BERING STRAIT NORSEMAN II 2016 MOORING CRUISE REPORT

Research Vessel Norseman II, Norseman Maritime Charters

Nome-Nome, 7th July to 15th July 2016

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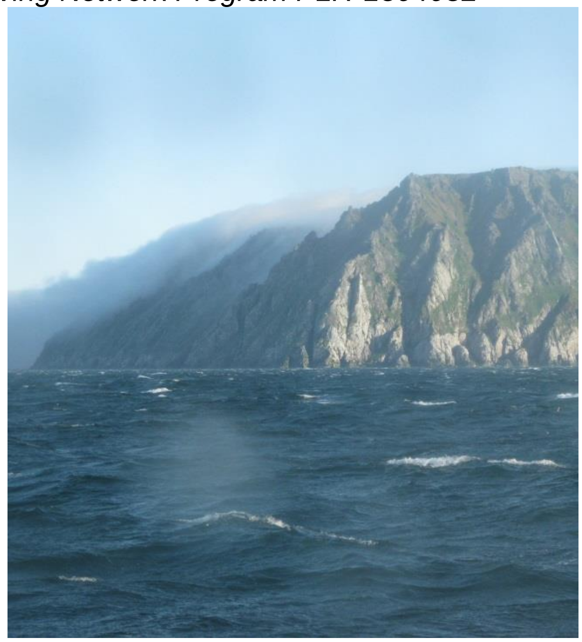
and the Bering Strait 2016 Science Team

Funding from NSF Arctic Observing Network Program PLR-1304052



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

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	Laurie Juranek, Burke Hales, Oregon State University (OSU) USA
	Peter Winsor,Hank Statscewich, University of Alaska, Fairbanks (UAF)

As part of the Bering Strait project funded by NSF-AON (Arctic Observing Network), in July 2016 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), whale acoustic (Stafford), and ocean acidification (Juranek and Hales) instrumentation. These moorings were deployed in the Bering Strait region in 2015 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).

The cruise loaded and offloaded in Nome, Alaska.

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.

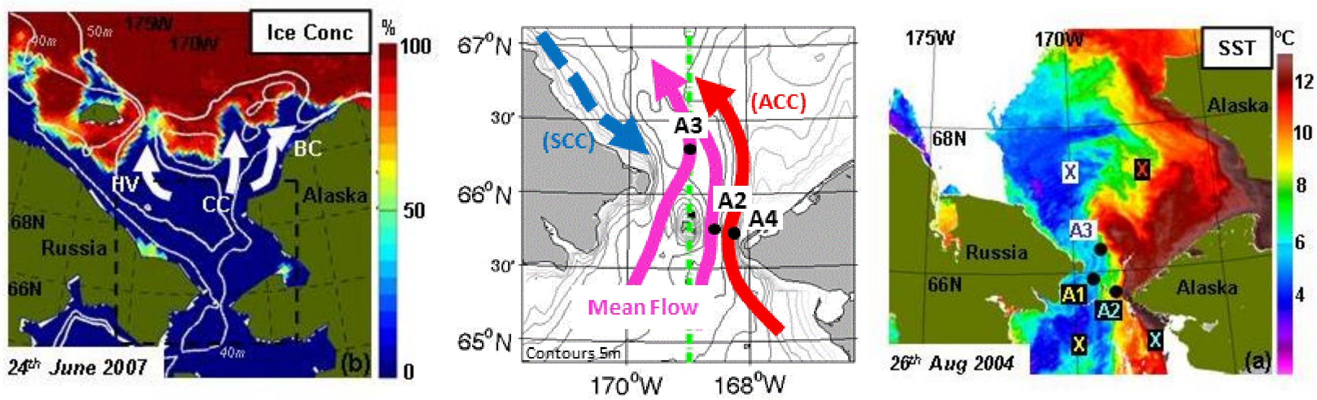


Figure 1: (Left) *Chukchi Sea ice concentration (AMSR-E) with schematic topography. White arrows mark three main water pathways melting back the ice edge [Woodgate et al., 2010].*
(Middle) *Detail of the Bering Strait, with schematic flows and mooring locations (black dots – A2, A3, A4). The main northward 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 showed 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 was attributable to weaker local winds, 2/3rds appeared to be driven by basin-scale changes between the Pacific and the Arctic. Remote data (winds, SST) proved insufficient for quantifying variability, indicating interannual change can still only be assessed by in situ year-round measurements [*Woodgate et al.*, 2012]. More recent data [*Woodgate*, 2015; *Woodgate et al.*, 2015a] show 2013 and 2014 also to be high flow years, with wind explaining less of the interannual change.

The work to be accomplished/started on this cruise will extend this mooring time-series to mid-2017.

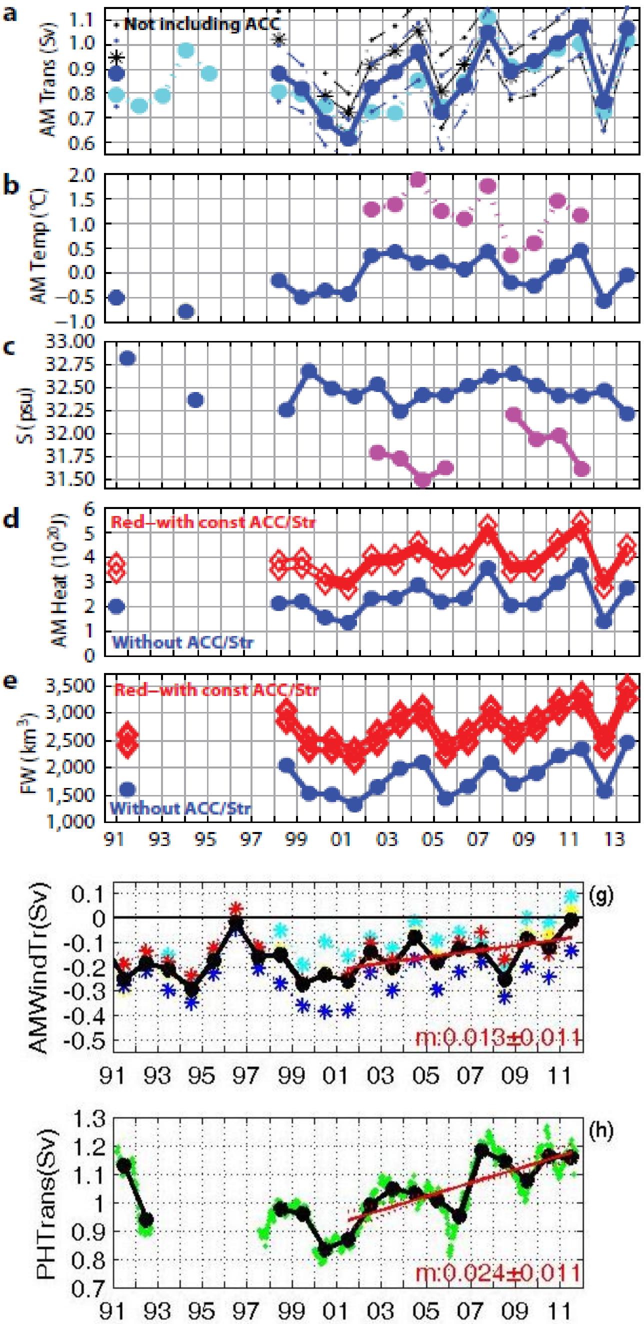


Figure 2, adapted from [Woodgate et al., 2012; Woodgate et al., 2015a]

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).*

International links: Maintaining the time-series measurements in Bering is important to several national and international programs, including particularly the Arctic Observing Network (AON), started as part of the International Polar Year (IPY) effort; and the international Arctic SubArctic Ocean Fluxes (ASOF) program. 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 a large variety of regional studies in the area (on topics from salmon to whales), 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.

2016 CRUISE SUMMARY:

Despite almost continual high winds and large amounts of fog, the 2016 cruise was remarkably successful, with all mooring operations being smoothly accomplished, and, due to a) the extremely efficient CTD operations of the Norseman II and b) the smallness of the CTD package, which allowed us to continue working in 5-6ft seas, a total of 277 CTD casts taken on 19 CTD lines (6 repeated).

Despite a consistently rough forecast (always for 20 knot winds or greater), conditions at the start of the cruise were milder than predicted, and this allowed for the mooring operations to be completed early in the cruise, despite minor delays due to fog. Note that sea states during the rest of the cruise were much higher (winds typically > 15 knots) and would have impeded or prevented mooring operations - thus the weather days built into the cruise plan are essential for successful mooring operations.

Cruise on-load started ~9:30am on Thursday 7th July 2016, and was mostly completed within 1-2hrs. We sailed at 2:10pm, after waiting for the ship to complete tie-down and ordering. A rapid transit to the strait allowed us to undertake underway temperature salinity (TS) and ADCP lines during the night, before arrival at the first mooring at ~ 8am on Friday 8th July 2016.

On Friday 8th July, after a pre-recovery CTD cast, conditions were good enough to attempt mooring recovery. Although A4 has been a site requiring dragging in previous years, the first mooring release functioned perfectly and the mooring was safely and smoothly recovered. We proceeded directly to site A2, took a pre-recovery CTD cast and again with favorable conditions, started the 2nd mooring recovery. Here the first release confirmed release, but the mooring failed to surface. However, releasing the backup release brought the mooring successfully to the surface, where again it was swiftly and smoothly recovered onto the ship. Steaming north brought us to the 3rd mooring site, A3, around 2pm, but in foggy conditions. However, after a pre-recovery CTD cast and a preliminary drift past the mooring to ensure the position was good, the fog cleared sufficiently to attempt the recovery. Here, on receiving the release command, the first release replied it was unable to release. Again the second release was used to finally release the mooring, which was smoothly and quickly recovered onto deck (where it was found the first release had released).

While mooring operations went smoothly, it was found that the recovered moorings had sustained considerable damage during the year. Unsurprisingly, the upper ISCAT units were all missing, having been predictably removed, likely by ice, in the spring. However, there was also very significant damage on all moorings on instruments deployed at ~ 45m depth, viz: breaking of vanes and brackets - A4; bending of 2.5cmx0.5cm ADCP cage bars - A2; skewing of ADCP frame and breaking of Seacat mounting - A3). At the time of writing this report, the source of the damage is unconfirmed, but is suspected to be ice keels. (Note that despite this damage, all data were successfully recovered.)

Mooring A3-16 was redeployed on the evening of Friday 8th July 2016, and a calibration CTD cast taken. After steaming underway/ADCP sections through the night, moorings A2-16 and A4-16 were redeployed on Saturday 9th July 2016 (each with a calibration CTD cast post deployment). All deployment operations went smoothly. For the rest of the cruise, we ran CTD and underway/ADCP lines - full details below.

Early in the CTD operations (~ 9am on Sunday 10th July 2016), at the end of the AL line, we deployed a Slocum autonomous glider for Hank Statscewich/Peter Winsor, UAF. We tracked the glider for ~ 1hr during some test dives, and took CTD casts before and after the deployment. The glider will traverse the Chukchi until late fall under an AOOS project with PIs Peter Winsor, Kate Stafford and Mark Baumgartner.

To track the Alaskan Coastal Current along the Alaskan Coast, we introduced two new sections between Point Hope and Cape Lisburne. The smallness of the CTD package used allowed us to continue this work in weather that would have shut down operations on a larger rosette. However, by the time of our arrival at Cape Lisburne (2:40pm Monday 11th July 2016), winds (gusting 45 knots) and seas had built sufficiently large that it was prudent to suspend operations for safety reasons. For the next ~ 13hrs we anchored up just north of Cape Lisburne, still experiencing winds at > 40 knots, but no seas, due to lack of fetch. When we resumed CTD operations (~ 6am, Tuesday 12th July 2016) a large (~5ft) swell from the south which remained through all the LIS and most of the CCL line.

Strong (northward) winds dogged the rest of the cruise also. North of the Diomede islands, winds appeared locally intensified, possibly due to funneling between the islands. To ensure the operation before weather worsened, we reran the BS line at the first opportunity, completing the cruise with other cross-strait lines, followed by repeats of the high resolution lines north of the Diomedes, which appear to clearly catch the properties of an eddy cast/trapped behind the islands.

We departed Bering Strait (from DB1) at midnight on Thursday 14th/Friday 15th July, arriving in Nome at 1pm for offload. Docking was delayed ~ 1hr due to a disabled ship unexpectedly on the pier - which was eventually repositioned by a tug. The offload and restuffing of the container, and the taking of shipments to air cargo all went smoothly, and the science party left the ship ~ 5pm.

Fog was almost ubiquitous during the cruise, and without a marine mammal watch, few wildlife sightings were made. A pod of whales (5-10 in number, but far off, likely gray whales) were spotted just South of CCL10, and at least qualitatively, there appeared to be more birds just north of the Diomede islands and by Cape Lisburne. These, and jelly fish sightings, are recorded in the event log. Just north of Cape Lisburne, in the shallows just north of the point, there were the largest collections of birds, and while anchored, we even encountered mosquitos.

For an ~ 3nm patch, sea ice was encountered between stations CCL16 and CCL14 on our southward CTD line. This was only observed by the night watch. The NOAA surface analysis from that day suggests the ice may have come from the Siberian Coastal Current. All our past cruises have never encountered sea ice in the US-Arctic.

Also notable this year is the increased amount of shipping. A few times during the cruise, we hove to, to allow commercial shipping to pass (e.g., during mooring operations), and on the transit from MBS1 to NBS9, we diverted course to avoid a northward-bound sail boat. Other ships encountered included ships destined to recover mooring anchors left by Shell in the northern Chukchi Sea.

Just prior to the cruise, we became aware of an international project, led by Quintillion, to lay a fiber-optic cable through the Chukchi Sea. Pre cruise discussions with the company suggested a minor adjustment to their route and to our historic (A2E) mooring position to ensure future operations and the cable can coexist without danger of dragging the cable during mooring dragging operations. This is still to be finalized. More details are given below. For 2017 a detailed route will be required for this cable to avoid complications.

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 from the Norseman II [*Woodgate and BeringStrait2013ScienceTeam*, 2013; *Woodgate et al.*, 2014; *Woodgate et al.*, 2015b]. Prior to that the last extensive surveys were in 2003 and 2004 from the Alpha Helix [*Woodgate*, 2003; *Woodgate*, 2004]). Our 2016 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, and the ability to work in rough seas). 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 and 24 were only taken during the first running of this line.

DLS and DLN *(Diomede Line)* (previously one line DL) – two consecutive lines running north from the Diomede Islands to A3, the southern portion DLS (stations DL1-12) at 1nm spacing, the northern portion DLN (stations DL13-A3) at 2.5nm spacing. These lines study the hypothesized eddy and mixing region north of the islands and were run at the start and end of the cruise.

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 (~ 1.7nm 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. This line was run only at the start of the cruise.

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.

NPH *(North Point Hope)* (US waters) - a new line, 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.

CD *(Cape Dyer)* (US waters) - a new line, 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.

LIS – from Cape Lisburne towards the WNW, a previous RUSALCA line, run by us also in 2011, 2012, 2013, 2014 and 2015 and close to the CP line occupied in previous Bering Strait cruises in 2003 and 2004 (station spacing ~ 3.6nm).

CCL – 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), incorporating a rerun of the high resolution DL line at the southern end. Although in 2015 this line was run at ~ 5nm resolution, this cruise we reverted to the historic spacing of ~ 10nm.

DLN, DLS lines repeated.

BS – the original BS line, rerun at ~ 1nm resolution at the end of the cruise.

MBS *(Mid Bering Strait)-* a 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.

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

DLS, DLa, DLb lines - repeated.

Prior lines not run this cruise

NNBS – *a new line run 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.*

SBS *– a line new in 2014, run just south of the strait, crossing the Alaskan Coastal Current before it enters the strait proper (~ 2.2nm resolution).*

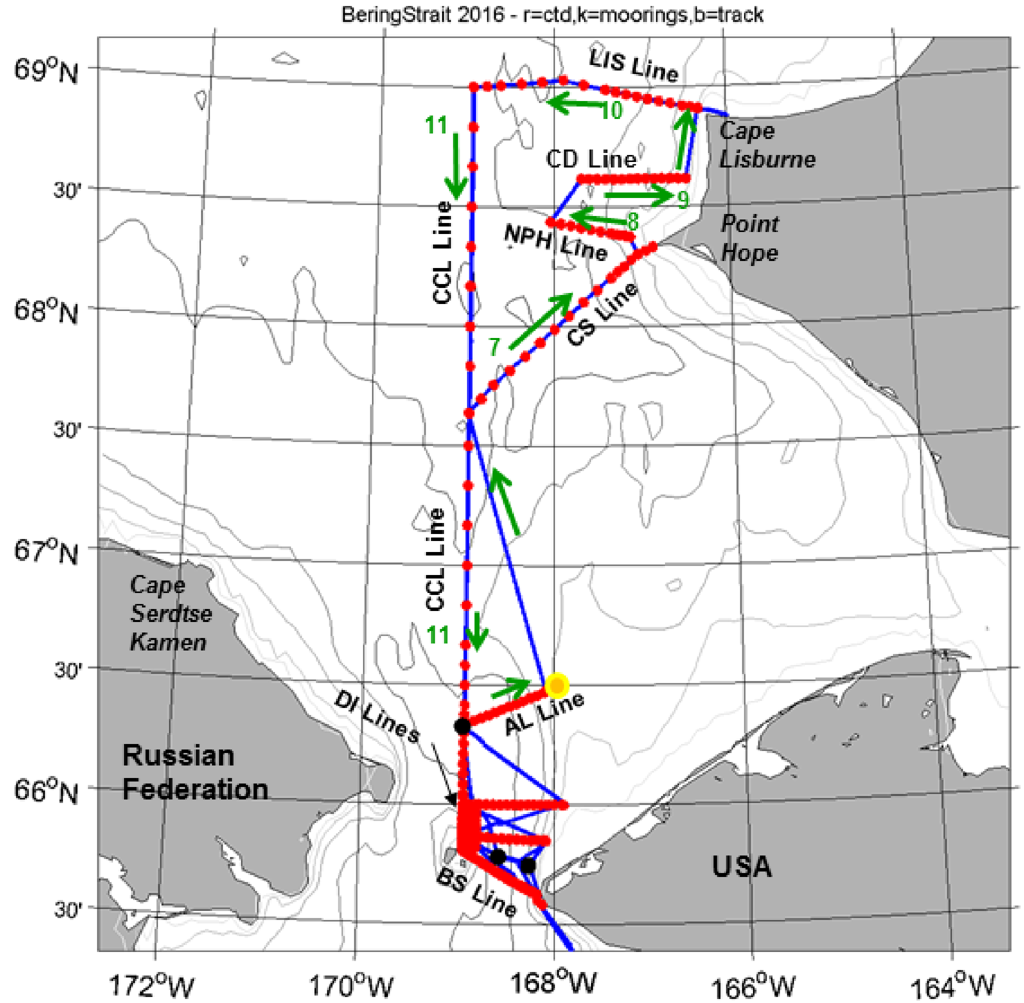
Summary of ADCP/Underway data lines

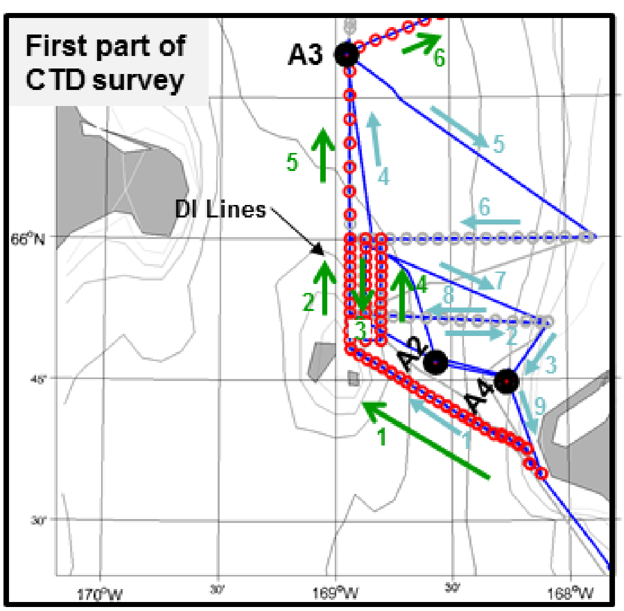
The ship's ADCP recorded for the duration of the cruise. Before and between mooring operations, two surveys of the strait were run were run exclusively for ADCP and underway data collection, viz:

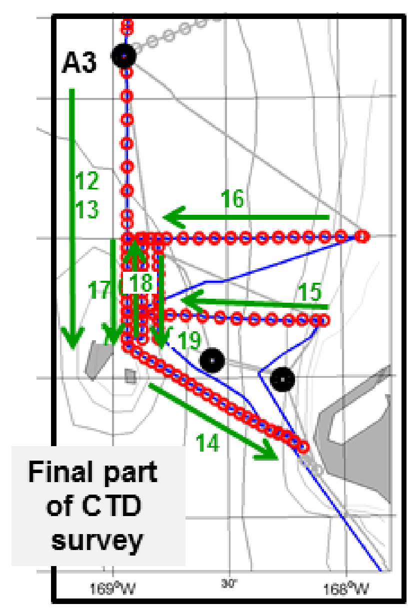
- west along the **BS** line, north along **DLS**, east along **MBS**, and return to A4.
- transit from A3 to east end of NBS, west along **NBS**, transit to east end of MBS, west along **MBS**, continue to A2. See maps for details of these lines.

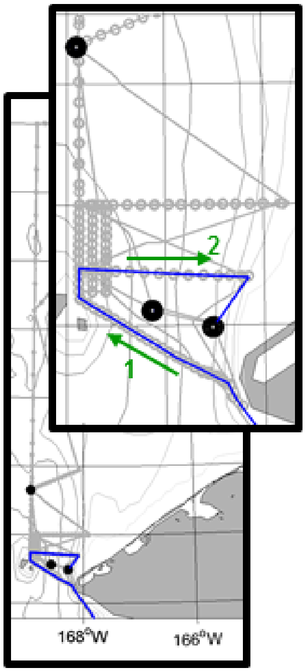
Contents

BERING STRAIT 2016 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.)*

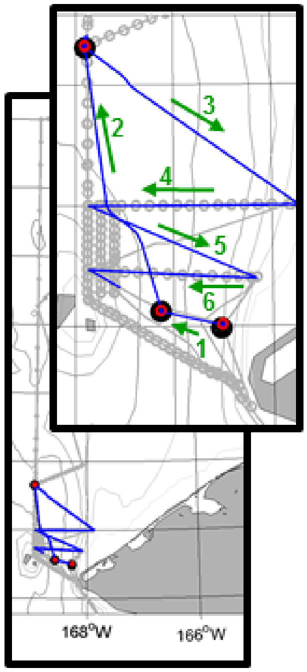




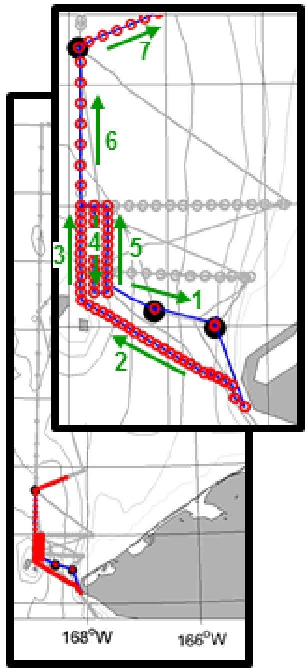




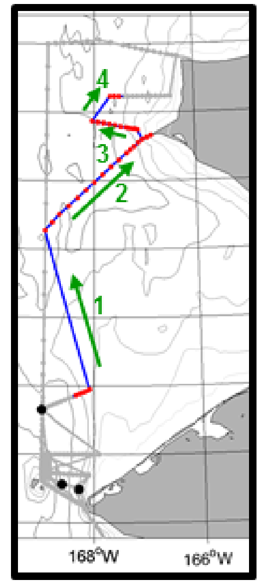
Day 1 *(local time)*
0800 7th July 2016
- 0800 8th July 2016



Day 2 *(local time)*
0800 8th July 2016
- 0800 9th July 2016

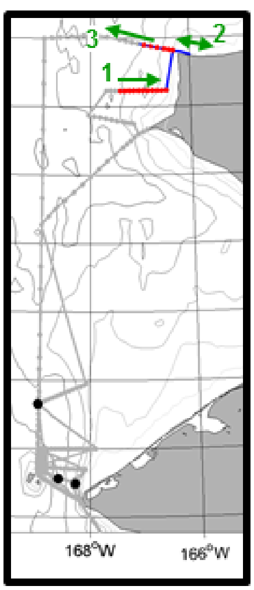


Day 3 *(local time)*
0800 9th July 2016
- 0800 10th July 2016

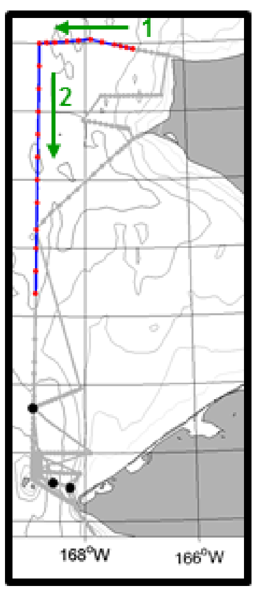


Day 4 *(local time)*
0800 10th July 2016
- 0800 11th July 2016

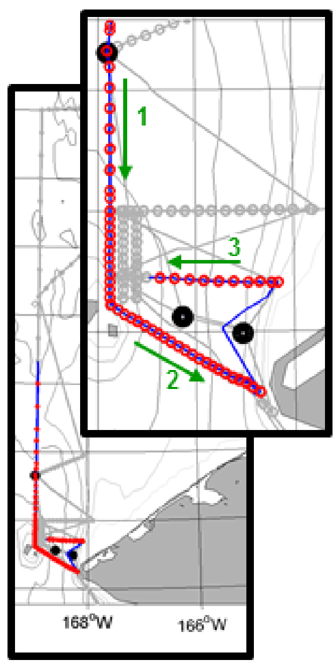
Bering Strait 2016 Mooring Cruise Norseman II



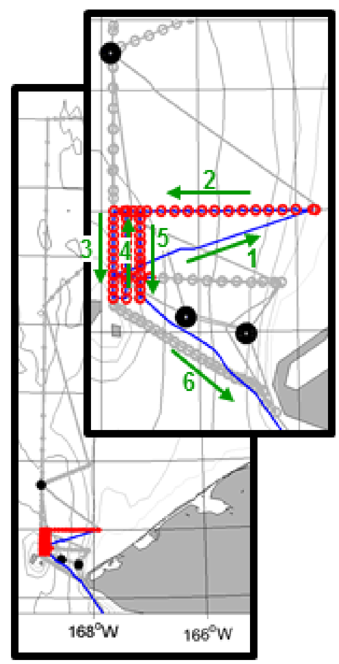
Day 5 *(local time)*
0800 11th July 2016
- 0800 12th July 2016



Day 6 *(local time)*
0800 12th July 2016
- 0800 13th July 2016



Day 7 *(local time)*
0800 13th July 2016
- 0800 14th July 2016



Day 8 *(local time)*
0800 14th July 2016
- 0800 15th July 2016

BERING STRAIT 2016 SCIENCE PARTICIPANTS

1.	Rebecca Woodgate (F)	UW	*Chief Scientist and UW PI*
2.	Jim Johnson (M)	UW	*UW Technical Mooring lead*
3.	An Nguyen (F)	UTA	*UTA Co-PI*
4.	Maike Sonnewald (F)	MIT	*MIT Postdoc - Moorings and CTD*
5.	Brita Irving (F)	UAF	*UAF Oceanography Technician, Glider and CTD assist*

UW – University of Washington, US
MIT – Massachusetts Institute of Technology, US
UTA - University of Texas, Austin
UAF – University of Alaska, Fairbanks

(Cabin Allocations: C4-Johnson; C5-Nguyen; C7-Sonnewald & Irving; C8-Woodgate)

BERING STRAIT 2016 NORSEMAN II CREW

1.	Mike Hastings (M)	NMC	*Captain*
2.	Wayne Peterson (M)	NMC	*Mate*
3.	Kevin Worthington (M)	NMC	*Chief Engineer*
4.	Jim Wells (M)	NMC	*Deck Boss*
5.	Austin Church (M)	NMC	*Deck Hand*
6.	Jorin Watson (M)	NMC	*Deck Hand*
6.	Luke Johnston (M)	NMC	*Deck Hand*
7.	Marlin Casey (M)	NMC	*Chief Cook*
8.	Darrin Hallman (M)	NMC	*Night Cook*

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

Ship contract arranged by:

Olgoonik Fairweather LLC, http://www.fairweather.com/fairweatherscience.html
Sheyna Wisdom, sheyna.wisdom@fairweather.com

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

BERING STRAIT 2016 CRUISE SCHEDULE (Times: Alaskan Daylight Time (GMT-8), 24hr format)

Spring 2016 to cruise	*Arrangement of charter of Norseman II by NSF and others for the Bering Strait mooring work*
End of April 2016	*Shipment of container of UW equipment to Nome, ETA mid-June*
April 2016	*UW visits to N2 in Seattle, to test CTD cable*
Sunday 3rd July 2016 *(Windy, foggy at sea)*	*UW science team (Rebecca, Jim, An, Maike) arrive Nome*
Monday 4th July 2016 *(Sunny, calm)*	*UW Instrument preparation (extract and start instruments)*
Tuesday 5th July 2016 *(Overcast, light wind, pm rain)*	*UW Instrument preparation (build ADCPs, ISCATs)* *Restuff container; Get first glider from air cargo*
Wednesday 6th July 2016 *(Sunny, moderately windy)*	*Finalize ISCATs, Get second glider from air cargo.* *Ship arrives early afternoon, offloads other cruise* *Discussions with Quintillion re cable location*
Thursday 7th July 2016 *(Moderate wind and fog)*	Science team due at ship at 10am, arrives at 0930 Flat and container arrive 10:30am, gear onloaded by 1145 Secure for sea, Sail 1408, Steaming for Strait Start underway systems, do safety brief, set up and test CTD Discussion of operations with captain and crew Run underway temperature and salinity (TS) and ADCP lines through the night, viz: (west along **BS**, north along **DLS**, east along **MBS**) to arrive A2 in am
Friday 8th July 2016 *(Moderate wind, patch fog, sea state 2-3ft)*	Arrive on site at A4-15 ~ 0800 0820 do A4-15 pre-recovery CTD 0830 Start **A4-15 mooring recovery** drift, all on deck by 0858 1000 do A2-15 pre-recovery CTD 1010 Start **A2-15 mooring recovery** drift, all on deck by 1030 Clean up recovered moorings while steaming to A3 1410 do A3-15 pre-recovery CTD 1420 Start A3-15 mooring recovery drift, wait for fog 1455 Start **A3-15 mooring recovery** drift, all on deck by 1515 Prep A3-16 deployment 1930 Start **A3-16 deployment**, anchor dropped 1944

1956 do A3-16 post-deployment CTD
Complete clean up
Run underway TS and ADCP lines through night (to east end of NBS, west along **NBS**, to east end of MBS, west along **MBS**) to arrive at A2 in am

Saturday 9th July 2016	Prep A2-16 deployment
(~ 20knot winds, 2ft seas)	0905 Start **A2-16 deployment**, anchor dropped 0922
	0943 do A2-16 post-deployment CTD
	Prep A4-16 deployment
(Rain)	1123 Start **A4-16 deployment**, anchor dropped 1146
	1157 do A4-16 post-deployment CTD
	Transit to BS24 to start CTD lines
	1332 Start **BS line** running west (BS24-BS11 with 0.5s)
	1815 Finish BS line
	1823 Start **DLS line** running north (DL1-12)
	2042 Finish DLS line
	2055 Start **DLa line** running south (DLa12-DLa1)
	2330 Finish DLa line
	2344 Start **DLb line** running north (DLb1-DLB12)
Sunday 10th July 2016	0209 Finish DLb line
(Often sunny, wind and seas building)	0232 Start **DLN line** running north (DL12-DL19)
	0514 Finish DLN line
	0530 Start **AL line** running east north east (A3,AL3-AL24)
	0901 Finish AL line
	0900-100 **Glider deployment**, with concluding CTD cast
	Steam to CS10US
	1730 Start **CS line** running north east (CS10-CS19 with 0.5s)
Monday 11th July 2016	0120 Finish CS line
(Increasingly stormy, winds and seas very rough, gusting 40+knots, 6ft+ seas)	0225 Start **NPH line** running west (NPH1-NPH11)
	0520 Finish NPH line
	0658 Start **CD line** running east (CD14-CD1)
	Steam up to Cape Lisburne in increasingly heavy seas
	1440 Take cast LIS1, but decide too rough.
	Steam to windshadow north of Cape Lisburne and anchor
Tuesday 12th July 2016	Wait for wind to abate, pull anchor at 0500, return to LIS line
(Stormy, ~ 4-5ft seas)	0554 Restart **LIS line** running west (LIS1-LIS 14n) in heavy seas
	1459 Finish LIS
	1533 Start **CCL line** running south (CCL22n to CCL4, and A3)
Wednesday 13th July 2016	1458 Finish CCL line
(Stormy, ~ 4-5ft seas, falling later in day, gusting 30kts behind islands)	1518 Start **DLN and DLS lines** running south (DL19-DL1)
	2143 Finish DL line
	2155 Start **BS line** running east (BS11-BS22 with 0.5s)
Thursday 14th July 2016	0308 Finish BS line

(Stormy, ~ 3-4ft seas)	Steam to historic mooring position A4W and to MBSn8 (to cross ACC) 0447 Start **MBS line** running west (MBSn8-MBSn1 with 0.5s) Steam across strait to NBS9 1129 Start **NBS line** running west (NBS9-NBS1 with 0.5s) 1608 Finish NBS line, 1619 Start **DLS line** running south (DL11-DL1) (clear blocked vent plug, system 2) 1844 Finish DLS line 1856 Start **DLa line** running north (DLa1-DLa12) 2059 Finish DLa line 2110 Start **DLb line** running south (DLb12-DLb1) (clear blocked vent plug, system 1)
Friday 15th July 2016 *(Stormy in Strait,* *calmer and sunny in Nome)*	0006 Finish DLb line, steam for Nome 1300 Arrive off Nome 1400 Dock in Nome, start offload and runs to Air Cargo 1700 Science Party leave ship. Evening - Science Party flies to Anchorage
Saturday 16th July 2016	*Science party returns to Seattle, etc.*

<u>Bering Strait 2016 Mooring cruise TOTALS</u>

8 days at sea (away from Nome) ***1408 7th July – 1400 15th July 2016***
8.3 days on ship (including on/offload) ***0930 7th July – 1700 15th July 2016***

Moorings recovered/ deployed: ***3/3***
CTD casts: ***277 (including 1 test cast)***

SCIENCE COMPONENTS OF CRUISE

The cruise comprised of the following science components:

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

- CTD operations - 277 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, and some meteorological data (air temperature, pressure, humidity, wind direction and wind speed).

- Moored Whale Observations (acoustic instruments on the moorings)

All recovered moorings and all deployed moorings carried Marine Mammal Acoustic Recorders from Kate Stafford, UW.

- Moored Ocean Acidification Observations

Recovered mooring A4-15 included pCO2 and pH sensors from Laurie Juranek and Burke Hales (OSU) to measure ocean acidification.

- 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)

MOORING OPERATIONS (Woodgate, Johnson, Nguyen, Sonnewald)

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], with 2012 being a year of low flow, but 2013 and 2014 returning to higher flow conditions [*Woodgate*, 2015; *Woodgate et al.*, 2015a]. The data recovered this cruise will indicate if 2015 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. A map of mooring stations is given above.

Three UW moorings were recovered on this cruise. These moorings (all in US waters – A2-15, A4-15, A3-15) were deployed from the Norseman II in July 2015, with mooring funding from NSF-AON (PI: Woodgate and Heimbach, *PLR1304052*).

Three UW moorings (A3-16, A2-16, A4-16) were deployed on this 2016 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.

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. The recovered A4-15 mooring also carried new pCO2 and pH sensors to study ocean acidification. 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 suggested to be a major part of the heat and freshwater fluxes [*Woodgate and Aagaard*, 2005; *Woodgate et al.*, 2006]. 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 nutrient sampler, ocean acidification and 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.**

2016 Recoveries and Deployments: Mooring operations mostly went smoothly in 2016.

For recoveries, the ship positioned ~ 200m away from the mooring such 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.**

The first of the moorings (A4-15) confirmed released immediately and was sighted at the surface within seconds of the confirmation of the release code.

