## REVISION NOTICE TABLE

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| DATE | DESCRIPTION OF REVISION |
| 13 March 2025 | Updated TSG channel names and formats. GG |

## PROCESSING NOTES

Cruise: 2022-069

Agency: OSD

Location: B.C. Coast

Project: Mooring Cruise

Chief Scientist: Spear D.

Platform: John P. Tully

Date: 12 July 2022 – 26 July 2022

Processed by: Germaine Gatien

Date of Processing: 27 January 2023 – 20 February 2023

Number of original HEX files: 88 Number of processed CTD files: 87

Number of rosette files: 34 Number of processed CHE files: 33

Number of original TSG files: 1 Number of processed TOB files: 10

# INSTRUMENT SUMMARY

CTD #0506 was mounted in a rosette and attached were 2 Wetlabs CSTAR transmissometer (1185DR & #1883DG), a SBE 43 DO sensor on the primary pump (#0997), SeaPoint Fluorometer on the secondary pump (#3982 and later 3641) and an altimeter (#73274).

Seasave version 7.26.7.121 was used for acquisition.

A Guildline model 8400B Autosal serial # 68572 was used to analyze salinity samples.

An IOS rosette with 24 10L bottles was used.

A thermosalinograph (SeaBird 45 S/N 0620) was mounted with a Wetlabs WETStar fluorometer (#1656) and flow meter.

# SUMMARY OF QUALITY AND CONCERNS

The digital Daily Science Log Book and rosette log sheets were generally in good order with comments about problems encountered. The equipment list lacked a note about a change of fluorometer, but that was mentioned in the log comments. The configuration file was not updated at sea. In order to have accurate information in the headers separate configuration files were created for processing.

The file names were non-standard for event numbers >99; they have been adjusted.

There were electrical problems during the casts in Saanich Inlet. The second cast was of much better quality, so cast #1 will not be archived.

In the daily log the column for the PAR sensor is marked YES for 5 casts, but PAR is not in the configuration file and on the header page of the log the PAR sensor is listed as NA, so it is assumed the YES entries are wrong.

There was no 10m soak. Acquisition started at the beginning of casts with ~2 minutes wait at the surface with pumps off. It was lowered to about 2.5m where the pumps were turned on and there was a wait that typically lasted about 1.5minutes before the full cast started.

Calibration sampling for salinity was inadequate since all samples were either at the bottom, 50m or the surface. Some sampling from mid-depths, at least from the deep casts at the end of the cruise would have been very helpful; suitable bottles were fired but only oxygen and nutrients were sampled there. The primary salinity was very close to bottle samples based on bottom samples. Previous uses of the primary sensors indicated minimal calibration drift. The difference between the 2 salinity channels varied with time and a study was made that suggests this was due to variability in the secondary data.

The primary temperature and salinity were chosen for archiving for most casts, but due to problems in the primary system during events #66 and #80, the secondary channels were selected. Recalibration was applied to secondary salinity to bring it into line with the primary.

There were 2 WetLabs CStar transmissometers in use during this cruise:

Channel Transmissometer refers to sensor #1185DR (650nm - red)

Channel Transmissometer:Green refers to sensor #1883DG (530nm - green)

For comparison with other Institute of Ocean Sciences cruises, note that the transmissometer wavelength is 650nm unless otherwise stated.

Channel Fluorescence:URU:Seapoint was removed from casts #2 to #135 due to sensor malfunction. CTD files with all processing steps applied that include the fluorescence channel were created, but will not be placed in the OSD Data Archive. A note was placed in file headers to say the files are available upon request.

There were many problems with the dissolved oxygen analysis at sea, most of which were addressed later during analysis data processing. There remain some outliers that could be due to CTD sensor malfunction, but are more likely due to problems in analysis at sea.

The SBE DO data were recalibrated based on the results of cruise 2022-035; during that cruise there was more deep sampling and rougher conditions that enable better flushing of Niskin bottles. Titrated samples from 2022-069 look reliable at depth, but near the surface they may be reading lower than ambient values due to incomplete flushing of Niskin bottles.

The SBE DO sensor has a fairly long response time so data accuracy is not as high when it is in motion as it is during stops for bottles. This will be especially true when vertical DO gradients are large. To get an estimate of the accuracy of the SBE DO data during downcasts (after recalibration) a rough comparison was made between downcast SBE DO and upcast titrated samples. Some of the difference will be due to problems with flushing of Niskin bottles and/or analysis errors and small mismatches in depth in the presence of large DO gradients, so the following statement likely underestimates SBE DO accuracy.

Downcast (CTD files) Oxygen:Dissolved:SBE data for this cruise are considered, very roughly, to be:

±0.30 mL/L from 0-100db

±0.15 mL/L from 100-300db

±0.07 mL/L from 300-500db

±0.02 mL/L below 500db

The Thermosalinograph system functioned well with lots of detail in the traces. There was an unexplained 50-minute gap in salinity and a short gap in fluorescence while the fluorometer was cleaned. There were no loop samples. Recalibration of salinity was based on comparisons of TSG data with co-incident CTD data as well as results from cruises before and after this one that used the same TSG. Temperature was close to that from the CTD (high by about 0.005C°) while salinity was recalibrated by subtracting 0.015psu. The conductivity cell calibration is probably drifting, though variations in the influence of bubbles in the loop may account for some of the differences among the various cruises.

TSG Fluorescence values looked slightly lower than CTD fluorescence, though few CTD casts had reliable fluorescence data. Comparisons to extracted chlorophyll rosette samples had the usual pattern of reading higher than CHL when CHL was low, and gradually dropping relative to CHL as CHL decreased. For CHL > 4ug/L fluorescence was about 50% of CHL.

The TSG data have been organized into individual files for each day.

# PROCESSING SUMMARY

##### Seasave

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

The deployment protocol was not described in the log, but plots of a sampling of casts suggests that the typical deployment was as follows:

* There was no 10m soak. Acquisition started at the beginning of casts with ~2 wait at the surface with pumps off. It was lowered to about 2.5m where the pumps were turned on and there was a wait that typically lasted about 1.5minutes before the full cast started.
* During bottle stops there was a wait of about 60s before bottles were closed.

##### Preliminary Steps

The digital Daily Science Log and paper rosette log sheets were obtained. The paper Daily log contained only details on mooring work

* Nutrients, extracted chlorophyll, dissolved oxygen, salinity data were obtained in QF spreadsheet format from the analysts.
* The cruise summary sheet was completed.
* The histories of the pressure sensor, conductivity and dissolved oxygen sensors were checked. The temperature, conductivity and pressure sensors had been used on 6 other cruises since the last factory recalibrations and the oxygen sensor on 2. See section 14 for details.

The configuration files were checked and no changes were found during the cruise, but the log notes that the fluorometer was changed after cast #135.

All parameters were correct except for the serial number of the 2nd fluorometer.

