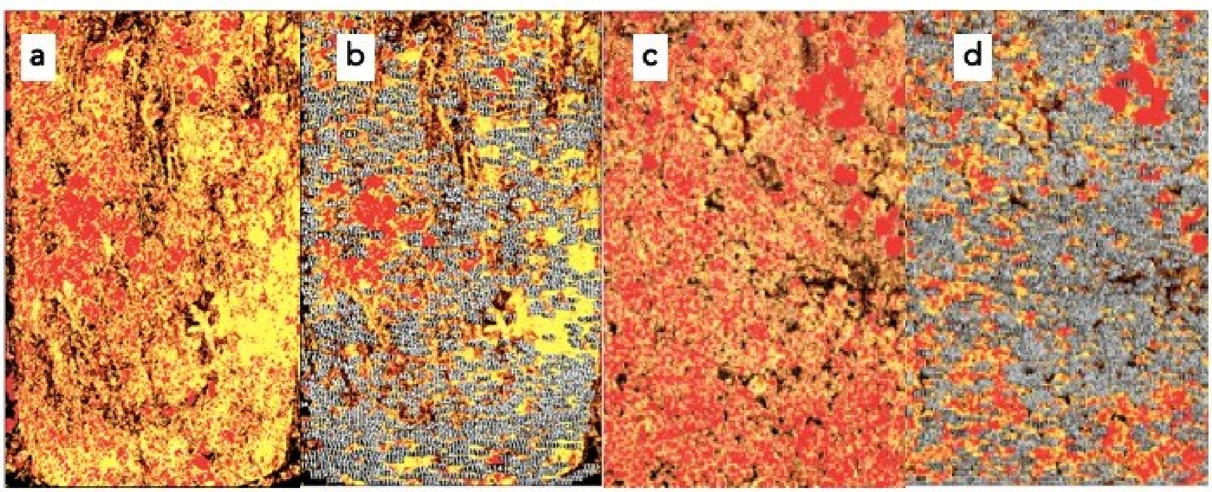


Figure 3: *Selected particles on mooring A4 on the releases (red, a) and vane (c, red) and those same particles counted on the releases (b) and vane (d).*

The comparison of images across years proved challenging and was subsequently abandoned because of inconsistencies in photographs, as well as the 'noise' inherent to a biological system. In looking at photographs from previous years, the distance and lighting on the mooring causes reflections and curvature which made it difficult to accurately capture the extent of comminutes. It is recommended that future cruises standardize photographs to make interannual comparisons more meaningful, and include a flat surface as sample for this method.

The initial goal of using ImageJ for image analysis was to quantity the number and average size of barnacles which had fouled the mooring as a proxy for age and extent of fouling communities, but several challenges prevented this. Primarily, the amount of fouling meant barnacles were often aggregated, making it impossible for the program to distinguish individual barnacles that were in close proximity. Additionally, many factors control the size and population of barnacle communities which may make tying number and extent to physical factors or prescribing biological explanations invalid.

Rather, providing areal extent of barnacle community is a method which quantifies relative fouling extent between moorings and years while remaining agnostic to other biological processes. It is recommended for future cruises that wish to continue to quantify fouling in this method to improve the quantification of areal extent using image processing software as suggested in this report.

We also suggest that a more controlled method of thresholding the images and removing the background be explored to prevent human bias. Under the current method, the images are manually curated to highlight the desired area to count, but future cruises may wish to explore means of automating this process.

Biofouling References

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BERING STRAIT 2019 UNDERWAY DATA REPORT – Woodgate (UW)

Underway CTD, ADCP and some meteorological data were collected during the cruise using the Norseman II's ship-based systems. These systems are set up by the Norseman II crew at the start of the cruise. **Action Item: Pre-cruise, develop checksheets for the setup of these instruments to ensure settings are as desired. Check the setups as soon as the ship leaves port.**

ADCP: This year, as last year, we collected data from the Norseman II's Teledyne RD Instruments 300kHz Workhorse Mariner ADCP (SN 19355), which is equipped with high accuracy bottom tracking. The ADCP is mounted 3m below the water line. This system was operational for the cruise, running with 1m bins and bottom track. The following file types are available for processing (file information copied from http://po.msrc.sunysb.edu/SBI/Healy_ADCPs.htm)

- *.ENR – raw binary ADCP data which contains every ping
- *.ENS – Binary ADCP data after the data has been preliminarily screened for backscatter and correlation
- *.ENX - Binary ADCP data after screening and rotation to earth coordinates
- *.STA - Binary ADCP ensemble data that has been averaged into short term averages
- *.LTA - Binary ADCP ensemble data that has been averaged into long term averages
- *.N1R - Raw NMEA ASCII data from the primary navigation source
- *.N2R - Raw NMEA ASCII data from the secondary navigation source, if available, and which should include Ashtech heading data
- *.NMS - Binary screened and averaged navigation data
- *.VMO - This ASCII file is a copy of the *.ini options file that was used during the data collection
- *.LOG - ASCII file containing a log of any errors the ADCP detected during the session

Preliminary data plots will be added to this report once available. Bottom track data was logging during this deployment. **Action Item: Ensure that bottom tracking is turned on. Process ADCP data.** Note also that since heading information is given by the ship's GPS position, it is not necessary to correct for magnetic declination. **Action Item: Check prior data for magnetic declination issue.**

MET DATA: Meteorological data (including wind speed and direction, air temperature, humidity and pressure) were recorded every 15 seconds with position, and course, during the cruise. **Action Item: Check position used for met sensors.** A preliminary plot of these data is given below. No data quality control has yet been applied to these data. **Action Item: Check if wind direction needs to be corrected for magnetic declination.**

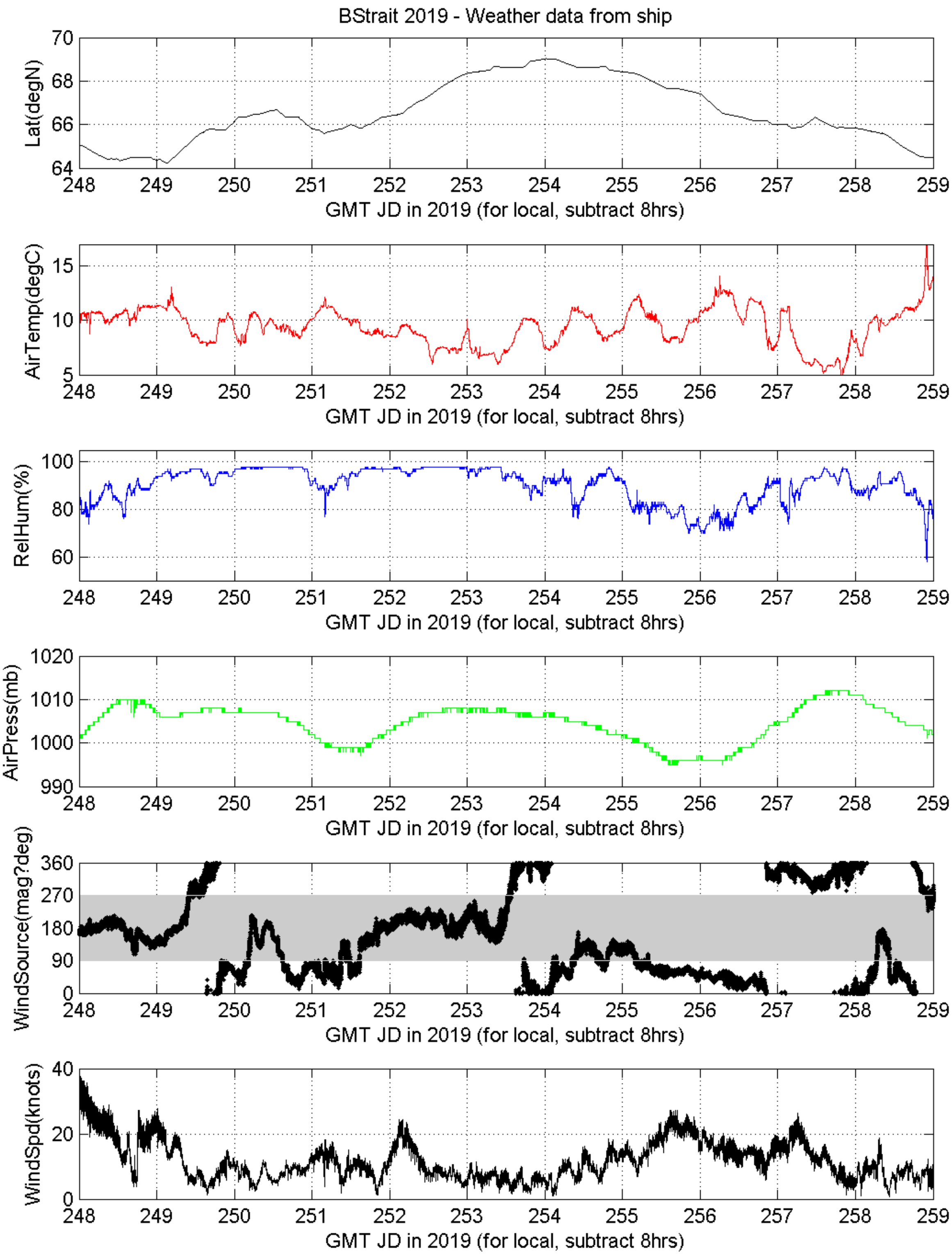
UNDERWAY TEMPERATURE AND CONDUCTIVITY DATA: The Norseman II used an Seabird SBE21 temperature conductivity sensor mounted 3.4m below the water line (slightly to port of the ship's ADCP, in the center of the ship) to collect underway data throughout the cruise, also logging position information and depth. A separate temperature sensor (SBE38) is placed closer to the intake to measure the temperature before it is warmed by the ship. **Action Item: Ensure depth is always logged in this file.** An hourly watch was kept on these data to ensure no loss of data. **Action Item: Continue hourly monitoring of underway data while at sea. Check the temperature and salinity data to the CTD casts.**

The calibration file used was the December 2016 calibration. **Action Item: Ensure the most recent calibration is used in the field.** Data were logged every 3 seconds. Preliminary plots of the underway temperature and salinity data are given below.

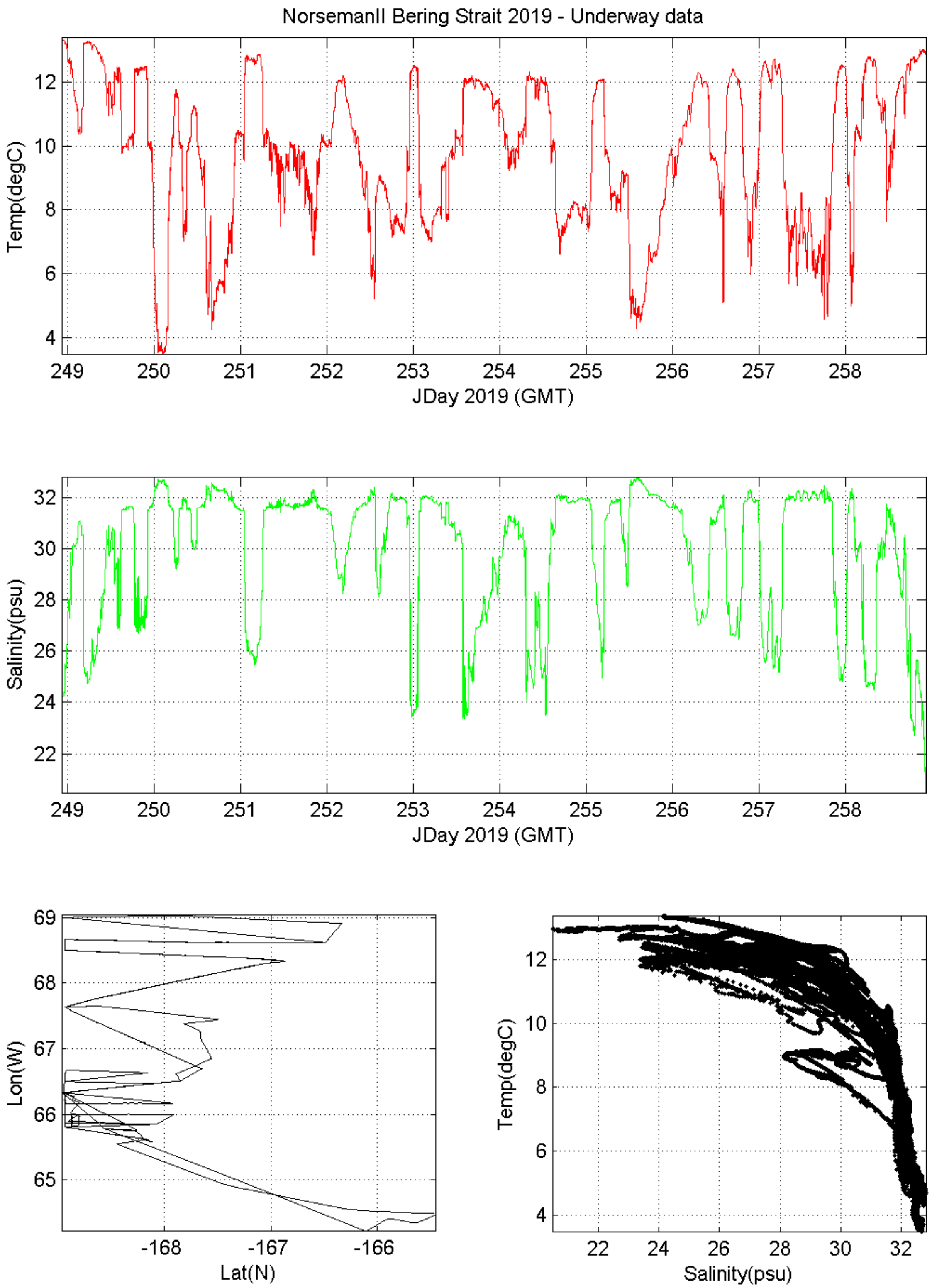
It is very important to remember when interpreting these data, that they are not synoptic, as is evidenced by the plots of the various crossings of the Bering Strait also shown below. **Action Item: Examine surface salinities and temperatures, especially in conjunction with prior data.**

BERING STRAIT 2019 METEOROLOGICAL DATA

Left port at Local~1400 5th Sep 2019 (GMT=JD248.92),
Returned to port ~ 1400 15th Sept 2019 (GMT=JD258.92)
(More pre and post cruise data available, from days 242, in Port Clarence, to 266 in Kodiak)

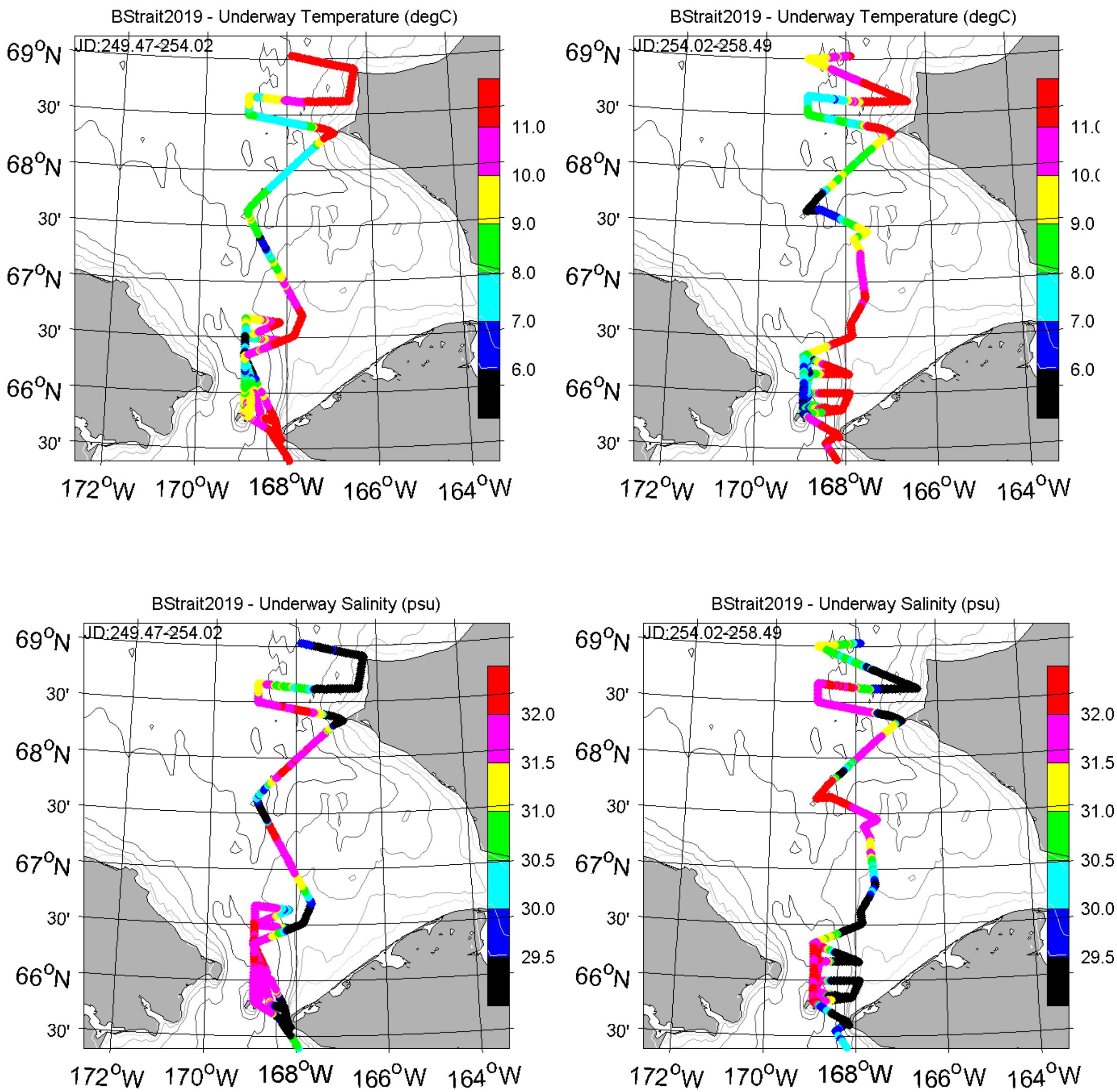


BERING STRAIT 2019 UNDERWAY TEMPERATURE SALINITY DATA



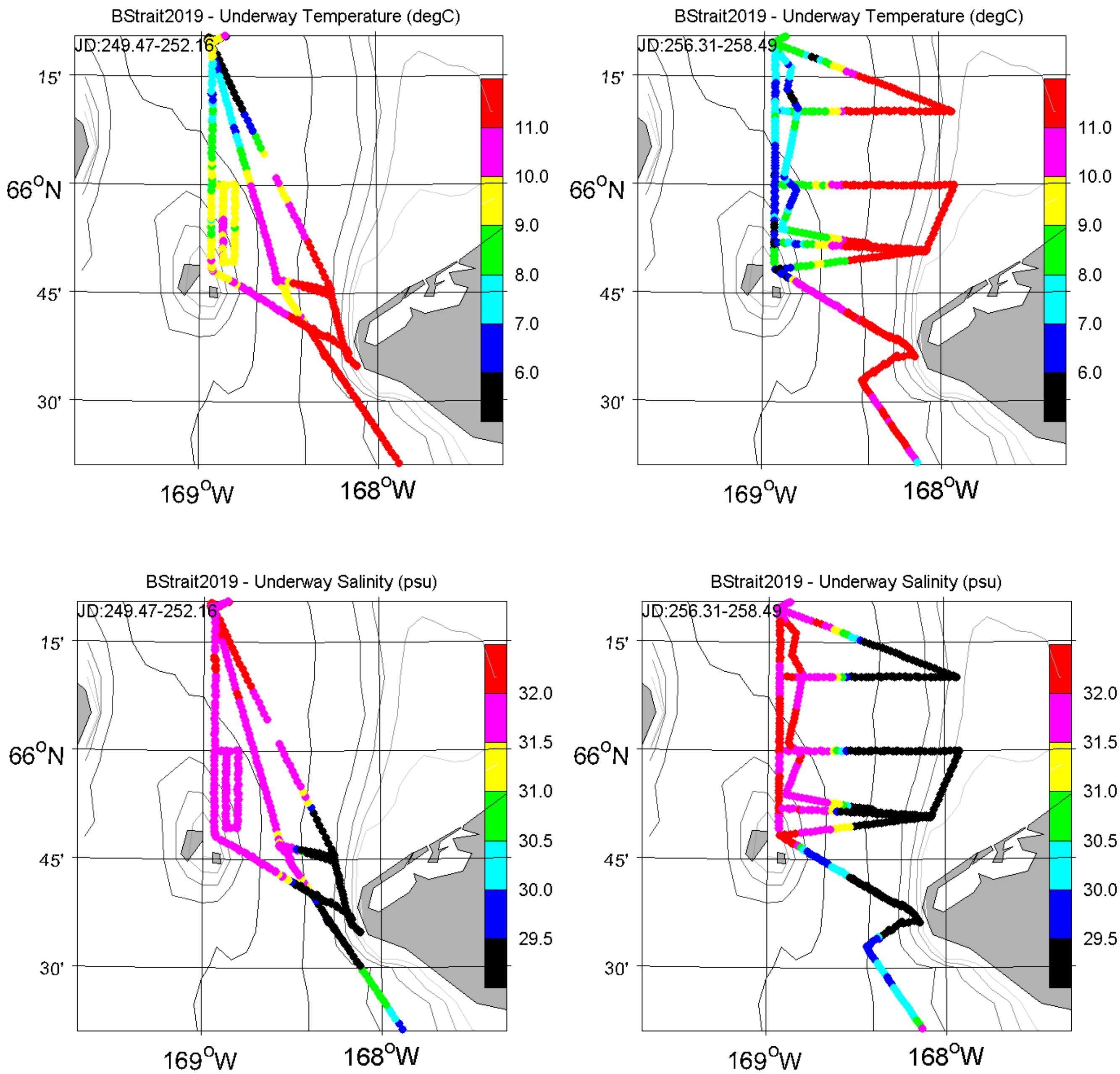
BERING STRAIT 2019 UNDERWAY TEMPERATURE SALINITY DATA (continued)
(Note multiple runnings of the Bering Strait (and other) lines are masked in these plots.)

