REVISION NOTICE TABLE

DATE	DESCRIPTION OF REVISION
8 July 2013	Corrections to Nitrate and Phosphate data; see headers for details.
20 June 2012	Few CHL values adjusted due to problems found during HPLC analysis.
26 June 2012	TSG files and related documents added – details in section 25. G.G.

PROCESSING NOTES

Cruise: 2011-27
Agency: OSD
Location: North-East Pacific
Project: Line P
Party Chief: Robert M.
Platform: John P. Tully
Date: June 3, 2011 – June 26, 2011

Processed by: Germaine Gatien
Date of Processing: 19 January 2012 – 27 April 2012
Number of original HEX files: 45
Number of CTD casts: 43
Number of bottle casts: 42
Number of original TSG files: 5 (Not processed)

INSTRUMENT SUMMARY

SeaBird Model SBE 911+ CTD (#0550) was used for this cruise. It was mounted in a rosette and attached were a Wetlabs CSTAR transmissometer (#1396DR), an SBE 43 DO sensor (#1176), a Wet Labs Eco-AFL/FL Fluorometer (#2216), a Biospherical QSP-400 PAR sensor (#4601) and an altimeter (no serial # available).

The deck unit was a Seabird model 11, serial #0471.
All casts were run with the LARS mid-ship station.
The salinometer used at IOS was a Guildline model 8400B Autosal, serial # 68572.

A thermosalinograph (SeaBird 21 S/N 3363) was mounted with a Wetlab/Wetstar fluorometer (WS3S-713P), remote temperature sensor #0603 and a flow meter.

SUMMARY OF QUALITY AND CONCERNS

The CTD log had an equipment list, but the altimeter serial number was missing from the log and from the configuration file. The Chief Scientist provided sampling notes with a good description of problems relevant to processing. For the first time there was an underway loops log which is extremely helpful. The rosette logs were generally in good order and notes from the Chief Scientist were very useful. Two casts were split into two files each.

Errors in header format prevented station name and water depth information from appearing in the IOS headers, so the hex files had to be edited. The colon is critical in entries like STATION: B1 and Depth (m): 125. Entries that apply to the whole cruise are easy to fix, but those that vary from cast to cast are not. This has been a recurring problem from 2011 Tully cruises.

Salinity samples were analyzed in two batches. Only those run in November are included in the final bottle files; the January samples were used to study the effect of long storage before analysis. This study

confirms that a 4-month wait leads to significantly lower quality. A later cruise using the same sensors but with analysis within 1 month shows secondary salinity calibration errors below 200m to be <<0.001.

The WetLabs ECO fluorometer was used for this cruise. It does not need to be pumped but has a poorer time response than the SeaPoint fluorometer and the alignment needs a larger correction. The traces are much smoother than from the SeaPoint, but in 2012 it was discovered that this can be improved by changing the sampling rate of the sensor.

A study was made of the effect of applying the hysteresis correction in the derivation of dissolved oxygen. The results show that errors below 2500db are reduced. At 4000db the difference between titrated samples and CTD DO was reduced by an order of magnitude, from 0.11mL/L to 0.01mL/L. The use of the correction may adversely affect DO data above 2000db, but the error appears to be minimal, <0.01mL/L.

The Oxygen:Dissolved:SBE data are considered, roughly, to be:

±0.5mL/L from 0 to 100db
±0.2mL/L from 100db to 400db
±0.08mL/L from 500db – 2500db
low by ~0.04mL/L below 2500db

Large sections of the thermosalinograph record lack positions but have time. Missing data were obtained from ship position files by matching times.

TSG salinity has been recalibrated based on comparisons with loop samples, rosette samples and the history of the instrument. The salinity reads lower relative to loop samples when the ship is stopped than when it is underway. There is no obvious change in flow rates, but both lab and intake temperatures show a tendency to rise early in a stop, maybe due to shallower water getting into the loop or due to heating from the ship. The ratio of TSG fluorescence to loop extracted chlorophyll is twice as high during stops than underway, but that may be because the majority of underway loops came from nearer shore where extracted chlorophyll tend to be higher which generally leads to a lower ratio of fluorescence to extracted chlorophyll.

Two changes have been made to processing methods for all cruises that occurred from January 2011 onwards:

- A new approach is being taken to the recalibration of the SBE Dissolved Oxygen data. The voltage channel is compared with bottles to find the slope and offset to enter in the configuration files. This method is the standard approach and is recommended by SeaBird.
- The transmissivity conversion has also been changed slightly so that it follows the method outlined in SeaBird Application Note 91. For more information on this see the document in folder: OSD_data_Archive\Cruise_Data\DOCUMENTS\Transmissivity

PROCESSING SUMMARY

1. Seasave

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

2. Preliminary Steps

The Log Book and rosette log sheets were obtained as well as sampling notes summarizing problems and points of interest with reference to processing. Errors in file name format for 3 casts were corrected in the raw files.

Extracted chlorophyll, nutrients, dissolved oxygen, salinity and DMS data were obtained in spreadsheet format from the analysts. The file creation date was added to the names of those files to avoid confusion in case some changes need to be made later. The draw temperature was recorded for DO sampling so concentration can be calculated in mass units as well as mL/L.

The cruise summary sheet was completed.
The history of the pressure sensor, conductivity and DO sensors were obtained. All had been recalibrated shortly before this cruise.

The calibration constants were checked for all instruments. The only error found was a small mistake in the PAR calibration constant. That was corrected and the file was saved as 2011-27-ctd.xmlcon. A single file was converted; all channels were present and the data look reasonable though the difference between T and C channels is much higher when in motion during the upcasts than for the downcast or while stopped for bottles. This suggests an alignment problem that might be caused by the rosette package being at an angle, or the secondary pump might not be operating efficiently on the upcast.

The PAR sensor was not always mounted. Based on notes from the chief scientist cast lists were prepared with and without PAR so that it will be easy to remove PAR as appropriate.

A colon was missing between the station name and depth labels and entries in the hex files for casts #1-20, The same thing occurred during several other spring/summer 2011 Tully cruises and is known to cause these entries to be missed when the files are converted to IOS HEADER format. TO correct this, the hex files were edited. This is easier than fixing both ROS and CNV files.

3. Initial Rosette File Conversion and DO Calibration Study

In order to study the SBE Dissolved Oxygen sensor calibration, rosette files were converted that included Oxygen Saturation (ml/l) and bottle position. The ROS files were converted to IOS HEADER format. Those files were put through CLEAN to add event numbers (*.BOT). The BOT files were then averaged to enable an ADDSAMP file to be prepared so that sample numbers can be added to the BOT files to produce SAM files. (Since bottles were fired out of order, the file was 1st ordered on bottle position, sample #s added and it was then reordered on bottle number.) Sample numbers were added to the ADDSAMP file based on rosette log records.

