BERING STRAIT NORSEMAN II 2018 MOORING CRUISE REPORT

Research Vessel Norseman II, Norseman Maritime Charters

Nome-Nome, 10th August to 19th August 2018

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Funding from NSF Arctic Observing Network Program PLR-1304052 & 1758565

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Related PIs: *Kate Stafford, UW, USA;*

*(**Top left:** Research vessel Norseman II, from www.norsemanmartime.com. **Top right:** Little Diomede Island, R Woodgate. **Bottom:** Tin City, R. Woodgate.)*

As part of the Bering Strait project funded by NSF-AON (Arctic Observing Network), in August 2018 a team of US scientists undertook a ~ 10 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-NSF) and whale acoustic (Stafford) instrumentation. These moorings were deployed in the Bering Strait region in 2017 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 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.

Key Statistics: 3 moorings recovered, 3 moorings deployed, 142 CTD casts on 7 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.

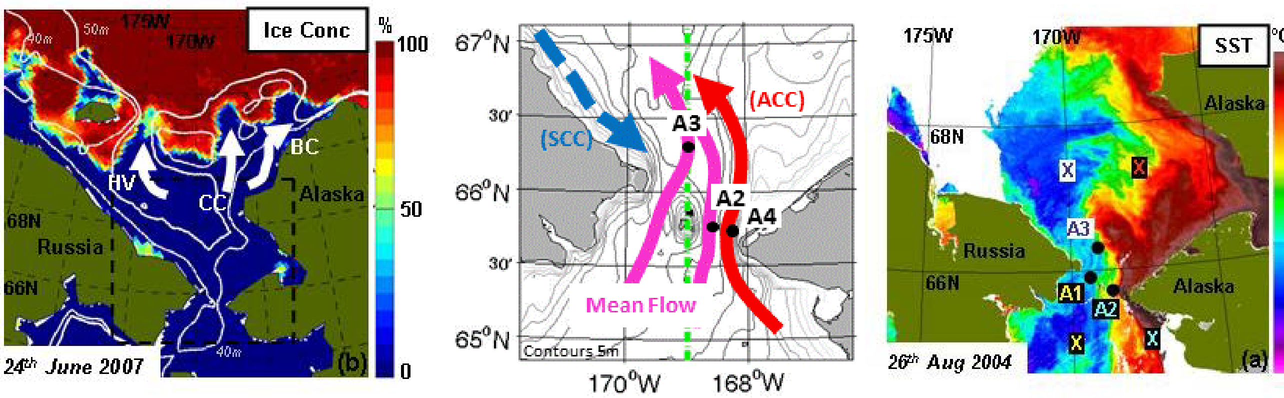


Figure 1: (Left) *Chukchi Sea ice concentration (AMSR-E) with schematic topography. White arrows mark three main water pathways melting back the ice edge [Woodgate et al., 2010].*
(Middle) *Detail of the Bering Strait, with schematic flows and mooring locations (black dots – A2, A3, A4). The main northward 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).

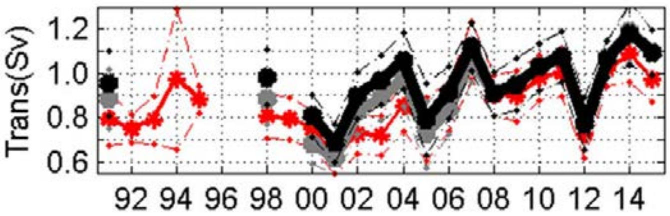


Figure 2, from Figure 3 of [Woodgate, 2018]*: Annual mean (x-axis, time in years) of Bering Strait mooring data from 1991 to 2015, showing transport for the whole strait, as estimated from A2 (red) or A3 (uncorrected data - grey; corrected data - black).*

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/started on this cruise will extend this mooring time-series to mid-2019, 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 mid-summer (August), 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).

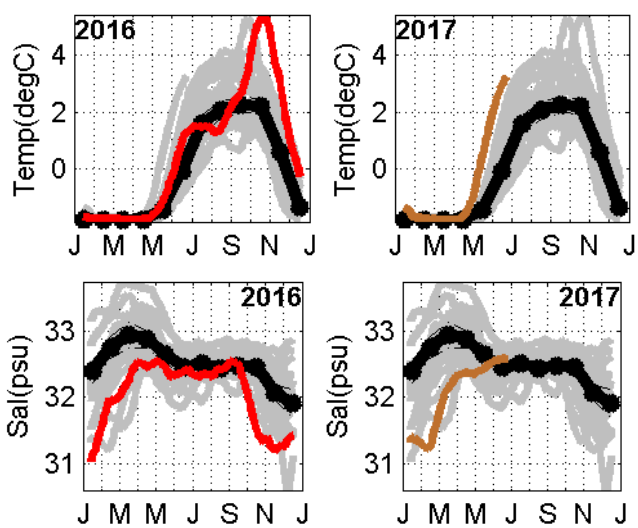


Figure 3: *30-day smoothed estimates from A3 mooring data for near-bottom temperature* ***(top)*** *and near-bottom salinity* ***(bottom)****, for 2016* ***(left column)*** *and 2017* ***(right column)****, showing labeled year in color, climatology [Woodgate et al., 2005b] in black, and all prior years of mooring data (1990-present) in grey. X-axis is labeled with month (J=Jan, M=Mar, 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.

2018 CRUISE SUMMARY:

Our 2018 cruise was later in the year than in previous years, and we expected more stormy weather, and indeed we were beset with several days of winds and seas which prevented work. Overall mooring operations went exceptionally smoothly, but weather preventing occupying all the usual CTD lines - only a subset - BS, CS, Lis, CCL, Al (in part), BS repeat, and SBS (part) - were run on the cruise. However, these sections did allow us to sample the strait after a strong southward wind event, yielding remarkable data documenting the shift of the Alaskan Current away from the US coast.

The cruise onloaded smoothly on the morning of Friday 10th August 2018, and we sailed ~1300 local time. During the transit, the CTD equipment was set up, test casts performed, and preparations made for mooring recoveries. Underway sections were steamed in the strait overnight, putting us at site A2 for recovery early Saturday morning.

On Saturday 11th August, weather conditions were very good for recovery, and all 3 moorings (A2, A4 and A3) were recovered without incident. With a storm forecast for Sunday, we chose to focus on mooring deployments (rather than instrument clean up), and managed to redeploy all 3 moorings on Saturday, finishing around 2300. We steamed underway sections in the night, with the plan to return to start CTD casts once everyone had opportunity to rest.

But by 1200 on Sunday 12th Aug it was apparent the storm was arriving and thus instead of starting CTD operations we went to anchor off Tin City (just S of the strait), with winds increasing to 30+ knots from the north, gusting 40knots. At our anchorage, ~ 1nm off the shore, even in these winds we had only ~ 3ft seas, but the winds and forecast suggested 11ft seas in the strait. The ship rode well enough for us to continue the clear-up, but not to undertake over the side work.

Winds continued high for 2.5 days (rest of Sunday, all Monday and almost all Tuesday), but by 2300 on Tuesday 14th August, they started to decrease, and we could up anchor and return to the strait, starting CTDing the BS line at 0030 local on Wednesday 15th August, and finishing around 0545 local. We then steamed north to start CTDing the CS line around 1730 local that evening, completing the line around 0200 on Thursday 16th August. Five hours of steaming (including an underway transit of the coastal waters off Point Hope) brought us to start CTDing the Lis line starting at 0700 on Thursday 16th August. The Lis line was completed at 1515 local on Thursday 16th August, and we started working south along the CCL line. Part way through this line, on cast CCL8 at ~0840 on Friday 17th August, the CTD hit bottom and the pump on one of the two CTD systems had to be replaced. We completed the CCL line at A3 at 1230 local on Friday 17th August, and started the high resolution version of the AL line towards the NE. Winds and seas picked up considerably during this section, and around 1700 local, we aborted the casts at AL22, but continued to steam for underway data until AL24.

With 30knot plus winds from the south and only just over a day to run before leaving the strait some 50nm S of us, our focus then became on making some headway southward. During the night we accomplished little over 2-3knots speed against the winds, but by 1300 on Sat 18th August we had managed to reach the Diomede Islands, and at 1330 we started the BS line heading eastward, despite high (30knot) winds and seas. Winds and seas came down briefly during this section, but increased again towards the coast, and we completed the BS line at BS22 at 1930. We used our remaining time to run the SBS line before turning for Nome just after 2300.

We arrived in Nome around noon on Sunday 19th August, offloaded (including restuffing the container) and were away from the ship by 3pm.

On this 2018 cruise, we completed 142 casts and 7 CTD lines, less than our usual count. Although this was primarily due to weather, the crewing of the Norseman2 was only 6 people this year, compared to 8-10 in previous years. This is really too few crew for 24hr science operations. Although the number of measurements is small compared to our previous cruises, the sections sampled - particularly the 2 Bering Strait sections after very different wind conditions - are extremely valuable in our understanding of the physical processes in the strait, and their impacts on the water properties of the Chukchi and beyond.

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 running 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 was only taken during the first running of this line. This line was run at the start of the cruise (under stormy southward wind conditions) and at the end of the cruise, under calmer/northward wind conditions.

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.

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 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 .

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, and 2017), typically incorporating a rerun of the high resolution DL line at the southern end, but this year ending at A3 to allow a running of the A3L line. Although in 2015 this line was run at ~ 5nm resolution, this cruise we reverted to the historic spacing of ~ 10nm.

AL *(A3 Line)* (US portion) – another previously-run line (previously run at ~ 1.7nm resolution, run this cruise at 0.85nm resolution), just north of the strait, running originally 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 aborted at AL22 due to weather. This line was run at the end of the cruise (under northward wind conditions).

BS – the original BS line, rerun at ~ 1nm resolution at the end of the cruise under strong northward wind conditions

SBS – a 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).

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:

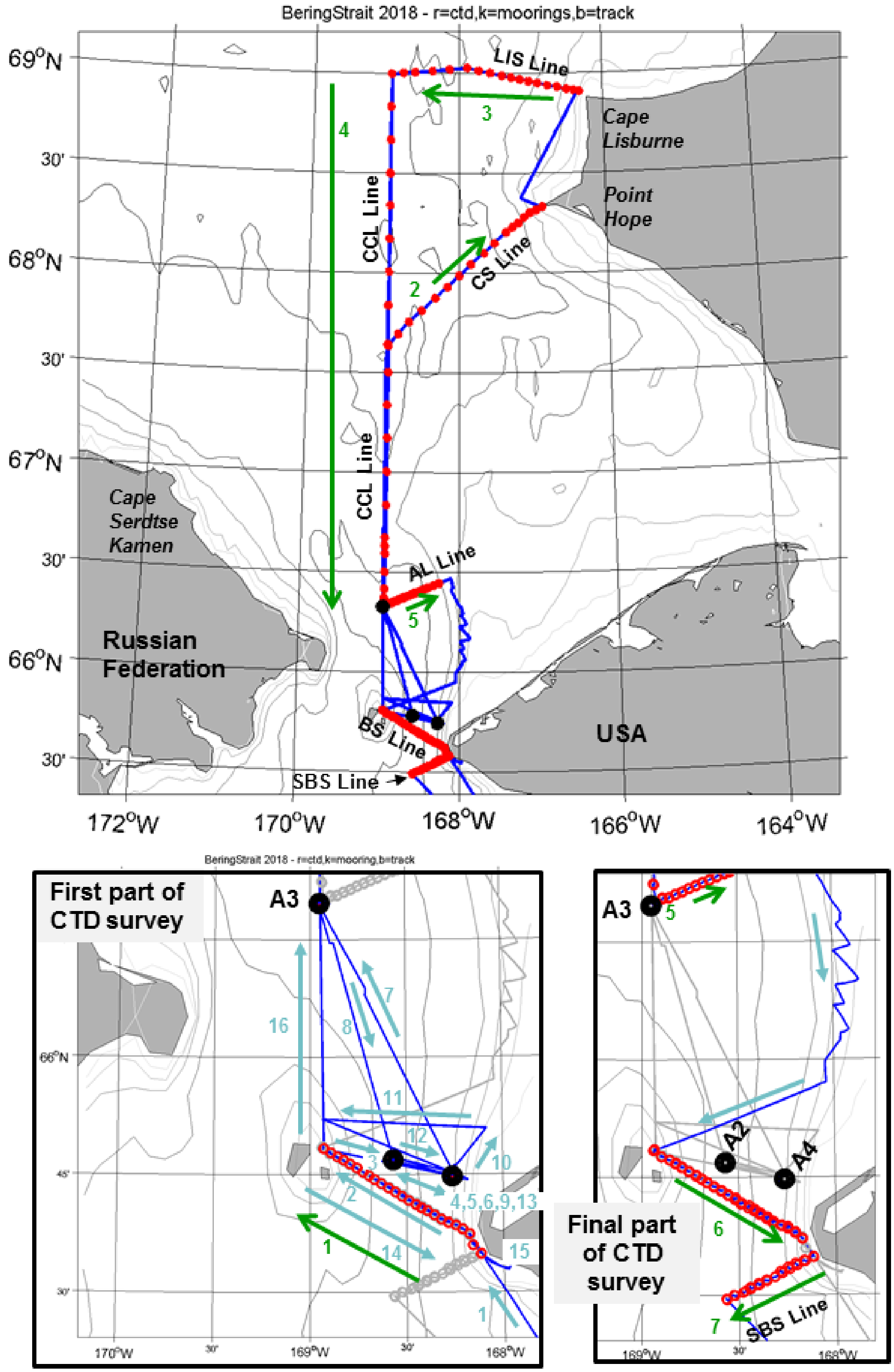
Before mooring work- West along the BS line from BS24 to BS11, back east from BS11 through the mooring positions to the old mooring site A5 just off the Alaskan Coast, and back to A2 for mooring recovery.

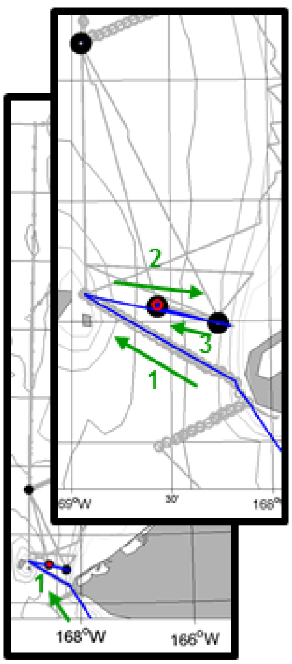
After mooring work - From A4, North to MBSn8, west along MBS, back to old A5, west along mooring line to BS11, east along BS line to BS24

See maps for details of these lines.

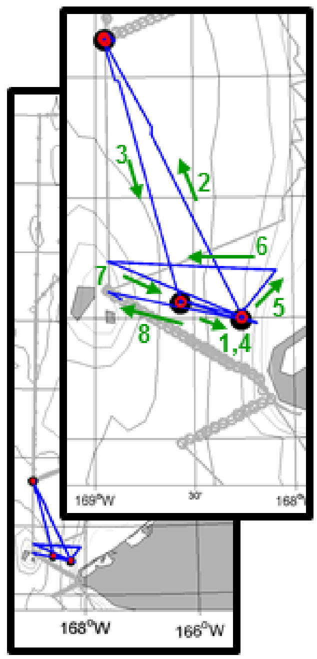
Contents

BERING STRAIT 2018 MOORING CRUISE MAP: *Ship-track, blue. Mooring sites, black. CTD stations, red. Arrows indicate direction of travel (on this figure, blue during mooring operations and transits, green arrows mark 7 CTD lines). 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.)*

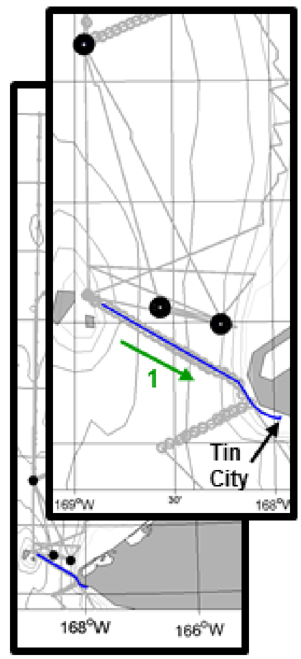




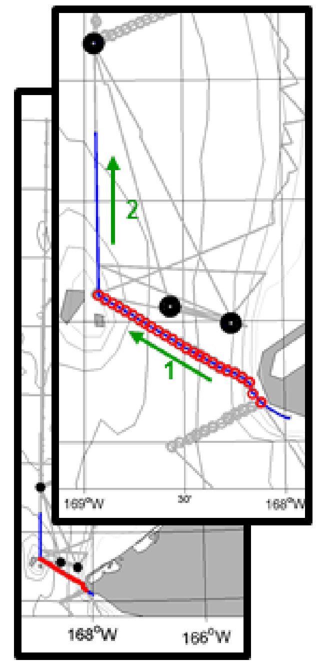
Day 1 *(local time)*
0800 10th Aug 2018
- 0800 11th Aug 2018



Day 2 *(local time)*
0800 11th Aug 2018
- 0800 12th Aug 2018

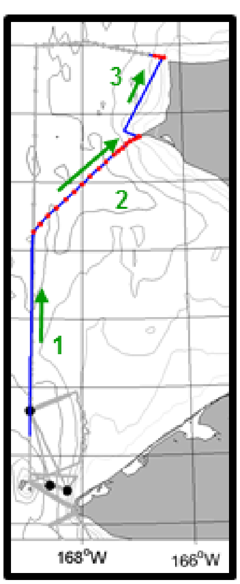


Day 3&4 *(local time)*
0800 12th Aug 2018
- 0800 14th Aug 2018

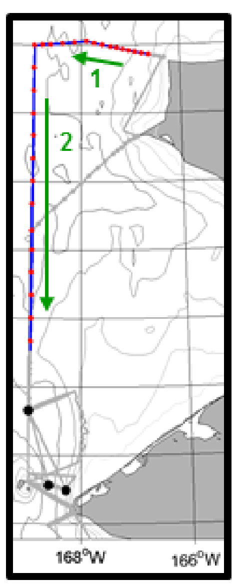


Day 5 *(local time)*
0800 14th Aug 2018
- 0800 15th Aug 2018

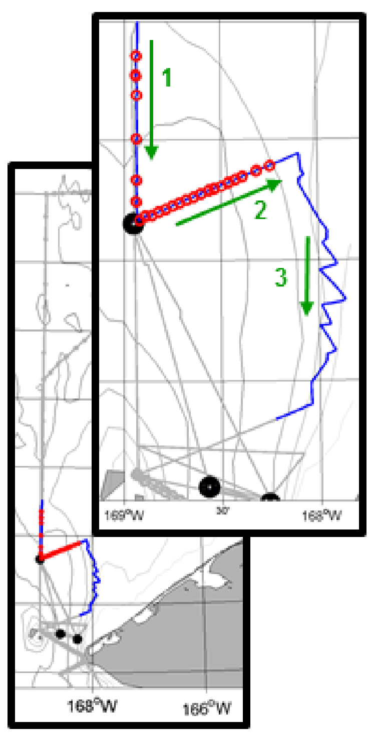
Bering Strait 2018 Mooring Cruise Norseman II



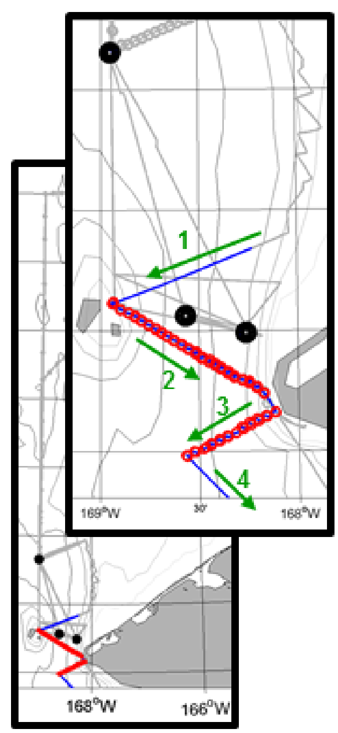
Day 6 *(local time)*
0800 15th Aug 2018
- 0800 16th Aug 2018



Day 7 *(local time)*
0800 16th Aug 2018
- 0800 17th Aug 2018



Day 8 *(local time)*
0800 17th Aug 2018
- 0800 18th Aug 2018



Day 9 *(local time)*
0800 18th Aug 2018
- 0800 19th Aug 2018

BERING STRAIT 2018 SCIENCE PARTICIPANTS

1. Rebecca Woodgate (F)	UW	*Chief Scientist and UW PI*
2. Cecilia Peralta Ferriz (F)	UW	*UW co PI and CTD lead*
3. Brett Morris (M)	UW	*UW grad student (Moorings and CTD)*
4. Katy Christensen (F)	UW	*UW grad student (Moorings and CTD)*
5. Zac Cooper (M)	UW	*UW grad student (Moorings and CTD)*

UW – University of Washington, US

Cabin Allocations:
main deck: C4-vacant
lower deck: C5-Morris & Cooper; C7-Peralta-Ferriz & Christensen; C8-Woodgate

BERING STRAIT 2018 NORSEMAN II CREW

1. Jake Meek (M)	NMC	*Captain*
2. Jim Wells (M)	NMC	*Mate (sailing also as Deck Boss and Engineer)*
3. Cass Lehfeldt (F)	NMC	*Deck Hand*
4. Andrew Wilson (M)	NMC	*Deck Hand*
5. Brennan Carney (M)	NMC	*Deck Hand*
6. Kasia Pawluskiewicz (F)	NMC	*Chief 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 2018 CRUISE SCHEDULE (Times: Alaskan Daylight Time (GMT-8), 24hr format)

Spring 2018	*Arrangement of charter of Norseman II by CPS for NSF for the Bering Strait mooring work*
Early June 2018	*UW visits N2 in Seattle, to test CTD cable*
End of June 2018	*Shipment of container of UW equipment to Nome, ETA 27th-29th July*
Monday 6th Aug 2018 *(Fine, light wind)*	*UW science team (Rebecca, Cecilia, Zac, Katy, Brett) arrive Nome*
Tuesday 7th Aug 2018 *(Fair)*	*UW Instrument preparation (extract and start instruments in lounge of Aurora Inn, return all gear to container)*
Wednesday 8th Aug 2018 *(Cloudy, turning fair)*	*UW Instrument preparation (build ISCATs, ADCPs)* *Restuff container*
Thursday 9th Aug 2018 *(Clouds and light rain)*	*Ship arrives around noon. Visit ship and discuss crew changes.*
Friday 10th August 2018 *(Fine)*	Science team arrive ship 0900. Flat and container arrive 0930, On-load finish 1100 Secure for sea, Sail 1300. Forecast good for Sat, poor for Sun. Safety briefings. Set up underway, CTD, and test tank 1600 CTD test cast Discussion of CTD and mooring operations with captain and crew ~2330 Arrive BS24, Run underway temperature and salinity (TS) and ADCP lines through night (west along BS, east through mooring positions to A5, west back to A2)
Saturday 11th August 2018 *(Clear, light winds)*	Arrive on site at A2-17 0700 0724 A2-17 pre-recovery CTD 0755 Start **A2-17 mooring recovery** drift, all on deck by 0815 Steam to A4-17 0913 A4-17 pre-recovery CTD 0927 Start **A4-17 mooring recovery** drift, all on deck by 0939 Clean up recovered moorings while steaming to A3-17 1317 A3-17 pre-recovery CTD 1327 Start **A3-17 mooring recovery** drift, all on deck by 1353 Prep A3-18 deployment 1630 Start **A3-18 deployment**, anchor dropped 1641 1650 A3-18 post-deployment CTD Prep A2-18 (and A4-18) during steam (put cleaning aside for now) 2103 Start **A2-18 deployment**, anchor dropped 2113 2122 A2-18 post-deployment CTD 2246 Start **A4-18 deployment,** anchor dropped 2257 2305 A4-18 post-deployment CTD 2309 Run underway TS/ADCP lines through night (north to MBSn8, run MBS west, transit to A5, run east past moorings to BS11)
Sunday 12th August 2018	0743 Arrive BS11, but winds picking up. Run underway TS/ADCP

(wind and seas picking up from 0700, winds from north)	east along BS and go to anchor off Tin City to hide from storm. Drop anchor off Tin City around 1200 PM - 2-3hrs of clean up on deck, start instrument downloads Do testtank calibrations
Monday 13th August 2018 *(Storm, 30-40knot winds from north)*	At anchor all day Continue clear up, instrument downloads and processing
Tuesday 14th August 2018 *(Storm, 30-40knot winds from north)*	At anchor all day Continue clear up, instrument downloads and processing 2300 Winds drop below 25 knots, weigh anchor and steam to strait
Wednesday 15th August 2018 *(winds abating, but seas still high)*	0024 Start **BS line** at high resolution, running to west 0546 Finish BS Line Steam to CSUS10 1732 Start **CS Line** at high resolution, running north east
Thursday 16th August 2018 *(Light winds, calmer seas)*	0155 Finish CS line, Steam north to Lis line 0657 Start **Lis line**, running west 1515 Finish Lis line 1543 Start **CCL line**, running south
Friday 17th August 2018 *(Starts fair, winds building from south)*	0840 On cast CCL8, CTD hits bottom, do test cast & replace pump 1226 Finish CCL line, Start **A3L** high resolution running north east 1628 Abort A3L line in increasing bad weather Attempt to steam south
Saturday 18th August 2018 *(V stormy, winds abatting)*	1300 Arrive BS11 1328 Start **BS line**, running southeast 1930 Finish BS line at BS22 Steam to BS24 (start of SBS line) 2024 Start **SBS line**, running southwest 2320 Finish SBS line at SBS6.5 Steam for Nome
Sunday 19th August 2018 *(medium winds, sunny)*	1200 Dock in Nome, start offload 1400 Offload complete, wait for pickup of container 1500 Science Party leave ship. *Evening - Woodgate and Peralta-Ferriz take red-eye to Seattle* *Rest of Science Party stay in Nome.*
Monday 20th August 2018	*Rest of Science party returns to Seattle.*

Bering Strait 2018 Mooring cruise TOTALS

9 days at sea (away from Nome) ***1300 10th August – 1200 19th August 2018***
9.25 days on ship (including on/offload) ***0900 10th August – 1500 19th August 2018***

Moorings recovered/ deployed: ***3/3***
CTD casts: ***142 (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 -** 142 casts on 7 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.

