REVISION NOTICE TABLE

DATE	DESCRIPTION OF REVISION
7 Sept. 2010	Based on analyst's recommendation, titrated DO value changed to 0 for samples #1&3, cast #1. G.G.
18-April-2010	Added Lisa Miller's Dissolved Inorganic Carbon and Alkalinity data to the rosette files. J.L.
8 April 2008	DMS data added to CHE files
10 Dec. 2007	Bottle data (CHL and Nutrients) added to casts #25,33,34,41,43 and 54.

PROCESSING NOTES

Cruise: 2007-15
Agency: OSD
Location: North-East Pacific
Project: Line P
Party Chief: Robert M.
Platform: John P. Tully
Date: 14 August 2007 – 1 September 2007
Processed by: Germaine Gatien
Date of Processing: 5 October 2007 – 26 November 2007
Number of original CTD casts: 84 Number of CTD casts processed: 83
Number of bottle casts: 83
Number of bottle casts processed: 78 for archive plus 5 with no rosette sampling
TSG files: 1 Number of TSG casts processed: 1

INSTRUMENT SUMMARY

A SeaBird Model SBE 911+ CTD (#0443) was mounted in a rosette and attached were a Chelsea/Seatech transmissometer (#953), an SBE 43 DO sensor (#1119, on the secondary pump), a Seapoint Fluorometer (#2356) with a 10X cable (on the primary pump), a Biospherical PAR sensor #4656 and an altimeter (#1252). The deck unit was an SBE 11+ model (#0619) and there was a mid-ship winch. Seasave version 7.12 was used. The primary and secondary pumps were 2467 and 051604, respectively. A SeaBird model 21 thermosalinograph (#2116737-2487) was mounted with fluorometer WS3S-713P. An oxygen plug and syringes were used during the whole cruise between CTD casts.

SUMMARY OF QUALITY AND CONCERNS

The CTD and rosette logs were in good order and notes from the chief scientist greatly simplified the processing job.

The calibration drift in this pressure sensor calibration appears to be accelerating. From the offset applied at sea for this cruise, it is presumed that someone did notice that the values at the surface were too low, but there is no record of that in the log book. It would be a big help to the CTD data processor to know if there was a check of surface pressure done at sea. Just entering it in the configuration file is not enough, because that entry is so often wrong that it is not treated as being reliable. Checks are made in processing, but the job would be more efficient if pressure test results were available.

The quality of the salinity comparison is much lower than usual. This may be due to an analysis problem. Outliers occur in batches that seem to be randomly distributed until put in the order in which they were analyzed. There is also a possibility that the presence of salt crystals may account for the scatter. There is no evidence of trouble with particular Niskin bottles. Even at times where there are not large errors, there

is some suggestion that the salinometer may not be performing as expected. When 23 bottles were fired at 2000db during 1 cast, even after 4 outliers were removed the results varied by ±0.002 and the outliers seemed randomly distributed. Fortunately there was a post-cruise calibration of the secondary salinity sensor which is compatible with the comparison with bottles, when many outliers were excluded.

It was very useful that the salinity analysis was done in a fairly random order so that we could separate sampling problems from analysis problems. It is recommended that this be done regularly.

Chemistry files were prepared for casts #2, 9, 29, 36 and 52 but there were no bottle data available; they are for the use of researchers from other institutions who gathered the samples. These files will not be archived.

There were patches of bad temperature and conductivity data (in both sensor pairs) below 900db for casts #9 through 17 (only the upcast was affected for #9). Similar problems were seen during 2007-13. In both cases the problem disappeared after a pump cable was replaced. The problem appears to have caused an interruption in the flow to the sensors in both downcasts and upcasts. Most of the bad data were seen clearly in editing and were removed, but some may remain undetected in high local gradients. For a fuller description of the problem see APPENDIX II of the cruise processing report 2007-13-proc.doc.

The salinity data are noisier than usual in areas of high temperature gradients, with small spikes (typically ~0.02); this is mostly two-sided noise so metre-averaging should minimize the error.

The altimetry was bad for many casts with sections of low values when the package was at least 1000m off the bottom. All altimeter header entries were examined and suspicious ones were removed. The near-shore casts did not have such noise, so the problem is presumed to be due to the presence of a weight, or some other adjustment to the rosette package in the offshore region, and not a malfunction of the altimeter.

Comments in the dissolved oxygen ADD files need to be preceded by the line *COMMENTS or they will not be included in the final chemistry files.

The dissolved oxygen data in the CTD files should be considered

- *±0.6ml/l from 0 –200db.*
- *±0.4ml/l from 200 to 400db; data tend to be somewhat high in this high gradient region.*
- *±0.2ml/l below 400.*
- *data below 500db tend to be low.*
- *data below 1000db are considered unreliable by the manufacturer.*

There were many loop samples and CTD casts with which to recalibrate the thermosalinograph data. The comparisons suggest that there was a sudden drop in salinity values between P24 and P35, so a different recalibration was applied to the sections before and after the shift. The thermosalinograph intake thermistor malfunctioned. Channel Temperature:Primary was prepared as a proxy for the intake temperature, by subtracting 0.14C° from the lab temperature, based on an estimate of the temperature change in the loop due to heating by the ship. The comparison of thermosalinograph salinity with loop samples and CTD data showed a lot of scatter especially after the shift in calibration, so TSG salinity should be considered ±0.02 up to 1:40 UTC on August 22, 2007 and ±0.15 after that time. The chief scientist noted that there problems with bubbles in the system and there are occasional notes in the log about the TSG having an airspace.

PROCESSING SUMMARY

1. Seasave

This step was completed at sea; the raw data files have extension HEX; this is a recent change with a newer version of SeaSave (in the past the output files were DAT.) File names were corrected for casts #10 through 14 (extra 0 removed) and files labelled for cast 100 were changed to 101.

2. Preliminary Steps

The Log Book was obtained together with rosette log sheets, a cruise report and notes from the chief scientist on particular issues that would affect the processing job. There are a number of problems noted including transmissivity spikes and occasional drift in CTD temperature and salinity values that suddenly revert to expected values which is likely due to pump problems.

Titrated chlorophyll, nutrients and salinity data were obtained in spreadsheet format.
The oxygen files were provided in individual ADD files.

The cruise summary sheet was completed.
The histories of the conductivity, DO and pressure sensors were obtained.

The calibration constants were checked for all instruments. The only error is that the pressure sensor has an offset of 5 entered. This is larger than has been found appropriate on recent cruises. It was changed to 3.8 but can be checked later to ensure that is appropriate. The new file was named 2007-15-ctd.con.

The PAR sensor was left in the configuration file even when taken off for deep casts (on for only 1-4, 6, 8, 22, 28, 35, 47, 51, 54 and 55). At the REMOVE stage PAR should be removed from all other casts.

3. Conversion of Raw Data

Data were converted using the configuration files as listed above. PAR was converted for all the CTD casts – where it was not mounted the channel will be removed later. After conversion corrections were made to station names based on the chief scientist's notes.

A few casts were examined and all expected channels are present. The upcast primary temperature and conductivity traces have excursions (~0.1C˚ and 0.005S/m) towards low values; these features are on the order of 1 or 2m in extent. This is not seen in the downcasts. The transmissivity has many small spikes but there is little obvious hysteresis, but for some of the later casts there are large segments of zero values in both the downcasts and upcasts.

The altimetry looks useful near the bottom of the casts. PAR data look fine and DO data have the usual hysteresis. Fluorescence looks ok with dark values on the order of 0.08 to 0.1.

Rosette files were converted using a start time of -2s and duration of 5s. After conversion corrections were made to station names based on the chief scientist's notes.

