BERING STRAIT NORSEMAN II 2013 MOORING CRUISE REPORT

Research Vessel Norseman II, Norseman Maritime Charters

Nome-Nome, 3rd – 10th July 2013

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and the Bering Strait 2013 Science Team

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(Photo from www.norsemanmartime.com)

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As part of the joint US-Russian RUSALCA (Russian US Long-term Census of the Arctic Ocean) Program and the Bering Strait AON (Arctic Observing Network), and a related ONR effort for measuring the Bering Strait throughflow, a team of US scientists undertook a 7 day cruise in the Bering Strait and southern Chukchi Sea region in July 2013 on the US vessel Norseman II, operated by Norseman Maritime Charters, and loading and off-loading in Nome, Alaska.

There were 4 primary goals of the expedition.

1) The recovery of 5 moorings carrying physical oceanographic (Woodgate, Weingartner), bio-optical (Whitledge), whale acoustic (Stafford), and ocean acidification (Prahl) instrumentation. These moorings were deployed in the Bering Strait region in 2012 with NSF and NOAA_RUSALCA funding.

2) The deployment of 3 moorings in the Bering Strait region, carrying physical oceanographic (Woodgate), bio-optical (Whitledge) and whale acoustic (Stafford) instrumentation. The funding for the physical oceanographic components of these moorings comes from ONR.

3) Accompanying CTD sections including water sampling.

4) Underway bridge-based marine mammal observations.

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; *Woodgate et al.*, 2012]; and are a major source of nutrients for ecosystems in the Chukchi Sea, 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.

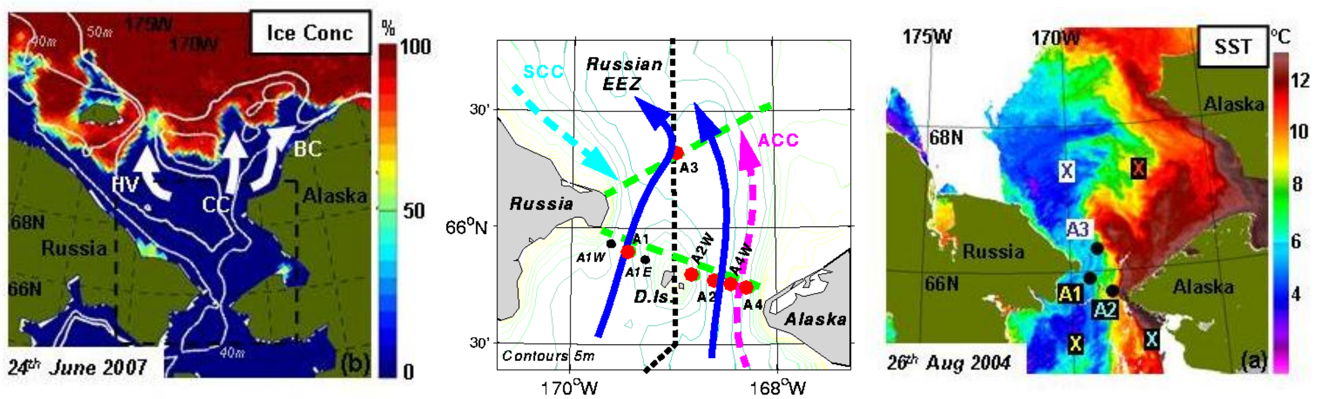


Figure 1: (Left) *Chukchi Sea ice concentration (AMSR-E) on 24th June 2007 with schematic topography. White arrows mark three main water pathways melting back the ice edge [Woodgate et al., 2010].*

(Middle) *Schematic of Bering Strait flows marking the Alaskan Coastal Current (ACC) and the Siberian Coastal Current (SSC) and mooring locations of the 8 mooring "high resolution" array deployed in the strait from 2007 to 2012 (black and red dots). Red dots indicate locations with lower and upper layer sensors. Depth contours are from IBCAO [Jakobsson et al., 2000]. D.Is. marks the Diomede Islands in the center of the strait.*

(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. These data have allowed us to quantify seasonal and interannual change [*Woodgate et al.*, 2005b; *Woodgate et al.*, 2006; *Woodgate et al.*, 2010; *Woodgate et al.*, 2012], and assess the strong contribution of the Alaskan Coastal Current (ACC) to the fluxes through the strait [*Woodgate and Aagaard*, 2005]. These data also show that the Bering Strait throughflow increased ~50% from 2001 (~0.7Sv) to 2011 (~1.1Sv), driving heat and freshwater flux increases [*Woodgate et al.*, 2012]. While ~ 1/3rd of this change is attributable to weaker local winds, 2/3rds appears to be driven by basin-scale changes between the Pacific and the Arctic. Remote data (winds, SST) prove insufficient for quantifying variability, indicating interannual change can still only be assessed by in situ year-round measurements [*Woodgate et al.*, 2012].

Analysis of prior data indicate that the physical fluxes of volume, freshwater and heat can be reasonably measured by a reduced array of 3 moorings (A2, A3 and A4) all in US waters. The mooring deployments accomplished on this cruise extend this mooring time-series to summer 2014.

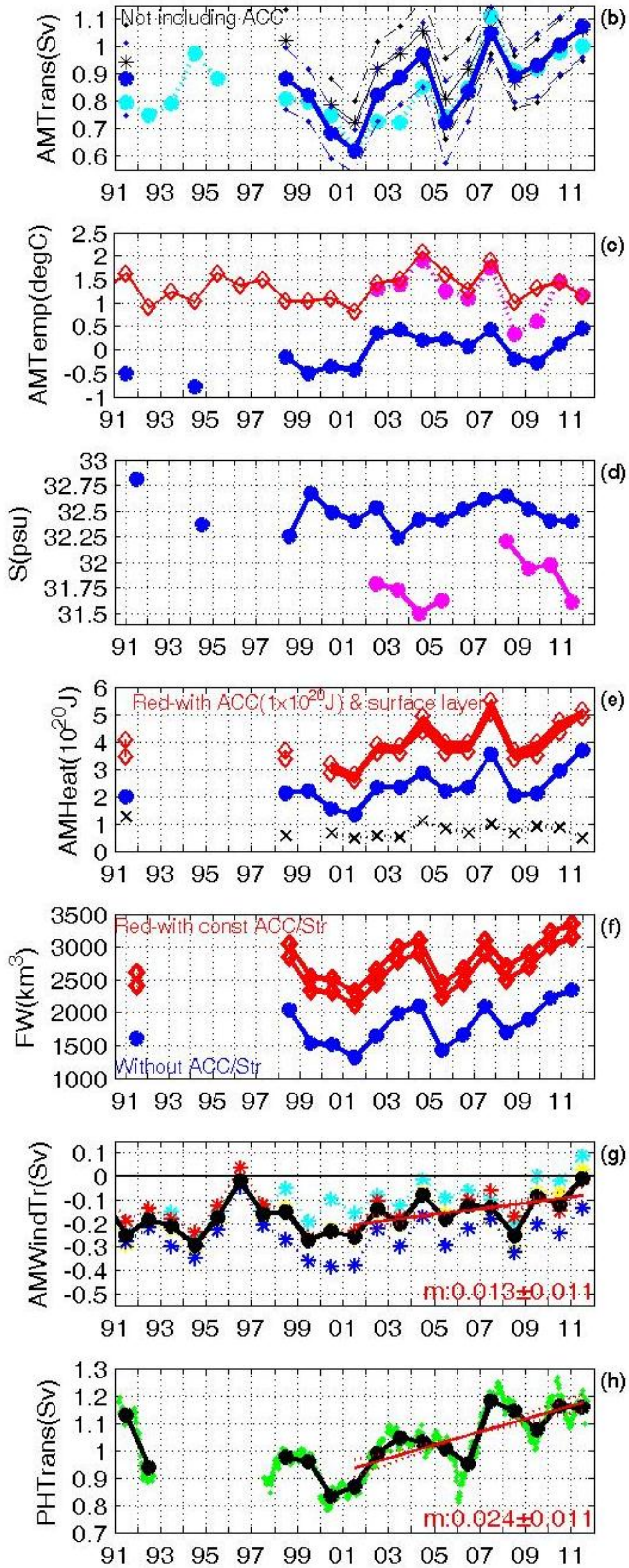


Figure 2, from [Woodgate et al., 2012]
a) *map as per Figure 1.*
b) *transport calculated from A3 (blue) or A2 (cyan), with error bars (dashed) calculated from variability; including adjustments estimated from 2007-2009 Acoustic Doppler Current Profiler data for 6-12m changes in instrument depth (black);*
c) *near-bottom temperatures from A3 (blue) and A4 (magenta-dashed), and the NOAA SST product (red diamonds);*
d) *salinities from A3 (blue) and A4 (magenta);*
e) *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;*
f) *freshwater fluxes: blue – from A3 only; red – including 800-1000km^3 (lower and upper bounds) correction for stratification and ACC;*
g) *transport attributable to NCEP wind (heading 330º, i.e., northwestward) at each of 4 points (coloured X in **(a)**) and the average thereof (black); and*
h) *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, e.g., the Arctic Observing Network (AON) started as part of the International Polar Year (IPY) effort; NSF's Freshwater Initiative (FWI) and Arctic Model Intercomparison Project (AOMIP), and the international Arctic SubArctic Ocean Fluxes (ASOF) program. Some of the CTD lines are part of the international Distributed Biological Observatory (DBO) effort. The mooring work also supports regional studies in the area, by providing key boundary conditions for the Chukchi Shelf/Beaufort Sea region; a measure of integrated change in the Bering Sea, and an indicator of the role of Pacific Waters in the Arctic Ocean.

2013 CRUISE SUMMARY:

Weather conditions were very good for the cruise, although fog was relatively frequent, hindering the marine mammal surveys and threatening mooring recovery operations. However, we were fortunate to accomplish the mooring operations at times of sufficient visibility, and the mooring recoveries were not delayed by the fog, although this remains a concern for future years. Overall, the mooring operations went very smoothly – all moorings released (finally) on command and dragging operations were not necessary. Extensive deck assistance from the Norseman II allowed us to start CTD operations immediately after completing mooring deployments, and this, accompanied by the efficient and speedy CTD operations of the Norseman II, allowed us to complete 9 CTD lines in a ~ 4 day period (a ~ 30% time saving on work from previous recent years). Winds and sea state increased for the second half of the cruise, and came close to shutting down CTD operations.

Overall, the cruise accomplished (to the best of our knowledge) the third extensive quasi-synoptic spatial survey of the southern Chukchi Sea in almost a decade (a similar survey was obtained from the Khromov in 2011 and 2012 [*Woodgate and RUSALCA11ScienceTeam*, 2011; *Woodgate and RUSALCA12ScienceTeam*, 2012]. Prior to that the last extensive surveys were in 2003 and 2004 from the Alpha Helix [*Woodgate*, 2003; *Woodgate*, 2004]). 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. In particular, the CS line is a DBO (Distributed Biological Observatory) line and was run by the Japanese research vessel Oshoro Maru (Chief Scientist: Toru Hirawake) ~ 1 day after our occupation of it. The 2013 Bering Strait mooring cruise also completed part of the third high resolution (~ 1nm) survey of the eddying region just north of the Diomede Islands, this time with underway ship's ADCP and temperature and salinity sampling.

This year's cruise took place earlier in the season than in previous years – sea-ice was present near Cape Lisburne about a week before the cruise. Remarkably fresh waters (~ 20psu) were observed along the Point Hope to Cape Lisburne coast, and sampling suggests ~ 1/3rd of the freshening was due to ice melt. An ice berg was also spotted just north of Cape Lisburne. Through winds were northwards for the start of the cruise, they turned southwards for the second half of the cruise and this allowed us to sample the Bering Strait line under two very different wind conditions.

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

Summary of CTD lines.

BS (US portion) – the main Bering Strait line, run at the start and at the end of the cruise. This line has been occupied by past Bering Strait mooring cruises. US portion only run here.

DL – a high resolution line running north from the Diomede Islands to study the hypothesized eddy and mixing region north of the islands. This was run at the start and end of the cruise.

AL (US portion) – another previously-run line, 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.

CS (US portion) – another cross strait line, run here from the US-Russian convention line (~168° 58.7'W) to Point Hope (US).

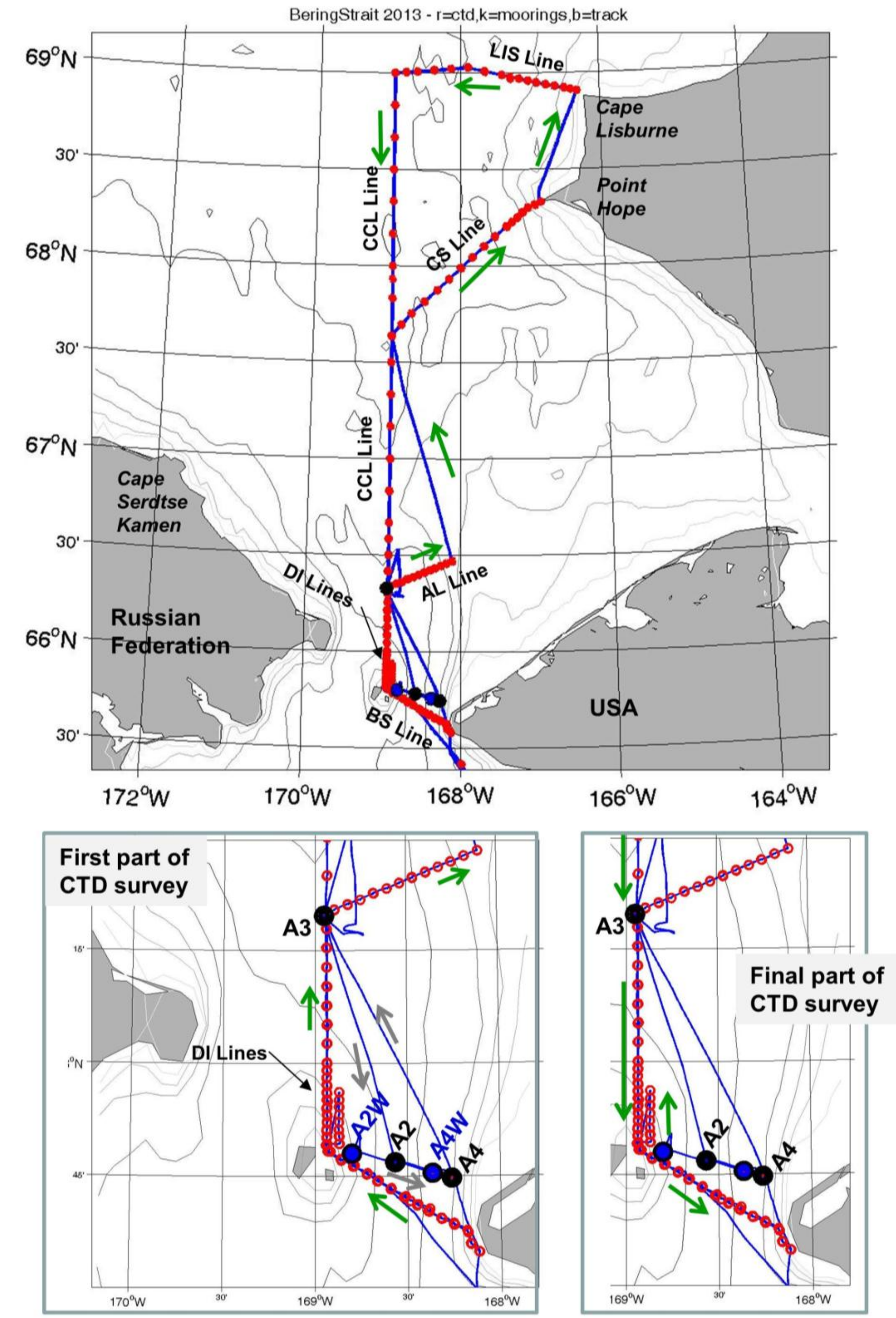
LIS – from Cape Lisburne towards the WNW, a previous RUSALCA line and close to the CP line occupied in previous Bering Strait cruises in 2003 and 2004.

CCL – a line running down the convention line from the end of the LIS line towards the Diomedes (also run in 2003, 2004, 2011 and 2012), incorporating a rerun of the high resolution DL line at the southern end.

DLa – another high resolution line, mapping the eddying/mixing region (part run on this cruise).
Finally, the US portion of the BS line was rerun at the end of the cruise.

Contents

***BERING STRAIT 2013 MOORING CRUISE MAP:** Ship-track, blue. Mooring sites, black. CTD stations, red. Grey and green arrows indicate direction of travel (grey during mooring operations, green during CTD operations). Depth contours every 10m from the International Bathymetric Chart of the Arctic Ocean (IBCAO) [Jakobsson et al., 2000]. Lower panels mooring detail: - black solid=recovered and redeployed; black with blue center =recovered, not redeployed.*



BERING STRAIT 2013 SCIENCE PARTICIPANTS

1.	Rebecca Woodgate (F)	UW	*Chief Scientist*
2.	Cecilia Peralta Ferriz (F)	UW	*UW Postdoc and CTD lead*
3.	Robert Daniels (M)	UW	*UW student, CTD and moorings*
4.	David Leech (M)	UAF	*UAF Mooring lead*
5.	Dean Stockwell (M)	UAF	*UAF PI*
6.	Patricia Rivera (F)	UAF	*UAF moored sampler, moorings, water sampling*
7.	Fred Prahl (M)	OSU	*OSU pH pCO2 mooring and water sampling*
8.	Kate Stafford (F)	UW	*Marine Mammals & moored acoustic recorder*

UW – University of Washington, US
UAF – University of Alaska, Fairbanks, US
OSU – Oregon State University, US

BERING STRAIT 2013 NORSEMAN II CREW

1.	Perry Seyler (M)	NMC	*Captain*
2.	Todd Campbell (M)	NMC	*Mate*
3.	Harry Burnet (M)	NMC	*Cook*
4.	Scotty Hameister (M)	NMC	*Deck Boss*
5.	Jim Wells (M)	NMC	*Deck Hand*
6.	Charlie Watson (M)	NMC	*Deck Hand, plus galley*
7.	Austin Church (M)	NMC	*Deck Hand*
8.	Jerry Taylor (M)	NMC	*Engineer*
9.	Mike Christison (M)	OF	*Health and Safety*

NMC – Norseman Maritime Charters, http://www.norsemanmaritime.com/index
OF – Olgoonik Fairweather LLC, http://www.fairweather.com/fairweatherscience.html

BERING STRAIT 2013 CRUISE SCHEDULE (Times Alaskan Daylight Time (GMT-8) 24hr format)

February and March 2013	*Arrangement of charter of Norseman II by NSF and others for the Bering Strait mooring work*
End of April 2013	*Shipment of container of UW equipment to Nome, ETA mid-June*
Monday 28th May 2013	*Sea survival training course in Seattle for cruise participants*
Saturday 29th June 2013	*UW mooring team (Rebecca, Cecilia, Robert) arrive Nome*
Sunday 30th June 2013 *(Stormy, strong swell from S)*	*UW Instrument preparation*
Monday 1st July 2013 *(Wind dropping, sunny by pm)*	*Ship docks from previous charter* *UW Instrument prep; Fred and Kate arrive evening.* *Sea Survival training course in Fairbanks for Pat and Dean*
Tuesday 2nd July 2013 *(Windy, rain squalls, increasing swell)*	*Dave, Pat and Dean arrive ~ noon* *Earlier than planned on-load of equipment, starting 1pm*
Wednesday 3rd July 2013 *(Weakening winds, moderate sea state)*	Finish on-load and sail ~ 1100 Safety brief and opening science meeting on board Test CTD cast at 2230 and 2315
Thursday 4th July 2013 *(Wind ~10knots, mild sea state, foggy)*	On site A2W-12 at 0845 CTD cast, Finish recovery at 0940 On site A2-12 at 1030, CTD cast, Finish recovery at 1128 On site A4W-12 at 1215, CTD cast, Finish recovery at 1318 On site A4-12 at 1400, CTD cast, Finish recovery at 1448 On site A3-12 at 1900, CTD cast, Finish recovery at 1932
Friday 5th July 2013 *(Foggy, light wind)*	Start deployment A3-13 at 1139, Finish deployment at 1152, Finish CTD at 1218 Start deployment A2-13 at 1652, Finish deployment at 1700 Finish CTD at 1715 Start deployment A4-13 at 1907, Finish deployment at 1941 Finish CTD at 2000 Transit to BS24 Start BS line running east (BS24) to west (BS11) at 2200
Saturday 6th July 2013 *(Light wind, patches of fog)*	Finish BS line at BS11 at 0345 (BSline=5.75hrs) Start DL line at DL1 at 0400, running north Finish DL line at DL19 at 1108 (DLline = 5.1hrs) Start AL line at A3 (AL12) at 1127, running east Finish AL line at AL24 at 1700 (ALline=5.5hrs) Transit to CS10
Sunday 7th July 2013 *(V light wind, started foggy, cleared to glassy calm by evening)*	Start CS line at CS10US at 0124, running east Finish CS line at CS19 at 1200 (CSline=10.5hrs) Transit to LIZ1 (Note with ship's draft at 3m, can shorten transit from previous years) Sighted ice berg at 68º55.246N 166º10.22W, but no sea-ice. Start LIZ line at LIZ1 at 1637, running west

Monday 8th July 2013	Finish LIZ line at LIZ14,at 0145 (LIZline=9.1hrs)
(Foggy, increasing southward	Start CCL line at CCL22,at 0213, running south.
wind and swell)	Passed Oshoro Maru (headed for CS line) between CS11 and 10
Tuesday 9th July 2013	Finish CCL line at A3,at 0100 (CCLline=22.75hrs)
(Overnight wind increasing,	Start DLline at DL19,at 0116, running south
almost halting CTD ops, later	Finish DL line at DL1 at 0753 (DLline=6.6hrs)
wind drops slightly, but sea	Start DLa line at DLa1 at 0806, running north
state remains moderate.	Break off DLa line at DLa8 at 1013 (3/4DLaline=2.1hrs)
Report from Oshoro Maru of	Start BS line at BS11 at 1117, running east
30kn winds off Cape Lisburne)	Finish BS line at BS24 at 1704 (BSline=5.75hrs)
	Turn for Nome at 1704
Wednesday 10th July 2013	Off Nome by 6am
(V light wind, overcast)	Dock 6:30am
	Crane gear off and stuff container 0700 to 0830
	Wait for air cargo to open
	Clear ship by 1100, Kate and Dave leave Nome pm and evening
Thursday 11th July 2013	Remainder of Science Party leave Nome am

TOTALS

7 days at sea (away from Nome) ***11:30 3rd July – 06:30 10th July 2013***
8 days on ship (including on/offload) ***13:00 2nd July – 11:00 10th July 2013***

Moorings recovered/ deployed: 5/3
CTD casts: 150

SCIENCE COMPONENTS OF CRUISE

The cruise comprised of the following science components:

- Mooring operations

Mooring operations were a joint UW/UAF operation, assisted by other cruise members.

- CTD operations

CTD operations were a joint UW/UAF operation, assisted by other cruise members.

-Water sampling

Water samples were taken by UAF and OSU teams, assisted by other cruise members, at various sites for various components, as per the following table:

Line	**Nutrients** *Rivera for PI Whitledge*	*Sample #*	**pCO2, DIC & Total Alk.** *Prahl*	*Sample #*	***Delta O18*** *Woodgate*	*Sam. #*
Pre-recovery casts ***(casts 3-7)***	A2-12 and A3-12	*1-10*	A3	*300-301*		
Post-deployment ***(casts 8-10)***	A2-13 and A3-13	*11-20*	-			
BS (BS24-BS11) ***(casts 11-24)*** from US to west	All	*21-97*	Half (odds)	*302-322*		
DL (DL1-DL19) **(casts 25-43)** to north	All of DL1 to 3; and half of DL4 to 19.	*98-163*	-			
AL (A3-AL24) **(casts 44-56)** to east (US)	All	*164-236*				
CS (CS10US – CS19) **(casts 57-73)** to east (US)	Half	*237-291*	-			
LIS (LIS1-LIS14) **(casts 74-89)** from US to west	All	*292-369*	-		LIS6.5 -6 bottles	*1-6*
CCL (CCL22-A3) **(casts 90-108)** to south	All	*370-483*				
DL (DL19-DL1) **(casts 109-127)** to south	All of DL1 to 3; and half of DL4 to 19	*484-547*	-			
Dla (DLa1-DLa8) **(casts 128-135)** to north	Half (even)	*548-571*	-			
BS (BS11-BS24) **(casts 136-150)** to east (US)	All	*572-657*	Half (odd)	*323-346*		
Total		**657**		***47***		**6**

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

- Whale Observations (including acoustic instruments on the moorings)

UW whale observer, Kate Stafford, took observations of marine mammal and was responsible for the moored acoustic whale recorders.

MOORING OPERATIONS (Woodgate, Leech, Daniels, Peralta-Ferriz)

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 2012 suggest that heat and freshwater fluxes are increasing through the strait [*Woodgate et al.*, 2006; *Woodgate et al.*, 2010; *Woodgate et al.*, 2012]. The work completed this summer should tell us if this is a continuing trend.

An overview of the Bering Strait mooring work (including access to mooring and CTD data) is available at http://psc.apl.washington.edu/BeringStrait.html. A map of mooring stations is given above.

Five UW-UAF moorings were recovered on this cruise. These moorings (all in US waters – A2W-12, A2-12, A4W-12, A4-12, and A3-12) were deployed from the Russian vessel Khromov in summer 2012 [*Woodgate and RUSALCA12ScienceTeam*, 2012] with funding from NSF-AON (PIs: Woodgate, Weingartner, Whitledge and Lindsay, ARC-0855748) with ship-time support from the NOAA-RUSALCA program (http://www.arctic.noaa.gov/aro/russian-american/)..

Three UW moorings (A2-13, A4-13, A3-13) were deployed on this 2013 Norseman II cruise under funding from ONR (PI: Woodgate, *N00014-13-1-0468*). 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 1-2 m 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). Bottom pressure gauges (BPG) were also recovered on the moorings at the east-west mooring extremes of the US channel of the strait (A2W-12 and A4-12) and at site A3-12 to the north of the strait. No BPGs were deployed. Two sites (A2, central eastern channel; and A3, the climate site) also carry ISUS nitrate sensors and some biooptics, both on recovery and redeployment. Recovered moorings A2W-12 and A3-12 and A4W-12 carried whale acoustic recorders, and whale recorders were deployed on the three new moorings also. Recovered mooring A3-12 also carried a suite of instruments to measure the inorganic carbon chemistry system in the strait, namely 1) SAMI-pH; 2) SAMI-pCO2; and 3) SBE-37. 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, the transmissometer, fluorometer and whale recording time-series measurements should advance our understanding of the biological systems in the region. This year's recoveries were the second year of year-round measurements of pCO2 and pH in the strait.

