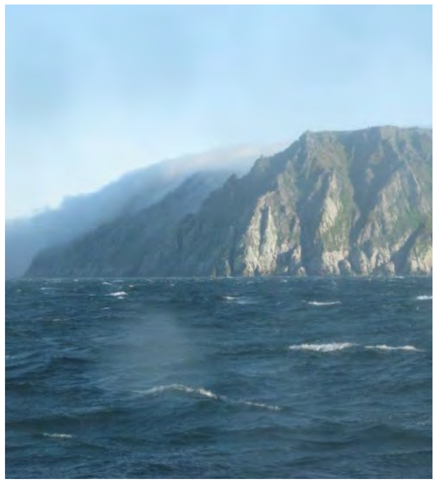
BERING STRAIT NORSEMAN II 2017 MOORING CRUISE REPORT

Research Vessel Norseman II, Norseman Maritime Charters

Nome-Nome, 7th July to 15th July 2017

Rebecca Woodgate, University of Washington (UW), *woodgate@apl.washington.edu*
and the Bering Strait 2017 Science Team

Funding from NSF Arctic Observing Network Program PLR-1304052



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(Left: Norseman II, from www.norsemanmartime.com. Right: Little Diomede Island, R Woodgate)

As part of the Bering Strait project funded by NSF-AON (Arctic Observing Network), in July 2017 a team of US scientists undertook a ~ 8 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 2016 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).

5) deployment of an autonomous glider in the southern Chukchi Sea (Statscewich).

6) deployment of two IABP (International Arctic Buoy Program) drifters (Rigor)

The cruise loaded and offloaded in Nome, Alaska.

Key Preliminary results

As discussed below (p.67)**, the mooring data show some remarkable changes this year, viz.:**
(i) a remarkably warm June (~ 3°C warmer than climatology);
(ii) remarkably early arrival of warm water in the strait in spring/summer 2017 (in hourly data, ~ 15 days earlier than in any prior recorded year and ~ 1 month earlier than the average);
(iii) very late departure of warm waters from the strait in late 2016 (in hourly data, more than 20 days later than any prior recorded year);
(iv) anomalously fresh waters in winter (~1psu low in winter, ~0.5psu low in the annual mean);
(v) a record maximum freshwater flux in 2016, of ~ 3500km^3/yr (relative to 34.8psu);
(vi) record high northward flows in fall 2016 (in 30-day smoothed data).

Key Statistics: 3 moorings recovered, 3 moorings deployed, 342 CTD casts on 19 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 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. Understanding the processes setting these fluxes is vital to prediction of future change in this region and likely in the Arctic and beyond.

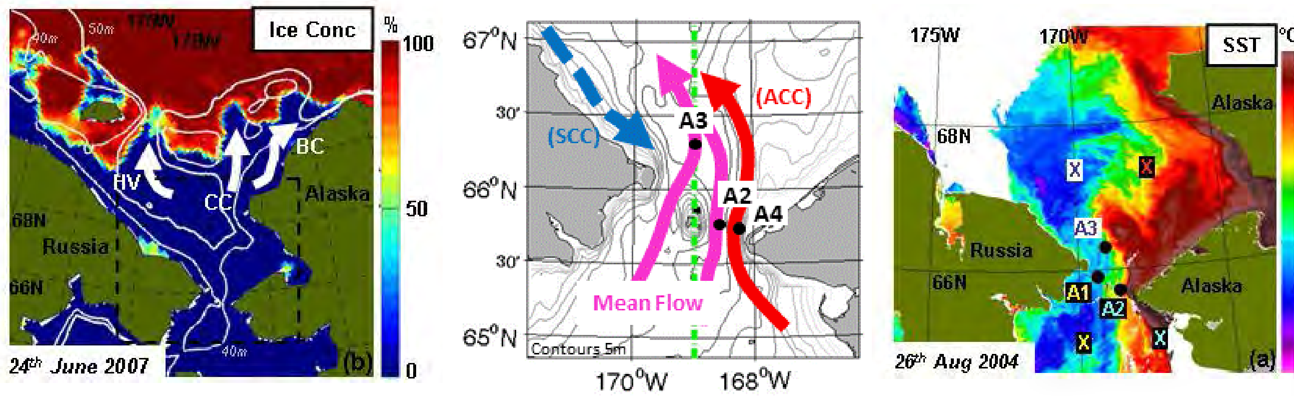


Figure 1: (Left) *Chukchi Sea ice concentration (AMSR-E) with schematic topography. White arrows mark three main water pathways melting back the ice edge [Woodgate et al., 2010].*
(Middle) *Detail of the Bering Strait, with schematic flows and mooring locations (black dots – A2, A3, A4). The main northward 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, seen 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.*, 2015a] . 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], and assess the strong contribution of the Alaskan Coastal Current (ACC) to the fluxes through the strait [*Woodgate and Aagaard*, 2005]. 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]. While ~ 1/3rd of this change is attributable to weaker local winds, 2/3rds appears to be driven by basin-scale changes between the Pacific and the Arctic. Remote data (winds, SST) prove insufficient for quantifying variability, indicating interannual change can still only be assessed by in situ year-round measurements [*Woodgate et al.*, 2012]. Indeed, data from 2012 indicate a surprisingly low flow year. Updating of fluxes to 2015 shows a continuation of the increasing transport trend, and suggests a strong control from far-field forcing, as opposed to local wind forcing.

The work to be accomplished on this cruise will extend this mooring time-series to mid-2018.

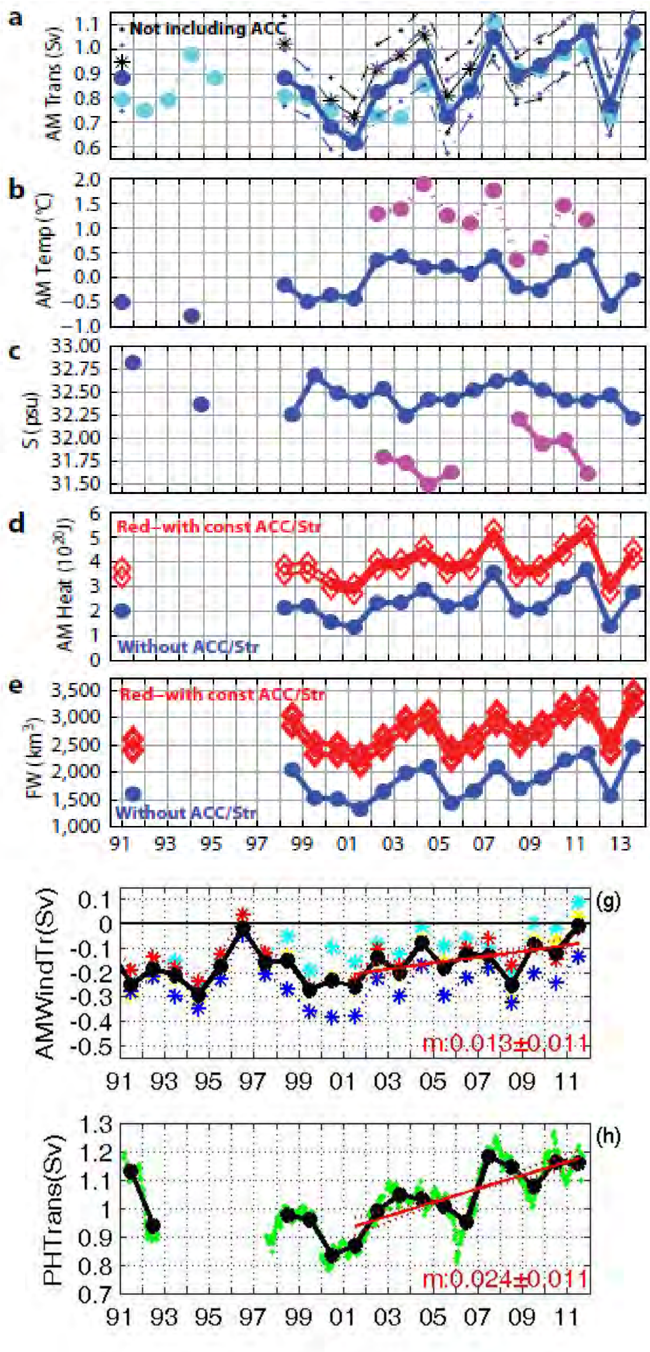


Figure 2, adapted from [Woodgate et al., 2012; Woodgate et al., 2015a]

a) *transport calculated from A3 (blue) or A2 (cyan), with error bars (dashed) calculated from variability; including adjustments estimated from 2007-2009 Acoustic Doppler Current Profiler data for 6-12m changes in instrument depth (black);*

b) *near-bottom temperatures from A3 (blue) and A4 (magenta-dashed);*

c) *salinities from A3 (blue) and A4 (magenta);*

d) *heat fluxes: blue - from A3 only; red – including ACC correction (1×10^{20}J) and contributions from surface layer of 10m (lower bound) or 20m (upper bound) at SST, with black x indicate heat added from 20m surface layer;*

e) *freshwater fluxes: blue – from A3 only; red – including 800-1000km^3 (lower and upper bounds) correction for stratification and ACC;*

g) *to 2011, transport attributable to NCEP wind (heading 330º, i.e., northwestward) at each of 4 points (coloured X in Figure 1) and the average thereof (black); and*

h) *to 2011, transport attributable to the pressure-head term from the annual (black) or weekly (green) fits.*

*Uncertainties are order 10-20%. Red lines on **(g)** and **(h)** indicate best fit for 2001-2011 (trends=m±error, in Sv/yr, error being the 95% confidence limit from a 1-sided Student's t-test).*

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.*, 2015a].

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; 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 measure of integrated change in the Bering Sea, and an indicator of the role of Pacific Waters in the Arctic Ocean.

2017 CRUISE SUMMARY:

Although weather on the 2017 cruise was anomalous, with a long (4-day) period of southward winds early in the cruise, overall the cruise was less stormy and foggy than in previous years. This clearly contributed to the cruise success, with all mooring operations going smoothly, and, due to the very efficient CTD operations of the Norseman II and the smallness of the CTD package, which allowed us to continue working in 5-6ft seas, a total of 324 CTD casts taken on 19 CTD lines (5 repeated).

Cruise onload started ~ 10am on Friday 7th July 2017 and was completed within 1-2hrs. We delayed sailing until 3:20pm to allow for instrument set up and tie down before sailing into stormy seas and a poor forecast ("small craft advisory" and 6-8ft seas for the strait). However, on arrival in the strait on Sat 8th July early am, we found the forecast was significantly wrong, and seas were almost calm.

These favorable weather conditions allowed a prompt start to the mooring work on Saturday 8th July 2017. Following pre-recovery CTD casts at each site immediately prior to recovery, moorings A2 and A4 were successfully recovered without major incident, with the iscat also being recovered from mooring A2. Biofouling was fairly extreme, especially on mooring A2. Clean-up was undertaken on the ~ 3.5 hr steam to mooring site A3, except for on the temperature-salinity sensors, which were placed in a dedicated calibration tank after recovery for ~ 10hrs to allow for an additional check on end-of-deployment salinities.

Arriving at site A3 ~ 1pm, we performed a pre-recovery CTD cast and then successfully recovered mooring A3, also without incident. Postponing mooring clean up, we then prepared and redeployed mooring A3, took a post-deployment CTD cast and steamed south again to the other mooring positions, cleaning the remaining recovered instruments. Mooring A2 was redeployed that evening (Sat 8th July), still in remarkably calm seas.

Overnight, after a post-deployment CTD cast at A2, we steamed an underway/marine mammal/bird survey west to Little Diomede, south to Fairway Rock, northeast back to Wales, west along the BS line back to Little Diomede, and finally from CTD site BS11 back east to the shallows off Wales via mooring site A4.

In the morning of Sunday 9th July 2017, continued good weather allowed for a smooth deployment of A4 (and subsequent post-deployment CTD cast) and then we steamed to CTD station BS24 (east end of the BS line) to start the supporting CTD sections by ~ 1030am. We completed the high resolution BS line by midafternoon and started working the high resolution eddy survey lines (DL, DLa and DLb) north of the Diomede islands, and as the winds and seas started to rise, continued CTDing north (at 1.3nm resolution, higher than in previous years) to A3 and then along the A3 line (again at higher than usual resolution, now 0.9nm resolution) into the morning of Monday 10th July 2017. By the northern half of the DL line (DL12+) winds were frequently greater than 20knots with building seas and frequent fog.

Although a glider deployment had been planned for the end of the A3L line, on arrival at the end of the CTD section on the morning of Monday 10th July 2017 it was obvious that sea-state and visibility were too poor for safe retrieval of the glider were it to malfunction on deployment. During the day, we steamed north into 10-12ft seas to the west end of the CS line (also a DBO site), eventually postponing the glider deployment until later in the cruise.

CTDing the CS line was started just after midnight Monday 10th July/Tues 11th July, still in significant seas and winds. While the coast offered some modest protection to the eastern end of these lines, CTD sections CS and subsequently CD were run still with significantly high seas and winds through to Tuesday 11th July afternoon. After a short (2hr) steam up the coast, the Lis CTD line was started in much the same wind and sea state late Tuesday 11th July afternoon. Only ~ half way through the line ~ midnight did the winds start to abate. The Lis line was completed ~ 2am Wednesday 12th July, a drifting buoying was deployed for the IABP (International Arctic Buoy Program)at site CCL22n, and the CCL line (running south) was started in increasingly calmer weather, with another buoy being deployed at CCL16.

Completing the CCL line at A3 took until ~ 10:30pm on Wednesday 12th July. During this section, winds dropped to ~ 5knots, and sea state was almost flat. Whales were observed in great number around and between stations CCL11 and 10, as well as large number of comb jellies in the surface waters, the latter being common for the rest of the cruise, but previously unobserved on our cruises, possibly due to worse sea-state or colder waters in previous years, or environmental change.

A rerun (at the new high resolution, 0.9nm) of A3L line, back towards the preferred glider deployment site, took till morning on Thursday 13th July and, after the addition of small underway survey of the Alaskan Coastal Current at this site, put us on target for the glider deployment at ~ 8:30am. Test dives of the glider all went smoothly, and after a deployment CTD cast, we left the glider to perform its tasks and we steamed back to the west to complete the final CTD sections of the cruise, viz a survey within the strait - the NNBS line (run west to east), the NBS line (run west to east), the MBS line (run west to east), each separated by an underway crossing of the strait to give spatial surface information. By ~ 3:30am on Friday, these were complete and we commenced a repeat of the eddy survey behind the Diomede Islands, and a final rerun of the high resolution Bering Strait line (run now west to east). A fair weather forecast for the steam south allowed us also to complete (at high resolution) the comparatively new line just south of the strait, before turning for Nome ~ 12:45am on the morning of Saturday 15th July 2017.

A calm transit, going between Sledge Island and the coast, brought us to Nome on time for a noon arrival on Saturday 15th July 2017. The ship tied by by 12:30pm (behind the Oshoro Maro a Japanese research vessel, and NOAA's vessel, the Fairweather), and off-load was mostly completely within 1-2hrs. We took air cargo to Northern Air Cargo (the glider) and Alaska Air (the CTD), and completed the offload and left the ship by ~ 3:30pm.

The anomalous southward winds during the cruise will make analysis of the CTD sections particularly interesting. We ask also if the seemingly unusual ubiquity of comb jellies is also remarkable for the strait.

As discussed below (p.67)**, the mooring data show some remarkable changes this year, viz.:**
(i) a remarkably warm June (~ 3°C warmer than climatology);
(ii) remarkably early arrival of warm water in the strait in spring/summer 2017 (in hourly data, ~ 15 days earlier than in any prior recorded year and ~ 1 month earlier than the average);
(iii) very late departure of warm waters from the strait in late 2016 (in hourly data, more than 20 days later than any prior recorded year);
(iv) anomalously fresh waters in winter (~1psu low in winter, ~0.5psu low in the annual mean);
(v) a record maximum freshwater flux in 2016, of ~ 3500km^3/yr (relative to 34.8psu);
(vi) record high northward flows in fall 2016 (in 30-day smoothed data).

Discussions prior to the cruise established that the Quintillion project was successful in laying their cable throughout the Chukchi Sea last summer. Although at the time of writing, it is still unclear where the cable lies on the surface of the sea floor and where it is buried, we established that only in few places is the reported cable position within 300m of our operations (viz, by CD14, a station we omitted this year; by Lis 9, which we replaced with 2 stations either side of the original position; and by our new station AL17.5, which we adjusted to be away from the cable). Subsequent studies in the area should however always be alert to the possibility of conflict.

Overall, the cruise accomplished the most extensive quasi-synoptic spatial survey of the southern Chukchi Sea in recent times. Similar (though less extensive surveys were taken in 2011 and 2012 from the Khromov [*Woodgate and RUSALCA11ScienceTeam*, 2011; *Woodgate and RUSALCA12ScienceTeam*, 2012] and in 2013, 2014, 2015, 2016 from the Norseman II [*Woodgate and BeringStrait2013ScienceTeam*, 2013; *Woodgate et al.*, 2014; *Woodgate et al.*, 2015b; *Woodgate et al.*, 2016]. Prior to that the last extensive surveys were in 2003 and 2004 from the Alpha Helix [*Woodgate*, 2003; *Woodgate*, 2004]). Our 2017 cruise accomplished more stations due to a combination of extremely efficient CTD operations (including taking profiles only, no bottles, and the high winch speed ~ 0.7m/s); the early completion of the mooring work; the ability to work in rough seas, and the lack of a more significant storm. In addition to a large scale water mass survey of the region, the repeat of several lines (and several stations) during this or subsequent cruises this year will allow for quantification of temporal variability.

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 southward wind conditions) and at the end of the cruise, under calm/northward wind conditions.

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

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

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

CD *(Cape Dyer)* (US waters) - a line new in 2016, running west-east towards the Alaskan Coast, midway between Point Hope and Cape Lisburne, set just south of some apparent topographic irregularities, also to chart the Alaskan Coastal Current transformation on its route along the Alaskan Coast. Note that due to the new Quintillion sea floor communications cable put in place in summer 2016, the westmost station on this section (CD14) was not taken this year.

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, and 2016 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 was 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, and 2016), typically incorporating a rerun of the high resolution DL line at the southern end, but this year ending at A3 to allow a rerunning 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) repeated at the higher (0.85nm) resolution.

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

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

MBS *(Mid Bering Strait)* – an east-west cross-strait line ~ 10nm N of the Bering Strait line, run in previous years, with ~ 1.7nm resolution, with higher resolution near the coast.

DLb, DLa and DL lines repeated.

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

SBS – a line new in 2014, run only once previously and then 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).

Prior lines not run this cruise

NPH *(North Point Hope)* (US waters) - a new line in 2016, crossing from north of Point Hope to the WNW, at 1.25nm spacing near the coast, and 2.5nm spacing after NPH5, to chart the Alaskan Coastal Current transformation on its route along the Alaskan Coast. This was not run this cruise.

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:

- from A2, west to Little Diomede, south past Little Diomede, southeast to Fairway Rock, northeast to BS22, west along BS to BS11, east back to A4 continuing on to the shallows, before returning to A4 for mooring deployment;

- from eastern end of extended A3L to AS1 and along AS1 to CS10 after the first running of the A3L line near the start of the cruise;

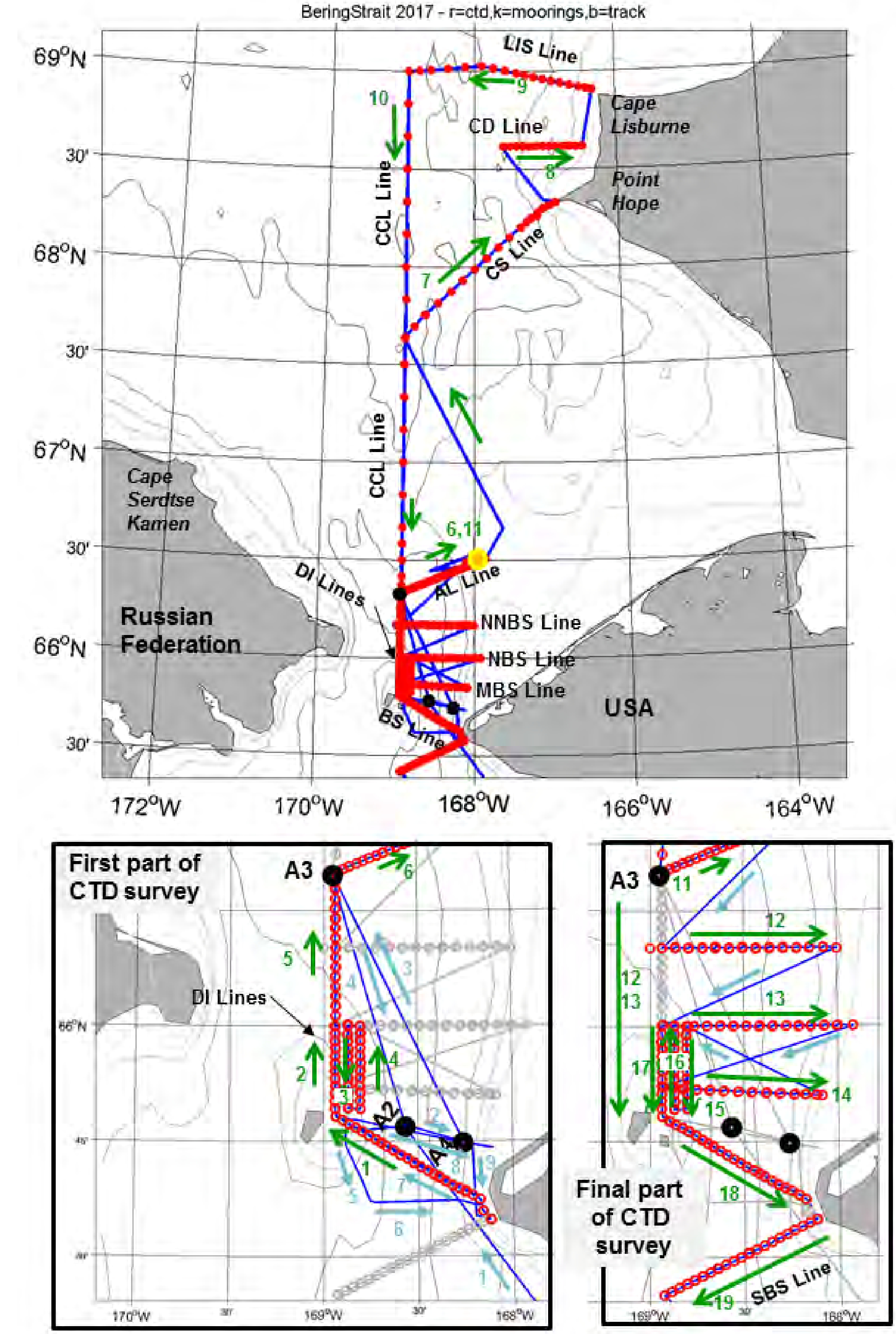
- from the eastern end of extended A3L northwest 4miles, southwest ~ 14nm parallel to the A3L line, but ~ 2.5nm north of it, to map the ACC.

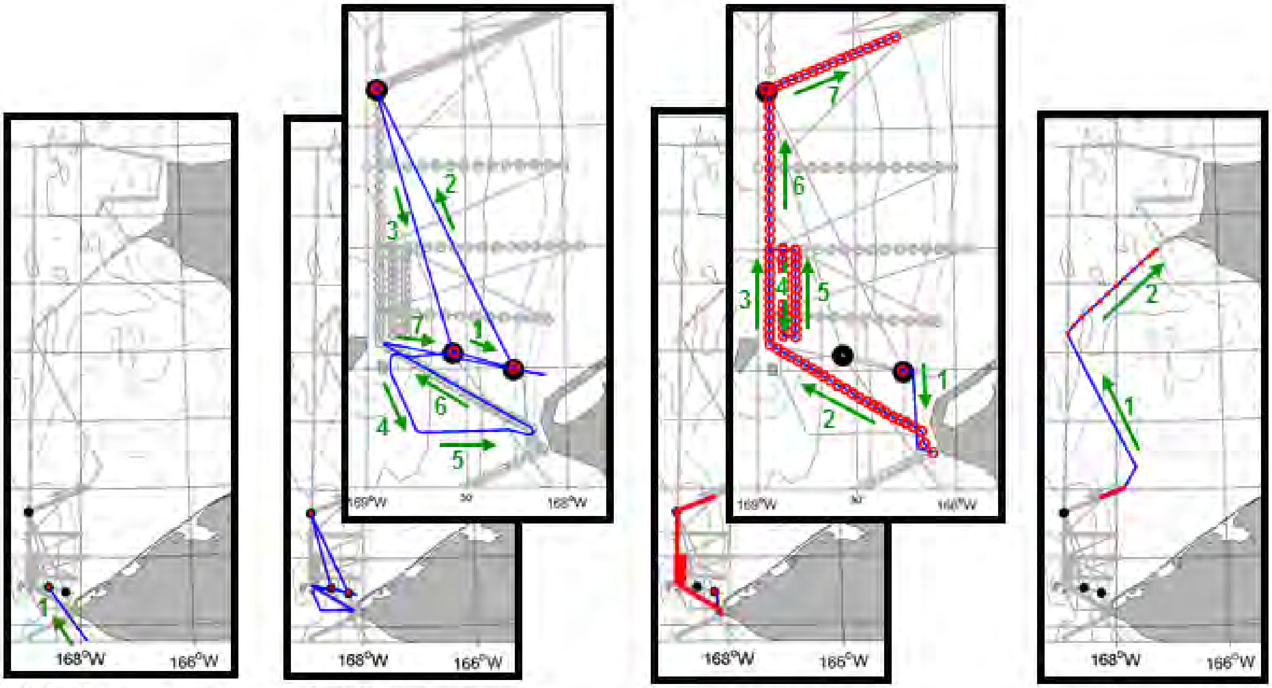
In addition, several transits between lines in the strait region (A3L, NNBS, NBS, MBS) were chosen to cross the strait rather than go along the strait, so as to allow a better mapping of the region.

See maps for details of these lines.

Contents

BERING STRAIT 2017 MOORING CRUISE MAP: *Ship-track, blue. Mooring sites, black. CTD stations, red. Glider deployment site, yellow. Arrows indicate direction of travel (on inset below, blue during mooring operations before CTD survey, green during CTD survey). 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.)*





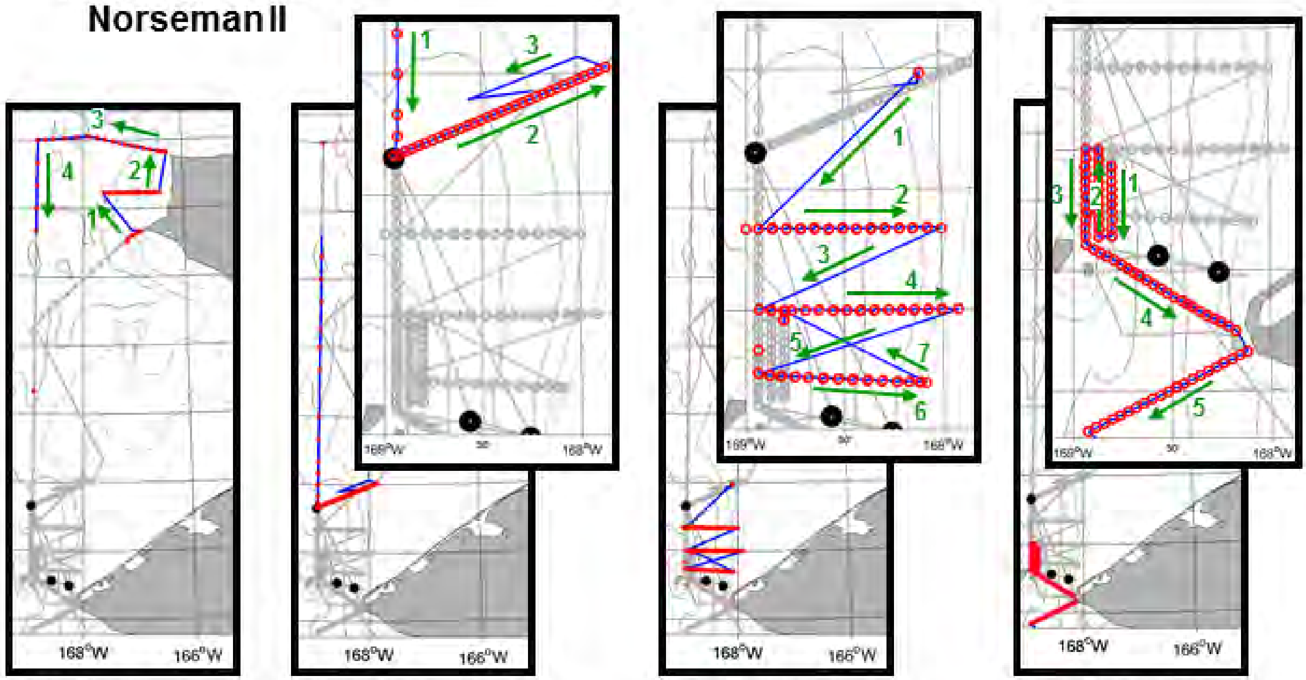
Day 1 *(local time)*
0800 7th July 2017
- 0800 8th July 2017

Day 2 *(local time)*
0800 8th July 2017
- 0800 9th July 2017

Day 3 *(local time)*
0800 9th July 2017
- 0800 10th July 2017

Day 4 *(local time)*
0800 10th July 2017
- 0800 11th July 2017

Bering Strait 2017 Mooring Cruise Norseman II



Day 5 *(local time)*
0800 11th July 2017
- 0800 12th July 2017

Day 6 *(local time)*
0800 12th July 2017
- 0800 13th July 2017

Day 7 *(local time)*
0800 13th July 2017
- 0800 14th July 2017

Day 8 *(local time)*
0800 14th July 2017
- 0800 15th July 2017

BERING STRAIT 2017 SCIENCE PARTICIPANTS

1.	Rebecca Woodgate (F)	UW	*Chief Scientist and UW PI*
2.	Jim Johnson (M)	UW	*UW Mooring lead*
3.	Cecilia Peralta Ferriz (F)	UW	*UW CTD lead*
4.	Kate Stafford (F)	UW	*UW PI (Marine Mammal Acoustics + Observer)*
5.	Erica Escajeda (F)	UW	*UW grad student (Marine Mammal and CTD assist)*
6.	Divya Panicker (F)	UW	*UW grad student (Marine Mammal and CTD assist)*
7.	Brita Irving (F)	UAF	*UAF oceanography technician, Glider and CTD assist*

UW – University of Washington, US UAF – University of Alaska, Fairbanks, US

Cabin Allocations:
main deck: C4-Johnson;
lower deck: C5-Escajeda, Panicker; C7-Stafford & Irving; C8-Woodgate, Peralta-Ferriz

BERING STRAIT 2017 NORSEMAN II CREW

1.	Mike Hastings (M)	NMC	*Captain*
2.	Jeff Rogers (M)	NMC	*Mate*
3.	Kevin Worthington (M)	NMC	*Chief Engineer*
4.	Jim Wells (M)	NMC	*Deck Boss*
5.	Tommy Reimer (M)	NMC	*Deck Hand*
6.	Luke Johnston (M)	NMC	*Deck Hand*
7.	Jeremy Whaley (M)	NMC	*Deck Hand*
8.	Dan Hill (M)	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 2017 CRUISE SCHEDULE (Times: Alaskan Daylight Time (GMT-8), 24hr format)

Spring 2017 to cruise	*Arrangement of charter of Norseman II by NSF and others for the Bering Strait mooring work*
Mid April 2017	*UW visits N2 in Seattle, to test CTD cable*
End of April 2017	*Shipment of container of UW equipment to Nome, ETA mid-June*
Monday 3rd July 2017 *(Cold, windy)*	*Some of UW science team (Rebecca, Jim) arrive Nome*
Tuesday 4th July 2017 *(Overcast, calm)*	*UW Instrument preparation (extract and start instruments)*
Wednesday 5th July 2017 *(Overcast, light wind)*	*UW Instrument preparation (build ISCATs, ADCPs)* *Restuff container. Rest of science team arrive on evening flight*
Thursday 6th July 2017 *(Windy)*	*Ship off Nome, waiting for weather to come to dock* *CTD training session in Aurora Inn (for ship's CTD operations and for new test tank setup)* *Emails with Quintillion re cable location* *Ship comes in pm, but goes out again as too many waves at dock*
Friday 7th July 2017 *(Moderate wind and waves)*	*Ship ties up am* Science team due at ship at 1000, arrives at 0930 Flat and container arrive ~ 1000, Load 1015, all done by 1145 Secure for sea. Sail 1520, steaming for strait into poor forecast Start underway systems, do safety brief, test cast CTD 2 runs to test SBE calibration tank Discussion of mooring operations with captain and crew Run underway temperature and salinity (TS) and ADCP lines through the night, arrive A2 in early am
Saturday 8th July 2017 *(Forecast "Small Craft Advisory", but actually < 10knots from N)*	Arrive on site at A2-16 ~ 0700 0720 A2-16 pre-recovery CTD 0734 Start **A2-16 mooring recovery** drift, all on deck by 0755 Steam to A4-16 0849 A4-16 pre-recovery CTD 0902 Start **A4-16 mooring recovery** drift, all on deck by 0913 Clean up recovered moorings while steaming to A3-16 1245 A3-16 pre-recovery CTD 1307 Start **A3-16 mooring recovery** drift, all on deck by 1324 Prep A3-17 deployment 1545 Start **A3-17 deployment**, anchor dropped 1558

1608 A3-17 post-deployment CTD
Complete clean up as steaming to A2-17
2020 Start **A2-17 deployment**, anchor dropped 2040
Run bird/mammal observing + underway TS and ADCP lines
through night (west to Little Diomede; south to Fairway Rock; NE to end of BS22; west along BS to BS11; east to A4 and continuing to shallows and returning to A4 for morning)

Sunday 9th July 2017
(wind and seas picking up, winds from north)

0730 Prep A4-17 deployment
0820 Start **A4-17 deployment**, anchor dropped 0837
0852 A4-17 post-deployment CTD
Transit to BS24 to start CTD lines
1024 Start **BS line** running west (BS24-BS11 with 0.5s)
1458 Finish BS line
1506 Start **DLS line** running north (DL1-12)
1721 Finish DLS line
1734 Start **DLa line** running south (DLa12-DLa1)
1941 Finish DLa line
1953 Start **DLb line** running north (DLb1-DLB12)
2227 Finish DLb line
2253 Start **DLN line** running north (DL12-DL19.5 with half stations)

Monday 10th July 2017
(Rough and winds > 20 knots, seas building, winds from north)

0311 Finish DLN line
0325 Start extended and new high resolution **A3L line**
running northeast (AL3, AL12.5 - AL27.5)
1017 Finish extended A3L line
Postpone glider deployment due to 10-12ft seas and fog
Steam to AS1 and north along AS to CS10US

Tuesday 11th July 2017
(still stormy 15-25 knots, still from north)

0002 Start **CS line** running northeast
0915 Finish CS line
1202 Start **CD line** running east (CD13-CD1) (Skip CD14)
1622 Finish CD line
Steam up to Cape Lisburne initially in shadow, but getting windier
1832 Start **LIS line** running west (Skip Lis9; add Lis8.5, 9.5).

Wednesday 12th July 2017
(winds abating, and turn to from South by afternoon)

0227 Finish LIS line
0252 Start **CCL line** running south (without 0.5s)
0252 Drop IABP buoy for I Rigor
1012 Drop IABP buoy for I Rigor
(CCL11 and CCL10 - many whales)
2239 Finish CCL line at A3
2251 Start **A3L line** at high resolution running eastnortheastward

Thursday 13th July 2017
(Light winds from S, flat seas)

0439 Finish extended A3L line
Steam underway box, returning to AI24 for glider
0830 Glider deployment
0939 Glider deployment CTD cast.
Steam southwest to NNSB1

1247 Start **NNBS line** running eastward
1638 Finish NNBS line
Steam southwest to NBS1
1923 Start **NBS line** running eastward
2322 Finish NBS line
Steam southwest to MBS1

Friday 14th July 2017
(Light winds from S, flat seas)

0218 Start **MBS line** running eastward
0535 Finish MBS
Steam northnorthwest to DLb12
0739 Start **DLb line** running south
1001 Finish DLb line
1013 Start **DLa line** running north
1223 Finish DLa line
1249 Start **DL line** running south
1512 Finish DL line
1520 Start **BS line** running east
1953 Finish BS line at BS22
Steam to SBS line
2017 Start **SBS line** running southwest

Saturday 15th July 2017
(Light winds)

0041 Finish SBS line and steam for Nome
1203 Arrive Port of Nome
1230 Tied up in Nome, start offload and runs to Air Cargo
1430 Offload mostly completed, wait for Air Cargo
1530 Science Party leave ship.
Evening - Most of Science Party flies to Anchorage

Sunday 16th July 2017

Science party returns to Seattle, etc.

<u>Bering Strait 2017 Mooring cruise TOTALS</u>

7.9 days at sea (away from Nome) ***1520 7th July – 1230 15th July 2017***
8.2 days on ship (including on/offload) ***1000 7th July – 1530 15th July 2017***

Moorings recovered/ deployed: ***3/3***
CTD casts: ***342 (including 2 test casts and 2 recasts)***

SCIENCE COMPONENTS OF CRUISE

The cruise comprised of the following science components:

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

- **CTD operations -** 342 casts on 19 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 all deployed moorings carried Marine Mammal Acoustic Recorders from Kate Stafford, UW.

- **Marine Mammal Bridge Observations (Bridge watch)**

From 0700 to 2300, when visibility was greater than 1 nautical mile, sea state was less than a Beaufort 6 and ship speed was greater than 5 knots, a marine mammal watch was maintained on the bridge, by Kate Stafford, UW and her team.

- **Glider Deployment**

Cruise participant Brita Irving deployed a Slocum Glider as part of an AOOS project for Peter Winsor (UAF), Kate Stafford (UW) and Mark Baumgartner (WHOI)

- **IABP Buoy Deployments**

Two IABP (International Arctic Buoy Program) buoys, measuring temperature (air and seawater), pressure and position were launched during the cruise for Ignatius Rigor (UW).

MOORING OPERATIONS (Woodgate, Johnson, 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.*, 2015a; *Woodgate*, submitted], with 2012 being a year of low flow, but 2013, 2014 and 2015 returning to higher flow conditions [*Woodgate*, 2015; *Woodgate et al.*, 2015a; *Woodgate*, submitted]. The data recovered this cruise will indicate if 2016 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 – A2-16, A4-16, A3-16) were deployed from the Norseman II in July 2016, with mooring funding from NSF-AON (PI: Woodgate and Heimbach, *PLR1304052*).

Three UW moorings (A3-17, A2-17, A4-17) were deployed on this 2017 Norseman II cruise under funding from the same NSF-AON grant (PI: Woodgate and Heimbach, *PLR1304052*). 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.*, 2015a; *Woodgate*, submitted].

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 three new moorings 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*, submitted]. 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, 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, an on-deck calibration tank was also established for recovered instruments. This is discussed below.

2017 Recoveries and Deployments: Mooring operations mostly went smoothly in 2017.

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.**

For the first mooring, A2-16, although the first mooring release (#32833) acoustically confirmed release, the mooring did not surface. Thus the second release (#32044) was activated and the mooring was sighted immediately. On deck the first release was found to have turned, but the hook was somehow jammed (despite having a spring), but freed up with some minor manipulation on deck. **Action item: Investigate mechanism of #32833 for jamming.**

For the second mooring, A4-16, the first mooring release (#32834) acoustically confirmed release and the mooring was sighted almost immediately.

For the third mooring, A3-16, the first mooring release (#32046) replied to the release code with 2s pings, indicating it had not released, thus the second release (#32831) was activated, and the mooring was sighted almost immediately. On deck, the first release (#32046) was found to be still locked, but unlocked when sent the release command. While we cannot rule out definitely that the disable code was sent by mistake (the reply would be the same), this is the third time releases have replied at 2s to the release code while in the water. **Action item: Investigate #32046 for cold test or other failure.**

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 (although it was insufficient to release the mooring for A2-16), 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 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 Captain and crew of the Norseman II are astoundingly good at catching the mooring on the first approach. 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 A2-16 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 the mild sea states of last year's recoveries were enough to mask the top float on the radar. 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 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 these 2017 recoveries (of 2016 moorings) A2-16 was the most heavily fouled, with A4-16 and A3-16 being both less fouled. Fouling was mostly by barnacles, up to 1inch+long in places with some bryozoan-like growth on several parts of the moorings. Three previously unnoticed life forms were also found on A4-16 - some form of worm cast; an unidentified brown gelatinous mass; and a white gelatinous growth, likely tunicates. Overall though, release hooks were generally clear of biofouling, and, salinity cells were clear of biological growth.

In contrast to 2016, when significant damage (hypothesized ice damage) was found on the moorings, in 2017 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 knots) 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. (On mooring A3-17, the iscat tether was dropped from the deck before it was completely unwound, and thus it had to be recovered (by hand), untangled, and redeployed.) **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.** 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. These positions match to within 30-60m of the ship's measurements of the GPS of the aft A-frame. **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 assisting with tending the quick release lines during lifting. The lines were passed off to the crew on the dog runs prior to deployment.

