## REVISION NOTICE TABLE

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| --- | --- |
| DATE | DESCRIPTION OF REVISION |
| 24 April 2025 | The correction applied to DO sensor #4372 on CTD #0443 was found to be inappropriate. Results of COMPARE for 2024-006 and 2024-069 plus a post-cruise calibration showed unusual calibration drift for this sensor with CTD DO drifting to higher values. The results from inlets are too unreliable to estimate how much drift had occurred by March 2024, but there was likely to be some, so all SBE DO values were multiplied by 0.97 to cancel the earlier +2.2% and reduce values by about 1% based on 2024-006 results. |
| 18 March 2025 | Updated channel names & formats in TSG file. GG |

## PROCESSING NOTES

Cruise: 2024-001

Agency: OSD

Location: B.C. Inlets

Project: Inlets

Chief Scientist: Johannessen S.

Platform: Vector

Date: 6 March 2024 – 18 March 2024

Processed by: Germaine Gatien

Final Processing: 27 September 2024 – 5 November 2024

Number of HEX files: 94 Number of CTD files processed: 93 (dropped test cast with pumps off)

Number of rosette files: 33 Number of CHE files processed: 32 (no sampling from cast #1)

Number of TSG files: 9 Number of TSG files processed: 1 (all data in one file)

# INSTRUMENT SUMMARY

Two CTDs were used during this cruise.

For Events 1 – 9 CTD #1222 was mounted in a rosette and attached were 2 Wetlabs CSTAR transmissometers (1201DR and 1883DG), a SBE 43 DO sensor on the primary pump (#4367), SeaPoint Fluorometer (#4186) with 3X gain on the secondary pump and an altimeter (#76341).

For Events 11 – 12 CTD #0433 was mounted in a rosette and attached were 2 Wetlabs CSTAR transmissometers (1201DR and 1883DG), a SBE 43 DO sensor on the primary pump (#4372), SeaPoint Fluorometer (#2228) with 3X gain on the secondary pump and an altimeter (#75321).

For Events 13 – 110 CTD #0433 was mounted in a rosette and attached were 2 Wetlabs CSTAR transmissometers (1201DR and 1883DG), a SBE 43 DO sensor on the primary pump (#4372), SeaPoint Fluorometer (#4186) with 3X gain on the secondary pump and an altimeter (#75321).

Seasave version 7.26.7.121was used for acquisition.

The data logging Computer was a Lenovo ThinkCentre.

The deck unit was a Seabird model 11+..

A Guildline model 8400B Autosal serial # 73274 was used to analyze salinity samples.

An IOS rosette with 24 10L bottles was used.

A thermosalinograph (SeaBird 21 S/N 3411) was in use.

# SUMMARY OF QUALITY AND CONCERNS

The Daily Science Log Book was in excellent order with many comments on problems or conditions experienced. There was a complete list of CTD equipment which was especially useful given several changes made during the cruise. The only missing item was an entry for the TSG. It is also recommended that a brief description of the deployment method be included in the header section. Sampling notes about issues encountered at sea were especially useful.

The digital logs were more of a problem, not because they were not complete. The current method of creating digital logs for rosette sampling does not work well for data processors. The data are stored on individual sheets with tabs indicating station name, but data processing must deal with event numbers in order to merge various data types. The compiled sample tab does help with the issue of reordering on event number, but it lacks the firing order and that order is definitely not obvious when changes occur on the fly. So either providing printed rosette sheets or finding some way to combine them in a single, scrollable file would help data processors and analysts.

There was no 10m soak before running the full casts. This was a deliberate choice in order to sample undisturbed surface water. Pumps were not on for some of the soak time, so pumped channels had some poor data very close to the surface.

The secondary temperature sensor malfunctioned on CTD #1222, so after cast #10 CTD #0443 was used. Fluorometer #2228 malfunctioned during events #11 and #12. Fluorometer #4186 was used for events 1-10 and 13-110.

Calibration based on sampling in inlets is not very reliable due to poor flushing of Niskin bottles. These sensors had not been used on other cruises since they were last serviced. The primary salinity appeared to be reasonably close to bottles for both CTDs at levels where flushing errors are expected to be small. Given reasonable comparison and no previous use, the salinity was not recalibrated. Dissolved oxygen appeared to be low by about 3% for CTD #1222 and 2% for CTD 0443. Both sensors had been used on other cruises since last service, but there was no calibration sampling done. Recalibration was applied to the CTD dissolved oxygen based on rough comparisons, since the values are typical of corrections for this type of sensor. However, the evidence is weaker than usual.

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, 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 0-200db

 ±0.10 mL/L from 200db to 300db

 ±0.05 mL/L below 300db.

