REVISION NOTICE TABLE

DATE	DESCRIPTION OF REVISION
2 Jan.2014	Corrected flags and entered pad values for sample #83 (event #15), removed incorrect comment for sample #79 (event 12), adjusted comment about nutrient sample #500 (event #74).
7 Sept. 2010	Based on reanalysis of raw data, titrated DO values adjusted for samples #1-4 cast #1 G.G.
08-May-2010	Added Lisa Miller's Dissolved Inorganic Carbon and Alkalinity data to the rosette files. J.L.
2Dec 2008	Corrections made to CHE files for casts 18, 44, 45 and loop salinity file

PROCESSING NOTES

Cruise: 2008-01
Agency: OSD
Location: North-East Pacific
Project: Line P
Party Chief: Robert M.
Platform: John P. Tully
Date: January 29, 2008 – February 19, 2008
Processed by: Germaine Gatien
Date of Processing: 13 March 2008 – 11 April 2008

Number of original CTD casts: 50 (1 up only)	Number of CTD casts processed: 49
Number of bottle casts: 47	Number of bottle casts processed: 47
Number of original TSG files: 3	Number of TSG files processed: 3

INSTRUMENT SUMMARY

A SeaBird Model SBE 911+ CTDs (#0550) was used during this cruise. It was mounted in a rosette and attached were a Wetlabs CSTAR transmissometer (#1005DR), an SBE 43 DO sensor (#0047), on the primary pump), a Seapoint Fluorometer (#2229) with a 10X cable (on the secondary pump), a Biospherical QSP-400 PAR sensor (#4656) and an altimeter (#43281). The deck unit was a model 911+ (#0619) and the logging computer was PAC02570 (HP Compaq#1). Seasave v7.12 was used.

A thermosalinograph (SeaBird 21 S/N 2487) was mounted with a Wetlab/Wetstar fluorometer (WS3S-713P) and flow meter. Temperature sensor #4652 was mounted at the intake.

SUMMARY OF QUALITY AND CONCERNS

The CTD and rosette logs were in good order and notes from the chief scientist were very helpful.

When duplicate samples are analyzed the method of naming is not consistent. On paper they are usually named with an 'a' or 'b' which is clear. But sometimes they are named by adding a '0' or '5' to the end, which frequently leads to trouble because the number may duplicate one used later in the cruise. It is recommended that either the 'a', 'b' method be used, or where that is not possible because programs won't accept that format, use a 4-digit sample number with a '9' as the first digit. This would be unambiguous. So, for example two sample #s 56a and 56b would be named 56 and 9056. Should there be a triplicate sample an 8 could be used, as in 8056.

The odd shifts in T and S below 2000db that were noted in the processing report for 2007-13 occurred during this cruise as well. These are very small shifts, but they are sudden and thus far unexplained. The most likely explanation for them is that one of the pumps is being affected in some way by high pressure.

No data were recorded from the top 19db of cast #3 (P2) or the top 13db or cast #18 (P8) and the upcast data are not suitable substitutes.

The altimeter did not work well for casts 6 and 13-56, so the header entries were removed.

There were many errors in the headers, including an “m” entered after some bottom depths; the “m” had to be removed for the data to be converted properly.

The dissolved oxygen bottle files had comments entered in the wrong place and the format was wrong for the flag channel.

The dissolved oxygen data in the CTD files should be considered

- ±0.4ml/l from 0 –150db
- ±0.2ml/l from150 – 400db
- ±0.1ml/l from 400 – 1200db
- data below 1200db are considered unreliable by the manufacturer.

There were many problems with Niskin bottles #13-18 closing prematurely, probably when other bottles were fired. There is some suggestion that the contents of those bottles may not be as homogenous as usual based on slightly larger differences among duplicates. The rosette files contain data from the firing pressure, but often the samples are clearly from lower in the water column. Where sufficient evidence exists the header comments indicate the probable level from which the samples came.

There are some doubts about the linearity of the Autosal. Since the error is largest for low salinity and small for salinity >34, it is not expected to affect the calibration of this cruise, since there were many deep calibration samples. Further testing of the Autosal was not complete at the time of processing.

Duplicate studies were done to test the reliability of Portasal salinity analysis at sea, including one test when 24 samples were fired at a single site and analyzed with two different salinometers. The range of values for the Portasal was 0.007 and standard deviation of 0.002. For the Autosal the range was 0.005 and the standard deviation was 0.0014. There were no obvious outliers, just a lot of scatter. Both salinometers show considerable scatter, but the Autosal looks better than the Portasal. Based on COMPARE and the Cast #55 study, the Portasal appears to be lower than the Autosal by about 0.0018 units. Where available Autosal salinity was selected for archiving, and where not available the Portasal salinity was used after being raised by 0.0018 to match the Autosal. It is recommended that this experiment be repeated occasionally on at least a limited basis to see if the results are the same.

There are 3 thermosalinograph files. In the 1st and 2nd files the intake temperature was not operating properly, so the temperature measured as the loop enters the lab was recalibrated to adjust for ship heating, based on the results of the 3rd file. The bulk of the data are in the 3rd file. Positions were not always available. The TSG track plot at the end of this report has one symbol per hour; the large gaps show where positions are not available.

Both loop chlorophyll samples and CTD fluorescence data suggest that the TSG fluorometer reads high by from 0.5 to 0.6ug/l.

PROCESSING SUMMARY

1. Seasave

This step was completed at sea; the raw data files have extension DAT.

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. Problems mentioned with individual casts are listed in the Particulars section at the end of the report. The following problems were noted that affect all or many CTD casts:

- The station names are written in inconsistent formats and need correcting.
- The rosette appears to have malfunctioned from P8 onwards, closing before the firing level.

Titrated chlorophyll, nutrients, DMS and salinity data were obtained in spreadsheet format. There are salinity data from a Portasal used at sea and an Autosal used at IOS. 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 transmissometer had not been recalibrated since October 2006, so it is better to use the post-cruise calibration that was done at IOS in March 2008. All other data were correct. A new con file was prepared using the post-cruise transmissivity calibration data and that file was named 2008-01-ctd.con.

3. Conversion of Raw Data

Data were converted using the configuration files as listed above. PAR was converted for all the CTD casts. It will be removed later from the casts for which it was not mounted.
Since it is known that there are many errors in station names, headers were examined and station names fixed and bottom depth entered, where needed, based on log entries. In many cases the bottom depth was entered with an "m" after the numbers; upon conversion to IOS HEADERS the information gets dropped because of the "m", so those needed to be removed.

A few casts were examined and all expected channels are present and look reasonable when plotted. The upcast temperature and conductivity traces are noisier and further apart than in the downcasts and the differences change sign between the down and up. The fluorescence has small spikes, but no major problems; the dark value is ~0.12ug/l. The transmissivity also has spikes at depth, but not huge ones. The dissolved oxygen shows the usual offset, but there is good detail in the profile, so the response time does not look too bad. PAR looks ok. The descent rate was extremely noisy for the offshore casts, but very steady for those near the end of the cruise. The altimeter has a very high noise level, but usually looks reasonable near the bottom. Despite the very rough conditions there is minimal spiking in the data, so the electrical systems worked well.

Rosette files were converted using a start time of -2s and duration of 5s and header station names and bottom depths were corrected as needed. The rosette files were then converted to IOS SHELL files. CLEAN was run to add event numbers and the output files were named *.BOT.

All BOT files were plotted. Many noisy sections were noted, but they were generally in both sensor pairs and so presumably reflect actual conditions at the time. CTDEDIT was used to clean stray spikes in primary salinity in casts #45 (bottle #19) and 46 (bottle #9) and from the secondary salinity of cast 45 (bottle #12). All primary salinity points were removed from bottle #11, cast #9, since they are varying a lot and look unbelievable and the secondary salinity looks near constant. The output editing files were copied to *.BOT.

One bottle was fired for cast #70, but no rosette file was created. The BL file is empty. The log notes that there were problems during the cast and it was believed that the sample came from near the surface. Looking at a plot of the full cast, it is clear that the CTD stopped at 5m and nowhere else except the bottom. So an appropriate range of scans was selected and patched into the BL file which was named 2008-01-9970.BL. The hex file was copied and given the same name, and conversion was rerun successfully. The data are very noisy, so the range in the BL file was adjusted a little which improved it a little, but examining the whole data set does show that there was high variability throughout the stop. The rosette file was renamed 2008-01-0070.ros. A note was added to the header about this problem.