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. At sites A2-12 and A3-12 water samples were taken for calibration of the deployed ISUS instruments, and at site A3-12, water samples were also taken from the depth of the pCO2 and pH instruments. Similarly, CTD casts were taken at each mooring site immediately after deployment, including water samples at A2-13 and A3-13. 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. Data from these pre-recovery casts have already been used to prove that some of the SBE sensors on A3-12 were reading 1-4 psu too fresh by the end of the deployment (see below). **Action item: On recovery, check the post deployment casts to see how reliable the comparison is.**

2013 Recoveries and Deployments: Mooring operations went very smoothly in 2013. For recoveries, the ship positioned ~ 200m away from the mooring such as to drift towards the mooring site. Ranging was done from the starboard rail, with the hydrophone connecting to the deck box inside at the aft end of the port laboratory. Without exception, acoustic ranges agreed to within 30m 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.

The EG&G deckset proved problematic during the recoveries, sending signals successfully but not registering replies, and the back-up deck set was used for the second half of the recoveries. **Action item: Investigate and fix issues with EG&G deckset; Continue to always take a spare deck set.**

All the moorings were recovered without dragging operations. Other than A4-12, all releases functioned well, although two (16579, 17302) had very stiff release hooks during post-recovery testing on deck. Release 32833 on mooring A4-12 confirmed release, but the mooring did not surface. The second release (17304) was also fired after ~ 5min, and the mooring surfaced. However on recovery, only the original release 32833 was found to have released. The second instrument, 17304, had activated the release mechanism but the release link remained held by the release, and fell out on deck with gentle pulling during recovery. On inspection, release 32833 was found to have a barnacle growing on the release mechanism despite the presence of anti-fouling paint, and we hypothesize this may have held down the mooring for the ~ 5min. This was also a bottom pressure gauge mooring, so an alternative possibility is that the mooring was hung up on the bottom pressure gauge. It is notable that, in recent years, within the UW instrumentation, it is the releases on the bottom pressure gauge moorings which are showing issues. This may be coincidence, or may relate to torque on the set up while in the water or damage to the releases during deployment. The moorings are "dropped" from the surface, and in the bottom pressure gauge case the releases are very close to the anchor and may be hitting it, although preliminary calculations suggest the drag on the mooring slows the releases so that any hit is at low speed. To counteract some of these release issues, all the releases on the new moorings were equipped with springs, which are designed to force open the release once the catch has been activated. Some of these springs had to be cut to size to fit into the release mechanism. Newly deployed releases 16898 and 16875 were stiff during deck checks, due to anti-fouling paint. ***Action items: Investigate 17304; continue with biofouling paint on releases and with double releases, but check that paint does not foul the release; Investigate patterns in previous mooring recovery issues; Recheck pin alignment on all releases and issues of grease on the 16000 and 1700 releases. Investigate springs for use on moorings, and test these springs on the releases prior to deployment.***

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. The line from the hook was then passed back to through the stern A-frame, reeled in using the small capstan, and finally attached to a hook from the A-frame. If the pick was too long for the crane, a second A-frame hook was used to elevate the remains of the mooring. Then the whole mooring was lowered onto deck, and any iscats present were recovered by hand. Recovery work was done by a deck team of 3 crew of the Norseman II – one on the A-frame controls, two on deck with on overhead safety lines ("dog runs") down each side of the 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; high A-frame or crane very helpful for recovery.**

This year we were fortunate that all mooring recoveries were accomplished before the region became fog-bound. Since fog appears to be more common near the islands, we deliberately recovered the moorings in that region first, a strategy which proved valuable, as shortly after recovery those sites became fog-bound. While good visibility is necessary for recovery (since with biofouling the moorings may not surface immediately), it is worth remembering that in calm seas, the ship's radar may be able to pick up the steel float on a surfaced mooring.

Biofouling was moderate to light in the recoveries this year, with A4-12 being the most fouled as per last year. Fouling was predominantly by barnacles, though there was also evidence of tube worms on the bottom pressure gauge on A4-12, and anoxic mud in recessed chambers of the ADCP float on A3-12 (possibly due to metabolically active sediment particles in spaces with poor water exchange). The iscat recovered from A4W-12 contained a lot of slit, while the iscat on A2-12 had bryozoans inside. Overall though, release hooks were generally clear of biofouling, except for 2 barnacles on A4-12. Throughout, salinity cells were clear of biological growth. The microcat on A3-12, which had been mounted horizontally, however, had a cell which was extremely clogged with slit, severely compromising salinity measurements (see below).

Mooring deployments were done through the aft A-frame, using the A-frame hook 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. When the ship was approximately 250m from the mooring position, mooring deployment started. The first pick was positioned below the ADCP, allowing most of the mooring to come off the deck during the first lift. Just as the ADCP was nearing the water, the iscat was deployed by hand and allowed to stream behind the boat. The first pick was released by a mechanical quick release, which was then repositioned to lift the anchor into the water. When the ship arrived on site, the anchor was dropped using the mechanical quick release. Positions were taken from the ship's measurements of the GPS of the aft A-frame, confirmed using a hand-held GPS on the upper aft deck. Slip lines were used to control equipment on the mooring as the mooring was lowered over the side. The same team of 3 Norseman II crew did the deployments, with one person on the A-frame, and the other 2 on the "dog runs' assisting the instruments up into the air and operating the quick release. For the first deployment, A3-12, a distance to site of 250m was used, and the mooring was ready to release at 150m. For the second deployment, a distance of 150m was used, but this left only just enough time for deployment. The third deployment started at 350m from site, and the mooring was towed for ~ 20min while the ship made ~ 0.5 knots over ground (through strong currents and wind) to the mooring site.

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, although there were some issues communicating with equipment via USB-to-serial port adaptors. **Action item: Check new laptops with all instrumentation.** Iscat housings and ADCP frames were assembled using a team of 3 people in Nome. The iscat loggers were equipped this year with lithium batteries, and the battery connectors proved problematic to give reasonable connections. **Action item: Reconsider iscat battery connectors**. New software for the ADCPs was found to erase the bottom track measurements unless preventative steps were taken. **Action item: Adjust check sheets to show must not use planning step.** Some other minor issues were noted with spare instrumentation. **Action item: check compass calibration on spare ADCP.**

Overall, data recovery on the moorings was very good. Many instruments were downloaded this year via a Seabird USB-serial port converter, as the newer laptops did not have serial ports and/or downloads were run in parallel to the laptop logging navigation. **Action item: Bring more laptops for these downloads.**

ISCAT SBE37IMS: Of the 5 iscats deployed on the recovered moorings, only 3 top sensors containing the inductive SBE37s (A2W-12, A2-12, and A4W-12) were recovered. These inductive SBE37s each took ~ 15hrs to download, even where the serial port could be attached directly to the SBE37, bypassing the inductive head. When downloading through the inductive head, it was found that a full download required two 9V batteries on the battery powered downloader. On 8964, which could be downloaded bypassing the inductive head, it was found that the commands to convert output to hex did not work, and only ascii data could be downloaded. In addition, the record contained 475 missing lines of data at regular intervals, relating to some repetitive glitch in the downloading. **Action item: Check with Seabird re conversion to hex and the downloading glitches; take sufficient 9V batteries, investigate external power source for the battery-powered reader.** Of the two iscats what were lost, one (A3-12) had broken predictably at the weak link. However the other, (A4-12), had broken above the lower stopper on the top iscat float and the cable (~20m) and weak link were still attached to the mooring. The break in the wire rope had corroded significantly suggesting the iscat float had been lost for some time. (The logger stopped data acquisition on 16th Oct 2012 and had only 2V battery by recovery, indicative also of the float being missing for some time.) **Action item: Investigate what could have caused this breakage.**

ISCAT LOGGERS: Of the 3 systems where the iscat float was recovered, on two of them (A2-12 and A2W-12) the logger was still connected and recording. In the third system (A4W-12), the logger ceased recording on 9th May 2013, and the cable was found to be unplugged and somewhat corroded on recovery, suggesting the system became unplugged sometime during the year in the water and not just on recovery. On this system, the logger voltage was ~ 6.8V. **Action item: Investigate why cable would unplug without losing iscat, and what can be done to prevent it.** Generally the data from the loggers was good, although logger 7 on A4W-12 had 25 bad records and loggers 22 and 27 (on A3-12 and A4-12) experienced multiple hours (>12hrs) where they took no data. **Action item: Investigate**.

. **ADCPs:** All the 5 ADCPs recovered were still running on recovery. Four of these had complete data sets, even though one (ADCP 1495 – A2-12) required external battery power to complete the download. The 5th ADCP (2269 from A4-12) worked according to the deployed settings from deployment until 22nd November 2012. It then restarted, after a pause of ~ 16hrs, and continued to take data on a different set of settings, which did not include bottom track, and apparently with compass issues although compass checks at sea suggest the compass was still good to 6deg.. **Action item: Investigate ADCP 2269; do on shore checks of all compasses**

SBEs: A seabird SBE16 or SBE16plus was recovered from each mooring, and in addition, mooring A3-12 carried two additional temperature salinity (TS) sensors, SBE37s.

The SBE19plus meters (1559 on A3-12 and 4973 on A2-12) both carried some external biooptics sensors (see table). Calibration information for these sensors is not available to us currently and the biooptic data are not included in this report. In addition A3-12's SBE16, 1559, was not equipped with a pump, so it is unclear if these external data will be good. There is some confusion on both the SBE16plus meters as to start and end times of records, but this has been generally corrected for in the data, using times in and out of the water, and comparison to tidal cycling of pressure signals from the overlying iscat for A2-12.

Three TS sensors (A2-12-4973 (pumped), A3-12-1559 (not pumped) and A3-12 SBE37-2316 (not pumped)) were deployed mounted horizontally in cages. On recovery, SBE37-2316's salinity cell was almost complete clogged, and we suspect similar clogging of cells on the other two instruments. Comparison to the vertical SBE37 (1430) on A3-12 and to CTD casts taken at recovery shows us that these horizontally mounted instruments experience large salinity errors, being up to 1-4psu too fresh. We note the manufacturer's recommendation that instruments be mounted at an angle of at least 15 degrees from the horizontal. **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.**

The pressure sensor on A2-12-4973 failed part way through deployment. **Action item: repair 4973 pressure sensor.** The pressure sensor on SBE37-2316 shows 2m of drift (to shallower depths). **Action item: replace 2316 pressure sensor.** SBE16-2341 on A4W-12 has a few (5) single point temperature spikes, which have been removed here by linear interpolation. SBE16-0008 on A4-12 would not communicate on recovery. Opening the meter, we found no leakage, and battery voltage was still good. This instrument has been returned to Seabird for investigation. **Action item: SBE0008 investigation.**

A preliminary review of the SBE data show annual cycles of temperature and salinity. Direct comparison with older data is necessary to ascertain if preliminary indications of freshening from previous years is significant. Winter salinities appear to be up to 0.5psu fresher, and summer salinities, on occasion 2 psu fresher than last year, although these numbers must be confirmed after post-cruise calibration. Scouring of the salinity sensors in the strait has in the past led to salinity drift of ~ 0.1pus in the sensors. There are interesting periods of freshening that appear to come from the west, rather than the east, also.

BPG: Bottom pressure gauges (BPG) returned full records, other than BPG 1333 on A4-12, which had a low battery on recovery and stopped recording in April. **Action item: Investigate current draw on 1333.** Differencing pressures across the strait suggests flow anomalies of between -100 and + 150cm/s. Note that since the absolute depths of the instruments are not known, the BGPs can only be used alone to give flow anomaly, not total flow.

Turbidity/Fluorescence: In addition to the optics sensors on the SBE16+, two independent Flntusb sensors were deployed on the moorings. Of these, #935 on A3-12 was still recording on recovery and gave good data, while #932 on A4-12 was not working on recovery and on opening, was found to have leaked significantly. This instrument has been returned to Wetlabs to see if any data may be rescued.

The A3-12 record suggests both an autumn and spring elevations of chlorophyll, with the autumn bloom being pulsed and the spring bloom being more consistent. Interestingly, peaks in the turbidity signal appear to be mostly independent of the chlorophyll peaks. These turbidity peaks occur from autumn and through the winter. See below.

Other Instrumentation: Other sensors on the moorings are described in individual cruise reports below.

Of the **2 ISUS nitrate sensors** recovered, one (ISUS88 on A2-12) returned a full year of data, while the other one (ISUS98 on A3-12) had a leaked battery pack and initial investigation suggest it recorded little/no data.

The **3 recovered whale recorders** yielded data from 1st Sept 2012 to mid-May 2013 at sites A2W-12 and A3-12, and to late June 2013 at site A4W-12.

The **Sami-pCO2 sensor** ran for the year, although the data show a very strong drift (as discussed below). **Sami pH sensor** acquired data for ~ 7 months, with only ~ 1/3rd of these data giving any prospect for a measure of pH.

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 2013 MOORING POSITIONS AND INSTRUMENTATION

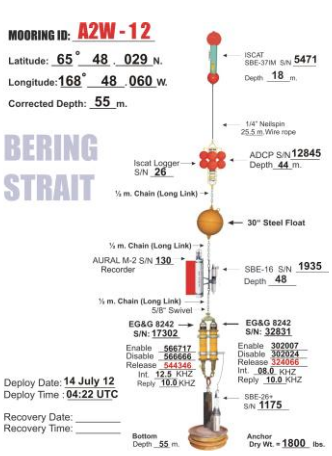
ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2012 Mooring Deployments (Recovered 2013)				
A2W-12	65 48.03	168 48.06	55	ISCAT, ADCP, SBE16, WR, BPG
A2-12	65 46.86	168 34.07	56	ISCAT, ADCP, SBE/FPAR, ISUS
A4W-12	65 45.42	168 21.95	56	ISCAT, ADCP, SBE16, WR
A4-12	65 44.75	168 15.77	50	ISCAT, ADCP, SBE16, FLT ,BPG
A3-12	66 19.61	168 57.05	59	ISCAT, ADCP, SBE37(2), pH, pCO2, SBE/TFPar, ISUS, WR, BPG, FLT

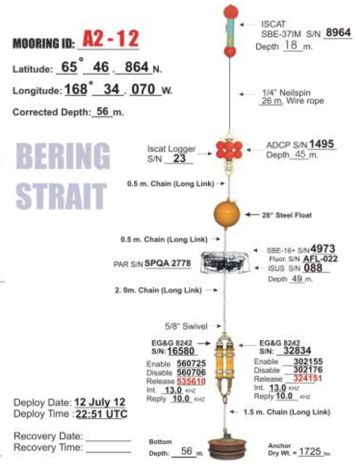
ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2013 Mooring Deployments				
A2-13	65 46.86	168 34.05	56	ISCAT, ADCP, SBE16+Fl, ISUS, SBE16, WR
A4-13	65 44.75	168 15.75	49	ISCAT, ADCP, SBE16, WR
A3-13	66 19.62	168 57.06	58	ISCAT, ADCP, SBE16, SBE16+Fl, ISUS, WR

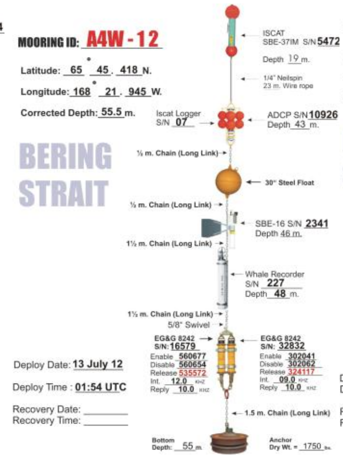
ADCP = RDI Acoustic Doppler Current Profiler
BPG=Seabird Bottom Pressure Gauge
FLT=Wetlabs Biowiper Fluoresence & Turbidity recorder
ISCAT = near-surface Seabird TS sensor in trawl resistant housing, with near-bottom data logger
ISUS= Nutrient Analyzer
pCO2 = SAMI pCO2 sensor
pH = SAMI pH sensor
SBE/TFPar = Seabird CTD recorder with transmissometer (T), fluorometer (F), PAR(Par)
SBE16+Fl/TFPar = Seabird CTD recorder with fluorometer (Fl)
SBE16 = Seabird CTD recorder
SBE37 = Seabird Microcat CTD recorder
WR=Whale Recorder

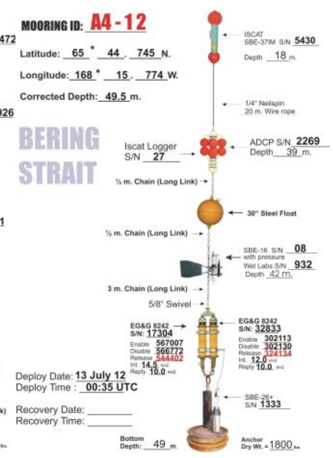
BERING STRAIT 2013 SCHEMATICS OF MOORING RECOVERIES

= in the eastern channel of the Bering Strait

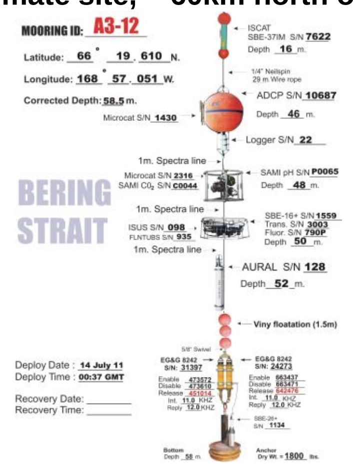






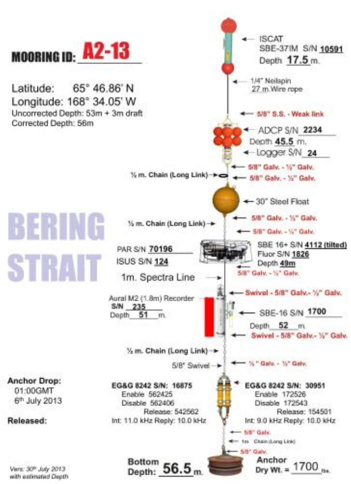


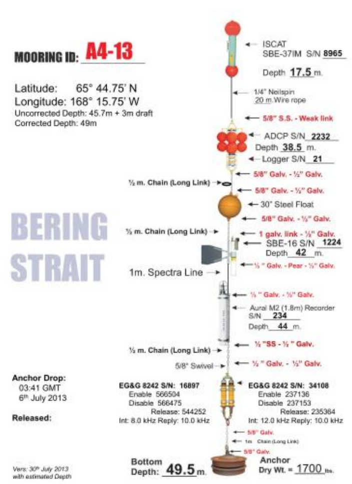
= at the climate site, ~ 60km north of the Strait



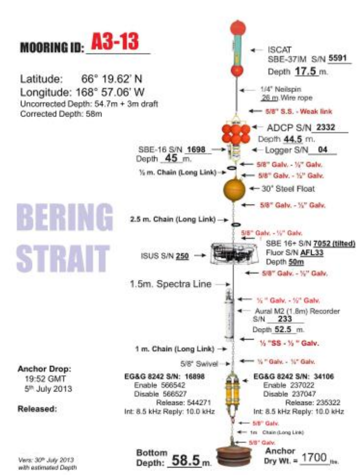
BERING STRAIT 2013 SCHEMATICS OF MOORING DEPLOYMENTS

= in the eastern channel of the Bering Strait

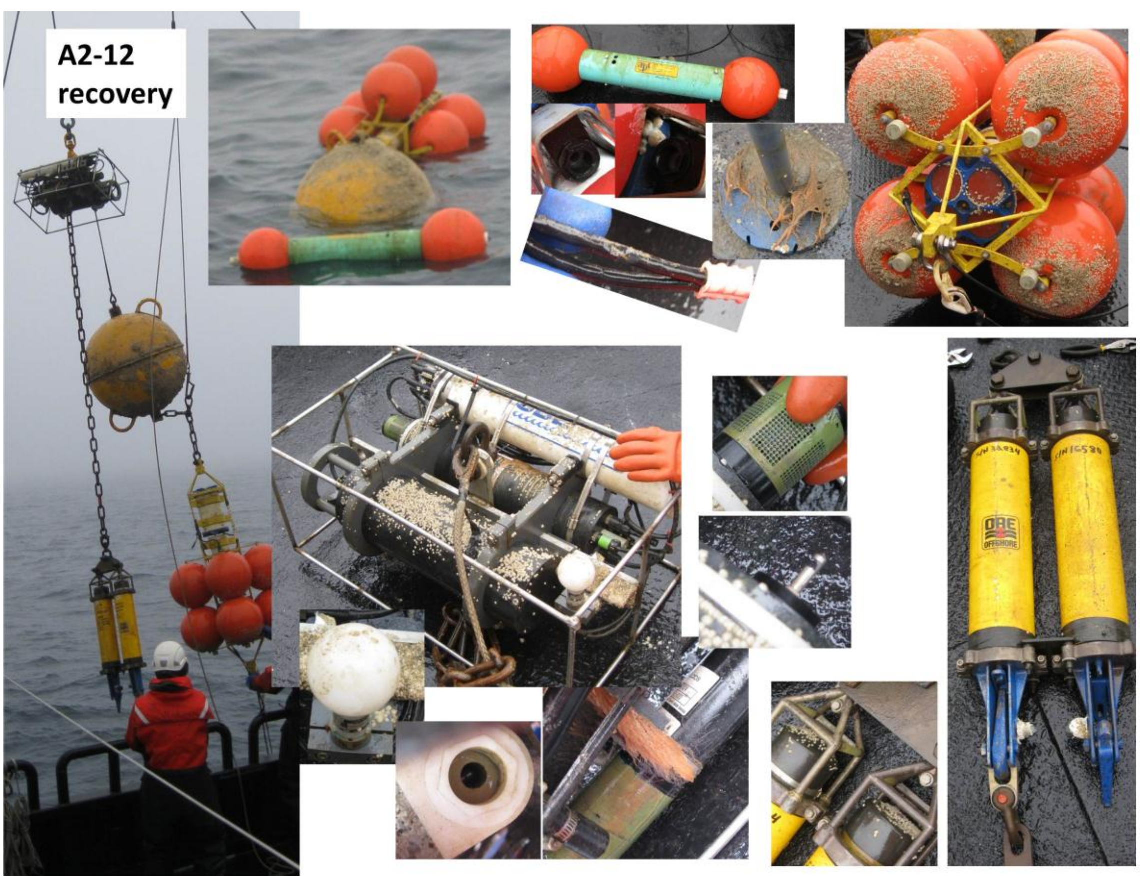




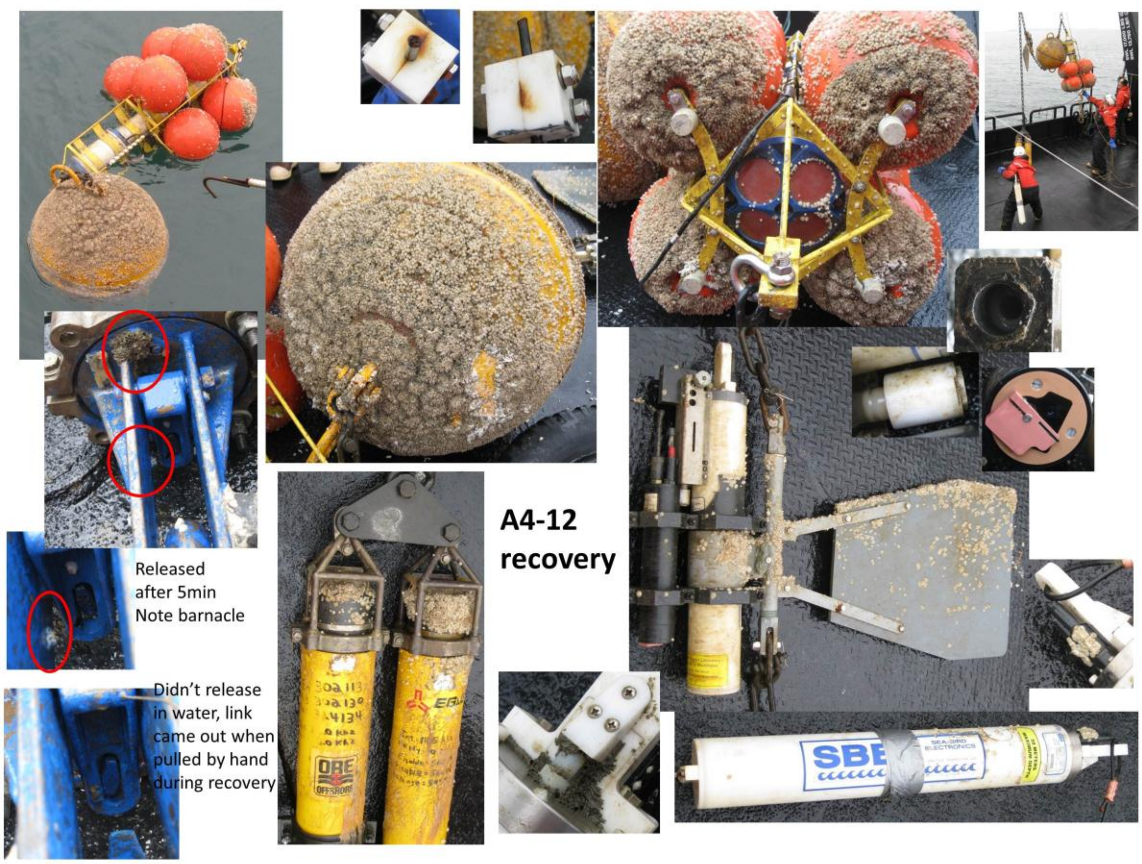
= at the climate site, ~ 60km north of the Strait



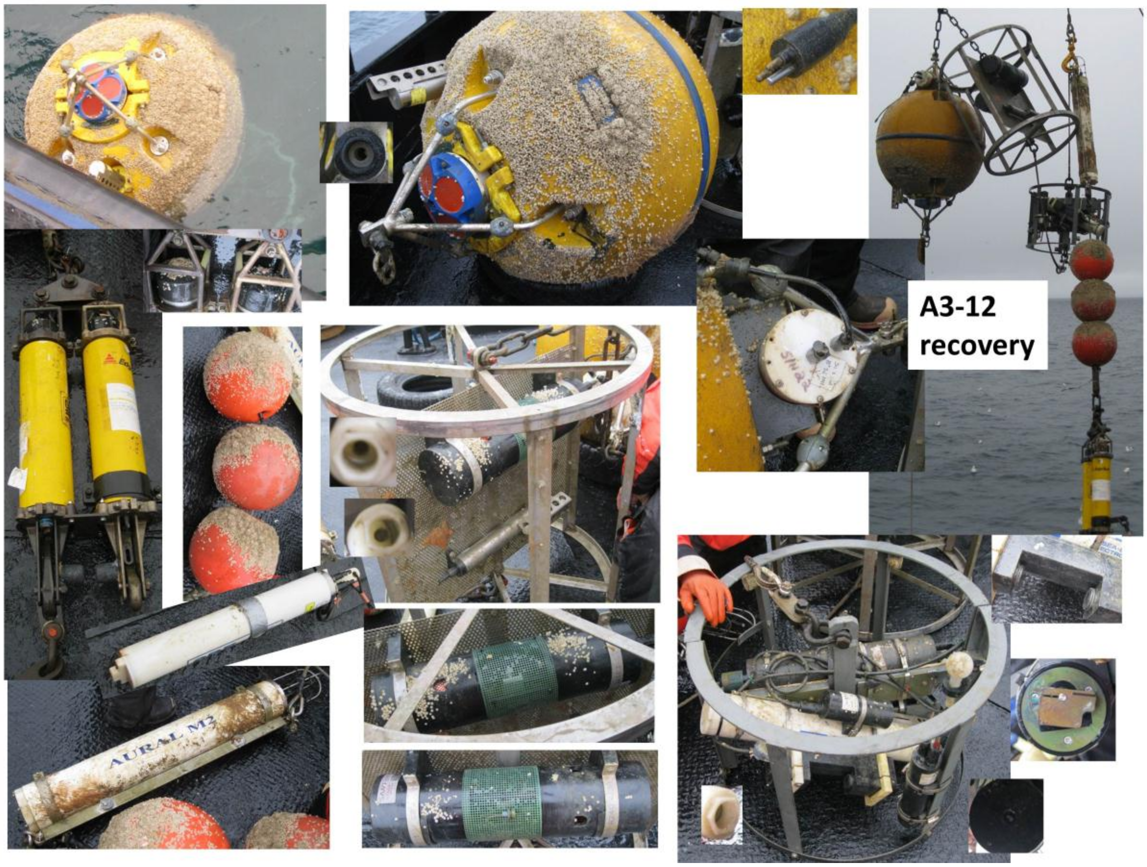
BERING STRAIT 2013 RECOVERY PHOTOS (in order from the Diomedes to the US, then A3)



