## REVISION NOTICE TABLE

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## PROCESSING NOTES

Cruise: 2024-032 Agency: OSD

Location: North-East Pacific Project: Strait of Georgia Ecosystem Survey

Chief Scientist: Gauthier S. Platform: Sir John Franklin

Date: 20 February 2024 – 7 March 2024

Processed by: Germaine Gatien Date of Processing: Sept. 13, 2024 – 2 October 2024

Number of original HEX files: 62 Number of processed CTD files: 62

Number of rosette casts: 29 Number of processed CHE files: 28 (excluded 1 test cast)

Number of original TSG hex files: 1 Number of processed TOB files: 0

# INSTRUMENT SUMMARY

CTD #506 was mounted in a rosette and attached were a Wetlabs CSTAR transmissometer (#983DR), a SBE 43 DO sensor (#0997), a SeaPoint Fluorometer(#3949) and a Valeport altimeter (#75321).

Seasave version 7.26.7.121 was used for acquisition.

A thermosalinograph (SeaBird 21 S/N 2488) was mounted with a Wetlabs WETStar fluorometer (#1663). The sampling interval of the TSG was 30s but the configuration file had 3s entered.

# SUMMARY OF QUALITY AND CONCERNS

The Daily Science Log Book was missing several important items including equipment lists for the CTD and the Thermosalinograph. Configuration files for the TSG were confusing, so an equipment list would have been especially helpful. There was an error in the acquisition rate entered in the TSG configuration file, so confirmation in the log would have helped. There was no description of the deployment method until it was changed at cast 86, so it is assumed the standard 10m soak was used until that cast.

There were 2 versions of the rosette log sheets. The Excel version has tabs with station numbers and the PDF has sheets in the same order. This is very awkward for those processing data as the order of collection is of most interest rather than the site and our methods for linking various data inputs are based on event #s. A PDF version is usually provided with sheets in event # order.

Lower-case letters were used for station names in the data files. These were replaced with upper-cast letters which are the standard format; entries in the Daily Science Log mostly had the standard format.

The primary conductivity sensor performed badly. There is no note in the log that the salinity differences were very large and no test data were sent to IOS for processing. A change of sensor or CTD would have been advised if the problem had been discovered earlier. It would also have led to better equipment choices for cruises that followed. Fortunately, the secondary sensors worked well for this cruise.

The log contained separate sounder readings from the top and bottom for many casts; this was very useful since readings at the bottom help establish if the altimeter and sounder are both working well.

Recalibration of channel Oxygen:Dissolved:SBE was based on the results of cruise 2024-002.

Based on the results of cruise 2024-002, Oxygen:Dissolved:SBE data in the downcast CTD files

are considered, very roughly, to be:

±0.30 mL/L from 0-100db

±0.10 mL/L from 100db to 200db

±0.05 mL/L below 200db.

There were problems encountered at sea in collecting thermosalinograph data. There was a 4-hour gap in GPS feed so positions are missing, and there could be a other cases of short interruptions in the feed. There was no flow meter data, but based on reports of later Franklin cruises it is believed that flow rates were likely low and possibly variable. Salinity values compared poorly with CTD data and temperatures in the lab were unusually high even allowing for normal heating in the loop. A low flow rate may explain those results. Fluorescence values were too high compared to CTD fluorescence and rosette chlorophyll samples when the most recent calibration parameters were used. There were no loop samples. The data reliability is considered low, so it was not recommended for archiving. When further information becomes available from other Franklin cruises, this decision can be revisited.

# PROCESSING SUMMARY

##### Seasave

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

##### Preliminary Steps

The Log Book and rosette log sheets were obtained.

* Nutrients, extracted chlorophyll, dissolved oxygen and salinity data were obtained in QF spreadsheet format from the analysts.
* The cruise summary sheet was completed.
* The history of use of the pressure sensor, conductivity and dissolved oxygen sensors was found. All sensors were used during 2024-002.
* The same configuration file was used throughout and was saved as 2024-032-ctd.xmlcon.

##### BOTTLE FILE PREPARATION

ROS files were created using 2024-032-ctd\*.xmlcon. The hysteresis correction and tau corrections were selected.

The files were converted to IOS Header format.

The IOS files were put through CLEAN to create BOT files.

Temperature and salinity were plotted for all BOT files to check for significant outliers.

There were large differences between the salinity channels until cast #86 when they suddenly appeared to be much closer. That was the first cast in Inlets. The configuration file used in conversion was rechecked and no errors were found and there was no change to the configuration during the cruise. The problem is not due to temperature as those differences were small, but conductivity differences were large.

