## REVISION NOTICE TABLE

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| DATE | DESCRIPTION OF REVISION |
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## PROCESSING NOTES

Cruise: 2023-021

Agency: IOS, Ocean Sciences Division, Sidney BC

Chief Scientist: Young K. Platform: Neocaligus

Location: Strait of Georgia Project: Strait of Georgia Plankton

Date: 5 May 2023 –7 May 2023

Processed by: Germaine Gatien

Date of Processing: 20 July 2023 – 9 August 2023

Number of original HEX files: 16 (including 2 files from Chito casts)

Number of CTD files: 14 Number of BOT files: 7

##### INSTRUMENT SUMMARY

A SeaBird Model SBE-25 CTD (s/n 0456) was used with temperature sensor #6566, conductivity sensor #5046, Wetlabs ECO Fluorometer #2216, dissolved oxygen sensor #3779, PAR sensor (4565) and pressure sensor # 0573. The data acquisition program was SBE SeaTerm version 1.59.

The data logging computer was an Acer WP-14.

# SUMMARY OF QUALITY AND CONCERNS

There was a digital log with positions and notes about sampling and a digital sampling log. Header information was entered in the raw files in a format that enabled easy conversion into IOS Header format.

Time was wrong in all files. This was corrected by adding 88.53 hours.

CTD casts were run at 14 sites; there were 2 sites which also had a separate CTD cast to enable Chito sampling. The Chito casts were not prepared for the archive due to frequent stops during downcasts; there was a standard CTD cast at each of those sites.

Surface bottles were fired at 7 sites, 5 were during the CTD soak. 2 samples were during Chito casts and were not added to the bottle files since there was a surface sample from the associated regular CTD cast. During 1 regular CTD casts and 2 Chito CTD casts salinity and nutrient samples were taken at the bottom of the cast using a Niskin mounted ~3m above the CTD. CTD data were extracted from the Chito casts for the bottles fired at the bottom of the cast. The files prepared for the archive will contain only 1 BOT file per site with the event number matching the regular CTD cast.

No data will be archived from channels Salinity:T0:C0 and Conductivity:Primary due to salinity values being much higher than bottle samples and well above the local climatology. The problem arose during the previous 2 cruises and continued through subsequent cruises for this program. The CTD salinity gradually grew a little closer to expected values but not close enough to archive. No objective method was found to correct salinity.

For details, see document “Study of CTD0456.docx” and associated documents:

CTD456\_vs\_Bottles.xlsx – Comparison of CTD salinity and bottles from 4 cruises

CTD456\_vs\_CTD1255.xlsx – Comparison of 2 CTDs from cruise 2023-022

The study showed that conductivity data were unreliable from all cruises between March and June 2023, so conductivity and salinity channels were removed.

The study also examined data from the SBE Dissolved Oxygen sensor. While there were problems seen in 2022-003, particularly at the bottom of casts and during upcasts, none were noted during 2021-020 nor during this cruise.

The waits at the surface after the 10m soak period were occasionally less than 10s; longer waits, preferably 30s, should allow near-surface waters to recover from the stirring caused by the CTD rising.

With only 5 points of comparison between CTD fluorescence and extracted CHL, and high near-surface gradients so that small vertical offsets lead to large differences, little can be concluded about the fluorometer performance during this cruise. When combined with 2 earlier cruises there was a little more noise in the comparisons than usual, but high gradients likely explain those. There is no evidence of poor calibration. As usual, these data are considered nominal.

# PROCESSING SUMMARY

Based on results of cruise 2023-003 a study was made of all 2023 cruises that used this CTD using preliminary data.

Document “Study of CTD0456.docx” compared the performance of this equipment during the following cruises which were all in the Strait of Georgia:

2023-002 – Feb

2023-003 – March

2023-021 – April

2023-021 – Early May

2023-022 - May/June

2023-053 – mid-June

##### 1. Seasave

This step was completed at sea.

##### 2. Preliminary Steps

A digital daily log was obtained as well as a sampling log.

The cruise summary sheet was completed.

Deep samples were taken during 2 CHITO casts; those casts will be used to obtain CTD data to go with the samples, but no CTD files are needed.

Surface samples were taken while the CTD was soaking. There were also surface samples during Chito casts but those will be included in the BOT files.

##### 3. Conversion of Raw Data

The configuration file used at sea was correct, but during the previous use of this equipment a pressure offset of 0.7db was found more appropriate. A test conversion was done using a 0.7db offset and starting and ending pressures were very close to 0.

The file used at sea, with the adjusted pressure offset, was saved as 2023-021-ctd.xmlcon and used to convert all HEX files.

Plots were made of a few casts and all expected variables were present.