- **Ad hoc Marine Mammal Bridge Observations**

No proper marine mammal watch was kept during this cruise. However, the ship's bridge personnel were asked to report sightings, and when possible, the crew/science team identified species and number. Details of these ad hoc sightings are included below.

MOORING OPERATIONS (Woodgate, Ferriz, 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 2017 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 – A2-17, A4-17, A3-17) were deployed from the Norseman II in July 2017, with mooring funding from NSF-AON (PI: Woodgate and Heimbach, *PLR1304052*).

Three UW moorings (A3-18, A2-18, A4-18) were deployed on this 2018 Norseman II cruise under funding from a new NSF-AON grant (PI: Woodgate and Peralta-Ferriz, *PLR1758565*). 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 A3-18 mooring also. 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), an on-deck calibration tank was also used for recovered instruments. This is discussed below.

2018 Recoveries and Deployments: Mooring operations went exceptionally smoothly in 2018.

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. For the all moorings, our routine was to communicate and range with 1 release and then attempt to release the other release (to test both instruments). This method worked perfectly on all moorings, with all releases responding correctly, release being confirmed on first sending and the mooring being sited within seconds of the release confirming.

The recovered moorings were all equipped with springs in the release mechanism, to assist with freeing the mooring hook on release. It appears this generally functions well, and thus the springs should be used in all future deployments. **Action item: Use springs on all future mooring deployments.** All recoveries used biofouling paint on the release links - this appeared to be generally successful at inhibiting barnacle growth. **Action items: Continue with biofouling paint on releases and with double releases, but check that paint does not foul the release or the spring.**

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, only the iscat on A3-17 was present on recovery.) 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.**

Fog was no hindrance to mooring recoveries this year. 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. **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.** It is worth remembering that although in exceptionally calm seas, the ship's radar may be able to pick up the steel float on a surfaced mooring, even mild sea states are enough to mask the top float on the radar. Though fog was not a problem for this cruise, not that for the prior July cruises, fog frequently (but not always) thinned or cleared towards late afternoon or evening. **Action item: Assess causes of foggy conditions, in order to predict best strategy for finding workable visibility.**

Biofouling was moderate/heavy in the recoveries this year. In 2013, 2014 and 2015, the A4 mooring had the most biofouling, athough in 2015, A2 had equal biofouling to A4 at depth. In 2017 recoveries (of 2016 moorings) A2-16 was the most heavily fouled, with A4-16 and A3-16 being both less fouled. In 2018, A2-17 was again the most fouled, with significant barnacle growth even on the releases. Barnacles were often >3cm long. Bryozoan growth was limited - instead mussles and white salphs and nudibranchs were plentiful. A separate report below attempts to quantify taxa and levels f biofouling over recent years, based on photographs from prior recoveries. Typically, but not always, release hooks were generally clear of biofouling,. Most salinity cells and pressure sensors were clear, with the following notable exceptions:

- A3-17 iscat SBE37IM (#14906), the only iscat recovered, had extensive small mussels in the opening of the cell
- A4-17 SBE16 (#1700) had a nudibranch blocking the outflow, and
- A3-17 SBE16 (#1698) had a barnacle growing around (and surrounding) the pressure sensor vent.

See photos below.

In contrast to 2016, when significant damage (hypothesized ice damage) was found on the moorings, in 2018 there was no mechanical damage to the mooring frames.

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.** On the first lift on A2-18, the positioning of the pick caused the float to rolled off the tire it was placed on and it hit part of the SBE on the mooring. On examination, it was considered that the cage appeared to have protected the cell and the deployment was continued. **Action item: 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.** 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 science team assisting with tending the tag lines during lifting. The release lines were kept by the crew on the dog runs.

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.

Instrumentation issues: Most instrumentation was started in Nome or aboard ship in the days prior to sailing.

All instrumentation was started successfully, using the older laptops, although one of the older laptops would only work intermittently. **Action item: Check new laptops with all instrumentation. Purchase new downloading laptop, and install also navigation software.**

The only start up issue was found with the spare logger, #6. Here the connections from the battery to the connector came loose. Lacking a better solution, we soldered the battery connector back on in Nome, but this is an inelegant fix. **Action item: Revisit the type of connector used for battery. Bring plug attachment tool**.

Action item: Continue to inventory numbers of the couplers, continue to test each coupler with an iscat prior to deployment. Make sure all spare instruments contain batteries, and have suitable pressure sensors and deployment history. Continue to exercise caution with the ADCP software.

For this instrument work, the Aurora Inn kindly allowed us to use their common room area. In previous years we have requested room 134 at the Aurora and used that, loading in through the back door. The common room area is however a much better alternative. **Action item: Continue to ask the Aurora for 134, but also request the common room area for set up.** This work was accomplished in one reasonably long day.

Iscat housings and ADCP frames were assembled using a group of 5 people in Nome (2 teams). 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: Check and recheck sizes and wet weather/boot requirements for all cruise personnel.**

Data recovery on the moorings was very good, although with some challenges with one ADCP and a surprising low battery (although a complete date set) on one SBE, as detailed below. Instruments were downloaded using the one working older laptop with serial port, the new download computer with serial port, and other laptops with USB-serial convertors. **Action item: Purchase a new download laptop.**

ISCAT SBE37IMS AND LOGGERS: Of the 3 iscats deployed on the recovered moorings:

- from **A2-17**, the top sensor, and all hardware above the weak link were missing. The logger recorded data until 28th January 2018, suggesting that ice was the cause of the top sensor loss.
- from **A4-17**, the top sensor, and all hardware above the weak link were missing. The logger recorded data until 11th January 2018, suggesting that ice was the cause of the top sensor loss.
- from **A3-17**, the top sensor was recovered (although the salinity cell entrance contained many mussels). **Action item: Check record for biofouling.** Both logger and SBE37 downloaded without incident, although the SBE37 download took between 12 and 24hrs, and skipped a record at the return of every executed command sent for the download. **Action item: Check how to convert download to hex to speed up transfer (and that such a downloaded file is readable). Try the SBE suggestion to fix the microcat download skipping a record at every return of executed.** Logger clocks were 14-27min slow on recovery, but note that loggers record also the timestamp from the iscat, and this is the time used for the processed data. **Action item: Be sure deployments have sufficient slack in communications cable, and IM coupler is very tight on the wire, to prevent loosening due to mooring strumming. On recovery, check on the tightness of the IM couplers on the wire incase that is the cause of erroneous data. On deployment, be sure to record DC (Display coefficients) command to file, and to write serial number on iscat shield.** Preliminary results are plotted below.

. **ADCPs:** Of the 3 ADCPs deployed on the recovered moorings:
- from **A2-17**, ADCP #2269 was still recording on recovery (with external battery voltage of 23.8V, lowest of all three ADCPs), but had stopped, lost its compass calibration and restarted on an 1hr, 4m bin plan without bottom track on 8th May 2018. **Action item: Investigate and possibly replace plug on 2269 or associated battery pack.**
- from **A3-17**, ADCP #2234 was also still recording on recovery (with external battery voltage of 34.8V), and returned a complete record of data.
- from **A4-17**, ADCP #2232 was also still recording on recovery (with external battery voltage of 38V, highest of all three ADCPs), and returned a complete record of data, even though one of the power pins on the plug had been corroded away. **Action item: Investigate and possibly replace plug on 2232 or associated battery pack.**
Action item: 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 **A2-17**, SBE #2341, deployed in tandem with the Aural Marine Mammal recorder in a vaned frame, was still recording on recovery, but would not download without external power. **ACTION ITEM: Test battery drawn down in cold once back in Seattle.** The salinity cell was clear on recovery. This instrument record contained 4 temperature spikes during the deployment. This appears to be a consistent issue with this instrument - temperature spikes have been recorded on all recent deployments (i.e.,all those for which we have records). However, these spikes are generally few in number (<12) and easily removed.
- from **A3-17**, SBE #1698, deployed attached to the ADCP cage, was still recording on recovery and returned a full record. The salinity cell was clear on recovery, but there was a barnacle growing around (and surrounding) the pressure sensor vent, but this does not appear to have affected the data in any way.
- from **A4-17**, SBE 1700, deployed in a vaned frame, was still recording on recovery and returned a full record. Although one end of the salinity cell was clear, a nudibranch was blocking the outflow of the cell. **Action item: Check record for biofouling.**

Preliminary results are plotted below, and suggest summer temperatures are warmer last year, and fall 2017 saltier than the very fresh winter of 2016-2017. **Action item: Once post calibrations are available, check start and end times with CTD casts to assess reliability of data.**

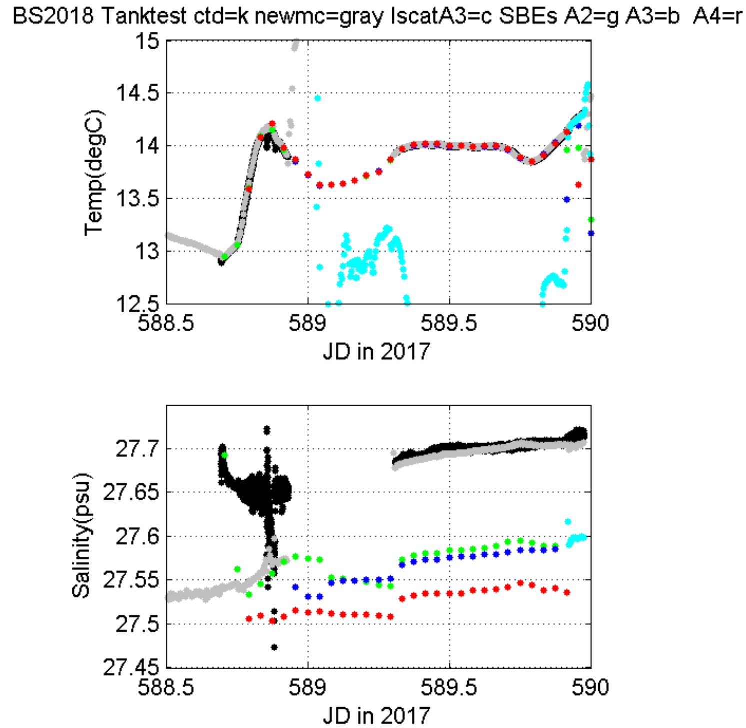
Action items: Do more thorough comparison of salinities with CTD casts and consecutive moorings. Revisit all prior salinity records. Mount SBEs vertically. Clean cells on instruments.

Post recovery tank calibrations: As an addition calibration test, uncleaned post-recovery SBE instruments were placed, for ~ 1.5 days, 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 #20129, brought as a mooring spare and last calibrated in June 2018.

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, the tank was designed to a) allow all instruments to be vertical and b) to include a pump to circulate water within the tank. We found this year that, due to the arrangement of the tank, with the rolling ship, the pump would frequently become unplugged from the power socket. Thus, although the tank was designed with a lid to prevent slopping of waters and evaporation, we found it more advantageous to leave the lid off, since then it was easy to ascertain if the pump was still running. This problem may explain some of the poor results in previous years.

Once instruments were recovered from the moorings, they were placed in the tank for a period of up to 1.5 days. 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 (see paper logs).



The Figure shows results for temperature (top panel) and salinity (bottom panel), with the following color scheme:
Calibration units:
- black: SBE19 being used as standard
- gray: SBE37 being used as standard
Recovered instruments:
- cyan: A3 iscat SBE37IM (#14906)
- green: A2 SBE16 (#2341)
- red: A4 SBE16 (#1700)
- blue: A3 SBE16 (#2234)

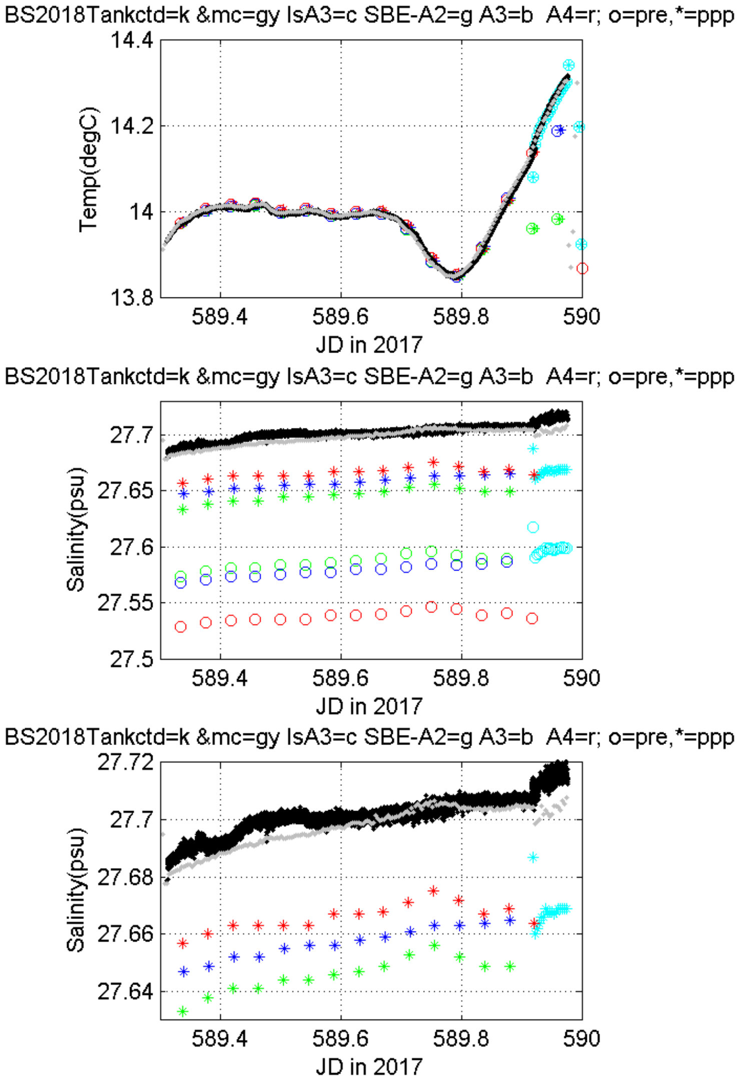
(Note the ISCAT SBE37 could only be placed in the tank after being removed from the iscat housing, at ~JD589.9, so the earlier discrepancies in temperature are because the instrument is not in the tank).

We find the following offsets(using precalibrations for the mooring data)

Instrument	**Temperature offset to SBE 19**	**Salinity offset to SBE19**
SBE37IM standard 20129 (gray)	<0.01degC	<0.01psu
SBE37IM A3 iscat #14906 (cyan)	<0.01degC	~0.11psu
SBE16 A3 #2234 (blue)	<0.005degC	~0.12psu
SBE16 A2 #2341 (green)	<0.005degC	~ 0.11psu
SBE6 A4 #1700 (red)	<0.005degC	~0.17psu

Such discrepancies are of the same order as found in post-cruise calibrations, but we must now wait for post-cruise calibrations to ascertain the corrections for individual instruments. **Action item: - return to this once SBEs have been post-cruise calibrated. Revisit test methodology in Seattle to improve reliability**.

Note: April 2019. With postcruise calibrations back from Seabird, we now find the following:



The Figure shows results for temperature (top panel) and salinity (bottom two panel, bottom being smaller salinity range just showing the postcals.), with the following color scheme:

Calibration units:
- black: SBE19 being used as standard
- gray: SBE37 being used as standard

Recovered instruments:
- cyan: A3 iscat SBE37IM (#14906)
- green: A2 SBE16 (#2341)
- red: A4 SBE16 (#1700)
- blue: A3 SBE16 (#2234)

Open circles represent the pre-cruise calibration shown above. Small * show data corrected for post-cruise calibrations at Seabird.

Post - pre salinity differences for the entire instrument record are:
A2-17 # 2341 = 0.07psu
A3-17 # 1698 = 0.1psu
A4-17 # 1700 = 0.14psu
A3-17Iscat # 14906 = 0.08psu.

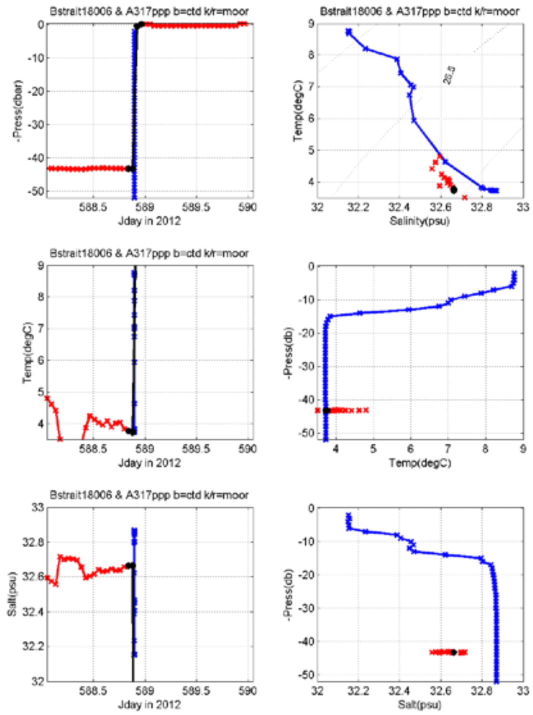
From the tank test, the remaining offsets once postcruise manufacturer's calibrations have been applied are then:

Instrument	**Temperature offset to SBE 19**	**Salinity offset to SBE19**	**Salinity offset from CTD cast**
SBE37IM standard 20129 (gray)	~0.001degC	<0.02psu	
SBE37IM A3 iscat #14906 (cyan) post cruise calibrated	~0.005degC	~0.04psu	~ 0.2psu**
SBE16 A3 #2234 (blue) post cruise calibrated	~0.002degC	~0.04psu	~ 0.15psu**
SBE16 A2 #2341 (green) post cruise calibrated	~0.001degC	~0.05psu	~ 0.05psu
SBE6 A4 #1700 (red) post cruise calibrated	~0.005degC	~0.03psu	agrees

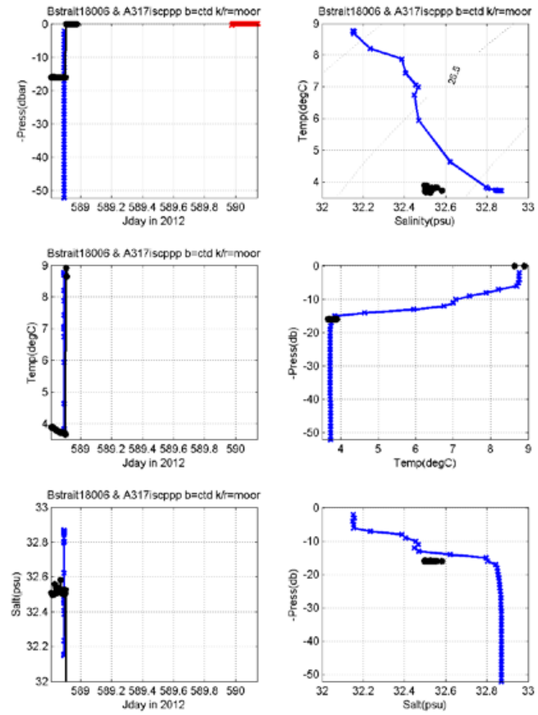
The final column of this table also gives salinity offset to the pre-recovery CTD cast, see plots below. A4 values span the CTD cast. A2 salinity difference is consistent with test tank. A3 salinities are both ~ 0.2psu too fresh, even though test tank suggests only 0.04psu too fresh - thus this likely means the CTD cast at A3 is not sampling the same water as the mooring **.
Overall thus, we conclude the test tank is the best control on the salinity.

Comparison of moorings (red and black(within 2hrs of cast) and pre recovery CTD casts (blue).