Note that while in general the sample numbers were entered in order of Niskin bottle #, cast #7 was an exception. Also there were two casts that were split. Only files 6/7 needed to be combined. The BOT files were renamed as 2011-27-0006.BOTx and 2011-27-0006.BOTy. The BOTy file was opened in Ultraedit to change the bottle numbers to match the rosette log sheet. The latter was not completely clear. In the BOTy file there are 3 firings at ~5m, whereas only 2 are shown on the log sheet, though there is a note from the Chief Scientist that Niskin #11 was fired at 5m but not sampled. There are errors in the firing order shown on the log sheet, but the Niskin #s agree with the bottle file entries when Niskin #s are matched, so as long as the sample numbers are assigned to the right Niskin #s, the building of the bottle files should work. Care will be needed in the MERGE stage because of the unusual sample # order.

File #10 was renamed #9 to match the downcast file – no joining was required because all bottles were in the second file.
Sample #250 was assigned twice, but once was for a pumping cast (#36) so this should not be a problem.

The ADDSAMP file was then used to add sample numbers to the BOT files and those files were bin-averaged on bottle numbers to produce SAMAVG files. Those files were then exported to a spreadsheet

2011-27-DO-cal.csv. The titrated DO values were added to that file and lines removed for which there was no DO sampling. A calculations was made of Φ using equation:

$$\Phi = Oxsol(T,S) * (1.0 + A*T + B*T^2 + C*T^3) * e^{(E*P/K)}$$

where A, B, C and E are taken from the calibration sheet for the sensor and P,T and K are from the CTD channels – K is temperature in Kelvin degrees. Then the ratio Titrated DO/ Φ was calculated and plotted against the SBE DO Voltage. This fit provides the M and B for the following equation:

$$\text{Titrated DO}/\Phi = M*(\text{SBE DO Voltage}) + B$$

From M and B the parameters Soc and Voffset that are to be entered in the DO configuration are:

$$Soc = M$$
$$Voffset = B/M$$

When all values are included the R^2 value was 0.9845. Removing values flagged "3" or "4" produced better results. Cast #1 had extensive areas of hypoxia and the CTD is known to recover slowly during the upcast in those conditions; so that cast was excluded and the fit looks good. Next, fits were done by gradually removing outliers. It is difficult and tedious to pick out outliers on the plots and find and eliminate them from the fit. A simpler approach was to use the M and B values from the factory calibration to determine the difference from the fit for each sample, as follows:

$$\text{Difference} = M*\text{Voltage} - B - DO/Phi$$

Watching how the plots change, the process stops when obvious outliers have been removed as judged by visual inspection and the R^2 value, being careful to stop before the DO range is significantly reduced. (The M and B from the first fit with all bottles was substituted for the factory values in the calculation of differences for subsequent fits.)

When the data were sorted on that difference, fits were done excluding points with differences > a chosen amount. For these data the fits are very similar. Excluding the differences >0.03 looks like a good choice and only involves rejecting 3 bottles, the flagged bottles and those from cast #1. This produced values for SOC and Voffset of 0.4694 and -0.5075. During 2011-09 when the sensor was last used, those values were found to be 0.4622 and -0.4935. These results are close, especially given a quite different ranges of DO and pressure.

Summary of Soc Voffset including the original values in the factory calibration

Bottles used		m	b	Soc	Voffset	R^2
	Original	0.4453	-0.2321	0.4453	-0.5212	
164	all	0.4647	-0.2328	0.4647	-0.5010	0.9845
155	all data except 3 and 4 flags	0.4698	-0.2394	0.4698	-0.5096	0.9989
144	no cast 1,no 3 or 4 flags	0.4705	-0.2390	0.4705	-0.5080	0.9995
142	excl. outliers diff>0.05 & cast #1	0.4692	-0.2377	0.4692	-0.5066	0.9998
141	excl. outliers diff>0.03 & cast #1	0.4694	-0.2382	0.4694	-0.5075	0.9998
139	excl. outliers diff>0.02 & cast #1	0.4690	-0.2378	0.4690	-0.5070	0.9998
134	excl. outliers diff>0.015 & cast #1	0.4689	-0.2378	0.4689	-0.5071	0.9999

Tests were done dividing the data into two sections. The differences between the two sections could be a sign of time-dependence, but the DO ranges and pressures are different in the two sections. If the Soc had

increased that might suggest calibration drift, but the change is small and in the opposite direction to the expected drift.

		m	b	Soc	Voffset	R^2
casts 4-31	exc. outliers diff>0.03	0.4703	-0.2412	0.4703	-0.5129	0.9997
casts 37-70	exc. outliers diff>0.03	0.4688	-0.2360	0.4688	-0.5034	0.9999

There were no severe outliers that had not already been flagged, though samples #50 and 213 should be checked in COMPARE as they had differences >0.05. (See 2011-27-do-cal-study.xls.)

The configuration file was updated with the new parameters Soc and Voffset and saved as 2011-27-ctd-new.xmlcon.

4. Hysteresis Study

Hysteresis tests were run on this sensor during 2011-26 and no changes were found appropriate.

5. BOTTLE FILE PREPARATION

The ROS files were recreated with the new configuration parameters. They were put through CLEAN to create BOT files. Temperature and salinity were plotted for all BOT files. The only data that looked odd were both salinity channels for cast #71 around 40db. When viewed in CTDEDIT it was obvious that all the data are noisy, so editing will not help. There was considerable vertical motion in the presence of a moderate gradient which probably accounts for the noisy data.

The header for cast #2 lacks position data, so that was added based on the log entry.

A preliminary header check turned up no problems and the maximum fluorescence value is ~11.6ug/L so there is no off-scale fluorescence, however, the minimum values are slightly negative, as was found for other recent cruises. A decision on what offset to apply to remove negative data will be made based on the profile data.

Files named 2011-27-0010 were renamed 2011-27-0009 and event # changed as needed; these come from the upcast that matches downcast #9.

Files 2011-27-0006.BOT and 2011-27-0007.BOT were joined in the same way described in section 3.

The addsamp.csv file prepared in the DO calibration step was sorted on Event_Number and Sample_Number and then converted to CST files. The CST files will form the framework for the bottle files.
SAM files were created using the Add Sample Number routine and those files were then bin-averaged.

Next, each of the analysis spreadsheets were examined to see what comments the analyst wanted included in the header file. These were used to create file 2011-27-bot-hdr.txt; it may need further editing to reflect problems found during processing.

Dates of creation were added to the names of spreadsheets from analysts.

EXTRACTED CHLOROPHYLL

Extracted chlorophyll and phaeo-pigment data were obtained in file QF2011-27chl.xls. The file included comments and flags and an event-number column. A simplified version of the spreadsheet was prepared

in which some columns were removed and the file was saved as 2011-27chl.csv which was then converted to individual CHL files.

DISSOLVED OXGYEN

Dissolved oxygen data were provided in spreadsheet 2011-27oxy.xls which includes flags, comments and a precision study. Draw temperatures are available. The spreadsheet page with the final data was simplified by removing a few unnecessary columns and the file was then saved as 2011-27oxy.csv. That file was converted into individual *.OXY files.