A quick check against bottle samples suggests that the problem was in the primary conductivity, but by event #86 the difference is much smaller.

No significant outliers were found in the plots of secondary data.

A preliminary header check turned up a few errors that were corrected in the ROS files; CONVERT and CLEAN were then rerun.

The BOT files were bin-averaged on bottle number.

The output was used to create file ADDSAMP.csv.

Casts #1 was removed from the list since there was no sampling.

There was a problem with cast #84. The log indicates that 24 bottles were fired but only 20 are entered in the BL file. The CTD log indicates 24 bottles were fired and gives 24 sample #s, but the rosette log shows the last 4 bottles were never fired or planned to be fired, and sample #s 189-192 were never used.

The file was then sorted on event number and Bottle Position order. Then sample numbers were added based on the rosette logs.

The ADDSAMP file was then reordered on event # & sample #.

The ADDSAMP file was used to add sample numbers to the BOT files – output \*.SAM.

The SAM files were bin-averaged on bottle # and called SAMAVG.

The addsamp.csv file was converted to CST files, which will form the framework for the bottle files.

Next, each of the analysis spreadsheets were examined to see what comments the analysts wanted included in the header file. These were used to create file 2024-032-bot-hdr.txt which will be updated as needed during processing.

DISSOLVED OXGYEN

Dissolved oxygen data were provided in spreadsheet QF2024-032\_OXY\*.xlsx which includes flags, comments and a precision study. Draw temperatures are available. The spreadsheet page with the final data was simplified and saved as 2024-032oxy.csv. That file was converted into individual \*.OXY files.

EXTRACTED CHLOROPHYLL

Extracted chlorophyll and phaeo-pigment data were obtained in file QF2024-032\_CHL QF\*.xlsx. The file included comments and flags and a precision study. A simplified version of the spreadsheet was prepared and saved as 2024-032chl.csv. The csv file was then converted to individual CHL files.

SALINITY

Salinity analysis was obtained in file QF2024-032\_SAL.xlsx which included a precision study. The analyses were carried out in a temperature-controlled lab 16 to 25 days after collection. The files were simplified and saved as 2024-032sal.csv. That file was then converted to individual SAL files.

NUTRIENTS

The nutrient data were obtained in spreadsheet QF2024-032\_NUTS\*.xlsx. This includes a precision study. The file was simplified, saved as 2024-032nuts.csv. The file was converted to individual NUT files.

The files were then put through CLEAN to reduce the headers to File and Comment sections only.

These 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 and saved as \*. MRGCLN1s.

The MRGCLN1s files were then merged with SAMAVG files using merge channel Bottle\_Number.

The output of the MRG files were exported to a spreadsheet and compared to the rosette log sheets to look for omissions.

Problems were found in some rosette sheets. A decision was made not to use Niskin #2, so the samples were entered next to the actual Niskin from which the samples came, but the pressures and depths were not corrected.

CTD salinity was checked and there are values <25psu, so silicate correction is needed.

##### Compare

Salinity

Compare was run with pressure as reference channel.

There are many samples, but only from the surface, 50m and the bottom of casts.

First, all points above 100db were removed. The surface bottle from cast #57 looked close to the average of the deep bottles for both sensor pairs and the salinity gradient was low at the surface, so it was included. The 50m bottle from cast #86 looks ok in the primary comparison but not in the secondary and the local gradient was high, so that was not included in the comparison.

Outliers in the primary were identified as those with differences outside the range -0.0035psu to -0.015psu.

Outliers in the primary were identified as those with differences outside the range -0.008psu to +0.012psu.

Both fits are flat with pressure.

The primary salinity was lower than bottles by an average of 0.0286psu (Std Dev 0.0033).  
The secondary salinity was lower than bottles by an average of 0.0002psu (Std dev0.0037).

These sensors were used in February 2024 on Line P when the primary was found to be high by 0.002psu and secondary high by 0.0003psu.

The bottles from the surface and 50m all have salinity considerably lower than bottles. This is expected due to large vertical salinity gradients and most samples coming from areas with flushing of Niskin bottles expected to be incomplete, so samples come from a little deeper in the water column.

The primary salinity is significantly low compared to bottle samples even at the bottom, while the secondary is very close to bottles. Our expectation is that errors due to incomplete flushing of Niskin bottles for bottom samples will have the opposite sign to such errors during upcasts. So, if sensor calibration were perfect, the CTD salinity would look like it is reading high if there is incomplete flushing. Having the primary salinity read much lower is surprisingly. The secondary salinity is close to bottles, so may actually be reading slightly low. However, the result is close to the comparison from 2024-002 when samples did not come from the bottom of casts, so any such error is likely small.

