REVISION NOTICE TABLE

DATE	DESCRIPTION OF REVISION
25 Aug 2020	Added HPLC data. S.H.
3 Feb 2020	Added DMSP data, all data padded due to problem with blank G.G.
16 August 2017	Reordered Nutrient samples 2013-18-0053.CHE G.G.
14 July 2016	Comment added to CHE and CTD files re fluorometer problem. See document Fluor-2228-problem.docx.
3 May 2016	Corrected format in channel Oxygen:Dissolved. G.G.
1 April 2015	Correction to header comment about salinity bottles in CHE files. G.G.

PROCESSING NOTES

Cruise: 2013-018
Agency: OSD
Location: North-East Pacific
Project: Line P
Party Chief: Robert M.
Platform: John P. Tully
Date: 20 August 2013 – 5 September 2013

Processed by: Germaine Gatien
Date of Processing: 4 March 2014 – 24 March 2014
Number of original HEX files: 56
Number of CTD files: 54 (1 surface test cast; 1 upcast data only)
Number of bottle files: 52
Number of bottle casts processed: 52
Number of original TSG files: 3
Number of processed TSG files: 3

INSTRUMENT SUMMARY

SeaBird Model SBE 911+ CTD (#0443) was used for this cruise. It was mounted in a rosette and attached were a Wetlabs CSTAR transmissometer (#1396DR), an SBE 43 DO sensor (#0997) on the secondary pump, a SeaPoint Fluorometer (#2228) with a 3X cable on the primary pump, a Biospherical QSP-200 PAR sensor (#4615) and an altimeter (#1204).

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

The deck unit was a Seabird model 11, serial number 0471.
All casts were run with the LARS mid-ship station.
The salinometer used at IOS was a Guildline model 8400B Autosal, serial # 68572.
An IOS rosette with 24 10L bottles was used.

SUMMARY OF QUALITY AND CONCERNS

The Daily Science Log Book and rosette sampling log sheets were generally in good order. However, there were a few events that were not well described.

One cast was interrupted and restarted. There was a note about a computer crash but it looked like it occurred at the end of the 2nd of those casts.

When an event number needs to be changed on a rosette sheet, a line through the old entry rather than an erasure alerts others that there might be some confusion in labels and other records. One error in the dissolved oxygen analysis log can be traced to such a change.

The notes about problems with the fluorometer were very confusing, but it is understood that the science crew were very confused themselves due to the fluorometer being mounted on a different external voltage than that indicated in the configuration file. Further problems arose because at least one person used the CTD computer to display data and changed the gain in the configuration files for his viewing pleasure. The chief scientist has suggested that a "lock screen" be used on the main CTD computer between casts.

The data from the SeaPoint fluorometer were bad for casts #1 to #39 and have been removed. Given the frequent gain changes in the configuration, tests were run to see if different gain settings could produce better results for those early casts, but in all cases fluorescence was much too low with any possible setting. For events #41-107 the fluorometer appears to have worked normally but these were all offshore casts with low chlorophyll; fluorescence values were mostly about 1 to 2 times extracted chlorophyll values, which is a typical result for this type of sensor for that range of extracted chlorophyll.

This fluorometer behaved very oddly during cruises 2013-38, -17 and 2013-50 with lower values than usual above 100m, but large dark values that got steadily worse with time. For this cruise, after event #41 the dark values look reasonable.

The comparison of CTD salinity with bottle samples indicated that the primary salinity was low by ~0.0026 and the secondary salinity high by ~0.0035. However, this comparison is not trusted since the analysis was run 2 to 3 months after collection so that there is likely some evaporation of samples. If the bottles are reading too high, this would imply that the secondary sensors are reading even higher than the comparison suggests. The primary would also be higher, possibly bringing it into good agremeent. The difference between the two salinity channels indicates a change from previous cruises when the T/C sensor pairs both produced salinity with 0.001 of bottles. There is some evidence that one sensor might have been damaged during a touch-down late in the previous cruise. Taken together with the comparison with bottles, this makes it seem more likely that one conductivity sensor has changed calibration suddenly rather than that two sensors have drifted in opposite directions quickly. The primary salinity was less noisy than the secondary and likely more accurate, so it was selected for archiving. No recalibration was applied to the salinity.

There were unusual excursions in salinity that appear to be due to varying alignment of T and C sensors. Such variations are always seen in CTD data, but not to the extent seen in these data. These features are not due to shed wakes overwhelming the CTD since there is no effect on temperature. They are often associated with high deceleration rates of the CTD. Descent rate variations can drop from +1.5m/s to -0.7m/s within 3m, so within 2 or 3 seconds, and often the deceleration is more extreme than that. The resulting errors are most notable in the top 100m because the local gradients are higher. The problem was worse in the secondary salinity. Small excursions could generally be corrected by interpolation, but for many of these features, the salinity points were deleted. The primary temperature data looked ok, so were not removed. While these alignment variations can be significant, editing plus metre-averaging of data should minimize the effect.

Based on a precision study run by the Dissolved Oxygen post-cruise analyst, the titrated values of dissolved oxygen are only reported with 2 decimal places. There were a number of problems noted including that the water traps on the Dosimat were left empty and the injection of bubbles into samples via the Alkaline Iodide bottle top dispenser during one cast. The comparison of titrated samples with the CTD Dissolved oxygen data is considered rougher than usual, though the fits do not look out of line with other cruises using this equipment.

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

±1.0mL/L from 0 to 100db

±0.4mL/L from 100db to 500db
±0.06mL/L below 500db

The draw temperatures are nominal but special note was made that one thermometer that was in use until part-way through cast #59 was found to be malfunctioning.

There were many problems with the TSG system and data were only acquired from the inward track starting near station P24. In the first file the time was wrong by almost 9 days and there was no signal from the flow meter. The data look reasonable, so this is presumed to be a problem with the meter only, not the flow. The flow rate was replaced with pad values for file #1 to make it clear that the flow is not zero, just unknown. The time was corrected by matching positions to those in the SCS files.

Flow in the loop was turned off near the end of the 2nd and 3rd TSG files. Temperature, salinity and fluorescence data have been removed where flow was off and the flow rate was left unedited to indicate what the problem was. There were only 4 CTD casts that overlapped with the TSG record and 2 of those were in sections where the flow rate was low for the TSG. There were 7 loop samples with most overlapping with the 1st file where flow rate is not available. Salinity is very noisy in one section, but overall the data had only discrete spikes that were removed.

Salinity was recalibrated based on a post-cruise calibration estimating rate of drift.

The TSG fluorometer values are a little higher than those from the CTD fluorometer; this sensor needs recalibration or replacement.

PROCESSING SUMMARY

1. **Seasave**

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

2. **Preliminary Steps**

The files from the 2nd cast (station P1) were sent to IOS for initial processing. The chief scientist had noted an error in the gain entry for the SeaPoint fluorometer. The parameters were checked and no other errors were found.

The Log Book and rosette log sheets as well as various analysis logs. There were many notes about the gain of the fluorometer. It appears that the cable was changed during the cruise a few times and that con files were changed accordingly. Unfortunately, someone occasionally changed the gain in the con file even though the cable had not been changed, so there is much room for error. It was also discovered that the fluorometer was not mounted on the voltage channel indicated in the configuration file, except for the last few casts.

The chief scientist provided a list of casts showing the cable believed to have been in use and the gain in the configuration file used in acquisition and the voltage channel on which the sensor was mounted. Conversions for all files had earlier been done assuming the fluorometer was mounted on Voltage 0 with gain 30X as a proxy for voltage. Since the sensor was really on Voltage 1 conversion was repeated with Voltage 1 and gains that match those provided by the chief scientist for all casts except #105 and 107, which were mounted on Voltage 0.

Plots were made to see if the fluorescence data look reasonable and they often do not. From casts #1 to 5 the shapes are odd, from casts #6 to #35 the traces are extremely noisy with often no sign of a signal at all. For casts #35-39 there was no signal. From cast #41 to the end, the traces have reasonable shapes and values may be ok, but there is frequent noise.