##### BOTTLE FILE PREPARATION

The ROS files were created using files 2022-069-ctd.xmlcon.

There were problems with the hex files from casts #144 (truncated file) and 145 (couldn’t convert at all.)

New copies of the files were obtained from S. Page and they converted properly. The faulty HEX files in OSDCommon were replaced.

The ROS files were converted to IOS format.

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

Temperature and salinity were plotted for all BOT files to check for outliers. There are several cases where the 2 salinity channels are very different, but only in cast #80 was there noise amenable to editing; file 2022-069-0080.bot was edited to interpolate a few spiky values in channel Salinity:T0:C0. The output file was then copied to \*.bot.

A preliminary header check was run and no problems were found.

The BOT files were bin-averaged on bottle number.

The output was used to create file ADDSAMP.csv. First, the file was 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 2022-069-bot-hdr.txt which will be updated as needed during processing.

There were no loops samples.

DISSOLVED OXGYEN

Dissolved oxygen data were provided in spreadsheet QF2022-069\_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 2022-069oxy.csv. That file was converted into individual \*.OXY files.

There were 2 samples in the DO file that had comments starting with “ALL:”; flag 3 was added to other samples (affects nutrients only) for samples #56 and 247.

EXTRACTED CHLOROPHYLL

Extracted chlorophyll and phaeo-pigment data were obtained in file QF2022-069\_CHL QF\*.xlsx. The file included comments and flags and a precision study. A simplified version of the spreadsheet was prepared and saved as 2022-069chl.csv. The csv file was then converted to individual CHL files.

SALINITY

Salinity analysis was obtained in file QF2022-069\_SAL.xlsx which included a precision study. The analyses were carried out in a temperature-controlled lab 50 to 61 days after collection. The files were simplified and saved as 2022-069sal.csv. That file was then converted to individual SAL files.

NUTRIENTS

The nutrient data were obtained in spreadsheet QF2022-069\_NUTS\*.xlsx. This includes a precision study. The file was simplified, saved as 2022-069nuts.csv. The file was converted to individual NUT files.

The SAL, CHL, OXY and NUT files were merged with CST files in 4 steps.

After the 4th step the files were put through CLEAN to reduce the headers to File and Comment sections only.

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. A few problems emerged:

* There was no sampling from event #1 as it was just a test firing. This file will not be processed.
* Event #46 had an error in the nutrient data. A sample #90 was reported but the sampling log doesn’t agree. That bottle was missed and the sample # was not used.
* Event #58 nutrients, salinity and CHL should be #57.
* Event #101 – some DO values got lost due to out-of-order sample #s.

All problems were resolved and notice sent to analysts who updated spreadsheets as needed.

##### Compare

Salinity

Compare was run with pressure as reference channel.

A problem was found in the initial comparison as one sample was mislabelled as #353 and should have been #253. The analyst was advised.

All bottles were fired at the surface, around 50m or at the bottom of casts. It is unfortunate that samples were not taken from some of the many bottles fired between 150 and 1500db, away from the effects of the bottom.

First data were removed from the comparison where the standard deviation in the CTD salinity was >0.001psu. Based on the average of the remaining data, more outliers were removed if more than 0.005psu from that average. The primary salinity was found to be higher than bottles by 0.0003psu (std dev 0.0020psu) and the secondary low by 0.0103psu (std dev 0.0030psu).

This suggests a difference of 0.010 between the two salinity channels. When the differences between the 2 channels are examined versus time it appears that it was larger ~0.12psu to 0.013psu early in the cruise.

After event #77 the differences are smaller, on the order of 0.010psu to 0.011psu.with the lowest values after event #123. The differences are still large but closer to the average differences found in the bottle comparison. There is a note in the log about the pump alignment being changed on the rosette to try to level the 2 pumps to improve alignment, but that seems unlikely to affect results significantly while stopped. After cast #135 the conductivity cells were cleaned, and that does look like it might have been effective. (For more details see file 2022-069-sal-study.xlsx.)

To determine which channel accounts for the drift plots were made using the same bottles but plotting differences for each channel against event #. The range of differences is the same for the 2 plots, though the actual differences are not. There is a lot of noise in both plots but it is quite clear that the secondary salinity has a larger change late in the cruise.

The primary salinity is the best choice to archive since values are very close to bottles and the secondary salinity performance is variable during this cruise and previous cruises. (See §15 for details).

The problem could be in the sensor or pump or plumbing, but the secondary does not look reliable.

Outliers were investigated; most had very high standard deviation in the CTD data indicating an area of large vertical or temporal gradients. One that did not was in an area where the salinity varied by 0.6psu during the stop, so the local gradient was very high overall; the CTD data come from 10s near the end of the stop when shed wake activity had settled down, but what is in the bottle likely came from earlier than that.

No samples appear to need flags. Bottle contents may come from a slightly different depth than CTD values, but there is no evidence of problems in sampling or analysis.

For full details for the COMPARE run see file 2022-069-sal-comp1.xls.

Dissolved Oxygen

COMPARE was run with pressure as the reference channel.

Plots were made of differences between CTD DO and titrated samples versus CTD DO. Usually this leads to a convincing linear fit though there is always scatter especially near the surface.

There is a clear trend but many outliers. Three in particular from cast #30 are way out of line with no obvious explanation.

* Because they were all deep (1500, 2000, 1501db) hysteresis is a possible cause, but there is no sign of hysteresis during cast #145. Moreover, a hysteresis problem would not create such large differences and of such a consistent size, -0.3281, -0.0327 and -0.3298mL/L.
* Poor flushing below the OMZ should lead to bottles reading a little higher than ambient conditions except at the bottom where it could read lower. Also, the descent rate was quite variable which would encourage flushing, so it seems unlikely that there would be a large error due to incomplete flushing of Niskin bottles.
* Both transmissometers show high values (though there are small spikes) at the bottom, so it is unlikely that mud affected either the CTD or the bottle sample.
* If the problem is with the CTD rather than samples we might expect to see some issues in other channels. The salinity sample from the bottom compared very well with Salinity:T0:C0.
* There were 3 bottles fired at the bottom and the range of SBE oxygen values was 1.374 to 1.376mL/L.
* Fluorescence values were very noisy and unbelievable through the deeper part of this cast. The DO sensor and fluorometer were both on the secondary system according to the log, so this could possibly have caused some problems with the CTD DO.
* Late in the cruise there was some shift in the differences between primary and secondary temperature and conductivity channels, and that likely was due to some change in the secondary system. This could possibly be related to small errors in CTD DO, but the fluorometry problem affected most of the upcast while the DO comparison at 1000db and 750db looked close to that from cast #145.
* The DO trace has no unusual noise, and up and down casts differ in the expected way with just a small vertical offset.
* We are left with either a problem with sample collection or analysis or a subtle error in CTD DO data.