No rosette file was created for cast #11. Many problems are noted in the log for this cast and no samples were taken. Cast #12 was the replacement rosette cast. No attempt will be made to create a rosette file for #11.

Because the salinity bottle data were not complete at this stage, a preliminary analysis was made of one cast with 12 bottles fired at 1500db, to see if either sensor pair has obvious problems. Those salinity samples had been analysed at sea on the Portasal. The average difference between the bottles was 0.003 for the primary and 0.001 for the secondary channels. The standard deviation was the same for both channels, 0.0019. There was considerable variability in the salinity (0.006 salinity units) but the differences between the two channels were remarkably constant, with a range of 0.0021 to 0.0025. A profile plot shows a lot of CTD motion at the bottom, which explains so much variation at depth. It is encouraging to see how well the two pairs of sensors tracked this motion. It appears that the secondary will be the better choice as it is a little less spiky and closer to the bottles, but this decision will be left until all bottle data have been studied.

4. WILDEDIT

The first attempt to run this routine failed for cast #46. A line was missing in the SeaBird headers (# nquan = 15). The cast was reconverted and the missing line appeared.
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

There were few casts suitable for testing for the best choice of parameters for CELLTM. Extremely noisy descent and ascent rates meant that the comparison was too corrupted by shed wakes. The few that had steady descent rates were in waters where significant temporal changes would affect the comparison. The only two casts that looked useful were #66 and 75. These were studied using settings (α = 0.01, β=7), (0.02, 7), (0.03, 7), (0.02, 9), (0.03, 9), (0.04, 7), (0.04, 9) and (0.0245, 9.5) to see what settings looked best for this cruise. The best choice overall was (0.02, 7) for both channels, though the differences were small for many. CELLTM was run using those values.

6. DERIVE

Program DERIVE was run twice:

on all casts to calculate primary and secondary salinity.

on a few 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. The differences are very noisy, especially in the shallow temperature, so these are very rough averages.

Cast #	Press	T1-T0	C1-C0	S1-S0	Descent Rate

1	200	+0.0009	-0.00027	-0.0035	High, Steady
24	200 1000 1450 2700 2800 2900	+0.0007 +0.0005 +0.0004 +0.0004 +0.0009 +0.0009	-0.0002 -0.0002 -0.0002 -0.00018 -0.00018 -0.00018	-0.003 -0.003 -0.0029 -0.0028 -0.0031 -0.0031	High, very noisy
55	200 1000 1450	+0.0005 +0.0005 +0.0003	-0.00019 -0.00023 -0.00015	-0.0023 -0.0025 -0.0023	High, very noisy
74	200	+0.0005	-0.0015	-0.0022	High, steady

None of these differences are large.

The salinity differences show no significant pressure dependence, but it was noted in cast #24, the only casts below 2000db that was examined, that there is a shift in differences at about 2564db. The change was only 0.0005C and 0.0003 salinity units, but it is odd. A report was made on similar observations during 2007-13 between 2100db and 2600db. Perhaps this has always been a feature of these instruments, but was never reported at IOS before that time. Different CTDs and sensors were used for these two cruises. The primary pump was thought the most likely source of the problem during 2008-01.

The salinity differences seem to go down with time, though these estimates are very rough and there are a number of other variables such as descent rate and local variability that might account for that.

8. Conversion to IOS Headers

The IOSSHELL routine was used to convert SEA-Bird 911+ CNV files to IOS Headers. Some files could not be converted because they were too big. STRIP was used to remove channels DESCENT_RATE and PUMP STATUS from casts 24, 34, 36, 40, 46 and 47 and then were converted successfully.
CLEAN was run to add event numbers and 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 and a few more station name errors were found and fixed. The water depth was missing for cast #46, the log entry is significantly lower than the maximum pressure sampled during the cast, so an estimate was made based on the maximum pressure plus the altimeter reading.

The cruise track was plotted and no problems found.

The average surface pressure is 1.5db, which seems a little low for the Tully. Cast #46 had surface pressures of -0.42db with “in-water” values and pumps on. Cast #70 in Rivers Inlet has a pressure of -0.2db at the end of the upcast; the salinity is low, but pumps were turned on and low salinity is expected near the surface there. For cast #73 the pumps were turned on at +0.5db which is surprising, so another indication that the pressure is reading low, though conditions were calm there so starting fairly shallow is reasonable. An adjustment of +0.5db looks advisable. The sensor was recalibrated in August 2007, but the older sensors are known to drift.

The altimeter readings from the header were exported to a spreadsheet and a few casts were checked. There is a lot of noise in the data for many casts, and the algorithm did not work well for casts #6 and 13-56. For these casts the altimeter reading was removed from the header of the CLN files. This was done for the SAMAVG bottle files as well.

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.
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.)

SALINITY

The salinity data were delivered in two series of spreadsheets, one for the samples analyzed at sea on the Portasal and the other for those run at IOS on the Autosal. The two sets were combined in two spreadsheets, 2007-16-autosal.csv and 2007-16-portasal.csv. There were a few problems in each set.

- For the Autosal set, there were two samples named 492a & 492b, so they were renamed as 492 and 9492.
- Some of the event numbers were missing from the Portasal data so those were added based on information in the log book. There was a sample named 140 in the spreadsheet which was not found on the analysis sheets. It looks like a second run on sample #14, so will be renamed #9014. Sample #2210 looks like a repeat of 221 and on the salinity analysis sheet the samples are called 221a and 221b, so 2210 was renamed 9221.

The loop data from each sheet were removed and combined in 2007-16-loop sal.csv. There is one sample #335 (P26) from the Portasal that is flagged “d” without explanation, but there is another sample #335 from the Autosal with no flag. The values are 34.4566 and 34.4575, respectively. When the Portasal salinity analysis sheets were checked there were 3 values 34.4595, 34.4567, 34.4593, so it is hard to guess where the Portasal value came from. Based on the time the sample was analyzed, it looks like it is a loop sample from P26 (which is missing), but the value suggests it is a deep sample.

A study of duplicates for each salinometer was made, but little can be concluded. There were many duplicate samples drawn, but most were run on different salinometers. There were 3 duplicates from the Autosal. For one pair the difference was 0.0002. For two of the duplicates there was also a value from the Portasal. For those cases one of the Autosal values stood out as an outlier among the 3 values. The differences between those two Autosal samples were 0.003 and 0.005.

For the Portasal 7 pairs of duplicates were found including 6 with an Autosal value as well. There were 3 values that are identified as outliers compared to the Autosal and the other Portasal values. Using the 4 duplicates that remain the average difference is 0.000015 and an SP value of 0.00017. This is encouraging, but there is probably not enough data to justify a precision statement for this data. See 2008-01-duplicates-sal.xls for details.

The chief scientist requested that Autosal data be selected for the archive where there is a choice. It will be useful to do COMPARE in two sections with Portasal and Autosal. The salinity files were simplified and the headers changed to standard names. File 2008-01-autosal.csv was converted to individual SALA files and 2008-01-portasal.csv was converted to individual SALP files. Cases of duplicates (from the same salinometer) were removed and either an average entered, or a note explaining that one of them was rejected as an outlier. These files will be used for two COMPARE runs.

Then the two spreadsheets were combined and rearranged on event numbers and sample numbers. Where there was a choice of Autosal or Portasal, the Portasal value was removed. An adjustment to the Portasal data was made by adding 0.0018 based on the study described below in section 12 and a flag “c” was added to the Portasal samples. A note was added in the comment column for all Portasal results so they can be identified later in the Archive and to indicate that values had been adjusted to match the Autosal. About one quarter of the values are from the Portasal. The combined spreadsheet was saved as 2008-01-sal.csv and converted to individual SAL files.

<u>DISSOLVED OXGYEN</u>

Dissolved oxygen files (*.add) were provided with a flag channel and comments entered in the headers. Unfortunately, the format was wrong (missing *COMMENTS) and the flags were misplaced by one or more spaces. Those items were fixed (casts 24, 35, 40 and 46). The comment for cast #46 is a little confusing as it says that flask numbers should be changed as the volumes are wrong. It is believed that this was fixed so the flags were removed. For cast #74 sample #9495 should be #496 judging from the value listed on the rosette sheet; this was changed in the ADD file. Some duplicates were taken and both were in the files. These were averaged, an "f" flag assigned, and a note added to the header comments listing both values. For cast #40 there are duplicates listed that don't make sense – I have interpreted sample #9282 as being the duplicate for #283. Since there has been a decision to increase the flag column width to 2, the ADD files were put through HEADEDIT to change the format from NQ2 to NQ3 for the flag channel.

