## REVISION NOTICE TABLE

|  |  |
| --- | --- |
| DATE | DESCRIPTION OF REVISION |
|  |  |
| 18 March 2025 | Updated channel names & formats in TOB and Loop files. Added position info to header. G.G. & SH |
| 18 July 2024 | Added DIC & ALK to casts 8, 11, 19, 37, 57, 77. G.G. |

## PROCESSING NOTES

Cruise: 2021-008

Agency: OSD

Location: North-East Pacific

Project: Line P

Chief Scientist: Robert M.

Platform: John P. Tully

Date: 24 August 2021 – 7 September 2021

Processed by: Germaine Gatien

Date of Processing: 18 November 2021 – 11 January 2022

Number of original HEX files: 44 Number of processed CTD files: 44

Number of rosette casts: 41 Number of processed CHE files: 41

Number of original TSG files: 2 Number of processed TOB files: 13

# INSTRUMENT SUMMARY

CTD #0443 was mounted in a rosette and attached were 2 Wetlabs CSTAR transmissometer (1185DR & #1883DG), a SBE 43 DO sensor on the primary pump (#3791), SeaPoint Fluorometer on the secondary pump (#3950), a Biospherical QSP-400 PAR sensor (#70613) and an altimeter (#76341).

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

Seasave version 7.26.7.121 was used for acquisition.

The data logging computer WP #102.

The deck unit was a Seabird model 11+ #425.

A Guildline model 8400B Autosal serial # 68572 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 excellent order with comments about problems encountered and a detailed list of equipment. The sampling notes provided by the Chief Scientist were a big help in processing data. The rosette logs include indications of depths at which there were longer waits before bottles were closed. The decision on the length of waits before bottle firing were based on an assessment of the vertical gradients of dissolved oxygen and salinity as noted during the downcast.

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.

While CTD fluorescence data are expressed in concentration units, they do not always compare well to extracted chlorophyll samples, especially far from shore. It is recommended that users check extracted chlorophyll values where available. The CTD fluorescence data are lower compared to extracted chlorophyll than usually observed.

Both salinity channels were found to be reading much lower relative to bottle samples than in 3 previous cruises using the same equipment and a little lower than during the cruise that followed. Channel Salinity:T1:C1 was found to be lower than bottles by an average of 0.0055psu in deep water. Since delayed analysis and small errors due to incomplete flushing both would have led to bottle values being too high, no recalibration was applied to the CTD salinity. While confidence in the bottle comparison is lower than usual, it is likely that channel Salinity:T1:C1 is within ±0.003psu.

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 0-175db except in areas of very large DO gradients

 ±0.20 mL/L from 175db-300db

 ±0.04 mL/L below 300db

Experiments were run on some casts with extending waits before closing Niskin bottles to 60s in depth ranges where salinity and dissolved oxygen gradients were high. There were only 3 salinity samples gathered at those depths, though 2 of the 3 suggest that flushing of bottles might have been improved from what is expected with a 30s wait. There were 29 dissolved oxygen samples available with the longer waits. There are 2 large outliers associated with very noisy CTD DO data. The fit between 3ug/L and 5ug/L is encouraging but more data are required to decide if the extra time improves data significantly. Noisy CTD DO makes the picture hard to interpret but the outliers are not as far out of line as usual. There is always some scatter in our fits and flushing conditions will vary among cruises. After the data from 2021-012 are processed the picture might become clearer.

The Thermosalinograph system functioned well with lots of detail in the traces. There were some single-point spikes in salinity; as they are all towards lower values they are likely due to bubbles. The TSG salinity data were recalibrated by adding 0.346psu based on comparisons with CTD data and loop samples. This correction is much larger than was used for this TSG system for cruises from February to June 2021, but during the August cruise, 2021-069, there was great variability and an estimate was made that salinity was low by 0.03psu. So significant calibration drift may have occurred.

Loop chlorophyll and salinity samples compared well with 5m rosette samples.

# PROCESSING SUMMARY

##### Seasave

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

The chief scientist provided a summary of sampling protocols and problems.

The CTD deployment protocol was:

* The rosette was brought to the surface. Pumps were turned ON. The rosette was brought down to 10m and kept there for 30 seconds. Once back at the surface, the data started to be archived, with the rosette at the surface for 30 seconds longer. Then the cast would start.
* For most bottles there was a wait for 30 seconds before closing a bottle. For depths where vertical DO and Salinity gradients were large the wait was 60 seconds before closing. Note was made on the sampling log when waits were 60s.

##### Preliminary Steps

The Log Book and rosette log sheets were obtained as well as sampling notes from the Chief Scientist.

