AWS-02 Phase I, SBI. July 15-August 13, 2002
CTD and Water Sampling Summary

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1. Introduction

This report describes the hydrographic sampling program carried out on the 2002 Western Arctic Shelf-Basin Interactions (SBI) mooring cruise. SBI is a multi-institutional, inter-disciplinary program studying the manner in which the shelves and open Arctic communicate with each other, and how this might be influenced by climate variability. The cruise took place from 15 July--13 August on the USCGC Polar Star. The principal investigator was Tom Weingartner of the University of Alaska Fairbanks (UAF). Co-principal investigator was Robert Pickart of the Woods Hole Oceanographic Institution (WHOI), who was also in charge of the hydrographic operations. The instrumentation (CTDs, water sampler, frame, bottles) was provided by the Polar Star. Processing of the CTD data was carried out by WHOI (under subcontract from the Scripps Institution of Oceanography, SIO), nutrients were done by the University of Washington, and the water sample salinity program was carried out by SIO. Additionally there was a lowered ADCP program (not described in this report).

In total, 90 CTD casts were completed comprising 6 cross-sections within the Chukchi and Beaufort Seas (Figure 1). Most of the sections crossed the outer shelf / upper slope with a station resolution of 5 km (occasionally XCTDs were used to increase the resolution). This data set represents the first such high-resolution survey of this portion of the western Arctic Ocean.

The Seabird 911+ system delivered high quality data and, except for a few stations, required only basic processing. Pre and post cruise calibrations, dual sensor comparisons and bottle salinity calibrations were used to determine the accuracy of the temperature and salinity. Except for the very fresh water, the sensors met or exceeded the stated accuracy for the instrument. Temperature was 0.001 °C and salinity was 0.002 in the saltier water (34.8) to 0.007 in the fresh water (30). High salinity gradients and poor bottle flushing prevented calibration with bottle salinities of the fresher water but the saltier water calibrations showed the CTD sensors were very stable and remarkably required no adjustments to the pre cruise calibration. CTD and bottle salinity comparisons show poor bottle flushing resulted in water samples with up to 10m depth displacement. This should be taken into account when using the bottle data. No bottle data exists for the aborted station 24. Nutrient analyses was skipped for stations 26 and 29 to balance spatial resolution and time constraints of analyses. Stations 69 to 90 are without bottle data due to a major technical problem with the water sampler. Because we were near the end of the cruise, the ship's alternate water sampler was not installed in order to save time for the additional CTD casts.

2. CTD Package

A Seabird 911plus CTD system was used with two temperature sensors, two conductivity sensors, and a Benthos PSA900d altimeter set for a 30m range. There were two water pumps, one for each temperature-conductivity sensor pair. In addition, a Wetlab's light scattering sensor to measure turbidity (stations 9 to 90) and a Seapoint chlorophyll fluorometer (stations 24 to 90) were attached to the Seabird underwater unit. The underwater unit was connected to a 24 position water sampler with 10-liter bottles. Separate from the CTD system but also mounted on the CTD frame, were upward and downward looking LADCPs and their common battery pack. See Appendix A for sensor serial numbers and details on each sensor.

3. Data Acquisition and Processing Procedure

Operationally, after the CTD was brought out of the hanger to the launching deck it was powered on and data acquisition begun. The CTD was lowered to 5m and after the water pumps activated the CTD was brought back up to the near-surface and then lowered at 30m/minute. After reaching a depth of over 150m the speed was increased to 60m/minute. The CTD was brought within 2m of the sea-floor if conditions were suitable for a near bottom approach. After closing a bottle, the package was raised to the surface with a variable number of stops for bottle closures along the way. Nutrients and salinity were sampled from the bottles. The data acquisition was ended after the CTD package was brought back on deck. The data collection started and ended with the CTD out of the water so that CTD and LADCP records could be combined based on the times the sensors entered and exited the water.

The 24Hz CTD data were collected in real time though the conducting sea-cable, modified through the deck unit and output to a PC computer. Seabird software running under Microsoft Windows (Seasoft-Win32 v.5.18 for stations 1 to 24 and Seasoft-Win32 v.5.24 for stations 25 to 90) was used for acquisition. Data were transferred through the ship's network to a second PC for post-station processing.

Seabird's DOS based processing software, Seasoft v.4.249 was used for batch processing files from the single scan binary data to 1 db averaged ascii files. The standard processing steps were: sensor alignment through advancing conductivity; spike removal; a correction for the thermal mass of the temperature sensors; filtering; removal of pressure reversals; averaging to 1 db levels; calculation of derived properties; and finally the file separation between downcast and upcast. Starting and ending surface pressures were recorded to monitor pressure sensor drift. In addition, time based, 1 second averaged ascii files were output for use in LADCP data processing.

Following the Seabird processing steps the data were brought into Matlab, which allowed for further computation and data visualization. With multiple programs centered around WHOI software written by Deborah West-Mack, both CTD 1dbar averaged files and water sample salinity data were imported, plotted, remaining spikes catalogued and removed using linear interpolation, CTD salinity calibrated to the bottle salinities and any particular data quality or station problem addressed. Corrections for temperature sensor drift, determined from the drift between previous laboratory calibrations, can also be applied with this software. In this case both sensors received no such correction because the trend was not trustworthy for one sensor, and in the other the value was near zero. The final output of this program were 1 db calibrated files which were put back onto the ship's network for use among the science party.

After the cruise, two more finishing steps were needed. First, remaining density inversions were removed. Secondly, the water sample nutrient and salinity data were merged with CTD data from the bottle stops into bottle files (*.nut). Due to the non-standard format of the nutrient data, special procedures, described later in the report, were used to merge the data.

4. Data Files

A summary file (Appendix C) contains the time and location of all the CTD and XCTD casts, and mooring deployments. Per station there are three files, a 1 db averaged downtrace file, a 1 db averaged uptrace file and a bottle file containing the water sample information.

Bottle files include water sample salinity, nutrients and CTD data.

sbisum_master.txt	Event summary of all CTD, XCTD and moorings.
sbi02###.dcc	1db averaged downtrace CTD file per station
sbi02###.ucc	1db averaged uptrace CTD file per station
sbi02###.nut	Bottle data per station
C3_000##.edf	XCTD data, 1 file per XCTD station

5. CTD Data Quality

The manufacturer's specified CTD sensor accuracy is 0.003mS/cm for conductivity, 0.001 °C for temperature and 0.015% of the full scale for pressure. The CTD sensors received laboratory calibrations in May 2002, prior to the cruise which were applied during the data processing. In addition to bottle salinity comparisons the dual sensors were compared at sea to investigate any sensor drift. After the cruise, laboratory calibrations were performed, between October and December, 2002. The post cruise calibrations were not applied to the data but used to show the small amount of drift in the sensors and show no additional corrections were needed. We found the temperature accuracy was better than 0.001 °C, conductivity ranged from 0.001 mS/cm at higher conductivity (29 mS/cm) and based on sensor differences was 0.004 mS/cm at lower (below 25 mS/cm) conductivity. Consistent with the combined temperature and conductivity accuracy, the higher salinity (34.8) was better than 0.002 based on bottle calibrations and the lower salinity (below 34.5) showed sensor differences of 0.007.

Pre and post cruise calibrations show both temperature sensors were very stable with less than 0.001°C shift between calibrations. The primary temperature changed 0.0003°C and the secondary temperature changed 0.0008°C. The changes are even less if only the calibration points between -2 to 6 °C, the temperature range of the data, are examined. The difference between the sensors is in agreement with the difference found by comparing station data during the cruise, less than 0.001°C. The sensors' drifts are less than the stated accuracy of the sensors and no adjustments need to be made to the data.

The conductivity sensors were also quite stable from the pre to post cruise calibrations. The primary conductivity increased 0.002 mS/cm and the secondary conductivity decreased 0.0004 mS/cm. 'Increased' here means the pre cruise calibration was reading too high by the time of the post cruise calibration. Examining the calibration points between 20 and 32 mS/cm, the range of the data, show the primary conductivity increased by only 0.001 mS/cm and the secondary sensor did not change. These results are consistent with the at-sea sensor comparisons for the higher conductivity, a 0.001 mS/cm difference in water over 29 mS/cm, however the larger sensor difference of 0.004 mS/cm in water with lower conductivity, below 25 mS/cm, is not seen in the calibration data. This may be due to the lack of calibration points for the lower conductivity water which skip from 0 to 28 mS/cm.

The CTD salinity differences between primary and secondary sensors result from a combination of the temperature and conductivity differences. The differences were 0.002 in the saltier water (34.8-34.9) and up to 0.007 in the fresh waters (30). The water sample salinities from the bottles in the saline (34.8-34.9) homogenous Atlantic Layer show the 0.002 difference in the 34.8-34.9 range is due to the primary sensors salinity reading +0.0005 to +0.001 higher than the bottles and the secondary sensors salinity reading -0.001 lower than the bottles. This 0.001 correction was not made to the CTD data. Because there are no meaningful bottle calibrations for salinity in the high gradient waters the accuracy of the lower salinity water must be based on the laboratory calibrations and the sensor comparisons. The pre and post cruise calibrations show the primary salinity may be +0.001 because of a change in the conductivity sensor and the secondary salinity may be -0.001 due to the change in the temperature sensor. However, the at-sea salinity data show a difference of 0.007. Thus, the best estimate is then around 0.007.