|  |  |  |  |
| --- | --- | --- | --- |
| **Pressure** | **CTD** | **Bottle** | **CTD-BOT** |
| **Cast #30** |  |  |  |
| 2124.3 | 1.344 | 1.672 | -0.328 |
| 2000.2 | 1.230 | 1.557 | -0.327 |
| 1501.4 | 0.614 | 0.944 | -0.330 |
| 1000.3 | 0.240 | 0.264 | -0.024 |
| 750.7 | 0.252 | 0.272 | -0.020 |
| **Cast #145** |  |  |  |
| 2010.02 | 1.327 | 1.374 | -0.047 |
| 1500.3 | 0.513 | 0.552 | -0.039 |
| 1000.86 | 0.221 | 0.245 | -0.024 |
| 750.695 | 0.251 | 0.277 | -0.026 |
| 500.065 | 0.605 | 0.630 | -0.025 |

The initial fit when outliers were excluded was:

CTD DO Corrected = CTD DO \* 1.0296 + 0.0063 R2 = 0.94

Forcing the offset to be zero produces a fit that looks better, except at the origin.

CTD DO Corrected = CTD DO \* 1.0311 R2 = 0.98

The results from the 2 previous cruises 2021-006 (Line P section only) and La Perouse 2021-005 were:

CTD DO Corrected = CTD DO \* 1.0168 + 0.0168 R2 = 0.68 (Only a few casts 2022-001)

CTD DO Corrected = CTD DO \* 1.0381 + 0.0140 R2 = 0.97 (2022-035)

The fit from this cruise is fairly close to 2022-035, a cruise to seamounts with few calibration casts, but deep sampling. For 2022-069 with more shallow protected sites, there are likely more problems with incomplete flushing of Niskin bottles; that could lead to a lower slope since flushing errors are largest near the surface and lowest near the OMZ. The offset from 2022-035 fits the 2022-069 data better. Using 2022-035 looks like the more reliable fit but all suffer from limited sampling and the current cruise has some concerns about analysis.

Major outliers were examined. Most had high standard deviation in the CTD DO collected in the 10s window and/or were at depths where vertical gradients were very high. Exceptions were:

* Event 30, Samples 48, 49, 50
* Event 101 sample 249

These were very large differences ~0.32mL/L and no obvious explanation was found. The analyst attached 4 flags with a suitable comment. He expressed an opinion that it was probably an analysis issue such as a DOSIMAT problem, but there is no way to prove that and given some CTD problems during the cruise, there is room for doubt.

Fluorescence

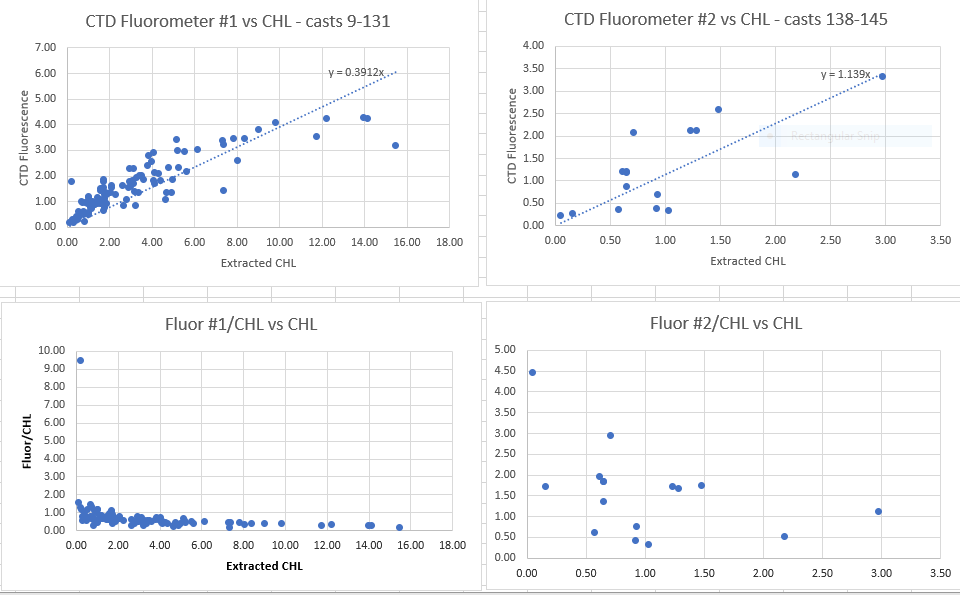
COMPARE was run with extracted chlorophyll and CTD Fluorescence using pressure as the reference variable.

Some of the fluorescence profiles looked very odd, especially during upcasts and even some downcasts. After cast #135 the fluorometer was replaced.

Comparing the performance of the 2 fluorometers is difficult because they the second was only used in low CHL conditions.

The performance we expect from the fluorometers is that they read higher than CHL when CHL<1ug/L and much higher if CHL is close to 0. As CHL rises, the fluorometer values gradually drop relative to CHL. Typical ratios of FL/CHL are 1 to 5 at CHL<0.5ug/L, ~1 for CHL=1, ~0.4 to 0.6 for CHL>5.

* Fluorometer #3982 was used through most of the cruise. It looks lower than expected at low CHL and gradually drops to about 30% of CHL at CHL=14. The shape of the distribution looks normal but with slightly lower values than usual.
* Fluorometer #3641 was only used in low CHL waters and the pattern for that looks normal, though there is not enough data to place much confidence in this result.



An initial look at full casts shows a big problem with fluorometer #3982. This initially is noted during cast #5 when values dropped to 0 at about 115db of the downcast and remained at 0 until the CTD came up to 55db. Cast #2 may also be affected but Saanich Inlet can have unusual profiles, so it is hard to judge. For many casts there are no 0 values in downcasts, but there are often sudden drops in value at the bottom of casts with many 0 values on the way up. The dark values look higher than usual for most casts. There are many spikes and odd drifts in values. While some of the data may be reliable, there is no objective way to separate good data from bad. The cruise sampled a wide variety of environments making such judgments especially difficult.

The profiles mostly look reasonable in shape in the top 100m, so keeping data near the surface could possibly be useful, but there is too much uncertainty to consider archiving the data. This channel should be removed from casts #2 to 135. If any researcher wants to see them, the files from immediately before that stage will be available.

When last used the dark value for this fluorometer was ~0.06ug/L. For this cruise it is ~0.2ug/L to 0.3ug/L during downcasts. The fluorometer used for events #136-145 had a dark values ~0.095ug/L.

For full details for the COMPARE run see file 2022-069-fl-chl-comp1.xls.

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

File 2022-069-ctd.xmlcon was used to convert all files.

The Tau function and the hysteresis function were selected since there was deep sampling. Depth was included in the conversion.

A few casts were examined and all expected channels are present.

There are many spikes in the first cast. It will not be archived.

Cast #15 needs some clipping before DELETE – started with pumps off and came back to surface.