First Half **Second half**



Focus on the strait only

First Half | **Second half**



BERING STRAIT 2019 TARGET CTD POSITIONS

The following lists give the positions of the CTD lines taken in US waters in the Bering Strait region in the last decade (including during the 2019 cruise) as part of the Bering Strait mooring cruises. Stations taken on this 2019 cruise are included in the full event log later in this cruise report.

```
%=========================================================
% Stations for BStrait Mooring Cruise 2019 NorsemanII
%=========================================================
%
% US-Russian convention line is at 168deg 58.7'W.
% All stations in this file are in US waters.
% (Let me know if any points are too close to border for you.)
%
% Time estimates are based on the 2013 NorsemanII cruise.
%=========================================================
% INCLUDING NEW LINES FROM 2017 CRUISE, viz
% - higher res DL north
% - higher res A3L
% - higher res SBS
% - LIS redone to avoid cable at LIS9
%=========================================================
% *****   MOORING POSITIONS *****
%=========================================================
% In likely order of servicing, i.e.,
% - recoveries from east to west in strait, then northern site;
% - deployments northern site, the west to east in strait.
% == 3 moorings to recover
% == 3 moorings to deploy
%-----------------------------------------
% RECOVERIES of moorings deployed in 2018
%-----------------------------------------
%NAME        Lat(N)          Long (W)      Water   Top
%            deg min         deg min       depth   Float
% A3-18     66  19.62      168  57.08     57m     15m
% A2-18     65  46.87      168  34.08     55m     15m
% A4-18     65  44.76      168  15.77     48m     15m
%--------------------------------
% DEPLOYMENTS for this 2019 cruise
%--------------------------------
% Target same as 2012 positions.
%NAME      Lat(N)         Long (W)      Water
%          deg min        deg min       depth
% A3-18    66  19.61      168  57.05     58m
% A2-18    65  46.86      168  34.07     56m
% A4-18    65  44.75      168  15.77     49m
%
%-----------------------
% INTERMOORING DISTANCES
%-----------------------
% A2 - A4 ~ 8nm
%------------
% To A3 from
%------------
```

```
%   A2  - 34nm
%   A4  - 39nm
%-------------
% To Nome from
%-------------
%   A4 - 120nm
%   CS1 - 200-220nm
%=========================================================
%
%=========================================================
% *****   HISTORIC CTD SECTIONS *****
%=========================================================
% There are 14 historic CTD lines here.
% These are the same positions as suggested in 2017, with
% the addition of 3 lines run in 2017 and the moving of
% one line (a change also made on the 2017 cruise).
% We may not have time for all of these, in which case
% we will do a subset.  But I've included
% them all, so you have the positions in advance.
% If operations/science dictate, then there
% might be different lines proposed while at sea.
%
% Naming is based on historic data.
% "+net" also refers to historic operations and
% is not relevant for this cruise.
% "no bottles" refers to historic operations and
% is not relevant for this cruise.  (No bottles
% will be taken on any CTD casts of this cruise.)
% Known Hazards are indicated.
%
% Stay a safe distance (300m?) from all deployed
% moorings.
%
% Except for around moorings or for mooring work,
% within 200m is ok for positions.
%
%=====================================
% BS = Bering Strait Line (US portion)
%=====================================
% - 15 stations
% - station spacing generally ~ 2nm
% Distances: - BS11-BS22 21.7nm
%            - BS22-BS24  3.1nm
% Total length 24.8nm
%--
% Time from NorsemanII, 6 hrs running W, 5 hrs running E
% Time from Khromov 10.5hrs
%-----------------------------------------------------
% Lat (N) Long (W)   Lat (N)     Long (W)    Name
%                   deg min     deg   min
  65.805  168.933   65  48.31   168  55.96  % BS11
  65.788  168.860   65  47.26   168  51.62  % BS12
  65.772  168.794   65  46.33   168  47.64  % BS13
  65.755  168.721   65  45.28   168  43.29  % BS14
```

```
  65.739  168.663   65  44.35   168  39.80  % BS15
  65.722  168.591   65  43.29   168  35.46  % BS16 + net
  65.704  168.521   65  42.23   168  31.28  % BS17
  65.695  168.486   65  41.70   168  29.16  % BS17S
  65.686  168.449   65  41.18   168  26.94  % BS18
  65.672  168.391   65  40.35   168  23.44  % BS19
  65.655  168.318   65  39.29   168  19.09  % BS20
  65.642  168.250   65  38.53   168  14.97  % BS21
  65.625  168.177   65  37.48   168  10.63  % BS22 + net
  65.599  168.161   65  35.96   168   9.66  % BS23
  65.582  168.117   65  34.91   168   7.00  % BS24
%
%This might also be run at the extra high resolution
% of 2014, viz:
65.805     168.933    65    48.31 168   55.96 %     BS11
65.797     168.897    65    47.79 168   53.79 %     BS11.5
65.788     168.86     65    47.26 168   51.62 %     BS12
65.780     168.827    65    46.8  168   49.63 %     BS12.5
65.772     168.794    65    46.33 168   47.64 %     BS13
65.764     168.758    65    45.81 168   45.47 %     BS13.5
65.755     168.721    65    45.28 168   43.29 %     BS14
65.747     168.692    65    44.82 168   41.55 %     BS14.5
65.739     168.663    65    44.35 168   39.8  %     BS15
65.731     168.627    65    43.82 168   37.63 %     BS15.5
65.722     168.591    65    43.29 168   35.46 %     BS16
65.713     168.556    65    42.76 168   33.37 %     BS16.5
65.704     168.521    65    42.23 168   31.28 %     BS17
65.695     168.486    65    41.7  168   29.16 %     BS17.5
65.686     168.449    65    41.18 168   26.94 %     BS18
65.679     168.42     65    40.77 168   25.19 %     BS18.5
65.672     168.391    65    40.35 168   23.44 %     BS19
65.664     168.355    65    39.82 168   21.27 %     BS19.5
65.655     168.318    65    39.29 168   19.09 %     BS20
65.649     168.284    65    38.91 168   17.03 %     BS20.5
65.642     168.25     65    38.53 168   14.97 %     BS21
65.634     168.214    65    38.01 168   12.8  %     BS21.5
65.625     168.177    65    37.48 168   10.63 %     BS22
65.599     168.161    65    35.96 168   9.66  %     BS23
65.582     168.117    65    34.91 168   7     %     BS24
%
%
%===========================
% AL = A3 Line (US portion)
%==========================
% Hazards on this line:
% == First station on this line is at mooring A3-17, so exact
% position needs to be altered to be a safe distance (300m?)
% from mooring A3-17 site.
%-----------------------------------------------------
% - 13 stations including cast at A3mooring site
% - station spacing ~ 1.9nm
% Distance: - A3 to AL24 = 22.2nm
% --
% Time from NorsemanII ~5.5hrs
```

```
% Time from Khromov ~9hrs
%----------------------------------------------------------
% Lat (N) Long (W)   Lat (N)      Long (W)     Name
%                    deg min      deg   min
   66.327  168.951   66  19.61    168   57.05  % A3-17
% *** Adjust this first position to be safe distance (300m?) from A3-17
   66.340  168.895   66  20.39    168   53.71  % AL13
   66.352  168.823   66  21.09    168   49.40  % AL14
   66.363  168.752   66  21.80    168   45.09  % AL15
   66.375  168.680   66  22.51    168   40.78  % AL16
   66.387  168.608   66  23.21    168   36.47  % AL17 + net
   66.399  168.536   66  23.92    168   32.16  % AL18
   66.410  168.464   66  24.63    168   27.84  % AL19
   66.422  168.392   66  25.33    168   23.53  % AL20
   66.434  168.320   66  26.04    168   19.22  % AL21
   66.446  168.249   66  26.75    168   14.91  % AL22 + net
   66.458  168.177   66  27.45    168   10.60  % AL23
   66.469  168.105   66  28.16    168    6.29  % AL24
%
%
%==========================================================
% CS = Cape Serdtse Kamen to Point Hope Line (US portion)
%==========================================================
% Hazards on this line:
% == Final station CS19 is shallow.  Check on
% modern charts to see if deep enough for NorsemanII.
% (this station was too shallow for the Khromov, but
% was ok for the NorsemanII in 2013).
%------------------------------------------------------------
% - 16 or 17 stations
% - station spacing ~ 5nm in the central Chukchi,
%                   ~ 2.2nm near the coast
% Distances: - CS10US to CS18 60.8nm
%            - CS18 to CS19    2.2nm
%--
% Time from NorsemanII (toCS19) ~ 10.5 hrs
% Time from Khromov (toCS18) ~12hrs
%-----------------------------------------------------------
%     Lat (N)     Long (W)       Name
%     deg min     deg   min
0 0   67   38.1   168   56.0     % CS10US + net
0 0   67   41.7   168   48.1     % CS10.5  - no bottles
0 0   67   45.3   168   39.9     % CS11
0 0   67   48.9   168   29.4     % CS11.5  - no bottles
0 0   67   52.5   168   18.8     % CS12 + net
0 0   67   55.9   168    9.1     % CS12.5  - no bottles
0 0   67   59.3   167   59.4     % CS13
0 0   68    2.7   167   49.7     % CS13.5  - no bottles
0 0   68    6.1   167   39.9     % CS14 + net
0 0   68    9.1   167   30.7     % CS14.5  - no bottles
0 0   68   12.1   167   21.4     % CS15
0 0   68   13.6   167   16.8     % CS15.5  - no bottles
0 0   68   15.0   167   12.2     % CS16
0 0   68   16.6   167    7.6     % CS16.5  - no bottles
```

```
0 0   68   18.0   167    2.9     % CS17 + net
0 0   68   18.9   166   57.6     % CS18
0 0   68   19.9   166   52.3     % CS19 *** SHALLOW **
%                 CS19 too shallow for Khromov.
%
%
%==================================================
% DL = Diomede Line (US only, 1nm east of border)
%==================================================
% This line is to map eddying area north of the Diomedes
% - 19 stations
% - station spacing ~ 1nm in South,
%                    ~ 2.5nm in north
% Distance: - DL1 to DL19  28.7nm
%--
% Time from NorsemanII - 5.5 hrs running N; 9hrs running S
% Time from Khromov to DL19 ~10hrs
%---------------------------------------------------
%     Lat (N)      Long (W)     Name
%     deg min      deg   min
0 0  65   49.28    168   56.2  % DL1
0 0  65   50.26    168   56.2  % DL2
0 0  65   51.23    168   56.2  % DL3
0 0  65   52.21    168   56.2  % DL4 + net
0 0  65   53.18    168   56.2  % DL5 - no bottles
0 0  65   54.15    168   56.2  % DL6
0 0  65   55.13    168   56.2  % DL7 - no bottles
0 0  65   56.10    168   56.2  % DL8
0 0  65   57.08    168   56.2  % DL9 - no bottles
0 0  65   58.05    168   56.2  % DL10
0 0  65   59.03    168   56.2  % DL11- no bottles
0 0  66    0.00    168   56.2  % DL12
0 0  66    2.55    168   56.2  % DL13- no bottles
0 0  66    5.10    168   56.2  % DL14
0 0  66    7.65    168   56.2  % DL15- no bottles
0 0  66   10.19    168   56.2  % DL16
0 0  66   12.74    168   56.2  % DL17- no bottles
0 0  66   15.29    168   56.2  % DL18
0 0  66   17.84    168   56.2  % DL19- no bottles
%
%
%==========================================
% DL A and B lines (Diomede A and B lines)
%==========================================
% These lines, with DL, form a grid to map
% eddying N of the Diomedes.
% - each line 12 stations
% - station spacing ~ 1nm
% Distances: - each line ~ 11nm
%--
% Estimate for NorsmanII for each line ~3.5hrs
% Time from Khromov for each line ~5hrs
%-------------------------------------------
%     Lat (N)       Long (W)     Name
```

```
%     deg min       deg   min
% Northbound leg
0 0   65   49.30    168   52.2  % DLa 1
0 0   65   50.27    168   52.2  % DLa 2
0 0   65   51.25    168   52.2  % DLa 3
0 0   65   52.22    168   52.2  % DLa 4
0 0   65   53.19    168   52.2  % DLa 5
0 0   65   54.16    168   52.2  % DLa 6
0 0   65   55.14    168   52.2  % DLa 7
0 0   65   56.11    168   52.2  % DLa 8
0 0   65   57.08    168   52.2  % DLa 9
0 0   65   58.05    168   52.2  % DLa 10
0 0   65   59.03    168   52.2  % DLa 11
0 0   66    0.00    168   52.2  % DLa 12
% Southbound leg
0 0   66    0.00    168   48.2  % DLb 12
0 0   65   59.03    168   48.2  % DLb 11
0 0   65   58.05    168   48.2  % DLb 10
0 0   65   57.08    168   48.2  % DLb 9
0 0   65   56.11    168   48.2  % DLb 8
0 0   65   55.14    168   48.2  % DLb 7
0 0   65   54.16    168   48.2  % DLb 6
0 0   65   53.19    168   48.2  % DLb 5
0 0   65   52.22    168   48.2  % DLb 4
0 0   65   51.25    168   48.2  % DLb 3
0 0   65   50.27    168   48.2  % DLb 2
0 0   65   49.30    168   48.2  % DLb 1
%
%
%============================================
% AS = from AL to CS Line
%============================================
% Across-topography line linking Al line with CS
% - 20 stations (counting first of CS line)
% - station spacing
%       AS1-7 at ~ 4nm spacing.
%       AS7-14 at 2nm spacing,
%       A14 to end 4nm
% Distances: - AS1 to CS10 64.7nm
%--
% Time from Khromov (12casts, odds+2&18) ~11hrs
% Estimate for NorsmanII 20 casts ~ 12hrs
% Estimate for Khromov 20 casts ~ 14hrs
%---------------------------------------------
%     Lat (N)        Long (W)       Name
%     deg min        deg   min
0 0   66   41.47     167   38.86   % AS 1
0 0   66   45.01     167   43.78   % AS 2-no bottles
0 0   66   48.55     167   48.70   % AS 3
0 0   66   52.09     167   53.62   % AS 4-no bottles
0 0   66   55.63     167   58.55   % AS 5
0 0   66   59.17     168    3.47   % AS 6-no bottles
0 0   67    2.71     168    8.39   % AS 7
%                          (2nm spacing over slope)
```

```
0 0   67    4.48     168   10.85   % AS 8-no bottles
0 0   67    6.25     168   13.31   % AS 9
0 0   67    8.02     168   15.77   % AS 10-no bottles
0 0   67    9.78     168   18.23   % AS 11
0 0   67   11.55     168   20.69   % AS 12-no bottles
0 0   67   13.32     168   23.15   % AS 13
0 0   67   16.86     168   28.07   % AS 14
%                           (back to 4nm spacing)
0 0   67   20.40     168   32.99   % AS 15-no bottles
0 0   67   23.94     168   37.92   % AS 16
0 0   67   27.48     168   42.84   % AS 17-no bottles
0 0   67   31.02     168   47.76   % AS 18
0 0   67   34.56     168   52.68   % AS 19-no bottles
0 0   67   38.10     168   56.00   % CS10US
%
%
%===============================
% LIS = Cape Lisburne Line
%===============================
% - 17 stations (including first of CCL line)
% - station spacing ~ 2nm near coast,
%              ~ 3nm and ~ 5nm away from coast
% Distances: - LIS1 to CCL22 57.2nm
%--
% Time from NorsemanII, ~ 10hrs
% Time from Khromov ~11hrs
%-----------------------------
%     Lat (N)        Long (W)     Name
%     deg min       deg   min
0 0   68   54.40    166   19.80  % LIS 1 + net
0 0   68   54.80    166   25.15  % LIS 2
0 0   68   55.20    166   30.51  % LIS 3
0 0   68   55.80    166   38.54  % LIS 4
0 0   68   56.40    166   46.57  % LIS 5
0 0   68   57.00    166   54.60  % LIS 6 + net
0 0   68   57.60    167    1.95  % LIS 6.5 - no bottles
0 0   68   58.20    167    9.30  % LIS 7
0 0   68   58.80    167   16.65  % LIS 7.5 - no bottles
0 0   68   59.40    167   24.00  % LIS 8
0 0   69    0.60    167   38.70  % LIS 9
0 0   69    1.80    167   53.40  % LIS 10 + net
0 0   69    1.35    168    7.95  % LIS 11
0 0   69    0.90    168   22.50  % LIS 12
0 0   69    0.45    168   37.05  % LIS 13
0 0   69    0.23    168   46.62  % LIS 14n + net
0 0   69    0.00    168   56.00  % CCL22n % was 56.2
%
%
%===============================
% CCL = Chukchi Convention Line
%===============================
% Hazards on this line:
% == First station on this line is the same as last station
% included in the LIS line above.  It does not need to be
```

```
% repeated.
% == Last station on this line is at mooring A3-14, so exact
% position needs to be altered to be a safe distance (300m?)
% from mooring A3-14 site.
% == There are 2 JAMSTEC moorings ~ 3nm east of station
% CCL16 on this line.  Those positions are:
% SCH13  68 2.002N   168 50.028W
% SCH13w 68 3.006N   168 50.003W
%---------------------------------------
% Line running from northern most point
% due south, ~ 1nm US side of conventionline
% - 20 stations (counting arriving at A3-14)
% - station spacing ~ 10nm until CCL8,
%      then reducing to ~5nm and ~2.5nm
% Distances: - CCL22 to A3-13 ~ 161nm
%--
% Time from NorsemanII, 21.5hrs
% Time from Khromov ~26hrs
%----------------------------------------
%      Lat (N)        Long (W)      Name
%      deg   min      deg   min
0 0    69     0.0     168  56.0   % CCL22
0 0    68    50.0     168  56.0   % CCL21
0 0    68    40.0     168  56.0   % CCL20
0 0    68    30.0     168  56.0   % CCL19
0 0    68    20.0     168  56.0   % CCL18 + Net
0 0    68    10.0     168  56.0   % CCL17
0 0    68    00.0     168  56.0   % CCL16
0 0    67    50.0     168  56.0   % CCL15
0 0    67    38.1     168  56.0   % CCL14 (same as CS10US) + Net + Prod
%
0 0    67    30.0     168  56.0   % CCL13
0 0    67    20.0     168  56.0   % CCL12
0 0    67    10.0     168  56.0   % CCL11
0 0    67    00.0     168  56.0   % CCL10 + Net
0 0    66    50.0     168  56.0   % CCL9
0 0    66    40.0     168  56.0   % CCL8
%          - spacing now 5nm
0 0    66    35.0     168  56.0   % CCL7
0 0    66    30.0     168  56.0   % CCL6
0 0    66    25.0     168  56.0   % CCL5
%          - spacing now 2.5nm
0 0    66    22.3     168  56.0   % CCL4
0 0    66    19.61    168  57.05  % A3-17
% *** Adjust this position to be safe distance (300m?) from A3-17
%
%
%=======================================
% NBS - North Bering Strait line
%=======================================
% Hazards on this line:
% == Section crosses shallow waters.
% Beware of shallows from NBS9 and eastwards.
% (Helix diverted N to avoid shallows between
```

```
% stations NBS10 and NBS11)
% == Consider terminating line at NBS9
%-----------------------------------------
% Another cross strait line, run previously
% at lower resolution (i.e. without the 0.5 stations).
% - stations 9 (NBS1-9) to 16 (NBS1-9 with 0.5s)
%    to 21 (full section, including shallows).
% - station spacing (with 0.5s) ~ 1.7nm
% Distance: - NBS1-9  25.8nm
%           - NBS1-14 44.1nm
%--
% Time from Helix to NBS9, 9 casts ~5.5hrs
% - Estimate for NorsemanII to NBS9, 9 casts, 6hrs
% - Estimate for NorsemanII to NBS9, 16 casts, 7.5hrs
% - Estimate Khromov to NBS9, 9 casts ~6.5hrs
% - Estimate Khromo to NBS9, 16 casts ~8hrs
% Time from Helix to NBS14, 14 casts ~8.5hrs
% - Estimate for NorsemanII to NBS14, 14 casts, 9hrs
% - Esimate for NorsemanII to NSB14, 21 casts, 10.5hrs
% - Estimate Khromov to NBS14, 14 casts ~10hrs
% - Estimate Khromov to NBS14, 21 casts ~13hrs
%------------------------------------------
%      Lat (N)        Long (W)     Name
%      deg   min      deg   min
0 0    66     0.0     168  56.0   % NBS1 % was 58.1
0 0    66     0.0     168  53.0   % NBS1.5
0 0    66     0.0     168  49.9   % NBS2
0 0    66     0.0     168  45.8   % NBS2.5
0 0    66     0.0     168  41.6   % NBS3
0 0    66     0.0     168  37.4   % NBS3.5
0 0    66     0.0     168  33.2   % NBS4
0 0    66     0.0     168  29.1   % NBS4.5
0 0    66     0.0     168  25.0   % NBS5
0 0    66     0.0     168  20.7   % NBS5.5
0 0    66     0.0     168  16.4   % NBS6
0 0    66     0.0     168  12.4   % NBS6.5
0 0    66     0.0     168   8.4   % NBS7
0 0    66     0.0     168   4.2   % NBS7.5
0 0    66     0.0     168   0.0   % NBS8 - 34m water
0 0    66     0.0     167  55.1   % NBS9 - 20m water
%  (consider terminating line here)
0 0    66     0.0     167  52.0   % NBS10 - 12m water
% (Helix diverted N to avoid shallows between these stations)
0 0    66     0.0     167  40.1   % NBS11 - 15m water
0 0    66     0.0     167  29.1   % NBS12 - 18m water
0 0    66     0.0     167  18.1   % NBS13 - 13m water
0 0    66     0.0     167  10.2   % NBS14 - 10m water
%
%
%====================================
% MBSn = Mid Bering Strait line
%====================================
% Just north of the Bering Strait line
% - 14 stations
```

```
% - station spacing 1.7nm, less near coast
% Distance: - 21.0nm total
%--
% Time from Helix (8casts only) ~2.5hrs
% - Estimate NorsemanII (8 casts only) ~ 4hrs
% - Estimate NorsemanII (14 casts)  ~ 6hrs
% - Estimate Khromov (8casts only)~5.5hrs
% - Estimate Khromov (14casts) ~7hrs
%---------------------------------------
%      Lat (N)        Long (W)     Name
%      deg   min      deg   min
0 0    65    52.1     168  56.0   % MBSn1 % was 57.0
0 0    65    52.0     168  52.5   % MBSn1.5
0 0    65    51.9     168  49.1   % MBSn2
0 0    65    51.8     168  45.0   % MBSn2.5
0 0    65    51.7     168  40.9   % MBSn3
0 0    65    51.6     168  36.4   % MBSn3.5
0 0    65    51.5     168  31.9   % MBSn4 % was 51.6
0 0    65    51.4     168  27.5   % MBSn4.5
0 0    65    51.3     168  23.0   % MBSn5 % was 51.4
0 0    65    51.2     168  18.5   % MBSn5.5
0 0    65    51.1     168  13.9   % MBSn6
0 0    65    51.1     168  10.4   % MBSn6.5
0 0    65    51.0     168   6.9   % MBSn7
0 0    65    50.9     168   5.0   % MBSn8
%
%
%=========================================================
% North North Bering Strait Line (NNBS)
%============================================
% A section across the ACC and main flow between
% the A3L line and the NBS line.
% With the 0.5s, at 1.76nm spacing
% 22.8nm length
%-----------------------------------
% Run for the first time in 2015 - check water depths on
% the eastern (NNBS7.5) end)
% Dovetails with DL line.  NNBS1 is the same as DL16

 66.170 168.937   66   10.19 168   56.20  %NNBS1
 66.170 168.865   66   10.19 168   51.88  %NNBS1.5
 66.170 168.793   66   10.19 168   47.55  %NNBS2
 66.170 168.721   66   10.19 168   43.23  %NNBS2.5
 66.170 168.648   66   10.19 168   38.91  %NNBS3
 66.170 168.576   66   10.19 168   34.58  %NNBS3.5
 66.170 168.504   66   10.19 168   30.26  %NNBS4
 66.170 168.432   66   10.19 168   25.94  %NNBS4.5
 66.170 168.360   66   10.19 168   21.62  %NNBS5
 66.170 168.288   66   10.19 168   17.29  %NNBS5.5
 66.170 168.216   66   10.19 168   12.97  %NNBS6
 66.170 168.144   66   10.19 168    8.65  %NNBS6.5
 66.170 168.072   66   10.19 168    4.32  %NNBS7
 66.170 168.000   66   10.19 168    0.00  %NNBS7.5
%=========================================================
```

```
%=============================================
%
% Two new lines to map the ACC as and after it rounds Point Hope
%
%==============================================
% NPH - North Point Hope Line
%----------------------------------------------
%  Crossing from Point Hope to the ENE roughly.
% - 11 stations,
%     from 1-5 and 1.25nm spacing
%     for the rest of the line at 2.5nm
% - Distance 21nm
% - new in 2016
%   - ** CHECK DEPTH OF SHALLOWEST  NPH1
%
% Run from east (NPH1) to west (NPH11)
% - estimate 3hrs 15min
%-----------------------------------------------
%     Lat (N)      Long (W)     Name
%     deg min      deg min
0 0   68  22.40     167  07.93   % NPH1
0 0   68  22.64     167  11.31   % NPH2
0 0   68  22.87     167  14.68   % NPH3
0 0   68  23.11     167  18.06   % NPH4
0 0   68  23.35     167  21.44   % NPH5
0 0   68  23.83     167  28.19   % NPH6
0 0   68  24.30     167  34.95   % NPH7
0 0   68  24.77     167  41.71   % NPH8
0 0   68  25.25     167  48.46   % NPH9
0 0   68  25.73     167  55.22   % NPH10
0 0   68  26.20     168  01.97   % NPH11
%
%
%==============================================
% CD- Cape Dyer
%----------------------------------------------
%  Crossing east west, midway between Point Hope
% and Cape Lisburne (near Cape Dyer) and trying
% to avoid some topographic irregularites just
% N of the line on the charts.
% - 14 stations, 2nm spacing
% - Distance 26nm
% - new in 2016
%   - ** CHECK DEPTH OF SHALLOWEST  CD1
%-----------------------------------------------
%     Lat (N)      Long (W)     Name
%     deg min      deg min
0 0   68  37.00     167  41.0   % CD14
0 0   68  37.00     167  35.5   % CD13
0 0   68  37.00     167  29.9   % CD12
0 0   68  37.00     167  24.4   % CD11
0 0   68  37.00     167  18.8   % CD10
0 0   68  37.00     167  13.3   % CD9
```

```
0 0   68  37.00     167   7.8   % CD8
0 0   68  37.00     167   2.2   % CD7
0 0   68  37.00     166  56.7   % CD6
0 0   68  37.00     166  51.2   % CD5
0 0   68  37.00     166  45.6   % CD4
0 0   68  37.00     166  40.1   % CD3
0 0   68  37.00     166  34.5   % CD2
0 0   68  37.00     166  29.0   % CD1
%==================================================
%=================================================
% DL = Diomede Line EXTRAS(US only, 1nm east of border)
%=================================================
% This line is to map eddying area north of the Diomedes
% - 19 stations
% - station spacing ~ 1nm in South,
%                   ~ 2.5nm in north
% Distance: - DL1 to DL19  28.7nm
%--
% Time from NorsemanII - 5.5 hrs running N; 9hrs running S
% Time from Khromov to DL19 ~10hrs
%
% (The info about is withOUT the 0.5)********
%--------------------------------------------------
%     Lat (N)      Long (W)     Name
%     deg min      deg   min
0 0  66    0.00    168   56.2  % DL12
0 0  66    1.28    168   56.2  % DL12.5
0 0  66    2.55    168   56.2  % DL13
0 0  66    3.83    168   56.2  % DL13.5
0 0  66    5.10    168   56.2  % DL14
0 0  66    6.38    168   56.2  % DL14.5
0 0  66    7.65    168   56.2  % DL15
0 0  66    8.92    168   56.2  % DL15.5
0 0  66   10.19    168   56.2  % DL16
0 0  66   11.47    168   56.2  % DL16.5
0 0  66   12.74    168   56.2  % DL17
0 0  66   14.02    168   56.2  % DL17.5
0 0  66   15.29    168   56.2  % DL18
0 0  66   16.57    168   56.2  % DL18.5
0 0  66   17.84    168   56.2  % DL19
0 0  66   18.73    168   56.2  % DL19.5
%
%
%==========================
% AL = A3 Line (US portion) - with extras
%=========================
% Hazards on this line:
% == First station on this line is at mooring A3-17, so exact
% position needs to be altered to be a safe distance (300m?)
% from mooring A3-15 site.
%-----------------------------------------------------
% - 13 stations including cast at A3mooring site
% - station spacing ~ 1.9nm
% Distance: - A3 to AL24 = 22.2nm
```

```
% --
% Time from NorsemanII ~5.5hrs
% Time from Khromov ~9hrs

% (The info about is withOUT the 0.5)********
%
%------------------------------------------------------
% Lat (N) Long (W)   Lat (N)      Long (W)     Name
%                    deg min      deg   min

%
   66.3270  168.9510   66   19.6100  168   57.0500    % A3-17
% *** Adjust this first position to be safe distance (300) from A3-17
   66.3335  168.9230   66   20.0000  168   55.3800    % new AL12.5
   66.3400  168.8950   66   20.3900  168   53.7100    % AL13
   66.3460  168.8590   66   20.7400  168   51.5550    % new AL13.5
   66.3520  168.8230   66   21.0900  168   49.4000    % AL14
   66.3575  168.7875   66   21.4450  168   47.2450    % new AL14.5
   66.3630  168.7520   66   21.8000  168   45.0900    % AL15
   66.3690  168.7160   66   22.1550  168   42.9350    % new AL15.5
   66.3750  168.6800   66   22.5100  168   40.7800    % AL16
   66.3810  168.6440   66   22.8600  168   38.6250    % new AL16.5
   66.3870  168.6080   66   23.2100  168   36.4700    % AL17
   66.3940  168.5657   66   23.6400  168   33.9400    % new AL17.5  % AND
MOVED OFF Q CABLE
   66.3990  168.5360   66   23.9200  168   32.1600    % AL18
   66.4045  168.5000   66   24.2750  168   30.0000    % new AL18.5
   66.4100  168.4640   66   24.6300  168   27.8400    % AL19
   66.4160  168.4280   66   24.9800  168   25.6850    % new AL19.5
   66.4220  168.3920   66   25.3300  168   23.5300    % AL20
   66.4280  168.3560   66   25.6850  168   21.3750    % new AL20.5
   66.4340  168.3200   66   26.0400  168   19.2200    % AL21
   66.4400  168.2845   66   26.3950  168   17.0650    % new AL21.5
   66.4460  168.2490   66   26.7500  168   14.9100    % AL22
   66.4520  168.2130   66   27.1000  168   12.7550    % new AL22.5
   66.4580  168.1770   66   27.4500  168   10.6000    % AL23
   66.4635  168.1410   66   27.8050  168    8.4450    % new AL23.5
   66.4690  168.1050   66   28.1600  168    6.2900    % AL24
%
%Then these are new
   66.4745  168.0690   66   28.5150  168    4.1350    % new AL24.5
   66.4800  168.0330   66   28.8700  168    1.9800    % AL25
   66.4855  167.9970   66   29.2250  167   59.8200    % new AL25.5
   66.4910  167.9610   66   29.5800  167   57.6650    % AL26
   66.4965  167.9250   66   29.9350  167   55.5100    % new AL26.5
   66.5020  167.8890   66   30.2900  167   53.3550    % AL27
   66.5075  167.8530   66   30.6450  167   51.2000    % new AL27.5
%
%==============================
% LIS = Cape Lisburne Line (redone to avoid Qcable at Lis9)
%==============================
% - 18 stations (including first of CCL line)
% - station spacing ~ 2nm near coast,
%              ~ 3nm and ~ 5nm away from coast
```

```
% Distances: - LIS1 to CCL22 57.2nm
%--
% Time from NorsemanII, ~ 10hrs
% Time from Khromov ~11hrs
%
% Times different now added stations
%-------------------------------
%     Lat (N)        Long (W)      Name
%     deg min       deg   min
   0    0          68   54.40    166   19.80  % LIS 1 + net
   0    0          68   54.80    166   25.15  % LIS 2
   0    0          68   55.20    166   30.51  % LIS 3
   0    0          68   55.80    166   38.54  % LIS 4
   0    0          68   56.40    166   46.57  % LIS 5
   0    0          68   57.00    166   54.60  % LIS 6 + net
   0    0          68   57.60    167    1.95  % LIS 6.5 - no bottles
   0    0          68   58.20    167    9.30  % LIS 7
   0    0          68   58.80    167   16.65  % LIS 7.5 - no bottles
   0    0          68   59.40    167   24.00  % LIS 8
69.0033 167.5633   69   00.20    167   33.8   % NEW ** LIS 8.5
%
%DO NOT DO LIS 9
%   0    0          69    0.60    167   38.70  % LIS 9  ** on Q cable - do
not do
%DO NOT DO LIS 9
%
69.0167 167.7267   69    1.00    167   43.60  % NEW ** LIS 9.5
   0    0          69    1.80    167   53.40  % LIS 10 + net
   0    0          69    1.35    168    7.95  % LIS 11
   0    0          69    0.90    168   22.50  % LIS 12
   0    0          69    0.45    168   37.05  % LIS 13
   0    0          69    0.23    168   46.62  % LIS 14n + net
   0    0          69    0.00    168   56.00  % CCL22n % was 56.2
%
%=====================================================
% - South Bering Strait section
%==================================================================
% First ran in 2014 and 2015 and then only partly
% Run in full in 2017
%
% To catch ACC before it enters the strait
%
%  22.5nm long
%  21 stations including halves
%---------------------------------------------------------------
% Lat(N)   Lon  (W)          Lat (N)        Lon (W)      NAME
% decdeg  decdeg        deg      min      deg   min

 65.5818  168.1167    65    34.91 168    7.00 % SBS1 = BS24
 65.5736  168.1571    65    34.42 168    9.43 %  SBS1.5
 65.5655  168.1975    65    33.93 168   11.85 % SBS2
 65.5573  168.2379    65    33.44 168   14.28 %  SBS2.5
 65.5491  168.2784    65    32.95 168   16.70 % SBS3
 65.5409  168.3188    65    32.45 168   19.13 %  SBS3.5
```

```
 65.5327  168.3592    65   31.96 168   21.55 % SBS4
 65.5245  168.3997    65   31.47 168   23.98 %  SBS4.5
 65.5163  168.4401    65   30.98 168   26.40 % SBS5
 65.5081  168.4805    65   30.49 168   28.83 %  SBS5.5
 65.5000  168.5209    65   30.00 168   31.26 % SBS6
 65.4918  168.5614    65   29.51 168   33.68 %  SBS6.5
 65.4836  168.6018    65   29.02 168   36.11 % SBS7
 65.4754  168.6422    65   28.52 168   38.53 %  SBS7.5
 65.4672  168.6826    65   28.03 168   40.96 % SBS8
 65.4590  168.7231    65   27.54 168   43.38 %  SBS8.5
 65.4508  168.7635    65   27.05 168   45.81 % SBS9
 65.4426  168.8039    65   26.56 168   48.24 %  SBS9.5
 65.4345  168.8444    65   26.07 168   50.66 % SBS10
 65.4263  168.8848    65   25.58 168   53.09 %  SBS10.5
 65.4181  168.9252    65   25.09 168   55.51 % SBS11
%==========================================================
% CS = Cape Serdtse Kamen to Point Hope Line (US portion)
% - with extras.
%==========================================================
% Hazards on this line:
% == Final station CS19 is shallow.  Check on
% modern charts to see if deep enough for NorsemanII.
% (this station was too shallow for the Khromov, but
% was ok for the NorsemanII in 2013).
% == NOAA mooring at:
%     67 54.712N, 168 11.628W
%-------------------------------------------------------------
% - 27 stations
% - station spacing ~ 2.5nm in the central Chukch (0.25 stations)
%                   ~ 2.2nm near the coast
% Distances: - CS10US to CS18 60.8nm
%            - CS18 to CS19    2.2nm
% Time from NorsemanII (toCS19) ~ 11hrs
%------------------------------------------------------------
%      Lat (N)     Long (W)       Name
%      deg min     deg   min
0 0    67   38.1   168   56.0     % CS10US + net
0 0    67   39.9   168   52.0  % new CS10.25
0 0    67   41.7   168   48.1     % CS10.5  - no bottles
0 0    67   43.5   168   44.0  % new CS10.75
0 0    67   45.3   168   39.9     % CS11
0 0    67   47.1   168   34.6  % new CS11.25
0 0    67   48.9   168   29.4     % CS11.5  - no bottles
0 0    67   50.7   168   24.1  % new CS11.75
0 0    67   52.5   168   18.8     % CS12 + net
0 0    67   54.2   168   13.9  % new CS12.25
0 0    67   55.9   168    9.1     % CS12.5  - no bottles
0 0    67   57.6   168    4.2  % new CS12.75
0 0    67   59.3   167   59.4     % CS13
0 0    68    1.0   167   54.5  % new CS13.25
0 0    68    2.7   167   49.7     % CS13.5  - no bottles
0 0    68    4.4   167   44.8  % new CS13.75
0 0    68    6.1   167   39.9     % CS14 + net
0 0    68    7.6   167   35.3  % new CS14.25
```

```
0 0   68    9.1   167   30.7     % CS14.5  - no bottles
0 0   68   10.6   167   26.0  % new CS14.75
0 0   68   12.1   167   21.4     % CS15
0 0   68   13.6   167   16.8     % CS15.5  - no bottles
0 0   68   15.0   167   12.2     % CS16
0 0   68   16.6   167    7.6     % CS16.5  - no bottles
0 0   68   18.0   167    2.9     % CS17 + net
0 0   68   18.9   166   57.6     % CS18
0 0   68   19.9   166   52.3     % CS19 *** SHALLOW **

%=========================================================
% North North Bering Strait Line (NNBS)
%============================================
%
% Add a shallower station to NNBS ...

% A section across the ACC and main flow between
% the A3L line and the NBS line.
% With the 0.5s, at 1.76nm spacing
% 22.8nm length
%-----------------------------------
% Run for the first time in 2015 - check water depths on
% the eastern (NNBS7.5) end)
% Dovetails with DL line.  NNBS1 is the same as DL16

 66.170 168.937   66   10.19 168   56.20  %NNBS1
 66.170 168.865   66   10.19 168   51.88  %NNBS1.5
 66.170 168.793   66   10.19 168   47.55  %NNBS2
 66.170 168.721   66   10.19 168   43.23  %NNBS2.5
 66.170 168.648   66   10.19 168   38.91  %NNBS3
 66.170 168.576   66   10.19 168   34.58  %NNBS3.5
 66.170 168.504   66   10.19 168   30.26  %NNBS4
 66.170 168.432   66   10.19 168   25.94  %NNBS4.5
 66.170 168.360   66   10.19 168   21.62  %NNBS5
 66.170 168.288   66   10.19 168   17.29  %NNBS5.5
 66.170 168.216   66   10.19 168   12.97  %NNBS6
 66.170 168.144   66   10.19 168    8.65  %NNBS6.5
 66.170 168.072   66   10.19 168    4.32  %NNBS7
 66.170 168.000   66   10.19 168    0.00  %NNBS7.5
 66.170 168.000   66   10.19 167   55.70  %NNBS8   *** NEW

%==============================================
% NPH - North Point Hope Line (Extended)
%----------------------------------------------
%  Crossing from Point Hope to the ENE roughly.
% ======= 2019
% - updated to add an extra 20nm and 8 stations,
% with extras at 2.5nm space to CCL
% - now have 19 stations, and 40nm
%
% Run from east (NPH1) to west (NPH11)
% - estimate 3hrs 15min to NPH11 and then another
% - 4 hrs for the rest
%-----------------------------------------------
```

```
%     Lat (N)      Long (W)     Name
%     deg min      deg min
0 0   68  22.40     167  07.93   % NPH1
0 0   68  22.64     167  11.31   % NPH2
0 0   68  22.87     167  14.68   % NPH3
0 0   68  23.11     167  18.06   % NPH4
0 0   68  23.35     167  21.44   % NPH5
0 0   68  23.83     167  28.19   % NPH6
0 0   68  24.30     167  34.95   % NPH7
0 0   68  24.77     167  41.71   % NPH8
0 0   68  25.25     167  48.46   % NPH9
0 0   68  25.73     167  55.22   % NPH10
0 0   68  26.20     168  01.97   % NPH11
% NEW
0 0   68  26.68     168  08.72   % NPH11.5
0 0   68  27.15     168  15.47   % NPH12
0 0   68  27.63     168  22.23   % NPH12.5
0 0   68  28.10     168  28.98   % NPH13
0 0   68  28.58     168  35.74   % NPH13.5
0 0   68  29.05     168  42.49   % NPH14
0 0   68  29.53     168  49.25   % NPH14.5
0 0   68  30.00     168  56.00   % CCL19
%End of new

%==============================================
% CD- Cape Dyer (extended)
%----------------------------------------------
%  Crossing east west, midway between Point Hope
% and Cape Lisburne (near Cape Dyer) and trying
% to avoid some topographic irregularites just
% N of the line on the charts.
% - 27 stations, 2nm spacing
% - first 14 due west to match 2016 line, now
% then angles to meet CCL20 at the Convention line
% - Distance 54nm
% - 27 stations
%   - ** CHECK DEPTH OF SHALLOWEST  CD1
%-----------------------------------------------
%     Lat (N)      Long (W)     Name
%     deg min      deg min
0 0   68  40.00     168  56.0   % CCL20

**NEW
0 0   68  39.79     168  50.6   % CD27
0 0   68  39.57     168  45.3   % CD26
0 0   68  39.36     168  39.9   % CD25
0 0   68  39.14     168  34.6   % CD24
0 0   68  38.93     168  29.2   % CD23
0 0   68  38.71     168  23.9   % CD22
0 0   68  38.50     168  18.5   % CD21
0 0   68  38.29     168  13.1   % CD20
0 0   68  38.07     168   7.8   % CD19
0 0   68  37.86     168   2.4   % CD18
0 0   68  37.64     167  57.1   % CD17
```

```
0 0   68  37.43     167  51.7   % CD16
0 0   68  37.21     167  46.4   % CD15
*END OF NEW, carry on with 2016 stations

0 0   68  37.00     167  41.0   % CD14
0 0   68  37.00     167  35.5   % CD13
0 0   68  37.00     167  29.9   % CD12
0 0   68  37.00     167  24.4   % CD11
0 0   68  37.00     167  18.8   % CD10
0 0   68  37.00     167  13.3   % CD9
0 0   68  37.00     167   7.8   % CD8
0 0   68  37.00     167   2.2   % CD7
0 0   68  37.00     166  56.7   % CD6
0 0   68  37.00     166  51.2   % CD5
0 0   68  37.00     166  45.6   % CD4
0 0   68  37.00     166  40.1   % CD3
0 0   68  37.00     166  34.5   % CD2
0 0   68  37.00     166  29.0   % CD1

%============================================
% SAS = S extension of AS line
%============================================
% Adding another 8 stations at 4nm spacing south
% from AS1 to the coast.
%--
% Estimate for NorsemanII 8 casts ~ 4hrs
% Not run yet
%---------------------------------------------
%     Lat (N)         Long (W)       Name
%     deg min         deg   min
0 0   66   37.91      167   34.00   % SAS 1
0 0   66   34.35      167   29.14   % SAS 2
0 0   66   30.79      167   24.29   % SAS 3
0 0   66   27.23      167   19.43   % SAS 4
0 0   66   23.68      167   14.57   % SAS 5
0 0   66   20.12      167    9.72   % SAS 6
0 0   66   16.56      167    4.86   % SAS 7
0 0   66   13.00      167    0.00   % SAS 8

%==================================================================
% - South Bering Strait section  redone - SBSnn
%==================================================================
% First ran in 2014 and 2015 and then only partly
% Run in full in 2017
% Re aligned in 2019 to start from BS22
% 2019 stations slightly off this (SBSn)
%
% To catch ACC before it enters the strait
%
%  22.5nm long
%  21 stations including halves
%---------------------------------------------------------------
% Lat(N)   Lon  (W)    Lat (N)        Lon (W)      NAME
% decdeg  decdeg    deg      min     deg   min
```

```
65.625 168.177      65   37.48     168   10.63 % SBSnn1 = BS22
65.614 168.215      65   36.86     168   12.87 % SBSnn1.5
65.604 168.252      65   36.24     168   15.12 % SBSnn2
65.594 168.289      65   35.62     168   17.36 % SBSnn2.5
65.583 168.327      65   35.00     168   19.61 % SBSnn3
65.573 168.364      65   34.38     168   21.85 % SBSnn3.5
65.563 168.402      65   33.76     168   24.09 % SBSnn4
65.552 168.439      65   33.14     168   26.34 % SBSnn4.5
65.542 168.476      65   32.52     168   28.58 % SBSnn5
65.532 168.514      65   31.90     168   30.83 % SBSnn5.5
65.521 168.551      65   31.29     168   33.07 % SBSnn6
65.511 168.589      65   30.67     168   35.31 % SBSnn6.5
65.501 168.626      65   30.05     168   37.56 % SBSnn7
65.490 168.663      65   29.43     168   39.80 % SBSnn7.5
65.480 168.701      65   28.81     168   42.05 % SBSnn8
65.470 168.738      65   28.19     168   44.29 % SBSnn8.5
65.459 168.776      65   27.57     168   46.53 % SBSnn9
65.449 168.813      65   26.95     168   48.78 % SBSnn9.5
65.439 168.850      65   26.33     168   51.02 % SBSnn10
65.428 168.888      65   25.71     168   53.27 % SBSnn10.5
65.418 168.925      65   25.09     168   55.51 % SBSnn11
```