On mooring A2-15, although ranging (on release 30951) went smoothly, releasing of the other release (#16875) was confirmed by the release, but the mooring did not surface. Rather than drift too far from the mooring, release 30951 was released also, and the mooring was sighted within seconds. On recovery, it was found that 16875 had also released**. Action item: Check why 16875 did not immediately free the mooring from the anchor.**

On arrival at the third and final mooring site, A3-15, conditions were foggy. An initial drift, interrogating release # 34106 confirmed the upright presence of the mooring, if suggesting the position was north ~ 130m from the recorded position. (This is estimated from uncalibrated 8242 deckset readings, and so may be an overestimate.). When shortly afterwards the fog cleared, an attempt was made to release the mooring after a second drift. Release 16898 replied slow to the release command, indicating the mooring hook had not turned. Again, rather than drift too far from the mooring, the other release was activated and the mooring was sighted within minutes. On recovery, again both releases were found to have activated. **Action item: Check why 16898 replied slow and did not free the mooring from the anchor.**

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

In all cases, once the mooring was on the surface, the ship repositioned, bringing the mooring tightly down the starboard side of the ship. One boat hook and a pole with a quick releasing hook attached to a line were used to catch the mooring, typically on a pear link fastened to the chain between the float and the ADCP or on eyes welded to the float surface. The line from the hook was then passed back to through the stern A-frame, and tied with a "cats paw" knot to a hook from the A-frame. This portion of the mooring was then elevated, allowing the second A-frame hook to be attached lower down the mooring chain, and tag lines to be attached if necessary. The iscat, if present, was recovered by hand at a convenient point in this operation, prior to recovery of most of the mooring. (This year, no iscats were 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 only a minor 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 this 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 and 2014, the A4 mooring had the most biofouling, athough in 2015, A2 had equal biofouling to A4 at depth. In these 2016 recoveries (of 2015 moorings) A4-15 was the most heavily fouled, then A2-15, with A3-15 having only light biofouling. Overall, fouling levels were comparable to last year, but with more fouling on A4-15 at depth. Fouling was mostly by barnacles and bryozoan-like growth on several parts of the moorings. Overall though, release hooks were generally clear of biofouling, and, salinity cells were clear of biological growth.

Unusually (uniquely in records since 2000), all moorings sustained **significant damage** while in the water, viz:

A4-15 - the vane on the SBE-Aural frame had been snapped off, and the mounting hoseclamp bracket was snapped.

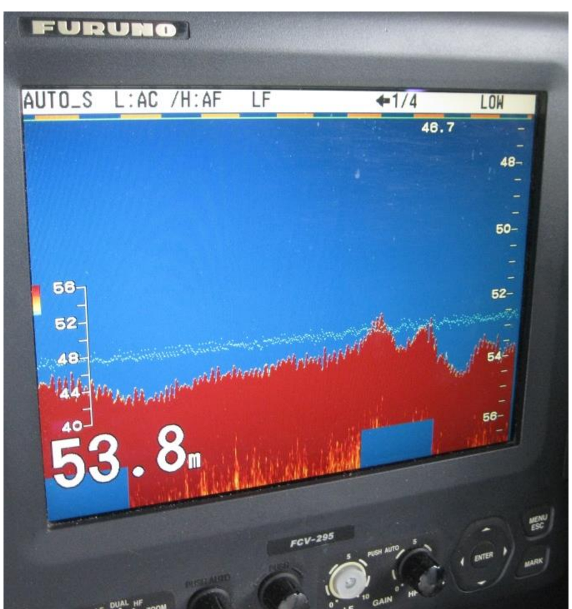
A2-15 - “banana” bars (2.5 cm x 0.5 cm) on the ADCP frame were bent, and the Aural cage around the hydrophone was also bent.

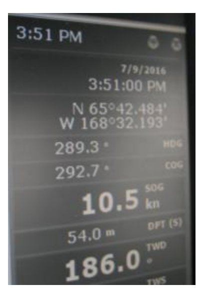
A3-15 - whole ADCP frame was bent ~ 10degrees out of true, “banana” bars were bent, one of clamps holding SBE onto the ADCP frame was broken off.

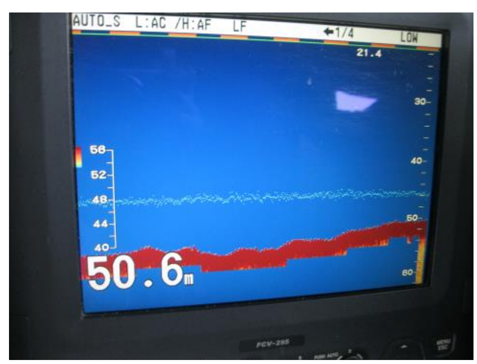
Additionally, on one mooring the bar holding the Aural was also bent.

Although we have no supporting evidence, we suspect this was due to ice damage, even at these depths (~ 45m). The Norseman II encountered ice ridges as high as one deck up from the main deck at Burger a week before our cruise. Such a ridge would have a keel deep enough to reach these depths. A preliminary look at the ADCP data suggest ice keels only to ~ 18m, however, those instruments are recording only every 30minutes and could miss a larger keel. Ice motion does suggest a possible jamming event north of the strait in winter. **Action item: Look for southward drift in ice, and ridging/blocking events in our and other ice data.**

Interestingly, around the mooring sites, and especially near A3, the bridge reported seeing significant (order 4m deep) irregularities, perhaps gouges on the sea floor. Though this was not measured quantitatively, the following photos of the ship’s bridge echosounder trace give some indication of the features. Note vertical scale changes between photos. Horizontal scale is not clear, but memory suggests a feature moves across the screen in < 1 min, implying (at 10knots) the horizontal range of these pictures is ~ 300m. Time/date stamp was taken just after left hand picture. Right hand picture was taken ~ 3-4min after right hand picture.







It is unclear what these features are. Although it is tempting to consider ice keel scouring, discussions with Quintillion suggest there is a significant boulder field in the strait region. **Action item: Look for more information on bottom type.**

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 250m and 600m from the mooring site. In the strong wind conditions of this cruise, 400m was found to be insufficient**. Action item: Start 600m away next year.** At the start of the deployment, the iscat was deployed by hand and allowed to stream behind the boat. The first pick (from one of the hooks of the aft A-frame) was positioned below the ADCP. 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 rather than relying on body weight.** 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 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. 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.** Iscat housings and ADCP frames were assembled using a group of 4 people in Nome (2 teams). Most of this preparation took us two days, allowing for delays in accessing the container. The extra day before the cruise was used for collection of extra freight, finishing ISCATS and dealing with the Quintillion cable issues, and dietary/clothing issues for the cruise. 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. The newer ADCP software was used carefully to prevent it erasing the bottom track commands. A temporary iscat communication issue was solved by replacing the microcat batteries. **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 extremely good - with all instruments returning complete records. 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, no top sensors containing the inductive SBE37s were recovered. Iscats appeared to have been lost at the weak link as per instrument design.

ISCAT LOGGERS: All 3 loggers were operational on recovery, and returned clean data records. Typically logger clocks were 10-18min slow by the time of recovery. However, as the data is recorded with the SBE37 timestamp, this clock drift has not been corrected for. This should be revisited if time accuracy of less than 1hr is required. Records show the iscats were lost in winter (A3-15 on 3rd January 2016 after 13:53GMT; A2-15 on 8th March 2016 after 16:30GMT; A4-15 on 11th March 2016 after 18:23GMT). The deployed depths of these sensors were 13-14m, 1-3m shallower than in previous years. However, preliminary ice thickness data suggests that even had the instruments been a few meters deeper they would have been lost at similar times. **Action item: Purchase new iscats for 2016 deployments. 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:** All the 3 ADCPs recovered were still running on recovery, and all yielded good data. **Action item: do on shore checks of all compasses.** Preliminary results are plotted below.

SBEs: A SBE16 was recovered from each mooring. None of these instruments were pumped. On mooring A3-15, the SBE was deployed on the ADCP frame without vaning. The SBEs on A4-15 and A2-15 were vaned on the Marine Mammal recorder, although the vane on A4-15 was lost at some stage during the year. Mooring A4-15 also carried an unpumped SBE37 mounted vertically with the cage of the ocean acidification sensors. Although all salinity cells appeared clear of biofouling on recovery, the salinity records from A4 do show some discrepancies between the SBE16 at 42m and the SBE37 at 43m - towards the end of the record, from day 500 (mid May) onwards the SBE37 yields fresher salinity readings, being ~ 0.25psu fresher by the time of recovery. Since the SBE37 lies lower in the water column (thus in denser waters) this discrepancy cannot be real, but is likely due to either to biofouling of the SBE37 cell or drift in either/both sensors. Sizeable (up to 0.1 psu) changes over the year are not uncommon in past data, as the salinities cells are scoured by sediment. These drifts will be identified (and corrected for) on post-cruise calibration. **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.

A preliminary review of the SBE data show annual cycles of temperature and salinity. Direct comparison with older data is necessary to ascertain interannual changes.

Post recovery tank calibrations: As an addition calibration test, uncleaned post recovery SBE instruments were placed, for some hours, in a Contico bin filled with salt water in conjunction with a recently calibrated SBE instrument. The intent was to ascertain to what extent cleaning changed the readings on the SBE instruments. Temperature records agreed well (to < 0.1 deg C), likely reflecting some non-homogeneity of the water. However, two of the instruments yielded salinity readings ~ 0psu (even though in the water values before recovery were reasonable) and the control SBE yielded only occasionally good data (see plots below). The issue of intermittent data may relate 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. **Action Item: Investigate this with Seabird. Replan this test for next year.**

However, results do support the salinity bias observed on A4, with the SBE37 reading ~ 0.07psu fresher than the SBE16, although the test also suggests even the SBE16 is reading 0.07psu too fresh compared to the control.

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). Data drives were returned to UW for reading

Ocean acidification sensors on mooring A4-15, deployed my Laurie Juraneck (OSU). These consisted of 2 SAMI instruments. The **SAMI pCO2** instrument (S61U SN 144, note contradiction with serial number on mooring drawing) was interrogated after recovery, and appeared to be still running, and containing 4478 data records. This instrument was stopped, and shipped back to OSU for reading. The **SAMI pH** instrument (P0029 SN 0076) was also interrogated after recovery, and appeared to have stopped due to low battery containing 3084 data records.

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 A2-16) for Kate Stafford, UW.

Note that Ocean Acidification sensors were not redeployed this year.

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 2016 MOORING POSITIONS AND INSTRUMENTATION

ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2014 Mooring Deployments				
A2-15	65 46.86	168 34.08	56 (56m from data)	ISCAT, ADCP, SBE16 with MMR
A4-15	65 44.76	168 15.77	49 (48m from data)	ISCAT, ADCP, SBE16 with MMR, SAMI pH and pCO2 with SBE37
A3-15	66 19.60	168 57.04	58 (58m from data)	ISCAT, ADCP with SBE16, MMR

ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2014 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

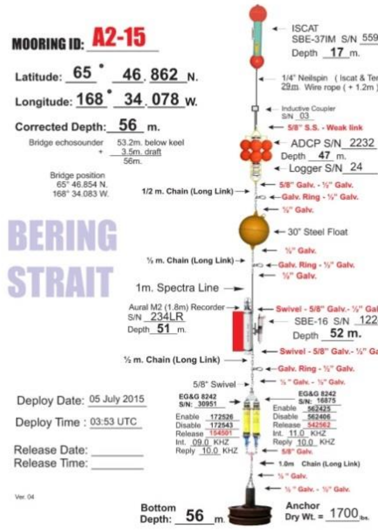
ADCP = RDI Acoustic Doppler Current Profiler
ISCAT = near-surface Seabird TS sensor in trawl resistant housing, with near-bottom data logger
SBE16 = Seabird CTD recorder , SBE37 = Seabird CTD recorder
MMR=Marine Mammal Recorder (new=new APL version)
SAMI pH and pCO2 = SAMI instruments for measuring ocean acidification parameters of pH and pCO2.

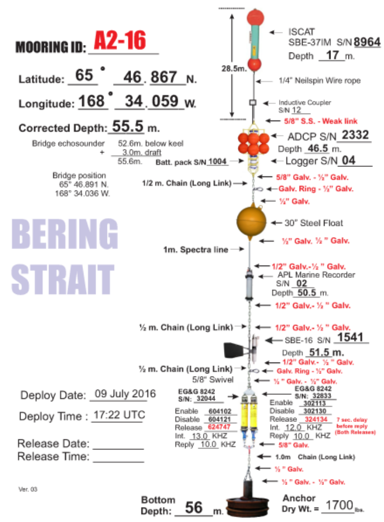
Note that recovered instrumentation suggest water depths as shown in the upper table. Prior estimates of water depth are from the ship's echosounder, assuming a draft of 3m. These data suggest that 2m is a better estimate of the ship's draft. **Action item: Consider this for CTD casts next year.**

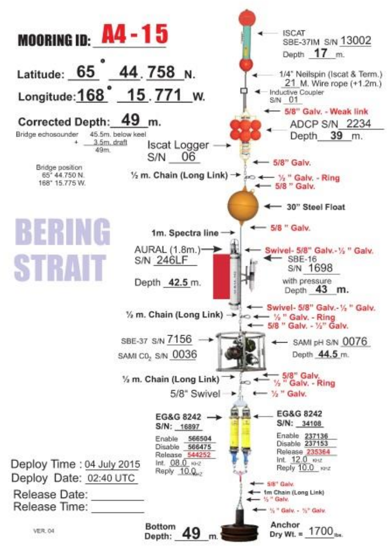
BERING STRAIT 2016 SCHEMATICS OF MOORING RECOVERIES AND DEPLOYMENTS

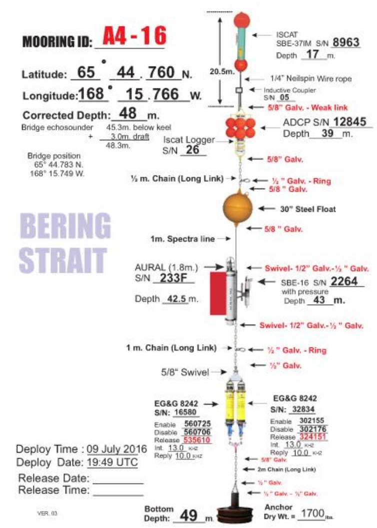
RECOVERED **DEPLOYED**

= in the eastern channel of the Bering Strait

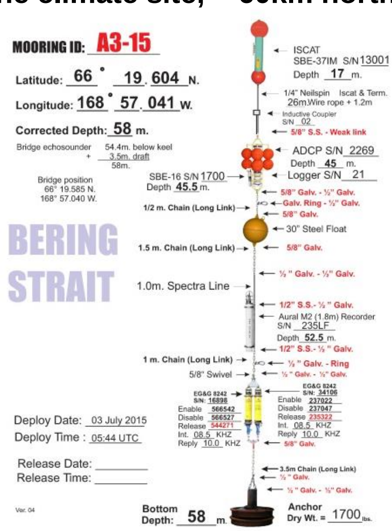


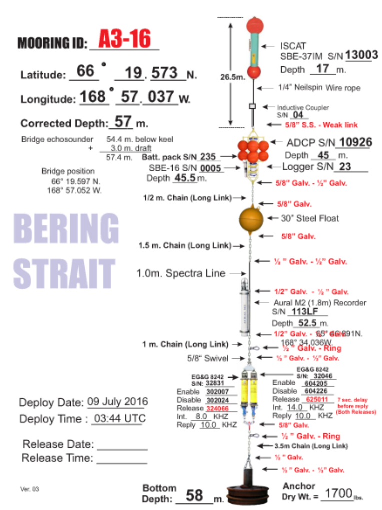






= at the climate site, ~ 60km north of the Strait





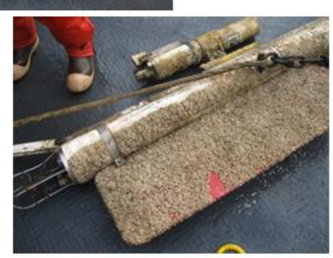
BERING STRAIT 2016 RECOVERY PHOTOS

A4-15 Recovery

- Aural vane lost

A2-15 Recovery

- Aural cage bent
- ADCP "banana" bars bent



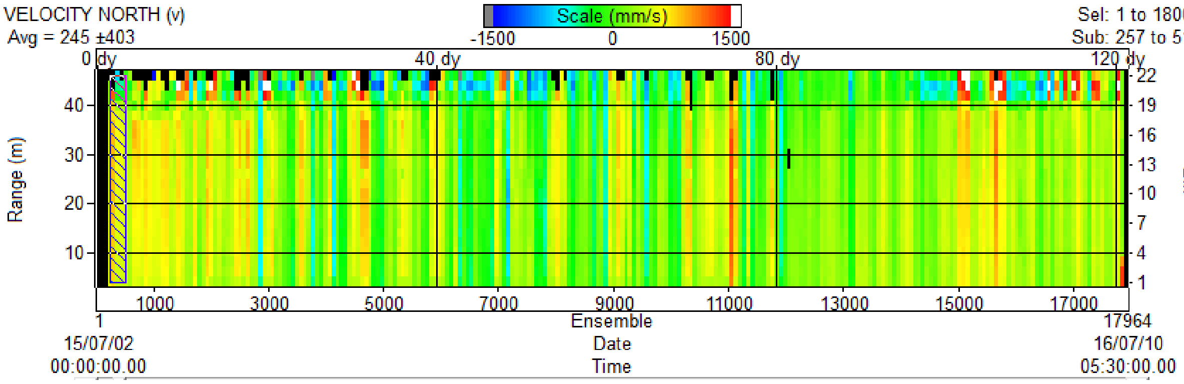
BERING STRAIT 2016 RECOVERY PHOTOS (continued)

A3-15 Recovery

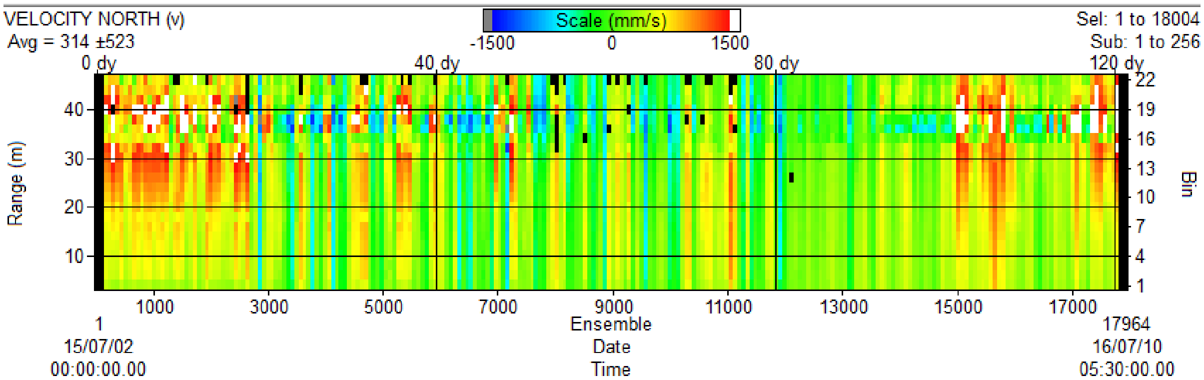
- ADCP frame bent in cage and "banana" bars

NORTHWARD VELOCITY from ADCPs.

A2-15

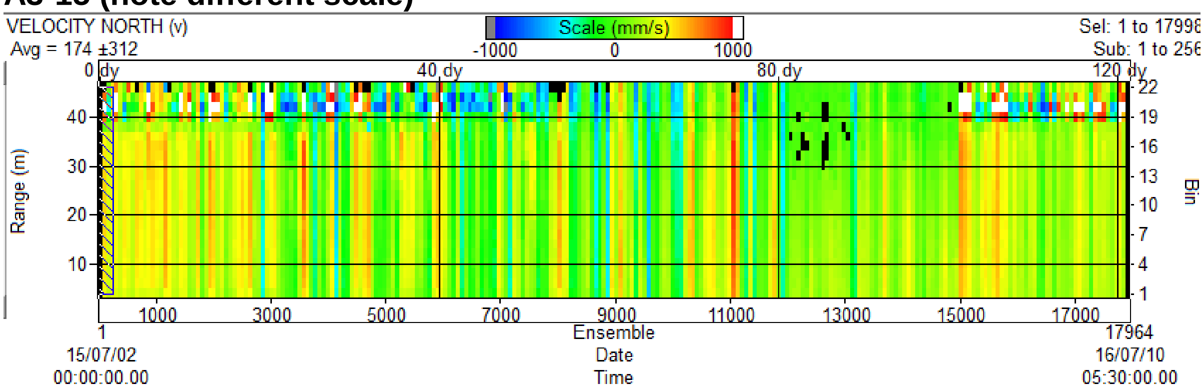


A4-15



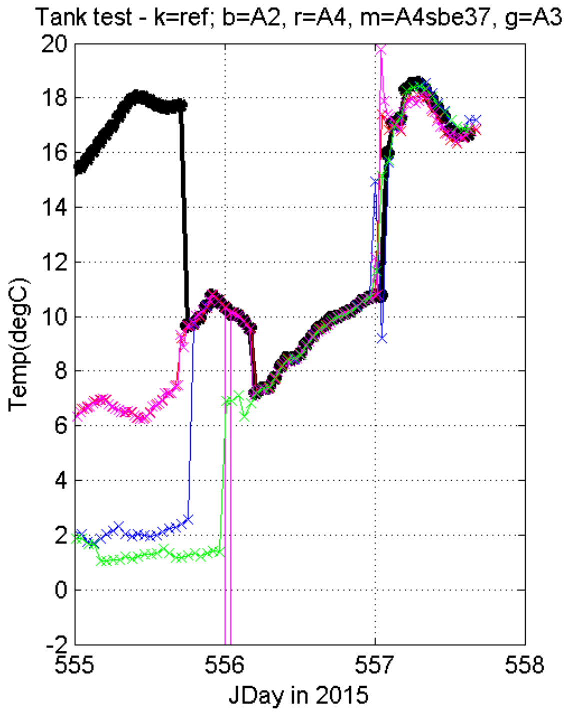
(weaker northward flows in winter compared to 2014)

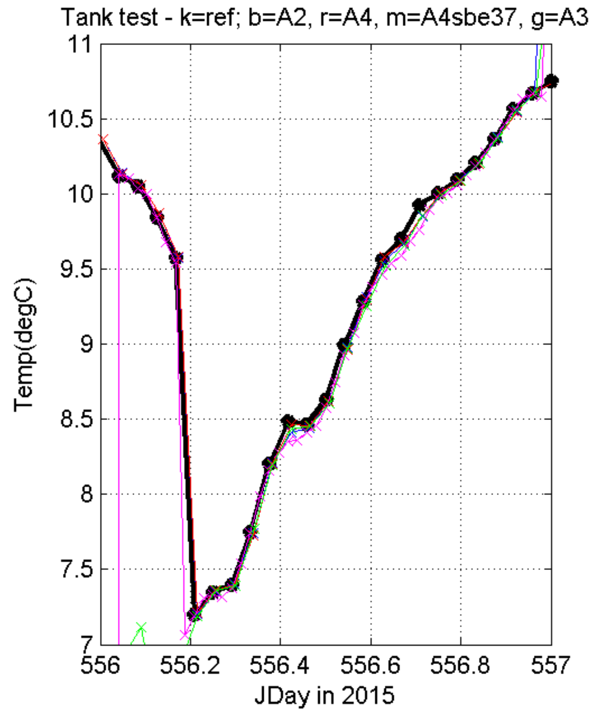
A3-15 (note different scale)

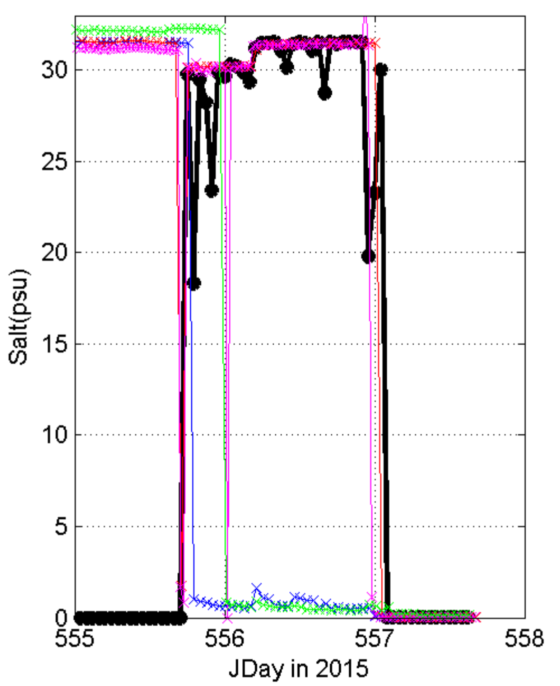


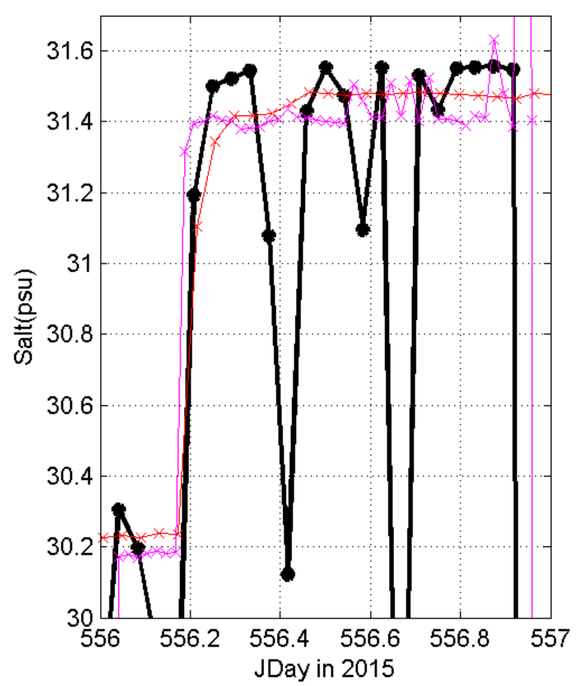
BERING STRAIT 2016 SBE PRELIMINARY RESULTS

- results of tank test
(black=reference, colors=recovered instruments)



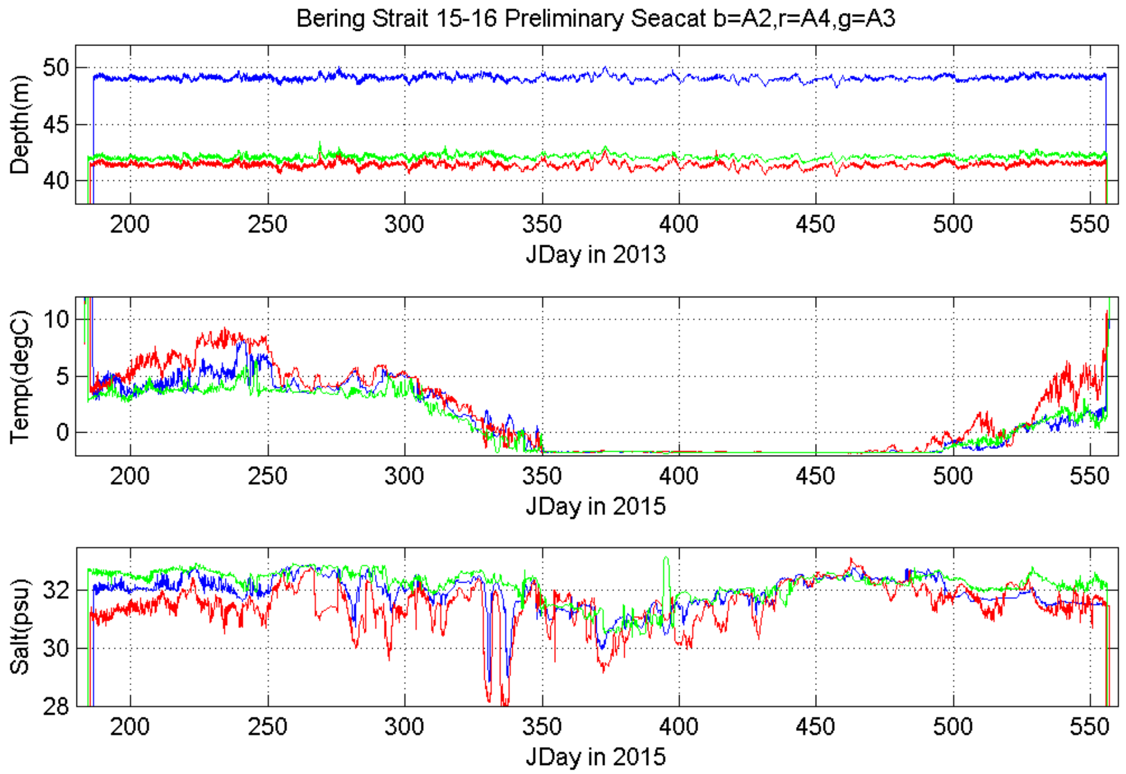


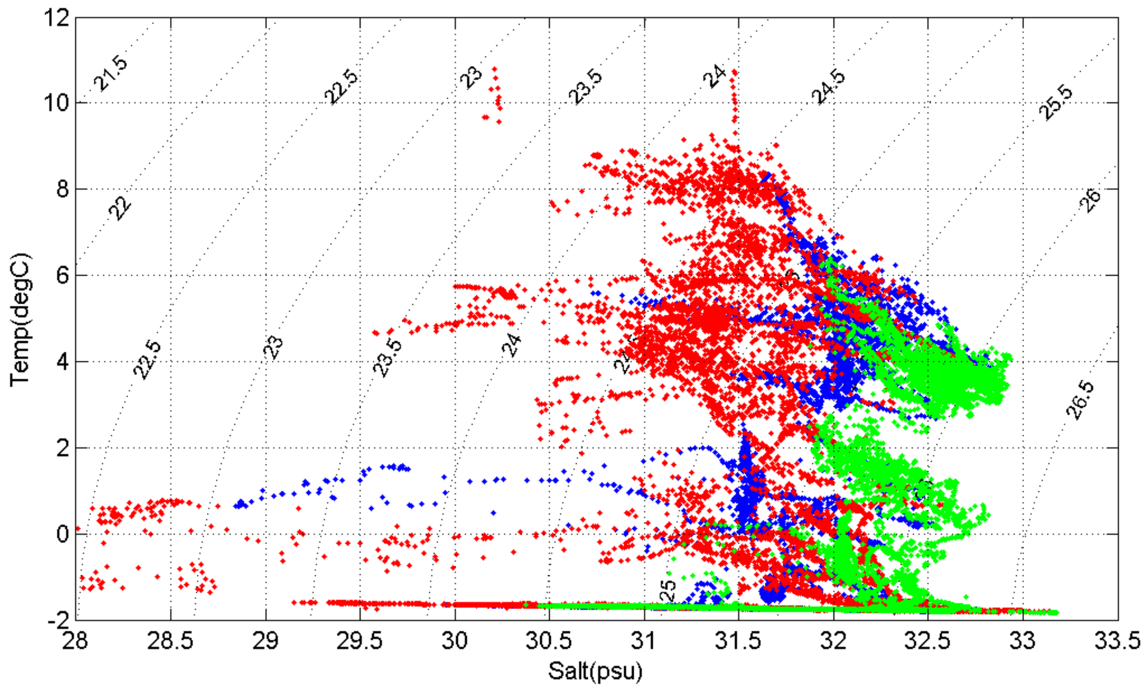




BERING STRAIT 2016 SBE PRELIMINARY RESULTS (continued)

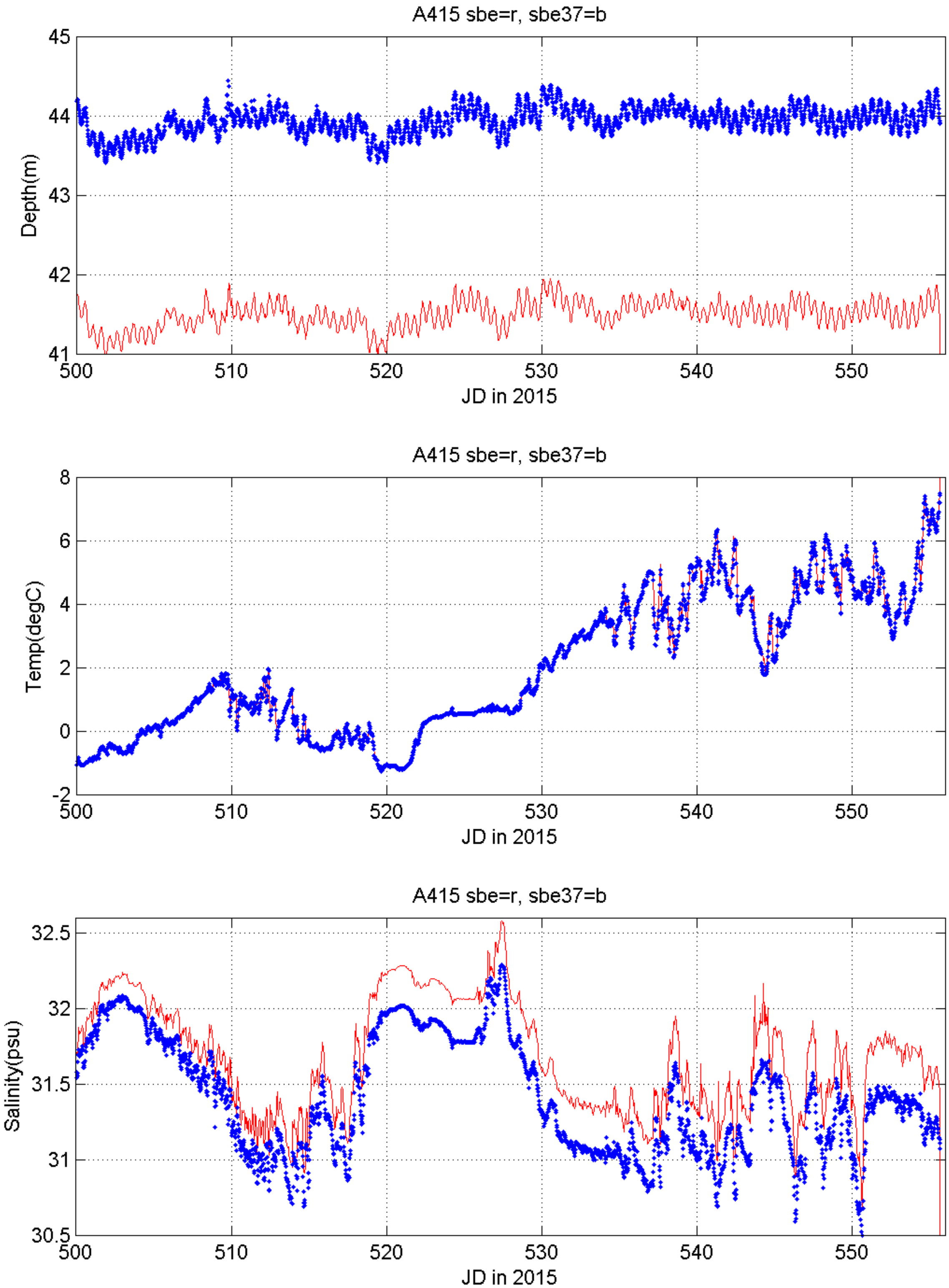
– all lower level TS Sensors
(maximum temperatures cooler than last year (~10degC), and waters also apparently fresher in summer and especially fall)





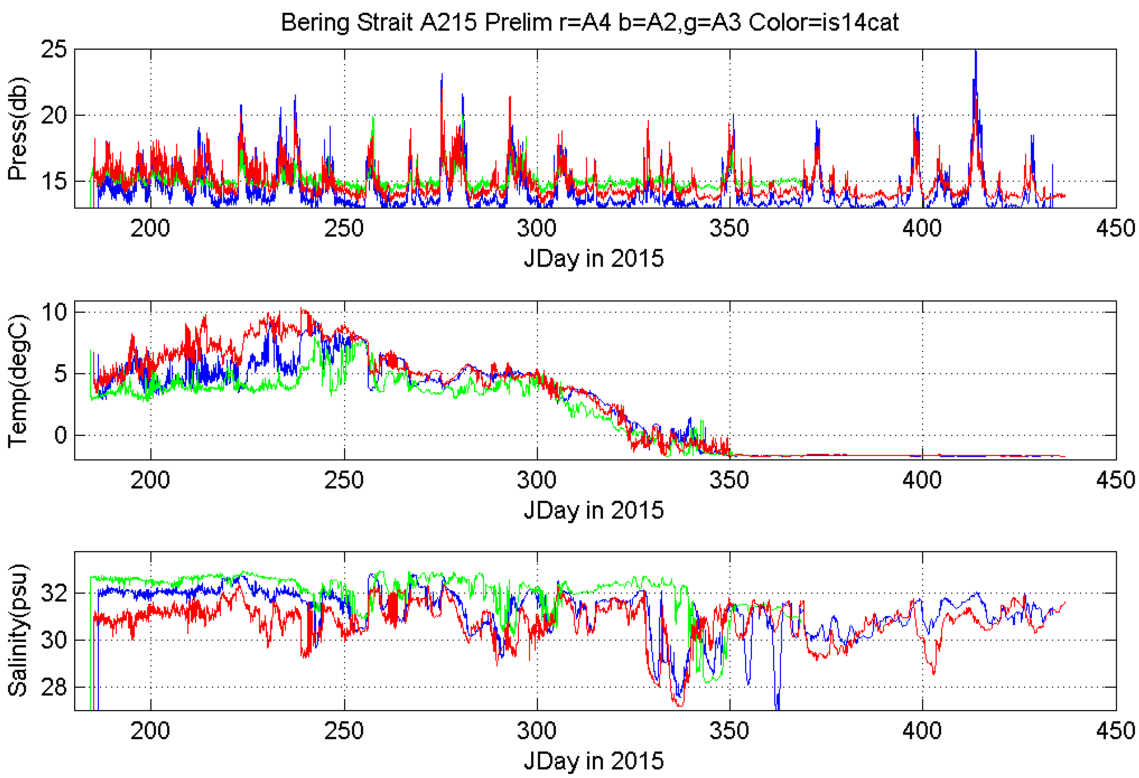
BERING STRAIT 2016 SBE PRELIMINARY RESULTS (continued)