<u>NUTRIENTS</u>

The nutrient spreadsheet was simplified and saved as 2008-01-nuts.csv. Extraneous columns were removed, header names were changed to standard format and lines were removed for which there was no sampling for all 3. Data were sorted on sample number. File 2008-01nuts.csv was then converted to NUT files.

<u>EXTRACTED CHLOROPHYLL</u>

Extracted chlorophyll data were obtained in file QF 2008-01CHL.xls. The file was edited to remove extraneous lines and columns, header names were changed to standard format, data were sorted on sample number, and the file was saved as 2008-01CHL.csv. 2008-01CHL.csv was converted to individual CHL files.

<u>DMS</u>

DMS data were obtained in file DMS 2008-01 summary.xls. There were duplicates for one sample for each cast. These were averaged and an f flag added.

The SAL, CHL, ADD, NUT and DMS files were merged with CST files in four steps. (Output: MRG1, MRG2, MRG3, MRG4 and MRG5), MRG5 was put through CLEAN to reduce the headers to File and Comment sections only (Output MRGCLN1.) That file was then merged with SAMAVG files (Output:MRG). Data were exported to a spreadsheet 2008-01-bottles.xls and compared to the rosette sheets to ensure all expected data are present. A number of problems were found and fixed.

One problem could not be resolved. According to the rosette sheets sample #304 was assigned to a bottle at 250db during cast #45 at P26. There is no salinity sampling noted for that sample. The salinity analysis sheet agrees with a value of 32.6208 for sample #304 and says it is from cast #45. But that value does not compare well with the CTD at that depth, and such a value can only be found for a few points around 4db for cast #45. The record was flagged "d".

11) Compare

<u>Salinity</u>

COMPARE was run twice using pressure as the reference channel.

The first run using bottles analyzed on an Autosal at IOS. There were many severe outliers, mostly from the casts mentioned by the Chief Scientist as having what looked like misfires of Niskin bottles. When outliers and all data above 150db were excluded, the primary salinity was high by an average of 0.0019 with a reasonably flat trendline, but a lot of scatter. The secondary was low by 0.0001 with a lot of scatter. There is no significant time dependence with the secondary being very flat with time, but the scatter is large.

The second run used bottles analyzed at sea on a Portasal. This data had many of the same outliers as for the Autosal data. When outliers and all data above 150db were excluded the primary salinity was high by an average of 0.0035 and the secondary, by 0.0017. Both show little pressure or temporal dependence, but the scatter means that slight variations in what is called an outlier makes a significant difference.

A separate run of COMPARE was done with Niskin Bottle # as the reference channel since it appears that some bottles closed at the wrong levels. There is clearly a problem with Niskin bottles #13 through 18 for some casts, but not all. The data were manipulated and colour coded to identify differences >0.01. Different colours were used to identify bottles that might be expected to be outliers because of high local gradients or noisy CTD data; this was based on salinity being <33 or standard deviation in the CTD being >0.001. Finally yet another colour was used to highlight differences that were not explained by CTD noise or being shallow. The unexplained outliers came from Niskin bottles #3 (74), 13 (24/ 35/ 40/ 46), 14 (24/ 35/ 40/ 46), 15 (24/ 35/ 40/ 46), 16 (24/35) and 17 (35). Niskin bottles #16 and 17 are out of line for a few other casts but the CTD data are also a little noisy. Niskin #18 is suspicious for cast #40. It does appear that something went wrong during casts 24, 35, 40 and 46, that caused Niskin bottles 13 through 17 to misfire and maybe #18.

To investigate this further, file 2008-01-bottles.xls was examined in detail. First large differences between bottle and CTD salinity were highlighted. Those that could be explained as surface samples were determined and a special emphasis was put on those with salinity differences >0.5. In each case the bottle salinity was higher than the CTD suggesting that they had closed prematurely. The dissolved oxygen, extracted chlorophyll and nutrients were also examined to see if it is only salinity that is bad, and if all are off, is there a constant offset – can we determine where they closed? Here are the casts during which bottles #13 and up were used:

- Cast #6: This was the first use of Niskin #13, and there is only CHL data. It looks ok. The only sampling from suspect bottles is near the surface in well-mixed waters, so while the pressure may be wrong, the T/S values are probably reasonably accurate.
- Cast #9: No IOS sampling. Sampled to 1300db. The only sampling from suspect bottles is near the surface in well-mixed waters, so while the pressure may be wrong, the T/S values are probably reasonably accurate.
- Cast #12: This looks ok for all properties. Sampled to 1300db. Lots of evidence.
- Cast #18: The sample from Niskin #13 is a minor outlier (~0.008) but the sign is wrong for premature closing. This record shows up as an outlier in DO and Nitrate vs CTD Salinity plot. But an examination of the CTD data shows an odd feature at about 150db and the CTD DO vs CTD Sal plot looks much like bottle vs CTD. And the standard deviation in the CTD data is high for Niskin #13. Sampled to 2000db. This cast seems ok.
- Cast #23: No IOS sampling. 2000db. The only sampling from suspect bottles is in the top 10db in well-mixed waters. All other bottles closed at 500db or deeper, so if the bottles fired at the surface really closed at the same time as bottles 8-12, it should be obvious..
- Cast #24: Big problems – Niskin bottles #13–17 look bad for all properties and bottle salinity looks a little off for bottles #12 and 18 but the former looks like it is related to local variability and the latter has a sign that shows it has nothing to do with premature closing. Nutrients seem ok for 12 and 18. This was the first very deep cast, went to 3266db. Bottle #13 was supposed to be

fired at 250db, but contents looks more like 1000db. There is a rough correspondence between bottles 13-17 and bottles below - Bottles intended to be fired at 250, 200, 175, 150 and 100db look like downcast data at 990, 978, 810, 610, 395. Bottle 18 probably fine.

- Cast #31: No bottle salinity and well mixed to the level where bottles 13 and up were used. Sampling to 300db. So this cast looks ok – there may have been premature closing, but the T/S data probably match those of the closing depth pretty well.
- Cast #34: No IOS sampling, went to 2000db. The suspect bottles were all supposed to be fired at 10db, so if there is a problem it will probably be pretty obvious to analysts since it won't look like surface water.
- Cast #35: Once again big problems. Sampling to 3671db. All properties look off for bottles #13-17 and bottle #18 little off, but wrong sign for premature closing.
- Cast #37: Shallow sampling, no bottle salinity, very well-mixed most of profile - no evidence of trouble. There could have been early closing of bottles, but the T/S data in rosette file are probably reasonably accurate. Don't know about other variables, FL looks well-mixed but Pressure and PAR is probably not useful.
- Cast #40: Big problems again in Niskin #12-18 – obvious in all properties.
- Cast #45: No useful bottle salinity; well-mixed so even if bottles fired early the T/S data should be reasonably close to in situ values of bottle. But pressures and PAR useless
- Cast #46: Deep cast 4300db. Lots of evidence that Bottles #13 to 16 are bad, but #17 & 18 look fine.
- Cast #47: Deep cast – little sampling for IOS and none using #13-#17– Should warn other researchers of potential problems as there could be trouble. Suspect bottles fired at 400 and 500db.
- Cast #51 to 2000m – No Bottle salinity. No evidence of trouble in nutrients, but well-mixed so wouldn't be obvious. Bottles may have closed early, but T/S data should be useful anyway. But can't determine pressure and PAR useless.
- Cast #55 to 1500m – only sampling at bottom, reasonable match there. Samples from the suspect bottles don't stand out at all, but all bottles fired at one depth.
- Cast #58: sampling to 425db. – Bottles #13, 14 and 15 at surface look questionable. There is only bottle salinity from #15 and it is clearly bad. DO vs CTD Sal looks bad and the CHL is very low (analyst commented on that), Nitrate high.
- Cast #61: Sampling to 320db. No salinity sampling from the suspect bottles. Bottle #14 is out of line in DO vs CTD Sal plot. No sampling from #13 and 15. #16 seems ok but hard to say.