BERING STRAIT 2013 RECOVERY PHOTOS (continued)

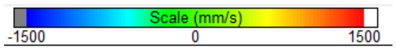


BERING STRAIT 2013 RECOVERY PHOTOS (continued)

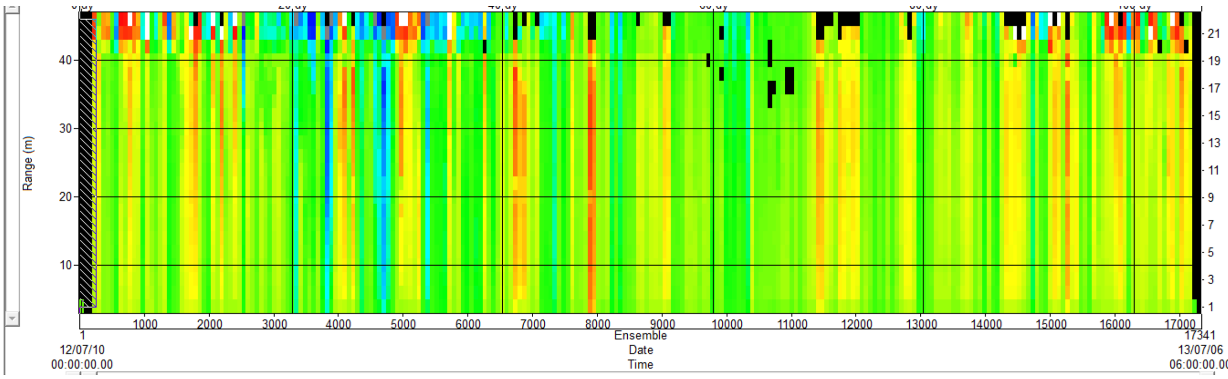


BERING STRAIT 2013 PRELIMINARY ADCP RESULTS

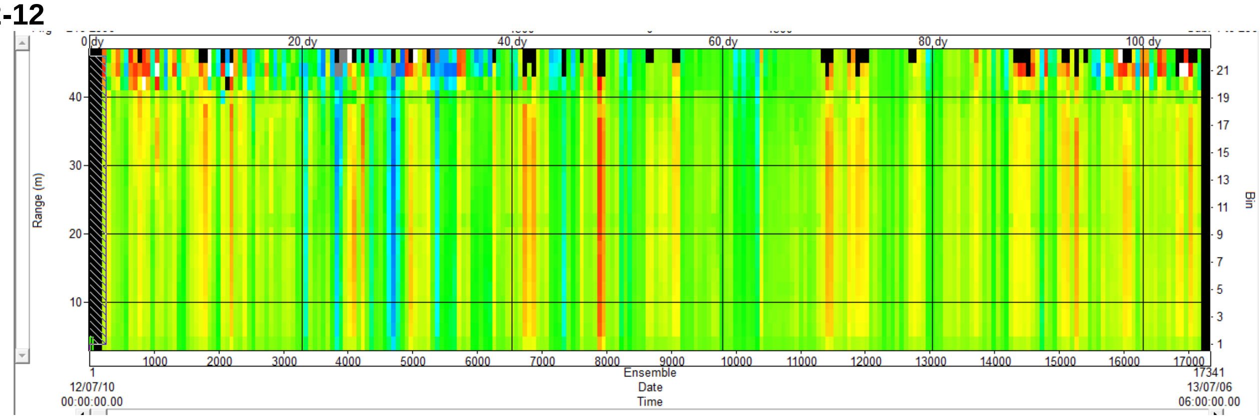
- NORTHWARD VELOCITY from ADCPs



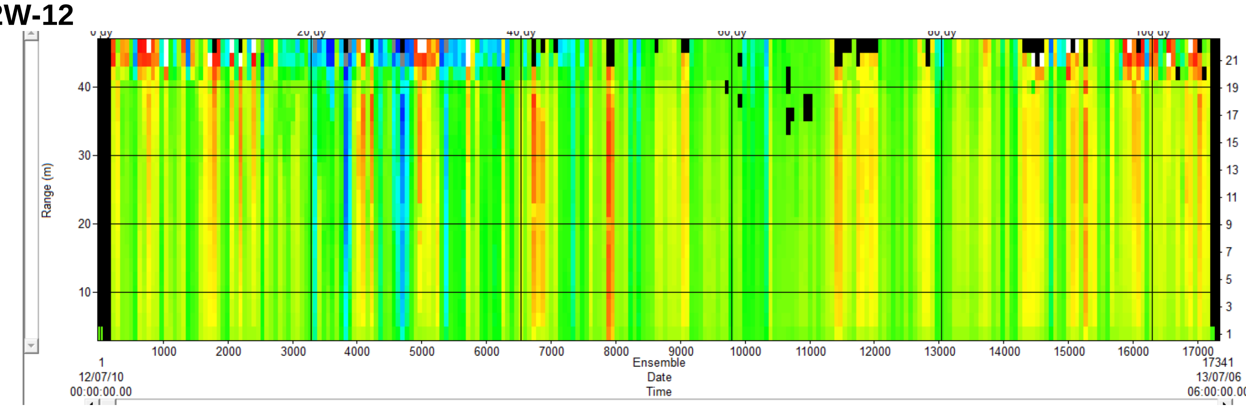
A2W-12



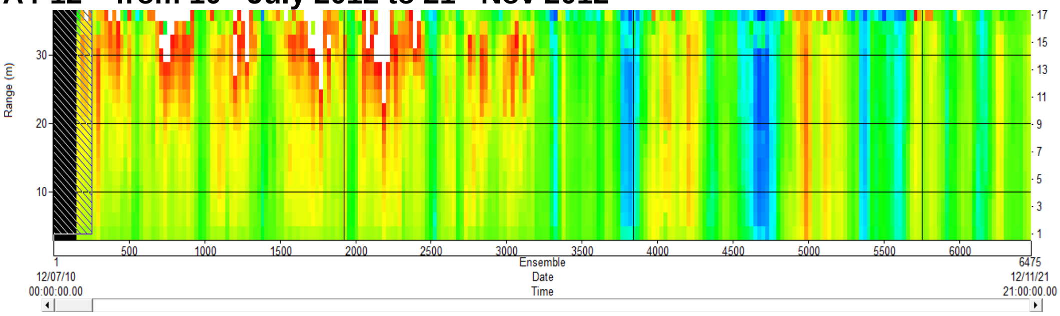
A2-12



A2W-12

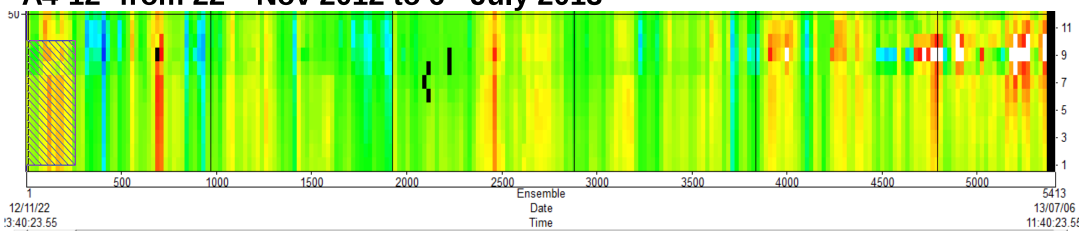


A4-12 – from 10th July 2012 to 21st Nov 2012

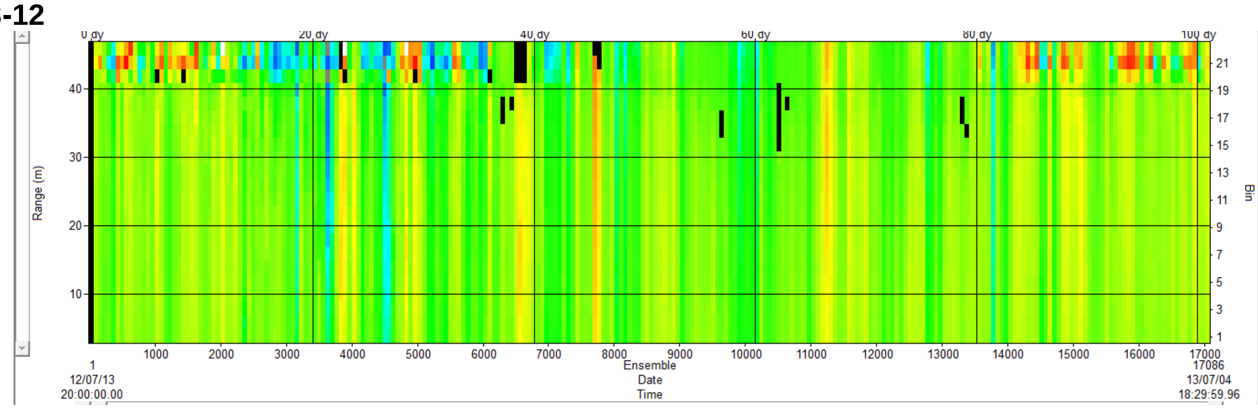


ADCP lost settings at this stage, and restarted without bottom track, yielding ..)

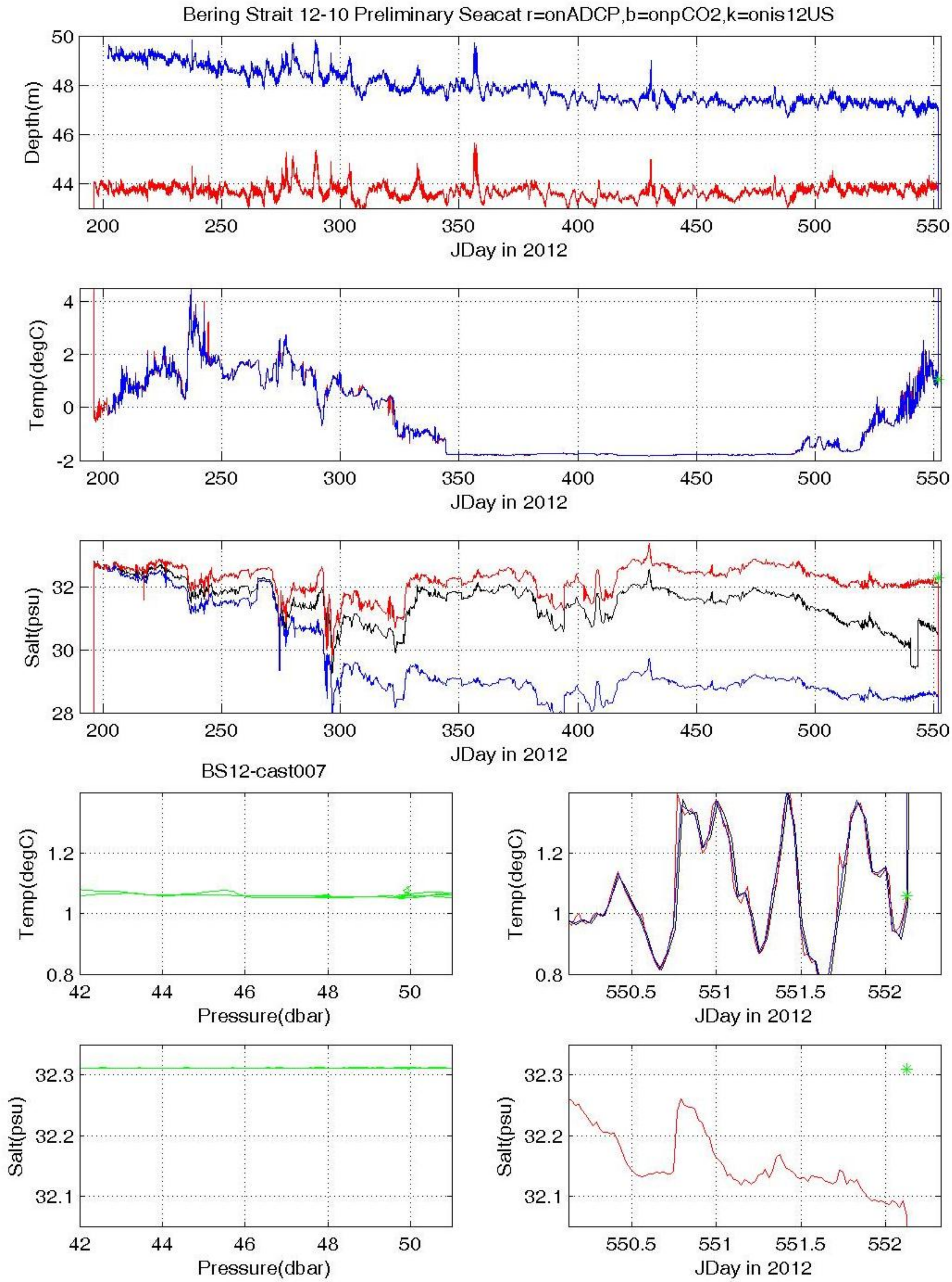
A4-12- from 22nd Nov 2012 to 6th July 2013



A3-12

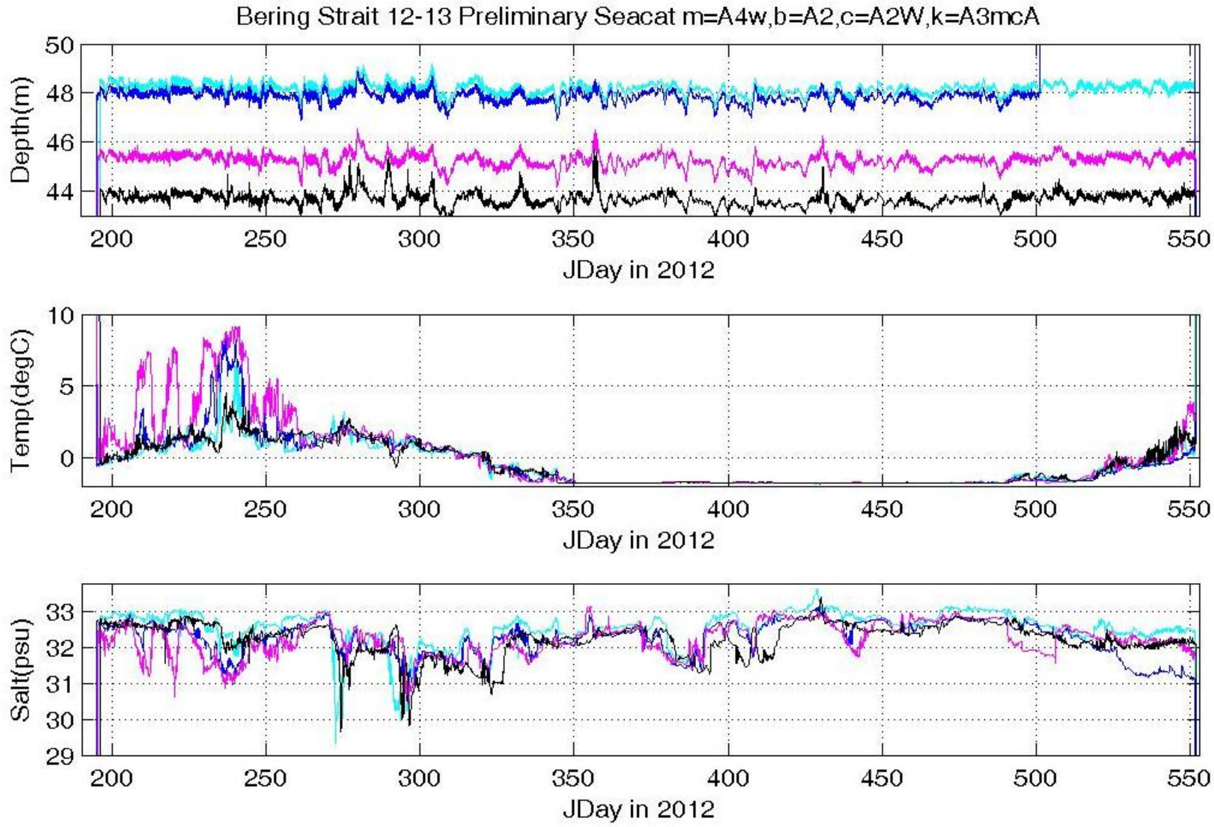


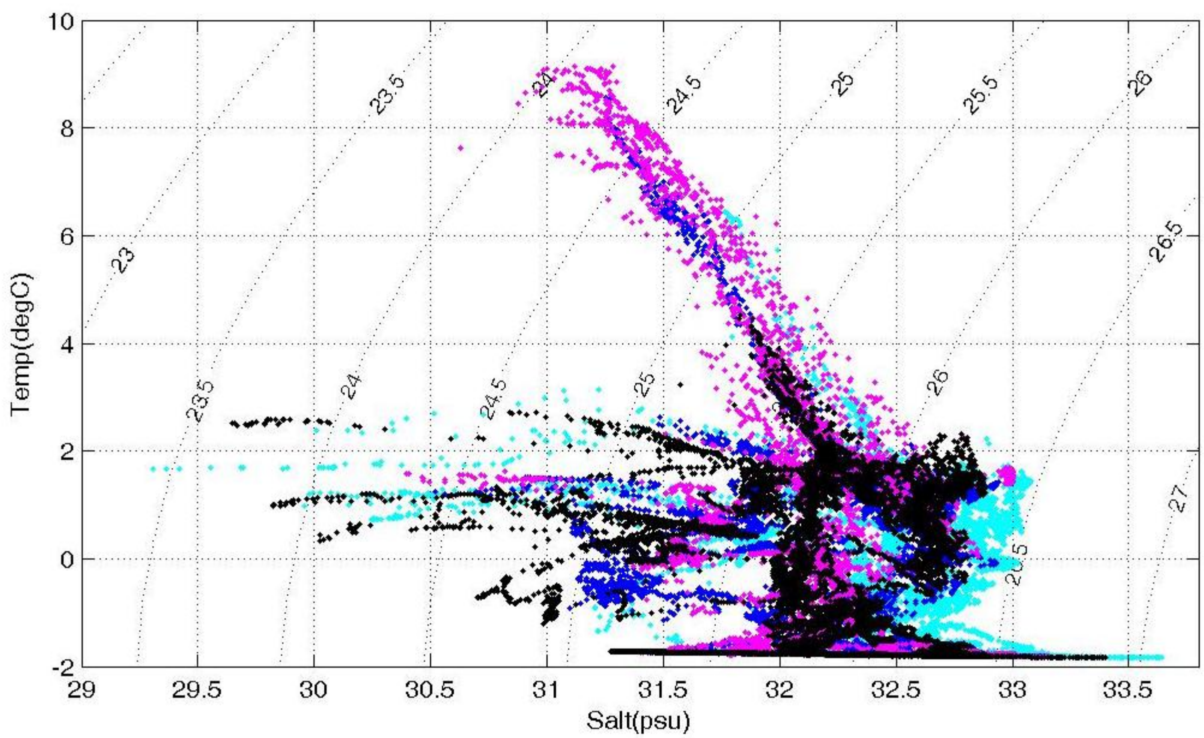
BERING STRAIT 2013 PRELIMINARY RESULTS
– A3-12 SBE CLOGGING



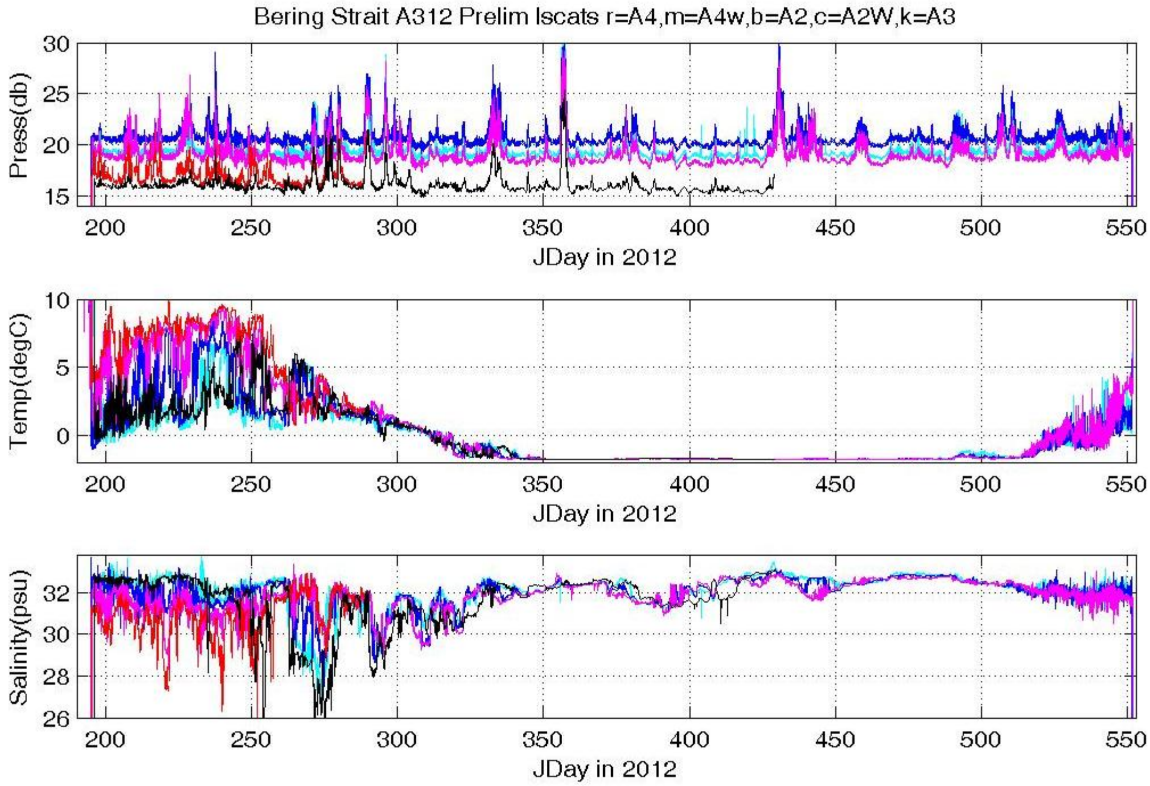
Red = Vertical Microcat. Black=Horizontal pumped SBE. Blue=Horizontal Microcat with no pump. Green lines and * = CTD cast pre recovery. Bottom left panels – bottom section of pre recovery CTD cast. Bottom right panels – extract from end of time-series.

