HLY-02-01 Service Group Bottle Data Documentation

5 May to 15 June 2002
Nome, Alaska to Nome, Alaska

Dr. Louis Codispoti, (on board PI)
Horn Point Laboratory
PO Box 775
2020 Horn Pt. Rd.
Cambridge, MD 21613
410.221.8479 phone
codispot@hpl.umces.edu

Dr. James Swift (PI)
Scripps Institution of Oceanography
Oceanographic Data Facility
9500 Gilman Rd. MC 0214
La Jolla, CA 92093-0214
858.534.3387 phone
jswift@ucsd.edu

On board team: Kristin Sanborn, Dean Stockwell, Robert Palomares, Doug Masten, Charlie Flagg, Erik Haberkern and Bob Williams

Funded by National Science Foundation OPP0125399

Instrumentation

CTD casts were performed with a rosette system consisting of a 12-place rosette frame with 30 liter Niskin-type bottles equipped with internal plastic coated springs and a 24-place SBE-32 Carousel pylon. To minimize toxicity the bottles were equipped with silicone O-rings.

Underwater electronic components consisted of a

- Sea-Bird Electronics, Inc. (SBE) 911plus CTD,
- WetLabs C-Star transmissometer with a 25cm pathlength and 660nm wavelength,
- Biospherical Instruments, Inc. Photosynthetically Active Radiation (PAR) sensor,
- Chelsea MkIII Aquatracka fluorometer, and
- Simrad, 5 volt - 500 meters altimeter.

Additionally, a Dr. Haardt fluorometer (CDOM), a Secchi disk and occasionally a Video Plankton Recorder (VPR) were mounted on the CTD package. The CTD and transmissometer were mounted horizontally along the bottom of the rosette frame. The PAR sensor was located at the top of the rosette. All sensors except the Secchi disk and the VPR were interfaced with the CTD, and the data from these instruments were incorporated into the CTD data stream. This instrument package provided pressure, dual temperature and conductivity channels as well as light transmissivity, at a sample rate of 24 scans per second.

The rosette system was suspended from a standard UNOLS 3 conductor 0.322" electromechanical cable. Before deployment of the CTD, the cell was flushed with a brine solution to ensure that the sensors did not freeze when the CTD was taken from the heated room where it was stored between stations.

The CTD used was serial number 09P12613-0474 and this instrument's sensor serial numbers are listed in Table 1.

TABLE 1. Instrument/Sensor Serial Numbers

Primary Temperature	Primary Conductivity	Secondary Temperature	Secondary Conductivity	Pressure	Transmissometer
SBE 3plus	SBE 4C	SBE 3plus	SBE 4C	401K-105	C-Star
03-2166	04-2319	03-2324	04-2113	69008	CST-479DR

Oxygen	Fluorometer	PAR
SBE 43	Aqua 3	QSP-2300
0060	88191	4644

The distance of the mid-points of the 30 L Niskin bottles from the bottom-mounted sensors was ~1m . The PAR sensor was ~ 0.6 m above the mid-point of the Niskin bottles, and the Secchi disk which is mounted on a rod was ~ 0.8 m above the mid-point of the 30 L Niskin bottles. The distance between the PAR sensor and the bottom mounted sensors was ~1.7 m. The 30 Liter Niskin bottles are ~1.0 m long.

On 29 May, before Station 018 Cast 04, a mishap damaged three of the SIO/STS/ODF 30 liter bottles. These were replaced with the USCG Ocean Test Equipment bottles. In most respects, the replacement bottles were similar to the General Oceanics bottles except they were equipped with external stainless steel springs instead of internal coated springs. Because of geometric considerations, the arrangement of the original bottles had to be changed. The bottles were renumbered using the tripping order sequence as the bottle number. Bottles 10 and 11 were damaged and replaced by bottles 4 and 5. Ocean Test Equipment bottles were placed in the slots that 4 and 5 had occupied.

After a few casts, the external springs on the Ocean Test Equipment bottles were replaced with SIO/STS/ODF internal springs.

Before Station 032, Cast 02, bottle 1 was replaced with an Ocean Test Equipment bottle. An internal spring was used on this bottle.

CTD Data

CTD Laboratory Calibration Procedures

Pre-cruise laboratory calibrations of CTD pressure, temperature and conductivity sensors were used to generate coefficients for the calculation of these parameters from their respective sensor frequencies. The conductivity calibrations were performed at Sea-Bird Electronics, Inc. in Bellevue, Washington. Calibration of the pressure and temperature sensors was performed by

Shipboard Technical Support/Oceanographic Data Facility (STS/ODF) personnel. These laboratory temperature calibrations were referenced to the International Temperature Scale of 1990 (ITS-90).

CTD Data Acquisition

The CTD 911plus was operated generally as suggested in the Sea-Bird CTD Operating and Repair Manual, which contains a description of the system, its operation and functions (Sea-Bird Electronics, Inc., 2002). One difference from Sea-Bird's operation is that data acquisition was started on deck. This procedure allows a check of the pressure offset and an unblocked reading of the transmissometer. The Seasoft acquisition program as described in the CTD Data Acquisition Software Manual (Sea-Bird Electronics, Inc., 2001) provided a real-time graphical display of selected parameters adequate to monitor CTD performance and information for the selection of bottle-tripping depths. Raw data from the CTD were archived on the PC's hard disk at the full 24 Hz sampling rate. The CTD data acquisition system (the deck unit, and a PC running Sea-Bird's Seasoft software) were prepared by the console operator prior to each station.

A CTD Station Sheet form was filled in for each deployment, providing a record of times, positions, bottom depth, bottle sampling depths, and every attempt to trip a bottle, as well as any pertinent comments. Bottom depths were logged in uncorrected meters (assuming a sound velocity of 1500 m/sec) from the ship's Bathy 2000, or if not operational then from the SeaBeam system. When the equipment and personnel were ready, data acquisition was started. The CTD operator pressed a control key (flag), which appends a summary line into one of the two files created for "inventory"files. This file contains a summary of the time, ship's position, and current scan number each time the control key is pressed. It is used as a reference to mark important events during the cast, such as on deck pressure, when the lowering was initiated, when the package was at the bottom, and on-deck pressure with ending position. After the initial flag, the rosette/CTD system was lowered into the water and held at or near the surface until the CTD pumps activated and a notation was made to this affect. The CTD was allowed to equilibrate for a period of time. Then, the operator again created a flag and simultaneously directed the winch operator to begin lowering. The rosette was lowered to within a few meters of the bottom on most casts using the altimeter to determine distance above the bottom. The operator created a flag at the deepest point of the cast.

The console operator and a member of the scientific party monitored the CTD data during the downcast via graphics windows on the display, and decided where to trip bottles on the up-cast or the bottles were tripped at standard predetermined depth. The depth of each bottle trip was written on the station log and flagged in the data file. The performance of all sensors was monitored during the cast. After the rosette recovery, the operator created a final flag denoting the end of the cast. The console operator terminated the data acquisition and turned off the CTD power. Any faulty equipment or exceptionally noisy data was noted by the operator on the log sheet.

CTD Data Processing

Pressure

CTD values determined on deck before and after each cast were compared to determine a pressure offset correction. The comparison suggested no pressure offset needed to be applied to the data.

Temperature

The temperature sensor was calibrated just before the expedition. The temperature sensors were monitored during the expedition and found to have a good agreement with one another. It appears that no additional corrections need to be applied to the data. A post-cruise calibration will be performed and if those results find that both of the sensors drifted by the same amount, the data will be reprocessed.

Conductivity

Corrected CTD pressure and temperature values were used with bottle salinities to back-calculate bottle conductivities. Comparison of these bottle values with the CTD primary conductivity values indicated an offset correction needed to be applied to the CTD data. On stations 000 to 021, 0.00009 mS/cm was added from Station 022 till the end of the leg 0.00037 was added to the conductivity data.

Transmissometer

A WetLab calibrated Transmissometer was utilized throughout the cruise. An on deck calibration check was performed and it was found there was little degradation from the last calibration.

Oxygen, Fluorometer, and PAR

The CTD oxygen data are only intended for qualitative use. Similarly, the fluorometric and PAR data are not calibrated.

CTD Data Processing

The Sea-Bird Seasoft CTD processing software was employed in the processing routine. The software consists of a number of programs that perform various functions, and may be combined to provide a semi-automated batch processing system. A more complete description may be found in the Sea-Bird Software Manual which is available from the Sea-Bird website (www.seabird.com).