Fluorescence looks odd on upcasts and really bad starting at about cast #30, the first deep cast. From cast #30 onwards the dark values are much higher than usual, ~0.18ug/L, but they often drop to 0 at the bottom and for much of the upcast. Fluorescence is extremely noisy below 300m and through many of the upcasts, but not all. It is noisy even during stops for bottles.

To see if downcast fluorescence looks reliable, a few values were picked out for comparison to CHL samples. It is hard to say whether the downcast data area worth keeping or not – values are a little higher than upcast values but that is normal.

From cast #136 onwards using fluorometer #3641fluorescence looks good.

There is some deep noise in transmissivity as well.

The descent rate was kept high; it was extremely noisy offshore but steady inshore. The T and C pairs were reasonably close during downcasts except at the surface. The altimetry looked ok even though the signal was sometimes noisy at the bottom of casts.

##### 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.

For cast #1 only WILDEDIT was also run on channels Fluorescence:URU:Seapoint, Oxygen:Voltage:SBE, Transmissivity:1 and Transmissivity:2. Those channels are not normally included since they are either naturally very spiky and the routine removes too much or, in the case, of dissolved oxygen the traces are usually very smooth. The pressure channel still had a few spikey records after this step so they were padded using a text editor. This cast will not be archived – cast #2 is at the same site.

##### ALIGN DO

A few casts were examined; both temperature channels were noisy during upcasts so the tests were not easy to interpret, but using +2.5s certainly improves the alignment and overall looks like a good choice. That setting has worked well for many SBE DO sensors in recent years.

ALIGNCTD was run on all casts using +2.5s.

##### 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. A few casts were checked for this cruise and the default setting does improve the data. CELLTM was run using (α = 0.0245, β=9.5) for both the primary and secondary conductivity.

##### DERIVE and Channel Comparisons

Program DERIVE was run on all casts to calculate primary and secondary salinity and dissolved oxygen concentration.

Plots were made to assess the results of the previous steps and no problems were found.

A single 0 value in the Pump Status channel was replaced with a 1; that channel was not put through WILDEDIT.

DERIVE was run a second time on the 2 deepest casts and a few shallower ones to find the differences between the pairs of temperature, conductivity and salinity channels. Results from the 2 previous cruises are included in grey for comparison.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cast # | Press | T1-T0 | C1-C0 | S1-S0 | Descent Rate |
| 2021-078-0038 | 300 | -0.0005 | -0.00068 | -0.0063 | High, Steady |
| 2021-078-0049 | 300 | -0.0005 | -0.00068 | -0.0063 | High, Steady |
| 2021-078-0071 | 350 | -0.0005 | -0.00064 | -0.0061 | High, Steady |
| 2021-078-0076 | 350 | -0.0005 | -0.00064 | -0.0061 | High, Steady |
| “ | 650 | -0.0005 | -0.00062 | -0.0059 | “ |
| 2022-035-0010 | 350 | -0.0002 | -0.00070 | -0.0078 | High, Moderate |
|  | 500 | 0 | -0.00071 | -0.0082 | “ |
|  | 1000 | 0 | -0.00069 | -0.0082 | “ |
| 2002-035-0023 | 350 | -0.0001 | -0.00077 | -0.0088 | High, Moderate |
|  | 1000 | -0.0001 | -0.00074 | -0.0090 | “ |
|  | 1940 | -0.0002 | -0.00071 | -0.0086 | “ |
| 2022-035-0027 | 350 | -0.0003 | -0.00080 | -0.0090 | High, F Steady |
| “ | 1000 | -0.0001 | -0.00080 | -0.0094 | “ |
| “ | 2000 | -0.0001 | -0.00077 | -0.0090 | “ |
| “ | 2500 | -0.0003 | -0.00077 | -0.0088 | “ |
| 2022-069-0030 | 350 | -0.0004 | -0.0011 | -0.0126 | High, Mod |
| “ | 1000 | -0.0002 | -0.0011 | -0.0130 | ‘ |
| “ | 2000 | -0.0004 | -0.0010 | -0.0128 | ‘ |
| 2022-069-0101 | 350 | -0.0003 | -0.0010 | -0.0115 | High, F Steady |
| 2022-069-0120 | 350 | -0.0005 | -0.0010 | -0.0009 | High, Steady |
| 2022-069-0130 | 350 | -0.0005 | -0.0010 | -0.0004 |  |
| 2022-069-0135 | 210 | -0.0006 | -0.0010 | -0.0110 |  |
| 2022-069-0136 | 210 | -0.0010 | -0.0006 | -0.0065 |  |
| 2022-069-0144 | 350 | -0.0012 | -0.0007 | -0.0068 | High, F Steady |
| 2022-069-0145 | 350 | -0.0011 | -0.0007 | -0.0070 | High, Mod |
| “ | 1000 | -0.0010 | -0.0007 | -0.0071 | ‘ |
| “ | 2000 | -0.0011 | -0.0006 | -0.0069 | ‘ |

The temperature differences are similar to previous uses until late in the cruise when they increase.

The salinity and conductivity differences are higher than during the previous cruises, until late in the cruise when they drop to similar values as seen during 2022-035.

There was a change of fluorometer after cast #135 and the conductivity cells were cleaned; the salinity difference drops between those casts #135 and #136, so perhaps either the cleaning or a slight change to the set-up affected conductivity. There was a change to pump alignment but that was at event #133. The increase in temperature differences is harder to explain though the ship was moving more offshore so it is possible that rougher conditions might affect alignment slightly.

##### Conversion to IOS Header Format

The IOSSHELL routine was used to convert SeaBird 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.

The CTD was kept at the surface with pumps off, then lowered to about 2 to 3m where it usually soaked for a while. Sometimes it was lowered to 3m but brought up to 1 to 2m for a while before the full cast was run. For casts #15 the full cast was started but it was discovered the pumps were off, so they returned to the surface, turned pumps on and then ran full cast.

Because there were so many variations in depth at which the pumps were turned on, and in an attempt to capture the best possible data, plots were examined to pick an appropriate initial scan #. These were saved in file clip.csv and CLIP was run on all casts.

Plots were made after this step to ensure pumps were on and depths look reasonable for the first records. A few refinements were made to the clip.csv file and CLIP was rerun.

##### Checking Headers

An initial header check showed evidence of some spikes but all appear to be from cast #1 or upcasts.

While cast #1 may be usable, cast #2 is at the same site and without spikes in the downcast. Profiles and T-S plots were compared and cast #2 is definitely better. Cast #1 will not be processed further.

The cross-reference check and header check were run.

* Event #2 was given station name SI2, but was a second attempt at SI.
* Station names or formats corrected (also in bottle files for #73): Casts #5, 73, 87, 89, 107 and 116.
* The Surface Check gave an average surface value of 1.0db before running CLIP and 2.2db after.
* On upcasts pressures were frequently about 0.3db when files end; conductivity is sometimes very low, sometimes not. So there is no clear evidence of pressure accuracy but certainly no sign of a large error. Two deck pressure readings were available: 0.3db and 0.6db. Pressure may be slightly high but within specifications.