An SBE21 Thermosalinograph was in use during the cruise. The system had no intake temperature, loop samples or flow-rate meter. A comparison of TSG temperature and salinity was made with 83 co-incident CTD casts. As expected in inlets, the TSG data are highly variable making comparisons very noisy. The TSG temperature in the lab was higher than the CTD temperature by a median of 0.25C in some of the quieter parts of the record, and that amount of heating in the loop is similar to results from other winter cruises on the Vector. A proxy for intake temperature was created by subtracting 0.25C from the lab temperature. The TSG salinity was mostly lower than CTD values, as expected due to bubbles in loop water. In quieter sections it appeared to be low by a median of 0.009psu, but even there the standard deviation was too large to justify recalibration.

The TSG temperature data from the lab were recalibrated based on the comparison with CTD data in order to create a proxy for intake temperature. The channels are identified as:

 Temperature:Primary – corrected temperatures serving as a proxy for intake temperature.

 Temperature:Lab - uncorrected TSG temperature data from the lab.

# PROCESSING SUMMARY

##### Seasave

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

##### Preliminary Steps

* The configuration files used at sea were checked. There was an error in the entries for transmissometer 1201DR. The offset was changed from -0.0119 to -0.1188
* Files were created for the 4 configurations:

2024-001-ctd1.xmlcon for Events 1-10

2024-001-ctd2a.xmlcon for Event 11

2024-001-ctd2b.xmlcon for Event 12

2024-001-ctd3.xmlcon for Events 13-110

Events 11 and 12 had the same equipment, but the NMEA download was accidentally not chosen for #11.

* The Log Book and rosette log sheets were obtained. They were in good order except for missing TSG info.
* Dissolved oxygen, extracted CHL, nutrient and salinity data were obtained in QF spreadsheet format from the analysts.
* The cruise summary sheet was completed.
* The history of the T, C and P sensors was checked and noted in section 14.

##### BOTTLE FILE PREPARATION

The ROS files were created using files 2024-001-ctd\*.xmlcon as noted above.

The ROS files were converted to IOS Header format with extension \*.BOT.

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

Temperature and salinity were plotted for all BOT files to check for outliers. No editing was found necessary.

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 sorted on sample numbers.

There was no sampling from bottles fired during event #1

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 2024-001-bot-hdr.txt which will be updated as needed during processing.

DISSOLVED OXGYEN

Dissolved oxygen data were provided in spreadsheet QF2024-001\_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 2024-001oxy.csv. That file was converted into individual \*.OXY files.

There were 2 samples (314 and 315) in the DO file that had comments starting with “ALL:” and CHL and NUTS were drawn from those bottles, so the same flags were added to the CHL and NUTS files. Salinity was not drawn from those 2 bottles..

EXTRACTED CHLOROPHYLL

Extracted chlorophyll and phaeo-pigment data were obtained in file QF2024-001\_CHL QF\*.xlsx. The file included comments, flags and a precision study. A simplified version of the spreadsheet was prepared and saved as 2024-001chl.csv. The csv file was then converted to individual CHL files.

NUTRIENTS

The nutrient data were obtained in spreadsheet QF2024-001\_NUTS\*.xlsx. This includes a precision study. The file was simplified, saved as 2024-001nuts.csv. The file was converted to individual NUT files.

SALINITY

Salinity analysis was obtained in file QF2024-001\_SAL.xlsx; there were no duplicates taken. The analyses were carried out at IOS 4- 13 days after collection. The files were simplified and saved as 2024-001sal.csv. That file was then converted to individual SAL files.

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

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 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.

There was no sampling from file #1, so it was dropped from the file list.

The output of the MRG files were exported to a spreadsheet. One problem was discovered: Event #10 was saved as #9 so those samples were missed in the merge process. They were renamed and the merge process was run again.

A header check and cross-reference listing were produced.

As mentioned in the log, the position was missing for event #11, so those data were added to the header based on the log BE entry. No other problems were noted.

##### Compare

Salinity

Compare was run with pressure as reference channel.

* CTD #1222

There were 3 casts with samples for this CTD with sampling at 2m, 50m and 5m off the bottom. These are not good levels for calibration sampling. As expected the samples from the bottom tend to have CTD values higher than bottles and the reverse during upcast sampling. The shallow samples are in high gradients and tend to have salinity lower than CTD salinity. The bottom sample from event #10 is likely the most reliable as the local vertical gradient was low.

All the samples from this CTD fit that pattern in a general way, but the actual differences show that something went wrong with one of the temperature sensors during event #4.

Given a clear problem the full casts were converted to see what happened. See section 5.

The secondary temperature clearly has a problem that started with a sudden drop in values followed by further more gradual drops, so the secondary salinity is presumed to be bad. The primary salinity may have drifted a little, but there are too few data to determine this.