The file names for event #9 will need to be fixed after conversion; they had been saved as #8.

Extracted chlorophyll, DMS, nutrients, dissolved oxygen and salinity data were obtained in spreadsheet format from the analysts.

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

The calibration constants were checked for all instruments. No errors were found except that the fluorometer gain setting may be wrong in some xmlcon files. Four configuration files were prepared as follows:
2013-18-ctd-3X.xmlcon – Fluorescence gain 3X, mounted on Voltage 1
2013-18-ctd-10X. xmlcon – Fluorescence gain 10X, mounted on Voltage 1
2013-18-ctd-3X-ch0. xmlcon – Fluorescence gain 3X, mounted on Voltage 0
2013-18-ctd-10X-ch0. xmlcon – Fluorescence gain 10X, mounted on Voltage 0
They were used following the information in file Fluo_config_files.docx.

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

3. Hysteresis Study

Hysteresis tests were run for cruise 2013-17 and no adjustments of DO parameters were found necessary.

4. BOTTLE FILE PREPARATION

A few test conversions were run to see now the fluorescence data looked. The results are puzzling from any voltage channel and with any gain, though they look better later in the cruise than early.
The ROS files were converted using file 2013-18-ctd*.xmlcon with Tau and Hysteresis corrections selected and choosing the particular version by following the scheme provided by the chief scientist in file "Fluo_config_ files.docx".

Those files were put through CLEAN to add event numbers (*.BOT).
Header Check was run on the BOT files and no problems were found.
Temperature and salinity were plotted for all BOT files. The secondary salinity looks fairly noisy in high gradient zones, but there are no real outliers. No editing was applied.

The BOT files were then averaged to enable an ADDSAMP file to be prepared. First the file was sorted on event number and Bottle Position order. Then sample numbers were added based on the rosette logs. The sample numbers generally are in the order of bottle position. A few problems were encountered:

- Cast #26 –The BL file is empty and no bottle file was produced. Samples were collected and the rosette sheet indicates sampling from cast #26. There is a rosette file for cast #27 which has no record of sampling and it has stops at appropriate levels. An examination of the full file provides an explanation – the file for cast #27 contains only upcast data from about 400db upwards. File #26 is missing that section. There is a note by file #27 about a computer crash, but it is file #26 that has the problem and there was no note about a restart. The rosette file for #27 will be renamed as #26. File #27 will not be processed further.
- Cast #44 – There is one more bottle than sample numbers. Niskin 18 closed before Niskin 14 at the surface. Niskin 18 was removed from the ADDSAMP file.

Sort was used to ensure that the ADDSAMP file was in sample number order.
SAM files were created using the Add Sample Number routine and those files were then bin-averaged.
Bin-average was then run using bottle numbers for bins to produce SAMAVG files.
The addsamp.csv file was ordered on sample number and converted to CST files. The CST files will form the framework for the bottle files.

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 2013-18-bot-hdr.txt.

EXTRACTED CHLOROPHYLL
Extracted chlorophyll and phaeo-pigment data were obtained in file QF2013-18.xls. Event numbers were missing, so those were added. A simplified version of the spreadsheet was saved as 2013-18chl.csv which was then converted to individual CHL files. Loop data were saved as file 2013-18chl-loops.csv.

DISSOLVED OXGYEN
Dissolved oxygen data were provided in spreadsheet QF2013-18oxy.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 2013-18oxy.csv. That file was converted into individual *.OXY files.

The post-cruise DO analyst noted that there were serious problems with the at-sea analysis, but that the standardizations look reasonably good despite that. However, precision was surprisingly low for an OSD cruise, so he reported the data to only 2 decimal places to reflect that.

SALINITY
Salinity analysis was provided in spreadsheet QF2013-18SAL.xls. The file was simplified, loop samples were removed and the file was saved as 2013-18sal.csv. That file was converted to individual SAL files. The salinity data were analyzed 58 to 76 days after collection. Loop samples were saved to 2013-18sal-loop.csv.

NUTRIENTS
The nutrient data were obtained in spreadsheet QF2013-18nuts.xls which included a report on precision. The file was simplified, reordered on sample numbers and loop samples were removed and the file was saved as 2013-18nuts.csv. The file was converted to individual NUT files. The loop data were saved as 2013-18nuts-loop.csv.

DMS
DMS data were obtained in file DMS summary (2013-18).xls. (There was a separate report on analysis techniques and problems.) The file was simplified and saved as 2013-18-DMS.csv and converted to individual DMS files.

The SAL, CHL, OXY, 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. The output files were named MRGCLN1s. Those files were then merged with SAMAVG files choosing the Bottle_Number from the SAMAVG files.

An initial header check did not turn up any problems.

Bottles with no sample numbers were removed from cast #1. These were fired for test purposes only.
A few problems were found in the course of running COMPARE:

- The ADDSAMP file needed correction
- For the Dissolved Oxygen data, samples #25 to 32 came from event #5, not #3. This was corrected in the spreadsheet and various files created from that s/s.

11) Compare

Fluorescence

The fluorometer used for 2013-18 has behaved oddly during other 2013 cruises. So, first some previous results were considered:

- 2012-12 – This cruise was chosen to get an idea of what we used to observe from this sensor. The dark values were <<0.1ug/L. The ratio FL/CHL was high for CHL<0.5 then fell rapidly to about 1 for CHL in the range 0.5 to 1ug/L. There were no high values, but based on other cruises, it is likely that the ratio would be <1 for CHL>5ug/L.
- 2012-25 – This cruise had higher CHL values giving a more complete picture of how things used to be with this sensor. The dark values are <<0.1ug/L. The ratio of FL/CHL for low CHL was not terribly high, up to 3.5 excluding an outlier. From 1 to 2ug/L the ratio is about 0.8 but there is a lot of scatter. For CHL from 3 to 5ug/L the scatter is even greater but a median value would be about 0.6.
- 2013-38 – The dark value increased through the cruise starting at ~0.16ug/L and gradually increasing to ~0.43ug/L at the end. The extracted CHL values were high ranging from 0.37 to 34.5ug/L and the associated fluorescence ranged from 0.16 to 12.17ug/L. The ratio of FL to CHL was about 1.8 when CHL was ~0.4ug/L which is may be a little low, but not far out of line. But the ratio fell below 1 for CHL > 1 with the ratio mostly around 0.4.
- 2013-17 – The ratio of FL/CHL was high for low CHL, fell to ~1 for CHL = 1ug/L and fell to about 0.4 for CHL ~7.6ug/L. The dark values continued to increase from those seen during 2013-38 starting at ~0.5 and ending at 1.6ug/L.
- 2013-50 – During this cruise there was some confusion about what gain cable was used. If the gain in the configuration file is correct, then the dark values started at about 1.7ug/L and increased somewhat though most later casts were shallow, so it is hard to judge. Those dark values are similar to the preceding cruises, so the gain likely was 10X.

So we expect to see dark values that are high, and a ratio of fluorescence to CHL that varies from high values for CHL<0.2ug/L, falling to about 0.4 to 1.5 for CHL=1, and median values of about 0.4 to 0.5 above that but allowing for considerable variation.

COMPARE was run and a table prepared from the results which includes fluorescence, extracted CHL the ratio FL/CHL, pressure, event numbers. Manipulating the results to look for patterns was not very fruitful. A few observations:

- Casts #2 and 3 have much lower fluorescence values than expected. A plot of FL/CHL vs CHL has the usual shape, but fluorescence looks low by a factor of 40 to 40. The data were converted assuming a 10X gain, but even if the cable was really a 1X, then that would only increase values by a factor of 10. And I don’t think we have a 1X gain cable.
- For casts #6-29 the shape of the fit is normal, but the fluorescence values are low by about a factor of 10. These were converted as 3X, so if it was really 1X, then the values would be 3 times higher, so still very low.
- The log mentions a change of cable before event #36, but there is no signal at all for events #35-39. Converting with the assumption that the sensor was on Voltage #0 produces extremely low values and this data is probably from a different sensor.