6. Data Issues

6.1. Bottle Flushing

High salinity gradients in the upper 200m were responsible for large salinity signals as well as large differences between the bottle and CTD samples.

Tests performed at sea indicate the CTD package wake effects and lack of bottle flushing (even after using 1 minute bottle stops) were responsible for the discrepancies between CTD sensors and bottle samples in the large gradient regions. Although the water sample values were within 10m of the CTD values, the differences were large enough to prevent their use in calibrations.

Waiting times and tests:

Station 25 and up: waiting 15 sec at bottle stop before firing bottle
Station 29: drew duplicate samples from each Niskin bottle
Station 57-68: increased waiting time to 1 minute before firing bottle
Station 57+58: fired a bottle after 15seconds and then again after total of 1 minute wait.

6.2. Data Spikes at High Winch Speeds

Noisy CTD data was generated by high winch speeds. The spikes in the data were removed by the standard processing de-spiking programs and were not a concern for the final output. The source of the problem, determined on the following cruise, was cross- talk between the data cable and the winch power cable which had been laid too close to each other. Separation of the cables solved the problem.

6.3. Rosette Water Sampler Malfunction

Beginning with station 62 we had problems with bottle firing. There were confirmed fires that did not close bottles and unconfirmed fires that did close bottles. There appeared to be a pattern to the bottles that did close and this pattern was used successfully for the next few stations. When the problem increased further on station 68 it was decided to stop water sampling altogether during the CTD casts. The ship had a spare water sampler that could have been swapped in, but it was decided to save the time for additional CTD casts, because this was near the end of the cruise.

The pattern for successful bottle firing was for every-other three bottles to close (Bottles 1-3, 7-9, 13-15, 19-21). Although during station 68 this pattern deteriorated. The bottle firing problem persisted through manual firing using the deck unit, cable replacement between the underwater unit and the water sampler and on deck tests while the CTD was in the hanger.

7. Data Quality Control

Bottle salinity and nutrients have not been quality controlled. The temperature and salinity from the secondary CTD sensors, the fluorometer and the light scattering sensor data have not been quality controlled.

The quality words in the down and up 1 db averaged files have not been adjusted to reflect interpolations or edits. The quality word remains at its default setting of '2' for pressure, and primary and secondary temperature and salinity.

7.1 Density Inversions

Density inversion were noted in the deep CTD profiles. To identify these, profiles of density versus pressure were made. It was determined that five stations needed to have bad temperature and salinity values removed manually. Erroneous temperature and salinity values for sensor 1 were replaced with the missing value flag, -9.00000. Temperature and salinity values for sensor 2 were left unchanged.

Stations 7 and 10 had density inversions in the shallow water that were corrected through interpolation. They are listed in section 9.3.

This table lists the records that were changed in stations 28, 30, 32, 65, and 66.

sbi02028.dcc:	884.0	-9.00000	0.12410	-9.00000	34.87338	0.0469	0.0357	29.42	17	22222111
sbi02028.dcc:	885.0	-9.00000	0.12220	-9.00000	34.87341	0.0329	0.0351	29.42	23	22222111
sbi02028.dcc:	886.0	-9.00000	0.12030	-9.00000	34.87343	0.2709	0.0288	29.42	25	22222111
sbi02028.dcc:	931.0	-9.00000	0.07060	-9.00000	34.87715	0.0891	0.0339	29.42	25	22222111
sbi02028.dcc:	934.0	-9.00000	0.06430	-9.00000	34.87737	0.0352	0.0365	29.42	25	22222111
sbi02028.dcc:	1124.0	-9.00000	-0.08240	-9.00000	34.88905	0.0702	0.0394	29.08	51	22222111
sbi02028.dcc:	1152.0	-9.00000	-0.09860	-9.00000	34.83081	7.9497	3.2596	29.83	143	22222111
sbi02030.dcc:	948.0	-9.00000	0.08980	-9.00000	34.87582	0.2005	0.0505	29.42	20	22222111
sbi02030.dcc:	1014.0	-9.00000	0.07200	-9.00000	34.87755	0.0419	0.0562	29.42	26	22222111
sbi02030.dcc:	1064.0	-9.00000	0.04100	-9.00000	34.87949	0.0725	0.0850	29.42	48	22222111
sbi02032.dcc:	398.0	-9.00000	0.53530	-9.00000	34.82113	0.0703	0.0861	29.43	24	22222111
sbi02032.dcc:	399.0	-9.00000	0.53520	-9.00000	34.82140	0.0681	0.0837	29.43	24	22222111
sbi02032.dcc:	435.0	-9.00000	0.53710	-9.00000	34.82402	0.0787	0.1188	29.43	24	22222111
sbi02065.dcc:	676.0	-9.00000	0.43590	-9.00000	34.85579	0.0289	0.0377	29.41	26	22222111
sbi02066.dcc:	801.0	-9.00000	0.14170	-9.00000	34.87160	0.0282	0.0312	29.41	20	22222111
sbi02066.dcc:	1210.0	-9.00000	-0.07650	-9.00000	34.88772	0.0272	0.0232	29.41	46	22222111
sbi02066.dcc:	1211.0	-9.00000	-0.07650	-9.00000	34.88769	0.0290	0.0264	29.41	54	22222111
sbi02066.dcc:	1212.0	-9.00000	-0.07640	-9.00000	34.88771	0.0275	0.0257	29.41	58	22222111

7.2 Data Spikes

Spikes in the CTD data that were not removed by the automated processing steps are listed below. Linear interpolation was used to correct the 8 stations. 2 of these stations had density inversions instead of spikes. They were corrected through interpolation instead of the above method (9.2) simply because they were edited in an earlier round of processing. All interpolations were of 4m or less except for 1 station with an interpolation of 8m.

Station	Beginning Pressure	Ending Pressure	Property
84	90	94	3
41	972	976	3
40	825	828	2
31	448	451	3
28	883	886	3
28	898	901	3
10	3	11	4
7	17	20	4

Property key is 2= Temperature, 3=Salinity, 4=Density inversion (no spike)

7.3 Final Data Product

For ease of distribution, it was decided that quality –controlled final data files would be converted to WOCE Hydrographic Programme format. For these data, bad data flags were inserted and the quality word set to 9 to indicate despiked. Oxygen units were converted from ml/l to umol/kg. See the document “Final Data Description.pdf” for a complete description.

8. Processing Water Samples

Phosphate, Nitrate, Silicate, and Nitrite were collected for all stations except 1 and 2 (test stations), 24, 26, 29 and 69-90(no bottles). These nutrients were analyzed on board by the UW group, who produced listings of the measured values at the nominal depths recorded as bottles were fired during the CTD cast.

Salinities were collected for all stations except 1 and 2 (test stations), 24 and 69-90. The salt samples were analyzed on board by the SIO group using a Guildline Autosalinometer. Temperature drift in the autosalinometer water bath was corrected for, based on standard samples run at the start and end of each tray of salt samples. The salts were listed by Niskin bottle number in one file per station (*.sal).

8.1 Bottle Salinity Quality

Unstable room temperatures throughout the cruise led to unstable autosalinometer water bath temperatures, which in turn decreased the accuracy of the measured salinities. However, the results of the tests (duplicate samples and increased waiting times) show the major discrepancy between CTD salinity and the water samples was caused by the lack of bottle flushing not the autosalinometer readings.

8.2 Nutrient Data

Because CTD v. water sample salinity differences do indicate up to a 10m separation between the water in the bottle and the location of the bottle stop, the nutrient data should be viewed with a +10m error range.

9. Combining Nutrient Water Samples with CTD Data

Phosphate, Nitrate, Silicate, and Nitrite were collected for all stations except 1 and 2 (test stations), 24, 26, 29 and 69-90(no bottles). These nutrients were analyzed on board by the UW group, who produced listings of the measured values at the nominal depths recorded as bottles were fired during the CTD cast.

A final product of the Matlab-based CTD processing program is a file containing nutrient data merged with CTD pressure, temperature, and salinity at sample depths. Merging these data required extra care since the nutrient file format did not conform to the CTD processing program's expectation that a record exist for each bottle fired (i.e., first record of nutrient file should match first bottle tag in CTD .btl file, second should match second, and so on.) The .btl file, a product of the Seabird stage of processing, contains CTD Salinity, Pressure, Temperature, and Conductivity, and time information for each bottle fired.