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. **Action item: Check new laptops with all instrumentation. Purchase new downloading laptop, and install also navigation software. Check all laptops have dedicated power supplies**. Iscat housings and ADCP frames were assembled using a group of 2 people in Nome (1 team). This preparation took us two days. The extra day before the cruise was used for collection of extra freight, dealing with the Quintillion cable issues, and training new team members in CTD operations. 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 requirements for all cruise personnel.**

Instrument set up went smoothly. The iscat loggers were equipped this year with alkaline batteries. **Action item: Check logic for timing of iscat setup**. The old ADCP software was used carefully to prevent it erasing the bottom track commands. Seacats were found to be missing one of their poison cell attachments - although an alternative was constructed in Nome, poisoning of seacats was postponed until just before deployment, when the poison cell attachments from the recovered instruments could be reused on the new instruments (with new poison). **Action item: Check Seacats have both poison fittings**. One recovered Seacat had lost its right-angle bracket **Action item: Replace missing bracket**. **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.**

Data recovery on the moorings was reasonably good, although with some challenges with the ADCPs and one SBE, as detailed below. All instruments were downloaded using the older laptops with serial ports. **Action item: Bring same number of laptops for these downloads.**

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

- from **A2-16**, the top sensor was recovered; and both logger and microcat downloaded cleanly giving good data. **Action item: Check with SBE so that microcat download does not skip a record at every return of executed.**
- from **A4-16**, the top sensor was missing. The coupler and weak link were however still present, along with 19.2m of wire. This suggests the iscat was cleanly cut from the cable just below the stopper block at the bottom of the top sensor. It is unclear how this could have happened without pulling the weak link. The logger recorded data until 12th January 2017, 1255GMT, suggesting that ice was the cause of the top sensor loss. **Action item: Investigate how iscat could be severed without breaking weak link.**
- from **A3-16**, the top sensor was missing, along with the coupler and the weak link. The logger recorded data until 14th April 2017, 1629GMT, suggesting that ice was the cause of the top sensor loss.

ISCAT LOGGERS: Of the 3 loggers deployed on the recovered moorings:

- from **A2-16**, the logger (#4) was operational and recorded a year of data. Clock check showed the logger to 1 day and 16min slow, and records show this is due to the logger being set a day late on deployment. The top float was recovered from this mooring also.
- from **A4-16**, the logger (#26) was operational and recorded data until 12th January 2017, 1255GMT. Clock check showed the logger also to be 1 day and 16min slow, and records show this is due to the logger being set a day late on deployment. The top float was not recovered from this mooring.

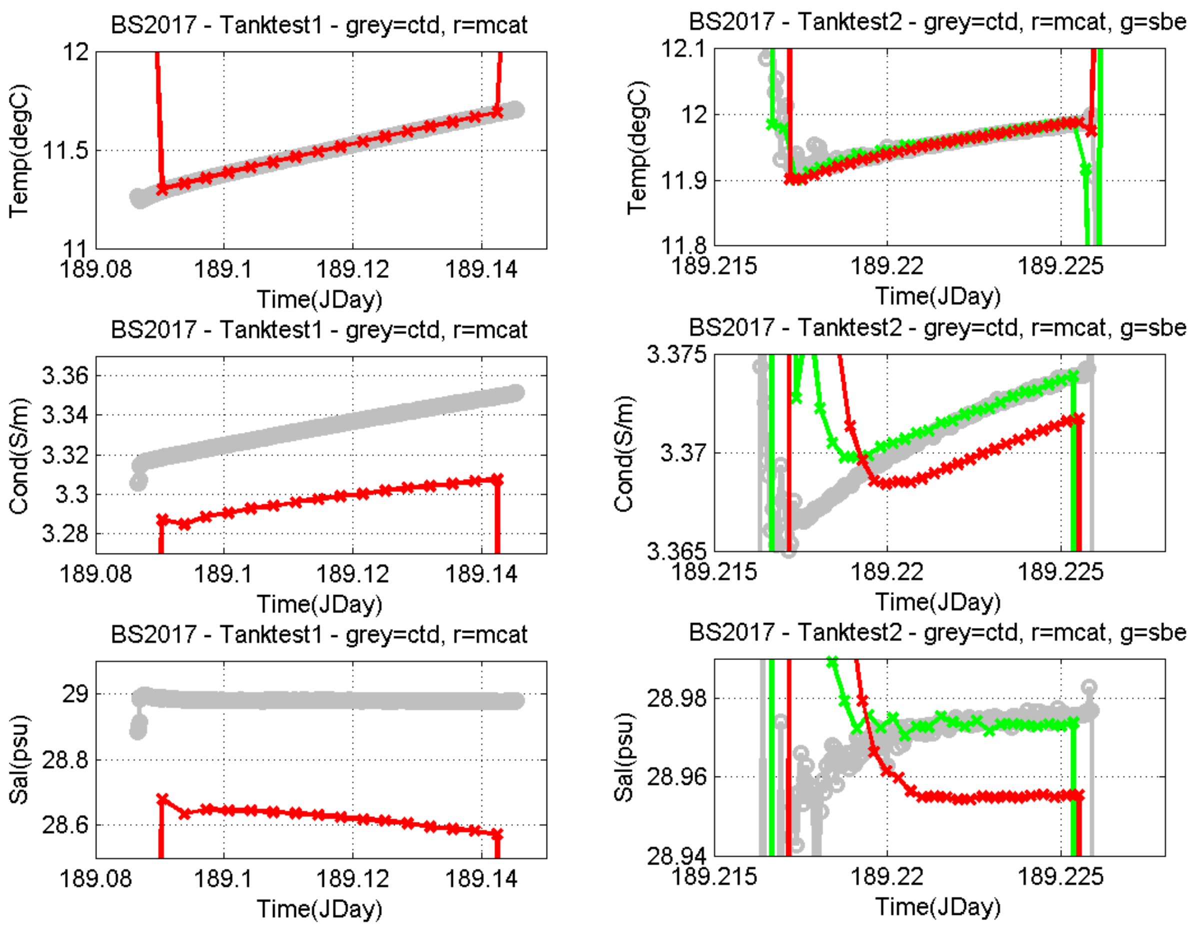
- from **A3-16**, the logger (#23) had too low batteries on recovery to be operational and clock time had also been lost. However, the logger recorded good data from the microcat until 14th April 2017, 1629GMT, which we assume is the date the top float was lost.
Note that loggers record also the timestamp 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 **A2-16**, ADCP #2332 was still recording on recovery and delivered a full deployment of data, as per the plan.
- from **A3-16**, ADCP #10926 was also still recording on recovery. Ultimately, the instrument delivered an almost complete record, but had issues for the first 2 days of deployment. The ADCP recorded well until deployment, but immediately after deployment it started writing short files of between 1 and 15 records. On 11th July 2016, at 0011GMT, it finally restarted successfully (record D044) and ran continuously on the original plan until stopped after recovery. On recovery, the internal battery voltage was 11V, the external 42V, and the power pin on the plug at the bottom of the ADCP was missing. We conclude some leakage or other failure in the plug causes power spikes which interrupted recording for the first 2 days of deployment, and that the instrument ran primarily on its internal battery. **Action item: Investigate with RDI this mode of failure. Replace plug. Check for compatibility old and new impulse plugs.**
from **A4-16**, ADCP #12845 was not pinging on recovery. Investigation showed the internal battery to be only 9.3V, and the power pin on the ADCP's endplate to be loose. The external battery voltage was still 42V. The instrument wrote multiple records (~ 300), of varying length, all on the original plan. Preliminary work suggests it may be possible to reconstruct these into a fairly continuous record from deployment (with 2-5 day gaps) from deployment to early February, but this is still to be confirmed. **Action item: Investigate with RDI this mode of failure. Write new program to convert from ADCP binary file into ascii (similar to the nearly obsolete BBList) such that it can be run in batch on multiple files. 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. All cells appeared clear on recovery. Of the 3 seacats deployed on the recovered moorings:
- from **A2-16**, SBE #1541, deployed in a vaned frame, was still recording on recovery and returned a full record.
- from **A3-16**, SBE #0005, deployed attached to the ADCP cage, was still recording on recovery and returned a full record. Note the right-angle pipe at the top of the SBE was missing by recovery.
- from **A4-16**, SBE #2264, deployed vaned on the marine mammal record, was not running on recovery, and on connection was found to have a flat battery and to have also lost its internal clock time (despite it having a new Lithium battery last year). External power was required to download the data record, which was good only until 22nd Sept 2016, 2100GMT. **Action item: Return to SBE for inspection and repair. Enquire with SBE re Lithium Battery care and expectations**.
Preliminary results are plotted below, and as outlined in the summary section, suggest a remarkably fresh winter (1psu fresher than climatology); a remarkably early warming (~ 15 days earlier than previously recorded) in the strait in 2017, and an anomalously long lingering of warm waters in the strait (into January).
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 ~ 10 hours, in a large-plastic bin filled with salt water in conjunction with a recently calibrated SBE instrument. The intent was to ascertain to what extent cleaning after recovery changed the readings on the SBE instruments. The preliminary test with this system was in 2016, and had significant limitations, likely relating to 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, the tank was designed to a) allow all instruments to be vertical and b) to include a pump to circulate water within the tank.

Prior to recovery, two tank tests were performed (see Figures), viz.:
= **Tank test 1:** SBE19 #924 (5second data) in tank with spare SBE37 #14550 (recording at 30second interval). (SBE-16 1224 was also in the tank, but had been wrongly set up and recorded no data.
= **Tank test 2:** SBE19 #924 (5second data) in tank with spare SBE37 #14550 (recording at 30second interval) and SBE-16 1#224 (recording at 30second interval).



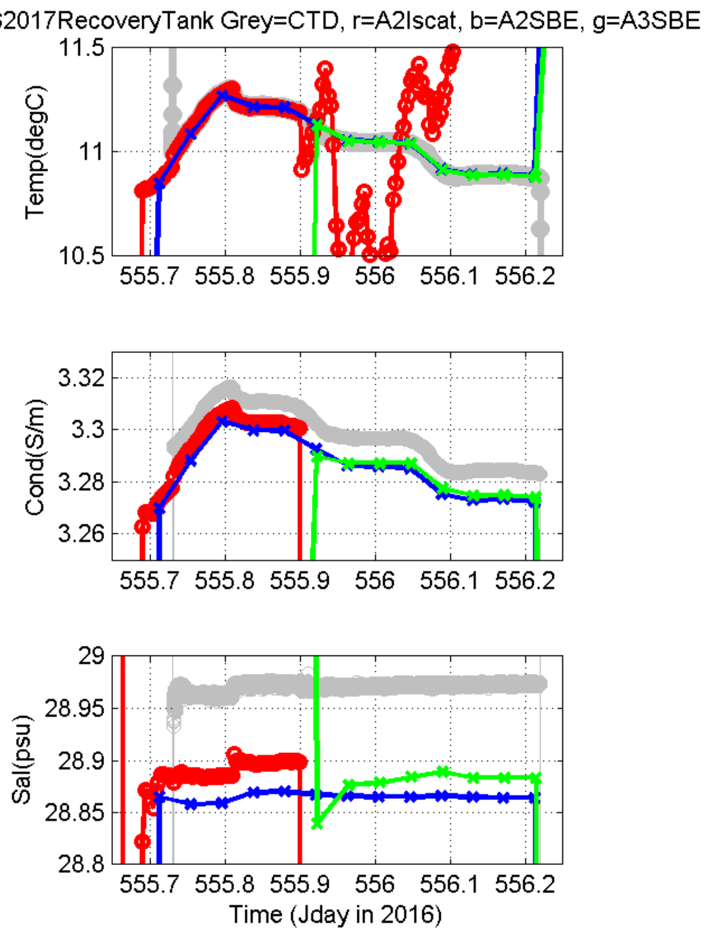
The first test is somewhat disappointing, but illustrates potential hazards of this system. Here, although temperatures agreed excellently (to ~ 0.003degC) the SBE37 was 0.3psu fresher than the SBE19. We have no clear explanation for this discrepancy.

The second test was more convincing, with the SBE16 agreeing in salinity with the SBE19 to 0.002psu and the SBE37 to ~ 0.02psu. The stated instrument accuracies are:

SBE19	0.01degC, 0,001S/m, equivalent to 0.02psu
SBE16	0.01degC, 0.001S/m, equivalent to 0.02psu
SBE37	0.002degC, 0.0003S/m equivalent to 0.005psu

Thus the agreement on the second test is within the limits of the calibration. It is however curious that the SBE19 and SBE16 agree much better than the supposedly more accurate SBE37. This may be a result of circulation of water in the cell. In any case, the first tank test shows that so far this procedure can only confirm a good calibration, since a bad agreement may be due to set up rather than instrument offset.

Once instruments were recovered from the moorings, they were placed in the tank for a period of up to 10hrs. Since recovered instrumentation is recording either hourly (SBE16s) or every 5min (SBE37), this allows a good comparison with the calibration CTD, still set at 5 second data.



Results from this longer run are encouraging. Again, temperatures agree well. (times of differing temperatures indicate when instruments were removed from the tank, e.g., A2iscat, removed ~ Julian Day 555.9).

In salinity, we find the following offsets to the calibration SBE-19, viz:
- A2iscat = ~ 0.07psu fresher
- A2sbe = ~0.09psu fresher
- A3sbe = ~ 0.1psu fresher.

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.

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

Aural Marine Mammal Acoustic sensors on all moorings were deployed by Kate Stafford, (UW). As reported below, unfortunately no useful data were recorded on these instruments.

Other Deployed Instrumentation: Deployed moorings also carried other instrumentation, viz:

Marine Mammal Acoustic sensors were deployed on all moorings (including a new prototype sensor on A4-16) 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 2017 MOORING POSITIONS AND INSTRUMENTATION

ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2016 Mooring Deployments				
A2-16	65 46.867	168 34.059	56	ISCAT, ADCP, new MMR, SBE16
A4-16	65 44.760	168 15.766	48	ISCAT, ADCP, SBE16 with MMR
A3-16	66 19.573	168 57.037	57	ISCAT, ADCP with SBE16, MMR

ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2017 Mooring Deployments				
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

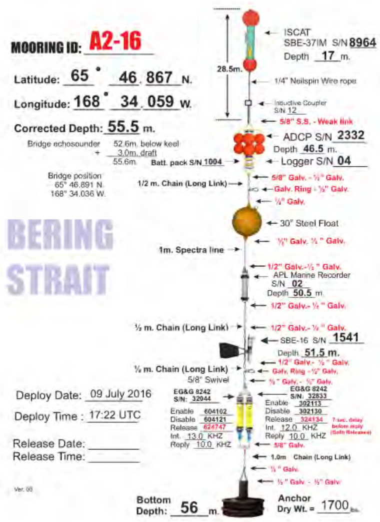
ADCP = RDI Acoustic Doppler Current Profiler
ISCAT = near-surface Seabird TS sensor in trawl resistant housing, with near-bottom data logger
SBE16 = Seabird CTD recorder,   SBE37 = Seabird CTD recorder
MMR=Marine Mammal Recorder   (new=new APL version)

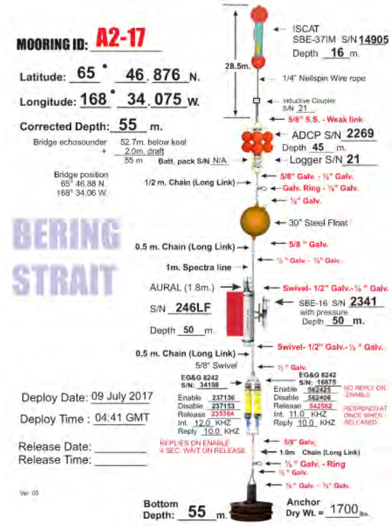
For 2016 deployments, water depths are assuming a ship's draft of 3m.
For 2017 deployments, water depths are assuming a ship's draft of 2m.

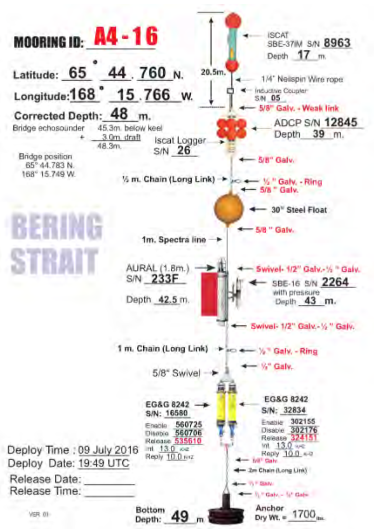
BERING STRAIT 2017 SCHEMATICS OF MOORING RECOVERIES AND DEPLOYMENTS

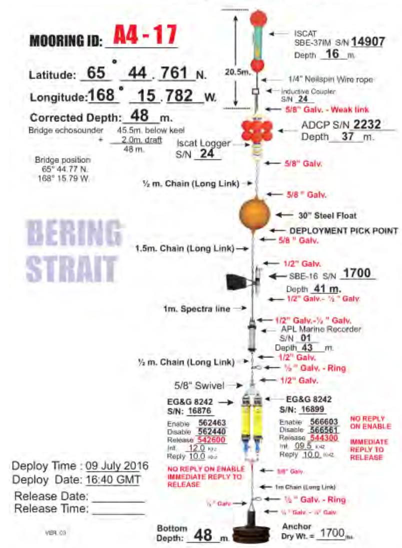
RECOVERED **DEPLOYED**

= in the eastern channel of the Bering Strait

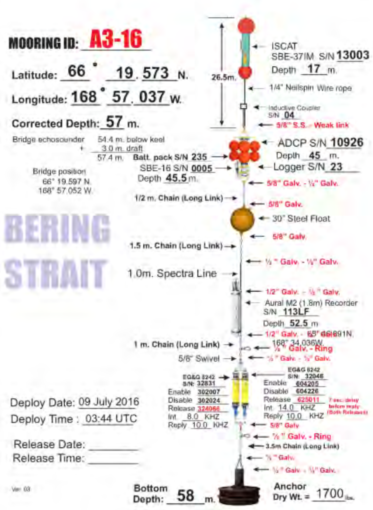


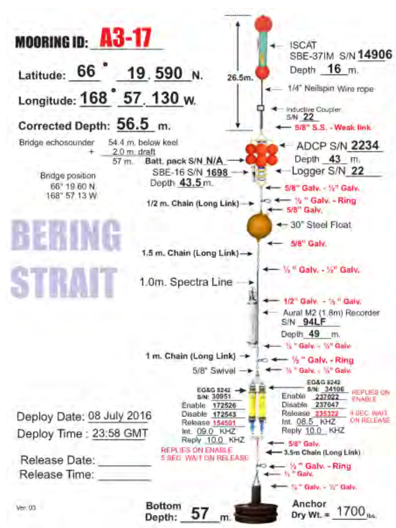






= at the climate site, ~ 60km north of the Strait





BERING STRAIT 2017 RECOVERY PHOTOS

A2-16
Recovery

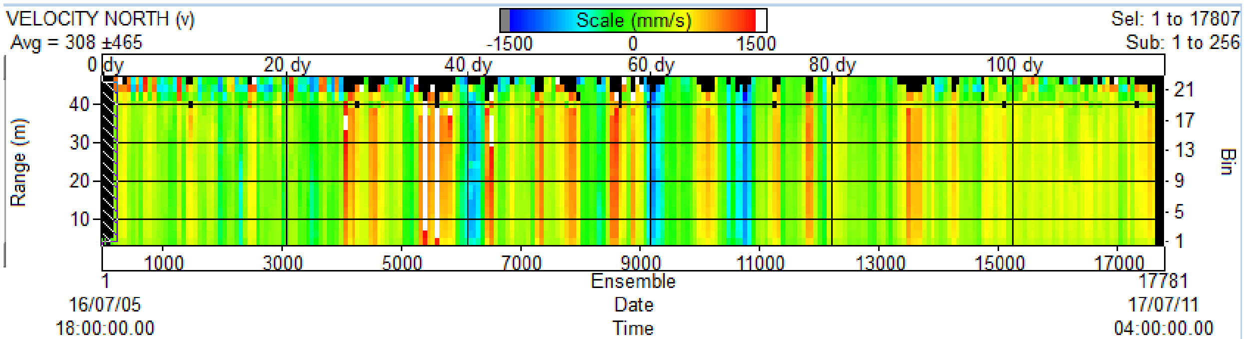
A4-16
Recovery

BERING STRAIT 2017 RECOVERY PHOTOS (continued)

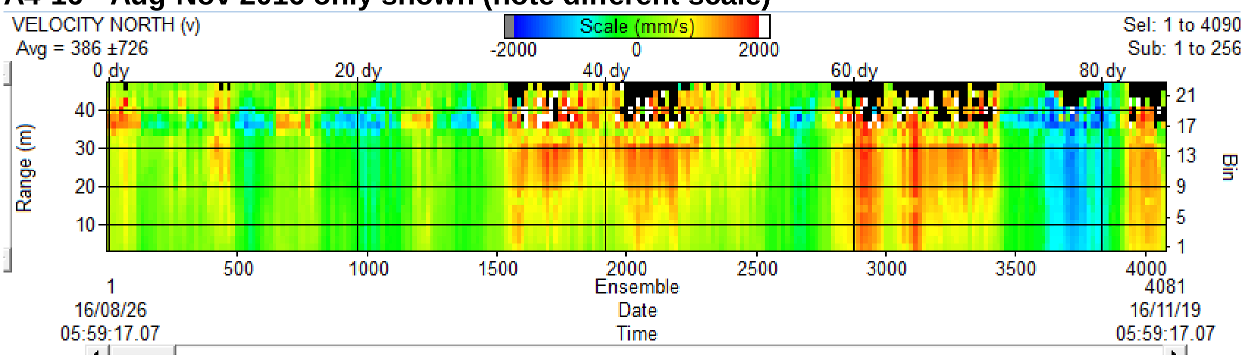
A3-16 Recovery

NORTHWARD VELOCITY from ADCPs.

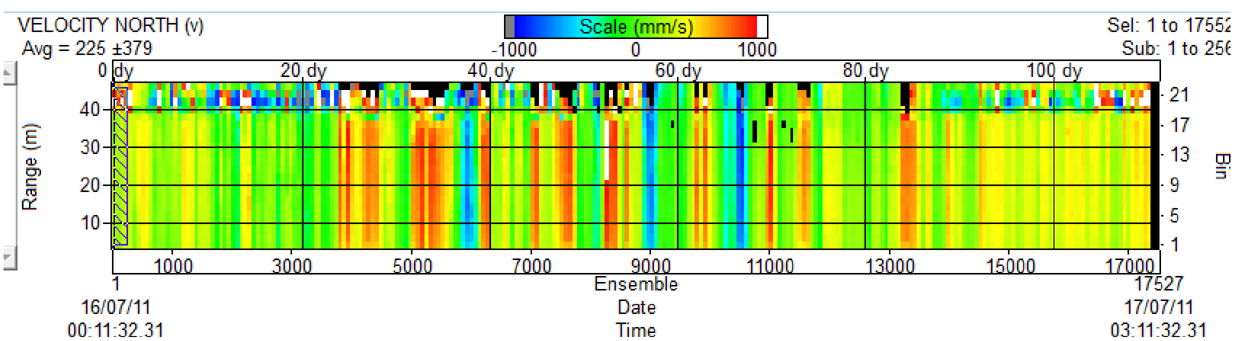
A2-16 (with stronger events than in 2015)



A4-16 - Aug-Nov 2016 only shown (note different scale)

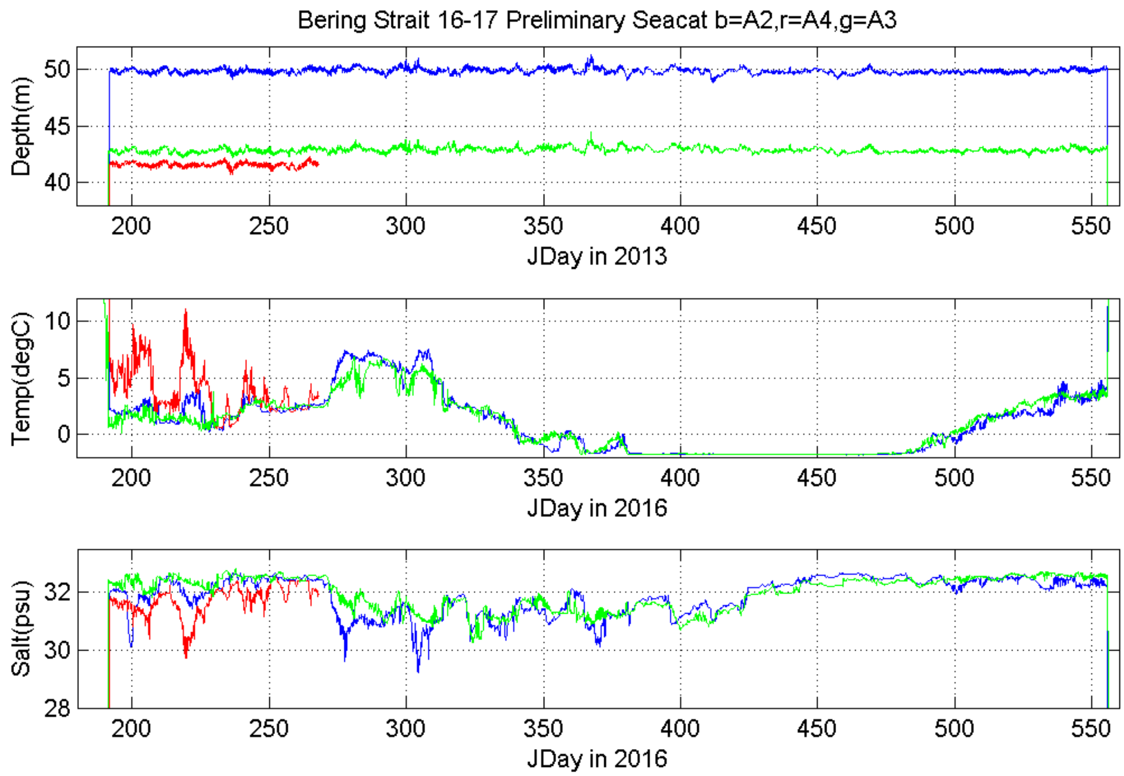


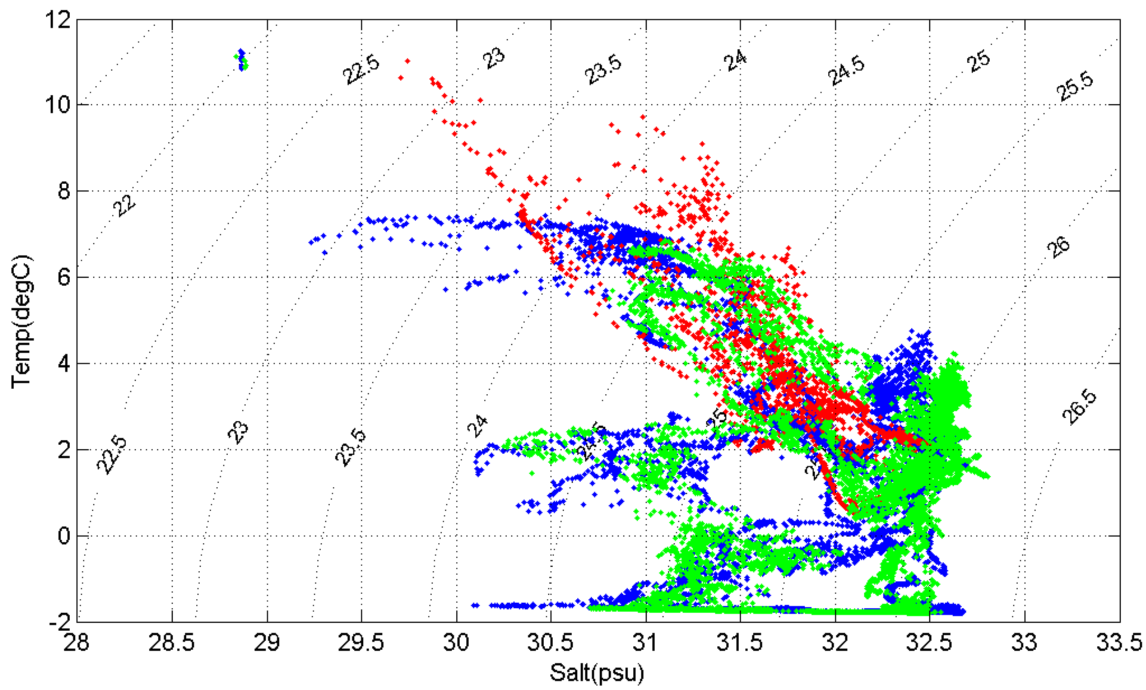
A3-16 (note different scale)



BERING STRAIT 2017 SBE PRELIMINARY RESULTS

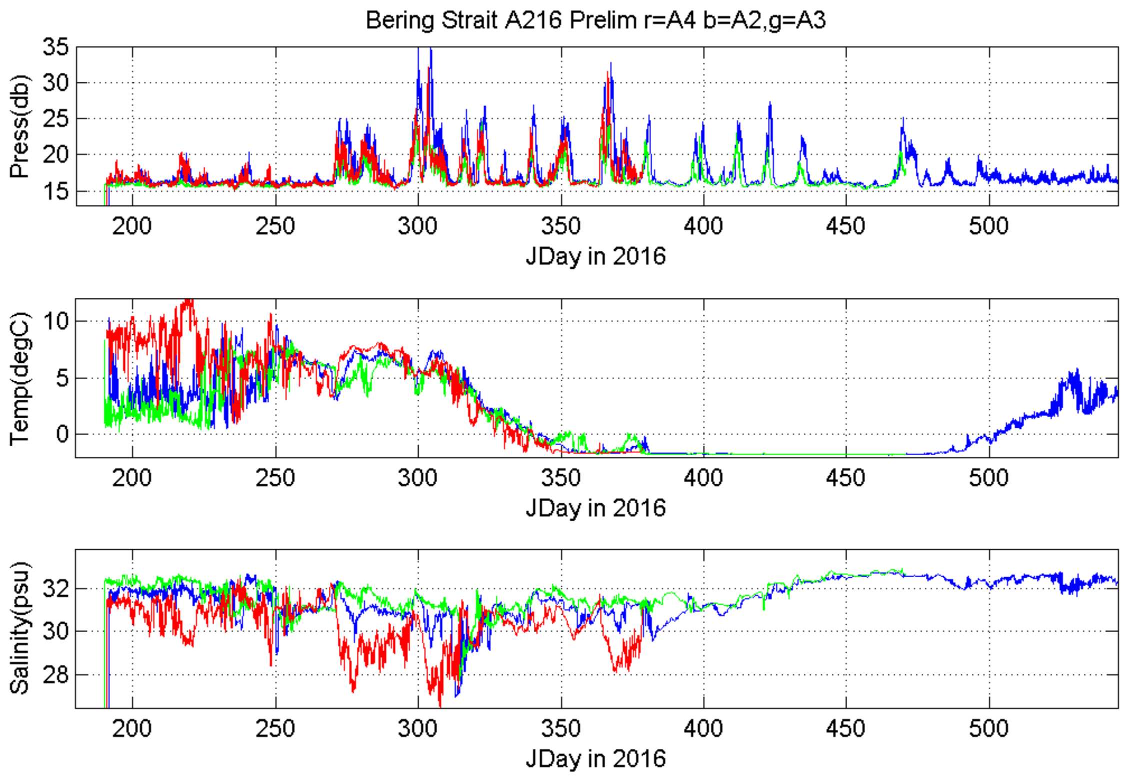
– all lower level TS Sensors
(maximum temperatures warmer than last year and waters also apparently fresher in fall)

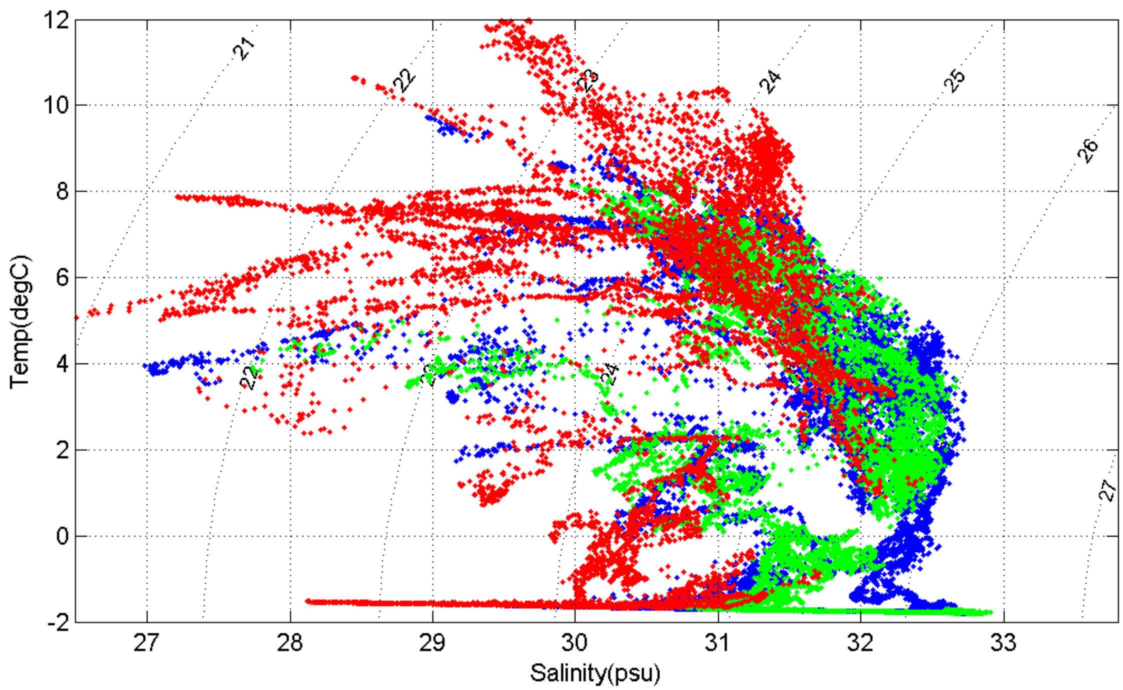




BERING STRAIT 2017 PRELIMINARY ISCAT RESULTS

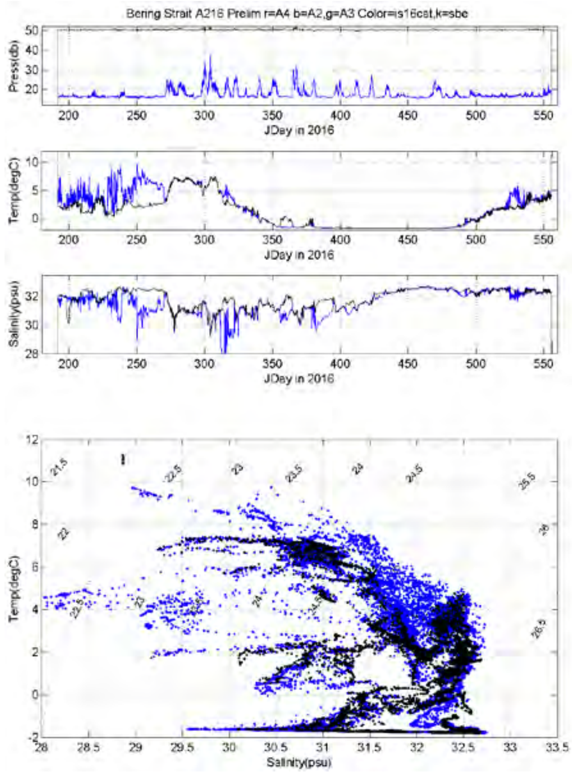
– all upper level TS Sensors
(also warmer and fresher than last year, and with greater pull down



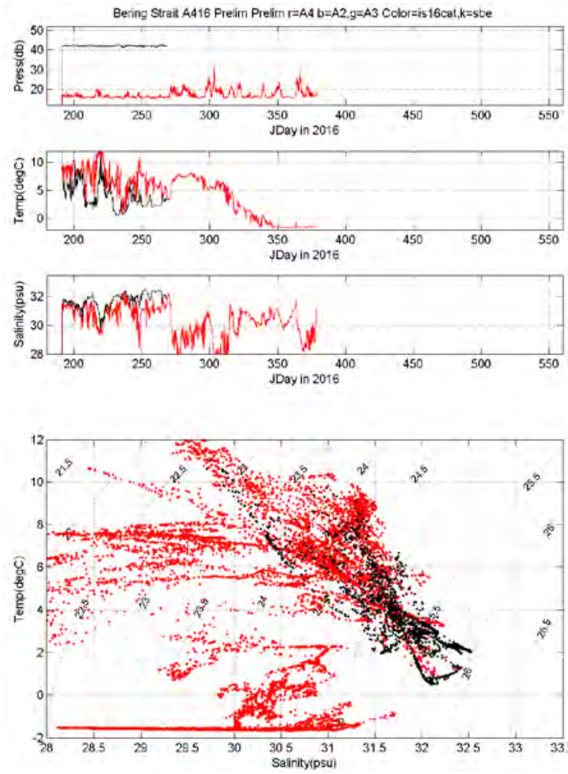


BERING STRAIT 2017 PRELIMINARY ISCAT AND SBE RESULTS (per mooring)

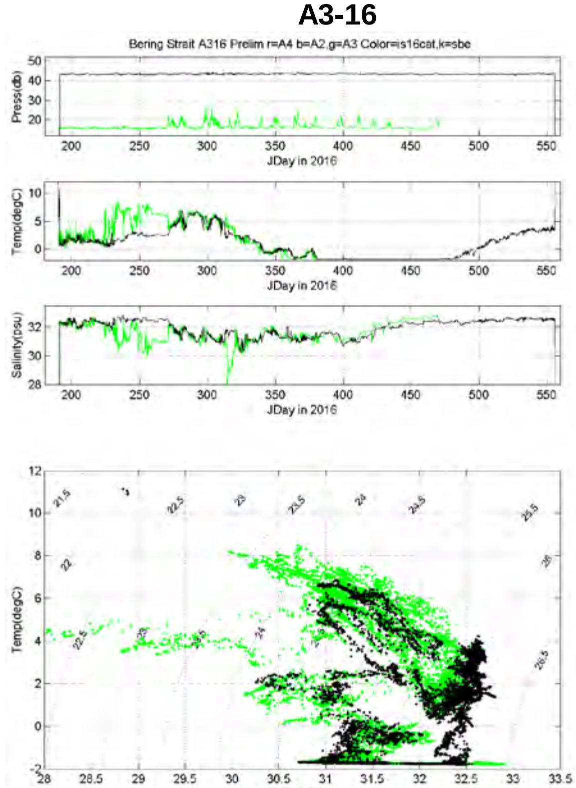
A2-16



A4-16



A3-16



CTD OPERATIONS (Woodgate, Peralta-Ferriz, Irving, Escajeda, Panicker, Johnson)

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

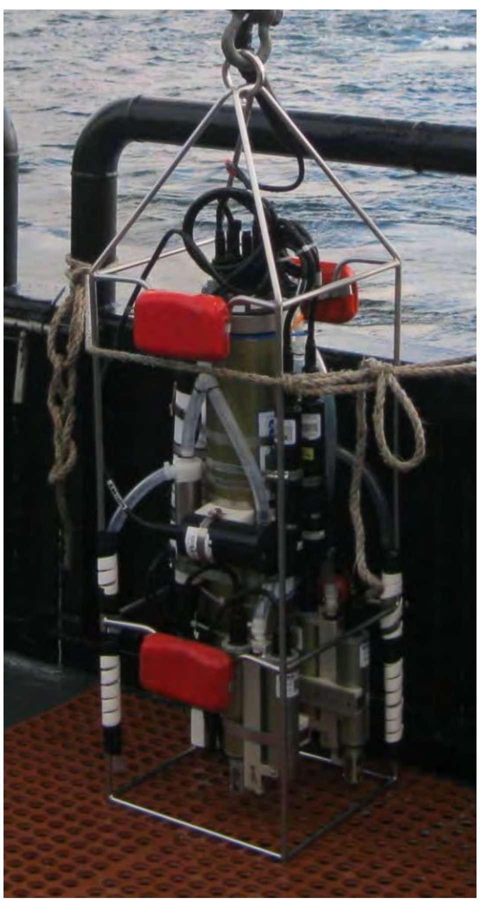
The CTD rosette system used on this cruise was loaned from APL-UW and, was the same set up as 2016 (in turn the same set up as in 2014, and 2015,with the exception of the transponder).

