## REVISION NOTICE TABLE

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| --- | --- |
| DATE | DESCRIPTION OF REVISION |
|  |  |
| 27 Mar 2025 | Updated channel names & formats in TOB files. G.G. |
| 21 Jul 2021 | Errors in Time:Julian channel name & data corrected in TSG files. G.G. |

## PROCESSING NOTES

Cruise: 2015-007

Agency: OSD

Location: North Pacific / Bering Sea / Chukchi Sea

Project: Canada’s Three Oceans / Distributed Biological Observatory

Party Chief: Vagle S.

Platform: Sir Wilfrid Laurier

Date: July 3, 2015 - July 22, 2015

Processed by: Germaine Gatien

Date of Processing: 22 July 2019 – 2 August 2019

Number of CTD HEX files: 54 Number of CTD files: 54 Number of CHE files: 41

Number of TSG HEX files: 5 Number of TOB files: 6 (1split)

# INSTRUMENT SUMMARY

A SeaBird Model SBE 911+ CTD (#0941) was used for this cruise. It was mounted in a custom-built compact 24-bottle rosette sampler and attached were a Wetlabs CSTAR transmissometer (#CST-1050-DR), an SBE 43 DO sensor (#1117), a SeaPoint Fluorometer (#2745), a Biospherical QSP-200L4S PAR sensor (#70123), a Biospherical Surface PAR (#40853) and an altimeter (#40853).

24 Ocean Test Equipment 10L bottles were mounted on the rosette.

A thermosalinograph (SeaBird 21 S/N 3274) was mounted with a fluorometer (SCF3275) and a remote temperature sensor #0271.

The data logging computer was a Dell Optiplex 755 (WGBCIOS101655.)

The data acquisition program was Seasave 7.23.2.

The deck unit was a Seabird model 11, serial # 11P53201-0800; it included a NMEA board to automatically add GPS positions into the header of the data files.

The salinometer used at IOS was a Guildline model 8400B Autosal, serial # 68572. Bottles were analyzed on 5 November 2015.

# SUMMARY OF QUALITY AND CONCERNS

The Daily Science Log Book and rosette log sheets as well as spreadsheets detailing sampling were provided. There are many deck pressure measurements recorded.

The primary temperature, salinity and DO channels have bad data. This is believed to have been caused by jellyfish parts getting lodged in the plumbing.

The file names included event numbers that correspond to the consecutive CTD casts but do not correspond to the events in the Daily Science Log and on the rosette log sheets. The entry under “Watch keepers in the Daily Science Log corresponds to the consecutive CTD casts and those numbers were entered at the top of the rosette sheets. Since the analysts used the consecutive CTD numbers the file names were not changed. A table was prepared to relate the 2 sets of event numbers.

The CTD was held at the surface for 2 to 5 minutes, then lowered to between 5 and 6m for a soak of about 2.5 minutes after which it was returned to about 1 or 2m. After a brief stop (usually ~15 seconds) the full cast was run. The data from the soak period were removed to ensure the best data are selected for the data to be archived.

The bottle comparison indicated that the salinity was low by about 0.002psu but delay in analysis and poor flushing can account for that. There was no significant drift in temperature and conductivity sensor calibrations, so CTD salinity is considered within +/-0.001psu.

Near-surface plots indicate no problem with pressure and deck measurements show the sensor was preforming well within specifications.

The first TSG file was large and caused some problems with software, so it was divided into 2 files. All TSG files were renamed based on cruise # and start time of file: YYYY-###-MM-DD-HHMMSS.

The TSG Salinity was found to be reading lower than the CTD salinity and loop samples by about 0.035psu. A comparison with data converted using a post-cruise calibration showed a drift downwards of about 0.021 to 0.25psu over 3 years ending 4 months after this cruise. The remaining difference is likely explained by bubbles in the loop water, delays in sample analysis and to a small extent differences in depth of TSG and CTD sampling. TSG Salinity was recalibrated by adding 0.022psu.