- The cable was changed before cast #41 and used up to cast #66. This group of casts looks about right, though there are no extracted chlorophyll values >0.64ug/L.
- Casts #67 to 77 were converted as 10X and these also look normal but have low CHL values too.
- We have no CHL after event #77.

So it appears that the data from event #42 onwards are probably ok, though there are many spikes. For events #1 to 39 there are problems that do not appear fixable. No gain error can explain them. If there was a problem with connectors, it may just be chance that the change of cable after cast #39 resolved it. Most interesting is that the dark values are ~0.12ug/L, so a little higher than we used to see, but not nearly as high as seen during cruises 2013-38, -17 and -50.

The plot of Fluorescence / Extracted CHL vs CHL looks as expected for casts #44 to #107. Chlorophyll values were all <0.065ug/L and the ratio started at about 5.5 for the lowest CHL point and then dropped, varying from 0.7 to 2.6 with a weak trend to lower ratios towards the top of the range. This pattern is typical of the SeaPoint fluorometers. So fluorescence should be kept for casts #41 to 107.

For more detail see file 2013-18-fl-chl-comp.xlsx.

Salinity

Compare was run with pressure as reference channel. Salinity samples were analyzed within 2 to 3 months of collection.

There were a number of clear outliers. A few were associated with noisy CTD salinity and some were from the surface where incomplete flushing of Niskin bottles is probably the cause. The results of COMPARE are not significant in those cases, so no quality flags or header comments were added. Other outliers had already been flagged by the analyst. Outliers that required some action were:

- Cast #9 -Sample #83 ~800db – The bottle is higher than the CTD by about 0.02. Flag 3 added plus comment.
- Cast #20, Sample #143 – sample had been flagged 3, but it stood out in COMPARE even for a surface sample. Change flag to 4 and add to comment.
- Cast #23 -Samples #165, 166, 167 - all were flagged 3 due to problem with inserts. Add to comments for all, and change to flag 4 for 166 and 167, leave 165 as 3 - minor outlier.
- Cast #54, Sample #381, surface: there was a 3 flag on this sample. Just a minor outlier, so leave flag and surface comparison does not justify change to comment.

In some cases 3 flags had been attached to samples, but they looked ok in the comparison. The flags were left, but an addition was made to the comment to say that they were not significantly out of line in a comparison with CTD salinity. These were:

- Cast #13 – samples #99, 102, 105, 108
- Cast #70 – Sample #473
- Cast #79 – Sample #540

After these changes were made to the analyst's spreadsheet, the file was reconverted to SAL files. When bottles above 300db and the outliers mentioned above, plus a few other flagged values, the primary salinity was found to be low by an average of 0.0026 and the secondary high by 0.0035. Standard deviations were ~0.003 for both channels. There is very little pressure dependence below 300m but there is clearly some near the surface, likely due to incomplete flushing. The fit against salinity also makes that clear. There is no obvious temporal variation. While the fits are flat against pressure, there is a lot of variability with a high standard deviation in the points included. This may be due to delayed analysis leading to some low bottles due to evaporation.

For full details for the COMPARE run see file 2013-18-sal-comp1.xls.

<u>Dissolved Oxygen</u>
COMPARE was run with pressure as the reference channel. Checks turned up a problem with hysteresis and that was because the hysteresis feature had not been turned on when the data were converted, so that step was repeated. When the data were reconverted with that feature, all sign of hysteresis had disappeared.

The fit of differences against DO concentration was noisier than usual. The post-cruise analyst noted many problems and attached flags to many bottles. Bottles flagged 4 were excluded plus the following outliers:
Cast #5 – bottles 1, 7, 8
Cast #23 – bottles 9, 16
Cast #31 - bottle #4
Cast #89 - bottle #4
Cast #105- bottle #9
These were not severe enough to warrant comments in the headers given the scatter in the fit.

The following changes were made to flags:

- Cast #9, sample #79 – This was the most severe outlier in the comparison. The sample had already been flagged 4 and was replaced with a pad value and flag 5.
- Cast #31, Sample #206 - This sample also looks enough out of line to need a flag 3. It had been flagged 2 by the analyst due to a noisy titration.

A few samples flagged 4 seemed ok in Compare but there was enough noise that this may not be significant.

The fits found were:

DOX_BOT = 1.052 * DOX_CTD +0.0163 with R^2 =0.9501

Or

DOX_BOT = 1.0555 * DOX_CTD when a zero offset is forced and R^2 =0.9447

To study what offset makes most sense, the bottles with DO <0.5 were investigated further; points with flag 3 were removed to see if this made a significant difference. It made a small difference because it removed bottles with the largest negative differences. Several other bottles were removed because there were very few CTD DO values available for comparison. The fits found were:

DOX_BOT = 1.0528 * DOX_CTD +0.0123 with R^2 =0.9484

Or

DOX_BOT = 1.0553 * DOX_CTD when a zero offset is forced and R^2 =0.9451

The large scatter and the many problems noted by the analyst do not lend a lot of confidence in these fits.

For more details see 2013-18-dox-comp1.xls.

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

Data from the MRG files were exported to a spreadsheet and casts were checked against rosette sheets to ensure all expected bottle data were present and to find any errors in the assignment of sample #s to bottle numbers by assessing if profiles look reasonable. Many errors were found in cast numbers and the DMS values had not been changed from < to 0 for the “not detectable” readings. The merging process was repeated after all corrections had been made.

5. Conversion of Full Files from Raw Data

All files were converted using the con files described in section 2.
After conversion file 2013-18-0008.cnv was changed to 2013-18-0009.cnv.

A few casts were examined and all expected channels are present. The descent rate was kept high, sometimes spiking to very high values, >2m/s, and there are many cases of the CTD slowing suddenly so there will be shed wake corruption.
The two temperature and conductivity channels are fairly smooth during the downcasts but noisy in the upcasts with some spikes and odd excursions in both channels.
Fluorescence is odd – sometimes increasing at the bottom, or having 2 local maxima or being almost constant with many spikes.
The altimetry, transmissivity, dissolved oxygen and PAR data look normal.

6. 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.

7. ALIGN DO

When used on other recent cruises the DO sensor data were found to be improved by using advances of +4s, +4.3s and +4.5s. Tests were run on a few casts with few stops during the upcast but the results are not easy to interpret because of noisy upcast temperature data. However, the +4.5s setting looks slightly better than 4.3s or +4s.
ALIGNCTD was used to advance the DO Voltage by 4.5s relative to the pressure.

8. CELLTM

The upcast data are noisy so the usual tests for CELLTM settings were also hard to interpret. Tests were run on a few casts using a variety of settings. The setting recommended by SeaBird does improve the data, so that was selected and was the choice made for all recent uses of this equipment.
CELLTM was run using (α = 0.0245, β=9.5) for both the primary and secondary conductivity.

9. 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.

10. 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 always very noisy, but these data are much noisier than usual. So these estimates are extremely rough.

Cast #	Press	T1-T0	C1-C0	S1-S0	Descent Rate
2013-38-0111	1900	-0.0002	0.00001	0.0018	High, Moderate
2013-17-0025	1800	-0.0003	0.00013	0.0018	High, X Noisy
2013-17-0036	1800	-0.0001	0.00013	0.0018	High, X Noisy
"	2800	-0.0005	0.00014	0.0022	High, X Noisy
2013-50-0030	650	-0.0005	0.00005	0.0014	High, Steady
2013-18-0009	650	-0.0005 XN	0.0003 XN	0.005 VN	High, F.Steady

2013-18-0042	650	~0 VN	0.0005	0.006 VN	High, Noisy
	1800	-0.0001	0.0005	0.0064	High, Noisy
"	2800	-0.0003	0.0005	0.0069	High, Noisy
"	3600	-0.0005	0.0005	0.0071	High, Noisy
2013-18-0059	1800	-0.0001	0.0005	0.0065	High, Noisy
"	2800	-0.0004	0.0005	0.0070	High, Noisy
"	3800	-0.0006	0.0005	0.0073	High, Noisy
2013-18-0089	1800	~0 XN	0.0005 XN	0.0062	High, XNoisy
"	2800	-0.0004 XN	0.0005 XN	0.0066	High, XNoisy
"	3800	-0.0006	0.0005	0.0069	High, XNoisy

Cast #64 was investigated but the differences were very odd with a shift in temperature differences at 1246db. Examination of the two temperature channels shows there was a large spike in the primary while there was a shift in the secondary by about 0.01C°. The secondary moves a little closer to the primary but the differences remain high even during the upcast. The spikes in the primary due to shed wakes continue in the primary but are either missing or smaller in the secondary. The secondary pump was clearly not working properly. Tests were run on casts before and after #64. The previous cast was shallow but there is no sign of a problem. For cast #66, the differences are very noisy, but the spikes look similar suggesting that the problem had resolved itself by cast #66.