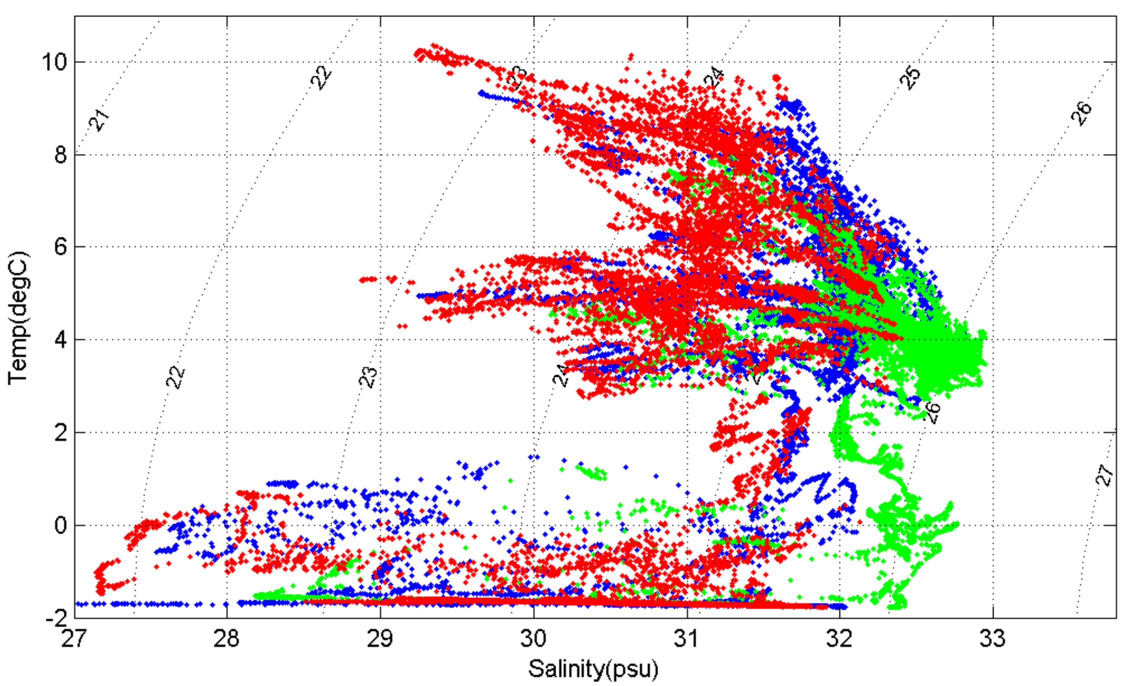
- difference between SBE16 and SBE37 sensors on A4-15



BERING STRAIT 2016 PRELIMINARY ISCAT RESULTS

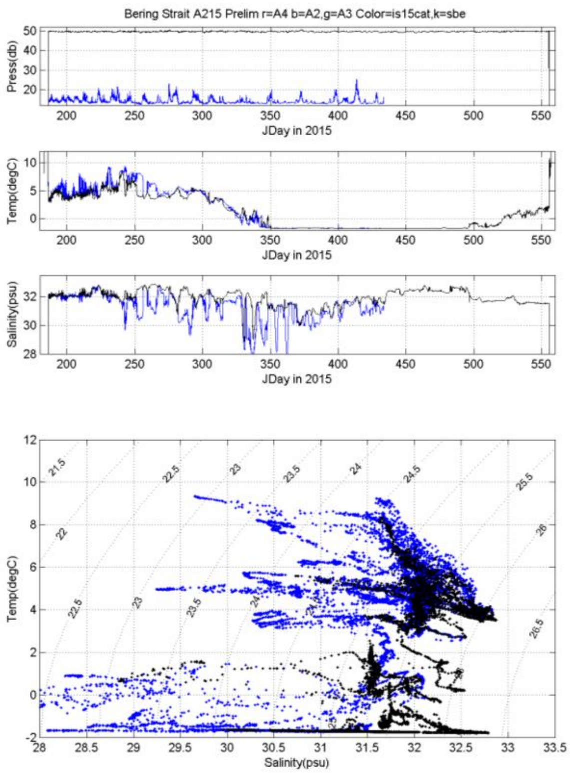
– all upper level TS Sensors
(also cooler and fresher than last year, and with less pull down



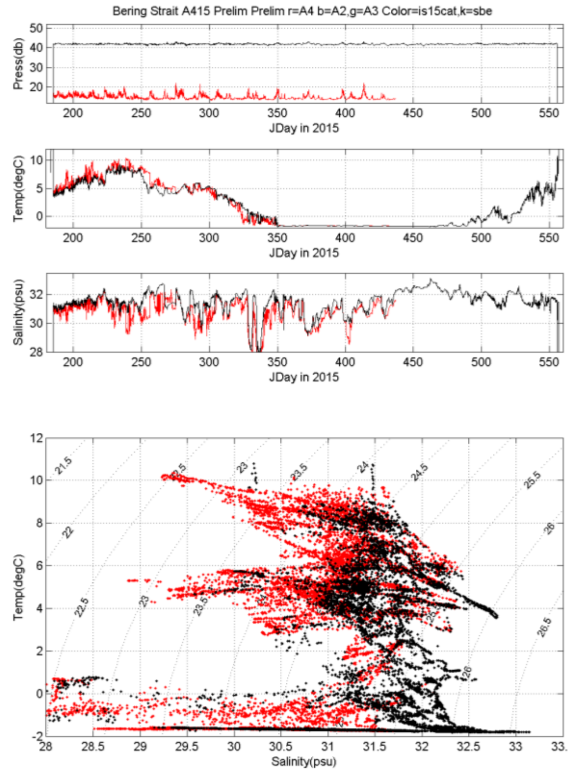


BERING STRAIT 2016 PRELIMINARY ISCAT AND SBE RESULTS (per mooring)

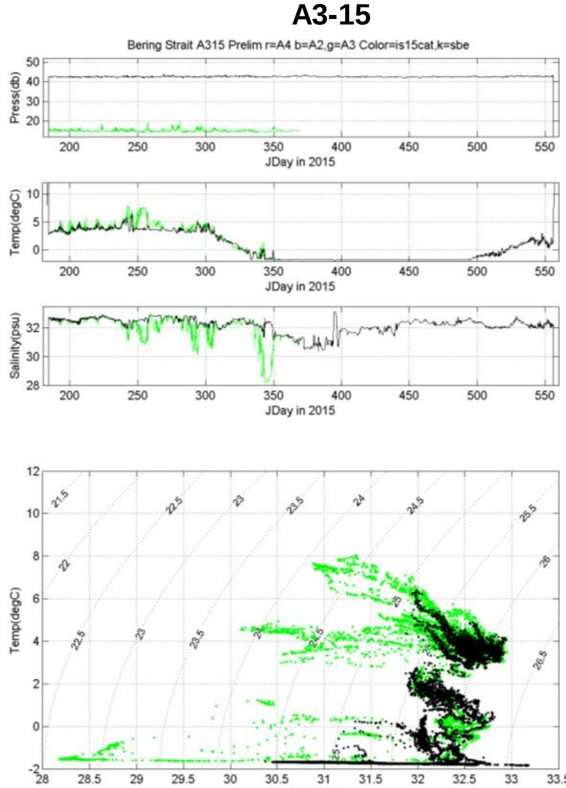
A2-15



A4-15



A3-15



CTD OPERATIONS (Woodgate, Nguyen, Irving, Sonnewald, Johnson)

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

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

one SBE9+ with pressure sensor (SN5915 – calibration 20th March 2015)
two SBE3 temperature sensors (SN0843, SN0844 – calibration 6th/7th March 2015)
two SBE4 conductivity sensors (SN0484, SN0485 – calibration 13th May 2016/6th March 2015)

(Note the primary conductivity sensor (#484) was calibrated immediately before shipping, as it was found to be cracked in pre-cruise tests.)

two SBE43 oxygen sensors (SN1753, SN1754 – calibration 16th Feb 2016/16th March 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 (UAT-377A)

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 2016, 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. (Note that for casts 119 to 133 inclusive, the CTD took the NMEA feed from the Bridge GPS rather than the aft GPS due to reliability issues with the Aft GPS. During the wait off Cape Lisburne, the aft GPS antenna was replaced, and reliability was resumed.) **Action item: Note casts 119-133 inclusive use bridge GPS, not aft GPS position.**

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, and data files (and a screen dump of the cast) 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).

The hydraulic system on the ship had been renewed since the last cruise. The test cast (cast 1) was done with extremely high (~ 1.5m/s winch speed). This was adjusted subsequently to give a lower/raise rate of ~ 0.7 m/s.

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 that operation.

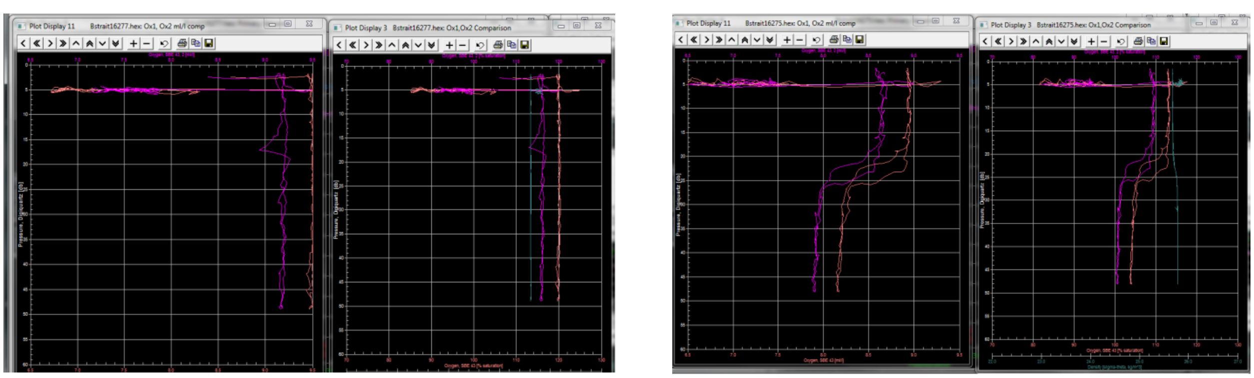
The efficiency of the crew made for very speedy CTD operations, and combined with the fast winch speed, resulted in commendably fast times for running lines. Since the CTD system required ~ 1min in the water to allow for the pumps to turn on (initiated by a manual command sent by the CTD driver), the CTD was generally put over the side and down to ~ 5m 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 prior to each cast. **Action Item: Bring syringe with better fit for flushing the CTD cell.**

Ship's draft was estimated at 3m, and this should be taken into account in viewing the data. Note that mooring data suggest that 2m may be a more appropriate correction between echo sounder depth and true water depth.

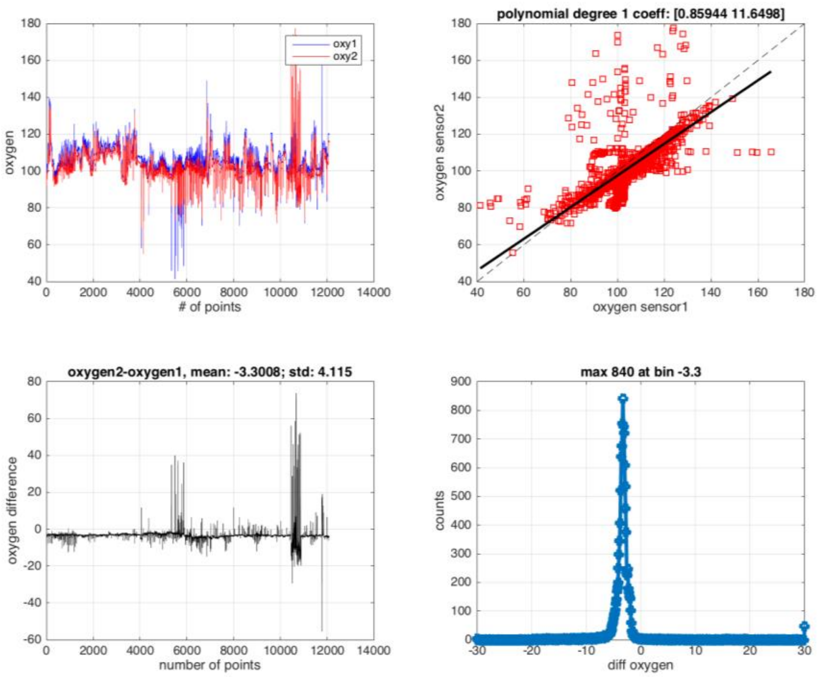
Overall, CTD data this year are exceedingly clean, although 3 problems should be noted.

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 ~ 3.3% (0.3ml/l) higher than Ox2 (#1754).



Example casts (277 left, 275 right) showing profiles of oxygen in ml/l (left) and % saturation (right).

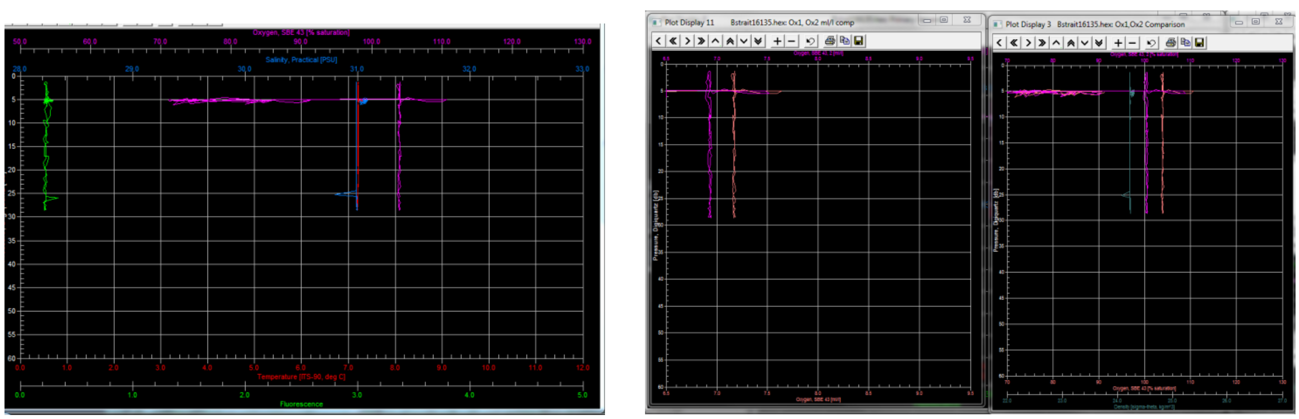
This issue is consistent through all the casts of the cruise, suggestive of some inaccuracies in the calibration values. Seabird calibration instructions note that coatings of oil on the sensor may cause a drift in the offset of the oxygen values. Note that Ox2 was more recently calibrated and thus might be expected to be less prone to drift. **Action Item: Refer this to Seabird and consider a standard offset to correct.**



Summary plots for the whole data set of offset of oxygen, as calculated from % saturation. (Plot from An Nguyen.)

If we are to apply a standard offset, how do we assess (in the absence of bottle data) which sensor is correct? One possible approach (suggested by Seabird) is to consider the surface saturation levels. In the absence of biological activity and at times of strong mixing, one might expect the surface saturation to be ~ 100%.

On cast 135 (LIS2) just after the storm, the water column was well mixed and fluorescence was low.



Cast 135

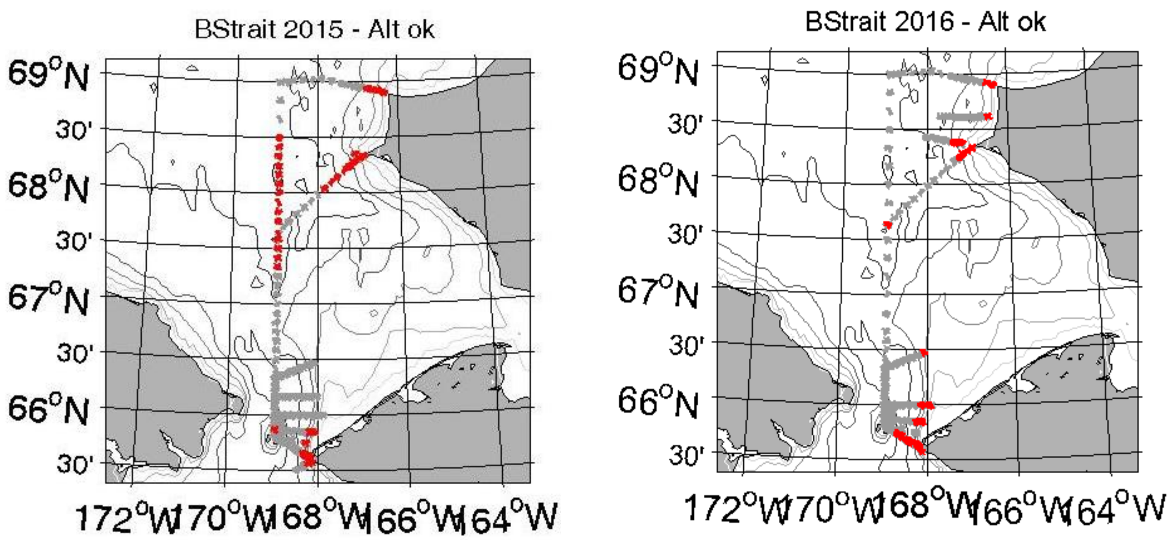
Ox1 was ~ 104% at the surface, while Ox2 was ~ 100.5% at the surface. This also suggests that Ox2 is more accurately calibrated. Ox2 was repaired before deployment, and thus might be expected to be less prone to issues. **Action Item: Check surface oxygen saturations across all casts, check with Seabird, consider offset.**

Action Item: Remember while viewing casts plots below (done on Ox1), oxygen may be 4% too high.

2) Altimeter. For the last two 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 cruise (Figure below). Subsequent laboratory tests in 2015/2016 found nothing wrong with the instrument.

Similar problems were experienced in 2016 - 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 2016, 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. In particular, at AL24 (where the altimeter failed on the original cast) a recast 1hr later, after the package had sat in the sun for that time, gave good altimeter readings. Similarly, on the Bering Strait sections, 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 (<2-3 deg C) waters. **Action Item: Cold-test the altimeter in Seattle.**



Sites where altimeter worked in 2015 (left) and 2016 (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 3m, and thus, as our target was 3m above bottom, we aimed to stop the CTD when CTD pressure matched the echosounder readout. In poor weather, we stopped further from the bottom. **Action Item: Revise keel estimate to ~ 2m. On viewing sections, recall bottom 3+m may be unsampled.**

3) Vent plug blockages. There were two incidences of blocked vent plugs. The first was on the secondary system and was only noticed after several casts. At that stage, dissimilarities between S1 and S2 were noted and the upper pipe on the secondary system (above the vent plug) was still full of water even several minutes after the cast, confirming the blockage. The vent hole was cleaned with the thin wire, and the system flushed with a syringe of water attached to the salinity cell. This cleared the problem, but secondary data from casts 241-250 inclusive are impacted and should be disregarded. A subsequent block on the primary system was found on cast 271. This was cleaned immediately, but the issue persisted into the oxygen signal on the subsequent downcast (272). In both cases, the secondary data were unaffected. Thus, the primary data from casts 271 and 272 should not be used, but the secondary data should be used instead. **Action Item: Instigate checks on primary-**

secondary system agreement during every upcast. Continue to bring wire and syringe for cleaning the system. Primary sensor data may be used for all casts, except 271 and 272. Secondary data may be used for all casts, except 241-250.

The CTD casts number 277 in total, including 1 test cast. CTD numbers relating to CTD lines are given in the event log included below. Preliminary data processing was done on board by Rebecca Woodgate, using the Seabird data processing software as described below. Preliminary sections (using the secondary sensors and pre-cruise calibrations) were plotted by An Nguyen and are included below. Note that
- Ox1 has been used and this may be 4% too high.
- Cast 271 had bad Ox1, and thus Ox2 is used here, possibly offset with 3.3%
- Cast 83 is missing from these plots

Summary of major CTD issues to be addressed:
1) Vent plug on system 2 blocked from cast 241 to 250 inclusive ... Ox2 and S2 bad, so use Ox 1 and S1
2) Vent plug system 1 blocked on cast 271 - Ox1 and S1 bad, so use Ox 2 and S2
3) System 1 ox still bad on cast 272. Recast at same location, as cast 273, so can ignore 272 or just use sensor 2 for it
4) Standard offset in Oxygen. Ox1 (1753) is ~3% or 0.3ml/l greater than Ox2 (1754). Well mixed cast 135 has Ox1 ~ 104% and Ox2 ~ 100.5%, suggesting Ox2 is closer.
5) Files for cast 224 must have been erroneously named 2234 during taking of data, and then the files renamed afterwards. Files in prelimprocessed have been corrected to 224.
6) Casts 119-133 inclusive are logging forward, not aft GPS position, due to reliability issues with the aft GPS, the antenna of which was eventually replaced during the cruise,
7) Several casts - *138,139,157,168,171,180,186,187,191,192* - have unusual and interesting TS-structure.

NOTES ON BERING STRAIT 2016 CTD PROCESSING
Rebecca Woodgate (based on 2015 processing)

Start with files from SeaSave for each cast, i.e.,
BStrait16nnn.hex and BStrait16nnn.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 = DatCnvBStrait2016_allvars.psa)
Inputs are: BStrait16nnn.hex and BStrait16nnn.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 2016 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: BStrait15nnn.rw1.cnv

=== 2) Do first basic quality control by plotting everything in Matlab
Matlab master code = **testplotsBStrait2016RW.m** which calls subroutine **CTDQCpump.m**
Inputs are: BStrait16nnn.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 **BStrait2016_CTDissuesbycast.xls**

=== 3) Now work through the 7 steps of SBEDataConversion. Start by applying the calibrations to to get the converted files, but this time excluding all the derived variables.

IN SBEDATA PROCESSING, RUN: DATA CONVERSION
(PSA file for this = DatCnvBStrait2016_CTDforprocess.psa)
Inputs are: BStrait16nnn.hex and BStrait16nnn.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 2016 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: BStrait15nnn.cnv

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

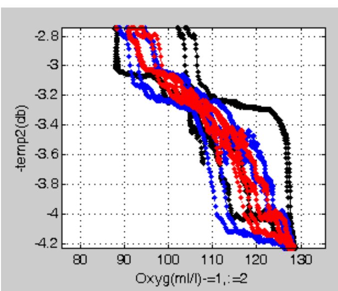
This step allows us to time-filter (i.e., smooth) the data. Routine allows us to select two filters, A and B. In 2014, we used A = 0.5 sec and B=0.15 sec, but in 2015 this appeared to remove too much variability.
Manual for the SBE9plus suggests to not filter Temperature and Conductivity, but to filter 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 = FilterBStrait2016_CTDforprocess.psa)
Inputs are: BStrait16nnn.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: BStrait16nnnA00B15.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 (see discussion below). This should be done on the Oxygen voltage.
IN SBEDATA PROCESSING, RUN: ALIGN
(PSA file for this = AlignCTDBStrait2016_CTDforprocessOx2.psa)
Inputs are: BStrait16nnnA00B15.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 = AdvOx2
THIS GIVES files called: BStrait16nnnA00B15AdvOx2.cnv

Oxygen Align between 2 and 5: To investigate the various oxygen options, 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.

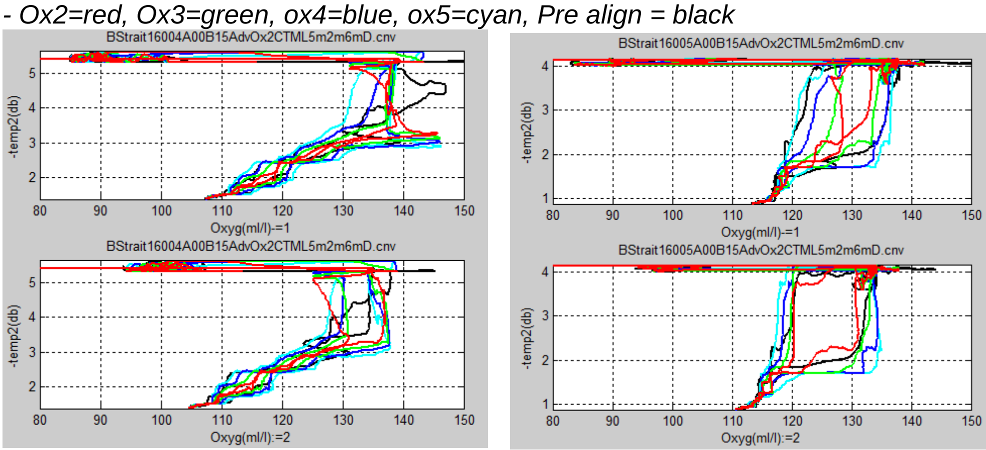


In 2015, the best agreement was found with an advance of +2 (see left)

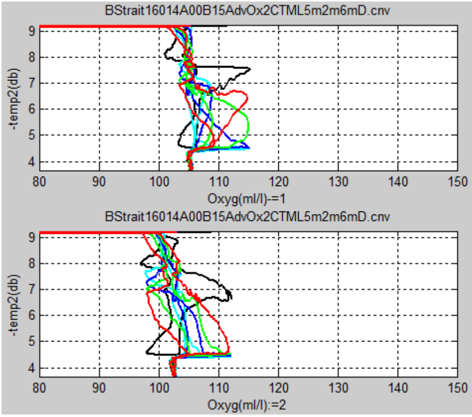
Illustration of Oxygen correction for cast 005. Black is original data, red is using Ox advance of 2, blue is using other examples of oxygen advance

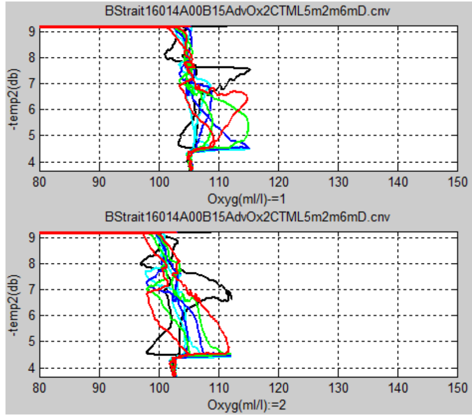
In 2016, we first selected some casts with oxygen structure: 4, 5 14, 15 16, but found no really good agreement for any value of Ox align.

Illustrations of Oxygen different oxygen advance values
- Ox2=red, Ox3=green, ox4=blue, ox5=cyan, Pre align = black



These two both have red = (ox2) best

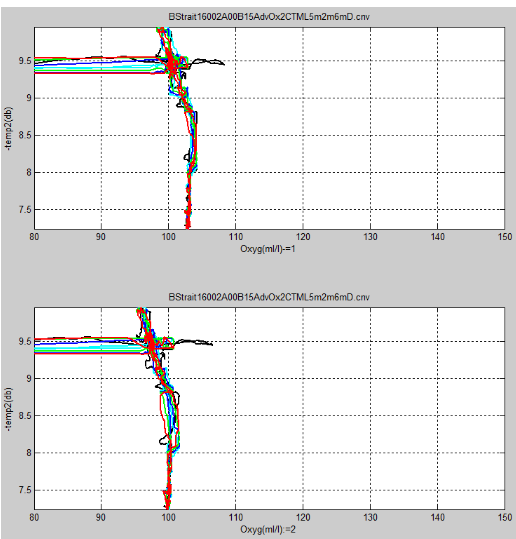


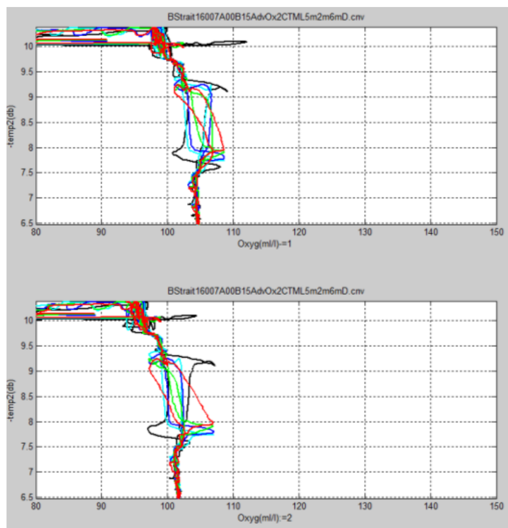


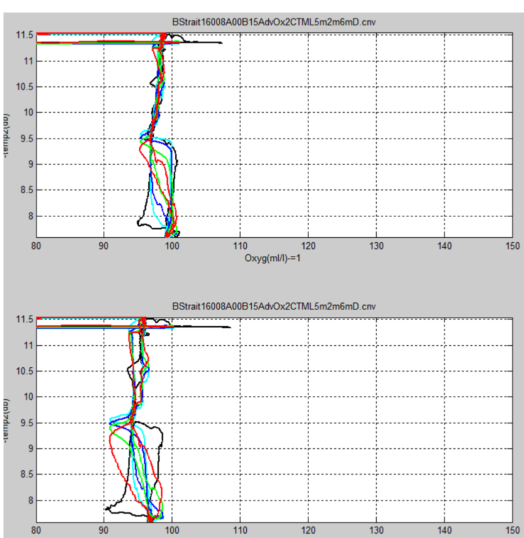
Here for Ox2, blue seems better for both. *Here arguable .. blue again??*

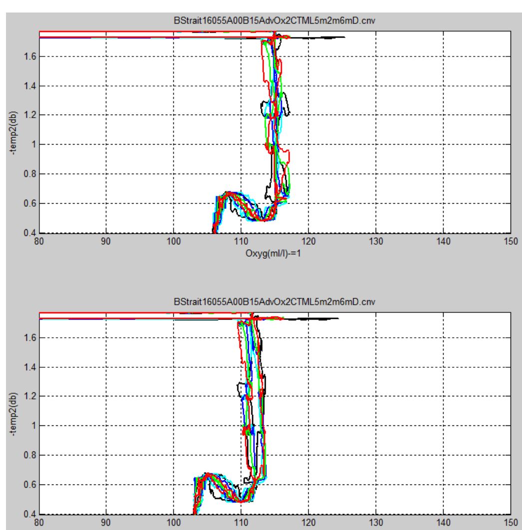
But these may not be casts which are actually the same down and up. Thus, instead of picking casts randomly, select profiles which have repeatable temperature salinity plots on down and up casts, viz:
istatforox=([2 7 8 9 10 55 83 90 107 128 129 174 178 186 188 191])

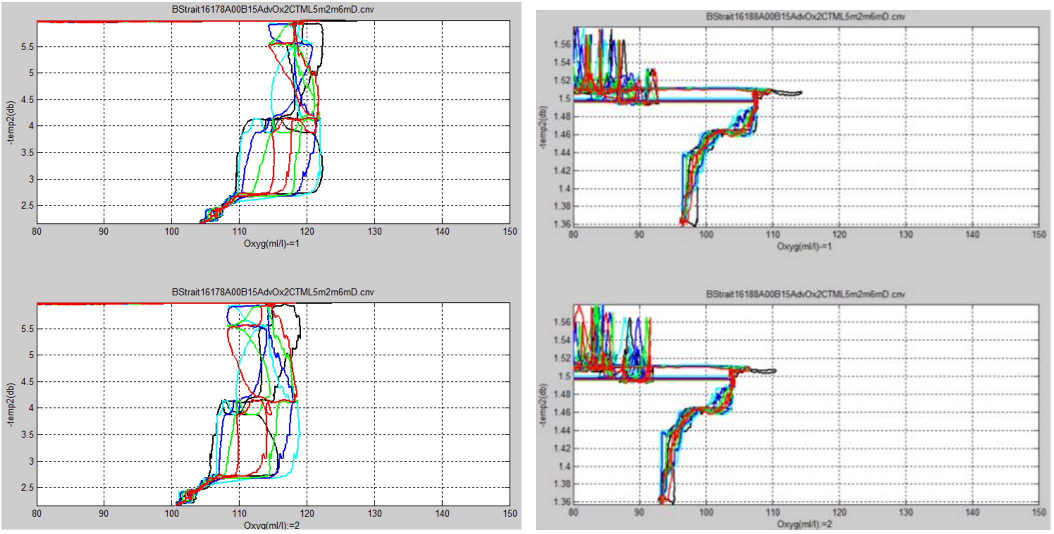
This (see plots below) suggests different numbers for Ox1 and Ox 2.
- red for system1 (Ox2), and green for system 2 (Ox3), though red often does ok too.



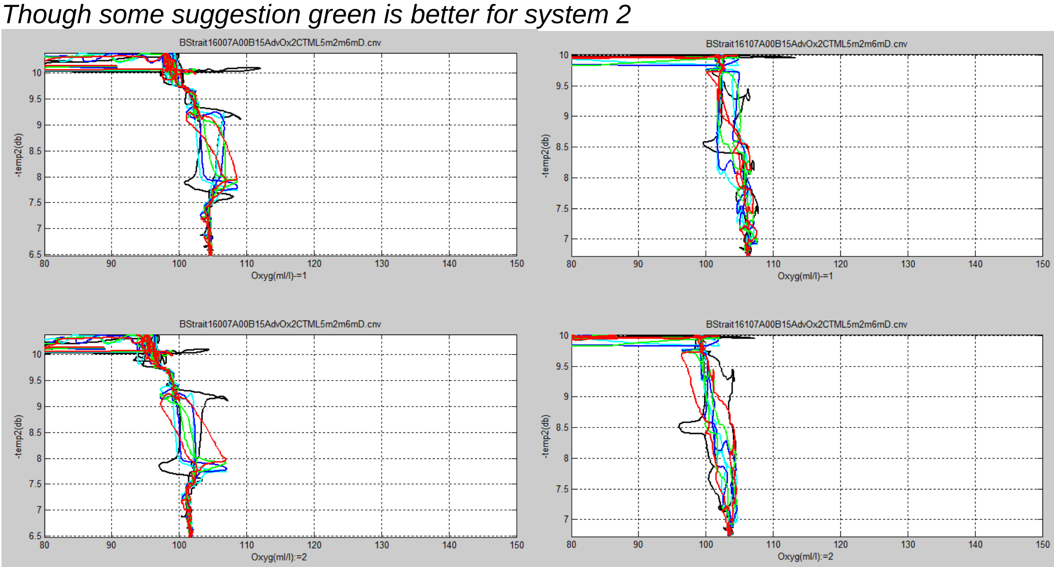




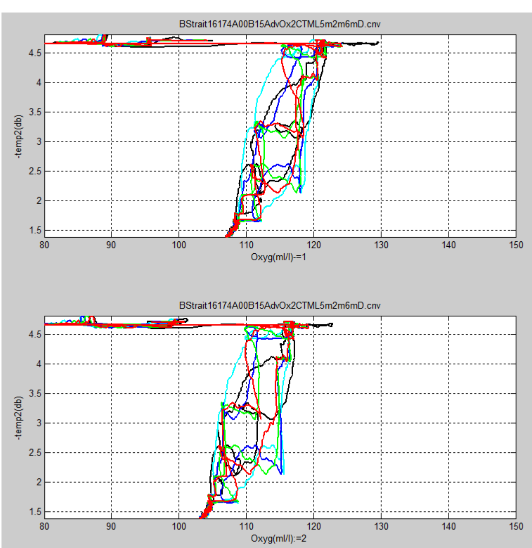




Though some suggestion green is better for system 2



But ultimately, only seem to be able to do good to 5%.



