## REVISION NOTICE TABLE

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| DATE | DESCRIPTION OF REVISION |

## PROCESSING NOTES

Cruise: 2022-025

Agency: OSD

Location: 2

Project: Sharing Science at Sea Leg 2

Chief Scientist: Page S.

Platform: Sir John Franklin

Date: 20September 2022 – 2 October 2022

Processed by: Germaine Gatien and Hana Hourston (RBR)

Final Processing: 27 March 2023 – 6 April 2022

Number of HEX files: 36 Number of CTD files processed: 35 (Cast #36 rejected – cast #38 is a rerun of #36)

Number of rosette files: 17 Number of bottle casts processed: 11 (6 had bottles fired but no sampling)

# INSTRUMENT SUMMARY

CTD #0585 was mounted in a rosette and attached were a Wetlabs CSTAR transmissometers (1201DR), a SBE 43 DO sensor on the primary pump (#1176), SeaPoint Fluorometer on the secondary pump (#2228) and an altimeter (#75321).

Seasave version 7.26.7.121was used for acquisition.

The deck unit was a Seabird model 11+ #1043.

The data logging computer was Nitro 5.

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

An IOS rosette with 24 10L bottles was used.

# SUMMARY OF QUALITY AND CONCERNS

The Daily Science Log Book and rosette log sheets were in good order with comments about problems encountered.

As noted during the previous use of this equipment on the Franklin, both temperature and conductivity channels were reasonably close during downcasts, but were unusually noisy during upcasts even when ascent rates of the CTD were very smooth. Fortunately, during stops for bottles, the noise disappears. While upcast data are always noisier when a rosette is in use, it seems worse on the Franklin than on other ships.

There were only 2 casts with dissolved oxygen calibration sampling and most samples were flagged due to air in samples; the analyst warned that “the data should be used with some caution”. There were also many local reversals in DO profiles. The comparison of SBE DO and titrated samples was thus too limited to produce a reliable recalibration scheme. The same equipment was used for cruise 2022-067, so the recalibration applied then was also applied to channel Oxygen:Dissolved:SBE for this cruise. Differences between samples and recalibrated Oxygen:Dissolved:SBE were mostly <0.2mL/L and below 500m differences they were <0.025mL/L.

The fluorometry channel was removed since values were extremely low; the sensor clearly malfunctioned. In previous uses this sensor was thought to have the wrong gain cable and values were multiplied by 10X which produced reasonable results. For this cruise values were low by even more than that and there is photographic evidence that the gain cable had been recorded correctly. Processed files with fluorescence were created and may be obtained by request.

# PROCESSING SUMMARY

##### Seasave

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

##### Preliminary Steps

* The configuration files used at sea was checked. There is some confusion about the fluorescence gain. During previous cruises using this fluorometer and also said to have a 10X gain, the resulting values were very low compared to extracted chlorophyll, but consistent with a 1X gain. For this cruise there are photos of the gain cable which is clearly labelled 10X. A check was made and the cable is indeed labelled properly. So the fluorometer has malfunctioned.
* One file was saved as 2022-025-ctd.xmlcon.
* The Log Book and rosette log sheets were obtained. They were in good order with useful comments.
* Dissolved oxygen, extracted chlorophyll, nutrient and salinity data were obtained in QF spreadsheet format from the analysts.
* The cruise summary sheet was completed.
* The history of the sensors was checked and all were used during 2022-002, 2022-015 and 2022-067. It was also used for 2022-075 shortly after this cruise.

##### BOTTLE FILE PREPARATION

The ROS files were created using file 2022-025-ctd.xmlcon.

They were converted to IOS Header format with extension \*.IOS.

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

Temperature and salinity were plotted for all BOT files to check for outliers. CTDEDIT was used to remove a few spikes in both salinity channels.

A preliminary header check was run; no problems were noted except that fluorescence is very low.

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 log notes some cases where bottles were fired but not sampled; they were removed from the ADDSAMP files.

Cast #64 had 24 bottles fired but one had no sample #s; it was removed from the ADDSAMP file.

Files with bottle firing but no samples taken were removed from the list of files to be processed.

The ADDSAMP file was sorted on sample numbers.