The differences in temperature show little variation through the cruise, but the differences in conductivity and salinity are significantly higher. The larger differences are seen early in the cruise. During cast #1 the difference was about 0.004 at 200m. During cast #9 the salinity difference was about 0.005 at 650m. There are only shallow casts from 2013-50 which preceded this cruise, but the comparison of 2013-50-0030 and 2013-18-0009 at 650m shows a notable difference. There were no cruises between these two that are known to have used this CTD. There was a CTD touch-down towards the end of 2013-50, but unfortunately there was no salinity sampling during the latter part of the cruise, so there is no way to determine which, if either, conductivity sensor was damaged.

11. Conversion to IOS Headers

The IOSSHELL routine was used to convert SEA-Bird 911+ CNV files to IOS Headers.
CLEAN was run to add event numbers and to replace pad values in the pressure channel with interpolated values based on record number.

12. Checking Headers

The header check was run. There are some bad values in cast #42 but they are in the upcast and the data are not in the rosette file.

The surface check showed only surface data from cast #108; this was a test cast and the pumps were not on, so the file will not be processed further. The average surface value was 3db which is reasonable. At the end of the cast at station SI03 the CTD was held very close to the surface for more than a minute with pumps running. Values at ~0.15db were very low for salinity and transmissivity, though most were clearly "in-water" values. The CTD must have been very close to the surface and possibly came out of the water very briefly. This suggests that the pressure is reasonably accurate.

The cross-reference check was compared with the log book and no problems were found.

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

The altimeter readings, maximum pressure and water depth were exported from the headers of the CLN and MRG files to spreadsheets. The water depths were checked against the log and corrections were made where a depth was wrong or missing. Where the CTD did not get within 15m of the bottom there should be no header altimetry entry and that was mostly the case. But occasionally there are spikes that are misinterpreted, so in cases where the CTD did not appear to get near the bottom, plots were made and the header removed when it was clear the data came from spikes. Plots were also made of some random casts. The same corrections were made to the SAMAVG files in case the MERGE process needs to be repeated.

13. Shift

Fluorescence

Normally a shift of +24 records is used to align fluorescence with temperature when the fluorometer is pumped. A few casts were tested to see if that setting improved alignment and the results showed that in some cases it did and in others it looked worse. However, there is virtually no signal in those that look worse. For a few casts (70 and 105) where there was a definite signal, there does appear to be some improvement after the alignment step, though it is very hard to judge given the noise in the upcast temperature.

SHIFT was run on all casts to advance the SeaPoint fluorescence by +24 records.

Conductivity

For the last 2 cruises during which this equipment was used, the conductivity shifts found appropriate for these sensors were -0.5 records for the primary and +1.4 records for the secondary.

Tests were run on 1000m casts from near the beginning and end of the cruise using a variety of settings close to those used recently. The results looked best using -0.7 records for the primary conductivity though a lot of noise remains and results vary from feature to feature. For the secondary the +1.4 setting looks bad, so a wide range of settings were tried. A setting of +0.4 looked best overall; once again the differences were small and much noise remained no matter what choice was made.

Two runs of SHIFT were used to apply advance the primary by -0.7 records and the secondary by +0.4 records.

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. The alignment looks as good as we are likely to achieve.

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: There were no warnings.

15. Other Comparisons

Previous experience with these sensors –

1. Salinity:

The conductivity sensors were both recalibrated in late January 2013 and were used on 3 previous cruises. The analysis of salinity calibration samples was done fairly quickly for all 3. The primary salinity was found to be low by 0.0005 for the 2 with the quickest analysis (2 to 4 weeks delay) and low by 0.0017 when there was a 3 to 6 week delay. The secondary was high by about 0.0006 and 0.0010 when analysis was quick and low by 0.0005 when it was slightly delayed. This gives some indication that the error associated with a delay of a few weeks is on the order of 0.001salinity units.

2. Dissolved Oxygen

The DO sensor was recalibrated in February 2013and has been used for 3 other cruises since then. The offset was forced to be 0 when there was little low DO data or data quality was lower than usual. The fits found were:

DOX_BOT = 1.0471 * DOX_CTD +0.0172 (2013-38)
DOX_BOT = 1.0540 * DOX_CTD (2013-17)
DOX_BOT = 1.0545 * DOX_CTD (2013-50)

The first case is equivalent to a slope of ~1.05 if the offset is forced to 0.

3. Pressure

The pressure sensor was recalibrated in March 2013 and the factory offset has been used for the 3 cruises on which it has been used. Deck observations during 2013-50 showed it to be within 0.2db.

Historic ranges – Profile plots were made with 3-standard deviation climatology ranges of T and S superimposed. The temperature data were all within the climatology except for some slightly high temperatures for cast #78 at P26 at the base of the surface mixed layer, around 30db. The log mentions that the ship was rolling during this and the previous cast. All other casts at that site are within the historic range, so this looks like a slightly deeper mixed layer due to a recent storm. Salinity values were slightly lower than the climatology minimum for some casts between P12 and P17 at about 150db. T-S plots show stable features, but obvious mixing. None of these excursions suggest a systemic error, so are not evidence of calibration errors.

Repeat Casts –

There were many repeat casts. AT P16 around 1400db along constant σ_t-lines temperatures are within 0.002C° and salinity within 0.0005 units. The two casts occurred about 3 hours apart. This is good repeatability.

Post-Cruise Calibration

There were no post-cruise calibrations available.

16. DETAILED EDITING

The first issue is to decide which sensor pair to edit. There were severe problems with the secondary temperature during cast #42, so at least for that cast the primary must be chosen. The noise level seems a little higher in the secondary salinity. One or other of the conductivity sensors has changed markedly since the last time they were used, so an attempt was made to establish which it was before choosing which to edit.

The primary salinity was found to be low by an average of 0.0026 and the secondary high by 0.0035. The difference between these is similar to the results of tests shown in section 6. There was an 8 to 10 week delay in analysis of salinity calibration samples which has been found in the past to lead to bottle salinities that appear to be too high, probably due to evaporation. Both CTD sensor pairs produced salinity that was close to bottles in previous uses, so we know that at least one of the pairs has had a significant change in calibration. The temperature sensors compared well in section 6 but the conductivity sensors did not. If we assume that evaporation has made bottles too high by about 0.002, then that implies that the primary salinity would be low by 0.0006 and the secondary high by 0.0055. For the primary that would mean there has been little change from previous results and that something has happened to the secondary conductivity. If that estimate of error in the bottle salinity is too low, it still implies that the primary is more accurate than the secondary.

This is not conclusive, but in the absence of a post-cruise calibration the best guess is that the primary salinity has drifted little. The change to the secondary is not critical if it is a simple offset, but there may be other problems since there is some suggestion that the sensor might have been damaged by hitting bottom near the end of the previous cruise.

The primary channels were selected for archiving.

CTDEDIT was used to remove 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. The descent rate was often noisy.

As noted on other recent Tully cruises, there are many odd excursions in salinity that do not appear to be related to shed wake corruption or stray spikes. These unstable features look like they are caused by misalignment of temperature and conductivity, possibly related to high deceleration rates of the CTD. Descent rates often vary from -1.5m/s to -0.7m/s within 3m, so within 2 or 3 seconds, and occasionally are much higher than that.
In some cases these features are too large and complex to be corrected by cleaning and the errors are not random due to the basic temperature gradients, so the salinity values were removed. Temperature points were not removed for those features. Such editing was applied to most casts.