Sample of a portion of a .btl file:

```
  Bottle       Date      Sal00      Sal11        Pr      T090       T190    C0mS/cm    C1mS/cm
 Position       Time
    1    Jul 20 2002    32.9768     32.9730     50.469    -1.4147     -1.4162  26.385620  26.381657 (avg)
           01:11:06                      0.031     0.0003     0.0004   0.000345   0.000351 (sdev)
```

2	Jul 20 2002	32.9749	32.9714	36.625	-1.4023	-1.4024	26.388010	26.385348	(avg)
	01:13:08			0.040	0.0005	0.0004	0.000394	0.000279	(sdev)
3	Jul 20 2002	32.4475	32.4801	16.869	-0.6377	-0.6690	26.604463	26.603608	(avg)
	01:15:25			0.041	0.0456	0.0195	0.002989	0.002629	(sdev)
4	Jul 20 2002	31.1452	31.1397	12.076	3.1626	3.1902	28.624506	28.642007	(avg)
	01:16:38			0.050	0.0160	0.0387	0.006194	0.022741	(sdev)
5	Jul 20 2002	31.0635	31.0637	3.774	3.5147	3.5033	28.835734	28.826695	(avg)
	01:18:22			0.028	0.0084	0.0088	0.004542	0.006046	(sdev)

Sample SIO nutrient file (.txt) :

Actual Pressure	uM Phosphate	uM Nitrate	uM Silicate	uM Nitrite	Bottle #	Seq. #
3.7	0.29	0.00	12.40	0.02	10	5
12	0.31	0.00	12.86	0.02	8	4
16.9	0.48	0.01	19.32	0.06	6	3
-9	-9.0	-9.0	-9.0	-9.0	-9	-9
-9	-9.0	-9.0	-9.0	-9.0	-9	-9

By first comparing the number of records in each nutrient file with the number of bottle tags in the .btl file, it was possible to determine if it was necessary to insert blank records in the nutrient file to get the order correct. In the above sample (station 5), two blank records were inserted to fill bottle positions 4 and 5 for which nutrients were not sampled. Files that required insertion of blank records were from stations 5, 10, 16, 25, 28, 34, and 36.

After this, the CTD_GUI module for incorporating nutrients, which was customized for this data format, was run to produce the final .nut file.

Sample final .nut file for station 5:

AWS-02 Phase 1 Station Number: 5 Bottle Data (pre-CTD calibration)

	CTD	CTD	CTD	CTD	CTD	CTD	CTD	CTD	Meas				
Bottle	Pres.	T1(90)	T2(90)	TH1(68)	TH2(68)	SAL1	SAL2	SAL	PO4	NO3	SIL	NO2	QUAL
Number	(db)	(oC)	(oC)	(oC)	(oC)	(psu)	(psu)	(psu)	(umol/L)	(umol/L)	(umol/L)	(umol/L)	*****
1	50.5	-1.4147	-1.4162	-1.4161	-1.4176	32.9768	32.9730	-9.0000	-9.000	-9.00	-9.00	-9.00	222221192222
2	36.6	-1.4023	-1.4024	-1.4034	-1.4035	32.9749	32.9714	-9.0000	-9.000	-9.00	-9.00	-9.00	222221192222
3	16.9	-0.6377	-0.6690	-0.6383	-0.6696	32.4475	32.4801	32.1714	0.480	0.01	19.32	0.06	222221122222
4	12.1	3.1626	3.1902	3.1627	3.1903	31.1452	31.1397	31.2070	0.310	0.00	12.86	0.02	222221122222
5	3.8	3.5147	3.5033	3.5153	3.5039	31.0635	31.0637	31.0899	0.290	0.00	12.40	0.02	222221122222

Overlayed profiles of the .txt files and .btl files data were made to verify the accuracy of the matching.

10. XCTD

XCTD Use:
1 used in test
9 used in Section 3 (8 good, 1 fail)
15 used in Section 3a (13 good, 2 fail)
8 used in Section 5 (7good, 1 fail)

The depth in the XCTD data and the actual depth disagree by varying amounts depending on the station. As explained by the Sippican help page, the depth calculation for the XCTD-1 (1100m) is hard coded. Four coefficients are listed in the header but only the first two are used in a quadratic equation: depth = a*time + b*time*time. Thus the depth is not as accurate as the ship's depth (Knudsen) or the CTD.

The coefficients given in the ascii out files (*.edf) are

Depth Equation : Standard
Depth Coeff. 1 : 0.0
Depth Coeff. 2 : 3.425432
Depth Coeff. 3 : -0.00047
Depth Coeff. 4 : 0.0

The XCTD data were not processed farther, nor have they been quality controlled.

Appendix A. CTD Configuration

Serial Number of Sensors:
Pressure: 57473 in CTD 09P12377-0416
Temperature Primary: 2015
Conductivity Primary: 1549
Temperature Secondary: 2498
Conductivity Secondary: 1115

Altimeter: Benthos (ex. Datasonics) PSA 900d specially set to 0-5v. We set dipswitches to have 30m range. Altimeter height = [(300* voltage/scale factor) + offset], where scale factor = full scale voltage * 300/full scale range. Here full scale voltage = 5v and full scale range = 30m so scale factor of 50 is used.

Light Scattering Sensor: Wetlab. Recording voltage. Deck test measured 0.3 with no blockage and 5V with a hand in front of it. The sensor was added to the CTD at Station 9.

Fluorometer: Seapoint Chorophyll Fluorometer with 10x cable. Sensitivity is 0.33 V/ug/l and Range is 15 ug/l. [Concentration = (V*30/gain) + offset] where gain = 10 and offset = 0. Added at Station 24.

Appendix B-1. Individual Station Notes

Station 1
Test station. One large pressure spike and deck unit turned off mid-cast. Deck unit fuses were blown. Cause was later determined to be a short in the termination. The old splice was removed and moisture was noticed in the seabird end of the cable. No moisture seen in the conducting wire end by the technician. The wire was not cut back. Only the splice was redone using a new seabird cable.

Station 2
Test station. Water sampler modem connection not working from deck unit to the PC. The water sample was tripped by manual fire and a marker file made for the bottle trips. No samples were taken so no need to process the bottle file. Jiggling computer cable after cast 'fixed' it until it died again later at station 12 during which the cable was replaced with one from Jim Schmidt (SIO). Lat and Lon only in header.

Station 3
Latitude and Longitude added to the acquisition configuration.

Station 4
Added Bottom tracker (however there was no change needed in the *.con file). Line was 5m but it didn't switch on until we touched (very lightly!). Altimeter, ground-truthed, is accurate. CTD read 1.7m off bottom when altimeter said 1.75m.

Station 6
Altimeter signal cleaner than before- we believe its because of reduced interference from the ship's V850 fathometer. We suspect V850 was changed from 200kHz to 50kHz.

Station 7
Altimeter even cleaner after ships V850 turned off. It became standard practice to turn off V850 for all subsequent stations.

Station 9
Changed *.CON file to include Wet Labs Light Scattering Sensor. Also added a user polynomial (slope =1) for flourometer if we decide to add it.

Station 24
Changed *.CON to include Seapoint Fluorometer and removed user polynomial. This station was the first, at the seaward end, of the originally planned BS Line. Because of the steep topography on the line the section was repositioned to the west. Ice conditions were heavy. The cast was aborted after 200m (bottom depth was 2150m) due to closing ice. In addition the J-Frame was leaking oil quickly due to missing set screws. Screws were replaced after the cast fixing the J-frame. No bottles taken.

Station 25
Acquisition computer died prior to cast. May be due to trouble with the modem connection for the water sampler that ran through a comm. port to USB converter. The conversion was necessary since the acquisition PC only had one comm port and one USB port. Computer would boot, Seasave would load but when acquisition started the computer would turn off. Set up Dave Leech's laptop to acquire station data without modem. Manually fired bottles from deck unit and put mark tags into data. This got messy. Bottles may be difficult to ID. In addition to problems with confirmation (confirmation light began with sequence off -on -off for a bottle fire. It then changed to on-off-on at the fourth bottle), there were also missing bottles on the frame so when we thought we were tripping the 6th bottle we may have been tripping the 7th bottle.

Handmade the bottle-tag (*.bl) file from the mark tags and scan numbers where the CTD was stopped for bottle closures. The CTD data from the possible water stops were compared with water sample salinities to determine the actual bottle-stops.

Bottle firing- started waiting 15 seconds at bottle-stop before firing bottle.

Station 26
Jim Schmidt (SIO) let us set up one of his computers that has 2 serial ports. However some means of exporting data was needed. CD writer software was added by ship's crew. New version of SEASAVE was added: v.5.25.

Station 28
On upcast there was danger of getting caught in ice. At 260db the package was relowered to 380db and then raised again. This means the bottles below 250 db may have leaked due to compression during relowering.

Station 37 - 39
Jelly-fish in the water. They were first seen in station 37. The package caught jelly-fish parts on these three casts.

Station 42
Prior to cast:

Retermination. The wire was cut back to first appearance from winch, about 30 ft, and pull-tested to 2000 pounds.

O-ring seal on the secondary conductivity unit at the connection of the secondary conductivity outflow to the pump tubing was replaced. O-ring had started to crumble.

Secondary temperature sensor protector (clear plastic disk and spout) that encases the thermister was missing one of the plastic screws that held it in place. This allows the protective cover to wobble as it flows through the water, potentially changing the temperature reading and/or calibration. The protector was removed and replaced with a functional cover from the spare sensor. Note this changing of protective covers may have changed the calibration.

Cable between water sampler and CTD has been worn near water sampler. Probably due to wear against a sharp corner on LADCP battery pack mounted directly below. Cable was repositioned to prevent further wear.