Looking at the CTD data during the bottle stops during events #4 and #7, there are CTD salinity values seen as a shed wake clearly passed through, that match the bottle salinity values. The source of the water in the shed wakes come from about 3m above for event #4 and 6m above for event #7. So the differences found during these 2 casts can be entirely accounted for by incomplete flushing. For event 10 there was no shed wake, but the salinity from the bottle can be found in CTD data from 14db above the firing level. The descent rate is very steady. The descent rate shows conditions were very calm, so it is likely that the mismatch between bottles and CTD are due to the Niskins containing water from slightly higher in the water column ( 3m above for event 4 and 6m above for event 7).

At 50m there are salinity values matching CTD salinity seen at some time during the stop for all 3 events, so again the differences may well be due to incomplete flushing.

There are insufficient data to recommend recalibration; what evidence exists suggests a small error with salinity likely well within ±0.005psu.

* CTD #0443

The fit of differences between CTD and bottle salinity were extremely noisy down to 50db. Below that all samples are from the bottom. With the aim of finding a fit that varies little with pressure, data above 200db were excluded as well as one outlier found in both primary and secondary, and another that had noisy CTD data for the secondary only. The average of those data showed the primary salinity to be high by 0.0027psu and the secondary to be low by an average of 0.0005psu. The standard deviations were 0.0013psu and 0.0012psu. When only bottles below 550db are included the primary is high by an average of 0.0018psu (5 bottles) and the secondary is low by an average of 0.0015psu (4 bottles).

When plotted against time the primary is very flat while the secondary differences decrease slightly with time. The later casts are shallower than the early ones, so the secondary looks closer to expectations. However, removing the bottle from the 1st cast in the comparison makes the 2 look similar, demonstrating the weakness of the comparison overall.

We expect that flushing errors will make the CTD look a little higher than bottles at the bottom of casts. So the primary salinity is likely closer to bottles than it appears and the secondary farther away than it appears. So the primary are likely a better choice for archival. Even if flushing errors are on the order of 0.005psu, that would mean the primary is low, but by only 0.002 to 0.003psu.

There was only one cast (#94) with salinity sampling that had a noisy descent rate which should limit flushing errors. The differences for bottom and 50m levels for that cast are just slightly lower than in the general fit, with CTD primary salinity being higher by 0.0025psu at the bottom and higher by 0.0001psu at 50m. lending some confidence to the conclusion that the primary is likely reading slightly high.

The primary sensors were used on some previous cruises with limited sampling which suggests salinity is low by ~0.001psu. The secondary sensors had not been used since the last service.

For full details for the COMPARE run see file 2024-001-sal-comp1.xls.

Dissolved Oxygen

COMPARE was run with pressure as the reference channel.

CTD 1222

There was only one calibration cast for this CTD and it was in protected waters where flushing is likely to be poor. The average of 3 bottles in deep water suggests the CTD is low by 3%.. The bottom bottles where flushing errors are usually of the opposite sign suggests a slightly larger error, as expected. Recalibration using 3% is a reasonable estimate.

CTD 0443

There are only 4 casts with sampling from this CTD. While they are deep, they are in very quiet waters where bottles do not flush well. As expected those fired at the bottom of casts indicate that the CTD data are low by about 3%, though if one of those bottles is excluded, and it does have a large gradient at the bottom, then a correction of about 2.2% is suggested.

Bottles fired above bottom but in fairly low vertical gradients suggest a correction of 1.8%; there is likely some error due to flushing so this is likely an underestimate.

Most of the bottles indicate the CTD data are reading high which is most unlikely and is presumed to be due to the fact that the Niskin bottles contain water from deeper levels where DO is lower. Flushing of Niskin bottles is expected to be poor in these very quiet waters.

The bottom bottles are likely fairly close, so an estimate of 2.2% is reasonable and in the range of values commonly found for these sensors. Even though the estimate is rough, it is almost certain that DO are values are low, so a small increases is appropriate.

For full details for the COMPARE run see file 2024-001-dox-comp1.xls.

Plots of Titrated DO and CTD DO against CTD salinity were examined. The only outliers found were in high vertical gradients, so no quality flags are recommended as the samples are likely fine.

Fluorescence

COMPARE was run with pressure as the reference channel.

The ECO fluorometer reads higher than the SeaPoint by about 30%, with the largest differences at low CHL.

The ECO is closer to CHL when CHL is high and the SeaPoint is closer when CHL is low.

At high CHL the ECO is higher by about 20% and closer to CHL. Since there is some error due to incomplete flushing of Niskin bottles and that error can vary in sign depending on the depth of the CHL maximum, we can’t determine that the ECO is more accurate because it is closer to CHL. The CTD fluorescence is likely to read low if the CHL maximum is shallow.