Cruise tracks were plotted, look reasonable and were added to the end of this report.

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 > 6 or <-6 plots of the altimetry were checked. In all cases the altimetry header entry looks reliable, to within a few metres. For some casts the header depth entry differs from the log. Where using the log depth leads to a check value <6m that depth was entered in the Water Depth header. In other cases a calculated value (Max Depth Sampled + Altimeter) was used.

* Casts #108, 116 and 117 - log value was entered in the Water Depth. Note that for 117, the log had vastly different values for BE and BO than EN. BE and BO look good.
* Casts #34 and #58 the log value looked a little better, but still differences are >6, so the calculated value is a better choice.
* For #5 and #141 the calculated value will be used.

For casts #108 and #117, the changes were also made to the SAMAVG files and MERGE was rerun.

For details see document “2022-069-altimeter-ctd.xlsx”.

##### Shift

Fluorescence

SHIFT was run on the SeaPoint fluorescence channel in 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 few casts to assess what settings are best to align conductivity with temperature (as judged by the effect on salinity as seen in T-S space). The last time these sensors were used the best settings were -0.75db for the primary conductivity. Tests were run on the 3 deepest casts and that setting worked better than -0.65, -0.7 or -0.85.

SHIFT was run on all SBE911 casts using -0.75 records for the primary conductivity channel.

It was not run on all secondary conductivity since it was anticipated that secondary channels would be archived. However, for casts #66 (just at the surface) and #80 (throughout) the primary salinity was later found to be corrupted in some sections while the secondary was ok. So those casts were reprocessed and SHIFT was run using -0.75 records for the secondary conductivity ( based on previous use of those sensors). The log mentions problems with these casts thought to be due to something in the plumbing.

##### DELETE

The following DELETE parameters were used:

Surface Record Removal: Last Press Min

Maximum Surface Pressure (relative): 10.00

Surface Pressure Tolerance: 1.0 Pressure filtered over 15 points

Swells deleted. Warning message if pressure difference of 2.00

Drop rates < 0.30m/s (calculated over 11 points) will be deleted.

Drop rate applies in the range: 10db to 10db less than the maximum pressure

Sample interval = 0.042 seconds. (taken from header)

COMMENTS ON WARNINGS: The only warnings concerned an upcast spike in cast #5 and a downcast spike in cast #105. The former is of no significance for profile data. The spike in cast #105 affected pressure, depth and dissolved oxygen and was removed by interpolating values for 2 records around 38db.

##### Other Comparisons

Experience with these sensors since last factory service –

The sensors had been used on 6 other cruises since they were last recalibrated except for the DO sensor which was used on only 2 other cruises..

* 2022-017 – No calibration sampling. Problems in secondary channels. TSG data good except big gap.
* Problems were noted during cruises 2022-048 and 2022-033 on the Franklin, suggesting pressure was too high by 1.5db or more. There were only 2 casts on the 2nd of those cruises. A lab test had a pressure of 1.25db. Cruise 2021-078 was on the Vector with the CTD stored on deck. Acquisition began early, included the 10m soak and sometimes included out-of-water values, so there was good evidence from both the beginning and end of the casts and pressure looked very good for both. Pumps were turned on and off at about 0.1 to 0.5db and the data look appropriate for being in water. Storage of the CTD in a warm lab may account for Franklin observations.
* 2022-018 & 2022-078 (Vector) had salinity sampling with only 5 samples from 2021-078 that found the primary low by 0.0002 and the secondary low by 0.0065psu.
* From 2022-035 the primary was found to be low by about 0.0002psu and secondary low by 0.0093psu.
* The dissolved oxygen sensor was recalibrated in October 2021. It was used for only a few casts on 2022-001 because of problems in the data that were actually due to a cable problem. There was calibration sampling from that cruise with a correction found to be slope=1.0168, offset=0.0437.
* From cruise 2022-035 the DO correction found was slope=1.0381, offset=0.014.

Historic ranges – Profile plots were made with 3-standard deviation climatology ranges of T and S superimposed. The only climatology available for many of the sites was based on large-scale blocks that include offshore values, so not useful for inlets. Where local climatology was available, temperature and salinity generally fell within the climatology in the offshore, but in inlets and near land near-surface salinity was usually below the climatological value and deeper values were near or below the minimum. Temperature was occasionally high near the surface and bottom as well in those areas. For the casts at HECS4 to HECS8 and CH14 and MA01 there were sections with temperatures above the maximum varying from a small section at HECS4 around 30-40db and a larger section from 40 -120m at HECS8. Interestingly, if the “NCOff” climatology were used for all those casts there would be no excursions except a small one at MA01. Perhaps the excursions are due to offshore water moving east.

None of these excursions suggest calibration drift.

Post-Cruise Calibration – None available.

Repeat Casts –Casts #1 and #2 were repeats but cast #1 was of very poor quality. There were no other repeat casts and near-by casts were not deep enough to expect a good comparison.

##### DETAILED EDITING

The primary channels were chosen for editing because the salinity is believed to be more accurate and there were problems with near-surface secondary salinity.

There were 2 exceptions: Cast #66 had poor data in the top 8m and cast #80 was poor throughout. The secondary salinity looked much better in both cases. So secondary channels were edited in those 2 cases.

All DEL files were copied to \*.EDT.

CTDEDIT was used to remove records that appear to be corrupted by shed wakes, and to clean salinity to remove spikes that appear to be due to small misalignment or instrumental noise.

All files required some editing, mostly near the top and bottom of casts.

Notes about editing applied were added to the files.

The edited files were copied to \*.EDT.

After editing, T-S plots were examined for all casts. Some small unstable features remain in some casts but come from areas where such features may well be real. No further editing was done.

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

CALIBRATE was first run on MRGCLN2 files using file 2022-069-recal-SIL.ccf to correct Silicate for bottles having Salinity <25psu.

Primary Salinity data will not be recalibrated, but for casts #66 & 80, the primary conductivity was corrupted and secondary channels selected for archival. So secondary salinity needs to be recalibrated to bring it into correspondence with primary salinity. Based on the results of COMPARE addition of 0.0124psu is appropriate at the time of cast #66.

Pressure does not require recalibration.

Dissolved Oxygen correction will be based on the comparison from cruise 2022-035 as described in §4.

File 2022-069-recal.ccf was prepared to add 0.0124psu to channel Salinity:T1:C1 and to apply the following correction to channel Oxygen:Dissolved:

CTD DO Corrected = CTD DO \* 1.0381 + 0.0140

This correction was first applied to the SAM and MRGCLN2 files.