The sequence of programs that were run in the processing of this cruise are as follows:

- ***DATCNV*** - Converts data from raw frequencies and voltages to corrected engineering units
- ***WILDEDIT*** - Eliminates large spikes
- ***CELLTM*** - Applies conductivity cell thermal mass correction
- ***FILTER*** – A low pass filter to smooth pressure for LOOPEDIT
- ***LOOPEDIT*** - Marks scans where velocity is less than selected value to avoid pressure reversals from ship roll, or during bottle flushing.
- ***DERIVE*** - Computes calculated parameters
- ***BINAVG*** - Average data into desired pressure bins

The quality control steps included:

- ***Sensor verification*** After the CTD was set up and sensor serial numbers and sensor location was entered into the computer, another check was made of the CTD to verify that there were no tabulation errors in the setup.

- ***Seasoft Configuration File*** was reviewed to verify that individual sensors were represented correctly, with the correct coefficients.
- ***Temperature*** was verified by comparison of the primary sensor data versus that from the secondary sensor.
- ***Conductivity*** was checked by comparison of the two sensors with each other and with bottle salinity samples.
- ***Position Check*** A chart of the ship's track was produced and reviewed for any serious problems. The positions were acquired from the ship's Trimble P-code navigation system.
- ***Visual Check*** Plots of each usable cast were produced and reviewed for any noise and spikes that may have been missed by the processing programs.
- The density profile was checked for inversions that might have been produced by sensor noise or response mismatches. Additional Sea-Bird programs were run on all or some stations to maximize the data quality:
- ***WFILTER*** - Provides a median filter for data smoothing of .CNV files
- ***WFILTER*** was employed on selected stations where there were spikes in the data, specifically in the transmissometer data. This program was run after ***WILDEDIT***

There were several modulo word errors at the beginning of the expedition. The ship personnel had reported problems with the CTD just days before the expedition. Once onboard, a check of all connections and cables was performed. It was found that a shielding around the winch motor eliminated the spiking and most of the noise in the CTD signal.

Appendix A is a tabulation of the stations sampled. There are separate columns for the maximum sampling depth of the bottle data and the CTD data. Bottom depths, distance above the bottom, as well as miscellaneous notes are included in this tabulation. The bottom depth was calculated by combining the distance above bottom, reported by the altimeter, and the maximum depth of the CTD package. If there was no altimeter reading, in instances where the package was 500 meters or more off the bottom, then the bottom depth is reported from the depth recorder (uncorrected) via the Bathy 2000 or SeaBeam.

The CTD down trace is being reported: If there was a problem with the down trace, the up trace was reported and a notation was made in the comments file.

The CTD data can be obtained via the NCAR/Earth Observing Laboratory (formerly JOSS [Joint Office for Science Support/UCAR]) web-site, www.eol.ucar.edu/projects/sbi . The data are reported using the WHP-Exchange format. The format can be obtained through the WOCE Hydrographic Program web-site, WHPO.ucsd.edu. Additional ascii files were created with comments recorded on the CTD Station Logs during data acquisition. These ascii files also include data processing comments noting any problems, the resolution, and footnoting that may have occurred. These comment files are also in the JOSS/EOL database.

CTD Data Footnoting

WHP water sample quality flags were assigned to the CTDTMP (CTD temperature) and CTDSAL (CTD salinity) parameters as follows:

2 Acceptable measurement.

3 Questionable measurement. *The data did not fit the bottle data, or there was a CTD conductivity calibration shift during the up-cast.*

4 Bad measurement. *The CTD up-cast data were determined to be unusable for calculating a salinity.*

7 Despiked. *The CTD data have been filtered to eliminate a spike or offset.*

WHP water sample quality flags were assigned to the CTDOXY (CTD O_2) parameter as follows:

1 Not calibrated. *Data are uncalibrated.*

2 Acceptable measurement.

3 Questionable measurement.

4 Bad measurement. *The CTD data were determined to be unusable for calculating a dissolved oxygen concentration.*

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

7 Despiked. *The CTD data have been filtered to eliminate a spike or offset.*

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

Data Comments

Fine structure that may appear in the upper ~ 10 m of our profiles may be caused by ship discharges/turbulence. To minimize this problem, engine cooling water discharges were restricted to the port side of the Healy starting with Station 002. At about this time, a procedure was adopted in order to induce bottle flushing under the prevailing quiescent conditions. The winch operator was instructed to "yo yo" bottles before the CTD operator tripped the bottle for most casts. In addition, the bottle was kept at depth for ~ 1 minute before tripping. On productivity casts keyed to light depths that often were closely spaced, the "yo yo" procedure was replaced by keeping the bottle at depth longer than 1 minute.

Bottle Data

Note: All salinity, nutrient and dissolved oxygen data collected by the service team have gone through several stages of editing and are not likely to change significantly. The chlorophyll observations that we report are, however, preliminary and will undergo post-cruise editing.

Bottle Sampling

There were six generic types of casts performed with differing sampling protocols. Generally speaking, the sampling during these casts were as follows, but there is some cast to cast variation.

- **Hydrographic**
    - ***Oxygen,***
    - ***Total CO2,***
    - ***Total Alkalinity,***
    - ***Nutrients***
    - ***Chlorophyll***
    - ***Salinity***

    - ***O18/O16***
    - ***Dissolved Organic Carbon***
    - ***Dissolved Inorganic Carbon***
    - ***Particulate Organic Matter***
    - ***Benthic***
    - ***Stable Isotopes***
    - ***PB^{210}***
    - ***Iodine***
    - ***Cesium***
- **Productivity**
    - ***Oxygen and/or Oxygen Respiration***
    - ***Productivity***
    - ***Nutrients***
    - ***Chlorophyll***
    - ***HPLC***
    - ***Bacteria***
    - ***Micro Zooplankton***
    - ***Bio-Optics***
- **Bio-Mark(ers)**
    - ***Dissolved Organic Matter***
    - ***Lignin***
    - ***Zooplankton***
- **Radium**
    - ***Nutrients***
    - ***Radium***
- **Zooplankton**
    - ***Nutrients***
    - ***Zooplankton***
- **CTD**
    - ***No samples***

The correspondence between individual sample containers and the rosette bottle from which the sample was drawn was recorded on the sample log for the cast. This log also included any comments or anomalous conditions noted about the rosette and bottles. One member of the sampling team was designated the sample cop, whose sole responsibility was to maintain this log and insure that sampling progressed in the proper drawing order.

Normal sampling practice included opening the drain valve before the air vent on the bottle, to check for air leaks. This observation together with other diagnostic comments (e.g., "lanyard caught in lid", "valve left open") that might later prove useful in determining sample integrity were routinely noted on the sample log. Drawing oxygen samples also involved taking the sample draw temperature from the bottle. The temperature was noted on the sample log.

Bottle Data Processing

After the samples were drawn and analyzed, the next stage of processing involved merging the different data streams into a common file. The rosette cast and bottle numbers were the primary identification for all ODF-analyzed samples taken from the bottle, and were used to merge the analytical results with the CTD data associated with the bottle.

Diagnostic comments from the sample log, and notes from analysts and/or bottle data processors were entered into a computer file associated with each station (the "quality" file) as part of the quality control procedure. Sample data from bottles suspected of leaking were checked to see if the properties were consistent with the profile for the cast, with adjacent stations, and, where applicable, with the CTD data. Various property-property plots and vertical sections were examined as well as the tabular data for both consistency within a cast and consistency with adjacent stations by data processors, who advised analysts of possible errors or irregularities, bottles that did not "fire" correctly ("mis-trips"), etc. The analysts reviewed and sometimes revised their data as additional calibration or diagnostic results became available. Further post-cruise QA/QC checking of the data were conducted, and additional bottle data quality notes are presented in the **ADDENDUM** to this document.

Based on the outcome of investigations of the various comments in the quality files, WHP water sample quality codes were selected to indicate the reliability of the individual parameters affected by the comments (see below). WHP bottle codes were assigned where evidence showed the entire bottle was affected, as in the case of a leak, or a bottle trip at other than the intended depth. Raw (unprocessed) CTD data are located in the EOL database as well. The file hly0201_ctd_raw.zip contains ssscc.cfg, ssscc.con, ssscc.dat and ssscc.hdr (where sss = station number and cc = cast number) files as acquired by the SeaBird SeaSave acquisition program, sbscan.sum file and calibration information for all sensors. The *.cfg file is datcnv.cfg with the beginning scan number and *.con files may include a correction based on the bottle salinity samples. The sbscan.sum file is a list of stations and beginning scan number. Configuration files for the various SeaBird CTD processing programs are also included where applicable.