CONCLUSIONS for Niskin Bottles #13-18 based on salinity (later other bottle data will be examined):
1. The following bottles are probably ok: cast 3 (all), 6 (all) 9(all)
2. The following bottles are definitely ok: Cast 12 (all), 18 (all), 24 (#18), 35 (#18), 46 (17 & 18), 55 (13-18)
3. We have insufficient evidence at this point to determine if the following are good or bad, and no way to correct them if we did know since there was no salinity sampling for the questionable bottles: 23, 27, 31, 34, 37, 45, 47, 61
4. We have good evidence that the following bottles were bad, but we have no bottle salinity so can't attempt to correct: 58 (13-14)
5. We have good evidence that the following bottles were bad, and since we have bottle salinity we might be able to make an estimate of pressure and temperature: 24 (13-17), 35 (13-17), 40 (13-18), 46 (13-16), 58 (15)

COMPARE was rerun using all the salinity data (Autosal where available and adjusted Portasal data if not). The resulting fit shows similar pressure dependence in both channels and the primary is high on average by 0.0014 and the secondary low by an average of -0.0005. If we assume that the Autosal data are reliable, then the secondary is close enough to the bottles that no recalibration is needed. This is what we expect, given these sensors were either never used before or recently recalibrated. When enough outliers were removed to get flat trendlines the primary salinity is high by 0.0017 and the secondary low by an average of 0.00017. There is a slight hint of time dependence, but it is almost the same for both sensors, so is more likely created by geographic variations.

No flags were added to samples from Niskins #13-18; this will be studied later.
Flag "d" and a header comment was added to each of the following outliers from other Niskin bottles based on COMPARE results and an examination of the full files:
Cast #15, sample #83 (only 1 bottle fired, looks like from deeper water – mixup or premature closing?)
Cast #45, sample #304 (this was flagged earlier as noted in section 10.)
Cast #70, sample #486 (only 1 bottle fired, looks like from deeper water – mixup or premature closing?)

Dissolved Oxygen
COMPARE was run using pressure as the reference channel. When differences >.5 and pressure>1200db were removed the fit was:

CTD-BOT = 1.0633 DOX-CTD - 0.0194

The membrane was replaced before this cruise and the instrument was recalibrated. (See 2008-01-dox-comp1.xls.)
The only severe outliers are the ones identified in the salinity comparison from Niskins #13-18. Flags will be added later.

Fluorescence
COMPARE was run using the CTD Fluorescence and the Titrated Chlorophyll from bottles. All values were low with the maximum 0.9mg/l for fluorescence and 1.0 for CHL. There is a lot of scatter in the fit of differences against Fluorescence and removing data from Niskin Bottles 13-18 makes little difference. Overall the fit gives CHL as either 70 or 75% of FL. There is little variation in differences with pressure, but the mixed-layer was deep for most of the casts. There is also huge scatter in a plot of FL/CHL against cast #, but it does show the ratio to be generally close to 1 for casts 3 to 18 and higher off-shore. At the end of cruise the ratio is extremely noisy, but there is a cluster of points with a ratio near 1. (See 2008-01-chl-fluor-comp.xls.)

All CHL data look reliable for casts 3, 6, 29, 36, 41, 43, 44, 56, 57, 60, 74. From other casts, most CHL data from 25db down and usually the surface bottles should be ok. But many bottles from 10 to 20db and a few deeper samples came from bottles that may have closed early.

12. Special Salinity Analysis Studies
A study was made of Duplicate Salinity from Portasal and Autosal. Part of this study was to look at the particular case of cast #55 during which 24 bottles were fired at 1500db.

First, the variations during cast #55 when 24 bottles were fired at 1500db were examined. The bottles were all analyzed on both the Autosal at IOS and the Portasal at sea (in single runs). The CTD data from the time of firing were examined and the variability was extremely low with standard deviations in salinity being ~0.0005 for the primary and ~0.0006 for the secondary and have ranges <0.002 from minimum to maximum values. The bottle salinities vary as follows:

	BOT Autosal	BOT Portasal	CTD Sal1
Average	34.4952	34.4934	34.4944
Standard Dev.	0.001445	0.001984	0.000574
Minimum	34.4924	34.4906	34.4932

Maximum	34.4972	34.4974	34.4951

For the cast #55 data analysis, the bath temperature was only 1C˚ above the room and sample temperatures for the Portasal, rather than the 3C˚ that is recommended. There is no obvious pattern in the values. The high standard deviations would suggest that the use of a Portasal at sea is less useful for recalibration purposes. The Autosal results were not great either, though decidedly better. As was found for the full comparison with bottles, the Autosal data were quite close to the secondary CTD salinity. The average difference between the two salinometers is 0.0016, with the Autosal higher.

For the wider comparison of the two salinometers, the two non-loop spreadsheets were combined in file 2007-16-auto-port-comp-sal.xls. All data which had been analyzed on only one salinometer were removed. The data were then rearranged so that the two types of salinometer could be compared. (In some cases there was 1 sample from one of the salinometers and 2 from the other.) The differences between the two salinometers were plotted against sample number. Outliers were identified by being outliers in that plot or by differences of >0.002 between duplicate samples on the same salinometer.

It was found that on average the Autosal salinity was higher than the Portasal salinity by 0.0029 with a standard deviation of 0.0069 when all data were included. When the data were broken down into groups analyzed during a single session, one day stands out as quite different from the others. The analysis of Feb. 11 gave Autosal salinity lower by 0.0015. When a few outliers plus the Feb. 11 data were removed from the mix, then the Autosal was higher by 0.0026 with a standard deviation of 0.0025. The following table summarizes the results for each session when outliers are excluded. A positive average indicates that the Autosal result was higher.

Date	Feb 3	Feb 9 page 1	Feb 9 page 2	Feb 10	Feb 11	Feb 16
Average diff	+0.0024	+0.0032	+0.0020	+0.0037	-0.0015	+0.0023
Std Dev	0.0014	0.0027	0.0021	0.0032	0.0030	0.0017
Temperature Bath/Samp/Rm	23/20/20	23/20/19	23/20/19	23/19-20/19	22/20/20	20.99/20/20

CTD salinity data were then extracted from the SAMAVG files and added to the spreadsheet. The primary conductivity sensor on the CTD was recalibrated shortly before this cruise; the secondary sensor was calibrated in 2007 but has never been used before as far as I know. There is some downward trend in the differences with time, but this may be a result of deeper sampling later. Outliers were identified with differences between the two sensors <0.001 and >0.004. When those were excluded the differences between the 2 CTD salinity channels was 0.0025 with the primary salinity higher. The Autosal salinity was lower than the primary salinity by an average of 0.0017 and higher than the secondary by 0.0006. The Portasal salinity was lower than the primary by ~0.0036 and lower than the secondary by 0.0011. So the Autosal is closest to the CTD, and very close to the secondary salinity. The standard deviation of the values included in this comparison was ~0.002 for the Autosal and ~0.005 for the Portasal.

From COMPARE we can calculate the difference between the two salinometers as follows:

Autosal – Portasal = (Sal0 – Portasal) – (Sal0 – Autosal)

From this we find that the Autosal is higher than the Portasal by either 0.0016 or 0.0018 depending on whether we use the primary or secondary CTD sensors to make the calculation. From the Cast #55 study we find a difference in the average salinity values of 0.0018.

The general study of duplicates suggested a larger difference, but there was a lot of variability in those results. Why would this be? One possible source of misinformation is that there were problems with some Niskin bottles. The biggest problems were for casts 24 and 35 as well as some of the bottles of casts 40 and 46. If this affects the Autosal-Portasal comparison, then since the samples were analyzed in batches for particular casts, the results for some days will be worse than others. Notably Feb. 9 would be very suspect, and Feb. 10 will have some problems and possibly a few from Feb. 11 will be affected. It is not clear why a misfire should affect. The results of Feb. 3 and 16 should not be affected

Based on this observation the duplicates were re-examined, outliers were removed aggressively (differences <0 and >0.0036 were rejected); the results then showed much less variation from day to day, but February 11 was still lowest and Feb. 9 highest. The standard deviations were reasonable ~0.001. What to make of this is quite unclear, except that this experiment may have been compromised by the problem with the Niskin bottles. If the bottles that closed prematurely were fired at a time when the local variability was very high – either on the fly or at the beginning of a bottle stop – it is possible that the contents of the Niskin bottles were less homogenous than usual.

A further complication arose late in the processing when a test was run on the Autosal linearity. This showed that though the results were good at 35psu, the Autosal read high by 0.009 at 30psu. If the errors are linear between those two values, it should not affect the comparison for this cruise very much as most samples used in the studies are from below 250m where the error would be <0.001. However, it does mean there is a bias to high values from the Autosal and that surface bottle salinity is apt to read high. It has been suspected for some time that the Autosal was reading high, but the fact that the error varies with salinity is new. If further tests confirm the initial results, a method will have to be derived to adjust the salinometer results appropriately.