Station 62 +962
Water sampler had problems firing bottles. There were confirms but no trips and also no confirms. The cast was stopped on the upcast after 4 bottles fired and restarted, calling the rest of the cast station 62a. This may be a problem since the file name is now 9 characters long.

The second file, sbi02062a was renamed sbi02962 and the station name within the header of the files *.dat and *.bl was also changed. *.dat and *.bl are the initial unprocessed files generated by the Seabird software. The data were processed and the two uptraces spliced together into a new sbi02062.cup and a new sbi02062.btl. The original unmodified station 62 files were renamed sbi02062_original.

Bottles 1-3, 7-9, 13-15,19-21 (every other three) would fire and the rest would not. This was tested from the deckunit and computer. Cable between water sampler and underwater unit replaced due to wear and signs of corrosion. Cable looked bad, particularly the neck of the cable attaching to the water sampler. But even with new cable the problem persisted. The next stations however were fine.

Station 64
Bottle file had too many tags and had to be edited.

Station 65
Brief temperature increase seen at 30m is seen by both sensors and a shadow of it appears on uptrace. Kept this anomaly because it looked real.

Station 67
Water sampler worked

Station 68
Pump had turned on at 10m, at start of cast, but as CTD was brought back to the surface the pump turned off and did not turn on again until at 50m. Downtrace 0 to 50m temperature and salinity was replaced with the uptrace data.

Water sampler sampled 4 bottles and then stopped working.

Stations 69-90
Water sampler option turned off

Appendix B-2. Individual Station Notes on Bottle Specific Issues

Station 5 Two bottles vents not closed, samples not taken.
Station 10 One bottle tripped on the fly, sample not taken.
Station 12 Bottle file is in upcast station 912, no bottles in down cast file.

Station 16	Two bottles compromised, samples not taken.
Station 20	One bottle with no sample.
Station 23	Mystery! 8Tags, 7bottles, we don't know which bottle is missing.
Station 24	No Bottles
Station 25	Bottles taken, but no bottle file. Hand made a bottle-tag file (*.bl) based on mark file and scan numbers of places where the CTD package was stopped for bottle-closers.
Station 26	One bottle with air vent not tight. No salt drawn. Bottle 29 should be at 50m and bottle 30 should be at the surface but it appears the 50m niskin was skipped and sample bottle 29 filled from the surface niskin. Sample bottle 30 was used at the start of sampling on the following station. Repositioned bottle 29 as the last sample in 026.sal and copied salt info from bottle 30 in 026.sal to 027.sal.
Station 27	Bottle from last station is really from this station.
Station 28	One bottle with air vent not tight. Salt sample missing for 88m, water sample #26, Niskin#15, Sequence #14.
Station 30	Salt sample missing from 175m, water sample #1, Niskin #15, Sequence # 14.
Station 31	Salt samples accidentally dumped from 0 to 125m, water samples #23 to 28.
Station 62	3 bottles in first sbi02062.btl and 1 bottle in the following sbi02962.btl file. The files were merged so that there is one sbi02062.btl file with 4 bottle tags to match the 4 water samples.
Station 64	Too many tags in *.btl file. Saved original *.btl and made new one with the correct number of tags.
Station 69+	No Bottles

Appendix C. Cruise Summary

USCGC POLAR STAR CRUISE AWS-02 PHASE 1, SHELF BASIN   INTERACTION

SHIP/CRS EXPOCODE	WOCE STNNBR	CAST	CAST TYPE	UTC DATE	TIME	EVENT CODE	POSITION LATITUDE	LONGITUDE	NAV	DEPTH	NC HT ABOVE BOTTOM	WIRE OUT	NO. BOTTLES	PARAMS	COMMENTS
AWS02SBI	1	1	ROS	020717	2315	BE	64 28.10 N	168 11.40 W	GPS	38					
AWS02SBI	1	1	ROS	020717	9999	BO	64 28.21 N	168 11.26 W	GPS	38	5	31	6	TEST	
AWS02SBI	1	1	ROS	020717	9999	EN	64 28.21 N	168 11.26 W	GPS	38					
AWS02SBI	2	1	ROS	020719	0222	BE	67 45.27 N	168 40.88 W	GPS	52					
AWS02SBI	2	1	ROS	020719	0233	BO	67 45.22 N	168 40.80 W	GPS	52	5	44	11	TEST	
AWS02SBI	2	1	ROS	020719	0246	EN	67 45.33 N	168 40.60 W	GPS	52					
AWS02SBI	3	1	ROS	020719	2108	BE	70 42.01 N	168 54.12 W	GPS	33					
AWS02SBI	3	1	ROS	020719	2115	BO	70 42.03 N	168 54.14 W	GPS	33	1.9	30	6	1,3-6	CC1
AWS02SBI	3	1	ROS	020719	2122	EN	70 42.06 N	168 54.16 W	GPS	33					
AWS02SBI	4	1	ROS	020719	2246	BE	70 42.02 N	168 13.02 W	GPS	45					
AWS02SBI	4	1	ROS	020719	2255	BO	70 42.07 N	168 13.15 W	GPS	45	0.0	44	5	1,3-6	CC2
AWS02SBI	4	1	ROS	020719	2306	EN	70 42.05 N	168 13.26 W	GPS	45					
AWS02SBI	5	1	ROS	020720	0103	BE	70 42.08 N	167 32.61 W	GPS	54					
AWS02SBI	5	1	ROS	020720	0111	BO	70 42.06 N	167 32.53 W	GPS	54	1.8	xx	5	1,3-6	CC3
AWS02SBI	5	1	ROS	020720	0120	EN	70 42.11 N	167 32.41 W	GPS	54					
AWS02SBI	6	1	ROS	020720	0819	BE	70 41.98 N	166 51.62 W	GPS	48					
AWS02SBI	6	1	ROS	020720	0825	BO	70 41.98 N	166 51.64 W	GPS	48	1.7	xx	5	1,3-6	CC4
AWS02SBI	6	1	ROS	020720	0831	EN	70.41.97 N	166 51.63 W	GPS	48					
AWS02SBI	7	1	ROS	020720	0958	BE	70 42.02 N	166 10.83 W	GPS	41					
AWS02SBI	7	1	ROS	020720	1002	BO	70 42.03 N	166 10.88 W	GPS	41	1.4	xx	5	1,3-6	CC5
AWS02SBI	7	1	ROS	020720	xxxx	EN	xx xx.xx N	xxx xx.xx W	GPS	41					
AWS02SBI	8	1	ROS	0207xx	1145	BE	70 42.10 N	165 30.21 W	GPS	44					
AWS02SBI	8	1	ROS	0207xx	1149	BO	70 42.11 N	165 30.25 W	GPS	44	1.4	xx	5	1,3-6	CC6
AWS02SBI	8	1	ROS	0207xx	1154	EN	70 42.10 N	165 30.25 W	GPS	44					
AWS02SBI	9	1	ROS	020721	0307	BE	73 00.25 N	166 00.51 W	GPS	60					
AWS02SBI	9	1	ROS	020721	0310	BO	73 00.25 N	166 00.51 W	GPS	60	2.0	56	7	1,3-6	CS1
AWS02SBI	9	1	ROS	020721	0315	EN	73 00.25 N	166 00.51 W	GPS	60					