Looking at plots against file pair #, both channels are flat with time, with the exception of 2 cases where the primary differences are notably smaller, being lower by 0.006psu and 0.001psu. These were from events #86 and #87.

The primary salinity is way out of line.

2 cases were examined for which the results actually look closer to expectations for the primary. Since the secondary salinity does not stand out, particular conditions during those casts does not appear to be a factor. Cast #86 has differences between the two channels of about 0.005psu throughout and cast #87 about 0.003psu. Those differences are still a little out of line with expectations, but much closer.

During 2 later cruises there are also reports of the primary salinity being bad. Only the secondary salinity should be archived and there is no evidence that it needs recalibration. It is certainly not reading low, but could be a little high.

There are no significant outliers in the secondary comparison.

For full details for the COMPARE run see file 2024-032-sal-comp1.xls.

Dissolved Oxygen

COMPARE was run with pressure as the reference channel.

The only samples are from 2 deep casts in inlets. Flushing of Niskin bottles tends to be poor in those areas. The complex DO gradients mean errors due to poor flushing vary in sign, and firing 2 bottles at the bottom of casts also lead to errors that are usually affect the sign of errors as well. There are some areas of fairly low gradients. Given these variations there are insufficient data to allow objective identification of outliers. However, when the offset was set to match that found during cruise 2024-002 and outliers were removed that came from very high gradient depths, the slope is close to that found during 2034-002. Offsets are not expected to vary according to the manufacturer, but finding exact values is difficult even when many samples are available, especially if low DO waters are not sampled.

The best choice for recalibration is to use the fit from 2024-002 when more data were available from areas that flush well:

CTD DO Corrected = CTD DO \*1.0232 + 0.032

Outliers: There are no outliers that cannot be explained due to large DO vertical gradients.

For full details for the COMPARE run see file 2024-032-dox-comp1.xls.

Fluorescence –

COMPARE was run with extracted chlorophyll and CTD Fluorescence from a SeaPoint fluorometer using pressure as the reference variable.

The pattern in the plot below is typical of these sensors, with fluorescence reading too high for CHL<1ug/L, close to CHL for 1<CHL<4ug/L and dropping to about 50% of CHL for CHL>5ug/L.

The dark value of fluorescence seen deep in inlets was 0.07ug/L.

The fit of FL vs CHL is shown below. The offset was set equal to the dark value in deep inlets.

##### Conversion of Full Files from Raw Data

Hex files were converted using configuration files 2024-032-ctd\*.xmlcon.

All expected channels were found and profiles look reasonable.

Descent rate, oxygen concentration and SBE salinity will be derived later.

##### WILDEDIT

Program WILDEDIT was run to remove spikes from the pressure, depth, conductivity & temperature only in the full cast files (\*.CNV).

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.

This worked well at removing a few single-point spikes noted before this step.

##### ALIGN DO

ALIGNCTD was run on all casts to advance the oxygen voltage by +2.5s, a setting which has worked well in the past for this type of sensor. Plots were examined during step #9 and alignment looked good..

##### CELLTM

The noise in the upcast data makes tests for the best parameters for this routine very difficult to interpret. In the past when upcast data were not so noisy, the default setting of (α = 0.0245, β=9.5) was generally found to be the best choice.

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

A few casts were checked and the default setting did improve the upcast/downcast salinity correspondence, though the T-S plot correspondence varies with features; the upcast data are so noisy that this is too complex to assess.

##### DERIVE and Channel Comparisons

Program DERIVE was run on all casts to calculate primary and secondary salinity, dissolved oxygen concentration and descent rate. Plots were examined and the alignment of dissolved oxygen looks good although both temperature and DO are noisy.

DERIVE was run a second time on some of the deeper casts to find the differences between the pairs of temperature, conductivity and salinity channels. Results from a few casts from 2024-002 are included for comparison.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cast # | Press | T1-T0 | C1-C0 | S1-S0 | Descent Rate |
| 2024-002-0050 | 1000 | -0.0003 | -0.00006 | -0.0006 | High, V Noisy |
|  | 2000 | -0.0004 | -0.00004 | -0.0002 | “ |
|  | 3000 | -0.0005 | -0.00001 | +0.0002 | “ |
|  | 4000 | -0.0007 | +0.00003 | +0.0011 | “ |
| 2024-002-0074 | 1000 | +0.0004 | -0.00015 | -0.0023 | High, X Noisy |
|  | 2000 | +0.0003 | -0.00012 | -0.0018 | “ |
|  | 3000 | -0.0001 | -0.00009 | -0.0010 | “ |
|  | 4000 | -0.0005 | -0.00006 | -0.0001 | “ |
| 2024-002-0090 | 1000 | +0.0003 | -0.00018 | -0.0024 | High, X Noisy |
|  | 2000 | -0.0001 | -0.00016 | -0.0020 | “ |
|  | 3000 | -0.0003 | -0.00012 | -0.0012 | “ |
| 2024-032-0058 | 700 | 0 | +0.00278 | +0.0283 | High, Steady |
| 2024-032-0067 | 560 | -0.0001 | +0.00272 | +0.0280 | High, Steady |
| 2024-032-0084 | 650 | 0 | +0.00260 | +0.0265 | High, Steady |