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 2022-025-bot-hdr.txt which will be updated as needed during processing.

DISSOLVED OXGYEN

Dissolved oxygen data were provided in spreadsheet QF2022-025\_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 2022-025oxy.csv. That file was converted into individual \*.OXY files.

There were no samples in the DO file that had comments starting with “ALL:”.

SALINITY

Salinity analysis was obtained in file QF2022-025\_SAL.xlsx; there were few duplicates so there is no precision study. The analyses were carried out in a temperature-controlled lab within 70-79 days of collection. The files were simplified and saved as 2022-025sal.csv. That file was then converted to individual SAL files.

EXTRACTED CHLOROPHYLL

Extracted chlorophyll and phaeo-pigment data were obtained in spreadsheet QF2022-025\_CHL QF\*.xlsx which included comments and flags and a precision study. A simplified version of the spreadsheet was prepared and saved as 2022-025chl.csv. The csv file was then converted to individual CHL files.

NUTRIENTS

The nutrient data were obtained in spreadsheet QF2022-025\_NUTS\*.xlsx. This includes a precision study. The file was simplified, saved as 2022-025nuts.csv. The file was converted to individual NUT files.

The SAL, CHL, OXY and NUT 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.

The output of the MRG files were exported to a spreadsheet and compared to the rosette log sheets to look for omissions. No problems were found.

##### Compare

Salinity

Compare was run with pressure as reference channel.

There were 54 bottles between 1m and 2013m. Most were shallow and some were from near the bottom of casts. Bottles were removed where pressure was <100db as well as a few outliers from the bottom of casts. This led to fairly flat fits with the primary salinity low by 0.0098psu and the secondary low by 0.0044psu. Standard deviations were 0.0020psu for both. These differences are both larger by 0.002psu from the previous 2 cruises, but similar to the cruise that followed, though there were few bottles in the later comparison.

Below 500m when 2 outliers are removed the differences are similar with the primary low by 0.0102psu and the secondary by 0.0050psu with standard deviations of 0.001psu. There are only 12 samples in that fit.

There was a long wait before analysis so bottle values may be a little high, making CTD salinity look lower than it really is. Flushing of Niskin bottles may also be incomplete which would have the same effect, but waits were long before bottles were closed and the 2 deep casts had noisy descent rates and low gradients, so flushing errors should be small.

During the cruise that followed the differences were similar. For that cruise the wait for analysis was shorter but errors due to incomplete flushing are likely larger. Those 2 differences would be offsetting, to some extent.

A correction of +0.008 for the primary salinity and +0.002psu for the secondary looks appropriate.

For full details for the COMPARE run see file 2022-025-sal-comp1.xls.

Dissolved Oxygen

COMPARE was run with pressure as the reference channel.

There were just 2 casts during which DO samples were taken.

Using all bottles, except for 2 excluded based on residuals, the fit is:

CTD DO Corrected = CTD DO \* 1.0835 + 0.0491

For all samples from cast #59 and the deepest bottles from cast #64, the analysts applied 3 flags with the comment:

 “All Samples had air in them prior to analysis. The samples all had water seals but their past conditions prior to the analysis was unknown.”

The analyst advised that the analysis data be used with caution.

There is no notable difference between fits for the 2 casts when the same outliers are excluded though the offsets differ by 0.008mL/L:

CTD DO Corrected = CTD DO \* 1.0835 + 0.0454 Cast #59

CTD DO Corrected = CTD DO \* 1.0831 + 0.0537 Cast #64

CTD DO Corrected = CTD DO \* 1.0852 + 0.0450 Cast #64 excluding samples flagged 3 (No DO<1.4mL/L in fit.)

Given that air in the samples might lead to higher DO thus making the CTD DO look lower than it should, and all samples near the origin were flagged for that problem, the offset may be larger than it would be if there were no air. So a fit was done of the bottles not flagged 3 with the offset forced to = ‑0.0255mL/L, the offset found during 2022-067. The resulting fit was:

CTD DO Corrected = CTD DO \* 1.0895 + 0.0255 Cast #64 excluding samples flagged 3 and offset forced to =-0.0255

During 2022-067 there were 5 samples taken at very low oxygen and the differences varied from -0.024 to -0.032.