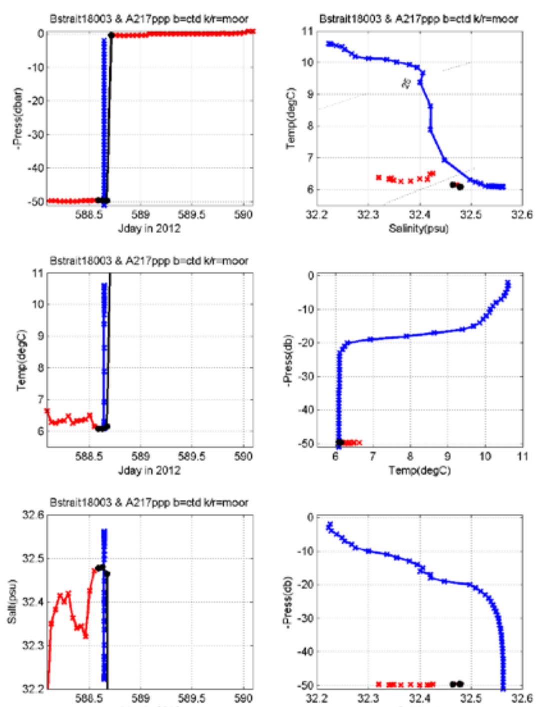
A3SBE



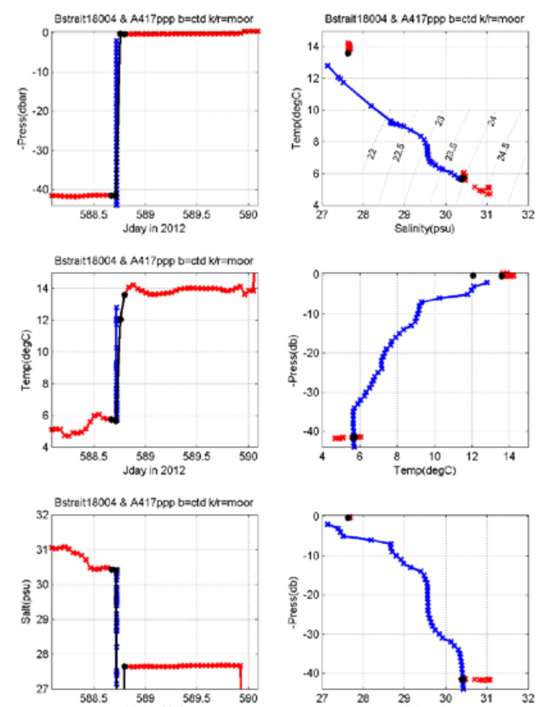
A3 iscat



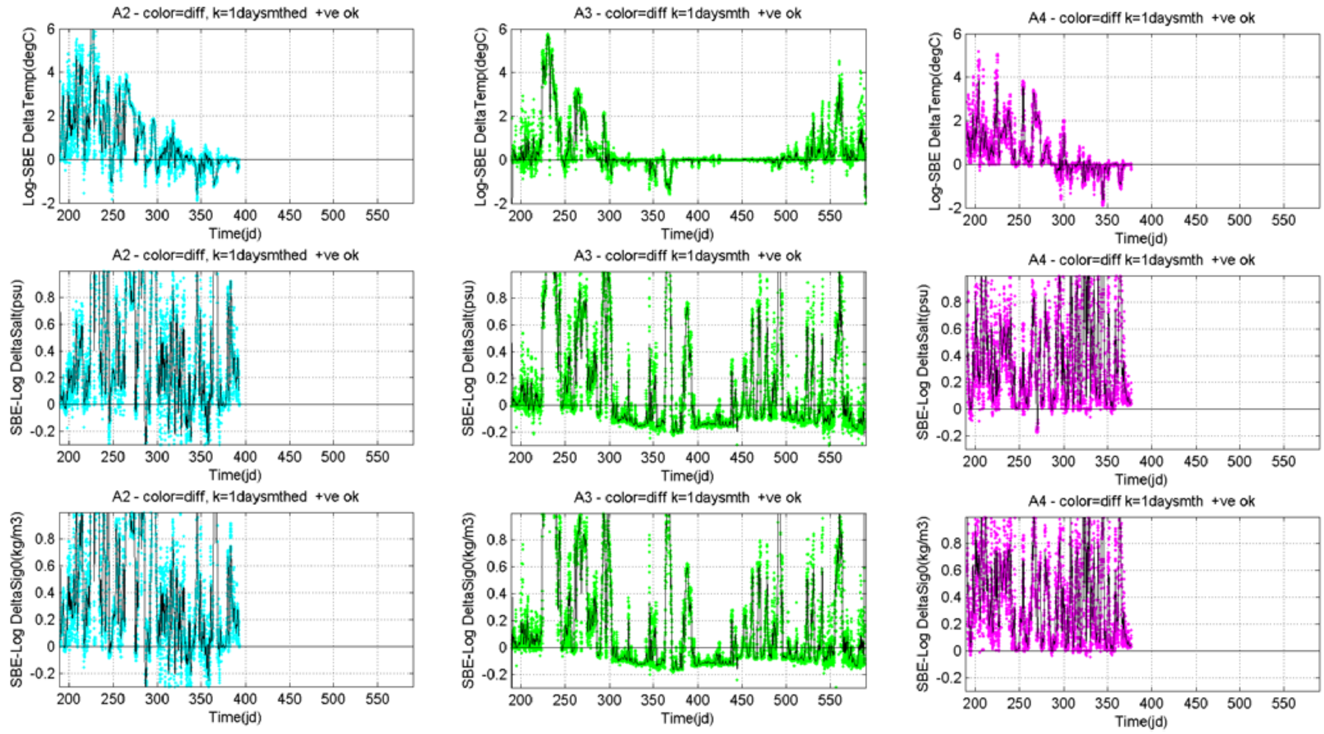
A2 SBE



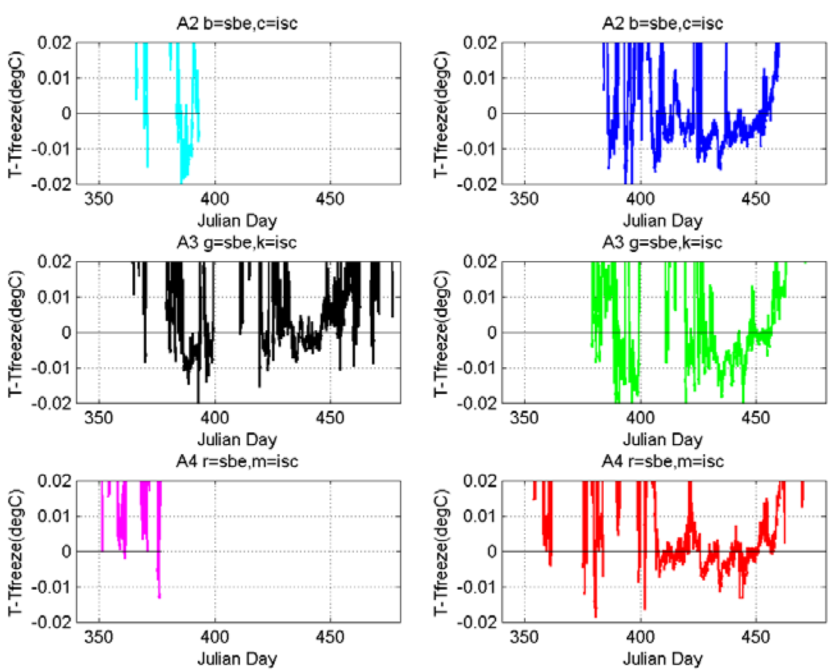
A4 SBE



Also, we find the following differences between the iscats and the SBEs on the same moorings. We expect ISCAT records to be warmer and fresher than the corresponding SBE. Typically they are although temperature inversions are often found in fall. However, stability dictates that ISCAT records should be less or equally dense to SBE records. While this is true at A4, A2 shows rare density inversions, and A3 shows an almost constant density inversion of ~ 0.1kg/m3, suggesting an uncorrected salinity drift of ~ 0.1psu in the combination of the instruments, e.g., with the A3SBE reading too fresh or the A3ISCAT reading too salty, or some combination of the two.



A comparison of measured temperature to freezing point computed from the measured salinity (below) is however inconclusive as to which instrument is incorrect.



If an instrument is reading erroneously fresh, then the computed freezing temperature will be less than the measured temperature, equivalent to a negative reading on these graphs. (Note 0.01ºC is equivalent to 0.18psu salinity change.)

The salinity difference at A3 inferred above is reinforced by the freezing point comparison. However, freezing point depressions of ~0.01ºC are frequently observed in the strait (see A2 and A4), and A3 values do not differ significantly from these norms.

It seems most likely, that A3 is too fresh still, however this in inconsistent with the tank test results.

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

Recovery: ***Aural Marine Mammal Acoustic*** sensors on all moorings were deployed by Kate Stafford, (UW). These instruments were cleaned but not opened. Their 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.

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 2018 MOORING POSITIONS AND INSTRUMENTATION

ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2017 Mooring Recoveries				
A2-17	65 46.876	168 34.075	55	ISCAT, ADCP, SBE16 with MMR
A4-17	65 44.761	168 15.782	48	ISCAT, ADCP, New MMR, SBE16
A3-17	66 19.590	168 57.130	56	ISCAT, ADCP with SBE16, MMR

ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2018 Mooring Deployments				
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

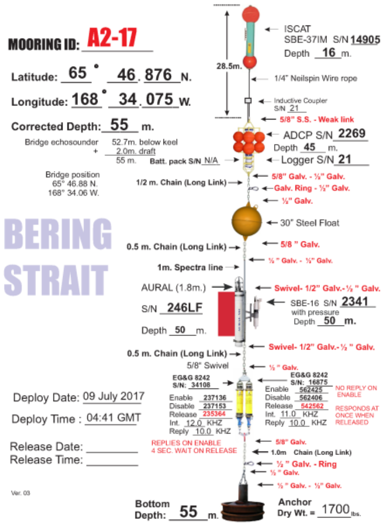
ADCP = RDI Acoustic Doppler Current Profiler
ISCAT = near-surface Seabird TS sensor in trawl resistant housing, with near-bottom data logger
SBE16 = Seabird CTD recorder, SBE37 = Seabird CTD recorder
MMR=Marine Mammal Recorder (new=new APL version)

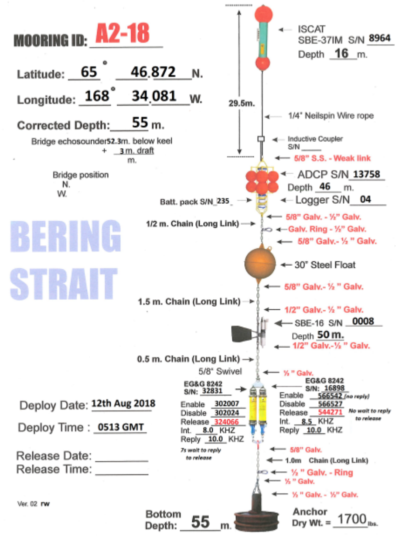
For 2017 deployments, water depths are assuming a ship's draft of 2m.
For 2018 deployments, water depths are assuming a ship's draft of 2-3m.

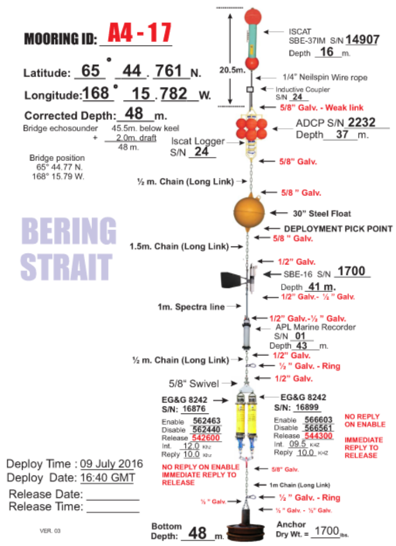
BERING STRAIT 2018 SCHEMATICS OF MOORING RECOVERIES AND DEPLOYMENTS

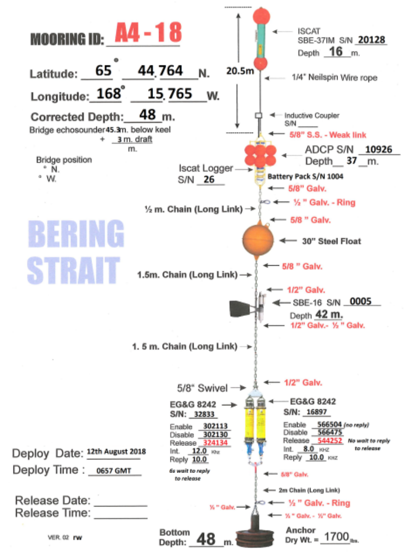
RECOVERED — DEPLOYED

= in the eastern channel of the Bering Strait

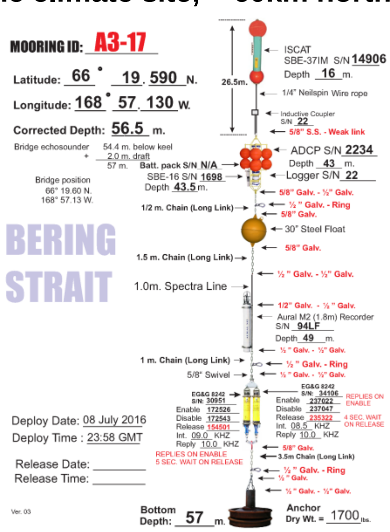


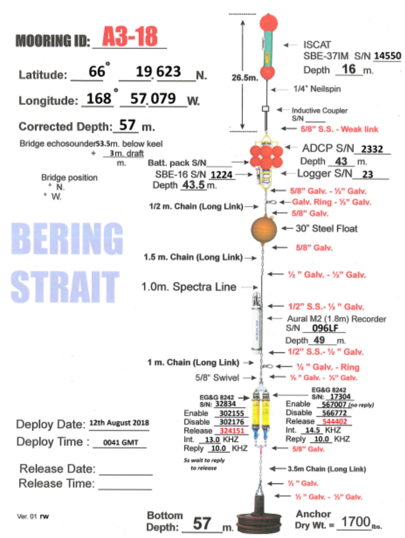






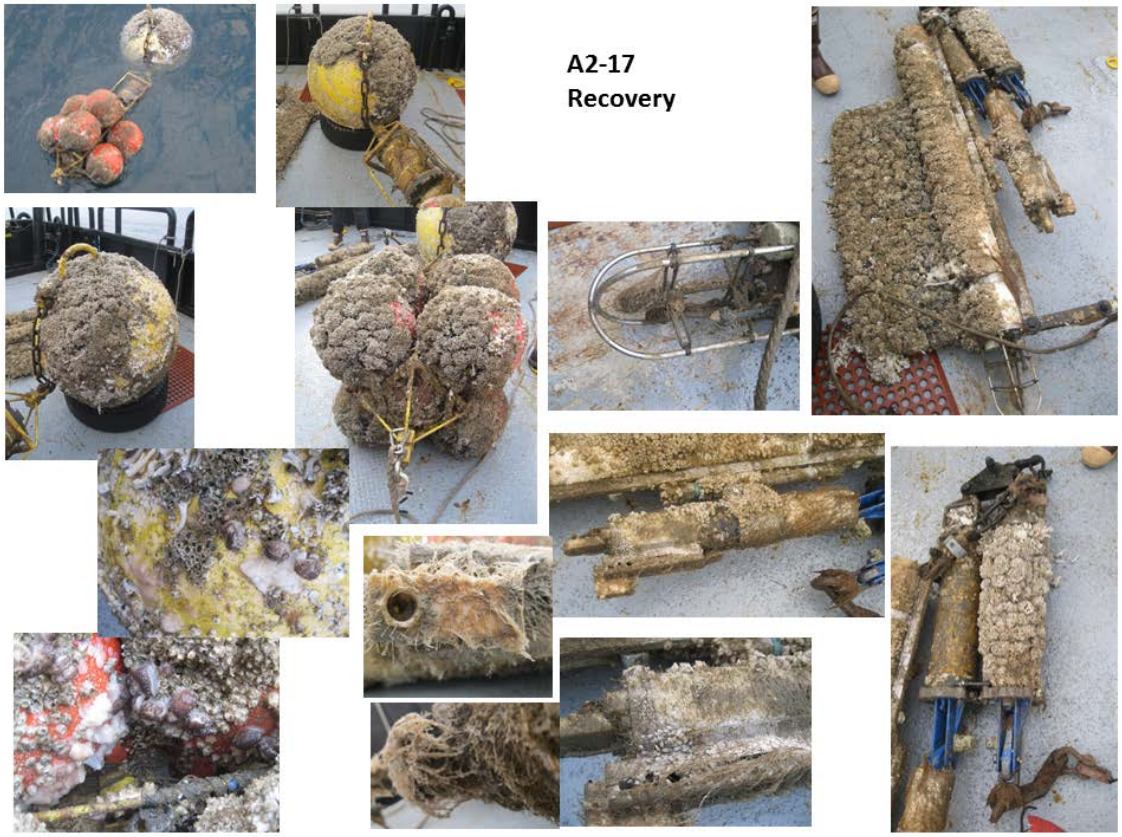
= at the climate site, ~ 60km north of the Strait



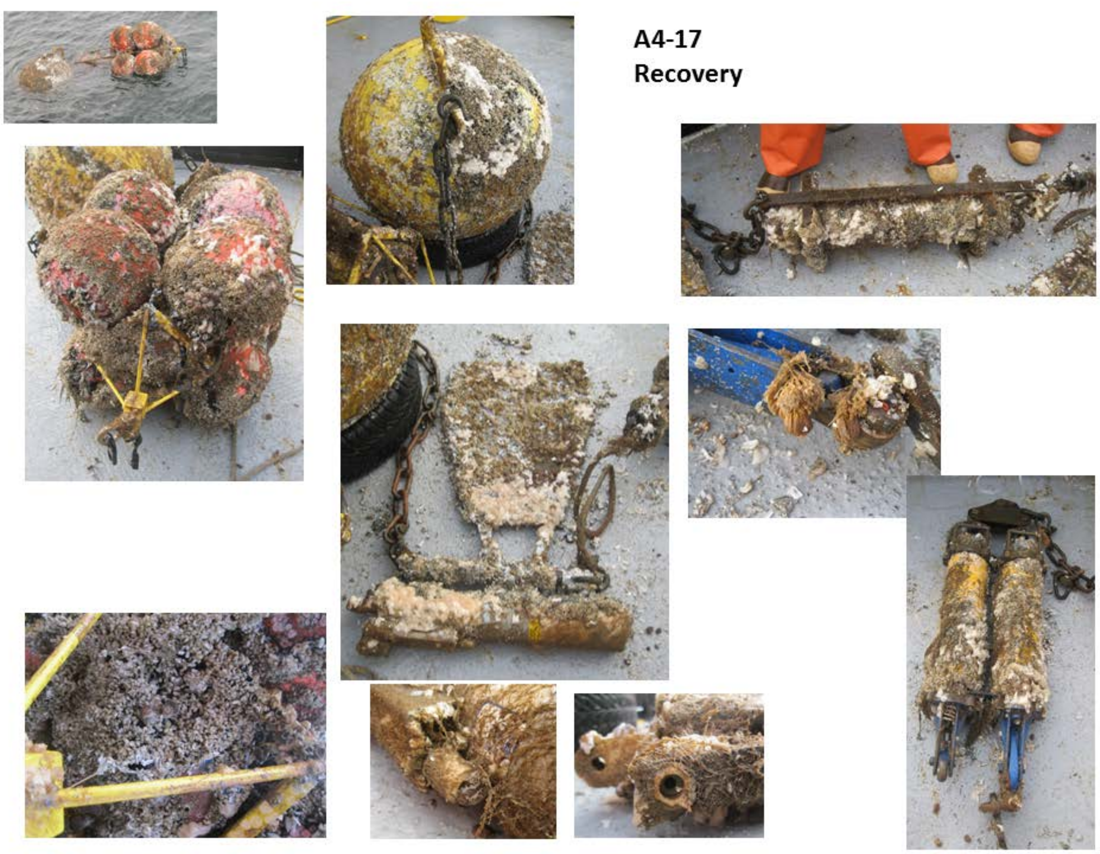


BERING STRAIT 2018 RECOVERY PHOTOS

A2-17 Recovery



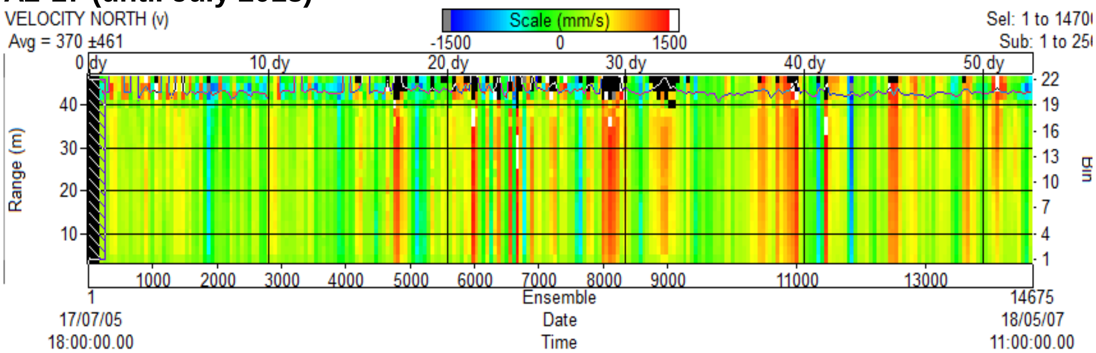
A4-17 Recovery



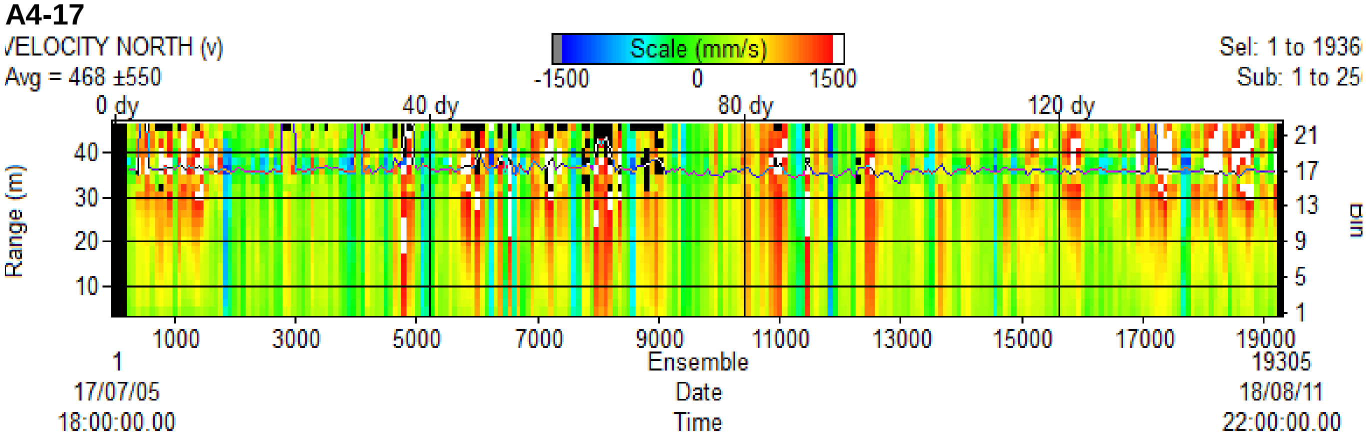
BERING STRAIT 2018 RECOVERY PHOTOS (continued)

NORTHWARD VELOCITY from ADCPs.