Bottle Data Footnoting

WHP water bottle quality codes were assigned as defined in the WOCE Operations Manual [Joyce] with the following additional interpretations:

2 No problems noted.

3 Leaking. *An air leak large enough to produce an observable effect on a sample is identified by a code of 3 on the bottle and a code of 4 on the oxygen. (Small air leaks may have no observable effect, or may only affect gas samples.)*

4 Did not trip correctly. *Bottles tripped at other than the intended depth were assigned a code of 4. There may be no problems with the associated water sample data.*

5 Not reported. *No water sample data reported. This is a representative level derived from the CTD data for reporting purposes. The sample number should be in the range of 80-99.*

9 The samples were not drawn from this bottle.

WHP water sample quality flags were assigned using the following criteria:

1 The sample for this measurement was drawn from the water bottle, but the results of the analysis were not (*yet*) received.

2 Acceptable measurement.

3 Questionable measurement. *The data did not fit the station profile or adjacent station comparisons (or possibly CTD data comparisons). No notes from the analyst indicated a problem. The data could be acceptable, but are open to interpretation.*

4 Bad measurement. *The data did not fit the station profile, adjacent stations or CTD data. There were analytical notes indicating a problem, but data values were reported. Sampling and analytical errors were also coded as 4.*

5 Not reported. *There should always be a reason associated with a code of 5,usually that the sample was lost, contaminated or rendered unusable.*

9 The sample for this measurement was not drawn.

Not all of the quality codes are necessarily used on this data set.

Pressure and Temperatures

All pressures and temperatures for the bottle data tabulations on the rosette casts were obtained by averaging CTD data for a brief interval at the time the bottle was closed on the rosette and then applying the appropriate corrections and offsets that were outlined earlier.

The temperatures are reported using the International Temperature Scale of 1990.

Salinity

Equipment and Techniques

Salinity samples were drawn into 200 ml Kimax 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 #57-526, 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 had been modified by ODF and contained an interface for computer-aided measurement. A computer (PC) prompted the analyst for control functions (changing sample, flushing) and logged results. 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.

PSS-78 salinity was calculated for each sample from the measured conductivity ratios. The difference (if any) between the initial vial of standard water and one run at the end as an unknown was applied linearly to the data to account for any drift. The data were added to the cruise database. 429 salinity measurements were made and 34 vials of standard water were used. 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 fair, sometimes varying as much as 3.5ºC during a run of samples. The laboratory temperature was generally 1-2ºC lower than the Autosal bath temperature.

Oxygen Analysis

Equipment and Techniques

Dissolved oxygen analyses were performed with an ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365nm wavelength ultra-violet light. The titration of the samples and the data logging were controlled by PC software. Thiosulfate was dispensed by a Dosimat 665 buret driver fitted with a 1.0 ml buret. The ODF method used a whole-bottle modified-Winkler titration following the technique of Carpenter (1965) with modifications by Culberson (1991), but with higher concentrations of potassium iodate standard (approximately 0.012N) and thiosulfate solution (50 gm/l). Standard KIO3 solutions prepared ashore were run at the beginning of each session of analyses, which typically included from 1 to 2 casts. Reagent/distilled water blanks were determined, to account for presence of oxidizing or reducing materials.

Sampling and Data Processing

Samples were collected for dissolved oxygen analyses soon after the rosette was brought on board. Using a Tygon drawing tube, nominal 125ml volume-calibrated iodine flasks were rinsed twice with minimal agitation, then filled and allowed to overflow for at least 3 flask volumes. The sample draw temperature was measured with a small platinum resistance thermometer embedded in the drawing tube. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice to assure thorough dispersion of the precipitate, once immediately after drawing, and then again after about 20 minutes. The samples were usually analyzed within a few hours of collection and then the data were merged into the cruise database. Thiosulfate normalities were calculated from each standardization and corrected to 20ºC. The 20ºC normalities and the blanks were plotted versus time and were reviewed for possible problems. New thiosulfate normalities were recalculated as a linear function of time, if warranted. The oxygen data were recalculated using the smoothed normality and an averaged reagent blank. Oxygens were converted from milliliters per liter to micromoles per kilogram using the sampling temperature. 531 oxygen measurements were made, with no major problems with the analyses.

Volumetric Calibration

Oxygen flask volumes were determined gravimetrically with degassed deionized water to determine flask volumes at ODF's chemistry laboratory. This is done once before using flasks for the first time and periodically thereafter when a suspect bottle volume is detected. The volumetric flasks used in preparing standards were volume-calibrated by the same method, as was the 10 ml Dosimat buret used to dispense standard iodate solution.

Standards

Potassium iodate was obtained from Johnson Matthey Chemical Co. and was reported by the supplier to be >99.4% pure.

Nutrient Analysis

Equipment and Techniques

Nutrient analyses (phosphate, silicate, nitrate+nitrite, urea, ammonium, and nitrite) were performed on an ODF-modified 6-channel Technicon AutoAnalyzer II, generally within a few hours after sample collection. Occasionally samples were refrigerated up to a maximum of 8 hours at 2-6ºC. All samples were brought to room temperature prior to analysis. The analog outputs from each of the six channels were digitized and logged automatically by computer (PC) at 2-second intervals.

Silicate was analyzed using the technique of Armstrong *et al*., (Armstrong, 1967). An acidic solution of ammonium molybdate was added to a seawater sample to produce silicomolybdic acid, which was then reduced to silicomolybdous acid (a blue compound) following the addition of stannous chloride. Tartaric acid was also added to impede PO_4 color development. 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 analysis, the seawater sample was passed through a cadmium reduction column where nitrate was quantitatively reduced to nitrite. Sulfanilamide was introduced to the sample stream followed by N-(1-naphthyl) ethylenediamine dihydrochloride which coupled to form a red azo dye. The stream was then passed through a 15mm flowcell and the absorbance measured at 540nm. The same technique was employed for nitrite analysis, except the cadmium column was bypassed, and a 50mm flowcell was used for measurement. Periodic checks of the column efficiency were made by running alternate equal concentrations of NO2 and NO3 through the NO3 channel.

Phosphate was analyzed using a modification of the Bernhardt and Wilhelms [Bernhardt 1967.] technique. An acidic solution of ammonium molybdate was added to the sample to produce phosphomolybdic acid, and then reduced to phosphomolybdous acid (a blue compound) following the addition of dihydrazine sulfate. The reaction product was heated to ~55ºC to enhance color development, then passed through a 50mm flowcell and the absorbance measured at 820m.

Ammonium is determined by the Berthelot reaction (Patton and Crouch 1977) in which sodium hypochlorite and phenol react with ammonium ion to produce indophenol blue, a blue compound, with an absorption maximum at 637nm. Sodium citrate is added to prevent precipitation of Ca^{+2} and Mg^{+2}. The solution is heated to 55°C and passed through a 50mm flowcell at 640nm.

Urea is analyzed via a modification of the method by Rahmatullah and Boyde (1980), which is based on the classic diacetyl monoxime method. A solution of diacetyl monoxime, thiosemicarbizide and acetone is followed by the addition of ferric chloride, which acts as a catalyst. The resultant solution is heated to 90°C and passed through a 50mm flowcell. The absorbance is measured at 520nm.

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 one cast, usually 12-24 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. After each group of samples was analyzed, the raw data file was processed to produce another file of response factors, baseline values, and absorbances. Computer-produced absorbance readings were checked for accuracy against values taken from a strip chart recording. The data were then added to the cruise database. 1217 nutrient samples were analyzed. No major problems were encountered with the measurements. The pump tubing was changed three times, and a stable deep seawater check sample was run frequently as a substandard check. The efficiency of the cadmium column used for nitrate was monitored throughout the cruise and ranged from 96-100%.

Nutrients, 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.

Also reported is N**, a parameter calculated from nitrate, nitrite, ammonium and phosphate concentrations. This parameter is defined as N** = ((N-16P + 2.98)μM) 0.87, where P = the phosphate concentration in μM, and N = (nitrate+nitrite+ammonium in μM). This parameter is quite similar to the original N* parameter defined by Gruber and Sarmiento (1997) except that we include ammonium concentrations because of the high ammonium concentrations that can occur in the SBI region. The underlying premise of both N* and N** is that the N/P atomic regeneration ratio in seawater is normally close to the 16/1 N/P Redfield ratio. The assumption is that deviations from this ratio in N/P ratios in a water mass arise primarily from nitrogen fixation which produces organic matter with N/P ratios in excess of 16/1, or denitrification which consumes nitrate and other forms of fixed nitrogen and converts these forms into elemental dinitrogen gas. Values less than 2.98 suggest that a water mass has experienced net denitrification and higher values suggest net nitrogen fixation. The factors 2.98 and 0.87 are explained by Gruber and Sarmiento (1997), and there is some debate about whether they should be included, but we do so in order to facilitate comparison with the distributions presented by Gruber and Sarmiento (1997).