DMS

DMS data were obtained in file DMS 2011-27 summary.xls. The file was saved as 2011-27dms.csv and edited. Event number, flag and comment flag channels were added. All entries "<" were replaced with "0"; a note in the header will explain that the minimum detectable level is 0.1 nmol/L. There was a set of duplicates for each cast sampled and they were both reported. The pairs were replaced by a single line with the average value and flag "6" was added. In some cases there were extra replicates run under different circumstances. The only values averaged for use in the CHE files are the ones reported in file "std dev of pairs 2011-27.xls". Headers were changed to standard format and unnecessary columns were removed. The file was then converted to individual DMS files.

SALINITY

Salinity analysis was done at IOS in two parts – some were run 2 months after collection and others 4 months after collection. Data were received in files QF2011-27SAL-6Dec0211.xls and QF2011-27SAL-20Jan0212.xls. The files were simplified and saved as 2011-27sal-Nov.csv and 2011-27sal-Jan.csv. Duplicates had been averaged.

An analysis of the internal standards used in the analysis was provided and showed a standard deviation of 0.005 and a range of 0.016. This is in line with other studies showing that bottle salinities increase with storage time, and more seriously that the scatter in values increases. Beyond 100 days storage the values are not trustworthy, though they mostly agree with each other within 0.002. Beyond 200days the scatter means you cannot even rely on the standards agreeing with each other, so they don't serve much purpose, except to demonstrate that storing salinity bottles that long reduces quality markedly.

The loop samples were copied to file 2011-27-loop.csv and then removed from the salinity file.

File 2011-27-sal-Nov.csv was converted into individual SAL files and file 2011-27-sal-Jan was moved to a separate folder and converted to individual files there.

NUTRIENTS

The nutrient data were obtained in spreadsheet QF2011-27nuts.xls which included a report on precisions. The file was simplified, reordered on sample numbers, header names were changed to standard format and the file was saved as 2011-27-nuts.csv. The file was converted to individual NUT files.

The SAL, CHL, ADD, NUT and DMS files were merged with CST files in 5 steps.
After the 5th step the files were put through CLEAN to reduce the headers to File and Comment sections only.

The merged files are ordered on sample number, but the SAMAVG files are ordered on bottle number, so one or the other set needs to be reordered in order to merge them. The MRGCLN1 files were reordered on Bottle_Number since that is the usual method used. The output files were named MRGCLN1s.

Those files were then merged with SAMAVG files choosing the Bottle_Number from the SAMAVG files.

11) Compare

Salinity

Compare was run with pressure as reference channel. Because the salinity was analyzed in two groups separated by 2 months, it was decided to do 2 runs of COMPARE to see how the results varied. These will involve different casts, so cannot be expected to be the same, but they have roughly the same # of bottles. The most obvious difference is that for the November data, the only significant outliers were due to analysis problems or were at the surface where local gradients probably account for the differences. For the January data there are many more outliers with 3 times as many bottles rejected from the fit, and most of the outliers being in the direction that suggests bottle values being too high. Only one of the outliers had been flagged by the analyst. After >16% of the bottles were rejected as outliers, the differences between the CTD and bottles was similar for the two groups, though the standard deviation in the comparison is a little higher for the January samples.

The samples run in January were not intended to be analyzed, but were in reserve in case more bottles were required to calibrate the CTD salinity. Since they are considered less reliable than those analyzed in November they will not be included in the bottle files.

The outliers from the November analysis were examined in light of COMPARE and no changes were needed in the flags, though a few comments were added:

- Sample 88, cast #15 – looks ok in COMPARE
- Sample #137, cast #12 – duplicate outliers, the first value looks best, 34.4631 so will be used.
- Sample 138, cast #21 – slight outlier in COMPARE
- Sample 431, cast #62 – ok in COMPARE
- Sample 436, cast #64 – outlier in COMPARE
- Sample 457, cast #65 – major outlier compared to CTD and loop salinity – replace with pad value and flag 5. Only below 100db are salinity values this high found.
- Sample 507, cast #70 – looks like wrong replicate was rejected.

The primary salinity was found to be low by an average of 0.0016 with a standard deviation of 0.0039. The secondary was low by 0.0015 with a standard deviation of 0.0037. Both showed little pressure or time variability.

During cast #64 salinity samples were taken from 22 bottles fired around 2000db. One was flagged by the analyst. The average excluding the flagged bottle showed the primary CTD salinity to be low by 0.0010 and the secondary by 0.0002 with standard deviation of 0.0016 for both.

No recalibration is appropriate for these sensors. They are within 0.002 and probably better. The sample values may have a slight skew towards high values, having sat for 2 months before analysis, though this effect is not thought to be large.

For full details for the COMPARE run see file 2011-27-sal-comp-Nov.xls.
NOTE: 2011-17 salinity analysis was done within 1 month of collection and both CTD salinity channels were very close to the bottles. That cruise followed 2011-27 immediately and used the same sensors.

Dissolved Oxygen

COMPARE was run with pressure as the reference channel.

As expected, the fit of differences against DO concentration is quite flat and most differences are within ±0.2mL/L. Only 5 cases had differences >0.5mL/L, 3 of those had already been flagged and 2 were from the surface where the difference was not significant. The 3 that had been flagged were studied to see if changes to flags or comments were warranted:

- Sample 72, cast #12 – Flagged "3" as a possible mis-trip. The nutrients and look off and the DO and salinity (Jan. analysis) look like this bottle fired around 100m. Changed flag to "5" and replaced with pad values.
- Sample #194, cast #31 – Changed flag to "5" and replaced with pad value since it is an obvious outlier and there were serious problems in titration, other samples look ok. Added a note to comment.
- Sample #211, cast #31 – Duplicates flagged as Chauvenet outlier. Severe outlier in COMPARE but this was found to be because the wrong value was entered – when this was corrected it was not an outlier. Somehow the Chauvenet number got entered instead of the average. That was fixed and the average used. The average looks ok, so a note was added to the comment, but the flag was not changed.

To test for hysteresis a plot was made of differences against DO concentration and points from above 1200db were excluded so the deep bottles show up in green. The plot does indicate that for similar DO values, the deep bottles have slightly lower values, the differences gradually growing from <0.01mL/L at 2000db, ~0.07mL/L at 3000 and ~0.1mL/L at 4000db. This observation led to the discovery that the hysteresis correction had not been turned on for the conversion of the CTD. The process was repeated and COMPARE rerun so it was possible to observe the effect of using this correction both above 2000db and below.

First, the fits using data from below 2000db were used to calculate the differences between CTD and bottles at DO values normally found between 2000 and 4000db. Those differences were considered the error; keep in mind that there is some error in bottle values themselves, and the hysteresis parameters may not be set ideally, so slight differences between the two approaches cannot be considered significant.

Below 2000db		study of hysteresis correction			
CTD DO	Error without	Error with	% error without	% error with	difference with-without
1.5	-0.016	-0.045	-1.04	-2.98	-0.029
2	0.028	-0.026	1.38	-1.28	-0.053
2.2	0.045	-0.018	2.04	-0.81	-0.063
2.5	0.071	-0.006	2.83	-0.25	-0.077
3	0.114	0.013	3.80	0.43	-0.101

This demonstrates that the improvements are slight (or possibly non-existent) until DO is >2, which is generally not reached until below 2500db. The question arises as to whether it costs anything to use this correction routinely. Are the data above 2000db affected by the correction? So the comparison was done using data from above 2000db to see if it looks better without the correction.