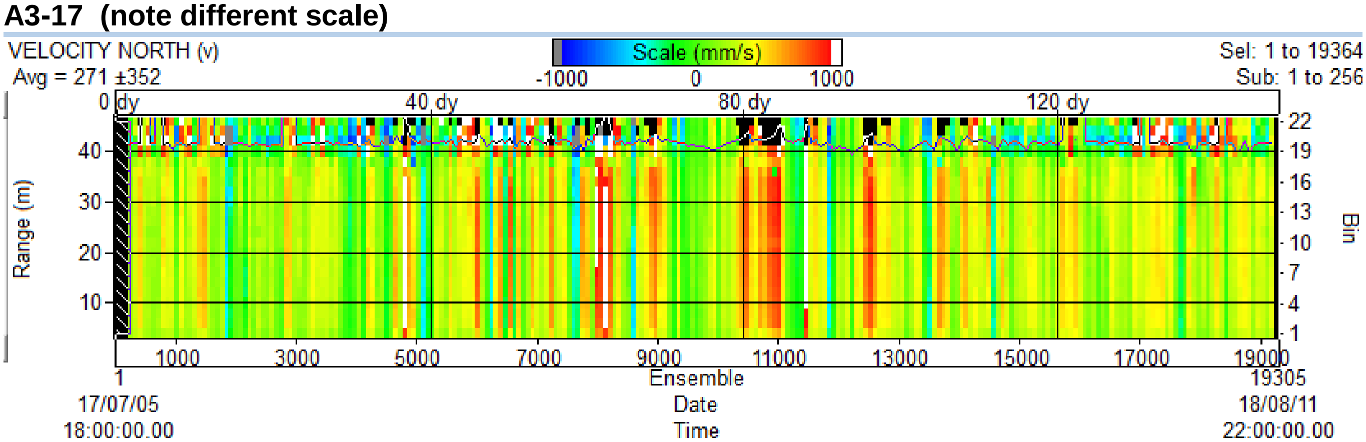
A2-17 (until July 2018)



A4-17

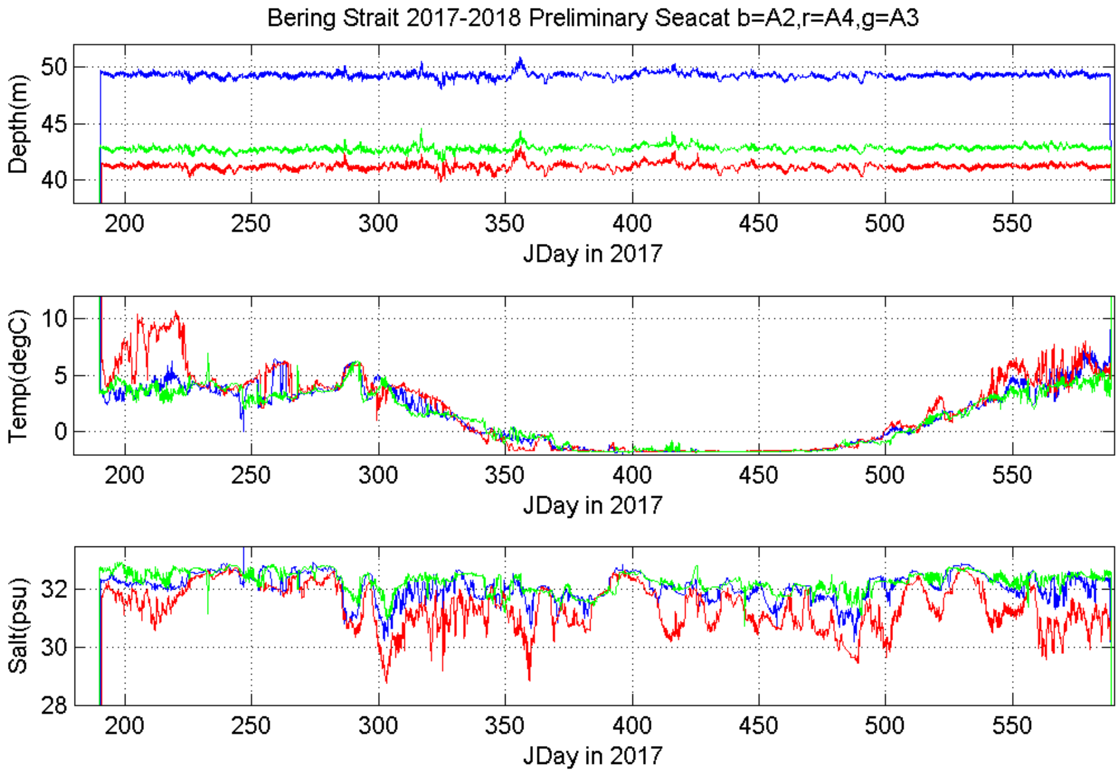


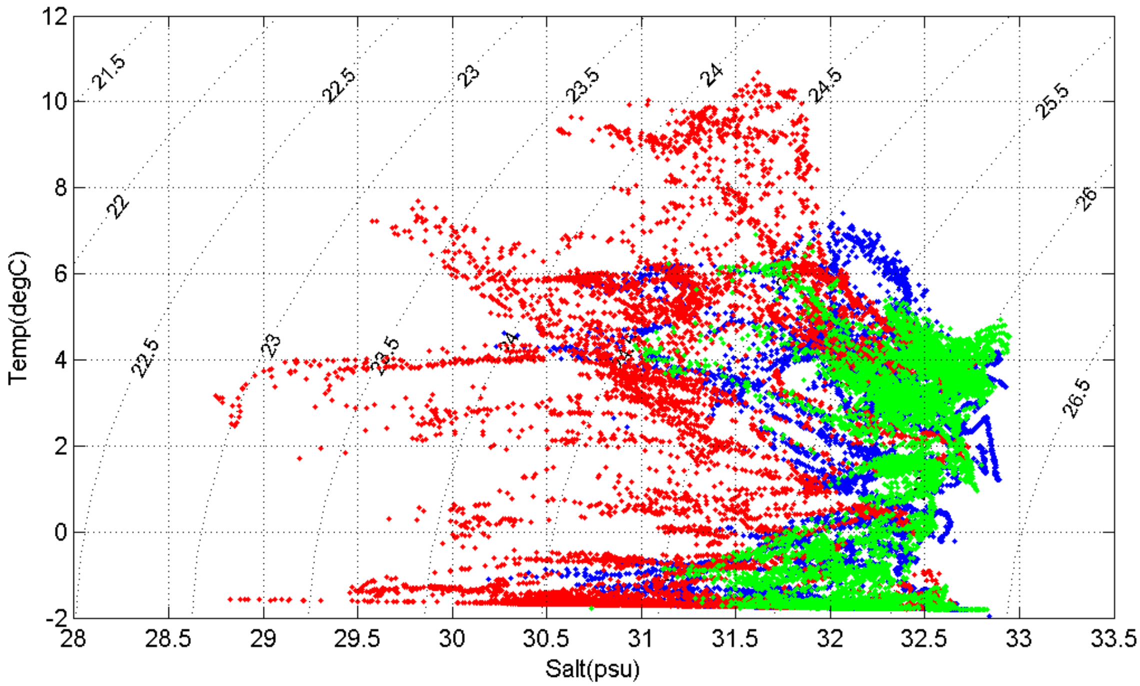
A3-17 (note different scale)



BERING STRAIT 2018 SBE PRELIMINARY RESULTS

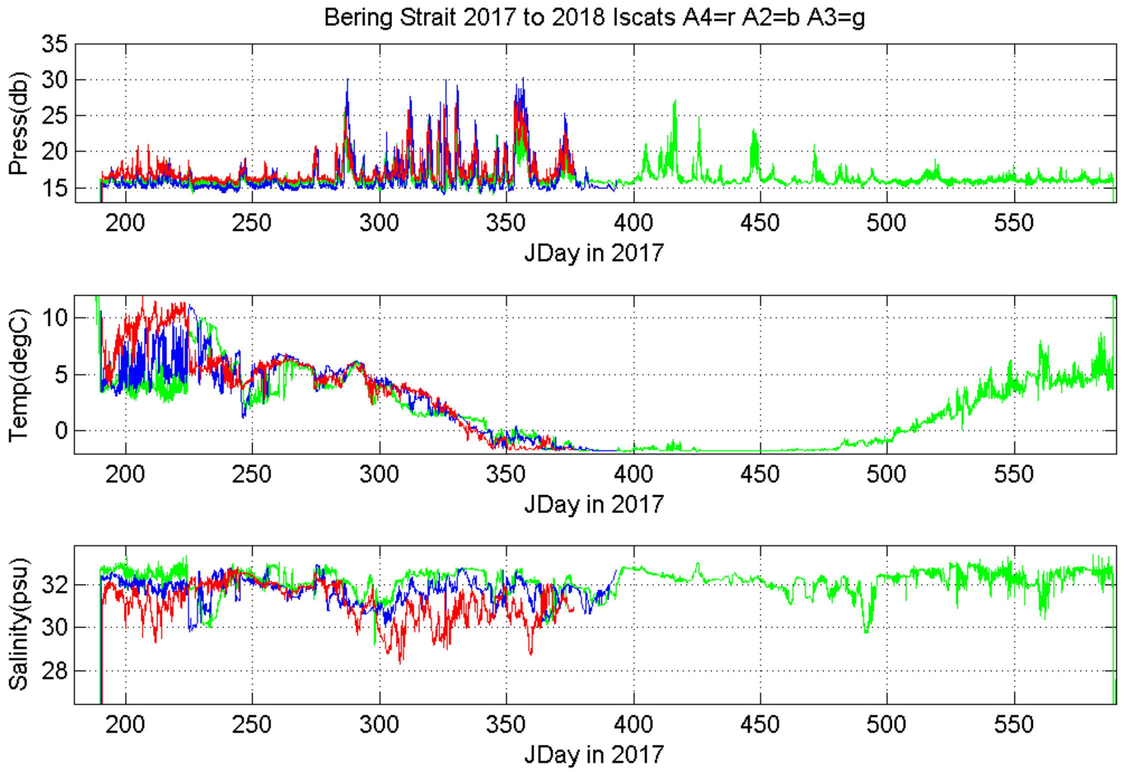
– all lower level TS Sensors
(early summer temperatures warmer than last year and waters also apparently saltier in fall)

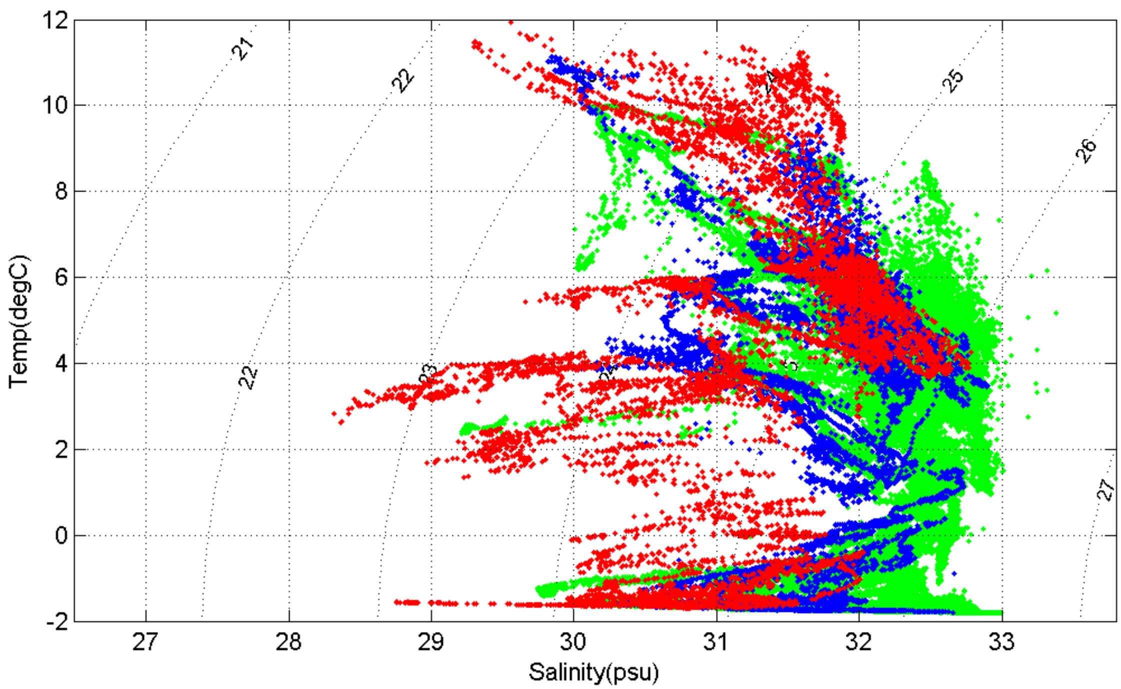




BERING STRAIT 2018 PRELIMINARY ISCAT RESULTS

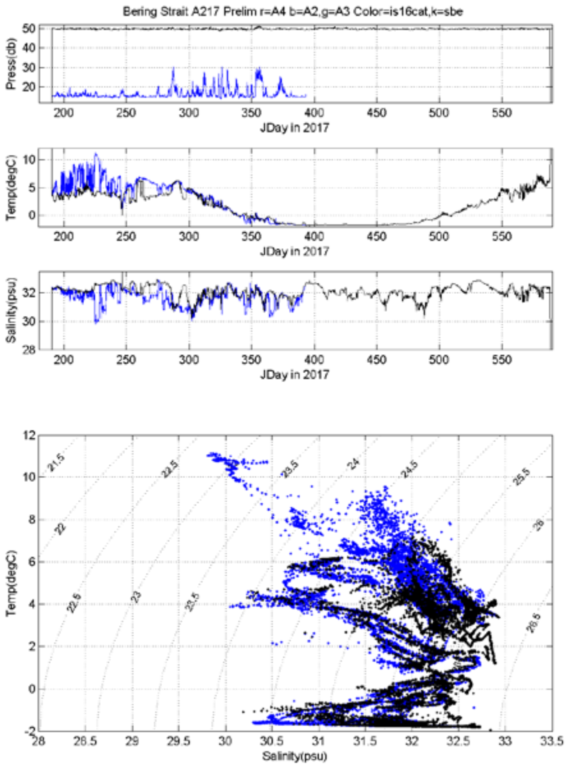
– all upper level TS Sensors
(warmer at A2 and A3 than last years, and overall saltier in winter)



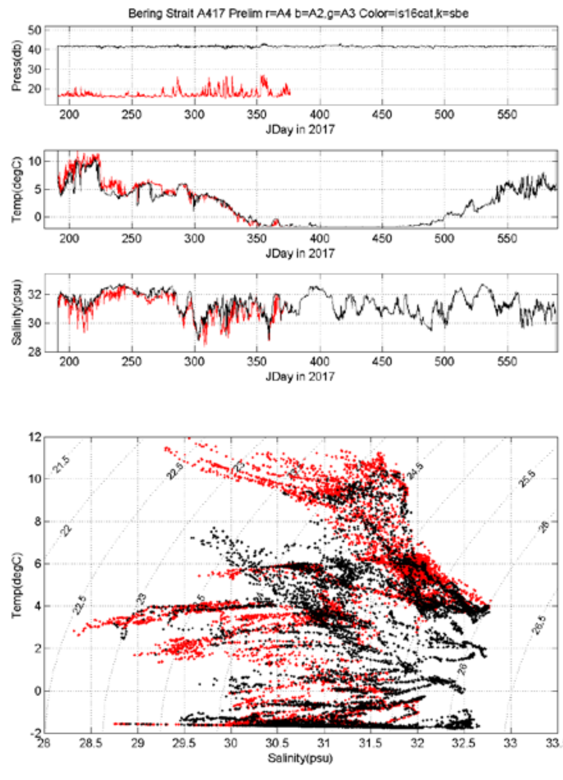


BERING STRAIT 2018 PRELIMINARY ISCAT AND SBE RESULTS (per mooring)

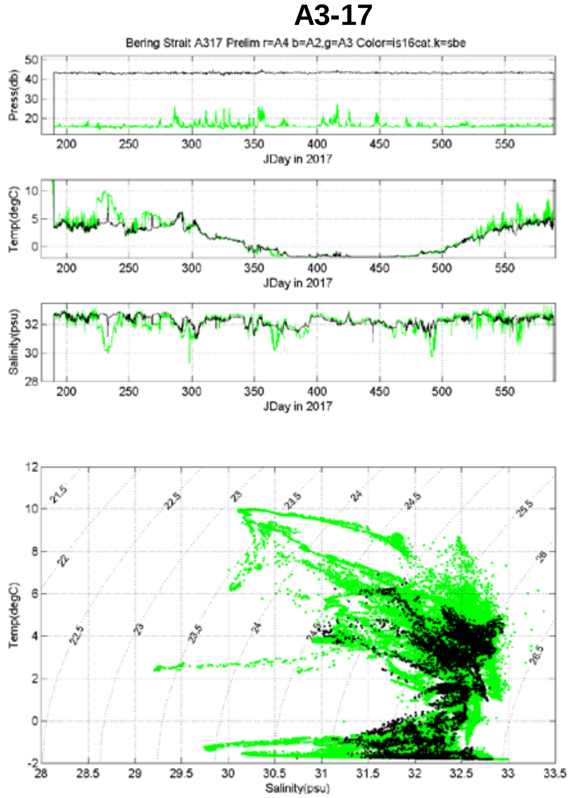
A2-17



A4-17



A3-17



CTD OPERATIONS (Woodgate, Peralta-Ferriz, Morris, Christensen, Cooper)

As in previous years, in 2018 the moorings were supported by annual CTD sections. This year (as per 2014, 2015, 2016 and 2017) 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 and 2017 (in turn 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 29th March 2018)
- 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	50-02-05-0340
Secondary	#844	#485	#1754	5T-90543-05-5236

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 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 2018, 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 2018 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 (~30 or 40m/min) is very close to the winch cut off speed. Also, 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 allow slower winch speed and 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 1 major problem should be noted.

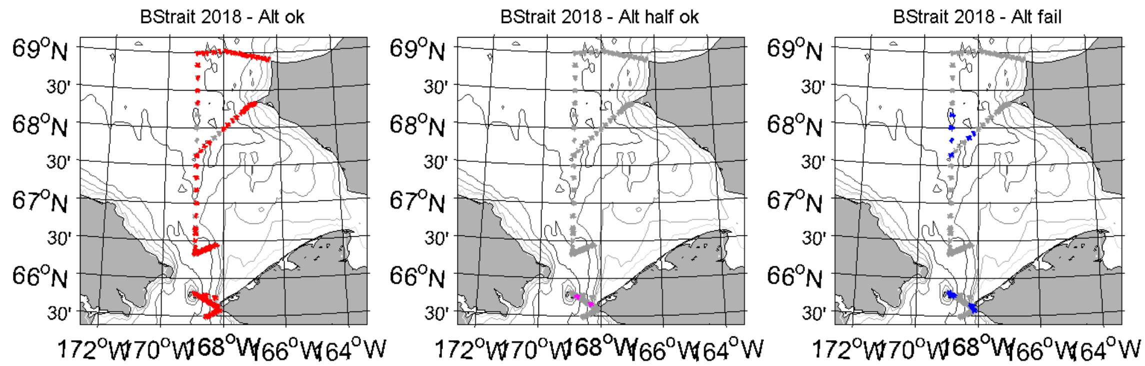
1) On cast 83 (middle of the CCL line, at CCL 8, the CTD hit bottom - after the CTD was stopped at the bottom of the cast, the winch operator paid out rather than taking in wire. This was caught by the CTD operator, who realised the CTD was not coming up. It is hypothesized the CTD laid over on one side, as system 1 of the dual system came up full of brown (silty) water. The system was flushed, and recast, but system 1 was still providing erroneous data, due to (it turned out) failure of the pump on that system. Once the pump was replaced (with SN 5T6915 3K 90741), cast 86 onwards, data appeared again to be good. Thus, data are bad on the following:

Cast 83, all primary sensors, up cast *(cast after preliminary clean of system 1)*
Cast 84, all primary sensors, down & up cast *(cast after thorough clean of system 1)*
Cast 85, all primary sensors, down & up cast *(recast without recovery to prove not due to vent plug)*

Action item: Retrain winch operator for hazards of CTD casts. Add instructions for CTD operator instructions to watch for the CTD to come up from the bottom of the cast. Add to instructions for CTD catcher on deck to watch CTD pulley to insure it comes up. Buy replacement pump.

Other issues with the CTD data have not resulted in poor data, viz:

1) Altimeter. In previous years, it was fund that the altimeter nly perfrmed well intermittently, and the pattern of success and failure appeared t 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.**

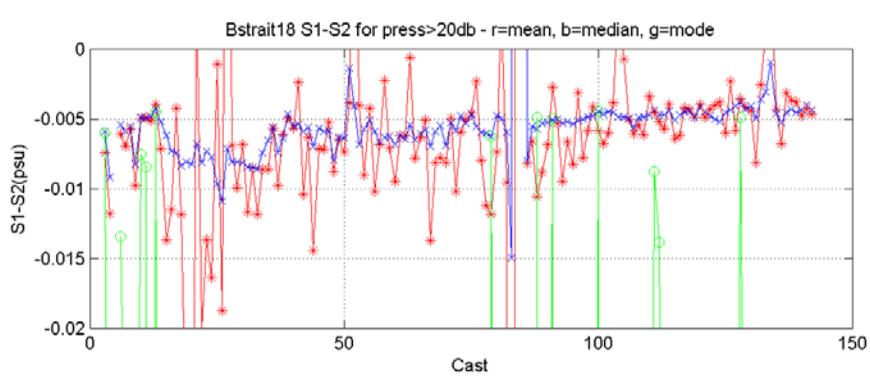


2) On cast 62 (Lis line), one of the CTD tubes was found to be disconnected on recovery. However, the data show no problems and thus likely this happened as the CTD came on deck after the cast.

3) On cast 133 (SBS line), the system 2 vent plug was found to be blocked on recovery. Since the data are however reasonable, likely this happened during the cast. It was cleared before the next cast.

4) Offset of ~ 2% between Oxygen sensors. The calibrated data show a consistent offset between the oxygen sensors, with Ox1 (#1753) reading consistently ~ 2% lower than Ox2 (#1754). A similar issue (albeit reversed) was found on last year's cruise and was eventually deemed to reflect the resolution of the sensors. Note that in processing the CTD data, the oxygen data must be aligned with temperature and results in changes of ~ 5% saturation between upcast and downcast. The cleanest oxygen data is found to be in system 1.

5) Offset between Salinity sensors. Prior years fund an offset in salinity between the two sensors on the CTD. This year, the salinity sensors agree to 0.006psu, which is within the calibration specification of the instruments. Note however the drift to greater consistency over the cruise, suggesting that the cells may have not been entirely clean at the start of the cruise.



Action item: Flush cells with freshwater on deck at start of cruise.

NOTES ON BERING STRAIT 2018 CTD PROCESSING
Rebecca Woodgate (based on 2017 processing)

Start with files from SeaSave for each cast, i.e.,
BStrait18nnn.hex and BStrait18nnn.hdr
Note:
- these were named wrong on the CTD computer in 2018.
- plots on the CTD computer were run using an old calibration.
Use matlab script aaa_BStrait18Filerenames.m to rename files and write the correct 2018 calibration into the XMLCON files.