This may make comparison with other years a little awkward, but the various fluorometers vary among the same brand, so this may not indicate a difference due to the model itself.

Subtracting dark values made little difference for these sensors.

For more details see document 2024-001-fl-chl-comp1.xls.

A fuller report on the comparison between ECO and SEAPOINT fluorometers is being prepared using data from multiple cruises.

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

All files were converted using 2024-001-ctd.xmlcon.

The Tau function was selected but not the hysteresis function since there was no sampling below 800m. Depth was included in the conversion.

A few casts were examined for each of the CTDs.

CTD 1222

Event #1 shows good correspondence between the 2 temperature channels during downcasts and noisy but similar upcast data.

Event #4 has poor correspondence between the 2 temperature channels from about 350db of the downcast. With a difference of ~0.0002C° at 340db and 0.0036C° at 515db and 0.01C° by 25db of upcast.

Events #5 to 9 all show large differences throughout, though profiles look very similar. The difference at 400m of event #9 are ~0.016C°.

The conductivity differences are very low for all events using that CTD.

The change at event #4 is clearly due to the secondary temperature channel.

The temperature differences (Secondary – Primary) for the 3 bottle casts were plotted together. The problem started at about 350db during the downcast of event #4 when the secondary temperature abruptly started to move lower than the primary.

The differences appear to get larger in the later 2 casts but the differences between downcast and upcast are not obvious in each of them. There may be continuing drift in the primary. Unfortunately, the differences between the primary and bottles does suggest slight drift there as well, but it is relatively small. It is hard to judge based on sampling at these levels.

CTD 0443

The primary and secondary temperature look bad for most of event #12 and the secondary looks bad at the bottom and questionable above that. The pumps were off, so cast #12 will not be prepared for the archive.

Otherwise, temperature channels are very close together and conductivity channels reasonably close.

Some spikes are seen in altimetry, perhaps due to steep slopes.

As reported in the log the fluorometer looked bad on casts #11 and 12; it was changed after cast 12.

The T and C pairs were close during downcasts but not upcasts. There is always more noise in upcast temperature and conductivity channels than in downcasts, but the upcast differences seem larger from Franklin cruises. The noise stops during bottle stops.

The descent rate is generally high with very steady rates in inlets; there are about 9 casts with noisy descent rates. None of those had dissolved oxygen sampling. Cast #94 was the only one with salinity sampling and the differences for bottom and 50m levels for that cast match the general fit well.

The transmissivity, DO, altimetry and fluorescence profiles look normal.

##### 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.

A few spikes noted in conductivity were successfully removed by this step.

##### 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 for both sensors. 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.

DERIVE was run a second time on a few of the deeper casts to find the differences between the pairs of temperature, conductivity and salinity channels.

Casts using CTD #1222 were not included in this step since the secondary temperature sensor malfunctioned.

Only the primary sensors on CTD #0443 were used on previous cruises, so no history of differences is available.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cast # | Press | T1-T0  | C1-C0 | S1-S0 | Descent Rate |
| 2024-001-0030 | 550 | -0.0003 | -0.00038 | -0.0038 | High, V. Steady |
| 2024-001-0050 | 550 | -0.0004 | -0.00033 | -0.0037 | High, F. Steady |
| 2024-001-0074 | 550 | -0.0003 | -0.00032 | -0.0031 | High, F. Steady |

The temperature and conductivity differences are small.

The salinity differences are consistent with the average difference found in COMPARE, 0.0033psu, when the CTD was stopped for bottles.

##### 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.

There was no 10m soak. There was a wait at the surface ranging from 60s to 180s, averaging 100s. (The test cast had a much shorter wait.)

It is best to remove some of the soak data to ensure DELETE picks values after the wait.

File clip.csv was prepared with the number of records to be removed for each file.

Plots were examined to see how many records needed to be removed. Estimates were entered in file CLIP.csv, based on being near the end of the soak period.

CLIP was run and plots made afterwards to ensure that too many records had not been removed. A few adjustments were made to the CLIP file and it was run on affected casts. There remain some noisy near-surface data; some may be removed by DELETE. A further clip by depth may be needed before running CTDEDIT.