* Nutrients, extracted chlorophyll, dissolved oxygen, salinity, DMS and DMSP 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. he temperature, conductivity and dissolved oxygen sensors had been used on 4 other cruises since the last factory recalibrations. See section 14 for details.

Based on notes from the chief scientist some water depth and station names were changed in the raw files.

The configuration file was checked. All parameters were correct and the file was saved as 2021-008-ctd.xmlcon.

##### BOTTLE FILE PREPARATION

The ROS files were created using files 2021-008-ctd.xmlcon.

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.

The file for event 49 was opened in CTDEDIT and channel Salinity:T1:C1 was edited very lightly at a few points at Niskin #1. The output files were 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 only problem found was during Event 49 where a 2nd bottle was accidentally fired at 25m. Changes made to the Sampling Log were inaccurate. (The MRG file was checked later and samples had been attributed to the right Niskin bottles.)

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 2021-008-bot-hdr.txt which will be updated as needed during processing.

Loops samples were moved from the salinity, chlorophyll and nutrient CSV files to a combined loop data file for later use.

DISSOLVED OXGYEN

Dissolved oxygen data were provided in spreadsheet QF2021-008\_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 2021-008oxy.csv. That file was converted into individual \*.OXY files.

There was 1 sample in the DO file that had comments starting with “ALL:” The only other sampling planned for that bottle (sample 476) was for nutrients and DIC; the nutrient samples were flagged 3; DIC data were not yet available but the analyst was informed.

 EXTRACTED CHLOROPHYLL

Extracted chlorophyll and phaeo-pigment data were obtained in file QF2021-008\_CHL QF\*.xlsx. The file included comments and flags and a precision study. A simplified version of the spreadsheet was prepared and saved as 2021-008chl.csv. The csv file was then converted to individual CHL files.

SALINITY

Salinity analysis was obtained in file QF2021-008\_SAL.xlsx which included a precision study. The analyses were carried out in a temperature-controlled lab 68 to 75 days after collection. The files were simplified and saved as 2021-008sal.csv. That file was then converted to individual SAL files.

NUTRIENTS

The nutrient data were obtained in spreadsheet QF2021-008\_NUTS\*.xlsx. This includes a precision study. The file was simplified, saved as 2021-008nuts.csv. The file was converted to individual NUT files.

DMS

DMS data were obtained in spreadsheet QF2021-008\_DMS\*.xls which includes duplicate analysis. Details on analysis are in file 2021-008 DMS report.doc. Only 2 figures are considered significant.

DMSP

DMSP-D and DMSP-T data were obtained in file QF2021-008\_DMSP\_summary\*.xls. The data were converted into DMSP files. Only 2 figures are considered significant.

The SAL, CHL, OXY, NUT, DMS and DMSP (DMSP-D and DMSP-T) files were merged with CST files in 6 steps.

After the 6th 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. Some adjustments were made:

* Event 3 -23 of 24 bottles were removed from the SAMAVG file; final merge step was repeated.
* Event 20 – DMSP sample 81 missing from QF file but is in REPORT and format wrong for sample #19 – Corrections made with analysts’ approval.
* Event 37 – SAL – sample 142B sample missing from QF file but is on log analysis sheet. Analyst notified and found missing 142B sample which had been mislabelled.
* Event 49 – Niskin 11 line removed from SAMAVG and merge redone. Looks fine after that.
* Event 63 – Sample 395 CHL mislabelled as from event 65.Analyst notified and change made.

##### Compare

Salinity

Compare was run with pressure as reference channel.

Sample #395 in event 63 is an extreme outlier – it couldn’t possibly be a surface sample. The comment says it was mislabeled as #373. It turned out to be the missing 142B sample mentioned above.

The 2 CTD salinity channels differ by about 0.0065psu using all data. There is a little pressure dependence in the differences with 0.0068psu below 2000m; this is a little larger than the 0.0046psu to 0.0060psu observed in recent uses of this equipment, but most of those cruises did not sample below 2000m. The smallest difference came from the most recent cruise. Using only data from 1000m to 2000m the differences between CTD channels while stopped for bottles are 0.0067psu (std. dev. 0.0003psu).

Excluding bottles above 600db or with standard deviation >0.008pus plus a few outliers, the primary salinity is low by an average of 0.0123 (std. dev. 0.0015psu) and the secondary is low by an average of 0.0055psu. The desorption error is estimated to be ~0.003psu after 2.5 months. There is likely some error due to evaporation which is expected to be somewhat random and only large if seals are poor. The analyst found no indication of poor seals but there is some scatter that could be attributed to evaporation. There is likely some evaporation from all bottles given the analysis delay but it is not expected to be large.