COMPARE was rerun for dissolved oxygen and shows that the correction was applied properly. As expected, the correction “appears” to be larger than desired except near the origin. When data are excluded based on using the same points as in the original fit, the average difference is 0.031mL/L, with a standard deviation of 0.023mL/L. This is a little larger difference than usual because the results of another cruise were used for the recalibration. Most likely 2022-069 had poorer flushing of Niskin bottles than 2022-035 making the CTD DO look as though it is reading a little too high. The difference at the origin was ~0.001mL/L which is excellent; that is an area where vertical gradients are low so any flushing errors would be negligible. At the surface differences are ~0.08mL/L.

See file 2022-069-DO-comp2.xls for details.

CALIBRATE was then run on the EDT files using the same recalibration file.

##### 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 were bin-averaged to 0.5m bins for the casts with DO bottle samples. Those files were then 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. The scatter was much higher than usual, as expected given the comparison of bottles with upcast data and the method of recalibration being based on a different cruise.

When outliers are excluded based on residuals, the downcast CTD DO was higher than the titrated samples by an average of ~0.08mL/L (standard deviation 0.04mL/L).

The two areas where the differences are lowest are in the OMZ and close to the surface where many of the differences are about 0.025mL/L. The local vertical gradients are quite low in those two areas, so they would best represent areas where flushing errors are insignificant. Little can be concluded from such a scattered plot. The fit against pressure is generally used to get a sense of how accurate the DO data are.

Based on the differences plotted against pressure a rough estimate of the downcast DO is:

±0.30 mL/L from 0-100db

±0.15 mL/L from 100-300db

±0.07 mL/L from 300-500db

±0.02 mL/L below 500db

For more detail see file 2022-069-dox-comp3.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. No problems were noted.

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

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

REORDER was run to get the two DO channels together.

For all casts except #66 and #80 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 and Flag.

Fluorescence:URU:Seapoint was removed from casts #2 to 135.

For casts #66 and #80 REMOVE was run to remove the following channels:

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

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

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

The Header Check was run; no problems were found.

Profile and T-S plots were examined.

Transmissivity:Green is very noisy during cast #109. The Red channel has some noise on upcast but looks normal on the downcast. No other channel had unusual noise during this cast. The data were left in the file since the near-surface data may be of interest and the upper limits of the noise do follow the same trace as the red channel.

No other problems were found.

The sensor history was updated.

##### Dissolved Oxygen Study

As a final check of dissolved oxygen data, % saturation was calculated and plotted. As expected in such a wide-ranging area sampled, there is a lot of variability. Values at 2 to 3m ranged between ~94% and 133%, except for Saanich Inlet where it was 160%. Even the off-shore casts had quite high values at about 110%. We usually see values in the 99% to 107% range in offshore casts at 3 to 4m. There are a few possible reasons why this should be higher than expected.

* The CTD files mostly start below 3db, so this is not actual surface sampling. If there is a gradient with DO increasing slightly with depth we would see higher saturation than expected.
* There was no 10m soak, so there may be bubble release from the tubing as pressure increases. For many of the casts there is a peak at about 10m which could real or it could be due to bubble release. Some bubbles may be released during the soak and more as pressure increases. If this is the case, surface salinity values may also be affected.
* The sensor recalibration may not be as reliable as thought – values may be a little too high.

This is always a rough check to see if the calibration of oxygen sensors is reasonably good, but is particularly unreliable when surface gradients are high and/or there is no 10m soak.

##### Final Bottle Files

SORT was run to arrange casts in pressure order.

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

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

REMOVE was run a second time on casts #66 and 80 only to remove

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

Channel Fluorescence:URU:Seapoint was removed from casts #2 to 135.

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

Standards check and a header check were run. No problems were found.

The track plot looks ok.

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

A cross-reference listing and no problems noted.

A header check was produced for the CHE files and showed some negative values for nitrate. There were 2 flags attached with the comment that the values were below the limit of detection. The negative values were replaced with 0 values in the MRGOXY2 files and channel limits corrected using a text editor. Reorder and Edit Header was then rerun.

##### Thermosalinograph Data

An IOS TSG45 was used for this cruise and data were saved in 1 file.

The file has extensions DAT but is in csv format, so it was opened in EXCEL.

(The formats for these files vary from cruise to cruise – generally in opening use DELIMITED, select COMMA and OTHER (\*). Usually choose TEXT for time. But these choices can vary depending on input formats).

For this cruise date and time were in a single column; they were separated by using Left and Right functions.

The spreadsheets were adjusted as follows:

* 2 lines of headers were added – channel names and units.
* A column with pressure was added with all values set to 4.5 (to enable derivation of salinity).
* A temperature difference column was available, so did not have to be added.
* The fluorescence channel is in volts. It was moved to column M. Then a concentration value was calculated in column F using scale 14.6 as determined in the most recent factory recalibration of the fluorometer. The clean water offset value was 0.081. For previous uses of this equipment it was sometimes found necessary to adjust the offset to obtain reasonable values, but during 2022-001 and 2022-008 no change was needed.

The minimum fluorescence found was 0.35ug/L in an area where near-surface chlorophyll was 0.57ug/L. CTD fluorescence was about 0.28ug/L but was suspected of reading low. So the TSG fluorescence. Another spot check had CHL ~3.1 at 5m where the TSG fluorometer read 2.5ug/L. The TSG usually does read a little lower for CHL>1, so this is a reasonable match. A more thorough comparison will be done later.

* The file is too big for some plotting programs. The data will be separated into separate files for each day. This is done by creating a FILE BREAK column with entries like 2022-069-202207 plus the date. The date was determined by using the function:

="2022-069-202207"&RIGHT(DAY(A3),2)

* There is a note in the log that the fluorometer was cleaned at about 03:00 on July 23rd.
* Time and Date formats are a problem – when converting from RAW choose TEXT but once opened in EXCEL set Time Format to HH:MM:SS and save the file again.
* NaN values were replaced with pad values, -99. There was a large section of padded conductivity values on July 22nd around 17:00. There were then a few very low values and another 2 pad values. The data between those 2 sections of pad values were later found to produce salinity spikes, so they were padded in the as well in the CSV file.

The file was then converted to IOS Header format with header info added. There are 10 IOS files, one for each day.

CLEAN was run to reset the number of records, min and max values, set the start and end times, and latitude and longitude limits.

ADD TIME CHANNEL was used to add Julian dates\*\* ( Decimal Year was inadvertently chosen – this was corrected later.) A record number was also added to enable averaging (for use in comparison to CTD files). Time zero was set to 31 December 2021 0:00:00. (Note that this step leads to problems plotting until REORDER is run.)

DERIVED QUANTITIES was run twice, first to derive salinity using the lab temperature and again to derive sigma-T.