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 = DatCnvBStrait2018_allvars.psa)
Inputs are: BStrait18nnn.hex and BStrait18nnn.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 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, 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) Salinity, Practical (PSU)
-- 13) Salinity, Practical, 2 (PSU)
-- 14) Time, NMEA (seconds)
-- 15) Latitude (deg)
-- 16) Longitude (deg)
-- 17) Altimeter (m)

-- 18) 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: BStrait18nnn.rw1.cnv

=== 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**

=== 3) Now work through the 7 steps of SBEDataConversion. Start by applying the calibrations to to get the converted files, but this time excluding all the derived variables.
IN SBEDATA PROCESSING, RUN: DATA CONVERSION
(PSA file for this = DatCnvBStrait2018_CTDforprocess.psa)
Inputs are: BStrait18nnn.hex and BStrait18nnn.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: BStrait18nnn.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 = FilterBStrait2018_CTDforprocess.psa)
Inputs are: BStrait18nnn.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: BStrait18nnnA00B15.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 = AlignCTDBStrait2018_CTDforprocessOx2.psa)
Inputs are: BStrait18nnnA00B15.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: BStrait18nnnA00B15AdvOx2.cnv

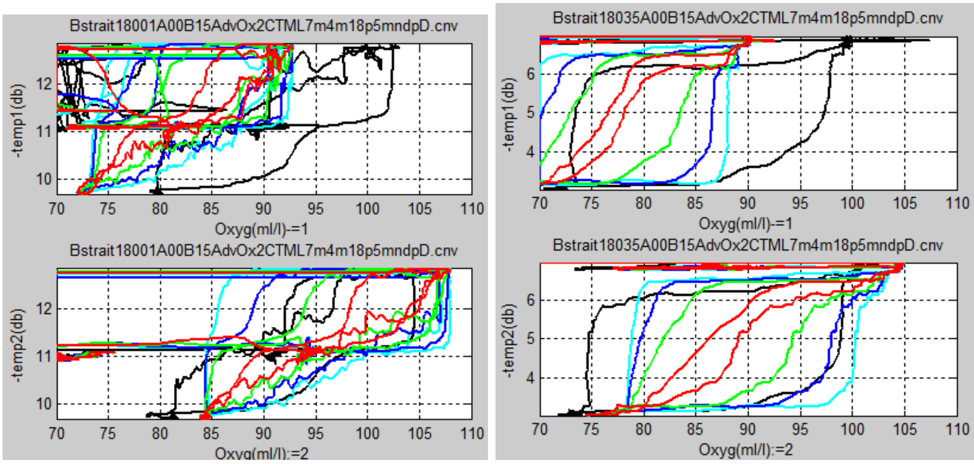
So, of these, it is suggested we investigate the various oxygen options. This we run this step with various values for the oxygen advance (2-5) and, by plotting oxygen against temperature, see which advance value gives the most consistent reading comparing the up and down casts. By eye we tally which are the best:

Red (2)	Green(3)	Blue (4)	Cyan (5)	Unclear
1 2 4 6 7 27 **35 37 38 39 40 51 53 54 55 56 57 58 59** 60 **61 62** 64 65 67 68 69	63	30	9 10 14 15 17 18 20 21 **22** 23 25 26 44 46	3 5 8 11 12 13 16 19 24 28 29 31 32 **33** 34 36 41 42 43 45 47 48 49 50 51 66
27	**1**	**1**		**26**

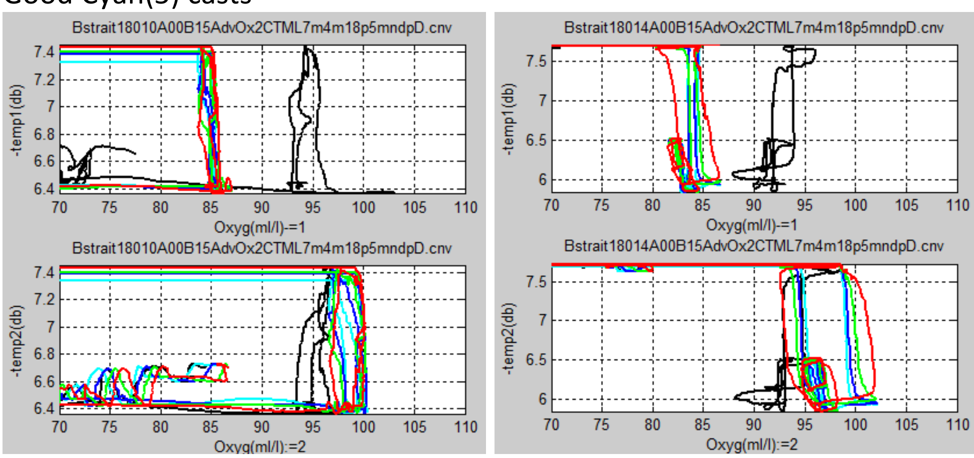
By this tally, Red (2) has the best fit most often, although cyan (5) is better for some casts. Many casts are unclear. Previous years have used (2). We continue to use 2 here, though examples show that up and down casts by differ by 5%-10%.

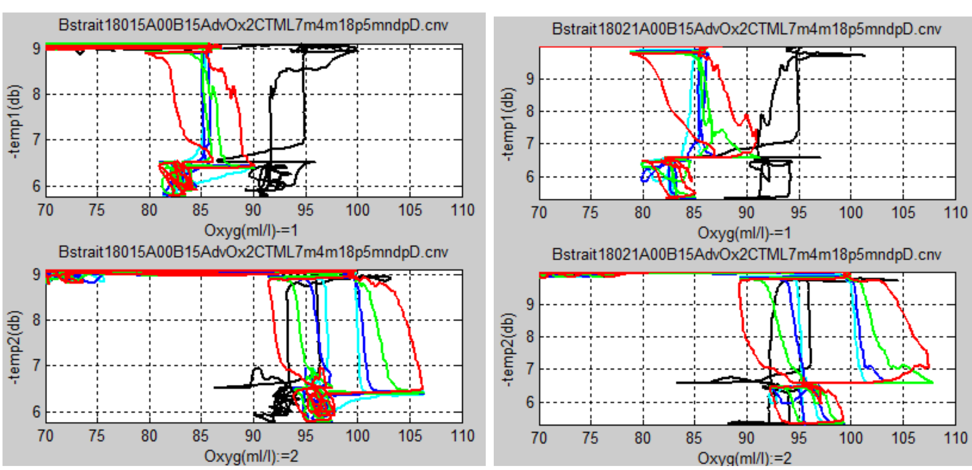
Finally conclude:
- at this stage will use Ox1, as it shows far less spread than Ox2.
- alignment is generally best for both as +2.
- recognize that up and down casts may differ by 5%-10% .

Good red(2) casts:



Good Cyan(5) casts





=== 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 = CellTMBStrait2018_CTDforprocess.psa)

Inputs are: BStrait18nnnA00B15AdvOx2.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: BStrait18nnnA00B15AdvOx2CTM.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.)

In 2018 these settings gave a good result and were used without further testing.

IN SBEDATA PROCESSING, RUN: LOOP EDIT

(PSA file for this = LoopEditBStrait2018_CTDforprocess.psa)

Inputs are: BStrait18nnnA00B15AdvOx2CTM.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: BStrait18nnnA00B15AdvOx2CTM 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 = DeriveCTDBStrait2018_CTDforprocess.psa)
Inputs are: BStrait18nnnA00B15AdvOx2CTML7m4m18p5mndp.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.)

*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: BStrait18nnnA00B15AdvOx2CTM 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_FilterCTDBStrait2018_CTDforprocess_MF17.psa)
Inputs are: BStrait18nnnA00B15AdvOx2CTM 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: BStrait18nnnA00B15AdvOx2CTM 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 = BinAvgBStrait2018_CTDforprocess.psa)
Inputs are: BStrait18nnnA00B15AdvOx2CTM L7m4m18p5mndp.cnv &
BStrait18nnnA00B15AdvOx2CTM 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: BStrait18nnnA00B15AdvOx2CTM L7m4m18p5mndpDBADCS010.cnv &
BStrait18nnnA00B15AdvOx2CTM L7m4m18p5mndp DMF17BADCS010.cnv

In 2018 this marks the end of the CTD pre processing.

BERING STRAIT 2018 CTD OPERATION NOTES

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**"
    - **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**"
    - 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, while
    - **Deck to Driver** "**CTD recovered**", 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 leaving CTD for long time, check "transponder is out"

BERING STRAIT 2018 CTD LINES

A total of 7 CTD lines were run on the cruise. This is a much smaller number than last year (19), primarily due to the very stormy weather which frequently prevented operations, but in part also due to manning issues.

Preliminary sections were plotted by Cecilia Peralta-Ferrriz 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.

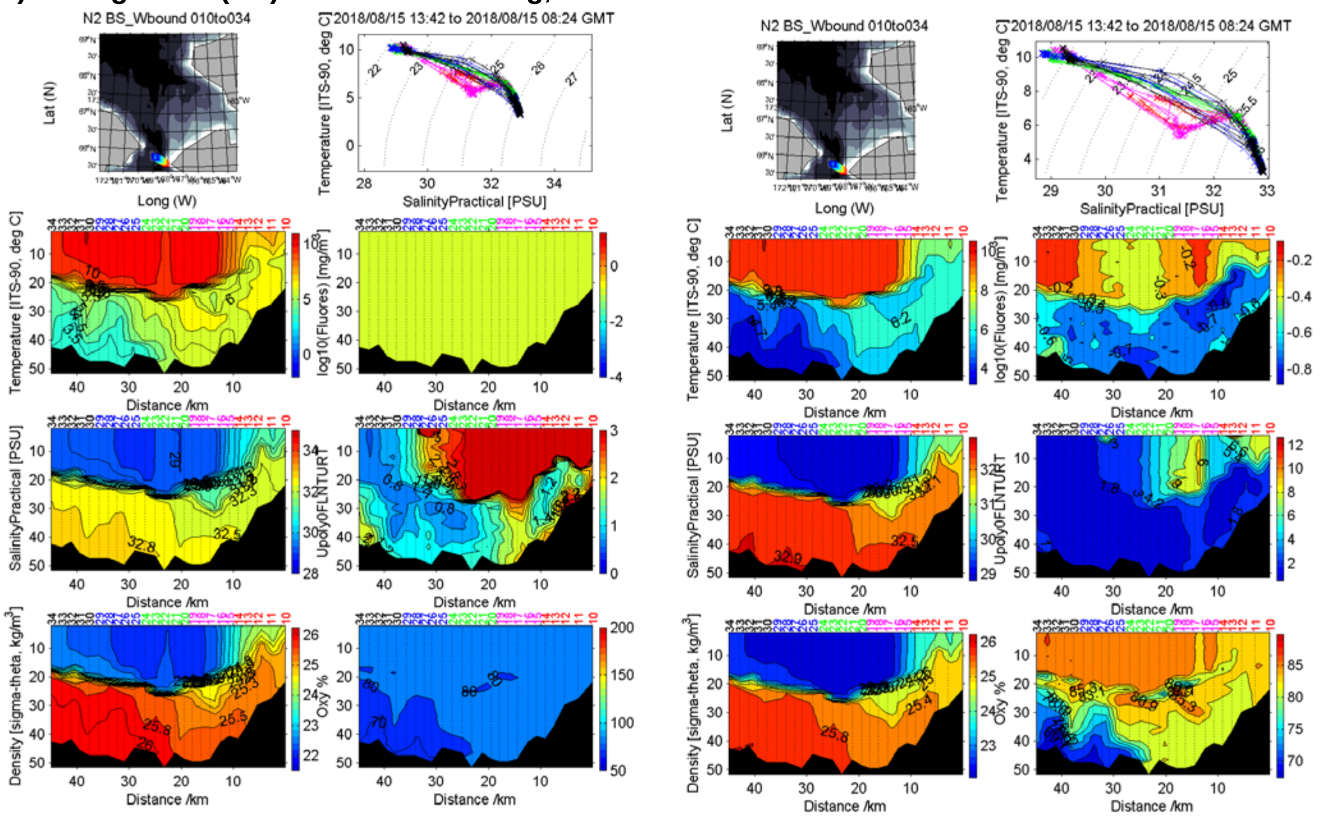
The plots below give all 7 sections on the same scales (left) and on a scale for that section (right), presented in order of data acquisition. Note that:
- this uses the S1 and Ox1 data,
- typically stops 2 to 3+ m above the bottom.

One repeat line - BS - was run during the cruise. This particularly interesting as the first running of the BS line was after the long storm with strong southward winds, and shows the Alaskan Coastal Current entirely separated from the Alaskan Coast. The repeat of this line, 3 days later, shows the Alaskan Coastal Current reestablished along the Alaskan Coast. **Action item: Investigate**

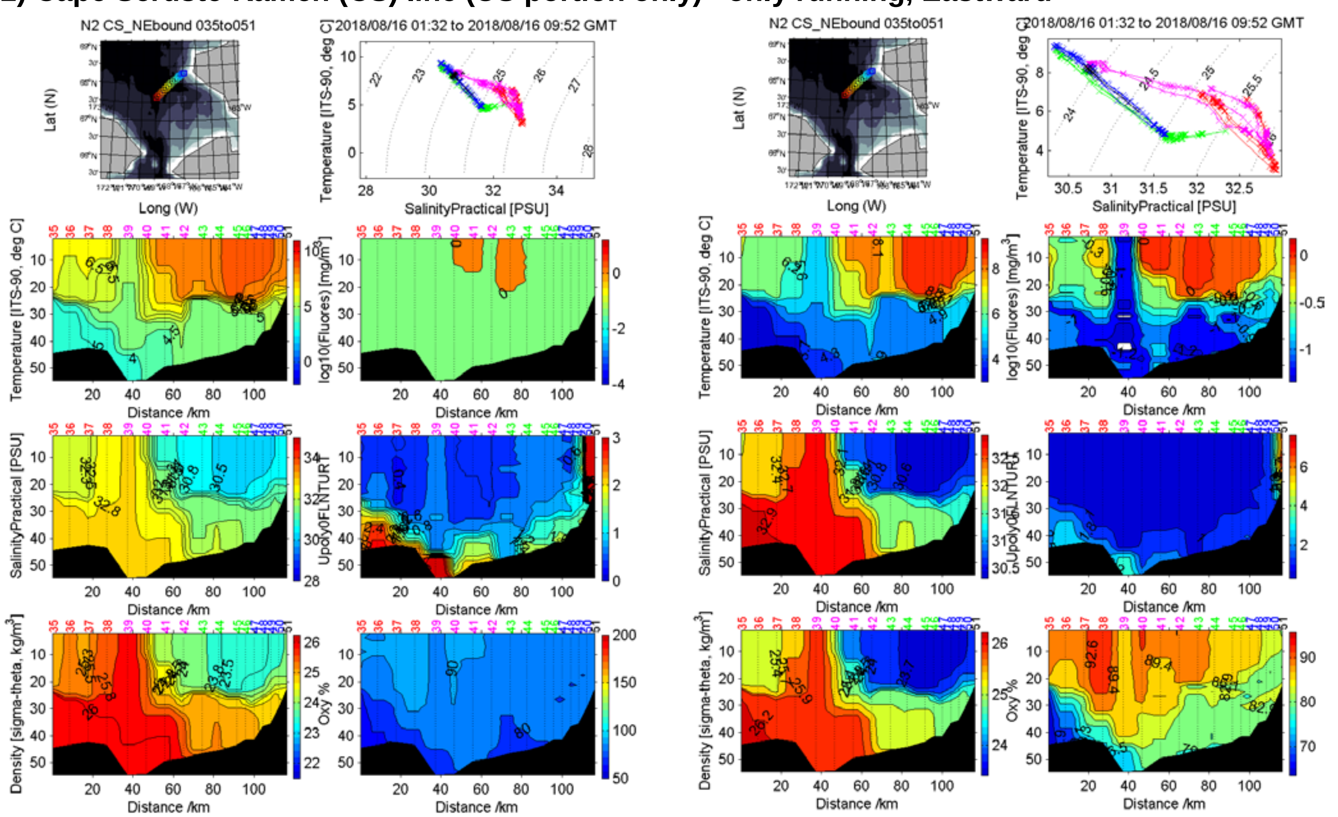
Note that underway data was taken on more repeats also.

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

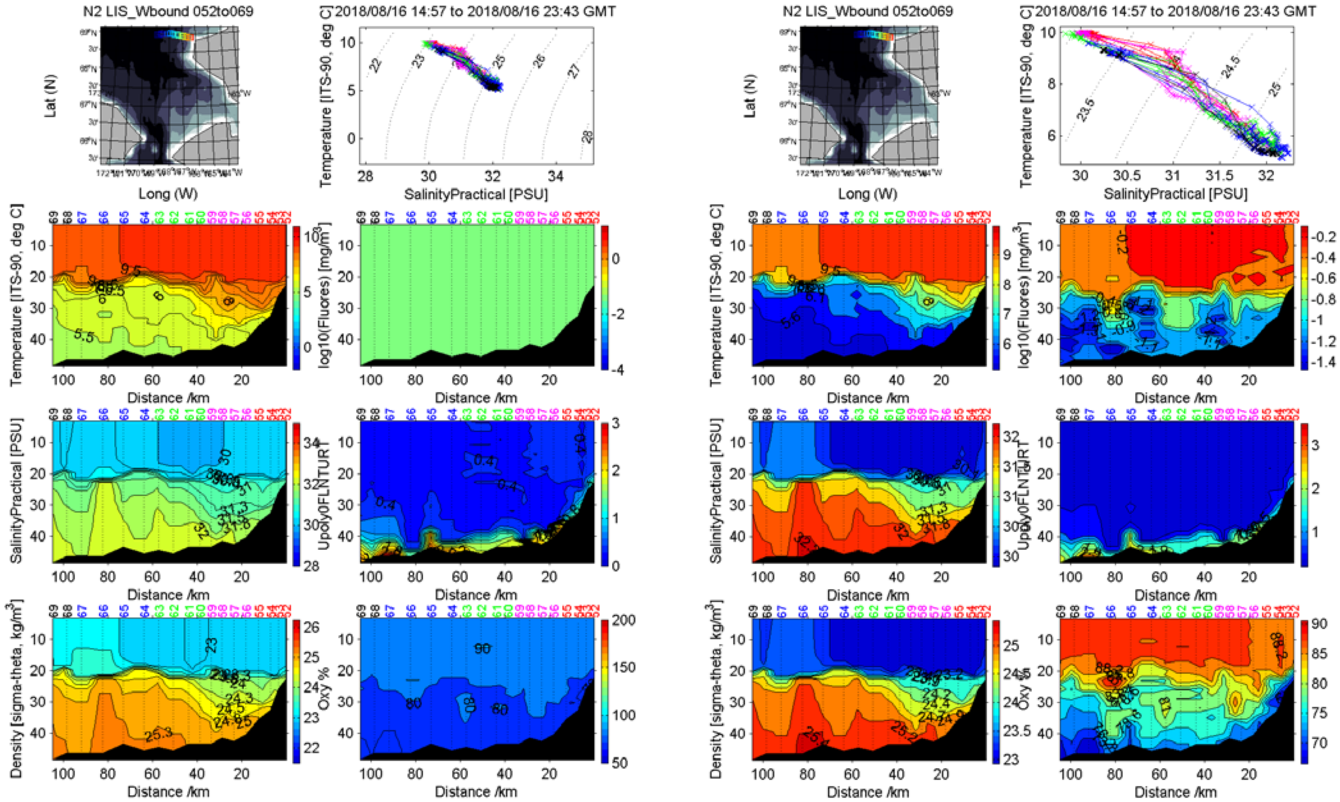
1) Bering Strait (BS) line – first running, Westward



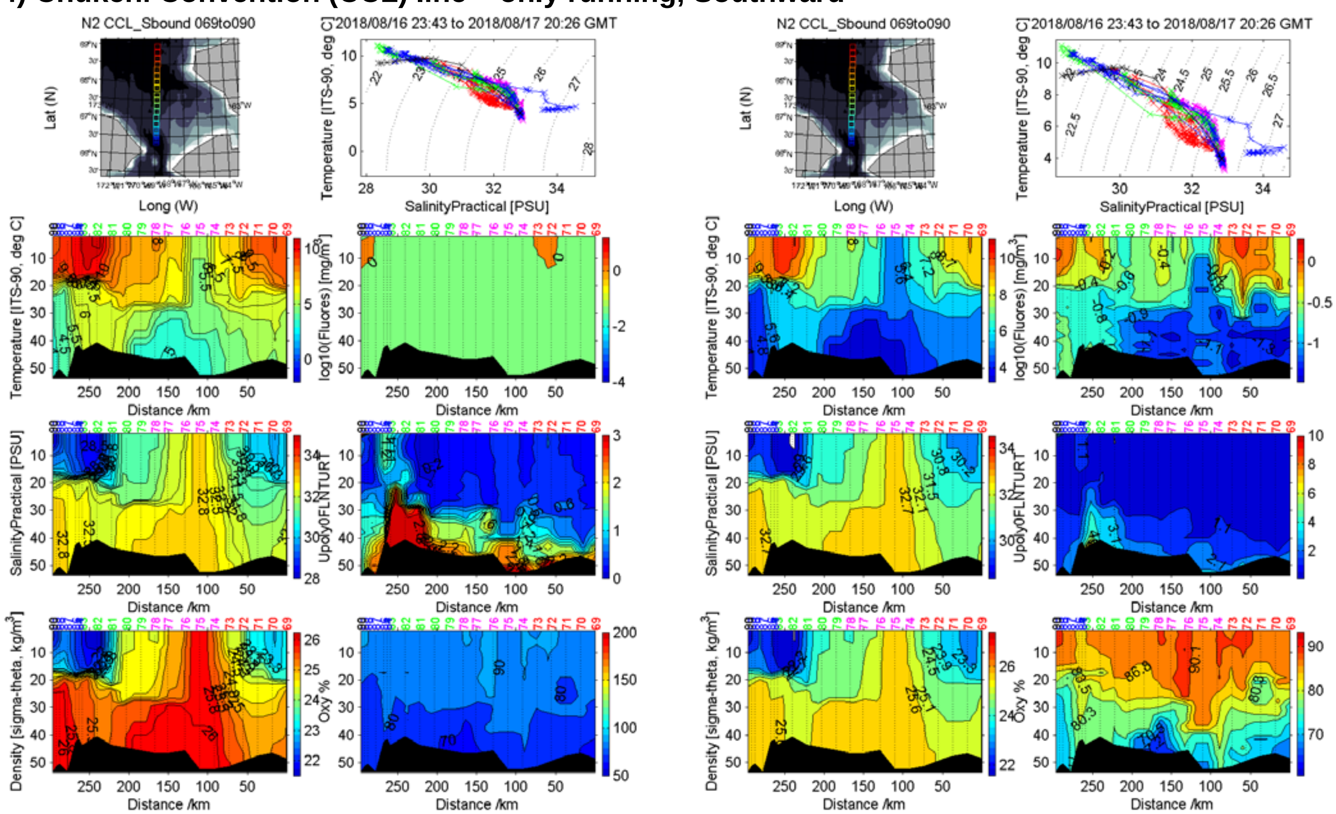
2) Cape Serdste-Kamen (CS) line (US portion only)– only running, Eastward



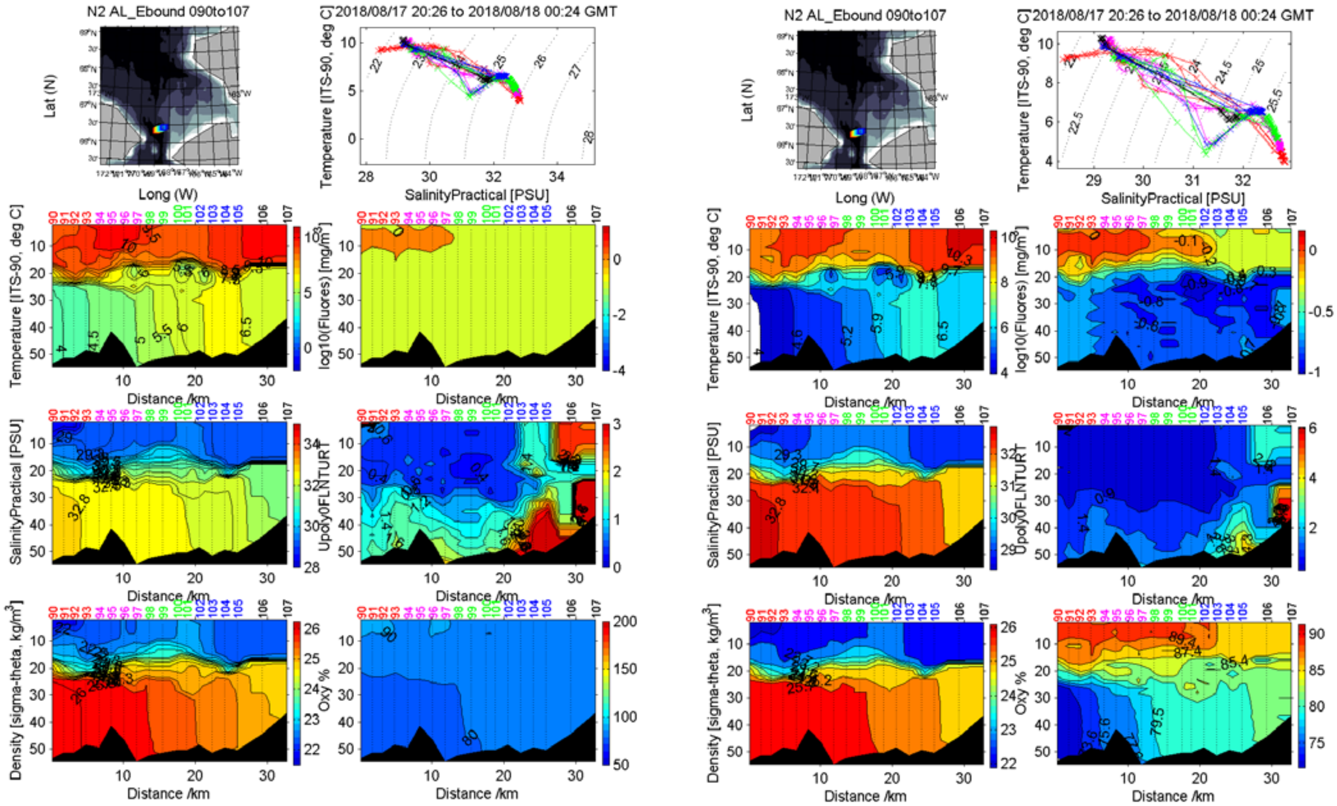
3) Cape Lisburne (LIS) line – only running, Westward