Above 2000db		study of hysteresis correction			
CTD DO	Error without	Error with	% error without	% error with	difference with-without
0.2	-0.019	-0.027	-9.38	-13.61	-0.008

1	-0.016	-0.025	-1.62	-2.45	-0.008
3	-0.010	-0.018	-0.33	-0.59	-0.008
5	-0.003	-0.011	-0.07	-0.22	-0.008
7	0.003	-0.004	0.04	-0.06	-0.007

The differences are slight and almost constant with the correction leading to values that are too low by about 0.008. A correction could be applied to remove that difference, but it would be very time-consuming to have to do that calculation for every data set. At this point we may conclude that if deep values good to within 0.1mL/L are desired, the cost may be errors in DO above 2000db on the order of 0.01mL/L.

The COMPARE results for the full data set suggest a slight correction is in order:

CTD DO (corrected) = CTD (original) * 1.0027 – 0.0259

A plot of differences against file pair # showed a slight decrease with time, but that is likely due to the lower DO values early in the cruise.
(See 2011-27-dox-comp1.xls and 2011-27-comp1-before fix.xls.)

Fluorescence

COMPARE was run using the Wet Labs ECO CTD Fluorescence and the Extracted Chlorophyll from bottles. Most of the values are very low. When CHL is high the CTD fluorescence has similar values, but there are only 3 values >2ug/L. When CHL is very low there is little signal from the CTD with values not starting to change until CHL is >0.2ug/L. It then quickly rises to values higher than the CHL.
(See 2011-27-chl-fluor-comp1.xls for the full COMPARE results.)

Plots of Titrated DO and CTD DO against CTD salinity were examined and no further problems were detected.

At this point the data from the MRGCLN2 files were exported to a spreadsheet for comparison with the rosette files to ensure no data were misplaced or missing. Errors were found in cast #44 – the ADDSAMP file was adjusted and the SAM and SAMAVG files recreated, and the MERGE steps repeated.

All MRG files were examined. Lines for bottles that had not been sampled were removed from the files and a few comments were combined where they applied to all samples. CLEAN was rerun on the MRG files. Data were exported to a spreadsheet again and the results look ok.

6. Conversion of Full Files from Raw Data

All files were converted using 2011-27-ctd550-new.con.
A few casts were examined and all expected channels are present. The descent rate is very noisy for some casts with obvious shed wake corruption.

The two temperature channels are fairly close during the downcasts though the primary looks noisier. During the upcasts traces differ much more and again the primary looks noisiest. The conductivity channels are similar to temperature. Fortunately, during stops the noise mostly disappears, though some primary conductivity spikes were seen during stops.
Altimetry looks useful at the bottom, fluorescence, PAR and transmissivity look normal.

7. WILDEDIT

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

The parameter "Keep data within this distance of the mean" was set to 0 so all spikes would be removed.

8. ALIGN DO

Tests were done on 2 casts to determine the offset between the DO voltage and the primary temperature. It is very hard to judge because the temperature is so noisy on the upcast, but 4s appears to align downcast features best and that setting was found appropriate for other recent cruises for which this sensor was used.
ALIGNCTD was used to advance the DO Voltage by 4.0s relative to the pressure.

9. CELLTM

The upcast data are extremely noisy so the usual tests for CELLTM settings are not helpful. The same equipment was used during 4 other recent cruises. The most recent had the same problem, but the earlier 3 while a little noisy did provide some results. The tests for 2011-26 in June 2011 were reasonably clear and the best choice was found to be ($\alpha = 0.02$, $\beta=7$) for the primary and ($\alpha = 0.03$, $\beta=9$) looked best overall. Those results also appeared useful for 2011-44 and 2011-16 when the same equipment was used. So they were applied to these casts as well.

10. DERIVE

Program DERIVE was run twice:

on all casts to calculate primary and secondary salinity and dissolved oxygen concentration.

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.

11. 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 often noisy so these are very rough estimates and if there was a spike at the given depth, nearby values were chosen.

Cast #	Press	T1-T0	C1-C0	S1-S0	Descent Rate
2011-16-0034	800	-0.0003	+0.00004	+0.0008	Extremely noisy
	1000	-0.0004	+0.00007	+0.0011	
	1950	-0.0007	+0.00005	+0.0015	
2011-16-0111	800	-0.0001	+0.00010	+0.0014	Noisy
	1000	-0.0003	+0.00009	+0.0015	
	1950	-0.0007	+0.00010	+0.0019	
2011-26-0017	800	-0.0001	+0.00012	+0.0016	Noisy,high
	1000	-0.0002	+0.00012	+0.0016	Noisy, high
	1950	-0.0006	+0.00013	+0.0022	V.Noisy, Mod
2011-26-0082	800	~0	+0.00006	+0.0007	VNoisy, VHigh
	1000	~0	+0.00007	+0.0008	
	1950	-0.0006	+0.00007	+0.0013	
	3200	-0.0008	+0.00008	+0.0018	
2011-27-0019	800	-0.0004	~0	+0.0005	High, X Noisy
	1000	-0.0004	~0	+0.0007	
	1950	-0.0009	+0.00004	+0.0010	
2011-27-0031	800	-0.0002	-0.00001	+0.0004	High, X Noisy
	1000	-0.0003	+.000001	+0.0006	
	1950	-0.0009	+0.00002	+0.0009	
	3200	-0.0014	+0.00002	+0.0015	
2011-27-0070	800	-0.0002	~0	+0.0002	High, X Noisy

	1000 1950 3200	-0.0005 -0.0006 -0.0012	+0.00001 -0.00001 ~0	+0.0003 +0.0005 +0.0012	

The differences are small and show little change with time. The pressure dependence is a little higher than for previous use, but not by a lot.

12. Conversion to IOS Headers

The IOSSHELL routine was used to convert SEA-Bird 911+ CNV files to IOS Headers. Cast #70 was too large to convert, so STRIP was used first to remove the Pump channel.

CLEAN was run to add event numbers and to replace pad values in the pressure channel with interpolated values based on record number.

13. Checking Headers

The header for cast #2 lacks position data, so that was added based on the log entry.

The header check was run. There are some negative values in pressure and fluorescence in cast #59. A decision on how to recalibrate fluorescence should be left until after DELETE and editing since there are clearly some surface spikes. There were no off-scale fluorescence values.

Surface check was run and shows an average surface pressure for the cruise was 2.4db which looks about reasonable for the Tully. Cast #59 was examined in detail because there are negative pressures at the end of the file. At -0.5db it looks like 1 sensor is out of the water and 1 in it. There only a few records between 0 and -0.5db, so it is not possible to say where the surface is. Cast #71 moves through 0 pressure at the end of the cast and "out-of-water" records are seen after 8 scans <0db. So any error in the pressure is <0.5db and likely very close to 0.