13. 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. The usual shift of +24 records (1s) was found to be appropriate. This is the shift that has been used in most other cruises. (Output: SHFFL)

Conductivity

Tests were run on 4 casts using shifts between -1s and +1s and T-S plots were prepared to compare the results. A setting of -0.7s worked best overall for the primary sensor; -0.2s was best for the secondary. All casts were put through two runs of SHIFT using those settings. (Output *.SHFC0 and SHFC1).

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 there is an offset in values between upcast and downcast due to the time response, alignment will not produce traces that overlie each other exactly.
SHIFTS of from +90 to +140 records were tested and values from +90 to 110 looked best at different levels.
SHIFT was run using +100 records for all casts.

14. 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: The only warning was for cast #11 which was an upcast only.

15. DETAILED EDITING

An examination of a few casts shows no significant difference in the noise level in the two salinity channels. Both sensors are close enough to the Autosal salinity that recalibration would not be needed. The secondary is closest to the bottle salinity for both salinometers, and is especially close to the Autosal. The secondary channels were selected for editing.
Graphical editing was done using program CTDEDIT. On-screen plots of descent rate and pump status were also used. For the off-shore casts, the descent rate was generally very noisy and sometimes extremely noisy. Shed wake artefacts were removed where clearly visible, i.e. below the mixed layer. A few surface records were removed from most casts and salinity was cleaned.

Casts #1, 45 and 56-75 required light editing; all other casts required heavy editing. Note was made of the editing details in the headers of the relevant files.
Two casts did not have any data in the top 10db. Cast #3 starts at ~19db of the downcast, and cast #18 begins at 13.7db. The upcast data will not be useful substitutes due to bottle stops.

16. Initial Recalibration

The secondary salinity is close to the Autosal results. There are some concerns about the Autosal, but they do not appear to be significant for sampling from the depths used in the comparisons for this cruise. No recalibration will be applied.

File 2008-01-ctd.ccf was prepared to add 0.5db to the pressure and to apply the following equation to the CTD Dissolved Oxygen channel:

CTD-BOT = 1.0633 DOX-CTD - 0.0194

COMPARE was then rerun with the DO data to check that the results were as expected and they were. (See 2008-01-dox-comp2.xls.)
The same DO and pressure calibration was applied to the edited files.

17. 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.

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.

19. Other Comparisons

<u>Previous experience with these sensors</u> –
1. Salinity: All sensors have been recalibrated since last use and the DO sensor was repaired recently.
2. Dissolved Oxygen – This sensor was recalibrated in Feb. 2007, but no other data have been processed for which it was used.
3. Pressure – This sensor was recently recalibrated, but is older and prone to drift.

Historic ranges – Profile plots were made with historic ranges of T and S superimposed. No excursions from those ranges were found for casts for which local climatology was available.

Repeat Casts – There were a number of repeat casts including 2 very deep ones at P26 (casts 46 and 47). Other stations with repeat casts to at least 500db were P4 (6, 9, 10 and 12), P12 (23 and 24) and P16 (31, 34 and 35). For the P4 casts there was a lot of variation with differences along lines of constant σ_t of about 0.01Cº and 0.005 around 250db, but they were larger below that, with cast #12 looking significantly cooler and fresher. At P12 the two casts are virtually identical at 1750db with differences of 0.001Cº and 0.0002. The results were similar for P16 at 1900db. At P26 differences were 0.002Cº and 0.0003 at 2700db. Given the small differences for the deeper casts, it is assumed that the results for P4 reflect real variations.

20. Final Calibration of DO

The first recalibration of dissolved oxygen corrects for calibration drift. Shift corrects for transit time errors. A further correction will be applied to at least partly correct for response time. To do this we compare downcast data to bottle data from the same pressure.

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 1200m are excluded plus outliers including the many bad rosette bottles, the differences were quite flat when plotted against CTD DO value or pressure, with the CTD data being high by an average of 0.040ml/l. That should fit the highest and lowest values, but is not so impressive through the high gradient zone. (See 2008-01-dox-comp3.xls.)

The thinned files were recalibrated by subtracting 0.040 and the comparison was rerun. That showed that the results were good. (See 2008-01-comp4.xls.)
Recalibration using file 2008-01-recal2.ccf was applied to the downcast files only. (AVG and CLIP) to subtract 0.040ml/l. (Output: COR2 and CLIPCOR)

The clipped, recalibrated files were 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 created by filtering before bin-averaging. The SAMCOR1 files were 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. Special note was made of the Niskin problem.

21. 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 casts #8-24, 28-30, 34-36, 40-44, 46-75 because the instrument was not mounted on the CTD for those casts.

A second SBE DO channel was added; REORDER was run 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

- *±0.4ml/l from 0 –150db*
- *±0.2ml/l from150 – 400db*
- *±0.1ml/l from 400 – 1200db*
- *data below 1200db 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.
A header check turned up a few problems which were resolved.
Profile plots were made and no problems were found.
The track plot looks ok. The cross-reference lists turned up no problems.
As a final check of dissolved oxygen data % saturation was calculated and plotted. The near-surface values for offshore casts ranged from 98 to 103% and closer to shore they ranged from 89 to 99% except for cast #1 in Saanich Inlet with 83%.

22. Study of pressure where Niskin bottles closed

Because researchers will want to know where the water in the suspect bottles really came from, a study was made of the bottle salinity and DO to see if there are any patterns to the bottle firing, and any possible way to make an estimate of the level at which the bottles closed.

The first step was to find any bottle salinity and DO samples from bottles 13 to 18. A search was made in the recalibrated, bin-averaged downcast files to find at what depth such values could be found. There are many sources of error in this analysis:

- The upcast and downcast can differ significantly especially for the shallow water. We don't have any way of estimating density for the bottle data, so there is no way to address this issue.
- There may be an error in the Autosal that affects low salinity more than high; below 250db this should not be significant.
- Small errors in the salinity will represent a significant difference in pressure for the deeper samples. For example an error of ±0.002 amounts to ±12db at 2500db for one cast tested. Near the surface this should not be such a large error unless the water is very well-mixed.
- For DO the deep values vary little, so a small error will lead to an even larger error in pressure.

First, casts #12 and #18 were examined because those were ones for which the bottle data seem to be ok. Looking at the differences there will give us some idea of what size errors we can expect, although there is no sampling below 150db so this is a limited result. An error of ±25db was found for salinity-based estimates and ±50db for DO based estimates.

Bottles #13 and #14 generally have values that are close. It looks like they closed at about the same level as Bottle #8. Bottle #13 appears to have been fired a short distance below #8. Bottle #18 looks ok except for cast #40. The matches are suggestive that each of bottles 13 through 17 fired at roughly the levels of bottles 7 through 11, respectively, but the matches are not thoroughly convincing. Based on this result it was decided that the emphasis should be on examining the upcast data since at least some of the bottles probably closed while stopped for other bottles.

The spreadsheet 2008-01-bottles.xls was used to compare the bottle salinity with the CTD salinity from the same bottle, and from bottles below it. The following conclusions were reached for casts 24, 35, 40, 46 and 55 where there were many bottles with salinity samples:

- Bottles #13 and 14 closed at the same time as #8. Comparing bottle salinity values shows a random distribution as to which is highest, suggesting that all closed while the CTD was stopped. If firing #8 caused the premature closing, they should be just as well mixed, though it is possible, that something else caused the closing and it could have been at the beginning or end of the stop period.

- Bottles #15 and 16 match the results for #9 and 10 for all casts where the comparison was possible after cast #18.
- Bottle #17 looks like it closed at about the same time as bottle #11 except for cast #46 during which it seems to have fired at the right time. The firing pressures for 11 and 17 were the same for all these casts, so there is no obvious explanation for #46 being different.
- Bottle #18 usually closed at the firing pressure except for cast #40 when it closed at about the same time as #12. Again there is no obvious explanation for this.
- Cast #55 was different; since all bottles were fired at the same pressure, there was not a lot of variation, but the bottle salinity fit the CTD salinity best with no offset in bottle #s. So it appears that all bottles were fired at the same time as they closed.
- Nutrients were checked to see if this correspondence fits those data. In a few cases the nutrients from bottle #13 look more like #7 than #8, which would make mathematical sense, but the salinity does not support this. And more often they look like #8.