AWS02SBI	10	1	ROS	020721 0550	BE 73 04.99 N	166 00.10 W	GPS	62					
AWS02SBI	10	1	ROS	020721 0600	BO 73 04.96 N	166 00.15 W	GPS	62	2.1	56	8	1,3-6	CS2
AWS02SBI	10	1	ROS	020721 0611	EN 73 04.93 N	166 00.38 W	GPS	62					
AWS02SBI	11	1	ROS	020721 0729	BE 73 10.33 N	165 59.41 W	GPS	63					
AWS02SBI	11	1	ROS	020721 0748	BO 73 10.36 N	165 59.66 W	GPS	64	1.8	59	7	1,3-6	CS3
AWS02SBI	11	1	ROS	020721 0747	EN 73 10.38 N	165 59.87 W	GPS	64					
AWS02SBI	12	1	ROS	020721 0918	BE 73 15.06 N	166 00.72 W	GPS	66					
AWS02SBI	12	1	ROS	020721 0924	BO 73 15.07 N	166 00.86 W	GPS	66	1.8	63	7	1,3-6	CS4
AWS02SBI	12	1	ROS	020721 0944	EN 73 15.07 N	166 00.21 W	GPS	67					
AWS02SBI	13	1	ROS	020721 1121	BE 73 20.19 N	165 59.99 W	GPS	72					
AWS02SBI	13	1	ROS	020721 1127	BO 73 20.20 N	166 00.09 W	GPS	72	1.6	66	7	1,3-6	CS5
AWS02SBI	13	1	ROS	020721 1135	EN 73 20.24 N	166 00.30 W	GPS	72					
AWS02SBI	14	1	ROS	020721 1245	BE 73 24.70 N	166 00.40 W	GPS	78					
AWS02SBI	14	1	ROS	020721 xxxx	BO xx xx.xx N	xxx xx.xx W	GPS	78	1.5	73	8	1,3-6	CS6
AWS02SBI	14	1	ROS	020721 1257	EN 73 24.64 N	166 00.51 W	GPS	78					
AWS02SBI	15	1	ROS	020721 1416	BE 73 29.58 N	166 00.04 W	GPS	91					
AWS02SBI	15	1	ROS	020721 1421	BO 73 29.58 N	166 00.13 W	GPS	91	1.8	90	9	1,3-6	CS7
AWS02SBI	15	1	ROS	020721 1429	EN 73 29.60 N	166 00.35 W	GPS	91					
AWS02SBI	16	1	ROS	020721 1618	BE 73 34.98 N	166 00.17 W	GPS	106					
AWS02SBI	16	1	ROS	020721 1622	BO 73 34.98 N	166 00.30 W	GPS	106	1.7	xx	9	1,3-6	CS8
AWS02SBI	16	1	ROS	020721 1642	EN 73 34.97 N	166 00.72 W	GPS	106					
AWS02SBI	17	1	ROS	020722 0004	BE 73 36.52 N	166 00.61 W	GPS	110					
AWS02SBI	17	1	ROS	020722 0011	BO 73 36.53 N	166 00.80 W	GPS	110	1.7	104	7	1,3-6	CS9
AWS02SBI	17	1	ROS	020722 0021	EN 73 36.61 N	166 01.37 W	GPS	110					
AWS02SBI	18	1	ROS	020722 0200	BE 73 40.07 N	166 01.45 W	GPS	116					
AWS02SBI	18	1	ROS	020722 0207	BO 73 40.08 N	166 01.63 W	GPS	116	2.9	110	9	1,3-6	CS10
AWS02SBI	18	1	ROS	020722 0218	EN 73 40.09 N	166 01.93 W	GPS	116					
AWS02SBI	19	1	ROS	020722 0354	BE 73 44.84 N	166 02.76 W	GPS	123					
AWS02SBI	19	1	ROS	020722 0400	BO 73 44.81 N	166 02.82 W	GPS	123	1.3	117	7	1,3-6	CS11
AWS02SBI	19	1	ROS	020722 0411	EN 73 44.75 N	166 03.04 W	GPS	124					
AWS02SBI	20	1	ROS	020722 0558	BE 73 50.15 N	165 59.84 W	GPS	139					
AWS02SBI	20	1	ROS	020722 0603	BO 73 50.11 N	165 59.90 W	GPS	136	1.0	132	6	1,3-6	CS12
AWS02SBI	20	1	ROS	020722 0612	EN 73 50.01 N	165 59.93 W	GPS	139					

AWS02SBI	21	1	ROS	020722 0832	BE	73 54.94 N	165 59.88 W	GPS	156					
AWS02SBI	21	1	ROS	020722 0838	BO	73 54.88 N	166 00.09 W	GPS	154	2.0	155	7	1,3-6	CS13
AWS02SBI	21	1	ROS	020722 0849	EN	73 54.79 N	166 00.42 W	GPS	153					
AWS02SBI	22	1	ROS	020722 1053	BE	73 59.99 N	166 00.95 W	GPS	175					
AWS02SBI	22	1	ROS	020722 1100	BO	73 59.98 N	166 00.93 W	GPS	176	1.8	168	7	1,3-6	CS14
AWS02SBI	22	1	ROS	020722 1110	EN	73 59.99 N	166 01.15 W	GPS	176					
AWS02SBI	23	1	ROS	020722 1237	BE	74 05.13 N	165 58.89 W	GPS	210					
AWS02SBI	23	1	ROS	020722 1245	BO	74 05.07 N	165 58.64 W	GPS	210	1.5	207	8	1,3-6	CS15
AWS02SBI	23	1	ROS	020722 1256	EN	74 05.01 N	165 58.30 W	GPS	210					
AWS02SBI	24	1	ROS	020726 2150	BE	71 39.79 N	150 47.36 W	GPS	2150					
AWS02SBI	24	1	ROS	020726 2150	BO	71 39.79 N	150 47.36 W	GPS	2150	2065	85	0	1,3-6	ABORT
AWS02SBI	24	1	ROS	020726 2150	EN	71 39.79 N	150 47.36 W	GPS	2150					
AWS02SBI	25	1	ROS	020727 2341	BE	71 50.70 N	151 40.34 W	GPS	2255					
AWS02SBI	25	1	ROS	020728 0041	BO	71 50.13 N	151 39.80 W	GPS	2260	1.8	2232	19	1,3-6	SB1
AWS02SBI	25	1	ROS	020728 0149	EN	71 50.07 N	151 38.86 W	GPS	2267					
AWS02SBI	26	1	ROS	020728 0330	BE	71 47.58 N	151 42.94 W	GPS	2109					
AWS02SBI	26	1	ROS	020728 0421	BO	71 47.97 N	151 42.52 W	GPS	2136	1.5	2100	12	1,3-6	SB2
AWS02SBI	26	1	ROS	020728 0513	EN	71 48.18 N	151 41.58 W	GPS	2144					
AWS02SBI	27	1	ROS	020728 0646	BE	71 44.74 N	151 45.36 W	GPS	1844					
AWS02SBI	27	1	ROS	020728 0733	BO	71 45.14 N	151 44.84 W	GPS	1898	2.2	1857	20	1,3-6	SB3
AWS02SBI	27	1	ROS	020728 0829	EN	71 45.60 N	151 44.24 W	GPS	1967					
AWS02SBI	28	1	ROS	020728 1606	BE	71 39.14 N	151 45.73 W	GPS	1141					
AWS02SBI	28	1	ROS	020728 1636	BO	71 39.32 N	151 44.47 W	GPS	1211	xxx	1150	19	1,3-6	SB4
AWS02SBI	28	1	ROS	020728 1731	EN	71 39.62 N	151 42.23 W	GPS	1265					
AWS02SBI	29	1	ROS	020729 0654	BE	71 42.22 N	151 46.14 W	GPS	1624					
AWS02SBI	29	1	ROS	020729 0730	BO	71 42.40 N	151 44.60 W	GPS	1585	1.9	1566	14	1,3-6	SB5
AWS02SBI	29	1	ROS	020729 0819	EN	71 42.61 N	151 42.66 W	GPS	1400					
AWS02SBI	30	1	ROS	020729 1123	BE	71 36.75 N	151 50.00 W	GPS	1070					
AWS02SBI	30	1	ROS	020729 1200	BO	71 36.82 N	151 47.63 W	GPS	1164	4.0	1119	20	1,3-6	SB6
AWS02SBI	30	1	ROS	020729 1245	EN	71 36.78 N	151 44.81 W	GPS	1220					

AWS02SBI	31	1	ROS	020729 1426	BE 71 34.07 N	151 54.22 W	GPS	825					
AWS02SBI	31	1	ROS	020729 1448	BO 71 34.05 N	151 53.22 W	GPS	878	1.5	846	20	1,3-6	SB7
AWS02SBI	31	1	ROS	020729 1519	EN 71 33.99 N	151 52.01 W	GPS	933					
AWS02SBI	32	1	ROS	020730 0612	BE 71 31.55 N	151 56.72 W	GPS	596					
AWS02SBI	32	1	ROS	020730 0632	BO 71 31.59 N	151 56.85 W	GPS	593	1.5	584	17	1,3-6	SB8
AWS02SBI	32	1	ROS	020730 0700	EN 71 31.66 N	151 57.03 W	GPS	585					
AWS02SBI	33	1	ROS	020730 0808	BE 71 28.99 N	151 58.72 W	GPS	295					
AWS02SBI	33	1	ROS	020730 0823	BO 71 29.15 N	151 59.18 W	GPS	290	1.5	279	12	1,3-6	SB9
AWS02SBI	33	1	ROS	020730 0843	EN 71 29.30 N	151 59.89 W	GPS	284					
AWS02SBI	34	1	ROS	020730 1035	BE 71 26.53 N	152 01.48 W	GPS	210					
AWS02SBI	34	1	ROS	020730 1045	BO 71 26.59 N	152 01.61 W	GPS	206	1.5	xx	9	1,3-6	SB10
AWS02SBI	34	1	ROS	020730 xxxx	EN 71 xx.xx N	152 xx.xx W	GPS	xx					
AWS02SBI	35	1	ROS	020730 1218	BE 71 23.98 N	152 02.89 W	GPS	162					
AWS02SBI	35	1	ROS	020730 1229	BO 71 23.95 N	152 02.93 W	GPS	162	1.5	155	8	1,3-6	SB11
AWS02SBI	35	1	ROS	020730 1242	EN 71 23.93 N	152 02.99 W	GPS	162					
AWS02SBI	36	1	ROS	020731 1052	BE 71 20.68 N	152 06.18 W	GPS	76					
AWS02SBI	36	1	ROS	020731 xxxx	BO 71 20.58 N	152 06.20 W	GPS	75	1.3	xx	5	1,3-6	SB12
AWS02SBI	36	1	ROS	020731 1109	EN 71 20.47 N	152 06.15 W	GPS	74					
AWS02SBI	37	1	ROS	020731 1208	BE 71 18.34 N	152 08.02 W	GPS	59					
AWS02SBI	37	1	ROS	020731 1213	BO 71 18.28 N	152 08.04 W	GPS	58	1.0	55	6	1,3-6	SB13
AWS02SBI	37	1	ROS	020731 1219	EN 71 18.22 N	152 08.08 W	GPS	58					
AWS02SBI	38	1	ROS	020731 1321	BE 71 15.92 N	152 10.45 W	GPS	50					
AWS02SBI	38	1	ROS	020731 1329	BO 71 15.86 N	152 10.63 W	GPS	50	1.5	45	5	1,3-6	SB14
AWS02SBI	38	1	ROS	020731 1336	EN 71 15.81 N	152 10.81 W	GPS	50					
AWS02SBI	39	1	ROS	020731 1452	BE 71 13.33 N	152 12.36 W	GPS	41					
AWS02SBI	39	1	ROS	020731 1458	BO 71 13.32 N	152 12.46 W	GPS	43	1.5	38	5	1,3-6	SB15
AWS02SBI	39	1	ROS	020731 1505	EN 71 13.30 N	152 12.59 W	GPS	43					
AWS02SBI	40	1	ROS	020801 1146	BE 71 29.57 N	151 38.10 W	GPS	865					
AWS02SBI	40	1	ROS	020801 1209	BO 71 29.83 N	151 37.84 W	GPS	962	3.8	930	11	1,3-6	East XCTD line
AWS02SBI	40	1	ROS	020801 1233	EN 71 30.08 N	151 37.54 W	GPS	1017					
AWS02SBI	41	1	ROS	020801 1314	BE 71 30.44 N	151 38.27 W	GPS	1101					
AWS02SBI	41	1	ROS	020801 1338	BO 71 30.65 N	151 37.81 W	GPS	1128	1.5	1100	7	1,3-6	East XCTD line
AWS02SBI	41	1	ROS	020801 1406	EN 71 30.89 N	151 37.48 W	GPS	1120					