The temperature differences are very small but those for conductivity and salinity are extremely high, and very different from the last time these sensors were used.

##### Conversion to IOS Header Format

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

Surface check found a minimum pressure of 2.15db which looks reasonable. The minimum pressure in the full files was 1.1db at the end of cast #78 in an inlet; the pumps were off at that time but transmissivity does show that the CTD was in water.

The cross-reference check was run.

* Two station names were wrong.
* Most station names with letters used lower-case; upper-case is the standard for most station names. The names were mostly standard in the log.
* File 2024-032-headers.csv was prepared with corrected names. For “le chan” the change was made to “Le Chan” and “calm1” to “Calm1”. These corrections will be done at the same time as water depth corrections.

The header check routine was run and no errors were found.

The altimeter and water depth readings from the headers of the CLN files were exported to a spreadsheet. A “Check Value” was calculated by subtracting water depth from maximum depth sampled plus altimetry header. Where that number was > 5m checks were made to see if the log entry differed from the header entry and whether the altimetry signal at the bottom provided a good header value.

19 such cases were found.

It was very helpful that the sounder reading at the bottom was included in the log as this is an area where bottom depths are likely to vary through a cast and the value when the deepest bottle was fired is most useful.

First, the log was checked to see if the water depths matched log entries and in many cases they did not match the BE reading. This suggests that the file was started before the full cast began.

* For 1 case (#3) there was no water depth in the file, but there was one in the log and it produces a good Check Value.
* For 1 case (#50) the header depth is clearly wrong and the log depth works well.
* For 5 cases using the BE reading from the log leads to a small Check Value.
* For 10 cases using the BO sounder reading leads to a small Check Value. In a few of these cases both the BE and BO readings lead to good results, but it the water depth when bottom samples were taken is likely of most interest to users.
* In 1 case (#59) there is no log BO reading and the check value is 20. Since the altimeter and sounder do appear to have worked very well, it is reasonable to add altimetry plus maximum pressure recorded to make an estimate for that cast.
* In 1 case (#85) there were no sounder depths in the log, so the altimetry plus maximum pressure recorded sum was used.

When those changes were made the Check Values were all <2m.

This is an unusually large number of corrections, but that is not unexpected given the areas sampled.

The corrections to water depth were added to file 2024-032-headers.csv.

Routine “Merge:CSV file to Headers” was run on CLN files used to enter revised station names and water depth – output MRH files.

The altimetry check and cross-reference checks were rerun and no further problems were found.

The same changes were made to the MRGCLN2 files with output MRGMRH extensions.

##### Shift

Fluorescence

SHIFT was run on the SeaPoint fluorescence channel for all casts using the usual advance of +24 records. Plots show that the fluorescence offset is reasonably close to the temperature offset after this step.

Dissolved Oxygen

The Dissolved Oxygen voltage channel was aligned earlier. A few casts were checked to see if the alignment looked ok, and it did. No further alignment is needed for the DO concentration channel.

Conductivity

Tests were run on a selection of casts to find the alignment shift best for the secondary conductivity sensor as judged by noise in T-S space. The primary conductivity is bad so wasn’t tested.

The best choice was -0.6 records for the secondary channel.

SHIFT was run on all casts using -0.6 records and salinity was recalculated for the secondary channel.

##### DELETE

DELETE was run on the SHFC1 files.

The following DELETE parameters were used for casts 1-39:

Surface Record Removal: Last Press Min

Maximum Surface Pressure (relative): 10.00

Surface Pressure Tolerance: 1.0 Pressure filtered over 9 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 = 042 seconds. (taken from header)

COMMENTS ON WARNINGS: There were no warnings.

##### Other Comparisons

Experience with these sensors since last factory service –

CTD #0550 has only been used on 1 cruise since it was last serviced:

2024-002 – Used for most of the cruise. Primary Salinity estimated high by 0.002 and secondary high by 0.0003. Dissolved oxygen was recalculated with scale/offset 1.0232/+ 0.032.

