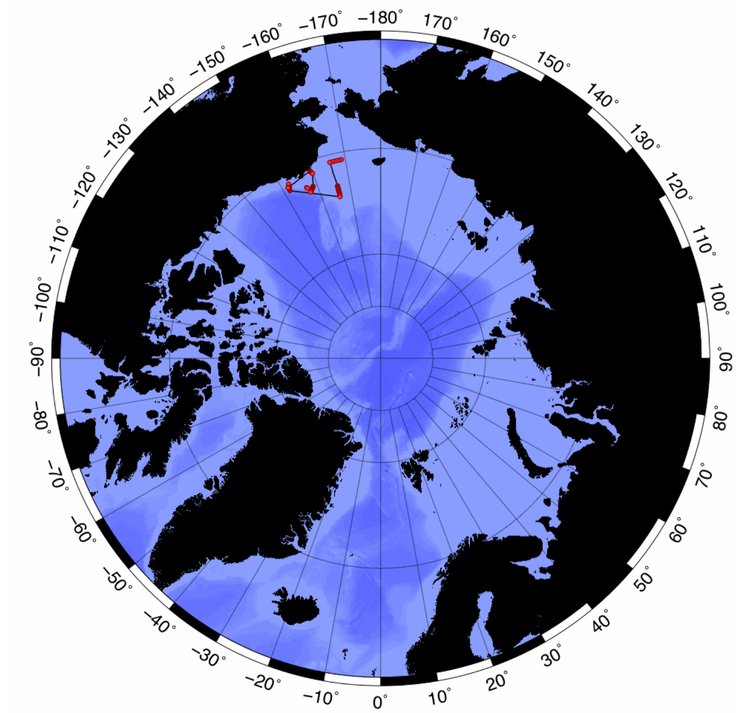
CRUISE REPORT: AWS020I

(Updated MAR 2014)



Highlights

CRUISE SUMMARY INFORMATION

Section Designation	**AWS02I**
Expedition designation (ExpoCodes)	**32PZ20020715**
Chief Scientists	**Thomas J. Weingartner / U Alaska** **Robert S. Pickart / WHOI**
Dates	2002 JUL 15 - 2002 AUG 13
Ship	USCGC *Polar Star*
Ports of call	Dutch Harbor, AK to Barrow, AK
Geographic Boundaries	74° 5' 4.2" N 168° 54' 8.3" W 151° 37' 49" W 70° 41' 59" N
Stations	63
Floats and drifters deployed	0
Moorings deployed or recovered	13 (5 individual plus an array of 8) deployed

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LINKS TO SELECT TOPICS

Shaded sections are not relevant to this cruise or were not available when this report was compiled.

Cruise Summary Information	**Hydrographic Measurements**
Description of Scientific Program	**CTD Data:**
Geographic Boundaries	Acquisition
Cruise Track (Figure): PI CCHDO	Processing
Description of Stations	Calibration
Description of Parameters Sampled	Temperature Pressure
Bottle Depth Distributions (Figure)	Salinities Oxygens
Floats and Drifters Deployed	**Bottle Data**
Moorings Deployed or Recovered	Salinity
	Oxygen
Principal Investigators	Nutrients
Cruise Participants	Carbon System Parameters
	CFCs
Problems and Goals Not Achieved	Helium / Tritium
Other Incidents of Note	Radiocarbon
Underway Data Information	**References**
Navigation Bathymetry	
Acoustic Doppler Current Profiler (ADCP)	
Thermosalinograph	
XBT and/or XCTD	
Meteorological Observations	**Acknowledgments**
Atmospheric Chemistry Data	
Data Processing Notes	

USCGC *Polar Star* Arctic West Summer 2002 Cruise Summary: Shelf-Basin Interactions

Robert S. Pickart
Woods Hole Oceanographic Institution

Thomas J. Weingartner
University of Alaska, Fairbanks

The field phase of the Shelf-Basin Interactions Experiment (SBI) began in 2002 with a series of three cruises to the Chukchi and Beaufort Seas. SBI is a multi-institutional program investigating how the western Arctic shelves communicate with the interior of the Canada Basin, from a coupled physical/biochemical perspective. The physical oceanographic (PO) component of SBI was carried out on the Coast Guard icebreaker *Polar Star,* from mid-July to mid-August. The primary aim of the PO component is to identify and understand the water masses and mechanisms by which shelf waters ventilate the western Arctic halocline.

The major goals of the 2002 Arctic West Summer cruise (AWSO2) were to (1) deploy a system of moorings that will measure the outflow from the Chukchi shelf (the UW/UAF component); (2) deploy a high-resolution moored array across the Beaufort slope, downstream of the outflows, to determine how these waters are fluxed into the interior (the WHOI component); and (3) conduct a hydrographic survey encompassing locations along the Chukchi and Beaufort shelfedge. The cruise was a resounding success on all accounts.

The moored instruments will measure currents, temperature, and salinity numerous times per day until September, 2003 (at which point they will be turned around for a second year-long deployment). A combination of discrete sensors and profiling instruments were used. Nearly all hydrostations during the cruise included water sample measurements of salinity and nutrients. The conductivity/temperature/depth (CTD) package was also outfitted with a lowered Acoustic Doppler Current Profiler (ADCP) measuring absolute horizontal velocity, a turbidity sensor, and a fluorometer (attached after the second CTD section). These additional sensors provided invaluable information on the origin and magnitude of the currents in the region.

Brief Synopsis

Polar Star embarked the science party in Dutch Harbor, AK on 15 July and sailed on calm seas to the first mooring site in the central Chukchi channel (Figure 1). After completing the mooring deployment and CTD section there, we proceeded to the 166°W site, which we refer to as the Herald Valley outflow site. (Herald Valley actually lies to the west of 166°W in the Russian EEZ. We were unable to obtain clearance to work in Russian waters; however, we believe that the measurements along 166°W will capture at least a portion of the outflow of Pacific-origin water from Herald Valley.) This location contained significant ice cover, but there were enough leads to allow the deployment of two moorings and occupation of a cross-slope CTD section.

Our next scheduled site was Barrow Canyon in the eastern Chukchi Sea, but heavy ice cover prohibited us from deploying our mooring, so we continued to the Beaufort slope site. There we did a cross-slope bathymetric survey in order to choose the precise mooring sites, but our initial line proved too steep to deploy moorings effectively. Thus we moved farther west, onto a gentler part of the Beaufort slope (with more favorable ice-conditions as well), where we deployed the high-resolution array as desired. The array consisted of eight moorings spaced 5 km apart, with an additional "whale-listening" mooring deployed for S. Moore of the National Marine Mammal Laboratory. A cross-slope CTD/XCTD section was occupied at this site as well.