##### Checking Headers

* The cross-reference check was run. No problems were found.
* The header check was run separately for the 2 CTDs and turned up a few issues:
	+ For CTD #1222 there are negative pressures as low as -0.82db at the beginning of a cast. Pumps were off, temperatures low and Red transmissivity high, suggesting that the CTD was above the surface. It appears to enter water at about -0.2db.
	+ For CTD #1222 there were no negative fluorescence readings.
	+ For CTD #0443 there were no negative pressures, the lowest was 0.62db.
	+ The pumps were off throughout Event #12; conductivity looks bad showing that this was not just a failure to record pump status. This cast was dropped from further processing. It was likely a test while trying to fix a problem with the fluorometer.
	+ For CTD #0443 there were negative values in ECO fluorescence. (It disappeared after DELETE and/or CTDEDIT.)
	+ The transmissivity spikes to 0 at the beginning of file #45. Deck pressures were available and appeared to be rising and during event #47 the reading was 1db. The low readings in transmissivity tend to be associated with near-surface conditions.
* Surface check was run and found an average of 1.3db but the first few casts were with a different CTD and the surface for those varied from -0.4 to +1.3. For CTD #0443 they ranged from 0.6db to 2.8db.
* Plots were made to see if there was any clear evidence of the surface pressure. The ECO fluorometry and transmissivity profiles show a sudden change at about 1db but this varies through the cruise starting at about 0.8db and ending at 1.4db.

Deck pressures also varied as follows: 0.9, 0.7, 0.8, 1.0, 1.2, 1.4db during casts 14, 31, 36, 47, 65, 97 respectively.

Since the pressure sensor might be affected by temperature change surface values may not be reliable.

Checks were made of temperature. There is a hint that lower water temperatures as judged by 1.5db downcast values might be associated with lower deck pressures. It is possible that the difference in temperatures in air and water affects the equilibration of the CTD.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Event # | Deck Pressure | 1st CTD Temperature | CTD Temp at 1.5db downcast | CTD Temp at 1.5db upcast |
| 14 | 0.9 | 5.5 | 7.2 | 7.2 |
| 31 | 0.7 | 8.5 | 6.1 | 6.1 |
| 36 | 0.8 | 5.8 | 6.5 | 6.6 |
| 47 | 1.0 | 5.5 | 6.9 | 6.8 |
| 65 | 1.2 | 5.5 | 7.8 | n/a |
| 97 | 1.4 | 10 | 8.6 | n/a |

Checks of data when the CTD moved in and out of water at the beginning and end of cruise 2024-069 in June suggest that pressure is high by about 1.1db. This is very close to the average of the March values,

So pressure should be recalibrated by subtracting 1.1db.

* Cruise tracks were plotted and were added to the end of this report.
* Water depth header entries were checked. Header values for altimetry and water depth were exported to file 2024-001-altimeter-ctd.xlsx.

A “check value” was calculated as follows:

Check Value = Absolute Values {(Altimetry header + Max. depth sampled - Water depth in Header}

This value is expected to be close to 0, but in an area with narrow channels and steep slopes larger check values are common. All cases with that value >5m were checked. There were 6 such casts:

* First water depth entries were checked against the log and in 2 casts (events 70 and 99) the log entry produces better check values, so the headers were changed to those values. The first was likely a case of shoaling between the entries in the log and the header and #99 was obviously a case of not replacing the entry from the previous cast.
* For 3 of the casts profile plots show the altimetry header entry is appropriate and differences are <6m, so no changes were made.
* This left 1 cast, #84 with a check value of 12.5m. This is from a narrow inlet likely to have with steep slopes, so a difference this large is reasonable, but given that the depth when the CTD was at the bottom of the cast is likely the more important value, an estimate was made of water depth by adding maximum depth sampled and altimetry at the bottom. Depth 276 was entered for cast #84.

These changes were made to 3 CLIP files. None of these casts were rosette casts, so no changes were needed for bottle files. The sounder appears to have worked very well.

##### 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 closer to the temperature offset after this step.

No change was made to the ECO fluorometry since it is not pumped and the alignment looks ok.

Dissolved Oxygen

The Dissolved Oxygen voltage channel was aligned earlier and the results look good. No further alignment will be applied.

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 best setting for CTD #1222 was +0.3 records for the primary (the secondary data are bad so were not aligned.)

SHIFT was run once on casts 1-10 using those settings. Salinity was recalculated for the primary channel.

The best setting for CTD #0433 was -0.7 records for the primary and -0.6 for the secondary.

SHIFT was run twice on casts #11-110 using those settings. Salinity was recalculated for both channels.

##### DELETE

The following DELETE parameters were used:

Surface Record Removal: Last Press Min

Maximum Surface Pressure (relative): 10.00

Surface Pressure Tolerance: 1.0 Pressure filtered over 15 points

Swells deleted. Warning message if pressure difference of 2.00

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

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

Sample interval = 0.042 seconds. (taken from header)

COMMENTS ON WARNINGS: There were no warnings.