The full package consisted of:

- one SBE9+ with pressure sensor
  - (SN5915 – calibration 23rd December 2016)
- two SBE3 temperature sensors
  - (T1 = SN0843 – calibration 29th December 2016)
  - (T2 = SN0844 – calibration 24th March 2015)
- two SBE4 conductivity sensors
  - (S1 = SN0484 – calibration 13th May 2016)
  - (S2 = SN0485 – calibration 28th December 2016)
- two SBE43 oxygen sensors
  - (Ox1 = SN1753 – calibration 20th December 2016)
  - (Ox2 = SN1754 – calibration 20th December 2016)
- one Wetlabs FLNTURT fluorescence/turbidity sensor (SN1622 – calibration 11th March 2010)
- one Benthos Altimeter (SN50485, repaired spring 2015)
- two Seabird pumps (SN50340, SN55236)
- 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 2017, in port tests in spring showed the existing termination 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. (Last year, there were intermittent issues with the Norseman II aft A-frame GPS. This year it was found to be non-functional in Nome. However, the ship carried a spare antenna and when that was replaced, the system worked well. **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).

While in 2017 the preference of the crew was to have the winch operated from a remote console on the deck by the A-frame, this was not always possible. This control unit only worked intermittently on this 2017 cruise and for many casts the winch had to be driven from the upper deck. Trouble shooting of this unit finally was successful to maintain operations on the aft deck, however consistency of winch speed was an issue. **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. Also, train CTD driver to check winch speed on read-out beside CTD console.** Our goal is a lower/raise rate of 30-40m/min.

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 ship's crew recovering the instrument, assisted at times by one science team member.. In bad weather, it was deemed necessary to always have two persons catching the CTD as it came aboard. We are grateful to the ship's Chief Engineer for assisting the manning of operations.

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.

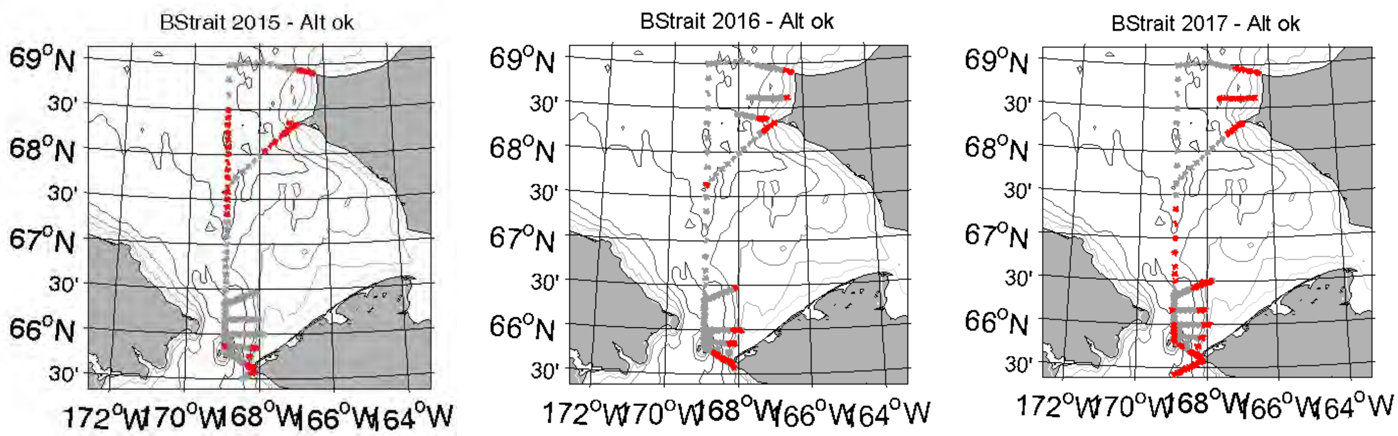
Overall, CTD data this year are exceedingly clean, although 4 problems should be noted.

1) Offset of ~ 3% or ~ 0.3ml/l between Oxygen sensors. The calibrated data show a consistent offset between the 2 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 be the resolution of the sensors. Note that in processing of CTD data, the oxygen data must be aligned with temperature and thus may result in changes of ~ 5% saturation. The cleanest oxygen data is found to be in system 1.

2) Altimeter. For the last three years, we have found problems with the altimeter on this CTD package. Tests in Seattle post the 2014 cruise showed the altimeter to be faulty and it was returned to Benthos for repair. However, even the repaired instrument did not function well during the 2015 or 2016 cruises (Figure below). Subsequent laboratory tests in 2015/2016 found nothing wrong with the instrument.

Similar problems were experienced in 2017 - although during some casts (see figure below) the altimeter functioned well, more frequently it gave reasonable data either only on part of the cast, or not at all. In 2017, there appears to be some spatial coherence to where the altimeter worked in the last two years, suggesting perhaps some function of the bottom type, but repeat casts at a fixed location did not always show the same altimeter behaviour, e.g., AL20 and others in that region. Similarly, there were differences on different runnings of the Bering Strait line, where the altimeter worked in the central strait when the line was run from the (warmer) east, whereas it failed in the central strait when the line was run from the (colder) west.

While we cannot rule out differences in bottom reflector, or interaction with ship's sensors - (the frequency of the altimeter is 200kHz, which is also one of the frequencies of the ship's echosounder; the ship's ADCP is at 300kHz) - our current best hypothesis is that the altimeter works only in warm (> 5-7 deg C) waters. We hypothesize that the greater area of working altimeter reflects the warmer water temperature found this year. **Action Item: Cold-test the altimeter in Seattle.**

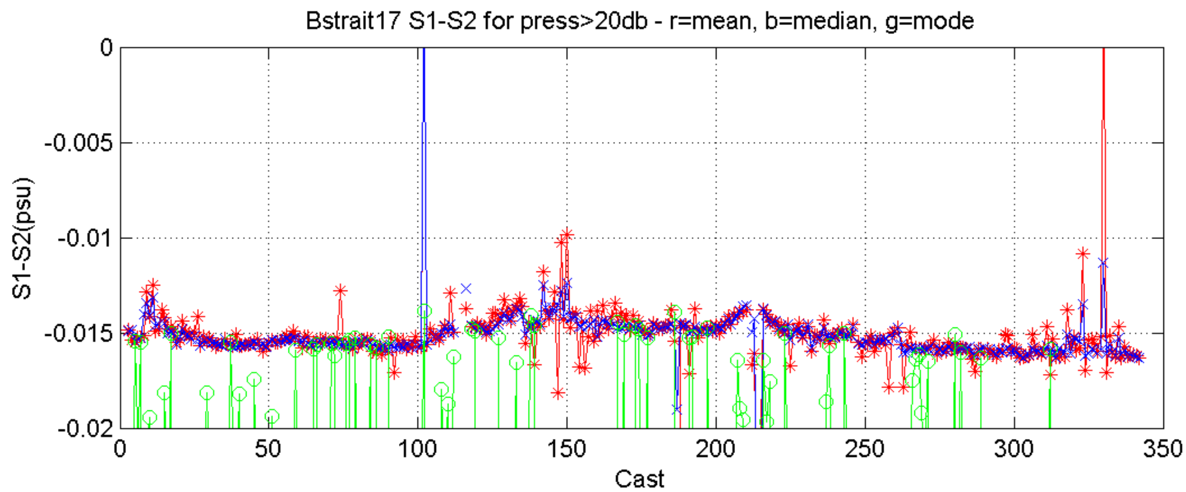


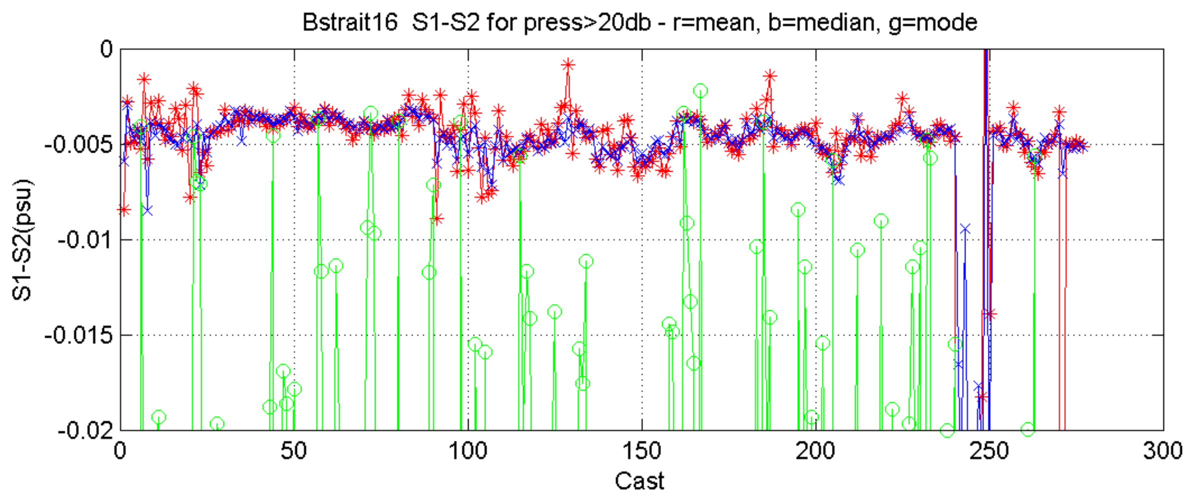
Sites where altimeter worked in 2015 (left), 2016 (middle) and 2017 (right).

As last year, in the end we abandoned attempts to solve this and just used the ship's echosounder depths and the SBE pressure sensor to decide on final depth for the CTD cast. We assumed a keel depth of 2m, and thus, as our target was 2m above bottom, we aimed to stop the CTD when CTD pressure matched the echosounder readout. In high seas, we stopped further from the bottom. **Action Item: On viewing sections, recall bottom 3+m may be unsampled.**

3) Vent plug blockages. There are so far identified only individual casts with vent plug blockages or some other pump anomaly. Where this was identified during the cast (2 casts - 216, 330), the cast was recast with a new number. Otherwise either the vent plug was cleaned, or the instrument corrected itself. **Action Item: Instigate checks on primary-secondary system agreement during every upcast. Continue to bring wire and syringe for cleaning the system.** Final processing of the CTD data is still to be done **Action item: check archived data for list of final issues.**

4) Offset of salinity sensors. Consistently throughout the cruise, we find an offset in salinity, with sensor C1 reading ~ 0.015psu fresher than C2. This is much greater than the difference between salinity sensors in 2016 (where C1 was ~ 0.005psu fresher than C2).
Seabird specifications state the initial accuracy of calibrated sensors should be ~ 0.003psu. Thus the inter-system difference from 2016 is within this accuracy (~ 2*0.003psu) whereas the 2016 system is not.





SBE suggested checking the in air frequencies and comparing them to calibration.
After recovery, we ran another series of tests, summarized in the following table:

#	.hex	Descript	C1			C2		
			Freq /Hz	Ratio	Sal /psu	Freq /Hz	Ratio	Sal /psu
0	12th July 2017	Between casts	2970	1.02	0.12	3150	1.03	0.17
			No effect from pump on			*No effect from pump on*		
1	Bstrait17433	After last cast	3100	1.07	0.3	3120	1.03	0.17
			No effect from pump on			*No effect from pump on*		
2	Bstrait17434	After 1 rinse	2911	1.001	0.01	3030	1.001	0.018
			No effect from pump on			*0.07psu spike on pump on*		
3	Bstrait17435	After 2 rinses	2909.5	1.0006	0.008	3027	1.001	0.01
			No effect from pump on			*0.05psu spike on pump on*		
4	Bstrait17436	After 3 rinses	2909	1.0004	0.007	3027	1.001	0.01
			No effect from pump on			*0.05psu spike on pump*		

						on		
5	Bstrait17437	Repeat after 3 rinses	2908.7	1.0003	0.0068	3026.7	1.0007	0.008
			Pump not turned on			*Pump not turned on*		
6	Bstrait17438	After night on deck	2909.6	1.0006	0.0068	3027.2	1.0008	0.009
			No effect from pump on			*No effect from pump on*		
	Air-shipped to Seattle							
7	In Seattle	After ship to Seattle	2925	1.006	0.03	3034	1.003	0.02
			Pump not turned on			*Pump not turned on*		
	CALIBRATION VALUES		2907.82		0	3024.55		0
	Throughout cruise S2 ~ 0.015 psu greater than S1							

Back in Seattle (14th July 2017), we performed further tests. By rinsing the cell with deionised water from a syringe, we could intermittently frequencies readings which were, at their lowest points, 2908.1 and 3024.9, which are within a few 10ths of a Hz of the calibration. Finally, we tested the system in the APL-freshwater tank, and obtained agreement between the two sensors of ~ 0.0005psu. We conclude thus that the cells are not damaged, but there is a calibration error in the gain at high salinities.

At the time of writing this cruise report, this matter is still in investigation with Seabird, using in air tests and cleaning of sensors. It seems likely however than this discrepancy indicates the final accuracy of the data set.

This cruise report will be updated should further information become available.

Action item: Update when further information is available. Establish an on deck, pre-first cast air test of the sensors.

Note finally some differences were made in the cruise-based processing of the data, re the surface soak. This is detailed below.

NOTES ON BERING STRAIT 2017 CTD PROCESSING
Rebecca Woodgate (based on 2015 processing)

Start with files from SeaSave for each cast, i.e.,
BStrait17nnn.hex and BStrait17nnn.hdr

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 = DatCnvBStrait2017_allvars.psa)
Inputs are: BStrait17nnn.hex and BStrait17nnn.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 2017 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: BStrait17nnn.rw1.cnv

=== 2) Do first basic quality control by plotting everything in Matlab
Matlab master code = **testplotsBStrait2017RW.m** which calls subroutine **CTDQCpump.m**
Inputs are: BStrait17nnn.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 **BStrait2017_CTDissuesbycast.xls**

*************************** *In 2017 -Issues:***
ISSUE 1: Offset in salinities
ISSUE 2: Offset in Oxygen
ISSUE 3: Occasional casts with pump issues (complete list still to be determined)
ISSUE 4: Occasional spikes - still to be checked.

=== 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 = DatCnvBStrait2017_CTDforprocess.psa)
Inputs are: BStrait17nnn.hex and BStrait17nnn.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 2017 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: BStrait17nnn.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 = FilterBStrait2017_CTDforprocess.psa)
Inputs are: BStrait17nnn.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: BStrait17nnnA00B15.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 = AlignCTDBStrait2017_CTDforprocessOx2.psa)
Inputs are: BStrait17nnnA00B15.cnv

*In DATA SETUP

--> Enter Advance values

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

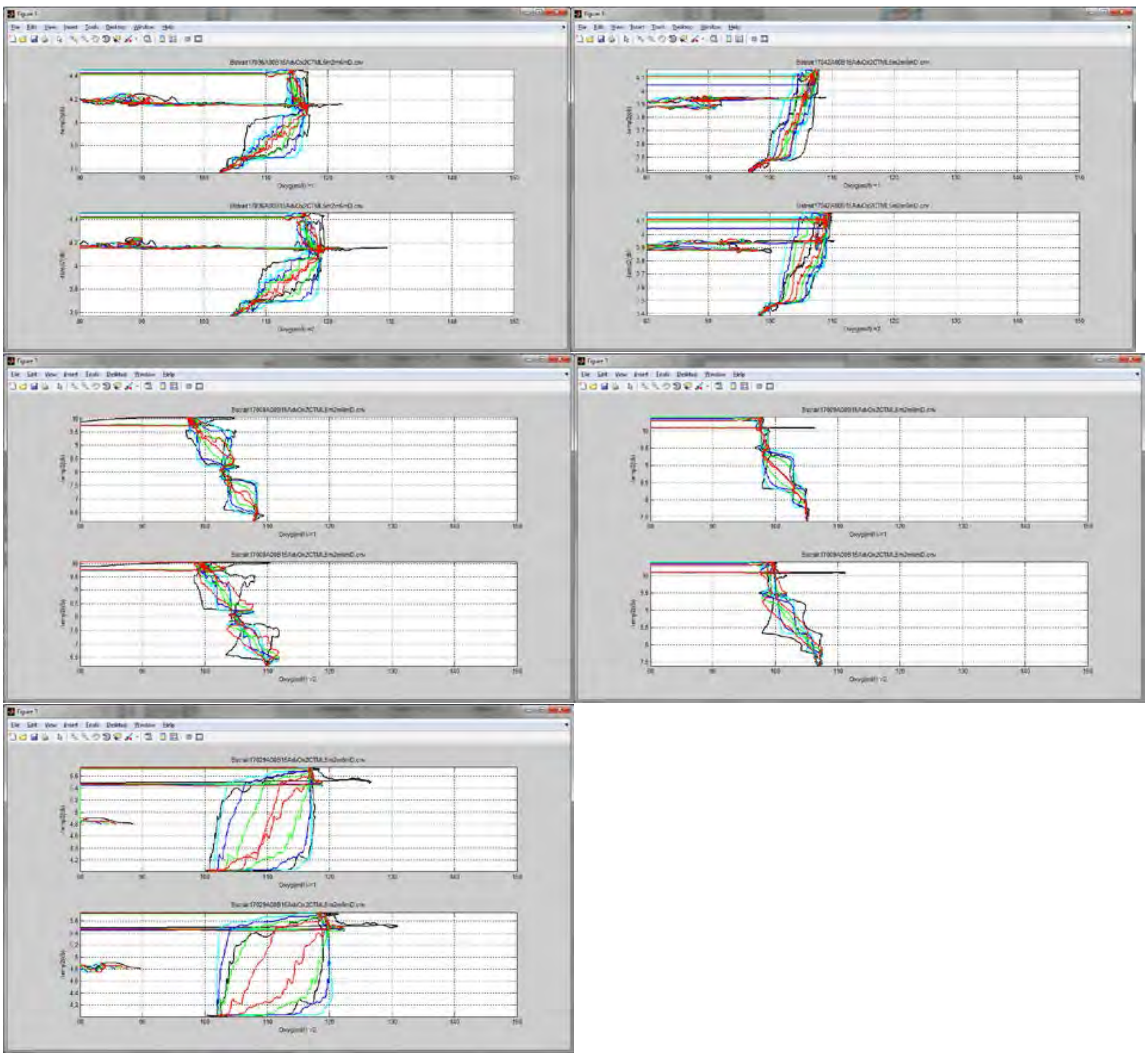
-- All others: 0

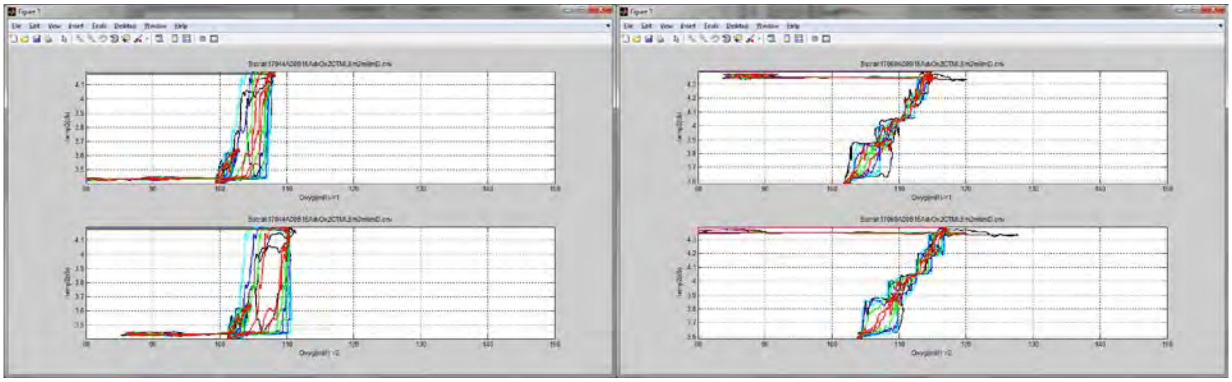
*In FILE SETUP

-- Append added = AdvOx5

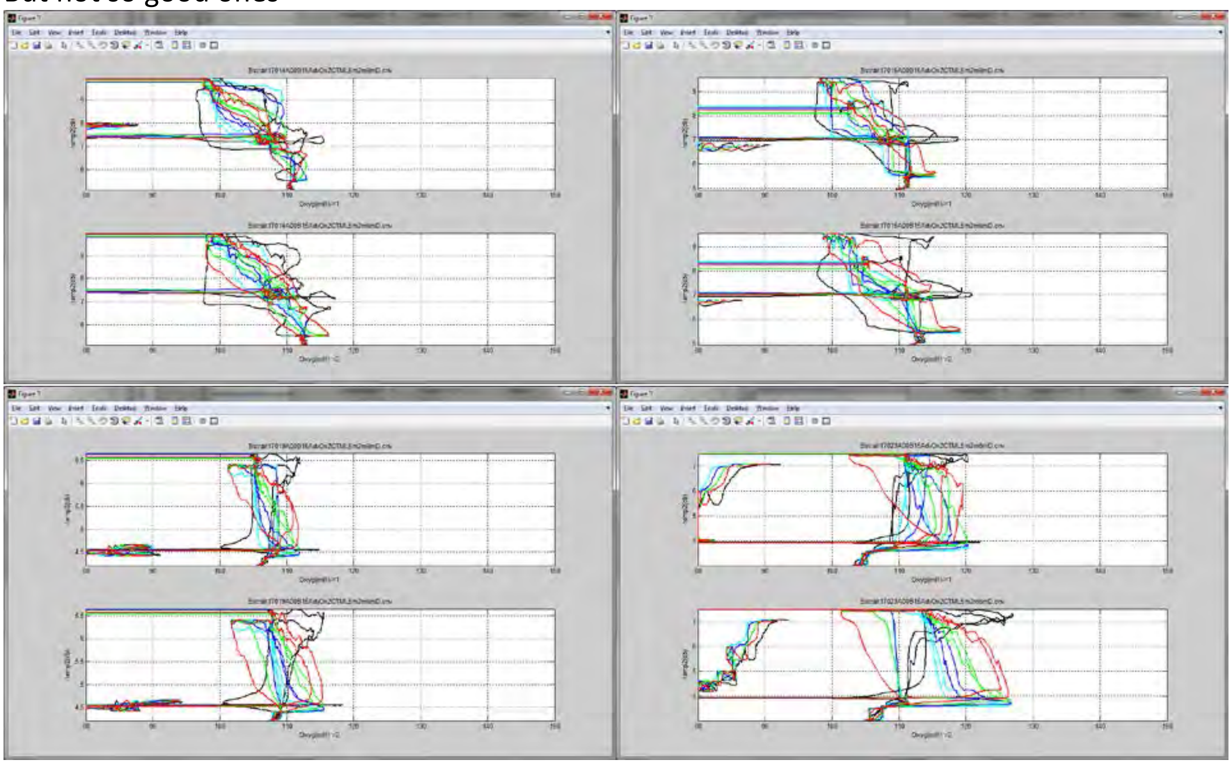
THIS GIVES files called: BStrait17nnnA00B15AdvOx2.cnv

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





But not so good ones



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% .

Some casts which have v poor correspondence between up and down casts in this metric, viz.:

Cast # 17,18,19,20	(BS19-BS17.5)
Cast # 22,23	(BS 16.5, 16)
Cast # 25	(BS15)
Cast # 31	(BS12)
Cast # 100,101	(AL19, Al19.5)
Cast # 126	(CS14)

(Casts checked up so far only to cast 147 inclusive)

=== 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 = CellTMBStrait2017_CTDforprocess.psa)
Inputs are: BStrait17nnnA00B15AdvOx2.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: BStrait17nnnA00B15AdvOx2CTM.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 are 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 SBEDATA PROCESSING, RUN: LOOP EDIT
(PSA file for this = LoopEditBStrait2017_CTDforprocess.psa)
Inputs are: BStrait17nnnA00B15AdvOx2CTM.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: BStrait17nnnA00B15AdvOx2CTM 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 = DeriveCTDBStrait2017_CTDforprocess.psa)
Inputs are: BStrait17nnnA00B15AdvOx2CTML7m4m18p5mndp.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: BStrait17nnnA00B15AdvOx2CTM 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_FilterCTDBStrait2017_CTDforprocess_MF17.psa)

Inputs are: BStrait17nnnA00B15AdvOx2CTM 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: BStrait17nnnA00B15AdvOx2CTM L7m4m18p5mndpDMF17.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 = BinAvgBStrait2017_CTDforprocess.psa)
Inputs are: BStrait17nnnA00B15AdvOx2CTM L7m4m18p5mndp.cnv &
BStrait17nnnA00B15AdvOx2CTM 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: BStrait17nnnA00B15AdvOx2CTM L7m4m18p5mndpDBADCS010.cnv &
BStrait17nnnA00B15AdvOx2CTM L7m4m18p5mndp DMF17BADCS010.cnv

In 2017 this marks the end of the CTD pre processing.

BERING STRAIT 2017 CTD OPERATION NOTES

As an aid to consistency for CTD operations, we created the following guidelines for CTD operators:

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,
     - `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**"

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

BERING STRAIT 2017 CTD LINES

A total of 19 CTD lines were run on the cruise. We were able to accomplish so many stations in part due to comparatively low winds this year, but also vitally due to (a) the efficiency and speed of ship and deck operations during the CTD work, (b) due to the great assistance from and preparedness of the ship's crew, which allowed us to start CTD operations immediately after mooring work, and (c) the smallness and lack of drag of the instrument in the water, which allowed us to operate in 5-6ft seas. .

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 19 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 3+ m above the bottom.

Various repeat stations and lines were run during the cruise, after intervals of hours and of days, i.e.: - the BS line
- the DLS, DLa and DLb lines
- the A3L line

(Note that underway data was taken on more repeats also).

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

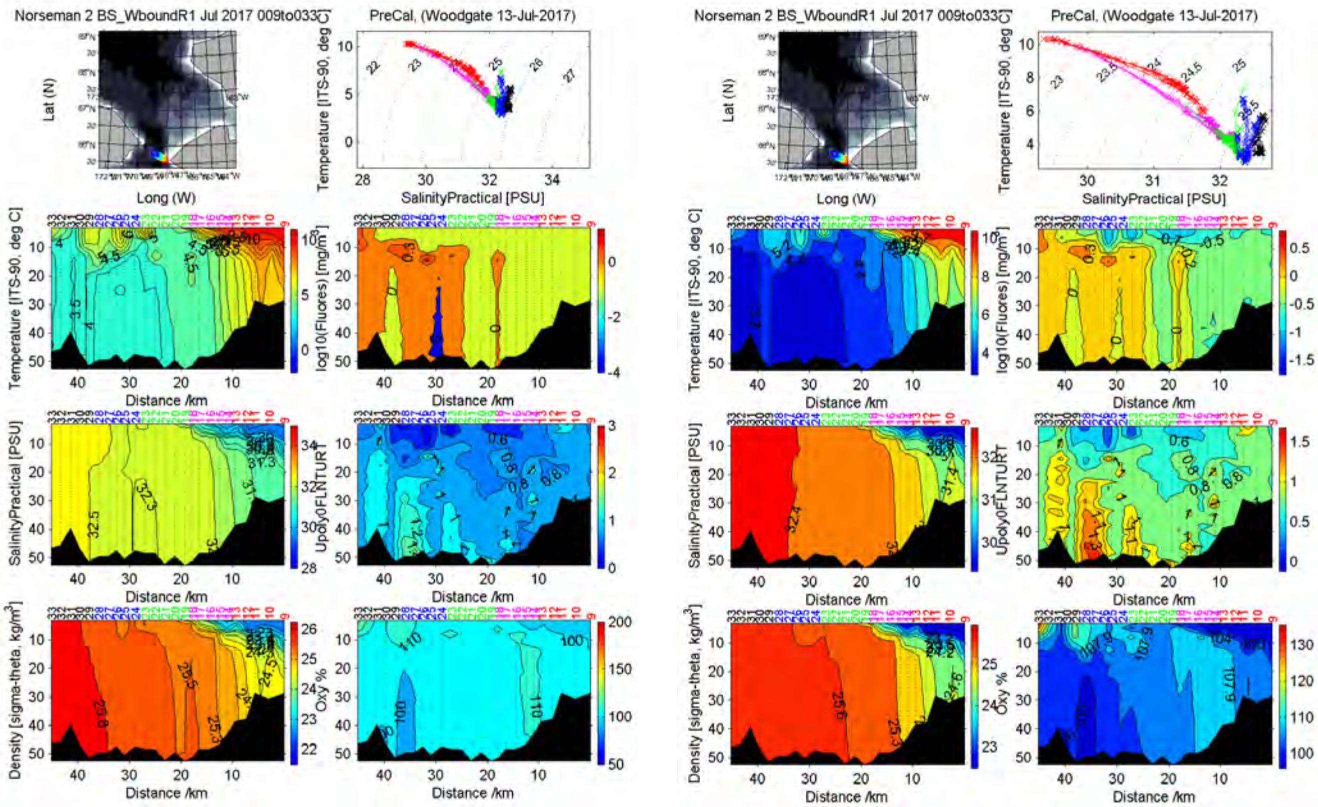
Many physical features are of interest and require further investigation, e.g.,

- the changing extent of the Alaskan Coastal Current, under varying wind conditions
- temperature and salinity changes relative to last year - note that, in contrast to last year, the Alaskan Coastal Current appears to be well established in the region at the time of the cruise. (See also underway data section.)

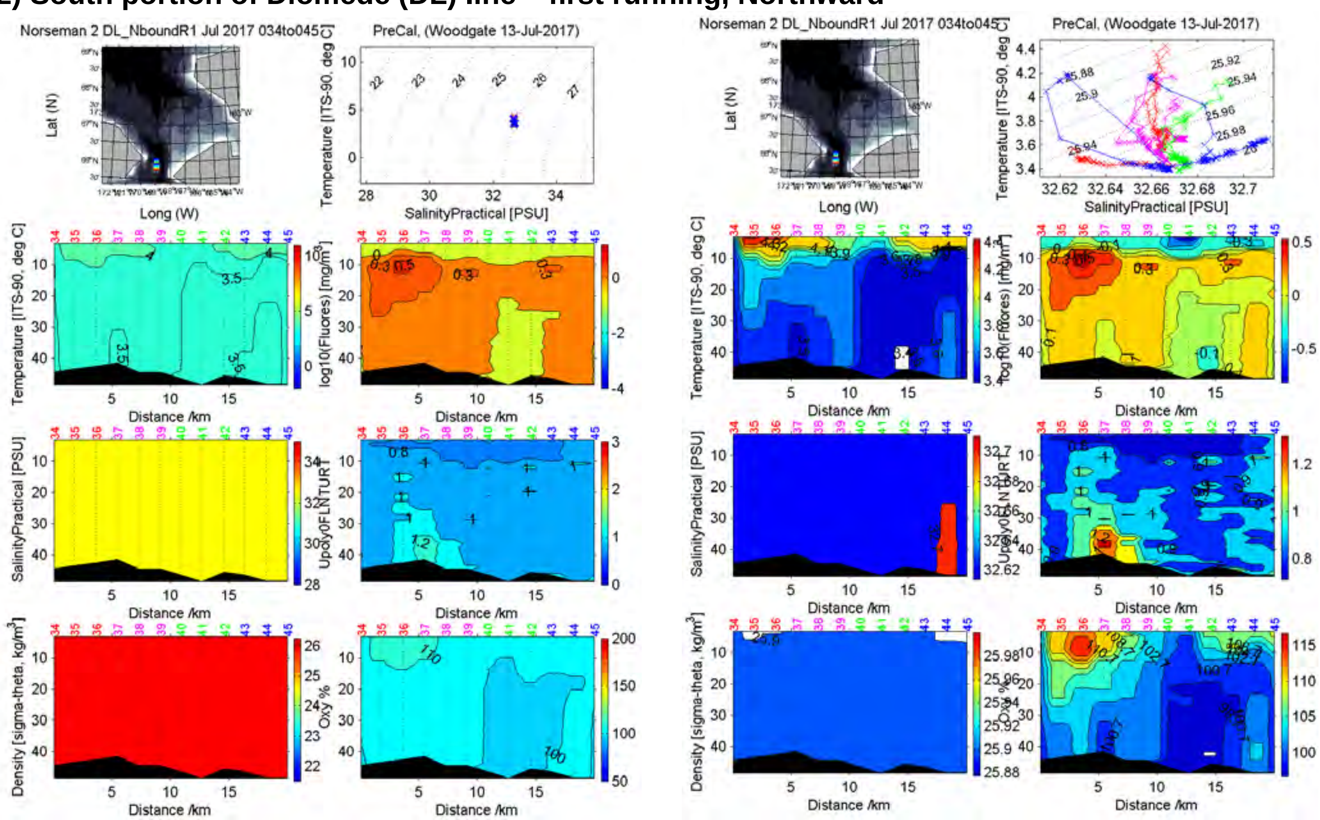
Action Item: Investigate

Also noteworthy in these data are the relationships between fluorescence, oxygen and turbidity, with suggestions of different ages of blooms, and possible fall out of blooms to the benthos. **Action Item: Investigate.** Oxygen values are calculated by Seabird software and are reported here in % saturation. Note we have no bottle samples with which to verify these data. **Action Item: Investigate.**

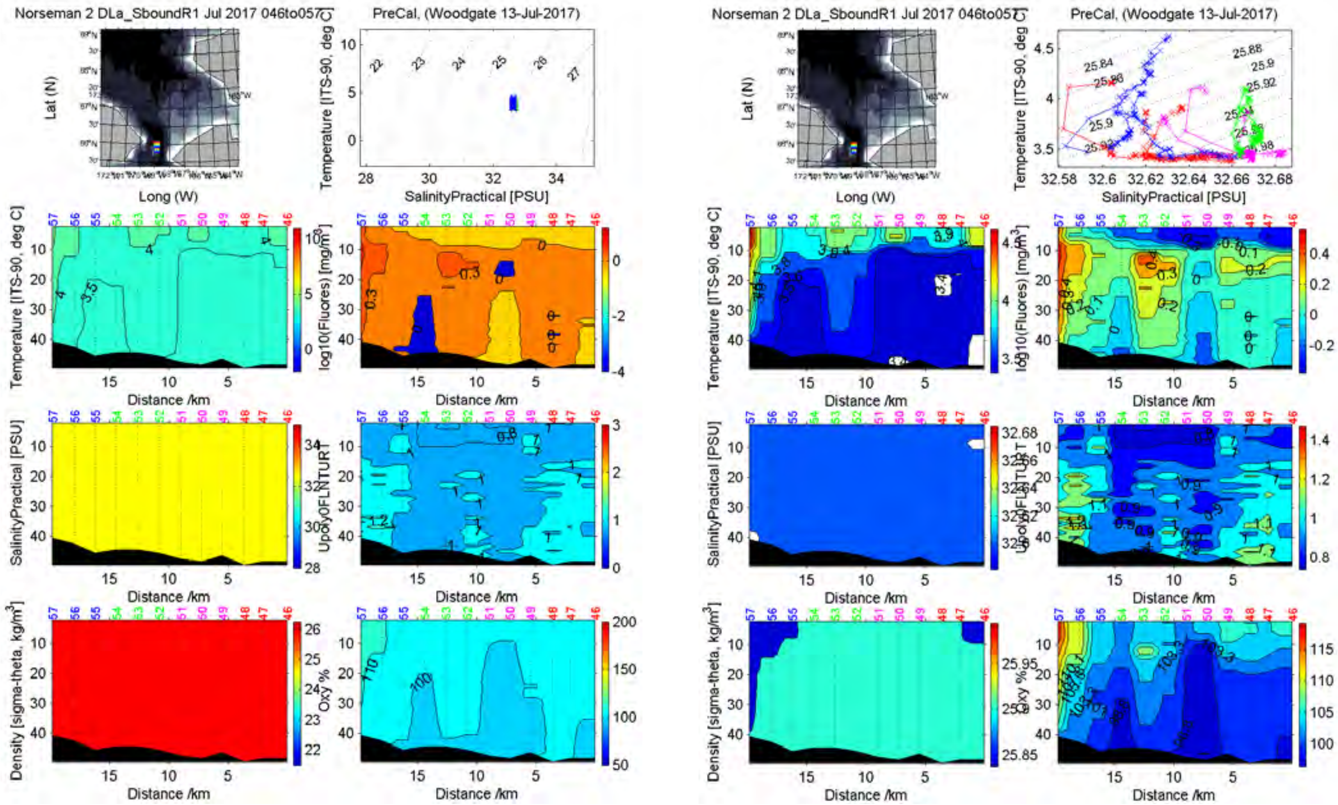
1) Bering Strait (BS) line – first running, Westward



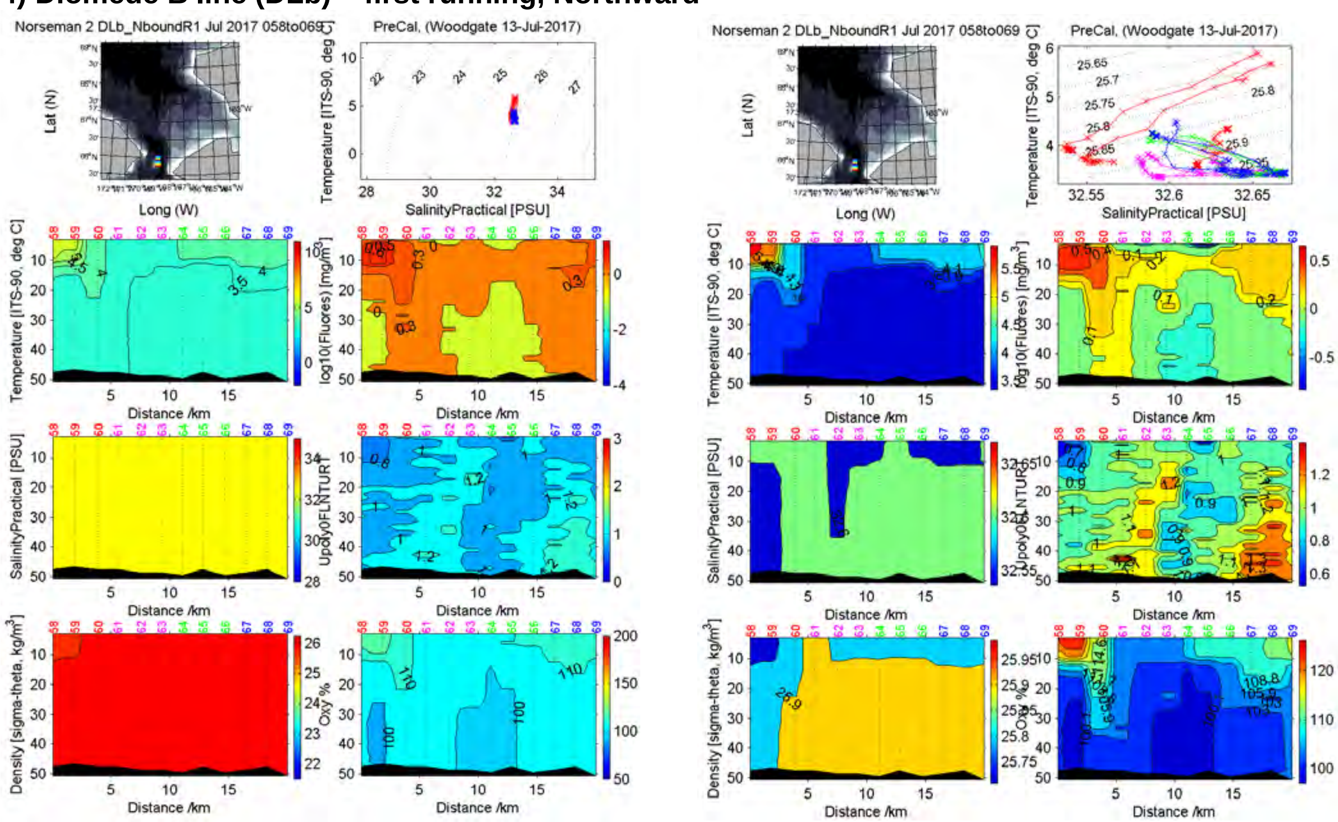
2) South portion of Diomede (DL) line – first running, Northward



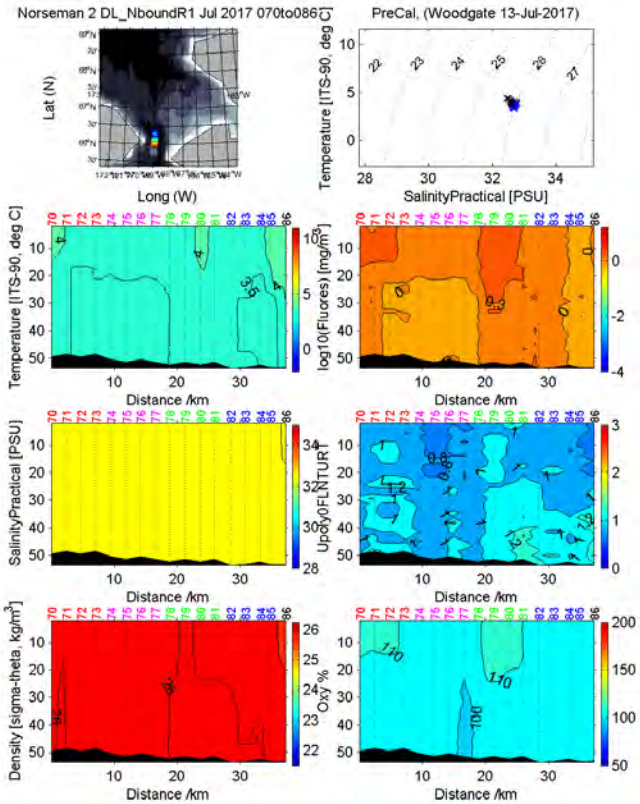
3) Diomede A line (DLa) – first running, Southward