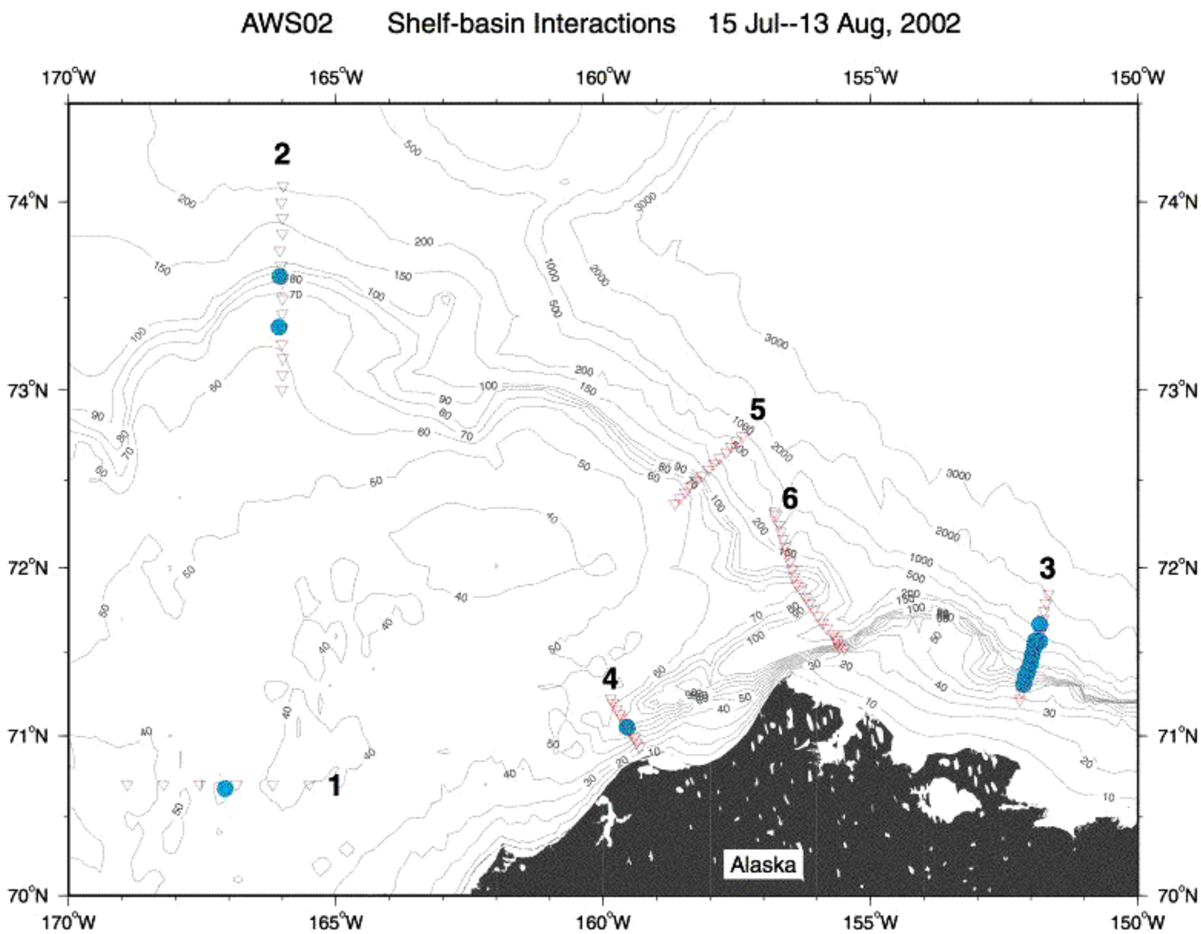

Figure 1: *AWSO2 CTD stations (inverted red triangles) and moorings (cyan circles).*

We then steamed back to Barrow Canyon, where the ice situation had improved substantially, and deployed our final mooring and occupied a short hydrographic section across the head of the Canyon. The final phase of the cruise consisted of two high-resolution hydrographic sections-one to the west of Barrow Canyon (including XCTDs), and a dogleg section spanning the mouth of the canyon. We then steamed back to Dutch Harbor, arriving on 13 August.

Some Preliminary Results

As seen in Figure 1, our hydrographic survey encompassed the three outflow branches of the Chukchi Sea: Herald Valley (Section 2), the central channel (Section 1), and Barrow Canyon (Sections 4 and 6). Additionally, we occupied sections downstream of both the Herald Valley outflow (Section 5) and Barrow Canyon outflow (Section 3). This survey represents the first systematic coverage of these outflows, as well as the first high-resolution crossings of the shelf and upper slope in this area of the western Arctic. Accordingly, our preliminary look at the data has revealed some fascinating insights on the origin and fate of the shelfedge boundary currents in this important region of the Arctic.