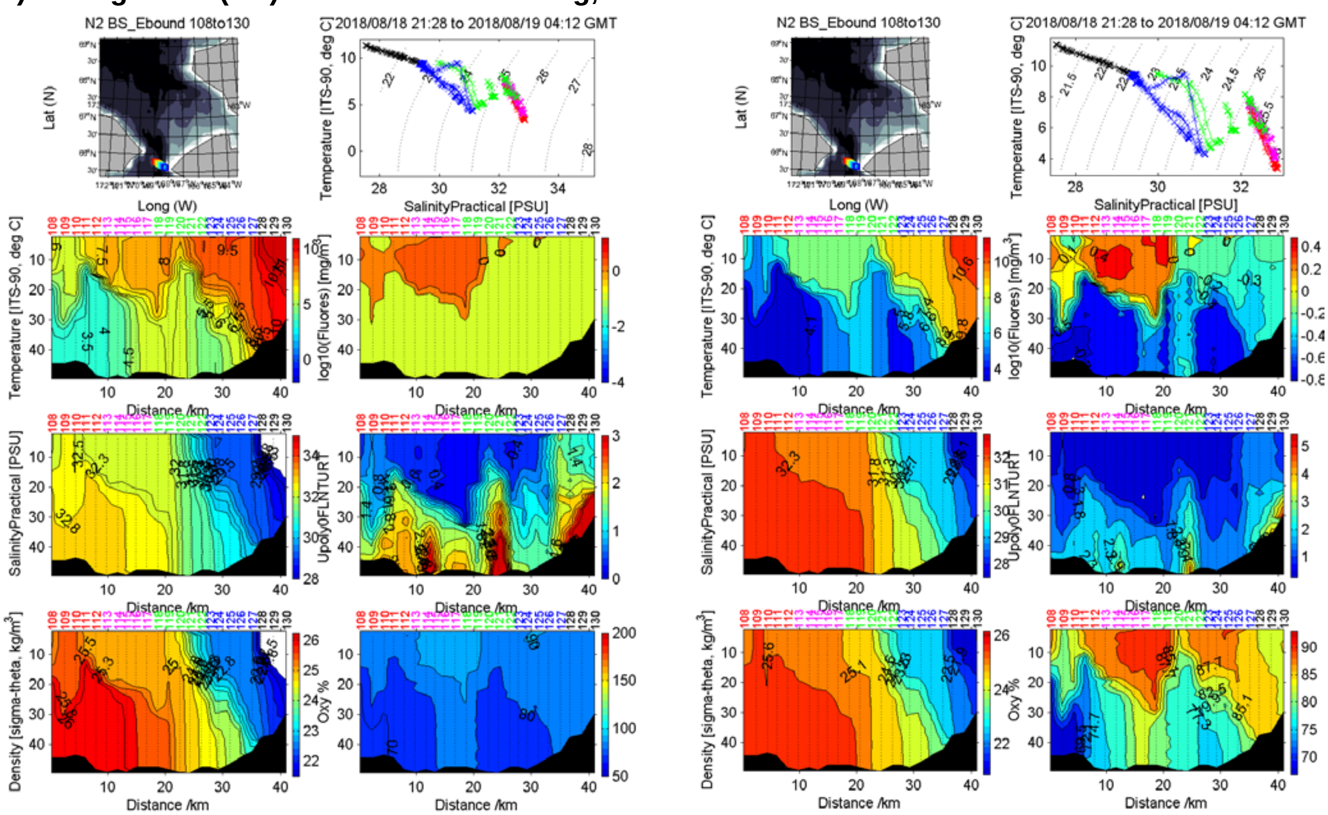
4) Chukchi Convention (CCL) line – only running, Southward



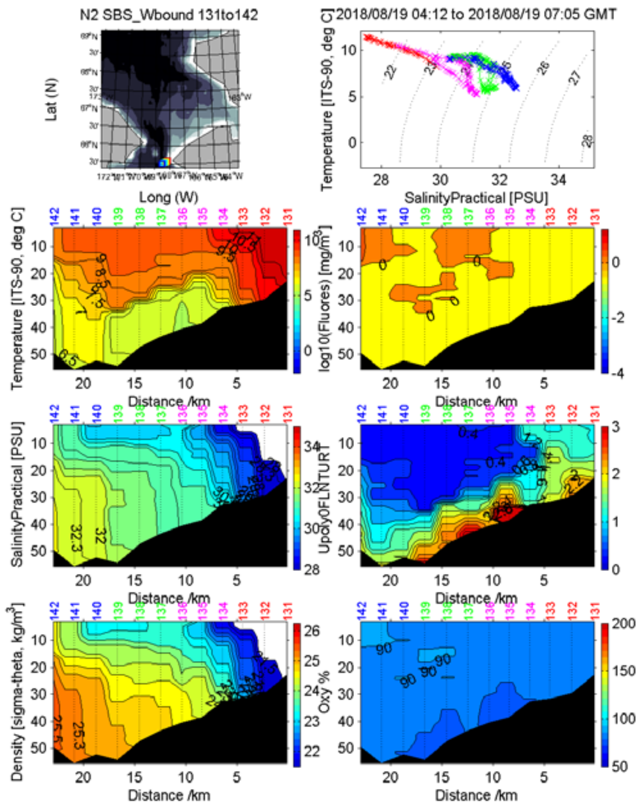
5) A3 (AL) line – only running, Eastward

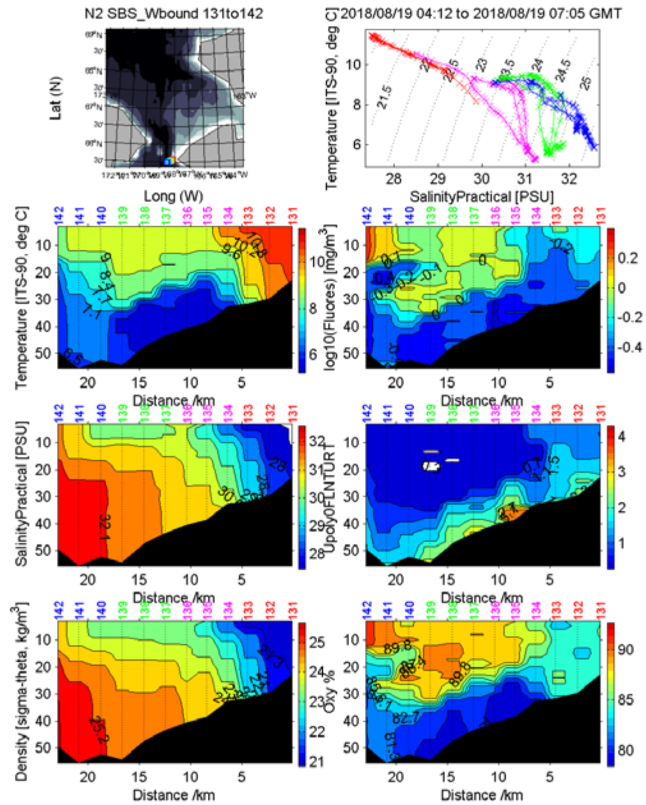


6) Bering Strait (BS) line – second running,Eastward



7) South Bering Strait (SBS) – only running, Southwestward





MARINE MAMMAL REPORT - Zac Cooper and Rebecca Woodgate, for Kate Stafford

Acoustic recorders

In 2018, acoustic recorders were recovered from all three moorings. These instruments have been shipped to Seattle and will be downloaded there. Only one acoustic recorder was deployed on the new 2018 moorings, and that was placed on A3-18.

Sighting survey

Only an ad hoc survey of marine mammals was undertaken during the cruise. Generally the bridge reported few sightings of marine mammals. The following list is those that were reported to the science team and identified by Zac Cooper. Sightings are given in local time - add 8 hrs to obtain GMT.

DATE YrMonDay	TIME (Local)	LAT (N) Deg, min	LON (W) Deg, min	SPECIES	#	COMMENTS
20180815	12:41	66º53.73'	168º56.70'	Humpback whale	5 to 6	Black flukes, spraying often
20180815	14:12	67º08.01'	168º56.96	Grey Whale	2 to 3	Spotted backs, grey color, spraying often
20180815	14:20	67º09.39'	168º56.97	Whale (unidentified)	1	Passed solo in front of ship, only spray seen
20180815	14:27	67º10.37'	168º56.99'	Humpback whale	3 to 5	White coloration on end of black fluke
20180815	14:34	67º11.34'	168º57.00'	Grey Whale	1	White spots on back

BIOFOULING REPORT - Zac Cooper and Rebecca Woodgate

For many years, the Bering Strait mooring project has collected photographic records of the biofouling on the recovered moorings, but no attempt has been made to process these data in any quantitative way. As a first move in this direction, Zac Cooper worked through the photographs and attempted to quantify taxa and amount of biofouling, based on areal coverage of instrumentation at the moorings sites. Here are some preliminary results.

Taxa reported on moorings

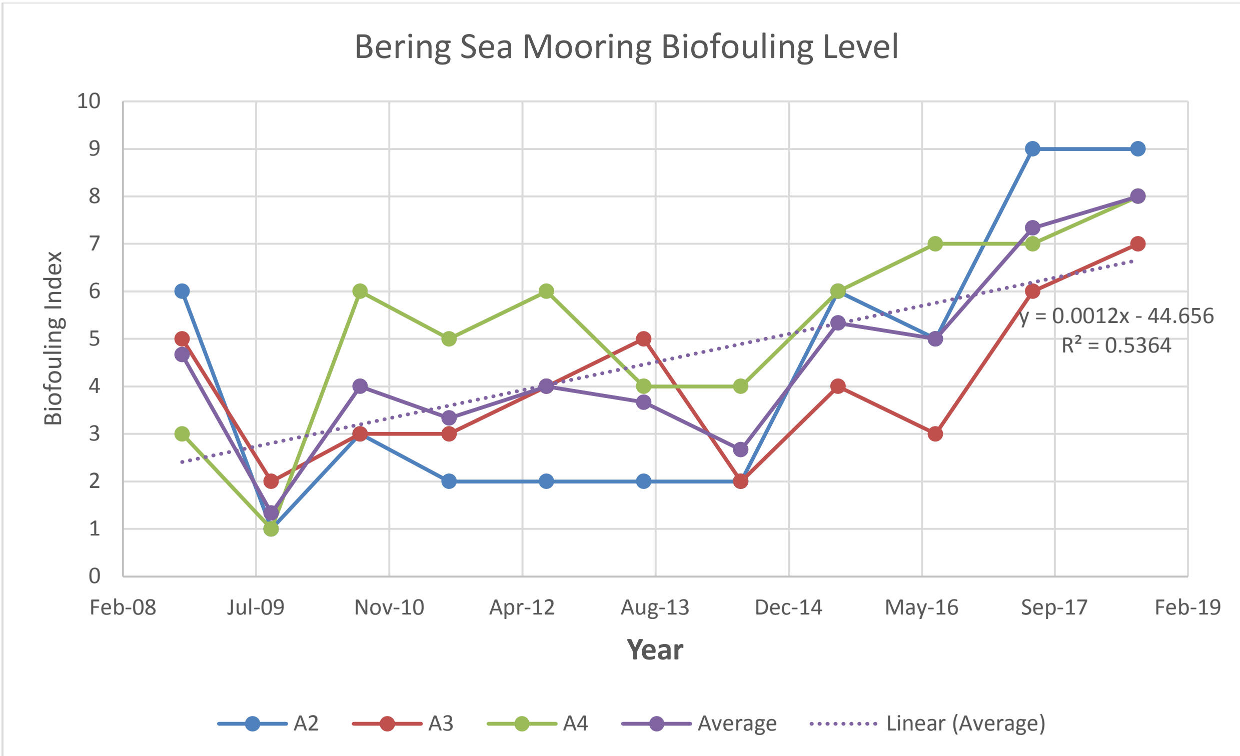
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Taxa noted in report*											
Barnacles	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Bryzoans						yes	yes	yes	yes	yes	
Hydroids			yes	yes	yes	yes	yes	yes	yes	yes	yes
Mussels	small			yes							yes
Sea Star	1, hand sized	yes			Basket star						
Gelatinous			Misc							brown	
Amphipods					yes						yes
Worms						Tube		Sipuncular		yes	
Nudibranchs								yes			yes
Anemones								yes			
Salps								yes			yes
Tunicates										yes	
Jellyfish											yes
Observations made by ...											
	Phys	Phys	Phys	Phys	**Bio**	Phys	Phys	**Bio**	Phys	Phys	**Bio**

* note this may be skewed by the ability of the cruise personnel to identify taxa, and so final row gives science discipline of person identifying taxa.

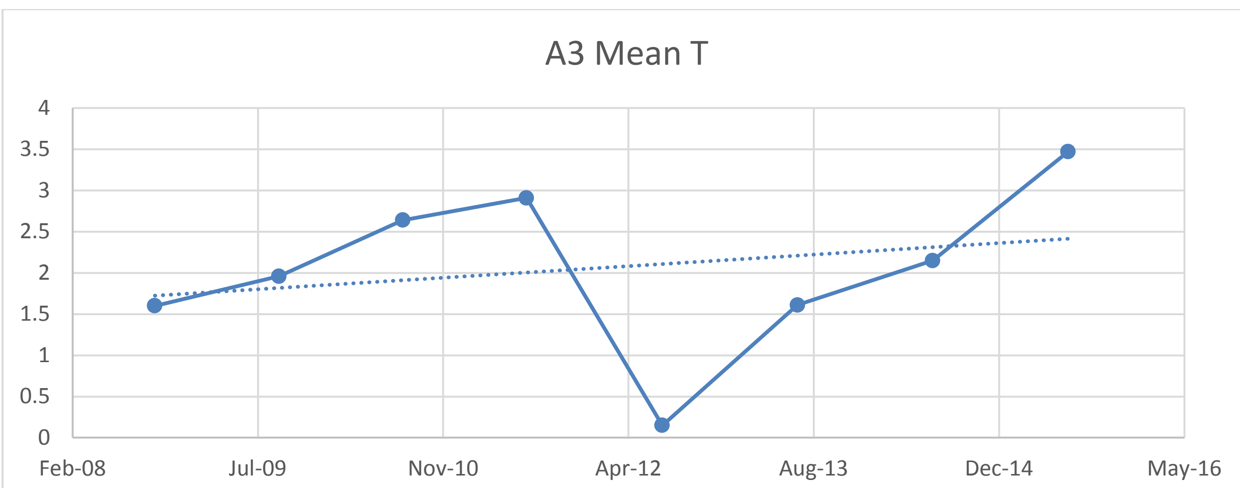
Visual estimate from photographs of level of biofouling on moorings

Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Month	**Oct**	**Sep**	**Aug**	**Jul**	**Jul**	**Jul**	**Jul**	**Jul**	**Jul**	**Jul**	**Aug**
Biofouling level (scale 1=little to 10=very high)											
A2	6	1	3	2	2	2	2	6	5	9	9
A3	5	2	3	3	4	5	2	4	3	6	7
A4	3	1	6	5	6	4	4	6	7	7	8
Average	*4.7*	*1.3*	*4*	*3.3*	*4*	*3.7*	*2.7*	*5.3*	*5*	*7.3*	*8*
A3 mean Temperature (degC)*											
	1.6	2.0	2.6	2.9	0.2	1.6	2.2	3.5			

* Mean temperature in the month of recovery is likely not the best indicator of annual growth. Other factors to consider here include duration of deployment, months of deployment and recovery, temperature and flow during the deployment.



Bering Sea Mooring Biofouling Level
Biofouling Index
10
9
8
7
6
5
4
3
2
1
0
Feb-08
Jul-09
Nov-10
Apr-12
Aug-13
Dec-14
May-16
Sep-17
Feb-19
Year
y = 0.0012x - 44.656
R² = 0.5364
A2
A3
A4
Average
Linear (Average)



A3 Mean T
4
3.5
3
2.5
2
1.5
1
0.5
0
Feb-08
Jul-09
Nov-10
Apr-12
Aug-13
Dec-14
May-16

BERING STRAIT 2018 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.**

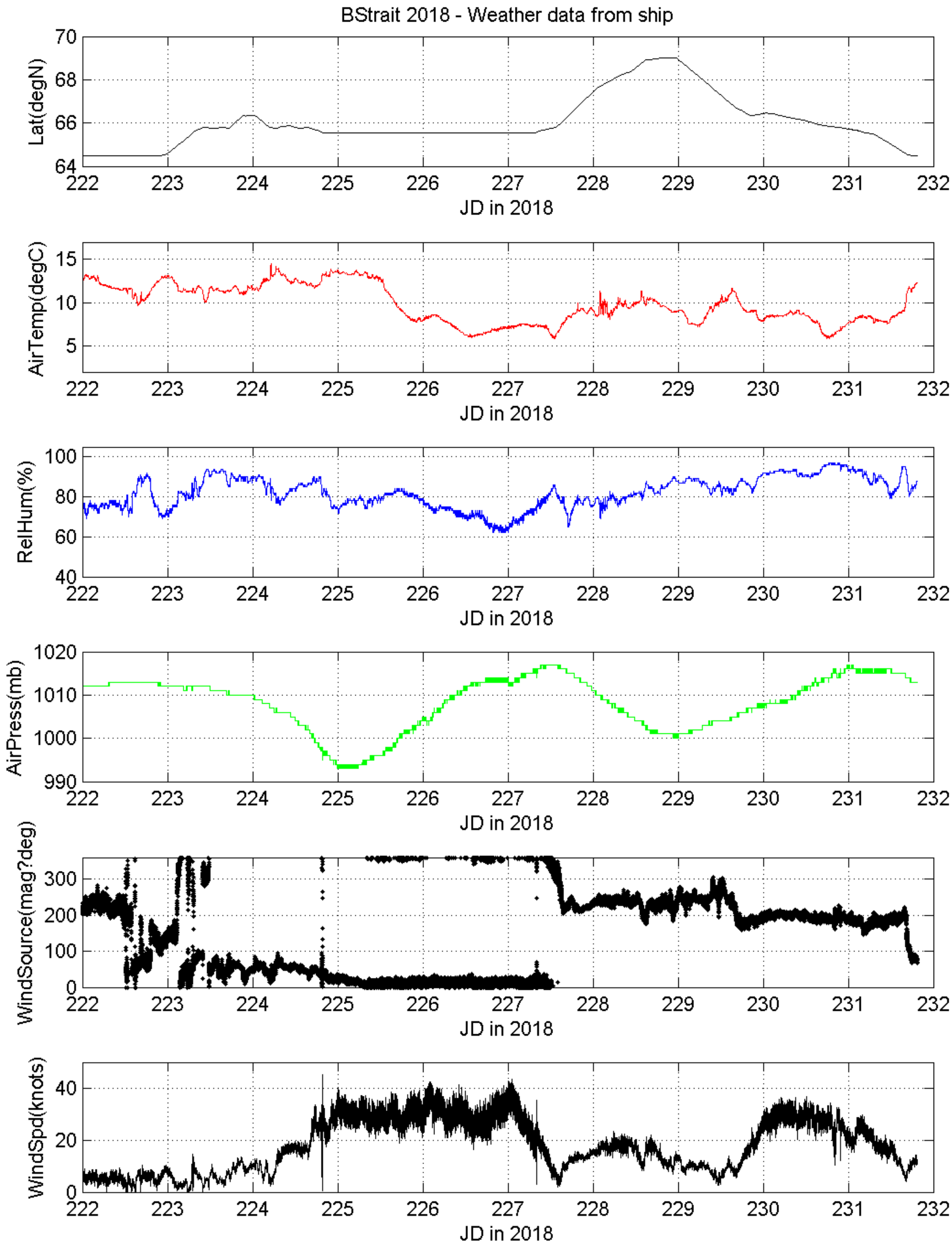
The calibration file used was the December 2016 calibration. **Action Item: Ensure the most recent calibration is used in the field.** Data were logged every 3 seconds. Preliminary plots of the underway temperature and salinity data are given below.