The rosette files were then converted to IOS SHELL files. Those files were copied to *.BOT. All BOT files were plotted. CTDEDIT was used to clean a few spikes in the primary salinity for cast #76. The output edited file was copied to *.BOT.

4. WILDEDIT

Program WILDEDIT was used to remove spikes from the pressure, conductivity and temperature channels only.
Parameters used were: Pass 1 Std Dev = 2 Pass 2 Std Dev = 5 Points per block = 50

5. CELLTM

Tests were run on several casts using settings (α = 0.01, β=7), (0.01, 9), (0.02, 7), (0.02, 9), (0.03, 7), (0.03, 9) and (0.0245, 9.5) to see what settings look best for this cruise. Several choices looked very similar, but overall (0.02, 7) looked best for the primary and (0.03, 7) for the secondary conductivity channel. CELLTM was run using those values.

6. DERIVE

Program DERIVE was run twice:

on all casts to calculate primary and secondary salinity.

on some deep casts to calculate the differences between primary and secondary channels for temperature, conductivity and salinity. These were placed in a test directory and will not be archived.

7. Test Plots and Channel Check

A sample of casts was plotted to check for agreement between the pairs of T and C sensors.

Cast #	Press	T1-T0	C1-C0	S1-S0	Descent Rate
11	500	-0.0001	+0.00038	+0.0046 VN	High
	1950	-0.0002	+0.00030	+0.0042 VN	High
14	500	-0.0008 VN	+0.00035	+0.0044	High, Noisy
	1950	-0.0004	+0.00029	+0.0039	High, Noisy
17	500	-0.0012XN	+0.00030 VN	+0.0045 XN	High
	1950	-0.0005 N	+0.00023	+0.0035	High
18	500	-0.0006	+0.00022	+0.003	High
	1950	-0.0002	+0.00017	+0.0026	High
24	500	-0.0006	+0.00020	+0.0029	High
	1950	-0.0005	+0.00014	+0.0023	High
37	500	-0.0005	+0.00011	+0.0018	High, Noisy
	1950	-0.0006	+0.00006	+0.0014	High, Noisy
	3900	-0.0007 N	+0.00002 N	+0.0007	High, Noisy
44	500	-0.0005	+0.00010	+0.0014	High
	1950	-0.0005	+0.00004	+0.0011	High
65	500	-0.0004 N	+0.00003 VN	+0.0005 VN	High
	1950	-0.0005	-0.00002	+0.0003	High
79	500	-0.0006	+0.00003	+0.0003	High
	1950	-0.0005	+0.00005	-0.0001	High, Noisy

N= Noisy data; VN = Very noisy data.

During cast #11 there were sections in which the temperature differences were large and a close examination of the data suggests both sensors were giving bad data. This looks like problems noted during cruises 2007-13 that cleared up after a new pump cable was attached. For this cruise a new pump cable was attached for cast #18.

All differences changed significantly between casts #11 and #24 but the temperature changed very little after that. The conductivity and salinity differences drifted throughout. After cast #37 there is little change in salinity. The results from the deep cast #37 suggest a slight pressure-dependence but the variation is small.

8. Conversion to IOS Headers

The IOSSHELL routine was used to convert SEA-Bird 911+ CNV files to IOS Headers. Problems arose for cast #48 because it was too large to convert. STRIP was used on the CNV file to remove channels that

are useful but not critical: Oxygen:Voltage:SBE, Status:Pump and Descent_Rate and it was then converted successfully.

CLEAN was run to replace pad values in the Pressure channel using linear interpolation based on scan number.

9. Checking Headers

The header check and header summary were run. The only error found was the absence of a station name in cast #61. The cruise track was plotted and no problems found.

The average surface pressure is 1.4db, which is low for the Tully. There are many cases of pressures <0 with in-water values for transmissivity and conductivity. Examination of individual casts suggests that the surface is at about -1.5db after the 3.8db offset was used, implying a total offset of +5.3db. The pressure offset used at sea was 5db. There is no explanation in the log book for this choice and during 2007-01 in February, a value of 3.8db looked about right. We expect drift in the calibration of the older pressure sensors but this seems higher than expected. It is likely that someone did a surface pressure test before the first cast.

There are frequent errors made in the offset entered in the configuration files used at sea, so that the processor replaces the offset with the value used for the last cruise on which it was used. It is not presumed to be the result of a surface test because those are not often done. So it is critical to make a note in the log book if such a test is done so the processor knows about it.

The CLN files were recalibrated to add 1.5db to the pressure, using file 2007-15-recal-p.ccf.

The altimeter readings from the header were exported to a spreadsheet and checking a few casts made it obvious there were problems. The algorithm is only supposed to enter a reading in the headers if the CTD gets within 15m of the bottom, but for many casts the altimetry read between 7 and 8 through most of the water column and gives low values for some shallow casts in deep water. Every cast was checked against the log book and the data in the file to ensure that the values made sense. Particular care was taken over cases with values between 7 and 8. Where they did not make sense the header entry and comment was removed from the CTD and bottle files; those changed are casts: 2, 3, 4, 8, 18, 22, 28, 35, 41, 42, 47, 51, 54, 56, 61, 66, 72 and 73. The near-shore casts were free of this noise, so the problem is presumed to be due to the presence of a weight or some other adjustment to the rosette package and not due to malfunction of the altimeter.

10. BOTTLE FILE PREPARATION

The BOT files were averaged to enable an addsamp file to be created. This file was edited to add sample numbers taken from the rosette sheets. A few corrections were required. Some of these errors were only discovered after the first run of COMPARE.

- On the rosette log sheet cast #14 indicates 24 bottles, 5 of which were at 10db. Only 23 bottles appear in the bottle file, with 4 of them at 10db. The only samples run at IOS from 10db come from bottle #19, sample #114. There were nutrient samples said to be from bottle #24, sample #119. There appear to be no samples at IOS from bottles 20 – 23, samples #115-118. There was sampling for a UBC student. It is not clear which sample to drop from the list. Marie Robert later confirmed that the sample was #118. Sample #119 was a loop sample.
- 2 bottles were fired during cast #24, one at 30db for bulk water only and one at 3db at which a salinity sample was taken with sample #172; that agrees with the log records. But the oxygen file for cast #24 shows a sample #177 with value 6.394ml/l. That sample # is listed as being from cast #25 in the logs. The rosette log indicates that an oxygen sample with value 6.394 was taken

- On the rosette log sheet cast #28 is shown to have 15 bottles fired, but there are actually only 14. There are no analyses for sample #216 and no sampling indicated on the rosette sheet except for an entry for ONAL, so it is assumed that the bottle did not fire.
- For cast #69 there was no sampling for bottle #12 and no sample number to go with that bottle, so it had to be removed from the list.
- For cast #84 two bottles were fired but only one was given a sample number; it is assumed sampling was from Niskin #2, so the first bottle was removed from the list.

Chemistry files were prepared for casts #2, 9, 29, 36 and 52 but there were no bottle data available; they are for the use of researchers from other institutions who gathered the samples. These files will not be archived.

The ADDSAMP file was converted to CST files to be used as a framework for the bottle files. It was also used to add sample numbers to the BOT files (output: SAM). The BOT files were then bin-averaged (SAMAVG.)

The extracted chlorophyll data were received in spreadsheet format and included rosette and loop samples. Working versions were saved as 2007-15chl.csv and 2007-15-loop-chl.csv. The latter file was set aside for study of the TSG fluorescence. The rosette file was simplified, and edited by adding the words "Extracted Chlorophyll" to the comments, changing headers to standard format and inserting pad values where there were blanks and reordered on sample number. The file was then converted into separate CHL files.