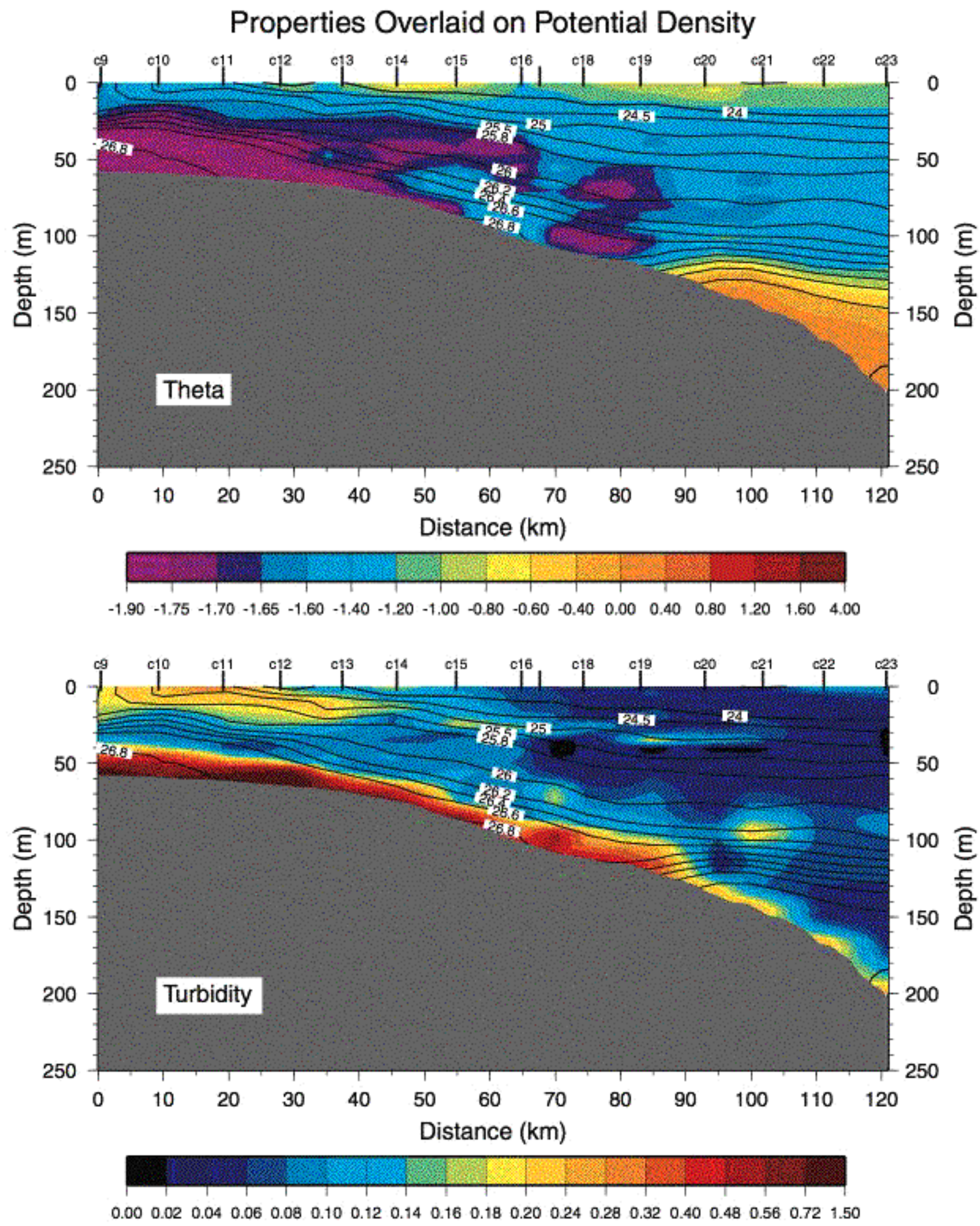

Figure 2: *Vertical Sections of Potential Temperature (top panel) and Turbidity (bottom panel) along 166°W (Section 2).*

Figure 2 shows the vertical sections of potential temperature and turbidity at the Herald Valley outflow site (Section 2). The outer shelf is filled with cold, dense Pacific-origin winter water as it flows eastward, forming a shelfbreak jet. Note the high turbidity in the bottom layer, likely due to sediments drawn into this water mass as it crosses the shelf. The small lenses of water at the shelfedge are likely the beginnings of eddies-a view which is supported by our downstream measurements. The second hydrographic section shown (Figure 3) is at the eastern end of the domain in the Beaufort Sea. This transect reveals the presence of a fully-developed subsurface anti-cyclonic eddy (centered near stations 28-29), comprised of cold, turbid, Pacific-origin winter water. This is the same type of eddy that has been observed repeatedly throughout the interior of the Canada Basin. Our sections suggest strongly that these features emanate from the shelf-edge boundary current. Do all of the eddies come from the Herald valley outflow, or do some originate from the Barrow Canyon outflow? How do these outflows vary in water composition and transport throughout the year? What are the physics governing the formation of the eddies? These are just a few of the questions that we hope to answer with this exciting data set. Further information on the cruise can be found at http://www.whoi.edu/arcticedge.

Data Documentation

Description of CTD operations and sampling equipment is provided in Appendix B; Dr. Robert Pickart's AWS-02 Phase I, SBI, July 15 – August 13, 2002 CTD Data Summary.

Salinity

There were 506 salinity samples analyzed.

Equipment and Techniques

Salinity samples were drawn into 200 ml high alumina borosilicate bottles, which were rinsed three times with sample prior to filling. The bottles were sealed with custom-made plastic insert thimbles and Nalgene screw caps This container provides very low container dissolution and sample evaporation.

A Guildline Autosal 8400A #57-396, standardized with IAPSO Standard Seawater (SSW) batch P-140, was used to measure the salinities. Prior to the analyses, the samples were stored to permit equilibration to laboratory temperature, usually 8-20 hours. The salinometer was modified by Shipboard Technical Support/Oceanographic Data Facility (STS/ODF) and contained an interface for computer-aided measurement. The salinometer was standardized with a fresh vial of standard seawater at the beginning and end of the run. The SSW vial at the end of the run was used as an unknown to check for drift. The salinometer cell was flushed until two successive readings met software criteria for consistency; these were then averaged for a final result. The estimated accuracy of bottle salinities run at sea is usually better than 0.002 PSU relative to the particular standard seawater batch used.

Laboratory Temperature

The temperature stability in the salinometer laboratory was poor.