So there is some evidence that the slope from the fit using both casts is a little low; the air in samples may be a small problem.

Cruise 2022-075 which followed this one and used the same equipment had no sampling with DO<1mL/L, so it offers no evidence on the appropriate offset. As well, most casts were in inlets where incomplete flushing is likely to occur, which tends to make the CTD DO values look more accurate than they really are. When just the 2 casts that were in more open water were included and the offset forced to = 0.0255, the fit was:

CTD DO Corrected = CTD DO \* 1.0915 + 0.0255

This is weak evidence, but further suggests that using the 2022-067 results are more appropriate for both 2022-025 and 2022-075.

So recalibration will be applied by using:

CTD DO Corrected = CTD DO \* 1.0939 + 0.0255

There were no extreme outliers.

For full details for the COMPARE run see file 2022-025-dox-comp1.xls.

Plots of Titrated DO and CTD DO against CTD salinity were examined. No further outliers were found.

Fluorescence

COMPARE was run with pressure as the reference channel.

The CTD fluorescence was much lower than Extracted Chlorophyll samples, the ratio FL/CHL being about 10X lower than expected for all levels of CHL. When CHL ranged from 1 to 4ug/L we usually see a ratio of ~1, but for these data the average was 0.17.
In 3 previous cruise using this fluorometer, values were thought to be low by about 10X and it was thought that the gain cable must not have been what was entered in the configuration file. But for this cruise a photo is available of the cable and it is 10X. So the problem must be with the fluorometer.

This channel will be kept in the files through most processing steps but will be removed from files to be archived. So data will be available if anyone requests it in order to see the profiles. Values are not reliable.

For more detail see file 2022-025-fl-chl-comp1xls.

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

All files were converted using 2022-025-ctd.xmlcon.

The Tau function was selected and the hysteresis function since there was sampling below 700m. Depth was included in the conversion.

A few casts were examined.

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 for these data they are noisier than usual. Fortunately, the noise stops during bottle stops. This feature seems common on Franklin cruises.

The descent rate is generally high with variable noise levels -very steady rates in inlets and very noisy with some complete reversals of the CTD in more exposed waters.

The transmissivity, DO and altimetry traces look normal. Fluorescence is extremely low.

##### 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.

There is no obvious difference in profiles after this step, but the only spikes noted before this step contained many records.

##### 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.

Plots were examined to determine if the previous steps had worked well. It is difficult to judge because the upcast temperature is so noisy, but the DO data look better aligned after this step than before and the upcast/downcast correspondence in a T-S plot appeared to be slightly improved.

DERIVE was run a second time on 3 casts deeper than 500m to find the differences between the pairs of temperature, conductivity and salinity channels. Data are included from the 3 previous cruises since the last factory calibration; 2022-067 had no sampling deeper than 600m..