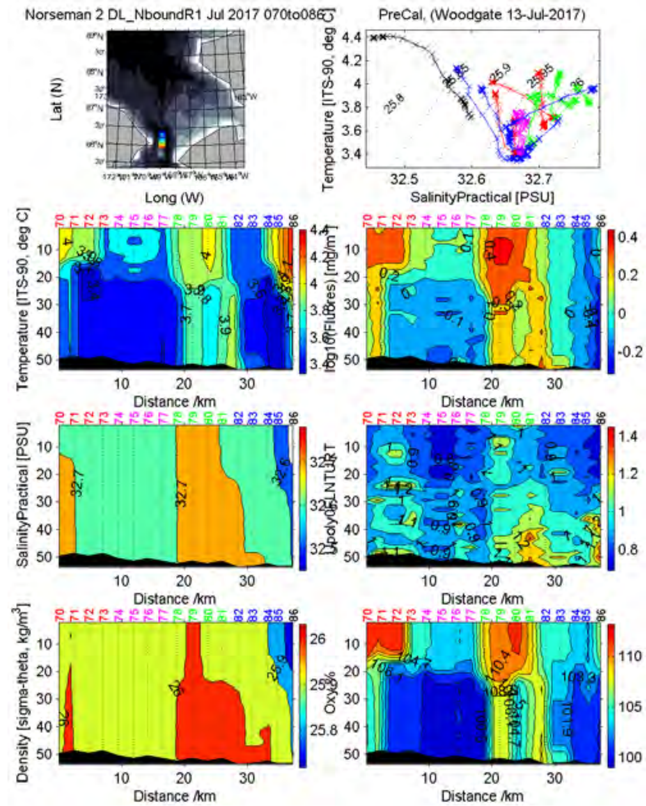


4) Diomede B line (DLb) – first running, Northward

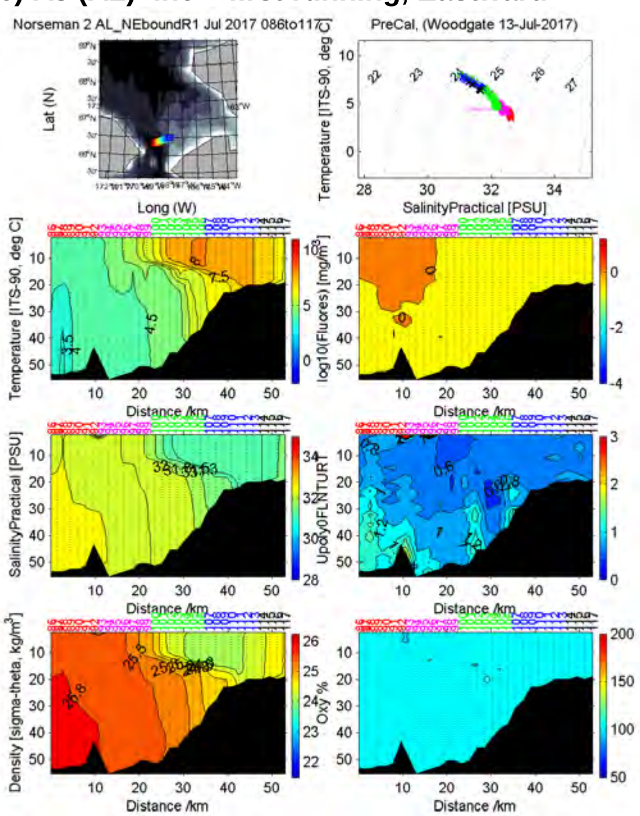


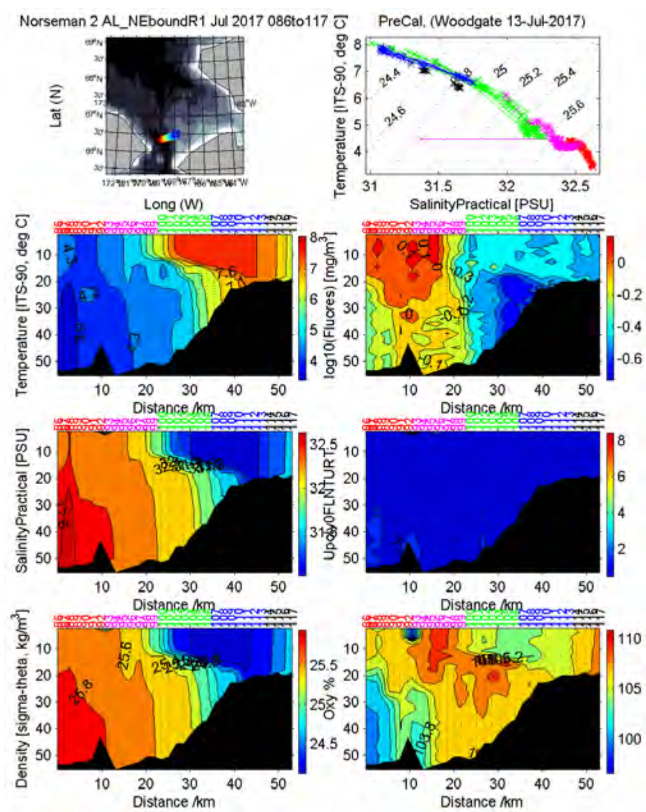
5) North portion of Diomede (DL) line – only running, Northward



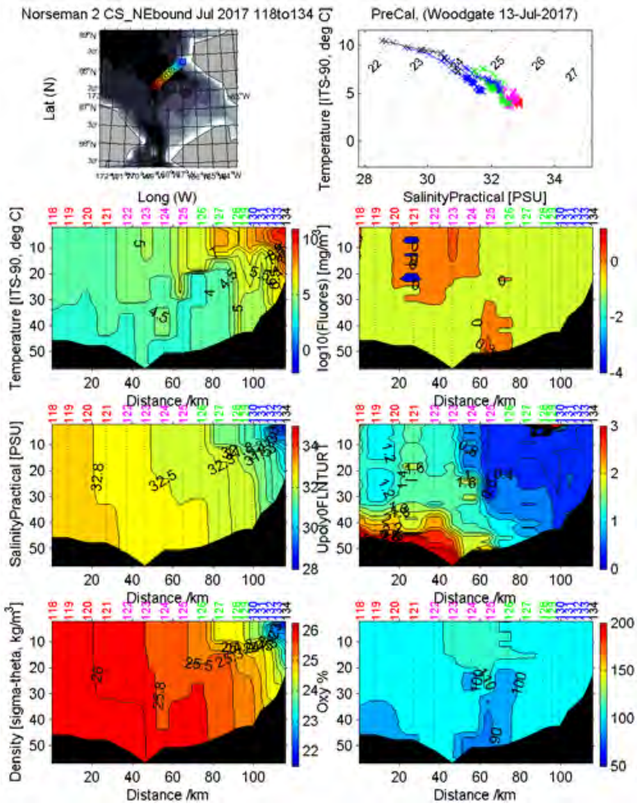


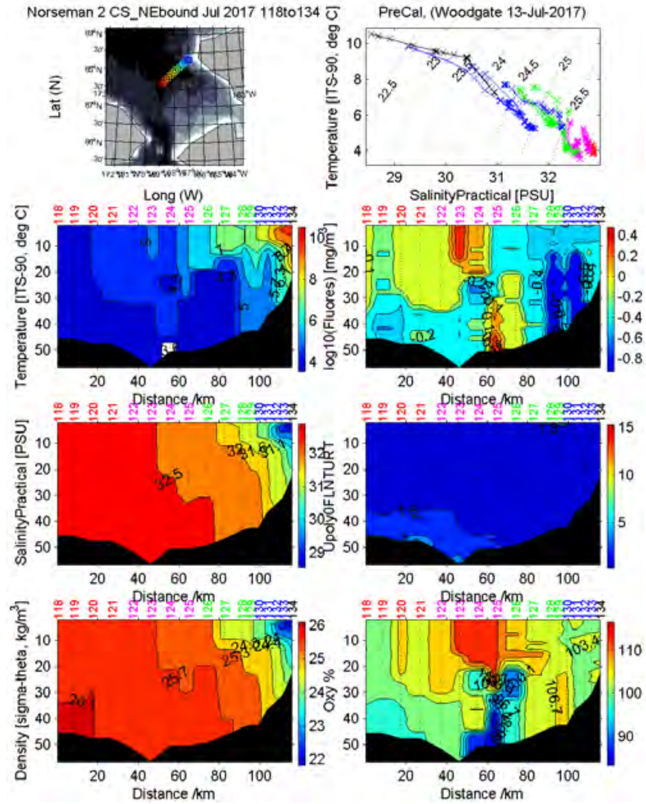
6) A3 (AL) line – first running, Eastward



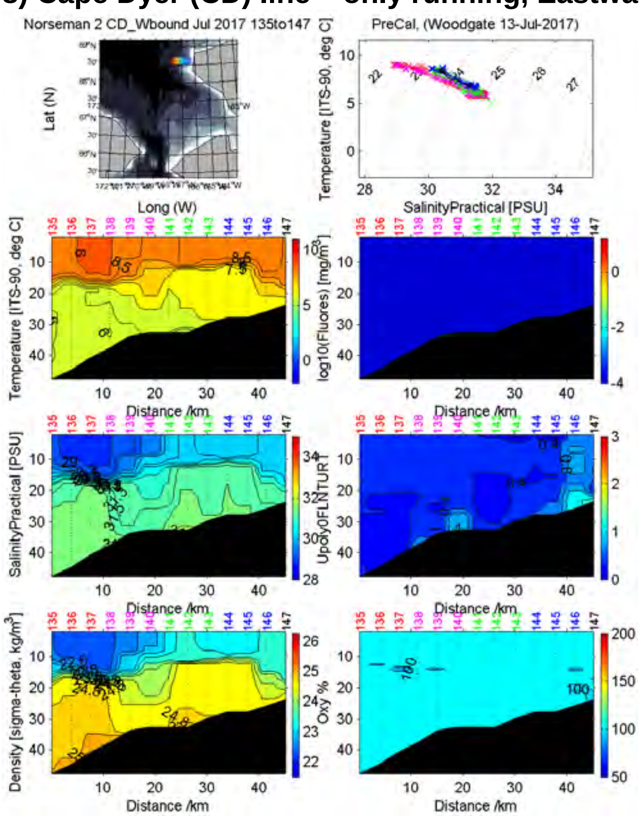


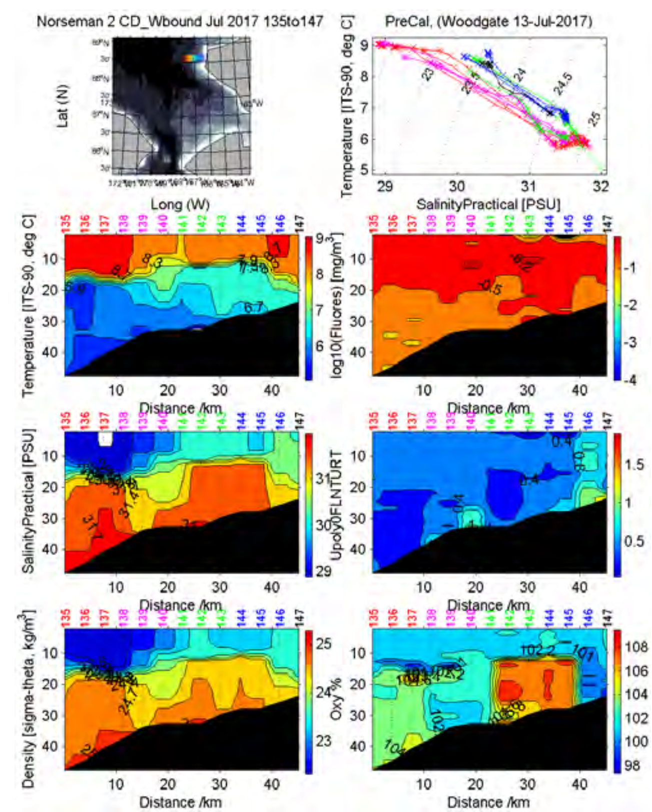
7) Cape Serdste-Kamen (CS) line (US portion only)– only running, Eastward



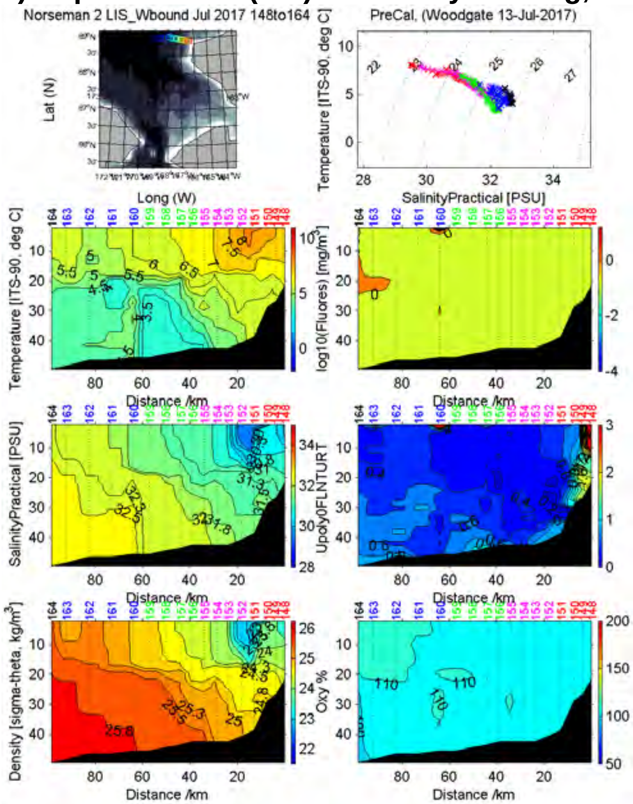


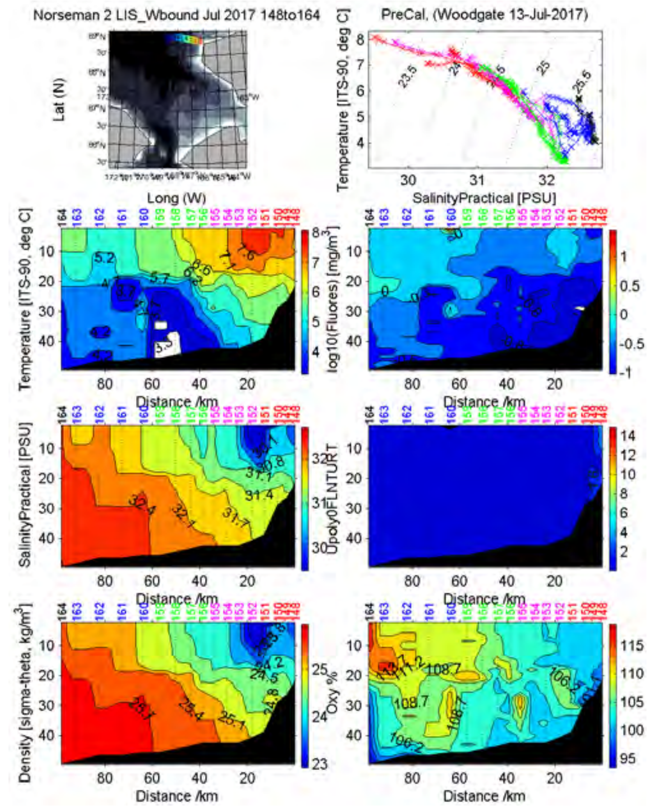
8) Cape Dyer (CD) line – only running, Eastward



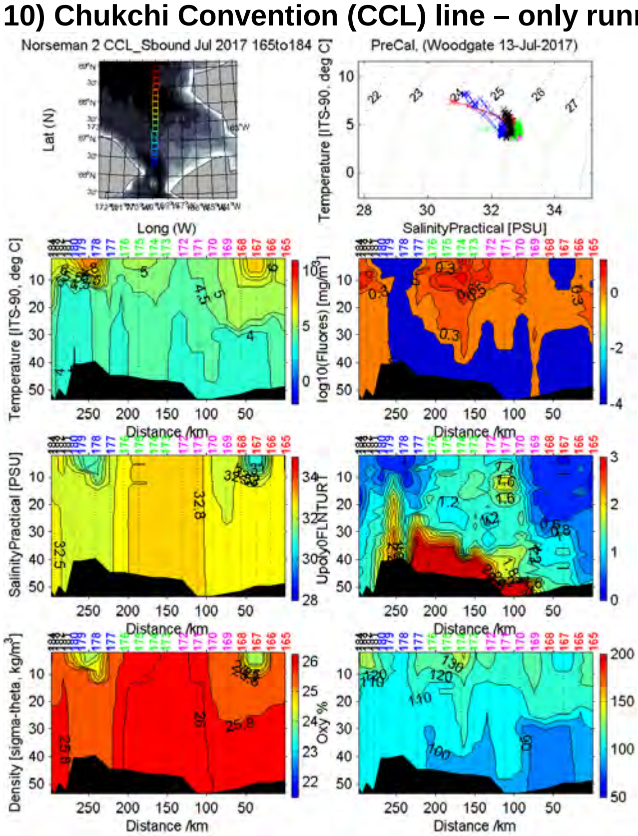


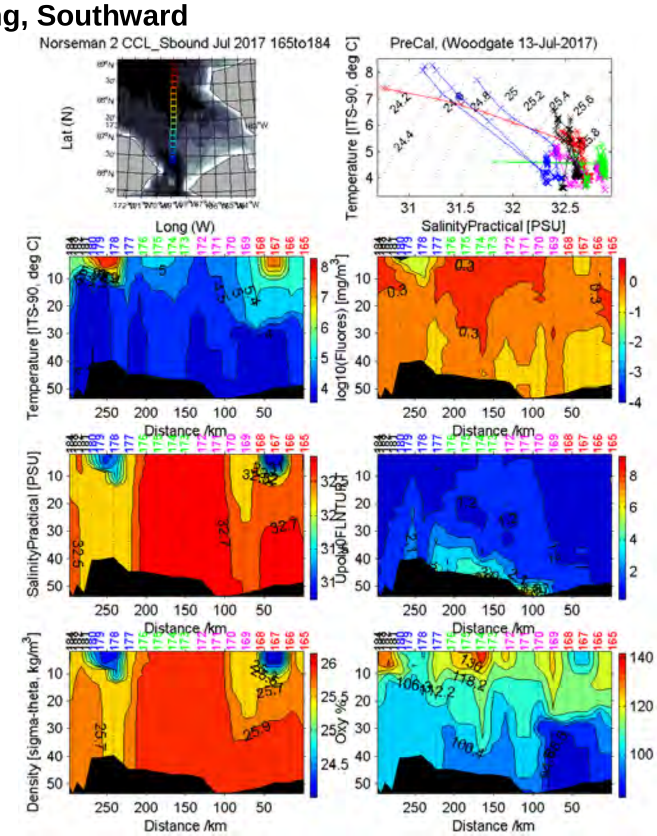
9) Cape Lisburne (LIS) line – only running, Westward



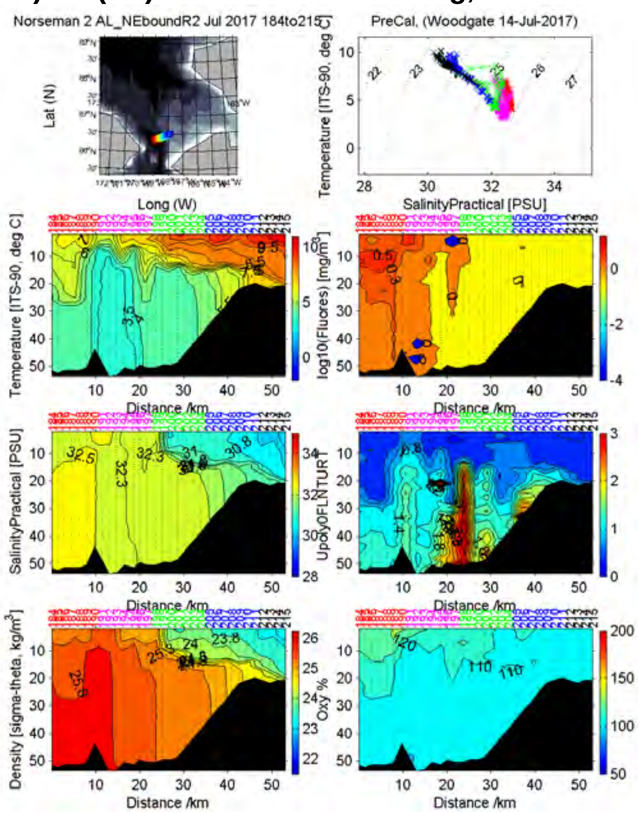


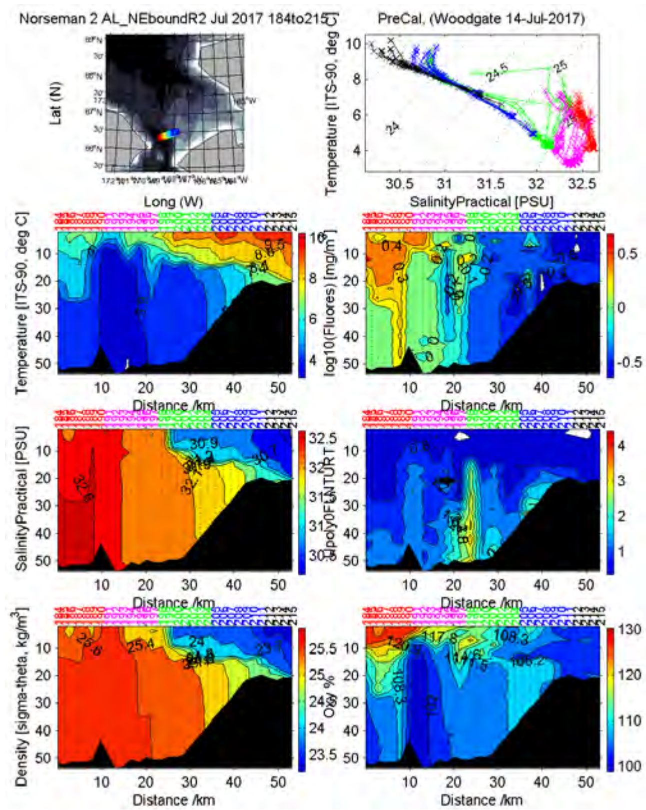
10) Chukchi Convention (CCL) line – only running, Southward



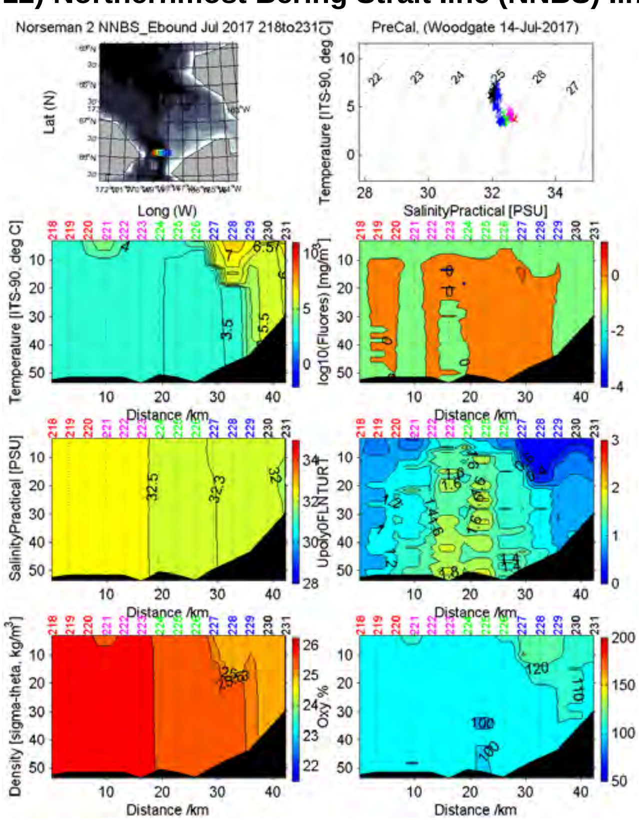


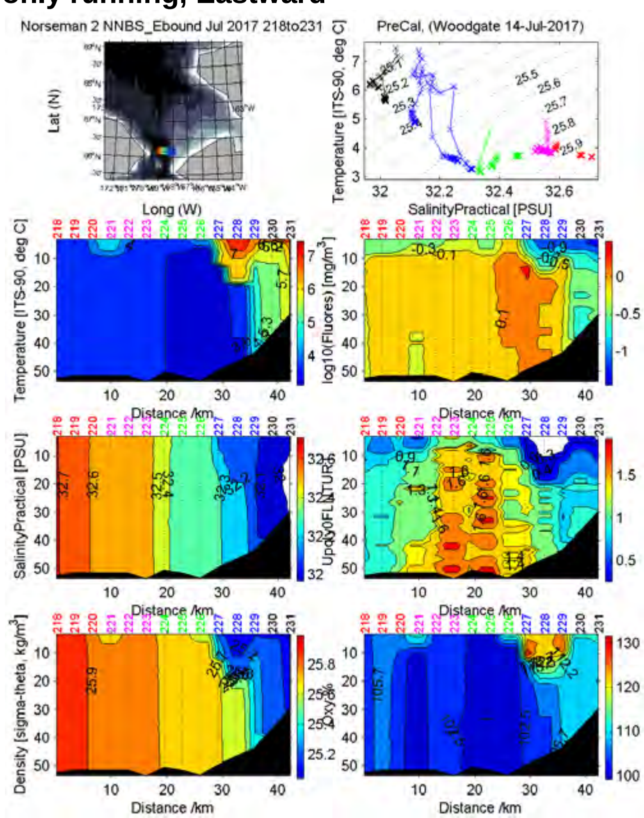
11) A3 (AL) line – second running, Eastward



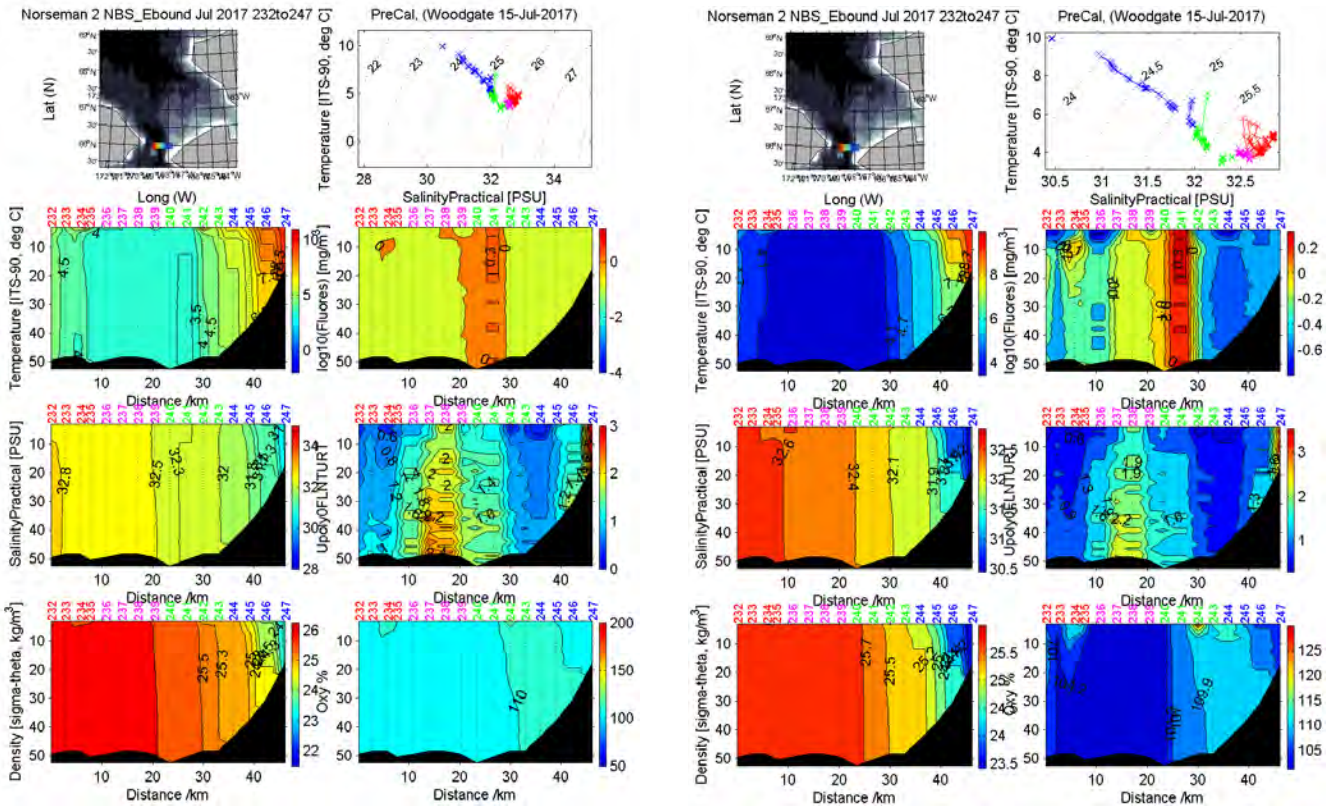


12) Northernmost Bering Strait line (NNBS) line – only running, Eastward

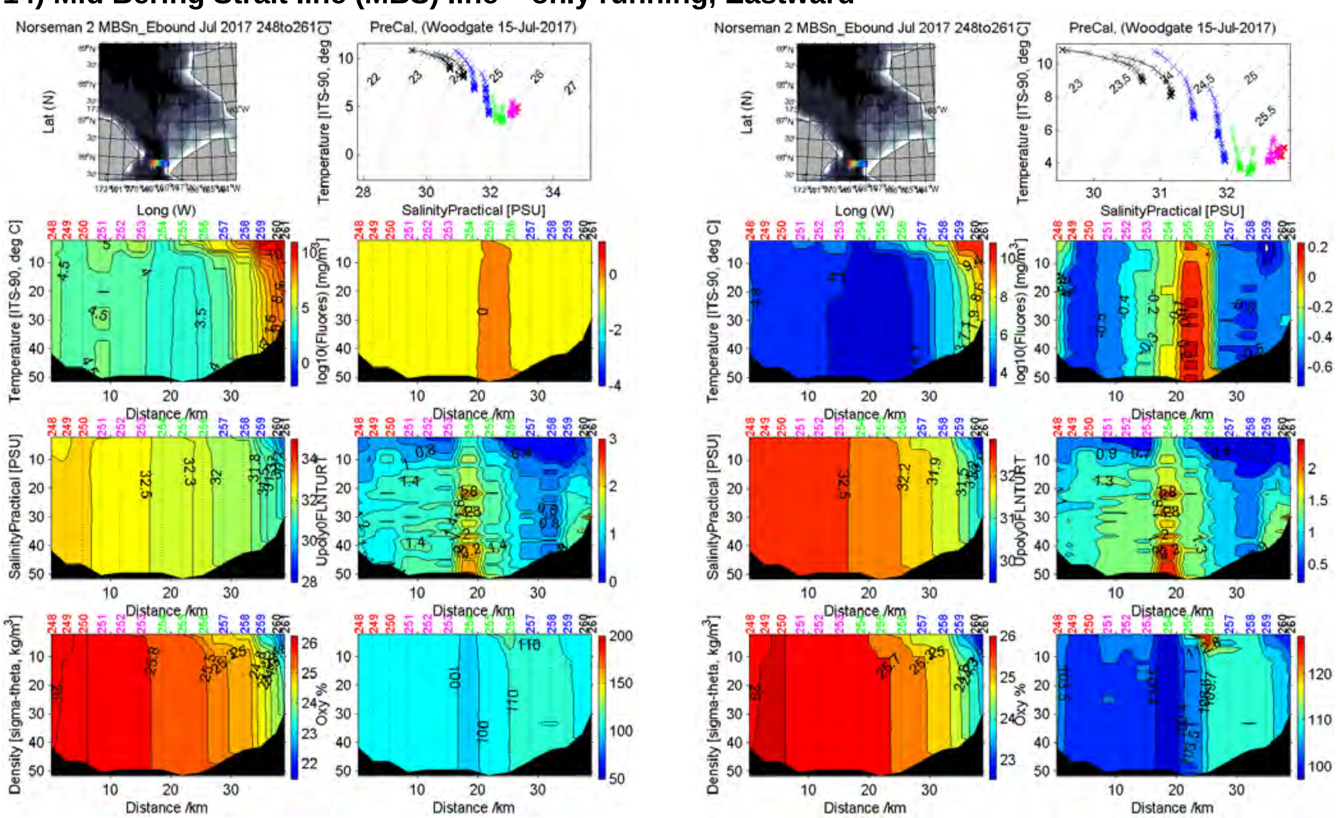




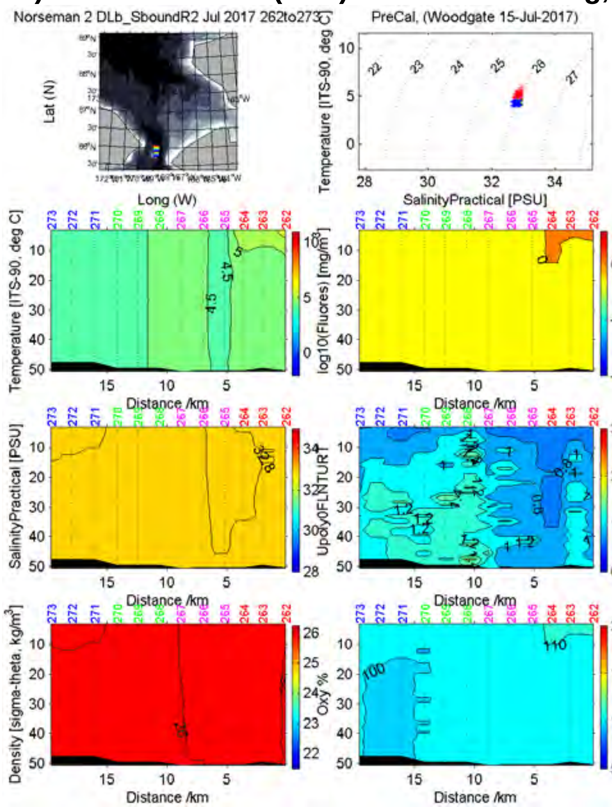
13) NorthBering Strait line (NBS) line – only running, Eastward

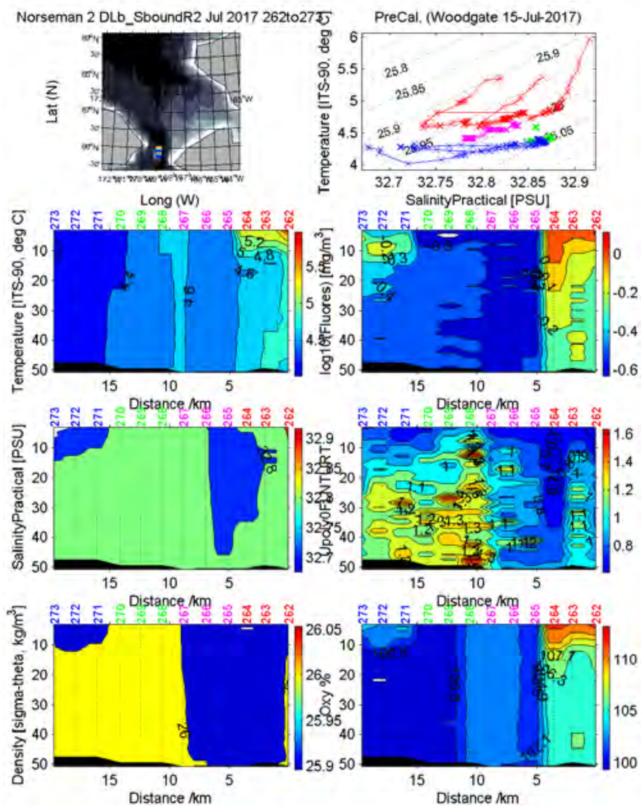


14) Mid Bering Strait line (MBS) line – only running, Eastward

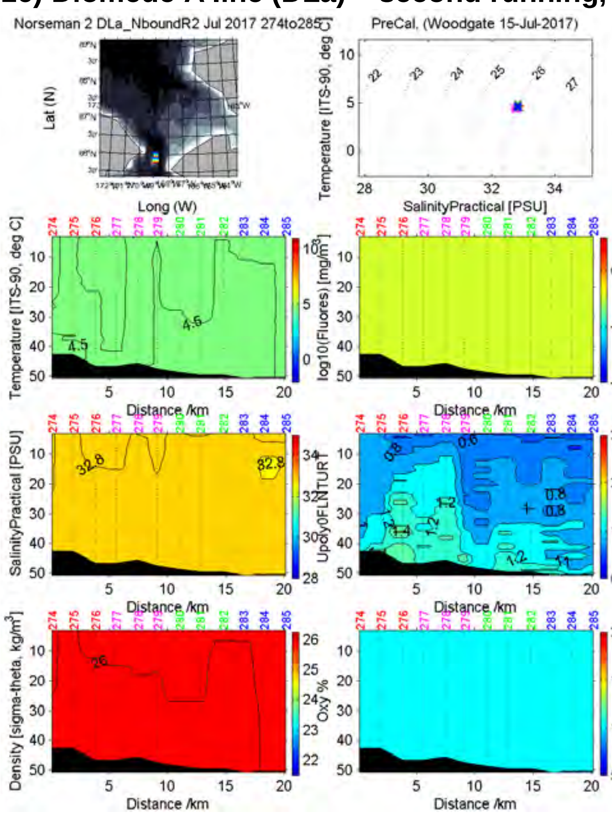


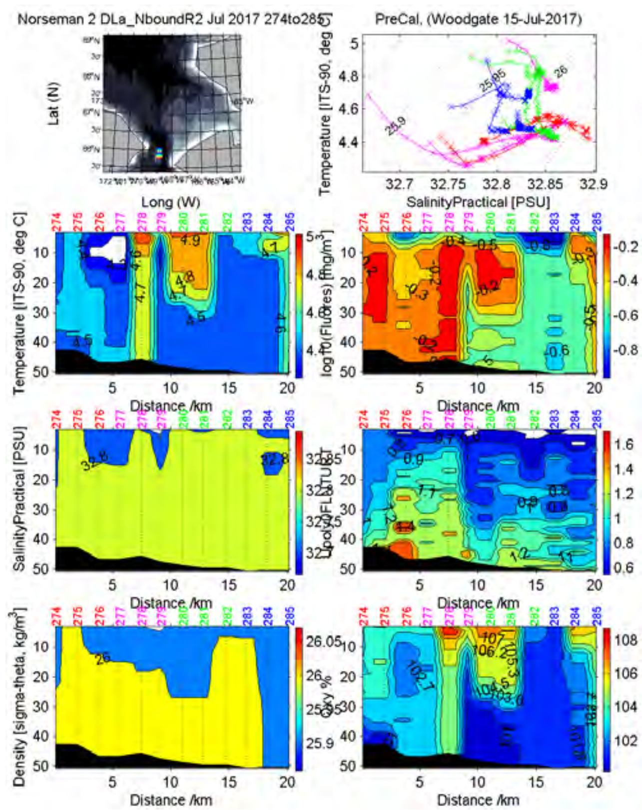
15) Diomede B line (DLb) – second running, Southward