TSG intake temperature read significantly higher than 5m CTD temperature, but the post-cruise calibration indicates no significant drift. The differences from the CTD may be due to small differences in the depth of TSG and CTD sampling since near-surface temperature gradients are frequently large. It is also possible that there is a little heating of water near the intake. The TSG lab temperature was recalibrated by subtracting 0.001C° based on a post-cruise factory calibration.

The TSG fluorescence data were removed as the values were extremely low compared to both CTD fluorescence and extracted CHL samples from 5m rosette bottles.

# PROCESSING SUMMARY

##### Seasave

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

There were 2 problems with the file names in the raw files:

* Files had cruise numbers that were standard in 2015 but that has changed, so the files were renamed with 2015-007 instead of 2015-07.
* The file names included event numbers that correspond to the consecutive CTD casts but do not correspond to the events in the Daily Science Log and on the rosette log sheets. Since the analysts used the consecutive CTD numbers the file names will not be changed. A table was prepared to relate the 2 sets of event numbers. The numbers that correspond to CTD casts are shown in the log book in the column named “Watch Keepers”.

##### Preliminary Steps

The Daily Science Log Book and rosette log sheets were obtained. A post-cruise report was available.

Spreadsheet 2015-07\_SWL\_Chem and Logs.xlsx contains a sampling log with details on bottles fired and results of analyses.

The cruise summary sheet was completed.

There was no history available for the pressure sensor, conductivity and DO sensors; this was the only cruise on which they were used after the last factory calibration.

The configuration files did not change through the cruise.

The calibration constants were checked for all instruments.

The CTD was held at the surface for 2 to 5 minutes, then lowered to around 5 or 6m for a soak of about 2.5 minutes after which it was returned to about 1 or 2m. After a brief stop (usually ~15 seconds though occasionally much longer) the full cast was run.

There were a number of deck readings of pressure that were all between -0.5db and -0.06db which is well within the specifications for the sensor.

There was no deep sampling, so no hysteresis tests were done.

##### BOTTLE FILE PREPARATION

The ROS files were converted in the same way as the full files except that bottle number and bottle position channels were included and oxygen concentration and salinity were derived.

The files were then converted to IOS Header files with BOT extensions.

An initial check showed significant differences between the primary and secondary conductivity and salinity. It looks like the primary sensor was not adjusting to gradients so that the problem was likely in the plumbing rather than the sensor itself. Values in low gradients near the bottom look reasonable.

A preliminary header check turned up no problems. There was no off-scale fluorescence.

Temperature and salinity were plotted for all BOT files. The results were troubling – something is wrong with the primary conductivity and possibly also with the temperature. A note was found about jellyfish parts getting lodged in the plumbing. No attempt was made to look for outliers in the primary channels. There were some spikes in the secondary salinity.

CTDEDIT was used to clean spikes in casts #8 and 11. There were noisy data in other casts but it looks like real variability rather than spikes due to minor misalignment or other instrumental noise.

The edited files were copied to BOT. A note was made in the header of each file about any editing done.

The BOT files were averaged on bottle number and those files were used to prepare an ADDSAMP file.

That file was edited to add sample numbers.

The ADDSAMP file was used to add sample numbers to the BOT files, creating SAM files. Those were bin-averaged on bottle number to create SAMAVG files.

Next, text file 2015-007-bot-hdr.txt was prepared to add an explanation of quality flags and some general comments from analysts.

Spreadsheet “2015-007\_SWL\_Chem and Logs \_2019-02-05b.xlsx” contained final analysis data. The file was simplified and saved as “2015-007\_Chem-simplified.csv” in preparation for combining with the CTD data from the rosette files.

The comments from various channels were combined into a single comment column.

The Bottle Integrity Column was renamed Flag: Niskin\_Bottle and the flags were all 0, which is in line with the flag definitions used for other channels.

A 6-line header was added to ensure proper channel names, formats and pad values were entered and comments added to the header.

File 2015-007\_Chem-simplified.csv with the 6-line header was converted to MRG1 files.

The MRG1 files were put through CLEAN to reduce the header to just the File Comments section.

SORT was run on channel bottle # and then merged with the SAM files with output MRG.

These files were put through CLEAN to remove SeaBird headers and comments from the secondary file.

##### Compare

Salinity

Compare was run with pressure as reference channel.