Fluorescence dark value at depth is ~0.6ug/L with no values <0; while rather high, values do not usually get close to 0 in the Strait of Georgia, so no attempt was made to correct the offset.

The pressure has steps but no reversals were noted.

Waits at the surface were sometimes shorter than 10s. A 30s wait at the top is recommended to allow surface waters to settle from the mixing caused in raising the CTD.

##### 4. WILDEDIT

The only spikes noted in the data occurred at the beginning or end of the casts or included many points, and will be removed in the normal course of editing. So WILDEDIT was not run.

##### 5. FILTER

Program FILTER was used to apply a low-pass filter with a time constant of 0.5s to pressure and depth. The results were excellent with pressure steps disappearing.

Next the temperature and conductivity were examined and the usual approach of applying a cosine filter, size 8, in routine WFILTER did a good job of removing small reversals.

In the past running WFILTER without the previous pressure filter did not produce as good results.

##### 6. ALIGNCTD

Generally, a setting of +2.5s is found suitable for this equipment, so ALIGNCTD was run with that setting on all casts, Plots were examined after this step and the results look good. This differs from the 2023-003 when the same sensor was used and most casts required a much higher setting. During 2023-020 +2.5s was also found to produce good results. This confirms that the 2023-003 problems were not with the sensor but more likely a problem with flow to the sensor.

ALIGNCTD was run with a setting of +2.5s for all casts.

##### 7. CELLTM

CELLTM was run on all casts using the SeaBird recommended parameters, (α, 1/β) = (0.04, 8).

##### 8. DERIVE

Program DERIVE was run to calculate salinity and dissolved oxygen concentration (tau correction included). Plots were examined and confirmed that steps 5, 6 and 7 had improved the data.

##### 9. Conversion to IOS Headers

The IOSSHELL routine was used to convert the CNV files to IOS Headers.

The IOS files for events 3 and 14 had their file names changed at this point by adding a leading 9 to the event numbers; these are the CHITO casts which are not intended to be archived but will be processed.

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

##### 10. Checking Headers

Track plots looked ok and were added to the end of this report.

All start times are off by about 88.53 hours. The System Upload Times are reasonable but not those from the CTD clock. The same thing was noted during 2023-020.

ADD TIME CHANNEL was used to advance the time channel by 88.53 hours.

A cross-reference list after this step showed good results with times close to the log entries.

Surface Check was run on the CLN files and the average was -0.02db, so using 0.7db as pressure offset in conversion was appropriate.

##### 11. CLIP

The next step is to remove the data collected during soaks at 10m. Plots were examined to see how many records should be removed from each cast. File clip.csv was prepared with 2 columns containing event # and # of records to removed. CLIP was run and output plots examined until all looked appropriate.

The surface check was then run on CLIP files and the average was 1.1db.

##### 12. SHIFT

Conductivity

This step was skipped since the conductivity data are not to be archived..

Fluorescence

The fluorometer was not pumped, so a shift in alignment is expected to be small or unnecessary. Profile plots of temperature and fluorescence were examined and no significant mis-alignment was noted. Shift was not run on fluorescence.

Dissolved Oxygen

This channel was aligned earlier, but checks were made by examining plots of temperature and dissolved oxygen. No further adjustment was made.

##### 13. DELETE

DELETE was run on all casts using the following parameters:

Surface Record Removal: Last Press Min. Surface Swell Pressure Tolerance: 1.0

Swells deleted. Warning message if pressure difference of 2.00

Drop rates < 0.3m/s (calculated over 5 points) was deleted from 10db to 10db above the maximum pressure.

COMMENTS ON WARNINGS: There were no warnings

##### 14. DETAILED EDITING

All DEL files were copied to \*.EDT so there will be a complete set of files even if some need no editing.

CTDEDIT was used to remove some data corrupted by shed wakes near the bottom of 8 casts.

Notes of editing details were made in the headers.

##### 15. Initial Bottle Data Steps

There was no rosette available for this cruise. There were surface bottles fired at 5 sites. At 3 sites there was also a Niskin mounted 3m above the CTD to collect near-bottom samples. This included 2 deep samples from Chito casts.

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 2023-021-bot-hdr.txt which will be updated as needed during processing.

File 2023-021-bottles\_plus\_CTD\_6linehdr. csv was created. A 6-line header was included and analysis data from the QF worksheets were added. Space was included for the addition of CTD data.

CTD data were bin-averaged in 0.5m bins. Data were then extracted from the shallowest data available below 0.5db and the sampling level for the 5 casts with deep bottles.

Workbook 2023-021-Bottle-comparison.xlsx was prepared to do a comparison of CTD and bottle data for salinity and fluorescence.

##### 16. Compare

Salinity Comparison

There were 6 bottle samples, 3 from the surface and 3 near the bottom.