Flushing errors are not expected to be large below 2000m but one deep cast was examined and the salinity gradient over 10m at various depths was recorded to get an very rough estimate of possible errors.

|  |  |
| --- | --- |
| Pressure | Estimated Flushing Error (10m) |
| 500 | 0.007 psu |
| 1000 | 0.002 psu |
| 2000 | 0.0014 psu |
| 3000 | 0.0005 psu |
| 4000 | 0.0003 psu |

The differences help explain why we get depth-dependence in bottle comparisons. A difference from other recent cruises is that the variations in pressure during bottle stops were lower during this cruise than usual, so somewhat larger flushing errors might be anticipated. The standard deviations in salinity during the bottle stops were also a little lower than during 2021-006. The fits of differences versus pressure are fairly flat but not as flat as from 2021-006, so this may indicate larger flushing errors than in the May/June cruise.

In summary, flushing errors are expected to be <0.002psu below 2000db and desorption errors on the order of 0.003psu. Some low-level evaporation of samples may affect most bottles; larger errors would likely be random. So it may be reasonable to assume bottles are reading too high by at least 0.005psu and possibly more than that.

The fits for the 2 salinity channels are very close in slope; if there had been a significant change in pressure dependence it was the same for both which is unlikely. There is some difference in the time dependence though. It is known that the primary salinity was bad during the downcast for event #37. It appears that the casts before that one are a little out of line and there appears to be time-dependence after that as well, though not a lot

There were 9 bottles fired at 2000db during event 51. In the normal comparison there is some overlap in the CTD data included when bottles are fired rapidly. So a special ROS file was prepared with just a single CTD value at firing time. The primary salinity was low by an average of 0.0122psu and the secondary was low by an average of 0.0053. The standard deviation in the CTD data was 0.0004psu for the primary and 0.0001 for the secondary CTD salinity. The standard deviation in the differences for both was ~0.002psu which matches the standard deviation in the bottle data. That reflects the level of precision expected from bottle analysis though the precision study in the QF file from the analyst indicated that the precision level was better than that, at <0.001psu. So the variability in bottle values likely includes some real variability in bottle contents that might be ascribed to variability in flushing efficiency or desorption or evaporation errors.

Comparisons for this cruise seems out of line with other recent cruises. Explanations were explored and no problems were discovered in the analysis and the analyst found the seals were good. There was no apparent drift as judged by comparing duplicates since the “B” samples were analyzed at the end and the “A” samples randomly. The differences between duplicates appear to be random with the “A” analysis time. While some of the cruises included areas with poor flushing, that would not explain the variations in differences between channels.

To further explore the problem a preliminary analysis was done of salinity data from cruise 2021-012 that immediately followed this one. It included a lot of bottles below 1000m and conditions looked good for flushing. The differences between salinity channels was ~0.0046psu, a difference also found for cruise 2021-069. Both salinity channels were closer to bottles than found for 2021-008 with the primary low by 0.008psu and the secondary by 0.0034psu, with a similar wait for analysis of samples. An estimate of errors in bottles is 0.005psu, so the estimate is the that the primary salinity is low by 0.003psu and the secondary high by 0.0015psu for 2012.

The wait for analysis and the different environments make it very hard to compare these cruises, but it is clear that there is something out of line with 2021-008 and that appears to be due to a problem in the primary plumbing. It is interesting that the dissolved oxygen which was also on the primary pump was only affected for 1 cast, at least not notably affected. There could be a small influence. .

During this cruise an experiment was run choosing a 60s wait before firing bottles at depths where the vertical gradient was large. Unfortunately, this did not work well for salinity since there were only 3 salinity samples from the bottles with longer waits. One of the bottles was associated with very noisy CTD data and is way off from the main fit, but an examination of the variability during the stop suggests it would have been even further out of line without the longer stop. The other 2 bottles look as though there might be an improvement in flushing as the CTD values are closer to bottles than some from a little deeper that had a 30s wait. There were more dissolved oxygen samples taken during this test; see those results below.

For full details for the COMPARE run see file 2021-008-sal-comp1.xls.

Dissolved Oxygen

COMPARE was run with pressure as the reference channel.

Two things make this comparison different from usual:

* Tests were done during some casts with waits of 60s rather than 30s before firing bottles at levels where vertical DO and salinity gradients were particularly large.
* The CTD primary system performed very badly during cast #37, particularly near the bottom of the cast. The data from that cast stand out as very bad in the comparison. For salinity only the 3 bottles near the bottom of cast #37 seemed notably out of line.