Finally conclude:
- at this stage will use Ox1, even though it might be 4% high, because it avoids the blocked vent plug issue on casts 241-250.
- thus will align for Ox1, which suggests using an advance of +2
- recognize that up and down casts may differ by 5% (which may also be due to hysteresis of temperature).

=== 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 = CellTMBStrait2016_CTDforprocess.psa)
Inputs are: BStrait16nnnA00B15AdvOx2.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: BStrait16nnnA00B15AdvOx2CTM.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. This seems 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 soak is about 4 m .. checks show this works with this routine and these settings.
IN SBEDATA PROCESSING, RUN: LOOP EDIT
(PSA file for this = LoopEditBStrait2016_CTDforprocess.psa)
Inputs are: BStrait16nnnA00B15AdvOx2CTM.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) = 5
-- Minimum soak depth (m) = 2
-- Maximum soak depth (m) = 6
--> Check box Use deck pressure as pressure offset
--> Check box Exclude scans marked bad
*In FILE SETUP
-- Append added = L5m2m6m
THIS GIVES files called: BStrait16nnnA00B15AdvOx2CTML5m2m6m.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 = DeriveCTDBStrait2016_CTDforprocess.psa)
Inputs are: BStrait16nnnA00B15AdvOx2CTML5m2m6m.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: BStrait16nnnA00B15AdvOx2CTML5m2m6mD.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_FilterCTDBStrait2016_CTDforprocess_MF17.psa)
Inputs are: BStrait16nnnA00B15AdvOx2CTML5m2m6mD.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: BStrait16nnnA00B15AdvOx2CTML5m2m6mDMF17.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 = BinAvgBStrait2016_CTDforprocess.psa)
Inputs are: BStrait16nnnA00B15AdvOx2CTML5m2m6m.cnv &
BStrait16nnnA00B15AdvOx2CTML5m2m6mDMF17.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: BStrait16nnnA00B15AdvOx2CTML5m2m6mDBADCS010.cnv &
BStrait16nnnA00B15AdvOx2CTML5m2m6mDMF17BADCS010.cnv

In 2016 this marks the end of the CTD pre processing.

BERING STRAIT 2016 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`: Bstrait16nnn.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**")
   - 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)
   - WAIT until –"11", "Pump on", Data ok (incl S and position), check #'s agree
   - **Driver to Deck**: "**return to surface and go down**"
   - check target depth ~ water depth under keel
   - **Deck to Driver**: "**Going down**"
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

   When at surface (**Deck to Driver: "At surface"**)
   - `real time control – Pump off`
   - `real time data – STOP`
   - Power off CTD Deck Unit
   - **Driver to deck**: "**Recover CTD**"
   - fill in Event Log for up cast
   - **Deck to Driver** "**CTD recovered**".
   - **Driver to Deck:** "**ready to go to next station**"
   - Deck tells bridge when can proceed to next station
5. THEN
   - screen dump to paint (Alt-print screen, Cntrl V, save as BStrait16nnn.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 long time to next CTD, check "transponder is out"

BERING STRAIT 2016 CTD LINES

A total of 19 CTD lines were run on the cruise. We were able to accomplish so many stations 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 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 Ox1 data, and may be ~ 4% too high
- is missing cast 83
- uses Ox2 for cast 271, possibly with a calculated offset
- 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
- casts at A3

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

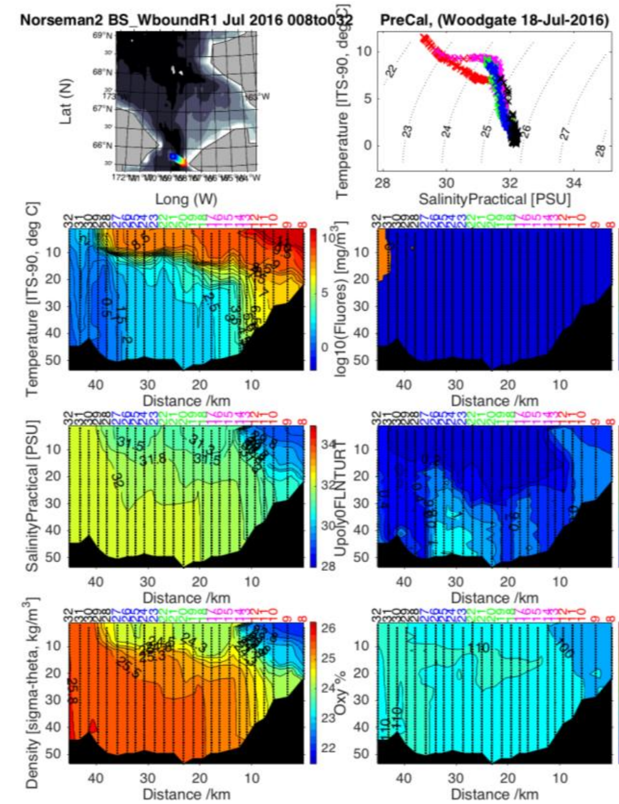
For full positions and times see event log and data file headers.

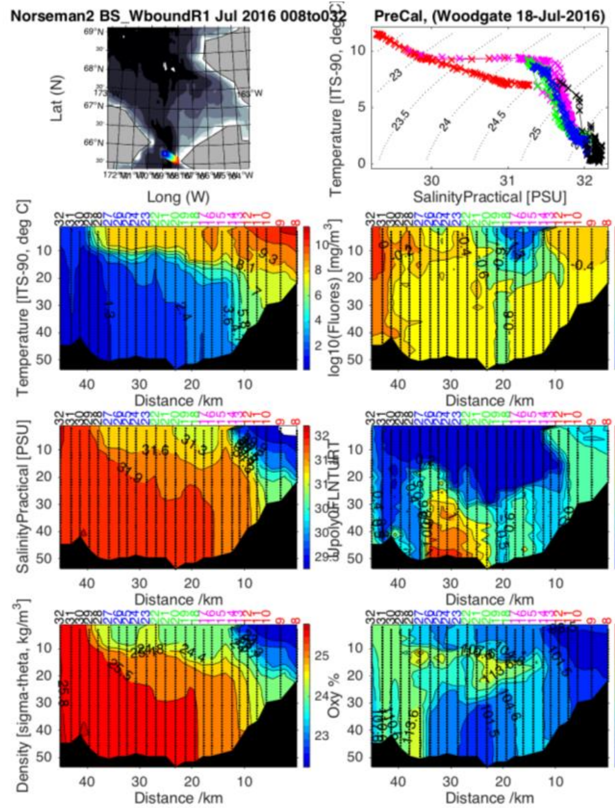
Many physical features are of interest and require further investigation, e.g.,
- limited extent of the Alaskan Coastal Current, which (data suggest) was only just arriving in the strait as we left);
- frequent 3-layer structure to the water column;
- presence of cold, fresh water overlaying warmer waters (suggestive perhaps of ice melt);
- deviations from the traditional pattern of warm, fresh waters at the surface;
- remarkable homogeneity of the water column in many places.

Action Item: Investigate

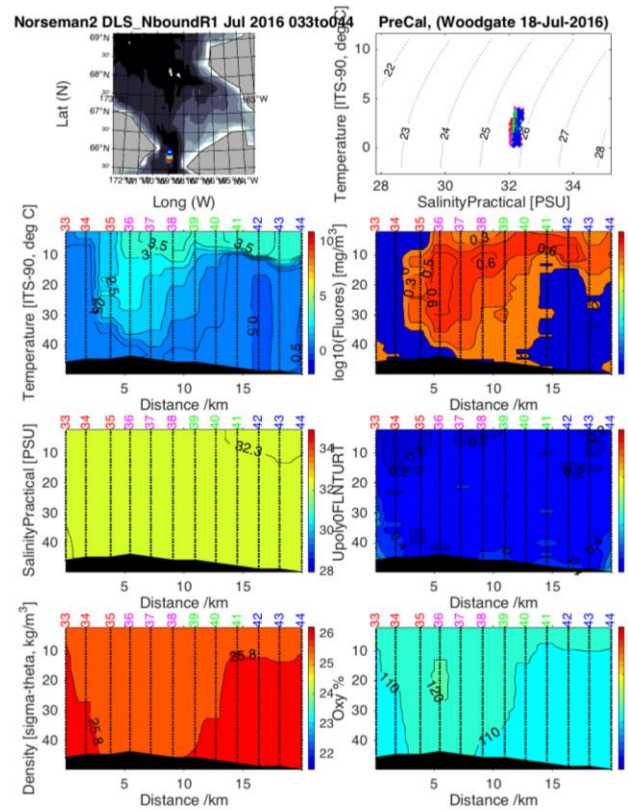
Also noteworthy in these data are the relationships between fluorescence, oxygen and turbidity, with suggestions of different ages of blooms, and possible fall out of blooms to the benthos. **Action Item: Investigate.** Oxygen values are calculated by Seabird software and are reported here in % saturation.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

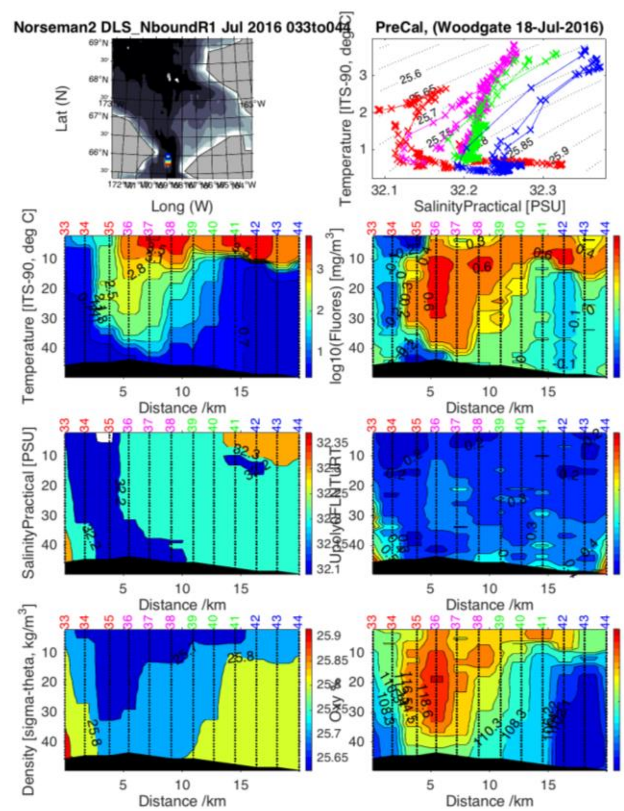
1) Bering Strait (BS) line – first running, Westward



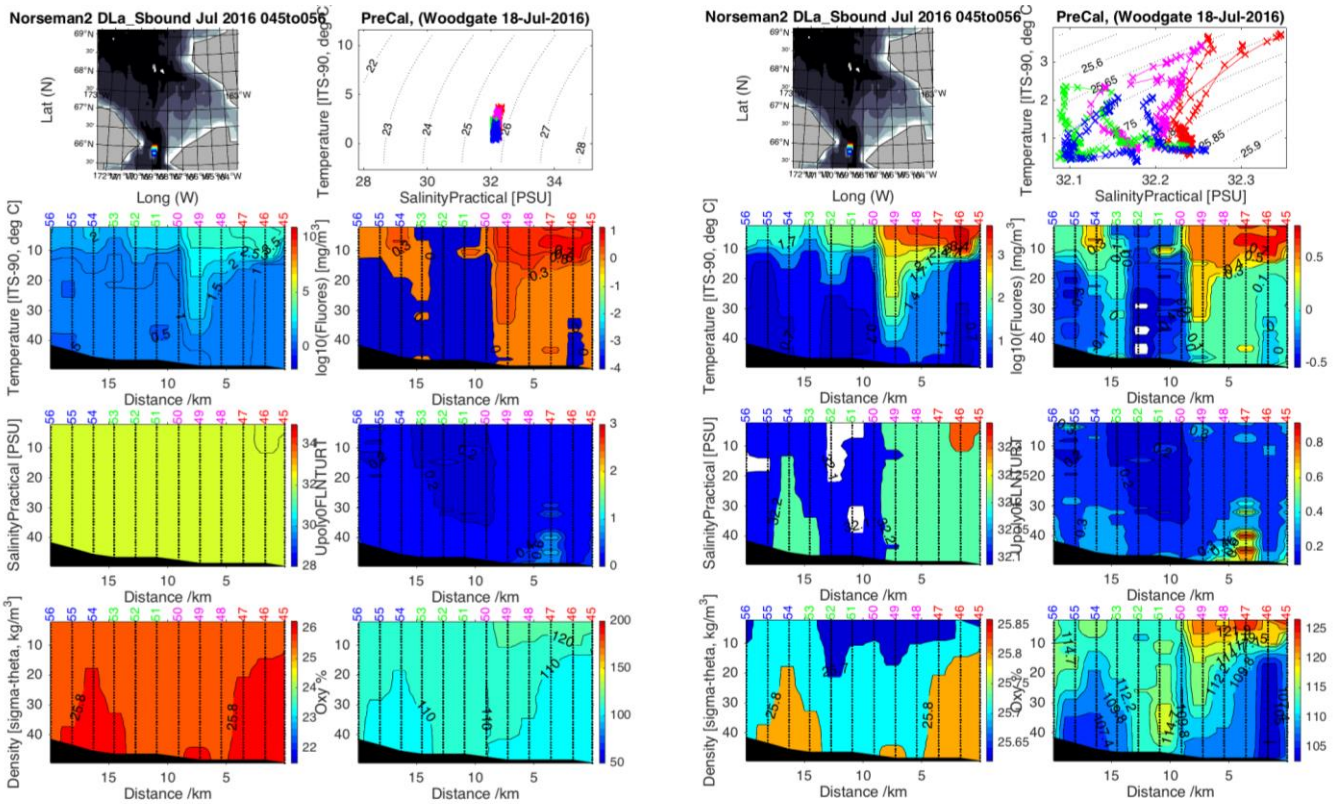


2) South portion of Diomede (DL) line – first running, Northward

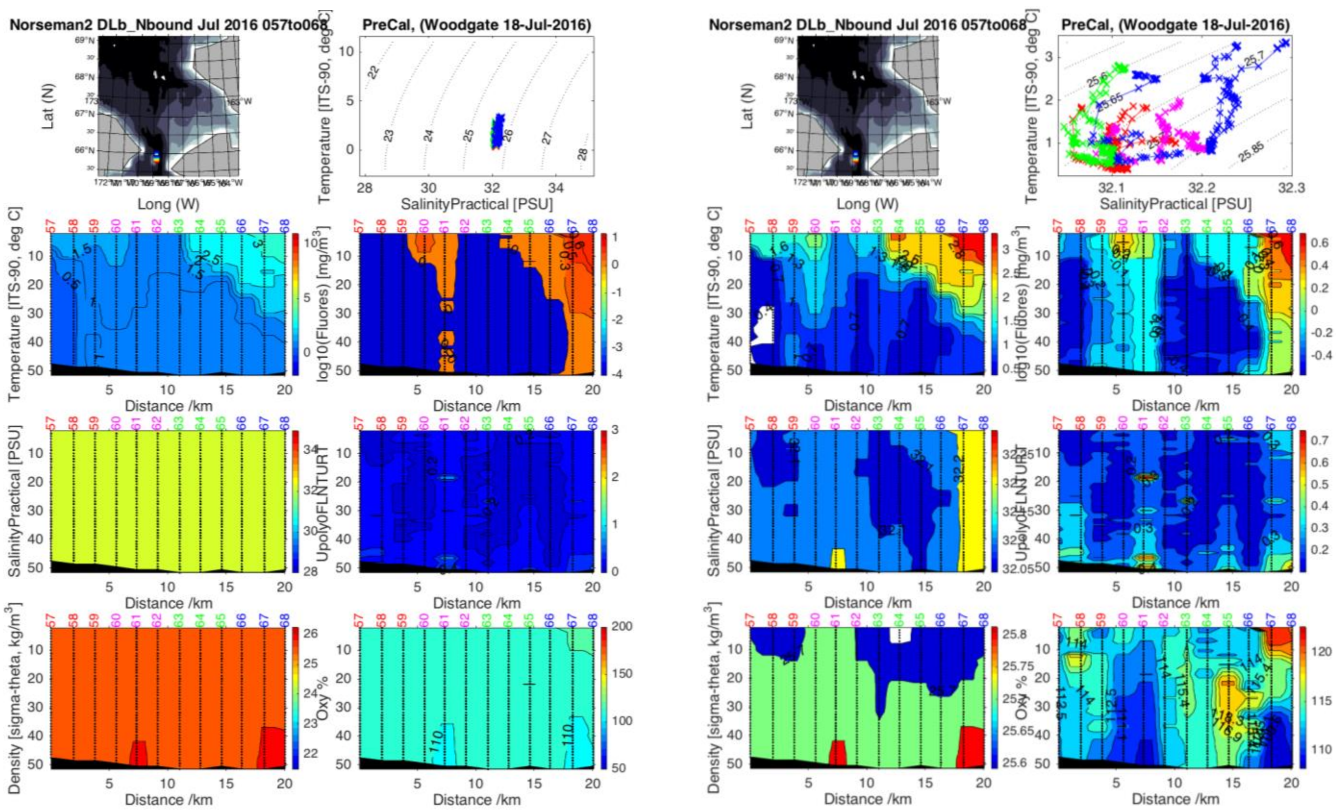




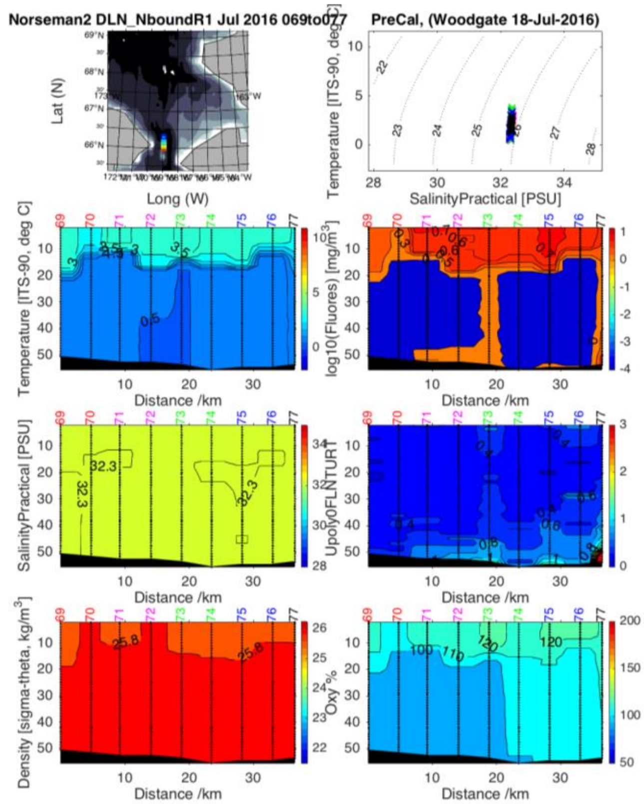
3) Diomede A line (DLa) – first running, Southward

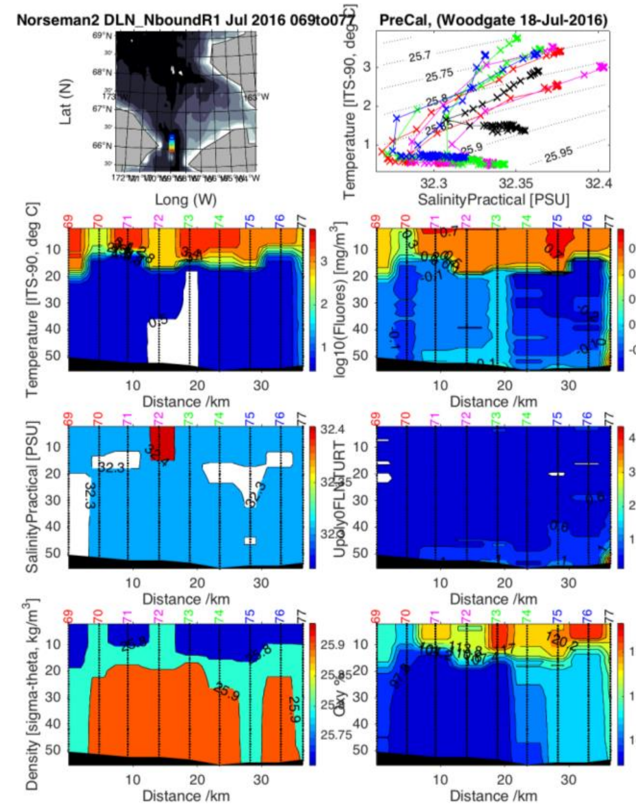


4) Diomede B line (DLb) – first running, Northward

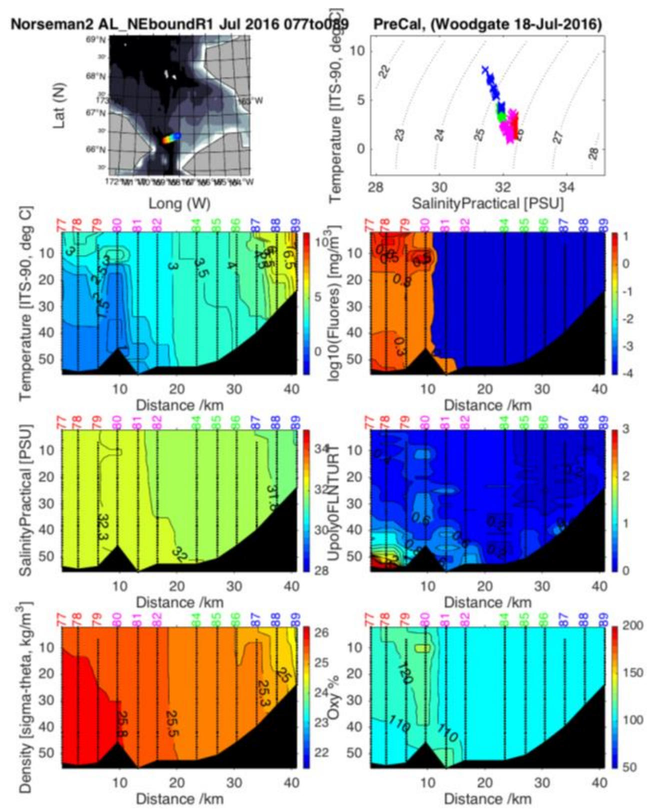


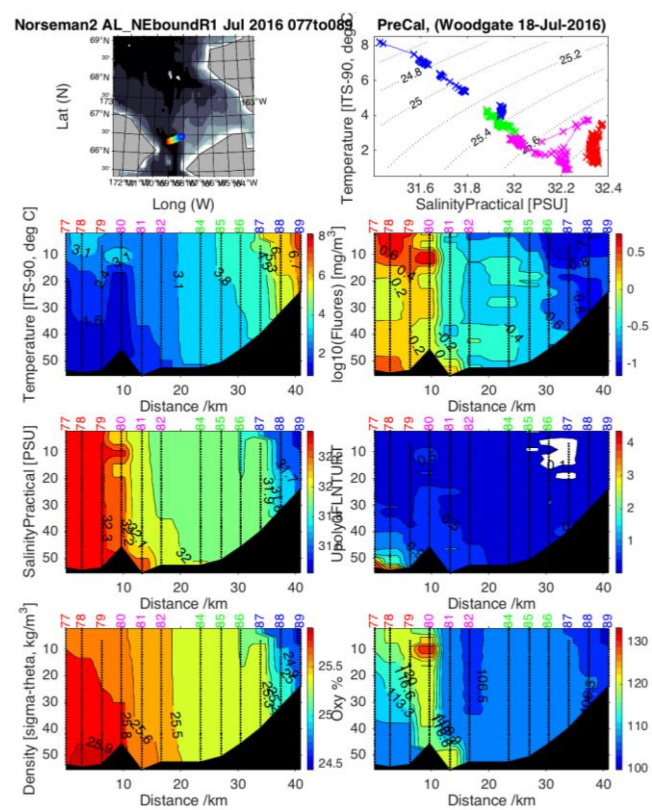
5) North portion of Diomede (DL) line – first running, Northward



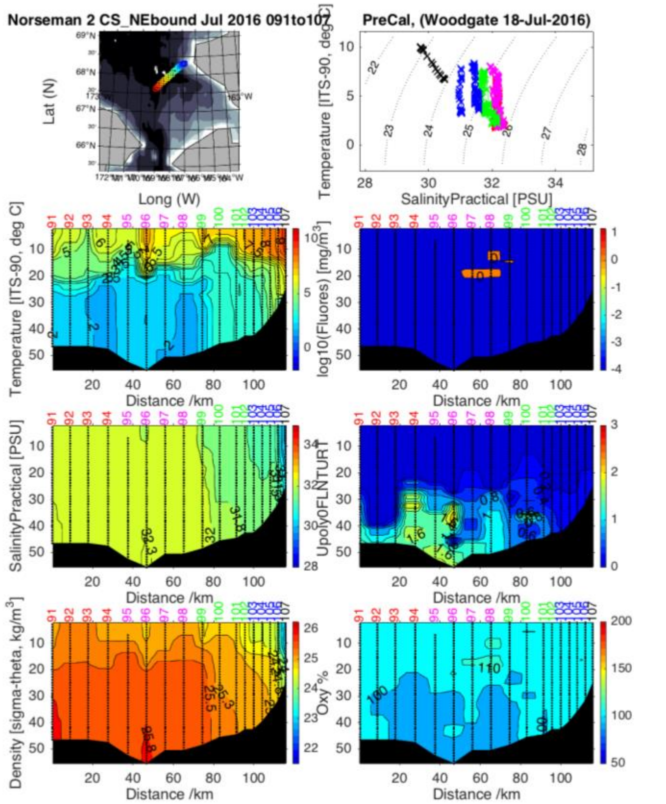


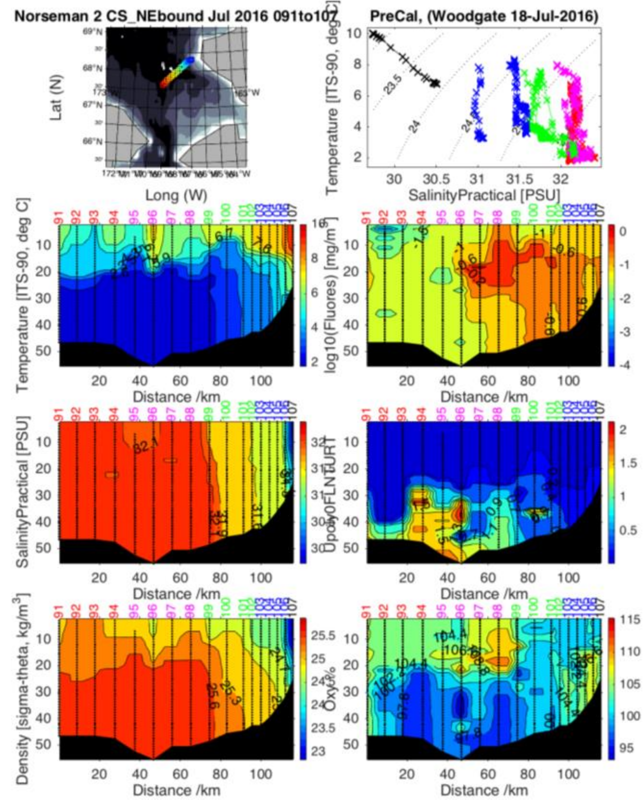
6) A3 (AL) line – only running, Eastward



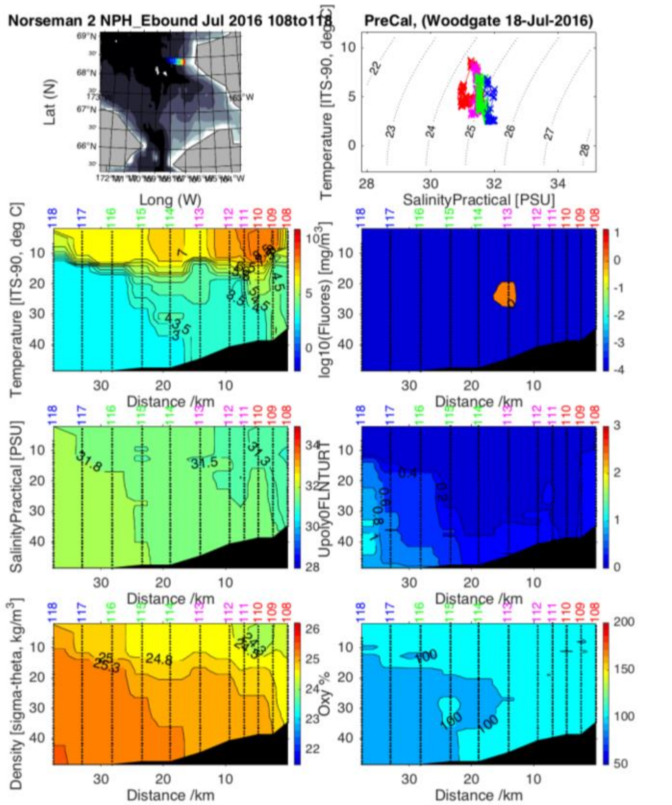


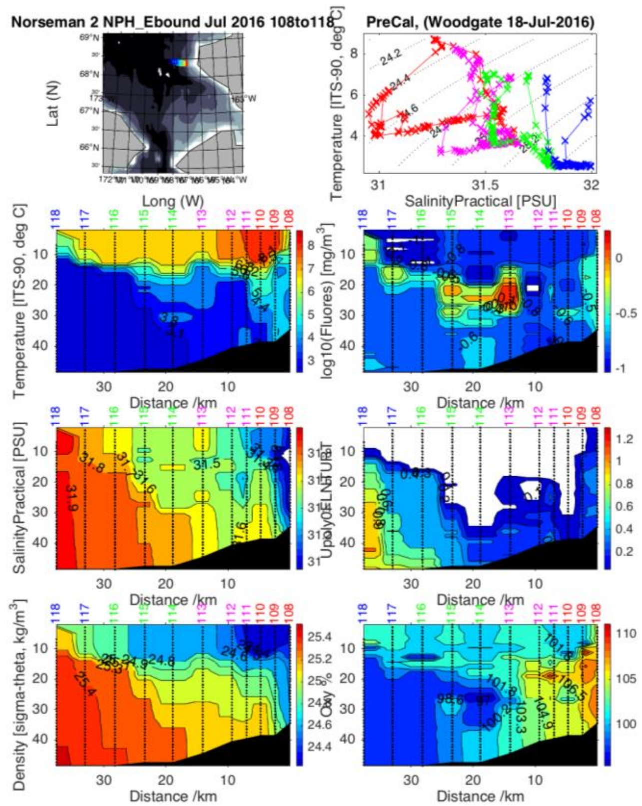
7) Cape Serdste-Kamen (CS) line (US portion only)– only running, Eastward



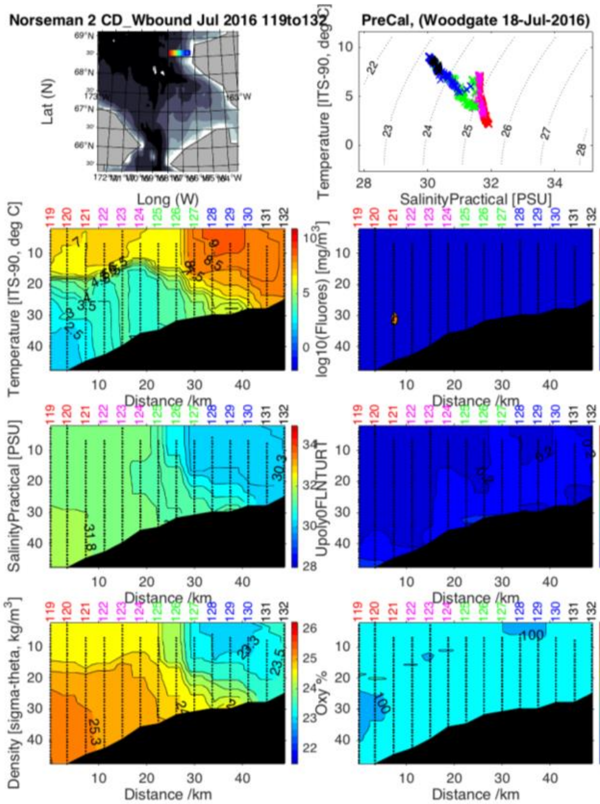


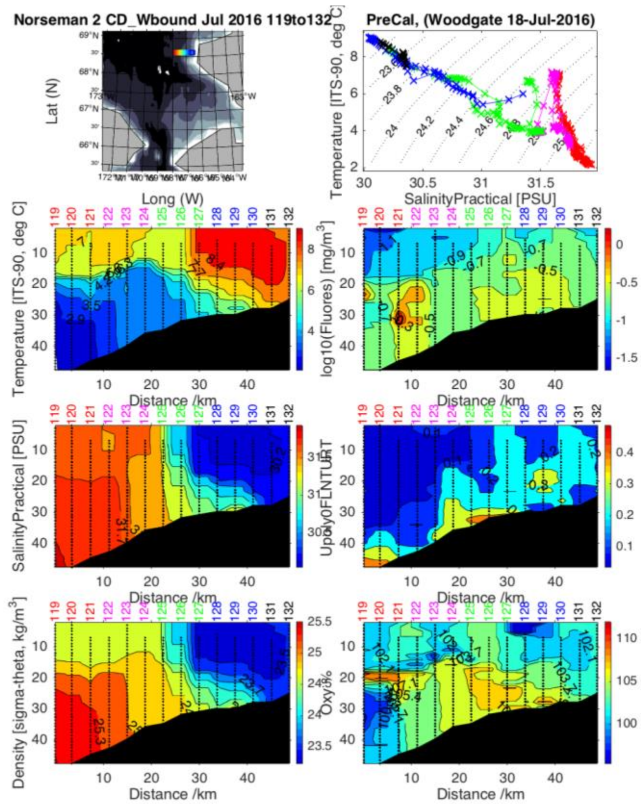
8) North Point Hope (NPH) line – only running, Westward



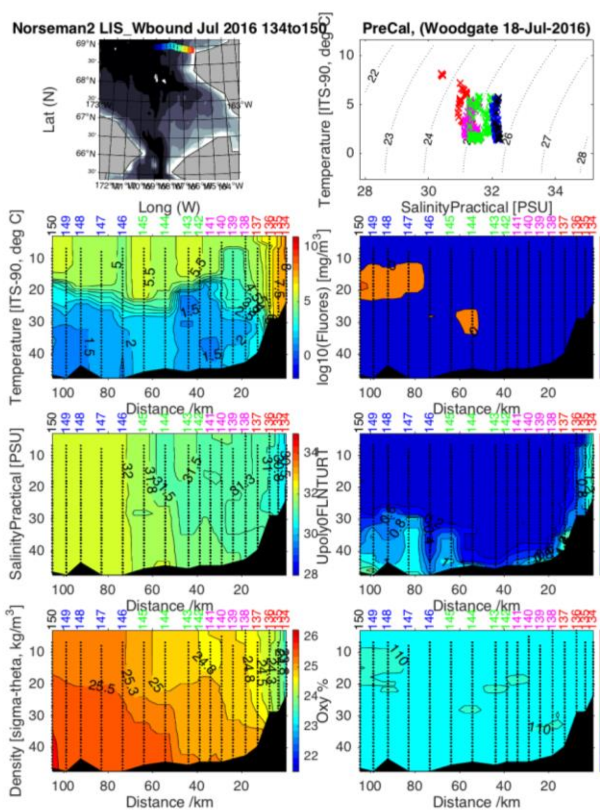


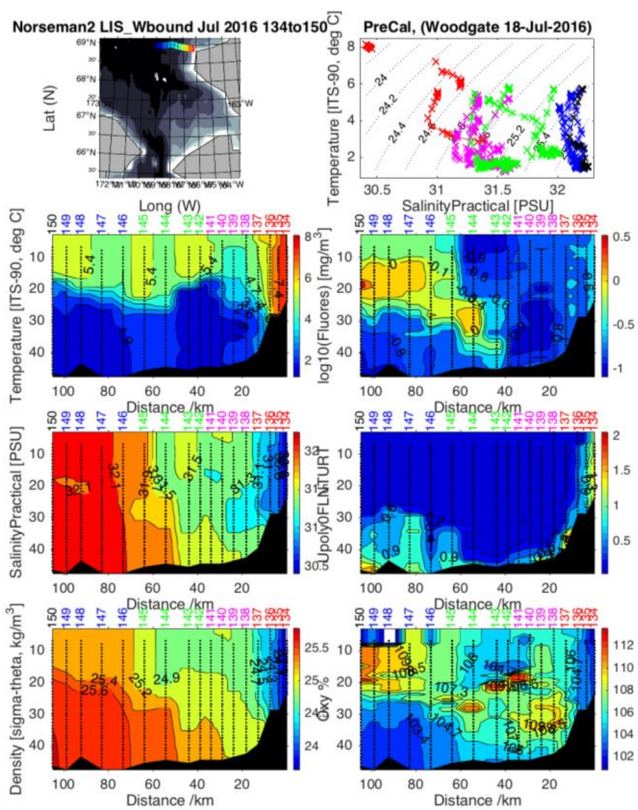
9) Cape Dyer (CD) line – only running, Eastward