REORDER was run to move the Julian date to after the Time/Date channels and to put salinity and fluorescence after the lab temperature. Also the record # was moved to the end.

a.) Plots

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

Time-series plots were produced. A few possible issues were investigated:

* The loop flow rate started at ~1.3, went up to ~2 at 05:00 on the 18th and stayed steady thereafter.
* Flow rate to the fluorometer varied more, starting at ~1.2, went up to about 2 at 05:00 on the 18th, dropped to about 1.5 on the 19th and 20th, varied a little until ~03:00 on the 23rd when flow was stopped so the fluorometer could be cleaned. After cleaning the flow rate went back to 2 and stayed there until the end.
* Fluorometry values were padded in the REO file from 3:04:30 to 3:06:50. This removed the large spike.
* Salinity generally looks remarkably spike free, but on the 22nd but starting at about 16:20 there is a gap in salinity and later a short gap in lab temperature followed by a large spike in salinity. There were a few bad conductivity values between many pad values. When those values were padded and the data reprocessed, the spike was gone. Otherwise, salinity looks remarkably spike free.

b.) Checking Time Channel

The CTD files were thinned to reduce the files to a single point from the downcast at or within 0.5db of 4.5db. These were exported to a spreadsheet which was saved as 2022-069-tsg-ctd-rosette-comp.xlsx. 84 CTD casts overlapped with TSG records, but one occurred at a time when the TSG data were corrupted, so it was dropped from the comparison.

The TSG files were averaged over 6 records (30 seconds) on record number to reduce the noise and file size. Standard deviations were included. Then required channels (times, positions, temperatures with standard dev, salinity with standard dev, fluorescence with standard dev, flow rate) were exported to a spreadsheet and that file was thinned to the closest times of CTDs and added to file 2022-069-ctd-tsg-rosette-comp.xlsx..

Comparisons were made of positions to check for good matches. The differences in positions are expected to be small despite the averaging because the ship was stopped at these times. The average differences were 0.0001º for both latitude and longitude. The largest differences were 0.0005º for both latitude and longitude. This is an excellent agreement.

c.) Comparisons

* Comparison of T, S and Fluorescence from TSG and CTD data

CTD fluorescence is only available from 10 casts late in the cruise.

The initial comparisons using all casts show a lot of variability which is not unexpected given the wide range of environments and many narrow passages.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Tint-Tctd | Tlab-Tctd | Stsg-Sctd |  | FLtsg/FLctd |
| Minimum | -1.1852 | -0.4201 | -5.6009 |  | 0..27 |
| Maximum | 1.0494 | 1.7805 | 2.2212 |  | 1.32 |
| Average | -0.0095 | 0.6219 | -0.6391 |  | 0.88 |
| Median | 0.0050 | 0.4837 | -0.0360 |  | 0.90 |
| Std. Dev. | 0.3733 | 0.3901 | 1.1996 |  | 0.31 |

The first part of the cruise has much lower variability and is likely a better area for comparison, and the last 2 casts were in deep offshore waters. When the comparison was reduced to casts #9 to #80 plus casts #144 and 145 the comparison shows little differences in the median temperature difference but the standard deviation is much lower. The salinity difference is a little lower while the standard deviation is much lower. This result suggests that the noise late in the cruise is random and does not indicate a change in calibration.

|  |  |  |
| --- | --- | --- |
|  | TSG Temp – CTD Temp | TSG Sal-CTD Sal |
| min | -0.1116 | -0.1552 |
| max | 0.2372 | 0.1189 |
| average | 0.0229 | -0.0549 |
| median | 0.0050 | -0.0147 |
| stdev | 0.0720 | 0.0426 |

The median difference found for salinity in this reduced comparison is between those found during 2022-001 and 2022-008 which preceded and followed this cruise.

The temperature differences are similar to those found during 2022-008.

The difference between the lab temperature and intake temperature is also very noisy, but shows the usual pattern of heating in the loop being dependent on intake temperature. When the intake temperature is close to the ambient temperature of the ship, the two readings are close.

There are few data available to check the fluorometer but the median difference of 0.90 shows the CTD and TSG sensors are in reasonable agreement.

* Comparison of Rosette samples and TSG data

TSG data were compared with rosette samples but the times differ because the TSG data were extracted to match the beginning of casts, while rosette samples came from the end. Also, the depths from which the samples came may vary. So this comparison is rough. Excluding rosette samples flagged 3 and 1 extreme outlier produced the same result.

There was only 1 rosette salinity sample that could be compared to the TSG. The TSG salinity was higher than the Rosette sample by 0.0191psu. When the TSG is compared to the downcast salinity (30.9187psu) at that level it is low by 0.0454psu. This could reflect temporal change but is most likely due to poor flushing of the Niskin bottle.

There are extracted chlorophyll samples from Niskin bottles available for comparison with the TSG fluorescence. They show the usual pattern of the TSG reading higher than CHL at low CHL and reducing to about 50% of the CHL for CHL>4ug/L. The median ratio is 78%. Given that the Niskin bottles may flush incompletely, we might expect the correct ratio to be lower. However, the CHL maximum depth is often below 4m, so flushing errors likely vary in sign and likely average out to some extent. This can partly explain the scatter in the comparison. The TSG fluorometer appears to have performed normally.

d.) Calibration History

The TSG was serviced and recalibrated shortly before cruise 2022-001.

* During 2022-0001 – Salinity close to CTD in open ocean; larger differences in inlets. No recal applied. Problem with intake thermistor that cleared up suddenly with temperature dropping by 1C° in 5s and 1.9C° in 25s. . TSG fluorescence was higher than Extracted CHL by up to a factor of 3 for the samples with CHL < 1ug/L and dropped sharply for CHL>0.5ug/L. There were only 2 samples with CHL>5ug/L and TSG fluorescence was about 30% of CHL for those.
* The TSG was also used for 2 cruises after this one. During 2022-008 salinity was low by 0.02psu and ruing 2022-022 it was low by about 0.038psu. The intake temperature did not work properly at the beginning of the cruise but suddenly cleared a few hours after flow started.

e.) Conclusions re TSG

1. The TSG clock worked well and position information was available and reliable.

2. The flow rate to the TSG started at ~1.3, went up to ~2 at 05:00 on the 18th and stayed steady thereafter. There was more variability in the flow to the fluorometer, but it was kept high except for a brief period when it was stopped for cleaning.

3. The cruise visited a wide variety of environments.

4.The TSG salinity was found to be lower than CTD salinity by a median of 0.015psu in sections of the cruise where the comparison had low scatter. This is intermediate between the results of the cruises before and after this one, so the conductivity sensor may be drifting fairly steadily.

5. The TSG intake temperature was higher than the CTD temperature by a median of 0.005C° when all data are included or when the choice is restricted to the “quiet section. This suggests that the scatter is due to minor mismatches in timing or sampling depths in areas of rapid temperature change.

6. The TSG fluorescence values are reasonably close to those from the CTD fluorometer for the few casts at the end of the cruise when reliable CTD fluorescence was available. The comparison of TSG fluorescence to extracted chlorophyll samples from rosettes show the usual patterns. The TSG fluorometer appears to have functioned normally.