The cross-reference check was compared with the log book and the only problem found was 1 cast with the wrong station name; that was corrected in both bottle files and full profile files.

The cruise track was plotted and added to the end of this report. No problems were found.

The altimeter readings from the headers of the CLN and MRGCLN2 files were exported to a spreadsheet. Most casts did not get within 15m of the bottom so there are no header entries. For 2 CLN files and 1 MRGCLN2 and SAMAVG files a spike was misinterpreted, so those readings were removed from the headers.

The Water Depth header was also examined. There were deviations from the log book entries for 3 cases. For cast #7 the log entry seems too low, whereas the header looks right for this site. For casts #61 and 62, the log entry was assumed to be correct, so the header entry was changed. All were corrected in the MRGCLN2, SAM, SAMAVG, IOS and CLN files.

13. Shift

<u>Fluorescence</u>

Tests were run on two casts to see what SHIFT value should be used to make the offset between the downcast and upcast fluorescence trace look like that of the temperature trace. The noisiness of the temperature traces makes this a difficult judgment, but the value used on other recent uses of the ECO sensor (+48 records or 2 seconds) looks appropriate.

SHIFT was run on all casts to advance the ECO fluorescence channel by +48 records. (Output: SHFFL1)

Conductivity

Tests were run on the two conductivity channels using a variety of shifts on 3 casts and then examining the results on a T-S plot to see what setting best minimizes unstable features without oversmoothing. The results looked best overall when a shift of -1s was applied to the primary and a shift of +0.5s to the secondary conductivity. The shift is larger for the primary and the same for the secondary as found when the same equipment was used during 2011-16 and 2011-26.
SHIFT was run twice on all casts using those settings.

Dissolved Oxygen

The Dissolved Oxygen voltage channel was aligned earlier. A few casts were checked to see if further alignment is needed for the DO concentration channel, but this does not appear necessary.

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 warnings are for casts #7 and 10 which contain only upcast data and from the upcast data near the surface for cast #59.

Header Check was repeated on the DEL files and the minimum fluorescence value is -0.091mL/L, so that setting should be used for recalibration.

15. Other Comparisons

Previous experience with these sensors –

1. Salinity:

   The sensors were both recalibrated in late March 2011 and were used for 2011-44, 2011-16, 2011-26 and 2011-09. For the first cruise, they were few calibration samples and for the others the bottle calibration was not trusted. No corrections were applied.

2. Dissolved Oxygen

   The DO sensor was repaired and recalibrated in April 2011. It was used for 2011-44, 2011-16, 2011-26 and 2011-09. There appeared to be some time dependence in the 2011-26 data, but not in any of the others. The variation in the slope and offset does not follow a simple relation with time. This may be a sign that the DO range, pressure range and number of samples available are significant in the fits. And the 2nd calibration to 2011-26 complicates the issue.

3. Pressure

   The sensor was recalibrated in April 2011 and was used for 2011-44, 2011-16, 2011-26 and 2011-09. No further offset was applied to any of those cruises.

Historic ranges – Profile plots were made with 3-standard deviation climatology ranges of T and S superimposed. The only excursions in the temperature data were some values a little below the historic maxima at casts at P16 and P17 around 200db. Salinity was slightly high in the halocline for casts from P18 to P21 around 125db. These excursions look real, not indicative of instrument malfunction.

Repeat Casts –

There were repeat casts at P4, P12, P16, P20 and P26. For most groups there were only small differences in T-S space and almost no variation below 1000db. But at P12 there is evidence of active mixing between 100 and 1000db. Below 1200db there is little difference among them.

When plotted together in T-S space, 2 deep casts from P26 that were 6 hours apart differed at 1500db by ~0.003C° and ~0.0005 in salinity which is excellent repeatability.

The other repeat casts were plotted together to check for any problems and none were found.

Post-Cruise Calibration
There were no post-cruise calibrations available.

16. DETAILED EDITING

The bottle comparison shows little difference between the primary and secondary salinity channels, but the primary is noisier than the secondary. The secondary sensors were chosen for archiving for 2011-44, 2011-16 (except for 1 cast), 2011-26 and 2011-09. So the secondary T and S channels were chosen for archiving, and so, editing.

CTDEDIT was used to remove large spikes, smaller spikes that appear to be due to instrumental problems and likely to affect the bin-averaged values and records corrupted by shed wakes including some surface records. Many of the casts had extremely noisy descent rates and required a lot of editing.

All EDU files were copied to EDT.

17. Initial Recalibration

The pressure looks ok.
SBE Dissolved Oxygen data will be recalibrated using equation

CTD DO (corrected) = CTD (original) * 1.0027 – 0.0259

The salinity comparison would suggest the values are likely within 0.001; no recalibration is justified.
The fluorescence channel will be adjusted by adding 0.091ug/L.
CALIBRATE was run using file 2011-27-recal1.ccf to apply the Dissolved Oxygen and Fluorescence corrections.

First, the SAM and MRGCLN2 files were recalibrated and COMPARE was run. The results show an excellent fit of differences versus CTD DO with an average difference of 0.0001mL/L. However, a fit against pressure shows that values below 3000db are a little too low, by an average of 0.04mL/L. There is a hint of time-dependence with CTD DO looking lower later in the cruise. This could be because there are more samples from below 3000db later in the cruise, but looking only at values from 1000 and 2000db shows similar patterns, though smaller differences. So there may be a little time-dependence and a little hysteresis. Fine-tuning this any further does not look justified since the corrections are within the scatter level. (See 2011-27-dox-comp2.xls.)

18. Final Calibration of DO

The initial recalibration of dissolved oxygen corrects for sensor calibration drift. Alignctd corrects for transit time errors. Those 2 steps may partly correct for response time errors, but a further correction is sometimes found appropriate to further correct for response time errors found by comparing downcast CTD data to bottle data from the same pressure.

Downcast 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.

COMPARE was run again. When the differences were plotted against DO concentration there is a lot of scatter. The differences are near-zero near the surface and near the DO minimum, a little low below 2500db and a little high elsewhere. While there appears to be a little time-dependence, the evidence is weak. Any recalibration for pressure or time dependence would be complex, and the scatter in the fits is too great to justify it. The errors are small.

19. Special Fluorometer Processing

There were no off-scale fluorescence data.

Special files were prepared for Dr. Peña by clipping the COR1 files to 150db. The clipped files were bin-averaged (0.25db bins), put through REMOVE and HEADEDIT and named as *.FCTD and saved. Since there was only an ECO fluorometer which does not need filtering, the usual second set was not prepared. The SAM files were put through REMOVE and named *.BOF and saved. A readme.doc file was prepared with some notes on the preparation of those files.

Since the ECO fluorometer was used no filtering is required.

20. 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 appeared to be necessary.

21. Final CTD File Steps (REMOVE and HEADEDIT)

REMOVE was run on all casts with a PAR sensor mounted to remove the following channels:
Scan_Number, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, Descent_Rate and Flag
REMOVE was on casts with no PAR sensor to remove the following channels:
Scan_Number, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, PAR, Descent_Rate and Flag

A second SBE DO channel (with umol/kg units) was added.
REORDER was run to get the two DO channels together.