All ED1 files were copied to EDT.

17. Initial Recalibration

The pressure does not need recalibration.

Based on the analysis in section 16, no calibration will be applied to the primary salinity. If, in future, a factory report on the primary conductivity sensor shows that it had drifted significantly and the secondary had not, then this decision can be revisited.

The COMPARE results suggest that the dissolved oxygen channel should be recalibrated using the fit:

DOX_BOT = 1.0528 * DOX_CTD +0.0123

Because a larger than usual proportion of samples were excluded as outliers, it was decided to look at 2013-58 which ran immediately after 2013-18 and had the same sensors. The comparison of bottles with CTD for that cruise resulted in fits:

DOX_BOT = 1.0558 * DOX_CTD +0.0214 with R^2 =0.9049

or

DOX_BOT = 1.0608 * DOX_CTD when a zero offset is forced and R^2 =0.8950

The fit with a free offset looks better as well as having a slightly higher R^2 value. There were a lot of oxygen bottles in this fit. However, the CTD data were noisier during bottle stops.

There was likely some drift during these two long cruises, so the fit with lower slope may be more appropriate for 2013-18. The precision for the titrations is stated to be 0.01mL/L for 2013-18 and 0.009 for 2013-58.

So file 2013-18-recal1.ccf was prepared to apply the correction:

DOX_CTD corrected = 1.0528 * DOX_CTD +0.0123

CALIBRATE was run on the MRGCLN2, SAM and EDT files using that file.

COMPARE was rerun to check that the DO correction was done correctly and it was. The average difference after removing a few outliers shows the CTD DO to be within 0.0001 of the bottles on average, though the standard deviation is 0.03mL/L. (See file 2013-18-sal-comp2.xls.)

18. Final Calibration of DO

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, the fit looked fine for low DO values, but the CTD data looked high at higher values. A return to the study before recalibration failed to find a fit that would produce a better result. Using the zero offset result produced even higher CTD values near the surface. So the issue is likely not one of calibration. The response time of the CTD may mean that the downcast data are reading a little too high below the maximum particularly in the high-gradient zones, typically 75 to 300m. So a correction to the downcast data is likely a good idea. A test of surface saturation rates does suggest that they are a little too high. The results vary depending on how outliers are identified. The trend line was forced through the origin since the CTD data looks rather noisy at depth as do differences near the origin. The most conservative correction was chosen.

So a second calibration was applied to these data using file 2013-18-recal2.ccf with the following correction:

DOX_CTD corrected = 0.991 * DOX_CTD

COMPARE was rerun and the high values still look slightly high, but there is little point in pursuing this further given the limitations in both the CTD and bottle data.

A plot of differences against pressure was used to make a final study of outliers and to make a rough estimate of the accuracy of downcast CTD dissolved oxygen.

19. Special Fluorometer Processing

Special files were prepared for Dr. Peña by clipping the COR2 files to 150db. The files were bin-averaged (0.25db bins) and put through HEADEDIT and named as *.FCTD1 and saved. A second set, *.FCTD2, were created by filtering before bin-averaging. 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.

A median filter, fixed size=11, was applied to the fluorescence channels in the COR1 files to reduce spikiness. A few casts were examined before and after this step and showed that the filter was effective.

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 was considered appropriate.

21. Final CTD File Steps (REMOVE and HEADEDIT)

A check was made of the cast lists with and without PAR sensor by plotting PAR. A few errors were found and corrected.
REMOVE was run on casts #1 - #39 with a PAR sensor mounted to remove the following channels:

Scan_Number, Temperature:Secondary, Salinity:T1:C1, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Fluorescence:URU:Seapoint, Altimeter, Status:Pump, Descent_Rate and Flag

REMOVE was run on casts #1 - #39 with no PAR sensor mounted to remove the following channels:

Scan_Number, Temperature:Secondary, Salinity:T1:C1, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Fluorescence:URU:Seapoint, Altimeter, PAR, Status:Pump, Descent_Rate and Flag

REMOVE was run on casts #41 - #107 with a PAR sensor mounted to remove the following channels:

Scan_Number, Temperature:Secondary, Salinity:T1:C1, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, Status:Pump, Descent_Rate and Flag

REMOVE was run on casts #41-107 with no PAR sensor mounted to remove the following channels:

Scan_Number, Temperature:Secondary, Salinity:T1:C1, Conductivity:Primary, Conductivity:Secondary, Oxygen:Voltage:SBE, Altimeter, PAR, Status:Pump, Descent_Rate and Flag

Profile and T-S plots were produced at this point to check for errors. No problems were found.

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:

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

For events #1-39 channel Fluorescence:URU:SeaPoint was removed due to a malfunction.

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

Based on the recommendation from SeaBird, the method for calibration of Dissolved Oxygen concentration was changed from that used for 2011 and some 2012 cruises. For more information see the SeaBird Application Note #64-2, June 2012 revision.

Based on a precision study run by the Dissolved Oxygen post-cruise analyst, the titrated values of dissolved oxygen are only reported with 2 decimal places.

The Oxygen:Dissolved:SBE data are considered, very roughly, to be:
±1.0mL/L from 0 to 100db
±0.4mL/L from 100db to 500db
±0.06mL/L below 500db

The two CTD salinity channels differed by about 0.006 with one reading lower than bottles and the other higher. Delay in analysis likely caused some evaporation of samples, so the two salinity channels are likely reading higher than the comparison suggests. The little information *available suggests that there has been little calibration drift in the primary salinity.*

For details on the processing see the report: 2013-18_Processing_Report.doc.

The cross-reference list was produced and one cast was found to be missing. There was an error in a cast list used at the remove stage. That was fixed and another run turned up no further problems.

The Standards Check routine was run and no problems were found.
The Header Check was run and no problems were found.
The final files were named CTD.

Profile plots were made and look ok.
The track plot looks ok.
The sensor history files were updated.

22. Dissolved Oxygen Study

As a final check of dissolved oxygen data, % saturation was calculated and plotted. The near-surface values ranged widely from about 68% in Saanich Inlet to 120% at P2. All other casts had values between 103% and 106% with values dropping as the ship moved offshore.

24. Final Bottle Files

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

REMOVE was run on all casts with a PAR sensor mounted to remove the following channels:
Scan_Number, Temperature:Secondary, Salinity:T1:C1, Conductivity:Primary, Conductivity:Secondary, Fluorescence:URU:SeaPoint (events 1-39 only), Oxygen:Voltage:SBE, Altimeter, Status:Pump, Descent_Rate and Flag
REMOVE was run on all casts with no PAR sensor mounted to remove the following channels:
Scan_Number, Temperature:Secondary, Salinity:T1:C1, Conductivity:Primary, Conductivity:Secondary, Fluorescence:URU:SeaPoint (events 1-39 only), Oxygen:Voltage:SBE, Altimeter, PAR, Status:Pump, 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.

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

A header check was run and an error was found in one cast, so that was reprocessed.

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 no problems were found.
A cross-reference list turned up no errors.
The track plot was produced on screen and no errors were found.

25. Thermosalinograph Data
The external thermistor was connected.
There were loop salinity nutrients, extracted chlorophyll and salinity samples taken, some while stopped and some while underway.
There were problems at sea with the TSG that involved rearranging filters and de-bubbler. Later it was found that data were not being archived. And finally there was a problem with the flow meter being blocked by a mussel.

a.) <u>Checking calibrations</u>
The configuration files for the 3 casts are identical and the parameters are correct. One file was renamed as 2013-18-tsg.xmlcon.

b.) <u>Conversion of Files</u>
The files were converted to CNV files using configuration file 2013-18-tsg.con. They were then converted to IOS HEADER format.
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.

Time-series plots were produced. As noted in the cruise report the flow is ~0 for first file. The data in the first file may be ok, the flow itself might not have been affected, but that will be checked against loop samples. Unfortunately there will be few overlaps with CTD casts.