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%Date	Time	1	Cast NO	Dowr	Depth (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon(min)	Altimeter	%	StationID	Windspeed	Winddir	Operator	Fog	WaterClar	Comments
%yyyymmdd	GMT					%Use Aft GPS		% Use Aft GPS		0=bad 1=goo	%		knots	from		0=clear	0=clear, 1=noclear	
%There should be one line for the beginning of the event and one line for the end											%							
%Date is GMT and has the format yyyymmdd											%							
%Time is GMT and has the format hhmm											%							
%Ty=Type: 1=CTD / 2=Net tow/4=prod cast x										Altimeter	%	THIS YEAR WE ONLY HAVE TYPE 1				Fog	Waterclarity	
%#,Number is consecutive for that event type											%							
%In/out (I/O): 1=In / 2=Out											%							
%Dep=waterdepth(m) from Furuno readout by CTD which is depth below keel, keel is 3m (10ft)																		
%LatD and LatM are Latitude Degrees and Minute and are positive N											%							
%LonD and LonM are Longitude Degrees and Min and are positive W											%							
%St is the name of the station (Line ID then station number)											%							
% SS = CTD operator estimate of sea state (Beaufort Scale)																		
%WSp=wind speed in m/s; WD=Wind direction from bridge																		
%Op=CTD operator																		
% when 3 lines for NET, dep indicates wire out for net																		
% Altimeter = 0 if complete rubbish, 0.5 if some good readings, 1 if good both up and down																		

%Date	Time	1	Cast NO	Dowr	Depth (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon(min)	Altimeter	%	StationID	Surf	Bot	Windspeed	Winddir	Operator	Fog	WaterClarity	Comments
20190906	0022	1	**1**	1	24.1	64	22.288	165	44.37	1	%	water test	213	233	25	SE	Max	0	1	Test cast, Forward GPS position ,start time from header
20190906	0099	1	**1**	2	24.5	64	22.455	165	44.668	1	%	water test	213	233	24.7	SE	Max	0	1	end time from header
20190906	1623	1	**2**	1	53	65	47.001	168	33.825	1	%	A218	213	260	5.1	NNE	Max			A218 cal cast, ~300m off, forward GPS position, start time from header
20190906	1699	1	**2**	2	53.1	65	47.083	168	33.772	1	%	A218		260	4.4	NNE	Max			end time from header
20190906	1904	1	**3**	1	44.9	65	44.876	168	15.793	1	%	A418	213	254	7.3	NNE	Max	0		A418 cal cast, forward GPS position, start time from header
20190906	1908	1	**3**	2	45	65	44.98	168	15.752	1	%	A418		254	6.7	NNE	Max	0		
20190907	0120	1	**4**	1	54.7	66	19.675	168	56.714	0	%	A318	213	264	8.3	NE	KC	1	3m	A318 cal cast, start time from header
20190907	0126	1	**4**	2	54.7	66	19.751	168	56.834	0	%	A318	213	264	8.4	NE	KC	1	3m	
20190907	0142	1	**5**	1	54.7	66	19.956	168	57.18	0	%	winchtest	212	264	6.8	NE	KG	1		off A318 for winch test
20190907	0148	1	**5**	2	54.7	66	20.017	168	57.29	0	%	winchtest	213	264	6.8	NE	KG	1		
20190907	0154	1	**6**	1	54.6	66	19.764	168	56.851	0	%	A318			6.8	NE	KG	1		near A318, winch test
20190907	0200	1	**6**	2	54.6	66	19.841	168	56.854	0	%	A318	213		8.8	NE	KG	1		
20190907	0205	1	**7**	1	54.6	66	19.692	168	57.266	0	%	A318	212		8.4	NE	KG	1		A318 cal cast, repeat, start time from header
20190907	0211	1	**7**	2	54.7	66	19.786	168	57.386	0	%	A318	212				KG	1		
20190907	0213	1	**8**	1	54.7	66	19.816	168	57.428	0	%	winchtest	213	257	10.3	NE	KG	1		off A318 for winch test
20190907	0219	1	**8**	2	54.6	66	19.876	168	57.556	0	%	winchtest	213	257	10.7	NE	KG	1		
20190907	0225	1	**9**	1	54.6	66	19.69	168	57.028	0	%	A318	213	262	9.4	NE	KG	1	3m	A318 cal cast, repeat again
20190907	0230	1	**9**	2	54.7	66	19.756	168	57.07	0	%	A318	213	262	9.2	NE	KG	1		
20190907	0235	1	**10**	1	54.6	66	19.814	168	57.156	0	%	A318	213	260	8.6	NE	KG	1	3m	A318 cal cast, repeat yet again, start time from header
20190907	0299	1	**10**	2	54.6	66	19.87	168	57.287	0	%	A318	213	260	8.7	NE	KG	1		latptop clock 1min fast - reset & timezone set to UTC, end time from header
20190907	1949	1	**11**	1	54.3	66	19.703	168	57.366	1	%	A319	212	260	9.9	NE	KG	0		A319 cal cast
20190907	1955	1	**11**	2	54.1	66	19.832	168	57.482	1	%	A319		260	8.9	NE	KG	0	3m	
20190908	0035	1	**12**	1	52.2	65	46.985	168	34.078	1	%	A219	213	253	13.3	E	KC	0		A219 Cal Cast
20190908	0041	1	**12**	2	52.3	65	47.064	168	34.146	1	%	A219		253	12.4	E	KC			
20190908	0210	1	**13**	1	45.4	65	44.844	168	15.79	1	%	A419	213	259	12.8	NE	KC	0	2m	A419 Cal Cast
20190908	0215	1	**13**	2	45.4	65	45.058	168	15.864	1	%	A419	214	259	12.8	NE	KC	0		
20190908	0358	1	**14**	1	23.9	65	34.828	168	6.871	1	%	BS24	213	236	10.1	E	KC	0	2m	System 1 vent plug blocked, cleared after cast. C sensor 843
20190908	0401	1	**14**	2	25.4	65	34.92	168	7.177	1	%	BS24	213	236	15.1	E	KC	0		
20190908	0410	1	**15**	1	28.6	65	35.942	168	9.57	1	%	BS23	212	237	14.5	E	KC	0	2m	
20190908	0414	1	**15**	2	29.2	65	35.986	168	9.768	1	%	BS23	213	237	15.4	E	KC	0		
20190908	0423	1	**16**	1	29.7	65	37.213	168	10.308	1	%	BS22	212	239	12	E	KC	0	2m	
20190908	0427	1	**16**	2	29.9	65	37.25	168	10.49	1	%	BS22	213	239	11.8	E	KC	0		
20190908	0435	1	**17**	1	36.8	65	37.938	168	12.741	1	%	BS21.5	212	246	12.8	E	KC	0	2m	
20190908	0439	1	**17**	2	37	65	37.98	168	12.944	1	%	BS21.5	212	246	14.2	E	KC	0		
20190908	0446	1	**18**	1	40	65	38.5	168	14.905	1	%	BS21	213	256	13.5	E	KC	0	2m	
20190908	0450	1	**18**	2	40.6	65	38.65	168	15.207	1	%	BS21		256	13	E	KC	0		
20190908	0456	1	**19**	1	43.6	65	38.963	168	16.832	1	%	BS20.5	212	256	13	E	KC	0	3m	
20190908	0500	1	**19**	2	43.9	65	39.137	168	16.984	1	%	BS20.5	212	256	13.9	E	KC	0		
20190908	0508	1	**20**	1	46.2	65	39.168	168	19.124	1	%	BS20	212	270	13.7	NE	KC	0	3m	
20190908	0512	1	**20**	2	46.7	65	39.39	168	19.394	1	%	BS20	212	270	12.6	NE	KC	0		
20190908	0519	1	**21**	1	48.3	65	39.809	168	21.114	1	%	BS19.5	212	276	14	E	KC	0	2.5m	
20190908	0524	1	**21**	2	48.6	65	40.04	168	21.355	1	%	BS19.5	212	276	15	E	KC	0		
20190908	0531	1	**22**	1	49.4	65	40.207	168	23.353	1	%	BS19	212	273	13.5	NE	KC	0	3m	
20190908	0536	1	**22**	2	49.8	65	40.442	168	23.606	1	%	BS19	212	273	15.8	NE	KC	0		
20190908	0541	1	**23**	1	50.3	65	40.672	168	24.966	1	%	BS18.5	213	268	15.7	NE	KC	0	3m	
20190908	0546	1	**23**	2	50.5	65	40.894	168	25.145	1	%	BS18.5	213	268	15.9	NE	KC	0		
20190908	0553	1	**24**	1	50.6	65	41.049	168	26.83	1	%	BS18	212	271	14.1	NE	KC	0	2.5m	
20190908	0559	1	**24**	2	51.7	65	41.349	168	27.091	1	%	BS18	212	271	15.2	NE	KC	0		
20190908	0607	1	**25**	1	51.8	65	41.585	168	28.95	1	%	BS17.5	212	262	12.3	NE	KC	0	2m	
20190908	0611	1	**25**	2	51.4	65	41.747	168	28.983	1	%	BS17.5	212	262	17.6	E	KC	0		
20190908	0618	1	**26**	1	51.9	65	42.101	168	31.111	1	%	BS17	213	262	15.2	NE	KC	0	2.5m	
20190908	0623	1	**26**	2	51.4	65	42.213	168	31.186	1	%	BS17	212	262	16.7	E	KC	0		
20190908	0630	1	**27**	1	50.1	65	42.678	168	33.227	1	%	BS16.5	213	260	14.4	NE	KC	0	2.5m	