The fit for Line P excluding cast #37 plus some outliers based on residuals was:

 CTD DO Corrected = CTD DO \* 1.0445 + 0.0004 R2 = 0.95

The only significant outliers were associated with either noisy CTD DO data or the bad CTD data from event #37. This result is close to the preliminary results from cruise 2021-012 which followed:

 CTD DO Corrected = CTD DO \* 1.0463 + 0.0012

A hysteresis check was run by plotting points below 900db in red – some points above that are in red as well as they were rejected from the main fit. There is no evidence of significant hysteresis.

The longer wait for bottles was studied. For dissolved oxygen there were 29 bottles fired after 60s. In the high gradient region points tend to lie above the general fit which is assumed to be because the Niskin bottles contain water from deeper in the water column. For this cruise the points in the high-gradient zone are reasonably close to the general fit. Most of the points that look out of line are associated with noisy CTD DO data. Exceptions are the 2 bottles from 75m during cast 11. A study of the CTD data during the stop shows values rising through most of the stop, slowing by 30s but not steady until about the 50s mark. The pressure was quite steady through the stop, so the Niskin bottle likely contained water from the shed wake that passed through when the CTD stopped.

Tests of wait times will require more data to decide if the extra time improves data significantly as there is always some scatter in our fits and flushing conditions will vary among cruises. After the data from 2021-012 are processed the picture might become clearer.

For full details for the COMPARE run see file 2021-008-dox-comp1.xls.

Fluorescence

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

Only 8 of 103 samples had chlorophyll values > 4ug/L.

The pattern is as usual with the fluorometer reading higher than CHL when CHL is <1ug/L, with the ratio of FL/CHL gradually dropping and setting at approximately 0.5 for CHL>2.5ug/L.

For full details for the COMPARE run see file 2021-008-fl-chl-comp1.xls.

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

File 2021-008-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 and no problems were noted. The transmissivity channels had similar shape. The altimetry looked good.

##### 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.

##### ALIGN DO

A few casts were examined; both temperature channels were noisy during upcasts so the tests were not easy to interpret, but using +3s improved the alignment and overall looks like a good choice.

ALIGNCTD was run on all casts using +3s.

##### 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 4 of the deeper casts to find the differences between the pairs of temperature, conductivity and salinity channels.

The conductivity differences were all small and though slightly higher than during previous cruises.

Temperature differences are small with a slight increase with pressure and time.

Salinity differences are higher than seen in the previous cruises for event #28 but then drop to values just a little higher than previous cruises. There is a hint of differences decreasing through the cruise.

When compared to differences during stops as seen in the COMPARE step the downcast differences are slightly smaller, but likely not significant.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cast # | Press | T1-T0  | C1-C0 | S1-S0 | Descent Rate |
| 2021-020-0037 | 320 | -0.0002 | ~ | +0.0002 | High, F.Steady |
| 2021-020-0082 | 350 | +0.0001 | +0.00017 | +0.0015 |  |
| 2021-020-0117 | 375 | +0.0004 | +0.00022 | +0.0021 | High, Noisy |
| 2021-006-0020 | 375 | +0.0004 | +0.00044 | +0.0043 | High, Noisy |
|  | 1200 | +0.0002 | +0.00042 | +0.0050 | “ |
| 2021-006-0039 | 1200 | 0 | +0.00042 | +0.0049 | High, XNoisy |
| “ | 2000 | -0.0002 | +0.00044 | +0.0055 | “ |
| “ | 3000 | -0.0003 | +0.00044 | +0.0057 | “ |
| 2021-006-0052 | 1200 | 0  | +0.00043 | +0.0057 | High, XNoisy |
| “ | 2000 | -0.0005 | +0.00042 | +0.0056 | “ |
| “ | 3000 | -0.0005 | +0.00044 | +0.0060 | “ |
| 2021-006-0077 | 1200 | -0.0005 | +0.00042 | +0.0059 | High XNoisy |
|  | 2000 | -0.0007 | +0.00044 | +0.0063 | “ |
|  | 3000 | -0.0006 | +0.00045 | +0.0062 | “ |
| 2021-005-0099 | 1000 | -0.0002 | +0.00050 | +0.0058 | High, Noisy |
|  | 1900 | -0.0004 | +0.00050 | +0.0064 | High, V. Noisy |
| 2021-005-0140 | 1000 | -0.0002 | +0.00055 | +0.0065 | High, Noisy |
|  | 1900 | -0.0005 | +0.00055 | +0.0072 | F. High, NOisy |
| 2021-069-0009 | 500 | +0.0002 | +0.00040 | +0.0044 | High, Noisy |
|  | 900 | -0.0001 | +0.00040 | +0.0048 | “ |
|  | 1850 | -0.0004 | +0.00041 | +0.0054 | “ |
| 2021-008-0028 | 1000 | 0 | +0.00060 | +0.0072 | High, V Noisy |
|  | 2000 | -0.0002 | +0.00060 | +0.0076 | “ |
| 2021-008-0046 | 1000 | 0 | +0.00051 | +0.0060 | High, Noisy |
|  | 2000 | -0.0004 | +.000051 | +0.0067 | “ |
|  | 3000 | -0.0005 | +0.00053 | +0.0069 | “ |
| 2021-008-0063 | 1000 | -0.0004 | +0.00046 | +0.0059 | High, Moderate |
|  | 2000 | -0.0006 | +0.00048 | +0.0063 | “ |
|  | 3000 | -0.0007 | +0.00049 | +0.0068 | “ |
| 2021-008-0077 | 1000 | -0.0003 | +0.00043 | +0.0055 | High, Noisy |
|  | 2000 | -0.0007 | +0.00043 | +0.0060 | “ |
|  | 3000 | -0.0008 | +0.00045 | +0.0063 | “ |
|  | 4000 | -0.0009 | +0.00047 | +0.0065 | “ |