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cast # | Press | T1-T0  | C1-C0 | S1-S0 | Descent Rate |
| 2022-002-0058 | 1000 | +0.0002 | +0.00031 | +0.0035 | High, XNoisy |
|  | 1900 | +0.0001 | +0.00025 | +0.0030 | “ |
| 2022-0002-0065 | 1000 | +0.0002 | +0.00030 | +0.0037 | High, XNoisy |
|  | 1900 | +0.0002 | +0.00027 | +0.0032 | “ |
| 2022-002-0142 | 1000 | +0.0001 | +0.00033 | +0.0040 | High, XNoisy |
|  | 1900 | +0.0002 | +0.00029 | +0.0033 | “ |
| 2022-015-0046 | 1000 | +0.0002 | +0.00040 | +0.0047 | High, Very Noisy |
|  | 1900 | +0.0002 | +0.00035 | +0.0041 | “ |
| 2022-015-0048 | 1000 | +0.0001 | +0.00040 | +0.0048 | High XNoisy |
|  | 1900 | +0.0000 | +0.00036 | +0.0043 | “ |
| 2022-015-0057 | 1000 | +0.0001 | +0.00043 | +0.0051 | High, VNoisy |
| 2022-015-0077 | 1000 | +0.0002 | +0.00045 | +0.0052 | High, Moderate |
| 2022-067-0008 | 600 | +0.0002 | +0.00067 | +0.0072 | High, Steady |
| 2022-067-0066 | 300 | +0.0001 | +0.00063 | +0.0066 | High, Steady |
| “ | 400 | +0.0001XN | +0.00063 | +0.0064 | “ |
| “ | 600 | +0.0002 | +0.00061 | +0.0072 | “ |
| 2022-067-0075 | 400 | +0.0003 | +0.00055 | +0.0054 | High, Steady |
| 2022-067-0106 | 400 | +0.0003 | +0.00048 | +0.0050 | High, Steady |
| 2022-067-0119 | 500 | +0.0002 | +0.00067 | +0.0073 | High, Moderate |
| 2022-067-0143 | 400 | +0.0002 | +0.00047 | +0.0045 | High, Moderate |
| 2022-067-0206 | 300 | +0.0002 | +0.00037 | +0.0038 | High, Steady |
| 2022-025-0059 | 500 | +0.0003 | +0.00052 | +0.0056 | High, Noisy |
|  “ | 1000 | +0.0003 | +0.00047 | +0.0051 | “ |
|  “ | 1800 | +0.0003 | +0.00042 | +0.0047 | “ |
| 2022-025-0062 | 500 | XN | +0.00051 | XN | High XNoisy |
|  “ | 1000 | +0.0001 | +0.00050 | +0.0058 | “ |
|  “ | 1800 | 0 | +0.00043 | +0.0054 | “ |
| 2022-025-0064 | 500 | +0.0001 | +0.00052 | +0.0058 | High, VNoisy |
|  “ | 1000 | +0.0001 | +0.00049 | +0.0058 | “ |
|  “ | 1800 | +0.0001 | +0.00044 | +0.0052 | “ |

Temperature differences vary little and are similar to previous cruises. Conductivity and salinity differences are appear to have risen slowly and steadily with time. Salinity differences appear to have some pressure dependence though without more deeper sampling this is hard to judge.

Cast #62 differences extremely noisy to about 850db ad then very quiet. The salinity differences from COMPARE were ~0.0052psu while the CTD was stopped for bottles. So the 2 results are close.

From cruise 2022-067 there was some evidence that the primary conductivity calibration was drifting with time, and that it might have more pressure dependence.

##### Conversion to IOS Header Format

The IOSSHELL routine was used to convert Sea-Bird 911+ CNV files to IOS Headers.

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

##### Checking Headers

* The cross-reference check was run. No problems were found.
* Cruise tracks were plotted and were added to the end of this report.
* The header check was run and showed pressures got as low as -1.4db.
* Surface check was run and found an average of 0.5db after the 10db soak, so the CTD would have been in water.
* During 2022-067 the CTD was kept running as the CTD left the water. Pressure readings at the end of casts ranged from about 0 to -1db, with a mean of -0.5db. The files were put through REVERSE and a surface check was made. This enabled plotting of surface pressure versus maximum cast pressure; this showed clearly that there was some hysteresis in the pressure. The deepest casts had surface readings ~ -1db while shallow casts trended towards about ~0.2db; no readings were <-1db. So, the error due to hysteresis is <1db which is the expected accuracy for this sensor. For the downcast the error is likely considerably smaller. No recalibration was needed.
* The CTD was also kept running as it left the water at the end of casts for this cruise as well. The CLN files were put through REVERSE and a surface check run on those files; the average pressure as the CTD was turned off was -0.5db with a range of -1.2 to +1.5db. Only 2 casts had positive final pressures and likely those were turned off in water. Excluding those 2 the average pressure as the CTD was turned off was -0.6db. When plotted against maximum pressure a similar result was obtained as during 2022-067 though with fewer data and most above 500m. It appears that the hysteresis error in pressure for shallow casts is about -0.3db increasing to between -0.6db and -1.2db for deep casts. So for the shallowest casts the error would be minimal and even for the deepest it should be <‑0.5db for the downcasts. 1db is the expected accuracy for this instrument.
* Water depth header entries were checked. Header values for altimetry and water depth were exported to file 2022-025-altimeter-ctd.xlsx. A “check value” was calculated as follows:

Check Value = Absolute Values {(Altimetry header-1) + Max. depth sampled - Water depth in Header}

This value is expected to be close to 0, but with sites close to shore and many in inlets with steep slopes, larger check values are common.