CONCLUSION: Bottles frequently closed prematurely between sometime after cast #18 and the end of the cruise. When bottles closed prematurely, the best match we can find is to use the rosette data from bottles as follows:

Actual Niskin Bottle #	Best Match Niskin Bottle #
13	8
14	8
15	9
16	10
17	11
18	12

All samples from bottles 13 through 18 will be flagged “d” from casts 24 onwards. A note will be put in the header about each sample indicating whether there is specific evidence that is relevant to figuring out what pressure the sample came from.

All DMS data from cast #27 were flagged “d” as some are clearly bad and the pattern does not fit that of premature closing of Niskin bottles.

23. Final Bottle Files

At this point the MRGCOR1 files were edited. All properties were flagged “d” for bottles 13-18 for casts 23 to the end of the cast. Specific header notes were added where there was evidence to suggest when the bottle closed. A comment was entered for Cast #55 but no flags were assigned; while the bottles may have closed out of order, this would not affect properties significantly.

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 casts #8-24, 28-30, 34-36, 40-44 and 46-75 because the instrument was not mounted on the CTD for those casts.

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 following comments were entered:

Analysis methods:

Chlorophyll samples were analyzed at sea using Chemistry Turner Designs fluorometer which was calibrated in May 2007 using pure chlorophyll a. Chlorophyll precision was determined by analyzing replicate samples drawn from one Niskin. For details see worksheet "Precision" in file QF 2008-01CHL.xls.

Oxygen samples are analyzed on an automated Winkler titration system following the procedures of Carpenter (1965). Samples were analyzed at sea using an automated titration system consisting of a Brinkman Dosimat (model 665) and a PC 900 Colorimeter.
For details on precision see file 2008-01-DO-duplicates.xls.

Salinity samples were collected in glass bottles and analyzed on a Guildline model 8400B Autosal or a Guildline Portasal 8410A. Salinometers are standardized with IAPSO standard seawater.
See file 2008-01-duplicates-sal.xls for information on precision.

Nutrient samples were collected in plastic tubes and analyzed fresh at sea using a Technicon AAII autoanalyzer following methods described in Barwell-Clarke and Whitney (1996). For details on nutrient duplicates and precision see file QF 2008-01nuts.xls, worksheet "precision".

DMS data are provided by C.S. Wong and researchers are asked to contact him before using them. The minimum detectable level for DMS is 0.10 nM, so "0" values should be interpreted as <0.10. For details on the collection and analysis of the DMS data see file 2008-01 DMS Report.doc.

References:
1. Carpenter, J.H. 1965. The Chesapeake Bay Institute Technique for the Winkler Dissolved Oxygen Method. Limmnol. & Oceanogr., 10: 141-143.
2. J. Barwell-Clarke and F. Whitney. 1996. Institute of Ocean Sciences Nutrient Methods and Analysis. Canadian Technical Report of Hydrography and Ocean Sciences, No. 182, 43 pp.

WARNING: All samples from Niskin Bottles #13 to #18 should be treated with care. While the CTD data corresponds to the level at which the bottle was fired, in many cases the bottle closed earlier. Notes in the headers of individual files indicate the probable level at which bottles closed, where evidence exists to make that estimate.

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

24. Thermosalinograph Data

a.) <u>Checking calibrations</u>

There were 3 identical files containing TSG data. All parameters were entered correctly. A copy was saved as 2008-01-TSG.con.
The history of the T/S sensors was obtained; they had been recalibrated since last used.

Notes from the log that affect the TSG processing include:

- The TSG fluorometer seemed unresponsive, possibly due to a film build-up.

- The TSG lacks lat/long positions except at the beginning of each file. This information will be retrieved elsewhere. Loop samples were taken at the same time as the 5m-Niskin for casts 47, 56, 57 and 73.
- For casts P21 and P35 there are only loop samples, as the CTD cast was cancelled. There were 17 loops between P26 and Hakai Passage (named 1-18, no #11).
- The secondary temperature had no flow until 6:20 on Feb. 4.
- Feb. 11, 2001: TSG Fluorometer brushed
- The flow was interrupted to clear a blockage in the flow meter between Julian Day 47.2 and 47.3.

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, Salinity:T0:C0 and Time Julian and then converted to IOS HEADER format. The Latitude and Longitude were bad, so that data was obtained from other files and provided by the Chief Scientist in spreadsheets 2008-0001 TSG.xls, 2008-002 TSG.xls and 2008-0003 TSG.xls. Some positions are missing – pad values will be inserted for those in the conversion process.

The XLS files were edited to add a scan column and a header row and were saved as CSV files with names in the format 2008-01-0001.csv. They were then converted to IOS format with extensions IOS2. Merge was then used to add the latitude and longitude from the IOS2 files to the IOS files using scan number as the merging channel.

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.

Time-series plots were produced. As indicated in the notes from the log, the secondary temperature is of no use in the first and second file, but looks ok for the third. All other channels look ok and an initial comparison of 2 CTD casts against TSG temperature and salinity looks reasonable.

The flow rate is ~1 with a few interruptions.
A preliminary track plot looks ok – because of the gaps in positions a plot was produced with symbols every 120 records (1 per hour) rather than drawing a line between positions. This looks useful and a better way to handle TSG plots in general.

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 4db and exported to a spreadsheet 2008-01-ctd-surf4.xls. The TSG files were opened in EXCEL, median and standard deviations (over 2minutes) were calculated for temperature and salinity, and the file was then reduced to the times when CTDs were run. Those files were combined in a spreadsheet (2008-01-ctd-tsg-comp.xls). Data were removed where there were no TSG data available. The positions were compared and were very close, with average differences for both latitude and longitude of <0.0001º and no difference greater than 0.0004º so the clock appears to have worked well.

This spreadsheet will also be used in step (e) to compare temperature, salinity and fluorescence.

d.) Alignment check

Recent uses of this equipment showed no alignment problems. There are variations in alignment, but they are not systematic. This step was skipped.

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

- T1 vs T2 The average difference over the whole record shows the TSG temperature to be high by 0.192. The median gives the same result.

- 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 41 casts that could be used. Graphs were prepared comparing the TSG temperature, salinity and fluorescence with those of the CTD.

  The temperature differences were plotted against standard deviations in the TSG temperature; there were only 28 casts with intake TSG temperature available and 6 of those were associated with noisy TSG data. From the 22 casts that remain the TSG was found to be high by an average of 0.179C° (or by 0.164C° when all data are included). The intake temperature was higher than the CTD by 0.01 when outliers were excluded and by 0.011 for a section in which the noise level is relatively quiet.

  For salinity there is more noise and while eliminating casts with large standard deviation produces some improvement, there is still a lot of scatter. The TSG salinity is low by an average of 0.146 if all data are included, by 0.083 if some outliers are excluded. Looking at a plot against cast #s there is a quiet section where the average indicates the TSG is low by 0.057. That section includes casts #40 to 47 where surface waters were very well-mixed making for a better match.

  The ratio of TSG fluorescence to CTD fluorescence ranges from 1.2 to 2.4 with a mean of about 1.7. This is slightly lower than during 2007-01 (2.3) at the same time of year. The fit of TSG vs CTD fluorescence is approximately

  TSG Fluorescence = CTD fluorescence + 0.5ug/l.

  (See 2008-01CTD-tsg-comp.xls)

- Loop Bottle Comparisons There were 26 loop bottles. The times were found in the log book, but that information was missing for a few samples. However, there appeared to be a pattern of taking samples every 6 hours, so that was assumed. The corresponding salinity values (using a median over a 2-minute window) were found in the TSG files. For 3 loop samples there was no TSG data.

  A plot of salinity differences between the TSG and Loop samples showed a lot of scatter, with 2 extreme outliers and 5 other outliers. The average of the differences when 8 outliers were excluded showed the TSG to be low by 0.053. The median difference indicated it was low by 0.049 when all data were used, by 0.049 when 2 extreme outliers were excluded and by 0.047 when 8 outliers were excluded. (See 2008-01-loop-sal-TSG-comp.xls.)

  When loop CHL is plotted against TSG fluorescence, the trendline is:

  TSG =~0.98*CHL+0.63.

  (This is similar to the fit of TSG against CTD fluorescence.) The average ratio of TSG FL/ Loop CHL is 2.6 and the median 2.5 if all data are used and 2.4 if the two highest values are excluded. The offshore casts have a slightly lower ratio. Near-shore, there is greater variability. (See 2008-01-loop-chl-TSG-comp.xls.)