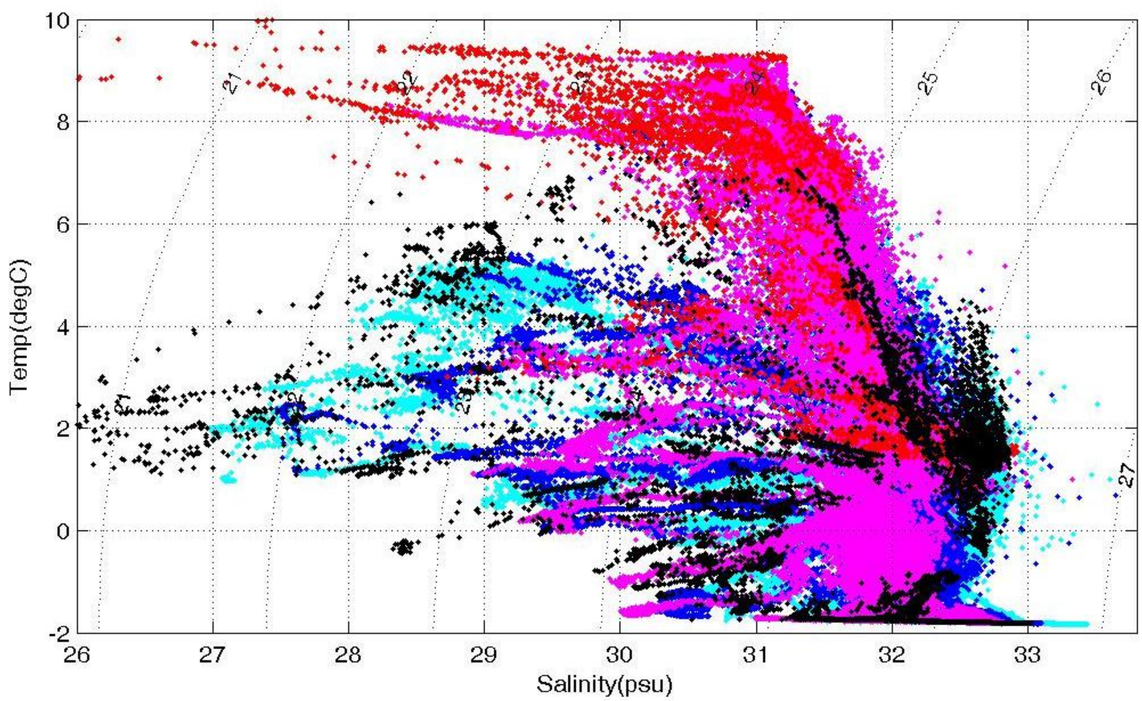
BERING STRAIT 2013 PRELIMINARY RESULTS
– all lower level TS Sensors





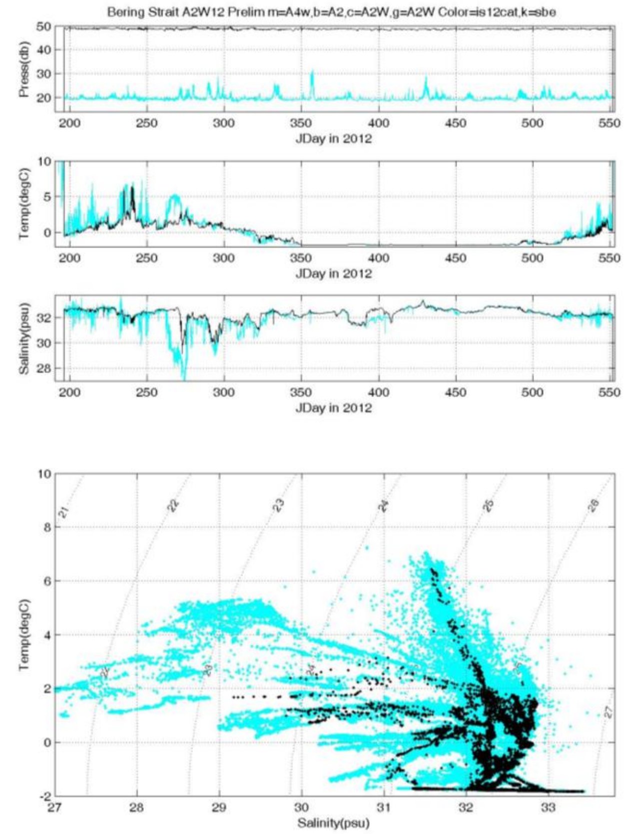
BERING STRAIT 2013 PRELIMINARY ISCAT RESULTS



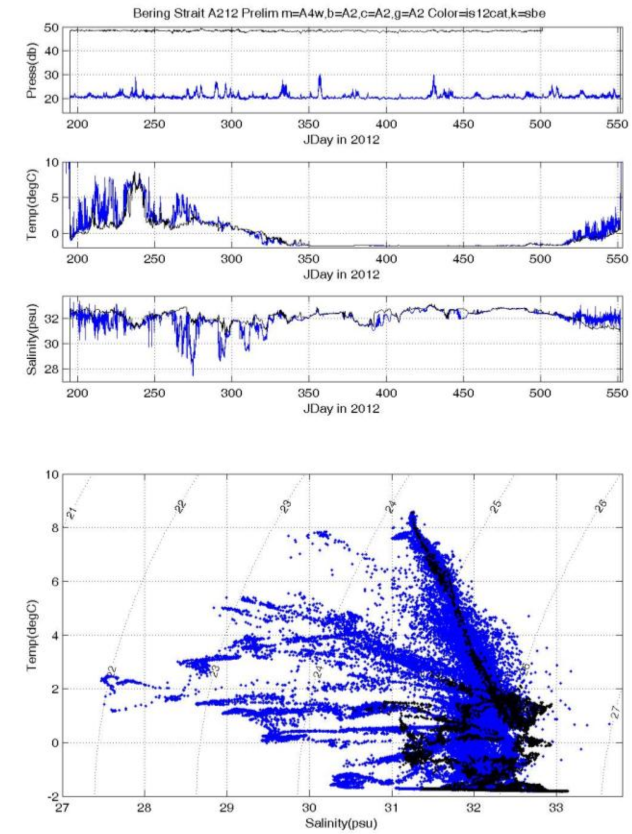


BERING STRAIT 2013 PRELIMINARY ISCAT AND SBE RESULTS (per mooring)

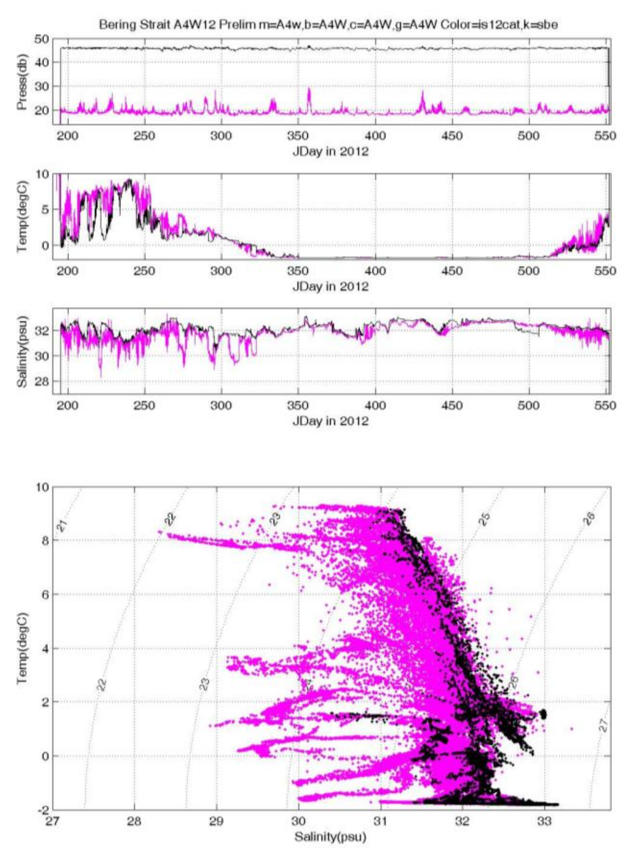
A2W-12



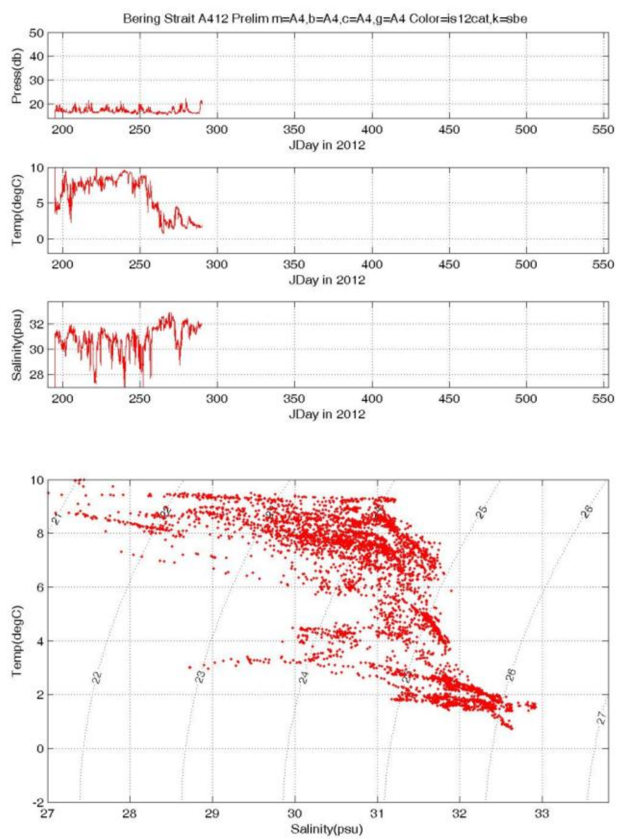
A2-12



A4W-12

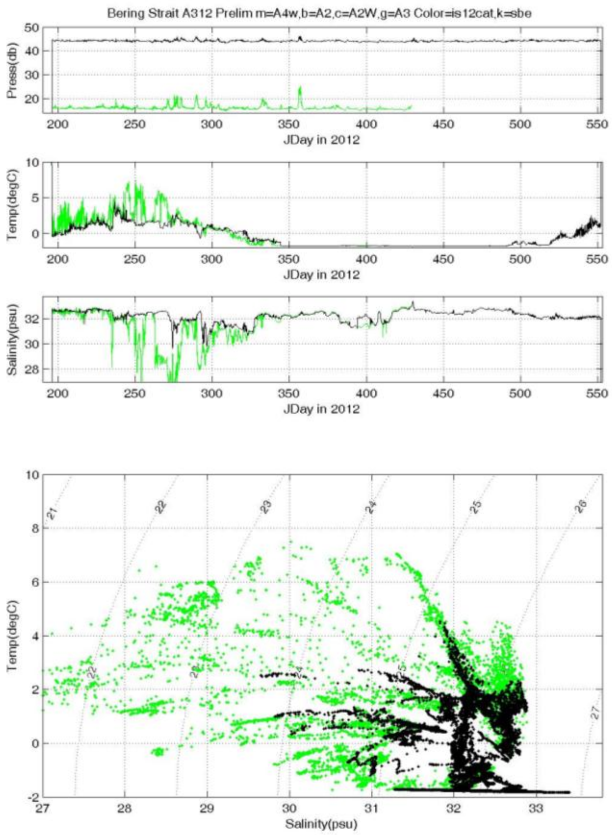


A4-12

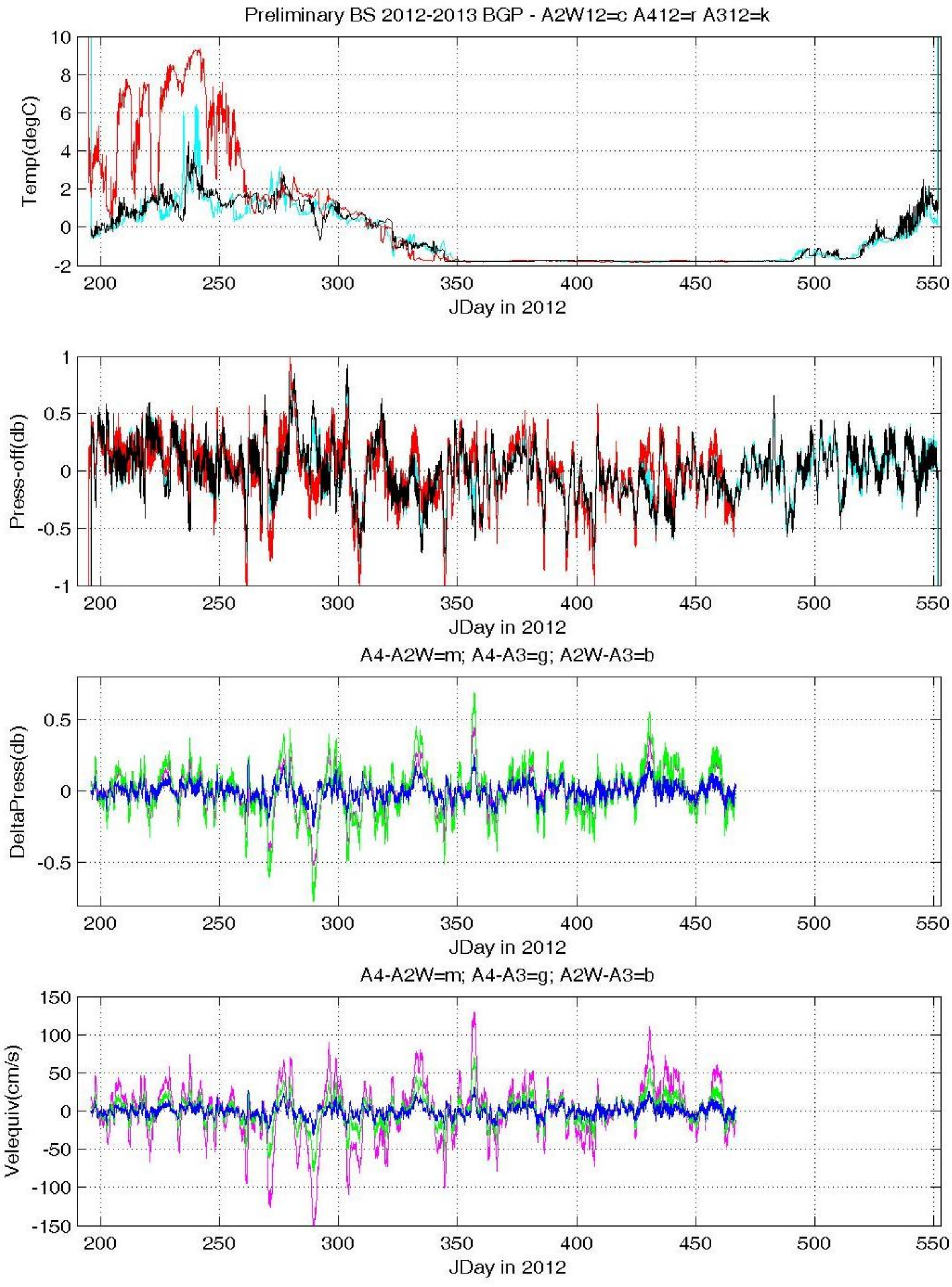


BERING STRAIT 2013 PRELIMINARY ISCAT RESULTS (continued)

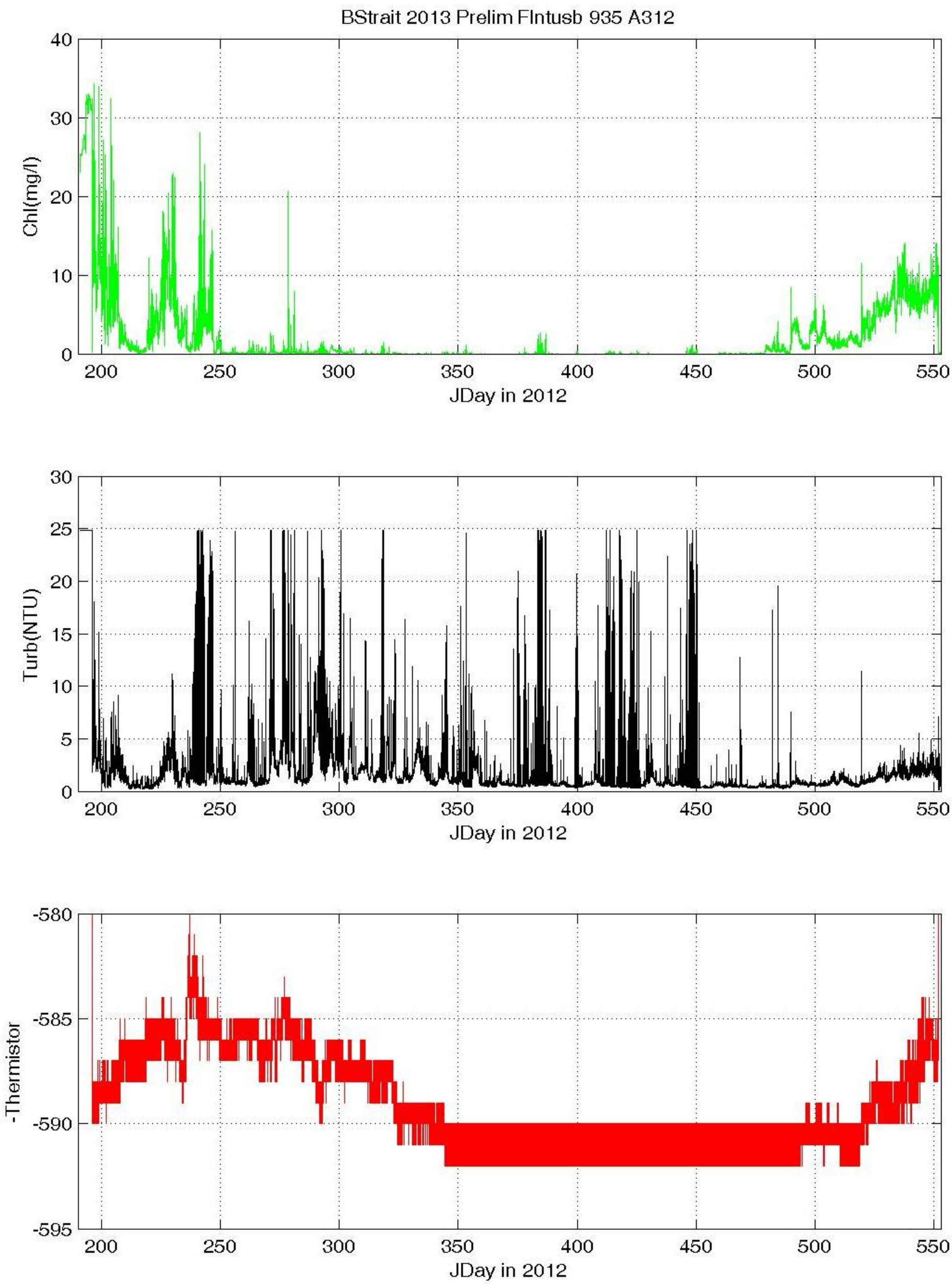
A3-12



BERING STRAIT 2013 PRELIMINARY BOTTOM PRESSURE GAUGES RESULTS



BERING STRAIT 2013 PRELIMINARY FLUORESENCE/TURBIDITY RESULTS



CTD OPERATIONS (Peralta-Ferriz, Daniels, Stockwell, Leech, Woodgate)

As in previous years, the moorings were supported by annual CTD sections, with water samples for various projects as described below.

The CTD rosette system used on this cruise was loaned from Peter Winsor (UAF). The SBE19plus CTD package, with oxygen and fluorometer with six 4-l bottles with internal rubber bands, was controlled by a SBE-33 deck-unit, connected to a PC running the software package Seasave v7.

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 for the very thin winch wire on the lightweight winch, also loaned from Peter Winsor. The target lower speed was ~ 0.3 m/s. Bottles were fired by the CTD operator at the deck-unit on the up-cast. Data were recorded in standard hexadecimal SBE format, incorporating NMEA GPS input from the Norseman II aft A-frame. 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, being placed up on boxes to allow for water sampling.

An event log was maintained on the CTD computer, and paper records for bottle fires were completed and scanned post cruise.

Preliminary data processing was done on board, using the Seabird data processing software as described below.

<u>Configuration for Bering Strait 2013 cruise – known instrument calibration dates in parentheses</u>
<u>*(SN in italics are taken from the cal sheets, not from the instruments)*</u>

- SBE19plus V2 Seacat CTD SN 6849 with strain gauge pressure (Calibration 21st Jun 2011)
- SBE43 Oxygen SN2136 (Voltage 0) (Calibration 21st Jun 2011)
- Wetlabs WETstar Fluorometer SN:WSCHL-1404 (Voltage1) (Calibration 1st Jun 2011)
- Teledyne Benthos Altimeter:7601 SN*53448* (Voltage6)
- SBE 5T Pump
- SBE 55 Ecowater sampler (SN81) with six 4-liter bottles with internal rubber bands (Part 801714)
- SBE 33 Carousel Deck Unit
- NMEA input from the Norseman II, Aft-A-frame GPS

CTD and water sampling operations were run with a team of 5 people at any time – 1 ship's crew driving the winch; 1 ship's crew deploying and recovering the package over the side; 1 science team member running the CTD console; 1 science team member in charge of picking bottle fire depths and managing water samples; and 1 science team member to rig the rosette and assist with water sampling. For simple water sampling, this could likely be reduced to 4 people. CTD operations were run 24hrs using a 2-watch system. The efficiency of the crew made for very speedy CTD deployments, and CTD lines run during the cruise were done in ~ 70% of the time taken in previous years.

In general, CTD operations went smoothly, and a total of 150 casts were taken (see map above and event log below for positions).

Since the system was loaned and unfamiliar to us, there were setup issues, which were resolved with assistance from shore (our thanks go to Hank Statscewich and Peter Winsor for prompt and helpful advice). Initial communication issues with the CTD system, which appeared to be transmitting garbage characters, were finally identified as due to a blown fuse in the SBE33 deck unit. **Action item: Check and bring spare fuses. Check and bring .xmlcon and .psa file.** Casts with strong temperature gradients yielded profiles with unrealistic salinity spikes, due to a mismatch in timing of the temperature and salinity sensors. Suspicion originally fell on a blocking of the venting tube, and this was cleaned out, but did not remove the spiking. The spiking was corrected in post processing during the cruise, but screen plots of the casts still contain this error. **Action item: Investigate if the correct time-lags can be incorporated in Seasave. Check for salinity-temperature timing during post processing.** Screen plots also have oxygen voltage mislabelled as fluorescence. Fluorescence data was successfully recorded (see section plots below), but is not included in the images of the CTD trace taken immediately post cruise. **Action item: Check .psa file for Seasave to include Fluorescence.**

Several problems were encountered with leaking bottles on the rosette. The spring mechanism for these bottles was an internal strip of rubber, which frequently was not under sufficient tension to hold the bottle shut once the vent plug had been released. Bottle failures are noted on the water sampling sheets. The closing power was somewhat but not sufficiently improved by twisting the strip of rubber, and thus finally the rubber strips were retensioned.

A likely challenge on data processing will be the oxygen data, which showed significant hysteresis between the down and up casts. No bottle oxygens or salinities were taken to calibrate the CTD.

Generally the ship drifted during CTD operations, though in strong current and wind the ship would manoeuvre for better CTD deployment. The package is light, but despite this there were only moderate problems with the CTD wire not being vertical. Weather was generally good for CTD operations, though at one stage winds and seas came close to shutting down the CTD operation. **Action item: Verify the safe working load of the winch wire.**

Ship's draft is 3m, and this should be taken into account in viewing the data.

CTD data was preliminary processed at sea by C. Peralta-Ferriz using standard SBE software and techniques, in the following steps:

1) Both up and down casts were converted from the .hex file.

2) Filtering was done using 2 low-pass filters – low pass filter A (1sec) for pressure, and low pass filter B (0.5 sec) for temperature and conductivity. (Other parameters were not filtered.) Filtered files have the code F in the filename.

3) Alignment was done using Advance values of 0.5 for temperature (established by on-board testing), 4 for Fluorescence and 3 for oxygen (both as per SBE19+notes). Aligned files have the code A05 in the filename.

4) Corrections for the Cell Thermal Mass were made using a thermal anomaly amplitude (alpha) of 0.04 and a thermal anomaly time constant (1/beta) of 8, both setting as recommended for the SBE19+. Files corrected for Cell Thermal Mass have the code C in the filename.

5) Loop editing was done with the following settings:

- -- Minimum ctd velocity (m/s) = 0.25
- -- Check box Remove Surface soak = 0.25
  - -- Surface soak depth (m) = 2
  - -- Minimum soak depth (m) = 1
  - -- Maximum soak depth (m) = 2.5

--> Check box Use deck pressure as pressure offset
--> Check box Exclude scans marked bad

Files corrected with these settings have the code L in the filename.

6) Final CTD files were then produced including calculations also for density, salinity and depth, and these files have the code D in the filename.

Thus from the original file BStrait13xxx.hex, the fully processed data file will become BStrait13xxxFA05CLD.cnv. These files also contain a column giving the number of bottles fired, and thus can be used to extract bottle firing information.

Files are also available split into up and down casts, (prefix u and d). It is unclear if the standardly processed .ROS files of bottle data contain the several corrections made above, and thus it is recommended to use the .cnv files for obtaining bottle data. **Action item: Include lat lon in the .cnv files to allow for estimates of ship's drift during the cast.**

A total of 9 CTD lines were run on the cruise, far more than planned in this short cruise. We were able to accomplish so many stations due to the efficiency and speed of ship and deck operations during the CTD work, and due to the great assistance from and preparedness of the ship's crew, which allowed us to start CTD operations immediately after mooring work.

Preliminary sections were plotted by C Peralta-Ferriz from the corrected data. The plots below give all 9 sections on the same scales, and then the DL lines again with a different set of scales.

Various repeat stations were run during the cruise, after intervals of hours and of days. It is of particular interest that the Bering Strait line was run under northward wind conditions at the start of the cruise and under southward wind conditions at the conclusion of the cruise, with the second occupation showing dramatic changes (reduced temperatures and higher salinities) in the waters near the Alaskan Coast. In addition, the Japanese ran the CS line very shortly after our occupation of it. Study of these co-located stations will give insight into the temporal variability of the region.

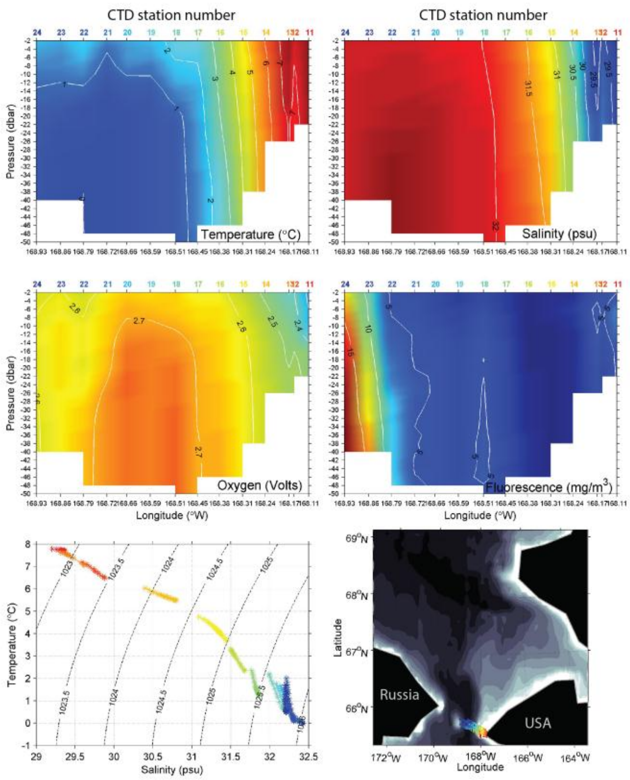
Remarkably fresh waters (21-26psu) were encountered off Point Hope and Cape Lisburne, and these are discussed below in the Delta-O18 sampling section.

Remarkable spatial variability in water properties was found on the repeat DL lines just north of the Diomede Islands. It will be informative to consider these data in light of the underway temperature, salinity and ADCP data recorded during the cruise.