7. No loop samples were available.

g.) Editing

Time-series plots were examined. The only editing required was to initial records of temperature, salinity and fluorescence before flow was well established.

All REO files were copied to EDT.

The first 49 points were padded for the intake temperature and 119 points (about were padded in the lab temperature, salinity and fluorescence channels. Editing to remove a spike in fluorescence when flow was off was done earlier using a text editor. File ED1 was copied to EDT.

h.) Preparing Final Files

\*\*The time channel added earlier was Decimal Year and should have been Time:Day\_of\_Year.

REMOVE was used to remove channel Pressure, Temperature:Difference and Decimal Year.

Add Time Channel was rerun to add Time:Day\_Of\_Year.

Reorder was also rerun to put that channel at the end of the list.

i.) Calibrate

CALIBRATE was used to add 0.015psu to channel Salinity

HEADER EDIT was used to change the DATA DESCRIPTION to THERMOSALINOGRAPH and add the depth of sampling to the header and to change channel names to standard names and formats and to add comments.

A cross-reference list was prepared:

Filename Latitude Longitude Date Time

---------------- ------- ---------- ----------- -------------- -----

2022-069-20220716 49 59.10 N 129 18.24 W UTC 2022/07/16 03:32

2022-069-20220717 50 34.86 N 129 42.12 W UTC 2022/07/17 00:00

2022-069-20220718 51 38.64 N 131 40.20 W UTC 2022/07/18 00:00

2022-069-20220719 52 31.14 N 131 39.30 W UTC 2022/07/19 00:00

2022-069-20220720 53 47.52 N 131 55.44 W UTC 2022/07/20 00:00

---------------- ----- ------- ---------- ----------- ---------- ---------

2022-069-20220721. 54 11.16 N 132 18.48 W UTC 2022/07/21 00:00

2022-069-20220722. 54 36.00 N 130 15.00 W UTC 2022/07/22 00:00

2022-069-20220723 52 11.22 N 131 2.22 W UTC 2022/07/23 00:00

2022-069-20220724 49 39.24 N 130 41.94 W UTC 2022/07/24 00:00

2022-069-20220725 48 13.02 N 127 41.82 W UTC 2022/07/25 00:00

The TSG sensor history was updated.

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

P**articulars - Mostly Notes from Daily Science Log**

1/2. Electrical blips on all sensors. Need to re-terminate.

11. Deck pressure 0.3db. DO blip at depth

15. Forgot to turn pump on – back to surface

30. Fluorescence signal below 1200 m. extends to the bottom. Very strange..

30. Salinity difference 0.13psu.

32. Fluorescence signal again starting at 600m.

31. Logged as 31 but changed to 32.

50. Fluorometer does not go to 0 any more, 0.2 minimum.

51. Crew making adjustment to LARS while rosette in water.

64. High surface DO and station name wrong. Should be JPS6.

66. Sal and Temp noisy on upcast above 50m. Something in plumbing? (Used Secondary for archive.)

80. Something in plumbing? Very odd uptrace. (Used secondary for archive.)

82. Deck pressure 0.6db.

86. Thin, fresh surface layer.

87. Sal diff ~0.012 on upcast.

97. Lots of jelly fish slime

101. Error message early in downcast; said would keep logging.

101. Bottle 12 numbered 9253 because bottles 11 and 12 had same sample ID.

108. Depth in hex file is goofy. Used pressure plus altimeter in log. 130m.

120. Start of thin fresh surface layer, Sal~16 top 5m. Almost uniform T,S below 150m.

122bb. Stopped acquisition before turning off pump – created new hex file to stop pump then brough out of water.

124. Came up to 1m before sending to the bottom

125. Near-surface getting fresher.

127. Surface DO>8ml/l.

132. Station may be wrong in hex file. Should be PC14. (Fixed.)

133. Started late in cast. Pump alignment changed on the rosette to try to level them. Could alter offset between S1 and S2. From profile below 150m the change, if any, is small.

133. strange fluorometer behaviour at depth.

134. TSG fluorometer cleaned.

135. Triton through both cond. Cells for cleaning. Swapped out fluorometers – removed 3982, installed 3641 gain 10X (0-15ug/L). Configuration file entry for fluorometer was NOT changed at sea, but was changed in processing.

136. Replaced fluorometer responding as expected.

143. Salinity offset seems reduced – cleaning on day shift may have helped.

144. Down to 7m to let winch operator set something. Did not return to surface. Upper 10m pretty uniform.

144. Hypoxia at about 300m. Did not trip bottle 21.

145. Down to 7m, then back up to start profile. Vent on bottle #23 seemed plugged.

**CRUISE SUMMARY – CTD**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CTD#** | **Make** | **Model** | | **Serial#** | | **Used with Rosette?** | | **CTD Calibration Sheet Competed?** | | |
| 1 | SEABIRD | 911+ | | 0506 | | Yes | | Yes | | |
| **Calibration Information - 0506** | | | | | | | | | | | |
| **Sensor** | | | | | **Pre-Cruise** | | | | **Post Cruise** | | |
| **Name** | | | **S/N** | | **Date** | | **Location** | | **Date** | **Location** | |
| **Temperature** | | | **2374** | | **3Feb2021** | | **Factory** | |  |  | |
| **Conductivity** | | | **3184** | | **3Mar2021** | | **Factory** | |  |  | |
| **Secondary Temp.** | | | **4883** | | **4Feb2021** | | **Factory** | |  |  | |
| **Secondary Cond.** | | | **4395** | | **3Mar2021** | | **Factory** | |  |  | |
| **Transmissometer** | | | **1185DR** | | **28Apr2021** | | **IOS** | |  |  | |
| **Transmissometer** | | | **1883DG** | | **28Apr2021** | |  | |  |  | |
| **SBE 43 DO sensor** | | | **997** | | **15Oct2021** | | **Factory** | |  |  | |
| **SeaPoint Fluor.** | | | **3982** | |  | | **Factory** | |  |  | |
| **SeaPoint Fluor.** | | | **3641** | |  | | **Factory** | |  |  | |
| **Pressure Sensor** | | | **0506** | | **29Jan2021** | | **Factory** | |  |  | |
| **Altimeter** | | | **76341** | | **2Oct2021** | | **Factory** | |  |  | |

**CRUISE SUMMARY – TSG**

# TSG Make/Model/Serial#: SEABIRD/45/0620

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Calibration Information** | | | | | |
| **Sensor** | | **Pre-Cruise** | | **Post Cruise** | |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **0620** | **12Jan22** | **Factory** |  |  |
| **Conductivity** | **0620** | **12Jan22** | **Factory** |  |  |
| **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. | **1656** | **12Mar2021** | **Factory** |  |  |

The following plots exclude casts #1 and #2 in Saanich Inlet.