HEADER EDIT was used to fix formats and channel names, to add “Mid-ship” to the instrument location section and to add the following comments:

Data Processing Notes:

Fluorescence, Transmissivity and PAR data are nominal and unedited except that some records were removed in editing temperature and salinity.

For details on how the transmissivity calibration parameters were calculated see the document in folder "\cruise_data\documents\transmissivity".

SBE DO calibration was done using the method described in the SeaBird Application Note #64-2.

The Oxygen:Dissolved:SBE data are considered, roughly, to be:
±0.5mL/L from 0 to 100db
±0.2mL/L from 100db to 400db
±0.08mL/L from 500db – 2500db
low by ~0.04mL/L below 2500db

For details on the processing see processing report: 2011-27-proc.doc.

The cross-reference list was produced and no problems were found.
The Standards Check routine was run and no problems were found.
The Header Check turned up an error in one channel name; that was fixed by rerunning Header Edit.
The final files were named CTD.

Profile plots were made and look ok.
The track plot looks ok.

22. Dissolved Oxygen Study

As a final check of dissolved oxygen data, % saturation was calculated and plotted. The near-surface values were all >100% and most were between ~105% and ~110%, except for 4 casts (SI03, P1, P3 and P6) that were slightly higher at ~116%. These look reasonable.

24. Final Bottle Files

The MRGCOR1 files were put through SORT to order on increasing pressure.

REMOVE was run on casts with a PAR sensor mounted to remove the following channels:
Scan_Number, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, Descent_Rate and Flag
REMOVE was on casts with no PAR sensor to remove the following channels:
Scan_Number, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, PAR, Descent_Rate and Flag

A second SBE DO channel was added with different units and REORDER to get the 2 SBE DO channels together.

HEADER EDIT was run to fix formats and units, fix a few headers, change the channel name Bottle_Number to Bottle:Firing_Sequence and the name Bottle:Position to Bottle_Number and to add a comment about quality flags and analysis methods and a few notes about the CTD data.

A header check was run on the final files and no problems were found.

For a final check the CHE bottle data were exported to a spreadsheet and compared with the rosette log sheets. No problems were found.

Plots were made of CTD Salinity versus SBE Dissolved Oxygen and bottle DO and no further outliers were identified.

Standards check was run on all files and a channel name error was found; that was fixed and no further errors were found.

25. Thermosalinograph Data

Two of the Thermosalinograph files are missing positions. The chief scientist converted the TSG files and combined them with data from ship position files, matching times between the two. In this way positions were obtained for the data with bad positions.
The 5 files were provided in XLS format. Some work was required to patch the missing positions and to ensure consistent format in dates and times. A final column was added containing the file number and headers were changed to the standard names and channel order. The files were then saved as CSV files.

a.) Checking calibrations
The chief scientist did the conversions using the calibrations that were used at sea. The only error is that the scale factor for the fluorometer was 15.0 whereas the last calibration value was 16.62. Since we know the fluorometer is reading much too high anyway, there seems little point in re-converting the data or attempting a correction. The header comments do indicate that the fluorescence data are nominal. To keep the 5 files consistent the same scale factor was used for the 3 files that were processed in the usual way.

The configuration file used at sea was saved as 2011-27-tsg.xmlcon and files 1 to 5 were converted to CNV files.
Files 1 to 3 were then converted to IOS headers.

b.) CLEAN was run to add End times and Longitude and Latitude minima and maxima to the headers. For files 1-3 ADD TIME CHANNEL was used to add date and channel based on Time:Julian. That had already been done for files 4 & 5.

Time-series plots were produced. Overall the records look good, but a few problems were noted:

- There is no flow for most of file #1. The flow was turned on to rates near 1 for only about 5 records, was then reduced to about 0.35 followed by 4 records near 1 at the end. These data are not useful, so file #1 will not be processed further.
- The salinity data contain many spikes with no corresponding temperature spikes – 1 or 2 points with differences from ~0.1 to ~0.5 from adjacent points.
- There are some shifts in salinity values that are not associated with significant temperature or flow or ship direction changes. It is impossible to determine whether the shifted values are good or bad, so they have been left.

CTDEDIT was used to remove salinity spikes containing 1 or 2 points with no corresponding spikes in temperature. A few records were removed from the beginning of file #2 because flow had not settled to values ~1.
Time-series plots were produced using the edited files which showed that the editing was effective.

The Loop files described in section 26 of this report were prepared before the TSG data were ready. One of them was saved as 2011-27-tsg-rosette-loop-comp.xls.

The edited files were opened in EXCEL. The TSG median value was calculated for intake temperature, salinity and fluorescence over 2 minutes as well as standard deviations in those 2-minute windows. Then data were removed except for times when there was a loop sample or rosette cast. The data remaining were added to file 2011-27-tsg-rosette-loop-comp.xls. From this spreadsheet individual sheets were prepared to compare TSG to Loop, TSG to Rosette and Loop to Rosette.
This spreadsheet will also be used in step (c) to compare temperature, salinity and fluorescence.

c.) Comparison of T, S and Fl from Loop and Rosette samples and TSG and CTD data
There were 34 loop samples for Salinity and 36 for extracted chlorophyll, as well as 5m rosette samples at most CTD casts.

- T1 vs T2 The intake thermistor was connected throughout the cruise. The differences between the two temperatures were mostly between 0.15Cº and 0.2Cº, with the larger differences found farthest from shore where the intake temperatures are lower.

- TSG vs CTD during stops for bottles
  When all data were included the TSG intake temperature was higher than the CTD temperature during bottle stops by an average of 0.046Cº while the median difference was 0.016Cº and the standard deviation was 0.13ºC. When 6 outliers were excluded, the average and median differences are 0.013 and 0.010Cº and the standard deviation is 0.03Cº. The near-surface gradients are likely to be high at this time of year, so the correspondence is probably as good as we can expect given uncertainties in matching depth and time.
  The TSG salinity is lower than the rosette bottle salinity by an average of 0.74 and a median of 0.024. When 4 outliers are excluded with differences >0.1 the TSG salinity is lower than the CTD by an average of 0.030, by a median of 0.020 and with a standard deviation of 0.02.
  The ratio of TSG fluorescence to CTD fluorescence ranges from 0.8 to 6.3 and a median of 1.8.

- Loop Bottle - TSG Comparisons The TSG salinity was lower than the loop samples by an average of 0.025 and a median of 0.023 when differences >0.05 were excluded. The median difference was ~0.020 while the ship was underway (10 cases), and ~0.028 while stopped (15 cases). The TSG fluorescence was higher than the Loop samples by an average of 5 times and a median of 3.7 times. The only obvious patterns is that the ratio is twice as high while the ship is stopped than while moving.
  To understand these changes data from a few files were plotted to see if there is a pattern. There is no obvious change in flow rates when the ship stops, but both lab and intake temperatures show a tendency to rise early in a stop with the intake temperature rising slightly more. Possible explanations are heating from the ship or the loop drawing water from a shallower level during stops. The local vertical gradients seem small, but perhaps it doesn't take much to show up in these comparisons.