20190908	0634	1	**27**	2	50.2	65	42.708	168	33.163	1	%	BS16.5	212	260	14.5	NE	KC	0		
20190908	0644	1	**28**	1	49	65	43.244	168	35.456	1	%	BS16	212		11.4	NE	KC	0	3m	
20190908	0648	1	**28**	2	49	65	43.284	168	35.409	1	%	BS16	212		12.2	NE	KC	0		
20190908	0657	1	**29**	1	49.5	65	43.802	168	37.645	1	%	BS15.5	213	259	10	NE	KC	0	3m	
20190908	0701	1	**29**	2	49	65	43.829	168	37.607	1	%	BS15.5	213	259	10.9	NE	KC	0		
20190908	0710	1	**30**	1	49	65	44.352	168	39.833	1	%	BS15	213	259	11.4	NE	KC	0	3m	
20190908	0714	1	**30**	2	49.3	65	44.382	168	39.768	1	%	BS15	213	259	11.2	NE	KC	0		
20190908	0722	1	**31**	1	49.6	65	44.816	168	41.57	1	%	BS14.5	213	256	12.3	NE	KC	0	4m	
20190908	0726	1	**31**	2	49.8	65	44.865	168	41.488	1	%	BS14.5	213	256	11.8	NE	KC	0		
20190908	0734	1	**32**	1	50.3	65	45.254	168	43.333	1	%	BS14	215	257	11.7	NE	KC	0	4m	
20190908	0738	1	**32**	2	50.4	65	45.352	168	43.296	1	%	BS14	213	257	10.6	NE	KC	0		
20190908	0747	1	**33**	1	50.2	65	45.77	168	45.47	1	%	BS13.5	212	257	11.6	NE	KC	0	3m	
20190908	0751	1	**33**	2	50.1	65	45.873	168	45.343	1	%	BS13.5	212	257	11.7	NE	KC	0		
20190908	0802	1	**34**	1	49.7	65	46.234	168	47.675	1	%	BS13	213	258	10.6	NE	Max	0	3.5m	
20190908	0806	1	**34**	2	49.5	65	46.344	168	47.591	1	%	BS13	212	258	9.9	NE	Max	0		
20190908	0817	1	**35**	1	47	65	46.771	168	49.582	1	%	BS12.5		255	9.7	NNE	Max	0	3m	trouble establishing comms w/ CTD, restarted SeaSave
20190908	0820	1	**35**	2	47.6	65	46.8	168	49.489	1	%	BS12.5	213	255	9.1	NE	Max	0		
20190908	0830	1	**36**	1	42.2	65	47.162	168	51.701	1	%	BS12	214	250	8	NNE	Max	0	3m	
20190908	0833	1	**36**	2	42.1	65	47.19	168	51.619	1	%	BS12	213	250	8.4	NE	Max	0		
20190908	0845	1	**37**	1	44.9	65	47.726	168	53.758	1	%	BS11.5	213	255	9.4	NE	Max	0	3.5m	
20190908	0847	1	**37**	2	44.9	65	47.652	168	53.685	1	%	BS11.5	212	255	5.7	E	Max	0		
20190908	0859	1	**38**	1	44.7	65	48.285	168	55.975	1	%	BS11	213	253	3.5	NE	Max		3m	too dark to see weather
20190908	0901	1	**38**	2	44.1	65	48.309	168	55.852	1	%	BS11	212	253	3.6	NE	Max			End BS line
20190908	0945	1	**39**	1	45.2	65	49.279	168	56.247	1	%	DL1	212	255	5.1	SE	Max		3.5m	Start DL line
20190908	0946	1	**39**	2	44.9	65	49.283	168	56.178	1	%	DL1	212	255	4.9	SE	Max			
20190908	0956	1	**40**	1	45.2	65	50.238	168	56.304	1	%	DL2	213	254	5.6	SE	Max		3m	
20190908	0958	1	**40**	2	46	65	50.257	168	56.209	1	%	DL2	212	254	5.7	SE	Max			
20190908	1008	1	**41**	1	45.9	65	51.216	168	56.233	1	%	DL3	213	254	6.5	SE	Max		3.5m	
20190908	1010	1	**41**	2	46.1	65	51.218	168	56.118	1	%	DL3	213	254	7.2	SE	Max			
20190908	1021	1	**42**	1	43.6	65	52.209	168	56.253	1	%	DL4	213	253	6.2	SE	Max		3m	
20190908	1023	1	**42**	2	45	65	52.226	168	56.102	1	%	DL4	212	253	6.5	SE	Max			
20190908	1033	1	**43**	1	46	65	53.163	168	56.223	1	%	DL5	213	256	7	E	Max		3m	
20190908	1036	1	**43**	2	45.9	65	53.129	168	56.159	1	%	DL5	213	256	7.1	E	Max			
20190908	1047	1	**44**	1	46.9	65	54.166	168	56.303	1	%	DL6	212	254	10.2	ESE	Max		3m	
20190908	1049	1	**44**	2	46.6	65	54.216	168	56.187	1	%	DL6	212	254	10	SE	Max			
20190908	1049	1	**45**	1	47	65	55.138	168	56.261	1	%	DL7	213	255	10.7	SE	Max		3.5m	
20190908	1101	1	**45**	2	47.3	65	55.188	168	56.158	1	%	DL7	213	255	13.2	SE	Max			
20190908	1111	1	**46**	1	47.7	65	56.111	168	56.29	1	%	DL8	213	255	11.9	SE	Max		3.5m	
20190908	1114	1	**46**	2	47.7	65	56.13	168	56.283	1	%	DL8	214	255	13.7	E	Max			
20190908	1124	1	**47**	1	48.7	65	57.097	168	56.285	1	%	DL9	213	257	9.1	ESE	Max		3m	
20190908	1126	1	**47**	2	48.8	65	57.134	168	56.22	1	%	DL9	213	257	8.7	E	Max			
20190908	1136	1	**48**	1	49.4	65	58.058	168	56.26	1	%	DL10	213	260	7.5	NE	Max		3m	
20190908	1139	1	**48**	2	49.6	65	58.065	168	56.198	1	%	DL10	213	260	7.9	NE	Max			
20190908	1149	1	**49**	1	50	65	59.042	168	56.261	1	%	DL11	213	258	8.4	NE	Max		3.5m	large hysterisis between up and down temp, salinity
20190908	1152	1	**49**	2	50.3	65	59.071	168	56.242	1	%	DL11	213	258	10.1	NE	Max			cleaned vent plugs after this cast
20190908	1204	1	**50**	1	50	65	59.945	168	56.26	1	%	DL12	212	258	10	NE	Max		3.5m	
20190908	1207	1	**50**	2	50.2	65	59.996	168	56.12	1	%	DL12	212	258	9.5	NE	Max			
20190908	1221	1	**51**	1	50.4	66	0.02	168	52.285	1	%	DLa12	214	258	8.6	NE	Max		2.5m	Start DLa line
20190908	1225	1	**51**	2	50.8	66	0.03	168	52.223	1	%	DLa12	212	258	8.7	NE	Max			
20190908	1237	1	**52**	1	50.2	65	59.023	168	52.25	1	%	DLa11	213	259	9.2	NE	Max		3m	biology! Nice subsurface fluor. Max
20190908	1240	1	**52**	2	50.3	65	59.09	168	52.116	1	%	DLa11	213	259	10.1	NE	Max			
20190908	1252	1	**53**	1	50.2	65	58.041	168	52.215	1	%	DLa10	213	259	11.6	NE	Max		3m	
20190908	1255	1	**53**	2	50.1	65	58.088	168	52.07	1	%	DLa10	213	259	10.6	NE	Max			
20190908	1307	1	**54**	1	49.9	65	57.08	168	52.267	1	%	DLa9	213	258	11	NE	Max		3m	
20190908	1310	1	**54**	2	49.7	65	57.103	168	52.159	1	%	DLa9	213	258	10.2	NE	Max			
20190908	1322	1	**55**	1	50	65	56.075	168	52.417	1	%	DLa8	213	257	10.5	ENE	Max		3.5m	
20190908	1325	1	**55**	2	50	65	56.1	168	52.301	1	%	DLa8	213	257	10.5	NE	Max			
20190908	1336	1	**56**	1	48.9	65	55.135	168	52.258	1	%	DLa7	213	257	9.7	NE	Max		2.5m	
20190908	1339	1	**56**	2	48.8	65	55.179	168	52.093	1	%	DLa7	213	257	10.8	NE	Max			
20190908	1351	1	**57**	1	48.3	65	54.146	168	52.328	1	%	DLa6	213	256	9.6	NE	Max		3.5m	
20190908	1354	1	**57**	2	47.7	65	54.179	168	52.187	1	%	DLa6	213	256	9.2	NE	Max			
20190908	1405	1	**58**	1	47.8	65	53.177	168	52.266	1	%	DLa5	214	257	10.7	NE	Max		3m	
20190908	1408	1	**58**	2	47.6	65	53.15	168	52.227	1	%	DLa5	212	257	12	NE	Max			
20190908	1418	1	**59**	1	47.5	65	52.216	168	52.268	1	%	DLa4	213	255	11.1	NE	Max		3.5m	
20190908	1421	1	**59**	2	47.8	65	52.257	168	52.171	1	%	DLa4	213	255	10.5	ENE	Max			
20190908	1433	1	**60**	1	46.9	65	51.24	168	52.307	1	%	DLa3	212	256	11.8	ENE	Max		3m	
20190908	1435	1	**60**	2	47	65	51.273	168	52.23	1	%	DLa3	212	256	10.9	ENE	Max			
20190908	1447	1	**61**	1	44.9	65	50.254	168	52.194	1	%	DLa2	213	254	8	E	Max		3.5m	
20190908	1450	1	**61**	2	45.2	65	50.27	168	52.043	1	%	DLa2	213	254	8.1	SE	Max			
20190908	1501	1	**62**	1	43	65	49.284	168	52.25	1	%	DLa1	213	253	8.6	SE	Max		3m	
20190908	1504	1	**62**	2	43.8	65	49.33	168	52.079	1	%	DLa1	212	253	9.5	SE	Max			End of Dla line

20190908	1518	1	**63**	1	48.3	65	49.351	168	48.476	1	%	DLb1	213	257	9.6	SE	Max		4m	
20190908	1521	1	**63**	2	48.3	65	49.416	168	48.405	1	%	DLb1	213	257	11.4	SE	Max			
20190908	1530	1	**64**	1	48.5	65	50.291	168	48.288	1	%	DLb2	212	256	10.2	SE	Max		4m	
20190908	1533	1	**64**	2	48.8	65	50.377	168	48.226	1	%	DLb2	212	256	10.4	SE	Max			
20190908	1542	1	**65**	1	48.8	65	51.248	168	48.263	1	%	DLb3	213	256	9.2	SE	Max		4m	
20190908	1545	1	**65**	2	49	65	51.328	168	48.166	999	%	DLb3	213	256	9.5	SE	Max			
20190908	1599	1	**66**	1	49.8	65	52.207	168	48.307	999	%	DLb4	999	999	9.3	SE	Max	0.75	3.5m	light enough to see weather
20190908	1599	1	**66**	2	49.8	65	52.26	168	48.24	999	%	DLb4	999	999	999	99	Max			hit bottom (radio comms)
20190908	1605	1	**67**	1	50.4	65	53.179	168	48.161	1	%	DLb5	999	999	9.7	SE	KG		7m	
20190908	1699	1	**67**	2	99	65	53.254	168	47.985	1	%	DLb5	212	999	11.1	SE	KG			
20190908	1615	1	**68**	1	50.5	65	54.13	168	48.135	1	%	DLb6	999	999	9.5	SE	KG		3m	
20190908	1620	1	**68**	2	50.5	65	54.146	168	48.303	1	%	DLb6	213	260	11	SE	KG			
20190908	1628	1	**69**	1	50.1	65	55.114	168	48.211	1	%	DLb7	213	258	9.7	SE	KG	0.75	3m	
20190908	1633	1	**69**	2	50.9	65	55.185	168	48.119	1	%	DLb7	213	258	10.3	SE	KG			cleaned vent plug on system 2 after cast
20190908	1640	1	**70**	1	50.9	65	56.139	168	48.219	1	%	DLb8	213	257	8.8	SE	KG	0.25	3m	
20190908	1644	1	**70**	2	50.9	65	56.18	168	48.371	1	%	DLb8	213	257	9.3	SE	KG			
20190908	1652	1	**71**	1	50.9	65	57.07	168	48.224	1	%	DLb9	213	257	8.8	SE	KG	0.25	3m	
20190908	1656	1	**71**	2	50.9	65	57.132	168	48.096	1	%	DLb9	213	257	8.7	SE	KG			
20190908	1703	1	**72**	1	50.8	65	58.01	168	48.121	1	%	DLb10	213	257	10.7	SE	KG	0.25	3m	
20190908	1707	1	**72**	2	50.8	65	58.039	168	48.187	1	%	DLb10	213	257	9.5	SE	KG			
20190908	1715	1	**73**	1	51.8	65	58.998	168	48.234	1	%	DLb11	212	258	8.8	SE	KG	0.25	3m	
20190908	1719	1	**73**	2	51.6	65	59.045	168	48.101	1	%	DLb11	212	258	9.3	SE	KG			
20190908	1727	1	**74**	1	51	66	0.013	168	48.173	1	%	DLb12	213	999	8.7	SE	KG	0.25	3m	did not establish comm. Had to restart seasave
20190908	1731	1	**74**	2	50.9	66	0.053	168	48.192	1	%	DLb12	213	999	7.7	SE	KG			End of DLb line
20190908	1756	1	**75**	1	50.3	65	59.958	168	56.11	1	%	DL12	213	258	9.1	SE	KG	0.5	3m	
20190908	1800	1	**75**	2	50.3	66	0.07	168	56.004	1	%	DL12	213	258	10.2	SE	KG			
20190908	1809	1	**76**	1	50	66	1.273	168	56.147	1	%	DL12.5	213	260	9.2	SE	KG	0.3	2m	
20190908	1813	1	**76**	2	49.7	66	1.395	168	56.211	1	%	DL12.5	213	260	9.9	SE	KG			
20190908	1822	1	**77**	1	50.8	66	2.57	168	56.253	1	%	DL13	213	257	7.4	SE	KG	0.3	2m	
20190908	1826	1	**77**	2	50.8	66	2.653	168	56.097	1	%	DL13	213	257	7.7	SE	KG			
20190908	1835	1	**78**	1	51	66	3.754	168	56.128	1	%	DL13.5	213	257	7.3	SE	KG	0.1	1m	
20190908	1840	1	**78**	2	50.9	66	3.818	168	56.227	1	%	DL13.5	213	257	8.3	SE	KG			
20190908	1849	1	**79**	1	52.6	66	5.041	168	56.262	1	%	DL14	213	260	7.6	SE	KG	0.1	1m	
20190908	1854	1	**79**	2	52.8	66	5.215	168	56.135	1	%	DL14	213	260	7.5	SE	KG			
20190908	1902	1	**80**	1	52.5	66	6.294	168	56.104	1	%	DL14.5	213	261	6.8	SE	KG	0.1	3m	
20190908	1908	1	**80**	2	52.4	66	6.469	168	56.196	1	%	DL14.5	213	261	7.2	SE	KG			pump 2 draining slowly, cleaned after cast
20190908	1916	1	**81**	1	52.1	66	7.599	168	56.095	1	%	DL15	213	260	6.4	SE	KG	0.2	2m	
20190908	1921	1	**81**	2	52.3	66	7.784	168	56.101	1	%	DL15	213	260	7.1	SE	KG			
20190908	1929	1	**82**	1	52.7	66	8.85	168	56.035	1	%	DL15.5	213	260	5.6	SE	KG	0.1	2m	
20190908	1935	1	**82**	2	53.2	66	9.03	168	56.114	1	%	DL15.5	213	260	4.6	SE	KG			
20190908	1942	1	**83**	1	52.8	66	10.079	168	56.019	1	%	DL16	213	259	3.1	SE	KG	0.1	2m	
20190908	1948	1	**83**	2	53.1	66	10.226	168	56.019	1	%	DL16	213	259	2.2	SE	KG			
20190908	1956	1	**84**	1	54.1	66	11.392	168	56.068	1	%	DL16.5	213	261	2.5	SE	KG	0.4	2m	
20190908	2002	1	**84**	2	54	66	11.522	168	56.173	1	%	DL16.5	213	261	1.5	SE	KG			
20190908	2011	1	**85**	1	55	66	12.607	168	56.155	0	%	DL17	213	268	1.7	SE	KG	0.5	2m	
20190908	2016	1	**85**	2	54.9	66	12.672	168	56.112	0	%	DL17	213	268	3	SE	KG			
20190908	2026	1	**86**	1	54.2	66	13.916	168	56.248	0	%	DL17.5	213	260	3.8	SE	KG	0.5	2m	
20190908	2031	1	**86**	2	54.4	66	14.027	168	56.274	0	%	DL17.5	213	260	3.2	SE	KG			
20190908	2040	1	**87**	1	55.3	66	15.198	168	56.24	0	%	DL18	212	260	4.1	SE	KG	0.5	2m	
20190908	2046	1	**87**	2	55.3	66	15.23	168	56.212	0	%	DL18	212	260	4.5	SE	KG			
20190908	2056	1	**88**	1	54.5	66	16.554	168	56.1	0	%	DL18.5	213	263	4.9	S	KG	0.4	3m	
20190908	2101	1	**88**	2	54.5	66	16.592	168	55.955	0	%	DL18.5	213	263	5.4	S	KG			
20190908	2110	1	**89**	1	54.1	66	17.822	168	56.219	1	%	DL19	213	260	6.3	S	KG	0.5	2m	
20190908	2116	1	**89**	2	54.1	66	17.895	168	56.231	1	%	DL19	213	260	6.1	S	KG			
20190908	2122	1	**90**	1	54.1	66	18.665	168	56.193	1	%	DL19.5	212	261	6.5	S	KG	0.5	3m	
20190908	2128	1	**90**	2	54.1	66	18.788	168	56.202	1	%	DL19.5	212	261	4.5	S	KG			
20190908	2140	1	**91**	1	53.8	66	19.83	168	57.218	1	%	A3-19	212	261	7.5	S	RW	0.4	2m	
20190908	2145	1	**91**	2	53.8	66	19.98	168	57.466	1	%	A3-19	212	261	6.9	S	RW			
20190908	2154	1	**92**	1	53.9	66	19.928	168	55.419	1	%	AL12.5	212	259	8.4	S	KG	0.6	4m	
20190908	2200	1	**92**	2	53.9	66	19.987	168	55.618	1	%	AL12.5	212	259	9.7	S	KG			
20190908	2208	1	**93**	1	53.6	66	20.314	168	53.594	1	%	AL13	213	259	9.8	S	KG	0.4	2m	
20190908	2214	1	**93**	2	53.7	66	20.336	168	53.573	1	%	AL13	213	259	9.2	S	KG			
20190908	2222	1	**94**	1	52.4	66	20.693	168	51.416	1	%	AL13.5	213	257	10.9	S	KG	0.3	3m	
20190908	2227	1	**94**	2	52.4	66	20.732	168	51.45	1	%	AL13.5	213	257	9.6	S	KG			
20190908	2235	1	**95**	1	52.6	66	21.037	168	49.295	1	%	AL14	213	258	10	S	KG	0.2	5m	
20190908	2241	1	**95**	2	53.1	66	21.108	168	49.259	1	%	AL14	213	258	11.3	S	KG			
20190908	2249	1	**96**	1	52.8	66	21.454	168	47.269	1	%	AL14.5	212	257	8.7	S	KG	0.1	5m	
20190908	2255	1	**96**	2	52.6	66	21.498	168	47.531	1	%	AL14.5	212	257	9.6	S	KG			
20190908	2305	1	**97**	1	45.6	66	21.766	168	44.988	1	%	AL15	213	250	7.8	S	KG	0.3	3m	
20190908	2309	1	**97**	2	45.9	66	21.838	168	44.942	1	%	AL15	213	250	9	S	KG			
20190908	2317	1	**98**	1	49.9	66	22.129	168	42.852	1	%	AL15.5	213	255	8.8	S	KG	0.4	5m	