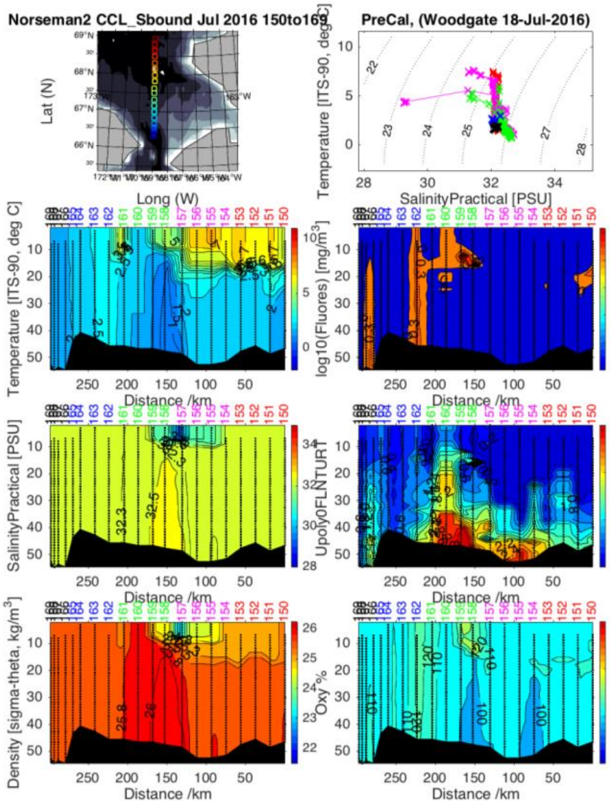


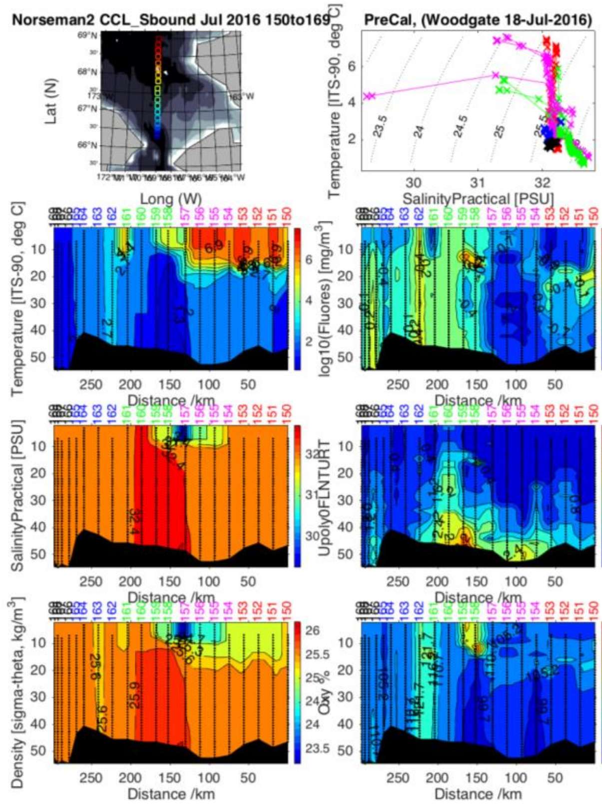
10) Cape Lisburne (LIS) line – only running, Westward



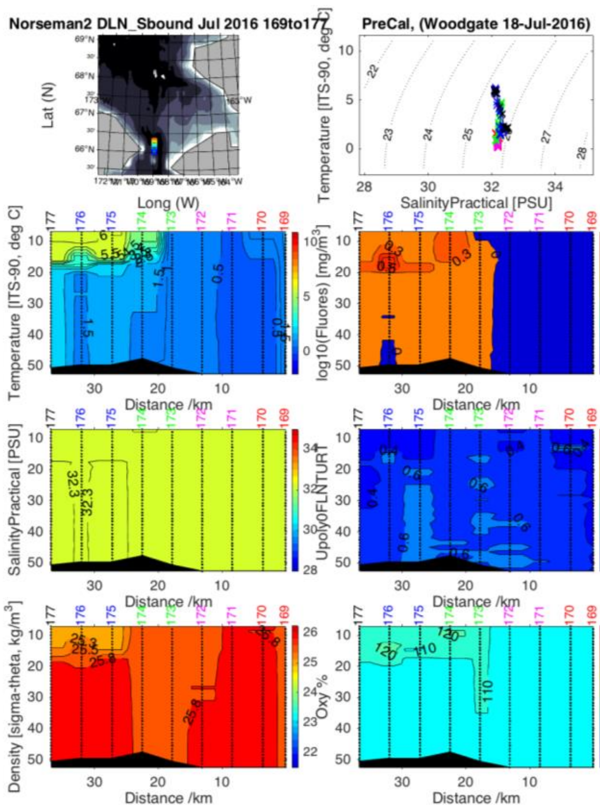


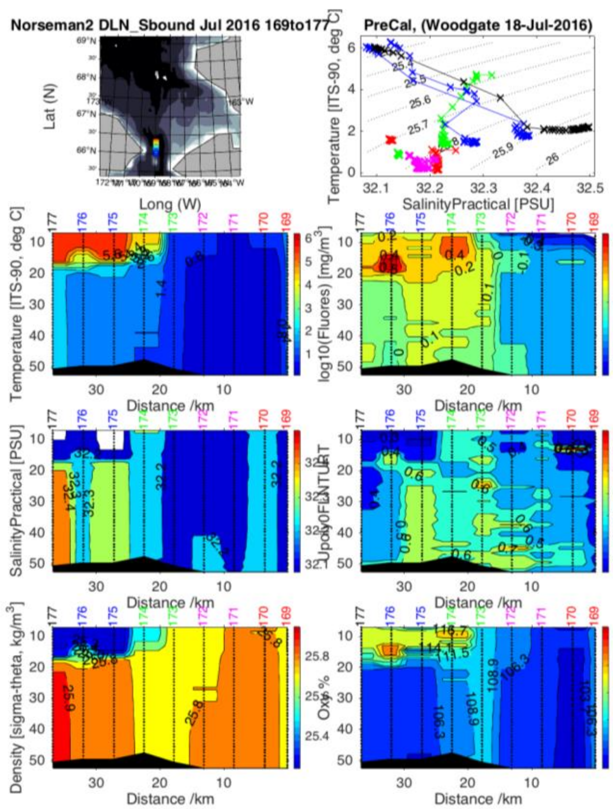
11) Chukchi Convention (CCL) line – only running, Southward



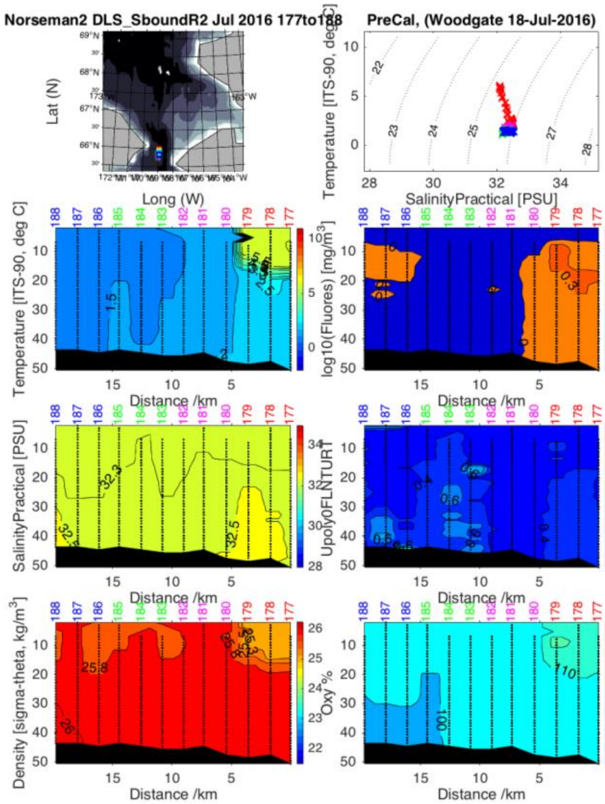


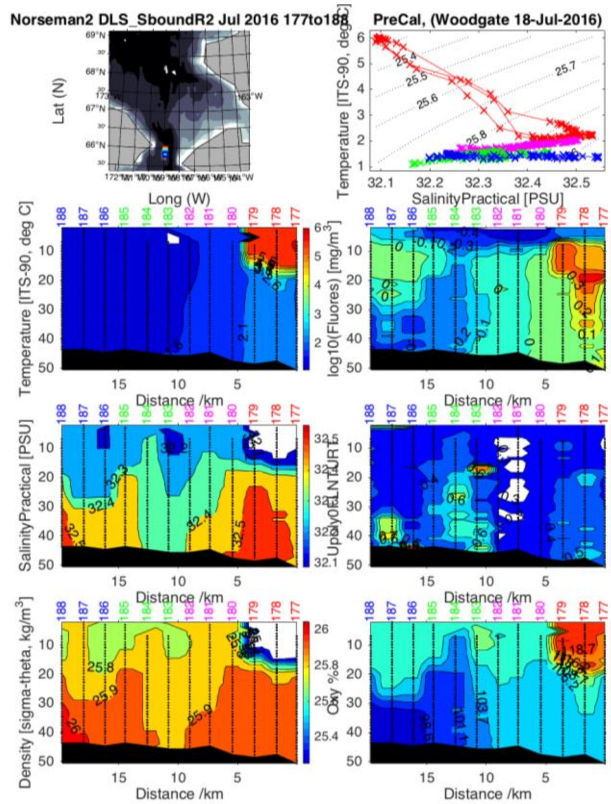
12) North portion of Diomede (DL) line – second running, Southward



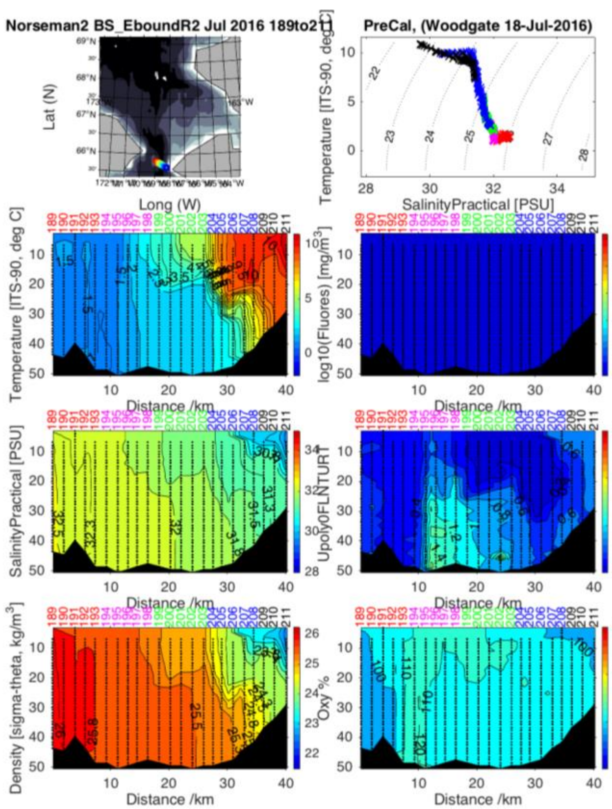


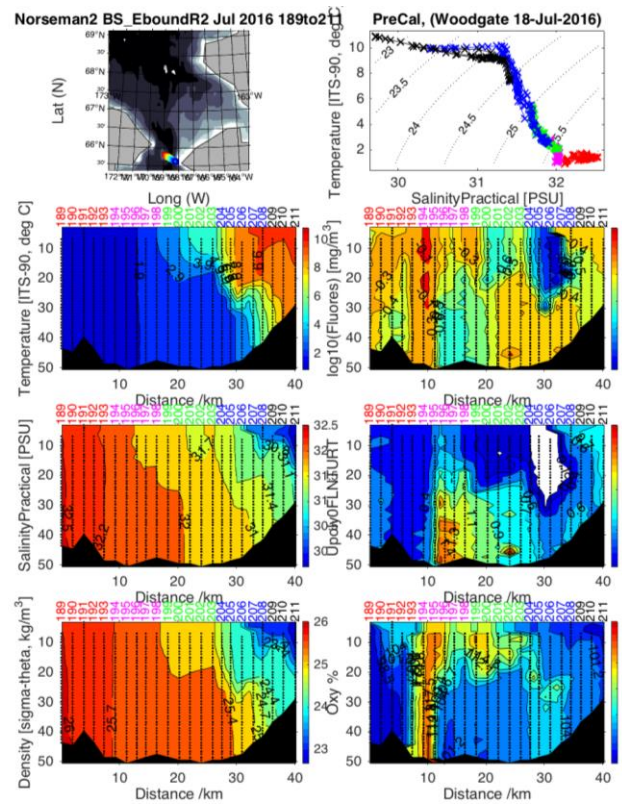
13) South portion of Diomede (DL) line – second running, Southward



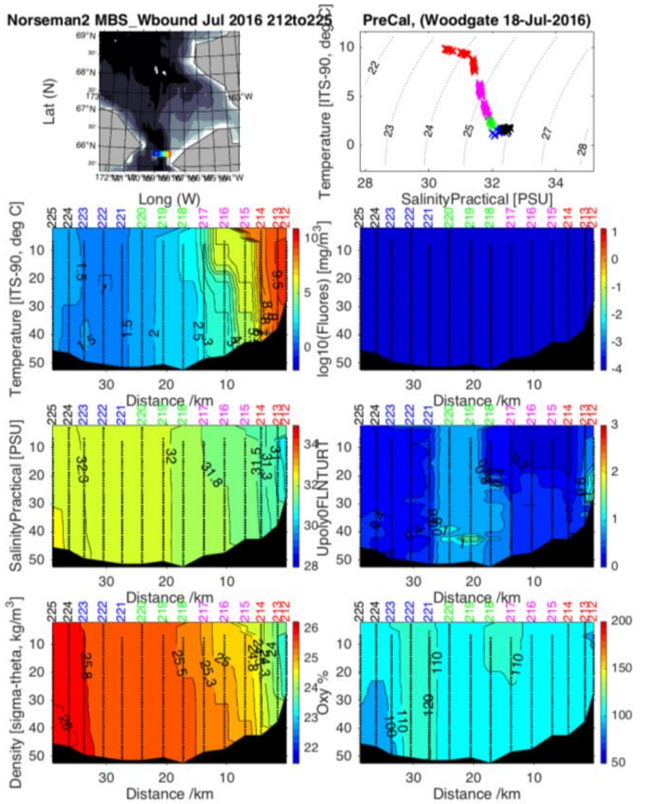


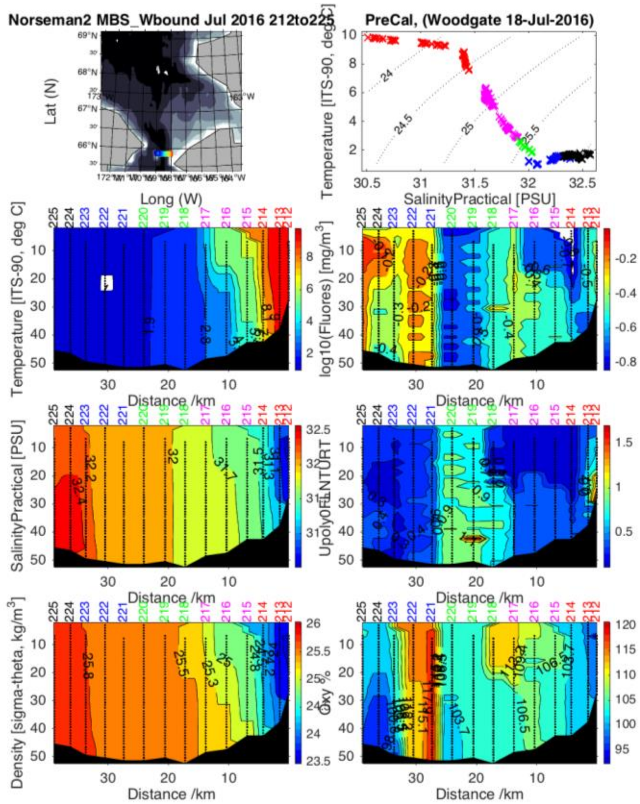
14) Bering Strait (BS) line – second running, Eastward



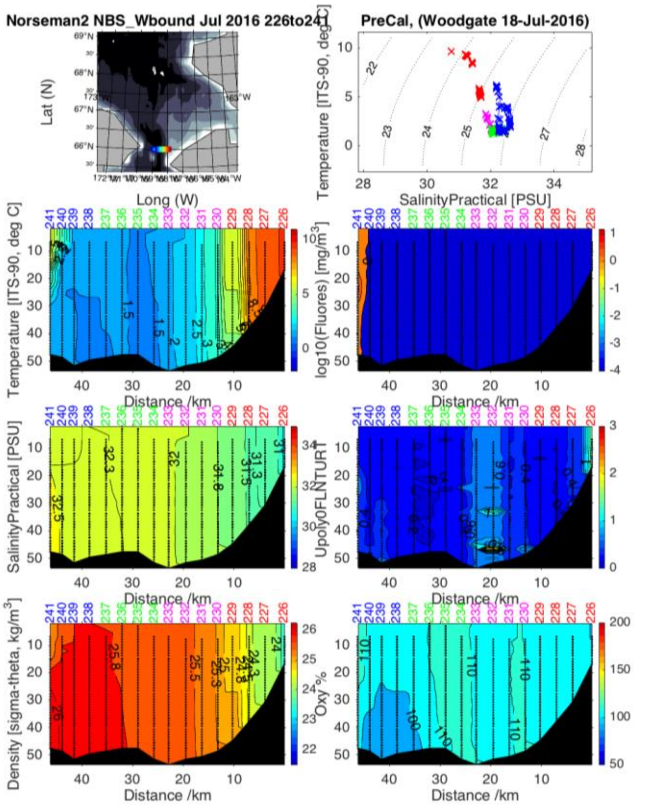


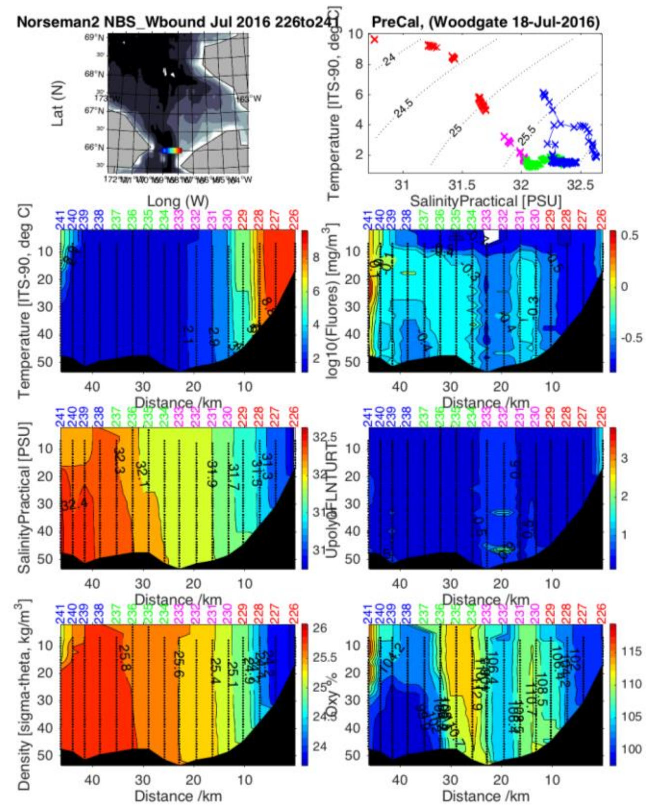
15) Mid Bering Strait (MBS) line – only running, Westward



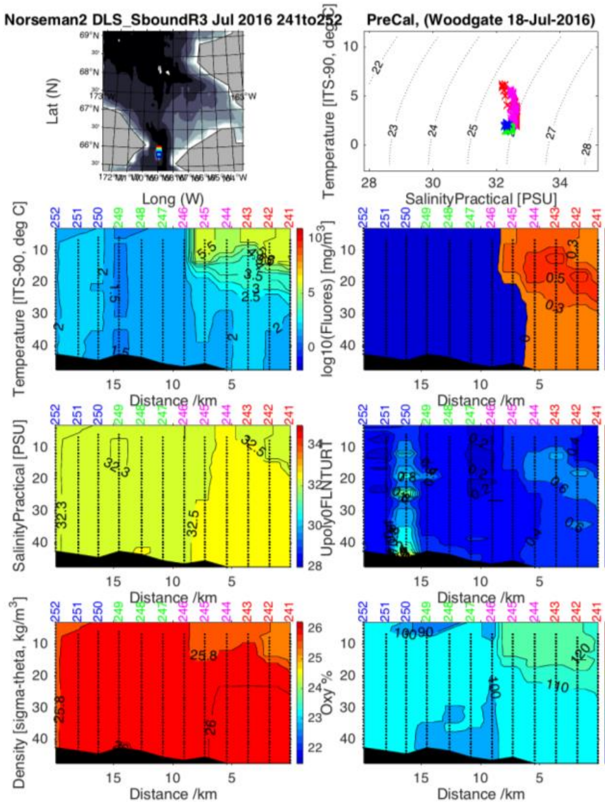


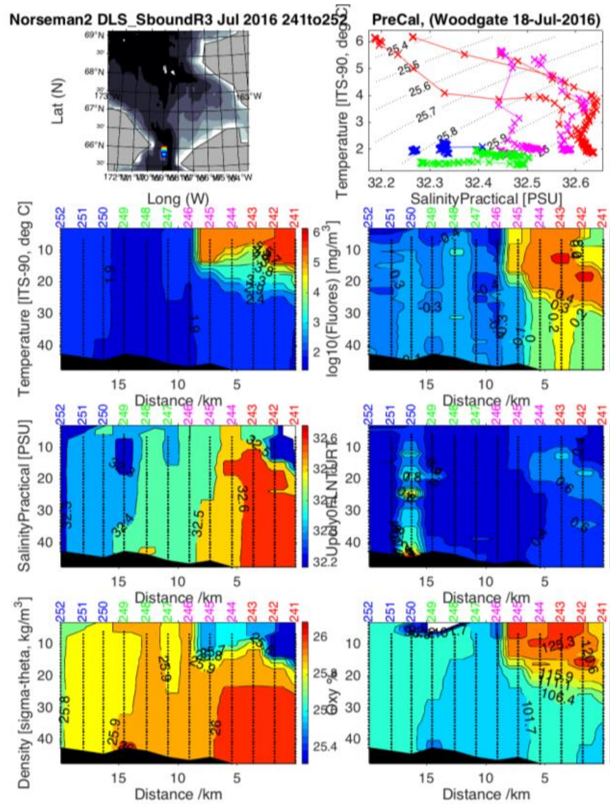
16) North Bering Strait (NBS) line – only running, Westward



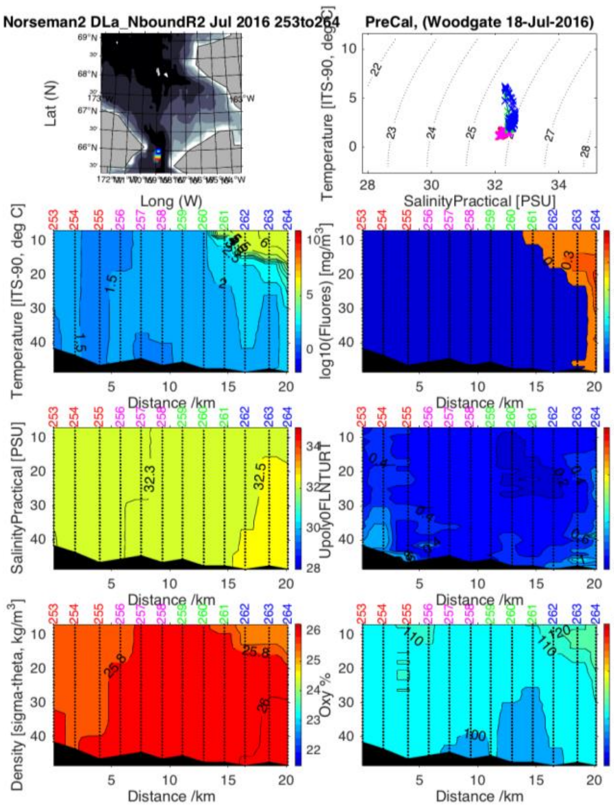


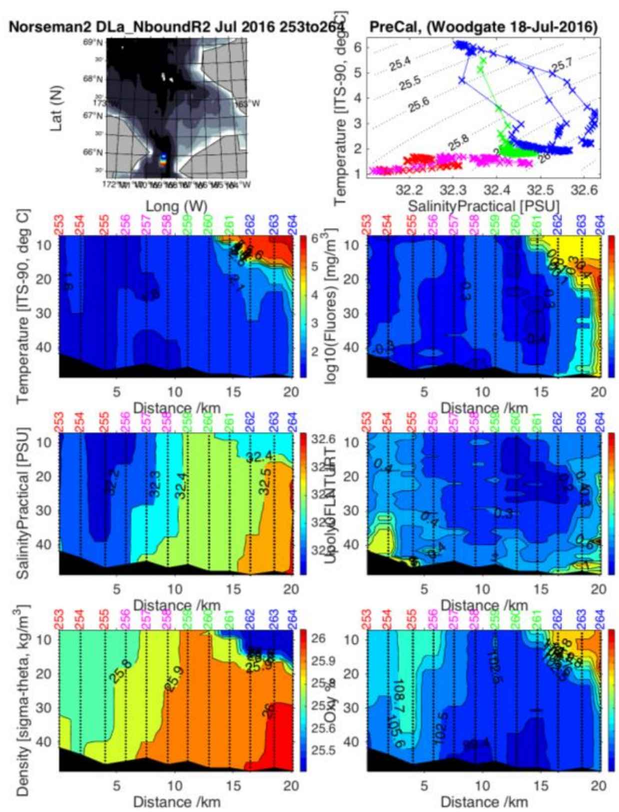
17) South portion of Diomede (DL) line – third running, Southward



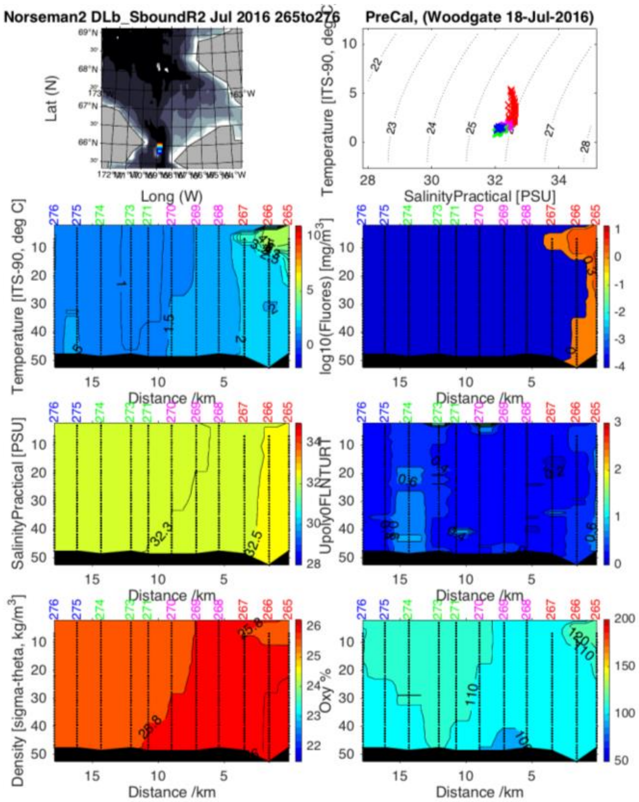


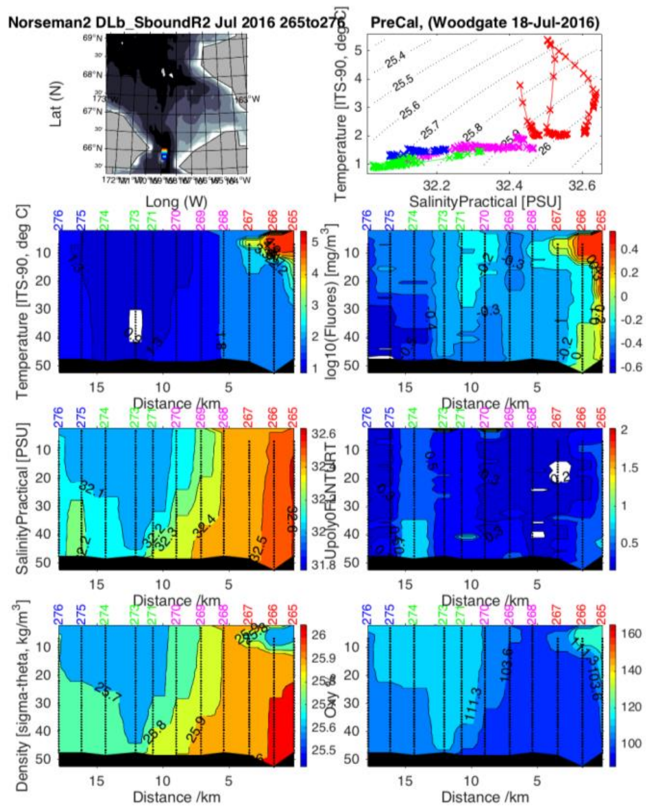
18) Diomede A line (DLa) – second running, Northward





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





GLIDER DEPLOYMENT REPORT - Brita Irving, UAF

On July 10, 2016 a G2 200m Slocum underwater glider was deployed off the Norseman II at 18:00 UTC at 66° 28.663'N 168° 04.688'W (the eastern end of the AL line). The glider, unit 191, was equipped with a DMON, a passive acoustic monitor that listens for marine mammals, a Neil Brown CTD, and a Wetlabs Ecopuck measuring chlorophyll and turbidity.

Prior to deployment, the glider ran through a final on deck status mission (status.mi). The mission completed normally so the Norseman II crew used the A-frame to lower the glider gently into the water at 17:20 UTC. The glider then ran through another status mission, then two test missions. The first mission, ini0.mi, did one dive to 3m then climbed to the surface and the second mission, ini1.mi, did three dives due North to 5m before returning to the surface. When the glider surfaced, science and engineering data were sent over Freewave radio to the ship to inspect. The data looked good so the glider was sent on its deployment mission at 18:00 UTC, July 10, 2016.

The ship remained near the glider for these tests. Once the glider had been finally deployed, a final CTD cast (cast 90) was taken at the site.

This deployment is funded by AOOS for a project by PIs Peter Winsor (UAF), Kate Stafford (UW) and Mark Baumgartner (WHOI). The glider is due to be recovered in the northern Chukchi in early October. Data from the project are/will be available on line 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 R Woodgate

OCEAN ACIDIFICATION REPORT for Juraneck, OSU - Rebecca Woodgate, JimJohnson

Mooring A4-15 contained a cage of sensors deployed by OSU, PI Laurie Juraneck. Three sensors were recovered:

- SBE37, #7156. This was downloaded on the ship, and had recorded hourly data throughout the deployment, although comparison with another SBE on the mooring suggests the final readings are erroneously fresh.
- SAMI pCO2. Although named in last year's report as sensor 0036, on obtaining communication with the instrument on the ship, we found the instrument self-reported as SAMI S61U, SN0144 and was still running. It reported also 4478 data records, with 0 error records and memory used of 174902, with instrument clock 1minute slow. The SAMI was stopped with the software "Stop" command, but was otherwise not interrogated.
- SAMI pH, P0029, SN-0076. On obtaining communication with the instrument on the ship, we found the instrument to report 3084 data records, 0 error records, and 712288 Memory used, with a flag "stopped due to low battery". The SAMI clock was 1 minute fast.

All three instruments were returned with the container shipment to UW, and will be shipped on from there to OSU in the fall.

Action Item: Ship to OSU. Follow up on data return.

MARINE MAMMAL ACOUSTIC REPORT for Stafford, UW - Jim Johnson, for Kate Stafford, UW.

No dedicated marine mammal observers were present on the cruise. Fog hindered even causal observations of marine bird and mammal life. Various birds were observed, especially just north of the Diomede Islands, but also intermittently elsewhere. Perhaps the highest concentration of bird life was found just north of Cape Lisburne, in the shallow region traversed east of the Cape, as the ship hid from bad weather. A pod of whales (5-10 in number, but far off, likely gray whales) were spotted just South of CCL10, and the ship reported a sighting of a beluga off Point Hope on the previous charter.

Marine mammal hydrophones were recovered from all recovered moorings A2-15, A3-15 and A4-15, and were redeployed on all moorings (A3-16 and A4-16 carried the Aural extended instruments used in the strait in previous years; mooring A2-16 carried a new APL prototype instrument.)

Harddrives from recovered instruments were handcarried back to Seattle for analysis by Kate Stafford, UW, the PI on this program.

Action Item: Follow up on data return.

SEA ICE OBSERVATIONS

Unusually, sea ice was encountered during the CCL line, ~ 3nm of ice between stations CCL16 and CCL14 on our southward CTD line. This was only observed by the night watch. The NOAA surface analysis from that day suggests the ice may have come from the Siberian Coastal Current. All our past cruises have never encountered sea ice in the US-Arctic.

BERING STRAIT 2016 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 high wind speeds (>15-20 knots) for most of the cruise, with the wind being almost exclusively from the south. **Action Item: Check if wind direction needs to be corrected for magnetic declination.** Relative humidity is high, consistent with the dominantly foggy conditions. While air temperature values are broadly consistent with a human assessment of the temperature, there is a warm period (JD194) while the ship anchored (in sun) in the lee of Cape Lisburne waiting out the storm. Since we were close enough to land to get mosquitos on the ship, it is possible this warmth is due to advection of land air to the ship or solar heating of the sensors.

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). **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 2015 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.