As expected the fit for the primary salinity looks very bad, especially above 40m.

When outliers were removed with standard deviation in the CTD Salinity >0.0008psu and differences >0.1psu, there remained only 16 bottles for the primary comparison but 68 for the secondary.

Using only those bottles, the primary was found to be lower than the bottles by an average of 0.0017psu with a standard deviation of 0.0047. The secondary was found to be low by 0.0021psu with a standard deviation of 0.0041. The data are all shallow and analysis was delayed for a 4 months, so we would expect the CTD to read slightly lower than bottles even if there were no calibration drift. Incomplete flushing of Niskin bottles would also contribute to CTD salinity looking low compared to samples.

The differences above 40m are all <0.5psu for the secondary but as high as 4.5psu for the primary. The small differences at depth show that the problem is not calibration. It is likely that there was a problem with the pump or tubing.

The sampling is too shallow to consider flagging outliers. The shallow outliers are almost all towards CTD being lower than bottles which is likely due primarily to incomplete flushing of bottles. Between 40 and 100db there are some casts with the CTD reading higher. With one exception wherever the CTD appeared to be reading higher than bottles by at least 0.03psu, the bottle was from the bottom of a cast where the effects of poor flushing lead to the CTD reading higher than bottles whereas during upcasts the opposite is true. The one exception was a near-surface bottle where local vertical gradients are high enough that the distance from the Niskin to the CTD could be significant.

There is no evidence that the outliers are due to problems with the bottles. No further flags were assigned.

A plot of differences versus file pair number shows no significant change with time for either sensor pair.

For full details for the COMPARE run see file 2015-007-sal-comp1.xls.

Extracted Chlorophyll versus CTD Fluorescence

In the usual pattern the CTD fluorescence tends to read higher than extracted chlorophyll when the latter values are very low. For CHL>2.5ug/L the fluorescence is generally about 50% of the extracted CHL. There is a lot of scatter in fits of FL vs CHL and FL/CHL vs CHL; this is likely due to some large gradients at mid-depths.

The fluorescence was about 73% of extracted CHL overall.

See file 2015-007-fl-chl.comp.xls.

##### Conversion of Full files from Raw Data

All files were converted using 2015-007-ctd.xmlcon. The hysteresis correction was not selected since all casts were shallow; the Tau correction will be used.

All channels were plotted for a few casts to check for problems in the conversion.

All casts were shallow so variability is high throughout and upcasts are quite different from downcasts in the top 30m or so. The primary temperature and conductivity channels look very different between downcast and upcast and do not track well with the secondary. The comparison between downcast and upcast are better for the secondary channels, though as usual there is a significant offset as the CTD tends to drag deeper water upwards during the upcasts. Transmissivity, altimetry, PAR, Spar and Fluorescence traces look normal. The dissolved oxygen looks bad and likely was suffering from the same problem as the primary temperature conductivity since they were on the same pump. Descent rates are mostly high and steady.

##### 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.

##### ALIGN DO

The DO signal looks very strange and is unlikely to be archived. Just in case some of the data proves useful, it was put through ALIGN using the parameter used with 2014 data that used the same CTD.

ALIGNCTD was used to advance the DO Voltage by 4.5s relative to the pressure.

##### CELLTM

As for ALIGNCTD tests are not helpful for these shallow casts with so many stops and high variability, so settings were used that are always found reasonable, and often the best choice.

CELLTM was run using (α = 0.0245, β=9.5) for both the primary and secondary conductivity.

##### DERIVE

Program DERIVE was run on all casts to calculate primary and secondary salinity and dissolved oxygen concentration (using the Tau correction).

##### Tests

Normally a second run of DERIVE is done to study the differences between channels for a few test casts, but there is no point in doing that for these data since the primary channels have no useful data.

There was also no point in doing a post-cruise check for the DO sensor.

##### 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.

##### Checking Headers

The header check was run. No problems were found.

Surface check was run and shows an average surface pressure for the cruise was -0.2db with associated low salinity values.

The pressure values look to be accurate – frequent pressure checks on deck were between -0 .05 and -0.01db. The sensor had been serviced very recently.