##### 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 and header check were run. No problems were found.
* Surface check was run and the average surface value was 3.3db. While not unreasonable for offshore when conditions are rough, the results of 2021-069 will be applied by subtracting 0.8db, so the average will be +2.5db.
* Cruise tracks were plotted and 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. The value was reduced by 2 to allow for the fact that depths are believed to be too high by 0.8db and that altimetry is averaged over the bottom 2m so are likely too high by an average of 1m. Where that number was > 5 or <-5 plots of the altimetry were checked.

Changes were made to 8 CLN and SAMAVG files: 5, 8, 12, 19, 42, 52, 57, 68. For 2 the log water depth entry was used and for the others the sum of the Max Depth Sampled plus altimetry – 2m was entered.

After the changes the MERGE routine was repeated to create MRG files with the right water depth entry.

##### 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

During 2021-006 and 2021-005 the best settings for aligning conductivity with temperature were -0.8db for both sensors. But for 2021-069 the best choice was also -0.8 records for the primary channels, but for the secondary a setting of -1.4 records was best overall, though, as usual, this varied from feature to feature.

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 settings overall were -0.6 records for the primary conductivity and -0.9 records for the secondary.

SHIFT was run twice on all SBE911 casts using -0.6 records for the primary and -0.9 for the secondary. 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. However, at the editing stage that followed it was discovered that the top 10db of data had been missed for cast #28 because there was a stop at 10db on the way down. So the Setting “Remove Surface Records …..in the top XXXXX dbars” was changed from 10 to 5 and DELETE was rerun on that cast.

##### Other Comparisons

Experience with these sensors since last factory service –

The pressure, temperature, and conductivity sensors were used during only 1 cruise since the last factory visit:

* 2021-020 – The salinity channels started out close and gradually drifted apart. Based on information from the Line P section of cruise 2021-006 it appeared that the primary salinity did not drift much during this cruise. The drift in secondary salinity appears to have been fairly sudden and then settled down. Dissolved oxygen was recalibrated using slope/offset =1.0515/-0.0131 based on cruise 2021-006. This correction seemed high since it was first use since previous factory calibration. Pressure looked ok. No TSG.
* 2021-006 Dissolved oxygen recal slope/offset = O 1.0515/-0.0131; Primary very close to bottles selected for archive; secondary high by 0.006psu.
* 2021-005 Dissolved oxygen recal slope/offset = 1.0536/-0.0018; Primary sal high by about 0 to 0.001psu, selected for archive; secondary high by 0.005 to 0.006psu. TSG salinity low by 0.191; intake temp high by 0.02C degrees – no recal applied.
* 2021-069 Poor info for recal of DO and SAL. Used 2021-005 correction for dissolved oxygen and salinity. Primary T/S selected for archive. Pressure corrected by adding 0.8db.
* 2021-012. Preliminary comparison in deep offshore water shows primary salinity low by 0.008 and secondary by 0.0034psu. The fit for dissolved oxygen was: slope/offset = 1.0465/ 0.0012

Historic ranges – Profile plots were made with 3-standard deviation climatology ranges of T and S superimposed. There were some excursions. Temperature was mostly within the climatology except that it was slightly high just below the mixed layer for a few casts at P12 and P26. Salinity was a little high at 70m for one cast and slightly low around 200m for a few others. There were no systematic outliers so no indication of problems with calibrations.

Post-Cruise Calibration – None available.