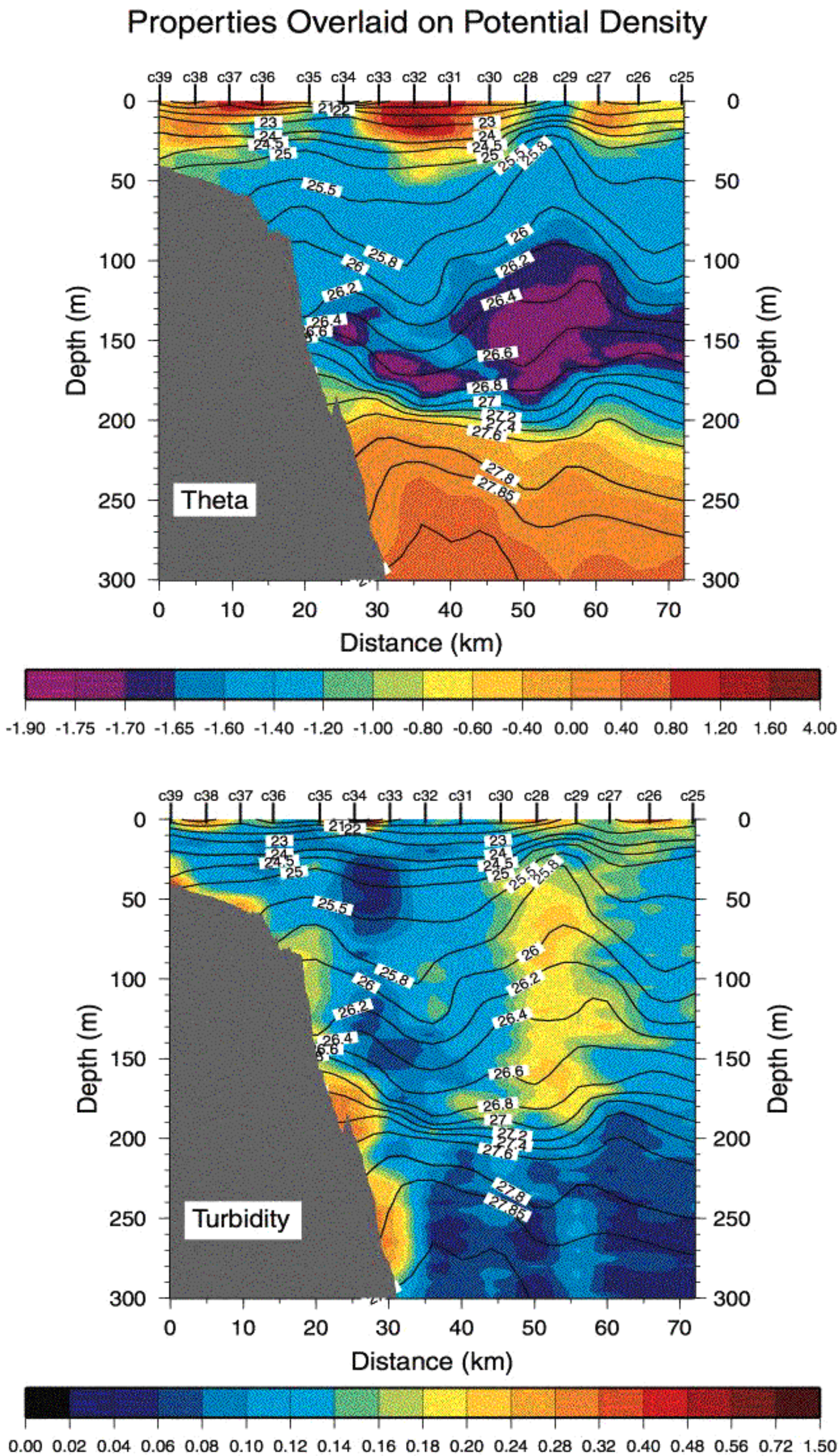

Figure 3: *Vertical Sections of Potential Temperature (top panel) and Turbidity (bottom panel) across the Beaufort slope (Section 3).*

Nutrients

There were 501 nutrient samples analyzed.

Equipment and Techniques

Nutrient analyses (phosphate, silicate, nitrate+nitrite, and nitrite) were performed on an ODF-modified 4-channel Technicon AutoAnalyzer II, generally within a few hours after sample collection. Occasionally samples were refrigerated for longer periods. The analog outputs from each of the four channels were digitized and logged automatically by computer (PC) at 2-second intervals. Protocols, in general, followed procedures outlined for the World Ocean Circulation Experiment by Gordon *et al.* (1993). These protocols allow for standardizing using techniques that require strict linearity or for techniques that can deal with any non-linearity in calibration curves. We use the latter approach and correct for non-linearity using polynomial equations when appropriate. We also do not correct for "carryover", but instead minimize this source by appropriate design of the flow characteristics of our system and by running samples in order of depth whenever possible.

Silicate was analyzed using the technique of Armstrong *et al.*, (Armstrong, 1967). The sample was passed through a 15mm flowcell and the absorbance measured at 660nm.

A modification of the Armstrong *et al.* (Armstrong 1967) procedure was used for the analysis of nitrate and nitrite. For the nitrate plus nitrite analysis, the seawater sample was passed through a cadmium reduction column where nitrate was quantitatively reduced to nitrite. The stream was then passed through a 15mm flowcell and the absorbance measured at 540nm. The same technique was employed for nitrite analysis, except that the cadmium column was bypassed, and a 50mm flowcell was used for measurement.

Phosphate was analyzed using a modification of the Bernhardt and Wilhelms (Bernhardt 1967.) technique. The reaction product was heated to ~55ºC to enhance color development, then passed through a 50mm flowcell and the absorbance measured at 820m.

Nutrient Standards

The silicate (Na_2SiF_6) and nitrite (NaNO2) primary standards were obtained from Johnson Matthey Company's Aesar Division and the supplier reported purities of >98% and 97% respectively. Primary standards for nitrate (KNO3) and phosphate (KH_2PO_4) were obtained from Fisher Scientific and the supplier reported purities of 99.999%.

Sampling and Data Processing

Nutrient samples were drawn into 45 ml polypropylene, screw-capped "oak-ridge type" centrifuge tubes. The tubes were cleaned with 10% HCl and rinsed with sample three times before filling. Standardizations were performed at the beginning and end of each group of analyses (typically 5-40 samples) with an intermediate concentration mixed nutrient standard prepared prior to each run from a secondary standard in a low-nutrient seawater matrix. The secondary standards were prepared aboard ship by dilution from primary standard solutions. Dry standards were pre-weighed at the laboratory at ODF, and transported to the vessel for dilution to the primary standard. Sets of 6-7 different standard concentrations covering the range of sample concentrations were analyzed periodically to determine the deviation from linearity, if any, as a function of concentration for each nutrient analysis. A correction for non-linearity was applied to the final nutrient concentrations when necessary.

There were some errors in the original calculations preformed on the ship. The raw data files were reprocessed at ODF after the cruise. The original data files were processed to produce other files containing response factors, baseline values, and absorbances. Concentrations were then calculated and any non-linear corrections applied. Computer-produced absorbance readings were checked for accuracy against values taken from a strip chart recording, which is produced simultaneously with the computer.

Nutrients, when reported in micromoles per kilogram, were converted from micromoles per liter by dividing by sample density calculated at 1 atm pressure (0 db), *in situ* salinity, and an assumed laboratory temperature of 25ºC.

Data Quality Notes

General Comments:

The initial nutrient (nitrate, nitrite, phosphate and silicate) data reported from this cruise contained significant errors. This version (July 2003) of the data should be free from major errors. Users are encouraged to report any suspicious values to Lou Codispoti (codispoti@hpl.umces.edu). Users should also be aware that as noted in the initial cruise report, bottle flushing was a problem during this cruise, and apparent depth offsets between bottle and CTD salinities could, at times, be on the order of 10 m. A comparison of companion CTD and bottle salinities can help to assess the effects of insufficient flushing. The user should also be aware that rosette tripping problems also arose during this cruise, and that ship effects may impact data from the upper ~10 m of the water column. Further comments on data quality are available the chief scientist's (Dr. R. Pickart's, Woods Hole Oceanographic Institution) CTD data summary report for this cruise.