Similarly the nutrient spreadsheet was separated into rosette and loop files. Both were simplified, the word "Nutrients" was inserted before comments, headers were changed to standard format and lines with no sampling were removed; the file was then sorted on sample number. The rosette file was then converted into NUT files and the loop file was set aside for use in the TSG processing. Note should be made that all phosphate data were flagged "d" due to problems with new equipment.

The raw salinity data are in two files: 2007-15 RAW SALINITY DATA.xls and 2007-15 RAWsaanichinletSALINITYDATA. xls and contains the Autosal results for both loop samples and rosette samples. The two files were combined, comments were removed that referred to station names that had been changed as these are now correct and have no bearing on the salinity quality. The header names were changed to standard format, unnecessary columns were removed and pad values were entered where the bottle had broken. The words Salinity Sample were inserted in the comments. The files were then separated into rosette and loop files, 2007-15-sal.csv and 2007-15-loop-sal.csv. The CTD file was converted into individual SAL files. The LOOP file was set aside for later work on the TSG data.

Dissolved oxygen files (*.add) were provided with a flag channel and comments entered in the headers. The words "Dissolved Oxygen" were inserted before the comments. Some of the files needed to be edited to add the line *COMMENTS to enable MERGE to capture the comments and the data in a few files needed rearranging. One sample number had to be fixed.

The SAL, CHL, ADD and NUT files were merged with CST files in four steps, and then put through CLEAN to reduce the headers to File and Comment sections only and to fix the pad value in bottle DO. (Output MRGCLN1.) That file was then merged with SAMAVG files (Output:MRG).

11. COMPARE

Salinity

COMPARE was run with pressure as the reference channel. The scatter was unusually high. It looked as though there might be errors in the sample numbers, but while a few were found and corrected, the scatter still looked bad. A run was done using the Niskin Bottle # as reference channel and this showed that the largest variability was from bottle #1, but the outliers from that bottle are generally from 5m where scatter is expected. There is no other bottle that stands out as problematic.

Cast #37 looks especially odd. There are major outliers at 3500, 2500 and 1500db, with minor outliers above and below them. The profile of bottle salinity values looks strange. The CTD data look ok. Cast #48 has a similar pattern though the outliers are not as extreme.

Plots were made of differences versus sample number to try to find some explanation for the problem. There is no obvious pattern; patches of very bad values occur randomly. There was a quieter section from about cast #68 to 89, but then the differences got noisy again. To ensure this was not because of shallow sampling near the coast, differences were plotted against salinity and the scatter is significant at depth.

For cast #58 23 bottles were fired at 3000db. Averaging the data from a 5s-window around bottle firing time, the primary CTD salinity varied from 34.6569 to 34.6572 and the secondary from 34.6574 to 34.6575 and temperature also looks almost constant. The bottle values varied from 34.6544 to 34.6630. When one clear outlier is rejected the range is 34.6544 to 34.6590. In the past repeat sampling at depth often showed some drift in results, but with a trend that suggests changing conditions in the lab or vertical motion of the rosette; this is not the case here. The changes look random and the CTD moved less than 2m during the sampling. The average of the 23 bottles shows that both sensors are slightly high, by no more than 0.001. However, the scatter in the bottles is ±0.002 even after 4 outliers are excluded. This seems like a rather large error.

In contrast, during 2007-13 a similar test was done at 2000db and of 23 bottles, 2 were outliers and all other differences were within ±0.001 of the average. During 2007-01 the same sort of test was more confusing because it was found that the salinity analysis from one session was unreliable. When only the 13 bottles done in another session were used, the variability was ~±0.001. So the results from this cruise are troubling. The problem must be either in the salinometer itself or how it is used, or else there is a problem in the sampling. There is no evidence of particular Niskin bottles being a problem and the only comments that would suggest problems with sampling techniques are for casts #81 to 85.

When only data below 1000db are used and a few outliers removed (using large differences and then residuals to identify outliers) flat fits are achieved with the primary salinity low by an average of 0.0006 and the secondary high by 0.0002. This fits the differences between the two sensors later in the cruise as noted in section 7. However, early in the cruise the differences between the pairs of sensors were larger even below 1000db. This is not related to the problem in deep salinity for casts 9 through 17 since many of the problems here are seen after the successful repair to the CTD.

A variety of plots were examined in COMPARE to try to determine the source of the drift in the differences through the cruise. During the early section the CTD data were frequently corrupted, so studies were made of changes from cast #18 onwards. When data were selected between 1150 and 1550db and differences >0.005 were excluded, there are only 16 bottles from 8 casts. Nonetheless, there is a clear difference between the two pairs of data. The secondary differences vary little through the cruise, but the primary shifts somewhat between casts #64 and 69. When data were selected at ~2000db,

there is only 1 bottle from each of 7 casts, but again the pattern is similar though the primary differences may be shifting a little more gradually. The secondary data look better and do not need recalibration.

Finally a study was made to see if the order of analysis was relevant. All differences were arranged in the order of analysis. The pressure was not available in this study, but all salinity values <33 were removed so that there are no data from the near surface where large differences are to be expected. This is roughly equivalent to using data from 100m down.

A pattern emerged from this study. The large differences are almost all from analyses done late on Sept. 13th and on Sept. 17th and 19th. The analyses early on the 13th and on Sept. 24th, 25th and 27th look as expected if we assume that the CTD performed well. Many of the bad values on the 19th came from the casts during which we know there were bad CTD data at depth, so the salinometer results may be fine. The large differences on the 13th and 17th are negative, indicating that the bottle salinity was too high. On the 19th the CTD is higher than the bottles, confirming that the large differences are more likely related to the pump cable problem. (See 2007-15-salinity analysis study.xls.)

It is problematic how to assign flags. There are many outliers in comparison to the CTD. Since the secondary CTD appears to be giving good data, it was decided to assign "d" flags where differences are >0.05 and where there is no indication of problems with the CTD data and where they were not from the top25db. Similarly for differences > 0.03 "c' flags were assigned. Below 1000db "c" flags were assigned if the differences were >0.008. While the repeat bottles at 3000db show a lot of variability, the differences are not large enough to justify a flag. They raise a concern about the analysis, but the values are still useful.

Flags were added as follows:
10. Sample #75, flagged "d" as an outlier. Sample #82 was already flagged "d" as a misfire.
14. Sample #96 and 110, flagged "c" as outliers in comparison to both CTD channels.
27. Sample #181, flagged "c", outlier in comparison to both CTD channels.
37. Samples #268 and 273 flagged "d" – extreme outliers in COMPARE; samples #267, 269, 270, 274, and 276 flagged "c" as moderate outliers in comparison to both CTD channels.
48. Sample #338, flagged "d", outlier in comparison to both CTD channels.

There was a post-cruise calibration of the secondary conductivity sensor which showed drift of about 0.003 but there were 2 cruises uses the sensor after this one and this was the first use since the presvious calibration. So an error estimate of 0 to +0.002 seems reasonable. This fits the conclusions reached in COMPARE, so except during casts #9 through 17, the salinity looks reliable.

<u>Dissolved Oxygen</u>
COMPARE was run using pressure as the reference variable. The best fit is against CTD DO values. When a few outliers and bottles from below 1200db are excluded the fit was:

CTD-BOT = 1.0864 * DOX-CTD -0.0116

There was no evidence of temporal variations. (See 2007-15-dox-comp1.xls.)
This sensor was used during 2007-01 but only for a few casts. The fit then was:

CTD-BOT = 1.0537 * DOX-CTD + 0.0032

The difference of offset sign for this data set may be related to the use of a plug throughout. The slope difference could be calibration drift, but keep in mind that there were few data in the 2007-01 comparison.

Plots were made of bottle DO and CTD DO versus CTD salinity and no outliers were found that had not been identified by the analyst or in COMPARE.