Repeat Casts – There were no repeat casts deep enough to expect a good comparison, but casts at P25 and P35 taken about 4.5 hours and 50 km apart were compared around 1550db and differences in temperature were ~0.001C° and in salinity ~0.0001psu along lines of constant density. This is excellent repeatability.

##### DETAILED EDITING

The primary channels were chosen for editing because the salinity was found to have fewer spikes though both channels were acceptable. The secondary will have to be chosen for event #37 because there was a problem with the primary plumbing and a slight hint of time dependence.

All DEL files were copied to \*.EDT.

CTDEDIT was used to remove records that appear to be corrupted by shed wakes. Salinity was cleaned to remove spikes that appear to be due to small misalignment or instrumental noise. All files required some editing. Notes about editing applied were added to the files.

After editing, T-S plots were examined for all casts. No further editing was found necessary.

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

Pressure was found to be high by 0.8db during 2021-069 when many surface values were available.

Evidence re the calibration of salinity is confusing. All cruises were affected by delayed analysis of salinity samples and incomplete flushing of bottles, but the estimated errors in bottle comparisons due to those effects vary from cruise to cruise. Results from 3 previous cruises suggested that the secondary salinity was high by 0.005 to 0.006psu after probable errors were considered. The results from this cruise show a large shift in calibration in both salinity channels with the secondary reading close to bottles after allowing for likely errors. The difference between the 2 salinity channels is larger than the most recent cruise but close to those from cruises before that one. There is slight drift in the difference between temperature channels. Partway through cast #37 the primary salinity looked very bad and primary temperature was suspicious, so there is doubt about the primary channels for the rest of the cruise.

Errors in the comparisons due to delayed salinity analysis are estimated to be about 0.003psu and there may be a further error due to incomplete flushing of Niskin bottles. Normally this is low for Line P due to rough seas, but conditions were quieter for this cruise than usual. Nonetheless, that error is unlikely to greater than 0.001psu at 2000db due to low salinity gradients. There could be some error due to evaporation, again likely to be small. If the error is ~0.005psu then the primary salinity is low by ~0.007psu and the secondary low by ~0.0005psu. A preliminary analysis of cruise 2021-012 suggests the primary was low by ~0.002psu allowing for errors in bottle values and the secondary high by ~0.002psu. The secondary salinity will not be recalibrated as it is likely within ±0.003psu.

No explanation was found for why the 2021-008 salinity is lower relative to bottles than for other 2021 cruises using the same equipment.

File 2021-008-recal.ccf was prepared to subtract 0.8db from the pressure and to apply the following correction to channel Oxygen:Dissolved:

CTD DO \* 1.0445 + 0.0004

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. When data are excluded based on using the same points as in the original fit, the average is 0.00008mL/L, with a standard deviation of 0.023mL/L. See file 2021-008-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 CTD DO was higher than the titrated samples by an average of ~0.043mL/L but the standard deviation was high, at 0.16mL/L. When outliers with high standard deviation in the CTD data were excluded the average difference was 0.009mL/L with a standard deviation of 0.047mL/L. The recalibration was obviously effective.

To see if it was useful to wait longer before firing bottles at depths with high DO vertical gradients, a fit was done with bottles plotted in green that had 60s waits. Naturally, many of these cases have high standard deviations in the CTD data due to large gradients, and some may have only 1 CTD record in the required depth range. So the comparison is unreliable to judge whether the longer waits were useful. However, we do usually find that the CTD DO reads higher relative to bottles after outliers are removed, than was found for these data, so it is likely that the longer waits did produce a better fit. And the outliers that were excluded are not as far “out” as is often seen.

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

 ±0.30 mL/L from 0-175db except in areas of very large DO gradients

 ±0.20 mL/L from 175db-300db

 ±0.04 mL/L below 300db

For more detail see file 2021-008-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.

Profile plots were examined. No problems were noted.

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

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

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

PAR was removed for casts #37,39,40,42,44,46,52,57,63,68,70,77,79,81.

Channel Oxygen:Dissolved:SBE was removed from cast #37.

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

REORDER was run to get the two DO channels together.

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

The Standards Check routine 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.

The 2 transmissivity values at 4000db were 59.7%/m and 94.3%/m which are similar to August 2020 (59.2%/m and 94.4%/m)

The sensor history was updated.

##### Dissolved Oxygen Study

As a final check of dissolved oxygen data, % saturation was calculated and plotted. Values at 2 to 3m ranged between ~60% to 150%. The lowest values were from Haro Strait and Juan de Fuca Strait, as usual. The highest were found at P2 on the outward journey, but on the return trip values at P2 had dropped to 106%. P1 values also dropped from about 110% on the outward trip to ~90% on the return. The offshore values were in the range 102% to 110% with the casts furthest from shore around 103% which is in the expected range.