20190908	2322	1	**98**	2	49.8	66	22.141	168	42.906	1	%	AL15.5	213	255	11.5	S	KG			
20190908	2330	1	**99**	1	55	66	22.51	168	40.71	1	%	AL16	213	261	10.9	S	KG	0.25	5m	abundant jelly fish at station
20190908	2336	1	**99**	2	55.1	66	22.526	168	40.781	1	%	AL16	213	261	11	S	KG			
20190908	2344	1	**100**	1	54.5	66	22.896	168	38.558	1	%	AL16.5	213	260	10.5	S	KG	0.3	3m	
20190908	2350	1	**100**	2	54.9	66	22.914	168	38.694	1	%	AL16.5	213	260	11.8	S	KG			
20190908	2358	1	**101**	1	53.3	66	23.23	168	36.335	1	%	AL17	213	261	12	S	KC	0.37	4m	
20190909	0003	1	**101**	2	53.4	66	23.261	168	36.29	1	%	AL17	212	261	11.8	S	KC			
20190909	0011	1	**102**	1	52.2	66	23.635	168	33.838	1	%	AL17.5	212	261	12.8	S	KC	0.37	4m	
20190909	0017	1	**102**	2	52.1	66	23.685	168	33.816	1	%	AL17.5	213	261	13.1	S	KC			
20190909	0024	1	**103**	1	51.3	66	23.939	168	32.161	1	%	AL18	212	260	12.1	S	KC	0.3	4m	
20190909	0029	1	**103**	2	51.2	66	23.966	168	32.16	1	%	AL18	212	260	12.6	S	KC			
20190909	0037	1	**104**	1	51.5	66	24.252	168	29.978	1	%	AL18.5	212	260	11.6	S	KC	0.48	3m	
20190909	0041	1	**104**	2	51.6	66	24.271	168	30.041	1	%	AL18.5	212	260	13	S	KC			
20190909	0049	1	**105**	1	51.9	66	24.623	168	27.807	1	%	AL19	212	260	14.3	S	KC	0.3	2m	tons of jellies, white
20190909	0054	1	**105**	2	51.9	66	24.669	168	27.745	1	%	AL19	213	260	14	S	KC			
20190909	0101	1	**106**	1	51	66	24.971	168	25.896	1	%	AL19.5	213	260	15.4	S	KC	0.1	1.5m	
20190909	0106	1	**106**	2	51	66	25.032	168	26.017	1	%	AL19.5	213	260	16.4	S	KC			
20190909	0115	1	**107**	1	50.7	66	25.35	168	23.616	1	%	AL20	212	259	16.8	S	KC	0.2	1.5m	
20190909	0120	1	**107**	2	50.5	66	25.44	168	23.586	1	%	AL20	212	259	15.5	S	KC			
20190909	0128	1	**108**	1	49.5	66	25.691	168	21.383	1	%	AL20.5	213	260	16.1	S	KC	0.4	1.5m	
20190909	0132	1	**108**	2	49.6	66	25.811	168	21.469	1	%	AL20.5	212	260	17.1	S	KC			
20190909	0141	1	**109**	1	46.6	66	26.007	168	19.223	1	%	AL21	212	256	16	S	KC	0.2	2m	
20190909	0145	1	**109**	2	46.4	66	26.083	168	19.213	1	%	AL21	212	256	14.1	S	KC			
20190909	0152	1	**110**	1	42.3	66	26.309	168	17.028	1	%	AL21.5	212	252	15.7	S	KC	0.2	2m	
20190909	0157	1	**110**	2	42.1	66	26.501	168	16.994	1	%	AL21.5	214	252	13.8	S	KC			
20190909	0205	1	**111**	1	39.4	66	26.73	168	14.959	1	%	AL22	212	249	16.7	S	KC	0.1	2m	
20190909	0209	1	**111**	2	39.4	66	26.802	168	14.92	1	%	AL22	212	249	16.5	SW	KC			
20190909	0217	1	**112**	1	36.2	66	27.056	168	12.723	1	%	AL22.5	212	246	15.4	SW	KC	0.1	2m	
20190909	0221	1	**112**	2	35.8	66	27.148	168	12.68	1	%	AL22.5	212	246	17.7	SW	KC			
20190909	0228	1	**113**	1	32.4	66	27.433	168	10.623	1	%	AL23	212	242	17.1	SW	KC	0.3	1.5m	
20190909	0231	1	**113**	2	32.1	66	27.507	168	10.584	1	%	AL23	212	242	19.5	SW	KC			
20190909	0239	1	**114**	1	28.4	66	27.792	168	8.383	1	%	AL23.5	212	239	16.3	S	KC	0.1	1m	
20190909	0242	1	**114**	2	28.2	66	27.88	168	8.351	1	%	AL23.5	212	239	20.3	S	KC			
20190909	0249	1	**115**	1	26.4	66	28.126	168	6.287	1	%	AL24	213	236	20	S	KC	0.1	1m	
20190909	0253	1	**115**	2	26.3	66	28.213	168	6.196	1	%	AL24	213	236	22.4	S	KC			
20190909	0259	1	**116**	1	24.2	66	28.502	168	4.127	1	%	AL24.5	213	233	22.8	S	KC	0.1	1m	
20190909	0303	1	**116**	2	24	66	28.606	168	4.01	1	%	AL24.5	214	233	22.9	S	KC			
20190909	0310	1	**117**	1	22.6	66	28.851	168	1.933	1	%	AL25	212	231	22.3	S	KC	0.1	0.5m	
20190909	0314	1	**117**	2	22.4	66	28.948	168	1.798	1	%	AL25	213	231	21.1	S	KC			
20190909	0320	1	**118**	1	21.6	66	29.219	168	0	1	%	AL25.5	212	231	20.8	S	KC	0.1	1m	
20190909	0323	1	**118**	2	21.8	66	29.298	167	59.892	1	%	AL25.5	212	231	22.6	S	KC			
20190909	0330	1	**119**	1	21.6	66	29.593	167	57.752	1	%	AL26	213	231	23.1	S	KC	0.1	1m	
20190909	0333	1	**119**	2	21.4	66	29.607	167	57.625	1	%	AL26	213	231	22.6	S	KC			
20190909	0339	1	**120**	1	21.6	66	29.853	167	55.581	1	%	AL26.5	999	999	19.6	SSW	RW	0	1m	
20190909	0342	1	**120**	2	21.5	66	29.909	167	55.424	1	%	AL26.5	999	999	20.7	SSW	RW			
20190909	0348	1	**121**	1	21.8	66	30.226	167	53.522	1	%	AL27	212	231	22.2	SSW	KC	0	1m	
20190909	0351	1	**121**	2	21.9	66	30.276	167	53.356	1	%	AL27	213	231	22.5	SSW	KC			
20190909	0353	1	**122**	1	22.1	66	30.601	167	51.284	1	%	AL27.5	213	232	22.7	SSW	KC	0	3m	
20190909	0400	1	**122**	2	22.3	66	30.651	167	51.075	1	%	AL27.5	213	232	22.1	SSW	KC			End of AL line
20190909	0517	1	**123**	1	27.6	66	41.369	167	38.837	1	%	AS1	213	238	23.5	SSW	KC	0	3.5m	
20190909	0521	1	**123**	2	27.4	66	41.427	167	38.622	1	%	AS1	213	238	22.1	SSW	KC			
20190909	0554	1	**124**	1	27.5	66	45.001	167	43.988	1	%	AS2	213	239	18.5	SSW	KC	0	3m	
20190909	0557	1	**124**	2	27.8	66	45.037	167	43.762	1	%	AS2	213	239	18.3	SSW	KC			
20190909	0630	1	**125**	1	28.8	66	48.55	167	48.858	1	%	AS3	212	237	12.6	SW	KC	0	3.5m	6-8ft swells
20190909	0633	1	**125**	2	28.1	66	48.613	167	48.589	1	%	AS3	213	237	16.3	SW	KC			
20190909	0706	1	**126**	1	29.9	66	52.058	167	53.693	1	%	AS4	215	238	14.7	SW	KC	0	3m	6-8ft swells
20190909	0709	1	**126**	2	29.8	66	52.085	167	53.485	1	%	AS4	213	238	15.1	SW	KC			
20190909	0741	1	**127**	1	31.2	66	55.612	167	58.757	1	%	AS5	214	241	14.8	SW	KC	0	3m	4ft swells
20190909	0744	1	**127**	2	30.8	66	55.636	167	58.609	1	%	AS5	214	241	15.1	SW	KC			
20190909	0816	1	**128**	1	31.3	66	59.168	168	3.629	1	%	AS6	213	240	14.3	SW	Max		3m	4ft swells
20190909	0818	1	**128**	2	31.8	66	59.196	168	3.478	1	%	AS6	213	240	15.5	SSW	Max			
20190909	0851	1	**129**	1	32.2	67	2.7	168	8.494	1	%	AS7	214	241	11.8	SW	Max		3m	
20190909	0852	1	**129**	2	32.7	67	2.731	168	8.288	1	%	AS7	213	241	11.4	SW	Max			
20190909	0911	1	**130**	1	33.6	67	4.469	168	10.988	1	%	AS8	214	241	11	SSW	Max		3m	
20190909	0913	1	**130**	2	33.4	67	4.493	168	10.788	1	%	AS8	213	241	11.2	SW	Max			
20190909	0949	1	**131**	1	34.8	67	6.24	168	13.481	1	%	AS9	213	245	11.5	SSW	Max		3m	systems 1&2 diverging, cleaned vent plugs and recast as 132
20190909	0951	1	**131**	2	34.9	67	6.291	168	13.254	1	%	AS9	213	245	11.4	SW	Max			cleaned vent plugs after this cast
20190909	0958	1	**132**	1	35.1	67	6.343	168	13.129	1	%	AS9_2	214	244	11.3	SSW	Max		3m	repeat deployment looks much better
20190909	1000	1	**132**	2	35	67	6.383	168	13.041	1	%	AS9_2	214	244	10.9	SSW	Max			
20190909	1018	1	**133**	1	36.4	67	8.029	168	15.912	1	%	AS10	212	245	11.3	SSW	Max		3.5m	
20190909	1020	1	**133**	2	36.6	67	8.065	168	15.712	1	%	AS10	212	245	10.7	SW	Max			

20190909	1039	1	**134**	1	37.9	67	9.777	168	18.367	1	%	AS11	213	247	10.7	SSW	Max	1	3.5m	
20190909	1041	1	**134**	2	37.8	67	9.796	168	18.182	1	%	AS11	213	247	11.1	SW	Max			
20190909	1100	1	**135**	1	39.5	67	11.55	168	20.811	1	%	AS12	214	248	7.7	SW	Max	1	3m	
20190909	1102	1	**135**	2	39.3	67	11.559	168	20.609	1	%	AS12	212	248	9.8	SW	Max			
20190909	1121	1	**136**	1	40.8	67	13.303	168	23.27	1	%	AS13	214	250	7.8	SW	Max	0.5	3m	
20190909	1123	1	**136**	2	40.7	67	13.288	168	23.048	1	%	AS13	213	250	7.4	SW	Max			
20190909	1156	1	**137**	1	43.2	67	16.868	168	28.201	0	%	AS14	213	252	5.4	SW	Max	0.75	3.5m	
20190909	1158	1	**137**	2	43.3	67	16.894	168	28.011	0	%	AS14	213	252	6.5	SW	Max			
20190909	1230	1	**138**	1	45.4	67	20.403	168	33.131	0	%	AS15	213	254	6.9	SW	Max	1	3.5m	getting into cold water
20190909	1232	1	**138**	2	45.3	67	20.404	168	32.998	0	%	AS15	213	254	6.5	SW	Max			
20190909	1303	1	**139**	1	46.5	67	23.965	168	38.007	0	%	AS16	213	255	6.7	SW	Max	1	3m	
20190909	1305	1	**139**	2	46.6	67	23.983	168	37.848	0	%	AS16	213	255	6.6	SSW	Max			
20190909	1336	1	**140**	1	47.4	67	27.484	168	42.941	0	%	AS17	213	256	8.6	SSW	Max	1	3m	strong thermocline, but very cold &well-mixed water beneath
20190909	1339	1	**140**	2	47.5	67	27.475	168	42.828	0	%	AS17	213	256	7.7	SSW	Max			
20190909	1409	1	**141**	1	48.2	67	31.033	168	47.862	0	%	AS18	213	256	8.7	SSW	Max	1	3.5m	
20190909	1412	1	**141**	2	48.3	67	31.04	168	47.757	0	%	AS18	213	256	8	SW	Max			
20190909	1442	1	**142**	1	48.3	67	34.572	168	52.805	0	%	AS19	213	256	9.2	SW	Max	1	3m	
20190909	1444	1	**142**	2	48.3	67	34.59	168	52.701	0	%	AS19	213	256	8.5	SW	Max			End of AS line
20190909	1512	1	**143**	1	48.7	67	38.103	168	56.056	0	%	CS10	212	257	9.3	SW	Max	0.5	3.5m	bloom/large fluor spike and high o2 levels
20190909	1515	1	**143**	2	48.7	67	38.117	168	55.938	0	%	CS10	212	257	9.1	SW	Max			
20190909	1548	1	**144**	1	48.3	67	41.652	168	48.254	0	%	CS10.5	213	256	9.3	SW	Max	0.5	3m	bloom/large fluor spike and high o2 levels
20190909	1550	1	**144**	2	48.4	67	41.649	168	48.139	0	%	CS10.5	213	256	8.5	SW	Max			
20190909	1622	1	**145**	1	48.4	67	45.273	168	39.894	0	%	CS11	213	256	7.5	SW	KG	0.9	2.5m	
20190909	1626	1	**145**	2	48.4	67	45.285	168	39.759	0	%	CS11	213	256	7.3	SW	KG			
20190909	1701	1	**146**	1	49.2	67	48.867	168	29.432	0	%	CS11.5	212	257	8.6	SW	KG	0.2	3m	
20190909	1706	1	**146**	2	49.1	67	48.849	168	29.275	0	%	CS11.5	212	257	9.2	SW	KG			
20190909	1742	1	**147**	1	54.8	67	52.513	168	18.862	0	%	CS12	212	262	6.8	SW	KG	0.8	2.5m	
20190909	1747	1	**147**	2	54.8	67	52.491	168	18.792	0	%	CS12	212	262	5.6	SW	KG			
20190909	1821	1	**148**	1	57.2	67	55.9	168	9.174	0	%	CS12.5	212	264	8.1	SE	KG	0.9	1m	
20190909	1826	1	**148**	2	57.1	67	55.877	168	9.134	0	%	CS12.5	212	264	8.9	S	KG			
20190909	1900	1	**149**	1	53.2	67	59.336	167	59.439	0	%	CS13	212	259	6.9	S	KG	0	1.5m	
20190909	1906	1	**149**	2	53.2	67	59.337	167	59.592	0	%	CS13	212	259	6.9	SW	KG			
20190909	1940	1	**150**	1	52.5	68	2.712	167	49.777	0	%	CS13.5	212	261	8.7	S	KG	0.35	3m	
20190909	1945	1	**150**	2	52.5	68	2.735	167	49.694	0	%	CS13.5	212	261	8.9	S	KG			
20190909	2020	1	**151**	1	50.7	68	6.12	167	39.901	0	%	CS14	213	256	5.3	S	KG	0.3	3m	
20190909	2025	1	**151**	2	50.7	68	6.118	167	39.939	0	%	CS14	213	256	6.4	S	KG			
20190909	2056	1	**152**	1	47.3	68	9.119	167	30.651	0	%	CS14.5	213	256	7.1	S	KG	0.85	3m	bloom/large fluor spike and high o2 levels
20190909	2101	1	**152**	2	47.4	68	9.105	167	30.615	0	%	CS14.5	213	256	6.8	S	KG			
20190909	2133	1	**153**	1	46.3	68	12.093	167	21.488	1	%	CS15	212	254	6	S	KG	0.9	4m	
20190909	2137	1	**153**	2	46.4	68	12.071	167	21.601	1	%	CS15	212	254	6.5	S	KG			
20190909	2155	1	**154**	1	44.3	68	13.616	167	16.824	1	%	CS15.5	212	252	5.7	S	KG	0.8	2m	
20190909	2159	1	**154**	2	44.6	68	13.628	167	17.049	1	%	CS15.5	212	252	6.1	S	KG			
20190909	2217	1	**155**	1	43	68	14.992	167	12.140	1	%	CS16	213	253	4	S	KG	0.3	3m	oxygen system 1 and 2 discrepancy
20190909	2222	1	**155**	2	43	68	15.057	167	12.456	1	%	CS16	213	253	4.3	S	KG			
20190909	2239	1	**156**	1	39.4	68	16.597	167	7.437	1	%	CS16.5	213	247	4	SE	KG	0	3m	oxygen offset between system 1 and 2
20190909	2243	1	**156**	2	39.6	68	16.589	167	7.438	1	%	CS16.5	213	247	4.6	S	KG			
20190909	2301	1	**157**	1	36.4	68	18.016	167	2.997	1	%	CS17	214	252	4.5	SE	KG	0	3m	oxygen offset between system 1 and 2
20190909	2305	1	**157**	2	36.9	68	18.025	167	3.517	1	%	CS17	214	252	3.8	SE	KG			
20190909	2329	1	**158**	1	32.1	68	18.8	166	57.566	1	%	CS18	213	244	4.7	S	KG	0	4m	oxygen offset between system 1 and 2
20190909	2333	1	**158**	2	32.2	68	18.774	166	57.971	1	%	CS18	213	244	4.6	SE	KG			
20190909	2353	1	**159**	1	25.3	68	19.854	166	52.204	1	%	CS19	214	232	4.7	SE	KG	0	1.5m	
20190909	2357	1	**159**	2	25.1	68	19.929	166	52.225	1	%	CS19	214	232	4.4	SE	KG			End of CS line
20190910	0034	1	**160**	1	34.9	68	22.399	167	7.892	1	%	NPH1	213	245	7.1	SW	KC	0	1.5m	
20190910	0038	1	**160**	2	35.3	68	22.499	167	8.246	1	%	NPH1	213	245	7.9	SW	KC			
20190910	0046	1	**161**	1	39	68	22.602	167	11.073	1	%	NPH2	212	253	9.8	SW	KC	0.1	2m	
20190910	0050	1	**161**	2	39.5	68	22.703	167	11.453	1	%	NPH2	212	253	9.5	SW	KC			
20190910	0058	1	**162**	1	39	68	22.811	167	14.489	1	%	NPH3	212	253	9.4	SW	KC	0	2m	
20190910	0103	1	**162**	2	39.2	68	22.961	167	14.949	1	%	NPH3	212	253	9.8	SW	KC			
20190910	0110	1	**163**	1	39.8	68	23.073	167	17.813	1	%	NPH4	214	265	9.3	SW	KC	0	2m	
20190910	0116	1	**163**	2	40	68	23.318	167	18.271	1	%	NPH4	212	265	9.9	SW	KC			
20190910	0124	1	**164**	1	41.5	68	23.291	167	21.259	1	%	NPH5	213	256	9.7	SW	KC	0	2m	
20190910	0129	1	**164**	2	40.1	68	23.458	167	21.545	1	%	NPH5	212	256	8.4	SW	KC			
20190910	0146	1	**165**	1	44.7	68	23.774	167	28.045	1	%	NPH6	213	258	6.4	SW	KC	0.1	2m	
20190910	0150	1	**165**	2	45.8	68	23.895	167	28.395	1	%	NPH6	213	258	7.4	SW	KC			
20190910	0207	1	**166**	1	48.1	68	24.211	167	34.697	1	%	NPH7	212	257	4.6	SW	KC	0	2m	Saildrone near this cast
20190910	0211	1	**166**	2	48.1	68	24.188	167	34.809	1	%	NPH7	212	257	4.3	SW	KC			
20190910	0230	1	**167**	1	50.5	68	24.706	167	41.551	0	%	NPH8	213	258	6.3	SW	KC	0	4m	
20190910	0235	1	**167**	2	50.2	68	24.709	167	41.57	0	%	NPH8	213	258	6.4	SW	KC			
20190910	0253	1	**168**	1	51.9	68	25.226	167	48.506	0	%	NPH9	213	260	9.1	SW	KC	0	5m	
20190910	0259	1	**168**	2	52	68	25.204	167	48.555	0	%	NPH9	213	260	7.8	SW	KC			
20190910	0317	1	**169**	1	52.5	68	25.73	167	55.29	0	%	NPH10	213	262	6.4	SW	KC	0	7m	