Historic ranges –Profile plots were made with 3-standard deviation climatology ranges of T and S superimposed. Local climatology was not available for many casts in inlets. All salinity data fell within the local climatology where available and the only excursions in temperature were around 100m where it was very slightly high at stations JE01 and 22 (Events 86 and 87). This looks like a real feature, and since there is no evidence of systematically high temperatures, it is not indicative of calibration problems.

Post-Cruise Calibration – None available.

Repeat Casts –There were no repeat casts and nearby casts were too shallow and in too active environments to provide reasonable tests of repeatability.

##### DETAILED EDITING

The \*.DEL files were zipped (2024-032-del.zip) and submitted to the CTD-QC-File Processor. DELPRED files were returned.

CTDEDIT was used to remove records that appear to be corrupted by shed wakes. Salinity was cleaned to remove spikes that appear to be due to small misalignment or instrumental noise. All files required light editing except for events #35 and #92 which required no editing.

Notes about editing applied were added to the files.

After editing, T-S plots were examined for all casts and no further editing was found necessary; some unstable features remain but are may be real given the active mixing in this region.

All EDU files were copied to \*.EDT.

The EDT files were zipped and sent to the CTD-QC file processor.

##### Corrections to Pressure, Salinity and Dissolved Oxygen Concentration

File 2024-032-recal1.ccf was prepared to apply the following correction to dissolved oxygen:

CTD DO Corrected = CTD DO \*1.0232 + 0.032

COMPARE was rerun on dissolved oxygen after recalibration.

There were only 2 casts with dissolved oxygen sampling and they both came from inlets where flushing of Niskin bottles is challenged, especially near the surface where vertical DO gradients are high. The fits are definitely improved. When the same outliers are excluded as in the original fit, the average difference shows the CTD DO is lower than bottles by about 0.007mL/L (standard deviations 0.034mL/L). In the areas of large vertical DO gradients, the CTD DO is higher than bottles, likely a sign of incomplete flushing. At great depth it is slightly lower than bottles which may also be a sign of flushing errors since the local gradient reverses sign around 300 to 350m, so such errors would make the CTD appear to be reading low in deeper water.

The complex gradients, limited data and large scatter in the fits make any conclusions about calibration unwise. For these 2 sites, the CTD data is probably more reliable than samples though slow response will smooth features.

For further details see file 2024-032-dox-comp2.xls.

##### Fluorescence Processing

A median filter, size 11, was applied to the fluorescence channel in the COR1 files. Plots of a few casts showed that the filter was effective. (Output:\*.FIL)

##### 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.

On-screen T-S plots were examined and no problems were noted.

##### Final Calibration of DO

The initial recalibration of dissolved oxygen corrects for sensor calibration drift. Alignctd corrects for transit time errors. Those 2 steps may partly correct for response time errors, but to see if a further correction is needed, a comparison is made of downcast CTD data to bottle data from the same pressure. Small differences are expected due to ship drift, temporal changes, incomplete flushing of Niskin bottles and delayed response and noise in CTD data.

Downcast files (bin-averaged to 0.5m-bins) were thinned and compared to the bottle values in the MRG files. COMPARE was run to study the differences between the downcast CTD DO data and the titrated samples from upcast bottles. Outliers were removed based on residuals in a fit against DO. Plots were then made against pressure using the same data.

The average difference between downcast recalibrated and thinned CTD DO and titrated bottle samples was 0.054 mL/L (std dev 0.100mL/L), but if large outliers were excluded it was 0.004mL/L (std dev 0.038mL/L). Near the surface differences are up to 0.3mL/L and at depth they are low by ~0.05mL/L.

There are insufficient data to estimate accuracy based on this comparison but the results of a previous cruise do appear reasonable.

Based on the results of a previous cruise Oxygen:Dissolved:SBE data in the downcast CTD files are considered, very roughly, to be:

±0.30 mL/L from 0-100db

±0.10 mL/L from 100db to 200db

±0.05 mL/L below 200db.

For details see files 2024-032-dox-comp3.xls

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

For all casts REMOVE was run to remove the following channels:

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

A second SBE DO channel (with umol/kg units) was added.

REORDER was run to get the two DO channels together.

HEADER EDIT was used to fix formats and channel names and to add comments about processing.

The Standards Check routine and Header Check were run; no problems were found.

Profile and T-S plots were examined and look ok.