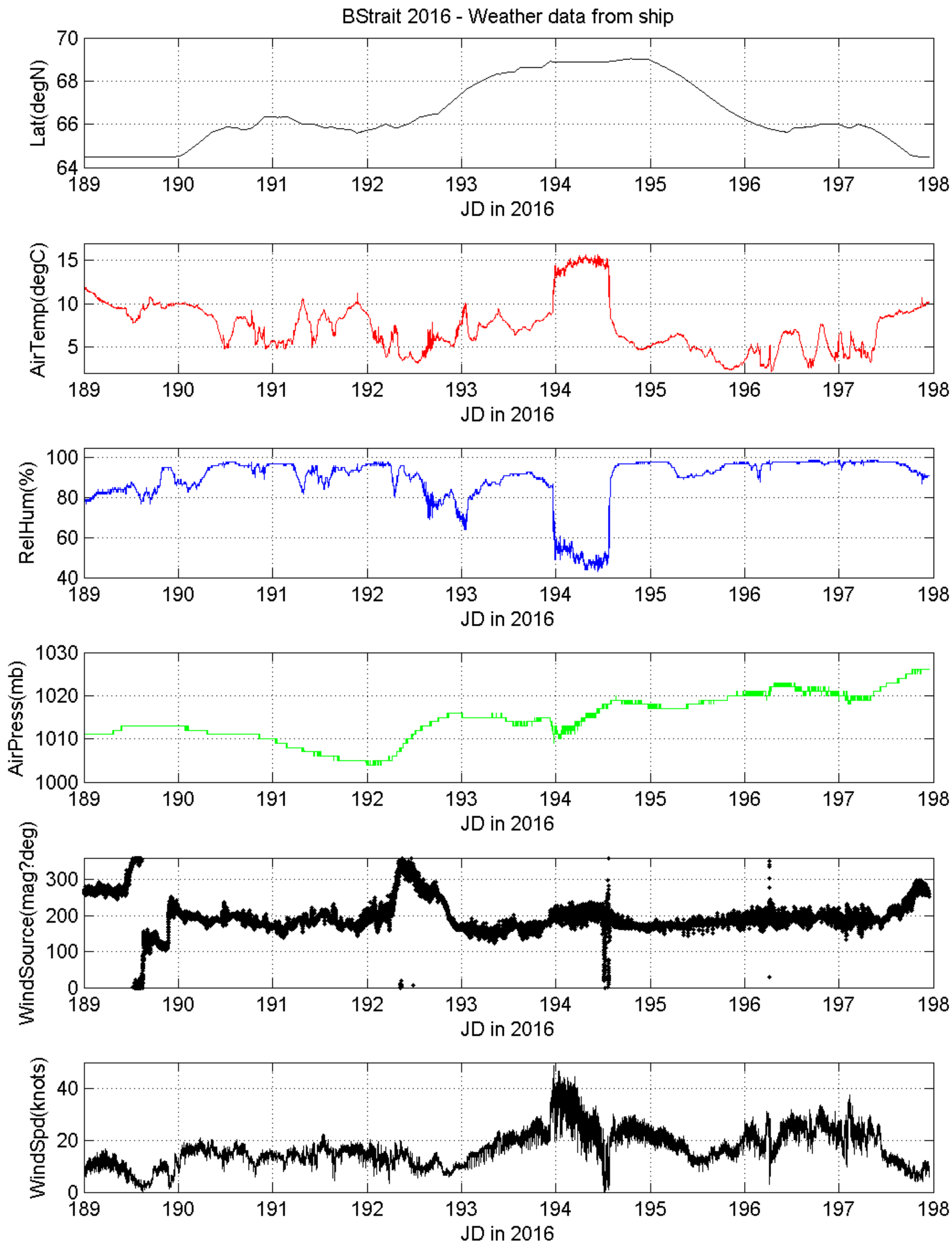
The following observations are worth of note:

- The typical pattern of waters being warmer and fresher near the Alaskan coast is evident in these data. However, in stark comparison to 2013 (which recorded salinities of 20psu), the lowest underway salinities recorded were ~ 29psu as per 2015 (in the strait, and off Point Hope), slightly fresher than 2014 (~ 30psu). In general though, salinities were higher than in 2015.
- Warmer waters are also found in the north of the study area, as per the last three years. Our hypothesis is that this is evidence of local solar heating since these waters are warmer than in the strait itself. **Action Item: Examine ice records.**
- A zone of freshwater was encountered around 67.75N, coincident with observations of sea ice in this region**. Action Item: Investigate sea-ice motion.**
- The second running of the eddy grid north of the Diomede Islands (DL lines) suggest a warm eddy trapped/cast off from the islands. **Action Item: Investigate this with ADCP and CTD and satellite data.**

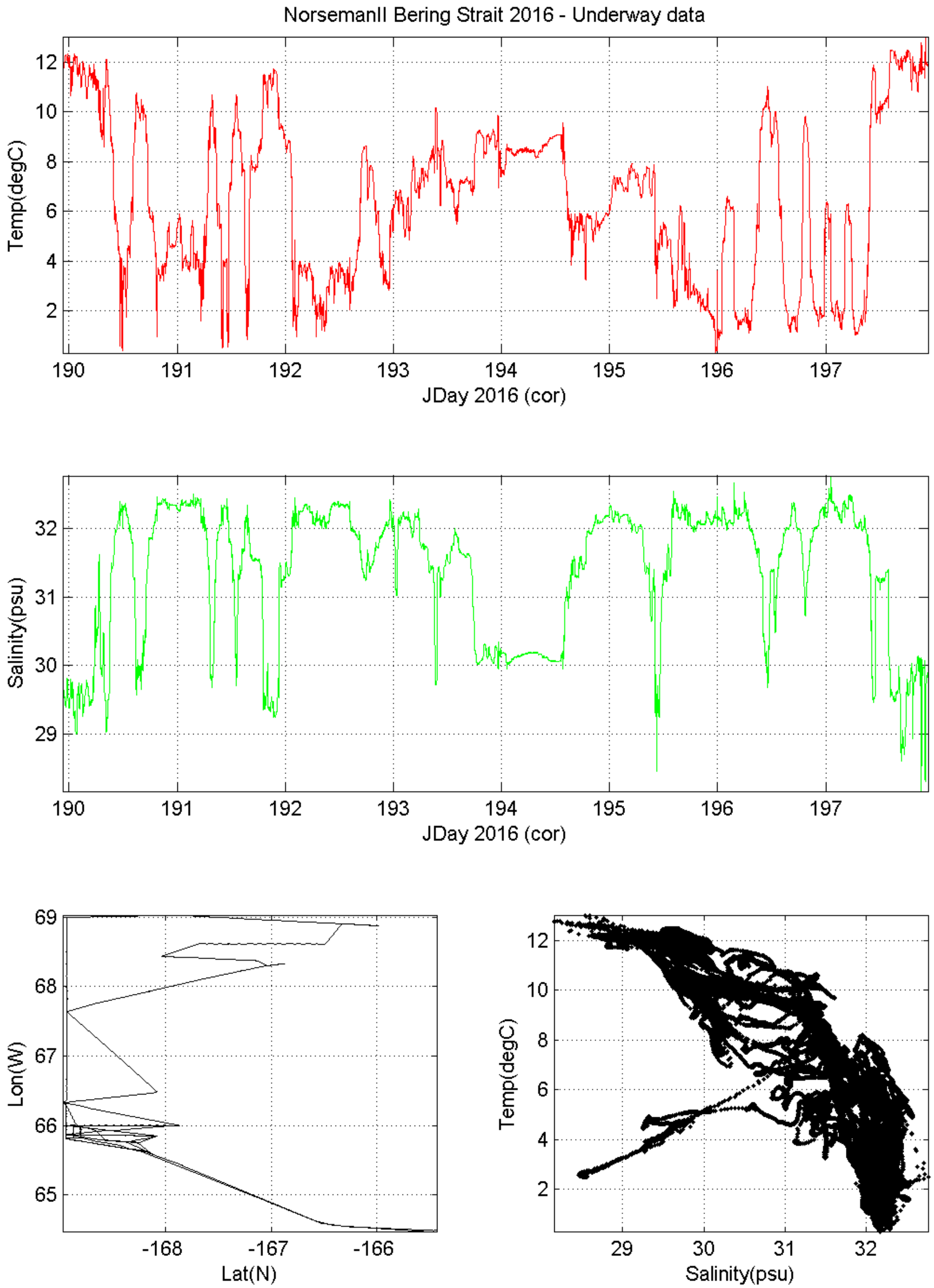
It is very important to remember when interpreting these data, that they are not synoptic, as is evidenced by the plots of the various crossings of the Bering Strait also shown below. Note that the second running of the Bering Strait line shows colder and saltier waters than the first running, possibly because the consistently strong northward winds confine the Alaskan Coastal Waters closer into the coast. **Action Item: Examine surface salinities and temperatures, especially in conjunction with prior data.**

BERING STRAIT 2016 METEOROLOGICAL DATA

Left Port at 2208 7th July 2016 (JD189), Returned to port 2200 15th July 2016 (JD 197)

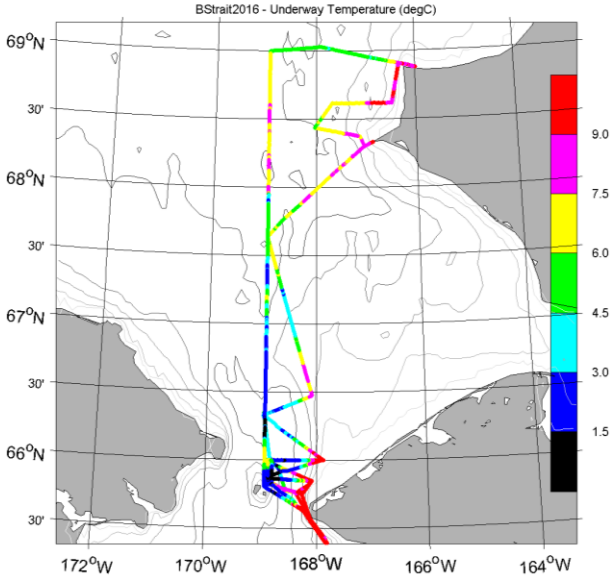


BERING STRAIT 2016 UNDERWAY TEMPERATURE SALINITY DATA

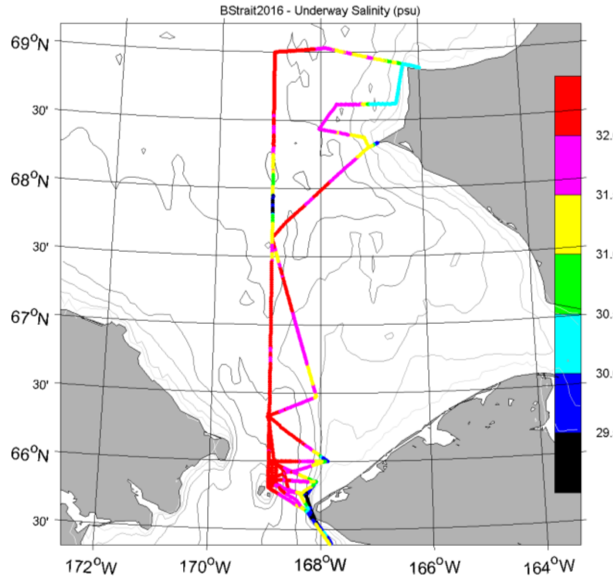


BERING STRAIT 2016 UNDERWAY TEMPERATURE SALINITY DATA (continued)

Temperature (degC)

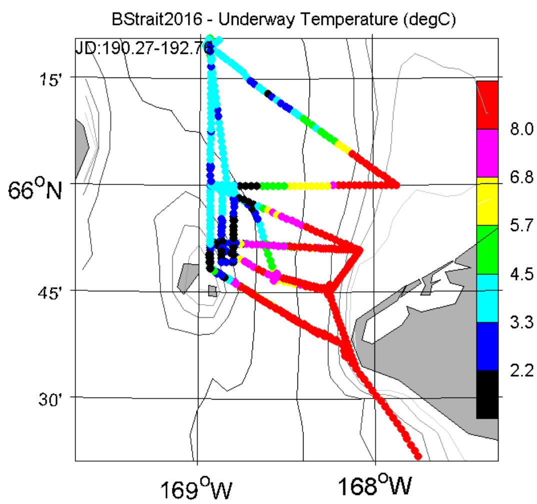


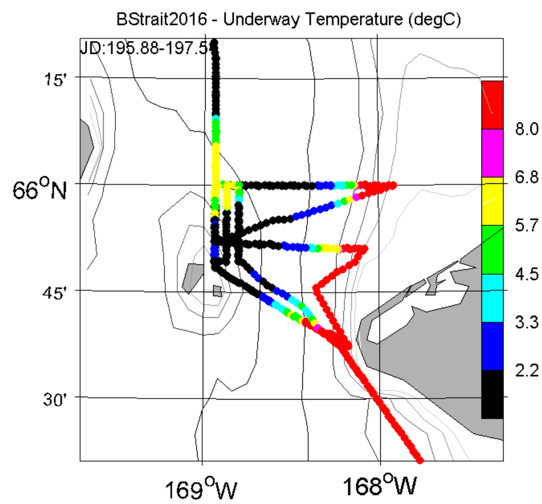
Salinity (psu)



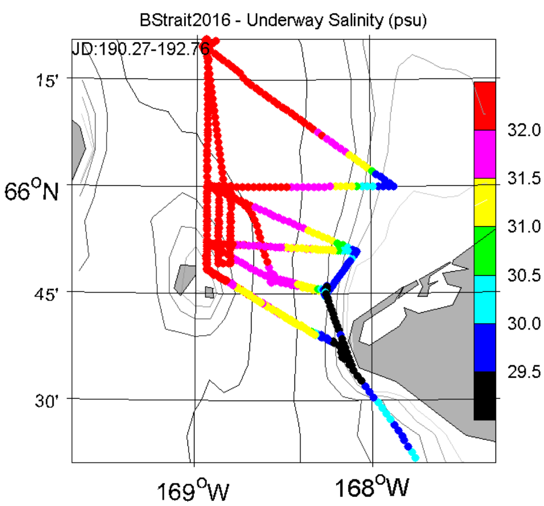
First half of Cruise **Second half of cruise**

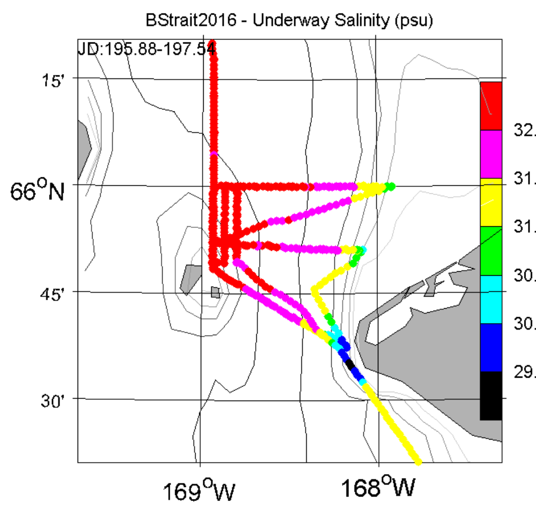
Underway Temperature (DegC)





Underway Salinity (psu)





QUINTILLION CABLE PROJECT
Just prior to leaving for the cruise, and on arrival in Nome, we became aware of a project by Quintillion and others to lay a fiber-optic cable through the Bering Strait and Chukchi Sea region. The notes below are gleaned from websites (listed below) and conversations with Gregory Green and Frank Cuccio pre cruise, and should be taken as provisional only.

Our concern was that a) the presence of the cable would be problematic for dragging operations around mooring positions in the future and b) that our future casts would need to have accurate knowledge of the cable position to ensure non-interference.

Maps below show details of the route compared to moorings and CTD lines. As regards the moorings, the proposed route lay 2nm from existing mooring A2, but only 500m west of historic mooring position A2E. After a discussion with Frank on Wednesday 6th July 2016, we reached a verbal agreement that the cable would be laid 200m west of its currently proposed position at this location and we would move site A2E 200m east of our current position to allow for a safe buffer for future mooring operations. At the time of writing of this report, this is still to be confirmed in writing from Quintillion.

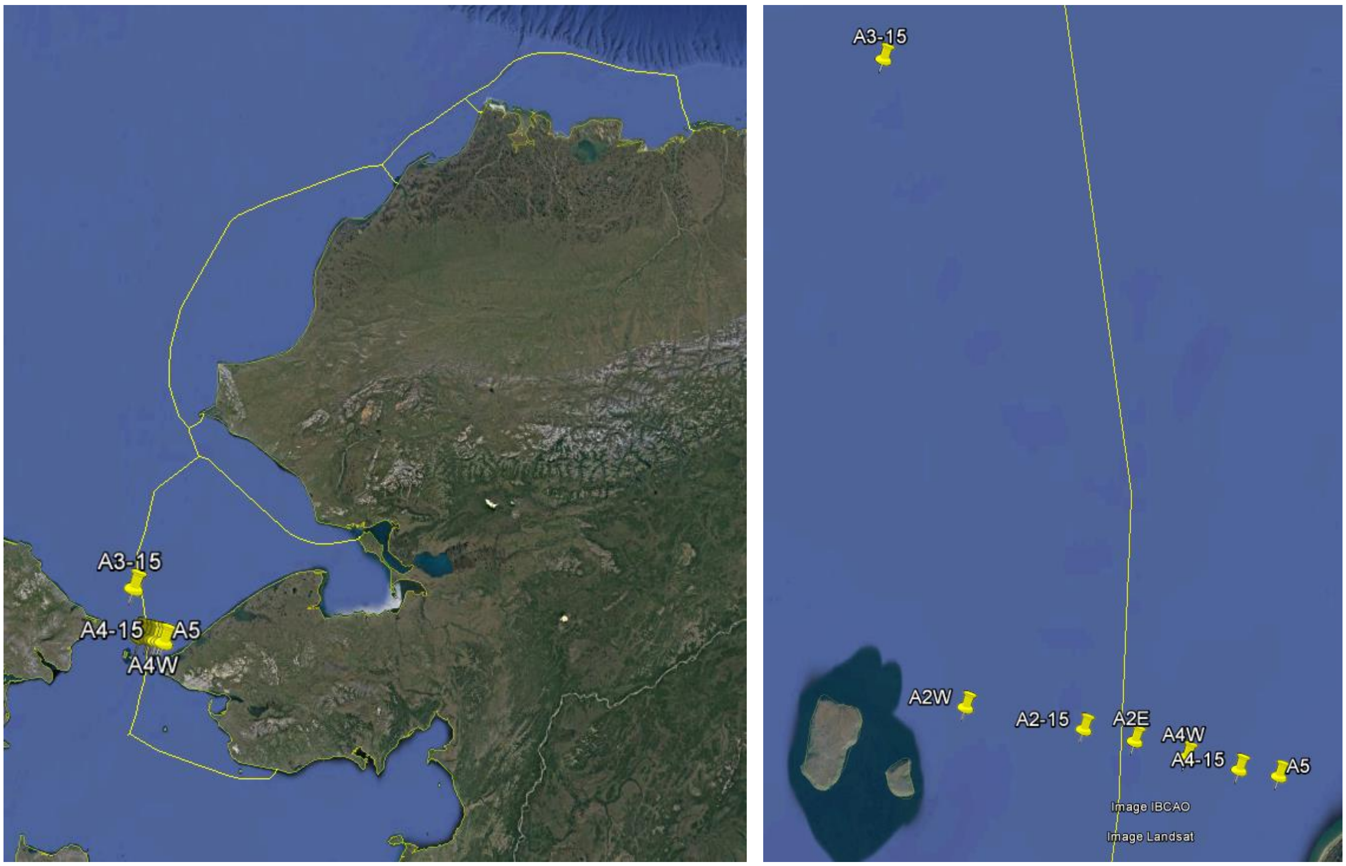
Other information:
Website for project:
http://subseaworldnews.com/2016/06/23/quintillion-to-begin-subsea-cable-laying-in-july/

(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
= Gregory A. Green, Principal Ecologist, marine mammal consultant for the project
Owl Ridge Natural Resource Consultants, Inc., 22116 45th Avenue SE, Bothell, WA 98021
Phone 206.331.1596, Email: ggreen@owlridgenrc.com Website: www.owlridgenrc.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.)

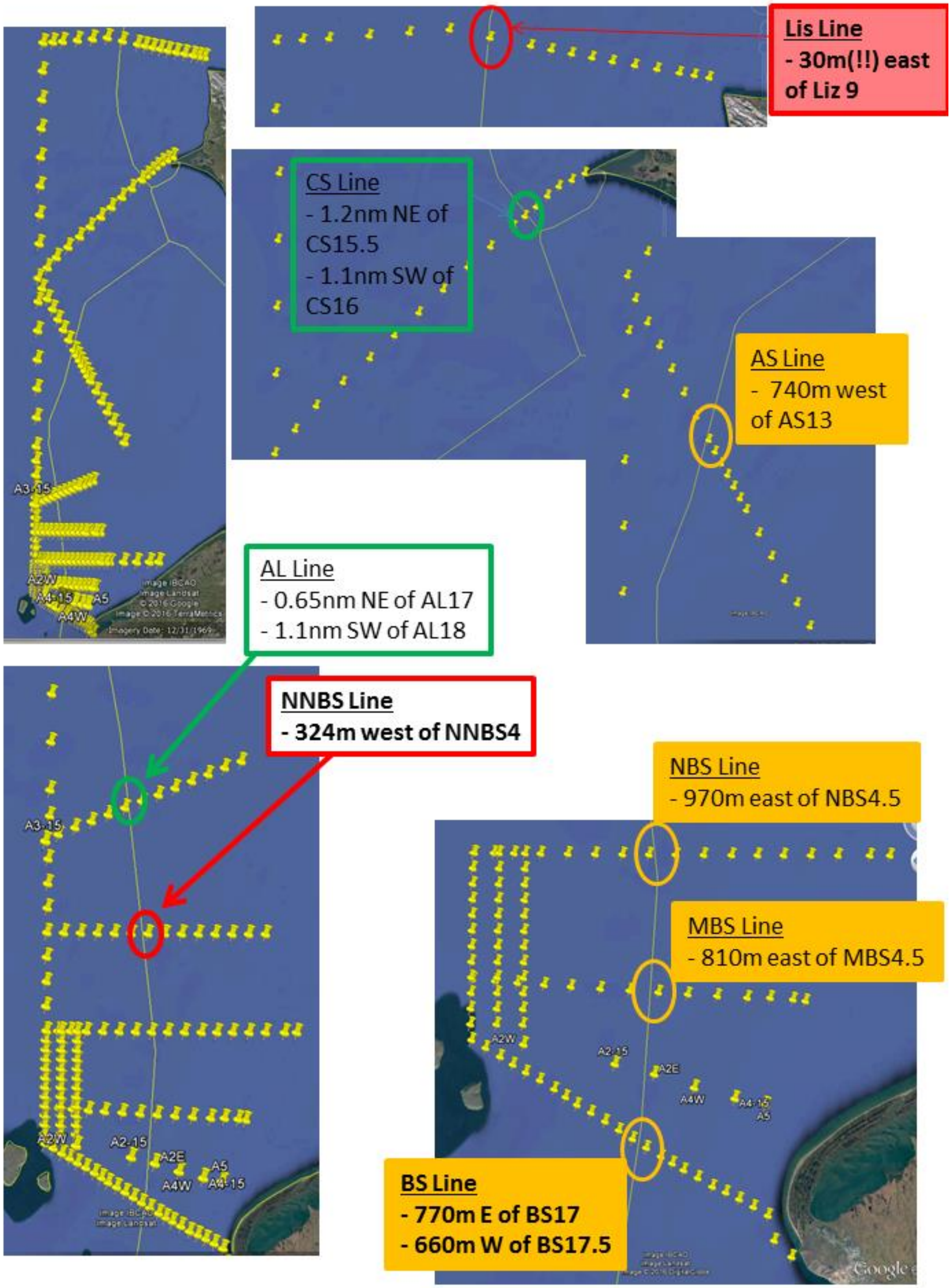


Google Earth images of cable routing as per position information from Catherine Berchok, NOAA. Right shows route relative to Bering Strait mooring positions, being ~9.3nm from A3, ~ 2nm from A2, and ~ 500m from A2E.

The proposed route crosses our standard CTD plan in many places, viz: (potential conflicts marked red**, see map below).

****LIS line**	**30m east of LIS9**
CS line	between CS15.5 and CS16 (about 1.1nm from each)
AS line	740m west of AS13
AL line	between AL17 and AL18 (0.65nm from AL17)
****NNBS**	**324m west of NNBS4**
NBS	970m east of NBS4.5
MBS	810m east of MSB4.5
****BS**	**between BS17 and BS17.5 (about 660m from each)**

Action Item: Get exact position of the line for 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

BERING STRAIT 2016 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 as part of the Bering Strait mooring cruises. Stations taken on this 2016 cruise are included in the full event log later in this cruise report.

```
%========================================================
% Stations for BStrait Mooring Cruise 2016 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.
%========================================================
%
%========================================================
% *****   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 2015
%-----------------------------------------
%NAME       Lat(N)        Long (W)      Water   Top
%          deg min        deg min       depth   Float
% A3-15    66  19.60     168  57.04     58m     15m
% A2-15    65  46.86     168  34.08     56m     15m
% A4-15    65  44.76     168  15.77     49m     15m
%--------------------------------
% DEPLOYMENTS for this 2016 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 12 historic CTD lines here.
% These are the same positions as suggested in 2015, with the addition of line NNBS.
% 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 2016 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 NorsemanII.
% (this station was too shallow for the Khromov, but
```

```
% was ok for the NorsemanII in 2013).
%------------------------------------------------------------
% - 16 or 17 stations
% - station spacing ~ 5nm in the central Chukchi,
%                   ~ 2.2nm near the coast
% Distances: - CS10US to CS18 60.8nm
%            - CS18 to CS19    2.2nm
%--
% Time from NorsemanII (toCS19) ~ 10.5 hrs
% Time from Khromov (toCS18) ~12hrs
%------------------------------------------------------------
%     Lat (N)     Long (W)       Name
%     deg min     deg   min
0 0   67   38.1   168   56.0     % CS10US + net
0 0   67   41.7   168   48.1     % CS10.5  - no bottles
0 0   67   45.3   168   39.9     % CS11
0 0   67   48.9   168   29.4     % CS11.5  - no bottles
0 0   67   52.5   168   18.8     % CS12 + net
0 0   67   55.9   168    9.1     % CS12.5  - no bottles
0 0   67   59.3   167   59.4     % CS13
0 0   68    2.7   167   49.7     % CS13.5  - no bottles
0 0   68    6.1   167   39.9     % CS14 + net
0 0   68    9.1   167   30.7     % CS14.5  - no bottles
0 0   68   12.1   167   21.4     % CS15
0 0   68   13.6   167   16.8     % CS15.5  - no bottles
0 0   68   15.0   167   12.2     % CS16
0 0   68   16.6   167    7.6     % CS16.5  - no bottles
0 0   68   18.0   167    2.9     % CS17 + net
0 0   68   18.9   166   57.6     % CS18
0 0   68   19.9   166   52.3     % CS19 *** SHALLOW **
%               CS19 too shallow for Khromov.
%
%
%================================================
% DL = Diomede Line (US only, 1nm east of border)
%================================================
% This line is to map eddying area north of the Diomedes
% - 19 stations
% - station spacing ~ 1nm in South,
%                   ~ 2.5nm in north
% Distance: - DL1 to DL19  28.7nm
%--
% Time from NorsemanII - 5.5 hrs running N; 9hrs running S
% Time from Khromov to DL19 ~10hrs
%--------------------------------------------------
%     Lat (N)      Long (W)     Name
%     deg min      deg   min
0 0  65   49.28    168   56.2  % DL1
0 0  65   50.26    168   56.2  % DL2
0 0  65   51.23    168   56.2  % DL3
0 0  65   52.21    168   56.2  % DL4 + net
0 0  65   53.18    168   56.2  % DL5 - no bottles
0 0  65   54.15    168   56.2  % DL6
0 0  65   55.13    168   56.2  % DL7 - no bottles
0 0  65   56.10    168   56.2  % DL8
0 0  65   57.08    168   56.2  % DL9 - no bottles
0 0  65   58.05    168   56.2  % DL10
0 0  65   59.03    168   56.2  % DL11- no bottles
0 0  66    0.00    168   56.2  % DL12
```

```
0 0  66    2.55    168   56.2  % DL13- no bottles
0 0  66    5.10    168   56.2  % DL14
0 0  66    7.65    168   56.2  % DL15- no bottles
0 0  66   10.19    168   56.2  % DL16
0 0  66   12.74    168   56.2  % DL17- no bottles
0 0  66   15.29    168   56.2  % DL18
0 0  66   17.84    168   56.2  % DL19- no bottles
%
%
%=========================================
% DL A and B lines (Diomede A and B lines)
%=========================================
% These lines, with DL, form a grid to map
% eddying N of the Diomedes.
% - each line 12 stations
% - station spacing ~ 1nm
% Distances: - each line ~ 11nm
%--
% Estimate for NorsmanII for each line ~3.5hrs
% Time from Khromov for each line ~5hrs
%-----------------------------------------
%     Lat (N)       Long (W)     Name
%     deg min       deg   min
% Northbound leg
0 0   65   49.30    168   52.2  % DLa 1
0 0   65   50.27    168   52.2  % DLa 2
0 0   65   51.25    168   52.2  % DLa 3
0 0   65   52.22    168   52.2  % DLa 4
0 0   65   53.19    168   52.2  % DLa 5
0 0   65   54.16    168   52.2  % DLa 6
0 0   65   55.14    168   52.2  % DLa 7
0 0   65   56.11    168   52.2  % DLa 8
0 0   65   57.08    168   52.2  % DLa 9
0 0   65   58.05    168   52.2  % DLa 10
0 0   65   59.03    168   52.2  % DLa 11
0 0   66    0.00    168   52.2  % DLa 12
% Southbound leg
0 0   66    0.00    168   48.2  % DLb 12
0 0   65   59.03    168   48.2  % DLb 11
0 0   65   58.05    168   48.2  % DLb 10
0 0   65   57.08    168   48.2  % DLb 9
0 0   65   56.11    168   48.2  % DLb 8
0 0   65   55.14    168   48.2  % DLb 7
0 0   65   54.16    168   48.2  % DLb 6
0 0   65   53.19    168   48.2  % DLb 5
0 0   65   52.22    168   48.2  % DLb 4
0 0   65   51.25    168   48.2  % DLb 3
0 0   65   50.27    168   48.2  % DLb 2
0 0   65   49.30    168   48.2  % DLb 1
%
%
%==========================================
% AS = from AL to CS Line
%==========================================
% Across-topography line linking Al line with CS
% - 20 stations (counting first of CS line)
% - station spacing
%       AS1-7 at ~ 4nm spacing.
%       AS7-14 at 2nm spacing,
```

```
%       A14 to end 4nm
% Distances: - AS1 to CS10 64.7nm
%--
% Time from Khromov (12casts, odds+2&18) ~11hrs
% Estimate for NorsmanII 20 casts ~ 12hrs
% Estimate for Khromov 20 casts ~ 14hrs
%-------------------------------------------
%    Lat (N)       Long (W)      Name
%    deg min        deg   min
0 0   66   41.47     167   38.86   % AS 1
0 0   66   45.01     167   43.78   % AS 2-no bottles
0 0   66   48.55     167   48.70   % AS 3
0 0   66   52.09     167   53.62   % AS 4-no bottles
0 0   66   55.63     167   58.55   % AS 5
0 0   66   59.17     168    3.47   % AS 6-no bottles
0 0   67    2.71     168    8.39   % AS 7
%                    (2nm spacing over slope)
0 0   67    4.48     168   10.85   % AS 8-no bottles
0 0   67    6.25     168   13.31   % AS 9
0 0   67    8.02     168   15.77   % AS 10-no bottles
0 0   67    9.78     168   18.23   % AS 11
0 0   67   11.55     168   20.69   % AS 12-no bottles
0 0   67   13.32     168   23.15   % AS 13
0 0   67   16.86     168   28.07   % AS 14
%                    (back to 4nm spacing)
0 0   67   20.40     168   32.99   % AS 15-no bottles
0 0   67   23.94     168   37.92   % AS 16
0 0   67   27.48     168   42.84   % AS 17-no bottles
0 0   67   31.02     168   47.76   % AS 18
0 0   67   34.56     168   52.68   % AS 19-no bottles
0 0   67   38.10     168   56.00   % CS10US
%
%
%==============================
% LIS = Cape Lisburne Line
%==============================
% - 17 stations (including first of CCL line)
% - station spacing ~ 2nm near coast,
%             ~ 3nm and ~ 5nm away from coast
% Distances: - LIS1 to CCL22 57.2nm
%--
% Time from NorsemanII, ~ 10hrs
% Time from Khromov ~11hrs
%------------------------------
%    Lat (N)       Long (W)     Name
%    deg min        deg   min
0 0   68   54.40    166   19.80  % LIS 1 + net
0 0   68   54.80    166   25.15  % LIS 2
0 0   68   55.20    166   30.51  % LIS 3
0 0   68   55.80    166   38.54  % LIS 4
0 0   68   56.40    166   46.57  % LIS 5
0 0   68   57.00    166   54.60  % LIS 6 + net
0 0   68   57.60    167    1.95  % LIS 6.5 - no bottles
0 0   68   58.20    167    9.30  % LIS 7
0 0   68   58.80    167   16.65  % LIS 7.5 - no bottles
0 0   68   59.40    167   24.00  % LIS 8
0 0   69    0.60    167   38.70  % LIS 9
0 0   69    1.80    167   53.40  % LIS 10 + net
0 0   69    1.35    168    7.95  % LIS 11
```

```
0 0   69    0.90    168   22.50  % LIS 12
0 0   69    0.45    168   37.05  % LIS 13
0 0   69    0.23    168   46.62  % LIS 14n + net
0 0   69    0.00    168   56.00  % CCL22n % was 56.2
%
%
%==============================
% CCL = Chukchi Convention Line
%==============================
% Hazards on this line:
% == First station on this line is the same as last station
% included in the LIS line above.  It does not need to be
% repeated.
% == Last station on this line is at mooring A3-14, so exact
% position needs to be altered to be a safe distance (300m?)
% from mooring A3-14 site.
% == There are 2 JAMSTEC moorings ~ 3nm east of station
% CCL16 on this line.  Those positions are:
% SCH13  68 2.002N   168 50.028W
% SCH13w 68 3.006N   168 50.003W
%---------------------------------------
% Line running from northern most point
% due south, ~ 1nm US side of conventionline
% - 20 stations (counting arriving at A3-14)
% - station spacing ~ 10nm until CCL8,
%      then reducing to ~5nm and ~2.5nm
% Distances: - CCL22 to A3-13 ~ 161nm
%--
% Time from NorsemanII, 21.5hrs
% Time from Khromov ~26hrs
%----------------------------------------
%      Lat (N)       Long (W)     Name
%      deg   min      deg   min
0 0    69     0.0     168  56.0   % CCL22
0 0    68    50.0     168  56.0   % CCL21
0 0    68    40.0     168  56.0   % CCL20
0 0    68    30.0     168  56.0   % CCL19
0 0    68    20.0     168  56.0   % CCL18 + Net
0 0    68    10.0     168  56.0   % CCL17
0 0    68    00.0     168  56.0   % CCL16
0 0    67    50.0     168  56.0   % CCL15
0 0    67    38.1     168  56.0   % CCL14 (same as CS10US) + Net + Prod
%
0 0    67    30.0     168  56.0   % CCL13
0 0    67    20.0     168  56.0   % CCL12
0 0    67    10.0     168  56.0   % CCL11
0 0    67    00.0     168  56.0   % CCL10 + Net
0 0    66    50.0     168  56.0   % CCL9
0 0    66    40.0     168  56.0   % CCL8
%         - spacing now 5nm
0 0    66    35.0     168  56.0   % CCL7
0 0    66    30.0     168  56.0   % CCL6
0 0    66    25.0     168  56.0   % CCL5
%         - spacing now 2.5nm
0 0    66    22.3     168  56.0   % CCL4
0 0    66    19.61    168  57.05  % A3-13
% *** 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 (new)
%=====================================
```

```
% 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
%
%
%=========================================================
% NEW  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
%==============================================
```

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% Bering Strait 2016 NORSEMAN2 log CTD

%Date	**Time**	**1**	**Cast NO**	**Down**	**Depth (m)**	**Lat (deg)**	**Lat (min)**	**Lon (deg)**	**Lon(min)**	**Altimeter**	**%**	**StationID**	**Windspeed**	**Winddir**	**Operator**	**Fog**	**WaterClar**	**Comments**

%Please fill in all data for every event (CTD/net tow) %
%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