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

The 10m-soak data need to be removed so that DELETE will select the most appropriate data.

In preparation plots were made to determine how many records should be removed.

CLIP was used to remove the soak data.

The altimeter readings and bottom depths from the headers of the CLN files were exported to spreadsheets. To see if the altimetry and/or bottom depth entries are reasonable a check value was calculated:

 Check = Water Depth – Altimetry – Max Depth Sampled

The altimetry value is calculated with an algorithm taking data from the bottom 2db so we can’t expect the check value to be exact. The 7 casts with Check value >3m were investigated. First, the header depths were checked against the log entries since the latter were frequently updated after the header was entered. For casts #16, 48, 49, 50 and 51 there was a difference between the header and log entry and changing to the log entry brought the check value to <2m. For cast #1 changing the header entry improved the value and for cast #2 the check value increased. Plots of altimetry shows that the header altimetry values were good. So variability in depth and/or small errors in reading or recording sounder readings likely account for the variability. The header entries were changed for 6 CLIP and SAM files and the merge with the bottle data was repeated.

The cruise tracks (with event #s and station names) were plotted and added to the end of this report. No problems were found.

##### Shift

Fluorescence

SHIFT was run on all casts using the standard setting advancing the SeaPoint fluorescence channel by +24 records. The results are not perfect but fluorescence

Conductivity

The casts are too shallow, have too many stops for bottles and data too variable to provide clear testing of alignment for secondary conductivity. The same sensors were used for 2010-05, 2011-18, 2012-09, 2013-05 and 2014-012 and a setting of -0.5s was found useful for those cruises But the results do not look good on these data. A setting of +0.5s made the data worse. A setting of -0.2s looked better than -0.5s but when compared with no shift, some small features were worse and others better. There may be some problems with the secondary system that are making alignment irregular.

SHIFT was not run on conductivity.

##### 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 were no warnings.

##### Other Comparisons

Previous experience with these sensors – This was the first known use of the pressure, temperature, conductivity and dissolved oxygen sensors after the previous factory calibration.

Post-Cruise Calibration -

The post-cruise calibration shows that secondary temperature channels had drifted low by ~0.00033C° and conductivity had shown no drift. So salinity is likely to be high by no more than 0.0003psu.

Historic ranges – There was no local climatology available.

Repeat Casts – There were no repeat casts; nearby casts are too shallow to test repeatability.

##### DETAILED EDITING

Only the secondary channels are suitable for archiving.

CTDEDIT was used to remove some near-surface records that look like they are affected by shed wakes

or ship effects and records corrupted by shed wakes, mostly near the bottom of the cast. Salinity was cleaned, mostly in areas with high temperature gradients that lead to spiky features that are unstable.

There are many unstable features that are small and could be real; they were left unedited.

All casts required some editing.

Plots were made to see if further editing was required. Many unstable features remain but most are fine-scale or would require removal of data where there is no obvious instrumental effect. A few casts were re-examined in CTDEDIT to see if further editing would be useful but in no case was extra editing applied.

##### Initial Recalibration

The bottle comparison indicates that the salinity is low by about 0.002psu but delay in analysis and poor flushing can account for that. The post-cruise calibration indicated that it was high by <0.001psu.

Near-surface plots indicate no problem with pressure and deck measurements show it is well within specifications.

The dissolved oxygen data are not suitable for archiving.

No recalibration will be applied to these data.

##### Special Fluorometer Processing

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

##### BIN AVERAGE of CTD files

The following Bin Average values were applied to the FIL files (output AVG):

Bin channel = pressure Averaging interval = 0.5 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. Some unstable features remain as described in section 16. These are mostly close to the surface and very heavy editing would be needed to remove them; often the unstable feature is due to a very small reversal in salinity. No further editing was applied.

##### Final CTD File Steps (REMOVE and HEADEDIT)

REMOVE was run on the AVG files to remove the following channels (Output \*.REM):

Scan\_Number, Temperature:Primary, Salinity:T0:C0, Conductivity:Primary, Oxygen:Dissolved:SBE Oxygen:Voltage:SBE, Altimeter, Status:Pump, Descent\_Rate and Flag

REORDER was run to put the channels in the usual order.