20190910	0323	1	**169**	2	52.3	68	25.702	167	55.364	0	%	NPH10	213	262	5.4	S	KC			
20190910	0341	1	**170**	1	51.3	68	26.196	168	2.107	0	%	NPH11	214	261	5.2	S	KC	0	5m	
20190910	0346	1	**170**	2	51.2	68	26.221	168	2.337	0	%	NPH11	213	261	5.1	S	KC			
20190910	0404	1	**171**	1	50.3	68	26.681	168	8.712	0	%	NPH11.5	213	260	5.3	SW	KC	0	3.5m	
20190910	0408	1	**171**	2	50.2	68	26.723	168	8.571	0	%	NPH11.5	213	260	3.9	SW	KC			
20190910	0427	1	**172**	1	49.8	68	27.154	168	15.578	0	%	NPH12	213	260	3.7	S	KC	0	3.5m	
20190910	0431	1	**172**	2	49.8	68	27.248	168	15.273	0	%	NPH12	213	260	3.1	SSW	KC			
20190910	0453	1	**173**	1	50.6	68	27.628	168	22.27	0	%	NPH12.5	213	260	5.3	SSW	KC	0	3.5m	
20190910	0458	1	**173**	2	50.7	68	27.599	168	22.244	0	%	NPH12.5	213	260	5.6	S	KC			
20190910	0516	1	**174**	1	50	68	28.104	168	29.03	1	%	NPH13	213	260	6.2	S	KC	0	3m	
20190910	0520	1	**174**	2	50	68	28.117	168	28.938	0	%	NPH13	213	260	4.6	SSW	KC			
20190910	0552	1	**175**	1	50.7	68	28.679	168	36.1	0	%	NPH13.5	212	259	5.8	S	KC	0	3.5m	cleaned vent plugs twice, and syringed cells once before cast
20190910	0557	1	**175**	2	50.8	68	28.737	168	36.194	0	%	NPH13.5	213	259	6.7	S	KC			
20190910	0615	1	**176**	1	51.4	68	29.033	168	42.53	0	%	NPH14	213	260	5.5	S	KC	0	4m	cleaned vent plugs before cast, as it wasn't draining
20190910	0620	1	**176**	2	51.7	68	29.027	168	42.633	0	%	NPH14	213	260	7.5	S	KC			
20190910	0639	1	**177**	1	51.9	68	29.515	168	49.166	0	%	NPH14.5	213	260	6.8	S	KC	0	4m	cleaned vent plugs before cast, precautionary measure
20190910	0644	1	**177**	2	51.9	68	29.53	168	49.085	0	%	NPH14.5	213	260	5.8	S	KC			
20190910	0704	1	**178**	1	53.1	68	29.996	168	56.033	0	%	CCL19	213	262	7	SE	KC	0	6m	believed to have sucked jellyfish on way up, both cells syringed
20190910	0709	1	**178**	2	53.3	68	29.96	168	56.158	0	%	CCL19	213	262	7.9	SE	KC			End of NPH Line
20190910	0818	1	**179**	1	50.9	68	40.001	168	55.968	1	%	CCL20	213	260	6.9	SE	Max	0.5	3m	
20190910	0821	1	**179**	2	51.1	68	40.002	168	55.79	1	%	CCL20	212	260	8.3	SE	Max			
20190910	0838	1	**180**	1	50.8	68	39.762	168	50.722	1	%	CD27	213	260	9.4	SE	Max	0.5	3m	
20190910	0841	1	**180**	2	51	68	39.709	168	50.886	1	%	CD27	213	260	7.7	SE	Max			
20190910	0858	1	**181**	1	51.7	68	39.559	168	45.656	1	%	CD26	213	262	5.9	SE	Max	0.25	3m	high fluorescence signal; cleaned vent plug after this cast
20190910	0901	1	**181**	2	51.8	68	39.513	168	45.543	1	%	CD26	213	262	6.1	SE	Max			
20190910	0918	1	**182**	1	50.6	68	39.367	168	39.972	0	%	CD25	213	260	5.1	SE	Max	0.25	3.5m	CTD wait time and scan time in seasave at 40 rather than 10;
20190910	0921	1	**182**	2	50.6	68	39.325	168	40.051	0	%	CD25	212	260	5.7	SSE	Max			cool bottom fluorescence signal
20190910	0938	1	**183**	1	51	68	39.139	168	34.662	0	%	CD24	214	261	5.8	SSE	Max	0.5	3m	CTD wait time and scan time returned to 10 in sea save;
20190910	0941	1	**183**	2	51.1	68	39.093	168	34.816	0	%	CD24	213	261	4.5	SE	Max			Cool bottom fluorescence signal
20190910	0959	1	**184**	1	49.7	68	38.948	168	29.265	0	%	CD23	214	258	3	SE	Max	0	3.5m	
20190910	1002	1	**184**	2	49.6	68	38.923	168	29.407	0	%	CD23	213	258	3.3	S	Max			
20190910	1020	1	**185**	1	49.8	68	38.709	168	23.93	1	%	CD22	214	259	5.5	SW	Max	0	4m	
20190910	1022	1	**185**	2	49.8	68	38.671	168	23.874	1	%	CD22	213	259	4.3	SW	Max			
20190910	1039	1	**186**	1	49.5	68	39.489	168	18.49	1	%	CD21	213	261	3	SSW	Max	0.25	3.5m	
20190910	1041	1	**186**	2	49.5	68	38.393	168	18.439	1	%	CD21	213	261	6.8	SW	Max			
20190910	1059	1	**187**	1	50	68	38.286	168	13.045	1	%	CD20	213	262	6	SW	Max	0	3m	
20190910	1101	1	**187**	2	50	68	38.23	168	12.898	1	%	CD20	212	262	4.8	SSW	Max			
20190910	1116	1	**188**	1	50	68	38.083	168	7.811	1	%	CD19	214	260	5	S	Max	0	3m	
20190910	1118	1	**188**	2	50	68	38.062	168	7.883	1	%	CD19	212	260	4.9	S	Max			
20190910	1136	1	**189**	1	50.3	68	37.883	168	2.472	1	%	CD18	214	259	7	SW	Max	0	2.5m	
20190910	1139	1	**189**	2	50.3	68	37.906	168	2.47	1	%	CD18	213	259	5.7	SW	Max			
20190910	1157	1	**190**	1	50.1	68	37.648	167	57.164	1	%	CD17	214	259	7.9	SW	Max	0	2m	
20190910	1200	1	**190**	2	50.2	68	37.677	167	57.136	1	%	CD17	213	259	5.6	WSW	Max			
20190910	1219	1	**191**	1	50.6	68	37.442	167	51.761	1	%	CD16	214	261	5.7	WSW	Max	1	3m	
20190910	1222	1	**191**	2	50.6	68	37.364	167	51.92	1	%	CD16	213	261	6.4	WSW	Max			
20190910	1240	1	**192**	1	50.5	68	37.214	167	46.471	1	%	CD15	214	262	4.8	WSW	Max	0	4m	
20190910	1244	1	**192**	2	50.5	68	37.134	167	46.743	1	%	CD15	212	262	5.8	WSW	Max			
20190910	1303	1	**193**	1	49.8	68	37.009	167	41.016	1	%	CD14	213	261	2.8	W	Max	0	4m	
20190910	1307	1	**193**	2	50	68	36.947	167	41.276	1	%	CD14	212	261	3.5	W	Max			
20190910	1326	1	**194**	1	48.5	68	37.009	167	35.515	1	%	CD13	213	262	2.9	WNW	Max	0.5	3m	
20190910	1328	1	**194**	2	48.6	68	36.948	167	35.722	1	%	CD13	212	262	3.1	NW	Max			
20190910	1347	1	**195**	1	46.6	68	37.092	167	29.892	1	%	CD12	213	259	2.6	W	Max	0	2.5m	strong surface fresh layer
20190910	1350	1	**195**	2	46.6	68	37.208	167	30.002	1	%	CD12	212	259	2.4	NW	Max			
20190910	1408	1	**196**	1	44.2	68	36.984	167	24.455	1	%	CD11	214	263	4	NW	Max	0	3m	
20190910	1411	1	**196**	2	44.3	68	37.129	167	24.567	1	%	CD11	213	263	3.5	NNW	Max			
20190910	1429	1	**197**	1	41.1	68	37.014	167	18.926	1	%	CD10	213	251	3.6	NW	Max	0	2.5m	freshwater lens on surface
20190910	1432	1	**197**	2	41.4	68	37.004	167	18.928	1	%	CD10	212	215	3.8	NW	Max			
20190910	1449	1	**198**	1	38.2	68	36.946	167	13.234	1	%	CD9	213	253	4.6	NW	Max	0	2.5m	freshwater lens on surface
20190910	1451	1	**198**	2	38.1	68	37.086	167	13.188	1	%	CD9	213	253	3.7	NW	Max			
20190910	1508	1	**199**	1	35.4	68	36.932	167	7.772	1	%	CD8	214	245	4	NW	Max	0	3m	freshwater lens on surface
20190910	1509	1	**199**	2	35.4	68	37.03	167	7.722	1	%	CD8	213	245	4.4	NNW	Max			
20190910	1526	1	**200**	1	34.1	68	36.938	167	2.385	1	%	CD7	214	246	6	NW	Max	0	3.5m	
20190910	1528	1	**200**	2	34.1	68	37.018	167	2.507	1	%	CD7	213	246	5.6	NNW	Max			
20190910	1547	1	**201**	1	32.9	68	36.959	166	56.786	1	%	CD6	213	241	5.5	N	Max	0	3m	
20190910	1548	1	**201**	2	32.9	68	36.984	166	56.721	1	%	CD6	213	241	6.2	NNW	Max			
20190910	1604	1	**202**	1	31.7	68	36.988	166	51.24	1	%	CD5	212	241	7	N	KG	0	2m	
20190910	1607	1	**202**	2	31.7	68	36.969	166	51.475	1	%	CD5	212	241	7.1	N	KG			
20190910	1624	1	**203**	1	31.1	68	36.998	166	45.464	1	%	CD4	213	243	8.4	NW	KG	0	2m	cleaned vent plugs after this cast
20190910	1629	1	**203**	2	31	68	36.889	166	45.397	1	%	CD4	213	243	6.4	N	KG			
20190910	1644	1	**204**	1	30.5	68	36.981	166	40.041	1	%	CD3	212	237	6.8	N	KG	0	3m	
20190910	1649	1	**204**	2	30.4	68	37.012	166	40.069	1	%	CD3	212	237	9.8	NNW	KG			

20190910	1704	1	**205**	1	29.5	68	37	166	34.468	1	%	CD2	213	239	4.4	NNW	KG	0	2m	
20190910	1707	1	**205**	2	29.4	68	36.979	166	34.331	1	%	CD2	213	239	999	999	KG			
20190910	1722	1	**206**	1	26.3	68	37.011	166	29.023	1	%	CD1	213	237	4.3	NE	KG	0	3m	Frequent clearing of vent plug through this line
20190910	1726	1	**206**	2	26.4	68	37.066	166	28.985	1	%	CD1	213	247	4	NE	KG			Casts <=206 scan length errors & supurious hex in headers
20190910	1748	1	**207**	1	28.9	68	40.076	166	27.52	1	%	CTDTest	213	240	3.8	NE	KG	0	2m	Seabird fix: send "autorun=n" to fish fixed this
20190910	1752	1	**207**	2	28.9	68	40.149	166	27.527	1	%	CTDTest	213	240	3.4	NE	KG			
20190910	1934	1	**208**	1	26.1	68	54.45	166	19.951	1	%	LIS1	213	238	2.4	NNW	KG	0	1.5m	Start of LIS line
20190910	1937	1	**208**	2	26.3	68	54.41	166	20.224	1	%	LIS1	213	238	2	NNW	KG			
20190910	1951	1	**209**	1	30.5	68	54.81	166	25.213	1	%	LIS2	213	239	4.8	N	KG	0	1.5m	
20190910	1955	1	**209**	2	30.8	68	54.895	166	25.361	1	%	LIS2	213	239	5.9	N	KG			
20190910	2009	1	**210**	1	32.1	68	55.181	166	30.458	1	%	LIS3	214	243	4.7	N	KG	0	1.5m	lots of jellyfish
20190910	2012	1	**210**	2	32	68	55.149	166	30.609	1	%	LIS3	214	243	4.9	N	KG			
20190910	2033	1	**211**	1	39	68	55.815	166	38.432	1	%	LIS4	214	251	4.2	N	KG	0	2m	
20190910	2037	1	**211**	2	39.4	68	55.772	166	38.565	1	%	LIS4	214	251	6.1	NE	KG			
20190910	2057	1	**212**	1	43.5	68	56.414	166	46.54	1	%	LIS5	213	252	4.4	N	KG	0	2m	
20190910	2101	1	**212**	2	43.5	68	56.352	166	46.717	1	%	LIS5	213	252	6.6	NNW	KG			
20190910	2121	1	**213**	1	44	68	57.024	166	54.501	1	%	LIS6	213	252	5.9	N	KG	0	2m	
20190910	2125	1	**213**	2	44.1	68	56.969	166	54.635	1	%	LIS6	213	252	7.7	N	KG			
20190910	2145	1	**214**	1	44.4	68	57.6	167	1.817	1	%	LIS6.5	214	252	4.2	N	KG	0	2m	vent plug cleaned on system 2 & both sensors syringed after cast
20190910	2149	1	**214**	2	44.4	68	57.557	167	1.901	1	%	LIS6.5	214	252	6.4	N	KG			
20190910	2209	1	**215**	1	44.3	68	58.202	167	9.189	1	%	LIS7	214	252	6.8	NW	KG	0	2m	
20190910	2214	1	**215**	2	44.3	68	58.138	167	9.284	1	%	LIS7	214	252	7.7	NNW	KG			
20190910	2234	1	**216**	1	44.5	68	58.828	167	16.559	1	%	LIS7.5	214	253	6	NNW	KG	0	3m	
20190910	2239	1	**216**	2	44.5	68	58.791	167	16.684	1	%	LIS7.5	214	253	6.4	NNW	KG			
20190910	2258	1	**217**	1	45	68	59.43	167	24.037	1	%	LIS8	214	254	5	NNW	KG	0	3m	
20190910	2303	1	**217**	2	45.2	68	59.476	167	24.191	1	%	LIS8	214	254	4.6	NNW	KG			
20190910	2327	1	**218**	1	45.8	69	0.234	167	33.769	1	%	LIS8.5	214	253	5.8	NW	KG	0	3m	sensors syringed after cast (jellyfish tentacle in system)
20190910	2331	1	**218**	2	45.8	69	0.216	167	33.872	1	%	LIS8.5	214	253	6.7	NW	KG			
20190910	2356	1	**219**	1	46.5	69	1.019	167	43.533	1	%	LIS9.5	214	256	5.5	NNW	KG	0	3m	
20190911	0001	1	**219**	2	46.6	69	0.957	167	43.664	1	%	LIS9.5	214	256	4.9	N	KG			
20190911	0026	1	**220**	1	47.1	69	1.804	167	53.301	1	%	LIS10	213	257	3.4	NW	KC	0	3m	Most northerly point
20190911	0030	1	**220**	2	47	69	1.767	167	53.409	1	%	LIS10	213	257	3.5	NW	KC			
20190911	0107	1	**221**	1	47.7	69	1.375	168	7.857	1	%	LIS11	213	256	4.2	N	KC	0	3m	
20190911	0113	1	**221**	2	47.7	69	1.375	168	7.964	1	%	LIS11	213	256	6.1	N	KC			
20190911	0149	1	**222**	1	48.5	69	0.936	168	22.454	1	%	LIS12	213	258	6.4	NNE	KC	0	5m	
20190911	0154	1	**222**	2	48.4	69	0.906	168	22.373	1	%	LIS12	213	258	6.3	NNE	KC			
20190911	0229	1	**223**	1	49.7	69	0.466	168	37.01	1	%	LIS13	213	261	2.4	NE	KC	0	7m	sensors syringed after cast (baby jelly in system)
20190911	0234	1	**223**	2	49.7	69	0.412	168	37.102	1	%	LIS13	212	261	2.7	NE	KC			
20190911	0258	1	**224**	1	50.4	69	0.257	168	46.597	1	%	LIS14	213	262	4.1	NE	KC	0	7m	lots of jellyfish + swarms of <5cm clear jellies/dumbells
20190911	0304	1	**224**	2	50.4	69	0.213	168	46.773	1	%	LIS14	213	262	4	NE	KC			
20190911	0328	1	**225**	1	50.6	69	0.035	168	56.046	1	%	CCL22	213	260	3.2	E	KC	0	7m	wire strumming, no dumbells or <5cm jellies, but other 20cm jellies
20190911	0334	1	**225**	2	50.7	69	0.039	168	56.211	1	%	CCL22	212	260	2.9	E	KC			
20190911	1023	1	**226**	1	26.6	68	36.998	166	29.274	1	%	CD1	214	238	9	ESE	Max	0	4m	
20190911	1024	1	**226**	2	26.6	68	36.995	166	29.48	1	%	CD1	214	238	9.8	ESE	Max			
20190911	1038	1	**227**	1	29.6	68	36.945	166	34.557	1	%	CD2	214	244	8.4	SE	Max	0	4m	
20190911	1040	1	**227**	2	29.7	68	37.046	166	34.6	1	%	CD2	213	244	7.5	SE	Max			
20190911	1057	1	**228**	1	30.5	68	36.958	166	40.107	1	%	CD3	214	241	6.3	ESE	Max	0	3.5m	
20190911	1058	1	**228**	2	30.6	68	37.039	166	40.125	1	%	CD3	213	241	7.5	ESE	Max			
20190911	1115	1	**229**	1	31.1	68	36.95	166	45.595	1	%	CD4	214	240	7.1	ESE	Max	0	3.5m	
20190911	1117	1	**229**	2	31.1	68	36.979	166	45.543	1	%	CD4	213	240	7.9	ESE	Max			
20190911	1134	1	**230**	1	31.8	68	36.958	166	51.259	1	%	CD5	214	241	11	ESE	Max	0	3m	
20190911	1135	1	**230**	2	31.8	68	37	166	51.32	1	%	CD5	213	241	12.7	SE	Max			
20190911	1150	1	**231**	1	32.9	68	36.982	166	56.866	1	%	CD6	214	245	15.3	SE	Max	0	3m	
20190911	1152	1	**231**	2	33	68	37.074	166	57.025	1	%	CD6	213	245	14.2	SE	Max			
20190911	1207	1	**232**	1	34.2	68	36.983	167	2.283	1	%	CD7	214	248	13.6	SE	Max	0	3m	
20190911	1209	1	**232**	2	34.2	68	37.084	167	2.443	1	%	CD7	213	248	11.7	SE	Max			
20190911	1224	1	**233**	1	35.5	68	36.97	167	7.788	1	%	CD8	213	249	15.2	ESE	Max	0	3.5m	
20190911	1226	1	**233**	2	35.7	68	37.085	167	7.951	1	%	CD8	212	249	13.6	SE	Max			
20190911	1241	1	**234**	1	38.2	68	36.94	167	13.102	1	%	CD9	214	252	12.7	ESE	Max	0	3m	
20190911	1243	1	**234**	2	38.2	68	37.059	167	13.093	1	%	CD9	214	252	14.2	SE	Max			
20190911	1301	1	**235**	1	41.4	68	36.944	167	18.814	1	%	CD10	214	259	10.9	SE	Max	0	2.5m	
20190911	1304	1	**235**	2	41.4	68	37.085	167	18.891	1	%	CD10	213	259	12.1	ESE	Max			
20190911	1321	1	**236**	1	44	68	36.98	167	24.415	1	%	CD11	215	264	10.3	ESE	Max	0	2.5m	
20190911	1324	1	**236**	2	44.1	68	37.127	167	24.585	1	%	CD11	214	264	10.9	SE	Max			
20190911	1340	1	**237**	1	46.4	68	36.932	167	29.851	1	%	CD12	215	266	9.7	SE	Max	0	2.5m	
20190911	1343	1	**237**	2	46.5	68	37.132	167	29.935	1	%	CD12	213	266	12.2	SE	Max			
20190911	1400	1	**238**	1	48.4	68	37.052	167	35.487	1	%	CD13	213	257	11.5	SE	Max	0	2.5m	ended data acquisition before turning off pump
20190911	1402	1	**238**	2	48.4	68	37.073	167	35.606	1	%	CD13	212	257	12.2	SE	Max			
20190911	1419	1	**239**	1	49.9	68	37.014	167	41.111	1	%	CD14	213	260	8.6	ESE	Max	0	2m	
20190911	1421	1	**239**	2	49.9	68	36.965	167	41.174	1	%	CD14	213	260	9.1	ESE	Max			
20190911	1437	1	**240**	1	50.5	68	37.19	167	46.521	1	%	CD15	213	261	9.3	ESE	Max	0	3m	

20190911	1440	1	**240**	2	50.5	68	37.118	167	46.626	1	%	CD15	213	261	9.6	SE	Max			
20190911	1455	1	**241**	1	50.8	68	37.452	167	51.734	1	%	CD16	213	259	9.7	SE	Max	0	3m	
20190911	1458	1	**241**	2	50.7	68	37.404	167	51.812	1	%	CD16	213	259	9.6	SE	Max			
20190911	1513	1	**242**	1	50.3	68	37.683	167	57.1	1	%	CD17	214	259	8.7	SE	Max	0	3.5m	midwater bloom
20190911	1516	1	**242**	2	50.2	68	37.668	167	57.175	1	%	CD17	212	259	9.4	ESE	Max			
20190911	1532	1	**243**	1	50.6	68	37.873	168	2.373	1	%	CD18	213	260	8.3	SE	Max	0	3m	subsurface bloom
20190911	1535	1	**243**	2	50.6	68	37.817	168	2.373	1	%	CD18	213	260	8	ESE	Max			
20190911	1552	1	**244**	1	50.4	68	38.097	168	7.901	0	%	CD19	213	259	7.4	ESE	Max	0	4m	subsurface bloom
20190911	1555	1	**244**	2	50.4	68	38.038	168	7.916	0	%	CD19	212	259	8.8	E	Max			vent plug cleaned after cast
20190911	1610	1	**245**	1	50.2	68	38.279	168	13.08	0	%	CD20	999	999	7.7	E	KG	0	3m	held at surface, cast aborted due to sensor discrepancy
20190911	1613	1	**245**	2	50.2	68	38.212	168	13.115	0	%	CD20	999	999	7.5	E	KG			
20190911	1615	1	**246**	1	50.2	68	38.186	168	13.143	0	%	CD20	212	258	7.6	E	KG	0	5m	yoyo'd (2nd downcast at 16:21 at 68 38.172 and 168 13.187)
20190911	1625	1	**246**	2	50.2	68	38.182	168	13.225	0	%	CD20	212	258	6.6	E	KG			
20190911	1639	1	**247**	1	49.9	68	38.47	168	18.46	0	%	CD21	213	259	6.3	E	KG	0	3m	
20190911	1643	1	**247**	2	50	68	38.56	168	18.346	0	%	CD21	213	259	6.1	E	KG			
20190911	1658	1	**248**	1	50.2	68	38.742	168	23.835	0	%	CD22	214	262	7.6	E	KG	0	3m	
20190911	1703	1	**248**	2	50.2	68	38.781	168	24.206	0	%	CD22	214	262	7.6	E	KG			
20190911	1716	1	**249**	1	50	68	38.971	168	29.151	0	%	CD23	213	261	8.8	E	KG	0	7m	
20190911	1722	1	**249**	2	49.9	68	39.011	168	29.521	0	%	CD23	213	261	8.4	E	KG			
20190911	1735	1	**250**	1	51.1	68	39.171	168	34.551	0	%	CD24	212	262	5.5	E	KG	0	5m	
20190911	1741	1	**250**	2	51.1	68	39.076	168	34.65	0	%	CD24	212	262	7.2	E	KG			
20190911	1755	1	**251**	1	51	68	39.414	168	39.861	0	%	CD25	213	262	8.6	E	KG	0	7m	
20190911	1800	1	**251**	2	50.8	68	39.329	168	40.032	0	%	CD25	213	262	9.1	E	KG			
20190911	1814	1	**252**	1	51.9	68	39.638	168	45.562	0	%	CD26	213	262	9.3	E	KG	0	8m	
20190911	1820	1	**252**	2	51.8	68	39.557	168	46.682	0	%	CD26	213	262	10.7	NE	KG			
20190911	1833	1	**253**	1	51.2	68	39.835	168	50.488	0	%	CD27	213	261	10.8	E	KG	0	10m	
20190911	1838	1	**253**	2	51.2	68	39.761	168	50.551	0	%	CD27	213	261	10.9	NE	KG			
20190911	1852	1	**254**	1	51.3	68	40.057	168	55.83	0	%	CCL20	213	261	11.7	NE	KG	0.5	7.5m	
20190911	1857	1	**254**	2	51.3	68	39.982	168	55.964	0	%	CCL20	213	261	11.7	NE	KG			
20190911	2009	1	**255**	1	53.3	68	30.013	168	56.13	1	%	CCL19	213	261	13.2	SE	KG	0	3m	
20190911	2014	1	**255**	2	53.2	68	30.079	168	56.058	1	%	CCL19	213	261	13.4	SE	KG			
20190911	2033	1	**256**	1	52	68	29.545	168	49.414	1	%	NPH14.5	213	260	14.5	SE	KG	0	3m	
20190911	2038	1	**256**	2	52	68	29.526	168	49.673	1	%	NPH14.5	213	260	14	SE	KG			
20190911	2059	1	**257**	1	51.8	68	29.073	168	42.297	1	%	NPH14	213	258	16.5	SE	KG	0	3m	
20190911	2103	1	**257**	2	51.8	68	29.126	168	42.295	1	%	NPH14	213	258	15.8	SE	KG			
20190911	2123	1	**258**	1	50.8	68	28.566	168	35.626	1	%	NPH13.5	214	258	14.5	SE	KG	0	5m	
20190911	2128	1	**258**	2	50.9	68	28.626	168	35.697	1	%	NPH13.5	214	258	14.9	SE	KG			
20190911	2149	1	**259**	1	50.2	68	28.06	168	28.894	1	%	NPH13	212	258	14.4	SE	KG	0	5m	
20190911	2154	1	**259**	2	50.2	68	28.125	168	28.923	1	%	NPH13	212	258	12.8	SE	KG			
20190911	2214	1	**260**	1	50.9	68	27.605	168	22.233	1	%	NPH12.5	213	257	13.8	SE	KG	0	5m	
20190911	2219	1	**260**	2	50.6	68	27.669	168	22.233	1	%	NPH12.5	213	257	11.5	SE	KG			
20190911	2238	1	**261**	1	49.9	68	27.105	168	15.463	1	%	NPH12	212	258	14.1	SE	KG	0	5m	
20190911	2244	1	**261**	2	50.3	68	27.201	168	15.488	1	%	NPH12	212	258	12.9	SE	KG			
20190911	2304	1	**262**	1	50.3	68	26.69	168	8.776	1	%	NPH11.5	212	258	14.3	SE	KG	0	4m	
20190911	2309	1	**262**	2	50.3	68	26.775	168	8.823	1	%	NPH11.5	212	258	13.1	SE	KG			
20190911	2329	1	**263**	1	51.5	68	26.182	168	2.004	1	%	NPH11	213	259	15.2	SE	KG	0	3m	
20190911	2334	1	**263**	2	51.5	68	26.26	168	2.023	1	%	NPH11	213	259	13.9	SE	KG			
20190911	2354	1	**264**	1	52.4	68	25.655	167	55.175	1	%	NPH10	213	259	15.1	SE	KG	0	4m	
20190911	2359	1	**264**	2	52.5	68	25.744	167	55.19	1	%	NPH10	213	259	14.1	SE	KG			
20190912	0019	1	**265**	1	52	68	25.225	167	48.502	1	%	NPH9	212	260	14.3	SE	KC	0	2m	
20190912	0025	1	**265**	2	52.1	68	25.333	167	48.519	1	%	NPH9	213	260	13.9	SE	KC			
20190912	0045	1	**266**	1	50.6	68	24.746	167	41.739	1	%	NPH8	212	260	15.9	ESE	KC	0	2m	
20190912	0050	1	**266**	2	50.7	68	24.859	167	41.744	1	%	NPH8	213	260	15.9	ESE	KC			
20190912	0110	1	**267**	1	48	68	24.291	167	34.956	1	%	NPH7	212	258	16.1	SE	KC	0	3m	
20190912	0115	1	**267**	2	48.4	68	24.43	167	34.973	1	%	NPH7	212	258	15.5	SE	KC			
20190912	0137	1	**268**	1	45.3	68	23.807	167	28.218	1	%	NPH6	213	261	15.8	SE	KC	0	3m	
20190912	0143	1	**268**	2	45.3	68	24.061	167	28.425	1	%	NPH6	214	261	13	SE	KC			
20190912	0207	1	**269**	1	40.8	68	23.183	167	21.455	1	%	NPH5	213	254	14.5	SE	KC	0	2m	
20190912	0212	1	**269**	2	41.2	68	23.353	167	21.489	1	%	NPH5	213	254	15.8	SE	KC			
20190912	0224	1	**270**	1	41.1	68	23.011	167	17.967	1	%	NPH4	212	249	12.8	SE	KC	0	3m	
20190912	0229	1	**270**	2	39	68	23.179	167	17.945	1	%	NPH4	213	249	13.2	SE	KC			
20190912	0240	1	**271**	1	39.6	68	22.813	167	14.729	1	%	NPH3	213	249	12.5	SE	KC	0	2m	
20190912	0245	1	**271**	2	39.3	68	22.947	167	14.801	1	%	NPH3	213	249	13.5	SE	KC			
20190912	0259	1	**272**	1	39.2	68	22.563	167	11.392	1	%	NPH2	213	249	14.8	SE	KC	0	2m	
20190912	0304	1	**272**	2	39.6	68	22.719	167	11.504	1	%	NPH2	213	249	13	SE	KC			
20190912	0319	1	**273**	1	35.1	68	22.273	167	7.933	1	%	NPH1	213	244	11.2	SE	KC	0	2m	
20190912	0323	1	**273**	2	35	68	22.36	167	8.063	1	%	NPH1	213	244	11.2	SE	KC			
20190912	0426	1	**274**	1	25.5	68	19.855	166	52.371	1	%	CS19	214	238	7.9	E	KC	0	3m	
20190912	0429	1	**274**	2	26.4	68	19.788	166	52.646	1	%	CS19	213	238	7.9	E	KC			
20190912	0443	1	**275**	1	32.4	68	18.889	166	57.791	1	%	CS18	214	259	8	E	KC	0	3.5m	
20190912	0446	1	**275**	2	32.7	68	18.906	166	58.392	1	%	CS18	214	259	8.8	E	KC			