Post cruise editing of the nutrient data from this cruise consisted of:

1) The entire original nutrient data suite were thoroughly re-examined, edited and recalculated by ODF personnel (primarily Susan Becker). This editing process included a major revision of the original silicate concentrations due to an initial calculation error.

2) Upon completion of this re-calculation and re-editing of the data, Lou Codispoti examined the corrected data and with the help of Susan Becker, and made some additional corrections. His examination consisted of reviewing the cruise notes written by the onboard nutrient analyst, a review and edit of the strip chart peaks, examination of the calibration factors and index of refraction corrections, a review of the tabular data, comparison of the tabular nutrient data from this cruise with data collected during the second SBI 2002 process cruise (HLY 02-03), and calculation of the parameter N* (Gruber and Sarmiento, 1997). A listing of the changes to the data arising from SB and LC's editing is given later in this report.

3) We believe that this version of the *Polar Star* nutrient data *per se* is generally free of major errors and should prove useful to SBI PIs. For example, deep (~750 db and deeper) nutrient values compare reasonably well with data collected on the *Healy*, the range of nutrient values seems reasonable, and calculations of the parameter N* (Gruber and Sarmiento, 1997) appeared to yield reasonable results. These data are not, however, of the quality of the nutrient data collected from the *Healy* during the SBI 2002 process cruises. In part, this is because, during the *Polar Star* cruise, bottle flushing was a problem whereas we took special precautions on the *Healy* to promote bottle flushing. Given the high degree of hydrographic and ecosystem stratification that can occur in the upper layers of Arctic waters during the seasons when ice is melting, the bottle flushing issue could prove to be significant in some cases. In addition, manpower limitations during the *Polar Star* cruise did not allow for the same level of shipboard QA/QC, and it is possible that some minor systematic errors still exist in the *Polar Star* data.

Specific corrections/problems:

The nitrite refractive index correction of 0.018 was used for all stations.

STATION	BOTTLE	COMMENTS
003	04	(run id = 00101) all data questionable and not included.
016	3-6 and 9	(run ids = 00301 and 00401) nitrite lost. Samples were rerun and all the rerun data looked ok. The rerun data was reported for all nutrients.
015	02	(run id = 00301) nitrate value looks low but peak height was low.
020	03-06	Shipboard processors assigned the bottle salinities incorrectly. Suspect that the surface bottle, 06, was not drawn and 03 was drawn. Corrected assignment for 03-06.
027		(run ids =00901 and 01001) there was a problem with nitrite in the original run so all samples were re-run. The phosphate, silicate and nitrite plus nitrate data compared reasonable well with the first run.
028		There was some confusion because there was a missing nutrient level. According to the run sheet the surface nutrient was missing. The data did not agree with this and it was assumed the missing level was the deep sample. All the values were shifted up one level.
046	06	(run id = 04201) nitrite value lost, nitrate value reported is nitrate plus nitrite.
049-052		(run id = 04901) the nitrate response factor changed over the course of the run but everything else looks ok. The data are somewhat questionable.
053	03 and 04	bottle salt value needs checking. Appears to have been switched with bottle 03. Values have been corrected.
063	08	(run id = 06201) phosphate value lost.
067	04	(run id = 06601) nitrite lost and nitrate is actually nitrate plus nitrite.
068	03 and 04	(run id = 06601) nitrite lost and nitrate is actually nitrate plus nitrite.

Data Distribution

The data discussed here can be obtained through the NCAR/Earth Observing Laboratory (formerly JOSS [Joint Office for Science Support/UCAR]) website, http://www.eol.ucar.edu/projects/sbi and the CLIVAR and Carbon Hydrographic Data Office website, http://cchdo.ucsd.edu. The data are reported using the WHP-Exchange (WOCE Hydrographic Program) format and the quality coding follows those outlined by the WOCE program (Joyce, 1994).

General rules for WHP-exchange data files:

1. Each line must end with a carriage return or end-of-line.
2. With the exception of the file type line, lines starting with a "#" character, or including and following a line which reads "END_DATA", each line in the file must have exactly the same number of commas as do all other lines in that file.

3. The name of a quality flag always begins with the name of the parameter with which it is associated, followed by an underscore character, followed by "FLAG", followed by an underscore, and then followed by an alphanumeric character, W.
4. The "missing value" for a data value is always defined as -999, but written in the decimal place format of the parameter in question. For example, a missing salinity would be written -999.0000 or a missing phosphate -999.00.
5. The first four characters of the EXPOCODE are the U.S. National Oceanographic Data Center (NODC) country-ship code, then followed by up to an 8 characters expedition name of cruise number, i.e. 32PZAWS02I.

CTD Data

CTD data was acquired and processed by the Woods Hole Oceanographic Institution (WHOI) Pickard group. A detailed description of their methods can be found in Appendix B, CTD Data Summary. WHOI CTD files were reformatted by the Oceanographic Data Facility (ODF) to comply with WHP-Exchange format standards. WHP-Exchange formatted CTD data is located in file 32PZAWS02I_ct1.zip. This file contains ssscc_ct1.csv files for each station and cast where sss=3 digit station identifier and cc=2 digit cast identifier.

Description of ssscc_ct1.csv file layout.

1st line	File type, here CTD, followed by a comma and a DATE_TIME stamp YYYYMMDDdivINSwho YYYY 4 digit year MM 2 digit month DD 2 digit day div division of Institution INS Institution name who initials of responsible person
# lines	A file may include 0-N optional lines at the start of a data file, each beginning with a "#" character and each ending with carriage return or end-of-line. Information relevant to file change/update history may be included here, for example.
2nd line	NUMBER_HEADERS = n (n = 10 in this table and the example_ct1.csv file.)
3rd line	EXPOCODE = [expocode] The expedition code, assigned by the user.
4th line	SECT_ID = [section] The SBI station specification. *Optional*.
5th line	STNNBR = [station] The originator's station number
6th line	CASTNO = [cast] The originator's cast number
7th line	DATE = [date] Cast date in YYYYMMDD integer format.
8th line	TIME = [time] Cast time that CTD was at the deepest sampling point.
9th line	LATITUDE = [latitude] Latitude as SDD.dddd where "S" is sign (blank or missing is positive), DD are degrees, and dddd are decimal degrees. Sign is positive in northern hemisphere, negative in southern hemisphere
10th line	LONGITUDE = [longitude] Longitude as SDDD.dddd where "S" is sign (blank or missing is positive), DDD are degrees, and dddd are decimal degrees. Sign is positive for "east" longitude, negative for "west" longitude
11th line	DEPTH = [bottom] Reported depth to bottom. Preferred units are "meters" and should be specified in Line 2. In general, corrected depths are preferred to uncorrected depths. Documentation accompanying data includes notes on methodology of correction. *Optional.*
next line	Parameter headings.
next line	Units.

data lines	A single _ct1.csv CTD data file will normally contain data lines for one CTD cast.
END_DATA	The line after the last data line must read END_DATA, and be followed by a carriage return or end of line.
other lines	Users may include any information they wish in 0-N optional lines at the end of a data file, after the END_DATA line.