BERING STRAIT 2013 CTD LINES – (in order, all times GMT)

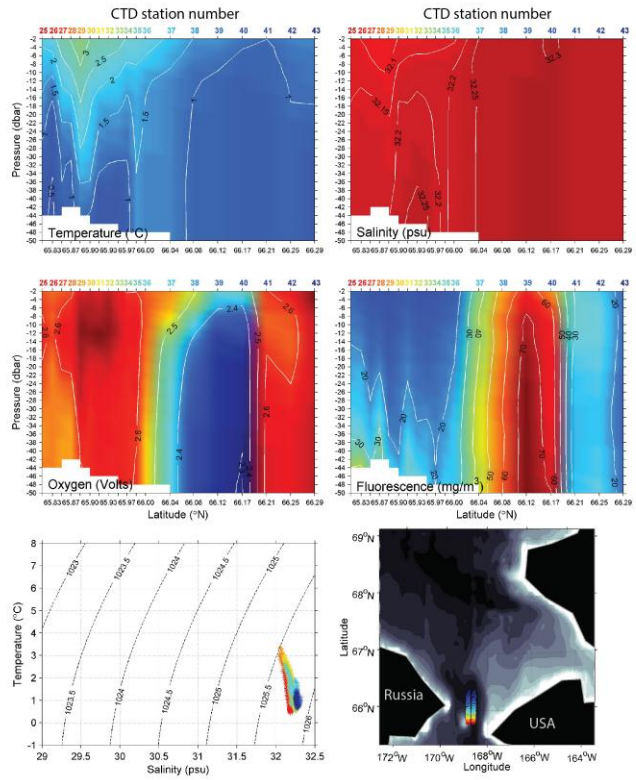
BS - 6th July 2013 0600 (start BS24) to 6th July 2013 1145 (end BS11)

Bering Strait 2013 -- CTD casts along BS line



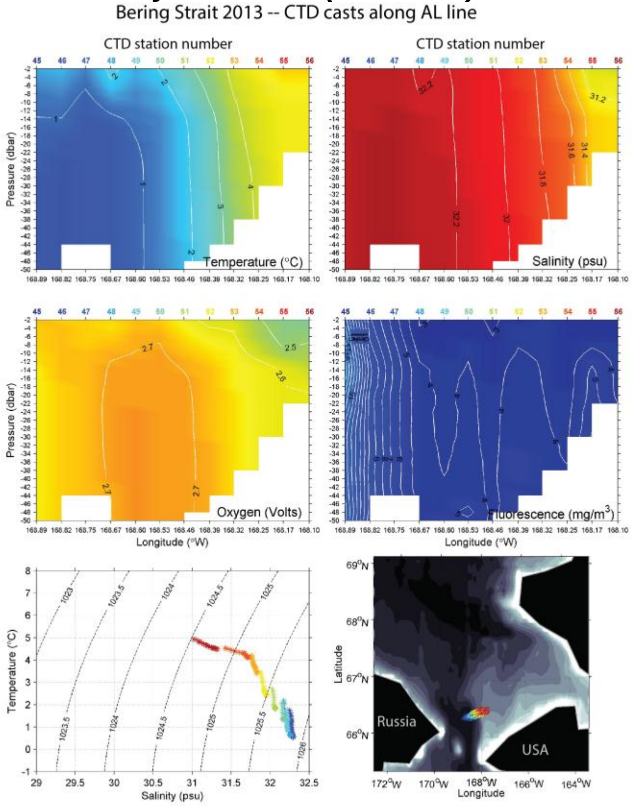
DL - 6th July 2013 1159 (start DL1) to 6th July 2013 1900 (end DL19)

Bering Strait 2013 -- CTD casts along DL line



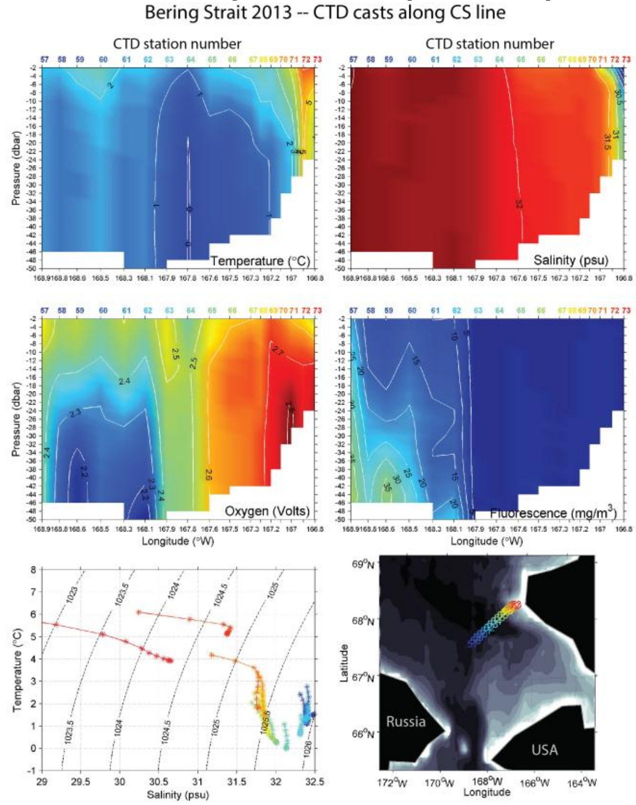
A3 – 6th July 2013 1927 (start A3-13) to 7th July 2013 0059 (end AL24)

Bering Strait 2013 -- CTD casts along AL line



CS – 7th July 2013 0924 (start CS10US) to 7th July 2013 1957 (end CS19)

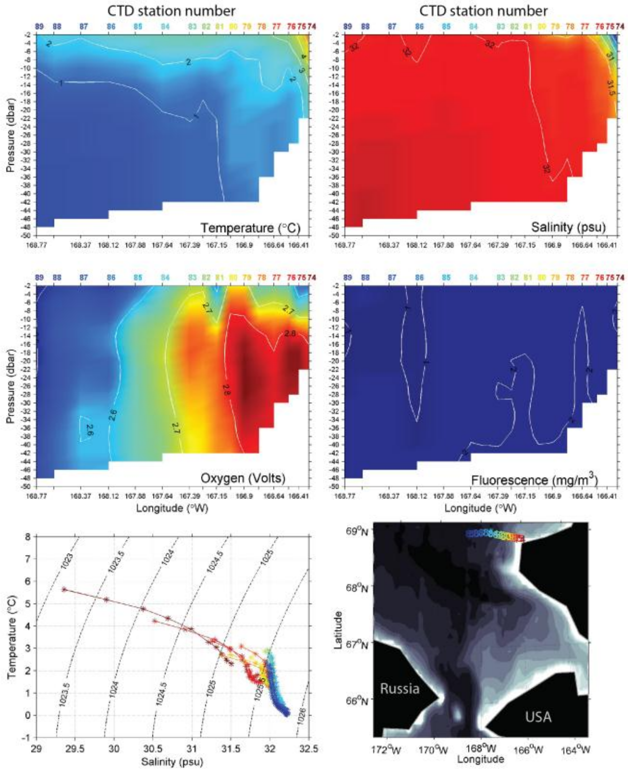
Bering Strait 2013 -- CTD casts along CS line



BERING STRAIT 2013 CTD LINES – (continued, all times GMT)

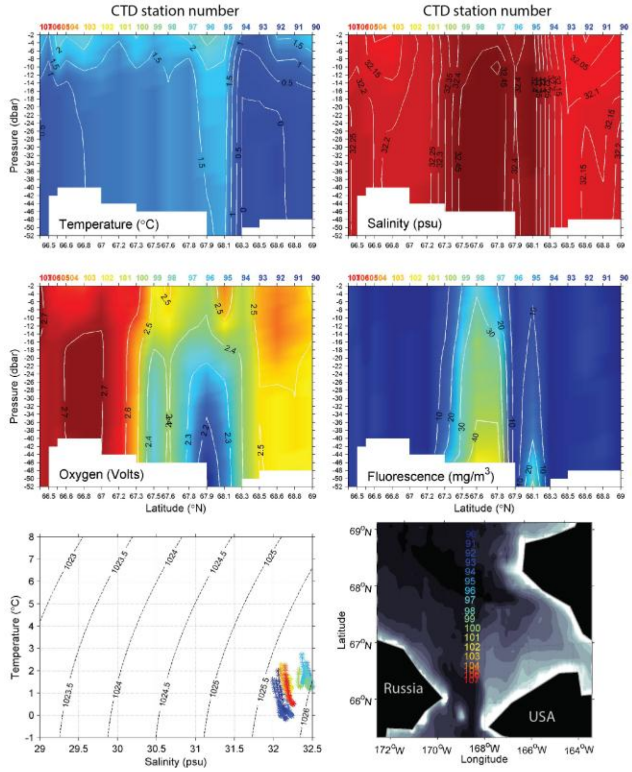
LIS – 8th July 2013 0037 (start LIS1) to 8th July 2013 0945 (end LIS14)

Bering Strait 2013 -- CTD casts along LIS line



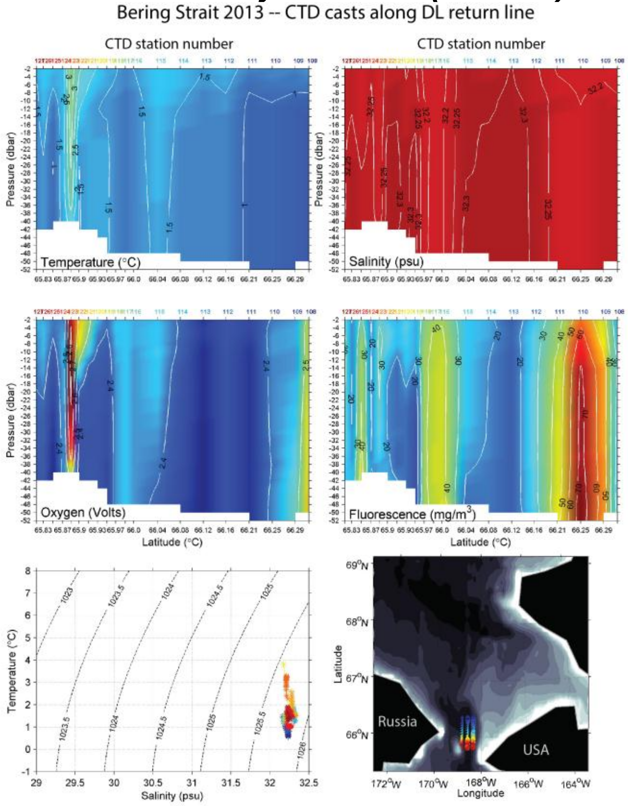
CCL – 8th July 2013 1013 (start CCL22) to 9th July 2013 0900 (end A3-13)

Bering Strait 2013 -- CTD casts along CCL line



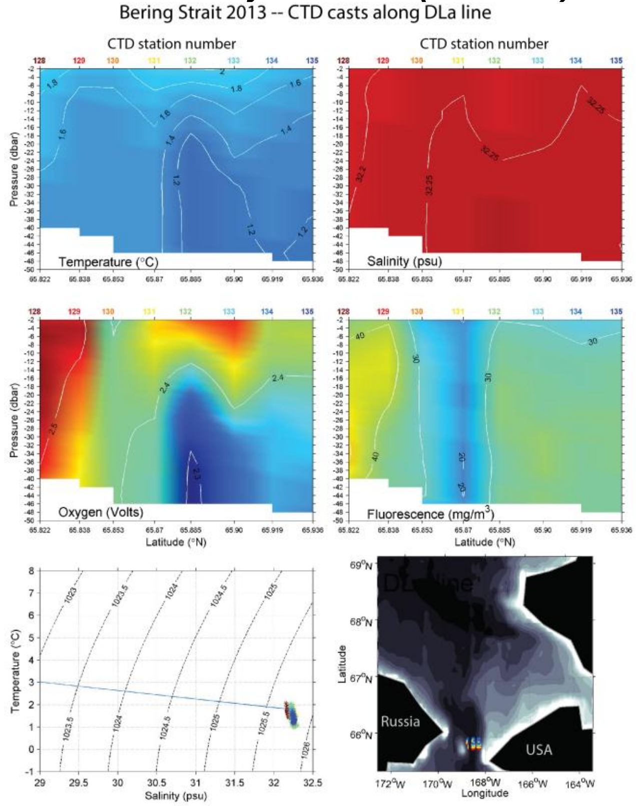
DL (repeat) - 9th July 2013 0916 (start DL19) to 9th July 2013 1553 (end DL1)

Bering Strait 2013 -- CTD casts along DL return line



DLa – 9th July 2013 1606 (start DLa1) to 9th July 2013 1813 (end DLa8)

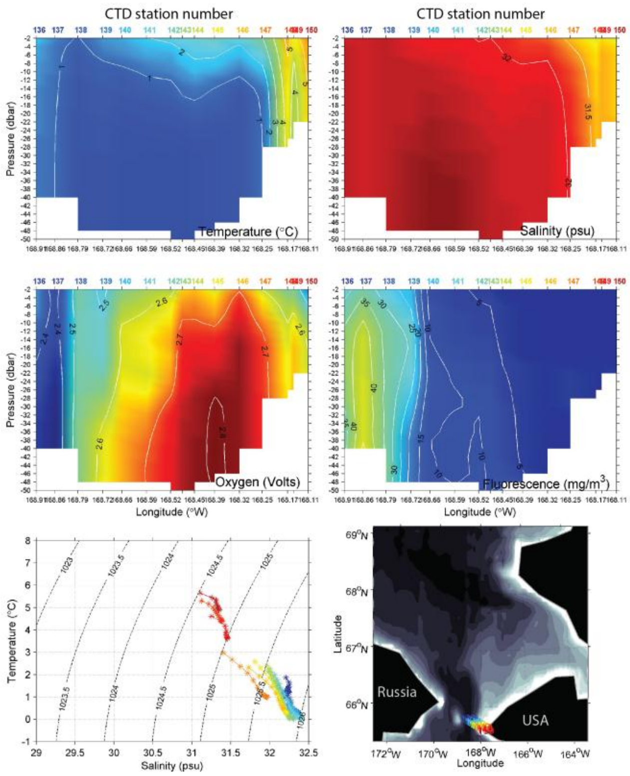
Bering Strait 2013 -- CTD casts along DLa line



BERING STRAIT 2013 CTD LINES – (continued, all times GMT)

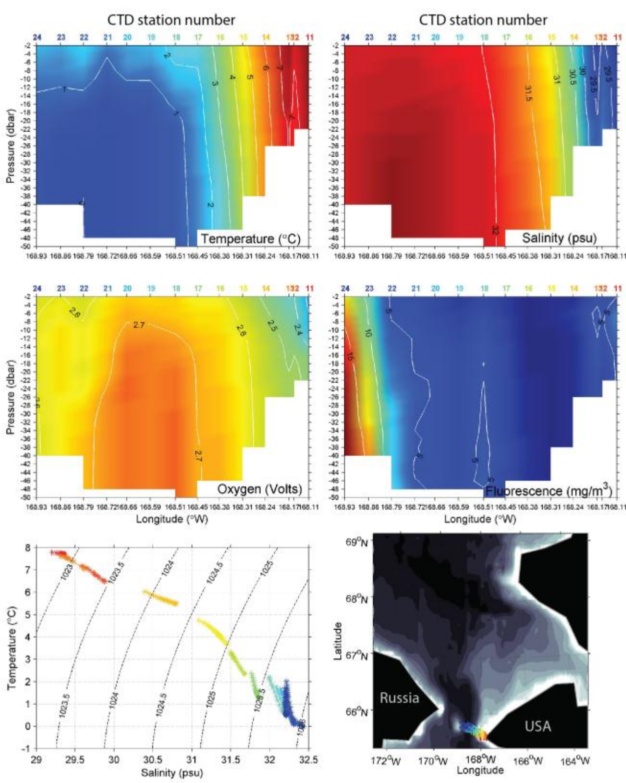
BS (repeat) – 9th July 2013 1917
to 10th July 2013 0104 (end BS24)

Bering Strait 2013 -- CTD casts along BS return line



(for comparison, the first running of the BS line is replotted here)
BS (orig)- 6th July 2013 0600 (start BS24) to 6th July 2013 1145 (end BS11)

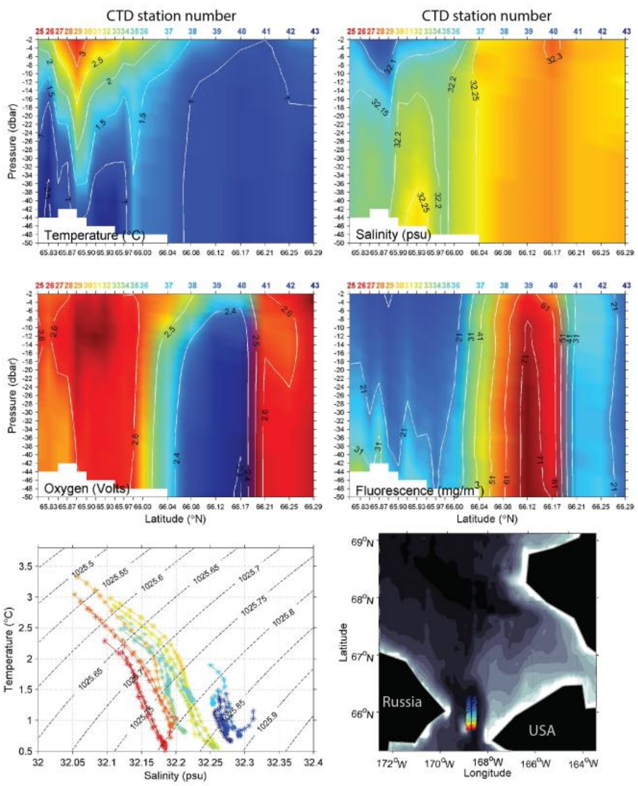
Bering Strait 2013 -- CTD casts along BS line



BERING STRAIT 2013 CTD LINES – REPEATS OF DL Lines (all times GMT)

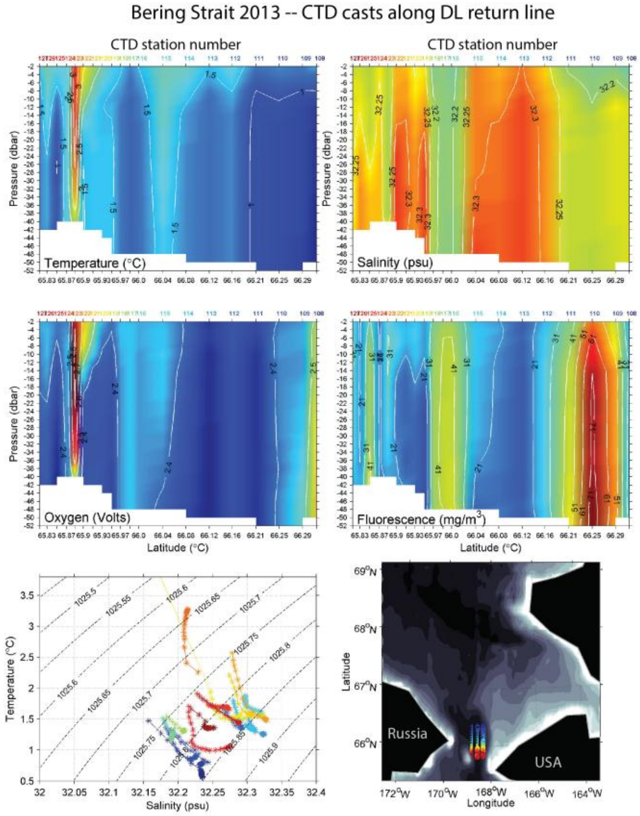
DL - 6th July 2013 1159 (start DL1) to 6th July 2013 1900 (end DL19)

Bering Strait 2013 -- CTD casts along DL line



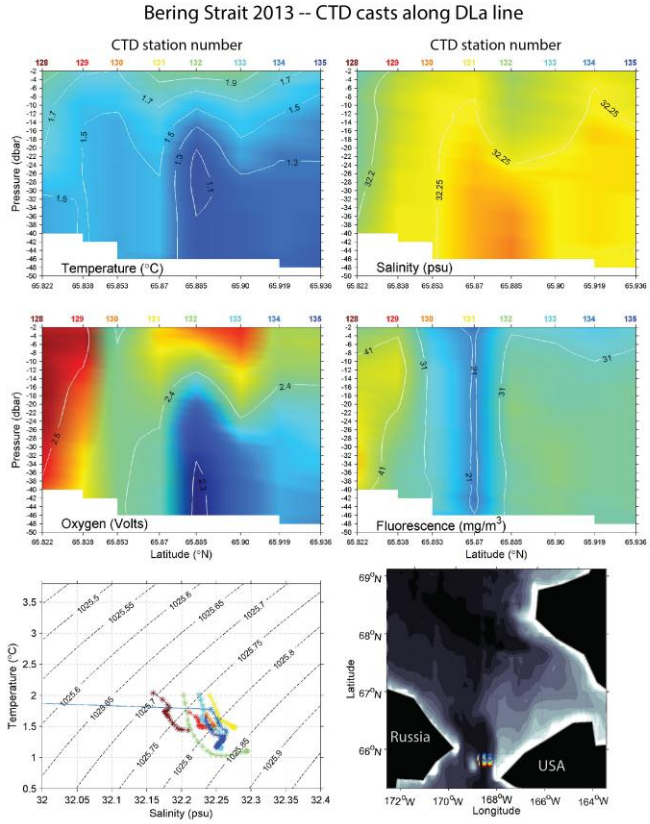
DL (repeat) - 9th July 2013 0916 (start DL19) to 9th July 2013 1553 (end DL1)

Bering Strait 2013 -- CTD casts along DL return line



DLa – 9th July 2013 1606 (start DLa1) to 9th July 2013 1813 (end DLa8)

Bering Strait 2013 -- CTD casts along DLa line



BERING STRAIT 2013 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.

ADCP: This year, the Norseman II installed a Teledyne RD Instruments 300kHz Workhorse Mariner ADCP (SN 19355), with high accuracy bottom tracking system. The ADCP is mounted 3m below the water line. This system was operational for the cruise, running with 4m bins. These data have not yet been processed. 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

Action item: Process ADCP data.

MET DATA: Meteorological data (including wind speed and direction, air temperature, humidity and pressure) were recorded every 15seconds with position, and course, during the cruise. These data have also not yet been investigated. It is believed that the wind sensor is currently faulty and all wind speed and direction data should be discarded, but that the air temperature, pressure and relative humidity are reliable. **Action item: Check meteorological data.**

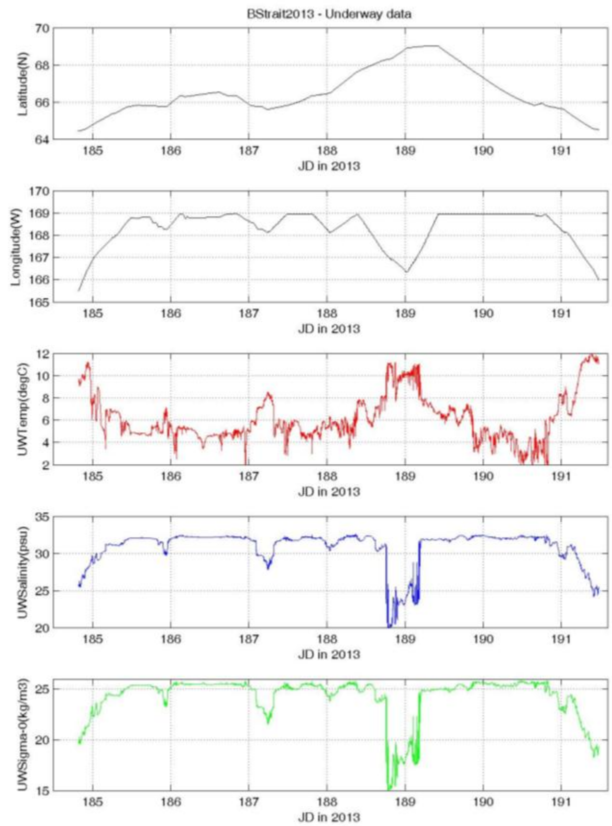
UNDERWAY TEMPERATURE AND CONDUCTIVITY DATA: The Norseman II used an Seabird SBE21 temperature conductivity sensor mounted 3m below the water line (co-located with the ship's ADCP) to collect underway data every 10s throughout the cruise. It would be possible to have included the ship's GPS in this data stream. However, unfortunately this was not activated for this cruise. Instead thus, the time of the SBE21 has been used to obtain position information from the science underway log of time and position of the ship's aft A-frame (used for science operations). The position information of the SBE21 may be in error up to the ship's length (35m) depending on the position of the sea water intake. **Action item: Establish position of the ship's sea-water intake.**

Preliminary plots of the underway temperature and salinity data are given below. Salinity data are taken from the SBE21, and appear to calculated with a pressure of ~ 3db, although differences in salinity caused by this 3db pressure change are small (1-2x10^{-3}psu).

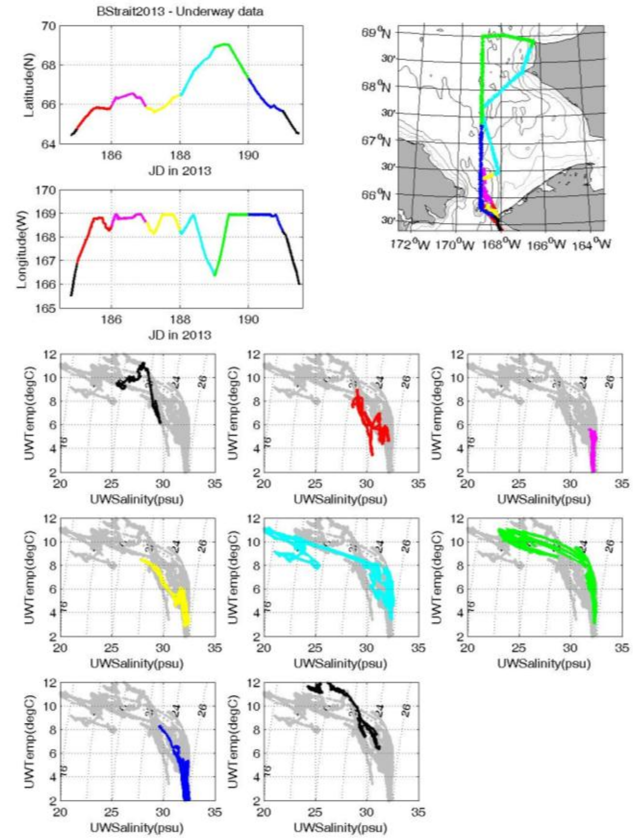
The typical pattern of waters being warmer and fresher near the Alaskan coast is evident in these data. Remarkably fresh salinities of 20psu are recorded near Point Hope, and waters remain remarkably fresh up to Cape Lisburne (see maps below also). Sea-ice was present north of Cape Lisburne only ~ 7 days before the cruise, so O18 isotopes were taken to establish the contribution of ice melt to the observed freshening (see report below). (An iceberg was also sighed north of the Cape Lisburne (at 68° 55.24N, 166°10.22W) as we started the LIZ line (8th July 2013, 0030GMT)). Note that these maps also suggest the warmest waters are also found in the north of the cruise. 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.

BERING STRAIT 2013 UNDERWAY TEMPERATURE SALINITY DATA

Time series



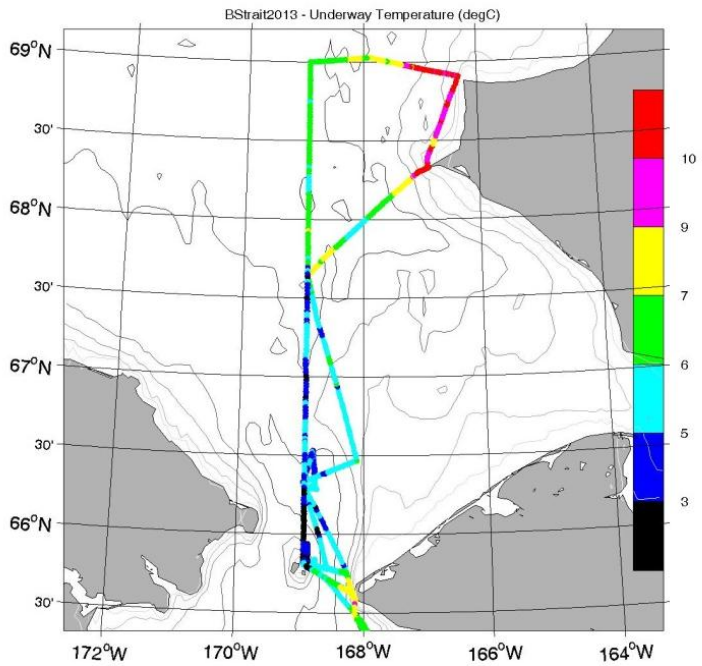
T-S plots by cruise day (indicated here by color)



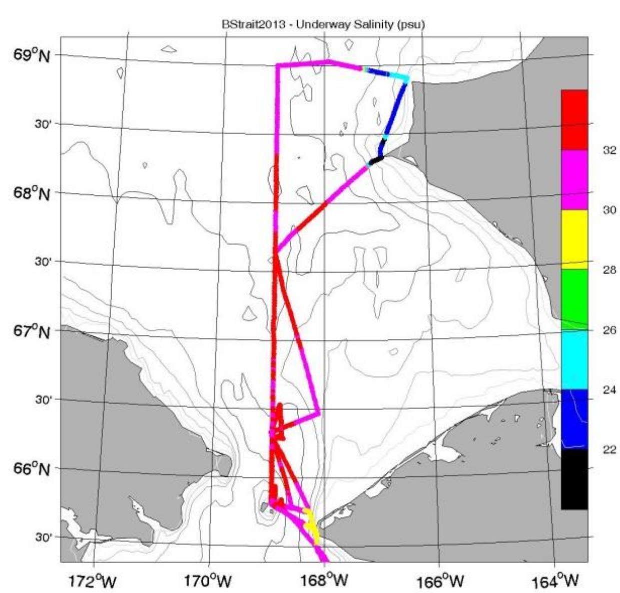
BERING STRAIT 2013 UNDERWAY TEMPERATURE SALINITY DATA (continued)

Maps of underway temperature and salinity with salinity plotted on two different scales. See notes above, especially concerning the aliasing of temporal change into spatial patterns.