Nutrient Standards

Na_2SiF_6, the silicate primary standard, was obtained from Johnson Matthey Company and Fisher Scientific and was reported by the suppliers to be >98% pure. Primary standards for nitrate (KNO3), nitrite ($NaNO_2$), and phosphate (KH_2PO_4) were obtained from Johnson Matthey Chemical Co. , Aesar Division, and the supplier reported purities of 99.999%, 97%, and 99.999%, respectively. Ammonia, (NH4(SO4)2) , and Urea primary standards were obtained from Fisher Scientific and reported to be >99% pure. In addition, cross-comparisons were made with KNO3 and KH2PO4 traceable to NIST that were assayed at ~ 99.98% and ~99.9% respectively. Standards for the remaining nutrients were compared with a suite of standards supplied by the University of Maryland. All standard intercomparisons, produced agreement well within the precision of our methods.

Data Quality Notes:

Silicate data from station 10, cast 5, station 10, cast 6 and station 11 cast 2 look reasonable, but are probably not of our normal quality due to problems with the molybdate reagent and baseline drift. Baseline problems suggest that the ammonium data from station 11, cast 2 are not of our normal quality.

Bottle Data Footnoting

WHP water bottle quality flags were assigned as defined in the WOCE Operations Manual [Joyce]. These flags and interpretation are tabulated in the Data Distribution, Bottle Data, Quality Flags section of this document.

Data Distribution

The CTD and bottle data can be obtained through the NCAR/Earth Observing Laboratory (formerly JOSS [Joint Office for Science Support/UCAR]) web-site, www.eol.ucar.edu/projects/sbi. 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). In addition, the format can be obtained through the WOCE Hydrographic Program website, WHPO.ucsd.edu. The descriptions in this document have been edited from the reference to annotate the format specific to this data distribution. ASCII files for each station were created with comments recorded on the CTD Station Logs during data acquisition. These ASCII files include data processing comments noting any problems, their resolution, and footnoting that may have occurred. A separate ASCII file was also created with the comments from the Sample Log Sheets that include problems with the Niskin bottles that could compromise the samples. Comments arising from inspection and checking of the data are also included in the ASCII file. These comments are included in Appendix B.

General rules for WHP-exchange:

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. 32H1HLY0201.

CTD Data

CTD data is located in file 32H1hly0403_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
CTDSAL		F8.3	CTD salinity
CTDSAL_FLAG_W		I1	CTDSAL quality flag
CTDOXY	UMOL/KG	F7.1	CTD oxygen, micromoles/kilogram
CTDOXY_FLAG_W		I1	CTDOXY quality flag
XMISS	%TRANS	F7.1	Transmissivity, percent transmittance
XMISS_FLAG_W		I1	XMISS quality flag
FLUOR	VOLTS	F8.3	Fluorometer, voltage
FLUOR_FLAG_W		I1	Fluorometer quality flag
PAR	VOLTS	F8.3	PAR, voltage
PAR_FLAG_W		I1	PAR quality flag
FLCDOM	VOLTS	F8.3	CDOM Fluorometer, voltage
FLCDOM_FLAG_W		I1	CDOM Fluorometer quality flag

Quality Flags

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

5 Acceptable measurement.

6 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.*

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

8 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 CTDOXY (CTD O_2), FLUORO (Fluorometer), PAR (PAR), SPAR (Surface PAR), and HAARDT (Haardt Fluorometer CDOM) parameter 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.*

Bottle Data

Description of 32H1HLY0201_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
#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
CTDOXY	UMOL/KG	F9.1	CTD oxygen, micromoles/kilogram
CTDOXY_FLAG_W		I1	CTDOXY quality flag
CTDOXY	ML/L	F9.3	CTD oxygen, milliliters/liter
CTDOXY_FLAG_W		I1	CTDOXY quality flag
OXYGEN	UMOL/KG	F9.1	bottle oxygen
OXYGEN_FLAG_W		I1	OXYGEN quality flag
OXYGEN	ML/L	F9.3	bottle oxygen, milliliters/liter
OXYGEN_FLAG_W		I1	OXYGEN quality flag
O2TEMP	DEGC	F6.1	Temperature of water from spigot during oxygen draw, degrees C
O2TEMP_FLAG_W		I1	O2TEMP 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
NH4	UMOL/KG	F9.2	AMMONIUM, micromoles/kilogram
NH4_FLAG_W		I1	NH4 quality flag
NH4	UMOL/L	F9.2	AMMONIUM, micromoles/liter
NH4_FLAG_W		I1	NH4 quality flag
UREA	UMOL/KG	F9.2	UREA, micromoles/kilogram
UREA_FLAG_W		I1	UREA quality flag
UREA	UMOL/L	F9.2	UREA, micromoles/liter
UREA_FLAG_W		I1	UREA quality flag
FLUORO	VOLTS	F8.3	Fluorometer, voltage
FLUORO_FLAG_W		I1	Fluorometer quality flag
PAR	VOLTS	F8.3	PAR, voltage
PAR_FLAG_W		I1	PAR quality flag
SPAR	VOLTS	F8.3	Surface PAR, voltage
SPAR_FLAG_W		I1	Surface PAR quality flag
HAARDT	VOLTS	F8.3	CDOM Fluorometer, voltage
HAARDT_FLAG_W		I1	CDOM Fluorometer quality flag
N**	UMOL/L	F9.2	N**, micromoles/liter
N**_FLAG_W		I1	N** quality flag
CHLORO	UG/L	F8.2	Chlorophyll, micrograms/liter
CHLORO_FLAG_W		I1	Chlorophyll quality flag
PHAEO	UG/L	F8.2	Phaeophytin, micrograms/liter
PHAEO_FLAG_W		I1	Phaeophytin quality flag
BTL_DEP	METERS	F5.0	bottle depth, meters
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 Flags

CTD data quality flags were assigned to CTDPRS (CTD pressure), CTDTMP (CTD temperature), CTDCOND (CTD Conductivity), and CTDSAL (CTD salinity) as defined in Data Distribution, CTD Data, Quality Flags section of this document. CTDOXY (CTD O_2), FLUORO (Fluorometer), PAR (PAR), and SPAR (Surface PAR) parameters are flagged with either a 2, acceptable or 9, not drawn.

Bottle quality flags were assigned to the BTLNBR (bottle number) as defined in the WOCE Operations Manual [Joyce] with the following additional interpretations:

2 No problems noted.

3 Leaking. *An air leak large enough to produce an observable effect on a sample is identified by a flag of 3 on the bottle and a flag of 4 on the oxygen. (Small air leaks may have no observable effect, or may only affect gas samples.)*

4 Did not trip correctly. *Bottles tripped at other than the intended depth were assigned a flag of 4. There may be no problems with the associated water sample data.*

9 The samples were not drawn from this bottle.

WHP water sample quality flags were assigned to the water samples using the following criteria:

1 The sample for this measurement was drawn from the water bottle, but the results of the analysis were not (*yet*) received.

2 Acceptable measurement.

3 Questionable measurement. *The data did not fit the station profile or adjacent station comparisons (or possibly CTD data comparisons). No notes from the analyst indicated a problem. The data could be acceptable, but are open to interpretation.*

4 Bad measurement. *The data did not fit the station profile, adjacent stations or CTD data. There were analytical notes indicating a problem, but data values were reported. Sampling and analytical errors were also flagged as 4.*

5 Not reported. *The sample was lost, contaminated or rendered unusable.*

9 The sample for this measurement was not drawn.

Not all of the quality flags are necessarily used on this data set.

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).

Carpenter, J. H., “The Chesapeake Bay Institute technique for the Winkler dissolved oxygen method,” *Limnology and Oceanography*, 10,pp. 141-143 (1965).

Culberson, C. H., Knapp, G., Stalcup, M., Williams, R.T., and Zemlyak, F., “A comparison of methods for the determination of dissolved oxygen in seawater,” Report WHPO 91-2, WOCE Hydrographic Programme Office (Aug 1991).

Gordon, L.I. , Jennings, J.C., Ross, A.A. and J.M. Krest, “A Suggested Protocol for Continuous Flow Automated Analysis of Seawater Nutrients in the WOCE Hydrographic Program and the Joint Global Ocean Fluxes Study”. 1993. WOCE Hydrographic Programs Office, Methods Manual WHPO 91-1.