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

 *Data Processing Notes:*

 *----------------------*

*The event numbers used correspond to the consecutive CTD casts rather than those found*

*on the rosette sampling log sheets and in the Daily Science Log Book. Since the analysts*

*also used the consecutive CTD event numbers, no change was made to file names. There*

*are notations in the log book in column "Watch Keepers" that contain the cast numbers*

*that are used in these files for event numbers.*

*See document "2015-007-event-number-guide.csv" to relate the two sets of event numbers.*

*The data from the primary temperature, salinity and DO channels are bad. This is*

*believed to have been caused by jellyfish parts getting lodged in the plumbing.*

*Transmissivity, Fluorescence: SeaPoint, PAR and PAR:Reference are nominal and unedited*

*except that some records were removed in editing temperature and salinity.*

*The bottle comparison indicated that the salinity was low by about 0.002psu but delay in*

*analysis and poor flushing may account for that. The post-cruise calibration indicated*

*that it was high by <0.001psu. Calibration is likely within 0.001psu, but larger errors*

*are expected due to minor misalignment in the presence of large vertical temperature*

*gradients, especially near the surface.*

*For further processing details see the processing report 2015-007\_Processing\_Report.doc.*

The Standards Check routine was run and no problems were found.

The Header Check was run and no problems were found.

The cross-reference list was produced and no problems were noted.

The final files were named CTD.

Profile plots were made and look ok.

The track plot looks ok.

The sensor history files were updated.

##### Final Bottle Files

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

REMOVE was run on the MRGSORT files to remove the following channels (Output \*.MRGREM):

Scan\_Number, Temperature:Primary, Salinity:T0:C0, Conductivity:Secondary, Oxygen:Dissolved:SBE, Oxygen:Voltage:SBE, Altimeter, Status:Pump, Descent\_Rate and Flag.

REORDER was to rearrange the channel order.

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, to fix the platform name and chief scientist’s name and to add a comment about quality flags and analysis methods and a few notes about the CTD data.

Standards Check was run on the final files until all problems were found and addressed; the only non-standard item is Phosphate which has had a change in format since 2015 and O18 which was delivered with a different format.

For a final check the CHE bottle data were exported to a spreadsheet and compared with the rosette log sheets. A few potential problems were noted:

* 2 bottles from cast #8 were included in the file but had not been sampled nor assigned sample numbers, so they were removed from the MRGREO file and HEADEDIT was rerun.
* For cast #22 there is a note in the log that samples came from Niskin #1 rather than #2 due to jellyfish in bottle 2. The sample number used (#143) was the one intended to come from bottle #2. The analysis data were moved to Niskin #2 with sample #142. Flag 2 was attached to all samples and a note of explanation was placed in the header. The changes were made in the MRGREO file and HEADEDIT was rerun.

A Header Check was run 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.

##### Thermosalinograph Data

Date were provided in 5 hex files, plus a few test files from before the start of the cruise.

The TSG files have non-standard names with the format month/day. These will be adjusted after conversion.

There was an intake thermistor but no flow meter.

a.) Checking calibrations

The calibrations were checked. The only change was that the fluorometer gain setting which was 10X for most files, but it was 30X for file 2015-007-07-13-145634. So 2 configuration files are needed. Files 2015-007-tsg10x.xmlcon and 2015-007-tsg30x.xmlcon were created. No errors were found in the parameters.

There was some CHL loop sampling taken but there is no record of when and the data were not available at the time of processing.

There was salinity loop sampling. Document “Salinity Data 2015-07 and 24 TSG.xlsx” was found and the loop data copied to file “2015-007-ctd-tsg-loop-rosette-comp.xlsx”.

b.) Conversion of raw files.

Configuration file 2015-007-tsg10X.xmlcon was used to convert all the files except for the July 13th file which was converted using 2015-007-tsg30X.xmlcon

After conversion the file names were changed to format 2015-007-MM-DD-HHMMSS.cnv based on the start time of the file.

The files 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 based on the Julian time.