Parameter names, units, format, and comments

Parameter	Units	Format	Comments
CTDPRS	DB	F7.1	CTD pressure, decibars
CTDPRS_FLAG_W		I1	CTDPRS quality flag
CTDTMP	ITS-90	F8.3	CTD temperature, degrees C (ITS-90)
CTDTMP_FLAG_W		I1	CTDTMP quality flag
CTDTMP2	ITS-90	F8.3	CTD temperature from secondary sensor, degrees C (ITS-90)
CTDTMP2_FLAG_W		I1	CTDTMP2 quality flag
CTDSAL		F8.3	CTD salinity
CTDSAL_FLAG_W		I1	CTDSAL quality flag
CTDSAL2		F8.3	CTD salinity from secondary sensor
CTDSAL2_FLAG_W		I1	CTDSAL2 quality flag
FLUOR	MG/L	F5.4	Fluorometer, microgram per Liter
FLUOR_FLAG_W		I1	FLUOR quality flag
TURBITY	VOLTS	F5.4	Turbidity, volts
TURBITY_W_FLAG			TURBITY quality flag

Quality Flags

CTD data quality flags were assigned to the CTDTMP (CTD temperature), CTDSAL (CTD salinity) and XMISS (Transmissivity) parameters as follows:

2 Acceptable measurement.

3 Questionable measurement. *The data did not fit the station profile or adjacent station comparisons (or possibly bottle data comparisons). The data could be acceptable, but are open to interpretation.*

4 Bad measurement. *The CTD data were determined to be unusable.*

5 Not reported. *The CTD data could not be reported, typically when CTD salinity is flagged 3 or 4.*

9 Not sampled. *No operational sensor was present on this cast*

WHP CTD data quality flags were assigned to the FLUOR (Fluorometer) and TURBITY (Turbidity) parameters as follows:

1 Not calibrated. *Data are uncalibrated.*

9 Not sampled. *No operational sensor was present on this cast. Either the sensor cover was left on or the depth rating necessitated removal.*

Description of 32PZAWS02.1_hy1.csv file layout.

1st line	File type, here BOTTLE, followed by a comma and a DATE_TIME stamp YYYYMMDDdivINSwho YYYY 4 digit year MM 2 digit month DD 2 digit day div division of Institution INS Institution name who initials of responsible person example: 20000711WHPSIOSCD
#lines	A file may include 0-N optional lines, typically at the start of a data file, but after the file type line, each beginning with a "#" character and each ending with carriage return or end-of-line. Information relevant to file change/update history of the file itself may be included here, for example.
2nd line	Column headings.
3rd line	Units.
Data lines	As many data lines may be included in a single file as is convenient for the user, with the proviso that the number and order of parameters, parameter order, headings, units, and commas remain absolutely consistent throughout a single file.
END_DATA	The line after the last data line must read END_DATA.
other lines	Users may include any information they wish in 0-N optional lines at the end of a data file, after the END_DATA line.

Header columns

Parameter	Format	Description notes
EXPOCODE	A12	The expedition code, assigned by the user.
SECT_ID	A7	The SBI station specification. *Optional.*
STNNBR	A6	The originator's station number.
CASTNO	I3	The originator's cast number.
BTLNBR	A7	The bottle identification number.
BTLNBR_FLAG_W	I1	BTLNBR quality flag.
DATE	I8	Cast date in YYYYMMDD integer format.
TIME	I4	Cast time (UT) as HHMM
LATITUDE	F8.4	Latitude as SDD.dddd where "S" is sign (blank or missing is positive), DD are degrees, and dddd are decimal degrees. Sign is positive in northern hemisphere, negative in southern hemisphere
LONGITUDE	F9.4	Longitude as SDDD.dddd where "S" is sign (blank or missing is positive), DDD are degrees, and dddd are decimal degrees. Sign is positive for "east" longitude, negative for "west" longitude
DEPTH	I5	Reported depth to bottom. Preferred units are "meters" and should be specified in Line 2. In general, corrected depths are preferred to uncorrected depths. Documentation accompanying data includes notes on methodology of correction. *Optional.*

Parameter names, units, and comments:

Parameter	Units	Format	Comments
CTDPRS	DB	F9.1	CTD pressure, decibars
CTDPRS_FLAG_W		I1	CTDPRS quality flag
SAMPNO		A7	Cast number *100+BTLNBR. *Optional*
CTDTMP	ITS-90	F9.4	CTD temperature, degrees C, (ITS-90)
CTDTMP_FLAG_W		I1	CTDTMP quality flag
CTDCOND	MS/CM	F9.4	CTD Conductivity, milliSiemens/centimeter
CTDCOND_FLAG_W		I1	CTDCOND quality flag
CTDSAL		F9.4	CTD salinity
CTDSAL_FLAG_W		I1	CTDSAL quality flag
SALNTY		F9.4	bottle salinity
SALNTY_FLAG_W		I1	SALNTY quality flag
SIGMA	THETA	F9.4	Sigma Theta
SIGMA_FLAG_W		I1	Sigma Theta quality flag
SILCAT	UMOL/KG	F9.2	SILICATE, micromoles/kilogram
SILCAT_FLAG_W		I1	SILCAT quality flag
SILCAT	UMOL/L	F9.2	SILCATE, micromoles/liter
SILCAT_FLAG_W		I1	SILCAT quality flag
NITRAT	UMOL/KG	F9.2	NITRATE, micromoles/kilogram
NITRAT_FLAG_W		I1	NITRAT quality flag
NITRAT	UMOL/L	F9.2	NITRATE, micromoles/liter
NITRAT_FLAG_W		I1	NITRAT quality flag
NITRIT	UMOL/KG	F9.2	NITRITE, micromoles/kilogram
NITRIT_FLAG_W		I1	NITRIT quality flag
NITRIT	UMOL/L	F9.2	NITRITE, micromoles/liter
NITRIT_FLAG_W		I1	NITRIT quality flag
PHSPHT	UMOL/KG	F9.2	PHOSPHATE, micromoles/kilogram
PHSPHT_FLAG_W		I1	PHSPHT quality flag
PHSPHT	UMOL/L	F9.2	PHOSPHATE, micromoles/liter
PHSPHT_FLAG_W		I1	PHSPHT quality flag
BTL_LAT		F8.4	Latitude at time of bottle trip, decimal degrees
BTL_LONG		F9.4	Longitude at time of bottle trip, decimal degrees
JULIAN		F8.4	Julian day and time as fraction of day of the bottle trip.