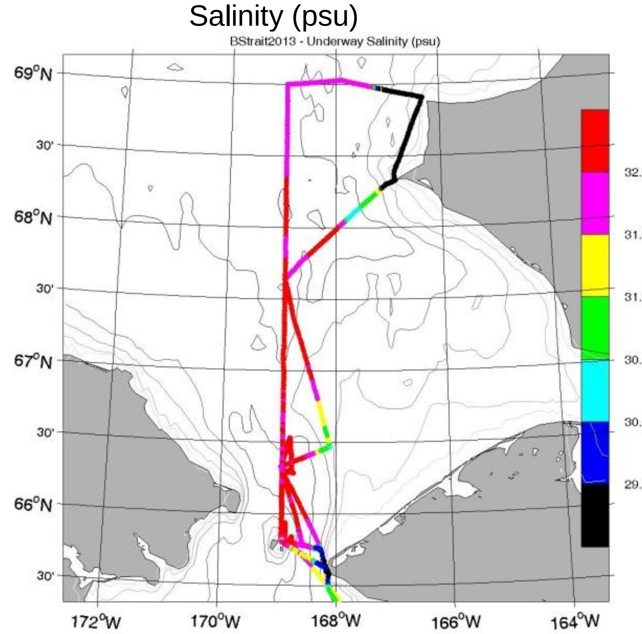
Temperature (deg C)



Salinity (psu)



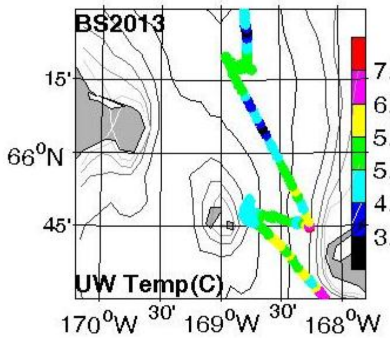
Salinity (psu)



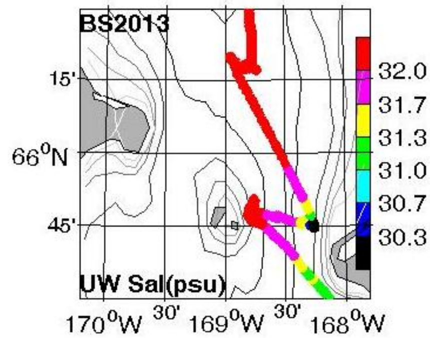
BERING STRAIT 2013 UNDERWAY TEMPERATURE SALINITY DATA (continued)

Data from various transits of the Bering Strait region.

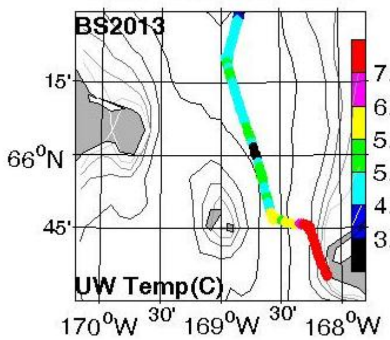
185JD08:13-186JD15:03



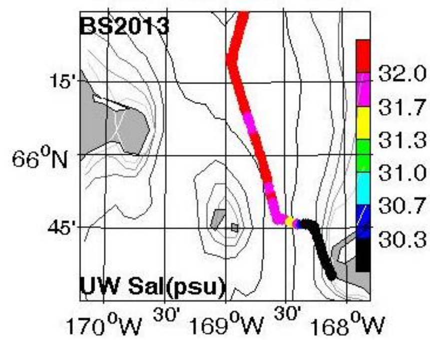
185JD08:13-186JD15:03



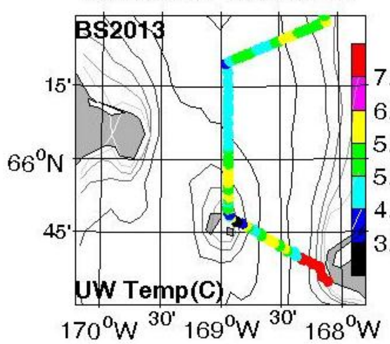
186JD15:03-187JD05:51



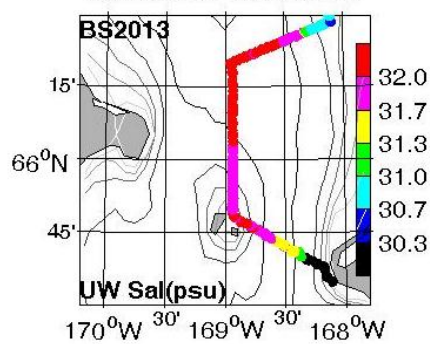
186JD15:03-187JD05:51



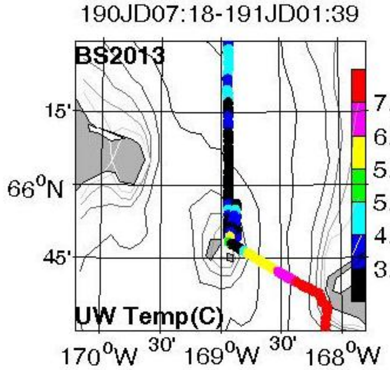
187JD05:51-188JD01:14



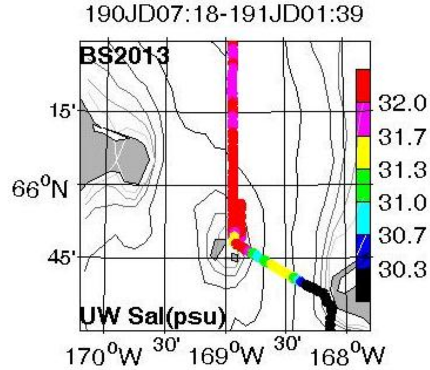
187JD05:51-188JD01:14



190JD07:18-191JD01:39

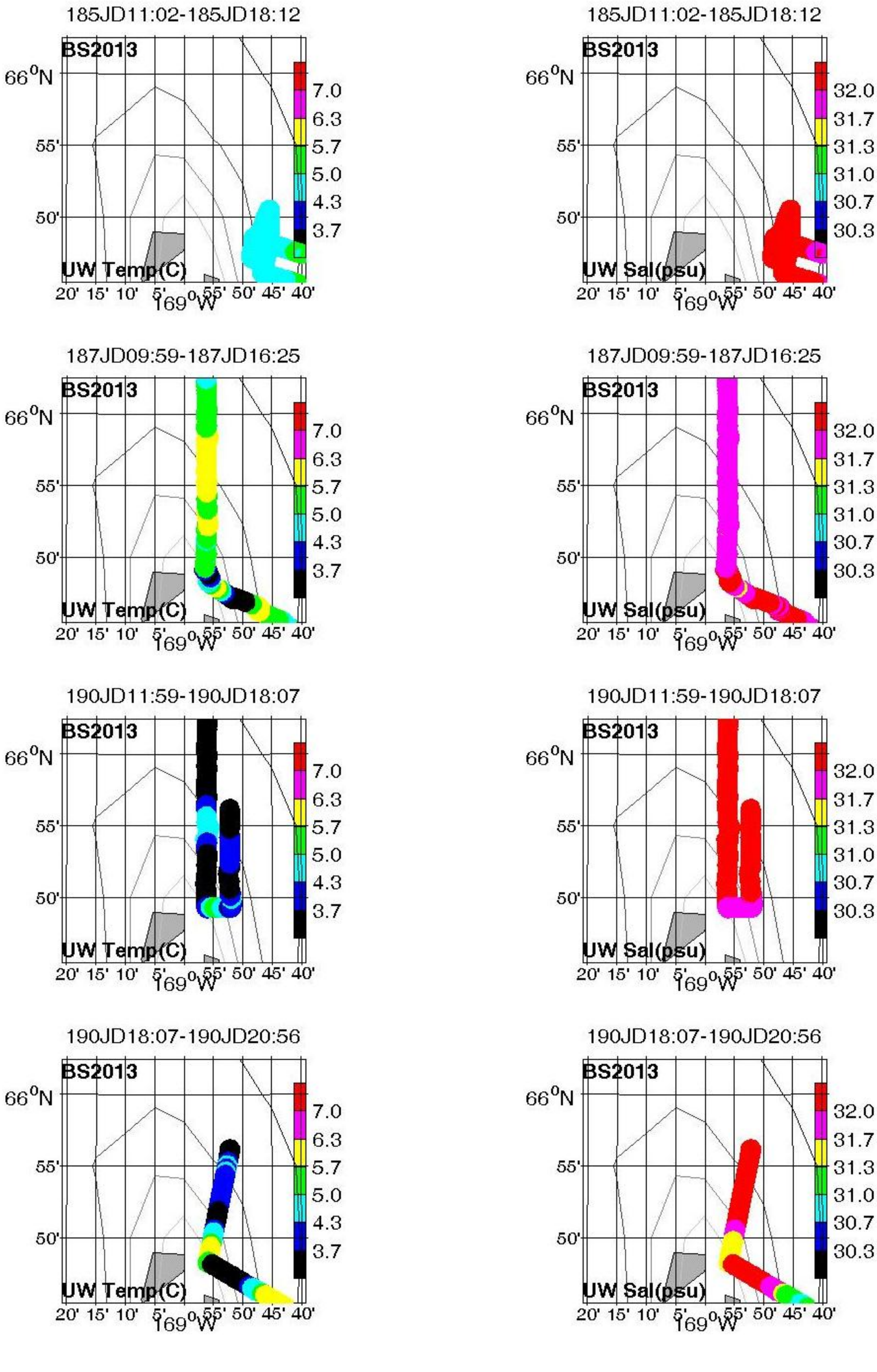


190JD07:18-191JD01:39



BERING STRAIT 2013 UNDERWAY TEMPERATURE SALINITY DATA (continued)

Data from various transits of the eddying region north of the Diomede Islands.

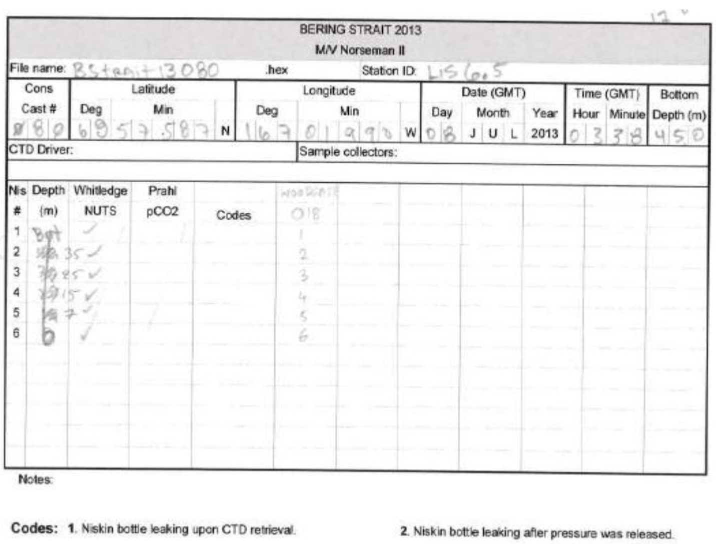


BERING STRAIT 2013 DELTA O-18 OXYGEN ISOTOPE REPORT – Woodgate, UW

Off Cape Lisburne, we observed some very fresh salinities (20-25psu) in surface underway data and in CTD casts, corresponding to a surface layer, varying in thickness from 12m to < 3m off shore.

		SurfaceS (psu) (end of cast)	Thickness of layer
Station 69	CS16	31	
Station 70	CS16.5	26.7	5m
Station 71	CS17	22.6	7m
Station 72	CS18	22.2	7m
Station 73	CS19	21.5	10m
Station 74	LIS1	24.2	12m
Station 75	LIS2	25.1	10m
Station 76	LIS3	25.6	7m
Station 77	LIS4	26.1	5m
Station 78	LIS5	24.7	5m
Station 79	LIS6	23.5	7m
Station 80	LIS6.5	26.2	4m
Station 81	LIS7	27.7	3m
Station 82	LIS7.5	31	

To ascertain the source of this freshwater (ice-melt versus river water), we took six O18 samples at station 80, LIS 6.5. (It would have been preferable to have sampled nearer to the coast.) In this cast, (see plot below), only the top bottle was sampled in the fresh layer.


BERING STRAIT 2013
M/V Norseman II

File name: BStrait13080 .hex Station ID: LIS 6.5

Cons Cast #	Latitude Deg	Latitude Min		Longitude Deg	Longitude Min		Date (GMT) Day	Month	Year	Time (GMT) Hour	Minute	Bottom Depth (m)
080	69	57.587	N	167	01.990	W	08	JUL	2013	03	38	450

CTD Driver:

Sample collectors:

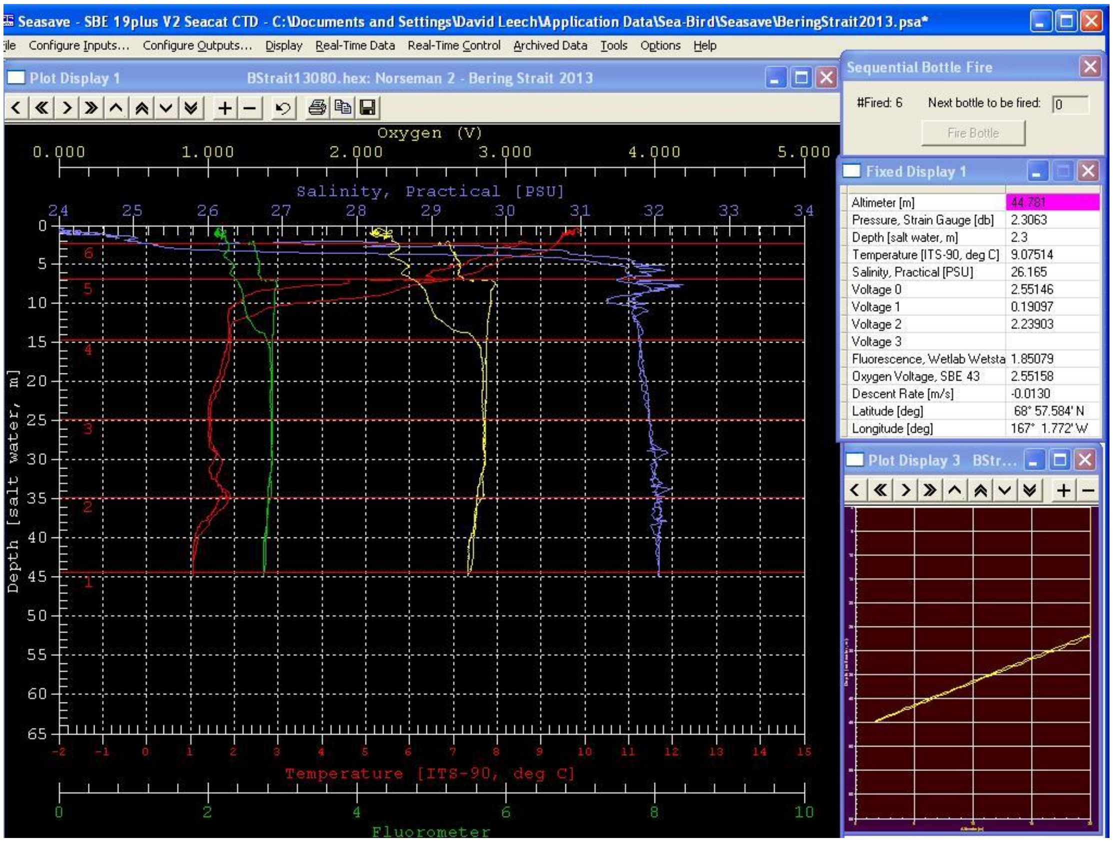
Nis #	Depth (m)	Whitledge NUTS	Prahl pCO2	Codes	O18
1	Bot	✓			1
2	35	✓			2
3	25	✓			3
4	15	✓			4
5	7	✓			5
6	0	✓			6

Notes:

Codes: 1. Niskin bottle leaking upon CTD retrieval. 2. Niskin bottle leaking after pressure was released.

Bottle depths from CTD cast sheet.

Sample 1 at ~ Bottom
Sample 2 at ~ 35m
Sample 3 at ~ 25m
Sample 4 at ~ 15m
Sample 5 at ~ 7m
Sample 6 at ~ surface



Samples were taken on 8th July 2013 in plastic nutrient bottles, and were sealed by hand and kept in the dark. They were brought back to Seattle as hold-luggage on 11th July 2013. In Seattle, bottle 2 was found to have leaked.
They were couriered (UPS) to OSU on 17th July 2013, arriving 18th July 2013, and run that day, courtesy of Jennifer McKay. Here are the results:

Data for: R. Woodgate
Data sent: July 81, 2013
Sample typ Seawater
Instrument Water equilibration device - Delta PlusXL IRMS
Analyst: J. McKay

Notes: 1. LROSS-5 (freshwater) and HOT-3 (seawater) are our d18O water standards that we use to calibrate the run each day. Their isotopic composition has been calibrated using the international standards VSMOW, GISP and SLAP.
2. Normally, one sample is repeated free of charge per run. The repeats are highlighted in matching colours.
3. The error (standard deviation) is ±0.05 permil or better for d18O data.
4. Information about the method we use for this analysis can be found at our website (http://stable-isotope.coas.oregonstate.edu/methods/water/water.html)

Date	Sample	d18O (permil, V-SMOW)	Comments
7/18/2013	Bstr 2013 1	-1.31	
	Bstr 2013 2	-1.25	
	Bstr 2013 3	-1.24	
	HOT-3	-0.12	
	Bstr 2013 4	-1.26	
	Bstr 2013 5	-1.11	
	Bstr 2013 6	-3.47	
	LROSS-5	-10.11	
	HOT-3	-0.12	
	LROSS-5	-10.08	
	Bstr 2013 5 rpt	-1.06	

expected d18O	HOT-3	-0.11	LROSS-	-10.10
7/18/2013	HOT-3	-0.12	LROSS-5	-10.11
	HOT-3	-0.12	LROSS-5	-10.08

From the files of at sea corrected CTD data from Cecilia Peralta-Ferriz, (BStrait13080FA05CLD.cnv), we obtain the bottle values for temperature and salinity (given in the table below).

Using conservation of salinity and O-18, we can then solve for the 3 fractions of water – sea water, ice melt and river water, if we can ascertain base values of salinity and O-18 for each component.

We assume sea water values based on the deepest sample taken at the site, and other values from the literature [*Macdonald et al.*, 1999], viz:

Salinity River water = 0.1psu	Salinity Ice = 6psu	Salinity Sea water = 32psu
O-18 River water = -20 per mil	O-18 Ice = 1 per mil	O-18 Sea water = -1.3 per mil

Using these values, we solve for the Fraction of each component for each bottle sample, viz:

Sample	Pressure (db)	Temp (degC)	Salinity (psu)	Delta O18	Frac RW	Frac ICE	Frac Sea
1	44.95	1.06	32.050	-1.31	0.0003	-0.0022	1.002
2	35.04	1.81	32.052	-1.25	-0.0025	0.0011	1.0014
3	24.94	1.41	31.912	-1.24	-0.0024	0.0064	0.9961
4	14.84	1.88	31.781	-1.26	-0.0010	0.0096	0.9914
5	7.00	5.65	31.946	-1.11	-0.0086	0.0126	0.9960
5resample				-1.06	-0.0109	0.0155	0.9954
6	2.34	9.06	26.238	-3.47	0.1245	0.0689	0.8066

To test the sensitivity of these results to our choice of end member, we solve also using the following parameters (changing O-18 of ice to -1 per mil).

Salinity River water = 0.1psu	Salinity Ice = 6psu	Salinity Sea water = 32psu
O-18 River water = -20 per mil	O-18 Ice = -1 per mil	O-18 Sea water = -1.3 per mil

and obtain very similar results:

Sample	Pressure (db)	Temp (degC)	Salinity (psu)	Delta O18	Frac RW	Frac ICE	Frac Sea
1	44.95	1.06	32.050	-1.31	0.0005	-0.0025	1.002
2	35.04	1.81	32.052	-1.25	-0.0027	0.0013	1.0014
3	24.94	1.41	31.912	-1.24	-0.0031	0.0072	0.9959
4	14.84	1.88	31.781	-1.26	-0.0020	0.0108	0.9911
5	7.00	5.65	31.946	-1.11	-0.0099	0.0143	0.9957
5resample				-1.06	-0.0126	0.0175	0.9951
6	2.34	9.06	26.238	-3.47	0.1173	0.0777	0.8050

Similarly, assuming a less extreme O-18 value of -18 for river water, i.e.,

Salinity River water = 0.1psu	Salinity Ice = 6psu	Salinity Sea water = 32psu
O-18 River water = -18 per mil	O-18 Ice = -1 per mil	O-18 Sea water = -1.3 per mil

yields the following:

Sample	Pressure (db)	Temp (degC)	Salinity (psu)	Delta O18	Frac RW	Frac ICE	Frac Sea
1	44.95	1.06	32.050	-1.31	0.0006	-0.0026	1.002
2	35.04	1.81	32.052	-1.25	-0.0030	0.0016	1.0013
3	24.94	1.41	31.912	-1.24	-0.0035	0.0076	0.9958
4	14.84	1.88	31.781	-1.26	-0.0022	0.0111	0.9911
5	7.00	5.65	31.946	-1.11	-0.0111	0.0157	0.9954
5resample				-1.06	-0.0140	0.0193	0.9947
6	2.34	9.06	26.238	-3.47	0.1310	0.0608	0.8081

These preliminary results suggest that the surface fresh layer off Cape Lisburne is ~ 20% diluted, with 2/3rds of that from river water and 1/3rd from ice, in the surface layer. Considering the layer as being ~ 10m thick, that is equivalent to ~ 2m of freshwater, consisting of ~ 1.3m of river water and 0.6m of sea-ice melt. This latter number seems a viable (conservative) estimate of recent ice melt in the region.

UAF BERING STRAIT 2013 Cruise Report--Moorings

-Pat Rivera--Whitledge Lab University of Alaska, Fairbanks.

ISUS Mooring

The Whitledge lab was in charge of recovering and deploying a total of four ISUS (nitrate analysis) instruments. Specific information regarding recovery and deployment are as follows:

Recovery

Mooring Site	**ISUS #**	**Duration**
A2-12	88	Ran for the entire deployment
A3-12	98	Ran from deployment (14th July 2012) to 31st July 1800, and subsequently only wrote one record, 4th Sept 2012 1800 GMT)

Deployment

Mooring Site	**ISUS #**
A2-13	124
A3-13	250

CTD casts were taken prior to mooring recovery and post mooring deployment for calibration purposes. On the recoveries, triplicate water samples (20 ml) for nutrients were taken at the estimated depth of the instrument to be recovered, as well as single water sampled at 2m above and 2m below the estimated depth. These are to act calibration points both prior to recovery and post deployment. The samples were frozen immediately at -23°C for analysis at the University of Alaska, Fairbanks.

UAF BERING STRAIT 2013 --Water Sampling

-Pat Rivera, Whitledge Lab University of Alaska, Fairbanks

The Whitledge lab, represented on the cruise by Pat Rivera, was responsible nutrient sampling on the cruise. All samples were taken at the following standard depths: 0m, 10m, 20m, 30m, 40m and bottom, and are to be analyzed for nitrate, nitrite, ammonium, urea, phosphate and silica.

Nutrients

We took nutrient samples at every station during the duration of the cruise with the exception of the DL and DLa lines and CS in which we took samples generally at every other station. Nutrient samples were taken at standard depths and transferred into 20 ml scintillation vials. We took a total of 657 samples. We froze samples at -23°C and shipped them to the University of Alaska, Fairbanks, for analysis.

OSU BERING STRAIT 2013 Cruise Report - Fred Prahl

Fred Prahl participated on the Bering Strait cruise (July 3-10, 2013) aboard the R/V Norseman II. The purpose was to recover a set of sensors deployed for a one-year period at ~48m water depth on the A3-12 mooring in the Chukchi Sea. These sensors, collectively contained within a cylindrical metal cage (30” x 34” dia.), were: 1) SAMI-pCO2; 2) SAMI-pH; and 3) SBE-37. The two SAMI sensors were setup to acquire data at a rate of one measurement every 3 hours from the time of mooring deployment in the summer of 2012 until recovery on this cruise. The SBE-37 was set to acquire temperature (T) and salinity (S) data on an hourly time interval. The SAMI-pCO2 was included as a means of obtaining continuous dissolved carbon dioxide (pCO2) measurements. The SAMI-pH was included on the package as a means of obtaining continuous pH measurements. The pCO2 and pH measurements, combined with T and S measurements obtained by the SBE-37, would allow unique definition of time variability in the speciation of the inorganic carbon chemistry system in the Bering Strait water represented by the A3 mooring and a way to gauge and monitor time variation the degree of ocean acidification at this site. The A3-12 mooring with this package of sensors was recovered successfully at ~2000 (ADT) on July 4, 2013.

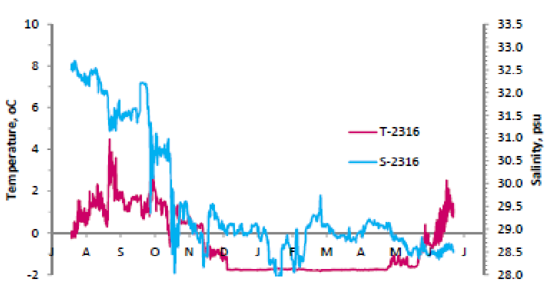
Samples for measurement of dissolved carbon dioxide (pCO2) concentration, total dissolved inorganic carbon (DIC) content and total alkalinity were collected using a rosette sampler attached to a CTD package at three depths along the Bering Strait (BS) sampling transect both at the beginning and end of the cruise. Samples were also taken at the A3-12 site (48m depth) at the time of mooring recovery in order to check the calibration of the in situ SAMI-pCO2 and SAMI-pH. Information about each water sample (latitude, longitude and water column depth of collection) is provided in the attached table. pCO2, DIC and total alkalinity analyses will be made as soon as possible after the cruise once the samples have been transport from Nome AK (end point of the cruise) to Oregon State University.