One surface bottle sample looks like it came from right at the surface in a high-gradient zone so the difference is very large. Excluding that sample CTD Salinity is higher than bottles by an average of 1.3psu.

See file 2023-021-CTD-bottle-comparison.xlsx for more detail on this cruise.

A study of how CTD salinity varied through a series of cruises in 2023 using CTD #0456 showed that it continued to be much higher than bottle samples, but that the differences gradually decreased with time until the mid-June cruise when conductivity, salinity and dissolved oxygen data were full of spikes. The CTD was sent for service after that cruise.

The CTD salinity is clearly bad; no justifiable method was found to enable recalibration. Conductivity and salinity channels will be removed from files to be placed in the OSD Data Archive.

For more information see documents 2023-021\_CTD\_Bottle\_comparisons.xlsx and CTD456\_vs\_Bottles.xlsx.

Fluorescence

The only extracted chlorophyll sampling was at the surface. With only 5 samples and a significant difference in sampling depths where near-surface gradients were often very high, there is little to learn from the comparison. The CTD fluorescence data is generally from slightly lower in the water column so some difference is expected and it could have either sign depending on where the maximum CHL is.

We usually find the ratio FL/CHL to be a little high when CHL is low, and fall to lower relative value as CHL rises. In this case 3 of 5 samples look like that, while the 2 from GEO1 are out of line. The near-surface fluorescence gradient was very high at that site, so this is likely a result of slight mismatch in depth.

To get a better picture, the data from 20223-003 and 2023-020 were combined with 2023-021. The usual pattern of FL/CHL being high for low CHL is seen and FL being ~30% to 40% of CHL for CHL>1.5ug/L. This is a very rough comparison given variable near-surface CHL gradients and few data. The 2023-021 data do show up as outliers.

Data from the Chito casts were not included since examination of near-surface fluorescence shows the sensor had a very low signal for the first 0.5m, then rose suddenly to high values, (changes as large as going from 1ug/L to 10ug/L between one scan and the next). The sensor had likely not equilibrated until about 0.5m.

See 2023-021-CTD-bottle-comparison.xlsx for more detail.

##### 17. Other calibration checks

Sensor History –

* 2023-002: The sensors were all used during 2023-002 and data looked good. Pressure was found to be low by 0.7db. Salinity data were in reasonable agreement with the few bottles collected and all salinity profiles fell within local climatology. Some temperature profiles were occasionally outside the climatology but the variations looked real and certainly did not look like evidence of calibration drift. There was no dissolved oxygen sampling but profiles looked reasonable..
* 2023-003: Pressure was converted with 0.7db offset and looked accurate. Conductivity data were bad, producing salinity higher than bottles by as much as 4psu and well above climatology maxima. There was no dissolved oxygen sampling. Temperatures were mostly within the climatology except for some low temperatures in deep water in south-central Strait of Georgia.
* 2023-020: Pressure was converted with 0.7db offset and looked accurate. Conductivity data were bad, producing salinity higher than bottles by 3.7psu early in the cruise and gradually dropping to 1.3psu at the end.; all were well above climatology maxima. There was no dissolved oxygen sampling, but profiles looked good. Temperatures were mostly within the climatology except for some low temperatures in deep water in south-central Strait of Georgia

Historic Ranges – All salinity data were above the historic ranges except for a few near-surface values where the ranges were very wide and a few well-mixed casts in the Gulf Islands, Temperatures were mostly within the climatology except for some low values below about 250db. Similar excursions were seen in March 2023 but further south and in April. These features do not suggest calibration drift as they are not systematic and this is a region of high variability.

Post-cruise calibrations – None were available.

##### 18 CALIBRATE

Pressure looks good.

Salinity cannot be corrected and will not be archived.

There was no dissolved oxygen calibration sampling. Without reliable salinity values dissolved oxygen could not be derived in mass units and hence surface DO saturation could not be derived except for bottle files where there were 3 casts with Salinity:Bottle values at the surface.(see §22.) dissolved oxygen saturation at 1db for those casts was found to be 117%, 119%, and 101%.. These values are reasonable, but given the large variability in this region do not prove DO calibration is good.

No recalibration was applied.

##### 19. Fluorescence Filter

The fluorescence data did not require filtering.

**20. Bin Average, Remove, Derive DO in mass units, Reorder**

The files were bin averaged using 1db bins.

REMOVE was run to remove Scan\_Number, Conductivity, Salinity:T0:C0, Oxygen:Voltage, Descent Rate and Flag channels.

Dissolved Oxygen could not be derived in mass units since the salinity data are not reliable. So near-surface saturation could not be calculated.

##### 21. HEADER EDIT and final checks of CTD files.

Header Edit was used to fix headers, fix formats and to add comments about processing.

A cross-reference listing was produced.