The track plot looks fine and was added to the end of this report.

c.) <u>Checking Time Channel</u>
An initial check of the files shows that the dates in the first file are wrong. The other 2 files look ok. While the first file is suspect anyway because of the flow rate being ~0 the data don't look too bad which may mean that the flow itself was ok, just that the flow meter malfunctioned. So attempts were made to figure out the time.

Information available to help fix the time for file #1 includes:

- File #1 Start: August 23 at 18:14 Position: 49.81, -142.25 (position is near P24)
  File #1 Stop: August 25 at 18:03 Position: 48.96, -130.67 (position is near P12)
- File #2 Start: September 3 at 14:40 Position: 48.97, -130.66 (~P12)
  File #2 Stop: September 4 at 2:30 Position: 48.86, -129.36 (around P9 to P10)
- File #3 Start: September 4 at 03:32 Position: 48.85, -129.19 (around P9)
  File #3 Stop: September 5 at 14:27 Position: 48.65, -123.45 (Saanich Inlet)
- The track plot for all 3 files show that the ship was moving shoreward and the cruise report confirms that there is only TSG data for the inward track.
- The dates for file #1 do not make sense for an eastward, i.e. shoreward path.
- The length of the record for file #1 is 47 hours, 49 minutes, or 2869 minutes. There are 5738 records which is exactly as expected for that time. So the interval looks right.
- Matching the time to the SCS records show both start and stop times for file #1 correspond to somewhere near P5 and P13 while travelling westward. So the time is obviously wrong.
- Perhaps the time is wrong but positions are right. So, matching the start position of file #1 to the SCS records from the shoreward track turns up a good match on September 1 at 14:31:36. Matching the stop position is a little less certain because the ship was on station, so drifting around that position, but the best match is the first time the ship reached that latitude and the time

was September 3 at 14:20:06. This gives a time interval of 47 hours 48.5 minutes. This is a good match to the file length.

- From the log we know the ship was at P12 on the inward track from about 14:00 to 20:30 on September 3. So having the end of file #1 and most of file #2 at P12 looks right.
- The temperatures towards the end of File #1look reasonable for being near P12.
- There is a note in the cruise report that the day after leaving P26 it was noticed that the TSG data were not being archived, but that it was started when the ship was at about P24. The start position of file #1 is near P24.

So an appropriate correction of time is to add 8 day, 20 hours, 17 minutes, or 212.2833 hours. Add Time Channel was used to add that time difference and CLEAN was run to fix the headers. The result matched the times found in the SCS file.

Note that P12 and P4 were occupied on the inward journey so that will provide some data for comparison with the TSG. There were also some loop samples, including 5 that overlap with File #1, so we should be able to determine if this file contains reasonable data.

The CTD data from the 4 overlapping casts were thinned to reduce the files to a single point from the downcast at or within 0.5db of 4db and exported to a spreadsheet which was saved as 2013-18-ctd-tsg-comp.xls. Cast #100 overlaps with file #2 but can also be compared with the end of file #1 as an extra check. The time will not be the same, so small differences are expected.

The 3 TSG files were opened in EXCEL, median and standard deviations (over 5 records) were calculated for intake temperature, salinity and fluorescence and the files were reduced to the times of CTD files and loop samples.

To check for problems in the TSG clock or bad matches of TSG and CTD data, the differences between latitudes and longitudes were found. The differences in latitude and longitude were all <0.0003°. This shows both the times and positions are reliable for both systems
This spreadsheet will also be used in step (d) to compare temperature, salinity and fluorescence.

d.) <u>Comparison of T, S and Fl from Loop & Rosette Samples and TSG and CTD data</u>

- <u>T1 vs T2</u> There is a lot of variability in the difference between the intake temperature and the lab temperature. The median difference between the intake and lab temperature for the 3 files were:
  - File #1: Median ΔT -0.23C° Std Dev 0.056C°, Flow rate unknown
  - File #2: Median ΔT -18C° Std Dev 0.034C° not including a section near the end when the flow was turned off. Median flow rate 1.1 not including final section.
  - File #3: Median ΔT- 0.32 C° Std Dev 0.396C° - flow varied significantly so studied in 3 sections. Salinity was very noisy when the rate was higher.
    - Median ΔT -0.24 Std Dev 0.058 median flow rate 1.0 – salinity very noisy
    - Median ΔT -0.29 Std Dev 0.058 median flow rate 0.73
    - Median ΔT -0.48 Std Dev 0.472 median flow rate 0.63

  The ship was on station for most of File #2 and the flow rate was high.

- <u>TSG vs CTD</u> The spreadsheet comparing CTD and TSG files was then examined to find the differences between the salinity, fluorescence and temperature channels for the CTD and the TSG. There are only 4 casts that overlap with the TSG and 2 of those had flow rates that were lower than optimal. Cast #100 was also compared with the end of TSG file #1 just to see if the results are reasonable; there is a significant time difference but they are at roughly the same site.
  1. *Intake Temperature* The TSG intake temperature is higher than the CTD 4m-temperature by an average of 0.019C°, varying from 0.0077 to 0.0408. The largest difference coincides with a high

standard deviation in the intake temperature. If we discard that value the average difference is 0.012C°.
2. *LAB TEMP* Using the same data as in the analysis of the intake temperature the lab temperature is found to be higher than the CTD temperature by 0.258C°.
3. *SALINITY* TSG salinity data are lower than the CTD salinity by an average of 0.04 with differences ranging from 0.031 to 0.057. The highest difference is from a time when the flow rate was only 0.55.
4. *FLUORESCENCE* The TSG fluorescence is 1.7 times higher, on average, than the SeaPoint fluorescence from the CTD but the highest ratios are from the two casts with lower flow rate. When the average flow rate is >1the ratios are 1.1 and 1.2.
5. The comparison of event #100 CTD salinity and fluorescence with the TSG data from the end of file #1 looks similar to the cases with an overlap. The two temperature channels differ by 0.1C° which is not bad given the time difference.
(See 2013-18-ctd-tsg-comp.xls.)

- <u>Loop Bottle - TSG Comparisons</u> Most loop samples did not coincide with TSG data. There were 7 that did and they include extracted chlorophyll and salinity samples. There was confusion in sample numbers since 2 were labelled as Loop 95 and none as Loop 96. It is assumed one of them is Loop 96 as there should be one of each and there is no indication that duplicates were taken at Loop 95. The higher salinity was presumed to come from the site further offshore.
  The TSG salinity was found to be lower than the CTD salinity by a median value of 0.041 and a standard deviation of 0.079. The differences ranged from 0.025 to 0.065. Reversing the assignment of sample numbers increases the differences.
  The TSG fluorescence is higher than the loop extracted chlorophyll by a median factor of 6.2 and standard deviation of 2.5. If one case where the flow rate is known to be low (~0.5) is excluded, the salinity is found to be low by 0.042 and the fluorescence high by a ratio of 7.0. Unfortunately, the case where the flow is low, is the only case with CHL >0.5ug/l. We expect the fluorometer to read relatively high for CHL<0.5ug/L. The ratio of TSG FL / CHL is 2.4 for the one higher CHL sample, 2.2ug/L, which is a higher ratio than expected, but the flow rate was low.
  (See 2013-185-loops-tsg-comp.xlsx.)

- <u>Surface rosette CHL vs TSG fluorescence</u>
  There were no near-surface salinity or extracted chlorophyll samples during the casts that overlap with the TSG record.

- <u>Calibration History</u>
  The TSG pressure, lab temperature and conductivity were recalibrated in March 2012 and it was used during 2013-01, 213-38 and 2013-17.
  The TSG fluorometer was recalibrated by inter-comparison on a CTD cast in August 2012.
  The TSG salinity was found to be low by 0.005, 0.04 and 0.03, but comparisons were not trusted due to flow rates that were often low and/or noisy salinity.
  In June 213 the TSG salinity was found to be low by 0.06 when the ship was stopped.
  Chlorophyll values were low with no values >1ug/L. When the lowest values are excluded the TSG fluorometer values were about 10-15% higher than those from the CTD fluorometer.
  The flow rate problems made comparisons with CHL unreliable for June 2013.
  There were insufficient data to recalibrate the TSG data in June 2013.