CTD Cast#	Sample#		Station	Lat	Lon	Date	UTC	Depth		CTD
7	300		A3-12	66.3282	168.9607	4-Jul	02:59	48		5
	301							48		6
12	302		BS23	65.5842	168.1650	6-Jul	06:19	30		1
	303							20		2
	304							0		4
14	305		BS21	65.6458	168.2538	6-Jul	07:02	40		1
	306							30		2
	307							0		6
16	308		BS19	65.6730	168.3863	6-Jul	07:51	50		1
	309							30		3
	310							0		6
18	311		BS17	65.7053	168.5210	6-Jul	08:50	52		1
	312							30		3
	313							0		6
20	314		BS15	65.7405	168.6623	6-Jul	09:46	50		1
	315							30		3
	316							0		6
22	317		BS13	65.7725	168.7925	6-Jul	10:40	50		1
	318							30		3
	319							0		6
24	320		BS11	65.8060	168.9323	9-Jul	11:38	45		1
	321							30		3
	322							0		6

136	323		BS11	65.8060	168.9323	9-Jul	19:17	45		1
	324							30		3
	325							0		6
138	326		BS13	65.7725	168.7925	9-Jul	20:07	48		1
	327							30		3
	328							0		6
140	329		BS15	65.7405	168.6623	9-Jul	20:58	50		1
	330							30		3
	331							0		6
142	332		BS17	65.7053	168.5210	9-Jul	21:53	50		1
	333							30		3
	334							0		6
145	335		BS19	65.6730	168.3863	9-Jul	22:52	54		1
	336							30		3
	337							0		6
147	338		BS21	65.6458	168.2538	9-Jul	23:51	42		1
	339							30		2
	340							0		6
149	341		BS23	65.5842	168.1650	10-	00:40	30		1
	342							20		2
	343							10		4
150	344		BS22	65.582	168.117	10-	00:59	0		5
	345							0		6
	346							0		6

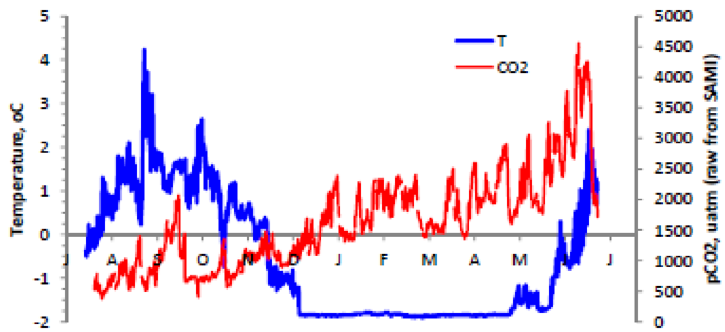
During the cruise, soon after recovery of the A3-12 mooring, data was downloaded from each of the three instruments (SAMI-pCO2, SAMI-pH, SBE-37). A preliminary assessment of the data obtained is summarized below.

SBE-37 Performance. A full year of temperature (T) and salinity (S) data was recovered from the SBE-37. The results are summarized just below in the left hand graph:



Comparison of the T record obtained from the SBE-37 with that for another microcat deployed at a proximate depth on the same mooring showed concordance. Comparison of the S record obtained from these two instruments revealed considerable discrepancy, however (see right hand graph above).

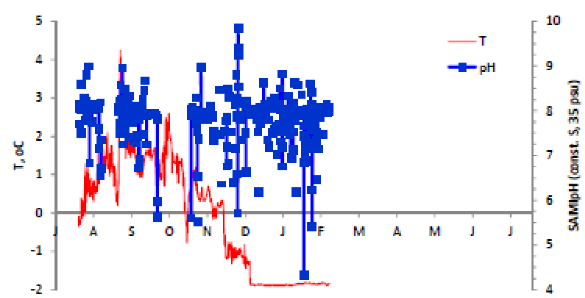
The cause of this discrepancy is now known. The SBE-37 was mounted horizontally in the cylindrical instrument cage on the mooring. As such, the passively flushed tube housing the conductivity sensor filled with sediment during the period of deployment thereby compromising the conductivity measurement. The microcat used for comparison was mounted vertically (as recommended by the vendor). Its T and S record are considered the most reliable benchmark for hydrographic variability at the A3-12 mooring site over the 2012-13 period deployment.



SAMI-pCO2 Performance. A full year of pCO2 data was also recovered from the new SAMI-pCO2 sensor we deployed on the A3-12 mooring from July 2012. The results are summarized in the graph to the right. This complete data set is suspicious. Assessments of pCO2 by this sensor at the beginning of the time series (~525 µatm) are ~2x higher than measurements of pCO2 in discrete water samples from our previous mooring deployment / recovery cruises indicate is the case. And, values recorded by the sensor continue to increase in a highly variable, saw-toothed pattern throughout the one-year deployment period to a value of ≤4000 µatm. This time series record, characterized by such high pCO2 values, is not trustworthy. The cause for the poor performance of this instrument is currently unknown and under investigation.

Notably, we were unable to obtain <u>any</u> data from another SAMI-pCO2 instrument (old ‘loaner’ from Mike deGrandpre) that was deployed on the previous 2011-12 A3-11 mooring.

SAMI-pH Performance. Only one-half year of pH data was obtained from the new SAMI-pH sensor we deployed on the A3-12 mooring from July 2012. Instrument data acquisition was terminated pre-maturely by insufficient battery power. During the period of operation, 1668 sampling time points were recorded. Of this number, only 34% provided a measure of ‘pH’. The results obtained are summarized in the graph below.



pH (estimated from the sensor response assuming, by default, a constant salinity of 35psu) ranged from ~4 to 10, averaging 7.9 (± 0.5). The cause for the low fraction of sampling records by the instrument yielding any measure of pH and the unbelievably wide range of variability in pH measurements obtained is currently unknown and under investigation. This data set will be reprocessed using the best estimates of salinity for the time series obtained from the vertically mounted microcat described above.

Notably, the SAMI-pH deployed as a new instrument on the previous 2011-2012 A3-11 mooring also terminated pre-maturely after ~1/2 year of operation due to insufficient battery power. Furthermore, pH ‘assessments’ were only obtained for the first month of operation. However, the assessments were continuous over that 1 month period, i.e. 100% of the sampling intervals yielded an estimate. And, variability in the assessments was much less than we found to be the case in this last year. pH values averaged 8.11 (± 0.08).

MARINE MAMMAL AND SEABIRD BERING STRAIT 2013 Cruise Report Kathleen Stafford, UW

Marine mammal hydrophones

During the Bering Strait mooring cruise 2013, 3 hydrophone packages were recovered from sites A2W-12 (65.80N 168.798W), A4W-12 (65.75N 168.365W) and A3-12 (66.327N 168.965W). Three hydrophones were deployed at sites A2-13 (65.78N 168.567W), A4-13 (65.745N 168.262W) and A3-13 (66.327N 168.965W). All three instruments deployed in 2012 were programmed to start on 1 September 2012 and sampled for 10 minutes every hour at a sample rate of 16384. The instruments on A2W-12 and A3-12 stopped recording in mid-May 2013, which was earlier than expected and was due to battery drain. The instrument at A4W-12 lasted until 24 June 2013, just a few weeks shy of the anticipated end date. No analysis of these data has occurred to date but a cursory exam of all three instruments showed that the following species were recorded on each: humpback whale, bowhead whale, beluga whale, walrus, and bearded seal. Because past years efforts have never been able to record for a full year despite changes in the duty cycle to ensure this, this year instruments with two 64-D cell battery packs were deployed. These are considerably larger than instruments used in past years. Adding these to the moorings took some degree of creativity. All three instruments were set to sample at 8192 Hz for 20 minutes every 60 starting 15 July 2013.

In order to document marine mammal species seen along the trackline of the R/V Norseman II during the 2013 mooring cruise, a marine mammal watch was kept on the bridge from ~0600-2200 daily. The watch was halted during mooring operations and heavy fog. Watches consisted of one person stationed primarily on the port side of the bridge (to stay out of the way of bridge operations), scanning roughly 60° to either side of the bow with a pair of Steiner 7 x 50 binoculars. When sightings were made the time, location, species and number of animals as well as any notes on observations were logged (Table 1).

The first few days of the cruise coverage was spotty as mooring operations were in full swing. Once the marine mammal hydrophones were recovered and redeployed, the visual survey was conducted from 0600-~2200 daily. This cruise was shorter than past years so there were many fewer sightings. There were also many foggy hours. A total of 52 sightings of 88 individual animals were obtained representing 9 species (Table 1).

Sightings for each species are shown in Figure 1.

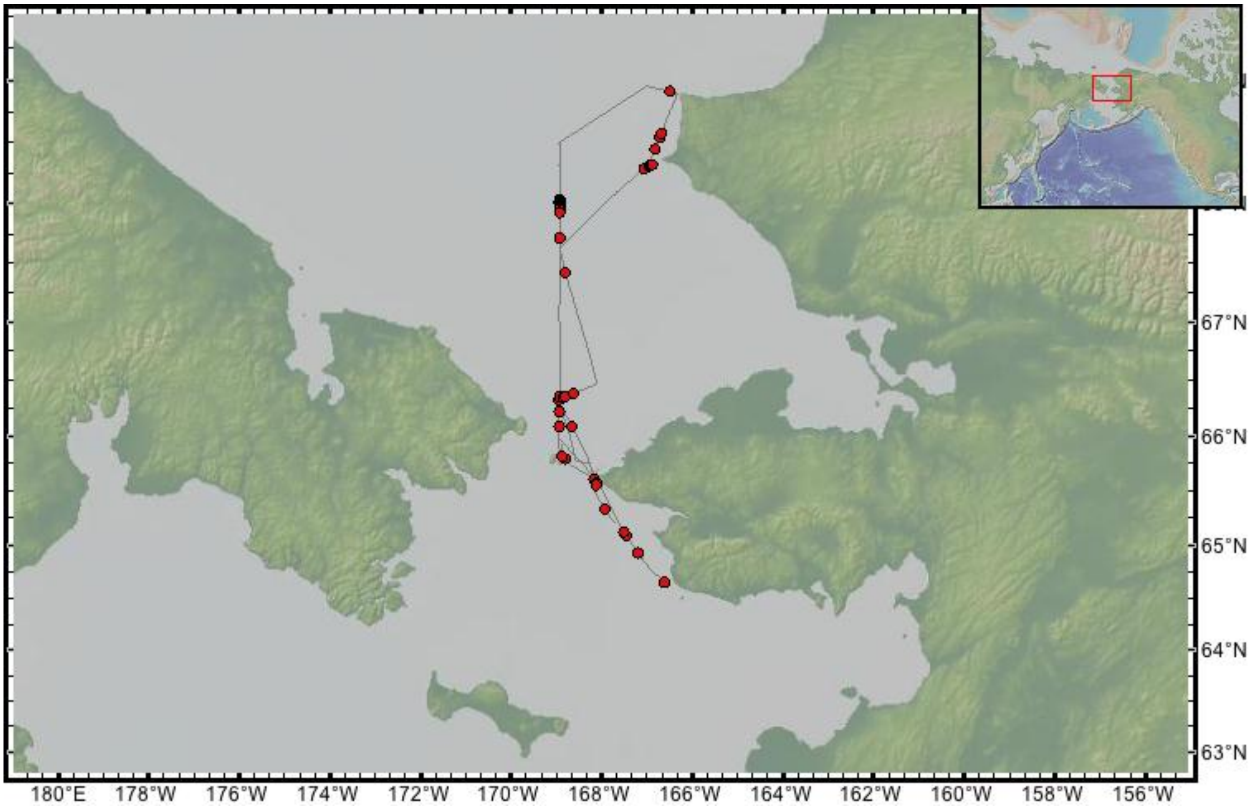


Figure 1. Trackline and marine mammal sightings from Bering Strait cruise 2013

Overall, there were few marine mammal sightings and species seen on the 2013 cruise when compared to the 2012 cruise. Part of the interannual discrepancy is likely due to the shorter cruise time and lots of time lost to fog. The majority of sightings from 2013 were gray whales, and the only other baleen whale sighted was a single humpback whale in the fog.

Table 1. Marine mammal sightings by species.

Species	#sightings	number animals
Harbor porpoise	1	1
Phoca spp	7	9
Gray whale	26	55
Ringed seal	7	8
Spotted seal	3	3
Humpback whale	1	1
Killer whale	1	4
Unid baleen whale	5	5
Walrus	2	2
sum	53	88

BERING STRAIT 2013 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 2013 cruise are included in the full event log later in this cruise report.

```
%========================================================
% Stations for BStrait Mooring Cruise 2013 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.)
% Time estimates are based on Khromov cruise including
% water sampling (which may be different on this cruise).
%========================================================
%========================================================
% *****   MOORING POSITIONS *****
%========================================================
% (from west to east in strait, then northern site)
% - 5 moorings to recover
% - 3 moorings to deploy
%------------------------------------------
% RECOVERIES of moorings deployed in 2012
%------------------------------------------
%NAME        Lat(N)          Long (W)      Water   Top
%            deg min         deg min       depth   Float
% A2W-12     65  48.03       168  48.06     55m    17m
% A2-12      65  46.86       168  34.07     56m    17m
% A4W-12     65  45.42       168  21.95     56m    17m
% A4-12      65  44.75       168  15.77     50m    17m
% A3-12      66  19.61       168  57.05     59m    15m
%---------------------------------
% DEPLOYMENTS for this 2013 cruise
%---------------------------------
% Target same as 2012 positions.
%NAME      Lat(N)         Long (W)      Water
%          deg min        deg min       depth
% A2-13    65  46.86      168  34.07     56m
% A4-13    65  44.75      168  15.77     50m
% A3-13    66  19.61      168  57.05     59m
%
%-----------------------
% INTERMOORING DISTANCES
%-----------------------
% A2W - 5.5nm - A2 - 5.2nm - A4W - 2.5nm - A4
%------------
% To A3 from
%------------
%   A2  - 34nm
%   A4  - 39nm
%-------------
% To Nome from
%-------------
%   A4 - 120nm
%   CS1 - 200-220nm
```

```
%=========================================================
% *****   HISTORIC CTD SECTIONS *****
%=========================================================
% There are 11 historic CTD lines here.
% We will not have time for all of these, but
% we will likely do a subset.  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.
% Known Hazards are indicated.
%
% Stay a safe distance (300m?) from all deployed
% moorings.
%
% Except for around moorings or for mooring work,
% with 200m is ok for positions.


%======================================
% BS = Bering Strait Line (US portion)
%======================================
% - 14 stations
% - station spacing generally ~ 2nm
% Distances: - BS11-BS22 21.7nm
%            - BS22-BS24  3.1nm
% Total length 24.8nm
% Time from Khromov ~10hrs
%---------------------------------------------------
% 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
  65.686  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
%
%
%============================
% AL = A3 Line (US portion)
%============================
% Hazards on this line:
% == First station on this line is at mooring A3-13, so exact
% position needs to be altered to be a safe distance (300m?)
% from mooring A3-13 site.
%------------------------------------------------------
% - 13 stations including cast at A3mooring site
```

```
% - station spacing ~ 1.9nm
% Distance: - A3 to AL24 = 22.2nm
% 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  % A3-13
% *** Adjust this first position to be safe distance (300m?) from A3-13
   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:
% == There are 2 Jamstec moorings 1nm N of this line, which are
% to be avoided.  2012 positions of these moorings are
% 67 42.182N, 168 50.016W
% 67 43.093N, 168 50.010W
% == Final station CS19 is shallow.  Check on
% modern charts to see if deep enough for Norseman.
% (this station was too shallow for the Khromov).
%-----------------------------------------------------------
% - 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 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 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
% 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 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 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:
% == Last station on this line is at mooring A3-13, so exact
% position needs to be altered to be a safe distance (300m?)
% from mooring A3-13 site.
%--------------------------------------
% Line running from northern most point
% due south, ~ 1nm US side of conventionline
% - 20 stations (counting arriving at A3-13)
% - station spacing ~ 10nm until CCL8,
%      then reducing to ~5nm and ~2.5nm
% Distances: - CCL22 to A3-13 ~ 161nm
% 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 Khromov to NBS9, 9 casts ~6.5hrs
% - Estimate Khromo to NBS9, 16 casts ~8hrs
% Time from Helix to NBS14, 14 casts ~8.5hrs
% - 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 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
%
%
%========================================================
%========================================================
```

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%BeringStrait 2013 NORSEMAN2 log CTD and NET log % **150 casts total**
%
%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 fc %
%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 % **THIS YEAR WE ONLY HAVE TYPE 1**
%#,Number is consecutive for that event type %
%In/out (I/O): 1=In / 2=Out %
%Dep=waterdepth(m) from bridge 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, after CTD 5 % THIS YEAR ALL THESE NUMBERS ARE DUBIOUS
%Op=CTD operator
% when 3 lines for NET, dep indicates wire out for net
%Fill in any comments if needed. %
% all times are GMT (which are Alaskan Daylight time (ship's time) + 8hrs)

% Date	**Time**	**Ty**	**#**	**I/O**	**Dep**	**LatD**	**LatM**	**LonD**	**LonM**	**##**	**St**	**SS**	**WSp**	**WD**	**Op**	**Comments (DO NOT USE COMMAS!!)**
20130704	0627	1	**1**	1	52.5	65	21.690	167	53.450	**%**	testcast		14.4	182	ACPF	Test cast en route to BS line
20130704	0635	1	**1**	2	52.5	65	21.000	167	53.650	**%**			5.7	51	ACPF	1, 5 ans 6 are leaking
20130704	0713	1	**2**	1	42.2	65	25.100	167	59.270	**%**	testcast2		15.6	197	ACPF	This is to test bottles - All bottles OK
20130704	0721	1	**2**	2	42.2	65	25.175	167	59.260	**%**					ACPF	
20130704	1645	1	**3**	1	50	65	48.091	168	47.935	**%**	A2W pre-recov		9	148	ACPF	At mooring site A2W - No bottles to be fired
20130704	1656	1	**3**	2	50	65	48.144	168	47.890	**%**	A2W				ACPF	
20130704	1839	1	**4**	1	52.8	65	46.860	168	33.930	**%**	A2 pre-recover		10.3	151	ACPF	At mooring site A2 - w/nutrients.
20130704	1849	1	**4**	2	54	65	46.980	168	33.800	**%**	A2				ACPF	Bottom 3 was leaking.used b4 -backup bottle instead
20130704	2019	1	**5**	1	51	65	45.460	168	21.810	**%**	A4W pre-recov		9.5	175	ACPF	At mooring site A4W - No nutrients All bottles fired ok.
20130704	2027	1	**5**	2	52	65	45.772	168	21.846	**%**	A4W				ACPF	
20130704	2200	1	**6**	1	45	65	44.710	168	15.760	**%**	A4 pre-recover		11	147	ACPF	Extreme wire slack/ backing up ship. 3 knot currents…
20130704	2214	1	**6**	2	45	65	45.335	168	15.690	**%**	A4				ACPF	All bottles fired ok. no nutrients.
20130705	0259	1	**7**	1	54.7	66	19.531	168	56.734	**%**	A3 pre-recover		14	201	RD	Had to return to bottom from 50m for water sampling.
20130705	0311	1	**7**	2	54.7	66	19.556	168	56.741	**%**	A3				RD	Bottle 3 was leaking. Cleaned CTD air vent.
20130705	2001	1	**8**	1	54.7	66	19.617	168	57.110	**%**	A3 post-deploy		5.7	125	ACPF	Calibration after mooring deployment in A3
20130705	2018	1	**8**	2	54.7	66	19.670	168	57.317	**%**	A3				ACPF	A3-13 cal cast double dipped to look for air bubbles, bottles ok
20130706	0105	1	**9**	1	53.2	65	46.878	168	34.128	**%**	A2 post-deploy		14.7	239	DAS	Calibration after mooring deployment in A2
20130706	0115	1	**9**	2	53.2	65	46.970	168	34.003	**%**	A2				DAS	A2-13 cal cast Bottles 3,5,6 leaking
20130706	0353	1	**10**	1	45.4	65	44.681	168	15.507	**%**	A4 post-deploy		10.9	106	RD	Calibration after mooring deployment A4-13
20130706	0400	1	**10**	2	45.4	65	44.796	168	15.505	**%**	A4				RD	A4-13 cal cast. Extra turns on bottle 5 & 6. Bottle 6 leaking
20130706	0600	1	**11**	1	24.4	65	34.888	168	7.062	**%**	BS24		12.1		RD	Start of BS line. ** Station name wrong in file
20130706	0607	1	**11**	2	24.4	65	34.957	168	7.207	**%**	BS24		156		RD	
20130706	0619	1	**12**	1	29.8	65	35.923	168	9.648	**%**	BS23		15.5		RD	** Station name wrong in file.

20130706	0625	1	**12**	2	29.8	65	36.043	168	9.860	**%**	BS23	190		RD	Jelly fish found on CTD. Strong currents.
20130706	0638	1	**13**	1	29.8	65	37.475	168	10.559	**%**	BS22	19.9		RD	** Station name wrong in file.
20130706	0648	1	**13**	2	30.7	65	37.775	168	10.933	**%**	BS22	230		RD	Passed front between BS21 and BS22.
20130706	0702	1	**14**	1	40.7	65	38.527	168	14.890	**%**	BS21	11.7		RD	** Station name wrong in file.
20130706	0711	1	**14**	2	41.2	65	38.748	168	15.221	**%**	BS21	193		RD	
20130706	0727	1	**15**	1	46.7	65	39.308	168	18.922	**%**	BS20	9.7		RD	
20130706	0736	1	**15**	2	47.3	65	39.442	168	19.262	**%**	BS20	163		RD	
20130706	0751	1	**16**	1	50.2	65	40.254	168	23.093	**%**	BS19			RD	
20130706	0801	1	**16**	2	50.6	65	40.673	168	22.872	**%**	BS19			RD	
20130706	0821	1	**17**	1	52.1	65	41.099	168	27.026	**%**	BS18	8.1		ACPF	Bottle 3 suspicious bc leaks slowly
20130706	0830	1	**17**	2	52	65	41.260	168	26.700	**%**	BS18			ACPF	
20130706	0850	1	**18**	1	52.8	65	42.183	168	30.986	**%**	BS17	8.6	234	ACPF	
20130706	0859	1	**18**	2	54	65	42.334	168	30.656	**%**	BS17			ACPF	
20130706	0919	1	**19**	1	50.2	65	43.311	168	35.465	**%**	BS16	5.2	171	ACPF	Cleaned pump tube before cast
20130706	0927	1	**19**	2	50.2	65	43.423	168	35.298	**%**	BS16			ACPF	
20130706	0946	1	**20**	1	50.2	65	44.321	168	39.731	**%**	BS15	4.8	210	ACPF	Bottles 3 and 6 were leaking
20130706	0955	1	**20**	2	50.2	65	44.449	168	39.488	**%**	BS15			ACPF	
20130706	1013	1	**21**	1	51.1	65	45.280	168	43.258	**%**	BS14	5.6	208	ACPF	
20130706	1021	1	**21**	2	51.2	65	45.414	168	43.039	**%**	BS14			ACPF	
20130706	1041	1	**22**	1	50.5	65	46.292	168	47.519	**%**	BS13	5.4	191	ACPF	we dipped back down during upward cast for about 10 m
20130706	1050	1	**22**	2	50.5	65	46.452	168	47.195	**%**	BS13			ACPF	with no reason. As soon as noticed we recover route up.
20130706	1109	1	**23**	1	42.8	65	47.169	168	51.605	**%**	BS12	4.9	105	ACPF	
20130706	1117	1	**23**	2	42.8	65	47.101	168	51.521	**%**	BS12			ACPF	
20130706	1138	1	**24**	1	45.3	65	48.333	168	55.944	%	BS11	2.8	200	ACPF	
20130706	1145	1	**24**	2	45.3	65	48.433	168	55.530	**%**	BS11			ACPF	Last CTD profile in BS line
20130706	1159	1	**25**	1	45.1	65	49.181	168	56.432	**%**	DL1	2.3	210	ACPF	Start of DL line
20130706	1208	1	**25**	2	45.1	65	49.147	168	56.525	**%**	DL1			ACPF	Had to dip down for a sample bc did not stop.
20130706	1221	1	**26**	1	46	65	50.264	168	56.110	**%**	DL2	5.6	245	ACPF	
20130706	1228	1	**26**	2	46	65	50.198	168	56.213	**%**	DL2			ACPF	
20130706	1241	1	**27**	1	46.3	65	51.244	168	56.258	**%**	DL3	3.7	140	ACPF	
20130706	1249	1	**27**	2	46.3	65	51.192	168	56.202	**%**	DL3			ACPF	
20130706	1302	1	**28**	1	44.5	65	52.212	168	56.136	**%**	DL4	2.8	70	ACPF	
20130706	1309	1	**28**	2	44.5	65	52.196	168	56.030	**%**	DL4			ACPF	
20130706	1324	1	**29**	1	46.4	65	53.200	168	56.177	**%**	DL5	1.2	90	ACPF	no bottles
20130706	1330	1	**29**	2	46.4	65	53.198	168	56.080	**%**	DL5			ACPF	
20130706	1343	1	**30**	1	46.9	65	54.214	168	56.138	**%**	DL6	9.4	176	ACPF	
20130706	1350	1	**30**	2	46.9	65	54.208	168	56.080	**%**	DL6			ACPF	
20130706	1402	1	**31**	1	47.3	65	55.167	168	56.237	**%**	DL7	4	56	ACPF	no bottles
20130706	1407	1	**31**	2	47.3	65	55.154	168	56.159	**%**	DL7			ACPF	
20130706	1418	1	**32**	1	48	65	56.150	168	56.260	**%**	DL8	2.2	1	ACPF	
20130706	1425	1	**32**	2	48	65	56.160	168	56.174	**%**	DL8			ACPF	
20130706	1438	1	**33**	1	49.3	65	57.178	168	56.253	**%**	DL9	6	62	ACPF	no bottles
20130706	1443	1	**33**	2	49.3	65	57.178	168	56.177	**%**	DL9			ACPF	