There were 9 cases where the check values was >5m. For 1 the entry in the header did not match the log. For 3 the differences were between 5 and 7m and in inshore areas where rapid change in depth is likely. For 4 the differences were larger, 9m to 16m. They were all deep casts and offshore where such large variations are less likely. Either the pressure sensor or the sounder likely have some error that is more significant at depth. While small errors in the CTD pressure are possible, errors of this size are more likely to be in the sounder readings. It is a problem that the log readings entered for the beginning, bottom and end of the casts are identical, so we have no indication of whether drift might account for the higher check values.

Knowing the depth when the bottom is reached is the most valuable for users.

The check value was entered in the header of CLN files for casts #53, 59, 62, 64 and the log value for cast #15, and the SAMAVG files for #59 and 62.

##### 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.

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 3 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 settings were -0.6 records for the primary and -0.1 records for the secondary conductivity.

SHIFT was run twice on all SBE911 casts 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 –

* During 2022-002 pressure was thought to be reading low by 0.6db.The primary salinity was lower than bottles by 0.0052psu & secondary salinity lower by 0.0019psu; primary was recalibrated by adding 0.0033psu and was selected for archiving. Dissolved oxygen was recalibrated using slope/offset=1.0076/0.0507.
* During 2022-015 the DO calibration appeared to shift so 2 recalibrations were applied with slope/offset= 1.0158/0.0449 and 1.0726/0.0449 for the early and late casts, respectively. The primary salinity was low by 0.0072psu and the secondary was low by 0.0024psu. Fluorescence values were low by a factor of 10 due to an error in the configuration. Pressure looked good.
* During 2022-067 the pressure was found to be within 0.5db. Primary salinity was low by 0.0081psu and secondary low by 0.0024psu. Secondary salinity was selected for archiving. Dissolved oxygen was recalibrated using slope/offset=1.0939/0.0255.

Historic ranges – Profile plots were made with 3-standard deviation climatology ranges of T and S superimposed. Many of the sites are likely not well represented in the climatology being near-shore and/or inlets. Below 100m many of those near-shore casts had temperatures below the climatology minimum and salinity above the minimum All the offshore casts fit within the climatology

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

##### DETAILED EDITING

The decision on which channel pair to use was not clear. The secondary salinity is closer to bottles and the primary salinity shows some sign of calibration drift, but the secondary salinity had more unstable features in T-S space, especially late in the cruise in deep water. Much more data would be lost in editing the secondary than the primary, so primary data will be chosen for editing and eventual archiving.

CTDEDIT was used to remove records that appear to be corrupted by shed wakes or ship effects and to clean salinity where small spikes appear to be due to small misalignment or instrumental noise. For many of the casts data was acquired at the surface while the pumps were off, so such records were removed.

All casts required editing except for event #35.

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 near-shore and some likely in areas of tidal mixing.

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

No correction is needed to silicate since all salinity values in bottle files were >31psu.

No correction is needed to pressure.

Salinity will be corrected by adding 0.008psu to the primary salinity and 0.002psu to the secondary, though it is expected that the secondary will not be archived.

The fit found in the dissolved oxygen comparison had a lower slope than found for the casts before and after it. The analyst had flagged most of the samples due to the presence of air in the samples. Both this cruise and the previous one included values with DO<<1mL/L. The offsets differed by 0.024mL/L, with the CTD closer to bottles for the earlier cruise. When the same offset was applied to the unflagged samples from this cruise, a similar slope was found. The correction used for 2022-067 will be applied to the 2022-025 data.

File 2022-025-recal1.ccf was prepared to add 0.008psu to Salinity:T0:C0 and add 0.002 to Salinity:T1:C1 and to apply the following correction to channel Oxygen:Dissolved:

CTD DO Corrected = CTD DO \* 1.0939 + 0.0255

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

COMPARE was rerun and shows that the corrections were applied properly

When 3 major outliers were excluded, the primary salinity was low by 0.0015psu and the secondary low by 0.0029psu. While still low, that amount can be due to delayed analysis.