Time-series plots were produced. A few problems were noted:

* The fluorescence values are very low but there is some variability – so the problem is not lack of a signal. The gain cable was changed in hopes that would improve things, but it did not. A quick check of extracted chlorophyll values found TSG FL~0.03 when CHL~1. The end of the final file may have no signal.
* The first file had a lot of salinity spikes in the first few hours. These look likely to be due to bubbles. There are other single-point salinity spikes that are isolated.

The temperature differences look believable.

The first file is very large and unwieldy. It was separated into two parts with the second file named

All files will be processed, but later channel Fluorescence:URU:Seapoint will be removed from all files.

The first file is very large so it was fractured into 2 parts with the 2nd named 2015-007-07-08-00002.atc. Both parts were put through CLEAN to update headers and then they were copied to \*.ATC.

c.) De-spiking and Editing

All files were put through program Simple Despike to replace simple spikes of size >0.04psu with the average of adjacent values.

Plots were then examined and no editing appears necessary after that step.

d.) Bin-averaging

The files were bin-averaged over 6 scans.

The track plot looks good. It was added to the end of this file.

e.) Checking Time Channel

The CTD data were thinned to reduce the files to a single point from the downcast at or within 0.5db of 5db. Those data were exported to file 2015-007-ctd-tsg-comp.csv.

Only the last 3 TSG files overlapped with CTD casts. They were opened in EXCEL and reduced to the times of CTD files. There were 53 matches.

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 median differences in latitude and longitude were 0.00003° and 0.00015°, respectively. The largest difference was ~0.0019° in longitude. Small differences are expected as the CTD times are only recorded to the nearest minute. The longitude did vary by 0.002° during the 60s centred around the time for the case with the largest difference.

This comparison shows that both the times and positions are reliable for both systems.

This spreadsheet will also be used in step (f) to compare temperature, salinity and fluorescence from the CTD and TSG.

f.) Comparison of T, S and Fl from Loop and Rosette samples and TSG and CTD data

* T1 vs T2 The intake thermistor was connected throughout the cruise. The differences between the two TSG temperatures were between 0.12 and 0.42Cº with a median of 0.22Cº. The differences were slightly larger than those from the 2014 C3O cruises in this area when we match intake temperatures and fairly close to 2013 results. The differences might reflect slightly different flow rates in the loop. As expected, the heating in the loop is greatest where intake temperatures are lowest. The range of temperatures is unusual for this area with none <3 Cº.
* TSG vs CTD The spreadsheet comparing CTD and TSG files was examined to find the differences between the salinity, fluorescence and temperature channels for the CTD and the TSG.

The differences between TSG and CTD channels vary more than usual.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Tintake-Tctd | Tlab-Tctd | SALtsg - SALctd | FLtsg/FLctd |
|  using all casts | median | 0.3148 | 0.5697 | -0.0734 | 0.1159 |
|  |  | average | 0.5891 | 0.8137 | -0.2248 | 0.1136 |
|  |  | stdev | 1.0858 | 1.0733 | 0.3579 | 0.0947 |
|  |  | max | 6.6199 | 6.7485 | 0.1024 | 0.4490 |
|  |  | min | -1.1692 | -0.9394 | -1.7907 | 0.0012 |
| excluding 2  | median | 0.2441 | 0.5466 | -0.0663 | 0.1179 |
| outliers |  | average | 0.4167 | 0.6441 | -0.1816 | 0.1169 |

Finally, 9 casts that appeared to be well-mixed in temperature in the top 10m were chosen and they generally had smaller differences except for 1 outlier. The results for the 8 were:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| median | 0.0868 | 0.2950 | -0.0340 | 0.0681 |
| average | 0.0634 | 0.2807 | -0.0778 | 0.0809 |

So the distance between the CTD sample and the level of the intake may explain much of the variability in temperature differences when temperature gradients are large. The salinity was generally better mixed so the effect on those data is smaller though still significant.

As noted earlier the TSG fluorescence is reading extremely low compared to the CTD fluorometer. The CTD fluorometer was lower than extracted CHL, so the problem is not CTD fluorescence that is too high. The TSG channel does not have useful data.

(See 2015-007-ctd-tsg-loop-rosette-comp.xls.)