20130706	1455	1	**34**	1	50	65	58.083	168	56.243 **%**	DL10	6.3	329 ACPF	
20130706	1502	1	**34**	2	50	65	58.136	168	56.156 **%**	DL10		ACPF	
20130706	1514	1	**35**	1	50.3	65	59.085	168	56.260 **%**	DL11	6.7	40 ACPF	no bottles
20130706	1520	1	**35**	2	50.3	65	59.098	168	56.124 **%**	DL11		ACPF	
20130706	1530	1	**36**	1	50.6	66	0.057	168	56.218 **%**	DL12	5.6	7 ACPF	bottle 6 was leaking
20130706	1537	1	**36**	2	50.6	66	0.121	168	56.100 **%**	DL12		ACPF	
20130706	1559	1	**37**	1	51.2	66	2.634	168	56.211 **%**	DL13	6	28 ACPF	no bottles
20130706	1605	1	**37**	2	51.2	66	2.682	168	56.094 **%**	DL13		ACPF	
20130706	1627	1	**38**	1	53	66	5.116	168	56.178 **%**	DL14	5.7	182 DAS	bottle 3 leaks have valve opened
20130706	1634	1	**38**	2	53	66	5.095	168	56.165 **%**	DL14		DAS	
20130706	1701	1	**39**	1	52.8	66	7.637	168	56.172 **%**	DL15	6.4	321 DAS	no bottles
20130706	1708	1	**39**	2	52.8	66	7.628	168	56.332 **%**	DL15		DAS	
20130706	1730	1	**40**	1	53.8	66	10.230	168	56.114 **%**	DL16	6.7	184 DAS	Bottles 3 and 6 were leaking
20130706	1740	1	**40**	2	53.8	66	10.286	168	56.321 **%**	DL16		DAS	
20130706	1800	1	**41**	1	55.7	66	12.775	168	56.095 **%**	DL17	6.1	28 DAS	No bottles
20130706	1809	1	**41**	2	55.7	66	12.811	168	56.154 **%**	DL17		DAS	
20130706	1830	1	**42**	1	55.8	66	15.310	168	56.131 **%**	DL18	3.5	2 DAS	Bottles 6 and 3 and 2 leak when valve opened
20130706	1839	1	**42**	2	55.8	66	15.360	168	56.335 **%**	DL18		DAS	
20130706	1900	1	**43**	1	54.9	66	17.844	168	56.228 **%**	DL19	3.4	302 DAS	no bottles
20130706	1908	1	**43**	2	54.9	66	17.904	168	56.369 **%**	DL19		DAS	Cleaned pump tube before cast
20130706	1927	1	**44**	1	54.6	66	19.597	168	57.169 **%**	A313	5.1	78 DAS	Cleaned pump tube before cast; wrong name in header file
20130706	1936	1	**44**	2	54.6	66	19.675	168	57.253 **%**	A313		DAS	1 2 3 5 6 leaking after valve opened
20130706	1953	1	**45**	1	54.6	66	20.380	168	53.600 **%**	AL13	3.8	5 RW	
20130706	2001	1	**45**	2	54.6	66	20.465	168	53.701 **%**	Al13	2.4	357 RW	All bottles leaked
20130706	2026	1	**46**	1	53.7	66	21.070	168	49.240 **%**	AL14	7	106 DAS	
20130706	2034	1	**46**	2	53.7	66	21.168	168	49.259 **%**	AL14		DAS	Bottles 2 and 5 leaked when valve opened Bottle 6 did not fire
20130706	2053	1	**47**	1	46.3	66	21.720	168	45.050 **%**	AL15		DAS	
20130706	2101	1	**47**	2	46.3	66	21.730	168	45.077 **%**	AL15		DAS	Bottles 3 and 6 leaked when valve opened
20130706	2122	1	**48**	1	55.9	66	22.554	168	40.642 **%**	AL16	6.6	252 DAS	
20130706	2132	1	**48**	2	55.9	66	22.634	168	40.828 **%**	AL16		DAS	Bottles 3 and 6 leaked when valve opened
20130706	2150	1	**49**	1	54	66	23.190	168	36.351 **%**	AL17	6	13 DAS	Bottles 1 and 3 went down with valve open
20130706	2159	1	**49**	2	54	66	23.230	168	36.272 **%**	AL17		DAS	
20130706	2215	1	**50**	1	52	66	23.912	168	32.169 **%**	AL18	6.2	51 DAS	
20130706	2224	1	**50**	2	52	66	23.960	168	32.171 **%**	AL18		DAS	Bottles 1 and 3 leaked after valve opened
20130706	2242	1	**51**	1	52.3	66	24.597	168	27.881 **%**	AL19	10.2	140 DAS	
20130706	2251	1	**51**	2	52.3	66	24.718	168	27.931 **%**	AL19		DAS	No sample on bottle 5
20130706	2307	1	**52**	1	51.1	66	25.306	168	23.457 **%**	AL20	8.1	230 DAS	
20130706	2316	1	**52**	2	51.1	66	25.415	168	23.533 **%**	AL20		DAS	Bottle 1 leak when valve opened slightly
20130706	2334	1	**53**	1	46.6	66	26.027	168	19.275 **%**	AL21	5.9	10 DAS	
20130706	2342	1	**53**	2	46.6	66	26.066	168	19.249 **%**	AL21		DAS	Bottle 5 leaked slightly when valve opened
20130707	0001	1	**54**	1	39.5	66	26.720	168	14.932 **%**	AL22	8.5	250 RD	
20130707	0009	1	**54**	2	39.8	66	26.762	168	15.128 **%**	AL22		RD	Bottle 1 leaked slightly when the valve was opened.
20130707	0029	1	**55**	1	32.3	66	27.488	168	10.622 **%**	AL23	7.4	220 RD	

20130707	0035	1	**55**	2	32.4	66	27.518	168	10.709	**%**	AL23			RD	No leaking bottles.
20130707	0053	1	**56**	1	25.3	66	28.152	168	6.141	**%**	AL24	8	292	RD	
20130707	0059	1	**56**	2	25.8	66	28.208	168	6.123	**%**	AL24			RD	No leaking bottles.
20130707	0924	1	**57**	1	48.5	67	38.095	168	55.995	**%**	CS10US	9.5	161	ACPF	
20130707	0931	1	**57**	2	48.5	67	38.153	168	55.993	**%**	CS10US			ACPF	
20130707	1006	1	**58**	1	48.2	67	41.684	168	48.140	**%**	CS10.5	10.7	124	ACPF	no bottles
20130707	1012	1	**58**	2	48.2	67	41.732	168	48.112	**%**	CS10.5			ACPF	
20130707	1050	1	**59**	1	48.1	67	45.249	168	39.978	**%**	CS11	12	152	ACPF	
20130707	1057	1	**59**	2	48.1	67	45.263	168	39.871	**%**	CS11			ACPF	
20130707	1137	1	**60**	1	48.8	67	48.909	168	29.403	**%**	CS11.5	11.1	175	ACPF	no bottles
20130707	1143	1	**60**	2	48.8	67	48.935	168	29.342	**%**	CS11.5			ACPF	
20130707	1225	1	**61**	1	54.5	67	52.513	168	18.803	**%**	CS12	10.7	160	ACPF	
20130707	1232	1	**61**	2	54.5	67	52.532	168	18.809	**%**	CS12			ACPF	
20130707	1312	1	**62**	1	56.9	67	55.905	168	9.149	**%**	CS12.5	8.4	94	ACPF	no bottles
20130707	1318	1	**62**	2	56.9	67	55.912	168	9.185	**%**	CS12.5			ACPF	
20130707	1357	1	**63**	1	52.9	67	59.367	167	59.362	**%**	CS13	8.5	137	ACPF	Bottles 3 and 5 were leaking, with vent opened
20130707	1404	1	**63**	2	52.9	67	59.424	167	59.474	**%**	CS13			ACPF	
20130707	1442	1	**64**	1	52.2	68	2.721	167	49.766	**%**	CS13.5	11	151	ACPF	no bottles
20130707	1447	1	**64**	2	52.2	68	2.767	167	49.876	**%**	CS13.5			ACPF	
20130707	1526	1	**65**	1	50.5	68	6.118	167	39.960	**%**	CS14	8.6	119	ACPF	
20130707	1533	1	**65**	2	50.5	68	6.186	167	40.091	**%**	CS14			ACPF	
20130707	1609	1	**66**	1	47.6	68	9.097	167	30.825	**%**	CS14.5	6.6	115	DAS	no bottles
20130707	1615	1	**66**	2	47.6	68	9.158	167	30.827	**%**	CS14.5			DAS	
20130707	1652	1	**67**	1	45.9	68	12.123	167	21.318	**%**	CS15	4.6	104	DAS	
20130707	1659	1	**67**	2	45.9	68	12.332	167	21.332	**%**	CS15			DAS	Bottles 2 and 3 leaked when valve opened
20130707	1719	1	**68**	1	44.5	68	13.612	167	16.714	**%**	CS15.5	4.5	113	DAS	
20130707	1725	1	**68**	2	44.5	68	13.626	167	16.634	**%**	CS15.5			DAS	Fired two bottles but no samples taken
20130707	1744	1	**69**	1	42.8	68	15.030	167	12.146	**%**	CS16	3.8	33	DAS	
20130707	1751	1	**69**	2	42.8	68	14.995	167	12.125	**%**	CS16			DAS	No sample bottle 3 Bottle 6 leaks
20130707	1813	1	**70**	1	39.8	68	16.612	167	7.593	**%**	CS16.5	2.7	280	DAS	No bottles
20130707	1819	1	**70**	2	39.8	68	16.625	167	7.867	**%**	CS16.5			DAS	
20130707	1842	1	**71**	1	36.4	68	17.997	167	2.911	**%**	CS17	3.9	10	DAS	
20130707	1849	1	**71**	2	36.4	68	18.067	167	3.425	**%**	CS17			DAS	Tripped two bottles at 20m sampled only one
20130707	1916	1	**72**	1	31.7	68	18.874	166	57.374	**%**	CS18	3.9	91	DAS	
20130707	1923	1	**72**	2	31.7	68	18.893	166	57.739	**%**	CS18			DAS	
20130707	1952	1	**73**	1	25.1	68	19.888	166	52.188	**%**	CS19	3.3	55	DAS	
20130707	1957	1	**73**	2	25.1	68	19.915	166	52.372	**%**	CS19			DAS	
20130708	0037	1	**74**	1	25.8	68	54.383	166	19.723	**%**	LIS1	12.5	278	RD	
20130708	0045	1	**74**	2	25.9	68	54.398	166	19.619	**%**	LIS1			RD	No leaks in bottles.
30130708	0100	1	**75**	1	30.8	68	54.815	166	25.145	**%**	LIS2	5	340	RD	
20130708	0106	1	**75**	2	30.7	68	54.800	166	25.067	**%**	LIS2			RD	No leaks in bottles.
20130708	0124	1	**76**	1	32.3	68	55.243	166	30.613	**%**	LIS3	7.6	239	RD	
20130708	0131	1	**76**	2	32.2	68	55.273	166	30.521	**%**	LIS3			RD	No leaks in bottles.

20130708	0156	1	**77**	1	39.9	68	55.800	166	38.581	**%**	LIS4	11.3	187	RD	
20130708	0204	1	**77**	2	39.5	68	55.846	166	38.509	**%**	LIS4			RD	Salps. No leaks in bottles.
20130708	0230	1	**78**	1	44.1	68	56.365	166	46.662	**%**	LIS5	6.8	312	RD	
20130708	0238	1	**78**	2	44	68	56.364	166	46.294	**%**	LIS5			RD	No leaks in bottles.
20130708	0307	1	**79**	1	44.7	68	56.965	166	54.545	**%**	LIS6	6.7	339	RD	
20130708	0314	1	**79**	2	44.5	68	56.951	166	54.329	**%**	LIS6			RD	No leaks in bottles.
20130708	0338	1	**80**	1	45	68	57.587	167	1.990	**%**	LIS6.5	6	17	RD	
20130708	0347	1	**80**	2	45	68	57.587	167	1.753	**%**	LIS6.5			RD	No leaks in bottles.
20130708	0411	1	**81**	1	44.7	68	58.214	167	9.377	**%**	LIS7	7.6	79	RD	
20130708	0419	1	**81**	2	44.8	68	58.207	167	9.218	**%**	LIS7			RD	No leaks in bottles.
20130708	0435	1	**82**	1	45	68	58.819	167	16.674	**%**	LIS7.5	8.1	54	RD	
20130708	0442	1	**82**	2	45.4	68	58.207	167	16.674	**%**	LIS7.5			RD	No samples taken.
20130708	0510	1	**83**	1	45.5	68	59.403	167	23.922	**%**	LIS8	9.8	207	RD	
20130708	0518	1	**83**	2	45.5	68	59.444	167	24.057	**%**	LIS8			RD	Bottle 3 leaking.
20130708	0558	1	**84**	1	46.7	69	0.443	167	38.702	**%**	LIS9	10	104	RD	
20130708	0606	1	**84**	2	46.8	69	0.602	167	38.977	**%**	LIS9			RD	No leaks in bottles.
20130708	0646	1	**85**	1	47.6	69	1.803	167	53.353	**%**	LIS10	7.8	240	RD	
20130708	0653	1	**85**	2	47.6	69	1.814	167	53.506	**%**	LIS10			RD	No leaks in bottles.
20130708	0732	1	**86**	1	48.2	69	1.364	168	7.701	**%**	LIS11	11.6	224	RD	
20130708	0740	1	**86**	2	48.2	69	1.368	168	7.828	**%**	LIS11			RD	No leaks in bottles.
20130708	0819	1	**87**	1	48.9	69	0.918	168	22.629	**%**	LIS12	9.7	198	ACPF	
20130708	0826	1	**87**	2	48.9	69	0.928	168	22.710	**%**	LIS12			ACPF	
20130708	0905	1	**88**	1	50.1	69	0.474	168	36.933	**%**	LIS13	10.1	237	ACPF	
20130708	0912	1	**88**	2	50.1	69	0.474	168	37.070	**%**	LIS13			ACPF	
20130708	0939	1	**89**	1	50.7	69	0.251	168	46.545	**%**	LIS14	9.8	212	ACPF	
20130708	0945	1	**89**	2	50.7	69	0.250	168	46.662	**%**	LIS14			ACPF	
20130708	1013	1	**90**	1	50.9	69	0.013	168	55.982	**%**	CCL22	9.3	219	ACPF	
20130708	1020	1	**90**	2	50.9	69	0.016	168	56.110	**%**	CCL22			ACPF	
20130708	1134	1	**91**	1	51.5	68	50.054	168	56.017	**%**	CCL21	10.4	23	ACPF	
20130708	1141	1	**91**	2	51.5	68	49.998	168	55.933	**%**	CCL21			ACPF	
20130708	1253	1	**92**	1	51.3	68	39.990	168	55.990	**%**	CCL20	10.2	254	ACPF	
20130708	1301	1	**92**	2	51.3	68	39.956	168	56.056	**%**	CCL20			ACPF	
20130708	1414	1	**93**	1	53.1	68	29.990	168	56.054	**%**	CCL19	9.2	291	ACPF	
20130708	1421	1	**93**	2	53.1	68	29.947	168	56.186	**%**	CCL19			ACPF	
20130708	1537	1	**94**	1	54.3	68	20.099	168	56.048	**%**	CCL18	11.5	65	ACPF	
20130708	1543	1	**94**	2	54.3	68	20.066	168	56.110	**%**	CCL18			ACPF	
20130708	1657	1	**95**	1	55.7	68	9.966	168	56.132	**%**	CCL17	11.6	106	DAS	
20130708	1705	1	**95**	2	55.7	68	9.946	168	56.212	**%**	CCL17			DAS	
20130708	1819	1	**96**	1	55.4	67	59.919	168	55.927	**%**	CCL16	11.8	129	DAS	
20130708	1827	1	**96**	2	55.4	67	59.881	168	55.955	**%**	CCL16			DAS	Bottle 3 leaking.
20130708	1939	1	**97**	1	49	67	49.939	168	55.891	**%**	CCL15	12.1	148	DAS	
20130708	1942	1	**97**	2	49	67	55.860	168	55.860	**%**	CCL15			DAS	
20130708	2114	1	**98**	1	48.6	67	38.122	168	56.049	**%**	CCL14	11.5	80	DAS	Same as CS10US

20130708	2122	1	**98**	2	48.6	67	38.119	168	55.871	**%**	CCL14			DAS	
20130708	2224	1	**99**	1	48.2	67	29.974	168	56.001	**%**	CCL13	12.4	77	DAS	
20130708	2231	1	**99**	2	48.2	67	29.957	168	55.954	**%**	CCL13			DAS	
20130708	2348	1	**100**	1	47.7	67	19.950	168	56.051	**%**	CCL12	13.7	102	DAS	
20130708	2356	1	**100**	2	47.7	67	19.934	168	55.966	**%**	CCL12			DAS	
20130709	0110	1	**101**	1	46.8	67	10.070	168	55.994	**%**	CCL11	13.7	160	RD	
20130709	0118	1	**101**	2	46.7	67	10.055	168	55.877	**%**	CCL11			RD	
20130709	0235	1	**102**	1	46	66	59.963	168	55.896	**%**	CCL10	15.6	90	RD	
20130709	0242	1	**102**	2	46.3	66	59.947	168	55.773	**%**	CCL10			RD	
20130709	0404	1	**103**	1	43.3	66	50.033	168	56.061	**%**	CCL9	16.2	176	RD	
20130709	0411	1	**103**	2	42.7	66	49.871	168	55.951	**%**	CCL9			RD	
20130709	0530	1	**104**	1	41.9	66	40.041	168	56.034	**%**	CCL8	15.8	270	RD	
20130709	0536	1	**104**	2	42	66	40.012	168	56.080	**%**	CCL8			RD	
20130709	0617	1	**105**	1	44.4	66	35.066	168	56.009	**%**	CCL7	16.7	287	RD	
20130709	0625	1	**105**	2	44.2	66	35.015	168	56.018	**%**	CCL7			RD	
20130709	0706	1	**106**	1	55.1	66	30.050	168	56.037	**%**	CCL6	15.2	293	RD	
20130709	0714	1	**106**	2	55.1	66	30.031	168	56.041	**%**	CCL6			RD	
20130709	0757	1	**107**	1	54.7	66	25.001	168	56.007	**%**	CCL5	14.8	269	RD	
20130709	0807	1	**107**	2	54.8	66	24.925	168	56.152	**%**	CCL5			RD	
20130709	0853	1	**108**	1	54.8	66	19.352	168	56.648	**%**	A3-13	15	300	ACPF	Got labeled wrong (as CCL4) in the header of seasave file.
20130709	0900	1	**108**	2	54.8	66	19.380	168	56.581	**%**	A3-13			ACPF	
20130709	0916	1	**109**	1	55	66	17.860	168	56.222	**%**	DL19	15.7	270	ACPF	no bottles
20130709	0922	1	**109**	2	55	66	17.857	168	56.162	**%**	DL19			ACPF	
20130709	0945	1	**110**	1	55.9	66	15.333	168	56.221	**%**	DL18	16	251	ACPF	No leaks in bottles.
20130709	0953	1	**110**	2	55.9	66	15.365	168	56.087	**%**	DL18			ACPF	
20130709	1016	1	**111**	1	55.4	66	12.782	168	56.297	**%**	DL17	15.3	180	ACPF	no bottles
20130709	1022	1	**111**	2	55.4	66	12.800	168	56.297	**%**	DL17			ACPF	
20130709	1045	1	**112**	1	53.8	66	10.184	168	56.154	**%**	DL16	18.3	263	ACPF	No leaks in bottles.
20130709	1052	1	**112**	2	53.8	66	10.193	168	56.035	**%**	DL16			ACPF	
20130709	1115	1	**113**	1	52.5	66	7.709	168	56.091	**%**	DL15	19.4	245	ACPF	no bottles
20130709	1121	1	**113**	2	52.5	66	7.692	168	56.056	**%**	DL15			ACPF	
20130709	1146	1	**114**	1	53	66	5.198	168	56.072	**%**	DL14	16.5	118	ACPF	No leaks in bottles.
20130709	1152	1	**114**	2	53	66	5.243	168	55.900	**%**	DL14			ACPF	
20130709	1218	1	**115**	1	50.8	66	2.678	168	56.039	**%**	DL13	17.5	293	ACPF	no bottles
20130709	1223	1	**115**	2	50.8	66	2.660	168	55.988	**%**	DL13			ACPF	
20130709	1247	1	**116**	1	50.7	66	0.064	168	56.138	**%**	DL12	17.3	314	ACPF	No leaks in bottles.
20130709	1255	1	**116**	2	50.7	65	59.976	168	56.015	**%**	DL12			ACPF	
20130709	1305	1	**117**	1	50.3	65	59.139	168	56.192	**%**	DL11	14.1	334	ACPF	No bottles
20130709	1311	1	**117**	2	50.3	65	59.062	168	56.039	**%**	DL11			ACPF	
20130709	1323	1	**118**	1	50	65	58.078	168	56.221	**%**	DL10	20	258	ACPF	No leaks in bottles.
20130709	1329	1	**118**	2	50	65	58.056	168	56.290	**%**	DL10			ACPF	
20130709	1340	1	**119**	1	48.8	65	57.104	168	56.122	**%**	DL9	16.1	305	ACPF	No bottles
20130709	1346	1	**119**	2	48.8	65	57.018	168	56.010	**%**	DL9			ACPF	

20130709	1356	1	**120**	1	47.9	65	56.087	168	56.152 **%**	DL8	14.3	297 ACPF	No leaks in bottles.
20130709	1402	1	**120**	2	47.9	65	56.009	168	56.108 **%**	DL8		ACPF	
20130709	1413	1	**121**	1	47.1	65	55.094	168	56.094 **%**	DL7	12.6	333 ACPF	no bottles
20130709	1418	1	**121**	2	47.1	65	54.983	168	55.853 **%**	DL7		ACPF	
20130709	1431	1	**122**	1	47	65	54.048	168	56.341 **%**	DL6	15.7	120 ACPF	
20130709	1436	1	**122**	2	47	65	54.067	168	56.123 **%**	DL6		ACPF	
20130709	1447	1	**123**	1	45.7	65	53.117	168	56.148 **%**	DL5	12.2	323 ACPF	no bottles
20130709	1451	1	**123**	2	45.7	65	53.003	168	55.990 **%**	DL5		ACPF	
20130709	1500	1	**124**	1	44	65	52.239	168	56.178 **%**	DL4	17.8	314 ACPF	
20130709	1507	1	**124**	2	44	65	52.097	168	56.119 **%**	DL4		ACPF	
20130709	1517	1	**125**	1	46	65	51.157	168	56.233 **%**	DL3	17.4	236 ACPF	
20130709	1523	1	**125**	2	46	65	51.042	168	56.345 **%**	DL3		ACPF	
20130709	1531	1	**126**	1	45.5	65	50.101	168	56.273 **%**	DL2	10	324 ACPF	
20130709	1538	1	**126**	2	45.5	65	50.215	168	56.273 **%**	DL2		ACPF	
20130709	1546	1	**127**	1	45.5	65	49.318	168	56.021 **%**	DL1	16.6	313 ACPF	
20130709	1553	1	**127**	2	45.5	65	49.264	168	56.197 **%**	DL1		ACPF	
20130709	1606	1	**128**	1	43.5	65	49.331	168	52.253 **%**	DLa1	12.3	100 DAS	no bottles
20130709	1612	1	**128**	2	43.5	65	49.326	168	52.057 **%**	DLa1		DAS	
20130709	1623	1	**129**	1	46.9	65	50.332	168	52.303 **%**	DLa2	13.5	270 ACPF	
20130709	1629	1	**129**	2	46.9	65	50.333	168	52.096 **%**	DLa2		ACPF	
20130709	1639	1	**130**	1	47.1	65	51.181	168	52.358 **%**	DLa3	15.4	251 DAS	no bottles
20130709	1644	1	**130**	2	47.1	65	51.184	168	52.270 **%**	DLa3		DAS	
20130709	1656	1	**131**	1	47.7	65	52.220	168	52.255 **%**	DLa4	15	261 DAS	
20130709	1703	1	**131**	2	47.7	65	52.220	168	52.255 **%**	DLa4		DAS	
20130709	1714	1	**132**	1	47.8	65	52.230	168	52.264 **%**	DLa5	16.7	286 DAS	no bottles
20130709	1720	1	**132**	2	47.8	65	53.178	168	52.139 **%**	DLa5		DAS	
20130709	1731	1	**133**	1	48.2	65	54.222	168	52.285 **%**	DLa6	15.3	279 DAS	
20130709	1738	1	**133**	2	48.2	65	54.209	168	52.116 **%**	DLa6		DAS	
20130709	1749	1	**134**	1	49.3	65	55.181	168	52.218 **%**	DLa7	15.8	303 DAS	no bottles
20130709	1754	1	**134**	2	49.3	65	55.166	168	52.121 **%**	DLa7		DAS	
20130709	1806	1	**135**	1	50	65	56.198	168	52.203 **%**	DLa8	18.5	269 DAS	
20130709	1813	1	**135**	2	50	65	56.171	168	52.114 **%**	DLa8		DAS	
20130709	1917	1	**136**	1	45	65	48.286	168	55.000 **%**	BS11	16.6	208 DAS	
20130709	1924	1	**136**	2	45	65	48.340	168	55.831 **%**	BS11		DAS	
20130709	1944	1	**137**	1	42.6	65	47.301	168	51.713 **%**	BS12	12.5	227 DAS	
20130709	1950	1	**137**	2	42.6	65	47.316	168	51.658 **%**	BS12		DAS	
20130709	2007	1	**138**	1	51	65	46.294	168	47.685 **%**	BS13	14	190 DAS	
20130709	2015	1	**138**	2	51	65	46.337	168	47.592 **%**	BS13		DAS	
20130709	2033	1	**139**	1	51.1	65	45.248	168	43.264 **%**	BS14	16.5	236 DAS	Bottles 1 and 2 and 3 top valve open during cast
20130709	2042	1	**139**	2	51.1	65	45.260	168	43.183 **%**	BS14		DAS	
20130709	2058	1	**140**	1	49.7	65	44.326	168	39.894 **%**	BS15	12.4	186 DAS	
20130709	2107	1	**140**	2	49.7	65	44.364	168	39.852 **%**	BS15		DAS	
20130709	2127	1	**141**	1	49.8	65	43.265	168	35.548 **%**	BS16	15.3	224 DAS	

20130709	2134	1	**141**	2	49.8	65	43.278	168	35.500	**%**	BS16			DAS	
20130709	2153	1	**142**	1	53.7	65	42.207	168	31.279	**%**	BS17			DAS	
20130709	2201	1	**142**	2	53.7	65	42.229	168	31.195	**%**	BS17			DAS	
20130709	2212	1	**143**	1	51.7	65	41.673	168	29.249	**%**	BS17s	13.6	170	DAS	
20130709	2218	1	**143**	2	51.7	65	41.725	168	29.186	**%**	BS17s			DAS	Bottle 6 leaked when valve opened
20130709	2229	1	**144**	1	52.2	65	41.179	168	27.066	**%**	BS18	13.7	172	DAS	
20130709	2237	1	**144**	2	52.2	65	41.245	168	27.004	**%**	BS18			DAS	
20130709	2252	1	**145**	1	50.2	65	40.334	168	23.531	**%**	BS19	15.8	200	DAS	
20130709	2301	1	**145**	2	50.2	65	40.387	168	23.413	**%**	BS19			DAS	
20130709	2321	1	**146**	1	47.4	65	39.298	168	19.175	**%**	BS20	15.2	24	DAS	
20130709	2328	1	**146**	2	47.4	65	39.352	168	19.286	**%**	BS20			DAS	
20130709	2351	1	**147**	1	41	65	38.500	168	15.121	**%**	BS21	14.2	257	DAS	
20130709	2352	1	**147**	2	41	65	38.603	168	15.247	**%**	BS21			DAS	
20130710	0020	1	**148**	1	30	65	37.447	168	10.646	**%**	BS22	14.2	253	RD	
20130710	0026	1	**148**	2	30	65	37.509	168	10.721	**%**	BS22			RD	
20130710	0040	1	**149**	1	28.8	65	35.933	168	9.605	**%**	BS23	14.5	89	RD	
20130710	0045	1	**149**	2	29.3	65	35.928	168	9.747	**%**	BS23			RD	
20130710	0059	1	**150**	1	23.3	65	34.903	168	6.967	**%**	BS24	15.6	117	RD	
20130710	0104	1	**150**	2	23.2	65	34.935	168	7.117	**%**	BS24			RD	