##### Dissolved Oxygen Study

As a final check of dissolved oxygen data, % saturation was calculated and plotted. Values at 2 to 3m ranged between ~82% in Saanich Inlet to 106% at station HS12. Most values in the open parts of the Strait of Georgia and Howe Sound were between 95% and 106%, with the highest values in Howe Sound. Lower values were found in inlets, and around the Gulf Islands and Discovery Islands. Values are reasonable for the area and season.

##### Final Bottle Files

As done earlier for full cast files, the station names and water depths were corrected using Routine “Merge:CSV file to Headers” and file 2024-032-headers.csv on MRGCLN2 files with output \*.MRGMRH.

CALIBRATE was run using file 2024-032-recal-sil.ccf to recalibrate silicate where salinity is <25psu. One file was checked with low salinity and the silicate value had changed.

CALIBRATE was run using file 2024-032-recal1.ccf to apply the following correction to dissolved oxygen:

CTD DO Corrected = CTD DO \*1.0232 + 0.032

SORT was run to arrange casts in pressure order.

For all casts REMOVE was run to remove the following channels:

Scan\_Number, Temperature:Secondary, Conductivity:Secondary, Oxygen:Voltage:SBE, Descent\_Rate, Status:Pump, Altimeter, Salinity:T1:C1, Event and Flag.

A second SBE DO channel with mass units was added for both the CTD DO and titrated DO and REORDER was run to get the pairs of DO channels together.

EDIT HEADERS was run to fix formats and channel names and to add comments about analyses and CTD processing.

Data were exported from the CHE files to file 2024-032-bottles-final.xlsx. The entries were compared with the rosette log sheets and no problems were found.

Standards check was run. No problems were found.

The track plot looks fine.

Plots of each file were examined and no problems were found.

A cross-reference listing and header check were produced for the CHE files.

##### Thermosalinograph Data

There was 1 thermosalinograph hex file.

There were a variety of configuration files with the raw data.

The configuration file created in acquisition was used to convert the hex file to CNV format.

The output file had no signal from the external temperature, and it was later determined that no thermistor was connected.

Initial conversion showed constant values for fluorescence for the first few days, until Feb 24 at about 13:30. Thereafter there are mostly fluorescence values around 1; since no scale/offset data were entered it is assumed the values are in volts. .

Conversion was rerun with no external temperature chosen and with no scale/offset entered for the fluorescence. The fluorescence values produced are assumed to be in volts, but attempts to produce values in ug/L using the scale and offset in the latest calibration produced unreasonable values.

For example on March 1st the fluorescence is fairly steady at about 1volt which converts to about 11ug/L and there are many spikes to much higher values. The CHL samples from that day range from 0.6 to 1ug/L. Even if there is some way that the sensor had been set to report concentration rather than voltage, there is still a problem since there are many large spikes that do not match CHL reports.

The traces looks suspicious as well; we expect a lot of variability, but the traces are frequently very smooth, then shift very abruptly to a higher range with many large spikes gradually falling to lower values. Some of the areas with low and steady values correspond to stops, but many do not.

No loop samples were found in the analysis spreadsheets for CHL or salinity.

The file contained data for temperature, conductivity, position and time information, but the external temperature values were all padded and it was determined that there was no such sensor connected.

The files were converted to CNV format.

The CNV files were 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.

A track plot was produced and made it obvious that the time in the file was incorrect. What appears to be just over 1 day, actually was much longer so the interval was likely incorrect; it had been set to 3s instead of 30s. Conversion was rerun with the right interval entered but that did not fix the times in the files.

The HEX file had to be edited to change the interval there as well. Then conversion was successful.

CONVERT to IOS Headers, CLEAN and ADD TIME CHANNEL were rerun.

The track plot was run and looks busy but reasonable. It was added to the end of this report.

Time-series plots were produced. An initial examination shows no sign of flow until the end of February 21 though the ship appears to have been moving. Fluorescence varies between being very flat and having a lot of spikes. Salinity has a lot of 1-sided spikes throughout the record; this might be caused by bubbles though the regularity of this suggests something instrumental.

A track plot was produced and added to the end of this report.