These values look reasonable and do not suggest any problem with DO calibration.

##### Final Bottle Files

SORT was run to arrange casts in pressure order.

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

PAR was removed for casts #37,39,40,42,44,46,52,57,63,68,70,77,79,81.

Channel Oxygen:Dissolved:SBE was removed from cast #37.

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

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

Data were exported from the CHE files to file 2021-008-bottles-final.xlsx. The entries were compared with the rosette log sheets and no problems were found.

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 header check were produced for the CHE files.

##### Thermosalinograph Data

An IOS TSG45 was used for this cruise and data were saved in 2 files. The files have extensions RAW but are in csv format, so the files were opened in EXCEL and combined in a single CSV file. (In opening use DELIMITED, deselect TAB, select COMMA and OTHER (\*).

It is necessary to choose TEXT for the time on the 2nd page of the text import wizard.)

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 added (Lab-Intake).
* 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. No clean water offset value was available. During 2021-006 a study was made to determine a suitable offset and 0.065ug/L was selected, so that was applied to these data as well. The minimum fluorescence found using that setting was 0.59ug/L. To see if that setting was reasonable, comparisons were made to CTD fluorescence and Extracted Chlorophyll samples from 4 CTD casts. The range of CHL was limited with most values being <3ug/L except for a very large value at P2. The TSG fluorometer read 3 times the CHL for CHL ~0.3ug/L and about 60% higher for CHL~0.5ug/L. At the one cast with high CHL at the surface, ~17.5ug/L, the TSG fluorescence was slightly higher at 18.7ug/L. These results look reasonable as these fluorometers always read higher than CHL at low values.
* A file break column was filled with the cruise #-data/time info from the original file name.
* The TSG was running for a while at the dock. Data were removed until the flow in both sensors had time to equilibrate.
* Time and Date formats are a problem – when converting from RAW choose TEXT but every time the file is opened in EXCEL set Time Format to HH:MM:SS and save the file again.
* The file break column was completed so that new files would be created at the beginning of each day by assigned file names like 20200210-000000 except for the first file which has a time later than 000000.

The break between the two files was only 15s so they were combined.

The file was then converted to IOS Header format with header info added. There are 13 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 – i.e. Decimal Year. A record number was also added to enable averaging (for use in comparison to CTD files). Time zero was set to 31 December 2020 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.

* The salinity traces have some spikes in most files, but most would be easily removed in CTDEDIT. There are also some cases of flow being off in the last 2 files.
* The loop flow rate was highly variable early in the cruise, settled to about 1.5 for a long time, then dropped to about 1 and slowly decreased to about 0.7. A new file was started and it went back to 4.5 and at the end had a period of very high and very low values.
* The flow to the fluorometer was noisy at the beginning and rose slowly from ~1 to 1.5 through the first file which covered most of the cruise. At the beginning of the 2nd file it returned to ~1 and then dropped at the end like the main loop flow.

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 2021-008-tsg-ctd-loop-rosette-comp.xlsx. All CTD casts overlapped with TSG records so there are 44 points of comparison.

The TSG files were averaged over 24 records (2 minutes) on record number to reduce the noise and file size. Standard deviations were included. Then required records (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 2021-008-ctd-tsg-loop-rosette-comp.xlsx.. The same file was thinned to the closest times to loop files and added to the TSG-Loop comparison.

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 0.000º for both latitude and longitude. There were 2 differences > 0.01º in longitude which is unusually large. In both cases there was a significant difference between the NMEA download and the beginning of data acquisition, so the CTD positions are less reliable. The times match since the System Upload time is used in conversion of the CTD files.

c.) Comparisons

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

The initial comparison between TSG and CTD data using all casts was:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Tint-Tctd | Stsg-Sctd | FLtsg/FLctd |
| average | 0.012 | -0.348 | 1.39 |
| stdev | 0.065 | 0.038 | 0.49 |
| median | 0.006 | -0.345 | 1.36 |

But a plot of salinity differences through the cruise shows that the casts near the beginning and end of the cruise are outliers, presumably because of large near-surface salinity gradients so that minor mismatches in depth of sampling are significant.

When events 3-11 and 89-90 were excluded from the comparison the results were much tighter with lower standard deviations except for fluorescence which did not have the same pattern of outliers, so changes were negligible.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Tint-Tctd |  | Stsg-Sctd | FLtsg/FLctd |
| average | 0.005 |  | -0.346 | 1.38 |
| stdev | 0.014 |  | 0.006 | 0.50 |
| median | 0.006 |  | -0.346 | 1.36 |

Fluorescence was about 10% higher from the TSG than from the CTD for most casts.