##### Other Comparisons

Experience with these sensors since last factory service –

* For CTD #1222 the pressure sensor was thought to be possibly low by <0.2db but evidence was weak. The conductivity sensors had no been used since last service. The oxygen sensor had only 1 use since purchase and there was no DO sampling from that cruise.
* For CTD #0443 the secondary conductivity sensor had not been used since the last service. The primary sensor was used on 4 previous cruises with some sampling; the most recent comparisons showed the salinity to be low by 0.0017psu and 0.0009psu. No reports were made of pressure errors but there was little evidence to go by. The DO sensor was used on 4 previous cruises since service, but there was no calibration sampling on those cruises.

Historic ranges –Profile plots were made with 3-standard deviation climatology ranges of T and S superimposed, but local climatology was only available for a few casts. For those casts, all temperature and data fell within the climatology down to 175db but below that temperatures were above range; similarly salinity data fell within the climatology in the upper 125db and was lower than the climatology range below that. These sites are close to shore and not regularly sampled in the past, so are likely not represented in the climatology. There is no evidence of calibration problems.

Post-Cruise Calibration – There were no post-cruise calibrations available.

##### DETAILED EDITING

The decision on which channel pair to use was clear for CTD 1222 since the secondary temperature sensor malfunctioned.

For CTD 0443 both channel pairs look similar in T-S space, with perhaps a slight advantage to the primary.

The primary channels were chosen for editing for both CTDs.

The DEL files were zipped and submitted to the QC CTD program

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

Most casts needed editing at the top and/or bottom of casts.

The following casts were not edited: 26, 50, 58, 64, 99, 110.

The following casts required heavy editing: 65, 66, 67, 68, 70, 71, 95, 96.

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. Small unstable features remain in many casts which is expected with most casts being close to shore and in areas of tidal mixing and mixing near sills.

The output files were submitted to the QC CTD program.

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

Comparisons with bottles from this cruise and any previous uses of sensors were limited.

Silicate requires recalibration since there was silicate sampling and salinity was <25psu for some samples.

File 2024-001-recal-sil.ccf was prepared and applied to the MRGCLN2 files.

For CTD #1222 the pressure appears to be within 0.02db but there are insufficient information to recalibrate salinity which is likely within ±0.005psu. A rough estimate suggests that dissolved oxygen is low by about 3%.

For CTD #0433 the pressure appears to be low by 1.1db and CTD DO low by about 2.2%.

File 2024-001-recal1.ccf was prepared to apply the following corrections:

File casts 1-10:

CTD DO Corrected = CTD DO \* 1.03

For casts 11-110:

 Pressure Corrected = Pressure -1.1

CTD DO Corrected = CTD DO \* 1.022

These corrections were first applied to the SAM and MRGCLN2 files.

COMPARE was rerun on dissolved oxygen and shows that the corrections were applied properly Pressures were also found to have been corrected appropriately.

Calibrate was then run the EDT files.

The following information was sent to Jeannette Bedard for entry in the sensor history.

*Notes for sensor history:*

*Pressure*

*1222 – low by ~-0.2db – no plan to recalibrate*

*0443 – high by ~1.1db – plan to subtract 1.1db.*

*Conductivity*

*3394 – salinity likely within ±0.005psu but very limited sampling and likely flushing effects; no recalibration applied. Chosen for archive*

*3321 – bad temperature sensor; no comparison done*

*2754 – Based on COMPARE - High by 0.0018; limited sampling and likely flushing effects; no recalibration applied. Chosen for archive.*

*1766 – Based on COMPARE - Low by 0.0015; limited sampling and likely flushing effects*

*Oxygen-Dissolved*

*4367 – very few data and limited depths; estimate low by 3%*

*4372 – few data and limited depths; estimate low by 2.2%*

##### 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 and imperfect matching of levels.

Since there were so few samples, the usual method for comparing downcast data to upcast bottles was not used. Instead DO values were found in the edited files to match the pressures of the samples considered most reliable. The differences were within the expected range. To get a better idea of how accurate the sensor is in shallower water, values were chosen from the surface and 100db. Gradients are larger, so as expected, differences between CTD and bottles are larger, but similar to those found from cruises with more extensive sampling.

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

 ±0.30 mL/L from 0-200db

 ±0.10 mL/L from 200db to 300db

 ±0.05 mL/L below 300db.

The data for this comparison are included in tab “Downcast-recal study” in file 2024-001-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. There are some small unstable features but from this complex region of intersecting narrow channels and active mixing they may well be real.

Profile plots were examined to see if there any problems. None were found.

##### 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.

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 and Flag:Prediction.

HEADER EDIT was used to fix formats and channel names and to add the 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. No problems were found.

##### Dissolved Oxygen Study

As a final check of dissolved oxygen data, % saturation was calculated and plotted. Given the wide variety of environments sampled it is not surprising that values at 2m ranged between 60% and 160%. This study is not very useful in inshore waters.