- Loop Bottle – Rosette Samples
  The loop salinity bottles were very close to the rosette bottles differing by an average of 0.0001 and a median of 0.0004.
  The ratio of extracted chlorophyll from the loop to that from rosette bottles ranged from 0.09 to 1.3 with an average of 0.87. The low value was from a case where both values were very low. When differences are calculated the loop CHL is lower by an average of 0.08ug/L and the median is lower by 0.03ug/L. In 9 out of 12 cases the loop is lower.

- Calibration History
  The TSG primary temperature and conductivity were recalibrated in March 2011 and were used for 2011-44, 2011-26 before this cruise and 2011-17 which followed this cruise. There were 2 other cruises on which it was mounted but there were problems with the data; one has not yet been processed and the other is not trusted.
  For 2011-44 the intake temperature looked unbelievable, being higher than the CTD by 0.41Cº and higher than the lab temperature by 0.2 Cº. The lab temperature was higher than the

CTD by 0.25Cº which is about the amount of heating we would expect to find in the loop at that time of year. The TSG Salinity was lower than the CTD salinity by ~0.007 during offshore casts though it was lower by much more in inlets with high near-surface gradients. The TSG fluorescence was higher than the CTD fluorescence by a median factor of 2.

For 2011-26 the salinity was extremely noisy but thought to be low by ~0.02. The fluorescence was higher than the CTD Fluorescence by about a median factor of 2. The temperature was high by ~0.005.

For 2011-19 the salinity was found to be low by ~0.024. The intake temperature was as close to the CTD temperature as can be expected. The TSG fluorometer was higher than the CTD Fluorometer by a median factor of ~1.8.

Conclusions

1. The flow rate was fairly steady.
2. The temperature in the loop increases by about 0.2Cº nearer shore where temperatures are higher and by about 0.25º further offshore. This is normal as heating is proportional to the difference between the ship and water temperatures.
3. The TSG intake temperature is within 0.1 Cº of the CTD temperature. During the cruise that followed it was even closer.
4. The TSG salinity is lower than the CTD salinity by a median of 0.02 when a few outliers are excluded, but the standard deviation is 0.02.
5. The TSG Salinity is lower than the loop samples by ~0.02 when the ship is moving and by 0.028 when it is stopped, with a value of 0.022 when the two are combined.
6. The loop salinity and rosette salinity samples are extremely close, within 0.001, lending weight to the comparisons with the loop.
7. The loop chlorophyll and rosette chlorophyll are also close, though the loop is a little lower.
8. The TSG fluorescence is higher than the CTD fluorescence by a median factor of ~1.8 which is similar to other cruise results. It is higher than the loop extracted chlorophyll samples by a median of ~3.7, though that varies from ~6 during stops for CTD casts and 3 when moving. This is consistent with the fact that the CTD fluorescence was generally higher than the extracted chlorophyll samples.
9. The salinity should be recalibrated by adding 0.022.

g.) Recalibration

File 2011-27-tsg-recal1.ccf was prepared to adjust salinity by adding 0.022. A few values were checked to ensure it was applied correctly and it was. Note that the salinity channel name was different in different files, so both are included in the recalibration file.

h.) Preparing Final Files

The files for casts 4 and 5 already have the correct names and headers and nothing needs to be removed,.

REMOVE was used to remove the following channels from casts 2 and 3: Position:New, Conductivity:Primary, Scan Number, Uploy0 and Flag.

HEADER EDIT was used to add a comment, change the DATA TYPE to THERMOSALINOGRAPH and add the depth of sampling to the header. Those files were saved as TOB files.
The TSG sensor history was updated.

The following note was added to files 4 and 5 only:

The position information was incorrect for part of this file, so missing latitude and longitude data were obtained from ship's position files by matching times.

As a final check plots were made of the cruise track and it looks fine.
The cruise plot was added to the end of this report.

26. Producing final files

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

LOOP FILE

A spreadsheet of surface rosette bottle data from the chief scientist (2011-27-che-surface.csv) was combined with loop sample data (file 2011-27-loop.csv). An error was found in the position of Loop JF2 – it was changed from -123.00 to -124.00W. A 6-line header was added and the file was saved as 2011-25-loop-6linehdr.csv. It was converted to IOS format, put through CLEAN (To add start and stop times and positions), SORT (to get in date order) and HEADEDIT (to add general comments and specific comments for flagged values). A final run of CLEAN was used to update headers after some corrections were applied. The final file was named 2011-01-surface.loop. A track plot and a plot of salinity versus date look reasonable.

Particulars (Log comments that are not in the Sampling Notes)

1. Jellyfish tentacles/goo
2. NMEA entered manually
3. Bottle 1 tripped in air during recovery
18. Pylon swapped because bottles 5, 9 and 11 not tripping
35. Descent rate slowed due to rough seas (0.75m/s)
37. Slowed on descent
38. Argo float deployed right after this cast
40. Pauses due to wrapping issues on the winch
42. Pause to swap operators
67. Bottle 1 tripped by accident ~1000m