AWS02SBI	42	1	ROS	020804 0357	BE 70 55.98 N	159 19.02 W	GPS	36					
AWS02SBI	42	1	ROS	020804 0401	BO 70 56.03 N	159 18.65 W	GPS	36	1.5	33	5	1,3-6	BC1
AWS02SBI	42	1	ROS	020804 0407	EN 70 56.10 N	159 18.10 W	GPS	36					
AWS02SBI	43	1	ROS	020804 0508	BE 70 57.62 N	159 22.52 W	GPS	48					
AWS02SBI	43	1	ROS	020804 0511	BO 70 57.66 N	159 22.33 W	GPS	49	1.4	45	5	1,3-6	BC2
AWS02SBI	43	1	ROS	020804 0517	EN 70 57.72 N	159 21.97 W	GPS	49					
AWS02SBI	44	1	ROS	020804 0615	BE 70 59.44 N	159 25.01 W	GPS	57					
AWS02SBI	44	1	ROS	020804 0618	BO 70 59.48 N	159 24.78 W	GPS	57	1.8	53	6	1,3-6	BC3
AWS02SBI	44	1	ROS	020804 0629	EN 70 59.54 N	159 24.39 W	GPS	57					
AWS02SBI	45	1	ROS	020804 0723	BE 71 01.19 N	159 29.76 W	GPS	73					
AWS02SBI	45	1	ROS	020804 0727	BO 71 01.22 N	159 29.60 W	GPS	73	1.4	68	6	1,3-6	BC4
AWS02SBI	45	1	ROS	020804 0735	EN 71 01.29 N	159 29.21 W	GPS	73					
AWS02SBI	46	1	ROS	020804 0844	BE 71 02.90 N	159 32.32 W	GPS	78					
AWS02SBI	46	1	ROS	020804 0847	BO 71 02.92 N	159 32.17 W	GPS	78	1.3	73	6	1,3-6	BC5
AWS02SBI	46	1	ROS	020804 0854	EN 71 02.97 N	159 31.77 W	GPS	80					
AWS02SBI	47	1	ROS	020804 0951	BE 71 04.39 N	159 35.46 W	GPS	76					
AWS02SBI	47	1	ROS	020804 0953	BO 71 04.42 N	159 35.31 W	GPS	76	1.2	72	5	1,3-6	BC6
AWS02SBI	47	1	ROS	020804 0959	EN 71 04.46 N	159 35.07 W	GPS	77					
AWS02SBI	48	1	ROS	020804 1123	BE 71 06.45 N	159 39.46 W	GPS	63					
AWS02SBI	48	1	ROS	020804 1125	BO 71 06.45 N	159 39.41 W	GPS	63	1.3	60	5	1,3-6	BC7
AWS02SBI	48	1	ROS	020804 1130	EN 71 06.48 N	159 39.29 W	GPS	63					
AWS02SBI	49	1	ROS	020804 1232	BE 71 07.92 N	159 41.53 W	GPS	65					
AWS02SBI	49	1	ROS	020804 1235	BO 71 07.92 N	159 41.50 W	GPS	65	1.6	60	6	1,3-6	BC8
AWS02SBI	49	1	ROS	020804 1240	EN 71 07.93 N	159 41.31 W	GPS	64					
AWS02SBI	50	1	ROS	020804 1342	BE 71 09.84 N	159 44.89 W	GPS	82					
AWS02SBI	50	1	ROS	020804 1345	BO 71 09.84 N	159 44.79 W	GPS	82	1.8	78	6	1,3-6	BC9
AWS02SBI	50	1	ROS	020804 1351	EN 71 09.84 N	159 44.53 W	GPS	83					
AWS02SBI	51	1	ROS	020804 1456	BE 71 12.02 N	159 48.82 W	GPS	62					
AWS02SBI	51	1	ROS	020804 1459	BO 71 12.02 N	159 48.65 W	GPS	61	1.5	xx	4	1,3-6	BC10
AWS02SBI	51	1	ROS	020804 1504	EN 71 12.02 N	159 48.52 W	GPS	61					
AWS02SBI	52	1	ROS	020804 1604	BE 71 13.64 N	159 51.69 W	GPS	55					
AWS02SBI	52	1	ROS	020804 1606	BO 71 13.63 N	159 51.60 W	GPS	55	1.2	52	6	1,3-6	BC11
AWS02SBI	52	1	ROS	020804 1612	EN 71 13.61 N	159 51.36 W	GPS	55					

AWS02SBI	53	1	ROS	020805 0513	BE 72 22.00 N	158 39.53 W	GPS	56					
AWS02SBI	53	1	ROS	020805 0519	BO 72 22.00 N	158 39.44 W	GPS	56	1.2	50	4	1,3-6	WBC1
AWS02SBI	53	1	ROS	020805 0522	EN 72 22.00 N	158 39.25 W	GPS	56					
AWS02SBI	54	1	ROS	020805 0609	BE 72 23.93 N	158 34.06 W	GPS	57					
AWS02SBI	54	1	ROS	020805 0612	BO 72 23.92 N	158 33.95 W	GPS	56	1.2	52	5	1,3-6	WBC2
AWS02SBI	54	1	ROS	020805 0618	EN 72 23.93 N	158 33.76 W	GPS	56					
AWS02SBI	55	1	ROS	020805 0712	BE 72 25.86 N	158 28.05 W	GPS	58					
AWS02SBI	55	1	ROS	020805 0715	BO 72 25.85 N	158 27.96 W	GPS	58	1.2	51	4	1,3-6	WBC3
AWS02SBI	55	1	ROS	020805 0720	EN 72 25.85 N	158 27.81 W	GPS	58					
AWS02SBI	56	1	ROS	020805 0813	BE 72 27.83 N	158 21.75 W	GPS	62					
AWS02SBI	56	1	ROS	020805 0816	BO 72 27.83 N	158 21.72 W	GPS	62	1.5	58	5	1,3-6	WBC4
AWS02SBI	56	1	ROS	020805 0821	EN 72 27.83 N	158 21.62 W	GPS	62					
AWS02SBI	57	1	ROS	020805 0942	BE 72 29.62 N	158 15.98 W	GPS	74					
AWS02SBI	57	1	ROS	020805 0945	BO 72 29.61 N	158 15.96 W	GPS	74	0.7	70	8	1,3-6	WBC5
AWS02SBI	57	1	ROS	020805 0953	EN 72 29.57 N	158 15.96 W	GPS	74					
AWS02SBI	58	1	ROS	020805 1106	BE 72 31.60 N	158 09.21 W	GPS	131					
AWS02SBI	58	1	ROS	020805 1111	BO 72 31.59 N	158 09.15 W	GPS	131	1.1	125	9	1,3-6	WBC6
AWS02SBI	58	1	ROS	020805 1122	EN 72 31.57 N	158 08.91 W	GPS	132					
AWS02SBI	59	1	ROS	020805 1234	BE 72 33.53 N	158 02.02 W	GPS	181					
AWS02SBI	59	1	ROS	020805 1240	BO 72 33.52 N	158 02.00 W	GPS	181	0.7	173	8	1,3-6	WBC7
AWS02SBI	59	1	ROS	020805 1259	EN 72 33.50 N	158 01.60 W	GPS	182					
AWS02SBI	60	1	ROS	020805 1420	BE 72 35.48 N	157 55.31 W	GPS	218					
AWS02SBI	60	1	ROS	020805 1427	BO 72 35.49 N	157 55.10 W	GPS	218	1.3	210	8	1,3-6	WBC8
AWS02SBI	60	1	ROS	020805 1441	EN 72 35.51 N	157 54.61 W	GPS	222					
AWS02SBI	61	1	ROS	020805 1600	BE 72 37.42 N	157 49.44 W	GPS	270					
AWS02SBI	61	1	ROS	020805 1611	BO 72 37.42 N	157 49.22 W	GPS	268	1.5	259	9	1,3-6	WBC9
AWS02SBI	61	1	ROS	020805 1635	EN 72 37.45 N	157 48.58 W	GPS	271					
AWS02SBI	62	1	ROS	020805 1800	BE 72 39.30 N	157 41.82 W	GPS	323					
AWS02SBI	62	1	ROS	020805 1810	BO 72 39.24 N	157 41.44 W	GPS	320	1.0	308	x	1,3-6	WBC10
AWS02SBI	62	1	ROS	020805 1837	EN 72 39.00 N	157 40.56 W	GPS	325					
AWS02SBI	63	1	ROS	020805 2103	BE 72 41.12 N	157 36.71 W	GPS	371					
AWS02SBI	63	1	ROS	020805 2115	BO 72 41.03 N	157 36.39 W	GPS	374	1.8	362	9	1,3-6	WBC11
AWS02SBI	63	1	ROS	020805 2137	EN 72 40.91 N	157 35.95 W	GPS	381					