Quality Codes

The WHP quality codes for the water bottle itself are:

1 Bottle information unavailable.
2 No problems noted.
3 Leaking.
4 Did not trip correctly.
5 Not reported.
9 Samples not drawn from this bottle.

The WHP bottle parameter data quality codes are:

1 Sample for this measurement was drawn from water bottle but analysis not received. Should be received at a later date.
2 Acceptable measurement.
3 Questionable measurement.
4 Bad measurement.
5 Not reported.
9 Sample not drawn for this measurement from this bottle.

References

Armstrong, F. A. J., Stearns, C. R., and Strickland, D. H., “The measurement of upwelling and subsequent biological processes by means of the Technicon Autoanalyzer and associated equipment,” *Deep-Sea Research*, 14, pp. 381-389, (1967).

Bernhardt, Wilhelms A., “The continuous determination of low level iron, soluble phosphate and total phosphate with the AutoAnalyzer”, *Technicon Symposia*, **I**, pp. 385-389 (1967).

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APPENDIX A: Bottle Quality Comments

Remarks for deleted samples, missing samples, PI data comments, and WOCE codes other than 2 fromUSCGC Polar Star, AWS02.1. Comments from the Sample Logs and the results of ODF's investigations are included in this report. Investigation of data may include comparison of bottle salinity and oxygen data with CTD data, review of data plots of the station profile and adjoining stations, and rereading of charts (i.e. nutrients). Units stated in these comments are degrees Celsius for temperature, Practical Salinity Units for salinity, and unless otherwise noted, milliliters per liter for oxygen and micromoles per liter for Silicate, Nitrate, Nitrite, Phosphate and Urea and Ammonium, if appropriate. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 003.001
104 All nutrient data are questionable and are not included. Footnote silicate, nitrate, nitrite and phosphate not reported.

Station 005.001
101-102 Shipboard: "Bottle vents not closed, samples not taken."

Station 010.001
101 Suspect no nutrient samples drawn. No sample log to confirm.
102 Shipboard: "One bottle tripped on the fly, sample not taken." Shorebased processor found nutrient sample drawn from this bottle. No salinity sample.

Station 016.001
107-108 Shipboard: "Bottles compromised, samples not taken."
Cast 1 Nutrients: "Samples were rerun; rerun data looks good for all samples."

Station 020.001
103 Shipboard: "One bottle (salinity) with no sample."

Station 023.001
108 Itappears that salinity was not drawn.
Cast 1 Shipboard: "8 tags, 7 bottles, don't know which bottle is missing."

Station 025.001
101 Suspect no samples drawn. No sample log to confirm.
102 Suspect no samples drawn. No sample log to confirm.
103 Suspect no samples drawn. No sample log to confirm.
105 Suspect no samples drawn. No sample log to confirm.

Station 027.001
101 NO2data not reported due to autoanalyzer error.
102 NO2data not reported due to autoanalyzer error.
Cast 1 Nutrients: Problem with nitrite in the original run, so all samples were re-run. The phospahte, silicate and nitrite plus nitrite data compared reasonably will with the first run. Data from the second run was reported for all nutrients. Shipboard: "Bottle from last station is really from this station." Not certain what this comment refers to, suspect salinity.

Station 028.001
101 Nutrients: there was some confusion because there was a missing nutrient level. According to the run sheet the surface nutrient was missing. The data did not agree with this and it was assumed the missing level was the deep sample. All the values were shifted up one level. Nutrients were not drawn.
110 Shipboard: "Air vent not tight." Salinity was not drawn, but nutrients were drawn and appear acceptable.

114 Shipboard: "Salinity sample missing." Footnote salinity not drawn. Cast 1 Shipboard: "At 260db the package was relowered to 380db and then raised again. The bottle below 250db may have leaked due to compression during lowering."

Station 030.001
114 Shipboard: "Salinity sample missing."

Station 031.001
115-120 Shipboard: "Salinity samples accidentally dumped."

Station 046.001
106 Nutrients: Nitrite value lost, nitrate value reported is nitrate plus nitrite.

Station 049.001
101-105 Nutrients: The nitrate response factor changed over the course of the run, Stations 049-052, but everything else looks okay. The data are somewhat questionable. Code nitrate questionable.

Station 050.001
101-106 Nutrients: The nitrate response factor changed over the course of the run, Stations 049-052, but everything else looks okay. The data are somewhat questionable. Code nitrate questionable.

Station 051.001
101-104 Nutrients: The nitrate response factor changed over the course of the run, Stations 049-052, but everything else looks okay. The data are somewhat questionable. Code nitrate questionable.

Station 052.001
101-106 Nutrients: The nitrate response factor changed over the course of the run, Stations 049-052, but everything else looks okay. The data are somewhat questionable. Code nitrate questionable.

Station 053.001
103-104 Salinities appear to be switched, changed the data.

Station 063.001
108 Phosphate value lost.

Station 067.001
104 Nutrients: Nitrite value lost, nitrate value reported is nitrate plus nitrite.

Station 068.001
103-104 Nutrients: Nitrite value lost, nitrate value reported is nitrate plus nitrite.

APPENDIX B:

AWS-02 Phase I, SBI, July 15 – August 13, 2002

CTD Data Summary

Contents

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 chief scientist was Tom Weingartner of the University of Alaska Fairbanks (UAF). The co-PI was Robert Pickart of the Woods Hole Oceanographic Institution (WHOI), who was 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, and nutrients were done by the University of Washington (UW), both under subcontract from the Scripps Institution of Oceanography (SIO). The water sample salinity program was carried out by SIO. Additionally there was a WHOI 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. The temperature accuracy was 0.001°C and the salinity accuracy 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 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 exist 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. Station List

Station Numbers Section Comments

Stations 1-2 Tests
Stations 3-8 Section 1 Chukchi Sea
Stations 9-23 Section 2 West Chukchi Slope
Stations 24 Aborted cast
Stations 25-39 Section 3 East Beaufort Slope
XCTD 1-8 Section 3 XCTDs between CTDs
XCTD 9-21 Section 3a Adjacent to Section 3
Stations 40-41 Section 3a Extention of XCTD line
Prior to Station 42 Wire Retermination
Stations 42-52 Section 4 Barrow Canyon Head
Stations 53-66 Section 5 East Chukchi Slope
XCTD Section 5 XCTDs between CTDs
Stations 67-90 Section 6 Barrow Canyon Mouth

Figure 1 shows the locations of the CTD stations.