Institute of Ocean Sciences CRUISE SUMMARY

CTDs

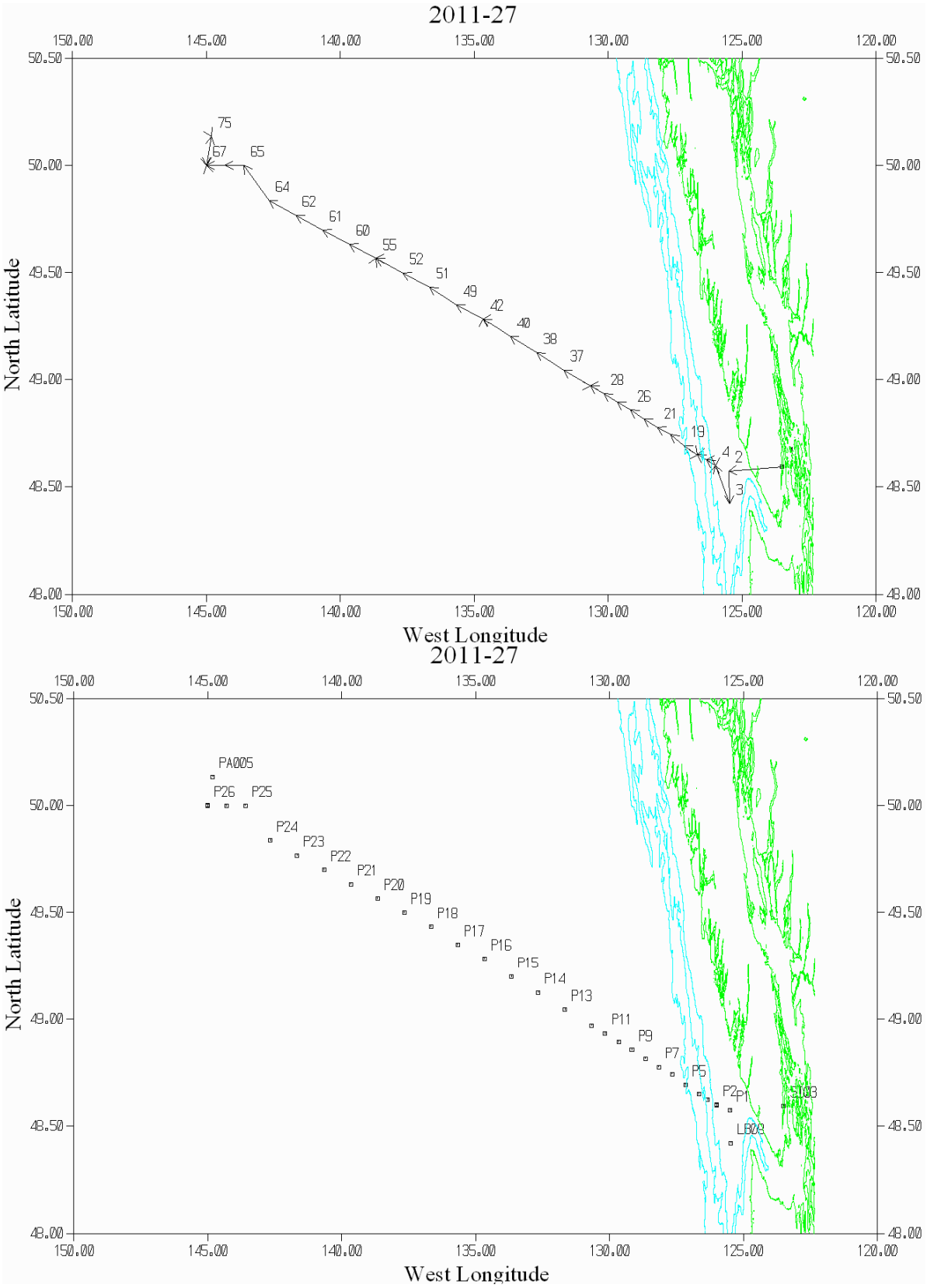
CTD#	Make	Model	Serial#	Used with Rosette?	CTD Calibration Sheet Competed?
1	SEABIRD	911+	0550	Yes	Yes

Calibration Information CTD #550					
Sensor		**Pre-Cruise**		**Post Cruise**	
Name	**S/N**	**Date**	**Location**	**Date**	**Location**
Temperature	**3396**	**1Apr2011**	**Factory**		
Conductivity	**2374**	**29Mar2011**	**Factory**		
Secondary Temp.	**2754**	**1Apr2011**	**Factory**		
Secondary Cond.	**2668**	**29Mar2011**	**Factory**		
Transmissometer	**1396DR**	**15Aug2011**	**IOS**		
SBE 43 DO sensor	**1176**	**1Apr11**	**Factory**		
PAR	**4601**	**16Mar2011**	**IOS**		
Eco-AFL Fluorometer	**2216**	**?**			
Pressure Sensor	**75636**	**13Apr2011**	**Factory**		
Altimeter	**?**				

TSG

Make/Model/Serial#: SEABIRD/21/3363 Cruise ID#: 2011-27

Calibration Information					
Sensor		**Pre-Cruise**		**Post Cruise**	
Name	**S/N**	**Date**	**Location**	**Date**	**Location**
Temperature	**3363**	**23Mar11**	**Factory**		
Conductivity	**3363**	**23Mar11**	**“**		
Wetlab/Wetstar FL	**WS3S-713P**	**18Jan01**	**“**		
Temperature:Secondary	**0603**	**03Mar11**	**“**		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North Latitude
West Longitude
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P21
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P19
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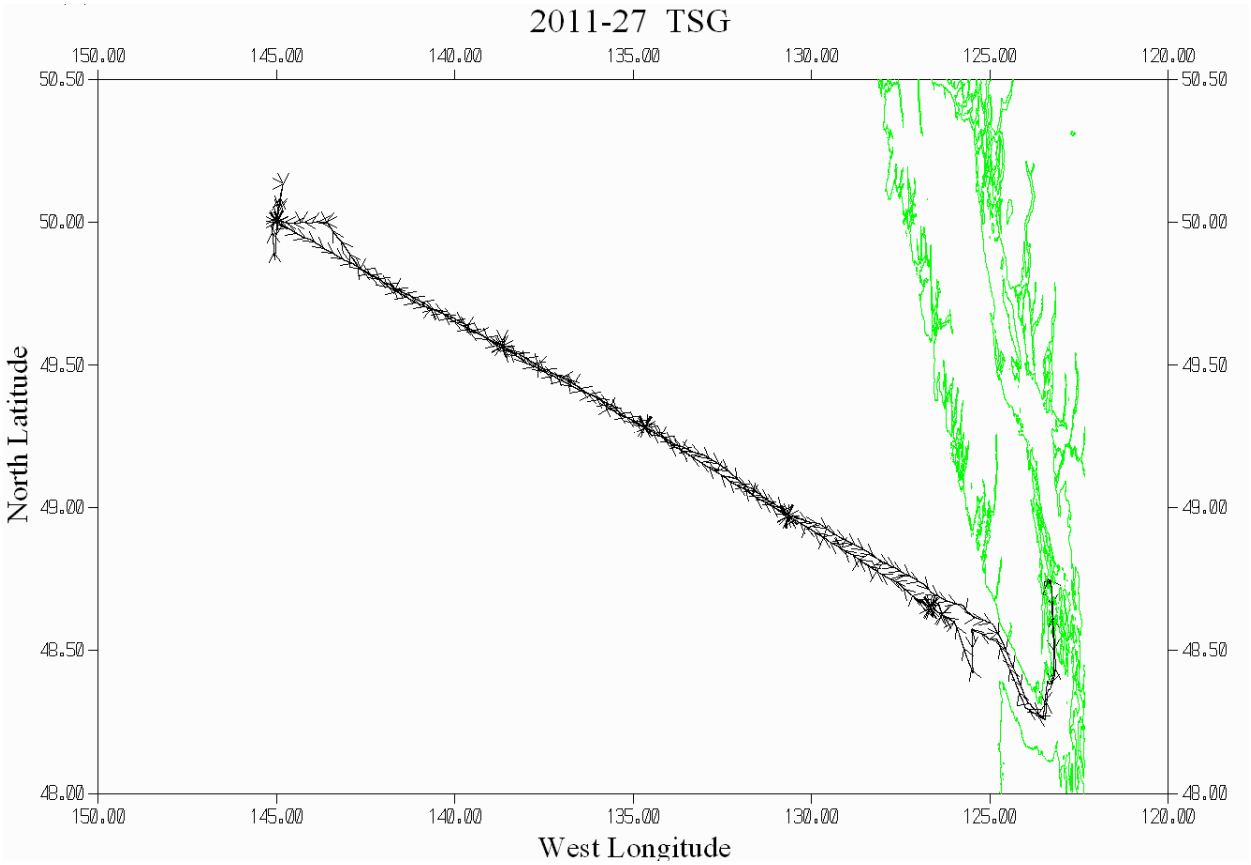
2011-27 TSG
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North Latitude
West Longitude