The analyst had flagged a lot of samples, including some that seem ok in the comparison. Flags were added, changed or removed as follows:
Cast 10 - Sample 82 - Bottle must have misfired - All samples look like from around 150db, not 250db.
Cast 27 – Analyst flagged "d" – too deep to tell from COMPARE as CTD doesn't work well there, but it does differ from another bottle that came from nearby, so flag left at d.
Cast 33 – Sample flagged by analyst as "d" and outlier in COMPARE. Left as "d".
Cast 34 – Analyst flagged "d" due to bubble, looks fine in COMPARE, so changed flag to "c".
Cast 37 – Analyst flagged 3 bottles "d"; all look fine in COMPARE, so changed flags to "c"
Cast 43 – Analyst flagged 1 bottle "d" as it had not been stored properly. The value looks just slightly out of line in COMPARE so flag changed to "c".
Cast 59 – Analyst flagged all samples "d" because stored improperly and 2 had bubbles. In COMPARE only the bottle at 2000db looks like a serious outlier and the CTD data is not reliable at that depth. All other flags were changed from "d" to "c".
Cast 76 – Changed flags at 25db and 600db from "d" to "c" since the two look ok (though possibly slightly out of line) in COMPARE. Flag at 2000db left at "d".
Cast 81 – Too deep for COMPARE to be useful. Flag left at "d".
Cast 85 – Three bottles were flagged "d". The two near the surface look ok in COMPARE, so flags were changed to "c". The bottle at 300db is a severe outlier in COMPARE so flag was left at "d".
Cast 90 – One bottle flagged "d" by analyst; changed to "c" since looks ok in COMPARE.
Cast 101 – Bottle at 10db was flagged "d" as a severe outlier in COMPARE.

Fluorescence
COMPARE was run using the CTD Fluorescence and the Titrated Chlorophyll from bottles. When all data were plotted there was a lot of scatter, with the surface data from the early and late casts standing out from the rest. Those were the only casts with high values of CHL. Looking at only casts 14 through 85, the bottle chlorophyll is about 0.25 times the CTD fluorescence, though CHL and FLUOR are closer for the lowest values. For the near-shore casts the data fall into two groups. Those from very close to shore and the shallowest bottles from a little further offshore group fairly closely and indicate that the chlorophyll is about 1.4 times the fluorescence.

12. SHIFT
Fluorescence
To find what shift is needed for the fluorescence, upcast and downcast profiles were examined to determine the vertical offset of the temperature and fluorescence traces. The differences between these two offsets are treated as a measure of how much the fluorescence needs to be shifted. The "excess" offset for the fluorescence was divided by the averaged descent/ascent rate and divided by 2(since the shift will be applied to both up and downcast) to find the shift (in seconds) to remove that offset. Values of from 0.8 to 1.6s were found, with most close to 1. For most cruises a shift of +24 records (1s) has been found to be appropriate. SHIFT was run using +24records. (Output: SHFFL)

Dissolved Oxygen
Tests were run on a few casts to determine the best SHIFT value to apply to the Dissolved Oxygen channel. This was judged by how the vertical offset between downcast and upcast traces compares with that of the temperature. Because of hysteresis alignment will not produce traces that overlie each other exactly. Values from +100 to +130 were tried and the best overall match of features was with +110 records, as found during 2007-01 when this sensor was last used. SHIFT was run using +110 records.

Conductivity

Tests were run on 4 casts with few or no stops for bottles, using shifts from -1s to +1s and T-S plots were prepared to compare the results. A setting of -0.5s worked best for the primary conductivity and +0.2s looked best for the secondary. All casts were put through two runs of SHIFT first using those values. Primary and secondary salinity were recalculated. (Output *.SHFC0 and SHFC1).

13. DELETE

The following DELETE parameters were used:

Surface Record Removal: Last Press Min Maximum Surface Pressure (relative): 10.00
Surface Pressure Tolerance: 1.0 Pressure filtered over 15 points
Swells deleted. Warning message if pressure difference of 2.00
Drop rates < 0.30m/s (calculated over 11 points) will be deleted.
Drop rate applies in the range: 10db to 10db less than the maximum pressure
Sample interval = 0.042 seconds. (taken from header)

COMMENTS ON WARNINGS: There were warnings about 2 casts.

61. Pressure <10db – this cast was run only to get a surface bottle, so only rosette data are needed and this file will not be processed further.

82. There is a skip in pressure from about 500 to 508db. In the original file there was a reversal of the CTD at that point, then the downcast continued. In order to make DELETE choose appropriate data it is necessary to use a text editor to remove data from the reversal. DELETE was rerun.

In editing it was found that DELETE had not picked the best data for cast #12 which had an initial lowering to 54db but was then returned to the surface before a full cast. The SHFC1 file was edited and run through DELETE again. Similarly cast #92 had an initial lowering to 11db, so it was edited and DELETE rerun.

14. DETAILED EDITING

There was a lot of noise in both salinity channels especially near the surface. The secondary salinity is closest to the bottles and shows less temporal drift that the primary, so was chosen for archiving. Graphical editing was done using program CTDEDIT. On-screen plots of descent rate and pump status were also used.

It was noted in editing cast #4 that features in the upcast and downcast traces are offset by more than usual, at 80db the difference is about 12db, and above that it is even higher. This is seen in both temperature and conductivity channels, but is not obvious in oxygen voltage. This could be due to internal wave action. The T-S plot looks ok and the pump status is 1 throughout. As mentioned earlier there were large segments of temperature and salinity data corrupted by the pump problem below 800db between casts #10 and 17. CTDEDIT was used to remove such data. Many casts had a lot of small spikes (1 to 3 points) in salinity (~.02 to .2 units) associated with high local temperature gradients; these were cleaned by interpolation unless they were clearly two-sided and unlikely to affect the metre-averaged data..
All casts required some editing. Note was made of the editing details in the headers of the relevant files.

15. Initial Recalibration

File 2007-15-recal1.ccf was prepared to apply the following equation to the dissolved oxygen channel:

DOX-CTD corrected = 1.0864 * DOX-CTD - 0.0116

This correction was first applied to the rosette and chemistry files and then COMPARE was rerun to check that the results were as expected and they were. The downcast files were recalibrated. (See 2007-15-dox-comp2.xls.)

16. Special Fluorometer Processing

The COR1 files were clipped to 100db and processed separately for A. Peña. (Output: CLIP)

A median filter, fixed size=11, was applied to the fluorescence channel in the COR files to reduce spikiness. One cast was examined before and after this step and showed that the filter was effective.

17. Final Calibration of DO

SHIFT corrects for the error in DO alignment with temperature due to transit time. The first recalibration corrects for the calibration drift in the sensor. A further correction is needed for the downcast data only, to allow for the "in-motion" error due to poor sensor time response. To check for this downcast data is compared with upcast bottles.

Files were bin-averaged to 0.5m bins for the casts with DO bottle samples. Those files were then thinned to the usual levels for bottles and compared to the bottle values in the MRG files. COMPARE was used to study the differences between the downcast CTD DO data and the upcast bottles. When data from below 1000m are excluded plus outliers, it was found that the differences were quite flat when plotted against CTD DO value, with the CTD data being high by an average of 0.204ml/l. The thinned files were recalibrated by subtracting 0.204ml/l from the SBE Dissolved Oxygen channel and COMPARE was rerun. The results showed that the recalibration was successful. (See 2007-15-dox-comp3.xls and 2007-15-dox-comp4.xls.)

The clipped files were recalibrated. One set was then bin-averaged (0.25db bins), put through REMOVE and HEADEDIT and named as *.FCTD1 and saved for Angelica Peña. A second set, *.FCTD2, were filtered before bin-averaging. The SAMCOR1 files were recalibrated to correct pressure, put through REMOVE and named *.BOF and saved for the use of Angelica Peña. A readme.doc file was prepared with some notes on the preparation of those files.