- Calibration History The TSG primary temperature and conductivity were recalibrated in December 2007. This was the first used since recalibration. At this time of year the heating in the loop is usually found to be about 0.20C° or 0.22C° though in 2007 it was lower at about 0.14C°.

Conclusions
The lab temperature is higher than that of the CTD by about 0.179Cº and the intake temperature by about 0.192Cº averaged over the whole record. A plot of differences versus CTD temperature shows that there is more heating when the in situ temperature is lower. At 5ºC there is a rise of 0.21Cº, while at 7ºC it is just 0.13 Cº. For this cruise there is a need to recalibrate the lab temperature for the first two files, but not the third because there was an intake thermistor working for that one. The fit found is:

Correction to Lab Temp = 0.038 * In situ Temp – 0.3954

We don't know the in situ temperature; however, the lab temperature is within 0.2 Cº of the in situ temperature, and in fact, probably somewhat closer since the near-shore temperatures were in the range 6 to 8ºC, so using the lab temperature in the correction would not introduce a significant error. A more serious problem is that we don't have a lot of data and there is a fair amount of noise in the data. During cruise 2007-13 when there was a lot of data the following fit was found:

Corrected Temp = Lab Temp + 0.01 * Intake Temp - 0.23

With that fit when the intake temperature is 23ºC there is no correction. This makes sense, as the ship temperature would be in equilibrium with in situ water temperature. When the offset to the fit for this cruise was forced to be -0.23, the slope was also found to be 0.01. However, the 2007-13 result is from early summer. To allow for that fact that the ambient temperature of the ship might be lower for this cruise, fits with different offsets were examined, but they did not fit the data as well. So the fit from 2007-13 will be applied. One thing this study shows is that it is a good idea to study this issue even when we have intake temperature available, since it may prove valuable for another cruise when it is not.

The intake temperature is higher than the CTD by about 0.01Cº. When we only look at data when the standard deviation in the TSG temperature is low, that difference is much smaller ~0.002 Cº which is as close as we could expect to come. No recalibration will be applied to the intake temperature.

The salinity is lower than that from the loop by about 0.053 and lower than the CTD by 0.08 or by 0.057 in the quietest section. The TSG salinity will be recalibrated by adding +0.055.

While there was a note in the log book that the TSG fluorescence seemed unresponsive, the comparison to loop and TSG do not suggest any problem other than an offset. It is likely that fluorescence was less variable than usual.

f.) Editing
The time-series plots were examined and the only large spikes were a few in fluorescence; they were not removed. There are two sections in file 3 with near-zero flow rate on Feb. 5 and Feb. 15. The latter interruption was noted in the log as a stop to clear a blockage. The former occurred during a period of very bad weather. CTDEDIT was used to remove the two temperature channels, the salinity and the fluorescence from the "no flow" periods of file 2008-01-0003.atc. Copies of the ATC files were saved as ED2 for the first two files, so that there is an ED2 file for all the TSG data.

g.) Recalibration
CALIBRATE was used to apply equation

Temperature:Primary = Temperature:Primary * 1.01 - 0.23

for files 1 and 2 and an offset of +0.055 to Salinity:T0:C0 for all files. No correction was applied to fluorescence or Temperature:Secondary.

h.) Preparing Final Files
REMOVE was used to remove channels Scan_Number, Temperature:Difference, Conductivity:Primary, Flag and UPloy0 (flow rate) from all files, plus Temperature:Secondary for files 1 and 2..

Reorder was run to put Temperature:Secondary before Temperature:Primary so that programs will selectively pick the intake channel.

HEADER EDIT was used to add a comment, change the DATA TYPE to THERMOSALINOGRAPH and add the depth of sampling to the header. For file #3 the name of channel Temperature:Primary was changed to Temperature:Lab and Temperature:Secondary to Temperature:Intake. The comment for files #1 and 2 includes a note to indicate that the Temperature:Primary was recalibrated to correct for heating in the loop based on the historic observations and data from file #3.

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.

Loop file 2008-01 loop.xls augments loop samples with surface rosette values so there is data for every cast. Salinity values analyzed on a Portasal were adjusted by adding 0.0018 to be consistent with the Autosal results as reported in section 12; flags and comments were added. Channel names were changed to standard form (except for the CTD in some names). An event # column with all 1's was added to enable conversion. The date and time formats needed to be adjusted. The file was converted to IOS format, put through CLEAN and HEADEDIT to get start and stop times and positions, and add general comments. The final file was named 2008-01-surface.loop.

Particulars:
1. 11 bottles sampled for SI cast. Other bottles closed to test rosette only.
3. Downcast data not recorded until 18.9db.
10/11. Lost communication with the water sampler. New file started on upcast.
12. Problem @600m – model message from carousel.
14. 8 bottles closed at 600m for bulk water, no sample numbers assigned. There are sample #s for 2 other bottles.
18. Downcast data not recorded until 13.7db.
28. 2 bottles closed at 5dbar, no rosette log.
31. When last Niskin was closed the rosette was half out of water, so file was closed and another opened without recording to close bottle 22. Sample 199 should go with bottle 21, not 22.
35. Possible error in OXY file pressure.
36. Large swells, odd negative descent rate.
40. Flakes in sample #266 DO.
42. Lost weight – had a spare.
46. Primary salinity problem on up cast, cleared at 400m.
56. Rosette problems. # of Niskins closed does not match # fired.
69. No samples – problems with rosette.
60. Problems with rosette, some fired, but probably at surface. Use salinity to confirm.
74. Some confusion over where bottles tripped.

Institute of Ocean Sciences
CRUISE SUMMARY
CTD

CTD#	Make	Model	Serial#	Used with Rosette?	CTD Calibration Sheet Competed?
1	SEABIRD	911+	0550	Yes	Yes

Calibration Information

Sensor		Pre-Cruise		Post Cruise	
Name	**S/N**	**Date**	**Location**	**Date**	**Location**
Temperature	4752	06Mar07	Factory “		
Conductivity	3321	13Mar07	“		
Secondary Temp.	2968	22Aug07	“		
Secondary Cond.	3038	11Oct07	“		
Transmissometer	1005DR	24Oct06	IOS	5MAR08	IOS
SBE 43 DO sensor	0047	06Feb2007	Factory		
PAR	4656		IOS		
Fluorometer	2229		IOS		
Pressure Sensor	75636	20/08/2007	Factory		
Altimeter	43281	?	?		