  There was a post-cruise calibration in December 2013 and the salinity was found to have drifted low by about 0.0088 due to conductivity drift and temperature was low by ~0.0006 for a net drift in salinity of about -0.008.

Conclusions

1. The TSG clock appears to have worked well except that the time was set wrong for the first file. Once corrected the time looks fine.
2. A mussel was found in the flow meter after file #1 was stopped, but there is no note as to whether this would have impeded the flow or not. The data do not look like there were serious problems with the flow. So the flow rate values should be replaced with pad values and the other data left as is.
3. The temperature in the loop increases by from ~0.13 to ~0.32Cº based on comparisons during stops for CTD casts, with the highest values occurring when the flow rate was lower.
4. The TSG intake temperature appears to be higher than the CTD temperature by from 0.008 to 0.04. We do not have a drift estimate for the intake thermistor.
5. The TSG Salinity is lower than that of the CTD by from about 0.03 to 0.06. The comparison with loop samples is similar. The post cruise calibration shows that the salinity was low by 0.0088 by December 2013. The TSG was used on at least one other long cruise after this one, so a correction of +0.006 is a reasonable estimate. The difference between this error and the comparison with CTD and loop samples may be due to noise in the TSG salinity as it is systematically towards low salinity values.
6. When the flow was high the TSG fluorescence was about 20% higher than the CTD fluorescence. The TSG fluorescence was much higher than extracted CHL but this is not unexpected for low CHL.

f.) Editing

The ATC files were copied to *.EDT.

CTDEDIT was used to remove salinity spikes in all files.
For file #1 the flow rate channel data were removed because the meter malfunctioned. Rather than just remove the channel pad values were entered to indicate that there was a problem.
For file #2, some data were removed from the end of the file where the flow was stopped (Temperature primary, Salinity and Fluorescence.)
For file #3 the salinity was too noisy to edit when the flow rate was ~1. Some data were removed from the end when the flow was turned off (Temperature primary, Salinity and Fluorescence.)

A text editor was used to replace the secondary temperature values with pad values to match the primary temperature which edited in the CTDEDIT phase.

Plots were examined and no further editing was deemed necessary.

g.) Recalibration

CALIBRATE was run using file 2013-18-tsg-recal1.ccf to add 0.006 to the salinity channel.

h.) Preparing Final Files

REMOVE was used to remove the following channels from all casts: Scan Number, Temperature:Difference, Conductivity:Primary and Flag channels.
The flow channel was not removed since it explains the gaps and some users may want to remove even more data based on this variable.

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

27. Loop File
An initial surface/loop file was prepared with rosette samples above 10db and all loop samples.
The CHE files were put through DERIVE to calculate sigma-t. They were then exported to a spreadsheet and sorted on pressure. All lines were removed except for the bottles fired near 5m. (2013-18-che.csv)
The loop sample data prepared for the TSG processing were added to the file and lined up appropriately with the CHE data. The data were then ordered on time.
The sampling method column was added entered ROS or UWS for rosette data and true loop data, respectively.
Comments were added as required.
A 6-line header was added and the original header removed.
The file break column was filled with value 1 so all data will be in a single file when converted.
The file was then saved as 2013-18-surface-6linehdr.csv.

CONVERT was run to get an IOS Header file, followed by CLEAN to get start and stop times and positions.

Header Edit was used to add general comments from the CHE files. Comments were added concerning flags on samples from Niskin bottles. The flags from the loop samples were entered automatically in the conversion process.
The final file was named 2013-18-surface.loop. A track plot looks reasonable and a plot of salinity versus date looks right.

<u>Particulars</u>

PAR on: 1-7, 15-18, 29, 36, 41, 44, 58, 60, 77-78, 85, 86.
PAR off: 9-13, 19-27, 31-35, 37-39, 42, 47-56, 59, 64-75. 79-83, 89-108.

1-5. Error in con file – fluorescence gain should have been 3X.
6. Fluorometer gain fixed in con file.
7. Problem with bottle 17.
9. CTD files named event #8. Fixed.
26. Negative spike in salinity at 283db.
27. Computer crash led to restart of previous cast with new file name.
29. Positive spike in salinity at 34db.
35. Missed a bottle trip so went down from 450 to 500db to get it.
36. Changed fluorometer cable from 3X to 10X.
55. Changed fluorometer cable from 10X to 30X.
67. Changed fluorometer cable from 3X to 10X
86. Sometime after this cast the TSG flow meter stopped working. Lots of bubbles and spikes in fluorescence. Later a mussel was found in the flow meter.
102. Changed fluorometer cable from 10X to 3X.
108. Test cast – surface only, no pumps.

Institute of Ocean Sciences
CRUISE SUMMARY
CTDs

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

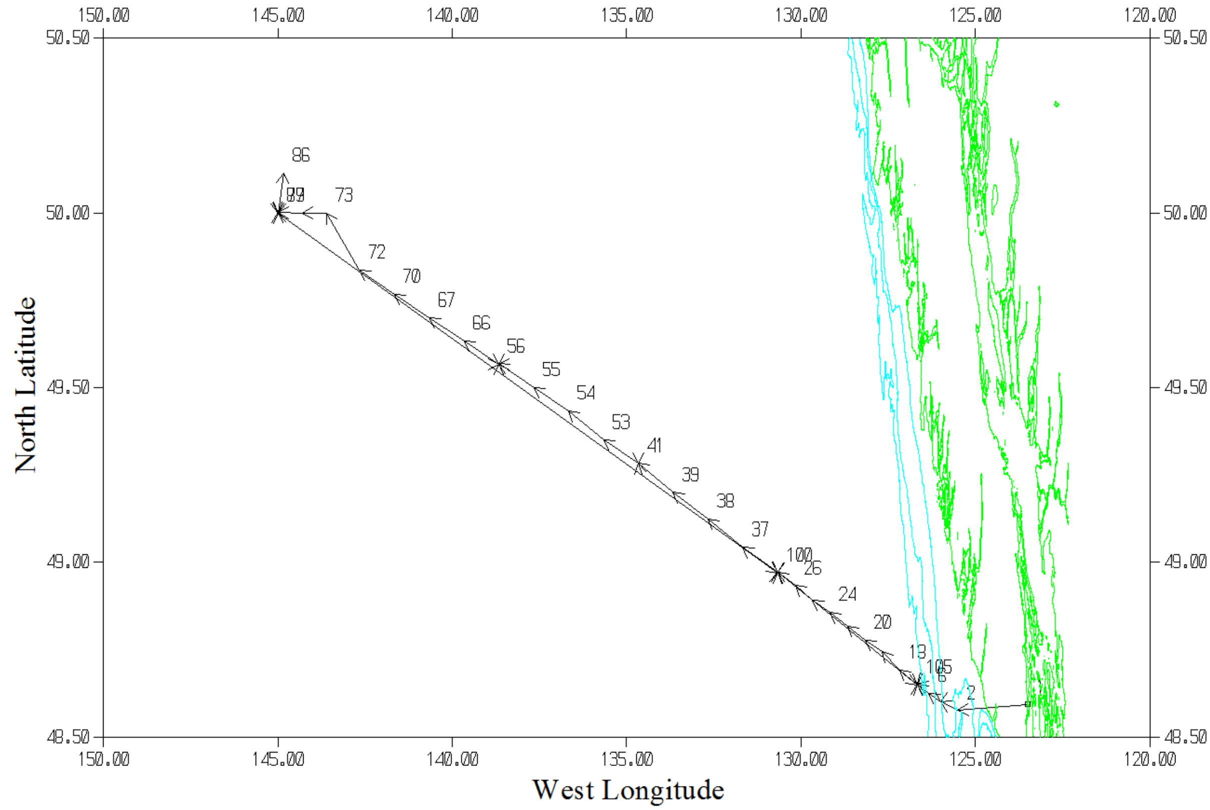
Calibration Information CTD #443					
Sensor		**Pre-Cruise**		**Post Cruise**	
Name	**S/N**	**Date**	**Location**	**Date**	**Location**
Temperature	**2023**	**31Jan2013**	**Factory**		
Conductivity	**2280**	**29Jan2013**	**Factory**		
Secondary Temp.	**2668**	**1Feb2013**	**Factory**		
Secondary Cond.	**2754**	**30Jan2013**	**Factory**		
Transmissometer	**1396DR**	**31Jan2013**	**IOS**		
SBE 43 DO sensor	**0997**	**16Feb2013**	**Factory**		
SeaBird Fluorometer	**2228**				
PAR	**4615**	**16Mar2011**	**IOS**		
Pressure Sensor	**63507**	**15Apr2011**	**Factory**		
Altimeter	**1204**				