* Loop Bottle - TSG Comparisons A spreadsheet was prepared by combining all loop sample data with TSG salinity (median over 25s).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Bottle Label** | **Loop Salinity** | **Date** | **Time**  | **TSG SAL** | **TSG Sal stdev** | **TSG med Sal - Loop Sal** |
| SWL-TSG-1 | 30.9470 | 13-Jul-15 | 22:25:00 | 30.9014 | 0.0075 | -0.0456 |
| SWL-TSG-2 | 31.0041 | 14-Jul-15 | 22:32:00 | 30.9644 | 0.0006 | -0.0397 |
| SWL-TSG-3 | 32.2906 | 16-Jul-15 | 09:48:00 | 32.2556 | 0.0260 | -0.0350 |
| SWL-TSG-4 | 31.7681 | 17-Jul-15 | 22:20:00 | 31.7146 | 0.0230 | -0.0535 |
| SWL-TSG-5 | 30.0553 | 18-Jul-15 | 23:36:00 | 30.0249 | 0.0004 | -0.0304 |
| SWL-TSG-6 | 30.3329 | 20-Jul-15 | 15:48:00 | 30.3267 | 0.0009 | -0.0062 |
|  |  |  |  | average difference |   | -0.0351 |
|  |  |  |  | std dev in differences |   | 0.0163 |

If the 2 cases with high standard deviation in the TSG salinity are excluded the average difference is -0.0305psu.

(See 2015-007-CTD-TSG-Loop-Rosette-comp.xls.)

* 5m rosette samples – There were no CHL loop samples but there are samples from 5m rosettes. The rosette CHL and Salinity bottle values were extracted and combined with the TSG fluorescence and salinity. There is a time difference since the TSG data is from the beginning of the cast rather than the end. There is also likely incomplete flushing of Niskin bottles which would lead to CHL that is a little low and bottle SAL a little high.

The TSG fluorescence has a median value of ~0.002 times the rosette bottle values based on 40 bottles, with a range from 0.000 to 0.020. This is not a typical result as TSG Fluorescence is usually higher than Extracted CHL for low CHL. For these data even when CHL is very low, fluorescence is <0.02 \* CHL.

There is a lot of variability in the comparison of TSG salinity and bottle salinity. The median shows the TSG to be reading low by ~0.10psu. The large outliers are all to one side and likely due to bubbles in the TSG data. When differences >0.1psu are excluded there are 19 casts left and the TSG salinity is low by a median of 0.054psu.

* Calibration History

The TSG primary temperature and conductivity were recalibrated in November 2012. There was a post-cruise calibration in November 2015. The intake temperature showed virtually no drift. The lab temperature was found to be high by ~0.0015C degrees. The salinity was low due to conductivity drift by roughly 0.017psu. Combined with the temperature drift the salinity could be low by roughly 0.018psu. To check on the factory drift estimates, the first and last files were converted using the post-cruise calibrations; these indicate salinity values were low by from 0.021psu to 0.025psu. Some of the drift may have occurred during the cruise that followed this one. An estimate was made that salinity is reading low by about 0.022psu.

Conclusions

1. The TSG clock appears to have worked well.

2. The temperature in the loop increases by between 0.12 and 0.42Cº with the greatest heating when intake temperatures are low, as expected. The post-cruise drift report for the lab temperature suggests it was reading high by ~0.0013Cº, though some of that may have occurred after this cruise. Temperature:Lab should be recalibrated by subtracting 0.001Cº. The effect on salinity is small compared to other sources of error.

3. The TSG intake temperature reads higher than the CTD by a median of 0.3148Cº The post-cruise calibration shows ~0Cº drift in the intake TSG temperature and the CTD sensor. So the difference likely reflects mismatches in the levels from which the CTD and TSG data came. This is supported by the fact that choosing 8 casts with low temperature gradients near the surface shows a median difference of <0.09Cº. That size error can be explained by a small temperature gradient though it is possible that there was some heating of water near the intake.