18. BIN AVERAGE of CTD files

The following Bin Average values were applied to the FIL files (output AVG):
Bin channel = pressure Averaging interval = 1.000 Minimum bin value = .000
Average value will be used. Interpolated values are NOT used for empty bins.
After averaging, page plots were examined on screen and no further editing was deemed necessary. Profile plots were made to check for bad data in transmissivity, fluorescence and dissolved oxygen. There were some bad transmissivity data in casts #94, 97 and 98; a text editor was used to replace the bad values with pad values in the AVG files. One record in the bottle file for #94 was also affected in the same way, so a pad value was entered in the MRGCOR1 file.

The second recalibration was applied to the averaged downcast files to subtract 0.204ml/l. (Output: COR2) (Note that this recalibration is not applicable to the bottle files when the CTD is stopped.)

19. Other Comparisons

Previous experience with these sensors –
1. Salinity:
Both conductivity sensors were recalibrated since they were last used. At that time the primary had drifted by about 0.003 and the secondary had not drifted at all.
2. Dissolved Oxygen: This sensor has been used only once before, during 2007-01, but two sensors were used then and there was little bottle data for this sensor.
3. Pressure: The pressure sensor has been drifting over the past 5 years with an offset of +3.8 used in February of this year.

Historic ranges – Profile plots were made with historic ranges of T and S superimposed. Most of the data fell within the ranges, but salinity was high at 125 to 130db from P18 to P20. This is at the bottom of the main halocline. Examination of ARGO data interpolated onto Line P shows a salinity anomaly of 0.2 to

0.4 in that region for August 2007, so this does not look like an instrumental problem. Cast #76 has temperature that is well above the historic maximum from 200 and 700db and below 1300db temperature is a little high and salinity low. This is believed to be the result of sampling an eddy. For casts 9 and 10 the temperature is a little high around 900 to 1000db. There are a few other minor excursions mostly in the top 25db. All excursions appear to reflect real variations not represented in the climatology.

Repeat Casts – There were many repeat casts including 2 deep ones at P26. There was a lot of variability near the surface but the differences along σ_t-lines were about 0.001C° and <0.001 units of salinity at 3000db.

20. FINAL CTD files steps (REMOVE and HEADEDIT)

The following channels were removed from all casts: Scan_Number, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, Descent_Rate and Flag.
The PAR channel was removed from all casts except: 1-8, 22, 28, 35, 47, 51, 54 and 55
THE DO CHANNELS were removed from 1-2.

A second SBE DO channel was added and the channels reordered to put the two SBE DO channels together.

HEADER EDIT was used to fix formats and channel names and to add the following comments:

Transmissivity and fluorescence are nominal and unedited except that some records were removed in editing temperature and salinity.

The dissolved oxygen data in the CTD files should be considered

- *±0.6ml/l from 0 –200db.*
- *±0.4ml/l from 200 to 400db; data tend to be somewhat high in this high gradient region.*
- *±0.2ml/l below 400.*
- *data below 500db tend to be low.*
- *data below 1000db are considered unreliable by the manufacturer.*

The Standards Check routine was run and HEADEDIT adjusted until no further problems were found. The final files were named CTD.

As a final check of dissolved oxygen, data % saturation was calculated and plotted. The near-surface values were between 85% and 130% with most between 100 and 105%. The highest were at stations P2 and P3, the lowest were at P1 and at the end of the cruise. These values are considered reasonable.

21. Final Bottle Files

The MRGCOR1 files were put through SORT to order on increasing pressure. REMOVE was run to remove Scan_Number, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Status:Pump, Descent_Rate, Altimeter and Flag.
The PAR channel was removed from all casts except: 1-4, 6, 8, 22, 28, 35, 47, 51, 54 and 55.
THE DO CHANNELS should be removed from 1-2.

A second SBE DO channel was added with different units. Then the files were reordered to put the two SBE DO channels together.

HEADER EDIT was run to fix formats and units and to add a comment about quality flags and analysis methods. The standard comments for hydro files were adapted to reflect the fact that the dissolved oxygen

and chlorophyll were analyzed on board, the salinity was analyzed at IOS and the nutrients were run with an Astoria Analyzer. The following comment was also added:

> *All phosphate data are flagged "d" because new equipment caused contamination ranging from 0.07 to -0.33 uM PO4.*
> *Phosphate data were recovered by comparing to archived data below 1000m at each station and correcting accordingly.*

Standards check was run on all files and HEADEDIT adjusted until all format problems were resolved. (Output: CHE1)

The pressure recalibration was not applied to the bottle files earlier, so CALIBRATE was used at this point to add 1.5db to the pressure channels using file 2007-15-recalp.ccf. (Output: CHE)

NOTE: The nutrients and extracted chlorophyll from surface bottles on casts with only surface sampling was accidentally left out of the spreadsheets that were used to prepare the CHE files. Files named 2007-15-surf-nuts.csv and 2007-15-surf-chl.csv were prepared, converted to CHL and NUT files and used to prepare new CHE files.

22. Thermosalinograph Data

a.) Checking calibrations

There was 1 file containing TSG data. A report was printed for the con file, the fluorometer calibration was corrected and serial number was entered and the primary temperature calibration was corrected; the resulting file was saved as 2007-15-TSG.con.

b.) Converting to IOS Headers, adding position headers and time channels, preliminary checks

The data were converted to CNV files using a SeaSoft routine. The channels converted were: Scan_Number, Temperature:Primary, Temperature:Secondary, Temperature:Difference, Conductivity:Primary, Fluorescence:URU:Wetlabs, UPloy0, Latitude, Longitude, Salinity:T0:C0 and Time Julian and then converted to IOS HEADER format.

Two spikes in positions were noted by the chief scientist; those were replaced with interpolated values. CLEAN was run to add End times and Longitude and Latitude minima and maxima to the headers. ADD TIME CHANNEL was used to add time and date channels in IOS SHELL format and the output files were named *.ATC. A track plot was produced and it looked correct; it was added to the end of the report.

Time-series plots were produced. As reported by the chief scientist the differences between the intake and lab temperatures are very large. In the plots the difference is a mirror image of the primary temperature and the differences are quite flat, but large. Both the fact that the lab temperature is lower than the intake temperature and that the intake temperatures are unbelievably high make it clear that the intake temperature is not right.

The salinity data have many spikes and jumps that are not associated with spikes in any other channel including the flow rate.

The flow rate varies greatly through the record. The rate is 0.8-1.2 for most of the record, with a day at about 0.5, and 1.5 days late in the cruise as ~1.5. There are several short drops to zero flow and then for the last 3 days the flow is ~0. Notes from the chief scientist indicate that the seawater loop was shut off for 30 minutes for maintenance on Julian day 235.4549 and 245.0299. She also noted that there were lots of problems with flow, bubbles, high salinity variability and differences between the two TSG

temperature sensors. She provided pCO2 data since it also has loop temperature readings in the hope that it might help recalibrate the lab temperature.

The differences between the temperature at the inlet and in the lab are much larger and noisier than usual. When the records from the end with 0 flow rate are excluded the average indicates that the lab temperature is lower by an average of 2.5C˚ and a median value of +2.4C˚. Usually we find that the lab temperatures are higher by something like 0.2˚.

It is clear that another round of editing will be required to remove data with 0 flow rate, but the comparison will be done first, keeping in mind that flow rate should be checked in deciding whether to include particular TSG data. The delay in editing was done in case the comparison makes it clear that other data should be removed as well as that with the low flow rate.

c.) Checking Time Channel

The CTD data, after editing and metre-averaging, were thinned to reduce the files to a single point at or within .3db of 4.5db and exported to a spreadsheet.