SBE DO was found to be high by an average of 0.0063mL/L with a standard deviation of 0.025mL/L when the same outliers were excluded as in fit. However, when only the unflagged samples were included it is high by an average of 0.016mL/L with a standard deviation of 0.020mL/L. This is higher than usual, but is based on very few points, most of which come from the above 200m where differences are always larger than average.

Calibrate was then run the EDT files.

##### 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.

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 recalibrated downcast CTD DO data and the titrated samples from upcast bottles.

There are too few bottles in the comparison to make an estimate of accuracy of the CTD DO, especially in light of the many SBE DO inversions near the surface. Moreover, the presence of air in most samples further limits reliability.

Excluding one clear outlier, all differences fall with ±0.4mL/L and those below 500db within 0.09mL/L.

Above that there is a lot of scatter as is expected because the profiles have many DO inversions in the top 600db of one cast and the top 200db of the other. Most differences are within 0.2 mL/L.

For more detail see file 2022-025-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. A problem was noted in cast #36; data had been removed from the bottom of the cast due to the pumps turning off. But dissolved oxygen data are bad above the point where that happened because of how DO concentration is derived. The log has a note about cast #38 being a “re-do” of cast #36 due to bad DO data. So cast #36 will not be archived.

There are some near-surface unstable features but this is expected from near-shore and inlet casts; such features may be real.

##### 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:

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

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.

Files CTD-FL were prepared. They contain the files from before REMOVE, so include fluorescence. A header was run to warn users that the sensor malfunctioned. The files contain all channels.

The sensor history was updated.

##### 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 92% and 126%. The casts from offshore of the shelf break were between 97% and 106% which is typical of such areas.

##### Final Bottle Files

MRGSORT was run to get files in pressure order.

A second SBE DO channel with mass units was added for both the CTD DO and titrated DO.

REORDER was run to get the pairs of DO channels together.

REMOVE was run to remove the following channels: Fluorescence:URU:Seapoint, Scan\_Number, Temperature:Primary, Conductivity:Primary, Oxygen:Voltage:SBE, Descent\_Rate, Status:Pump, Altimeter, Salinity:T0:C0 and Flag.

HEAD EDIT was run to fix some header entries, add comments to the headers and to ensure formats and units are correct.

Files CHE-FL were prepared. They contain the files from before REMOVE, so include fluorescence. A header was run to warn users that the sensor malfunctioned. The files contain all channels.

Data were exported from the CHE files to file 2022-025-bottles-final.xlsx. The entries were compared with the rosette log sheets and no data were 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.

##### Comparison between with Park Canada RBR CTD attached to rosette with SBE911+ CTD

During cruise 2022-025 there were 6 casts during which the RBR was strapped to the rosette.

SBE and RBR CTD files for those 6 casts were obtained and SBE DO converted to % saturation.

An initial examination of the data were made in a spreadsheet but variability was complex. It was clear that data from late in the cruise looked different from early in the cruise but the last 2 casts were much deeper, so determining whether the shift was due to time or pressure was difficult.

So the data were thinned so they could be studied using COMPARE which only allows a maximum of 50 records per file. Since differences close to the surface tended to be out of line, data were thinned to 4m and then every 5m. Comparisons were made of temperature, salinity and dissolved oxygen saturation.

An initial examination confirmed that the results from events #17 and #18 were different from events #11, 12, 14 and 15. A plot of temperature profiles shows very different conditions. The first 4 of these events are in shallow water, and fairly well mixed vertically. Events 17 and 18 have much higher vertical gradients above 80m. Event #17 is of a similar depth to event #12 but has a much larger vertical gradient. Salinity profiles show a similar pattern with higher variability for the latter 2 events. The descent rate of the CTD is very similar for all these casts, high and steady.

A summary of COMPARE results:

Temperature

The RBR temperature is generally higher than the SBE temperature but differences are very small at low gradients, mostly <0.003C° below 80m. The cases with larger differences almost all include the RBR reading much higher than the SBE and most of the large differences are from the last 2 events. The vertical gradients were very high for those 2 events, so this may indicate that the RBR has a slower response, but given the way it was mounted it may also be affected by shed wakes carrying water from above, raising the temperature and there may be small mismatches between the pressure matches.