Gruber, N. and J.L. Sarmiento, “Global patterns of marine nitrogen fixation and denitrification.” *Global Biogeochem. Cycles,* 11(2), pp. 235-266, (1997).

Intergovernmental Oceanographic Commission, Scientific Committee on Oceanic Research Manual and Guides 29 Protocols for the Joint Global Ocean Flux Study (JGOFS) Core Measurements. UNESCO, 170pp., 1994.

Joyce, T. ed., and Corry, C. ed., “Requirements for WOCE Hydrographic Programme Data Reporting,” Report WHPO 90-1, WOCE Report No. 67/91 3.1,. pp. 52-55, WOCE Hydrographic Programme Office, Woods Hole, MA, USA (May 1994, Rev. 2), UNPUBLISHED MANUSCRIPT

Patton, C.J. and Crouch, S.R., “Spectrophotometric and kinetics investigation of the Berthelot reaction for the determination of ammonia,” *Analytical Chemistry*, 49(3), pp.464-469 1977.

Sea-Bird Electronics, Inc, CTD Data Acquisition Software Manual, March 2001

Sea-Bird Electronics, Inc., CTD Operating and Repair Manual, February 2002

APPENDIX A Station Tabulation

USCGC HEALY HLY-02-01 SBI Process 1 5-May-2002 to 15-June-2002

CAST TYPE:

- ROS= Hydrographic
- BIO= Bio-Markers
- PRO= Productivity
- RAD= Radium
- ZOO= Zooplankton
- CTD= CTD only, no samples

Station Number	Cast Number	Date	Cast Type	Latitude	Longitude	Time	Bottom Depth	Distance Above Bottom	Maximum Sampling Depth Bottle	Maximum Sampling Depth CTD	Remarks
0	1	8-May-2002	ROS	64 59.01 N	169 07.66 W	1917	47	5	42	42	
0	2	8-May-2002	BIO	65 00.79 N	169 03.04 W	2232	21	8	13	41	
0	3	9-May-2002	ROS	65 01.91 N	169 03.06 W	0027	49	6	43	43	
1	1	10-May-2002	ROS	67 27.47 N	168 53.10 W	0601	49	3	45	45	
1	2	10-May-2002	RAD	67 28.85 N	168 49.84 W	0844	49	7	42	42	
1	3	10-May-2002	BIO	67 30.40 N	168 45.72 W	1357	49	37	12	12	
1	4	10-May-2002	PRO	67 30.37 N	168 52.47 W	1718	50	33	17	17	
2	1	12-May-2002	ROS	70 37.96 N	167 27.50 W	1846	50	4	46	46	
2	2	12-May-2002	BIO	70 38.23 N	167 24.59 W	2109	51	9	42	42	
2	3	12-May-2002	RAD	70 38.34 N	167 23.39 W	2235	51	10	41	41	
3	1	14-May-2002	ROS	71 55.09 N	166 15.25 W	1635	45	3	42	42	
3	2	14-May-2002	CTD	71 53.95 N	166 10.18 W	1955	45	9	36	36	
3	3	14-May-2002	PRO	71 53.39 N	166 07.96 W	2125	45	8	36	36	
3	4	14-May-2002	RAD	71 52.68 N	166 05.26 W	2324	45	4	41	41	
4	1	15-May-2002	PRO	71 37.02 N	165 59.99 W	1919	43	7	36	36	
5	1	17-May-2002	ROS	72 42.44 N	161 14.28 W	0454	50	4	46	46	
5	2	17-May-2002	RAD	72 42.72 N	161 14.32 W	0650	48	2	46	46	
6	1	17-May-2002	PRO	72 55.22 N	160 31.26 W	1721	71	11	60	60	
6	2	17-May-2002	ROS	72 55.27 N	160 30.63 W	1851	73	4	69	69	
6	3	18-May-2002	RAD	72 53.78 N	160 34.84 W	0213	62	3	56	59	
7	1	18-May-2002	ROS	73 02.16 N	160 23.05 W	0849	164	3	161	161	
7	2	18-May-2002	RAD	73 01.88 N	160 25.74 W	1350	151	4	96	147	
7	3	18-May-2002	RAD	73 01.86 N	160 27.09 W	1520	149	5	144	144	
7	4	18-May-2002	PRO	73 01.98 N	160 28.76 W	1716	149	5	140	144	
8	1	19-May-2002	ROS	73 14.81 N	160 00.48 W	0210	548	6	542	543	
8	2	19-May-2002	RAD	73 15.23 N	160 03.71 W	0443	691	-99	249	249	
8	3	19-May-2002	RAD	73 15.52 N	160 05.34 W	0601	-999	-99	139	249	

CAST TYPE:
ROS= Hydrographic
BIO= Bio-Markers
PRO= Productivity
RAD= Radium
ZOO= Zooplankton
CTD= CTD only, no samples

Station Number	Cast Number	Date	Cast Type	Latitude	Longitude	Time	Bottom Depth	Distance Above Bottom	Maximum Sampling Depth Bottle	Maximum Sampling Depth CTD	Remarks
9	1	19-May-2002	PRO	73 16.90 N	160 07.59 W	1843	1151	-99	60	102	
9	2	19-May-2002	ZOO	73 17.66 N	160 09.82 W	2033	1173	-99	12	12	
9	3	19-May-2002	ROS	73 18.62 N	160 12.04 W	2247	1150	8	1142	1144	
9	4	20-May-2002	ROS	73 19.45 N	160 13.28 W	0054	1211	-99	202	202	
9	5	20-May-2002	BIO	73 20.22 N	160 14.80 W	0303	1160	171	990	997	
9	6	20-May-2002	RAD	73 20.56 N	160 21.31 W	0611	1176	-99	101	252	
9	7	20-May-2002	RAD	73 21.06 N	160 22.24 W	0728	1163	-99	200	252	
10	1	20-May-2002	PRO	73 26.93 N	159 50.17 W	1927	1894	-99	100	101	
10	2	20-May-2002	ROS	73 25.86 N	159 44.32 W	2221	1950	-99	202	203	
10	3	21-May-2002	ROS	73 26.37 N	159 44.92 W	0050	1918	8	1908	1910	
10	4	21-May-2002	BIO	73 26.57 N	159 45.66 W	0324	1927	-99	502	504	
10	5	21-May-2002	RAD	73 26.58 N	159 46.52 W	0453	1919	-99	199	252	
10	6	21-May-2002	RAD	73 26.62 N	159 47.39 W	0613	1908	-99	100	259	
11	1	21-May-2002	PRO	73 36.66 N	159 33.39 W	1835	2516	-99	-999	-999	CTD Data lost
11	2	21-May-2002	PRO	73 36.48 N	159 34.44 W	1920	2524	-99	100	100	
11	3	22-May-2002	ROS	73 44.68 N	158 57.13 W	0349	3057	19	3038	3038	
11	4	22-May-2002	ROS	73 45.05 N	158 58.81 W	0646	3125	-99	200	302	
11	5	22-May-2002	RAD	73 45.40 N	159 00.59 W	0850	3124	-99	249	252	
11	6	22-May-2002	BIO	73 45.64 N	159 01.44 W	0953	3124	-99	149	252	
12	1	23-May-2002	ROS	73 26.34 N	157 32.34 W	1106	2850	19	2831	2832	
12	2	23-May-2002	ROS	73 26.60 N	157 33.30 W	1348	2834	-99	228	247	
12	3	23-May-2002	PRO	73 26.85 N	157 34.17 W	1655	2857	-99	140	142	
12	4	23-May-2002	RAD	73 27.01 N	157 35.09 W	1848	2852	-99	253	253	
12	5	23-May-2002	BIO	73 27.32 N	157 36.70 W	2106	2808	-99	2461	2499	
12	6	23-May-2002	RAD	73 27.94 N	157 38.65 W	2356	2809	-99	46	252	
12	7	24-May-2002	RAD	73 28.21 N	157 39.23 W	0105	2855	-99	218	253	
13	1	24-May-2002	PRO	73 20.21 N	158 11.31 W	1824	2379	-99	100	502	
14	1	25-May-2002	ROS	73 05.91 N	158 09.15 W	0426	2140	8	2133	2134	
14	2	25-May-2002	ROS	73 05.58 N	158 09.91 W	0703	2150	-99	224	302	
14	3	25-May-2002	RAD	73 05.46 N	158 10.60 W	0851	2138	-99	299	302	
14	4	25-May-2002	PRO	73 05.77 N	158 12.43 W	1636	2163	-99	149	152	
14	5	25-May-2002	RAD	73 05.68 N	158 12.66 W	1817	2157	-99	249	256	
14	6	25-May-2002	RAD	73 05.62 N	158 13.07 W	1931	2152	-99	150	267	