AWS02SBI	64	1	ROS	020805 2248	BE	72 43.06 N	157 30.39 W	GPS	426						
AWS02SBI	64	1	ROS	020805 2302	BO	72 42.96 N	157 30.56 W	GPS	426	1.7	413	9	1,3-6	WBC12
AWS02SBI	64	1	ROS	020805 2331	EN	72 42.78 N	157 29.93 W	GPS	427					
AWS02SBI	65	1	ROS	020806 0044	BE	72 44.69 N	157 23.83 W	GPS	760					
AWS02SBI	65	1	ROS	020806 0103	BO	72 44.61 N	157 23.70 W	GPS	800	1.9	776	11	1,3-6	WBC13
AWS02SBI	65	1	ROS	020806 0129	EN	72 44.42 N	157 23.59 W	GPS	848					
AWS02SBI	66	1	ROS	020806 0253	BE	72 46.93 N	157 16.54 W	GPS	1360					
AWS02SBI	66	1	ROS	020806 0323	BO	72 46.85 N	157 15.84 W	GPS	1348	1.5	1325	16	1,3-6	WBC14
AWS02SBI	66	1	ROS	020806 0407	EN	72 46.80 N	157 14.52 W	GPS	1351					
AWS02SBI	67	1	ROS	020806 1135	BE	72 14.89 N	156 42.67 W	GPS	245					
AWS02SBI	67	1	ROS	020806 1144	BO	72 14.84 N	156 42.54 W	GPS	245	1.3	239	8	1,3-6	BCM1
AWS02SBI	67	1	ROS	020806 1159	EN	72 14.74 N	156 42.31 W	GPS	245					
AWS02SBI	68	1	ROS	020806 1341	BE	72 19.19 N	156 47.91 W	GPS	263					
AWS02SBI	68	1	ROS	020806 1350	BO	72 19.13 N	156 47.98 W	GPS	261	0.7	253	9	1,3-6	BCM2
AWS02SBI	68	1	ROS	020806 1407	EN	72 19.01 N	156 48.13 W	GPS	258					
AWS02SBI	69	1	ROS	020806 1626	BE	72 18.11 N	156 46.01 W	GPS	261					
AWS02SBI	69	1	ROS	020806 1635	BO	72 18.10 N	156 46.08 W	GPS	263	2.5	xx	0	1,3-6	BCM3
AWS02SBI	69	1	ROS	020806 1645	EN	72 18.07 N	156 46.23 W	GPS	257					
AWS02SBI	70	1	ROS	020806 xxxx	BE	72 12.40 N	156 40.41 W	GPS	224					
AWS02SBI	70	1	ROS	020806 xxxx	BO	72 12.38 N	156 40.44 W	GPS	225	1.9	215	0	1,3-6	BCM4
AWS02SBI	70	1	ROS	020806 xxxx	EN	72 12.34 N	156 40.51 W	GPS	225					
AWS02SBI	71	1	ROS	020806 2033	BE	72 09.84 N	156 38.21 W	GPS	205					
AWS02SBI	71	1	ROS	020806 2040	BO	72 09.81 N	156 38.19 W	GPS	205	1.3	190	0	1,3-6	BCM5
AWS02SBI	71	1	ROS	020806 2047	EN	72 09.77 N	156 38.19 W	GPS	201					
AWS02SBI	72	1	ROS	020806 2157	BE	72 07.34 N	156 35.48 W	GPS	179					
AWS02SBI	72	1	ROS	020806 2204	BO	72 07.30 N	156 35.46 W	GPS	179	0.8	172	0	1,3-6	BCM6
AWS02SBI	72	1	ROS	020806 2209	EN	72 07.27 N	156 35.47 W	GPS	179					
AWS02SBI	73	1	ROS	020806 2307	BE	72 04.70 N	156 32.55 W	GPS	149					
AWS02SBI	73	1	ROS	020806 2312	BO	72 04.66 N	156 32.59 W	GPS	149	1.5	142	0	1,3-6	BCM7
AWS02SBI	73	1	ROS	020806 2317	EN	72 04.63 N	156 32.60 W	GPS	147					
AWS02SBI	74	1	ROS	020807 0053	BE	72 02.23 N	156 30.34 W	GPS	119					
AWS02SBI	74	1	ROS	020807 0057	BO	72 02.20 N	156 30.30 W	GPS	118	1.6	112	0	1,3-6	BCM8
AWS02SBI	74	1	ROS	020807 0105	EN	72 02.16 N	156 30.19 W	GPS	118					

AWS02SBI	75	1	ROS	020807 0203	BE 71 59.55 N	156 27.93 W	GPS	80					
AWS02SBI	75	1	ROS	020807 0207	BO 71 59.56 N	156 27.90 W	GPS	80	1.7	75	0	1,3-6	BCM9
AWS02SBI	75	1	ROS	020807 0211	EN 71 59.57 N	156 27.88 W	GPS	80					
AWS02SBI	76	1	ROS	020807 0318	BE 71 56.78 N	156 25.75 W	GPS	64					
AWS02SBI	76	1	ROS	020807 0322	BO 71 56.77 N	156 25.84 W	GPS	64	1.5	60	0	1,3-6	BCM10
AWS02SBI	76	1	ROS	020807 0325	EN 71 56.77 N	156 25.87 W	GPS	64					
AWS02SBI	77	1	ROS	020807 0428	BE 71 54.24 N	156 22.93 W	GPS	65					
AWS02SBI	77	1	ROS	020807 0431	BO 71 54.24 N	156 22.95 W	GPS	65	1.2	xx	0	1,3-6	BCM11
AWS02SBI	77	1	ROS	020807 0433	EN 71 54.23 N	156 22.97 W	GPS	65					
AWS02SBI	78	1	ROS	020807 0521	BE 71 52.08 N	156 18.15 W	GPS	72					
AWS02SBI	78	1	ROS	020807 0524	BO 71 52.08 N	156 18.15 W	GPS	72	1.1	xx	0	1,3-6	BCM12
AWS02SBI	78	1	ROS	020807 0527	EN 71 52.08 N	156 18.15 W	GPS	72					
AWS02SBI	79	1	ROS	020807 0615	BE 71 49.75 N	156 13.10 W	GPS	83					
AWS02SBI	79	1	ROS	020807 0619	BO 71 49.75 N	156 13.12 W	GPS	83	0.8	xx	0	1,3-6	BCM13
AWS02SBI	79	1	ROS	020807 0622	EN 71 49.76 N	156 13.14 W	GPS	83					
AWS02SBI	80	1	ROS	020807 0725	BE 71 47.60 N	156 08.52 W	GPS	93					
AWS02SBI	80	1	ROS	020807 0729	BO 71 47.58 N	156 08.51 W	GPS	93	1.1	xx	0	1,3-6	BCM14
AWS02SBI	80	1	ROS	020807 0732	EN 71 47.58 N	156 08.50 W	GPS	93					
AWS02SBI	81	1	ROS	020807 0840	BE 71 45.17 N	156 03.70 W	GPS	103					
AWS02SBI	81	1	ROS	020807 0843	BO 71 45.17 N	156 03.72 W	GPS	103	0.8	xx	0	1,3-6	BCM15
AWS02SBI	81	1	ROS	020807 0848	EN 71 45.17 N	156 03.73 W	GPS	103					
AWS02SBI	82	1	ROS	020807 0940	BE 71 43.01 N	155 59.22 W	GPS	108					
AWS02SBI	82	1	ROS	020807 0944	BO 71 43.01 N	155 59.21 W	GPS	108	1.4	xx	0	1,3-6	BCM16
AWS02SBI	82	1	ROS	020807 0947	EN 71 43.02 N	155 59.21 W	GPS	108					
AWS02SBI	83	1	ROS	020807 1045	BE 71 40.66 N	155 54.21 W	GPS	121					
AWS02SBI	83	1	ROS	020807 1050	BO 71 40.66 N	155 54.12 W	GPS	121	1.1	xx	0	1,3-6	BCM17
AWS02SBI	83	1	ROS	020807 1054	EN 71 40.66 N	155 54.03 W	GPS	121					
AWS02SBI	84	1	ROS	020807 1249	BE 71 38.62 N	155 49.07 W	GPS	176					
AWS02SBI	84	1	ROS	020807 1255	BO 71 38.63 N	155 48.96 W	GPS	174	1.6	xx	0	1,3-6	BCM18
AWS02SBI	84	1	ROS	020807 1300	EN 71 38.64 N	155 48.86 W	GPS	172					
AWS02SBI	85	1	ROS	020807 1429	BE 71 36.63 N	155 43.09 W	GPS	221					
AWS02SBI	85	1	ROS	020807 1435	BO 71 36.64 N	155 42.70 W	GPS	220	0.8	xx	0	1,3-6	BCM19
AWS02SBI	85	1	ROS	020807 1441	EN 71 36.66 N	155 42.37 W	GPS	218					