The TSG file was opened in EXCEL, median and standard deviations were calculated for temperature, salinity and fluorescence and saved as 2007-15-0001.xls. The file was then reduced to the times when CTDs were run. Those files were combined in a spreadsheet (2007-15-ctd-tsg-comp.xls). The positions were compared and were very close, with average differences for both latitude and longitude of <0.0001º and no difference greater than 0.0003º so the clock appears to have worked well.
This spreadsheet will also be used in step (d) to compare temperature, salinity and fluorescence.

d.) Comparison of T, S and Fl from TSG and CTD data

- T1 vs T2 As noted earlier the intake temperature is clearly wrong, so comparing the lab temperature to it is pointless.

- TSG vs CTD The spreadsheets comparing CTD and TSG files were then examined to find the differences between the salinity, fluorescence and temperature channels for the CTD and the TSG. There were 50 casts that could be used. Graphs were prepared comparing the TSG temperature, salinity and fluorescence with those of the CTD.

  A graph made of the differences between CTD temperature and TSG lab temperature versus flow rate shows no relationship between the two. There were no cases of zero flow rate in the comparison, but there was a range from 0.4 to 1.6. Outliers are seen at rates of 0.5, 1, 1.1, 1.2 and 1.5.

  When all data are included, the TSG temperature is higher than the CTD by about 0.20C˚, the TSG salinity is lower by 0.25 and the TSG fluorescence is 2.5 times that of the CTD. When data are rearranged by increasing standard deviation of the relevant TSG quantity and the 10 points with the least variability are selected, the TSG is higher than the CTD by 0.14C˚, the salinity low by 0.12 and the TSG fluorescence higher than the CTD by about 3. Including the top 30 points gave similar values for temperature and fluorescence, but the salinity was lower by only 0.10.

  The CTD mixed-layer depth calculation indicates that salinity variations are low in the top 10m for casts 32-34, 36, 42, 43-52, 57-59, 62-66, 69, 72, 78, 79. Some of these are unavailable because there were no CTD data from the level of the intake. From the available casts the 5 records for which the TSG standard deviation is largest in the relevant channel were excluded and

then averages were calculated. The results indicate that the TSG temperature is high by 0.13C°, the salinity low by 0.14 and the fluorescence about 2.5 times that of the CTD.

However, when all CTD casts are used there is an obvious shift from low salinity differences up to August 22, ranging from the TSG being low by 0.01 to 0.1 before the shift and low by 0.1 to 0.3 afterwards. The average of the 5 well-mixed casts before the shift gives the TSG salinity to be low by 0.019 and from the 13 well-mixed casts after the shift the TSG is low by an average of 0.193. The shift occurs between P24 and P35, near Station Papa. There is no corresponding shift in the temperature differences between TSG and CTD. Examination of the log shows no note of any event at that time to explain a shift. There are entries at other times (before and after the shift) noting problems with the bubbler being empty or that there were bubbles in the loop. The TSG flow rate went down late on the 16th and on the 17th at around 1300 UTC it was noted that the bubbler was not full and the flow rate was low so it was set higher. A plot of the differences between TSG and CTD salinity versus TSG flow rate show no relationship.

- TSG-pCO2 temperature comparison
  The pCO2 data were reduced to the times of the CTD casts and, as above, the well-mixed casts were compared. This confirmed that the TSG intake temperature was bad. The pCO2 intake temperature was higher than the CTD by from 0.011 to 0.019C° depending on how many casts were included; this is very good agreement given that times differ slightly and the depth of sampling may not match exactly. The pCO2 lab temperature was higher than the pCO2 intake temperature by about 0.35C°. From past TSG data at this time of year when the inlet temperatures are quite high, we expect warming on the order of 0.14 to 0.16C°. The TSG lab temperature is lower than the pCO2 lab temperature by 0.23C°. Between these latter two observations it appears that the pCO2 lab temperature is reading high by about 0.2C°. The intake pCO2 temperature looks reliable, and the TSG lab temperature is higher than that by an average of 0.12C° which is close to what we expect.

- Loop Bottle Comparisons There were 22 loop salinity samples. The data from file 2007-15-0001.xls were reduced to the times of loop samples (2007-15-loop.xls) and combined with the loop data in file 2007-15-loop-sal-comp.xls.

  The loop salinity values were compared with the median TSG salinity and there is a lot of scatter. When one value is excluded because the standard deviation in the TSG salinity was extremely high, the TSG salinity is lower than the loop samples by an average of 0.18. When the first 5 loop samples from August 16th are excluded the TSG salinity is low by an average of 0.23. The other loop samples are all from August 23rd to 28th and there is no hint of drift during that time. It looks like a step change between the two groups of loop samples. There were some problems in the sampling/analysis noted in the CTD processing that might explain high salinity values in the loop samples. The analyses of rosette samples run on the same day as the later loop samples do not show any noteworthy problems. There were problems on the day the earlier samples were run, but they were marked by high bottle results; only one of those 4 samples has a value higher than the TSG salinity. Another explanation might be salt crystals in sample bottles, a problem noted in the log book. However, the CTD comparison shows a similar shift, so analysis and sampling are unlikely to be the explanation. Something must have happened that changed the calibration.

  Plots of differences against the standard deviation in the TSG salinity might suggest that noisy TSG data is the explanation for some of the scatter, but it is not very convincing. Plots against flow rate and TSG salinity do not show any relationship. There is a clear relationship between the lab temperature and TSG Sal – Loop Sal. When the lab temperature is lower the differences are

close to zero and when higher about 0.23. But the lower temperatures occur in the earlier part of the record so time may be the relevant factor.

Temperatures from the pCO2 records for the intake and lab temperature were found for the times of the loops samples. A plot of (TSG salinity - loop salinity) versus intake temperature again shows the lowest differences when the temperature is lower.

The fluorescence/chlorophyll ratio is noisy with an average of 6.4 and a range of 3.3 to 9.3, with the highest value coming from the farthest offshore. There were no samples from Juan de Fuca Strait but there were some taken close to shore at the end of the cruise. Chlorophyll is about 15% of the TSG fluorescence.

- Calibration History The TSG was used during 2007-12, -13 and -14 in May and June 2007, but there was no inlet thermistor or loop sampling for the first of those. The lab temperature was temperature dependent ranging from about 0.07 to 0.17Cº. It is usually high by about 0.14 to 0.16Cº at this time of year. The salinity was found to be low by 0.07 and 0.05 during the latter two cruises.

Conclusions
The inlet temperature is wrong and there is no hope of correcting it.
The lab temperature is probably high by 0.14Cº. This is supported by both the comparison with the CTD and the usual amount of heating due to ship effects at this time of year. It is not consistent with the pCO2 equilibrium temperature, but that appears to be reading high by about 0.12Cº. The pCO2 inlet temperature agrees well with the CTD. The pCO2 temperature difference suggests ship heating effect to be about 0.35Cº, which seems too high. So it is likely the pCO2 equilibrium temperature is too high.

The salinity calibration appears to have shifted between casts #43 and 45, from being low by about 0.02 up to #43 to being low by 0.19 from #45 onwards, based on comparison to CTD data in well-mixed surface waters. The flow rate does not change at that point and there is no mention in the logs of equipment problems at that point. The loop samples show a lot of variability, but before cast #43 the differences are ~0, and after #45 the average is -0.23. During 2007-13 and 2007-14 the salinity was low by 0.07 and 0.05, so reasonably consistent with the value before the shift. The noise level in the salinity data seems higher after the shift with most spikes being towards lower values. The chief scientist noted that there were problems with bubbles in the TSG and the loop was shut down for 30 minutes for maintenance shortly after the apparent shift. Close examination of the TSG data shows the first sign of trouble at 1:40 UTC on August 22, 2007. It seems likely that the conductivity sensor did not change calibration suddenly, but that problems in the loop worsened abruptly, resulting in salinity values that were consistently low.