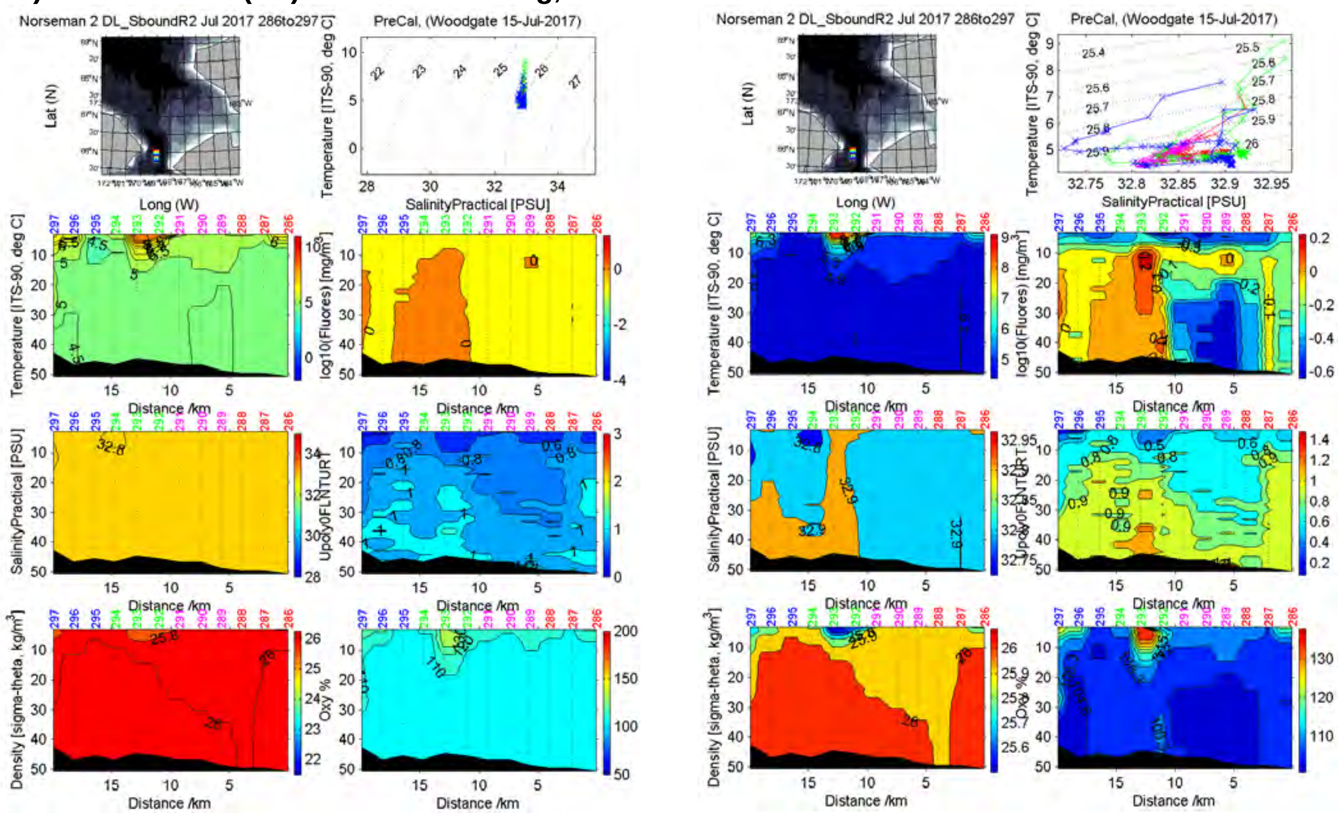


16) Diomede A line (DLa) – second running, Northward

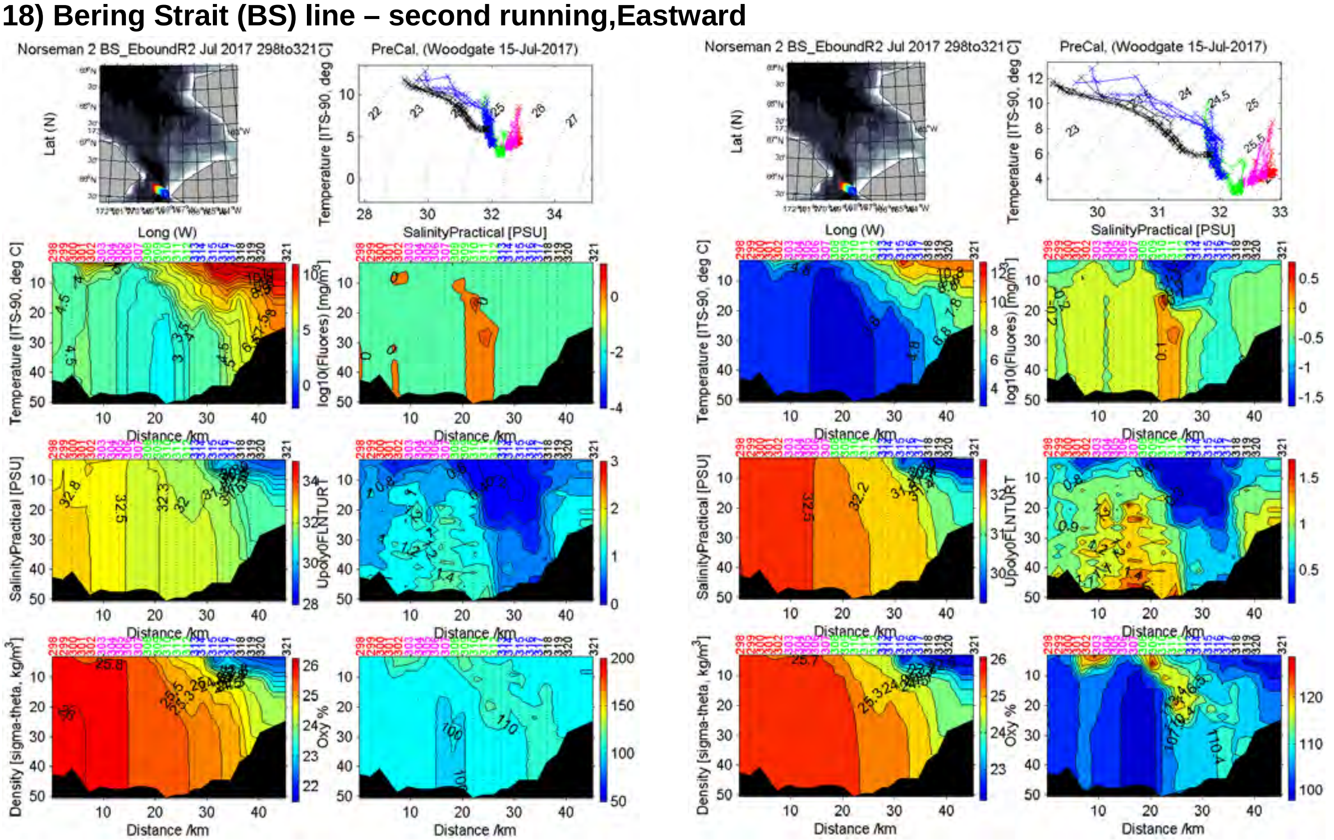




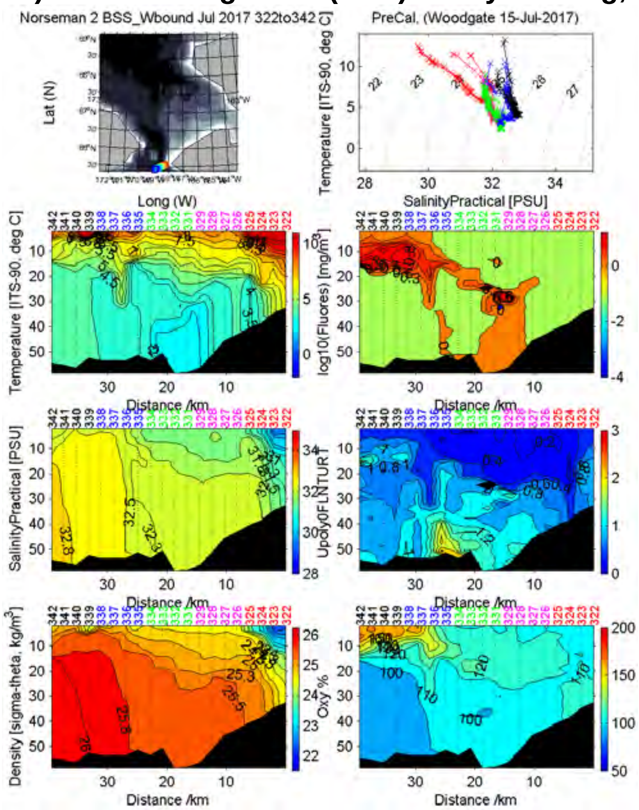
17) Diomede line (DL) – second running, Southward

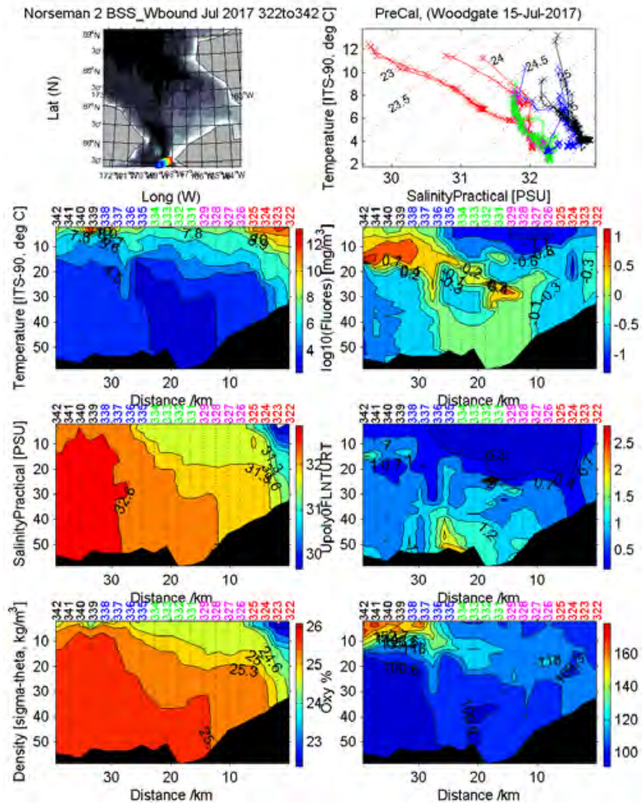


18) Bering Strait (BS) line – second running,Eastward



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





GLIDER DEPLOYMENT REPORT - Brita Irving, UAF

On July 13, 2017 a G2 200m Slocum underwater glider was deployed off the Norseman II at 17:30 UTC in the southern Chukchi Sea at 66° 29.159'N 168° 06.139'W, near station AL24 of the AL line. The 2017 Whale Glider, unit 595, was equipped with a DMON (a passive acoustic monitor that listens for marine mammals); a Neil Brown CTD, and a Wetlabs FLNTU Ecopuck (measuring chlorophyll and turbidity).

The Norseman II arrived at the old end of the AL CTD line, station AL24, at approximately 16:30 UTC where the glider ran through a final on deck status mission. The Norseman II crew used the A-frame to deploy the glider off the aft deck at 16:50UTC. Once in the water the glider ran through another status mission then was sent on two check-out missions. The first mission, ini0.mi, did a single dive to 3m and surfaced and the second mission, g595_tst.mi, did two dives to approximately 20m. After surfacing, the glider's science and engineering data were reviewed and the glider was sent on its deployment mission at 17:30 UTC, July 13, 2017.

The glider will spend the next several months traversing in and out of the Alaskan Coastal Current as the glider flies north off the west coast of Alaska toward Utqiaġvik (Barrow).

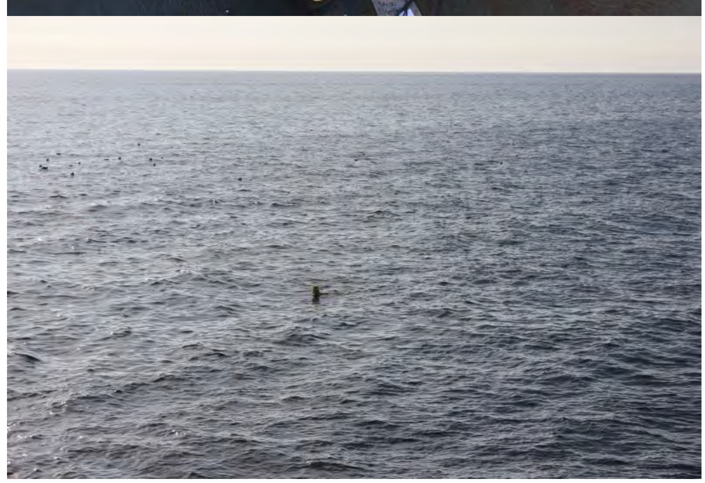
The 2017 Whale Glider was purchased with NPRB Grant 1515 and will be the 3rd multi-month mission in the Pacific Arctic with continued support by AOOS and NPRB.

Data from last year's mission is available at:

http://dcs.whoi.edu/chukchi_2016/chukchi_2016.shtml

http://www.ims.uaf.edu/artlab/tools/gliders/diagnostics/Chukchi/unit_191/unit_191_enginerring_diagnostics.html





Photos by D.Panicker

MARINE MAMMAL REPORT - Kate Stafford,
Kate Stafford, Erica Escajeda, Divya Panicker

Acoustic recorders

In 2017, acoustic recorders were recovered from all three moorings. Unfortunately, due to a programming error during the 2016 cruise, none of the instruments recorded data. This was very likely due to the communications cable being removed from the instrument before the program was finished sending instructions to the hydrophones. This theory was tested during the 2017 cruise by recreating several programming scenarios with a spare hydrophone package.

Hydrophone instruments were deployed in 2017 on each of the three moorings – the programming on these was double checked to ensure that the instruments will record this year. Unless further funding is acquired for the passive acoustic monitoring instruments, these may be removed from the Bering Strait moorings in 2018.

Sighting survey

A one-person marine mammal watch was held on the bridge during daylight hours between 0700-2300 daily when visibility was greater than 1 nautical mile, and sea state was less than a Beaufort 6 and ship speed was greater than 5 knots. From 7-14 July, 357 km were surveyed under the above conditions. A storm over the 9-10 of July 2017 precluded observations during long stretches of those days. Of particular interest is the very high number of harbor porpoise sightings. Harbor porpoise are notoriously difficult to see in all but very calm conditions. We had nearly 3 days of flat calm water with little fog and during this time we regularly spotted porpoise. Their presence in the Pacific Arctic is poorly known but these sightings suggest that they may be fairly common in the Bering Strait region.

129 cetacean sightings of 276 animals total (Table 1; Figures 1 and 2) and 27 sightings of 59 total pinnipeds (Table 2; Figure 3).

Species	# animals	# sightings
Harbor porpoise	68	39
Gray whale	161	66
Minke whale	1	1
Humpback whale	1	1
Unid large whale	45	22
Grand Total	**276**	**129**

Species	# animals	# sightings
Bearded seal	1	1
Walrus	39	7
Ringed seal	2	2
Spotted seal	2	2
Unid phocid	15	15
Grand Total	**59**	**27**

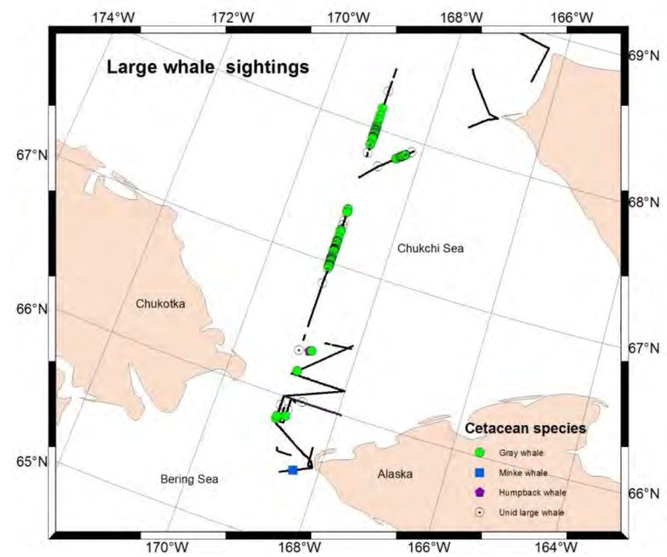


Figure 1. Locations of all large cetaceans sighted 7-17 July 2017. On-effort ship track is shown as black line.

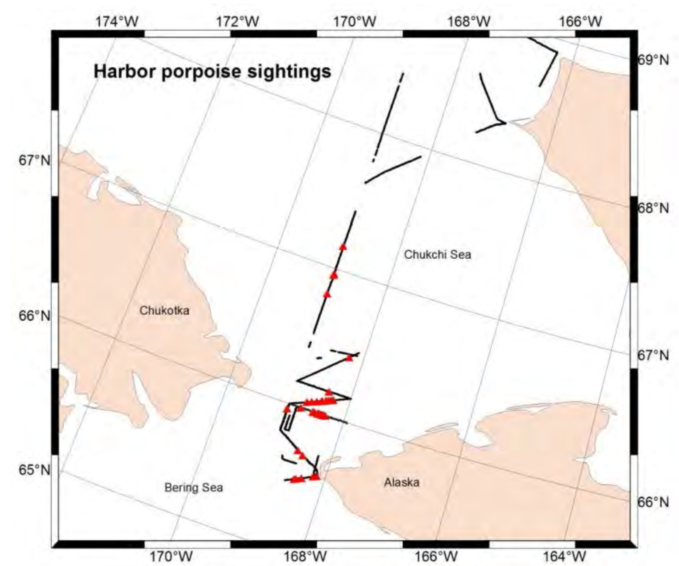


Figure 2. Location of all harbor porpoise sighted from 7-14 July 2017. On-effort ship track is shown as black line.

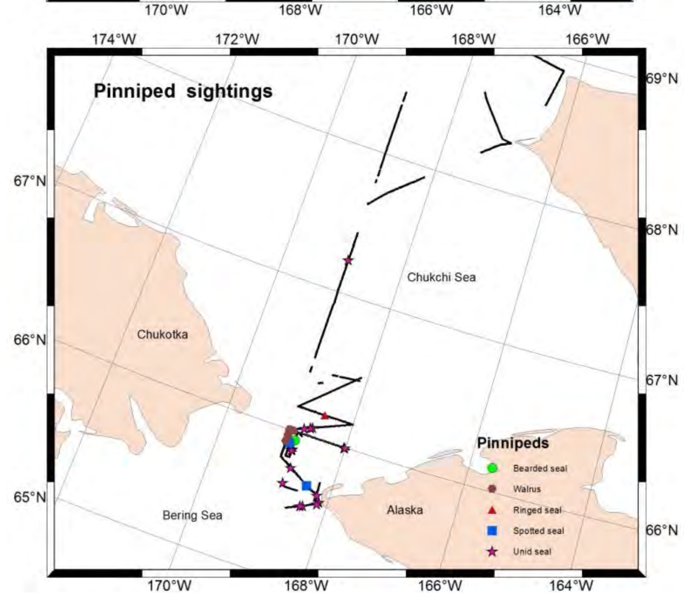


Figure 3. Location of all pinniped sightings 7-14 July 2017. On-effort ship track is shown as black line.

BERING STRAIT 2017 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 set up 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 4m bins. 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. Note the moderately low wind speeds (<20 knots) for most of the cruise, and the long period of wind from the north (9^{th}-13^{th} July 2017). **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 (but unfortunately, not 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 next year depth is 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.

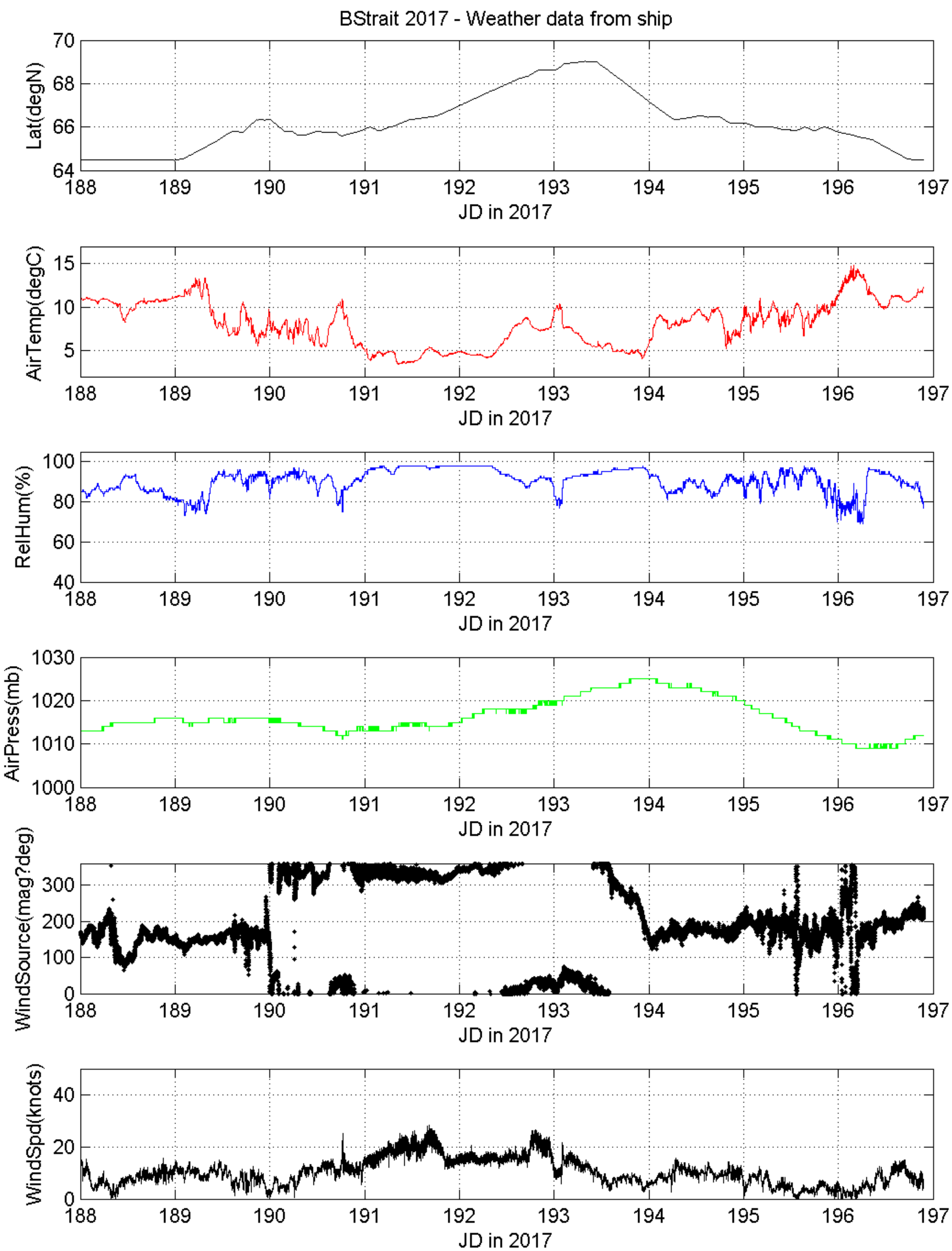
The following observations are worth of note:

- The typical pattern of waters being warmer and fresher near the Alaskan coast is evident in these data. Overall in the region, water temperatures are warmer away from the coast, compared to 2016 (2016 plots included below for reference.)

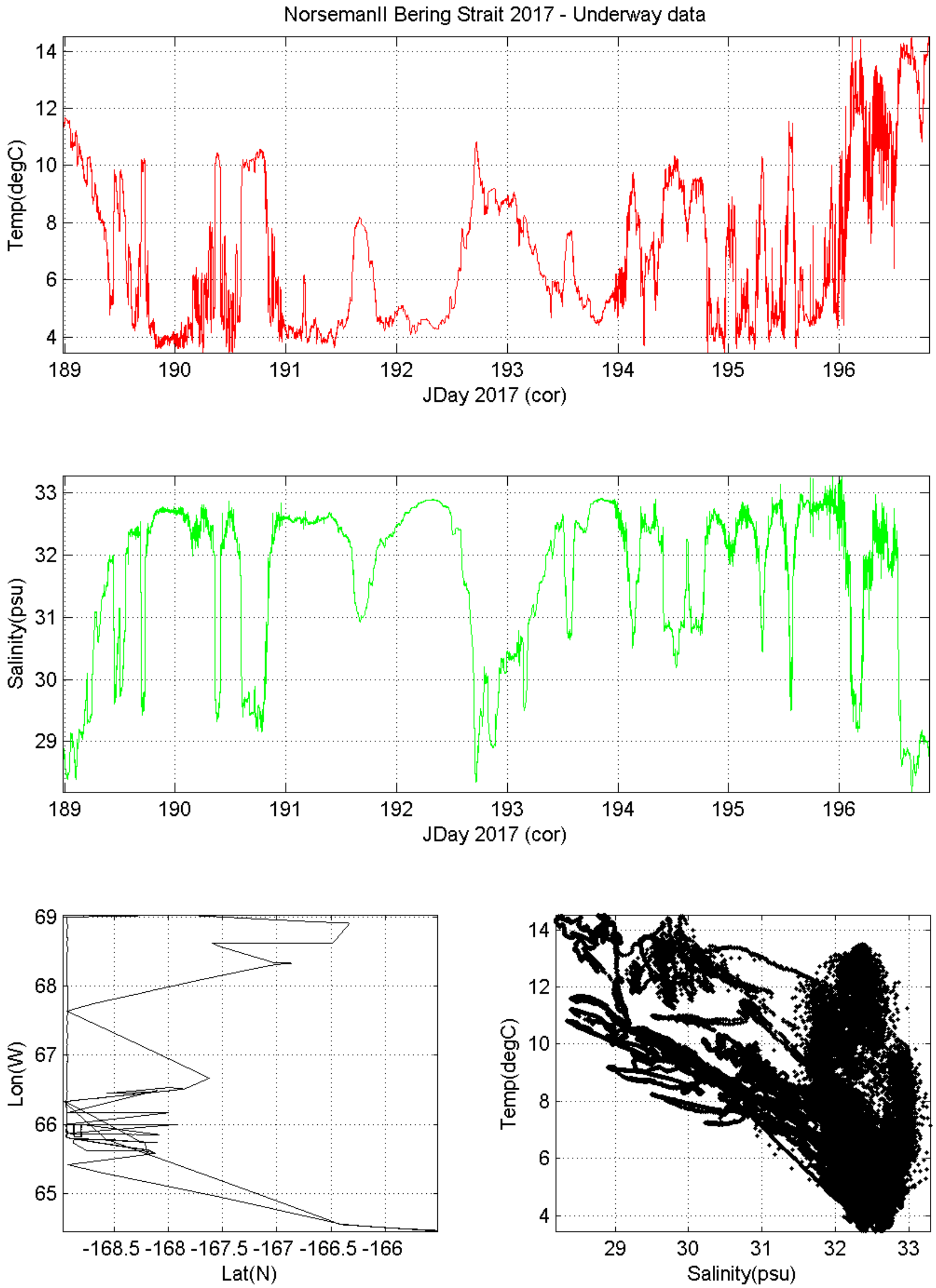
It is very important to remember when interpreting these data, that they are not synoptic, as is evidenced by the plots of the various crossings of the Bering Strait also shown below. **Action Item: Examine surface salinities and temperatures, especially in conjunction with prior data.**

BERING STRAIT 2017 METEOROLOGICAL DATA

Left Port at 2320 7th July 2017 (JD188), Returned to port 2030 15th July 2017 (JD 198)
(Note usual southward winds for 4 days of the cruise, plus much slower winds than 2016)

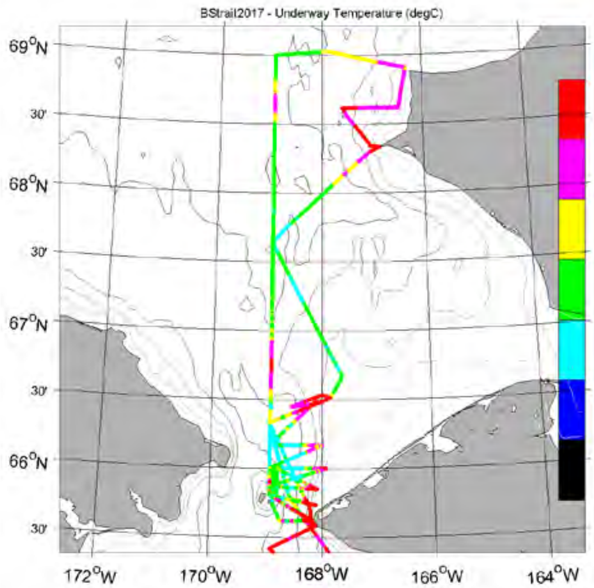


BERING STRAIT 2017 UNDERWAY TEMPERATURE SALINITY DATA

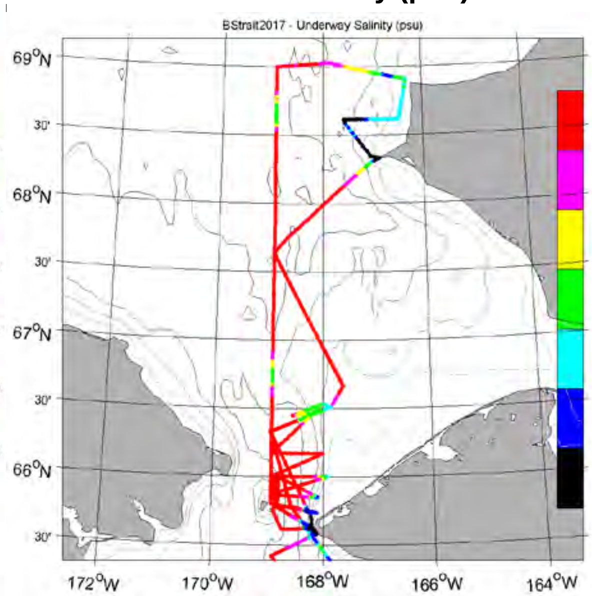


BERING STRAIT 2017 UNDERWAY TEMPERATURE SALINITY DATA (continued)

Temperature (degC)

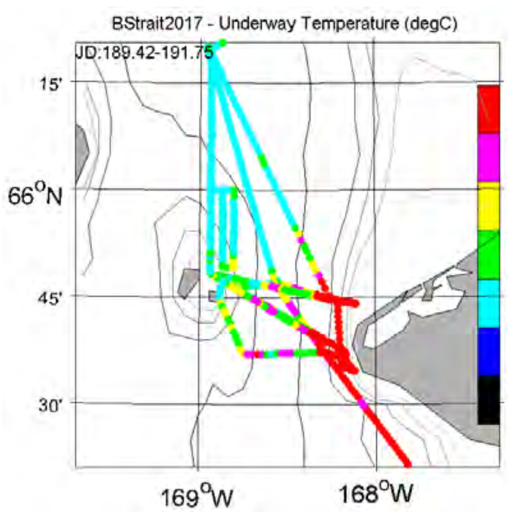


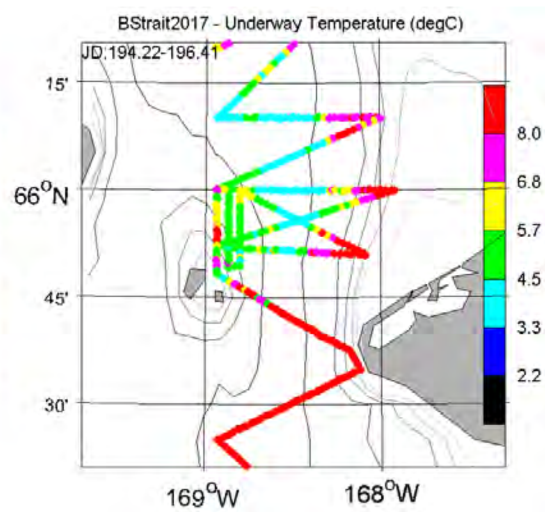
Salinity (psu)



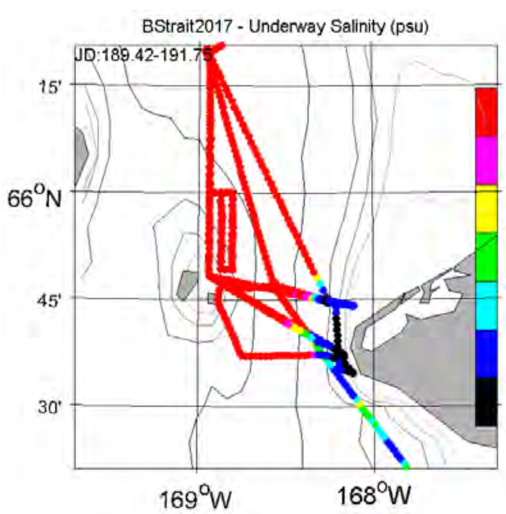
First half of Cruise | **Second half of cruise**

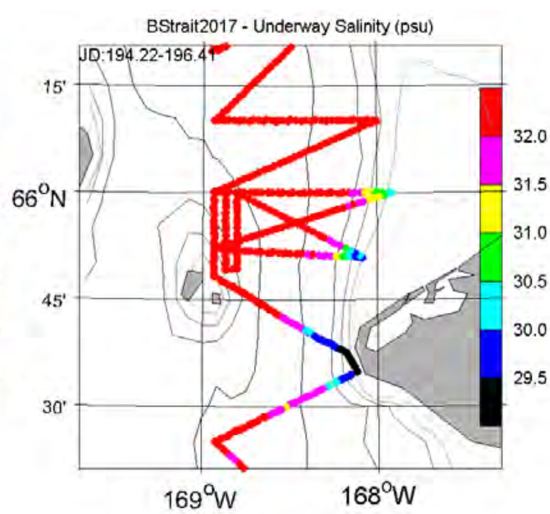
Underway Temperature (DegC)





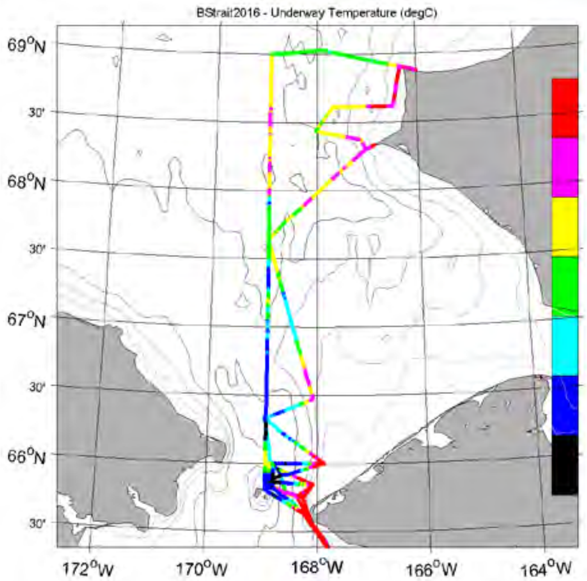
Underway Salinity (psu)



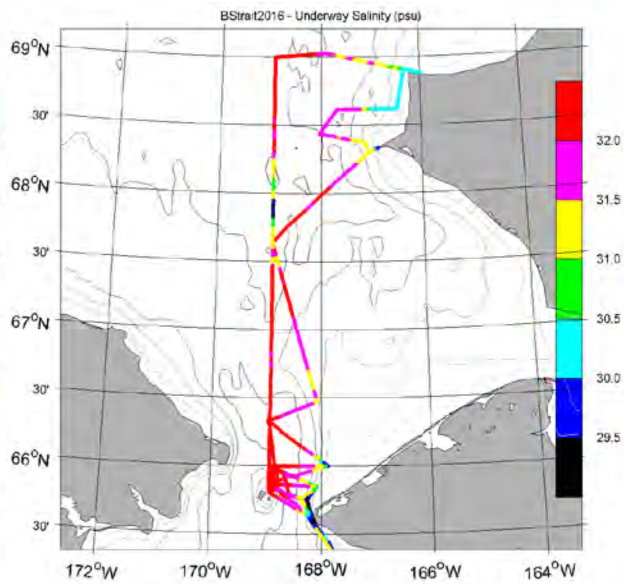


BERING STRAIT 2016 UNDERWAY TEMPERATURE SALINITY DATA (for reference)

Temperature (degC)

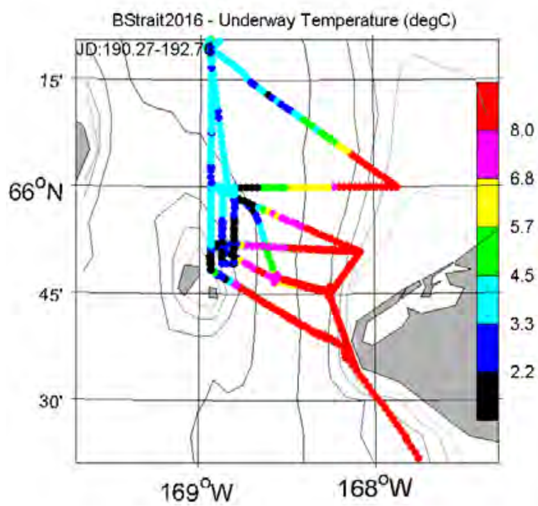


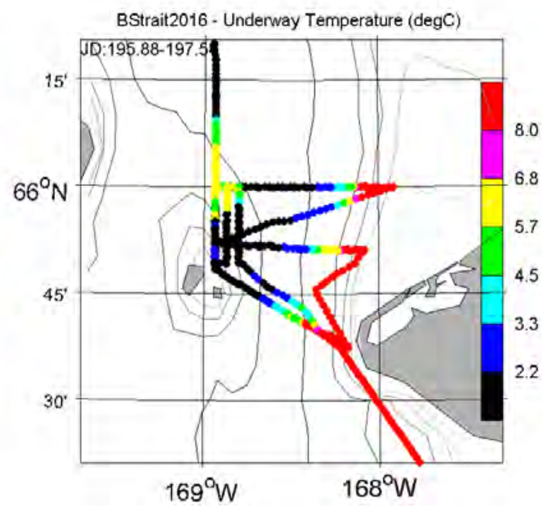
Salinity (psu)



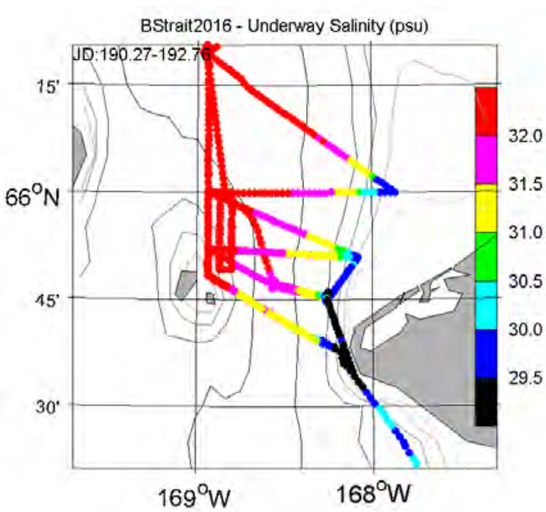
First half of Cruise ***Second half of cruise***

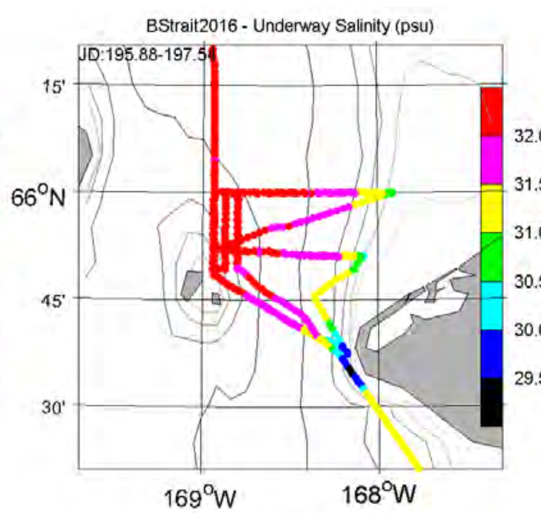
Underway Temperature (DegC)





Underway Salinity (psu)





QUINTILLION CABLE PROJECT

As reported last year, an international project from by Quintillion was to lay a communications cable throughout the Chukchi Sea. Details from last year are:
Website for project:
http://subseaworldnews.com/2016/06/23/quintillion-to-begin-subsea-cable-laying-in-july/

(route image reproduced from that website, accessed 25th July 2016)

Contacts:
= Frank Cuccio, Quintillion contact for possible conflict mitigation)
Mobile: 908 892 0052   Email: fcuccio@qexpressnet.com

Some Specifications:
- Fiber-optic cable to be laid summer 2016, with work starting in Nome currently (July 2016), and cable laying ships due to sail from Dutch 17-18th July, and lay the cable working north. The cable laying is scheduled to be finished this season.
- Cable runs from Nome to Prudhoe, with links going ashore in Barrow, Wainwright, Point Hope and Kotzebue.
- Cable to remain in place for 20-25 years.
- Cable is armored (core about 17mm, with armor about 25-30mm)
- the route has been surveyed at a swath width of 500m. The cable design has been finalized and all the cable sections have been manufactured.
- to be laid some buried, some just laid on the sea floor. The intent is to bury wherever possible in all areas south of the Bering Strait. North of the Bering Strait, they plan only to bury in waters which are shallower than 50m. On some seafloors (e.g., boulders, as in the strait, and probably elsewhere too) it cannot be buried and will just lie on the surface. Where buried, it is to be buried at least 1.5m deep (using a plough-like system, which digs a trench ~ 1ft wide, 1.5m deep, lays the cable at the bottom, and generally covers the cable over with the sediment it moved, or the sides may fall in covering the cable). In areas of greater ice keel risk, will be buried deeper (no details were given about these locations.)