##### Checking Time Channel

* The CTD files were thinned to reduce the files to a single point from the downcast within 0.5db of 6db. These were exported to a spreadsheet which was saved as 2023-025-tsg-ctd-comp.xlsx. All 62 CTD casts overlapped with TSG records, and had data within 0.5m of 6m.
* The TSG ATC files were opened in EXCEL and reduced to times of CTD data in the spreadsheet. They were added to 2024-032-tsg-ctd-comp.xls.
* At the time of the test cast it appears the TSG was recording data but not actually drawing water; the salinity was near zero and temperature over 16°C and fluorescence low.
* 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 were <0.0004º for latitude and -0.0001 º for the longitude, but the averages were larger and the maxima and minima differences very high. While the time matches in the comparison are not exact, the ship was on station, so we don’t expect large differences.
  + A few of the larger ones were examined to see if the ship was moving significantly at the time. The largest was during cast #47. The TSG file shows a constant position from 3:05 until 6:56 during which time the CTD shows a net and rosette cast at QU39 and a rosette cast at QU36, 2 stations that are some distance apart. Events 45 to 51 all have large differences though #50 is just a little out of line.
  + To see if there were other cases of positions getting “stuck” a few other cases of fairly large differences were checked. At BU07 the latitude values are constant for about 30 minutes while longitude did vary a little. Constant values are unlikely but the ship was stopped, so errors would be small.

So the positions from the TSG are not completely reliable.

* TSG Fluorescence read very close to 0.4 until event #35, thereafter it varied from 0.4 to 1.6 volts.

##### Comparison of Temperature, Salinity and Fluorescence from TSG and CTD data

Differences between TSG and CTD records:

Events #3-105 for Temperature and Salinity and cast #35-105 for fluorescence.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Ttsg-Tctd | SALtst-SALctd | FLtsg/FLctd |
| median | 2.2463 | -0.8339 | 0.63 |
| average | 2.2167 | -0.9850 | 0.64 |
| stdev | 0.2193 | 0.4965 | 0.29 |
| max | 2.7154 | -0.0422 | 1.39 |
| min | 1.3453 | -2.4254 | 0.15 |

Event #1 is a major outlier with TSG salinity low by 28.35 and TSG lab temperature high by 7.85C, so it is assumed flow had not been established and these data were excluded from all comparisons.

When all other casts were included, the TSG temperature was higher than the CTD temperature by a median of 2.25Cº and TSG Salinity is low by a median of 0.8339psu (std dev 0.4965psu).

When outliers with latitude or longitude differences >0.01° were excluded it made little difference to these results, so the position errors only concern the GPS feed. The fluorescence data are small with virtually no variation until cast #35, so only casts #35-105 were included in the comparison.

The temperature and salinity differences are larger than expected. Heating in the loop is not expected to be >1C° even allowing for a longer loop and deeper intake for the Franklin. In a later cruise it was reported that it was impossible to maintain a flow of 1L/s, so that could be a factor. A quick check of another cruise that used this equipment does not suggest such large differences, although this was a winter cruise, so we expect somewhat more heating in the loop.

The temperature at the intake (based on CTD temperature at 6m) varied little during this cruise. We expect the TSG to read higher than the CTD due to heating in the loop, especially if the flow rate is low. We also expect the amount of heating to be greater when input temperatures are lower and it does that. The differences are just a lot higher than expected. Perhaps the TSG is actually drawing water from a little shallower, so a few casts were examined to see if that might account for these differences.

* For event #35 the CTD read 7.4°C at 6m and the TSG read 9.7°. We would expect heating in the loop to be something like 0.5C° or possibly as high as 1C° given the low flow rate. Looking at a profile from that cast, we see where the CTD reads between 7.9 and 8.9°C. That would require looking below 20m for a source, so not reasonable. TSG Salinity was 26.3psu while the minimum CTD salinity was 26.8psu at 2m.
* For cast #91 to match the CTD temperature allowing for some heating we would have to look around 20m and to match the salinity we need to look close to the surface.
* For cast #24 the results are similar needing to look lower for a temperature match and higher for a salinity match.

Given that both temperature and salinity are increasing with depth we can’t explain one being too high and the other too low based on drawing water from above or below 6m.

Bubbles in the loop water can explain salinity being lower, but this is more than usually noted in other TSG systems. Another factor could be time in the loop so we may not be matching well, but given the ship is stopped, this should not make much difference. Would time in the loop lead to more or fewer bubbles?

Some sea surface temperature data from the bridge were available. Values are lower than CTD temperature which is expected since they are from the surface and are calculated from sound speed. They were not useful in assessing intake temperature.

There is great variability in the differences among casts. Some of this is expected due to some being in areas of tidal mixing, others in quiet inlets, other in fairly open water. The largest differences come from heads of inlets and the southern Strait of Georgia in more open water. Nearby casts at stations 38 and 39 have vastly different differences (Events 17 and 19). So this doesn’t seem weather or geographically related.

The fluorescence values are in volts and the CTD fluorescence in ug/L. Using the latest calibration parameters available led to values that are much higher than CTD fluorescence and CHL values from rosette casts. So fits were done of TSG in volts vs CTD FL and CHL.