%%%%%%%%%% STARTING HERE FOR 2015

%Date	**Time**	**1**	**Cast NO**	**Down**	**Depth (m)**	**Lat (deg)**	**Lat (min)**	**Lon (deg)**	**Lon(min)**		**%**	**StationID**	**Windspeed**	**Winddir**	**Operator**			**Comments**
20160708	137	1	**1**	1	18.8	64	38.199	166	36.66		%	watertest	15.8	201	atn			test
20160708	137	1	**1**	2	18.5	64	38.286	166	36.57		%	watertest	15.6	203	atn			time added afterwards
20160708	1618	1	**2**	1	44.8	65	45.165	168	15.48		%	A4-15 recovery	17.3	195	atn			gps was unhooked from computer, restarted seasave after rehooking.
20160708	1622	1	**2**	2	44.9	65	45.368	168	15.329		%	A4-15 recovery	14.9	190	atn			
20160708	1802	1	**3**	1	52.7	65	46.93	168	34.109		%	A2-15 recovery	13.6	185	MS			
20160708	1807	1	**3**	2	53	65	47.015	168	33.989		%	A2-15 recovery	12.4	192	MS			
20160708	2209	1	**4**	1	54.6	66	19.848	168	57.276		%	A3-15 recovery	14.5	189	BI			
20160708	2214	1	**4**	2	54.6	66	19.947	168	57.28		%	A3-15 recovery	12.9	172	BI			
20160709	356	1	**5**	1	54.5	66	19.72	168	57.084		%	A3-16 deploy	15.4	171	ms			
20160709	402	1	**5**	2	54.5	66	19.86	168	57.26		%	A3-16 deploy	14.1	186	ms			
20160709	1743	1	**6**	1	53.4	65	47.207	168	33.868		%	A2-16 deploy	15.8	165	BI			altimeter plug checked prior to cast - okay
20160709	1747	1	**6**	2	53.3	65	47.278	168	33.889		%	A2-16 deploy	15.1	173	BI			GPS cable fixed
20160709	1957	1	**7**	1	45.5	65	44.964	168	15.851		%	A4-16 deploy	16.1	170	ms			
20160709	2002	1	**7**	2	45.4	65	45.236	168	15.73		%	A4-16 deploy	16.4	171	ms			
20160709	2132	1	**8**	1	23.3	65	34.913	168	6.946	1	%	BS24	18.2	154	BI			
20160709	2135	1	**8**	2	23.4	65	34.985	168	7.16	1	%	BS24	17.8	152	BI			
20160709	2144	1	**9**	1	29.7	65	35.95	168	9.864	1	%	BS23	16.4	166	MS			
20160709	2148	1	**9**	2	30.6	65	36.068	168	10.18	1	%	BS23	12.4	165	MS			
20160709	2157	1	**10**	1	29.7	65	37.553	168	10.615	1	%	BS22	15.9	176	BI			
20160709	2200	1	**10**	2	30.2	65	37.69	168	10.794	1	%	BS22	17.9	170	BI			
20160709	2206	1	**11**	1	37	65	38.041	168	12.865	1	%	BS21.5	11	170	BI			
20160709	2210	1	**11**	2	37.1	65	38.256	168	12.914	1	%	BS21.5	14.3	191	BI			
20160709	2217	1	**12**	1	40.5	65	38.556	168	15.006	1	%	BS21	18.2	171	BI			
20160709	2221	1	**12**	2	41	65	38.762	168	15.126	1	%	BS21	15.9	184	BI			
20160709	2227	1	**13**	1	44.5	65	38.915	168	17.098	1	%	BS20.5	13.6	180	BI			
20160709	2232	1	**13**	2	44.7	65	39.194	168	17.251	1	%	BS20.5	15.8	189	BI			
20160709	2238	1	**14**	1	46.8	65	39.162	168	19.116	1	%	BS20	16.4	172	BI			
20160709	2242	1	**14**	2	47.2	65	39.26	168	19.31	1	%	BS20	16.8	176	BI			
20160709	2249	1	**15**	1	49	65	39.707	168	21.351	1	%	BS19.5	16.9	177	BI			
20160709	2253	1	**15**	2	49	65	39.827	168	21.49	1	%	BS19.5	16.8	175	BI			Very clear surface water for last ~3 stations
20160709	2300	1	**16**	1	50.2	65	40.28	168	23.503	1	%	BS19	9.8	180	BI			
20160709	2304	1	**16**	2	50.3	65	40.397	168	23.432	1	%	BS19	14.2	206	BI			
20160709	2310	1	**17**	1	50.9	65	40.694	168	25.244	1	%	BS18.5	14.5	185	BI			
20160709	2314	1	**17**	2	51.2	65	40.818	168	25.298	1	%	BS18.5	14.7	182	BI			
20160709	2320	1	**18**	1	52	65	41.111	168	27.04	1	%	BS18	14.9	187	BI			
20160709	2324	1	**18**	2	52	65	41.246	168	27.133	1	%	BS18	15.1	181	BI			
20160709	2331	1	**19**	1	52.1	65	41.612	168	29.219	1	%	BS17.5	13.8	187	BI			
20160709	2335	1	**19**	2	52	65	41.735	168	29.228	1	%	BS17.5	14.1	184	BI			
20160709	2343	1	**20**	1	52.9	65	42.159	168	31.334	1	%	BS17	11.8	190	BI			
20160709	2347	1	**20**	2	53.4	65	42.281	168	31.244	1	%	BS17	13.7	208	BI			
20160709	2356	1	**21**	1	50.6	65	42.679	168	33.455	1	%	BS16.5	15.5	187	BI			
20160709	2359	1	**21**	2	50.6	65	42.779	168	33.509	1	%	BS16.5	15.3	181	BI			
20160710	7	1	**22**	1	50	65	43.185	168	35.598	1	%	BS16	13.6	182	ms			
20160710	11	1	**22**	2	50.1	65	43.278	168	35.679	1	%	BS16	17.3	184	ms			
20160710	19	1	**23**	1	50.2	65	43.695	168	37.602	1	%	BS15.5	14.1	184	ms			

20160710	23	1	**23**	2	50.3	65	43.772	168	37.613	1 %	BS15.5	12.9	195 ms			
20160710	31	1	**24**	1	50	65	44.252	168	39.922	1 %	BS15	16.1	192 ms			
20160710	36	1	**24**	2	50	65	44.319	168	39.865	1 %	BS15	16.8	201 ms			
20160710	43	1	**25**	1	50.4	65	44.766	168	41.642	1 %	BS14.5	13.4	203 ms			
20160710	47	1	**25**	2	50.3	65	44.869	168	41.514	1 %	BS14.5	15.2	226 ms			
20160710	55	1	**26**	1	51	65	45.212	168	43.339	1 %	BS14	16.8	200 ms			
20160710	59	1	**26**	2	51.1	65	45.311	168	43.378	0.5 %	BS14	16.8	198 ms			
20160710	107	1	**27**	1	51.4	65	45.734	168	45.564	1 %	BS13.5	15.9	206 ms			
20160710	110	1	**27**	2	51.4	65	45.875	168	45.585	0 %	BS13.5	18.1	199 ms			
20160710	120	1	**28**	1	51.1	65	46.315	168	47.722	0 %	BS13	15.1	202 ms			
20160710	124	1	**28**	2	50.7	65	46.452	168	47.719	0 %	BS13	17.9	197 ms			
20160710	132	1	**29**	1	48.1	65	46.799	168	49.762	0 %	BS12.5	11.2	198 ms			%Altimeter cable, unplugged and replugged pre cast
20160710	136	1	**29**	2	48.2	65	46.894	168	49.632	0 %	BS12.5	14.7	227 ms			Altimeter didn't get any fix
20160710	144	1	**30**	1	43.1	65	47.179	168	51.804	0 %	BS12	10.3	218 ms			
20160710	148	1	**30**	2	43.1	65	47.246	168	51.786	0 %	BS12	6.6	240 ms			
20160710	157	1	**31**	1	45.6	65	47.676	168	53.832	0 %	BS11.5	14.8	228 ms			%Plugged replugged bottom altimeter cable pre cast
20160710	201	1	**31**	2	45.9	65	47.658	168	53.686	0 %	BS11.5	11.3	247 ms			Altimeter still not getting fixes
20160710	211	1	**32**	1	45.4	65	48.278	168	55.997	0 %	BS11	14.3	194 ms			
20160710	215	1	**32**	2	45.3	65	48.386	168	56.064	0 %	BS11	13.2	180 ms			
20160710	223	1	**33**	1	46	65	49.288	168	56.284	0 %	DL1	9.8	198 ms			
20160710	227	1	**33**	2	46.1	65	49.297	168	56.248	0 %	DL1	7.2	176 ms			
20160710	234	1	**34**	1	46.3	65	50.219	168	56.32	0 %	DL2	15.4	170 rw			
20160710	240	1	**34**	1	46.4	65	50.216	168	56.406	0 %	DL2	13.1	165 rw			
20160710	249	1	**35**	1	46.9	65	51.323	168	55.99	0 %	DL3	18.5	183 ms			
20160710	253	1	**35**	2	46.7	65	51.342	168	55.995	0 %	DL3	18.5	171 ms			
20160710	300	1	**36**	1	44.5	65	52.206	168	56.251	0 %	DL4	13.5	179 ms			
20160710	304	1	**36**	2	44.5	65	52.219	168	56.224	0 %	DL4	14.2	171 ms			
20160710	312	1	**37**	1	46.7	65	53.147	168	56.174	0 %	DL5	9.5	193 ms			
20160710	316	1	**37**	2	46.8	65	53.168	168	56.187	0 %	DL5	9.9	178 ms			
20160710	324	1	**38**	1	47.5	65	54.141	168	56.395	0 %	DL6	14.5	228 ms			
20160710	328	1	**38**	2	47.7	65	54.176	168	56.294	0 %	DL6	13	229 ms			
20160710	337	1	**39**	1	47.9	65	55.144	168	56.183	0 %	DL7	13.4	208 ms			
20160710	341	1	**39**	2	47.7	65	55.193	168	56.14	0 %	DL7	11.7	206 ms			
20160710	349	1	**40**	1	48.6	65	56.095	168	56.22	0 %	DL8	11.4	191 ms			
20160710	353	1	**40**	2	48.6	65	56.141	168	56.181	0 %	DL8	13	190 ms			
20160710	402	1	**41**	1	49.7	65	57.096	168	56.215	0 %	DL9	11.7	201 ms			
20160710	406	1	**41**	2	49.6	65	57.141	168	56.173	0 %	DL9	12.7	200 ms			
20160710	414	1	**42**	1	50.7	65	58.046	168	56.207	0 %	DL10	13.9	205 ms			
20160710	418	1	**42**	2	50.7	65	58.093	168	56.13	0 %	DL10	14.7	209 ms			
20160710	425	1	**43**	1	50.9	65	59.016	168	56.185	0 %	DL11	15	208 ms	1		Start fog reporting (clear=0; fog=1)
20160710	429	1	**43**	1	51	65	59.064	168	56.126	0 %	DL11	14.1	208 ms	1		
20160710	437	1	**44**	1	51.2	65	59.995	168	56.232	0 %	DL12	13.7	209 ms	1	0	Start water clarity reporting (clear=0, murky=1)
20160710	442	1	**44**	2	51.3	66	0.04	168	56.19	0 %	DL12	13.2	209 ms	1	0	
20160710	455	1	**45**	1	51.7	66	0.03	168	52.198	0 %	DLa12	10.2	215 ms	1	0	erroneously named DL13 in hdr
20160710	459	1	**45**	2	51.8	66	0.04	168	52.083	0 %	DLa12	12.6	201 ms	1	0	
20160710	509	1	**46**	1	51.2	65	59.078	168	52.091	0 %	DLa11	13.6	211 ms	0	0	erroneously named DL14 in hdr
20160710	513	1	**46**	2	51.4	65	59.126	168	52.016	0 %	DLa11	11.2	197 ms	0	0	
20160710	523	1	**47**	1	50.9	65	58.08	168	52.106	0 %	DLa10	10.5	197 ms	0	0	erroneously named DL15 in hdr
20160710	528	1	**47**	2	51	65	58.139	168	52.066	0 %	DLa10	9.6	207 ms	0	0	
20160710	537	1	**48**	1	50.6	65	57.089	168	52.149	0 %	DLa9	4	157 ms	0	0	erroneously named DL16 in hdr
20160710	541	1	**48**	2	50.5	65	57.117	168	52.123	0 %	DLa9	6.9	220 ms	0	0	
20160710	551	1	**49**	1	50.5	65	56.088	168	52.21	0 %	DLa8	12.3	221 ms	0	0	erroneously named DL17 in hdr
20160710	555	1	**49**	2	50.6	65	56.132	168	52.186	0 %	DLa8	12.6	240 ms	0	0	
20160710	604	1	**50**	1	49.7	65	55.117	168	52.208	0 %	DLa7	13.7	216 ms	0	0	erroneously named DL18 in hdr
20160710	608	1	**50**	2	49.8	65	55.155	168	52.183	0 %	DLa7	12.9	240 ms	0	0	
20160710	617	1	**51**	1	48.7	65	54.122	168	52.224	0 %	DLa6	10.4	199 ms	0	0	
20160710	621	1	**51**	2	48.7	65	54.159	168	52.229	0 %	DLa6	8.9	226 ms	0	0	
20160710	630	1	**52**	1	48.5	65	53.174	168	52.213	0 %	DLa5	9.4	212 ms	0	0	erroneously named DLa6 in hdr
20160710	635	1	**52**	2	48.5	65	53.176	168	52.234	0 %	DLa5	8.9	269 ms	0	0	
20160710	643	1	**53**	1	48.1	65	52.187	168	52.175	0 %	DLa4	11.8	239 ms	0	0	
20160710	647	1	**53**	2	48.4	65	52.196	168	52.183	0 %	DLa4	10.6	262 ms	0	0	
20160710	657	1	**54**	1	47.8	65	51.225	168	52.185	0 %	DLa3	10.8	257 ms	0	0	
20160710	701	1	**54**	2	48	65	51.266	168	52.143	0 %	DLa3	9.8	279 ms	0	0	
20160710	712	1	**55**	1	46.1	65	50.258	168	52.234	0 %	DLa2	16.8	273 atn	0	0	
20160710	717	1	**55**	2	45.8	65	50.293	168	52.143	0 %	DLa2	16.2	273 atn	0	0	
20160710	726	1	**56**	1	43.8	65	49.268	168	52.264	0 %	DLa1	13.4	277 atn	0	0	

20160710	730	1	**56**	2	43.8	65	49.272	168	52.233	0 %	DLa1	14.6	277	atn	0	0	
20160710	744	1	**57**	1	49.5	65	49.227	168	48.25	0 %	DLb1	15.5	304	atn	0	0	
20160710	748	1	**57**	2	49.5	65	49.264	168	48.159	0 %	DLb1	15.2	308	atn	0	0	
20160710	757	1	**58**	1	49.6	65	50.261	168	48.226	0 %	DLb2	11.8	323	atn	0	0	
20160710	801	1	**58**	2	49.6	65	50.286	168	48.23	0 %	DLb2	13.3	322	atn	0	0	
20160710	811	1	**59**	1	49.7	65	51.241	168	48.237	0 %	DLb3	16.7	339	atn	0	0	
20160710	815	1	**59**	2	49.7	65	51.266	168	48.18	0 %	DLb3	15.2	336	atn	0	0	
20160710	823	1	**60**	1	50.7	65	52.243	168	48.228	0 %	DLb4	15	4	atn	0	0	
20160710	827	1	**60**	2	51.6	65	52.237	168	48.197	0 %	DLb4	17.1	352	atn	0	0	
20160710	836	1	**61**	1	51.2	65	53.18	168	48.253	0 %	DLb5	19.5	1	atn	0	0	
20160710	840	1	**61**	2	51.4	65	53.156	168	48.213	0 %	DLb5	17.6	352	atn	0	0	
20160710	850	1	**62**	1	51.5	65	54.126	168	48.187	0 %	DLb6	16.5	346	atn	0	0	
20160710	854	1	**62**	2	51.5	65	54.128	168	48.153	0 %	DLb6	15.4	337	atn	0	0	
20160710	903	1	**63**	1	52.1	65	55.145	168	48.05	0 %	DLb7	15.8	354	atn	0	0	
20160710	907	1	**63**	2	52.1	65	55.142	168	48.044	0 %	DLb7	14.7	346	atn	0	0	
20160710	915	1	**64**	1	52	65	56.12	168	48.125	0 %	DLb8	13.9	354	atn	0	0	
20160710	920	1	**64**	2	51.9	65	56.1	168	48.124	0 %	DLb8	13	344	atn	0	0	
20160710	928	1	**65**	1	51.8	65	57.078	168	47.952	0 %	DLb9	14.3	348	atn	0	0	
20160710	932	1	**65**	2	51.8	65	57.062	168	47.937	0 %	DLb9	12.9	334	atn	0	0	
20160710	940	1	**66**	1	51.9	65	58.012	168	48.091	0 %	DLb10	15	345	atn	0	0	
20160710	944	1	**66**	2	52	65	58.008	168	48.032	0 %	DLb10	14.1	334	atn	0	0	
20160710	953	1	**67**	1	52.7	65	59.065	168	48.129	0 %	DLb11	14.8	339	atn	0	0	
20160710	957	1	**67**	2	52.8	65	59.057	168	48.056	0 %	DLb11	14.6	327	atn	0	0	
20160710	1005	1	**68**	1	52	66	0.016	168	48.161	0 %	DLb12	16.7	343	atn	0	0	
20160710	1009	1	**68**	2	52	66	0.025	168	48.073	0 %	DLb12	14.6	329	atn	0	0	
20160710	1032	1	**69**	1	51.3	66	0.046	168	56.166	0 %	DL12	13.2	327	atn	0	0	
20160710	1036	1	**69**	2	51.8	66	0.015	168	56.121	0 %	DL12	12.2	330	atn	0	0	
20160710	1054	1	**70**	1	52.1	66	2.592	168	56.205	0 %	DL13	11.5	324	atn	0	0	
20160710	1058	1	**70**	2	51.9	66	2.62	168	56.135	0 %	DL13	11.4	321	atn	0	0	
20160710	1116	1	**71**	1	53.8	66	5.04	168	56.457	0 %	DL14	11.4	329	atn	0	1	murky water
20160710	1120	1	**71**	2	53.9	66	5.027	168	56.371	0 %	DL14	11.9	327	atn	0	1	
20160710	1139	1	**72**	1	53.4	66	7.632	168	56.317	0 %	DL15	10	320	atn	0	0	
20160710	1144	1	**72**	2	53.2	66	7.628	168	56.277	0 %	DL15	9.3	324	atn	0	0	
20160710	1202	1	**73**	1	54	66	10.177	168	56.249	0 %	DL16	8.8	318	atn	0	0	
20160710	1206	1	**73**	2	54.2	66	10.171	168	56.105	0 %	DL16	11	316	atn	0	0	
20160710	1225	1	**74**	1	55.9	66	12.718	168	56.24	0 %	DL17	7.2	297	atn	0	0	
20160710	1229	1	**74**	2	56.2	66	12.726	168	56.17	0 %	DL17	8.4	292	atn	0	0	
20160710	1248	1	**75**	1	56.3	66	15.288	168	56.297	0 %	DL18	8.7	296	atn	0	0	
20160710	1252	1	**75**	2	56.4	66	15.296	168	56.202	0 %	DL18	8.7	300	atn	0	0	
20160710	1310	1	**76**	1	55.4	66	17.848	168	56.211	0 %	DL19	13.1	295	atn	0	0	
20160710	1314	1	**76**	2	55.3	66	17.827	168	56.169	0 %	DL19	11.3	294	atn	0	0	
20160710	1330	1	**77**	1	54.9	66	19.638	168	56.799	0 %	A3-16	9	277	atn	0	0	
20160710	1334	1	**77**	2	54.8	66	19.655	168	56.797	0 %	A3-16	9.2	272	atn	0	0	
20160710	1345	1	**78**	1	55.1	66	20.399	168	53.748	0 %	AL13	4.9	266	atn	0	0	
20160710	1349	1	**78**	2	54.9	66	20.395	168	53.658	0 %	AL13	9.2	273	atn	0	0	
20160710	1404	1	**79**	1	53.9	66	21.101	168	49.397	0 %	AL14	9.7	275	atn	0	0	
20160710	1408	1	**79**	2	54.4	66	21.135	168	49.398	0 %	AL14	9.5	278	atn	0	0	
20160710	1421	1	**80**	1	46.9	66	21.741	168	44.986	0 %	AL15	8.9	277	atn	0	0	
20160710	1425	1	**80**	2	45.9	66	21.767	168	45.021	0 %	AL15	8.9	271	atn	0	0	
20160710	1439	1	**81**	1	56.1	66	22.485	168	40.641	0 %	AL16	10.1	260	atn	0	0	drastic drop in fluorescence, lots of jelly fish (big plume)
20160710	1443	1	**81**	2	56.1	66	22.503	168	40.676	0 %	AL16	9.8	257	atn	0	0	
20160710	1457	1	**82**	1	53.9	66	23.207	168	36.422	0 %	AL17	8.7	255	atn	0	0	jelly fish, deep mixed layer
20160710	1501	1	**82**	2	54.2	66	23.261	168	36.4	0 %	AL17	10	265	atn	0	0	
20160710	1514	1	**83**	1	52	66	23.884	168	32.109	0 %	AL18	9.5	265	BI	0	0	
20160710	1519	1	**83**	2	51.9	66	23.918	168	32.119	0 %	AL18	10.9	249	BI	0	0	
20160710	1534	1	**84**	1	52.7	66	24.591	168	27.805	0 %	AL19	11.4	259	BI	0	0	
20160710	1538	1	**84**	2	52.5	66	24.625	168	27.807	0 %	AL19	9.3	258	BI	0	0	
20160710	1552	1	**85**	1	51.4	66	25.279	168	23.432	0 %	AL20	12.2	252	BI	0	0	
20160710	1556	1	**85**	2	51.5	66	25.303	168	23.417	0 %	AL20	10.7	244	BI	0	0	
20160710	1608	1	**86**	1	47.2	66	26.008	168	19.215	0 %	AL21	10.9	247	BI	0	0	visibility: endless
20160710	1612	1	**86**	2	46.7	66	26.021	168	19.198	0 %	AL21	11.3	245	BI	0	0	
20160710	1625	1	**87**	1	39.8	66	26.722	168	14.876	0 %	AL22	11.2	258	BI	0	0	beautiful blue skies and clear water
20160710	1628	1	**87**	2	39.8	66	26.771	168	14.857	0 %	AL22	9.9	257	BI	0	0	
20160710	1642	1	**88**	1	32.2	66	27.392	168	10.524	0 %	AL23	12.3	270	BI	0	0	so clear you can see the ctd soaking at 5 m
20160710	1645	1	**88**	2	32.2	66	27.378	168	10.497	0 %	AL23	12.6	290	BI	0	0	
20160710	1658	1	**89**	1	26	66	28.165	168	6.268	0 %	AL24	13.8	271	rw	0	0	all vv clear

20160710	1701	1	**89**	2	25.9	66	28.198	168	6.207	0 %	AL24	12.6	272 rw	0	0	
20160710	1758	1	**90**	1	24.3	66	28.665	168	4.679	1 %	Glider	12.3	261 rw	0	0.5	cast post glider deployment, altimeter working
20160710	1801	1	**90**	2	24.2	66	28.713	168	4.559	1 %	Glider	9.4	256 rw	0	0.5	water somewhat murky
20160711	130	1	**91**	1	48.7	67	38.111	168	56.002	1 %	CS10US	13.3	159 ms	0	0	Altimeter working
20160711	134	1	**91**	2	48.6	67	38.159	168	55.999	1 %	CS10US	8.7	150 ms	0	0	
20160711	203	1	**92**	1	48.4	67	41.696	168	47.967	0 %	CS10.5	13.1	165 ms	0	0	
20160711	207	1	**92**	2	48.3	67	41.744	168	47.959	0 %	CS10.5	12.3	153 ms	0	0	
20160711	235	1	**93**	1	48.2	67	45.256	168	39.818	0 %	CS11	12.7	171 ms	0	0	
20160711	239	1	**93**	2	48.5	67	45.31	168	39.831	0 %	CS11	13.1	154 ms	0	0	
20160711	312	1	**94**	1	49.2	67	48.931	168	29.446	0 %	CS11.5	14.4	163 ms	0	0	
20160711	316	1	**94**	2	48.9	67	48.968	168	29.301	0 %	CS11.5	14.3	163 ms	0	0	
20160711	349	1	**95**	1	54.7	67	52.494	168	18.928	0 %	CS12	12.3	159 ms	0	0	
20160711	353	1	**95**	2	54.8	67	52.542	168	18.881	0 %	CS12	12	163 ms	0	0	
20160711	425	1	**96**	1	56.9	67	55.9	168	9.103	0 %	CS12.5	13.6	146 ms	0	0	
20160711	429	1	**96**	2	57	67	55.947	168	9.089	0 %	CS12.5	12.7	148 ms	0	0	
20160711	502	1	**97**	1	53	67	59.303	167	59.458	1 %	CS13	14.4	157 ms	0	0	Altimeter worked on downcast
20160711	506	1	**97**	2	53.6	67	59.352	167	59.458	0 %	CS13	14.9	154 ms	0	0	
20160711	538	1	**98**	1	52.1	68	2.658	167	49.697	0 %	CS13.5	14.6	159 ms	0	0	
20160711	542	1	**98**	2	52.5	68	2.723	167	49.81	0 %	CS13.5	13.6	140 ms	0	0	
20160711	615	1	**99**	1	51.1	68	6.063	167	39.887	0 %	CS14	15.7	159 ms	0	0	
20160711	620	1	**99**	2	50.8	68	6.141	167	39.99	0 %	CS14	15.4	149 ms	0	0	
20160711	649	1	**100**	1	47	68	9.067	167	30.613	0 %	CS14.5	16.2	147 ms	0	0	
20160711	653	1	**100**	2	47.2	68	9.103	167	30.647	0 %	CS14.5	16.1	144 ms	0	0	
20160711	723	1	**101**	1	46.1	68	12.08	167	21.377	0 %	CS15	15.7	142 ms	0	0	
20160711	727	1	**101**	2	46.5	68	12.125	167	21.384	0 %	CS15	15.1	148 ms	0	0	
20160711	744	1	**102**	1	44.4	68	13.574	167	16.755	0 %	CS15.5	15.7	140 ms	0	0	
20160711	748	1	**102**	2	44.3	68	13.627	167	16.79	0 %	CS15.5	15.3	150 ms	0	0	
20160711	803	1	**103**	1	43.4	68	14.98	167	12.222	1 %	CS16	16.1	145 atn	0	0	Altimeter worked down and up
20160711	807	1	**103**	2	43.3	68	15.028	167	12.218	1 %	CS16	17.2	152 atn	0	0	
20160711	824	1	**104**	1	40	68	16.587	167	7.589	1 %	CS16.5	17.6	146 atn	0	0	Altimeter worked down and up
20160711	827	1	**104**	2	40	68	16.627	167	7.569	1 %	CS16.5	18.4	148 atn	0	0	
20160711	843	1	**105**	1	36.6	68	17.975	167	2.858	1 %	CS17	17.7	142 atn	0	0	Altimeter worked down and up
20160711	847	1	**105**	2	36.5	68	18.035	167	2.891	1 %	CS17	17.9	150 atn	0	0	
20160711	903	1	**106**	1	32.4	68	18.875	166	57.532	1 %	CS18	18.2	151 atn	0	0	Altimeter worked down and up
20160711	906	1	**106**	2	32.2	68	18.931	166	57.652	1 %	CS18	21.3	156 atn	0	0	
20160711	927	1	**107**	1	25.4	68	19.873	166	52.459	1 %	CS19	21.4	161 atn	0	0	Altimeter worked down and up
20160711	930	1	**107**	2	25.4	68	19.936	166	52.61	1 %	CS19	20.2	160 atn	0	0	
20160711	1025	1	**108**	1	35.4	68	22.39	167	7.918	1 %	NPH1	20.2	163 atn	0	0	Altimeter worked down and up
20160711	1028	1	**108**	2	35.3	68	22.456	167	8.005	1 %	NPH1	19.5	159 atn	0	0	
20160711	1039	1	**109**	1	40	68	22.66	167	11.305	1 %	NPH2	21.4	147 atn	0	0	Altimeter worked down and up
20160711	1043	1	**109**	2	39.8	68	22.77	167	11.345	1 %	NPH2	22.1	162 atn	0	0	
20160711	1053	1	**110**	1	39.5	68	22.792	167	14.684	1 %	NPH3	21.3	152 atn	0	0	Altimeter worked down and up
20160711	1056	1	**110**	2	40.8	68	22.878	167	14.732	1 %	NPH3	21.9	158 atn	0	0	
20160711	1110	1	**111**	1	40.8	68	23.06	167	17.825	1 %	NPH4	21.1	148 atn	0	0	Altimeter worked down and up
20160711	1113	1	**111**	2	39.5	68	23.141	167	17.847	1 %	NPH4	19.5	159 atn	0	0	
20160711	1123	1	**112**	1	41.8	68	23.301	167	21.305	1 %	NPH5	21.1	179 atn	0	0	Altimeter worked down and up
20160711	1126	1	**112**	2	40.2	68	23.383	167	21.341	1 %	NPH5	21.4	166 atn	0	0	
20160711	1144	1	**113**	1	45.1	68	23.693	167	28.129	0 %	NPH6	22.8	176 atn	0	0	Altimeter bad again
20160711	1148	1	**113**	2	45.8	68	23.778	167	28.174	0 %	NPH6	21.1	169 atn	0	0	
20160711	1207	1	**114**	1	48.5	68	24.277	167	34.885	0 %	NPH7	20.6	180 atn	0	0	Bad altimter cast (surface ok)
20160711	1210	1	**114**	2	48.3	68	24.341	167	34.954	0 %	NPH7	21.3	166 atn	0	0	
20160711	1228	1	**115**	1	50.5	68	24.738	167	41.451	0 %	NPH8	21.5	182 atn	0	0	gps issues?ROUGH
20160711	1232	1	**115**	2	50.9	68	24.835	167	41.568	0 %	NPH8	22.5	171 atn	0	0	Altimeter allbad (incl surface)
20160711	1251	1	**116**	1	52.6	68	25.274	167	48.313	0 %	NPH9	20.7	183 atn	0	0	ROUGH - 4-5ft seas, driver wrong in header
20160711	1255	1	**116**	2	51.9	68	25.361	167	48.376	0 %	NPH9	19.9	172 atn	0	0	Altimeter allbad (incl surface)
20160711	1314	1	**117**	1	52.4	68	25.706	167	55.206	0 %	NPH10	21.3	176 rw	0	0	ROUGH - 4-5ft seas
20160711	1318	1	**117**	2	52.5	68	25.811	167	55.26	0 %	NPH10	22.1	179 rw	0	0	Altimeter allbad (incl surface)
20160711	1336	1	**118**	1	51.8	68	26.155	168	1.946	0 %	NPH11	20.6	176 rw	0	0	ROUGH 4-5ft seas
20160711	1340	1	**118**	2	51.5	68	26.264	168	1.965	0 %	NPH11	19.6	181 rw	0	0	Altimeter allbad (incl surface)
20160711	1458	1	**119**	1	50.5	68	36.986	167	40.852	0 %	CD14	17.2	167 rw	0	0	hex logging FORWARD not aft GPS, (xls positions aft unless stated otherwise)
20160711	1502	1	**119**	2	50.3	68	37.053	167	40.867	0 %	CD14	20.2	161 rw	0	0	
20160711	1517	1	**120**	1	49.1	68	36.951	167	35.664	0 %	CD13	18.5	161 bi	0	0	aft GPS
20160711	1521	1	**120**	2	49.3	68	37.033	167	35.628	0 %	CD13	16.6	154 bi	0	0	fore GPS
20160711	1540	1	**121**	1	47.1	68	36.942	167	30.015	0 %	CD12	20.5	163 bi	0	0	
20160711	1544	1	**121**	2	47.3	68	37.026	167	29.971	0 %	CD12	16.9	163 bi	0	0	
20160711	1604	1	**122**	1	44.6	68	36.879	167	24.341	0 %	CD11	22	158 bi	0	0	can't see ctd soaking because too many bubbles from wave action

20160711	1608	1	**122**	2	44.6	68	36.969	167	24.329	0 %	CD11	19.8	161	BI	0	0	forward GPS on upcast
20160711	1630	1	**123**	1	42.9	68	36.906	167	18.813	0 %	CD10	21.2	164	bi	0	0	
20160711	1634	1	**123**	2	42.1	68	36.968	167	18.883	0 %	CD10	20	170	bi	0	0	
20160711	1653	1	**124**	1	39.3	68	36.913	167	13.335	0 %	CD9	22.8	171	bi	0	0	
20160711	1656	1	**124**	2	38.6	68	37.008	167	13.259	0 %	CD9	19.4	163	bi	0	0	
20160711	1719	1	**125**	1	35.9	68	36.922	167	7.787	0 %	CD8	22	169	bi	0	1	poor visibilty
20160711	1723	1	**125**	2	36.1	68	37.005	167	7.802	0 %	CD8	21.2	178	bi	0	1	
20160711	1746	1	**126**	1	34.3	68	36.934	167	2.194	0 %	CD7	24.7	166	bi	0	1	
20160711	1750	1	**126**	2	35	68	37.078	167	2.209	0 %	CD7	23.7	161	BI	0	1	
20160711	1810	1	**127**	1	33.8	68	36.932	166	56.7	0 %	CD6	21.9	168	bi	0	1	overcast skies
20160711	1813	1	**127**	2	33.5	68	37.041	166	56.689	0 %	CD6	20.4	171	bi	0	1	
20160711	1835	1	**128**	1	31.9	68	36.929	166	51.227	0 %	CD5	24.4	170	bi	0	1	overcast skies and windy
20160711	1838	1	**128**	2	32.1	68	37.03	166	51.168	0 %	CD5	23.1	175	bi	0	1	
20160711	1901	1	**129**	1	31.3	68	36.938	166	45.641	0 %	CD4	25.3	165	bi	0	1	foggy water, overcast skies and rain
20160711	1904	1	**129**	2	31.4	68	37.015	166	45.614	0 %	CD4	16.9	163	bi	0	1	very odd bottom feature
20160711	1925	1	**130**	1	30.8	68	36.921	166	40.148	0 %	CD3	28.5	171	bi	0	1	
20160711	1928	1	**130**	2	30.7	68	37.007	166	40.113	0 %	CD3	26.7	178	BI	0	1	
20160711	1950	1	**131**	1	30.3	68	36.912	166	34.541	0 %	CD2	26.5	169	bi	0	1	no vis, cloudy
20160711	1953	1	**131**	2	29.8	68	36.97	166	34.578	0 %	CD2	27	177	bi	0	1	
20160711	2017	1	**132**	1	26.5	68	36.915	166	29.007	1 %	CD1	26.2	175	bi	0	1	
20160711	2020	1	**132**	2	26.4	68	36.971	166	29.065	1 %	CD1	18.6	174	bi	0	1	
20160711	2240	1	**133**	1	25.6	68	54.446	166	19.616	1 %	LIS1	33.5	188	bi	0	1	no vis, windy, clear skies
20160711	2243	1	**133**	2	26.2	68	54.528	166	19.557	1 %	LIS1	34	197	bi	0	1	
20160712	1354	1	**134**	1	25.7	68	54.377	166	19.867	1 %	LIS1	19	200	atn	0	0	hex and xls log back on aft gps
20160712	1357	1	**134**	2	26.3	68	54.448	166	19.813	1 %	LIS1	18.8	211	atn	0	0	
20160712	1410	1	**135**	1	30.3	68	54.744	166	24.98	1 %	LIS2	24.6	200	atn	0	0	v well mixed - good check on Ox - seems Ox1 104%, Ox2 100.5% - believe ox 2 more??
20160712	1413	1	**135**	2	30.5	68	54.825	166	24.901	1 %	LIS2	19.7	194	atn	0	0	goodly swells
20160712	1428	1	**136**	1	33.1	68	55.131	166	30.526	1 %	LIS3	23.2	202	atn	0	0	
20160712	1431	1	**136**	2	32.6	68	55.202	166	30.492	1 %	LIS3	23.8	190	atn	0	0	goodly swells
20160712	1453	1	**137**	1	40	68	55.773	166	38.612	0 %	LIS4	21.2	181	bi	0	0	clear air, clear water, 3-4 feet sea
20160712	1456	1	**137**	2	39.9	68	55.86	166	38.665	0 %	LIS4	25.6	179	bi	0	0	2 layer again
20160712	1517	1	**138**	1	44.1	68	56.366	166	46.622	0 %	LIS5	18.3	186	bi	0	0	3-4 foot seas
20160712	1520	1	**138**	2	45.4	68	56.454	166	46.613	0 %	LIS5	20	177	bi	0	0	
20160712	1542	1	**139**	1	44.6	68	56.962	166	54.621	0 %	LIS6	23	181	bi	0	0	4 ft seas
20160712	1546	1	**139**	2	44.9	68	57.038	166	54.662	0 %	LIS6	21.4	181	bi	0	0	
20160712	1605	1	**140**	1	45.3	68	57.554	167	1.973	0 %	LIS6.5	21.4	187	bi	1	0	3 ft seas, vis minimal
20160712	1609	1	**140**	2	45.2	68	57.637	167	1.96	0 %	LIS6.5	22.2	181	bi	1	0	
20160712	1629	1	**141**	1	45.1	68	58.162	167	9.316	0 %	LIS7	25.6	182	bi	1	0	4 ft seas
20160712	1633	1	**141**	2	44.8	68	58.255	167	9.325	0 %	LIS7	22.3	180	bi	1	0	
20160712	1654	1	**142**	1	45.2	68	58.757	167	16.667	0 %	LIS7.5	23.7	181	bi	1	1	4 ft chop
20160712	1658	1	**142**	2	46.2	68	58.835	167	16.737	0 %	LIS7.5	21.9	174	bi	1	1	
20160712	1721	1	**143**	1	45.8	68	59.39	167	24.022	0 %	LIS8	26.4	173	bi	1	1	4-5 ft seas
20160712	1725	1	**143**	2	46.6	68	59.487	167	24.021	0 %	LIS8	25.2	178	bi	1	1	
20160712	1809	1	**144**	1	47.3	69	0.578	167	39.049	0 %	LIS9	22.2	180	bi	1	1	5-6 ft seas
20160712	1814	1	**144**	2	46.8	69	0.699	167	39.038	0 %	LIS9	21.7	177	bi	1	1	
20160712	1906	1	**145**	1	47.8	69	1.798	167	53.309	0 %	LIS10	24.1	170	bi	1	1	4-5 ft seas
20160712	1910	1	**145**	2	48	69	1.898	167	53.351	0 %	LIS10	24.1	180	bi	1	1	
20160712	2014	1	**146**	1	48.2	69	1.326	168	7.927	0 %	LIS11	23	167	bi	1	1	4-5 ft seas
20160712	2018	1	**146**	2	47.9	69	1.414	168	7.976	0 %	LIS11	21.9	174	bi	1	1	
20160712	2115	1	**147**	1	48.8	69	0.876	168	22.535	0 %	LIS12	21.6	166	bi	1	1	4-5 ft seas, fog lifting
20160712	2119	1	**147**	2	49.4	69	0.943	168	22.559	0 %	LIS12	21.9	170	bi	1	1	
20160712	2214	1	**148**	1	49.9	69	0.413	168	37.031	0 %	LIS13	23.8	166	bi	1	1	5 ft seas
20160712	2218	1	**148**	2	50.2	69	0.481	168	37.078	0 %	LIS13	25.6	176	bi	1	1	
20160712	2255	1	**149**	1	51	69	0.199	168	46.658	0 %	LIS14n	24.8	161	bi	1	1	5-6 ft seas, sun trying to break through
20160712	2259	1	**149**	2	51.1	69	0.279	168	46.713	0 %	LIS14n	27	170	bi	1	1	
20160712	2333	1	**150**	1	51	68	59.973	168	56.044	0 %	CCL22n	5.8	999	ms	1	1	Wind direction not logged
20160712	2337	1	**150**	2	50.9	69	0.063	168	56.132	0 %	CCL22n	5.43	999	ms	1	1	
20160713	135	1	**151**	1	52.9	68	49.929	168	55.952	0 %	CCL21	21.6	181	ms	0.5	0.5	4 ft seas, altimeter seemed to be trying…
20160713	140	1	**151**	2	51.3	68	50.013	168	56.004	0 %	CCL21	23	172	ms	0.5	0.5	
20160713	328	1	**152**	1	50.9	68	39.972	168	55.961	0 %	CCL20	21.9	178	ms	0	0	4-5ft seas, some bubbles in water
20160713	332	1	**152**	2	51.1	68	40.051	168	56.022	0 %	CCL20	24.2	165	ms	0	0	
20160713	514	1	**153**	1	52.9	68	29.963	168	56.097	1 %	CCL19	21.8	176	ms	0	0	4-5ft swell
20160713	518	1	**153**	2	53.1	68	30.062	168	56.146	0 %	CCL19	19.8	180	ms	0	0	
20160713	652	1	**154**	1	54	68	19.928	168	56.051	0 %	CCL18	19.7	174	ms	0	0	4ft swell
20160713	656	1	**154**	2	54.2	68	19.98	168	56.095	0 %	CCL18	19.4	181	ms	0	0	
20160713	825	1	**155**	1	55.5	68	9.953	168	56.094	0 %	CCL17	16.2	172	ms	0	0	4ft swell