A particularly interesting result is the slow trend to colder and saltier water during the time anchored at Tin City during the storm, which is likely related to the upwelling of deeper waters as the ACC moves away from the coast. **Action Item: Investigate.**

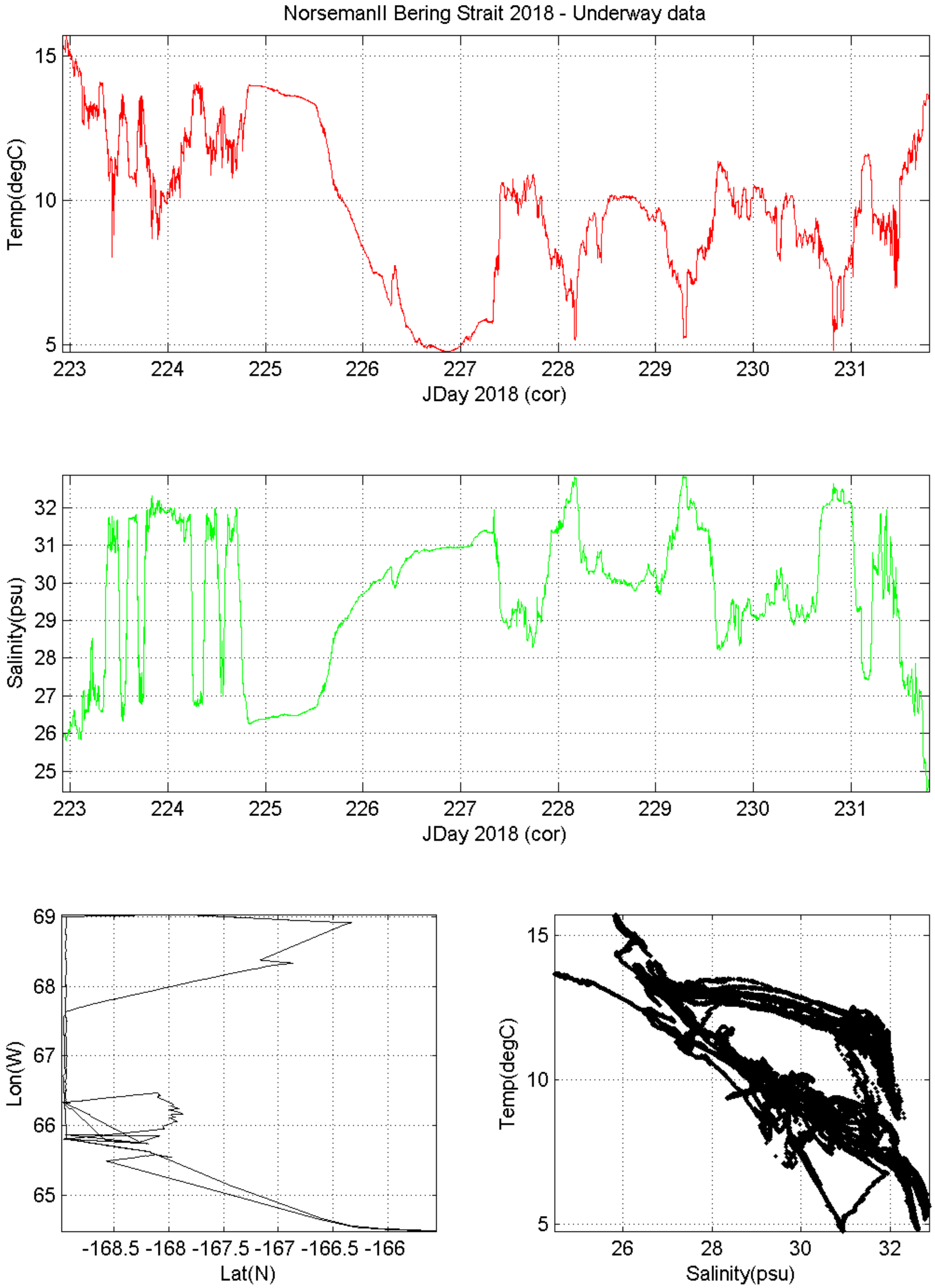
It is very important to remember when interpreting these data, that they are not synoptic, as is evidenced by the plots of the various crossings of the Bering Strait also shown below. **Action Item: Examine surface salinities and temperatures, especially in conjunction with prior data.**

BERING STRAIT 2018 METEOROLOGICAL DATA

Left Port at 1900 10th Aug 2018 (JD222), Returned to port 2000 19th Aug 2018 (JD 231)
(Note strong southward storm for JD225-227, and northward storm for JD230)



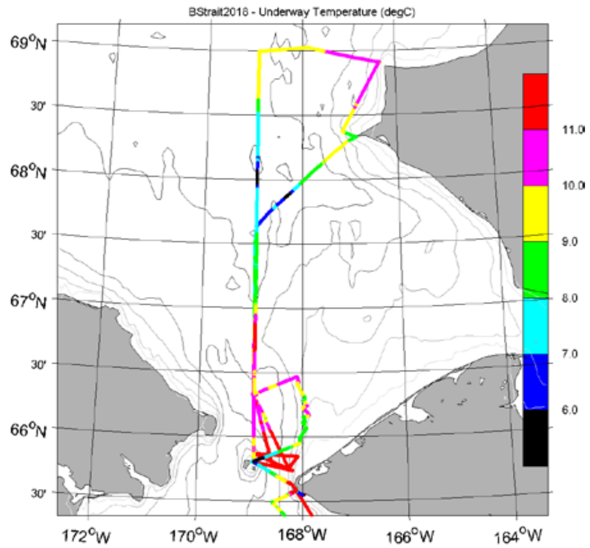
BERING STRAIT 2018 UNDERWAY TEMPERATURE SALINITY DATA
Note drift to colder saltier waters during the southward storm, and much fresher salinities than in 2017 (27psu versus 29psu)



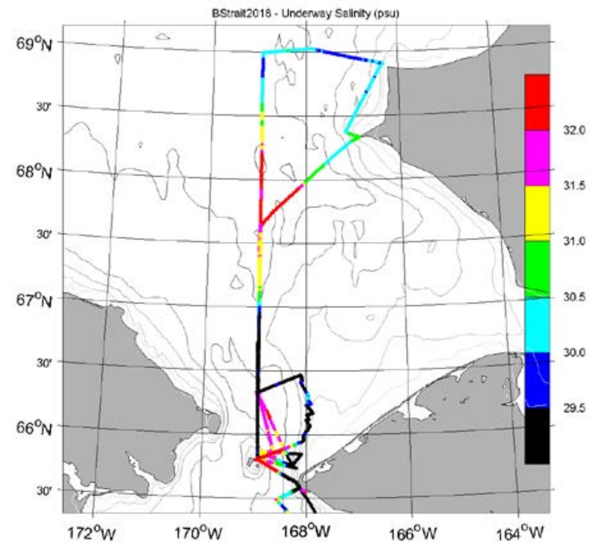
BERING STRAIT 2018 UNDERWAY TEMPERATURE SALINITY DATA (continued)

(Note multiple runnings of the Bering Strait (and other) lines are masked in these plots.)

Temperature (degC)

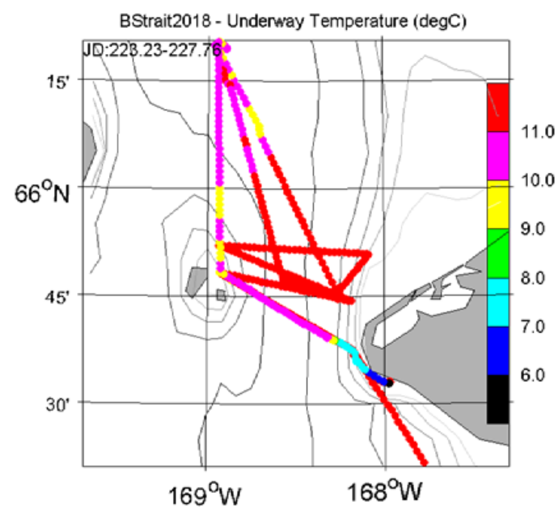


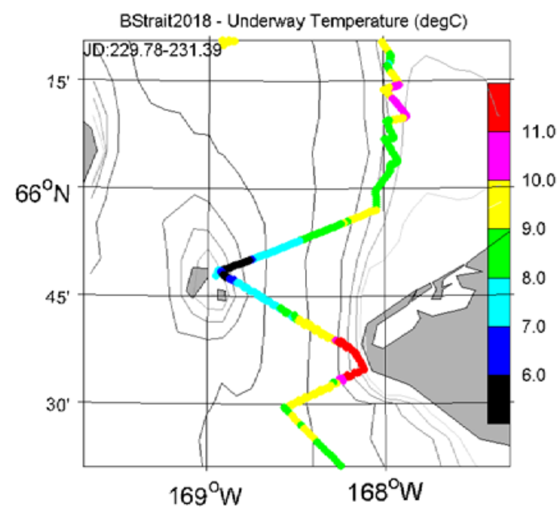
Salinity (psu)



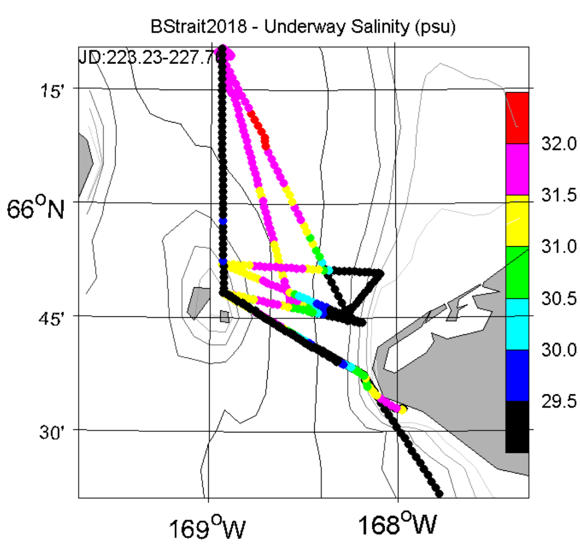
First half of Cruise | **Second half of cruise**

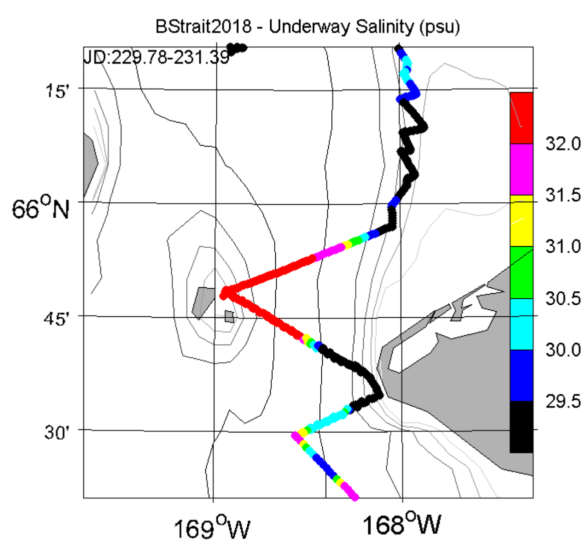
Underway Temp-erature (DegC)





Underway Salinity (psu)