CAST TYPE:
ROS= Hydrographic
BIO= Bio-Markers
PRO= Productivity
RAD= Radium
ZOO= Zooplankton
CTD= CTD only, no samples

Station Number	Cast Number	Date	Cast Type	Latitude	Longitude	Time	Bottom Depth	Distance Above Bottom	Maximum Sampling Depth Bottle	Maximum Sampling Depth CTD	Remarks
15	1	26-May-2002	CTD	73 02.14 N	157 56.33 W	1005	2031	-99	-999	498	
16	1	27-May-2002	ROS	72 52.50 N	158 16.67 W	0031	1080	45	1035	1037	
16	2	27-May-2002	ROS	72 51.54 N	158 17.55 W	0305	993	-99	200	299	
16	3	27-May-2002	BIO	72 51.97 N	158 19.29 W	0507	1086	-99	595	601	
16	4	27-May-2002	RAD	72 52.23 N	158 20.53 W	0639	1068	-99	297	303	
16	5	27-May-2002	RAD	72 52.36 N	158 21.29 W	0738	1017	-99	253	254	
17	1	27-May-2002	PRO	72 51.05 N	158 29.35 W	1752	424	-99	139	202	
17	2	27-May-2002	ZOO	72 50.89 N	158 30.45 W	1940	398	-99	31	102	
17	3	27-May-2002	ROS	72 51.98 N	158 33.60 W	2134	437	8	429	430	
17	4	27-May-2002	BIO	72 51.85 N	158 35.10 W	2340	407	159	248	303	
17	5	28-May-2002	RAD	72 51.79 N	158 35.95 W	0052	406	-99	135	252	
17	6	28-May-2002	RAD	72 51.75 N	158 36.90 W	0214	381	129	253	254	
18	1	28-May-2002	ROS	72 44.73 N	158 36.98 W	1538	229	3	226	227	
18	2	28-May-2002	ROS	72 44.61 N	158 37.12 W	1648	229	3	226	227	
18	3	28-May-2002	PRO	72 44.42 N	158 37.39 W	1846	226	106	119	123	
18	4	29-May-2002	RAD	72 44.99 N	158 42.90 W	0141	217	3	214	214	
18	5	29-May-2002	RAD	72 45.18 N	158 44.11 W	0248	216	57	159	206	
19	1	29-May-2002	PRO	72 36.36 N	158 45.36 W	1629	90	9	81	81	
19	2	29-May-2002	ROS	72 36.44 N	158 47.53 W	1802	86	6	81	81	
19	3	29-May-2002	RAD	72 36.39 N	158 50.11 W	1955	75	6	69	70	
20	1	30-May-2002	CTD	72 27.51 N	159 26.87 W	0820	49	4	46	46	
21	1	30-May-2002	CTD	72 20.41 N	159 42.89 W	1114	48	4	44	44	
22	1	30-May-2002	PRO	72 14.57 N	159 47.34 W	1621	46	3	43	43	
22	2	30-May-2002	ZOO	72 14.53 N	159 48.54 W	1747	45	3	18	42	
22	3	30-May-2002	ROS	72 14.48 N	159 49.48 W	1856	46	3	43	43	
22	4	30-May-2002	RAD	72 14.39 N	159 51.21 W	2053	46	4	42	42	
22	5	31-May-2002	BIO	72 14.35 N	159 59.75 W	0502	44	42	2	36	
23	1	1-Jun-2002	PRO	71 24.35 N	158 07.59 W	1652	92	4	85	88	

CAST TYPE:

ROS= Hydrographic
BIO= Bio-Markers
PRO= Productivity
RAD= Radium
ZOO= Zooplankton
CTD= CTD only, no samples

Station Number	Cast Number	Date	Cast Type	Latitude	Longitude	Time	Bottom Depth	Distance Above Bottom	Maximum Sampling Depth Bottle	Maximum Sampling Depth CTD	Remarks
24	1	2-Jun-2002	ROS	71 48.78 N	155 41.09 W	1535	103	3	99	100	
24	2	2-Jun-2002	PRO	71 49.15 N	155 42.87 W	1752	107	3	95	104	
24	3	2-Jun-2002	ZOO	71 49.22 N	155 43.54 W	1910	99	17	81	82	
24	4	2-Jun-2002	RAD	71 49.27 N	155 44.44 W	2106	97	5	92	92	
25	1	3-Jun-2002	CTD	71 43.00 N	155 24.89 W	0658	188	4	-999	184	
26	1	3-Jun-2002	PRO	71 33.29 N	154 33.66 W	1615	37	8	28	30	
27	1	4-Jun-2002	ROS	71 29.69 N	153 53.91 W	0746	50	2	45	48	
27	2	4-Jun-2002	ZOO	71 29.69 N	153 53.92 W	0931	49	5	11	44	
27	3	4-Jun-2002	RAD	71 29.66 N	153 53.95 W	1029	49	4	33	45	
28	1	4-Jun-2002	PRO	71 42.33 N	154 13.13 W	1626	51	5	46	46	
29	1	4-Jun-2002	ROS	71 46.75 N	154 24.10 W	2001	121	4	118	118	
30	1	5-Jun-2002	ROS	71 49.97 N	154 37.51 W	0026	181	4	176	176	
31	1	5-Jun-2002	ROS	71 55.68 N	154 49.31 W	0430	399	6	393	392	
31	2	5-Jun-2002	BIO	71 55.68 N	154 49.87 W	0623	420	168	209	252	
31	3	5-Jun-2002	RAD	71 55.68 N	154 50.28 W	0738	456	153	303	303	
31	4	5-Jun-2002	RAD	71 55.69 N	154 50.62 W	0837	496	199	199	296	
31	5	5-Jun-2002	PRO	71 56.94 N	154 56.00 W	1802	342	6	139	336	
32	1	6-Jun-2002	ROS	72 04.35 N	154 27.99 W	0150	1311	10	1300	1302	
32	2	6-Jun-2002	ROS	72 04.98 N	154 28.65 W	0431	1464	-99	174	203	No samples
32	3	6-Jun-2002	BIO	72 05.46 N	154 28.14 W	0606	1475	-99	301	301	
32	4	6-Jun-2002	RAD	72 05.79 N	154 28.71 W	0722	1520	-99	175	253	
32	5	6-Jun-2002	RAD	72 06.08 N	154 29.02 W	0831	1554	-99	252	252	
32	6	6-Jun-2002	ROS	72 06.35 N	154 29.29 W	0937	1578	-99	169	202	
32	7	6-Jun-2002	PRO	72 07.59 N	154 29.28 W	1624	1674	-99	140	201	
32	8	6-Jun-2002	ZOO	72 07.81 N	154 29.18 W	1852	1690	-99	51	52	
33	1	7-Jun-2002	ROS	72 11.24 N	154 23.77 W	0759	1805	10	1795	1795	
33	2	7-Jun-2002	ROS	72 11.22 N	154 22.49 W	1031	1910	-99	199	302	
33	3	7-Jun-2002	RAD	72 11.39 N	154 21.36 W	1219	1958	-99	165	304	
33	4	7-Jun-2002	RAD	72 11.48 N	154 20.23 W	1332	1995	-99	301	301	
33	5	7-Jun-2002	BIO	72 11.49 N	154 18.90 W	1452	2066	-99	1579	1599	
33	6	7-Jun-2002	PRO	72 11.36 N	154 17.41 W	1642	2132	-99	140	192	
33	7	7-Jun-2002	ZOO	72 11.15 N	154 16.64 W	1803	1975	-99	11	11	

CAST TYPE:

ROS= Hydrographic
BIO= Bio-Markers
PRO= Productivity
RAD= Radium
ZOO= Zooplankton
CTD= CTD only, no samples