The fit of CTD fluorescence versus TSG voltage when expressed as (FL in volts-Offset)\*Scale would be:

CTD FL = (TSG FL volts -0.2462)\*2.8859

This looks nothing close to the calibration parameters which have scale =13.9 and offset 0.063.

If the outliers are excluded the fit looks very flag with virtually no variation in fluorescence.

A similar fit was made versus extracted CHL from rosettes and a similar picture emerges.

When expressed as (TSG FL in volts-Offset)\*Scale would be:

Extracted CHL = (TSG FL volts -0.4469)\*2.4145

So the scales are similar. And if a few outliers are excluded the fit is flat with CHL apparently not varying with fluorescence. We don’t expect fits against CHL to be great since they measure different things, but the general picture emerges that the TSG fluorescence data does not look reliable.

What explanations do we have for the differences?

* The differences in do not appear related to the intake depth.
* They don’t have a clear geographic relationship though there may be some influence from that, just not likely enough to explain what we are seeing.
* We have little experience with what effect the ship has on CTD data? But at worst it would stir water which would not account for both high temperature and low salinity.
* If there was a low flow rate the effects are unpredictable as there would certainly be more heating and possibly more bubbles. The flow rate may have been erratic as well.
* The variable and low flow rate may explain the odd TSG fluorescence values and scatter in fits against the CTD fluorescence and CHL.. So these data do not look suitable for archiving.
* Despite the large differences the standard deviations are not particularly high in temperature, so it may be reasonable to recalibrate the TSG temperature to create a proxy for intake temperature.
* Salinity does not look reliable enough to archive; it

Given all these limitation we are left with a choice of not archiving due to low quality or archive with only lab temperature and a proxy for intake temperature with only 2 decimal places for the latter.

See 2024-032-tsg-ctd-comp.xls for details.

##### Calibration History

There is no history for this TSG since it was last serviced at the factory.

##### Conclusions

1.) The TSG clock probably worked well but the GPS feed was interrupted for almost 4 hours at one point and there may be other cases of not refreshing promptly, though the only evidence was for that was seeing no change in either latitude or longitude for a few minutes.

2.) The salinity data are not salvageable.

3.) An estimate of intake temperature for the TSG could be made since the differences between the lab temperature and CTD temperature are relatively steady. But fewer decimal points should be used than usual for an intake proxy.

4.) Only temperature is worth archiving, and even positions have some problems.

##### Editing

It was decided not to archive, so not editing was applied.

##### Recalibration

None applied.

##### Preparing Final Files

Not prepared for archive.

P**ARTICULARS - Notes from Daily Science Log and Rosette logs**

55. Station name should be T01, not HC.

68. NIskin #7 has crack in lower ring. Replaced by Niskin 23.

86. all inlet stations 60s soak at surface, no 10m soak.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Calibration Information - 506** | | | | | |
| **Sensor** | | **Pre-Cruise** | | **Post Cruise** | |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **2374** | **16Feb2023** | **Factory** |  |  |
| **Conductivity** | **3184** | **18Jan23** | **Factory** |  |  |
| **Secondary Temp.** | **4883** | **23Feb2023** | **Factory** |  |  |
| **Secondary Cond.** | **4395** | **18Jan2023** | **Factory** |  |  |
| **Transmissometer** | **983DR** | **11Feb2024** | **Factory** |  |  |
| **SBE 43 DO sensor** | **997** | **25Jan2023** | **Factory** |  |  |
| **PAR sensor** | **70613** | **24Feb2021** | **Factory** |  |  |
| **SeaPoint Fluor.** | **3949** |  | **Factory** |  |  |
| **Pressure Sensor** | **0506** | **22Feb2023** | **Factory** |  |  |
| **Valeport Altimeter** | **75321** | **23Sept2020** | **Factory** |  |  |

# \*altimeter changed to 70613 before cast 116

# TSG Make/Model/Serial#: SEABIRD/21/2488

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Calibration Information** | | | | | |
| **Sensor** | | **Pre-Cruise** | | **Post Cruise** | |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature-SBE21** | **2488** | **2FebJan23** | **Factory** |  |  |
| **Conductivity-SBE21** | **2488** | **2488** | **2FebJan23** |  |  |
| **Wetlabs WETStar Fluor.**  For depths deeper than, and including, 125 dbar, we would wait 30 seconds before closing a bottle. For depths shallower than, and including, 100 dbar, we would wait 60 seconds before closing a bottle. | **1663** | **17June2021** | **Factory** |  |  |

External sensor SBE38 – not connected.