3. Data Files

For the cruise there is one summary file of 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 uptrace CTD data.

sbisum_master.txt Event summary of all CTD, XCTD, and moorings.
sbi020##.dcc 1db averaged downtrace CTD file per station
sbi020##.ucc 1db averaged uptrace CTD file per station
sbi020##.nut Bottle data per station
C3_000##.edf XCTD data, 1 file per XCTD station

4. CTD Package

A Seabird 911+ 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.

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 was 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.

5. 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 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 1-2m 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-Mac, 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 implemented. 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 nonstandard format of the nutrient data, special procedures, described below, were used to merge the data.

6. 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).

7. CTD Sensor Accuracy

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 verify that 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 needed 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.

8. Data Issues

8.1. 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.

8.2. 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.

8.3. Nutrient Data

Because CTD versus 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.

8.4. 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.

8.5. 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.

9. Data Quality

9.1. Uncontrolled

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.

9.2. Density Inversions

Deep density inversions appeared in some of the CTD profiles. To identify these, profiles of density versus pressure were made for all of the casts. 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

9.3. 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 these. Two of the 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 one 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)

10. 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 uptrace 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.

11. 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 (7 good, 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.

12. 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, groundtruthed, 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 Beaufort Slope 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 jellyfish 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 13. 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.

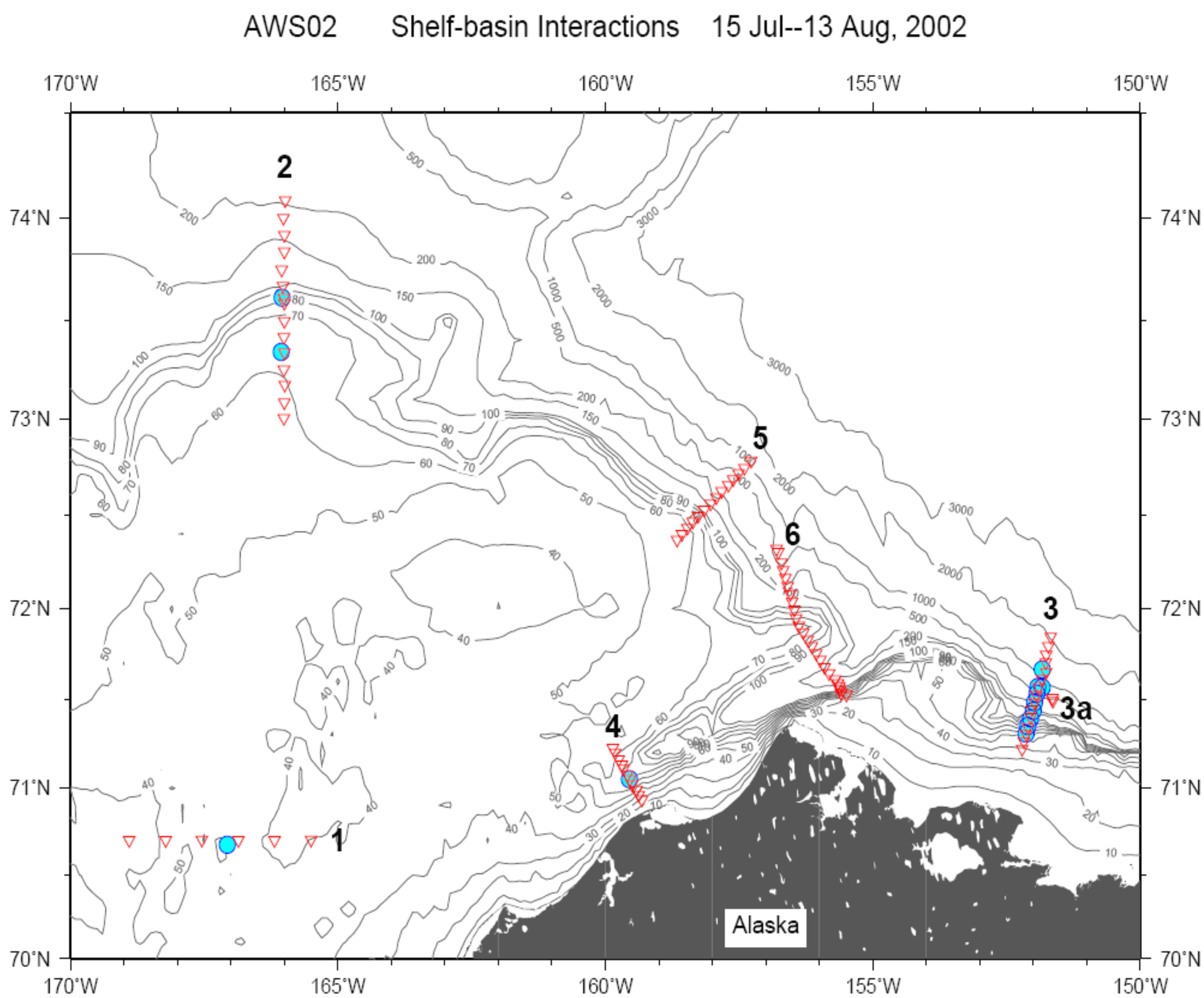
Station 28
One bottle with air vent not tight. Salt sample missing for 88m, water sample #26, Niskin#15, Sequence #14.

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



CCHDO Data Processing Notes

Date	Person	Data Type	Action	Summary
2010-09-07	Fields, Justin	BTL	Website Update	Copied from CARINA collection
	This bottle file was part of the CARINA collection compiled by Bob Key.			
2010-09-08	Fields, Justin	BTL	Note	Data originally obtained from ODF
	These data were originally provided by ODF in 2007.			
2014-03-07	Kappa, Jerry	CrsRpt	Website Update	new PDF version online
	I've placed a new PDF version of the cruise report: 32PZ20020715do.pdf into the directory: http://cchdo.ucsd.edu/data/co2clivar/arctic/32PZ20020715/ . It includes all the reports provided by the cruise PIs, summary pages and CCHDO data processing notes, as well as a linked Table of Contents and links to figures and tables.			