The TSG fluorescence is about 2.5 times the CTD fluorescence. All the chlorophyll samples are from well offshore. Loop chlorophyll is about 15% of the TSG fluorescence based on loop samples, implying that it is about 38% of the CTD fluorescence. The rosette samples show that the chlorophyll is about 25% of the CTD fluorescence in the offshore regions and higher than the CTD fluorescence in the near-shore regions. So the 38% is reasonably consistent with most samples at about 25% and some at more 100%.

e.) Editing
CTDEDIT was run twice to clean spikes in salinity that were not associated with spikes in temperature. It was run a third time to replace Temperature, Salinity and Fluorescence with pad values in sections for which the flow rate was zero. The salinity data still look very odd, but there is no obvious way to edit it. The salinity drops to low values with no great change in temperature. There is no correlation to whether

the ship was stopped or steaming, nor does flow rate seem implicated except that of course, where it goes to 0 all the data look bad.

f.)**Calibrate**
Since the intake temperature is not available, two versions of Temperature:Primary will be archived: the original values will be named Temperature:Lab and values adjusted to remove the effects of heating in the loop will be named Temperature:Primary.
EDIT HEADERS was used to change the name of channel Temperature:Primary to Temperature:Lab.
ADD TIME CHANNEL was used to add a channel Temperature:Primary.
Then CALIBRATE was run using file 2007-15-tsg-recal1.ccf to set Temperature:Primary equal to Temperature:Lab minus 0.14Cº, and to raise Salinity:T0:C0 by 0.02 up to record #16997, and by 0.19 after that point.

g.) **Preparing Final Files**
REMOVE was used to remove the following channels: Scan_Number, Temperature:Secondary, Temperature:Difference, Conductivity:Primary, Flag and UPloy0 (flow rate).

HEADEDIT was used to was used to add a comment, change the DATA TYPE to THERMOSALINOGRAPH and to add the depth of sampling to the header.

The TSG sensor history was updated.
As a final check plots were made of the cruise track and data; no problems were noted.

25. Producing final files
A cross-reference listing was produced for CTD and CHE files.
The sensor history was updated.

Particulars:
Oxygen sensor plug and syringes used between casts throughout cruise.
1-16 - No station names in headers
9 to 17. Problems similar to those during 2007-13. Downcast ok for #9.
1 & 2.No DO sensor mounted.
1. Large differences between C and T sensors.
3, 10, 20, 22 – wrong UTC time in Input Header.
10. Wrong start time in header
10-14 Wrong file names (extra zero)
11. Cast started soon after pump turned on.
12. Went down to 54db then brought back up to surface and started again. Temp difference often high, spikes in T.
14. At about this time flow rate to TSG increased, bubbler was 1/5 empty.
17. Spikes in T channel. Power pump cables removed, regreased and reconnected to try to correct problems in T0, T1, C0, C1 at high pressures.
18. New cable, data better.
19. Stopped at 1600db for a short time.
24, 84, 91. 2 bottles closed - one at surface with sample # and one for bulk water only, no sample number assigned.
57. Stop at 1850m to switch winch operators
57, 72-74, 76, 78-83. Loops taken at same time as the 5m Niskin.
58. Winch problems.
59. Problem noted in salinity bottles, salt crystals. Bottles for P33 rinsed first.
60. 5m bottle failed to trip.
61. Cast to 5m only to get 5m bottle tripped.
68/69. Noise level and apparent signal increase when stopped on station. Bubbles on transducer?
76. Airspace in TSG, flow rate ~0.57, adjusted flow rate to 0.67 to get rid of airspace.
81. Bad salinity 35-55m. Bug in sensor? Flushed with DMQ after cast.
82. Salinity noisy on upcast – secondary? OXY odd too.
83. Data better after flush of pump.
85. TSG was ½ full, flow rate increased at 1639 and TSG filled up.
93. CTD down to 12db, returned to surface because pumps not on; started again.
94. Transmissometer signal starts quitting.
101. New transmissometer cable before this cast.
101. File labelled 100.

Institute of Ocean Sciences CRUISE SUMMARY

Cruise ID#: 2007-15	
Dates: Start: 14 August 2007	End: 1 September 2007
Location: N.E. Pacific	
Vessel: John P. Tully	Party Chief: Robert M.

CTD #	Make	Model	Serial#	Used with Rosette?	CTD Calibration Sheet Competed?
1	SEABIRD	911+	0443	Yes	Yes

CTD Calibration Information

Calibration Information					
Sensor		Pre-Cruise		Post Cruise	
Name	S/N	Date	Location	Date	Location
Temperature	2106	25apr07	Factory		
Conductivity	2424	25apr07	"		
Secondary Temp.	4752	6Mar07	"		
Secondary Cond.	1763	23Dec06	"		
Transmissometer	953DR	23April07	IOS		
SBE 43 DO sensor	1119	10/Nov/2006	Factory		
Fluorometer	2356		IOS		
PAR	4656	11/Feb/2003			
Pressure Sensor	63507	25/Oct/2004	Factory		
Altimeter	1252	?	?		

TSG Calibration Information

Calibration Information					
Sensor		Pre-Cruise		Post Cruise	
Name	S/N	Date	Location	Date	Location
Temperature	2487	10/04/07	Factory		
Conductivity	2487	10/04/07	"		
Wetlab/Wetstar Fluorometer	WS3S-713P	18/01/01	"		
Temperature 2	2416	23/Dec/06			
Flow Meter	?	?	?		

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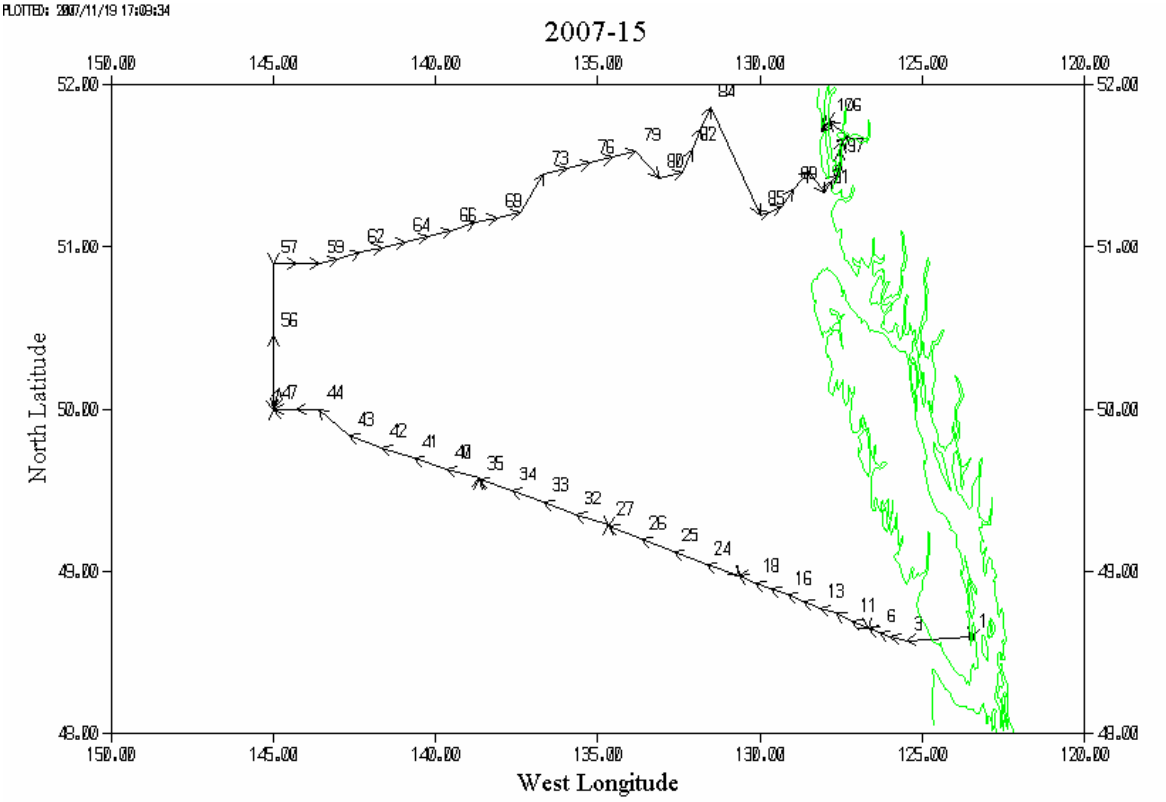