20190912	0501	1	**276**	1	36.2	68	18.031	167	2.895	1	%	CS17	214	254	10.2	E	KC	0	2.5m	
20190912	0504	1	**276**	2	37	68	18.087	167	3.318	1	%	CS17	214	254	9.1	E	KC			
20190912	0520	1	**277**	1	40	68	16.586	167	7.515	1	%	CS16.5	214	258	11.5	E	KC	0	3m	
20190912	0524	1	**277**	2	40	68	16.545	167	7.549	1	%	CS16.5	214	258	12	E	KC			
20190912	0541	1	**278**	1	43.3	68	14.979	167	12.198	1	%	CS16	214	261	11.4	E	KC	0	2.5m	
20190912	0544	1	**278**	2	43.1	68	14.956	167	12.26	1	%	CS16	214	261	13	NE	KC			
20190912	0600	1	**279**	1	44.6	68	13.588	167	16.799	1	%	CS15.5	214	254	11.4	E	KC	0	3m	
20190912	0604	1	**279**	2	44.5	68	13.666	167	16.908	1	%	CS15.5	213	254	11.7	E	KC			
20190912	0621	1	**280**	1	46.6	68	12.113	167	21.398	1	%	CS15	214	256	14.5	E	KC	0	2.5m	
20190912	0625	1	**280**	2	46.2	68	12.098	167	21.51	1	%	CS15	213	256	14.9	E	KC			
20190912	0642	1	**281**	1	46.7	68	10.618	167	26.02	1	%	CS14.75	215	255	14.9	E	KC	0	3m	5-6 ft swells, 1 foot chop
20190912	0646	1	**281**	2	46.7	68	10.597	167	26.158	1	%	CS14.75	214	255	13.8	E	KC			
20190912	0703	1	**282**	1	47.4	68	9.096	167	30.686	1	%	CS14.5	214	256	14.1	E	KC	0	1.5m	seas building from here to end of CS line with waves up to 6-10ft
20190912	0708	1	**282**	2	47.5	68	9.109	167	30.775	1	%	CS14.5	214	256	13.5	E	KC			
20190912	0725	1	**283**	1	48.8	68	7.611	167	35.302	1	%	CS14.25	214	256	14.4	E	KC		2.5m	seas building from here to end of CS line with waves up to 6-10ft
20190912	0729	1	**283**	2	48.8	68	7.6	167	35.415	1	%	CS14.25	214	256	14	E	KC			
20190912	0745	1	**284**	1	50.8	68	6.107	167	39.902	1	%	CS14	214	259	12.3	E	KC		2.5m	seas building from here to end of CS line with waves up to 6-10ft
20190912	0750	1	**284**	2	51.1	68	6.094	167	40.072	1	%	CS14	213	259	10.1	E	KC			
20190912	0809	1	**285**	1	52.6	68	4.417	167	44.772	1	%	CS13.75	214	260	15.6	NE	Max		3m	seas building from here to end of CS line with waves up to 6-10ft
20190912	0812	1	**285**	2	52.5	68	4.421	167	44.858	1	%	CS13.75	214	260	18.2	NE	Max			
20190912	0832	1	**286**	1	52.6	68	2.71	167	49.679	1	%	CS13.5	214	259	16.9	NE	Max		3m	seas building from here to end of CS line with waves up to 6-10ft
20190912	0835	1	**286**	2	52.5	68	2.702	167	49.763	1	%	CS13.5	214	259	17.9	NE	Max			
20190912	0855	1	**287**	1	51.3	68	1.013	167	54.499	1	%	CS13.25	214	259	16.4	NE	Max		3m	seas building from here to end of CS line with waves up to 6-10ft
20190912	0857	1	**287**	2	51.2	68	1.019	167	54.612	0	%	CS13.25	214	259	16.7	NE	Max			
20190912	0917	1	**288**	1	53.3	67	59.303	167	59.396	1	%	CS13	215	262	18.5	NE	Max		2.5m	seas building from here to end of CS line with waves up to 6-10ft
20190912	0920	1	**288**	2	53.4	67	59.307	167	59.496	0	%	CS13	214	262	17.9	NE	Max			
20190912	0940	1	**289**	1	59.5	67	57.612	168	4.19	0	%	CS12.75	214	268	17.1	NE	Max			seas building from here to end of CS line with waves up to 6-10ft
20190912	0944	1	**289**	2	59.6	67	57.624	168	4.349	0	%	CS12.75	215	268	16.9	NE	Max			
20190912	1005	1	**290**	1	57.7	67	55.913	168	9.067	1	%	CS12.5	214	265	17.6	NE	Max		3m	seas building from here to end of CS line with waves up to 6-10ft
20190912	1008	1	**290**	2	57.5	67	55.924	168	9.235	0	%	CS12.5	214	265	17.2	NE	Max			
20190912	1028	1	**291**	1	56.5	67	54.211	168	13.893	0	%	CS12.25	215	264	18	NE	Max		3m	seas building from here to end of CS line with waves up to 6-10ft
20190912	1031	1	**291**	2	56.7	67	54.188	168	13.992	0	%	CS12.25	214	264	18.2	NE	Max			
20190912	1053	1	**292**	1	55.3	67	52.518	168	18.756	0	%	CS12	214	264	17.4	NE	Max		2.5m	seas building from here to end of CS line with waves up to 6-10ft
20190912	1055	1	**292**	2	55.2	67	52.513	168	18.861	0	%	CS12	215	264	19	NE	Max			
20190912	1118	1	**293**	1	51.5	67	50.713	168	24.067	0	%	CS11.75	214	261	20	NE	Max		3m	seas building from here to end of CS line with waves up to 6-10ft
20190912	1120	1	**293**	2	51.4	67	50.686	168	24.17	0	%	CS11.75	215	261	21.8	NE	Max			
20190912	1142	1	**294**	1	49.5	67	48.915	168	29.357	0	%	CS11.5	215	261	20.5	NE	Max		3m	seas building from here to end of CS line with waves up to 6-10ft
20190912	1145	1	**294**	2	49.6	67	48.892	168	29.467	0	%	CS11.5	215	261	21.7	NE	Max			
20190912	1206	1	**295**	1	48.8	67	47.125	168	34.549	0	%	CS11.25	214	259	19.2	NE	Max		2.5m	seas building from here to end of CS line with waves up to 6-10ft
20190912	1209	1	**295**	2	49.1	67	47.115	168	34.583	0	%	CS11.25	214	259	18.8	NE	Max			
20190912	1232	1	**296**	1	48.7	67	45.318	168	39.846	0	%	CS11	214	258	18.7	NE	Max		3.5m	seas building from here to end of CS line with waves up to 6-10ft
20190912	1234	1	**296**	2	48.6	67	45.316	168	39.881	0	%	CS11	213	258	19.2	NE	Max			
20190912	1256	1	**297**	1	48.7	67	43.526	168	43.978	0	%	CS10.75	213	257	20.2	NE	Max		2.5m	seas building from here to end of CS line with waves up to 6-10ft
20190912	1258	1	**297**	2	48.2	67	43.51	168	44	0	%	CS10.75	213	257	20.7	NE	Max			
20190912	1319	1	**298**	1	48.5	67	41.72	168	48.04	0	%	CS10.5	214	254	22.7	NE	Max		2.5m	seas building from here to end of CS line with waves up to 6-10ft
20190912	1322	1	**298**	2	48.7	67	41.713	168	48.083	0	%	CS10.5	214	254	21.4	NE	Max			
20190912	1343	1	**299**	1	48.6	67	39.903	168	51.939	0	%	CS10.25	214	256	23.3	NE	Max		2m	seas building from here to end of CS line with waves up to 6-10ft
20190912	1344	1	**299**	2	49.1	67	39.88	168	51.923	0	%	CS10.25	213	256	23.2	NE	Max			salinity difference (0.03psu) on up cast
20190912	1410	1	**300**	1	49	67	38.085	168	55.985	0	%	CS10	215	253			Max		2.5m	syringed both sensors before cast, took a small knock on rail on recovery.
20190912	1412	1	**300**	2	49.1	67	38.086	168	55.965	0	%	CS10	215	253	24.3	NE	Max			Finished line and called off casting cos of weather
20190913	0704	1	**301**	1	22.5	66	30.64	167	51.354	1	%	AL27.5	214	232	16.5	NE	KC	0	2m	
20190913	0707	1	**301**	2	22.3	66	30.655	167	51.427	1	%	AL27.5	212	232	16.5	NE	KC			
20190913	0715	1	**302**	1	22.1	66	30.282	167	53.366	1	%	AL27	214	232	20.2	NE	KC	0	2m	
20190913	0717	1	**302**	2	22.1	66	30.258	167	53.385	1	%	AL27	214	232	17.9	NE	KC			
20190913	0726	1	**303**	1	21.8	66	29.934	167	55.583	1	%	AL26.5	214	231	16.5	NE	KC	0	2m	
20190913	0728	1	**303**	2	21.9	66	29.912	167	55.639	1	%	AL26.5	214	231	14.9	NE	KC			
20190913	0737	1	**304**	1	21.9	66	29.591	167	57.66	1	%	AL26	214	231	14.9	NE	KC	0	2m	
20190913	0739	1	**304**	2	21.7	66	29.58	167	57.691	1	%	AL26	214	231	14.9	NE	KC			
20190913	0747	1	**305**	1	22	66	29.233	167	59.811	1	%	AL25.5	214	232	14.4	NE	KC	0	2.5m	
20190913	0750	1	**305**	2	21.9	66	29.226	167	59.847	1	%	AL25.5	214	232	17.1	NE	KC			
20190913	0758	1	**306**	1	22.7	66	28.886	168	1.954	1	%	AL25	214	232	15.6	NE	KC	0	2.5m	
20190913	0801	1	**306**	2	22.7	66	28.892	168	1.971	1	%	AL25	215	232	14.9	NE	KC			
20190913	0811	1	**307**	1	24.3	66	28.521	168	4.144	1	%	AL24.5	215	234	16.7	NE	Max		2.5m	
20190913	0813	1	**307**	2	24.3	66	28.51	168	4.125	1	%	AL24.5	215	234	17.1	NE	Max			
20190913	0822	1	**308**	1	26.4	66	28.185	168	6.3	1	%	AL24	215	237	14.7	NE	Max		2m	might have mislabeled as 24.5 in seasave
20190913	0824	1	**308**	2	26.3	66	28.175	168	6.272	1	%	AL24	215	237	17.1	NE	Max			
20190913	0834	1	**309**	1	28.7	66	27.811	168	8.434	1	%	AL23.5	215	239	15	NE	Max		2m	
20190913	0836	1	**309**	2	28.5	66	27.822	168	8.428	0	%	AL23.5	215	239	16.1	NE	Max			
20190913	0846	1	**310**	1	32.5	66	27.477	168	10.618	1	%	AL23	216	241	15.6	NE	Max		2m	
20190913	0847	1	**310**	2	32.2	66	27.495	168	10.599	1	%	AL23	215	241	15.9	NNE	Max			
20190913	0858	1	**311**	1	36.3	66	27.106	168	12.734	1	%	AL22.5	215	243	17.2	NE	Max		2m	

20190913	0859	1	**311**	2	36.3	66	27.133	168	12.76	1	%	AL22.5	215	243	18.8	NE	Max			
20190913	0910	1	**312**	1	39.5	66	26.763	168	14.958	1	%	AL22	215	249	17	NE	Max		2m	
20190913	0912	1	**312**	2	39.5	66	26.781	168	14.984	0	%	AL22	215	249	16.9	NNE	Max			
20190913	0922	1	**313**	1	42.5	66	26.397	168	17.037	1	%	AL21.5	215	252	16.1	NE	Max		2m	
20190913	0924	1	**313**	2	42.4	66	26.431	168	17.057	1	%	AL21.5	215	252	17.8	NNE	Max			
20190913	0935	1	**314**	1	46.5	66	26.039	168	19.236	1	%	AL21	216	256	16	NE	Max		2.5m	
20190913	0938	1	**314**	2	46.6	66	26.05	168	19.287	1	%	AL21	215	256	16.9	NE	Max			
20190913	0948	1	**315**	1	49.8	66	25.687	168	21.344	1	%	AL20.5	216	260	17.1	NE	Max		2.5m	
20190913	0951	1	**315**	2	49.8	66	25.713	168	21.367	1	%	AL20.5	215	260	16.5	NNE	Max			
20190913	1000	1	**316**	1	51.2	66	25.317	168	23.531	1	%	AL20	216	262	16.3	NE	Max		2.5m	
20190913	1003	1	**316**	2	51.2	66	25.307	168	23.563	1	%	AL20	216	262	17.2	NE	Max			
20190913	1013	1	**317**	1	51.1	66	25.006	168	25.744	1	%	AL19.5	217	262	15.6	NE	Max		3m	
20190913	1015	1	**317**	2	51	66	24.978	168	25.741	1	%	AL19.5	216	262	17.1	NNE	Max			
20190913	1025	1	**318**	1	52.1	66	24.624	168	27.884	1	%	AL19	216	261	17.3	NE	Max		3m	
20190913	1028	1	**318**	2	52.4	66	24.592	168	27.861	1	%	AL19	215	261	16.6	NE	Max			
20190913	1037	1	**319**	1	51.8	66	24.262	168	30.025	1	%	AL18.5	216	264	16.9	NE	Max		3m	
20190913	1041	1	**319**	2	52	66	24.22	168	30.027	1	%	AL18.5	215	264	16.4	NNE	Max			
20190913	1050	1	**320**	1	51.4	66	23.921	168	32.211	1	%	AL18	217	261	14.6	NE	Max		3m	
20190913	1053	1	**320**	2	51.7	66	23.891	168	32.222	1	%	AL18	216	261	14.7	NNE	Max			salinity difference (0.03psu) on up cast
20190913	1103	1	**321**	1	52.3	66	23.626	168	33.967	1	%	AL17.5	216	262	14.4	NNE	Max		3m	syringed both sensors and cleaned vent plugs before this cast
20190913	1105	1	**321**	2	52.3	66	23.61	168	33.942	1	%	AL17.5	215	262	16.1	NNE	Max			
20190913	1117	1	**322**	1	53.9	66	23.198	168	36.501	1	%	AL17	217	266	10.6	NNE	Max		2.5m	
20190913	1118	1	**322**	2	53.7	66	23.171	168	36.651	1	%	AL17	215	266	13.7	NE	Max			
20190913	1127	1	**323**	1	54.9	66	22.862	168	38.638	1	%	AL16.5	217	266	13.8	NE	Max		3m	
20190913	1130	1	**323**	2	55.1	66	22.825	168	38.62	1	%	AL16.5	215	266	13.2	NNE	Max			
20190913	1139	1	**324**	1	55.4	66	22.516	168	40.837	1	%	AL16	216	265	9.7	NE	Max		3m	
20190913	1142	1	**324**	2	55.5	66	22.479	168	40.888	0	%	AL16	215	265	14.3	NNE	Max			
20190913	1151	1	**325**	1	50.1	66	22.173	168	42.92	1	%	AL15.5	216	260	13.5	NE	Max		3m	
20190913	1154	1	**325**	2	50	66	22.142	168	42.958	1	%	AL15.5	215	260	14.6	NE	Max			
20190913	1203	1	**326**	1	45.1	66	21.818	168	45.1	1	%	AL15	219	259	10	NE	Max		3m	
20190913	1205	1	**326**	2	46	66	21.792	168	45.286	1	%	AL15	216	259	14.5	NE	Max			
20190913	1214	1	**327**	1	53	66	21.447	168	47.223	1	%	AL14.5	216	263	14.7	NE	Max		3m	
20190913	1216	1	**327**	2	53	66	21.424	168	47.265	1	%	AL14.5	215	263	13.6	NE	Max			
20190913	1226	1	**328**	1	53.3	66	21.113	168	49.488	1	%	AL14	217	263	13.3	NE	Max		3.5m	
20190913	1228	1	**328**	2	53.1	66	21.079	168	49.555	1	%	AL14	216	263	14.7	NNE	Max			
20190913	1237	1	**329**	1	52.4	66	20.762	168	51.537	1	%	AL13.5	216	262	13.2	NE	Max		3m	
20190913	1240	1	**329**	2	52.3	66	20.742	168	51.582	1	%	AL13.5	215	262	13.1	NNE	Max			
20190913	1249	1	**330**	1	54.3	66	20.411	168	53.66	1	%	AL13	219	264	14.5	NE	Max		3m	
20190913	1251	1	**330**	2	54.3	66	20.408	168	53.695	1	%	AL13	215	264	14.1	NNE	Max			
20190913	1249	1	**331**	1	54.4	66	20.024	168	55.299	1	%	AL12.5	216	264	13.1	NE	Max		3m	
20190913	1302	1	**331**	2	54.3	66	20.02	168	55.343	1	%	AL12.5	216	264	12.8	NNE	Max			
20190913	1311	1	**332**	1	54.4	66	19.756	168	57.011	0	%	A3-19	217	263	13.5	NE	Max		3m	
20190913	1313	1	**332**	2	54.4	66	19.769	168	57.073	0	%	A3-19	215	263	13	NNE	Max			
20190913	1638	1	**333**	1	24.8	66	10.159	167	55.67	1	%	NNBS8	215	236	16.4	NE	KG	0	.5m	
20190913	1641	1	**333**	2	25.1	66	10.143	167	55.62	1	%	NNBS8	215	246	14.1	NE	KG			
20190913	1655	1	**334**	1	33.3	66	10.191	167	59.927	1	%	NNBS7.5	216	244	13.2	NE	KG	0	.5m	
20190913	1700	1	**334**	2	33	66	10.124	167	59.968	1	%	NNBS7.5	216	244	12.9	NE	KG			
20190913	1713	1	**335**	1	39.6	66	10.228	168	4.32	1	%	NNBS7	216	252	9.3	NE	KG	0	.5m	
20190913	1718	1	**335**	2	39.6	66	10.205	168	4.519	1	%	NNBS7	216	252	13.9	NE	KG			
20190913	1730	1	**336**	1	46.2	66	10.212	168	8.606	1	%	NNBS6.5	216	260	9.6	NE	KG	0	.5m	
20190913	1736	1	**336**	2	46.7	66	10.22	168	9.841	1	%	NNBS6.5	215	260	12.5	NE	KG			
20190913	1748	1	**337**	1	48.2	66	10.221	168	12.914	1	%	NNBS6	216	257	8.8	NE	KG	0	.5m	stopped short due to shipboard depth outage
20190913	1753	1	**337**	2	48.6	66	10.271	168	13.139	1	%	NNBS6	216	257	13.5	NNE	KG			
20190913	1805	1	**338**	1	51.1	66	10.215	168	17.128	1	%	NNBS5.5	216	261	10.7	NNE	KG	0	.5m	
20190913	1812	1	**338**	2	51.4	66	10.315	168	17.311	1	%	NNBS5.5	216	261	13.2	NNE	KG			
20190913	1825	1	**339**	1	54.6	66	10.188	168	21.493	1	%	NNBS5	217	267	12	NNE	KG	0	1.5m	cleaned vent plugs after this cast
20190913	1831	1	**339**	2	56.1	66	10.265	168	21.632	1	%	NNBS5	217	267	14.2	NNE	KG			
20190913	1844	1	**340**	1	50.9	66	10.181	168	25.855	1	%	NNBS4.5	217	262	13.9	NNE	KG	0	1.5m	
20190913	1850	1	**340**	2	51.4	66	10.205	168	25.812	1	%	NNBS4.5	217	262	13.2	NE	KG			
20190913	1905	1	**341**	1	51.6	66	10.191	168	30.279	1	%	NNBS4	217	262	9.1	NNE	KG	0	1.5m	
20190913	1910	1	**341**	2	52.1	66	10.258	168	30.44	1	%	NNBS4	217	262	14.2	NNE	KG			
20190913	1923	1	**342**	1	55.4	66	10.197	168	34.626	1	%	NNBS3.5	217	264	8.9	NNE	KG	0	1.5m	
20190913	1929	1	**342**	2	55.1	66	10.215	168	34.741	1	%	NNBS3.5	217	264	13.1	NE	KG			
20190913	1942	1	**343**	1	53.1	66	10.204	168	38.83	1	%	NNBS3	217	265	11.2	NE	KG	0	1.5m	Beat 2017 # of CTDS, new record
20190913	1947	1	**343**	2	53.2	66	10.183	168	38.969	1	%	NNBS3	217	265	11.5	NE	KG			
20190913	2001	1	**344**	1	53.4	66	10.184	168	43.214	1	%	NNBS2.5	217	261	7.7	NNE	KG	0	2m	
20190913	2006	1	**344**	2	52.9	66	10.194	168	43.304	1	%	NNBS2.5	217	261	9.7	NE	KG			
20190913	2019	1	**345**	1	54.5	66	10.199	168	47.549	0	%	NNBS2	216	263	7.2	N	KG	0	2m	
20190913	2025	1	**345**	2	54	66	10.2	168	47.618	0	%	NNBS2	216	263	10.4	N	KG			
20190913	2038	1	**346**	1	53.5	66	10.19	168	51.893	0	%	NNBS1.5	216	261	9.5	NW	KG	0	2m	
20190913	2043	1	**346**	2	53.8	66	10.2	168	52.032	0	%	NNBS1.5	216	261	12.6	NW	KG			