Station Number	Cast Number	Date	Cast Type	Latitude	Longitude	Time	Bottom Depth	Distance Above Bottom	Maximum Sampling Depth Bottle	Maximum Sampling Depth CTD	Remarks
34	1	8-Jun-2002	PRO	72 32.06 N	154 29.97 W	1837	2936	-99	139	201	
34	2	8-Jun-2002	ROS	72 32.84 N	154 33.34 W	2215	2928	17	2911	2911	
34	3	9-Jun-2002	ROS	72 33.32 N	154 34.28 W	0119	2929	-99	223	302	
34	4	9-Jun-2002	BIO	72 33.54 N	154 34.44 W	0311	2922	-99	495	603	
34	5	9-Jun-2002	RAD	72 33.61 N	154 34.54 W	0422	2920	-99	101	303	
34	6	9-Jun-2002	RAD	72 33.63 N	154 34.71 W	0523	2907	-99	199	303	
35	1	10-Jun-2002	ROS	72 11.05 N	155 02.88 W	0039	1012	2	1007	1010	
36	1	10-Jun-2002	PRO	71 53.57 N	155 40.18 W	1651	125	12	101	113	
37	1	11-Jun-2002	ROS	71 39.03 N	155 45.51 W	0351	183	3	179	180	
37	2	11-Jun-2002	BIO	71 39.00 N	155 45.79 W	0539	176	24	150	152	
37	3	11-Jun-2002	RAD	71 38.98 N	155 45.83 W	0641	179	6	149	172	
37	4	11-Jun-2002	RAD	71 38.96 N	155 45.83 W	0739	176	9	149	167	
38	1	12-Jun-2002	ZOO	71 33.00 N	156 12.02 W	0104	168	8	19	160	
39	1	12-Jun-2002	ROS	71 24.22 N	157 11.22 W	1351	119	4	114	115	
39	2	12-Jun-2002	ROS	71 24.38 N	157 11.41 W	1607	122	22	99	99	
39	3	12-Jun-2002	RAD	71 24.49 N	157 11.50 W	1744	122	7	100	115	

APPENDIX A: Bottle Quality Comments

Remarks for deleted samples, missing samples, PI data comments, and WOCE codes other than 2 from SBI Process HLY-02-01. 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 Ammounium, if appropriate. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 000.001

104 SampleLog: "Leaking report by DOC/DON." Data is acceptable.

105 Possible problems in oxygen analyses, new reagents, high room T, etc. Oxygen looks high relative to CTD. Code oxygen bad.

108 SampleLog: "Bottle leaked." Data is acceptable.

109 Possible problems in oxygen analyses, new reagents, high room T, etc. Oxygen looks high, lab temp high, possible bubbles in reagents. Code oxygen bad. Sample Log: "Air leak (leak with valve open, air vent closed)." Data is acceptable.

112 Sample Log: "Large spigot difficult to line up vertical orientation." Data is acceptable.

Station 000.003

301 SampleLog: "Bottle did not trip." Code bottle did not trip as scheduled.

Station 001.001

101-112 Sample Log: "Yo Yoed bottles to encourage flushing." Data are acceptable.

108 Samplelog: "Bottle did not trip." Code bottle did not trip as scheduled.

109 Samplelog: "Air leak, airvent not closed." Data are acceptable.

Station 001.003

308 Samplelog: "Bottle leaked." Data is acceptable.

Station 001.004

401 Samplelog: "No trip." Code bottle did not trip as scheduled.

406 Samplelog: "Slight drip." Data are acceptable.

Station 002.001

103-110 Salinity was not drawn.

111 Samplelog: "Collar cracked on small spigot." Data are acceptable.

112 Salinity has not drawn.

Station 002.002

209 Samplelog: "Bottle had a slight leak." Data are acceptable.

Station 002.003

301 Samplelog: "Bottle did not trip." Code bottle did not trip as scheduled.

Station 003.001

101-112 Sample log: "Gantry broke, took > 10 min to get rosette in bay." Water froze in bottles so aborted O2 and salt per PI. Salinity was not drawn.

Station 003.004

401 Samplelog: "Slight leak." Bottle and samples are acceptable.

407 Samplelog: "Slight leak." Bottle and samples are acceptable.

Station 004.001

401-412 Sample log: "Ship had to maneuver during cast." Data are acceptable.
406 Samplelog: "Leaking - reported by CHL." Bottle and samples are acceptable.
Station 005.001
109 Samplelog: "Loose vent leaking." Data are acceptable.
Station 006.001
101 SampleLog: "Small leak." Data are acceptable.
101-112 Sample Log: "Did not yo-yo bottles for flush. Bottles were soaked at trip depth for 1 min. Salts taken to check flushing." Data are acceptable.
103 SampleLog: "Leaked form spigot when vented." Data are acceptable.
112 SampleLog: "Leak when top vent cracked, from bottom cap." Data are acceptable.
Station 006.002
204 Samplelog: "O2 redrawn." Oxygen is acceptable.
208 Samplelog: "Salt big spigot." Salinity is acceptable.
Station 007.003
301-312 Salinity differences high and variable, very high gradients. Leave as is.
Station 007.004
401-412 Sample log: "Did not "yo-yo" on prod cast."
Station 008.001
112 Samplelog: "Cut bottom O-ring." Data are acceptable.
Station 008.002
201-212 No salts drawn.
Station 009.003
309 Samplelog: "Slight leak." Data are acceptable.
Station 009.004
404 Samplelog: "Bottle large spigot dripping." Data are acceptable.
Station 010.001
108 SampleLog: "Small leak on small spigot before venting." Data are acceptable.
Station 010.002
101-112 Salinity was not drawn.
Station 010.004
407 SampleLog: "Leak." Data are acceptable.
Station 010.005
501 SiO3questionable, possibly lower precision, molybdate problems."
507 Samplelog: "mistripped at 200m - operator error." Data are acceptable.
508 Sample Log: "First at 150m." Data are acceptable. SiO3 questionable, possibly lower precision, molybdate problems."
Station 010.006
603 SiO3questionable, possibly lower precision, molybdate problem.
610 SiO3questionable, possibly lower precision, molybdate problems.
Station 011.002
201 SiO3questionable due to baseline issues. NH4 questionable due to baseline issues.
203-204 SiO3 questionable due to baseline issues. NH4 questionable due to baseline issues.
208-209 SiO3 questionable due to baseline issues. NH4 questionable due to baseline issues.
211-212 SiO3 questionable due to baseline issues. NH4 questionable due to baseline issues.
Station 011.003
307 Samplelog: "Slight leak." Data are acceptable.

309 Samplelog: "Leaks." Data are acceptable.
Station 011.004
407 Samplelog: "Slight drip from spigot on venting." Data are acceptable.
Station 012.001
103 Sample Log: "Repaired with new PVC patches to cover bolts to replace old white patches before this cast during a 10 hr down period." Data are acceptable.
104 Sample Log: "Leaking from bottom endcap- large leak. O-ring changed after cast." Data are acceptable.
106 Samplelog: "See 106 comment." Data are acceptable.
Station 012.004
401 Autoanalyzer error, NH4 lost.
403 Autoanalyzer error, NH4 lost.
404 SampleLog: "Leaking." Data are acceptable.
Station 012.007
702 Nutssample originally reported as from NB 4 in HYDNU file
708 Nutssample originally reported as from cast 6 in HYDNU file
Station 014.001
101 Sample log: "Cap on O2 flask 1161 slightly loose when reshaken. Oxygen is acceptable.
104 Phosphate in this sample looks a little high. No obvious problem. Leave as is.
107 Samplelog: "Slight leak." Data are acceptable.
109 Samplelog: "Slight leak." Data are acceptable.
Station 014.002
201-212 Salinity was not drawn.
212 Samplelog: "Air leak (Probable cause- loose air vent)." Data are acceptable.
Station 015.001
101-112 No water samples were taken.
Station 016.001
101 SampleLog: "Tiny leak from spigot." Data are acceptable.
104 SampleLog: "Bottom leak." Data are acceptable.
106 SampleLog: "Big time leak- vent open." Data are acceptable.
107 SampleLog: "Small leak." Data are acceptable.
108 SampleLog: "Tiny leak." Data are acceptable.
109 SampleLog: "Vent leak also." Data are acceptable.
Station 016.002
101 SampleLog: "Slight leak in spigot." Data are acceptable.
101-108 Salinity was not drawn.
107 SampleLog: "Slight leak." Data are acceptable.
109 SampleLog: "Slight leak." Data are acceptable.
Station 016.004
405 First bottle tripped in series of 8 bottles. CTD salinity different by 0.011 from subsequent trips. Possibly incomplete flushing at time of first trip. Leave as is.
Station 017.001
101-112 Sample log: "Not enough water for dup Chl." Data appear acceptable.
Station 017.003
301 Silicate is anomalously high. No apparent errors in analyses, processing, etc. Leave as is for now. Phosphate seems a little high. See comments for silicate.