AWS02SBI	86	1	ROS	020807 1554	BE	71 35.27 N	155 40.27 W	GPS	177					
AWS02SBI	86	1	ROS	020807 1602	BO	71 35.29 N	155 39.21 W	GPS	174	1.5	159	0	1,3-6	BCM20
AWS02SBI	86	1	ROS	020807 1609	EN	71 35.29 N	155 38.44 W	GPS	173					
AWS02SBI	87	1	ROS	020807 1701	BE	71 34.33 N	155 38.25 W	GPS	144					
AWS02SBI	87	1	ROS	020807 1707	BO	71 34.37 N	155 37.52 W	GPS	141	1.3	136	0	1,3-6	BCM21
AWS02SBI	87	1	ROS	020807 1712	EN	71 34.42 N	155 36.87 W	GPS	140					
AWS02SBI	88	1	ROS	020807 1757	BE	71 33.16 N	155 37.20 W	GPS	102					
AWS02SBI	88	1	ROS	020807 1802	BO	71 33.24 N	155 36.88 W	GPS	104	1.2	98	0	1,3-6	BCM22
AWS02SBI	88	1	ROS	020807 1806	EN	71 33.32 N	155 36.54 W	GPS	104					
AWS02SBI	89	1	ROS	020807 1857	BE	71 32.02 N	155 35.56 W	GPS	55					
AWS02SBI	89	1	ROS	020807 1900	BO	71 32.05 N	155 35.39 W	GPS	56	1.2	53	0	1,3-6	BCM23
AWS02SBI	89	1	ROS	020807 1903	EN	71 32.07 N	155 35.24 W	GPS	56					
AWS02SBI	90	1	ROS	020807 2010	BE	71 31.56 N	155 29.34 W	GPS	42					
AWS02SBI	90	1	ROS	020807 2013	BO	71 31.61 N	155 29.26 W	GPS	43	1.4	39	0	1,3-6	BCM24
AWS02SBI	90	1	ROS	020807 2015	EN	71 31.64 N	155 29.20 W	GPS	43					
AWS02SBI	CC1	1	MOO	020719 1752	PO	70 40.39 N	167 03.85 W	GPS	-	-	-	-	-	CC Mooring, 51m (corrected)
AWS02SBI	CS1	1	MOO	020721 2100	PO	73 20.33 N	166 03.59 W	GPS	-	-	-	-	-	CS Mooring, 68m (corrected)
AWS02SBI	CS2	1	MOO	020722 0059	PO	73 36.68 N	166 02.52 W	GPS	-	-	-	-	-	CS Mooring, 105m (corrected)
AWS02SBI	BC1	1	MOO	020803 2306	PO	71 03.09 N	159 32.82 W	GPS	-	-	-	-	-	BC Mooring, 78m (corrected)
AWS02SBI	BS1	1	MOO	020802 0400	PO	71 18.49 N	152 08.00 W	GPS	-	-	-	-	-	BS Mooring, 57m (corrected)
AWS02SBI	BS2	1	MOO	020801 2103	PO	71 21.13 N	152 05.88 W	GPS	-	-	-	-	-	BS Mooring, 81m (corrected)
AWS02SBI	BS3	1	MOO	020801 0418	PO	71 23.69 N	152 02.87 W	GPS	-	-	-	-	-	BS Mooring, 147m (corrected)
AWS02SBI	BS4	1	MOO	020731 2236	PO	71 26.18 N	152 00.23 W	GPS	-	-	-	-	-	BS Mooring, 200m (corrected)
AWS02SBI	BS5	1	MOO	020731 0704	PO	71 29.09 N	151 58.29 W	GPS	-	-	-	-	-	BS Mooring, 283m (corrected)
AWS02SBI	BS6	1	MOO	020730 1858	PO	71 31.91 N	151 56.04 W	GPS	-	-	-	-	-	BS Mooring, 600m (corrected)
AWS02SBI	BS7	1	MOO	020729 2218	PO	71 34.07 N	151 54.84 W	GPS	-	-	-	-	-	BS Mooring, 793m (corrected)
AWS02SBI	BS8	1	MOO	020729 0235	PO	71 39.98 N	151 50.12 W	GPS	-	-	-	-	-	BS Mooring, 1425m (corrected)
AWS02SBI	ARP	1	MOO	020729 2313	PO	71 33.92 N	151 50.22 W	GPS	-	-	-	-	-	BS ARP, 955m (corrected)
AWS02SBI	X09	1	XCD	020731 0002	PO	71 33.06 N	151 54.83 W	GPS	-	-	-	-	-	SB line
AWS02SBI	X11	1	XCD	020731 0122	PO	71 30.10 N	151 57.72 W	GPS	-	-	-	-	-	SB line
AWS02SBI	X12	1	XCD	020731 0804	PO	71 27.55 N	152 00.03 W	GPS	-	-	-	-	-	SB line
AWS02SBI	X13	1	XCD	020731 0859	PO	71 24.86 N	152 01.98 W	GPS	-	-	-	-	-	SB line
AWS02SBI	X14	1	XCD	020731 1003	PO	71 22.45 N	152 04.01 W	GPS	-	-	-	-	-	SB line
AWS02SBI	X15	1	XCD	020731 xxxx	PO	71 20.00 N	152 06.50 W	GPS	-	-	-	-	-	SB line
AWS02SBI	X16	1	XCD	020731 1248	PO	71 17.14 N	152 09.08 W	GPS	-	-	-	-	-	SB line
AWS02SBI	X17	1	XCD	020731 1415	PO	71 14.78 N	152 10.89 W	GPS	-	-	-	-	-	SB line
AWS02SBI	X19	1	XCD	020801 0630	PO	71 20.43 N	151 39.92 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X21	1	XCD	020801 0656	PO	71 19.77 N	151 40.14 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X22	1	XCD	020801 0722	PO	71 18.76 N	151 40.19 W	GPS	-	-	-	-	-	SB East line

AWS02SBI	X23	1	XCD	020801 0805	PO 71 21.25 N	151 39.71 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X24	1	XCD	020801 0823	PO 71 22.08 N	151 39.57 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X25	1	XCD	020801 0840	PO 71 22.95 N	151 39.43 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X26	1	XCD	020801 0858	PO 71 23.80 N	151 39.16 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X27	1	XCD	020801 0913	PO 71 24.58 N	151 39.16 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X28	1	XCD	020801 0929	PO 71 25.43 N	151 39.08 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X29	1	XCD	020801 0943	PO 71 26.26 N	151 38.91 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X30	1	XCD	020801 0959	PO 71 27.10 N	151 38.80 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X31	1	XCD	020801 1015	PO 71 27.92 N	151 38.54 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X34	1	XCD	020801 1053	PO 71 28.83 N	151 38.43 W	GPS	-	-	-	-	-	SB East line
AWS02SBI	X35	1	XCD	020805 0855	PO 72 28.79 N	158 18.19 W	GPS	-	-	-	-	-	WBC line
AWS02SBI	X36	1	XCD	020805 1031	PO 72 30.68 N	158 11.87 W	GPS	-	-	-	-	-	WBC line
AWS02SBI	X37	1	XCD	020805 1158	PO 72 32.56 N	158 05.48 W	GPS		WBC line				
AWS02SBI	X38	1	XCD	020805 1332	PO 72 34.49 N	157 59.39 W	GPS		WBC line				
AWS02SBI	X39	1	XCD	020805 1508	PO 72 36.40 N	157 52.44 W	GPS		WBC line				
AWS02SBI	X40	1	XCD	020805 1706	PO 72 38.40 N	157 46.56 W	GPS		WBC line				
AWS02SBI	X41	1	XCD	020805 1908	PO 72 40.28 N	157 40.09 W	GPS		WBC line				

Key to abbreviations:

BC	Barrow Canyon	CS	Chukchi Slope
BCM	North Barrow Canyon	SB	Beaufort Slope
BS	Beaufort Slope	WBC	Western Beaufort Slope
CC	Central Channel/ Chukchi Sea		