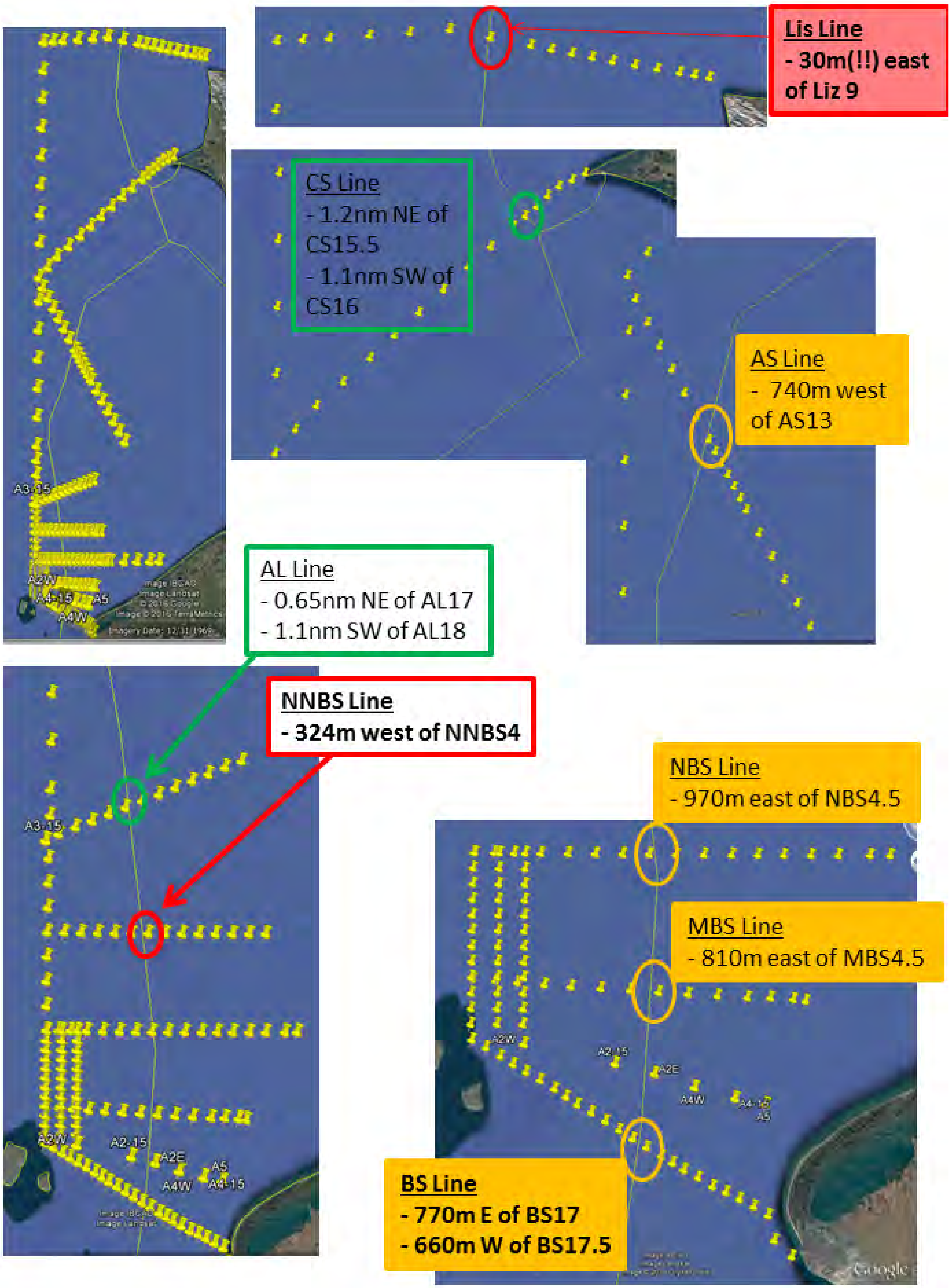
This year, 2017, positions of the cable were obtained from Frank Cuccio, although the information as to where the cable is/is not buried is still to be provided. Quintillion request a 300m separation from our stations and the cable positions. This impacted our cruise only in 3 places:
- new station AL17.5, which we moved to be off the cable.
- old station CD14 , which we skipped

- old station Lis9, which we replaced with two neigbouring stations Lis8.5 and Lis9.5.
In the strait, the cable is 2nm from our mooring position A2.

Here is a list of where the cable crosses our lines, with distance to nearest station:

BS line - between BS17 (0.5nm) and BS17.5 (1000yards)
A2 mooring - 2nm
MBS - between MBSn4 (1.3nm) and MBSn5 (870yards)
NBS - between NBS4.5 (0.5nm) and NBS5 (further)
NNBS - between NNBS3.5 (further) and NNBS4 (472yards)
AL - between AL17 (0.8nm) and AL18 (further)
AS - off AS13 (845yards)
CS - between CS15.5 (further) and CS16 (1nm)
NPH - between NPH7 (further) and NPH6 (944yards)
CD - between CS14 (900 yards) and CD13 (further)
LIS - only 32 yards from Lis9

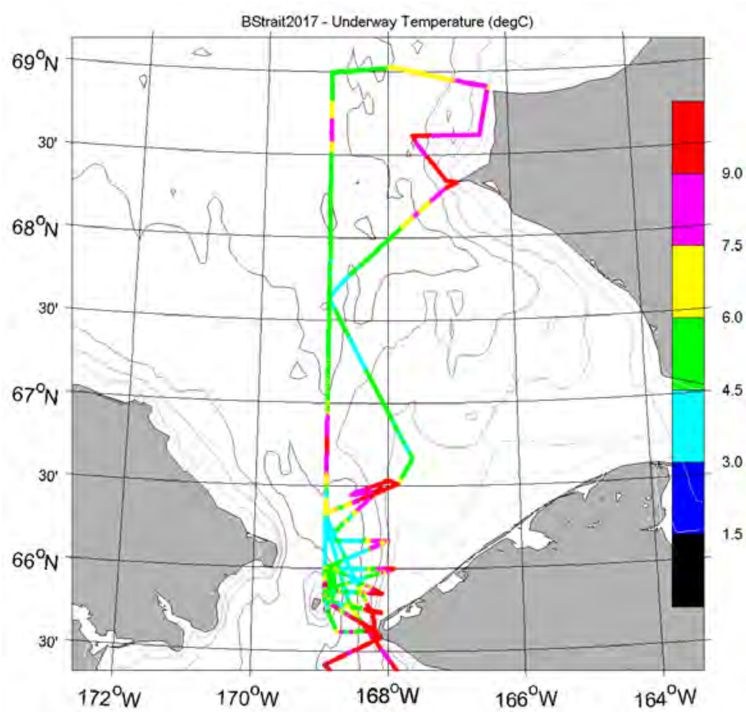
Action Item: Get information about where the cable is buried and exact position of the line and depth to check for any new stations on next year's cruise.


Lis Line
- 30m(!!) east of Liz 9
CS Line
- 1.2nm NE of CS15.5
- 1.1nm SW of CS16
AS Line
- 740m west of AS13
AL Line
- 0.65nm NE of AL17
- 1.1nm SW of AL18
NNBS Line
- 324m west of NNBS4
NBS Line
- 970m east of NBS4.5
MBS Line
- 810m east of MBS4.5
BS Line
- 770m E of BS17
- 660m W of BS17.5
A3-15
A2W
A4-15
A5
A4W
A2-15
A2E
Google

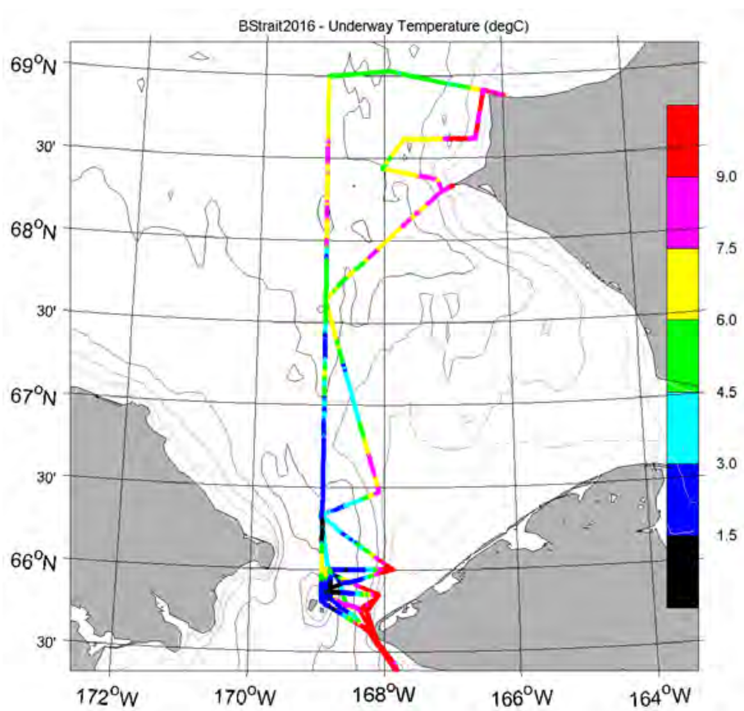
PRELIMINARY INTERANNUAL COMPARISONS FROM BERING STRAIT 2017 MOORING DATA

Although post-cruise calibrations and extensive data quality control are still to be performed, it is informative to make some preliminary interannual comparisons with past data.

1) From underway data, compared to last year's cruise (which was on the same dates) the **strait is remarkably warm already in July 2017.**



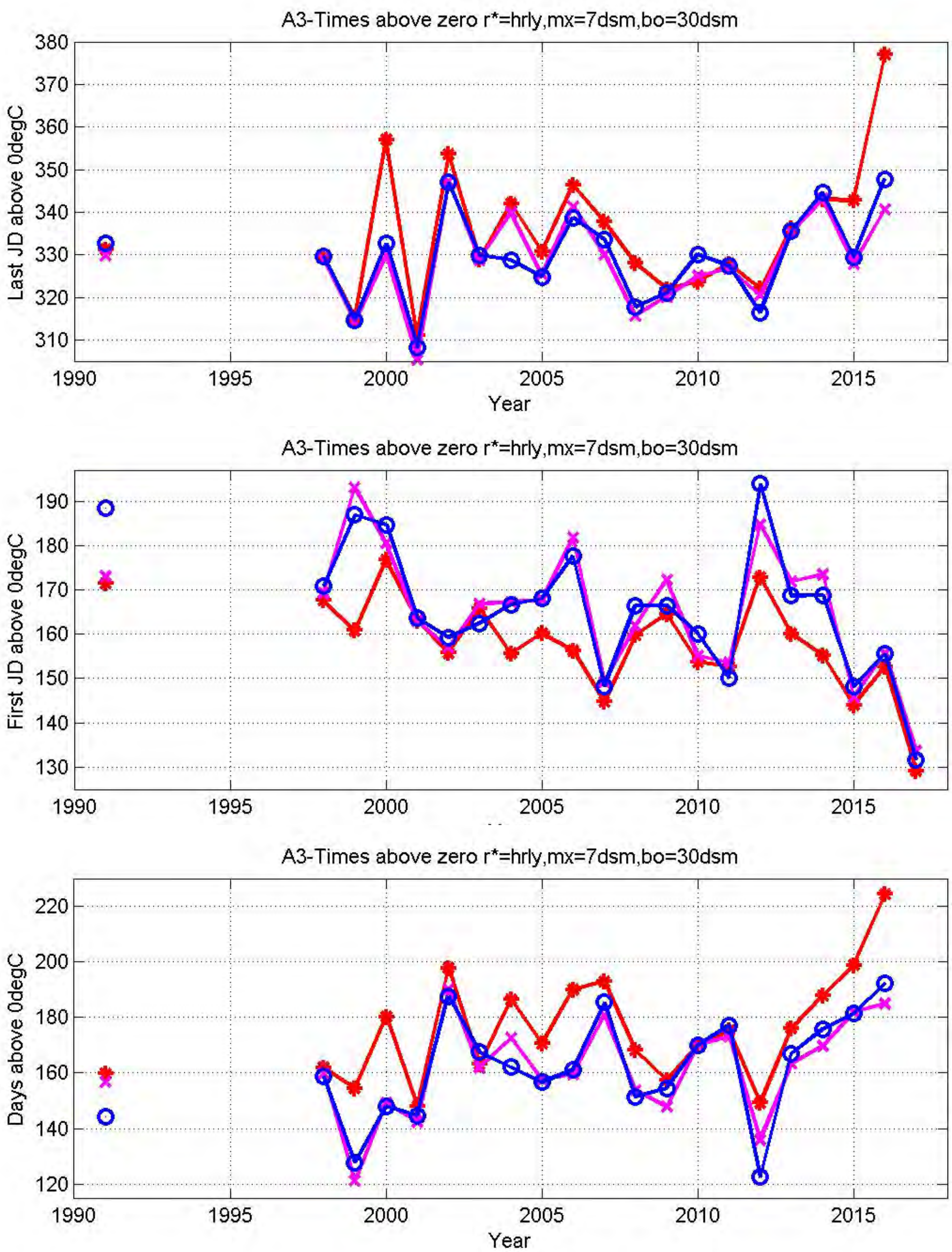
Underway (i.e., ~ 3m/surface) Temperature (°C) from Norseman II 2017 Bering Strait Cruise (7th-15th July 2017)



Underway (i.e., ~ 3m/surface) Temperature (°C) from Norseman II 2016 Bering Strait Cruise (7th-15th July 2016)

2) Compared to prior mooring data, we find in 2016-2017:

- **the strait cooled remarkably late in 2016** (in hourly data, waters above 0°C are found into mid January, **~20 days later** than any previous recorded year) *(top panel*); and
- **the strait warmed remarkably early in 2017** (in hourly, 7-day smoothed and 30-day smoothed data, waters above 0°C are found as early as mid-May, **~15 days earlier** than in any previous year and **~1 month earlier than the average**) *(middle panel);*
- 2016 summer season is one of the longest on record (*bottom panel).*



Last day above °C after the summer

First day above °C after the winter

Number of days between first and last days above °C

By year, Julian Day for last day above 0°C (top); first day above 0°C (middle); and length of warm season (bottom) calculated from A3 mooring data, either hourly (red), 7-day smoothed (magenta) or 30-day smoothed (blue).

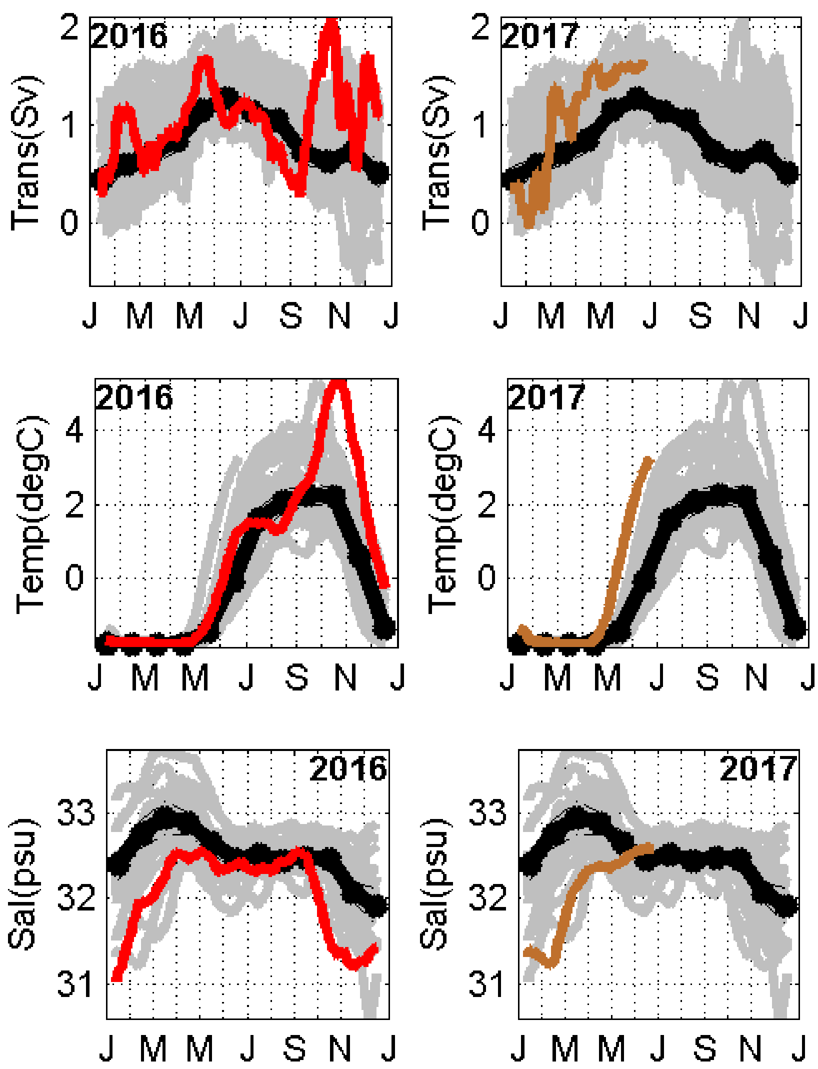
3) Compared to mooring data from 1990-present and the 1990-2004 Bering Strait climatology [*Woodgate et al.*, 2005b], the new 30-day smoothed data show

Fall 2016 has

anomalously high flows (highest in the record) *(top left panel)*
anomalously high temperatures (comparable to previous high in 2005) and
anomalously late cooling *(both middle left panel)*
anomalously low salinities (~ 0.5-1psu less than climatology) *(bottom left panel)*

Early 2017 has

above average, but not record extreme, northward flow *(top right panel)*
anomalously high temperatures (~ 3 degrees warmer than June climatology) and
anomalously early warming *(both middle right panel)*
anomalously low salinities (~ 1psu less than climatology) *(bottom right panel)*



30-day smoothed estimates from A3 mooring data for transport (top), near-bottom temperature (middle) 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, [submitted].

4) In terms of annual means, preliminary mooring data suggest 2016 has:

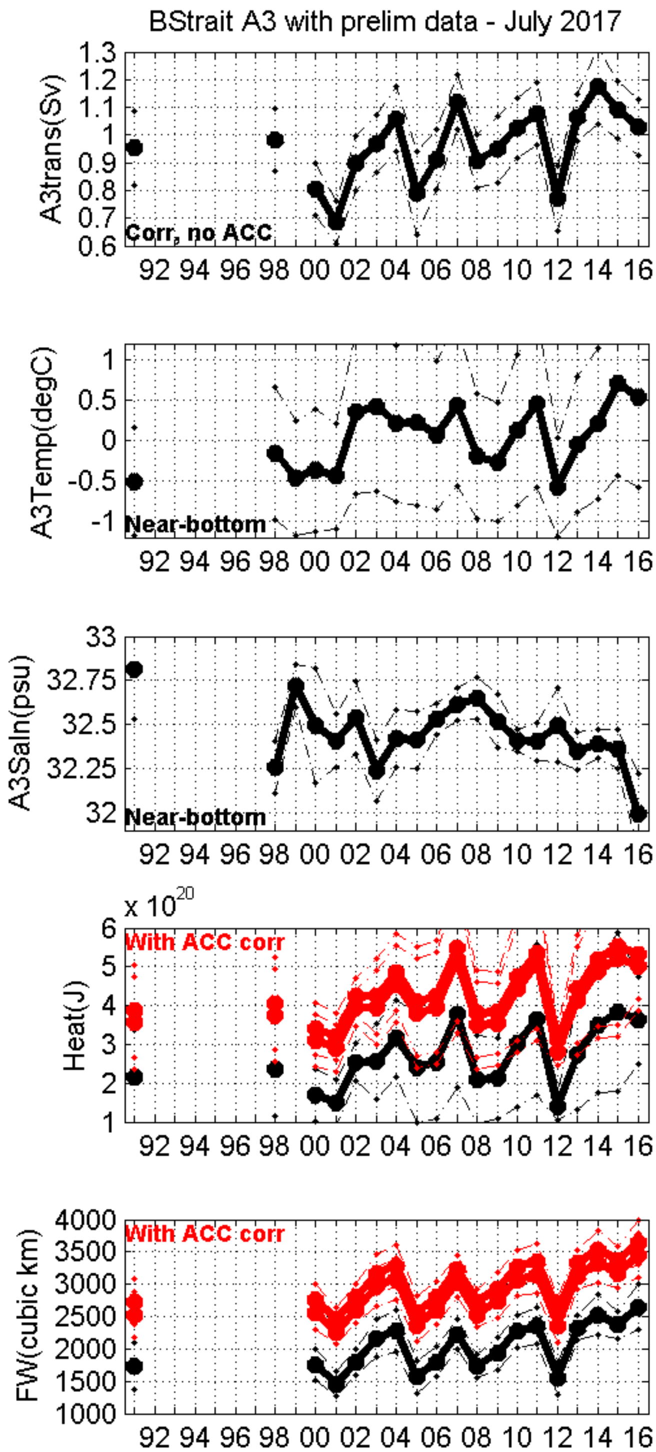
Annual Mean Transport ~ 1Sv, viz,, higher than climatology, but less than 2013-2015

Temperature ~ 0.5degC, viz.,cooler than 2015, but as warm as 2007 and 2011

Record minimum salinity, ~ 32 psu, viz., ~ 0.5 psu fresher than climatology

High heat fluxes, comparable to previous high years

Record maximum freshwater fluxes ~ 3500km^3/yr (relative to 34.8psu) including a standard correction for the Alaskan Coastal Current and stratification



Using preliminary versions of the recovered mooring data, annual mean properties: as estimated from A3 for the Bering Strait:
Top - volume transport (Sv);
2^{nd} - near-bottom temperature (°C);
3^{rd} - near-bottom salinity (psu);
4^{th} - (black) heat flux relative to -1.9°C, including (red) standard correction for Alaskan Coastal Current (ACC) and stratification (an additional 1.4-1.7x10^{20}J/yr); and
5^{th} - (black) freshwater flux relative to 34.8psu, including (red) standard correction for ACC and stratification (an additional 800-1000km^3/yr).

Data are corrected for instrument depth changes and known salinity offsets. For discussion on calculations, see Woodgate, [submitted].