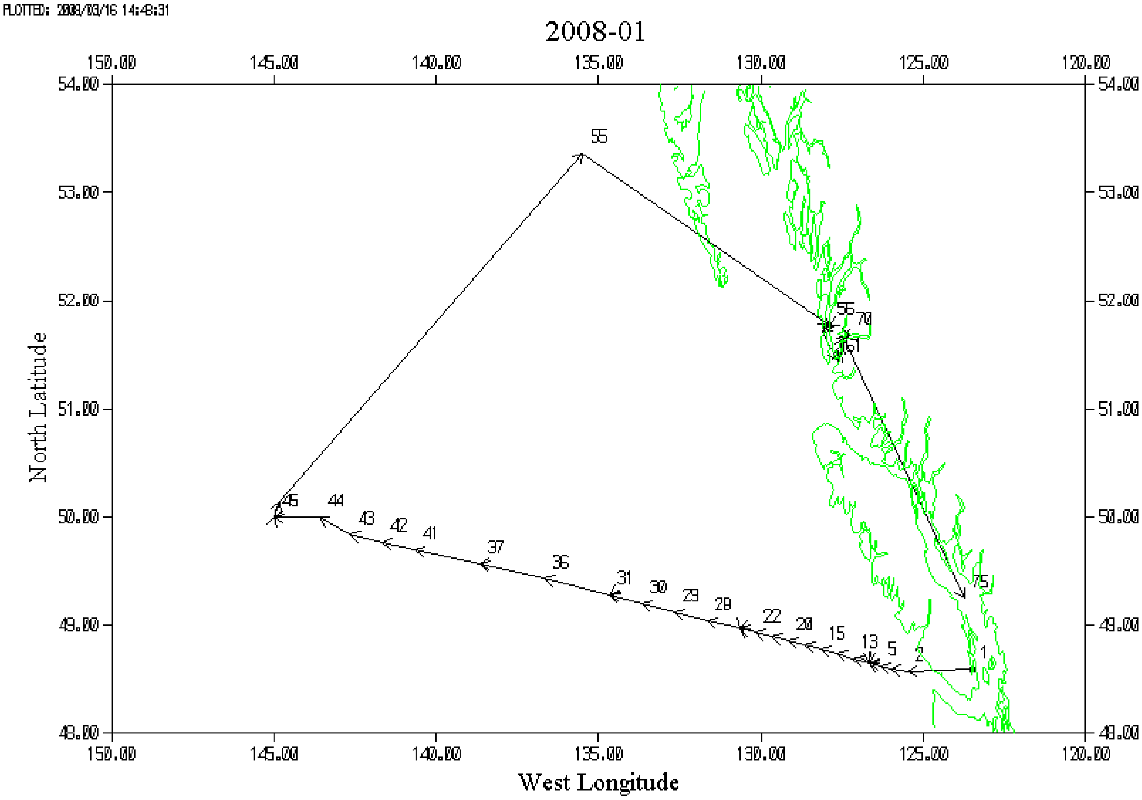
TSG

Make/Model/Serial#: SEABIRD/21/2487 **Cruise ID#:** 2008-01

Calibration Information

Sensor		Pre-Cruise		Post Cruise	
Name	**S/N**	**Date**	**Location**	**Date**	**Location**
Temperature	2487	01/12/07	Factory		
Conductivity	2487	01/12/07	“		
Wetlab/Wetstar	WS3S-713P	8/01/01	“		
Temperature 2	4652	22/Dec/06			
Flow Meter	?	?			

PLOTTED: 2008/03/16 14:48:31



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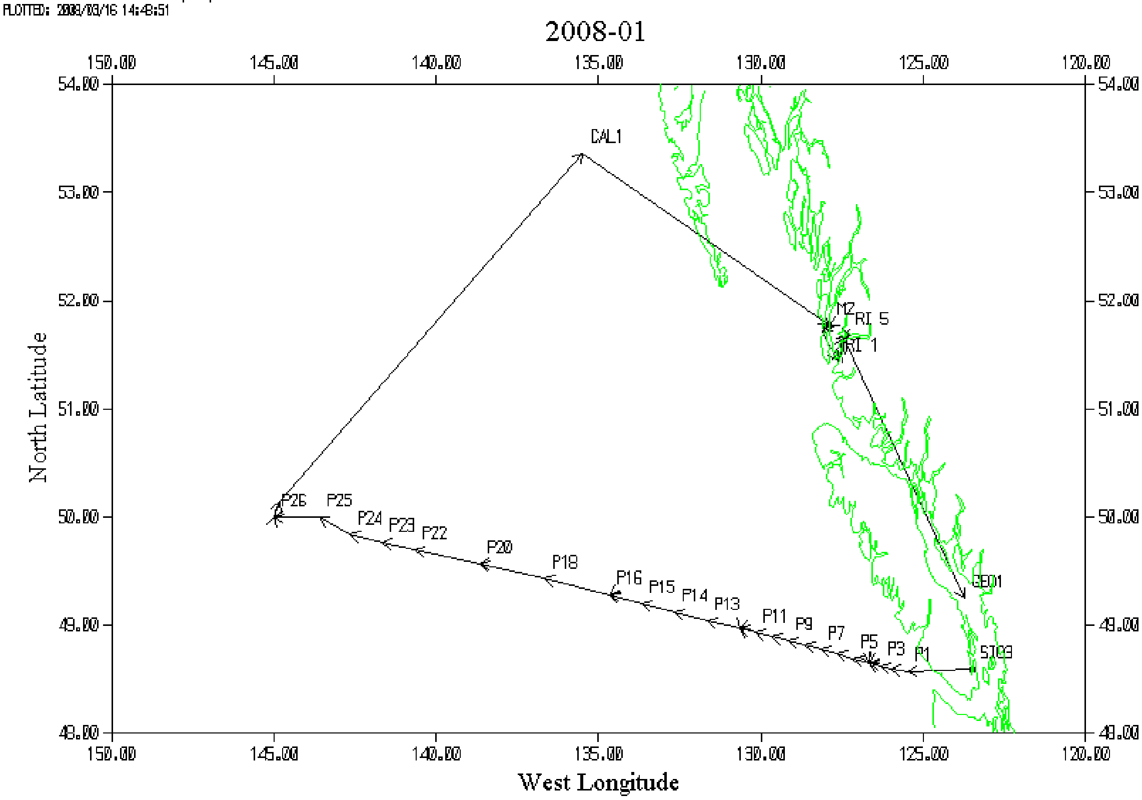

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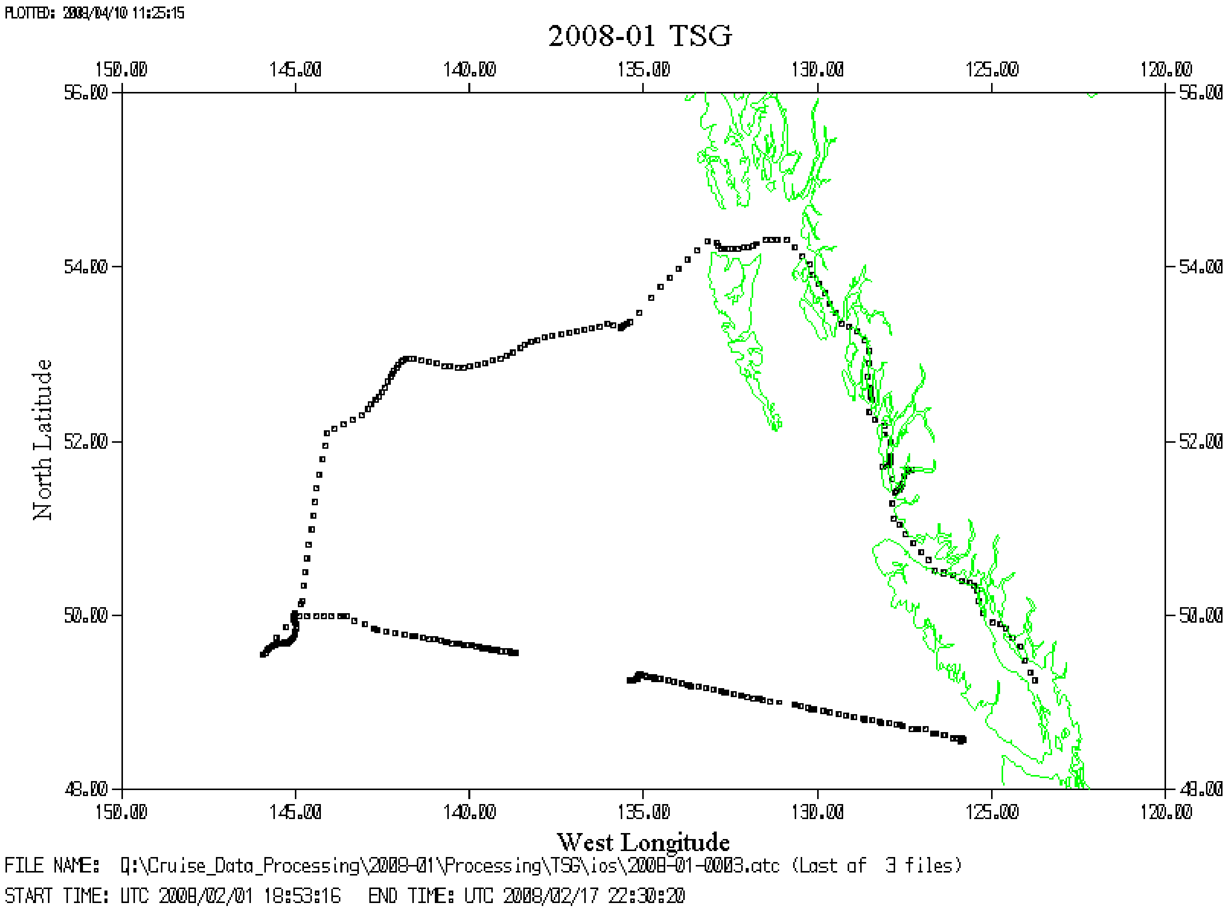

PLOTTED: 2008/04/10 11:25:15
2008-01 TSG
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140.00
135.00
130.00
125.00
120.00
56.00
54.00
52.00
50.00
48.00
North Latitude
West Longitude
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START TIME: UTC 2008/02/01 18:53:16 END TIME: UTC 2008/02/17 22:30:20