BERING STRAIT 2018 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 2018 cruise) as part of the Bering Strait mooring cruises. Stations taken on this 2018 cruise are included in the full event log later in this cruise report.

```
%=========================================================
% Stations for BStrait Mooring Cruise 2018 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 2017
%-----------------------------------------
%NAME        Lat(N)          Long (W)      Water   Top
%            deg min         deg min       depth   Float
% A3-17     66  19.59      168  57.13     56m     15m
% A2-17     65  46.88      168  34.08     55m     15m
% A4-17     65  44.76      168  15.78     48m     15m
%----------------------------------
% DEPLOYMENTS for this 2018 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 the 2018 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

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% Bering Strait 2018 NORSEMAN2 log CTD

%Date	Time	1	Cast NO	Down(	Depth (m)	Lat (de	Lat (min)	Lon (deg	Lon(min)	Altimeter	%	StationID	Windsp	Winddir	Operat	Fog	WaterCla	Comments
%Please fill in all data for every event (CTD/net tow)										0=bad	%		knots			0 = clea	0=clear	
%There should be one line for the beginning of the event and one line for the end										1=good	%					1=fog	1=not clear	
%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	Down (1),Up (2)	Depth (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon(min)	Altimeter	%	StationID	Wind speed	Winddir	Driver	Fog	Water Clarity	Comments
20180811	411	1	**1**	1	20	65	7.86	167	25.92	1	%	test	2.3	N	acpf			
20180811		1	**1**	2		65	7.94	167	26.07	1	%	test			acpf			
20180811	423	1	**2**	1	18.9	65	8.07	167	26.19	1	%	test2	2.9	NE	acpf			
20180811	430	1	**2**	2	18.5	65	8.16	167	26.26	1	%	test2	3.8	NE	acpf			
20180811	1524	1	**3**	1	52.3	65	47.04	168	34	1	%	A2-17	5	NE	acpf	0	0.5	A2 recovery
20180811	1527	1	**3**	2	52.2	65	47.11	168	34.13	1	%	A2-17	3.8	NE	acpf			
20180811	1713	1	**4**	1	45.1	65	44.99	168	15.7	1	%	A4-17	8	E	acpf	0	0.5	A4 recovery
20180811	1716	1	**4**	2	45.5	65	45.15	168	15.67	1	%	A4-17	7.2	E	acpf			
20180811	2117	1	**5**	1	54	66	19.52	168	56.82		%	A3-17	9.6	NE	acpf	0	0.5	A3 recovery CAST ATTEMPT - no cast bc drifting towards mooring
20180811		1	**5**	2		66		168			%	A3-17			acpf			
20180811	2127	1	**6**	1	54	66	19.87	168	57.2	1	%	A3-17	9.5	NNE	acpf	0	0.5	A3 recovery
20180811	2131	1	**6**	2	53.9	66	19.94	168	57.26	1	%	A3-17	9.3	NE	acpf			
20180812	50	1	**7**	1	53.8	66	19.75	168	57.34	1	%	A3-18	11.6	NE	acpf	0	0.5	A3 deployment: CTD out of water on recovery, but pumps off beforehand
20180812	54	1	**7**	2	53.8	66	19.78	168	57.48	1	%	A3-18	9.9	NE	acpf			
20180812	522	1	**8**	1	52.1	65	47	168	34.05	1	%	A2-18	4.2	NE	acpf	0		A2 deployment
20180812	527	1	**8**	2	52.9	65	47.09	168	33.97	1	%	A2-18	5.8	NE	acpf			many logs on site
20180812	705	1	**9**	1	45.4	65	45	168	15.58	1	%	A4-18	13.7	ENE	acpf	0		A4 deployment
20180812	709	1	**9**	2	45.7	65	45.15	168	15.55	1	%	A4-18	15.7	ENE	acpf			
20180815	824	1	**10**	1	23.4	65	34.89	168	6.99	0	%	BS24	20.8	N	acpf	0	1	** Starting BS line Wbound **
20180815	827	1	**10**	2	23.6	65	34.8	168	7.04	0	%	BS24	22.1	N	acpf			water very mucky
20180815	840	1	**11**	1	27.4	65	35.98	168	9.51	0	%	BS23	21.9	N	acpf	0	1	
20180815	842	1	**11**	2	28.5	65	35.94	168	9.57	0	%	BS23	21.9	N	acpf			
20180815	856	1	**12**	1	29.5	65	37.42	168	10.5	0	%	BS22	18.9	N	acpf	0	1	
20180815	859	1	**12**	2	29.3	65	37.38	168	10.56	0	%	BS22	19.1	N	acpf			
20180815	909	1	**13**	1	37	65	38.04	168	12.74	0	%	BS21.5	16.5	N	acpf	0	1	
20180815	912	1	**13**	2	36.7	65	37.99	168	12.78	0	%	BS21.5	17.4	N	acpf			
20180815	922	1	**14**	1	39.7	65	38.54	168	14.8	0	%	BS21	18.8	N	acpf	0	1	CTD reached 43m - almost bottom
20180815	925	1	**14**	2	39.8	65	38.5	168	14.8	0	%	BS21	15.8	N	acpf			but all looks good: profile and CTD
20180815	934	1	**15**	1	44.1	65	38.9	168	17.09	1	%	BS20.5	19.2	N	acpf	0	1	
20180815	938	1	**15**	2	44.3	65	38.8	168	17.08	1	%	BS20.5	18.1	N	acpf			
20180815	948	1	**16**	1	46.5	65	39.29	168	19.22	1	%	BS20	16.5	N	acpf	0	1	
20180815	952	1	**16**	2	46.6	65	39.25	168	19.21	1	%	BS20	17.1	N	acpf			
20180815	1001	1	**17**	1	48.8	65	39.84	168	21.4	1	%	BS19.5	18.1	N	acpf	0	1	
20180815	1004	1	**17**	2	48.2	65	39.82	168	21.41	1	%	BS19.5	15.1	N	acpf			

20180815	1014	1	**18**	1	49.9	65	40.38	168	23.56	1	%	BS19	18.4	N	acpf	0	1	
20180815	1018	1	**18**	2	50.1	65	40.35	168	23.56	1	%	BS19	15.5	N	acpf			
20180815	1026	1	**19**	1	50.7	65	40.77	168	25.37	1	%	BS18.5	14.8	N	acpf	0	1	
20180815	1031	1	**19**	2	50.3	65	40.7	168	25.41	1	%	BS18.5	12.2	N	acpf			
20180815	1039	1	**20**	1	51.1	65	41.19	168	27.12	1	%	BS18	13.9	N	acpf	0	0.5	
20180815	1042	1	**20**	2	51.3	65	41.17	168	27.13	1	%	BS18	12.1	N	acpf			
20180815	1052	1	**21**	1	50.6	65	41.69	168	29.31	1	%	BS17.5	14.8	N	acpf	0	0.5	
20180815	1055	1	**21**	2	51.8	65	41.67	168	29.3	1	%	BS17.5	11.9	N	acpf			
20180815	1105	1	**22**	1	52.2	65	42.23	168	31.44	1	%	BS17	13.3	N	acpf	0	0.5	
20180815	1108	1	**22**	2	51.5	65	42.22	168	31.45	1	%	BS17	14.6	N	acpf			
20180815	1118	1	**23**	1	49.7	65	42.8	168	33.52	1	%	BS16.5	14.8	N	acpf	0	0.5	Jelly fish tentacles
20180815	1122	1	**23**	2	49.5	65	42.79	168	33.49	1	%	BS16.5	13.1	N	acpf			
20180815	1131	1	**24**	1	49.9	65	43.32	168	35.62	1	%	BS16	12.3	N	acpf	0	0.5	jelly fish
20180815	1136	1	**24**	2	49.7	65	43.3	168	35.66	1	%	BS16	13.5	N	acpf			
20180815	1146	1	**25**	1	48.7	65	43.86	168	37.83	1	%	BS15.5	10.9	N	rw	0		5m off bottom
20180815	1149	1	**25**	2	49.9	65	43.85	168	37.83	1	%	BS15.5	8.1	N	rw			
20180815	1159	1	**26**	1	48.8	65	44.39	168	39.99	1	%	BS15	8.9	N	acpf	0	0.5	
20180815	1202	1	**26**	2	49.5	65	44.4	168	40.01	1	%	BS15	9.2	N	acpf			
20180815	1210	1	**27**	1	49.6	65	44.84	168	41.64	1	%	BS14.5	9.3	N	acpf	0	0.5	
20180815	1213	1	**27**	2	49.7	65	44.86	168	41.68	1	%	BS14.5	8.9	N	acpf			
20180815	1221	1	**28**	1	50.4	65	45.31	168	43.49	1	%	BS14	9.5	N	acpf	0	0.5	
20180815	1226	1	**28**	2	50.3	65	45.34	168	43.5	1	%	BS14	8.3	N	acpf			
20180815	1235	1	**29**	1	50.2	65	45.86	168	45.44	1	%	BS13.5	6.5	NNW	acpf	0	0.5	
20180815	1239	1	**29**	2	50.6	65	45.88	168	45.41	1	%	BS13.5	7.1	NNW	acpf			
20180815	1249	1	**30**	1	49.5	65	46.36	168	47.55	1	%	BS13	8.7	NW	acpf	0	0.5	
20180815	1253	1	**30**	2	49	65	46.39	168	47.49	1	%	BS13	10.7	NW	acpf			
20180815	1302	1	**31**	1	47.3	65	46.86	168	49.56	1	%	BS12.5	8.4	NW	acpf	0	0.5	
20180815	1305	1	**31**	2	47.4	65	46.93	168	49.53	1	%	BS12.5	5.8	NW	acpf			
20180815	1314	1	**32**	1	43.3	65	47.3	168	51.5	1	%	BS12	8.2	NW	acpf	0	0.5	
20180815	1318	1	**32**	2	43.2	65	47.31	168	51.5	1	%	BS12	7.3	NW	acpf			
20180815	1326	1	**33**	1	46	65	47.81	168	53.53	1	%	BS11.5	7.5	NW	acpf	0	0.5	
20180815	1330	1	**33**	2	46	65	47.83	168	53.45	1	%	BS11.5	7.1	NW	acpf			
20180815	1342	1	**34**	1	45.4	65	48.34	168	55.8	1	%	BS11	6	NW	acpf	0	0.5	
20180815	1346	1	**34**	2	44.9	65	48.37	168	55.64	1	%	BS11	5.5	NW	acpf			** END OF BS LINE WBOUND**
20180816	132	1	**35**	1	48.2	67	38.09	168	55.97	1	%	CS10	16.7	SW	kmc	0	0	** Starting CS line Ebound **
20180816	137	1	**35**	2	48	67	38.12	168	55.81	1	%	CS10	18.9	W	kmc	0	0	4 m off target
20180816	208	1	**36**	1	48.1	67	41.63	168	48.25	1	%	CS10.5	17.4	SW	kmc	0	0	
20180816	213	1	**36**	2	47.7	67	41.64	168	48.1	1	%	CS10.5	19.4	SW	kmc	0	0	
20180816	246	1	**37**	1	47.6	67	45.31	168	39.62	1	%	CS11	18.6	SW	kmc	0	0	
20180816	250	1	**37**	2	48.1	67	45.32	168	39.49	1	%	CS11	19.1	W	kmc	0	0	
20180816	324	1	**38**	1	48.7	67	48.76	168	29.77	1	%	CS11.5	18.7	W	zsc	0	0.5	
20180816	329	1	**38**	2	48.5	67	48.75	168	29.56	1	%	CS11.5	19.4	W	zsc	0	0.5	
20180616	405	1	**39**	1	54.2	67	52.47	168	18.97	0	%	CS12	17.3	SW	zsc	0	0.5	
20180816	409	1	**39**	2	53.8	67	52.47	168	18.84	0	%	CS12	16.3	W	zsc	0	0.5	
20180816	443	1	**40**	1	56.4	67	55.86	168	9.14	0	%	CS12.5	17.8	SW	zsc	0	0.5	.png not captured of data
20180816	447	1	**40**	2	56.6	67	55.87	168	9.02	0	%	CS12.5	17.9	SW	zsc	0	0.5	.png not captured of data
20180816	521	1	**41**	1	52.3	67	59.24	167	59.63	1	%	CS13	18.5	SW	zsc	0	0.5	
20180816	525	1	**41**	2	52.2	67	59.26	167	59.54	1	%	CS13	18.2	W	zsc	0	0.5	
20180816	557	1	**42**	1	51	68	2.65	167	50.3	1	%	CS13.5	21	WSW	zsc	0	0.5	Hydraulic failed on descent
20180816	602	1	**42**	2	51.2	68	2.69	167	50.17	1	%	CS13.5	21	SW	zsc	0	0.5	
20180816	637	1	**43**	1	50.5	68	6.05	167	39.97	1	%	CS14			zsc	0	1	
20180816	641	1	**43**	2	50.6	68	6.01	167	39.77	1	%	CS14	19.9	W	zsc	0	1	
20180816	710	1	**44**	1	47	68	9.02	167	31.43	1	%	CS14.5	19	SW	zsc	0	1	
20180816	714	1	**44**	2	46.7	68	9.06	167	31.35	1	%	CS14.5	19.4	SW	zsc	0	1	
20180816	747	1	**45**	1	45.9	68	12.17	167	21.82	1	%	CS15	19.9	SW	zsc	0	0.5	Heavy rolling of the ship
20180816	752	1	**45**	2	45.5	68	12.27	167	21.74	1	%	CS15	20.2	SW	zsc	0	0.5	

20180816	811	1	**46**	1	43.8	68	13.73	167	16.69	1	%	CS15.5	18.6	SW	zsc	0	0.5	
20180816	817	1	**46**	2	43.5	68	13.81	167	16.55	1	%	CS15.5	20.5	WSW	zsc	0	0.5	
20180816	833	1	**47**	1	43.3	68	15.02	167	11.95	1	%	CS16	20.5	W	zsc	0	0.5	
20180816	837	1	**47**	2	42.6	68	14.97	167	11.75	1	%	CS16	18.7	W	zsc	0	0.5	
20180816	854	1	**48**	1	38.5	68	16.68	167	7.29	1	%	CS16.5	20.3	W	zsc	0	0.5	
20180816	858	1	**48**	2	38.9	68	16.68	167	7.14	1	%	CS16.5	22.2	W	zsc	0	0.5	
20180816	915	1	**49**	1	35.8	68	18.04	167	2.58	1	%	CS17	20.1	W	acpf	0	0.5	
20180816	919	1	**49**	2	35.7	68	18.05	167	2.39	1	%	CS17	20	W	acpf			
20180816	934	1	**50**	1	31.8	68	18.9	166	57.36	1	%	CS18	19.7	W	acpf	0	0.5	
20180816	937	1	**50**	2	31	68	18.89	166	57.19	1	%	CS18	20.7	W	acpf			
20180816	952	1	**51**	1	24.7	68	19.89	166	52.19	1	%	CS19	18.1	SW	acpf	0	0.5	
20180816	955	1	**51**	2	24.9	68	19.86	166	51.98	1	%	CS19	18	SW	acpf			** END OF CS LINE Ebound**
20180816	1457	1	**52**	1	26.4	68	54.5	166	19.75	1	%	LIS1	14.7	S	acpf			** START of LIS line Wbound**
20180816	1500	1	**52**	2	26.3	68	54.54	166	19.71	1	%	LIS1	16.9	S	acpf			fog right at the coast
20180816	1516	1	**53**	1	30.2	68	54.78	166	24.94	1	%	LIS2	15.3	SW	bam	0	0.5	
20180816	1519	1	**53**	2	30.3	68	54.78	166	24.94	1	%	LIS2	14.1	SW	bam			
20180816	1536	1	**54**	1	31.9	68	55.17	166	30.36	1	%	LIS3	19.3	SW	bam	0	0.5	
20180816	1542	1	**54**	2	32.1	68	55.18	166	30.2	1	%	LIS3	18.1	SW	bam			
20180816	1606	1	**55**	1	38.6	68	55.8	166	38.22	1	%	LIS4	17.8	SW	bam	0	0.5	
20180816	1612	1	**55**	2	38.1	68	55.86	166	38.09	1	%	LIS4	18	SW	bam			
20180816	1636	1	**56**	1	43.8	68	56.35	166	46.39	1	%	LIS5	17.7	SW	bam	0	0.5	jellyfish
20180816	1641	1	**56**	2	43.5	68	56.35	166	46.26	1	%	LIS5	15.9	SW	bam			
20180816	1705	1	**57**	1	43.9	68	56.98	166	54.45	1	%	LIS6	16.6	SW	bam	0	0.7	
20180816	1710	1	**57**	2	44.5	68	57.01	166	54.32	1	%	LIS6	16.2	SW	bam			
20180816	1732	1	**58**	1	44.5	68	57.59	167	1.89	1	%	LIS6.5	16.2	SW	bam	0	0.5	cleaned vent plugs, one before, one after cast
20180816	1736	1	**58**	2	44	68	57.62	167	1.75	1	%	LIS6.5	16.4	SW	bam			
20180816	1759	1	**59**	1	44.7	68	58.15	167	9.21	1	%	LIS7	15.6	SW	bam	0	0.5	winch stopped about 3/4 way down, about 32 meters
20180816	1804	1	**59**	2	44.4	68	58.161	167	9.07	1	%	LIS7	14.7	SW	bam			
20180816	1827	1	**60**	1	44.4	68	58.78	167	16.49	1	%	LIS7.5	15.3	SW	bam	0	0	
20180816	1831	1	**60**	2	44.5	68	58.78	167	16.35	1	%	LIS7.5	13.7	SW	bam			
20180816	1854	1	**61**	1	45.1	68	59.36	167	23.96	1	%	LIS8	16.6	SW	bam	0	0.5	jellyfish on the vent plug
20180816	1858	1	**61**	2	45.1	68	59.35	167	23.82	1	%	LIS8	14.6	SW	bam			
20180816	1926	1	**62**	1	46	69	0.16	167	33.81	1	%	LIS8.5	11.4	SW	bam	0	0.5	system 1 pump exhaust pipe off on recovery
20180816	1931	1	**62**	2	46.1	69	0.15	167	33.71	1	%	LIS8.5	12.4	SW	bam			but data ok
20180816	1958	1	**63**	1	46.4	69	0.95	167	43.56	1	%	LIS9.5	11.1	SW	bam	0	0	replaced tape on cable
20180816	2002	1	**63**	2	46.6	69	0.94	167	43.56	1	%	LIS9.5	11.3	SW	bam			
20180816	2029	1	**64**	1	47.1	69	1.75	167	53.21	1	%	LIS10	10.9	W	bam	0	0	jellyfish?
20180816	2034	1	**64**	2	47.1	69	1.72	167	53.13	1	%	LIS10	11.4	W	bam			
20180816	2113	1	**65**	1	47.6	69	1.3	168	7.53	1	%	LIS11	10.2	SW	kmc	0	0.5	
20180816	2117	1	**65**	2	47.7	69	1.25	168	7.49	1	%	LIS11	8.8	SW	kmc			
20180816	2155	1	**66**	1	48.4	69	0.85	168	21.93	1	%	LIS12	12.3	SW	kmc	0	0.5	winch stopped after 30 m again
20180816	2200	1	**66**	2	48.5	69	0.83	168	21.84	1	%	LIS12	13.5	W	kmc			
20180816	2238	1	**67**	1	49.4	69	0.39	168	36.66	1	%	LIS13	8.6	SW	kmc	0	0.5	
20180816	2243	1	**67**	2	49.9	69	0.35	168	36.61	1	%	LIS13	8.8	SW	kmc			
20180816	2310	1	**68**	1	50.1	69	0.17	168	46.35	1	%	LIS14	13	SW	kmc	0	0.5	
20180816	2315	1	**68**	2	50.2	69	0.17	168	46.21	1	%	LIS14	14.2	SW	kmc			**END OF LIS LINE WBOUND**
20180816	2343	1	**69**	1	50.1	68	59.94	168	56.13	1	%	CCL22	14.4	SW	kmc	0	0.5	** START OF CCL LINE SBOUND**
20180816	2348	1	**69**	2	50.5	68	59.92	168	56.03	1	%	CCL22	13	SW	kmc			
20180817	53	1	**70**	1	50.8	68	50.05	168	56.15	1	%	CCL21	9.5	W	kmc	0	0.5	
20180817	58	1	**70**	2	51	68	50.08	168	56.17	1	%	CCL21	8.9	W	kmc			
20180817	206	1	**71**	1	50.6	68	39.99	168	56.22	1	%	CCL20	8.3	SW	kmc	0	0.5	Winch stopped in middle
20180817	211	1	**71**	2	50.3	68	40.01	168	56.28	1	%	CCL20	8.1	SW	kmc			
20180817	318	1	**72**	1	53.1	68	29.97	168	56.15	1	%	CCL19	10.9	SW	zsc	0	0.5	Winch stopped in middle
20180817	323	1	**72**	2	52.8	68	30.02	168	56.2	1	%	CCL19	10.5	SW	zsc			
20180817	433	1	**73**	1	53.7	68	20.32	168	55.87	1	%	CCL18	8.4	W	zsc	0	0.5	
20180817	438	1	**73**	2	53.9	68	20.34	168	55.75	1	%	CCL18	10.5	W	zsc			

20180817	549	1	**74**	1	55.6	68	10.29	168	56.09	0	%	CCL17	9.9	SW	zsc	0	0.5	
20180817	554	1	**74**	2	55	68	10.27	168	56.16	0	%	CCL17	9.2	W	zsc			
20180817	703	1	**75**	1	55.5	68	0.35	168	56.11	0	%	CCL16	10.7	SW	zsc	0	0.5	
20180817	708	1	**75**	2	55.2	68	0.31	168	56.06	0	%	CCL16	10.9	SW	zsc			
20180817	815	1	**76**	1	48.7	67	50.26	168	56.25	0	%	CCL15	9.4	SW	zsc	0	0.5	Winch stopped at 30 m
20180817	820	1	**76**	2	48.7	67	50.26	168	56.37	0	%	CCL15	9.8	SW	zsc			
20180817	937	1	**77**	1	48.1	67	38.63	168	56.26	0	%	CCL14	7	W	acpf	0	0	Clear visibility finally!
20180817	942	1	**77**	2	48.1	67	38.55	168	56.29	0	%	CCL14	6.7	W	acpf			
20180817	1036	1	**78**	1	47.6	67	30.13	168	55.86	1	%	CCL13	4.3	W	acpf	0	0	winch stopped at ~20 and ~30m
20180817	1041	1	**78**	2	48.1	67	30.15	168	55.64	1	%	CCL13	8.2	W	acpf			
20180817	1146	1	**79**	1	47.3	67	20.32	168	56.03	1	%	CCL12	5.8	W	acpf	0	0	winch stopped at 20m
20180817	1150	1	**79**	2	47.4	67	20.3	168	56.16	1	%	CCL12	5	W	acpf			
20180817	1254	1	**80**	1	46.3	67	10.35	168	55.73	1	%	CCL11	7.8	W	acpf	0	0	winch stopped at ~32m
20180817	1300	1	**80**	2	46.5	67	10.41	168	55.61	1	%	CCL11	7.4	W	acpf			
20180817	1409	1	**81**	1	45.6	67	0.32	168	55.74	1	%	CCL10	10.4	W	acpf	0	0	
20180817	1414	1	**81**	2	45.6	67	0.13	168	55.48	1	%	CCL10	12.1	W	acpf			
20180817	1526	1	**82**	1	42.5	66	50.11	168	55.88	1	%	CCL9	8.2	SW	bam	0	0	
20180817	1530	1	**82**	2	42.8	66	50.13	168	55.76	1	%	CCL9	9	SW	bam			
20180817	1640	1	**83**	1	40.9	66	40.4	168	56.23	1	%	CCL8	8.1	SW	bam	0		hit bottom, primary data bad on upcast
20180817	1645	1	**83**	2	41	66	40.48	168	56.42	1	%	CCL8	8.6	S	bam			
20180817	1707	1	**84**	1	44.4	66	37.9	168	56.35	1	%	CCL7.5	8.4	S	bam			After cleaning, test cast - primary data still bad
20180817	1713	1	**84**	2	43.6	66	37.99	168	56.54	1	%	CCL7.5	9.5	S	bam			
20180817	1716	1	**85**	1	43.3	66	38.05	168	56.54	1	%	CCL7.5b	10.8	S	bam			Recast without recovering - primary data still bad
20180817	1720	1	**85**	2	43.2	66	38.12	168	56.55	1	%	CCL7.5b	10.3	S	bam			
20180817	1754	1	**86**	1	44.1	66	35.54	168	56.11	1	%	CCL7	11.9	SE	bam	0	0.5	Cast after replacing Pump1. Primary data now good.
20180817	1757	1	**86**	2	43.9	66	35.59	168	56.26	1	%	CCL7	12.1	S	bam			S/N of new pump for system 1: 5T6915 3K 90741
20180817	1841	1	**87**	1	54.1	66	30.09	168	56.21	1	%	CCL6	14.4	S	bam	0	0.5	
20180817	1846	1	**87**	2	53.7	66	30.19	168	56.34	1	%	CCL6	13.7	S	bam			
20180817	1928	1	**88**	1	53.9	66	24.94	168	56.14	1	%	CCL5	17.1	S	bam	0	0.5	
20180817	1933	1	**88**	2	54.8	66	25.06	168	56.32	1	%	CCL5	15.5	S	bam			
20180817	1958	1	**89**	1	53.2	66	22.27	168	56.21	1	%	CCL4	16.1	S	bam	0	0.5	
20180817	2003	1	**89**	2	53.2	66	22.42	168	56.42	1	%	CCL4	18	S	bam			**END OF CCL LINE
20180817	2026	1	**90**	1	53.7	66	19.97	168	55.21	1	%	A3-18	15.8	S	bam	0	0.5	
20180817	2031	1	**90**	2	53.8	66	20.08	168	55.23	1	%	A3-18	18.5	S	bam			
20180817	2039	1	**91**	1	54.1	66	20.46	168	53.43	1	%	AL12.5	19.1	S	bam	0		**START OF AL LINE
20180817	2044	1	**91**	2	54	66	20.63	168	53.48	1	%	AL12.5	18.8	S	bam			
20180817	2052	1	**92**	1	52.5	66	20.55	168	51.39	1	%	AL13.5	21.9	SW	bam	0	0.5	?? Problem with station names here?? (Missing 13)
20180817	2057	1	**92**	2	52.2	66	20.7	168	51.4	1	%	AL13.5	18.6	SW	bam			
20180817	2106	1	**93**	1	52.9	66	20.98	168	49.33	1	%	AL14	20.4	S	rw	0	1	
20180817	2111	1	**93**	2	53	66	21.11	168	49.35	1	%	AL14	18.9	S	rw			
20180817	2119	1	**94**	1	53.1	66	21.32	168	47.14	1	%	AL14.5	16.5	S	kmc	0	1	
20180817	2125	1	**94**	2	53.4	66	21.45	168	47.12	1	%	AL14.5	15.8	S	kmc			
20180817	2133	1	**95**	1	45.4	66	21.74	168	45.05	1	%	AL15	16.2	S	kmc	0	1	
20180817	2138	1	**95**	2	45.3	66	21.85	168	45.09	1	%	AL15	18.4	S	kmc			
20180817	2147	1	**96**	1	50.2	66	22.095	168	42.82	1	%	AL15.5	17.9	S	kmc	0	0.5	
20180817	2152	1	**96**	2	49.9	66	22.23	168	42.87	1	%	AL15.5	18	S	kmc			
20180817	2200	1	**97**	1	55.3	66	22.48	168	40.69	1	%	AL16	19	S	kmc	0	0.5	
20180817	2205	1	**97**	2	55.2	66	22.6	168	40.73	1	%	AL16	18.9	S	kmc			
20180817	2213	1	**98**	1	54.6	66	22.8	168	38.53	1	%	AL16.5	20.1	S	kmc	0	0.5	
20180817	2219	1	**98**	2	54	66	22.92	168	38.52	1	%	AL16.5	16.5	S	kmc			
20180817	2227	1	**99**	1	53.5	66	23.2	168	36.25	1	%	AL17	20.2	S	kmc	0	0.5	
20180817	2233	1	**99**	2	53.3	66	23.35	168	36.27	1	%	AL17	20.9	S	kmc			
20180817	2241	1	**100**	1	52.1	66	23.62	168	33.75	1	%	AL17.5	20.1	S	kmc	0	1	Jellyfish (here or previous)
20180817	2247	1	**100**	2	52.3	66	23.78	168	33.8	1	%	AL17.5	21.8	S	kmc			
20180817	2254	1	**101**	1	51.2	66	23.85	168	32.07	1	%	AL18	20.5	S	kmc	0	1	
20180817	2259	1	**101**	2	51.3	66	24	168	32.08	1	%	AL18	22.4	S	kmc			

20180817	2307	1	**102**	1	51.5	66	24.24	168	29.88	1	%	AL18.5	25.2	S	kmc	0	0.5	
20180817	2312	1	**102**	2	51.6	66	24.21	168	29.9	1	%	AL18.5	22.3	S	kmc			
20180817	2320	1	**103**	1	51.8	66	24.58	168	27.73	1	%	AL19	24.1	S	kmc	0	1	Green Water
20180817	2325	1	**103**	2	52.4	66	24.73	168	27.65	1	%	AL19	25	S	kmc			
20180817	2333	1	**104**	1	50.9	66	24.95	168	25.49	1	%	AL19.5	26.6	S	kmc	0	1	
20180817	2338	1	**104**	2	50.8	66	25.11	168	25.39	1	%	AL19.5	25.1	S	kmc			
20180817	2346	1	**105**	1	50.9	66	25.32	168	23.41	1	%	AL20	27.1	S	kmc	0	1	
20180817	2351	1	**105**	2	51.1	66	25.47	168	23.28	1	%	AL20	25.2	S	kmc			
20180818	5	1	**106**	1	46.5	66	26.01	168	19.06	1	%	AL21	28.6	S	kmc	0	1	Weather picking up, skipping 0.5 stations following
20180818	11	1	**106**	2	46.9	66	26.19	168	18.92	1	%	AL21	28.6	S	kmc			
20180818	24	1	**107**	1	39.5	66	26.66	168	14.85	1	%	AL22	28.3	S	kmc	0	1	
20180818	28	1	**107**	2	39.1	66	26.78	168	14.71	1	%	AL22	27.1	S	kmc			Ended line here due to high seas
20180818	2128	1	**108**	1	43.8	65	48.44	168	56.39	0	%	BS11	30.5	S	kmc	0	1	**START OF BS LINE
20180818	2132	1	**108**	2	45.4	65	48.61	168	56.11	0	%	BS11	28.9	S	kmc			lots of birds
20180818	2144	1	**109**	1	45.2	65	47.63	168	53.93	0	%	BS11.5	21.6	S	kmc	0	1	fog further off, birds
20180818	2148	1	**109**	2	45.3	65	47.69	168	53.86	0	%	BS11.5	18.6	S	kmc			
20180818	2159	1	**110**	1	43.9	65	47.21	168	51.4	0	%	BS12	25.4	S	kmc	0	1	
20180818	2203	1	**110**	2	44.9	65	47.28	168	51.35	0	%	BS12	24.2	S	kmc			
20180818	2212	1	**111**	1	47.7	65	46.74	168	49.57	0	%	BS12.5	26.9	S	kmc	0	0.5	puffins, auklets, winch cutout
20180818	2216	1	**111**	2	48.3	65	46.89	168	49.39	0	%	BS12.5	26.1	S	kmc			
20180818	2226	1	**112**	1	49.6	65	46.24	168	47.59	0	%	BS13	27	S	kmc	0	0.5	winch cutout
20180818	2230	1	**112**	2	49.8	65	46.37	168	47.46	0	%	BS13	24.4	S	kmc			
20180818	2241	1	**113**	1	50.6	65	45.71	168	45.41	1	%	BS13.5	23	S	kmc	0	0.5	
20180818	2245	1	**113**	2	51.2	65	45.81	168	45.3	0	%	BS13.5	21.6	S	kmc			
20180818	2255	1	**114**	1	50.1	65	45.16	168	43.19	1	%	BS14	23.5	S	kmc	0	0.5	winch cutout
20180818	2300	1	**114**	2	50.4	65	45.31	168	43	1	%	BS14	23	S	kmc			
20180818	2309	1	**115**	1	49.7	65	44.74	168	41.5	1	%	BS14.5	24.3	S	kmc	0	0.5	winch cutout
20180818	2312	1	**115**	2	50.6	65	44.84	168	41.35	1	%	BS14.5	23.2	S	kmc			
20180818	2321	1	**116**	1	49.2	65	44.3	168	39.78	1	%	BS15	19.3	S	kmc	0	1	
20180818	2326	1	**116**	2	49.5	65	44.4	168	39.68	1	%	BS15	21.7	S	kmc			
20180818	2336	1	**117**	1	49.2	65	43.76	168	37.74	1	%	BS15.5	22.4	S	kmc	0	1	
20180818	2340	1	**117**	2	49.5	65	43.88	168	37.57	1	%	BS15.5	22.1	S	kmc			
20180818	2351	1	**118**	1	49.1	65	43.24	168	35.43	1	%	BS16	22.4	S	kmc	0	1	
20180818	2355	1	**118**	2	49.2	65	43.38	168	35.28	1	%	BS16	21.8	S	kmc			
20180819	6	1	**119**	1	49.7	65	42.69	168	33.34	1	%	BS16.5	22.2	S	kmc	0	1	
20180819	10	1	**119**	2	51.1	65	42.83	168	33.21	1	%	BS16.5	18	S	kmc			
20180819	21	1	**120**	1	51.9	65	42.16	168	31.2	1	%	BS17	22.4	S	kmc	0	1	lots of birds, winch cutout
20180819	26	1	**120**	2	52.2	65	42.4	168	30.93	1	%	BS17	20.3	S	kmc			
20180819	39	1	**121**	1	51.1	65	41.57	168	29.36	1	%	BS17.5	19.9	S	kmc	0	1	birds again
20180819	43	1	**121**	2	51.8	65	41.78	168	29.06	1	%	BS17.5	18.9	S	kmc			
20180819	55	1	**122**	1	51.4	65	41.08	168	27.06	1	%	BS18	19.5	S	kmc	0	1	
20180819	101	1	**122**	2	51.4	65	41.41	168	26.73	1	%	BS18	15.9	S	kmc			
20180819	113	1	**123**	1	51.2	65	40.71	168	25.27	1	%	BS18.5	21.7	S	kmc	0	1	
20180819	118	1	**123**	2	50.8	65	40.96	168	25.07	1	%	BS18.5	18.6	S	kmc			
20180819	131	1	**124**	1	49.6	65	40.25	168	23.57	1	%	BS19	18.2	S	kmc	0	1	few birds
20180819	136	1	**124**	2	49.9	65	40.49	168	23.35	1	%	BS19	18.2	S	kmc			
20180819	150	1	**125**	1	48.1	65	39.69	168	21.42	1	%	BS19.5	21.8	S	kmc	0	1	lot of birds
20180819	155	1	**125**	2	48.4	65	39.97	168	21.18	1	%	BS19.5	23.2	S	kmc			
20180819	208	1	**126**	1	46.7	65	39.16	168	19.46	1	%	BS20	22.8	S	kmc	0	1	
20180819	213	1	**126**	2	46.7	65	39.42	168	19.33	0	%	BS20	22.3	S	kmc			
20180819	227	1	**127**	1	43.8	65	38.79	168	16.91	1	%	BS20.5	26	S	kmc	0	1	
20180819	231	1	**127**	2	43.6	65	38.96	168	16.9	1	%	BS20.5	25	S	kmc			
20180819	245	1	**128**	1	39.7	65	38.48	168	14.92	1	%	BS21	23.9	S	kmc	0	1	
20180819	249	1	**128**	2	40.1	65	38.76	168	14.85	1	%	BS21	26.2	S	kmc			
20180819	307	1	**129**	1	36.1	65	37.87	168	12.67	1	%	BS21.5	23.4	S	kmc	0	1	
20180819	310	1	**129**	2	36.4	65	38.07	168	12.61	1	%	BS21.5	26.1	S	kmc			

20180819	327	1	**130**	1	29.8	65	37.13	168	10.44	1	%	BS22	26.2	S	kmc	0	1	skip BS23
20180819	330	1	**130**	2	29.9	65	37.25	168	10.44	1	%	BS22	25	S	kmc			
20180819	409	1	**131**	1	25	65	34.81	168	6.98	1	%	BS24	25.9	S	zsc	0	1	
20180819	412	1	**131**	2	24.8	65	34.9	168	7.11	1	%	BS24	26.6	S	zsc			**END OF BS LINE**
20180819	424	1	**132**	1	33.6	65	34.3	168	9.66	1	%	SBS1.5	25.5	S	zsc	0	1	** START OF SBS LINE**
20180819	427	1	**132**	2	33.3	65	34.43	168	9.9	1	%	SBS1.5	22.2	S	zsc			
20180819	438	1	**133**	1	36.2	65	33.78	168	12.14	1	%	SBS2	27	S	zsc	0	1	C2 vent plug found blocked on recovery, but data ok, Plug cleared
20180819	443	1	**133**	2	37.9	65	34.03	168	12.63	1	%	SBS2	26.7	S	zsc			difficult to lower below 30m due to current
20180819	455	1	**134**	1	40.1	65	33.32	168	14.4	1	%	SBS2.5	22.2	SE	zsc	0	1	difficult to lower below 30m due to current
20180819	500	1	**134**	2	40.5	65	33.57	168	14.94	1	%	SBS2.5	21.4	S	zsc			
20180819	512	1	**135**	1	41.5	65	32.79	168	16.72	1	%	SBS3	24.7	S	zsc	0	0.5	winch out at 30 m
20180819	517	1	**135**	2	42.1	65	33.03	168	17.26	1	%	SBS3	21.1	S	zsc			Strong current from SBS1.5 to SBS3
20180819	529	1	**136**	1	44.2	65	32.31	168	18.97	1	%	SBS3.5	22	SE	zsc	0	0.5	
20180819	534	1	**136**	2	44.4	65	32.32	168	19.07	1	%	SBS3.5	23.5	S	zsc			
20180819	544	1	**137**	1	46	65	31.81	168	21.5	1	%	SBS4	22.1	S	zsc	0	0.5	
20180819	549	1	**137**	2	50.8	65	31.94	168	21.66	1	%	SBS4	20	S	zsc			
20180819	600	1	**138**	1	52.5	65	31.31	168	23.9	1	%	SBS4.5	21.4	S	zsc	0	0.5	
20180819	606	1	**138**	2	50.8	65	31.5	168	24.1	1	%	SBS4.5	21.8	S	zsc			
20180819	617	1	**139**	1	56.4	65	30.83	168	26.38	1	%	SBS5	21.7	S	zsc	0	0.5	
20180819	622	1	**139**	2	57	65	30.99	168	26.6	1	%	SBS5	22.3	S	zsc			
20180819	633	1	**140**	1	57	65	30.34	168	28.8	1	%	SBS5.5	24.5	S	zsc	0	0.75	
20180819	638	1	**140**	2	58	65	30.53	168	28.08	1	%	SBS5.5	22.4	S	zsc			
20180819	650	1	**141**	1	58.5	65	29.97	168	31.32	1	%	SBS6	22.3	S	zsc	0	0.5	winch cut out at 20 m
20180819	655	1	**141**	2	58.5	65	30.04	168	31.6	1	%	SBS6	20.6	S	zsc			
20180819	705	1	**142**	1	53	65	29.4	168	33.78	1	%	SBS6.5	23	S	zsc	0	0.75	
20180819	710	1	**142**	2	53.1	65	29.54	168	33.97	1	%	SBS6.5	20	S	zsc			**END OF SBS LINE**