20160713	830	1	**155**	2	55.7	68	10.033	168	56.2	0 %	CCL17	18.7	176	ms	0	0
20160713	939	1	**156**	1	55.2	67	59.929	168	56.12	0 %	CCL16	17.3	172	atn	0	0 1-2ft
20160713	943	1	**156**	2	55.5	67	59.98	168	56.095	0 %	CCL16	15.5	176	atn	0	0 (calm sea likely due to seaice which was spotted just 1/2 hr later)
20160713	1058	1	**157**	1	49.1	67	49.955	168	55.657	0 %	CCL15	9.7	183	atn	0	0 3ft
20160713	1102	1	**157**	2	48.7	67	50.022	168	55.622	0 %	CCL15	13.3	197	atn	0	0 very fresh surface! Likely due to seaice (spotted between CCL 15 and 14)
20160713	1222	1	**158**	1	48.6	67	38.039	168	56.046	0 %	CCL14	7.9	185	atn	0	0 3ft
20160713	1226	1	**158**	2	48.1	67	38.117	168	55.972	0 %	CCL14	12	195	atn	0	0 huge max in fluo at 15m
20160713	1324	1	**159**	1	48.1	67	29.944	168	56.015	0 %	CCL13	12.2	177	atn	0	0 3ft
20160713	1328	1	**159**	2	48.4	67	30.04	168	55.998	0 %	CCL13	14.2	188	atn	0	0 same huge max in fluo
20160713	1437	1	**160**	1	47.7	67	19.944	168	56.011	0 %	CCL12	8.7	178	atn	0	0 3ft
20160713	1441	1	**160**	2	47.5	67	20.035	168	55.916	0 %	CCL12	12	187	atn	0	0 well mixed top to bottom, fresh layer is gone, max fluo is gone
20160713	1552	1	**161**	1	46.5	67	9.956	168	56.047	0 %	CCL11	14.1	173	bi	0	0 3 ft swell
20160713	1555	1	**161**	2	46.9	67	10.039	168	55.963	0 %	CCL11	16.2	182	bi	0	0 strong 2 temp layer, fluor signal strong
20160713	1705	1	**162**	1	45.9	66	59.919	168	55.788	0 %	CCL10	14	176	bi	0	1 2 ft swell
20160713	1709	1	**162**	2	45.8	66	59.959	168	55.673	0 %	CCL10	14.9	182	bi	0	1 v well mixed, ox 120%. On port 5-10min after cast, several broad whale blows, 1 tail
20160713	1824	1	**163**	1	42.9	66	49.916	168	55.876	0 %	CCL9	17	187	bi	0	1 2-3 ft chop
20160713	1827	1	**163**	2	42.9	66	49.993	168	55.755	0 %	CCL9	17.5	185	bi	0	1 extremely well mixed
20160713	1945	1	**164**	1	41.5	66	39.969	168	56.048	0 %	CCL8	16.2	185	bi	1	1 3 ft seas
20160713	1948	1	**164**	2	41.8	66	40.062	168	56.158	0 %	CCL8	16.7	188	bi	1	1 well mixed
20160713	2030	1	**165**	1	44	66	34.929	168	56.091	0 %	CCL7	14.9	189	bi	1	1 3 ft seas
20160713	2024	1	**165**	2	43.9	66	35.001	168	56.173	0 %	CCL7	15.4	190	bi	1	1 well mixed, very little flou
20160713	2114	1	**166**	1	54.4	66	29.937	168	56.072	0 %	CCL6	15.7	184	bi	1	1 3 ft seas
20160713	2118	1	**166**	2	54.7	66	30.025	168	56.258	0 %	CCL6	14.7	196	bi	1	1 strong flou signal with depth
20160713	2200	1	**167**	1	54.6	66	24.959	168	56.066	0 %	CCL5	13.6	194	bi	1	1 fog lifting, 1 mile radius, 3 ft chop
20160713	2204	1	**167**	2	54.9	66	25.036	168	56.141	0 %	CCL5	15.9	192	bi	1	1
20160713	2228	1	**168**	1	53.9	66	22.989	168	56.096	0 %	CCL4	17.3	180	bi	1	1 3 ft seas
20160713	2232	1	**168**	2	54.1	66	22.385	168	56.185	0 %	CCL4	16.4	185	bi	1	1
20160713	2254	1	**169**	1	54.4	66	19.774	168	57.092	0 %	A3-16	21.1	174	bi	1	1 3 ft seas. (Lonminwas 17.994, likely typo for 19.774, as per CTD)
20160713	2258	1	**169**	2	54.5	66	19.881	168	57.161	0 %	A3-16	18.7	185	bi	1	1
20160713	2318	1	**170**	1	55.1	66	17.825	168	56.296	0 %	DL19	19.4	199	ms	1	1 3ft seas
20160713	2311	1	**170**	2	54.8	66	17.929	168	56.345	0 %	DL19	19.5	181	ms	1	1
20160713	2346	1	**171**	1	56	66	15.233	168	56.276	0 %	DL18	22.3	188	ms	0	0 3ft seas
20160713	2350	1	**171**	2	55.9	66	15.34	168	56.266	0 %	DL18	21.2	173	ms	0	0
20160714	15	1	**172**	1	55.6	66	12.686	168	56.206	0 %	DL17	22.7	200	ms	1	0 4ft swell
20160714	20	1	**172**	2	56.3	66	12.802	168	56.165	0 %	DL17	24	191	ms	1	0
20160714	47	1	**173**	1	54.3	66	10.144	168	56.292	0 %	DL16	23.3	215	ms	0	0 4ft swell, altimeter trying in new and interesting ways!
20160714	51	1	**173**	2	53.6	66	10.239	168	56.32	0 %	DL16	22.7	200	ms	0	0
20160714	118	1	**174**	1	52.6	66	7.646	168	56.238	0 %	DL15	21	187	ms	0	1 4ft
20160714	122	1	**174**	2	52.6	66	7.755	168	56.052	0 %	DL15	22.9	181	ms	0	1
20160714	151	1	**175**	1	53.4	66	5.068	168	56.191	0 %	DL14	21.6	195	ms	0	1 4ft
20160714	156	1	**175**	2	53.2	66	5.196	168	56.127	0 %	DL14	23.9	202	ms	0	1
20160714	225	1	**176**	1	51.7	66	2.499	168	56.231	0 %	DL13	22.6	190	ms	1	1 4.5ft
20160714	229	1	**176**	2	51.3	66	1.618	168	56.17	0 %	DL13	12.6	191	ms	1	1
20160714	257	1	**177**	1	50.7	65	59.953	168	56.233	0 %	DL12	22.7	198	ms	0	1 5ft chop
20160714	301	1	**177**	2	50.8	66	0.039	168	56.158	0 %	DL12	20.9	186	ms	0	1
20160714	312	1	**178**	1	49.8	65	58.987	168	56.303	0 %	DL11	21.8	207	ms	0	1 4ft
20160714	316	1	**178**	2	49.9	65	59.07	168	56.246	0 %	DL11	20.7	207	ms	0	1
20160714	330	1	**179**	1	50.1	65	57.986	168	56.311	0 %	DL10	19	204	ms	0	1 3-4ft
20160714	334	1	**179**	2	50.1	65	58.052	168	56.174	0 %	DL10	19.8	210	ms	0	1
20160714	345	1	**180**	1	49.2	65	56.995	168	56.215	0 %	DL9	17	213	ms	0	1 3-4ft
20160714	349	1	**180**	2	49.7	65	57.067	168	56.004	0 %	DL9	16.7	202	ms	0	1
20160714	401	1	**181**	1	48.3	65	55.974	168	56.177	0 %	DL8	17.6	189	ms	1	0 4ft
20160714	405	1	**181**	2	48.3	65	56.027	168	56.052	0 %	DL8	16.8	164	ms	1	0
20160714	415	1	**182**	1	47.4	65	55.07	168	56.415	0 %	DL7	16.1	189	ms	0	0 4ft
20160714	418	1	**182**	2	47.9	65	55.133	168	56.351	0 %	DL7	17.9	188	ms	0	0
20160714	428	1	**183**	1	47.6	65	54.099	168	56.419	0 %	DL6	18.8	184	ms	1	0 4ft
20160714	432	1	**183**	2	48.2	65	54.151	168	56.462	0 %	DL6	18.3	198	ms	1	0
20160714	444	1	**184**	1	46.5	65	53.128	168	56.297	0 %	DL5	15.6	194	ms	1	0 4ft
20160714	448	1	**184**	2	46.7	65	53.199	168	56.348	0 %	DL5	16.5	185	ms	1	0
20160714	459	1	**185**	1	45	65	52.132	168	56.17	0 %	DL4	19.9	181	ms	1	0 4ft
20160714	502	1	**185**	2	45.1	65	52.188	168	56.13	0 %	DL4	22.1	183	ms	1	0
20160714	512	1	**186**	1	46.7	65	51.22	168	56.246	0 %	DL3	19.8	206	ms	1	0 4ft
20160714	515	1	**186**	2	46.6	65	51.274	168	56.22	0 %	DL3	16.2	209	ms	1	0
20160714	525	1	**187**	1	45.9	65	50.261	168	56.266	0 %	DL2	22.4	205	ms	1	0 4ft
20160714	529	1	**187**	2	46.3	65	50.334	168	56.22	0 %	DL2	22.2	209	ms	1	0
20160714	539	1	**188**	1	45.7	65	49.275	168	56.269	0 %	DL1	26.4	201	ms	1	0 4ft

20160714	543	1	**188**	2	45.7	65	49.345	168	56.209	0 %	DL1	29.3	203 ms	1	0	
20160714	555	1	**189**	1	45.4	65	48.383	168	55.986	0 %	BS11	27.6	207 ms	1	0	3ft
20160714	558	1	**189**	2	45.5	65	48.482	168	55.839	0 %	BS11	26.2	203 ms	1	0	
20160714	609	1	**190**	1	46.7	65	47.791	168	53.75	0 %	BS11.5	21.8	206 ms	0	0	4ft
20160714	612	1	**190**	2	46.9	65	47.819	168	53.676	0 %	BS11.5	22.4	207 ms	0	0	
20160714	622	1	**191**	1	42.4	65	47.173	168	51.741	0 %	BS12	15.3	200 ms	0	0	3ft
20160714	625	1	**191**	2	42.6	65	47.233	168	51.739	0 %	BS12	6.3	236 ms	0	0	
20160714	635	1	**192**	1	48	65	46.714	168	49.69	0 %	BS12.5	19.3	196 ms	1	0	4ft
20160714	639	1	**192**	2	47.8	65	46.809	168	49.663	0 %	BS12.5	16.5	206 ms	1	0	Birds!
20160714	648	1	**193**	1	51.2	65	46.257	168	47.738	0 %	BS13	14.5	199 ms	1	0	3ft
20160714	652	1	**193**	2	50.1	65	46.389	168	47.688	0 %	BS13	12.2	219 ms	1	0	
20160714	702	1	**194**	1	51.2	65	45.738	168	45.554	0 %	BS13.5	14.9	201 ms	1	0	3ft
20160714	706	1	**194**	2	51.1	65	45.851	168	45.475	0 %	BS13.5	12.2	212 ms	1	0	
20160714	715	1	**195**	1	51	65	45.195	168	43.379	0 %	BS14	15.9	190 atn	1	0	3ft
20160714	720	1	**195**	2	51	65	45.294	168	43.328	0 %	BS14	56.9	195 atn	1	0	
20160714	728	1	**196**	1	50.2	65	44.738	168	41.507	0 %	BS14.5	15.5	193 atn	1	0	4ft
20160714	732	1	**196**	2	50.2	65	44.822	168	41.393	0 %	BS14.5	14.8	201 atn	1	0	
20160714	740	1	**197**	1	49.8	65	44.279	168	39.722	0 %	BS15	13.1	184 atn	1	0	3ft
20160714	744	1	**197**	2	50	65	44.36	168	39.627	0 %	BS15	14.5	192 atn	1	0	
20160714	754	1	**198**	1	49.9	65	43.729	168	37.687	0 %	BS15.5	15.1	185 atn	1	0	3ft
20160714	758	1	**198**	2	50.1	65	43.816	168	37.62	0 %	BS15.5	16.7	188 atn	1	0	
20160714	808	1	**199**	1	49.9	65	43.189	168	35.49	0 %	BS16	17.5	183 atn	1	0	4ft
20160714	812	1	**199**	2	50.2	65	43.27	168	35.419	0 %	BS16	17	188 atn	1	0	
20160714	821	1	**200**	1	50.1	65	42.673	168	33.367	0 %	BS16.5	18.7	188 atn	1	0	4ft
20160714	825	1	**200**	2	50	65	42.758	168	33.31	0 %	BS16.5	18.7	189 atn	1	0	
20160714	835	1	**201**	1	52.4	65	42.127	168	31.276	0 %	BS17	20.8	180 atn	1	0	3ft
20160714	839	1	**201**	2	53.1	65	42.221	168	31.213	0 %	BS17	19.8	189 atn	1	0	
20160714	848	1	**202**	1	51.7	65	41.592	168	29.207	0 %	BS17.5	19.2	185 atn	1	0	4ft
20160714	852	1	**202**	2	52.4	65	41.688	168	29.161	0 %	BS17.5	18.6	189 atn	1	0	
20160714	902	1	**203**	1	51.8	65	41.078	168	26.955	0 %	BS18	22.7	189 atn	1	0	4ft
20160714	906	1	**203**	2	51.3	65	41.175	168	26.916	0 %	BS18	21.2	195 atn	1	0	
20160714	914	1	**204**	1	50.7	65	40.679	168	25.149	0 %	BS18.5	22.3	189 atn	1	0	3ft
20160714	918	1	**204**	2	50.8	65	40.801	168	25.086	0 %	BS18.5	21.4	198 atn	1	0	
20160714	927	1	**205**	1	50	65	40.272	168	23.422	1 %	BS19	22.4	190 atn	1	0	4ft
20160714	931	1	**205**	2	50	65	40.387	168	23.325	0 %	BS19	23.1	198 atn	1	0	
20160714	942	1	**206**	1	48.7	65	39.763	168	21.205	1 %	BS19.5	24.4	286 atn	1	0	4ft
20160714	945	1	**206**	2	48.1	65	39.87	168	21.14	1 %	BS19.5	23.2	195 atn	1	0	
20160714	956	1	**207**	1	46.3	65	39.233	168	18.98	1 %	BS20	4.8	198 atn	1	0	4ft
20160714	1000	1	**207**	2	46.3	65	39.357	168	18.916	1 %	BS20	23.8	198 atn	1	0	altimeter working in warm water
20160714	1009	1	**208**	1	43.9	65	38.87	168	17.029	1 %	BS20.5	21.5	189 atn	1	0	4ft
20160714	1013	1	**208**	2	43.8	65	39.079	168	17.022	1 %	BS20.5	20.7	196 atn	1	0	
20160714	1026	1	**209**	1	40.2	65	38.564	168	14.959	1 %	BS21	25.3	195 atn	1	0	3ft
20160714	1030	1	**209**	2	40.1	65	38.732	168	14.889	1 %	BS21	27.4	193 atn	1	0	
20160714	1043	1	**210**	1	37	65	37.988	168	12.973	1 %	BS21.5	25.9	191 atn	1	0	4ft
20160714	1046	1	**210**	2	36.9	65	38.156	168	12.982	1 %	BS21.5	24.7	192 atn	1	0	
20160714	1105	1	**211**	1	29.6	65	37.425	168	10.656	1 %	BS22	25.4	185 atn	1	0	3ft
20160714	1108	1	**211**	2	29.7	65	37.523	168	10.649	1 %	BS22	24.3	195 atn	1	0	
20160714	1247	1	**212**	1	28.6	65	51.004	168	4.905	1 %	MBSn8	23.3	202 atn	0	0	2ft
20160714	1250	1	**212**	2	28.6	65	51.107	168	4.789	1 %	MBSn8	25.5	190 atn	0	0	
20160714	1300	1	**213**	1	37.4	65	51.009	168	6.932	1 %	MBSn7	21.6	205 atn	0	0	3ft
20160714	1303	1	**213**	2	37.5	65	51.126	168	6.815	1 %	MBSn7	29.1	205 atn	0	0	
20160714	1319	1	**214**	1	44.1	65	51.088	168	10.563	1 %	MBSn6.5	24.4	198 atn	0	0	4ft
20160714	1322	1	**214**	2	44.1	65	51.22	168	10.416	1 %	MBSn6.5	27.5	204 atn	0	0	
20160714	1338	1	**215**	1	45	65	51.041	168	14.044	1 %	MBSn6	24.1	193 atn	0.5	0	4ft
20160714	1342	1	**215**	2	45	65	51.152	168	13.94	1 %	MBSn6	22.6	198 atn	0.5	0	
20160714	1400	1	**216**	1	48.8	65	51.175	168	18.567	0 %	MBSn5.5	23.4	205 atn	1	0	4-5ft
20160714	1404	1	**216**	2	49.1	65	51.291	168	18.438	0 %	MBSn5.5	26.3	206 atn	1	0	in cold water again: altimeter stops working
20160714	1422	1	**217**	1	50.3	65	51.18	168	23.07	0 %	MBSn5	26.3	203 atn	1	0	4ft
20160714	1427	1	**217**	2	50.3	65	51.327	168	22.92	0 %	MBSn5	23.4	185 atn	1	0	
20160714	1443	1	**218**	1	54.1	65	51.282	168	27.622	0 %	MBSn4.5	25.6	204 atn	1	0	4ft
20160714	1447	1	**218**	2	54.2	65	51.398	168	27.513	0 %	MBSn4.5	24.5	188 atn	1	0	
20160714	1503	1	**219**	1	51.8	65	51.419	168	31.95	0 %	MBSn4	26	198 bi	1	0	4ft
20160714	1507	1	**219**	2	51.7	65	51.538	168	31.924	0 %	MBSn4	24.9	193 bi	1	0	
20160714	1522	1	**220**	1	52	65	51.557	168	36.496	0 %	MBSn3.5	22.6	193 bi	1	0	3ft
20160714	1526	1	**220**	2	51.9	65	51.667	168	36.439	0 %	MBSn3.5	23.8	188 bi	1	0	
20160714	1545	1	**221**	1	51.5	65	51.651	168	40.941	0 %	MBSn3	23.1	186 bi	1	0	4ft

20160714	1549	1	**221**	2	51.4	65	51.763	168	40.902	0 %	MBSn3	23.5	184 bi	1	0	very well mixed
20160714	1602	1	**222**	1	51.1	65	51.736	168	45.006	0 %	MBSn2.5	16.9	197 bi	1	0	3-4 ft seas
20160714	1607	1	**222**	2	52.4	65	51.83	168	44.934	0 %	MBSn2.5	18	194 bi	1	0	
20160714	1620	1	**223**	1	49.3	65	51.831	168	49.203	0 %	MBSn2	19.7	191 bi	1	0	3-4 ft seas
20160714	1624	1	**223**	2	49.6	65	51.909	168	49.186	0 %	MBSn2	21	189 bi	1	0	
20160714	1635	1	**224**	1	47.9	65	51.929	168	52.556	0 %	MBSn1.5	28.6	209 bi	0	0	3-4 ft seas, foggy
20160714	1639	1	**224**	2	47.8	65	52.016	168	52.47	0 %	MBSn1.5	25.6	206 bi	0	0	
20160714	1652	1	**225**	1	46.3	65	52.029	168	56.043	0 %	MBSn1	20.3	187 bi	0	0	3-4 ft seas
20160714	1655	1	**225**	2	46.2	65	52.101	168	55.988	0 %	MBSn1	19.9	193 bi	0	0	
20160714	1927	1	**226**	1	18.4	65	59.964	167	54.034	1 %	NBS9	29.1	215 bi	0	1	3 ft seas, water vis poor, fog lifted
20160714	1929	1	**226**	2	18.2	66	0.013	167	54.888	1 %	NBS9	28.1	210 bi	0	1	altimeter working - warm water again
20160714	1947	1	**227**	1	31.3	65	59.988	168	0.122	1 %	NBS8	26.9	195 bi	1	1	3-4 ft seas
20160714	1950	1	**227**	2	32	66	0.083	168	0.024	1 %	NBS8	32	207 bi	1	1	
20160714	2004	1	**228**	1	38	65	59.958	168	4.233	1 %	NBS7.5	30.4	195 bi	0	1	2-3 ft seas
20160714	2008	1	**228**	2	37.8	66	0.065	168	4.157	1 %	NBS7.5	29.1	207 bi	0	1	
20160714	2023	1	**229**	1	45.7	65	59.941	168	8.464	1 %	NBS7	26.5	195 bi	0	1	4 ft seas, visibility bad but water is clear?
20160714	2026	1	**229**	2	45.5	66	0.067	168	8.418	1 %	NBS7	26.1	205 bi	0	1	
20160714	2041	1	**230**	1	47.9	65	59.974	168	12.43	0 %	NBS6.5	25.2	192 bi	0	0	3-4 ft seas
20160714	2045	1	**230**	2	48.3	66	0.082	168	12.373	0 %	NBS6.5	24.9	201 bi	0	0	
20160714	2059	1	**231**	1	51.1	65	59.958	168	16.463	0 %	NBS6	25.8	207 bi	1	0	4-5 ft seas, lots of small jellies
20160714	2103	1	**231**	2	51.9	66	0.077	168	16.403	0 %	NBS6	27.5	196 bi	1	0	
20160714	2119	1	**232**	1	53.5	65	59.917	168	20.726	0 %	NBS5.5	23.8	195 bi	0	0	4-5 ft seas, small jellies and bird
20160714	2123	1	**232**	2	52.2	66	0.019	168	20.672	0 %	NBS5.5	23.1	193 bi	0	0	
20160714	2137	1	**233**	1	55.1	65	59.946	168	25.111	0 %	NBS5	23.9	206 bi	0	0	4-5 ft seas
20160714	2141	1	**233**	2	55.5	66	0.048	168	25.06	0 %	NBS5	21.7	198 bi	0	0	
20160714	2156	1	**234**	1	51.5	65	59.951	168	29.031	0 %	NBS4.5	21.5	198 bi	0	0	4-5 ft seas
20160714	2200	1	**234**	2	55.3	66	0.071	168	28.924	0 %	NBS4.5	23.5	187 bi	0	0	
20160714	2215	1	**235**	1	51.9	65	59.927	168	33.255	0 %	NBS4	22.6	198 rw	1	0	4-5foot, small jellies
20160714	2219	1	**235**	2	52.3	66	0.041	168	33.14	0 %	NBS4	24.1	197 rw	1	0	
20160714	2234	1	**236**	1	51.6	65	59.932	168	37.412	0 %	NBS3.5	24.1	192 rw	0.5	0	4-5foot
20160714	2238	1	**236**	2	50.8	66	0.063	168	37.286	0 %	NBS3.5	23.4	197 rw	0.5	0	4-5foot
20160714	2252	1	**237**	1	51.5	65	59.953	168	41.574	0 %	NBS3	22.2	205 rw	0.5	0	4-5foot
20160714	2256	1	**237**	2	51.3	66	0.06	168	41.48	0 %	NBS3	22.1	192 rw	0.5	0	4-5foot
20160714	2311	1	**238**	1	52	65	59.944	168	45.911	0 %	NBS2.5	19.3	188 ms	0	1	3ft
20160714	2315	1	**238**	2	52.1	66	0.04	168	45.872	0 %	NBS2.5	18.4	187 ms	0	1	
20160714	2330	1	**239**	1	51.8	65	59.943	168	49.972	0 %	NBS2	22.7	194 ms	1	1	3-4ft
20160714	2334	1	**239**	2	52.1	66	0.031	168	49.894	0 %	NBS2	18.9	198 ms	1	1	
20160714	2347	1	**240**	1	50.6	65	59.939	168	53.015	0 %	NBS1.5	26.7	196 ms	0	1	3-4ft
20160714	2351	1	**240**	2	51.1	66	0.035	168	52.919	0 %	NBS1.5	25.5	200 ms	0	1	
20160715	4	1	**241**	1	50.6	65	59.972	168	56.074	0 %	NBS1	22.4	207 ms	0	1	3-4ft, 2nd sensor data bad
20160715	8	1	**241**	2	50.7	66	0.065	168	55.975	0 %	NBS1	25.7	195 ms	0	1	
20160715	19	1	**242**	1	50.8	65	58.948	168	56.187	0 %	DL11	23.1	187 ms	0	1	3-4ft, 2nd sensor data bad
20160715	23	1	**242**	2	50.3	65	59.062	168	56.143	0 %	DL11	21.6	186 ms	0	1	
20160715	33	1	**243**	1	49.9	65	57.985	168	56.262	0 %	DL10	22.1	191 ms	0	1	4ft, 2nd sensor data bad
20160715	37	1	**243**	2	50.2	65	58.089	168	56.252	0 %	DL10	19.4	192 ms	0	1	
20160715	47	1	**244**	1	49.1	65	57.016	168	56.274	0 %	DL9	19.5	176 ms	0	1	4ft, 2nd sensor data bad
20160715	51	1	**244**	2	49	65	57.095	168	56.132	0 %	DL9	20.3	183 ms	0	1	
20160715	102	1	**245**	1	48.1	65	56.029	168	56.264	0 %	DL8	18.7	166 ms	0	1	4ft, 2nd sensor data bad
20160715	105	1	**245**	2	48	65	56.091	168	56.144	0 %	DL8	16.2	182 ms	0	1	
20160715	115	1	**246**	1	48	65	55.068	168	56.263	0 %	DL7	20.4	183 ms	0.5	0.5	4ft, 2nd sensor data bad
20160715	119	1	**246**	2	47.9	65	55.135	168	56.115	0 %	DL7	14.7	185 ms	0.5	0.5	
20160715	129	1	**247**	1	47.3	65	54.101	168	56.309	0 %	DL6	24	191 ms	1	0	4ft, 2nd sensor data bad
20160715	132	1	**247**	2	47	65	54.187	168	56.175	0 %	DL6	22.9	186 ms	1	0	
20160715	143	1	**248**	1	46.3	65	53.118	168	56.287	0 %	DL5	22.1	179 atn	1	1	4-4.5ft, 2nd sensor data bad
20160715	146	1	**248**	2	47.5	65	53.204	168	56.272	0 %	DL5	27.2	189 atn	1	1	
20160715	156	1	**249**	1	44.3	65	52.127	168	56.323	0 %	DL4	10.7	171 atn	1	1	4ft, 2nd sensor data bad
20160715	200	1	**249**	2	43.8	65	52.193	168	56.319	0 %	DL4	13.6	175 atn	1	1	
20160715	209	1	**250**	1	46.5	65	51.15	168	56.303	0 %	DL3	22.9	202 atn	1	0.5	4ft, 2nd sensor data bad
20160715	213	1	**250**	2	46.5	65	51.261	168	56.26	0 %	DL3	20.2	211 atn	1	0.5	
20160715	225	1	**251**	1	46.6	65	50.226	168	56.341	0 %	DL2	35.6	212 atn	1	0.5	4ft, 2nd vent plug unblocked pre this cast, 2nd sensor data ok again
20160715	228	1	**251**	2	46	65	50.346	168	56.246	0 %	DL2	26.6	211 atn	1	0.5	
20160715	240	1	**252**	1	45.9	65	49.208	168	56.299	0 %	DL1	35.2	204 ms	1	1	4ft
20160715	244	1	**252**	2	45.5	65	49.354	168	56.281	0 %	DL1	33.3	199 ms	1	1	
20160715	256	1	**253**	1	43.3	65	49.16	168	52.267	0 %	DLa1	32.3	180 atn	1	1	4ft
20160715	300	1	**253**	2	43.6	65	49.238	168	52.201	0 %	DLa1	30.4	181 atn	1	1	
20160715	307	1	**254**	1	45.1	65	50.134	168	52.213	0 %	DLa2	27.2	194 atn	0.5	1	4ft

20160715	310	1	**254**	2	44.8	65	50.21	168	52.17	0	%	DLa2	27.7	192	atn	0.5	1	
20160715	318	1	**255**	1	47.5	65	51.25	168	52.381	0	%	DLa3	25.6	184	ms	0.5	0.2	3-4ft
20160715	321	1	**255**	2	47.7	65	51.369	168	52.381	0	%	DLa3	24.2	187	ms	0.5	0.2	
20160715	328	1	**256**	1	48.8	65	52.22	168	52.176	0	%	DLa4	31	202	ms	1	1	4ft
20160715	332	1	**256**	2	48.1	65	52.349	168	52.135	0	%	DLa4	29.3	205	ms	1	1	
20160715	338	1	**257**	1	48.1	65	53.188	168	52.372	0	%	DLa5	27.2	175	ms	1	1	4ft
20160715	342	1	**257**	2	48.3	65	53.294	168	52.322	0	%	DLa5	22.4	197	ms	1	1	
20160715	348	1	**258**	1	48.9	65	54.153	168	52.337	0	%	DLa6	24.5	187	ms	1	1	3-4ft
20160715	352	1	**258**	2	48.1	65	54.247	168	52.26	0	%	DLa6	21.6	185	ms	1	1	
20160715	358	1	**259**	1	49.3	65	55.094	168	52.316	0	%	DLa7	24.2	193	ms	1	0	4ft
20160715	402	1	**259**	2	49.4	65	55.175	168	52.208	0	%	DLa7	24.3	202	ms	1	0	
20160715	410	1	**260**	1	50.8	65	56.068	168	52.244	0	%	DLa8	24.7	183	ms	0	0	4ft
20160715	414	1	**260**	2	50.3	65	56.156	168	52.095	0	%	DLa8	20.1	196	ms	0	0	
20160715	421	1	**261**	1	50.1	65	57.046	168	52.202	0	%	DLa9	22	177	ms	1	0	3ft
20160715	425	1	**261**	2	50.1	65	57.128	168	52.013	0	%	DLa9	23	186	ms	1	0	
20160715	432	1	**262**	1	50.3	65	57.992	168	52.194	0	%	DLa10	22.3	182	ms	1	0	4ft
20160715	436	1	**262**	2	50.3	65	58.083	168	51.999	0	%	DLa10	23	186	ms	1	0	
20160715	444	1	**263**	1	51.3	65	59.083	168	52.193	0	%	DLa11	23.3	186	ms	1	1	4ft
20160715	448	1	**263**	2	50.8	65	59.18	168	52.011	0	%	DLa11	25.9	190	ms	1	1	
20160715	454	1	**264**	1	50.7	65	59.97	168	52.144	0	%	DLa12	24.3	180	ms	1	0	4ft
20160715	459	1	**264**	2	51	66	0.065	168	51.95	0	%	DLa12	24.2	186	ms	1	0	
20160715	510	1	**265**	1	51.9	65	59.902	168	48.17	0	%	DLb12	21.2	176	ms	1	0	4ft
20160715	514	1	**265**	2	51.2	66	0.014	168	47.994	0	%	DLb12	25.7	188	ms	1	0	
20160715	524	1	**266**	1	52.1	65	58.988	168	48.048	0	%	DLb11	20.1	175	ms	0	0	4ft
20160715	528	1	**266**	2	52.1	65	59.104	168	47.859	0	%	DLb11	25.3	177	ms	0	0	
20160715	538	1	**267**	1	50.6	65	57.977	168	48.073	0	%	DLb10	19.5	155	ms	1	0	4ft
20160715	542	1	**267**	2	51.8	65	58.092	168	47.93	0	%	DLb10	20.1	154	ms	1	0	
20160715	553	1	**268**	1	51.6	65	56.961	168	48.138	0	%	DLb9	25.3	199	ms	0	0	4ft
20160715	557	1	**268**	2	52	65	57.069	168	48.014	0	%	DLb9	23.6	194	ms	0	0	
20160715	607	1	**269**	1	51.5	65	56.018	168	48.041	0	%	DLb8	21.4	190	ms	1	0	4ft
20160715	611	1	**269**	2	51.7	65	56.168	168	47.839	0	%	DLb8	22.6	193	ms	1	0	
20160715	622	1	**270**	1	51.8	65	55.018	168	48.187	0	%	DLb7	26	191	ms	1	0	4ft
20160715	626	1	**270**	2	51.6	65	55.166	168	48.037	0	%	DLb7	24.5	191	ms	1	0	
20160715	637	1	**271**	1	51.2	65	54.031	168	48.106	0	%	DLb6	19.7	181	ms	1	0	4ft, sensor 1 vent plug plugged - sensor 1 data bad, use sensor 2
20160715	641	1	**271**	2	51	65	54.202	168	47.984	0	%	DLb6	21.4	186	ms	1	0	
20160715	655	1	**272**	1	51.5	65	53.132	168	47.998	0	%	DLb5	16.8	170	ms	1	0	4ft, Cleaned vent plug, but ox1 data still bad at start; use ox 2 OR cast 273
20160715	700	1	**272**	2	50.9	65	53.328	168	47.907	0	%	DLb5	17.2	181	ms	1	0	
20160715	701	1	**273**	1	50.9	65	53.356	168	47.902	0	%	DLb5_recast	18.4	185	ms	1	0	4ft, recast without coming out of water, at same location. Take as DLB5 cast
20160715	705	1	**273**	2	51.1	65	53.488	168	47.866	0	%	DLb5_recast	15.1	185	ms	1	0	
20160715	717	1	**274**	1	50.1	65	52.117	168	48.082	0	%	DLb4	20.7	192	atn	1	0	4ft, cleaned sensor 1 plug again pre this cast - data seems ok
20160715	721	1	**274**	2	50.3	65	52.231	168	47.969	0	%	DLb4	24.1	193	atn	1	0	
20160715	731	1	**275**	1	49.1	65	51.144	168	48.072	0	%	DLb3	27.3	191	atn	1	0	4ft
20160715	735	1	**275**	2	49.3	65	51.281	168	47.927	0	%	DLb3	26.7	195	atn	1	0	
20160715	746	1	**276**	1	49.4	65	50.256	168	48.058	0	%	DLb2	25.7	192	atn	1	0	4ft
20160715	750	1	**276**	2	49.2	65	50.396	168	48.019	0	%	DLb2	23.7	185	atn	1	0	
20160715	802	1	**277**	1	48.8	65	49.201	168	48.084	0	%	DLb1	24.2	178	atn	1	0	4ft
20160715	806	1	**277**	2	49.2	65	49.342	168	48.032	0	%	DLb1	25.4	184	atn	1	0	

END OF CRUISE