Salinity

The RBR salinity is higher than the SBE Salinity by roughly 0.02psu at most depths for the first 4 casts. For the last 2 events the differences are on the order of 0.02 in the top 20db but increase to about 0.03psu below that. The results below 30m are steady for the first 4 and below 100db are steady for the 2nd group. The fact that the differences increase when the local gradient decreases might suggest there is some effect of shed wakes on the RBR in shallower water, lowering salinity. The vertical salinity gradient is very low for cast #12, so response time should not be an issue and shed wakes should not cause a large difference. For cast #18 the vertical gradient at depth is a little larger, so we might expect slow response or shed wakes to lower the RBR salinity, but instead it is higher relative to the SBE. So it is possible there was some change in the sensor between the two areas.

Dissolved Oxygen Saturation

The RBR dissolved oxygen saturation is lower than that from the SBE sensor by about 3.4% for the first group and 2.6% for the second group, with a lot of noise near the surface for the 2nd group. Some of the difference is likely due to different temperature input.

Fluorescence

Unfortunately, the SeaPoint fluorometer malfunctioned producing very low values. So there is no comparison of value to be made. There were 4 chlorophyll samples available from one of the casts, #17. The RBR fluorescence ranges from 51 to 78% of the extracted chlorophyll values. The chlorophyll came from the upcast while stopped, while the RBR were taken from the downcast. The surface samples do not match in pressure. Upcast data were checked but were too noisy for a reasonable check except at 21m where the RBR value was about 2ug/L, so closer to the chlorophyll sample than it appears in the chart below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| RBR Press | RBR FL | CHL Press | CHL | RBR/CHL |
| 2.2 | 6.18 | 1.2 | 9.13 | 0.68 |
| 5 | 1.42 | 4.9 | 1.83 | 0.78 |
| 9.9 | 0.65 | 10.5 | 1.17 | 0.56 |
| 21 | 0.97 | 20.6 | 1.9 | 0.51 |

There are limits to accuracy of all the sensors. There was limited calibration sampling for the SBE sensors. The temperature differences could be due to how the RBR was mounted. The temperature in deep, low-gradient waters is very close to SBE temperature. The RBR salinity is likely reading high by ~0.03psu. It may have drifted with time. Fluorescence looks reasonable. For dissolved oxygen there are errors possible in both sensors, but the 2 are generally within 3% of each other, with the RBR lower.



**Particulars - Mainly notes from log of concern in processing + some notes on processing**

* + - 1. Test cast. All bottles tripped at 9m, no sampling.

4. Sample 21C taken from bottle 15, not homogenous with other SPC samples.

7. Bottle fired as demo for filming – labelled 7.

7, 9, 47, 51, 52 – bottles fired but no samples taken.

11, 12, 14, 15, 17, 18. Parks RBR attached to frame.

25. Wrong times for start and bottom – presume refers to log, not file.

37. Redo, got an odd interruption where the pump turned off and the O2 sensor went wild. Might be the UHF radio.

**2022-025 CRUISE SUMMARY – CTD**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CTD#** | **Make** | **Model** | **Serial#** | **Used with Rosette?** | **CTD Calibration Sheet Competed?** |
| **1** | **SEABIRD** | **911+** | **0585** | **Yes** | **Yes** |
| **Sensor** | **Pre-Cruise** | **Post Cruise** |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **2449** | **28Jan2021** | **Factory** |  |  |
| **Conductivity** | **1764** | **01Feb2021** | **Factory** |  |  |
| **Secondary Temp.** | **4484** | **02Feb2021** | **Factory** |  |  |
| **Secondary Cond.** | **2128** | **02Feb2021** | **Factory** |  |  |
| **Transmissometer** | **1201DR** | **17Feb2022** | **Factory** |  |  |
| **SBE 43 DO sensor** | **1176** | **04Feb2021** | **Factory** |  |  |
| **SeaPoint Fluor.** | **2228** |  | **Factory** |  |  |
| **Pressure Sensor** | **0585** | **17Feb2021** | **Factory** |  |  |
| **Valeport Altimeter** | **75321** | **23Sept2020** | **Factory** |  |  |