TSG

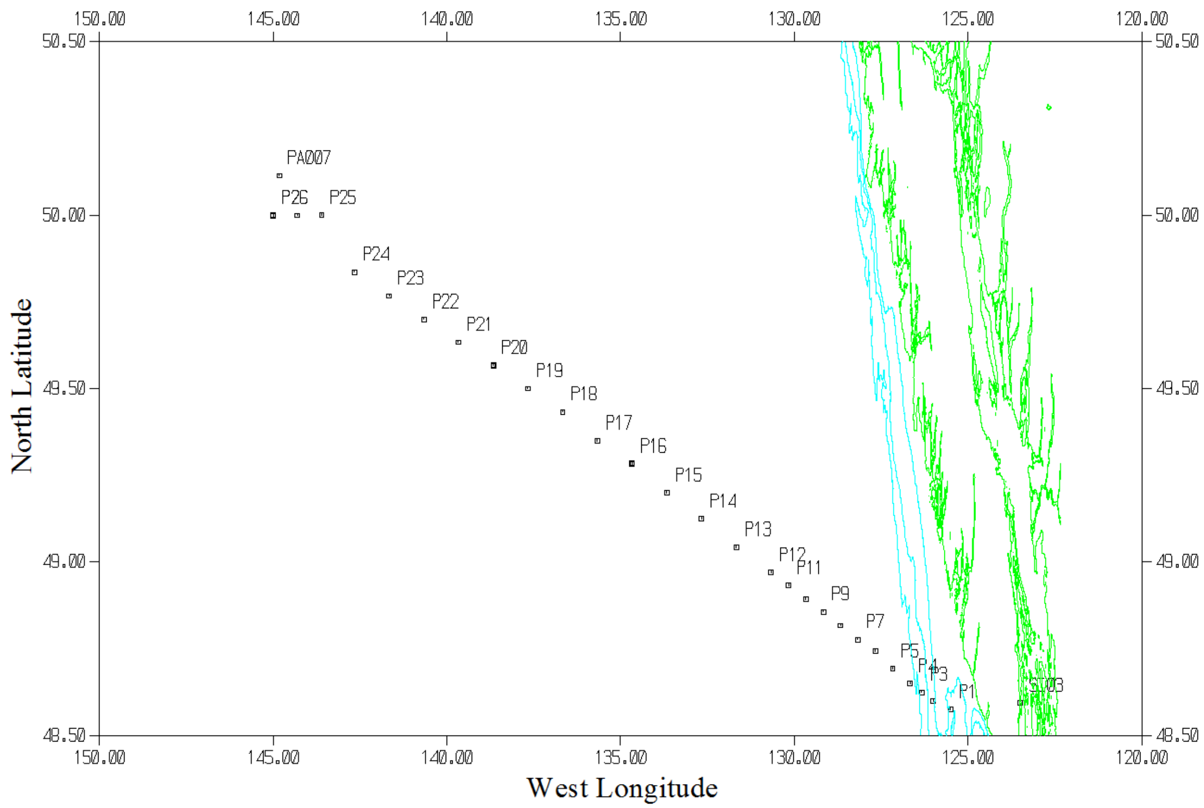
Make/Model/Serial#: SEABIRD/21/2487 Cruise ID#: 2013-18

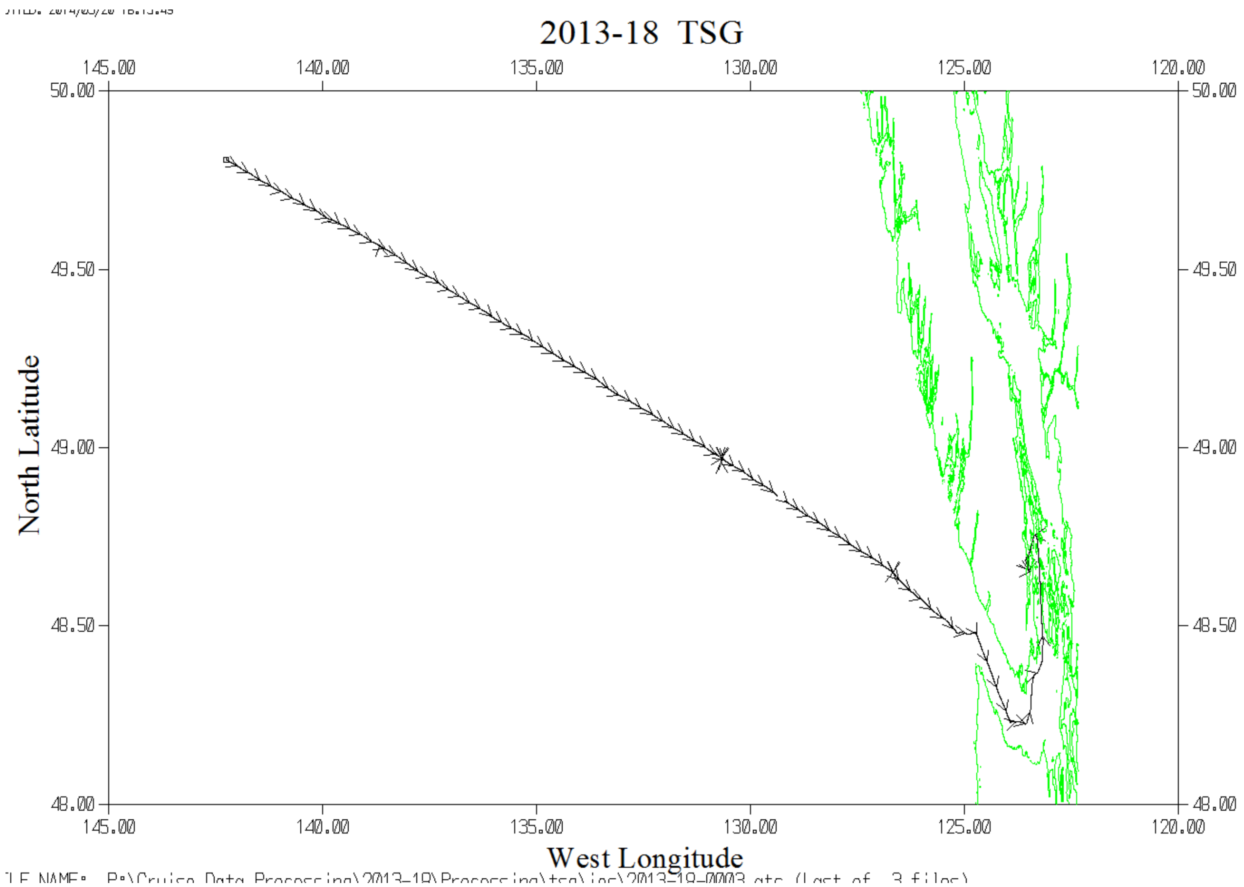
Calibration Information					
Sensor		**Pre-Cruise**		**Post Cruise**	
Name	**S/N**	**Date**	**Location**	**Date**	**Location**
Temperature	**3363**	**7Mar12**	**Factory**		
Conductivity	**3363**	**7Mar12**	**“**		
Wetlab/Wetstar FL	**WS3S-713P**	**Aug12**	**IOS**		
Temperature:Secondary	**0603**	**7Mar12**	**“**		
Flow meter	**?**	**n/a**			

2013-18



2013-18




2013-18 TSG
North Latitude
West Longitude
145.00
140.00
135.00
130.00
125.00
120.00
50.00
49.50
49.00
48.50
48.00