##### Final Bottle Files

MRGSORT was run to get files in pressure order.

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.

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.

HEAD EDIT was run to add comments to the headers.

Data were exported from the CHE files to file 2024-001-bottles-final.xlsx. The entries were compared with the compiled sampling document and no data were found to be missing.

A Header Check and Standard Check were prepared and no problems were found.

The track plot looks ok.

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

##### Thermosalinograph processing

There were 9 thermosalinograph files.

The XMLCON files used were identical, so one was saved as 2024-001-tsg.xmlcon.

There were no loop samples, flow meter or intake thermistor.

The intake is at about 2m. The only method to check calibration is to compare with the CTD casts.

a.) Checking calibrations

The configuration file parameters were checked and are correct.

b.) Conversion of Files

The file was converted to CNV format.

The file was converted to IOS HEADER format.

CLEAN was run to add End times and Longitude and Latitude minima and maxima to the headers.

ADD TIME CHANNEL was used to add Time and Date channels.

Time-series plots were produced but there were many plots making it awkward to interpret due to the many breaks, so the 9 ATC files were joined into a single file 2024-001-0001.join. The time-series plots looked good. The temperature and salinity look spike-free and have good resolution.

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

c.) Checking Time Channel

* The CTD files were thinned to reduce the files to a single point from the downcast within 0.5db of 2db. These were exported to a spreadsheet which was saved as 2024-001-tsg-ctd-comp.xlsx. There were 85 CTD casts with 2m data available that overlapped with TSG data. The TSG files were averaged over 2 minutes with standard deviations included. They were opened in EXCEL and reduced to the times of CTD casts. Those data were added to 2024-001-tsg-ctd-comp.xls.
* 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 both 0.0000º with a maximum difference of 0.0006º. So the TSG times and positions of both systems are accurate.

d.) Comparison of Temperature and Salinity from TSG and CTD data

The spreadsheet was then used to look at the accuracy of the TSG. As expected, the standard deviations are generally extremely high so most casts were not useful. Time-series plots show the steadiest data came while the ship was underway.

When all data were included the TSG temperature was found to be higher than the CTD by an average of 0.061Cº but the median showed it lower by 0.439Cº. Similarly the average and median of salinity differences were vastly different.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| All casts | lat diff | long diff | Ttsg-Tctd | SALtsg-SALctd |
| average | 0.0000 | 0.0000 | 0.0614 | -1.2662 |
| median | 0.0001 | 0.0000 | 1.4397 | 3.0372 |
| stdev | 0.0001 | 0.0001 | 0.4190 | 2.0360 |
| max | 0.0004 | 0.0003 | 0.8755 | 0.0557 |
| min | -0.0001 | -0.0006 | -1.2013 | -9.5600 |

The data set were reduced by first picking 20 casts with the lowest standard deviation in temperature. Then 5 of those were removed based on high standard deviation in salinity.

The results then look a little more reasonable. Having temperature in the lab higher by about 0.26C° is reasonable for the Vector based on use in the past. The salinity difference is still highly variable. With such high variability in the salinity traces there may be an issue of time lag, though the effect on salinity should be random. There is also the issue of variability in the effect of bubbles in the loop.

|  |  |  |
| --- | --- | --- |
| 15 casts with low Std Dev in Temp and Sal | Ttsg-Tctd | SALtsg-SALctd |
| Average | 0.2590 | -0.0334 |
| Median | 0.2633 | -0.0093 |
| Std Dev | 0.0748 | 0.0623 |
| Max | 0.4149 | 0.0121 |
| Min | 0.0970 | -0.1970 |

Given the possible sources of error the salinity difference does not look unreasonable, but too variable to suggest recalibration.

For temperature it would be reasonable to create a proxy for intake temperature by subtracting 0.26C°.

A brief check was made to see if there was an obvious lag between features in salinity and temperature, but no consistent relationship was found.

See 2024-001-tsg-ctd-comp.xls for details.

Calibration History

This TSG was recalibrated shortly before this cruise.

In previous VECTOR use in summer, heating in the loop was estimated to be about 0.2C° but in March and further north it is expected to be higher as it is inversely related to intake temperature.

Salinity is generally low in the lab but that is more likely due to bubbles than calibration drift. There is too much variability to consider recalibration; it should just be kept in mind that it is reading low, on average.

Conclusions

1. The TSG time is accurate.

2. The TSG lab temperature was higher than the CTD temperature by roughly 0.26Cº but variability was high. Based on history recalibration by subtracting 0.26Cº is justified.

3. The TSG Salinity is low but the difference is too variable to justify recalibration.

f.) Editing

No editing was needed.

REMOVE was used to remove the following channels: Scan Number and Flag channels.

g.) Recalibration

Add Channels was used to add Channel Temperature:Lab with values set equal to Temperature:Primary.