20190913	2056	1	**347**	1	53.7	66	10.189	168	56.22	0	%	NNBS1	215	261	12.8	NW	KG	0	2m	cleaned vent plug and syringed system 1 after this cast
20190913	2102	1	**347**	2	53.7	66	10.175	168	56.293	0	%	NNBS1	215	261	12.8	NW	KG			
20190913	2217	1	**348**	1	51	65	59.97	168	55.909	1	%	NBS1	217	259	16.5	NW	KG	0	4m	
20190913	2222	1	**348**	2	50.5	65	59.968	168	55.743	1	%	NBS1	217	259	17.3	NW	KG			
20190913	2231	1	**349**	1	50.6	66	0	168	53.056	1	%	NBS1.5	217	268	16.4	NW	KG	0	3m	
20190913	2237	1	**349**	2	51	65	59.905	168	52.039	1	%	NBS1.5	217	268	17.5	NW	KG			
20190913	2249	1	**350**	1	51.7	66	0.02	168	49.862	1	%	NBS2	216	261	16.8	NW	KG	0	2m	
20190913	2255	1	**350**	2	52.1	65	59.997	168	49.791	1	%	NBS2	216	261	17.4	NW	KG			
20190913	2308	1	**351**	1	51.9	65	59.998	168	45.87	1	%	NBS2.5	217	268	16.2	NW	KG	0	2m	
20190913	2313	1	**351**	2	51.6	65	59.939	168	45.746	1	%	NBS2.5	217	268	17.3	NW	KG			
20190913	2327	1	**352**	1	51.5	66	0.029	168	41.656	1	%	NBS3	216	264	17.8	NW	KG	0	1.5m	
20190913	2332	1	**352**	2	51.2	65	59.975	168	41.652	1	%	NBS3	216	264	15.6	NW	KG			
20190913	2346	1	**353**	1	50.6	65	59.995	168	37.421	1	%	NBS3.5	216	259	15.4	NW	KG	0	2m	
20190913	2351	1	**353**	2	51	66	0.035	168	37.407	1	%	NBS3.5	216	259	17.7	NW	KG			
20190914	0005	1	**354**	1	51.3	65	59.98	168	33.288	1	%	NBS4	216	261	16.5	NW	KC	0	2m	
20190914	0010	1	**354**	2	51.8	66	0.019	168	33.289	1	%	NBS4	215	261	17.8	NW	KC			
20190914	0024	1	**355**	1	51.2	65	59.967	168	29.116	1	%	NBS4.5	215	260	16.6	NW	KC	0	1m	
20190914	0028	1	**355**	2	51.1	66	0.024	168	29.139	1	%	NBS4.5	214	260	16.9	NW	KC			
20190914	0042	1	**356**	1	54.3	65	59.967	168	25.022	1	%	NBS5	216	264	14.1	N	KC	0	1.5m	
20190914	0048	1	**356**	2	55	66	0.059	168	25.091	1	%	NBS5	216	264	15.1	NNW	KC			
20190914	0103	1	**357**	1	51.5	65	59.971	168	20.737	1	%	NBS5.5	215	261	16.4	NNW	KC	0	0.5m	
20190914	0109	1	**357**	2	51.7	66	0.072	168	20.753	1	%	NBS5.5	216	261	16.9	N	KC			
20190914	0123	1	**358**	1	50.6	65	59.949	168	16.427	1	%	NBS6	216	261	17.1	NNW	KC	0	1m	
20190914	0128	1	**358**	2	50.4	66	0.008	168	16.408	1	%	NBS6	216	261	15.2	NNW	KC			
20190914	0141	1	**359**	1	48	65	59.944	168	12.421	1	%	NBS6.5	216	259	16.8	N	KC	0	1m	
20190914	0146	1	**359**	2	49	65	59.981	168	12.39	1	%	NBS6.5	216	259	15.6	N	KC			
20190914	0159	1	**360**	1	45.1	65	59.997	168	8.34	1	%	NBS7	215	256	17.6	NW	KC	0	1m	
20190914	0204	1	**360**	2	45.1	65	59.995	168	8.291	1	%	NBS7	215	256	15	N	KC			
20190914	0217	1	**361**	1	38	65	59.968	168	4.175	1	%	NBS7.5	216	248	14.8	NNW	KC	0	1.5m	
20190914	0221	1	**361**	2	37.7	65	59.958	168	4.106	1	%	NBS7.5	216	248	13.7	N	KC			
20190914	0234	1	**362**	1	32	65	59.996	167	59.987	1	%	NBS8	215	243	15.4	NNW	KC	0	1.5m	
20190914	0238	1	**362**	2	31.6	65	59.966	167	59.964	1	%	NBS8	216	243	16.3	NNW	KC			
20190914	0254	1	**363**	1	19.5	65	59.99	167	55.104	1	%	NBS9	215	230	15.1	N	KC	0	0.5m	
20190914	0257	1	**363**	2	19.1	66	0	167	55.068	1	%	NBS9	216	230	14.9	NW	KC			end of NBS line,
20190914	0408	1	**364**	1	28.9	65	50.866	168	5.022	1	%	MBS8	216	241	19.3	NNW	KC	0	2m	
20190914	0411	1	**364**	2	27.9	65	50.823	168	5.004	1	%	MBS8	217	241	18.5	NNW	KC			
20190914	0419	1	**365**	1	37.4	65	51	168	6.927	1	%	MBS7	215	251	18.1	NW	KC	0	2m	
20190914	0423	1	**365**	2	37.3	65	50.982	168	6.819	1	%	MBS7	216	251	14.8	NW	KC			
20190914	0436	1	**366**	1	43.9	65	51.078	168	10.377	1	%	MBS6.5	216	256	17.4	NW	KC	0	2m	
20190914	0440	1	**366**	2	44.7	65	51.089	168	10.315	1	%	MBS6.5	216	256	20.3	NW	KC			
20190914	0455	1	**367**	1	45.1	65	51.089	168	13.895	1	%	MBS6	216	256	18.8	NW	KC	0	2m	
20190914	0459	1	**367**	2	44.7	65	51.14	168	13.827	1	%	MBS6	216	256	20	NW	KC			
20190914	0518	1	**368**	1	48.4	65	51.24	168	18.472	1	%	MBS5.5	215	259	22.1	NW	KC	0	3m	
20190914	0522	1	**368**	2	48.5	65	51.351	168	18.361	1	%	MBS5.5	216	259	21.5	NW	KC			stopped here on MBS line due to big swell (6-10ft)
20190914	1141	1	**369**	1	54.7	66	19.633	168	56.686	0	%	A3	216	264	12.3	NW	Max	0	3m	
20190914	1143	1	**369**	2	54.5	66	19.646	168	56.736	0	%	A3	215	264	13.6	NW	Max			fish! (baby salmon?)
20190914	1154	1	**370**	1	54.9	66	18.737	168	56.169	0	%	DL19.5	216	265	12.2	NW	Max	0	3m	
20190914	1156	1	**370**	2	54.9	66	18.726	168	56.307	0	%	DL19.5	216	265	13	NW	Max			
20190914	1206	1	**371**	1	54.6	66	17.849	168	56.171	0	%	DL19	216	265	13	NW	Max	0	3m	
20190914	1208	1	**371**	2	54.2	66	17.856	168	56.313	0	%	DL19	216	265	11.5	NW	Max			
20190914	1221	1	**372**	1	54.9	66	16.594	168	56.18	0	%	DL18.5	216	265	11.4	NW	Max	0	2.5m	
20190914	1224	1	**372**	2	54.9	66	16.577	168	56.254	0	%	DL18.5	216	265	11.7	NW	Max			
20190914	1233	1	**373**	1	55.6	66	15.303	168	56.068	0	%	DL18	216	265	10.4	NW	Max	0	3m	
20190914	1239	1	**373**	2	55.7	66	15.3	168	56.132	0	%	DL18	216	265	10.8	NW	Max			
20190914	1251	1	**374**	1	54.6	66	14.039	168	56.142	0	%	DL17.5	216	264	11.2	NW	Max	0	2.5m	
20190914	1254	1	**374**	2	54	66	14.042	168	56.23	0	%	DL17.5	216	264	11.4	NW	Max			
20190914	1307	1	**375**	1	55.3	66	12.765	168	56.135	0	%	DL17	216	264	10	WNW	Max	0	2.5m	
20190914	1309	1	**375**	2	55.4	66	12.798	168	56.159	0	%	DL17	216	264	12	WNW	Max			
20190914	1323	1	**376**	1	53.9	66	11.487	168	56.149	0	%	DL16.5	216	264	11.3	WNW	Max	0	3m	flushed both salinity sensors
20190914	1326	1	**376**	2	53.4	66	11.516	168	56.233	0	%	DL16.5	214	264	10.9	WNW	Max			
20190914	1339	1	**377**	1	52.9	66	10.204	168	56.151	0	%	DL16	217	263	11.2	WNW	Max	0	3m	
20190914	1342	1	**377**	2	53	66	10.217	168	56.253	0	%	DL16	216	263	13.2	NW	Max			
20190914	1355	1	**378**	1	52.8	66	8.93	168	56.182	0	%	DL15.5	216	264	15.9	NW	Max	0.5	3m	
20190914	1357	1	**378**	2	52	66	8.934	168	56.234	0	%	DL15.5	215	263	13	NW	Max			
20190914	1410	1	**379**	1	52.1	66	7.704	168	56.221	0	%	DL15	216	262	13.3	NW	Max	1	2m	
20190914	1413	1	**379**	2	52.3	66	7.703	168	56.204	0	%	DL15	216	262	14.6	NW	Max			
20190914	1427	1	**380**	1	52.9	66	6.395	168	56.139	0	%	DL14.5	216	262	14.8	NW	Max	0.5	2m	
20190914	1430	1	**380**	2	52.8	66	6.426	168	56.166	0	%	DL14.5	216	262	16.2	NW	Max			
20190914	1444	1	**381**	1	52.8	66	5.11	168	56.126	0	%	DL14	216	262	13.1	NW	Max	0	2m	
20190914	1447	1	**381**	2	52.9	66	5.156	168	56.135	0	%	DL14	216	262	13.7	NW	Max			
20190914	1501	1	**382**	1	51.1	66	3.836	168	56.132	0	%	DL13.5	216	262	14	NW	Max	0	2m	

20190914	1504	1	**382**	2	51.6	66	3.884	168	56.106	0	%	DL13.5	215	262	13.1	NW	Max			
20190914	1517	1	**383**	1	51.2	66	2.588	168	56.163	0	%	DL13	216	262	12.1	NW	Max	0	3m	
20190914	1520	1	**383**	2	51	66	2.605	168	56.154	0	%	DL13	216	262	11.9	NW	Max			
20190914	1534	1	**384**	1	50.3	66	1.286	168	56.135	0	%	DL12.5	215	259	11.5	NW	Max	0	3m	
20190914	1536	1	**384**	2	49.1	66	1.328	168	56.184	0	%	DL12.5	215	259	13.8	NW	Max			
20190914	1550	1	**385**	1	50.7	65	59.984	168	56.196	0	%	DL12	216	261	11.3	NW	Max	0	3m	
20190914	1552	1	**385**	2	50.4	65	59.993	168	56.236	0	%	DL12	216	261	12.7	NW	Max			
20190914	1602	1	**386**	1	49.8	65	58.998	168	56.18	0	%	DL11	216	259	11.6	NW	KG	0	3m	
20190914	1608	1	**386**	2	50.4	65	59.043	168	56.198	0	%	DL11	216	259	10.6	NW	KG			
20190914	1617	1	**387**	1	49.9	65	58.024	168	56.17	0	%	DL10	215	259	11	NW	KG	0	2m	
20190914	1623	1	**387**	2	50	65	58.076	168	56.194	0	%	DL10	215	259	10.7	NW	KG			
20190914	1633	1	**388**	1	49.1	65	57.059	168	56.157	0	%	DL9	216	259	11.5	NW	KG	0	5m	
20190914	1638	1	**388**	2	49.3	65	57.091	168	56.228	0	%	DL9	216	259	9.7	NW	KG			
20190914	1648	1	**389**	1	48.1	65	56.069	168	56.152	0	%	DL8	215	257	9.5	NW	KG	0	1m	
20190914	1654	1	**389**	2	47.9	65	56.111	168	56.225	0	%	DL8	215	257	9.8	NW	KG			
20190914	1703	1	**390**	1	47.1	65	55.109	168	56.139	0	%	DL7	216	260	9.9	NW	KG	0	5m	
20190914	1709	1	**390**	2	47.9	65	55.084	168	56.193	0	%	DL7	216	260	10.3	NW	KG			
20190914	1718	1	**391**	1	46.5	65	54.128	168	56.168	0	%	DL6	216	257	8.3	NW	KG	0	1m	
20190914	1723	1	**391**	2	47.2	65	54.155	168	56.242	0	%	DL6	216	257	8.7	NW	KG			
20190914	1732	1	**392**	1	46.4	65	53.161	168	56.159	0	%	DL5	216	257	9.4	NW	KG	0	1m	
20190914	1738	1	**392**	2	45.9	65	53.16	168	56.201	0	%	DL5	216	257	8.2	NW	KG			
20190914	1746	1	**393**	1	43.9	65	52.199	168	56.166	0	%	DL4	216	254	9.2	NW	KG	0	1m	
20190914	1752	1	**393**	2	43.9	65	52.19	168	56.199	0	%	DL4	216	254	8.6	NW	KG			
20190914	1800	1	**394**	1	46.5	65	51.259	168	56.196	0	%	DL3	215	256	7.8	NW	KG	0	1.5m	Bridge reports strong current between some of these stations
20190914	1804	1	**394**	2	46.2	65	51.341	168	56.242	0	%	DL3	215	256	9.2	NW	KG			
20190914	1815	1	**395**	1	46.1	65	50.262	168	56.109	0	%	DL2	216	257	5.2	NW	KG	0	1.5m	
20190914	1821	1	**395**	2	45.9	65	50.402	168	56.106	0	%	DL2	216	257	6.8	NW	KG			
20190914	1833	1	**396**	1	45.9	65	49.238	168	56.086	0	%	DL1	216	255	7.5	NW	KG	0	2m	
20190914	1838	1	**396**	2	45.7	65	49.31	168	56.082	0	%	DL1	216	255	6.8	NW	KG			
20190914	1857	1	**397**	1	46.2	65	52.103	168	55.934	0	%	MBSn1	216	261	8.7	NW	KG	0	2m	recovered plastic bucket with russian "wheat" from ocean
20190914	1902	1	**397**	2	47.4	65	52.066	168	55.595	0	%	MBSn1	216	261	9.1	NW	KG			
20190914	1916	1	**398**	1	47.6	65	52.001	168	52.652	0	%	MBSn1.5	216	261	9.2	NNW	KG	0.5	1.5m	
20190914	1921	1	**398**	2	47.6	65	52.023	168	52.396	0	%	MBSn1.5	216	261	10.1	NNW	KG			
20190914	1931	1	**399**	1	49.3	65	51.895	168	49.161	0	%	MBSn2	216	268	6.5	NNW	KG	0.7	2.5	
20190914	1937	1	**399**	2	49	65	51.838	168	48.928	0	%	MBSn2	216	268	9.5	NW	KG			
20190914	1948	1	**400**	1	50.8	65	51.827	168	45.153	0	%	MBS2.5	216	263	5.2	NNW	KG	0.8	3m	strange ~5m thick bolus low density, warm, high Fl, at 30m both sensors
20190914	1954	1	**400**	2	51.9	65	51.892	168	44.882	0	%	MBS2.5	216	263	6.5	NNW	KG			
20190914	2006	1	**401**	1	50.8	65	51.707	168	40.989	0	%	MBSn3	216	263	4.8	N	KG	0.8	5m	cleaned vent plug on system 1 and 2 after cast
20190914	2011	1	**401**	2	51	65	51.752	168	40.74	0	%	MBSn3	216	263	8.5	NW	KG			
20190914	2025	1	**402**	1	51.4	65	51.602	168	36.555	1	%	MBSn3.5	216	263	5.9	N	KG	0.5	4m	flushed both salinity sensors before cast
20190914	2030	1	**402**	2	51	65	51.664	168	36.41	1	%	MBSn3.5	216	263	9.1	NNW	KG			
20190914	2044	1	**403**	1	51.1	65	51.491	168	31.943	1	%	MBSn4	216	263	3.7	NW	KG	0.4	4m	
20190914	2050	1	**403**	2	50.7	65	51.51	168	31.835	1	%	MBSn4	216	263	6.9	NNW	KG			
20190914	2104	1	**404**	1	53.7	65	51.406	168	27.627	1	%	MBSn4.5	216	263	2.7	NW	KG	0	2.5m	
20190914	2109	1	**404**	2	53.7	65	51.524	168	27.489	1	%	MBSn4.5	216	263	4.8	NW	KG			
20190914	2125	1	**405**	1	49.7	65	51.291	168	22.936	1	%	MBSn5	215	262	7	NW	KG	0	2m	
20190914	2131	1	**405**	2	49.9	65	51.472	168	22.653	1	%	MBSn5	215	262	4	NW	KG			
20190914	2144	1	**406**	1	47.7	65	51.193	168	18.566	1	%	MBSn5.5	215	266	3.9	NW	KG	0	2.5m	cast just after front in ocean color
20190914	2149	1	**406**	2	48.3	65	51.348	168	18.251	1	%	MBSn5.5	215	266	5.8	NW	KG			front of ACC??
20190914	2203	1	**407**	1	44.8	65	51.057	168	13.889	1	%	MBSn6	216	999	3.7	NNW	rw	0	0.5m	4-6m off bottom as rolling
20190914	2209	1	**407**	2	44.4	65	51.211	168	13.438	1	%	MBSn6	216	999	7.1	NW	rw			
20190914	2218	1	**408**	1	43.8	65	51.028	168	10.511	1	%	MBSn6.5	215	263	4.3	NNW	KG	0	.5m	
20190914	2224	1	**408**	2	43.9	65	51.174	168	10.043	1	%	MBSn6.5	215	263	6	N	KG			
20190914	2234	1	**409**	1	37.5	65	50.929	168	6.747	1	%	MBSn7	216	253	3.2	NNW	KG	0	1.5m	
20190914	2238	1	**409**	2	36.7	65	50.974	168	6.312	1	%	MBSn7	216	253	4.5	NNW	KG			
20190914	2244	1	**410**	1	27.8	65	50.797	168	5.02	1	%	MBSn8	215	238	3.7	N	KG	0	1m	
20190914	2247	1	**410**	2	25.9	65	50.864	168	4.689	1	%	MBSn8	215	238	5.2	N	KG			end of MBS line
20190915	0135	1	**411**	1	44.9	65	48.329	168	55.874	0	%	BS11	216	256	1.4	NW	KC	0	2m	
20190915	0140	1	**411**	2	45	65	48.349	168	55.869	0	%	BS11	216	256	3.1	NW	KC			
20190915	0150	1	**412**	1	45.2	65	47.784	168	53.853	0	%	BS11.5	215	258	2.6	N	KC	0	2m	
20190915	0154	1	**412**	2	45.9	65	47.79	168	53.682	0	%	BS11.5	215	258	4.9	N	KC			
20190915	0202	1	**413**	1	42.1	65	47.23	168	51.661	0	%	BS12	215	256	5.9	N	KC	0	2m	up and down casts different
20190915	0207	1	**413**	2	42.1	65	47.168	168	51.668	0	%	BS12	215	256	6.4	NNW	KC			
20190915	0215	1	**414**	1	46.8	65	46.788	168	49.794	0	%	BS12.5	216	260	6.6	N	KC	0	3m	
20190915	0220	1	**414**	2	47.5	65	46.879	168	49.449	0	%	BS12.5	215	260	8.6	N	KC			
20190915	0229	1	**415**	1	50.7	65	46.273	168	47.873	1	%	BS13	216	262	9.6	N	KC	0	2m	
20190915	0234	1	**415**	2	49.8	65	46.334	168	47.683	1	%	BS13	215	262	9.4	N	KC			
20190915	0243	1	**416**	1	49.8	65	45.783	168	45.637	1	%	BS13.5	217	264	9.5	N	KC	0	1m	
20190915	0248	1	**416**	2	50.7	65	45.8	168	45.48	1	%	BS13.5	215	264	8.7	N	KC			
20190915	0257	1	**417**	1	50.2	65	45.269	168	43.478	1	%	BS14	216	262	8.3	NNE	KC	0	2m	syringed both sensors before this cast
20190915	0302	1	**417**	2	50.8	65	45.318	168	43.26	1	%	BS14	215	262	10.1	N	KC			

20190915	0309	1	**418**	1	49.6	65	44.817	168	41.716	1	%	BS14.5	216	260	7.6	N	KC	0	1m	
20190915	0314	1	**418**	2	49.5	65	44.868	168	41.587	1	%	BS14.5	216	260	12.6	N	KC			
20190915	0322	1	**419**	1	49.2	65	44.365	168	39.925	1	%	BS15	215	260	12.3	NNE	KC	0	1m	
20190915	0327	1	**419**	2	49.1	65	44.427	168	39.761	1	%	BS15	216	260	11.4	N	KC			
20190915	0336	1	**420**	1	49.1	65	43.815	168	37.711	1	%	BS15.5	215	261	10.1	N	KC	0	2m	
20190915	0341	1	**420**	2	49.3	65	43.844	168	37.542	1	%	BS15.5	215	261	9	N	KC			
20190915	0350	1	**421**	1	48.8	65	43.402	168	35.572	1	%	BS16	215	262	9.2	NNE	KC	0	2m	
20190915	0356	1	**421**	2	49.3	65	43.38	168	35.341	1	%	BS16	215	262	7.4	NE	KC			
20190915	0405	1	**422**	1	49.6	65	42.789	168	33.422	1	%	BS16.5	216	261	7.9	NE	RW	0	2.5m	syringed both sensors before this cast
20190915	0409	1	**422**	2	49.6	65	42.826	168	33.289	1	%	BS16.5	216	261	8	NE	RW			
20190915	0419	1	**423**	1	53.3	65	42.275	168	31.404	1	%	BS17	216	262	8	NE	RW	0	2.5m	header marked BS27 instead of BS17
20190915	0423	1	**423**	2	52.5	65	42.372	168	31.403	1	%	BS17	215	262	8.3	NE	RW			
20190915	0435	1	**424**	1	51.1	65	41.733	168	29.261	1	%	BS17.5	216	262	9	NE	KC	0	2.5m	
20190915	0438	1	**424**	2	51.2	65	41.819	168	29.287	1	%	BS17.5	216	262	7.6	NE	KC			
20190915	0451	1	**425**	1	51.4	65	41.219	168	27.043	1	%	BS18	216	270	8.7	NE	KC	0	2.5m	
20190915	0455	1	**425**	2	50	65	41.416	168	27.038	1	%	BS18	216	270	9.2	NE	KC			
20190915	0508	1	**426**	1	50.4	65	40.778	168	25.285	1	%	BS18.5	215	264	10.4	NE	KC	0	2.5m	
20190915	0512	1	**426**	2	50.6	65	40.929	168	25.208	1	%	BS18.5	215	264	10.4	NE	KC			
20190915	0524	1	**427**	1	49.6	65	40.355	168	23.552	1	%	BS19	215	262	9.7	NE	KC	0	2m	
20190915	0528	1	**427**	2	49.7	65	40.496	168	23.551	1	%	BS19	215	262	9.9	NE	KC			
20190915	0544	1	**428**	1	48.1	65	39.842	168	21.311	1	%	BS19.5	216	260	10.2	NE	KC	0	2m	
20190915	0548	1	**428**	2	48.6	65	39.954	168	21.532	1	%	BS19.5	216	260	10.5	NE	KC			
20190915	0605	1	**429**	1	46.2	65	39.296	168	19.118	1	%	BS20	215	259	9.6	NE	KC	0	2m	
20190915	0609	1	**429**	2	47.1	65	39.415	168	19.3	1	%	BS20	216	259	8.5	NE	KC			
20190915	0624	1	**430**	1	44	65	38.921	168	17.023	1	%	BS20.5	216	264	8.3	NE	KC	0	2m	
20190915	0628	1	**430**	2	44.3	65	39.059	168	17.326	1	%	BS20.5	216	264	7.9	E	KC			
20190915	0645	1	**431**	1	39.9	65	38.551	168	14.901	1	%	BS21	217	253	5.9	SE	KC	0	1.5m	
20190915	0649	1	**431**	2	40.2	65	38.762	168	14.834	1	%	BS21	215	253	8.5	SE	KC			
20190915	0705	1	**432**	1	36.8	65	38.028	168	12.729	1	%	BS21.5	215	253	16.3	SE	KC	0	2m	both cells syringed before this cast
20190915	0709	1	**432**	2	36.8	65	38.213	168	12.728	1	%	BS21.5	215	253	14.8	SE	KC			4kt current
20190915	0728	1	**433**	1	29.4	65	37.27	168	10.381	1	%	BS22	216	241	11.4	SE	KC	0	1.5m	
20190915	0731	1	**433**	2	29.8	65	37.378	168	10.502	1	%	BS22	215	241	14.5	SE	KC			end of BS line
20190915	0751	1	**434**	1	27.7	65	36.222	168	8.916	1	%	BStoSBS1	216	252	16.2	SE	KC	0	2m	header marked BStoSBS1 instead of "near BS23"
20190915	0755	1	**434**	2	27.3	65	36.291	168	9.339	1	%	BStoSBS1	216	252	12.5	SE	KC			
20190915	0812	1	**435**	1	38.8	65	36.164	168	14.589	1	%	SBSn2	215	253	11.5	SE	Max	0	2m	
20190915	0814	1	**435**	2	38.6	65	36.331	168	14.707	1	%	SBSn2	215	253	10.9	SE	Max			
20190915	0833	1	**436**	1	44.1	65	35.098	168	18.563	1	%	SBSn3	215	260	7.6	SE	Max	0	2m	
20190915	0836	1	**436**	2	44.1	65	35.242	168	18.47	1	%	SBSn3	216	260	8.8	SSE	Max			
20190915	0856	1	**437**	1	46.7	65	34.018	168	22.583	1	%	SBSn4	217	264	7.2	SE	Max	0	1.5m	suspect blocked vent plug
20190915	0900	1	**437**	2	47.1	65	34.236	168	22.771	1	%	SBSn4	215	264	5.3	SE	Max			cells flushed andvent plugs cleaned after this cast
20190915	0919	1	**438**	1	49.6	65	32.915	168	26.487	1	%	SBSn5	216	260	4.7	SE	Max			
20190915	0923	1	**438**	2	49.6	65	33.3	168	26.642	1	%	SBSn5	215	260	5.3	SE	Max			