A header check and standards check were run on the CTD files and no errors were found.

The sensor history was updated.

Plots of CTD casts were examined and no problems were found.

##### 2. Final BOT file preparation

For 3 sites, there were 2 CTD casts, a regular cast and a CHITO cast. The CHITO casts have no 10m soak and multiple stops during both the downcast and the upcasts, so no CTD file was prepared for those.

A single bottle file will also be produced for each site with event # matching the regular casts.

There were surface bottles fired when the regular cast began. During the CHITO cast bottles were fired at the surface and at the bottom of the cast. The only sampling in the surface bottles from the CHITO casts was extracted chlorophyll. Those data will not be included in the bottle files since the CTD data collected at that time is not of good quality with pumps not yet on and fluorescence had not equilibrated, and we have chlorophyll data from the surface of the regular casts. The salinity samples from the bottom of the CHITO cast are useful as there was a sufficient wait before firing and CTD data look ok, so those will be included in the BOT files.

Workbook 2023-021-bottles\_plus\_CTD\_6linehdr. csv was adjusted to change the event # for the CHITO bottom bottle records to match that of the regular cast.

That file was converted to IOS Header files for each cast.

The time and date are present as channels as these cannot be converted directly into header entries.

CLEAN was run to add START and END time to the headers. The END TIME is identical so the START time so it will be removed later. CLEAN was also used to enter 0 flags where the flag channels are empty.

Change Units was run to get the dissolved oxygen data in mass units; this will only succeed where Salinity:Bottle data are available.

DERIVED Quantities was run to derive dissolved oxygen saturation where Salinity:Bottle data were available. The saturation was available near the surface for 3 casts and values there were 117%, 119%, and 101%. The 2 higher rates were associated with higher CHL and fluorescence values.

The downcast salinity is not reliable, but only at cast #12 (Stn 42) does it appear to be <25psu even allowing for values being too high by 1psu to 4psu. Fortunately, one bottle sample was available for that cast and was also very low. So silicate correction is possible for that cast.

CALIBRATE will only apply to this correction if there is a salinity channel available – it will only work on one cast. So, all UNT files were copied to COR1 first.

CALIBRATE was then run on cast #12 with output COR1.

REORDER was run to get the 2 DO channels together.

REMOVE was run to remove Date and Time channels.

Header Edit was run to add comments and to remove END TIME (same as START TIME) and TIME ZERO.

The final files have extensions BOT.

The standards check was run and some empty channels were reported. Empty channels remain for DO in mass units, but it is useful to retain these as they make it clear that mass units were not always derivable due to the lack of reliable CTD salinity data. No other errors were found.

A cross-reference list and header check were run on the BOT files and it was found the hemisphere was wrong for the longitude. E was changed to W for all files using a text editor.

A track plot showed the editing was appropriate.

Plots were made of all BOT casts. With just 1 or 2 levels these were not very useful.

Finally, all data from BOT files were extracted to a spreadsheet and compared to the event log; no problems were found.

PARTICULARS – Notes from log

Surface bottles snapped during CTD soaks.

Chito casts – bottle fired at depth for salinity sample.

3. Only enough water for 1 NUT replicate

4. Niskin 3m above CTD

12. Lots of sediment in water.

14. Chito cast = 250m only enough water for 1 full salinity, toke ¾ of the other.

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**CRUISE SUMMARY**

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| --- | --- | --- | --- | --- | --- |
| Cruise ID#: 2023-021 | | | | | |
| Dates: Start: 5 May 2023 End: 7 May 2023 | | | | | |
| Location: Strait of Georgia Plankton | | | | | |
| Chief Scientist: Young K. | | | | | |
| **CTD#** | **Make** | **Model** | **Serial#** | **Used with Rosette?** | **CTD Calibration Sheet Competed?** | |
| 1 | SEABIRD | 25 | 456 | No | Yes | |

**CTD CALIBRATION INFORMATION**

**Make/Model/Serial#: SEABIRD/SBE25/0456 Cruise ID#: 2022-003**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Calibration Information** | | | | | |
| **Sensor** | | **Pre-Cruise** | | **Post Cruise** | |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **6566** | **30Mar2021** | **Factory** |  |  |
| **Conductivity** | **5046** | **30Mar2021** | **Factory** |  |  |
| **ECO Fluorometer** | **2216** | **8Mar2017** | **Factory** |  |  |
| **SBE43 Oxygen** | **3779** | **15Oct2021** | **Factory** |  |  |
| **QSP BiosphericalPAR** | **4565** | **24Feb2021** | **Factory** |  |  |
| **Pressure**    **D:\Te****lewo****rk\2022-0** **28\Process****ing\ios\** | **573** | **4Feb****2022** | **Factory** |  |  |