Calibrate was run using file 2024-001-tsg-recal1.ccf to subtract 0.26Cº from Temperature:Primary.

h.) Preparing Final Files

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.

The TSG sensor history was updated.

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

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

**Particulars -**

9. File saved as event 9 should be 10. Renamed.

11. Prior to this event CTD was swapped to #0443 due to T sensor. Also swapped C2 sensor cable from primary CTD to secondary CTD due to faulty cable on secondary CTD.

11. NMEA not activated in con file. SeaPoint fluorometer 2228 looks bad.

12. SeaPoint fluorometer 2228 looks bad. No spare cable available. Pumps Off throughout – not processed for archive!

13. SeaPoint fluorometer changed to S/N 4186. Looks good. Altimeter didn’t kick in due to aft lead on cable on the sill.

14. Didn’t trust altimeter. Deck pressure 0.9db

34. Changes to sample IDs due to overestimate of depth.

31. Deck pressure 0.7db.

36. Deck pressure 0.8db.

47. Deck pressure 1.0db.

52. Changes to sample IDs – missed 2nd at 50m.

65. Stopped acquisition at 10m upcast – retrieval issues

66. Deck pressure 1.2db.

67. Started deeper than usual to not shock load on cable.

71. Sounder showing 290-305m. Very steep bottom topography; did not trust the altimeter readout.

76. Bottle 12 did not close.

83. Sounder bit jumpy.

85. Very extensive oil sheen on surface, lot of debris.

87. Lot of freshwater at surface; variable conductivity.

96. Ship sewage release on station.

97. Deck pressure 1.4db.

103. Huge phytoplankton bloom also seen in nets. Slight slick on surface waters, likely natural.

104. Possible galley discharge during station.

110. Ship sewage release on station.

**2024-001 CRUISE SUMMARY – CTD**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CTD#** | **Make** | **Model** | **Serial#** | **Used with Rosette?** | **CTD Calibration Sheet Competed?** |
| **1** | **SEABIRD** | **911+** | **1222** | **Yes** | **Yes** |
| **2** | **SEABIRD** | **911+** | **0443** | **Yes** | **Yes** |
| **Calibration Information - 1222** |
| **Sensor** | **Pre-Cruise** | **Post Cruise** |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **2710** | **7Mar2023** | **Factory** |  |  |
| **Conductivity** | **3394** | **28Feb2023** | **Factory** |  |  |
| **Secondary Temp.** | **2668** | **01Feb2023** | **Factory** |  |  |
| **Secondary Cond.** | **3321** | **18Jan2023** | **Factory** |  |  |
| **Transmissometer** | **1201DR** | **11Jan2024** | **IOS** |  |  |
| **Transmissometer** | **1883DG** | **11Jan2024** | **IOS** |  |  |
| **SBE 43 DO sensor** | **4367** | **27Mar2023** | **Factory** |  |  |
| **SeaPoint Fluor.** | **4186** | **Aug 2023** | **Factory** |  |  |
| **WetLabs ECO Fluor** | **2216** | **8Mar2017** | **Factory** |  |  |
| **Pressure Sensor** | **1222** | **17Mar202** | **Factory** |  |  |
| **Valeport Altimeter** | **76341** | **10Feb2021** | **Factory** |  |  |
| **Calibration Information - 0443** |
| **Sensor** | **Pre-Cruise** | **Post Cruise** |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **2106** | **15Feb2023** | **Factory** |  |  |
| **Conductivity** | **2754** | **14Feb2023** | **Factory** |  |  |
| **Secondary Temp.** | **5130** | **18Mar2023** | **Factory** |  |  |
| **Secondary Cond.** | **1766** | **18Jan2023** | **Factory** |  |  |
| **Transmissometer** | **1201DR** | **11Jan2024** | **IOS** |  |  |
| **Transmissometer** | **1883DG** | **11Jan2024** | **IOS** |  |  |
| **SBE 43 DO sensor** | **4372** | **27Mar2023** | **Factory** |  |  |
| **SeaPoint Fluor.\*** | **2228** | **Jan 2019** | **Factory** |  |  |
| **SeaPoint Fluor.\*\*** | **4186** | **Aug 2023** | **Factory** |  |  |
| **WetLabs ECO Fluor** | **2216** | **8Mar2017** | **Factory** |  |  |
| **Pressure Sensor** | **0443** | **23Mar2022** | **Factory** |  |  |
| **Valeport Altimeter** | **76341** | **10Feb2021** | **Factory** |  |  |

* Events 11-12

\*\* Events 13-110Plots exclude Event #1 in Saanich Inlet



Plots exclude Event #1 in Saanich Inlet