4. The TSG Salinity was found to be reading lower than the CTD by a median of 0.073psu and by 0.066 when 2 outliers are excluded. But there is still a lot of scatter in the fit with most outliers on the low side. For the 8 casts with low temperature gradients the median difference was 0.034psu. The difference from loop samples shows the TSG salinity to be reading low by 0.035psu or by 0.030psu if 2 cases with noisy TSG salinity are excluded. An estimate of calibration drift due to temperature and conductivity drift is about 0.022psu. The fact that loop salinity samples are higher than TSG salinity by ~0.005psu to 0.010psu more than can be explained by calibration drift may be due to the 6-month delay in analysis of samples. The lab temperature drifted upwards by 0.0013Cº over the 3 years since last calibration so can only account for a very small part of the salinity error. Differences between the TSG and CTD larger than 0.022psu are likely due to bubbles or mismatch of depths. Applying a correction of 0.022psu looks reasonable to address calibration drift.

5. The fluorescence from the TSG looks bad and should not be archived.

g.) Recalibration

CALIBRATE was run using file 2015-007-recal1.ccf to add 0.22psu to all TSG salinity data and to subtract 0.001Cº from the Temperature:Lab channel.

i.) Preparing Final Files

REMOVE was used to remove the following channels from all files: Scan Number, Fluorescence:URU:Seapoint, Temperature:Difference 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.

As a final check plots were made of the cruise track and time-series and all look fine.

The cruise plot was added to the end of this report.

##### Producing final files

A cross-reference listing was produced for CTD and CHE files.

The sensor history was updated.

Particulars

Surface pressures -0 .05 to -0.01

0. Test – bottles fired just for integrity check. Slow dribbles on the lower spigot which gets slower, considered ok.

44. Pump turned on part-way down.

209. Computer program crashed and had to be restarted.

105. Used bottle 1 for NUTS, SAL, DIC,O18 and Ba samples instead of 2 since bottle 2 is full of jellyfish.

218. Strong current – wire angle

TSG

July 4 15:00 – File to Dutch Harbour -Fluorometer gain 10X

July 12 02:29 – File started leaving Dutch Harbour

July 13 14:56– New file with fluorometer gain 30X

July 14 22:38– back to 10X gain.

July 18 23:33 - New file started between DB03 and DB04

July 21 18:00 - Stopped sampling at anchor in Barrow

# Institute of Ocean Sciences

# CRUISE SUMMARY

**CTDs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CTD#** | **Make** | **Model** | **Serial#** | **Used with Rosette?** | **CTD Calibration Sheet Competed?** |
| 1 | SEABIRD | 911+ | 0941 | Yes | Yes |

|  |
| --- |
| **Calibration Information CTD #941** |
| **Sensor** | **Pre-Cruise** | **Post Cruise** |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **5048** | **19Dec2014** | **Factory** |  | **Factory** |
| **Conductivity** | **3579** | **18Dec2014** | **Factory** |  | **Factory** |
| **Secondary Temp.** |  **5073** | **23Dec2014** | **Factory** |  | **Factory** |
| **Secondary Cond.** | **3581** | **17Dec2014** | **Factory** |  | **Factory** |
| **Transmissometer** | **1050DR** | **14June2014** |  | **12Apr2016** |  |
| **SBE 43 DO sensor** | **1117** | **19Dec2014** | **Factory** |  | **Factory** |
| **SeaPoint Fluorometer** | **2745** |  |  |  |  |
| **PAR** | **70123** |  |  |  |  |
| **Surface PAR** | **20281** |  |  |  |  |
| **Pressure Sensor** | **941** | **6April 2015** | **Factory** |  | **Factory** |
| **Altimeter** | **40853** |  |  |  |  |

# TSG Make/Model/Serial#: SEABIRD/21/3274

|  |
| --- |
| **Calibration Information** |
| **Sensor** | **Pre-Cruise** | **Post Cruise** |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **3274** | **2Nov2012** | **Factory** | **10Dec2015** | **Factory** |
| **Conductivity** | **3271** | **2Nov2012** | **Factory** | **10Dec2015** | **Factory** |
| **Temperature SBE38** | **0271** | **2Nov2012** | **Factory** | **10Dec2015** | **Factory** |
| **WETStar Fluorometer** | **3654** | **?** | **Factory** |  |  |