BERING STRAIT 2017 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 2017 cruise) as part of the Bering Strait mooring cruises. Stations taken on this 2017 cruise are included in the full event log later in this cruise report.

```
%=========================================================
% Stations for BStrait Mooring Cruise 2017 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 2016
%-----------------------------------------
%NAME        Lat(N)          Long (W)      Water   Top
%            deg min         deg min       depth   Float
% A3-16     66  19.57      168  57.04     57m     15m
% A2-16     65  46.87      168  34.06     56m     15m
% A4-16     65  44.76      168  15.77     48m     15m
%--------------------------------
% DEPLOYMENTS for this 2017 cruise
%--------------------------------
% Target same as 2012 positions.
%NAME      Lat(N)         Long (W)      Water
%          deg min        deg min       depth
% A3-16    66  19.61      168  57.05     58m
% A2-16    65  46.86      168  34.07     56m
% A4-16    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 2016, with
% the addition of 2 lines run in 2016 (NPH and CD).
% 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 2017 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 %     BS11J Jim
65.788     168.86     65    47.26 168   51.62 %     BS12
65.780     168.827    65    46.8  168   49.63 %     BS12AJ     AJ
65.772     168.794    65    46.33 168   47.64 %     BS13
65.764     168.758    65    45.81 168   45.47 %     BS13Z Zack
65.755     168.721    65    45.28 168   43.29 %     BS14
65.747     168.692    65    44.82 168   41.55 %     BS14J Jorin
65.739     168.663    65    44.35 168   39.8  %     BS15
65.731     168.627    65    43.82 168   37.63 %     BS15J Jack
65.722     168.591    65    43.29 168   35.46 %     BS16
65.713     168.556    65    42.76 168   33.37 %     BS16J Jim
65.704     168.521    65    42.23 168   31.28 %     BS17
65.695     168.486    65    41.7  168   29.16 %     BS17S Scotty
65.686     168.449    65    41.18 168   26.94 %     BS18
65.679     168.42     65    40.77 168   25.19 %     BS18J Joanne
65.672     168.391    65    40.35 168   23.44 %     BS19
65.664     168.355    65    39.82 168   21.27 %     BS19H Harry
65.655     168.318    65    39.29 168   19.09 %     BS20
65.649     168.284    65    38.91 168   17.03 %     BS20J John
65.642     168.25     65    38.53 168   14.97 %     BS21
65.634     168.214    65    38.01 168   12.8  %     BS21A Andy
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 A3-15, 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
```

```
%------------------------------------------------------
% Lat (N) Long (W)   Lat (N)      Long (W)     Name
%                    deg min      deg   min
   66.327  168.951   66  19.61    168   57.05  % A3-14
% *** Adjust this first position to be safe distance (300m?) from A3-15
   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 NormsemanII.
% (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  % A3-13
% *** Adjust this position to be safe distance (300m?) from A3-13
%
%
%========================================
% 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   66.0000   19.6100  168.0000   57.0500 % A3-17
% *** Adjust this first position to be safe distance (300) from A3-17
   66.3335  168.9230   66.0000   20.0000  168.0000   55.3800    % new AL12.5
   66.3400  168.8950   66.0000   20.3900  168.0000   53.7100  % AL13
   66.3460  168.8590   66.0000   20.7400  168.0000   51.5550    % new AL13.5
   66.3520  168.8230   66.0000   21.0900  168.0000   49.4000  % AL14
   66.3575  168.7875   66.0000   21.4450  168.0000   47.2450    % new AL14.5
   66.3630  168.7520   66.0000   21.8000  168.0000   45.0900  % AL15
   66.3690  168.7160   66.0000   22.1550  168.0000   42.9350    % new AL15.5
   66.3750  168.6800   66.0000   22.5100  168.0000   40.7800  % AL16
   66.3810  168.6440   66.0000   22.8600  168.0000   38.6250    % new AL16.5
   66.3870  168.6080   66.0000   23.2100  168.0000   36.4700  % AL17
   66.3940  168.5657   66.0000   23.6400  168.0000   33.9400    % new AL17.5
% AND MOVED OFF Q CABLE
   66.3990  168.5360   66.0000   23.9200  168.0000   32.1600  % AL18
   66.4045  168.5000   66.0000   24.2750  168.0000   30.0000    % new AL18.5
   66.4100  168.4640   66.0000   24.6300  168.0000   27.8400  % AL19
   66.4160  168.4280   66.0000   24.9800  168.0000   25.6850    % new AL19.5
   66.4220  168.3920   66.0000   25.3300  168.0000   23.5300  % AL20
   66.4280  168.3560   66.0000   25.6850  168.0000   21.3750    % new AL20.5
   66.4340  168.3200   66.0000   26.0400  168.0000   19.2200  % AL21
   66.4400  168.2845   66.0000   26.3950  168.0000   17.0650    % new AL21.5
   66.4460  168.2490   66.0000   26.7500  168.0000   14.9100  % AL22
   66.4520  168.2130   66.0000   27.1000  168.0000   12.7550    % new AL22.5
   66.4580  168.1770   66.0000   27.4500  168.0000   10.6000  % AL23
   66.4635  168.1410   66.0000   27.8050  168.0000    8.4450    % new AL23.5
   66.4690  168.1050   66.0000   28.1600  168.0000    6.2900  % AL24
%
%Then these are new
   66.4745  168.0690   66.0000   28.5150  168.0000    4.1350    % new AL24.5
   66.4800  168.0330   66.0000   28.8700  168.0000    1.9800  % AL25
   66.4855  167.9970   66.0000   29.2250  167.0000   59.8200    % new AL25.5
   66.4910  167.9610   66.0000   29.5800  167.0000   57.6650  % AL26
   66.4965  167.9250   66.0000   29.9350  167.0000   55.5100    % new AL26.5
   66.5020  167.8890   66.0000   30.2900  167.0000   53.3550  % AL27
   66.5075  167.8530   66.0000   30.6450  167.0000   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
%
%=================================================================
% SBS - South Bering Strait section
%=================================================================
% First (and only time) ran in 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 2017 NORSEMAN2 log CTD

%Please fill in all data for every event (CTD/net tow) **0=bad 1=good** % knots **0 = clea 0=clear, 1=noclear**
%There should be one line for the beginning of the event and one line for the end %
%Date is GMT and has the format yyyymmdd %
%Time is GMT and has the format hhmm %
%Ty=Type: 1=CTD / 2=Net tow/4=prod cast x Altimeter % **THIS YEAR WE ONLY HAVE TYPE 1** Fog Waterclarity
%#,Number is consecutive for that event type %
%In/out (I/O): 1=In / 2=Out %
%Dep=waterdepth(m) from Furuno readout by CTD which is depth below keel, keel is 3m (10ft)
%LatD and LatM are Latitude Degrees and Minute and are positive N %
%LonD and LonM are Longitude Degrees and Min and are positive W %
%St is the name of the station (Line ID then station number) %
% SS = CTD operator estimate of sea state (Beaufort Scale)
%WSp=wind speed in m/s; WD=Wind direction from bridge
%Op=CTD operator
% when 3 lines for NET, dep indicates wire out for net
% Altimeter = 0 if complete rubbish, 0.5 if some good readings, 1 if good both up and down
%Fill in any comments if needed. % KNOTS

%Date	Time	1	Cast NO	Down	Depth (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon(min)	Altimeter	%	StationID	Windspd(kn)	Winddir	Operator	Fog	WaterClarit	Comments
20170708	335	1	**1**	1	18.2	64	40.6	166	37.978	1	%	test			acpf			no figures
20170708	338	1	**1**	2	18.2	64	40.62	166	38.04	1	%	test			acpf			positions taken from file
20170708	340	1	**2**	1	18.6	64	40.72	166	38.105	1	%	test2			acpf			yoyoed ~3times to check winch speed
20170708	346	1	**2**	2	18.7	64	40.86	166	38.21	1	%	test2	9	130	acpf			
20170708	1519	1	**3**	1	53	65	47.039	168	34.097	0	%	A2recovery	7.4	165	acpf	0		
20170708	1524	1	**3**	2	53.1	65	47.114	168	34.092	0	%	A2recovery	7.3	167	acpf	0		
20170708	1649	1	**4**	1	45.6	65	44.906	168	15.705	1	%	A4recovery	9.5	180	acpf	0		
20170708	1654	1	**4**	2	45.4	65	45.171	168	15.462	1	%	A4recovery	7.1	182	acpf	0		
20170708	2045	1	**5**	1	54.6	66	19.819	168	57.184	0	%	A3recovery	6	164	acpf	0		
20170708	2050	1	**5**	2	54.7	66	19.877	168	57.186	0	%	A3recovery	6	144	acpf	0		
20170709	8	1	**6**	1	54.3	66	19.707	168	57.183	0	%	A3deployment	2.7	310	acpf	0		
20170709	17	1	**6**	2	54.5	66	19.723	168	57.426	0	%	A3deployment	3.2	314	acpf	0		
20170709	451	1	**7**	1	53.8	65	47.03	168	33.72	0	%	A2deployment	3.7	300	DP			
20170709	457	1	**7**	2	53.8	65	47.06	168	33.66	0	%	A2deployment	6.3	336	DP			
20170709	1652	1	**8**	1	45.6	65	44.886	168	15.972	1	%	A4deployment	9.7	30	EE	0		
20170709	1656	1	**8**	2	45	65	44.947	168	15.997	1	%	A4deployment	10.2	24	EE	0		
20170709	1824	1	**9**	1	26.7	65	34.711	168	7.044	1	%	BS24	19.2	11	BI	0	1	
20170709	1826	1	**9**	2	28.5	65	34.754	168	7.181	1	%	BS24	21.6	13	BI	0	1	
20170709	1836	1	**10**	1	28.7	65	35.881	168	9.567	1	%	BS23	10.2	30	BI	0	0.5	visibility about 2m
20170709	1839	1	**10**	2	29.7	65	35.879	168	9.706	1	%	BS23	10.8	4	BI	0	0.5	
20170709	1850	1	**11**	1	29.7	65	37.369	168	10.466	1	%	BS22	11	5	BI	0	0.5	
20170709	1852	1	**11**	2	29.8	65	37.402	168	10.519	1	%	BS22	14.2	10	BI	0	0.5	
20170709	1900	1	**12**	1	36.9	65	37.899	168	12.741	1	%	BS21.5	14	23	BI	0	0.5	
20170709	1903	1	**12**	2	37	65	37.919	168	12.776	1	%	BS21.5	13.6	20	BI	0	0.5	
20170709	1912	1	**13**	1	40.5	65	38.528	168	15.062	1	%	BS21	10.9	20	BI	0	0.5	
20170709	1915	1	**13**	2	40.8	65	38.361	168	15.158	1	%	BS21	13	29	BI	0	0.5	
20170709	1921	1	**14**	1	44.3	65	38.779	168	17.041	1	%	BS20.5	12.4	31	BI	0	0.5	
20170709	1924	1	**14**	2	44.4	65	38.874	168	17.155	1	%	BS20.5	12.2	22	BI	0	0.5	
20170709	1932	1	**15**	1	46.8	65	39.169	168	19.163	1	%	BS20	10.8	22	BI	0	0.5	
20170709	1935	1	**15**	2	47.2	65	39.247	168	19.225	1	%	BS20	12.4	13	BI	0	0.5	
20170709	1942	1	**16**	1	48.7	65	39.704	168	21.318	1	%	BS19.5	11.5	10	BI	0	0.5	
20170709	1946	1	**16**	2	49.1	65	39.8	168	21.365	1	%	BS19.5	12.9	16	BI	0	0.5	
20170709	1953	1	**17**	1	50.4	65	40.265	168	23.436	0	%	BS19	10.9	24	BI	0	0.5	
20170709	1959	1	**17**	2	50.5	65	40.396	168	23.329	0	%	BS19	10.9	29	BI	0	0.5	
20170709	2005	1	**18**	1	51.1	65	40.648	168	25.181	0	%	BS18.5	10.9	34	BI	0	0.5	
20170709	2008	1	**18**	2	51.1	65	40.713	168	25.202	0	%	BS18.5	11	52	BI	0	0.5	

20170709	2014	1	**19**	1	51.8	65	41.082	168	26.925	0	%	BS18	10.7	32	rw	0	0.5	1.5m
20170709	2017	1	**19**	2	51.9	65	41.149	168	26.97	0	%	BS18	12.3	29	rw	0	0.5	operator maybe wrong in file
20170709	2025	1	**20**	1	52.4	65	41.581	168	29.155	0	%	BS17.5	10.5	6	rw	0	0.5	
20170709	2028	1	**20**	2	52.2	65	41.638	168	29.161	0	%	BS17.5	12.6	17	rw	0	0.5	
20170709	2036	1	**21**	1	53.3	65	42.105	168	31.267	0	%	BS17	9.9	6	BI	0	0.5	
20170709	2040	1	**21**	2	53	65	42.204	168	31.238	0	%	BS17	12.1	11	BI	0	0.5	
20170709	2048	1	**22**	1	50.4	65	42.693	168	33.307	0	%	BS16.5	11	356	BI	0	0.5	
20170709	2051	1	**22**	2	50.43	65	42.767	168	33.285	0	%	BS16.5	12.6	355	BI	0	0.5	
20170709	2059	1	**23**	1	50.1	65	43.18	168	35.711	0	%	BS16	13.4	341	BI	0	0.5	
20170709	2103	1	**23**	2	50.2	65	43.212	168	35.633	0	%	BS16	12.3	348	BI	0	1	5m visibility, winch speeds set right
20170709	2111	1	**24**	1	50.1	65	43.778	168	37.813	0	%	BS15.5	9.8	347	BI	0	1	
20170709	2115	1	**24**	2	50.2	65	43.822	168	37.752	0	%	BS15.5	9.7	4	BI	0	1	
20170709	2123	1	**25**	1	50	65	44.333	168	39.976	0	%	BS15	11.1	352	BI	0	1	large fluor max at 15m
20170709	2126	1	**25**	2	49.8	65	44.345	168	40.091	0	%	BS15	9.5	345	BI	0	1	
20170709	2132	1	**26**	1	50.4	65	44.748	168	41.716	0	%	BS14.5	10.7	328	BI	0	1	
20170709	2136	1	**26**	2	50.1	65	44.822	168	41.616	0	%	BS14.5	10.4	340	BI	0	1	
20170709	2143	1	**27**	1	51	65	45.198	168	43.505	0	%	BS14	12	321	BI	0	1	
20170709	2147	1	**27**	2	51	65	45.228	168	43.41	0	%	BS14	13.5	335	BI	0	1	
20170709	2155	1	**28**	1	51.2	65	45.745	168	45.692	0	%	BS13.5	14.1	311	BI	0	1	
20170709	2159	1	**28**	2	50.9	65	45.773	168	45.604	0	%	BS13.5	12	331	BI	0	1	
20170709	2208	1	**29**	1	50.9	65	46.284	168	47.855	0	%	BS13	10.9	322	BI	0	1	
20170709	2211	1	**29**	2	50.7	65	46.299	168	47.771	0	%	BS13	10.7	328	BI	0	1	
20170709	2218	1	**30**	1	47.4	65	46.744	168	49.862	0	%	BS12.5	10.1	324	BI	0	0.5	1-2m visibility, no handbrake turn, stro
20170709	2221	1	**30**	2	47.4	65	46.793	168	49.863	0	%	BS12.5	10.3	327	BI	0	0.5	
20170709	2229	1	**31**	1	42.7	65	47.251	168	51.83	0	%	BS12	11.7	311	BI	0	0.5	
20170709	2234	1	**31**	2	42.8	65	47.196	168	51.915	0	%	BS12	10.1	319	BI	0	0.5	
20170709	2243	1	**32**	1	45.6	65	47.755	168	54.007	0	%	BS11.5	11.3	320	BI	0	0.5	
20170709	2246	1	**32**	2	45.6	65	47.776	168	53.909	0	%	BS11.5	10.8	343	BI	0	0.5	
20170709	2254	1	**33**	1	44.4	65	48.255	168	56.144	0	%	BS11	12.6	311	BI	0	0.5	
20170709	2258	1	**33**	2	45	65	48.28	168	56.166	0	%	BS11	12.5	320	BI	0	0.5	large fluor max at 10m
20170709	2306	1	**34**	1	45.3	65	49.27	168	56.46	0	%	DL01	9.7	318	DP	0	0.5	
20170709	2309	1	**34**	2	45.6	65	49.26	168	56.36	0	%	DL01	9	336	DP	0	0.5	
20170709	2318	1	**35**	1	45.6	65	50.23	168	56.47	0	%	DL02	6.2	304	DP	0	0.5	
20170709	2322	1	**35**	2	45.9	65	50.2	168	56.41	0	%	DL02	9	309	DP	0	0.5	
20170709	2331	1	**36**	1	46.3	65	51.24	168	56.43	0	%	DL03	13.2	333	DP	0	0.5	
20170709	2335	1	**36**	2	46.1	65	51.32	168	56.31	0	%	DL03	12.5	344	DP	0	0.5	
20170709	2342	1	**37**	1	44	65	52.23	168	56.34	0	%	DL04	13.5	344	DP	0	0.5	
20170709	2346	1	**37**	2	44.3	65	52.19	168	56.21	0	%	DL04	14.8	344	DP	0	0.5	
20170709	2355	1	**38**	1	46.5	65	53.16	168	56.4	0	%	DL05	14.7	334	DP	0	0.5	
20170709	2358	1	**38**	2	46.4	65	53.15	168	56.34	0	%	DL05	14.9	344	DP	0	0.5	
20170710	6	1	**39**	1	47.3	65	54.16	168	56.43	0	%	DL06	15.2	333	DP	0	0.5	water clarity at 3m
20170710	10	1	**39**	2	47.2	65	54.16	168	56.32	0	%	DL06	15	339	DP	0	0.5	
20170710	18	1	**40**	1	47.5	65	55.11	168	56.41	0	%	DL07	15.5	336	DP	0	0.5	water clarity at 3m
20170710	21	1	**40**	2	47.3	65	55.11	168	56.29	0	%	DL07	13.6	348	DP	0	0.5	
20170710	29	1	**41**	1	48	65	56.09	168	56.39	0	%	DL08	14.5	330	DP	0	0.5	water clarity at 2m
20170710	32	1	**41**	2	48.2	65	56.09	168	56.26	0	%	DL08	14	329	DP	0	0.5	
20170710	42	1	**42**	1	49.3	65	57.12	168	56.28	0	%	DL09	15.1	331	DP	1	0.5	water clarity at 2.5m
20170710	45	1	**42**	2	49.1	65	57.11	168	56.15	0	%	DL09	13.1	334	DP	1	0.5	
20170710	53	1	**43**	1	50.1	65	58.02	168	56.44	0	%	DL10	16.3	318	DP	1	0.5	water clarity at 2.5m
20170710	58	1	**43**	2	50.5	65	58.03	168	56.29	0	%	DL10	15.7	336	DP	1	0.5	
20170710	105	1	**44**	1	50.4	65	59.03	168	56.36	0	%	DL11	16.9	331	DP	1	0.5	water clarity at 2.5m
20170710	109	1	**44**	2	50.4	65	59.03	168	56.24	0	%	DL11	16.5	333	DP	1	0.5	
20170710	117	1	**45**	1	50.8	66	0.01	168	56.44	0	%	DL12	15.7	324	DP	1	0.5	water clarity at 1.5m
20170710	121	1	**45**	2	51.2	66	0.01	168	56.32	0	%	DL12	15.2	326	DP	1	0.5	
20170710	134	1	**46**	1	51.1	66	0.21	168	52.24	0	%	DLa12	14.9	330	DP	1	0.5	water clarity at 2m

20170710	137	1	**46**	2	51.3	66	0.04	168	52.14	0	%	DLa12	14.9	328	DP	1	0.5	
20170710	147	1	**47**	1	50.6	65	58.91	168	52.44	0	%	DLa11	15.8	343	DP	1	0.5	water clarity at 2m
20170710	151	1	**47**	2	50.3	65	58.86	168	52.52	0	%	DLa11	17.2	347	DP	1	0.5	
20170710	157	1	**48**	1	50.5	65	58.09	168	52.14	0	%	DLa10	16.2	341	DP	1	0.5	water clarity at 2m
20170710	200	1	**48**	2	50.3	65	58.04	168	52.2	0	%	DLa10	17	347	DP	1	0.5	
20170710	208	1	**49**	1	50.1	65	57.1	168	52.13	0	%	DLa9	12.3	343	DP	1	0.5	water clarity at 2m (lots of bubbles)
20170710	212	1	**49**	2	50	65	57.03	168	51.98	0	%	DLa9	15.2	339	DP	1	0.5	
20170710	220	1	**50**	1	50.5	65	56.15	168	52.12	0	%	DLa8	15.9	341	DP	1	0.5	water clarity at 2m (lots of bubbles)
20170710	223	1	**50**	2	50.2	65	56.1	168	52.16	0	%	DLa8	15.4	350	DP	1	0.5	
20170710	231	1	**51**	1	49.2	65	55.21	168	52.11	0	%	DLa7	16.1	343	DP	1	0.5	water clarity at 2m
20170710	234	1	**51**	2	49.4	65	55.15	168	52.13	0	%	DLa7	15.9	347	DP	1	0.5	
20170710	242	1	**52**	1	48.1	65	54.23	168	52.14	0	%	DLa6	15.7	346	DP	1	0.5	water clarity at 2m
20170710	245	1	**52**	2	47.7	65	54.16	168	52.16	0	%	DLa6	14.3	352	DP	1	0.5	
20170710	253	1	**53**	1	48	65	53.25	168	52.13	0	%	DLa5	17.2	347	DP	1	0.5	water clarity at 2m
20170710	256	1	**53**	2	48	65	53.21	168	52.17	0	%	DLa5	18.6	353	DP	1	0.5	
20170710	304	1	**54**	1	47.8	65	52.279	168	52.094	0	%	DLa4	17.3	346	EE	1	2.5	From now on, WaterClar is visibility de
20170710	308	1	**54**	2	47.8	65	52.208	168	52.171	0	%	DLa4	14.1	344	EE	1	2.5	
20170710	315	1	**55**	1	47.1	65	51.321	168	52.191	0	%	DLa3	16.4	347	EE	1	2	
20170710	319	1	**55**	2	47.5	65	51.274	168	52.254	0	%	DLa3	15.9	352	EE	1	2	
20170710	326	1	**56**	1	45	65	50.354	168	52.11	0	%	DLa2	16.6	347	EE	1	2	
20170710	329	1	**56**	2	45.3	65	50.324	168	52.161	0	%	DLa2	17.8	345	EE	1	2	
20170710	338	1	**57**	1	43	65	49.386	168	52.119	0	%	DLa1	16.3	336	EE	1	2	
20170710	341	1	**57**	2	43.2	65	49.351	168	52.185	0	%	DLa1	15.4	348	EE	1	2	
20170710	353	1	**58**	1	48.5	65	49.223	168	48.368	0	%	DLb1	17.6	334	EE	1	2	
20170710	356	1	**58**	2	48.6	65	49.206	168	48.306	0	%	DLb1	17.4	336	EE	1	2	
20170710	406	1	**59**	1	48.7	65	50.265	168	48.52	0	%	DLb2	16.7	334	EE	1	2	
20170710	411	1	**59**	2	49	65	50.243	168	48.437	0	%	DLb2	18.5	335	EE	1	2	
20170710	420	1	**60**	1	49.1	65	51.342	168	48.403	0	%	DLb3	17.5	333	EE	1	2	
20170710	424	1	**60**	2	49.1	65	51.325	168	48.305	0	%	DLb3	15.6	348	EE	1	2	
20170710	432	1	**61**	1	49.7	65	52.225	168	48.566	0	%	DLb4	18.7	329	EE	1	2	
20170710	437	1	**61**	2	49.9	65	52.217	168	48.36	0	%	DLb4	17.4	348	EE	1	2	
20170710	446	1	**62**	1	50.8	65	53.273	168	48.501	0	%	DLb5	18.9	331	EE	1	2	
20170710	451	1	**62**	2	50.7	65	53.249	168	48.324	0	%	DLb5	18.4	348	EE	1	2	
20170710	500	1	**63**	1	51.2	65	54.225	168	48.427	0	%	DLb6	19.2	337	EE	1	2	
20170710	504	1	**63**	2	51.1	65	54.208	168	48.28	0	%	DLb6	17.7	348	EE	1	2	
20170710	513	1	**64**	1	51.3	65	55.191	168	48.309	0	%	DLb7	17.7	335	EE	0	2	
20170710	517	1	**64**	2	51.3	65	55.179	168	48.094	0	%	DLb7	15.6	344	EE	0	2	
20170710	526	1	**65**	1	51.3	65	56.137	168	48.474	0	%	DLb8	18	331	EE	0	2	
20170710	530	1	**65**	2	51.1	65	56.115	168	48.363	0	%	DLb8	17.5	338	EE	0	2	
20170710	539	1	**66**	1	51.2	65	57.145	168	48.367	0	%	DLb9	17.7	334	EE	0	2	
20170710	543	1	**66**	2	51.6	65	57.141	168	48.243	0	%	DLb9	18.2	340	EE	0	2	
20170710	552	1	**67**	1	51.1	65	58.12	168	48.371	0	%	DLb10	20.6	332	EE	0	2	
20170710	557	1	**67**	2	51.5	65	58.143	168	48.161	0	%	DLb10	19	342	EE	0	2	
20170710	607	1	**68**	1	51.8	65	59.077	168	48.348	0	%	DLb11	22.2	333	EE	0	2	
20170710	613	1	**68**	2	52.4	65	59.052	168	48.101	0	%	DLb11	17.8	329	EE	0	2	
20170710	622	1	**69**	1	51.9	65	59.992	168	48.496	0	%	DLb12	18.2	328	EE	0	2	
20170710	627	1	**69**	2	51	65	59.983	168	48.367	0	%	DLb12	19.2	339	EE	0	2	
20170710	653	1	**70**	1	50.7	66	0.01	168	56.369	0	%	DL12	18.1	339	EE	0	2	
20170710	659	1	**70**	2	51.3	65	59.947	168	56.318	0	%	DL12	21.6	338	EE	0	2	
20170710	711	1	**71**	1	50.3	66	1.36	168	56.208	0	%	DL12.5	18.7	347	ACPF	0	2	in meters of visibility.
20170710	717	1	**71**	2	50.2	66	1.32	168	56.172	0	%	DL12.5	18.8	336	ACPF	0	2	
20170710	728	1	**72**	1	51.5	66	2.618	168	56.224	0	%	DL13	16.7	339	ACPF	0	2	
20170710	734	1	**72**	2	51.5	66	2.593	168	56.126	0	%	DL13	16.5	344	ACPF	0	2	
20170710	745	1	**73**	1	51.7	66	3.878	168	56.218	0	%	DL13.5	18.1	335	ACPF	1	2	Fog came in
20170710	750	1	**73**	2	51.7	66	3.85	168	56.101	0	%	DL13.5	18.2	339	ACPF	1	2	

20170710	801	1	**74**	1	53.3	66	5.133	168	56.236	0	%	DL14	15.5	338	ACPF	1	2	
20170710	807	1	**74**	2	53.6	66	5.094	168	56.233	0	%	DL14	19.4	319	ACPF	1	2	
20170710	818	1	**75**	1	53.1	66	6.436	168	56.265	0	%	DL14.5	17.2	330	ACPF	1	2	
20170710	824	1	**75**	2	53	66	6.409	168	56.203	0	%	DL14.5	18.9	334	ACPF	1	2	
20170710	834	1	**76**	1	52.8	66	7.666	168	56.209	0	%	DL15	21.4	324	ACPF	1	2	
20170710	840	1	**76**	2	52.7	66	7.657	168	56.02	0	%	DL15	18.8	334	ACPF	1	2	
20170710	850	1	**77**	1	52.8	66	8.922	168	56.224	0	%	DL15.5	23.6	326	ACPF	1	2	
20170710	855	1	**77**	2	53.1	66	8.911	168	56.113	0	%	DL15.5	21.4	336	ACPF	1	2	
20170710	905	1	**78**	1	53.5	66	10.171	168	56.228	0	%	DL16	21.5	330	ACPF	1	2	
20170710	910	1	**78**	2	53.2	66	10.15	168	56.022	0	%	DL16	19.4	346	ACPF	1	2	
20170710	924	1	**79**	1	54.4	66	11.486	168	56.194	0	%	DL16.5	21.4	333	ACPF	1	2	
20170710	930	1	**79**	2	54.2	66	11.438	168	56.217	0	%	DL16.5	22.8	335	ACPF	1	2	
20170710	941	1	**80**	1	55.4	66	12.763	168	56.295	0	%	DL17	19	338	ACPF	1	1	1 = NO CLEAR - null visibility
20170710	947	1	**80**	2	55.8	66	12.789	168	56.13	0	%	DL17	21.2	339	ACPF	1	1	
20170710	958	1	**81**	1	54.6	66	13.982	168	56.312	0	%	DL17.5	20.8	338	ACPF	1	1	return cast had primary Osensor offset
20170710	1004	1	**81**	2	54.4	66	13.981	168	56.04	0	%	DL17.5	15	320	ACPF	1	1	
20170710	1016	1	**82**	1	55.9	66	15.297	168	56.406	0	%	DL18	21	327	ACPF	1	1	
20170710	1022	1	**82**	2	55.6	66	15.285	168	56.2	0	%	DL18	20.9	343	ACPF	1	1	
20170710	1033	1	**83**	1	55.1	66	16.558	168	56.371	0	%	DL18.5	19.1	324	ACPF	1	1	tmperature inversion in here somewhe
20170710	1040	1	**83**	2	55.6	66	16.551	168	56.145	0	%	DL18.5	20.6	335	ACPF	1	1	
20170710	1051	1	**84**	1	54.7	66	17.863	168	56.362	0	%	DL19	21.5	321	ACPF	1	1	
20170710	1057	1	**84**	2	54.6	66	17.85	168	56.162	0	%	DL19	15.9	338	ACPF	1	1	
20170710	1106	1	**85**	1	54.8	66	18.733	168	56.382	0	%	DL19.5	20.3	321	ACPF	1	1	
20170710	1111	1	**85**	2	55	66	18.724	168	56.307	0	%	DL19.5	16	330	ACPF	1	1	
20170710	1125	1	**86**	1	54	66	20.026	168	57.199	0	%	A3-17	20.3	327	ACPF	1	1	
20170710	1130	1	**86**	2	54.2	66	20.015	168	57.904	0	%	A3-17	16.6	334	ACPF	1	1	
20170710	1139	1	**87**	1	54.2	66	20.049	168	55.222	0	%	AL12.5	20.9	345	ACPF	1	1	
20170710	1146	1	**87**	2	54.7	66	20.028	168	55.263	0	%	AL12.5	18.8	336	ACPF	1	1	
20170710	1155	1	**88**	1	54.7	66	20.406	168	53.769	0	%	AL13	18.4	320	ACPF	1	1	Return cast had primary Osensor offse
20170710	1201	1	**88**	2	54.3	66	20.404	168	53.618	0	%	AL13	20.6	340	ACPF	1	1	Both O sensors agreed well on down ca
20170710	1209	1	**89**	1	52.5	66	20.786	168	51.718	0	%	AL13.5	22.4	325	ACPF	1	1	
20170710	1215	1	**89**	2	52.2	66	20.774	168	51.634	0	%	AL13.5	25.7	334	ACPF	1	1	
20170710	1224	1	**90**	1	54.2	66	21.135	168	49.424	0	%	AL14	23.6	334	ACPF	1	1	
20170710	1229	1	**90**	2	53.9	66	21.124	168	49.367	0	%	AL14	22.6	336	ACPF	1	1	
20170710	1237	1	**91**	1	53	66	21.47	168	47.276	0	%	AL14.5	20.1	325	ACPF	1	1	
20170710	1242	1	**91**	2	53.7	66	21.464	168	47.19	0	%	AL14.5	23	239	ACPF	1	1	
20170710	1250	1	**92**	1	45.8	66	21.819	168	45.224	0	%	AL15	21.1	324	ACPF	1	1	
20170710	1254	1	**92**	2	45.6	66	21.819	168	45.145	0	%	AL15	19.4	322	ACPF	1	1	
20170710	1302	1	**93**	1	49.5	66	22.171	168	43.014	0	%	AL15.5	20.1	326	ACPF	1	1	Likely CTD out of water after soak, but
20170710	1308	1	**93**	2	53.7	66	22.141	168	42.775	0	%	AL15.5	14.1	330	ACPF	1	1	and duplicate sensors were consistent
20170710	1316	1	**94**	1	55.7	66	22.507	168	40.848	0	%	AL16	16.4	327	ACPF	1	1	
20170710	1322	1	**94**	2	55.8	66	22.509	168	40.738	0	%	AL16	17.9	324	ACPF	1	1	
20170710	1330	1	**95**	1	55.3	66	22.871	168	38.685	0	%	AL16.5	17.4	308	ACPF	1	1	
20170710	1335	1	**95**	2	55	66	22.871	168	38.606	0	%	AL16.5	18.4	327	ACPF	1	1	
20170710	1343	1	**96**	1	54.1	66	23.248	168	36.587	0	%	AL17	18.6	322	ACPF	1	1	
20170710	1347	1	**96**	2	53.9	66	23.25	168	36.503	0	%	AL17	19.7	326	ACPF	1	1	
20170710	1356	1	**97**	1	52.5	66	23.667	168	34.008	0	%	AL17.5	18.2	330	ACPF	1	1	
20170710	1401	1	**97**	2	52.9	66	23.662	168	33.927	0	%	AL17.5	20.8	333	ACPF	1	1	
20170710	1409	1	**98**	1	51.6	66	23.928	168	32.316	0	%	AL18	17.1	320	ACPF	1	1	
20170710	1414	1	**98**	2	51.8	66	23.959	168	32.211	0	%	AL18	18.5	331	ACPF	1	1	
20170710	1422	1	**99**	1	51.9	66	24.286	168	30.126	0	%	AL18.5	21.2	326	ACPF	1	1	
20170710	1427	1	**99**	2	51.9	66	24.284	168	30.106	0	%	AL18.5	18.1	333	ACPF	1	1	
20170710	1435	1	**100**	1	52.2	66	24.645	168	27.955	0	%	AL19	20.3	328	ACPF	1	1	Strongest halocline so far.
20170710	1440	1	**100**	2	52.9	66	24.648	168	27.891	0	%	AL19	16.8	335	ACPF	1	1	
20170710	1448	1	**101**	1	50.4	66	25.007	168	25.788	0	%	AL19.5	19.2	325	ACPF	0	1	

20170710	1453	1	**101**	2	51.3	66	25.009	168	25.71	0	%	AL19.5	17.6	340	ACPF	0	1	
20170710	1501	1	**102**	1	50.9	66	25.33	168	23.637	0	%	AL20	21.7	327	rw	0	2	2m of clarity
20170710	1506	1	**102**	2	50.9	66	25.357	168	23.504	0	%	AL20	23.1	330	rw	0	2	5m off bottom due to swell/waves
20170710	1514	1	**103**	1	50	66	25.697	168	21.51	0	%	AL20.5	19.8	322	rw	0	-99	99meanstoo rough to tell
20170710	1519	1	**103**	2	49.8	66	25.71	168	21.391	0	%	AL20.5	20.7	322	rw	0	-99	5m off bottom due to swell/waves
20170710	1527	1	**104**	1	46.9	66	26.056	168	19.271	0.1	%	AL21	22.3	325	rw	0	2	
20170710	1532	1	**104**	2	46.5	66	26.064	168	19.155	0.1	%	AL21	22.5	327	rw	0	2	(meeting 13min)
20170710	1553	1	**105**	1	42.7	66	26.412	168	17.191	0	%	AL21.5	20.5	318	rw	0	2	
20170710	1557	1	**105**	2	42.4	66	26.433	168	17.09	0	%	AL21.5	22.3	322	rw	0	2	5m off bottom due to swell/waves
20170710	1605	1	**106**	1	39.3	66	26.772	168	14.96	0	%	AL22	27.2	321	rw	0	-99	v sharp TS cline
20170710	1608	1	**106**	2	39.5	66	26.805	168	14.853	0	%	AL22	23.5	327	rw	0	-99	5m off bottom due to swell/waves
20170710	1616	1	**107**	1	36.2	66	27.101	168	12.862	1	%	AL22.5	23.6	324	rw	0	2	
20170710	1620	1	**107**	2	36.3	66	27.106	168	12.725	1	%	AL22.5	19.6	330	rw	0	2	10m off bottom due to swell/waves
20170710	1628	1	**108**	1	32.5	66	27.466	168	10.708	1	%	AL23	21.9	313	BI	0	2	
20170710	1632	1	**108**	2	31.8	66	27.486	168	10.561	1	%	AL23	25.5	319	BI	0	2	
20170710	1639	1	**109**	1	28.4	66	27.815	168	8.539	1	%	AL23.5	23.1	326	BI	0	2	
20170710	1643	1	**109**	2	28.2	66	27.827	168	8.354	1	%	AL23.5	22.4	331	BI	0	2	8m off bottom due to swell/waves
20170710	1653	1	**110**	1	26.3	66	28.171	168	6.37	1	%	AL24	25	320	BI	0	2	
20170710	1656	1	**110**	2	25.9	66	28.174	168	6.22	1	%	AL24	23.8	330	BI	0	2	bottom 28m, stopped at 20m, continue
20170710	1704	1	**111**	1	24	66	28.53	168	4.155	1	%	AL24.5	21.8	327	rw	0	2	
20170710	1708	1	**111**	2	23.7	66	28.523	168	3.99	1	%	AL24.5	21.6	326	rw	0	2	10m off bottom due to swell/waves, st
20170710	1715	1	**112**	1	22.4	66	28.882	168	2.04	1	%	AL25	21.7	333	rw	0.2	2	well mixed
20170710	1719	1	**112**	2	22.3	66	28.882	168	1.853	1	%	AL25	22.4	327	rw	0.2	2	5m off bottom due to swell/waves, sto
20170710	1727	1	**113**	1	21.7	66	29.231	167	59.854	1	%	AL25.5	23.2	322	rw	0.2	2	well mixed
20170710	1730	1	**113**	2	21.7	66	29.217	167	59.71	1	%	AL25.5	24	331	rw	0.2	2	5m off bottom due to swell/waves, sto
20170710	1739	1	**114**	1	21	66	29.562	167	57.673	1	%	AL26	23.7	322	rw	0.2	2	well mixed
20170710	1742	1	**114**	2	21.1	66	29.522	167	57.464	1	%	AL26	22.2	337	rw	0.2	2	5m off bottom due to swell/waves, sto
20170710	1750	1	**115**	1	22.5	66	29.965	167	55.667	1	%	AL26.5	21.7	319	rw	0.5	2	well mixed, but maybe bottomlayer < 4
20170710	1754	1	**115**	2	21.9	66	29.952	167	55.415	1	%	AL26.5	25.6	330	rw	0.5	2	5m off bottom due to swell/waves, sto
20170710	1801	1	**116**	1	21.9	66	30.319	167	53.553	0	%	AL27	21.6	313	rw	1	2	
20170710	1805	1	**116**	2	21.6	66	30.304	167	53.419	0	%	AL27	22.3	325	rw	1	2	5m off bottom due to swell/waves, sto
20170710	1813	1	**117**	1	22.3	66	30.67	167	51.307	0	%	AL27.5	21.7	316	rw	1	2	
20170710	1817	1	**117**	2	22.1	66	30.656	167	51.068	0	%	AL27.5	24.2	324	rw	1	2	5m off bottom due to swell/waves, sto
20170711	802	1	**118**	1	48.7	67	38.36	168	55.813	0	%	CS10	16.4	334	acpf	0	2	2m of clarity
20170711	808	1	**118**	2	48.5	67	38.304	168	55.617	0	%	CS10	16.5	344	acpf	0	2	Lots of birds.
20170711	842	1	**119**	1	47.8	67	41.718	168	48.14	0	%	CS10.5	16.3	350	acpf	0	2	
20170711	847	1	**119**	2	48.1	67	41.716	168	48.05	0	%	CS10.5	16.9	347	acpf	0	2	Lots of birds.
20170711	924	1	**120**	1	47.6	67	45.32	168	39.796	0	%	CS11	16.2	346	acpf	0	2	
20170711	928	1	**120**	2	49.2	67	45.326	168	39.654	0	%	CS11	16.2	350	acpf	0	2	
20170711	1007	1	**121**	1	48.7	67	48.921	168	29.432	0	%	CS11.5	12.4	357	acpf	0	2	
20170711	1011	1	**121**	2	49	67	48.909	168	29.349	0	%	CS11.5	13.5	356	acpf	0	2	
20170711	1051	1	**122**	1	54.1	67	52.497	168	18.932	0	%	CS12	14.2	4	acpf	0	2	
20170711	1057	1	**122**	2	54.5	67	52.481	168	18.754	0	%	CS12	16.2	358	acpf	0	2	
20170711	1134	1	**123**	1	56.5	67	55.909	168	9.14	0	%	CS12.5	15.7	11	acpf	0	2	
20170711	1139	1	**123**	2	57.1	67	55.928	168	9.312	0	%	CS12.5	16.5	5	acpf	0	2	
20170711	1216	1	**124**	1	52.7	67	59.294	167	59.501	0	%	CS13	15.3	356	acpf	0	2	
20170711	1222	1	**124**	2	52.6	67	59.303	167	59.433	0	%	CS13	14.7	2	acpf	0	2	
20170711	1259	1	**125**	1	52	68	2.693	167	49.745	0	%	CS13.5	15	8	acpf	0	3	3m - improved clarity
20170711	1303	1	**125**	2	52.3	68	2.707	167	49.808	0	%	CS13.5	19.3	7	acpf	0	3	
20170711	1340	1	**126**	1	50.2	68	6.097	167	39.97	0	%	CS14	15.1	10	acpf	0	3	Spikes in salinity at thermocline level. \
20170711	1345	1	**126**	2	50.4	68	6.083	167	39.927	0	%	CS14	15.4	17	acpf	0	3	
20170711	1418	1	**127**	1	46.9	68	9.083	167	30.823	0	%	CS14.5	16.4	9	acpf	0	3	Spikes again (likely timing issue) but les
20170711	1422	1	**127**	2	46.9	68	9.137	167	30.741	0	%	CS14.5	16.2	8	acpf	0	3	
20170711	1454	1	**128**	1	45.8	68	12.076	167	21.498	1	%	CS15	14.4	11	BI	0	3	
20170711	1459	1	**128**	2	45.9	68	12.157	167	21.416	1	%	CS15	13.6	12	BI	0	3	

20170711	1515	1	**129**	1	44	68	13.591	167	16.884	1	%	CS15.5	14.9	6	BI	0	3	
20170711	1520	1	**129**	2	44	68	13.66	167	16.762	1	%	CS15.5	16.1	6	BI	0	3	
20170711	1548	1	**130**	1	42.9	68	14.986	167	12.389	1	%	CS16	17	10	BI	0	3	
20170711	1552	1	**130**	2	42.7	68	15.049	167	12.267	1	%	CS16	18.1	14	BI	0	3	
20170711	1610	1	**131**	1	39.5	68	15.548	167	7.591	1	%	CS16.5	16.2	9	BI	0	3	3m vis
20170711	1613	1	**131**	2	39.4	68	16.602	167	7.534	1	%	CS16.6	17.7	10	BI	0	3	stopped 6m from bottom due to swell
20170711	1630	1	**132**	1	36.1	68	17.952	167	2.857	1	%	CS17	17.4	15	BI	0	3	
20170711	1633	1	**132**	2	36.3	68	18.005	167	2.897	1	%	CS17	17.6	17	BI	0	3	stopped 5m from bottom due to swell
20170711	1650	1	**133**	1	31.8	68	18.865	166	57.773	1	%	CS18	16.8	11	BI	0	3	
20170711	1653	1	**133**	2	32	68	18.98	166	57.827	1	%	CS18	17.7	17	BI	0	3	
20170711	1712	1	**134**	1	25	68	19.822	166	52.285	1	%	CS19	12.9	18	BI	0	4	
20170711	1715	1	**134**	2	25.1	68	19.882	166	52.379	1	%	CS19	14.9	15	BI	0	4	
20170711	2002	1	**135**	1	48.8	68	36.936	167	35.588	1	%	CD13	21.7	35	BI	0	2	
20170711	2007	1	**135**	2	48.7	68	36.996	167	35.697	1	%	CD13	22.6	28	BI	0	2	
20170711	2029	1	**136**	1	46.5	68	36.97	167	29.907	1	%	CD12	20.4	25	RW	0	3	
20170711	2033	1	**136**	2	46.2	68	36.97	167	29.775	1	%	CD12	22.4	38	RW	0	3	stopped 5m from bottom due to swell
20170711	2051	1	**137**	1	44.2	68	36.967	167	24.446	1	%	CD11	19.9	30	RW	0	3	
20170711	2055	1	**137**	2	44.2	68	37.003	167	24.373	1	%	CD11	21.8	26	RW	0	3	stopped 5m from bottom due to swell
20170711	2113	1	**138**	1	41.7	68	36.99	167	18.908	1	%	CD10	18.1	31	RW	0	3	
20170711	2118	1	**138**	2	41.6	68	37.049	167	18.783	1	%	CD10	18.9	39	RW	0	3	stopped 5m from bottom due to swell
20170711	2136	1	**139**	1	38.7	68	36.923	167	13.401	1	%	CD9	19	31	RW	0	3	
20170711	2140	1	**139**	2	38.6	68	36.97	167	13.388	1	%	CD9	19.5	24	RW	0	3	stopped 5m from bottom due to swell
20170711	2159	1	**140**	1	35.6	68	36.96	167	7.874	1	%	CD8	19.3	28	RW	0	2.5	
20170711	2203	1	**140**	2	35.9	68	37.032	167	7.745	1	%	CD8	20.3	29	RW	0	2.5	stopped 5m from bottom due to swell
20170711	2220	1	**141**	1	34.1	68	36.973	167	2.232	1	%	CD7	18.9	26	RW	0	3	
20170711	2226	1	**141**	2	34	68	37.062	167	2.191	1	%	CD7	20.1	30	RW	0	3	stopped 5m from bottom due to swell
20170711	2243	1	**142**	1	33	68	36.949	166	56.83	1	%	CD6	17.3	29	BI	0	2	
20170711	2246	1	**142**	2	32.8	68	37.006	166	56.737	1	%	CD6	20.7	31	BI	0	2	sharp MLD and saltier than previous st
20170711	2302	1	**143**	1	31.9	68	36.94	166	51.31	1	%	CD5	19.1	31	DP	0	2.5	
20170711	2305	1	**143**	2	31.8	68	36.98	166	51.19	1	%	CD5	17.7	29	DP	0	2.5	
20170711	2322	1	**144**	1	31	68	36.94	166	45.66	0.7	%	CD4	14.6	26	DP	0	2	
20170711	2326	1	**144**	2	31	68	37.01	166	45.51	1	%	CD4	16.1	25	DP	0	2	
20170711	2342	1	**145**	1	30.5	68	36.94	166	40.16	1	%	CD3	13.1	24	DP	0	3	
20170711	2345	1	**145**	2	30.5	68	36.99	166	40.05	1	%	CD3	13.4	28	DP	0	3	
20170712	2	1	**146**	1	30.3	68	36.94	166	34.63	1	%	CD2	12.1	16	DP	0	2.5	
20170712	5	1	**146**	2	29.5	68	36.99	166	34.51	1	%	CD2	9.8	25	DP	0	2.5	
20170712	19	1	**147**	1	26.7	68	36.97	166	29.22	1	%	CD1	9.4	10	DP	0	2.5	
20170712	22	1	**147**	2	26.2	68	37.01	166	29.09	1	%	CD1	11.9	17	DP	0	2.5	
20170712	232	1	**148**	1	25.8	68	54.37	166	19.83	1	%	LIS1	16	64	DP	0	1	
20170712	235	1	**148**	2	26	68	54.43	166	19.91	1	%	LIS1	13	59	DP	0	1	
20170712	252	1	**149**	1	31	68	54.77	166	25.26	1	%	LIS2	15.4	58	DP	0	1.5	
20170712	255	1	**149**	2	31	68	54.81	166	25.29	1	%	LIS2	13.4	52	DP	0	1.5	
20170712	311	1	**150**	1	32.1	68	55.174	166	30.555	1	%	LIS3	14.6	50	EE	0	2.5	operator maybe wrong in file
20170712	314	1	**150**	2	32	68	55.203	166	30.572	1	%	LIS3	15.6	60	EE	0	2.5	