301-312 Autoanalyzer error, urea lost.
309 Samplelog: "Significant leak with vent closed." Data are acceptable.
Station 017.004
401-412 Autoanalyzer error, urea lost.
Station 017.006
603 Autoanalyzer error, urea lost.
608 Samplelog: "No water from Bottle 8- Spout fell off."
611 Autoanalyzer error, urea lost.
Station 018.001
101-112 Sample Log: "Cast aborted on way up because an ice floe made it unsafe to continue the cast."
Station 018.002
201-212 PAR sensor cap was left on. No PAR data. Autoanalyzer error, urea lost.
Station 018.003
310 NH4value high, AA peak is normal. Contamination? Code NH4 questionable. Urea value high, AA peak is normal. Contamination? Code urea questionable.
Station 019.001
109 SampleLog: "Air leak, O2 redrawn." Oxygen is acceptable.
Station 019.002
202 Samplelog: "Empty after Pb210." Data are acceptable.
Station 022.001
104 Samplelog: "Leaking from bottom on vent, bottom did not seat." Data are acceptable.
Station 022.002
204 Samplelog: "Leaking, spewing on venting. Did not reseat this time."
Station 022.003
301 Sample log: "Leaking from spigot, flowing when vented. Air leak at top." Data are acceptable.
Station 024.002
201 Sample log: "Nuts drew before O2 (should not be a problem)." Oxygen is acceptable.
210 Samplelog: "Leak from bottom end cap after o2 draw." Data are acceptable.
Station 024.003
301 Autoanalyzer error, NH4 lost.
Station 024.004
405 Autoanalyzer error, NH4 lost.
Station 026.001
101-112 Bottles were tripped off by 1; 2 was deep, 1 was shallow.
Station 027.001
101 Samplelog: "Only 14 liters on (Cesium sample, by R. Nelson)."
101-112 Bottles were tripped off by 1; 2 was deep, 1 was shallow." Data are acceptable as reported.
Station 029.001
101 SampleLog: "Leaking with air vent closed - heavy leak." Data are acceptable.
110 SampleLog: "Small leak from bottom cap." Data are acceptable.
Station 030.001
101 SampleLog: "Leaking (Strong Leak)." Data are acceptable.
Station 031.001

101 SampleLog: "Still leaking - check bolts." Data are acceptable.
Station 032.001
101 Sample Log: "spigot - vent leak." (NOTE: following this cast, ODF bottle 1 was replaced with USCG bottle 9. The ODF bottle was found to have cracks in area of bolts to metal backplate.) Data are acceptable.
102 SampleLog: "Bottom cap- check." Data are acceptable.
107 SampleLog: "Spigot - vent small leak." Data are acceptable.
Station 032.004
406 Autoanalyzer error, urea lost.
412 Autoanalyzer error, urea lost.
Station 032.005
503 Autoanalyzer error, urea lost.
507 Autoanalyzer error, urea lost.
Station 032.006
601-612 Autoanalyzer error, urea lost.
609 SampleLog: "Air vent left open." Data are acceptable.
Station 032.008
808 SampleLog: "Top valve was not closed." Data are acceptable.
Station 033.001
101-112 Sample Log: "Jellyfish on rosette; pulled strings off 1 and 12." Data are acceptable.
Station 033.007
705 Sample Log: "Leaking from bottom. Nuts drawn first; was not leaking then." Data are acceptable.
Station 034.003
308 SampleLog: "Small spigot hole small drip." Data are acceptable.
Station 034.004
101-112 PAR sensor cap was left on. No PAR data.
Station 035.001
101-112 Autoanalyzer error, urea lost. Salinity was not drawn.
Station 036.001
101 Samplelog: "Bact opened bottle before O2 drawn." Oxygen is acceptable.
101-110 Autoanalyzer error, urea lost.
Station 037.001
101-112 Sample log: "Ship maneuvering before cast - ice. Rushed though tripping a bit last 2-3 bottles - ice, but yo-yoed." Data are acceptable. Autoanalyzer error, urea lost.
Station 037.003
301-302 Autoanalyzer error, urea lost.
311-312 Autoanalyzer error, urea lost.
Station 037.004
406-407 Autoanalyzer error, urea lost.
Station 039.001
101-112 Autoanalyzer error, urea lost.
110 Samplelog: "Leaking after O2 draw, reseated then stopped." Data are acceptable.
Station 039.002
203-212 Autoanalyzer error, urea lost.
Station 039.003

301 Autoanalyzer error, urea lost.
312 Autoanalyzer error, urea lost.

ADDENDUM

Additional Precision and Accuracy Notes for Nutrient and Dissolved Oxygen Data: 2002 SBI (Western Arctic Shelf Basin Interactions) Process Experiment Cruises (HLY 02-01 & HLY 02-03)

L.A. Codispoti[1, *]

[1]University of Maryland Center for Environmental Sciences, P.O. Box 775, Cambridge, MD 21613, USA, codispot@hpl.umces.edu

Introduction:

This document provides supplementary information about the precision and accuracy of the hydrographic nutrient and dissolved oxygen data collected during the SBI (Western Arctic Shelf-Basin Interactions) 2002 process cruises (HLY 02-01, HLY 02-03). The material herein supplements comments submitted with the Service Team Activity Reports for cruises HLY 02-01 and HLY 02-03, and the comments on methods in Codispoti et al. (2005). The Service Team Activity Report for each cruise discusses the procedures employed, the purity of standards, etc. in considerable detail.

Precision of the Dissolved Oxygen Analyses:

Examination of data from Niskin bottles tripped in mixed surface layers or in layers of uniform concentration suggest that the precision of our results (including sample collection and "pickling" errors) is ~ ± 0.01 ml/l (± 0.45 µM).

Precision of Nutrient Analyses:

Comparisons of nitrite samples drawn from Niskin bottles tripped at the same depth suggests that the within-run precision of the nitrite analyses is better than ± 0.01 µM. Station to station baseline variability could introduce an additional uncertainty of ~ 0.01 µM. During HLY 02-01, determinations of the silicate concentration of a deep water "check" sample during 38 separate autoanalyzer runs over a three week period gave an average of 10.8 µM and a standard deviation of 0.2 µM. During HLY 02-03 two deep water "check" samples were used. The first lasted almost one month, and the average of 72 runs was 10.2 µM. with a standard deviation of 0.2 µM. The second was used for ~ one week, and the average value over 17 runs was 10.0 µM with a standard deviation of 0.1 µM. To estimate run-to-run and cruise-to-cruise precision for nitrate and phosphate, nitrate and phosphate values from 18 samples collected between 2200 – 3300 db where vertical gradients were weak were examined. Seven of these samples were collected during HLY 02-01 and the remaining 11 were collected during HLY 02-03. Since there should be some natural variability and since this comparison includes sampling error, these samples should give a robust estimate of precision. The average nitrate value was 14.77 µM with a standard deviation of 0.13 µM. The average phosphate value was 1.05 µM with a standard deviation of 0.01 µM.

Within-run precision of the ammonium and urea analyses was generally better than ± 0.05 µM, but the accuracy and precision of these methods suffers from, the relative instability of these methods, the labile nature of ammonium and urea, variation in ammonium baselines, and refractive index effects, we suggest that differences of less than ~ 0.2 µM in ammonium and urea concentrations may not be significant. Because the refractive index of sea-water increases linearly with salinity and because there can be salt effects in some analyses, standards were prepared in a low nutrient sea-water matrices with salinities ranging from 30 to 34, depending on the source of the low nutrient sea water. During HLY 02-01, salinities ranged between 29-35, and maximum refractive index errors arising from deviations between matrix salinity and sample salinity would be approximately 0.03 for ammonium, 0.02 µM for nitrate, 0.01 µM for nitrite, 0.01 µM for phosphate, 0.2 µM for silicate, and 0.05 µM for urea. During HLY 02-03 customized refractive index corrections were applied to samples with salinities < 29, so the maximum refractive index errors should be similar for both cruises.

Acknowledgements

These data would not exist were it not for the dedication of the men and women who serve on the USCGC *Healy* and for the leadership of the chief scientists (J.M. Grebmeier and L.W. Cooper). The members of the hydrographic team that produced the data were: Carney Cheng, Emily Cooper, John Gunn, Erik Haberkern, Doug Masten, Robert Palomares, Kristin Sanborn, Dean Stockwell, and Bob Williams. The help provided by Steve Roberts and Greg Stossmeister of the Joint Office for Science Support (JOSS) is also deeply appreciated. Finally, we are grateful for the financial support provided by the Office of Polar Programs at the National Science Foundation *via* Arctic System Science Program grant OPP0125399 to J.H. Swift.

Reference:

Codispoti, L.A., Flagg, C., Kelly, V, Swift, J.H., 2005. Hydrographic conditions during the 2002 SBI process experiments. Deep-Sea Research II 52:3199-3226.