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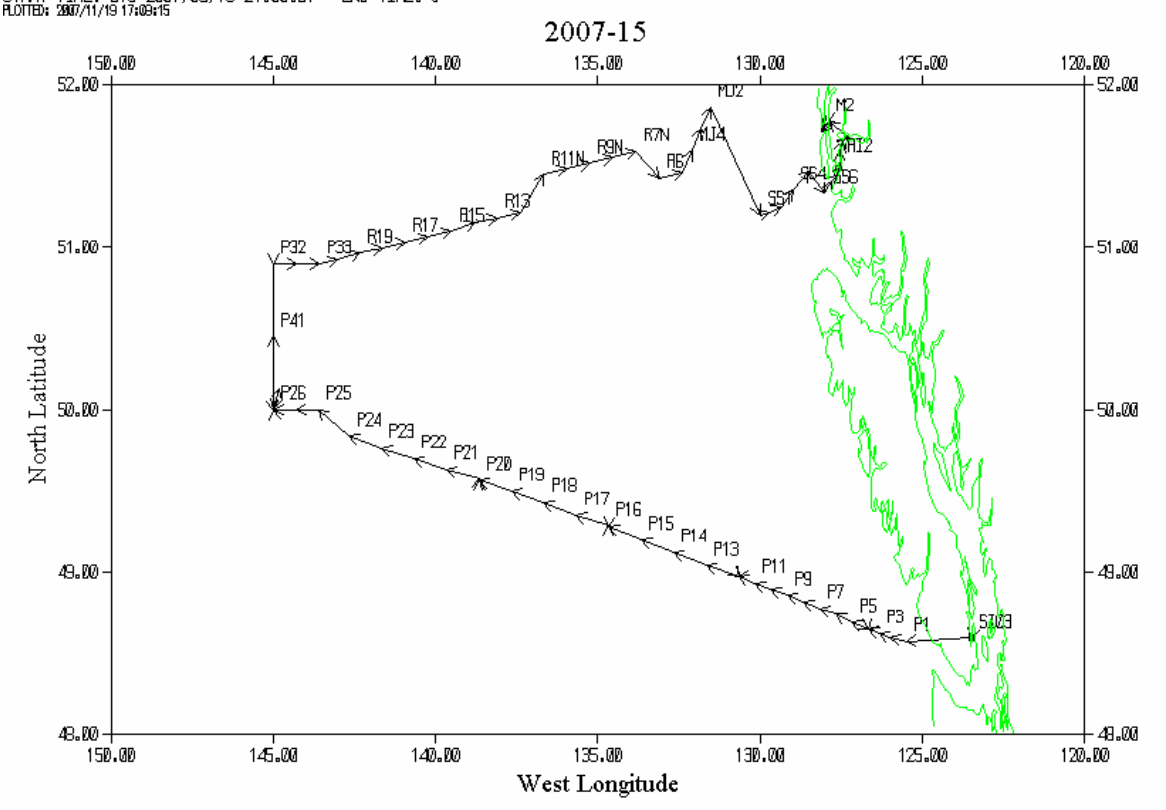

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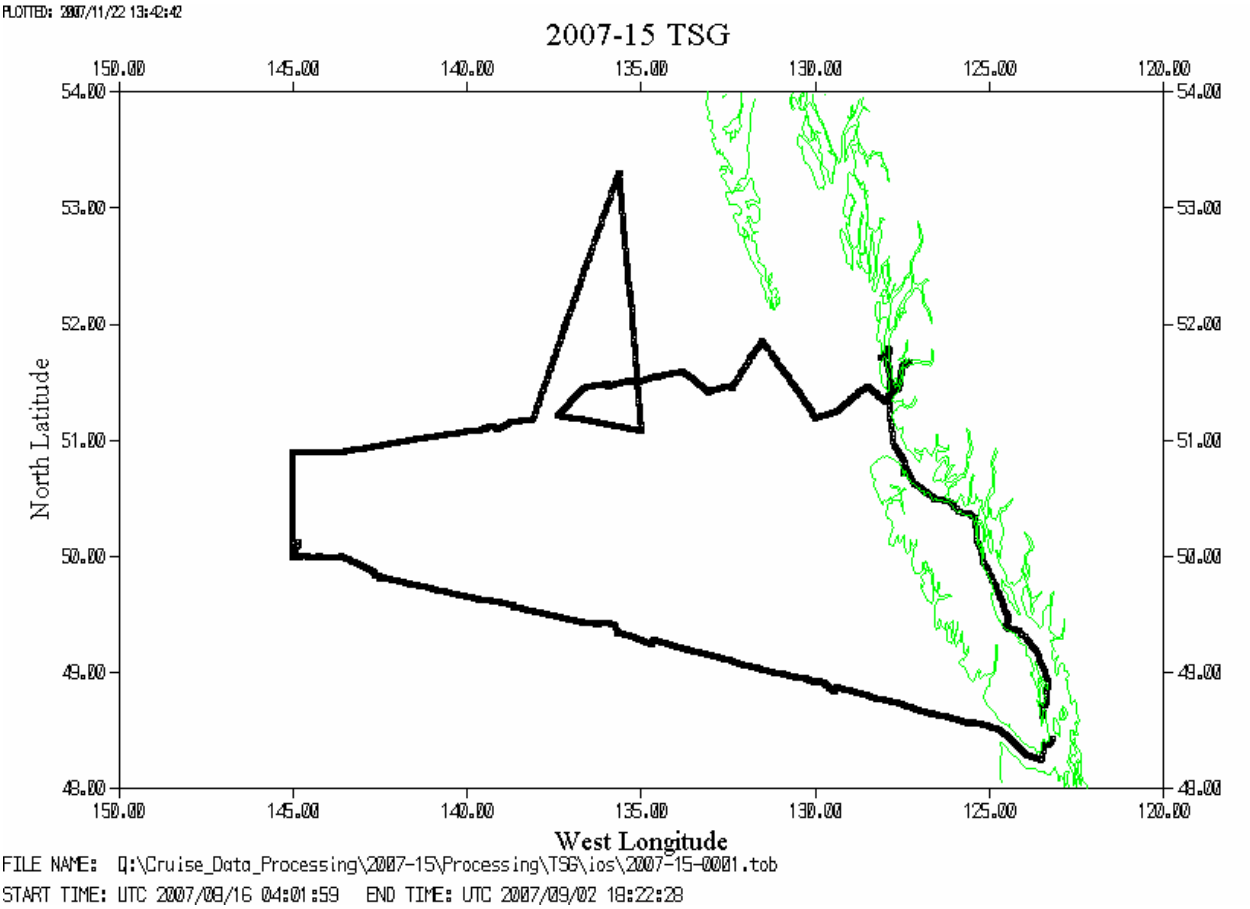
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