20170712	337	1	**151**	1	39.6	68	55.749	166	38.541	1	%	LIS4	13.3	47	EE	0	2.5	
20170712	341	1	**151**	2	39.5	68	55.781	166	38.628	1	%	LIS4	14.4	42	EE	0	2.5	
20170712	405	1	**152**	1	43.3	68	56.356	166	46.608	1	%	LIS5	15.9	52	EE	0	2.5	
20170712	410	1	**152**	2	44	68	56.421	166	46.708	1	%	LIS5	18.4	58	EE	0	2.5	
20170712	433	1	**153**	1	44.1	68	56.953	166	54.567	1	%	LIS6	15.2	52	EE	0	3	
20170712	437	1	**153**	2	46.1	68	56.981	166	54.675	1	%	LIS6	15.6	56	EE	0	3	
20170712	459	1	**154**	1	44.8	68	57.548	167	1.8	1	%	LIS6.5	15.6	48	EE	0	3	
20170712	503	1	**154**	2	44.7	68	57.556	167	1.837	1	%	LIS6.5	17.1	60	EE	0	3	
20170712	525	1	**155**	1	44.3	68	58.163	167	9.312	0	%	LIS7	11.8	37	EE	0	3	
20170712	529	1	**155**	2	44.5	68	58.196	167	9.313	0	%	LIS7	12.3	46	EE	0	3	
20170712	550	1	**156**	1	45	68	58.767	167	16.741	0	%	LIS7.5	14.3	42	EE	0	2.5	

20170712	554	1	**156**	2	44.9	68	58.785	167	16.75	0	%	LIS7.5	14.1	57	EE	0	2.5	interesting layer at 15-25m depth
20170712	615	1	**157**	1	45.7	68	59.369	167	24.086	0	%	LIS8	13.7	36	EE	0	2.5	
20170712	620	1	**157**	2	45.6	68	59.409	167	24.059	0	%	LIS8	12	39	EE	0	2.5	layer around 20-27m depth
20170712	647	1	**158**	1	46.2	69	0.18	167	33.757	0	%	LIS8.5	10.8	31	EE	0	3	
20170712	652	1	**158**	2	46.6	69	0.22	167	33.791	0	%	LIS8.5	11.4	35	EE	0	3	
20170712	718	1	**159**	1	47	69	0.962	167	43.706	0	%	LIS9.5	11.7	15	ACPF	0	3	
20170712	723	1	**159**	2	46.9	69	0.991	167	43.616	0	%	LIS9.5	11.1	21	ACPF	0	3	
20170712	750	1	**160**	1	47.3	69	1.78	167	53.451	0	%	LIS10	11.6	14	ACPF	0	3	
20170712	754	1	**160**	2	47.2	69	1.787	167	53.416	0	%	LIS10	10.4	18	ACPF	0	3	
20170712	832	1	**161**	1	48.2	69	1.324	168	8.013	0	%	LIS11	11.5	34	ACPF	0	3	
20170712	837	1	**161**	2	48.3	69	1.356	168	7.986	0	%	LIS11	11.4	30	ACPF	0	3	
20170712	913	1	**162**	1	48.7	69	0.85	168	22.567	0	%	LIS12	10.8	18	ACPF	0	3	
20170712	918	1	**162**	2	48.7	69	0.901	168	22.537	0	%	LIS12	11.2	19	ACPF	0	3	
20170712	955	1	**163**	1	49.8	69	0.407	168	37.137	0	%	LIS13	7.2	351	ACPF	0	3	
20170712	958	1	**163**	2	49.7	69	0.442	168	37.082	0	%	LIS13	8.7	358	ACPF	0	3	
20170712	1023	1	**164**	1	50.3	69	0.181	168	46.69	0	%	LIS14	10	16	ACPF	0	3	
20170712	1027	1	**164**	2	50.6	69	0.218	168	46.652	0	%	LIS14	10.1	21	ACPF	0	3	
20170712	1052	1	**165**	1	50.8	68	59.947	168	56.08	0	%	CCL22n	9.7	4	ACPF	0	3	**DROPPED JIMS BUOY @ 1057**
20170712	1056	1	**165**	2	50.8	68	59.979	168	56.038	0	%	CCL22n	10.9	11	ACPF	0	3	**Buoy # 321150**
20170712	1206	1	**166**	1	51.2	68	49.944	168	56.009	0	%	CCL21	6.5	3	ACPF	0	3	
20170712	1211	1	**166**	2	51.1	68	50.007	168	56.012	0	%	CCL21	6	341	ACPF	0	3	
20170712	1319	1	**167**	1	50.8	68	39.94	168	55.991	0	%	CCL20	6.8	354	ACPF	0	3	
20170712	1324	1	**167**	2	50.9	68	40.013	168	56.015	0	%	CCL20	5.8	353	ACPF	0	3	
20170712	1435	1	**168**	1	52.6	68	29.966	168	55.954	0	%	CCL19	5.5	288	ACPF	0	3	
20170712	1440	1	**168**	2	52.6	68	30.042	168	56.015	0	%	CCL19	5.4	280	ACPF	0	3	
20170712	1548	1	**169**	1	53.8	68	19.905	168	56.013	0	%	CCL18	6.4	301	BI	1	3	
20170712	1553	1	**169**	2	54.2	68	19.997	168	56.034	0	%	CCL18	5.5	300	BI	1	3	Deep MLD ~26m, distinct two layer wa
20170712	1700	1	**170**	1	55.5	68	9.911	168	56.012	0	%	CCL17	8.2	293	BI	0	3.5	
20170712	1704	1	**170**	2	55.2	68	9.959	168	56.006	0	%	CCL17	8.1	290	BI	0	3.5	density inversion??
20170712	1812	1	**171**	1	55.4	68	59.888	168	56.007	0	%	CCL16	7.6	270	BI	0	3	**DROP JIMS BUOY HERE.** Whales!
20170712	1817	1	**171**	2	55.2	67	59.957	168	55.993	0	%	CCL16	7.2	267	BI	0	2	interesting fluor/turb structure, lots of
20170712	1928	1	**172**	1	48.8	67	49.945	168	55.571	0	%	CCL15	6.7	263	BI	1	2	
20170712	1932	1	**172**	2	48.8	67	50.001	168	55.507	0	%	CCL15	6.2	271	BI	1	2	interesting fluor/turb structure, therma
20170712	2048	1	**173**	1	48.1	67	38.101	168	56.009	0	%	CCL14	8	272	BI	1	1	
20170712	2053	1	**173**	2	48.2	67	38.044	168	55.833	0	%	CCL14	7.3	255	BI	1	1	well mixed, large turb signal at bottom
20170712	2148	1	**174**	1	47.7	67	30.104	168	56.106	0	%	CCL13	7	235	BI	1	1.5	
20170712	2152	1	**174**	2	47.9	67	30.068	168	55.984	0	%	CCL13	7.6	234	BI	1	1.5	well mixed, large turb signal at bottom,
20170712	2256	1	**175**	1	47.3	67	20.03	168	56.046	1	%	CCL12	4.5	200	BI	0	1.5	
20170712	2300	1	**175**	2	47.3	67	20.054	168	55.865	1	%	CCL12	3.8	181	BI	0	1.5	sucked a jellyfish? on downcast then re
20170712	6	1	**176**	1	46.2	67	10.01	168	56.00	1	%	CCL11	5.6	156	DP	0	2	
20170712	10	1	**176**	2	46.3	67	10.00	168	55.89	1	%	CCL11	6.3	151	DP	0	2	Lots of whales
20170713	119	1	**177**	1	45.5	67	0.07	168	56	1	%	CCL10	6.3	145	DP	0	1.5	
20170713	123	1	**177**	2	45.7	67	0.02	168	55.99	1	%	CCL10	6.3	158	DP	0	1.5	Lots of whales
20170713	238	1	**178**	1	42.7	66	50.04	168	56.03	1	%	CCL9	8.9	163	DP	0	4.5	
20170713	241	1	**178**	2	42.5	66	50.02	168	55.94	1	%	CCL9	9.3	159	DP	0	4.5	lots of jellyfish
20170713	350	1	**179**	1	41	66	40.078	168	56.054	1	%	CCL8	7.7	153	EE	0	2.5	
20170713	353	1	**179**	2	41.4	66	40.068	168	56.105	1	%	CCL8	7.8	147	EE	0	2.5	Lots of jellyfish at surface
20170713	430	1	**180**	1	43.6	66	35.046	168	56.023	1	%	CCL7	7.1	166	EE	0	2	
20170713	434	1	**180**	2	43.6	66	35.027	168	56.075	1	%	CCL7	8.4	171	EE	0	2	Fluor spike
20170713	509	1	**181**	1	54.2	66	30.02	168	56.042	1	%	CCL6	11.3	179	EE	0	1	Fluor/Ox spike
20170713	513	1	**181**	2	54.3	66	30.019	168	55.984	1	%	CCL6	11	172	EE	0	1	
20170713	549	1	**182**	1	54.3	66	25.037	168	56.02	0	%	CCL5	6.8	188	EE	0	1	Soak was a bit deep, 15 m
20170713	555	1	**182**	2	54.4	66	25.052	168	56.071	0	%	CCL5	7.2	171	EE	0	1	
20170713	615	1	**183**	1	53.2	66	22.337	168	56.004	0	%	CCL4	10.7	182	EE	0	1	
20170713	619	1	**183**	2	53.3	66	22.348	168	56.004	0	%	CCL4	11	165	EE	0	1	Fluor spike around 10 m

20170713	639	1	**184**	1	53.7	66	19.866	168	57.121	0	%	A3-17	12.4	201	EE	0	1	
20170713	644	1	**184**	2	53.7	66	19.882	168	57.124	0	%	A3-17	14.9	182	EE	0	1	Fluor spike
20170713	651	1	**185**	1	53.7	66	20.014	168	55.328	0	%	AL12.5	12.7	184	EE	0	1	
20170713	656	1	**185**	2	53.7	66	20.071	168	55.351	0	%	AL12.5	13.1	181	EE	0	1	Fluor spike around 12 m
20170713	703	1	**186**	1	53.7	66	20.39	168	53.66	0	%	AL13	12.8	184	ACPF	0	1.5	
20170713	708	1	**186**	2	53.7	66	20.47	168	53.485	0	%	AL13	12.5	190	ACPF	0	1.5	
20170713	714	1	**187**	1	52	66	20.669	168	51.684	0	%	AL13.5	12.8	183	ACPF	0	1.5	S2 out for lunch.
20170713	719	1	**187**	2	52.1	66	20.74	168	51.505	0	%	AL13.5	13.7	193	ACPF	0	1.5	Cleaned vent plug in pump2
20170713	730	1	**188**	1	53	66	21.13	168	49.332	0	%	AL14	12.8	179	ACPF	0	1.5	
20170713	734	1	**188**	2	53.2	66	21.211	168	49.23	0	%	AL14	12.3	176	ACPF	0	1.5	S2 back from lunch and OK.
20170713	741	1	**189**	1	52.7	66	21.413	168	47.343	0	%	AL14.5	10.6	170	ACPF	0	1.5	
20170713	746	1	**189**	2	52.9	66	21.5	168	47.2	0	%	AL14.5	9.2	161	ACPF	0	1.5	
20170713	754	1	**190**	1	44.9	66	21.803	168	45.135	0	%	AL15	11.5	163	ACPF	0	1	
20170713	758	1	**190**	2	45.3	66	21.86	168	45.089	0	%	AL15	12.4	165	ACPF	0	1	
20170713	806	1	**191**	1	49.8	66	22.144	168	42.95	0	%	AL15.5	11.7	157	ACPF	0	2	
20170713	811	1	**191**	2	50.1	66	22.21	168	42.878	0	%	AL15.5	12.6	156	ACPF	0	2	
20170713	819	1	**192**	1	55.4	66	22.516	168	40.82	0	%	AL16	11.7	149	ACPF	0	2	Lots of jellyfish at surface
20170713	825	1	**192**	2	55.5	66	22.584	168	40.898	0	%	AL16	12.1	155	ACPF	0	2	
20170713	833	1	**193**	1	55.1	66	22.786	168	38.818	0	%	AL16.5	11.8	159	ACPF	0	2	Lots of jellyfish at surface
20170713	838	1	**193**	2	55.2	66	22.886	168	38.667	0	%	AL16.5	11.9	157	ACPF	0	2	
20170713	852	1	**194**	1	53.8	66	23.202	168	36.537	0	%	AL17	11.3	154	ACPF	0	2	Big spike in fluorescence at ~13 m
20170713	857	1	**194**	2	53.7	66	23.285	168	36.671	0	%	AL17	12.2	159	ACPF	0	2	
20170713	906	1	**195**	1	52.3	66	23.589	168	34.07	0	%	AL17.5	11.8	171	ACPF	0	1.5	
20170713	910	1	**195**	2	52.4	66	23.706	168	33.974	0	%	AL17.5	14	175	ACPF	0	1.5	
20170713	917	1	**196**	1	51.2	66	23.847	168	32.342	0	%	AL18	11.2	174	ACPF	0	1.5	
20170713	921	1	**196**	2	51.4	66	23.918	168	32.177	0	%	AL18	10.8	172	ACPF	0	1.5	
20170713	928	1	**197**	1	51.5	66	24.203	168	30.158	0	%	AL18.5	10.5	177	ACPF	0	1.5	
20170713	932	1	**197**	2	51.7	66	24.306	168	30.034	0	%	AL18.5	9.9	180	ACPF	0	1.5	
20170713	939	1	**198**	1	52.1	66	24.632	168	27.876	0	%	AL19	9.3	173	ACPF	0	1.5	Saltier in surface layers!
20170713	944	1	**198**	2	52.1	66	24.684	168	27.845	0	%	AL19	10.5	171	ACPF	0	1.5	
20170713	951	1	**199**	1	51.1	66	24.91	168	25.916	0	%	AL19.5	11.6	190	ACPF	0	2	
20170713	955	1	**199**	2	51	66	25.033	168	25.745	0	%	AL19.5	10	192	ACPF	0	2	
20170713	1003	1	**200**	1	51	66	25.281	168	23.611	1	%	AL20	11.4	193	ACPF	0	1.5	
20170713	1007	1	**200**	2	50.9	66	25.376	168	23.427	1	%	AL20	11.7	199	ACPF	0	1.5	
20170713	1013	1	**201**	1	50.1	66	25.618	168	21.6	1	%	AL20.5	11.5	198	ACPF	0	2.5	
20170713	1018	1	**201**	2	49.7	66	25.718	168	21.434	1	%	AL20.5	10.9	197	ACPF	0	2.5	
20170713	1025	1	**202**	1	46.5	66	25.985	168	19.29	1	%	AL21	10.6	195	ACPF	0	2.5	
20170713	1029	1	**202**	2	46.2	66	26.129	168	19.094	1	%	AL21	11	192	ACPF	0	2.5	
20170713	1036	1	**203**	1	42.7	66	26.35	168	17.22	1	%	AL21.5	9.8	187	ACPF	0	2.5	
20170713	1040	1	**203**	2	42.2	66	26.437	168	17.008	1	%	AL21.5	9.4	182	ACPF	0	2.5	
20170713	1047	1	**204**	1	39.4	66	26.72	168	14.979	1	%	AL22	9.3	179	ACPF	0	2	
20170713	1050	1	**204**	2	39.2	66	26.779	168	14.84	1	%	AL22	9.3	183	ACPF	0	2	
20170713	1057	1	**205**	1	36.1	66	27.074	168	12.823	1	%	AL22.5	10.6	187	ACPF	0	2.5	
20170713	1101	1	**205**	2	36	66	27.118	168	12.698	1	%	AL22.5	10.3	195	ACPF	0	2.5	
20170713	1108	1	**206**	1	32.4	66	27.382	168	10.745	1	%	AL23	9.6	191	ACPF	0	2.5	
20170713	1111	1	**206**	2	32	66	27.452	168	10.579	1	%	AL23	9.6	191	ACPF	0	2.5	
20170713	1118	1	**207**	1	28.2	66	27.747	168	8.485	1	%	AL23.5	8.4	182	ACPF	0	3	
20170713	1122	1	**207**	2	28	66	27.819	168	8.327	1	%	AL23.5	8.3	181	ACPF	0	3	
20170713	1128	1	**208**	1	25.8	66	28.104	168	6.36	1	%	AL24	10.6	182	ACPF	0	3	
20170713	1131	1	**208**	2	25.8	66	28.169	168	6.198	1	%	AL24	10.9	182	ACPF	0	3	
20170713	1138	1	**209**	1	23.7	66	28.46	168	4.161	1	%	AL24.5	9.4	181	ACPF	0	3	
20170713	1141	1	**209**	2	23.6	66	28.538	168	4.014	1	%	AL24.5	11.7	181	ACPF	0	3	
20170713	1148	1	**210**	1	22.2	66	28.817	168	1.963	1	%	AL25	9	178	ACPF	0	3	
20170713	1151	1	**210**	2	22	66	28.853	168	1.815	1	%	AL25	9.1	177	ACPF	0	3	
20170713	1157	1	**211**	1	21.3	66	29.173	167	59.864	1	%	AL25.5	8.9	181	ACPF	0	3	

20170713	1200	1	**211**	2	21.3	66	29.223	167	59.687	1	%	AL25.5	9.7	188	ACPF	0	3	
20170713	1207	1	**212**	1	21.1	66	29.546	167	57.69	1	%	AL26	9.7	179	ACPF	0	3	
20170713	1210	1	**212**	2	21.1	66	29.561	167	57.548	1	%	AL26	10.2	180	ACPF	0	3	
20170713	1217	1	**213**	1	21.3	66	29.899	167	55.561	1	%	AL26.5	8.7	181	ACPF	0	4	
20170713	1219	1	**213**	2	21.2	66	29.918	167	55.385	1	%	AL26.5	8.5	188	ACPF	0	4	
20170713	1226	1	**214**	1	21.4	66	30.253	167	53.469	1	%	AL27	10.2	189	ACPF	0	4	
20170713	1229	1	**214**	2	21.5	66	30.298	167	53.289	1	%	AL27	9.7	188	ACPF	0	4	
20170713	1236	1	**215**	1	21.7	66	30.616	167	51.3	1	%	AL27.5	8.3	188	ACPF	0	4	
20170713	1239	1	**215**	2	21.7	66	30.656	167	51.106	1	%	AL27.5	9	192	ACPF	0	4	
20170713	1739	1	**216**	1	25	66	29.392	168	6.263	1	%	glider near AL24	9	170	rw	0	2	not to bottom, cos transponder not on
20170713	1742	1	**216**	2	25	66	29.423	168	6.263	1	%		9	170	rw	0	2	
20170713	1743	1	**217**	1	25	66	29.454	168	6.264	1	%	glider near AL24	8.9	174	rw	0	2	recast in place
20170713	1746	1	**217**	2	25	66	29.505	168	6.248	1	%		9	180	rw	0	2	
20170713	2047	1	**218**	1	53	66	10.163	168	56.146	0	%	NNBS1	8.9	172	BI	0	3.5	3-3.5m vis
20170713	2051	1	**218**	2	52.9	66	10.185	168	56.244	0	%	NNBS1	8.4	162	BI	0	3.5	thoroughly mixed to bottom
20170713	2104	1	**219**	1	52.7	66	10.139	168	51.891	0	%	NNBS1.5	10.3	170	BI	0	3	
20170713	2109	1	**219**	2	52.8	66	10.311	168	51.897	0	%	NNBS1.5	7.5	163	BI	0	3	
20170713	2122	1	**220**	1	53.8	66	10.096	168	47.601	0	%	NNBS2	11.5	184	BI	0	1.5	
20170713	2126	1	**220**	2	53.5	66	10.242	168	47.589	0	%	NNBS2	11.3	185	BI	0	1.5	blip in sal caused density inversion
20170713	2139	1	**221**	1	52.9	66	10.104	168	43.169	0	%	NNBS2.5	8.9	170	BI	0	2.5	
20170713	2144	1	**221**	2	52.7	66	10.244	168	43.155	0	%	NNBS2.5	8.9	171	BI	0	2.5	same as above-jellyfish likely
20170713	2157	1	**222**	1	52.4	66	10.125	168	38.984	0	%	NNBS3	10.4	174	BI	0	3	
20170713	2203	1	**222**	2	52.5	66	10.341	168	38.991	0	%	NNBS3	7.8	168	BI	0	3	
20170713	2216	1	**223**	1	55.2	66	10.056	168	34.609	0	%	NNBS3.5	10	189	BI	0	3	
20170713	2220	1	**223**	2	5.2	66	10.193	168	34.55	0	%	NNBS3.5	10.8	185	BI	0	3	
20170713	2234	1	**224**	1	51.2	66	10.126	168	30.274	0	%	NNBS4	7.7	196	BI	0	3	
20170713	2239	1	**224**	2	51.8	66	10.288	168	30.288	0	%	NNBS4	10.6	190	BI	0	3	
20170713	2252	1	**225**	1	51.4	66	10.044	168	26.054	0	%	NNBS4.5	10.5	194	BI	0	3	
20170713	2257	1	**225**	2	51.3	66	10.174	168	25.977	0	%	NNBS4.5	8.6	185	BI	0	3	
20170713	2309	1	**226**	1	56.2	66	10.09	168	21.64	0	%	NNBS5	8.5	201	DP	0	2.5	
20170713	2314	1	**226**	2	56	66	10.25	168	21.61	0	%	NNBS5	11.6	195	DP	0	2.5	comb jellies
20170713	2327	1	**227**	1	51.4	66	10.09	168	17.31	0	%	NNBS5.5	9.2	210	DP	0	2.5	
20170713	2331	1	**227**	2	51.2	66	10.25	168	17.23	0	%	NNBS5.5	10.3	189	DP	0	2.5	
20170713	2343	1	**228**	1	48.2	66	10.1	168	12.94	1	%	NNBS6	8.2	205	DP	0	7	chlorophyll max at 20m and high DO
20170713	2347	1	**228**	2	48.1	66	10.2	168	12.83	1	%	NNBS6	7.1	188	DP	0	7	less jellies
20170713	2359	1	**229**	1	46	66	10.11	168	8.8	1	%	NNBS6.5	4.8	217	DP	0	5	chlorophyll max at 20m and high DO
20170714	3	1	**229**	2	46.3	66	10.23	168	8.72	1	%	NNBS6.5	5.3	206	DP	0	5	
20170714	18	1	**230**	1	39.4	66	10.16	168	4.3	1	%	NNBS7	2.4	196	DP	0	6	more jellies
20170714	22	1	**230**	2	39.5	66	10.24	168	4.28	1	%	NNBS7	3.7	197	DP	0	6	
20170714	35	1	**231**	1	33	66	10.06	168	0.05	1	%	NNBS7.5	5.1	225	DP	0	6	
20170714	38	1	**231**	2	32.8	66	10.13	168	59.93	1	%	NNBS7.5	4.3	223	DP	0	6	
20170714	323	1	**232**	1	49.8	66	0.137	168	55.879	1	%	NBS1/DL12	7.3	170	EE	0	2	
20170714	326	1	**232**	2	49.9	66	0.19	168	55.81	1	%	NBS1/DL12	8.2	178	EE	0	2	
20170714	337	1	**233**	1	50.4	65	59.994	168	52.34	0	%	NBS1/DLa12	9.3	188	EE	0	2.5 to 3	
20170714	342	1	**233**	2	50.7	66	0.1	168	52.074	0	%	NBS1/DLa12	7.2	175	EE	0	2.5 to 3	
20170714	353	1	**234**	1	50.7	66	0.005	168	48.49	0	%	NBS2/DLb12	10.8	199	EE	0	3	
20170714	357	1	**234**	2	50.8	66	0.021	168	48.307	0	%	NBS2/DLb12	10.2	211	EE	0	3	
20170714	405	1	**235**	1	51	66	0.012	168	45.979	0	%	NBS2.5	11.4	216	EE	0	3	
20170714	409	1	**235**	2	51.1	66	0.054	168	45.824	0	%	NBS2.5	10.2	218	EE	0	3	
20170714	421	1	**236**	1	50.9	66	0.038	168	41.831	0	%	NBS3	9.3	206	EE	0	2.5	
20170714	425	1	**236**	2	51	66	0.083	168	41.732	0	%	NBS3	8.9	217	EE	0	2.5	
20170714	438	1	**237**	1	50.2	66	0.008	168	37.7	0	%	NBS3.5	6.9	172	EE	0	3	
20170714	442	1	**237**	2	50.5	66	0.116	168	37.491	0	%	NBS3.5	6.3	186	EE	0	3	
20170714	454	1	**238**	1	51.1	65	59.977	168	33.434	0	%	NBS4	4.3	188	EE	1	3	
20170714	458	1	**238**	2	51.6	66	0.051	168	33.157	0	%	NBS4	5.2	178	EE	1	3	

20170714	510	1	**239**	1	51.5	66	0.01	168	29.29	0	%	NBS4.5	6.7	192	EE	0	2	
20170714	514	1	**239**	2	51	66	0.064	168	29.112	0	%	NBS4.5	6.7	191	EE	0	2	
20170714	526	1	**240**	1	54.8	65	59.934	168	25.127	0	%	NBS5	8.8	196	EE	0	2	
20170714	531	1	**240**	2	54.5	66	0.087	168	24.91	0	%	NBS5	9.1	198	EE	0	2	
20170714	542	1	**241**	1	51.7	65	59.938	168	20.866	0	%	NBS5.5	8.7	203	EE	0	2	
20170714	546	1	**241**	2	51.9	66	0.083	168	20.645	0	%	NBS5.5	9.2	204	EE	0	2	
20170714	559	1	**242**	1	50.7	65	59.991	168	16.493	0	%	NBS6	9.4	214	EE	0	2.5	
20170714	603	1	**242**	2	50.6	66	0.067	168	16.299	0	%	NBS6	8.4	219	EE	0	2.5	
20170714	614	1	**243**	1	48	65	59.929	168	12.491	0	%	NBS6.5	4.8	221	EE	0	4	
20170714	618	1	**243**	2	47.8	66	0.062	168	12.355	0	%	NBS6.5	5.2	210	EE	0	4	
20170714	629	1	**244**	1	45.7	65	59.94	168	8.672	0	%	NBS7	5.4	208	EE	0	4	
20170714	634	1	**244**	2	45.1	66	0.073	168	8.432	0	%	NBS7	3.7	143	EE	0	4	
20170714	645	1	**245**	1	38.1	65	59.974	168	4.365	1	%	NBS7.5	4.8	226	EE	0	3	
20170714	649	1	**245**	2	38	66	0.109	168	4.167	1	%	NBS7.5	5.4	220	EE	0	3	
20170714	702	1	**246**	1	31.8	65	59.99	168	0.184	1	%	NBS8	4.4	201	ACPF	0	3	
20170714	705	1	**246**	2	31.5	66	0.076	168	0.03	1	%	NBS8	3.5	200	ACPF	0	3	
20170714	719	1	**247**	1	18.7	65	59.989	167	55.103	1	%	NBS9	2.6	175	ACPF	0	3	
20170714	722	1	**247**	2	18.5	66	0.062	167	55.009	1	%	NBS9	3	160	ACPF	0	3	
20170714	1018	1	**248**	1	44.2	65	52.194	168	56.101	0	%	MBSn1/DL4	2	232	ACPF	0	2	
20170714	1021	1	**248**	2	43.8	65	52.272	168	56.246	0	%	MBSn1/DL4	3.4	227	ACPF	0	2	
20170714	1033	1	**249**	1	47.2	65	51.952	168	52.78	0	%	MBSn1.5	3.5	189	ACPF	0	2	
20170714	1037	1	**249**	2	47.3	65	52.002	168	52.638	0	%	MBSn1.5	4.6	192	ACPF	0	2	
20170714	1048	1	**250**	1	48.9	65	51.864	168	49.292	0	%	MBSn2	4.5	186	ACPF	0	2.5	
20170714	1052	1	**250**	2	48.9	65	51.948	168	49.111	0	%	MBSn2	4.6	179	ACPF	0	2.5	
20170714	1103	1	**251**	1	49.9	65	51.755	168	45.19	0	%	MBSn2.5	5.5	193	ACPF	0	2.5	INSANE AMOUNT OF JELLY FISH
20170714	1107	1	**251**	2	51.5	65	51.827	168	44.945	0	%	MBSn2.5	4.5	194	ACPF	0	2.5	
20170714	1118	1	**252**	1	50.7	65	51.686	168	41.113	0	%	MBSn3	3.9	175	ACPF	0	2.5	
20170714	1122	1	**252**	2	50.7	65	51.746	168	40.875	0	%	MBSn3	3.8	170	ACPF	0	2.5	
20170714	1135	1	**253**	1	51.5	65	51.565	168	36.614	0	%	MBSn3.5	6.5	194	ACPF	0	2.5	
20170714	1139	1	**253**	2	51.2	65	51.655	168	36.383	0	%	MBSn3.5	4.7	163	ACPF	0	2.5	
20170714	1151	1	**254**	1	51.3	65	51.463	168	32.03	0	%	MBSn4	4.3	178	ACPF	0	1.5	
20170714	1155	1	**254**	2	51.1	65	51.533	168	31.761	0	%	MBSn4	5	168	ACPF	0	1.5	
20170714	1207	1	**255**	1	53.9	65	51.364	168	27.678	0	%	MBSn4.5	5.7	215	ACPF	0	1.5	
20170714	1212	1	**255**	2	53.8	65	51.485	168	27.396	0	%	MBSn4.5	4.7	209	ACPF	0	1.5	
20170714	1224	1	**256**	1	50.1	65	51.266	168	23.116	0	%	MBSn5	4.6	213	ACPF	0	2	
20170714	1228	1	**256**	2	50.2	65	51.375	168	22.835	0	%	MBSn5	3.6	205	ACPF	0	2	
20170714	1240	1	**257**	1	48.5	65	51.17	168	18.645	0	%	MBSn5.5	2	163	ACPF	0	3	
20170714	1244	1	**257**	2	48.5	65	51.298	168	18.376	0	%	MBSn5.5	1.7	133	ACPF	0	3	
20170714	1256	1	**258**	1	44.9	65	51.068	168	14.12	0	%	MBSn6	2	174	ACPF	0	3	
20170714	1300	1	**258**	2	44.7	65	51.15	168	13.787	0	%	MBSn6	1.2	147	ACPF	0	3	
20170714	1309	1	**259**	1	44.1	65	51.087	168	10.544	1	%	MBSn6.6	0.6	120	ACPF	0	3	
20170714	1313	1	**259**	2	43.9	65	51.107	168	10.391	1	%	MBSn6.6	0.9	130	ACPF	0	3	
20170714	1322	1	**260**	1	37.4	65	50.999	168	7.066	1	%	MBSn7	0.5	36	ACPF	0	3	
20170714	1326	1	**260**	2	37.7	65	51.032	168	6.889	1	%	MBSn7	0.4	43	ACPF	0	3	
20170714	1332	1	**261**	1	30.2	65	50.928	168	5.197	1	%	MBSn8	0.6	143	ACPF	0	2.5	
20170714	1335	1	**261**	2	29.8	65	50.948	168	5.138	1	%	MBSn8	1.3	221	ACPF	0	2.5	
20170714	1539	1	**262**	1	50.8	65	59.923	168	47.946	0	%	DLb12	3.8	205	BI	0	1.5	
20170714	1543	1	**262**	2	50.9	65	59.988	168	47.744	0	%	DLb12	3.8	210	BI	0	1.5	
20170714	1553	1	**263**	1	50.8	65	58.864	168	48.593	0	%	DLb11	3.4	186	BI	0	3	
20170714	1558	1	**263**	2	51.6	65	58.829	168	48.421	0	%	DLb11	3.9	164	BI	0	3	jelly around 13m on downcast
20170714	1604	1	**264**	1	50.7	65	58.031	168	48.288	0	%	DLb10	3.2	148	BI	1	2	
20170714	1608	1	**264**	2	50.7	65	57.971	168	48.255	0	%	DLb10	3.6	160	BI	1	2	
20170714	1615	1	**265**	1	50.8	65	57.161	168	48.335	0	%	DLb9	3.4	156	BI	1	2.5	
20170714	1620	1	**265**	2	50.8	65	57.132	168	48.355	0	%	DLb9	3.4	160	BI	1	2.5	very well mixed
20170714	1628	1	**266**	1	50.7	65	56.172	168	48.265	0	%	DLb8	2.5	159	BI	0	4	

20170714	1633	1	**266**	2	50.9	65	56.138	168	48.276	0	%	DLb8	2.9	170	Bl	0	4	very well mixed
20170714	1641	1	**267**	1	50.9	65	55.162	168	48.288	0	%	DLb7	3.3	142	Bl	0	4	
20170714	1645	1	**267**	2	50.9	65	55.142	168	48.283	0	%	DLb7	2.5	157	Bl	0	4	very well mixed
20170714	1653	1	**268**	1	50.2	65	54.201	168	48.2	0	%	DLb6	2.9	125	Bl	0	3	
20170714	1658	1	**268**	2	50.3	65	54.155	168	48.163	0	%	DLb6	2.9	136	Bl	0	3	
20170714	1706	1	**269**	1	50.1	65	53.233	168	48.152	0	%	DLb5	3.8	123	Bl	0	3	
20170714	1711	1	**269**	2	50.1	65	53.218	168	48.235	0	%	DLb5	3	146	Bl	0	3	very well mixed
20170714	1719	1	**270**	1	49.7	65	52.305	168	48.154	0	%	DLb4	3.1	151	Bl	0	3	
20170714	1723	1	**270**	2	49.7	65	52.306	168	48.167	0	%	DLb4	3.3	155	Bl	0	3	
20170714	1731	1	**271**	1	48.6	65	51.288	168	48.117	0	%	DLb3	3.6	139	Bl	0.5	3	
20170714	1736	1	**271**	2	48.6	65	51.263	168	48.107	0	%	DLb3	3	154	Bl	0.5	3	
20170714	1744	1	**272**	1	48.5	65	50.272	168	48.168	0	%	DLb2	4.7	143	Bl	0	3	
20170714	1748	1	**272**	2	48.5	65	50.226	168	48.148	0	%	DLb2	3.9	161	Bl	0	3	
20170714	1757	1	**273**	1	48.1	65	49.325	168	48.142	0	%	DLb1	2.5	175	Bl	0	3.5	
20170714	1801	1	**273**	2	48.1	65	49.376	168	48.227	0	%	DLb1	1.7	155	Bl	0	3.5	
20170714	1813	1	**274**	1	42.7	65	49.192	168	52.262	0	%	DLa1	1.8	192	Bl	0	2.5	
20170714	1816	1	**274**	2	43	65	49.255	168	52.16	0	%	DLa1	2.4	152	Bl	0	2.5	
20170714	1824	1	**275**	1	44.3	65	50.183	168	52.197	0	%	DLa2	2.9	145	Bl	0	2	
20170714	1827	1	**275**	2	45	65	50.244	168	51.927	0	%	DLa2	3.4	136	Bl	0	2	
20170714	1835	1	**276**	1	46.7	65	51.199	168	52.247	0	%	DLa3	3.9	170	Bl	0	2	
20170714	1838	1	**276**	2	46.7	65	51.299	168	52.164	0	%	DLa3	3.6	158	Bl	0	2	
20170714	1845	1	**277**	1	47.4	65	52.193	168	52.329	0	%	DLa4	4.1	139	Bl	0	3	
20170714	1849	1	**277**	2	47.4	65	52.195	168	52.291	0	%	DLa4	4.2	129	Bl	0	3	
20170714	1856	1	**278**	1	47.4	65	53.165	168	52.271	0	%	DLa5	4.2	146	Bl	0	2.5	
20170714	1900	1	**278**	2	47.6	65	53.236	168	52.135	0	%	DLa5	4.1	146	Bl	0	2.5	
20170714	1907	1	**279**	1	47.9	65	54.042	168	52.322	0	%	DLa6	5.2	129	Bl	0	2.5	
20170714	1911	1	**279**	2	47.5	65	54.117	168	52.221	0	%	DLa6	5	138	Bl	0	2.5	
20170714	1918	1	**280**	1	48.7	65	55.105	168	52.243	0	%	DLa7	5.2	155	Bl	0	2.5	
20170714	1922	1	**280**	2	48.8	65	55.126	168	52.109	0	%	DLa7	6.7	149	Bl	0	2.5	
20170714	1930	1	**281**	1	49.5	65	56.026	168	52.335	0	%	DLa8	5.2	151	Bl	0	3	
20170714	1933	1	**281**	2	49.9	65	56.095	168	52.282	0	%	DLa8	5.5	168	Bl	0	3	
20170714	1941	1	**282**	1	49.6	65	57.077	168	52.29	0	%	DLa9	6.7	153	Bl	0	3	
20170714	1945	1	**282**	2	49.6	65	57.162	168	52.166	0	%	DLa9	6	158	Bl	0	3	
20170714	1953	1	**283**	1	49.9	65	58.022	168	52.269	0	%	DLa10	6.1	161	Bl	0	3	
20170714	1957	1	**283**	2	50	65	58.071	168	52.159	0	%	DLa10	5.4	171	Bl	0	3	possible jelly in secondary line
20170714	2007	1	**284**	1	50.2	65	58.986	168	52.242	0	%	DLa11	6.4	183	rw	0	3	
20170714	2011	1	**284**	2	50.4	65	59.032	168	52.036	0	%	DLa11	6.1	191	rw	0	3	
20170714	2019	1	**285**	1	50.5	65	59.993	168	52.349	0	%	DLa12	6.8	206	Bl	0	4	4-4.5m vis
20170714	2023	1	**285**	2	50.9	66	0.046	168	52.19	0	%	DLa12	6	204	Bl	0	4	
20170714	2049	1	**286**	1	50.2	66	0.126	168	56.155	0	%	DL12	5.2	185	Bl	0	2	
20170714	2053	1	**286**	2	50.4	66	0.151	168	56.183	0	%	DL12	4.7	196	Bl	0	2	WALRUS & MLD back… *finally…*
20170714	2104	1	**287**	1	49.9	65	58.977	168	56.248	1	%	DL11	3.5	179	Bl	0	2	cleaned vent plug pre this cast
20170714	2109	1	**287**	2	50.1	65	58.979	168	56.009	1	%	DL11	5.9	197	Bl	0	2	
20170714	2118	1	**288**	1	49.6	65	57.943	168	56.296	0	%	DL10	4.6	184	Bl	0	3.5	
20170714	2122	1	**288**	2	49.7	65	57.964	168	56.464	0	%	DL10	5.6	182	Bl	0	3.5	
20170714	2130	1	**289**	1	48.7	65	57.039	168	56.192	1	%	DL9	2.4	201	Bl	0	3.5	
20170714	2134	1	**289**	2	48.9	65	57.04	168	55.991	1	%	DL9	2.6	189	Bl	0	3.5	chlor max around 12m
20170714	2143	1	**290**	1	47.7	65	56.112	168	56.212	0	%	DL8	4	188	Bl	0	3.5	
20170714	2147	1	**290**	2	47.5	65	56.152	168	56.336	0	%	DL8	3.9	187	Bl	0	3.5	
20170714	2156	1	**291**	1	47.2	65	55.105	168	56.275	1	%	DL7	4.5	198	Bl	0	3.5	
20170714	22	1	**291**	2	47.1	65	55.112	168	56.152	1	%	DL7	3.2	202	Bl	0	3.5	depth scanner ~ 2.5-3m deep
20170714	2209	1	**292**	1	46.7	65	54.178	168	55.979	1	%	DL6	3	209	Bl	0	3	
20170714	2212	1	**292**	2	46.6	65	54.128	168	55.818	1	%	DL6	2.6	186	Bl	0	3	"exotic" profile
20170714	2221	1	**293**	1	46	65	53.159	168	56.143	1	%	DL5	3.8	204	Bl	0	2	
20170714	2225	1	**293**	2	45.6	65	53.124	168	56.163	1	%	DL5	4.2	205	Bl	0	2	lots of dead birds, water sample taken,

20170714	2233	1	**294**	1	44.7	65	52.181	168	56.071	1	%	DL4	3.5	173	BI	0	2.5	
20170714	2236	1	**294**	2	46.3	65	52.151	168	55.747	1	%	DL4	3.1	164	BI	0	2.5	
20170714	2243	1	**295**	1	46.3	65	51.309	168	56.197	0	%	DL3	2.6	182	BI	0	2.5	
20170714	2248	1	**295**	2	46.1	65	51.227	168	56.216	0	%	DL3	2.2	187	BI	0	2.5	
20170714	2255	1	**296**	1	45.6	65	50.315	168	56.207	0	%	DL2	1.7	195	BI	0	3	
20170714	2259	1	**296**	2	45.9	65	50.314	168	56.304	0	%	DL2	1.4	149	BI	0	3	
20170714	2308	1	**297**	1	45.3	65	49.36	168	56.21	1	%	DL1	4.2	196	DP	0	3	high surface temperature
20170714	2312	1	**297**	2	45.4	65	49.36	168	56.19	1	%	DL1	4.4	186	DP	0	3	
20170714	2320	1	**298**	1	44.4	65	48.33	168	56.13	1	%	BS11	5	197	DP	0	2.5	
20170714	2324	1	**298**	2	44.6	65	48.3	168	56.04	1	%	BS11	6	194	DP	0	2.5	
20170714	2332	1	**299**	1	45.3	65	47.69	168	53.79	0	%	BS11.5	3.9	86	DP	0	2.5	
20170714	2336	1	**299**	2	45.4	65	47.63	168	53.65	0	%	BS11.5	3.9	89	DP	0	2.5	
20170714	2342	1	**300**	1	42.3	65	47.24	168	51.76	0	%	BS12	6	167	DP	0	1.5	
20170714	2345	1	**300**	2	42.5	65	47.2	168	51.84	0	%	BS12	5.6	199	DP	0	1.5	
20170714	2353	1	**301**	1	47.2	65	46.83	168	49.75	0	%	BS12.5	5	198	DP	0	1.5	
20170714	2356	1	**301**	2	48	65	46.86	168	49.53	0	%	BS12.5	5.2	187	DP	0	1.5	
20170715	3	1	**302**	1	49.6	65	46.35	168	47.63	0	%	BS13	5.2	182	DP	0	1.5	
20170715	7	1	**302**	2	49.8	65	46.37	168	47.51	0	%	BS13	4.9	184	DP	0	1.5	
20170715	15	1	**303**	1	50.6	65	45.82	168	45.43	1	%	BS13.5	4.2	187	DP	0	1.5	high temperature on surface
20170715	18	1	**303**	2	50.7	65	45.82	168	45.28	1	%	BS13.5	3.7	175	DP	0	1.5	brown and white particles on water (cc
20170715	29	1	**304**	1	50.7	65	45.22	168	43.37	1	%	BS14	4.5	178	DP	0	2.5	
20170715	32	1	**304**	2	50.4	65	45.26	168	43.17	1	%	BS14	3.6	164	DP	0	2.5	
20170715	38	1	**305**	1	49.8	65	44.78	168	41.57	1	%	BS14.5	1.5	174	DP	0	1.5	
20170715	42	1	**305**	2	50	65	44.78	168	41.44	1	%	BS14.5	1.1	162	DP	0	1.5	
20170715	49	1	**306**	1	49.7	65	44.34	168	39.9	0.5	%	BS15	0.9	14	DP	0	1.5	
20170715	52	1	**306**	2	49.9	65	44.45	168	39.81	0	%	BS15	0.6	231	DP	0	1.5	
20170715	101	1	**307**	1	50	65	43.79	168	37.67	0	%	BS15.5	2.1	255	DP	0	1.5	
20170715	104	1	**307**	2	49.8	65	43.81	168	37.52	0	%	BS15.5	0.7	247	DP	0	1.5	
20170715	112	1	**308**	1	49.9	65	43.29	168	35.5	0	%	BS16	4.4	256	DP	0	1.5	
20170715	117	1	**308**	2	49.9	65	43.26	168	35.43	0	%	BS16	4.1	261	DP	0	1.5	
20170715	124	1	**309**	1	50.2	65	42.75	168	33.42	1	%	BS16.5	3.2	258	DP	0	4	
20170715	128	1	**309**	2	50.3	65	42.73	168	33.36	0.5	%	BS16.5	2.8	260	DP	0	4	
20170715	136	1	**310**	1	52.9	65	42.24	168	31.36	1	%	BS17	2.3	269	DP	0	6	chlorophyll max of 5 at 15m
20170715	139	1	**310**	2	53.2	65	42.25	168	31.44	0.5	%	BS17	1.9	253	DP	0	6	chlorophyll max of 5 at 11m
20170715	148	1	**311**	1	51.7	65	41.7	168	29.23	1	%	BS17.5	1	8	DP	0	6.5	
20170715	152	1	**311**	2	51.3	65	41.69	168	29.32	0.5	%	BS17.5	1.1	294	DP	0	6.5	
20170715	201	1	**312**	1	52.1	65	41.23	168	26.91	1	%	BS18	0.6	271	DP	0	7	white stringy matter on water
20170715	205	1	**312**	2	51.8	65	41.27	168	26.91	1	%	BS18	2.2	288	DP	0	7	
20170715	213	1	**313**	1	50.9	65	40.81	168	25.25	1	%	BS18.5	3.2	250	DP	0	10	
20170715	217	1	**313**	2	51	65	40.85	168	25.3	1	%	BS18.5	3.1	246	DP	0	10	
20170715	227	1	**314**	1	50.2	65	40.44	168	23.67	1	%	BS19	2.6	234	DP	0	10	
20170715	231	1	**314**	2	50.6	65	40.55	168	23.76	1	%	BS19	1.9	155	DP	0	10	
20170715	242	1	**315**	1	48.6	65	39.89	168	21.35	1	%	BS19.5	2	243	DP	0	6	
20170715	246	1	**315**	2	48.7	65	39.92	168	21.4	1	%	BS19.5	2.1	245	DP	0	6	
20170715	256	1	**316**	1	46.7	65	39.324	168	19.145	1	%	BS20	2.1	227	EE	0	6	
20170715	300	1	**316**	2	46.8	65	39.413	168	19.273	1	%	BS20	1.8	259	EE	0	6	
20170715	310	1	**317**	1	44.2	65	38.952	168	17.159	1	%	BS20.5	2	70	EE	0	4	
20170715	313	1	**317**	2	44.2	65	39.038	168	17.158	1	%	BS20.5	1.4	138	EE	0	4	
20170715	323	1	**318**	1	40.2	65	38.589	168	15.039	1	%	BS21	0.2	1	EE	0	3	
20170715	326	1	**318**	2	40.5	65	38.636	168	15.205	1	%	BS21	1.4	354	EE	0	3	
20170715	337	1	**319**	1	36.8	65	38.033	168	12.812	1	%	BS21.5	2.1	45	EE	0	2.5	
20170715	340	1	**319**	2	36.7	65	38.065	168	12.794	1	%	BS21.5	3.6	69	EE	0	2.5	
20170715	350	1	**320**	1	30	65	37.485	168	10.723	1	%	BS22	3.6	26	EE	0	2	
20170715	353	1	**320**	2	29.9	65	37.495	168	10.714	1	%	BS22	2.9	22	EE	0	2	
20170715	417	1	**321**	1	24.1	65	34.904	168	7.094	1	%	BS24	0.8	286	EE	0	3	

20170715	420	1	**321**	2	27.6	65	34.901	168	7.243	1	%	BS24	0.5	203	EE	0	3	header labeled as BS22 by mistake
20170715	428	1	**322**	1	33.3	65	34.444	168	9.523	1	%	SBS1.5	2.4	34	EE	0	3	
20170715	431	1	**322**	2	33.3	65	34.475	168	9.596	1	%	SBS1.5	1.6	42	EE	0	3	
20170715	439	1	**323**	1	36.7	65	33.958	168	11.914	1	%	SBS2	0	0	EE	0	2.5	
20170715	443	1	**323**	2	36.4	65	33.965	168	11.956	1	%	SBS2	1.1	16	EE	0	2.5	
20170715	452	1	**324**	1	40.2	65	33.469	168	14.373	1	%	SBS2.5	0.9	171	EE	0	3.5	
20170715	455	1	**324**	2	40.3	65	33.534	168	14.4	1	%	SBS2.5	2.9	150	EE	0	3.5	
20170715	505	1	**325**	1	42.1	65	32.965	168	16.665	1	%	SBS3	2.7	124	EE	0	4	
20170715	508	1	**325**	2	42	65	33.008	168	16.63	1	%	SBS3	2	127	EE	0	4	
20170715	518	1	**326**	1	44.3	65	32.508	168	19.106	1	%	SBS3.5	3.7	150	EE	0	5	
20170715	522	1	**326**	2	44.4	65	32.488	168	19.122	1	%	SBS3.5	3.6	137	EE	0	5	
20170715	531	1	**327**	1	46.5	65	31.968	168	21.509	1	%	SBS4	3.4	142	EE	0	5	
20170715	534	1	**327**	2	46.3	65	31.957	168	21.467	1	%	SBS4	4.3	131	EE	0	5	Fluor spike around 20-25m
20170715	543	1	**328**	1	52.8	65	31.49	168	23.978	1	%	SBS4.5	3.1	158	EE	0	4	
20170715	548	1	**328**	2	52.7	65	31.475	168	23.975	1	%	SBS4.5	4.2	144	EE	0	4	
20170715	556	1	**329**	1	57.7	65	30.988	168	26.38	1	%	SBS5	2.5	147	EE	0	4	
20170715	601	1	**329**	2	57.5	65	30.977	168	26.485	1	%	SBS5	4	191	EE	0	4	Large Fluor spike around 25-30m
20170715	609	1	**330**	1	57.4	65	30.48	168	28.799	1	%	SBS5.5	6.1	188	EE	0	4	
20170715	615	1	**330**	2	57.5	65	30.509	168	28.793	1	%	SBS5.5	5.1	163	EE	0	4	Recast needed - double fluor spike (on
20170715	617	1	**331**	1	57.5	65	30.535	168	28.834	1	%	SBS5.5 recast	5.1	186	EE	0	4	
20170715	622	1	**331**	2	58.3	65	30.601	168	28.908	1	%	SBS5.5 recast	5.1	186	EE	0	4	Recast looks good, maybe sucked up a
20170715	631	1	**332**	1	58.9	65	29.975	168	31.228	1	%	SBS6	4.4	173	EE	0	4	
20170715	635	1	**332**	2	59.4	65	29.971	168	31.327	1	%	SBS6	4	162	EE	0	4	Four individual fluor spikes at various d
20170715	644	1	**333**	1	54.2	65	29.488	168	33.62	1	%	SBS6.5	4.9	164	EE	0	4	
20170715	648	1	**333**	2	53.8	65	29.484	168	33.707	1	%	SBS6.5	5.9	168	EE	0	4	Double fluor spikes ~18 m and ~22m de
20170715	656	1	**334**	1	54.4	65	29.056	168	36.133	1	%	SBS7	5.2	174	EE	0	4	
20170715	701	1	**334**	2	54.7	65	29.073	168	36.123	1	%	SBS7	7.1	171	EE	0	4	Single fluor spike ~17m
20170715	710	1	**335**	1	52.2	65	28.544	168	38.489	1	%	SBS7.5	7.2	164	ACPF	0	3.5	
20170715	713	1	**335**	2	54.1	65	28.57	168	38.677	1	%	SBS7.5	6.1	188	ACPF	0	3.5	Single spike at around 14m
20170715	722	1	**336**	1	54.5	65	28.028	168	40.943	1	%	SBS8	5.6	188	ACPF	0	2.5	
20170715	726	1	**336**	2	54.5	65	28.037	168	40.886	1	%	SBS8	5.6	184	ACPF	0	2.5	Oxygen max off current plotting charts
20170715	735	1	**337**	1	53.7	65	27.55	168	43.309	1	%	SBS8.5	4.5	174	ACPF	0	1.5	
20170715	739	1	**337**	2	54	65	27.555	168	43.481	1	%	SBS8.5	4.1	188	ACPF	0	1.5	Fluor fat spike 10-15m
20170715	748	1	**338**	1	54.4	65	27.027	168	45.801	1	%	SBS9	4.8	158	ACPF	0	1.5	
20170715	752	1	**338**	2	54.5	65	27.043	168	45.961	1	%	SBS9	3.6	173	ACPF	0	1.5	Big spike in Fluor and Oxyg.
20170715	800	1	**339**	1	53.3	65	26.558	168	48.167	1	%	SBS9.5	3.8	166	ACPF	0	1.5	
20170715	804	1	**339**	2	53.3	65	26.591	168	48.321	1	%	SBS9.5	2.8	151	ACPF	0	1.5	Spike again in Fluor and Oxyg.
20170715	813	1	**340**	1	57.9	65	26.066	168	50.65	1	%	SBS10	2.7	181	ACPF	0	1.5	
20170715	817	1	**340**	2	57.7	65	26.04	168	50.665	1	%	SBS10	4.1	171	ACPF	0	1.5	
20170715	825	1	**341**	1	56.3	65	25.584	168	53.036	1	%	SBS10.5	4.5	156	ACPF	0	1.5	The fluor spike continues
20170715	829	1	**341**	2	56.2	65	25.55	168	53.205	1	%	SBS10.5	5.4	155	ACPF	0	1.5	
20170715	837	1	**342**	1	55.6	65	25.087	168	55.465	1	%	SBS11	4.6	129	ACPF	0	1.5	
20170715	841	1	**342**	2	55.4	65	25.062	168	55.4	1	%	SBS11	4.6	132	ACPF	0	1.5	**THE END OF Bstrait 2017**
%			**-1**								% Marker to mark end of cruise							
%DECK CHECKS FOR CTD ZERO																		
% 20170715%	845		**343**	Turned on on deck after last cast														
%			**344**	After rinsing and flushing cells														
%			**345**	After second set of rinsing and flushing cells														
%			**346**	after third set of rinsing and flushing cells														
%			**347**	Just checking communication. OK.														
% left on deck over night to dry																		
%			**348**	After night of drying on deck														