Heating in the loop (Lab Temperature – Intake Temperature) was plotted against intake temperature. This shows the usual pattern of reducing heating as intake temperatures approach the ambient ship temperature.

Since there was a lot of variability in the flow rate to the TSG, that was investigated to see if it had affected heating in the loop.

This plot shows great variability in the heating in the loop but no obvious trend. The flow rate was particularly noisy near the beginning and end of the cruise and most cases of high flow were short-lived.

* Comparisons of Loop samples and TSG data

There were 21 loop Salinity and Chlorophyll samples of which 7 were taken while stopped and the rest while underway. The loops were compared with TSG data. As is usually the case, TSG fluorescence was higher than Extracted CHL by up to a factor of 5 for the samples with CHL < 0.5ug/L. Fluorescence was close to loops between 1 and 2ug/L. There were no CHL samples >2ug/L.

There was one salinity loop sample that was clearly bad; it had already been flagged and a salinity of 34.5psu was clearly not right. They analyst was informed and changed the flag to 5. Once that outlier was excluded the TSG salinity was lower than loop samples by a median 0.357psu. There were 2 other outliers but they were compensating in the median. Differences while stopped and underway were 0.358psu and 0.0356psu, respectively, so no significant difference.

* Comparison of 5m Rosette samples and Loop samples

There were 7 salinity and extracted chlorophyll loop samples taken during rosette casts. Salinity values were reasonably close with the loops higher by a median of 0.0036psu but the standard deviation was 0.0048psu) with a lot of variability. The chlorophyll samples from the 2 sources were very close with a median ratio (Loop/Niskin) of 0.98 and standard deviation of 0.18. The largest difference was 0.18ug/L and that was from the only cast with both the loop and Niskin chlorophyll samples flagged 36. All chlorophyll values were < 2ug/L and most < 0.6ug/L.

d.) Calibration History

* The TSG and fluorometer were recalibrated shortly before cruise 2021-001.
* During 2021-001 the TSG salinity was found to be lower than CTD salinity by a median of 0.178psu, and lower than loops by 0.181psu with no significant difference between underway and stopped samples. There was no evidence of drift through the cast. The TSG intake temperature was higher than the CTD temperature by ~0.02C° offshore but if only casts with a low standard deviation in the intake temperature are included it is high by a median of 0.009C°. No recalibration was applied as the differences were reasonably small given some differences in depth and time between the 2 data sets. The TSG fluorescence values were about 32% of fluorescence from the CTD and 74% of the loop CHL samples. Loop and rosette salinity samples compared very well, while the loop chlorophyll was about 75% of that from the rosette.
* During 2021-006 the TSG salinity was recalibrated by adding 0.183psu. TSG temperature were higher than those from co-incident CTDs by about 0.01 C°. The TSG fluorescence values were about 50% higher than those from the CTD and higher than loop CHL samples by 50 to 300%. For the cases where the CHL was in the range 0.49 to 5.0ug/L, the TSG fluorescence was higher than loop samples by 8%, but the loop chlorophyll values were lower than rosette samples.
* During 2021-005 the TSG salinity was recalibrated by adding 0.191psu. TSG temperature were higher than those from co-incident CTDs by about 0.02 C°. The TSG fluorescence values were close to those from the CTD and higher than rosette CHL samples for low CHL and about 50% of CHL when CHL>4ug/L. There were too few loop samples to conclude much but the comparisons do not suggest a problem.
* During 2021-069 salinity was low by varying amounts according to regions; it was recalibrated by adding 0.30psu but values are likely too low in the inlets. The TSG fluorescence values were reasonably close to those from the CTD fluorometer and about 50% of rosette CHL samples when CHL>4ug/L.

e.) Conclusions re TSG

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

2. The flow rate as recorded by the meter was somewhat erratic ranging from 0.8 to 2.5 but the median was 1.3 and it was generally high. While stopped the average was 1 L/min with a range of 0.7 to 1.3L/min. There were some spikes.

3. The flow rate to the fluorometer was similar with a median rate of 1L/min but a range of 0.7 to 3.6 during CTD stops.

4. The TSG salinity was found to be lower than CTD salinity by a median of 0.346psu when 5 initial casts and 2 late ones were excluded, thus eliminating cases where the near-surface salinity gradients were high. Compared to loops it was low by 0.357psu with no significant difference between cases where the ship was stopped or underway. It is assumed that the low salinity is due to bubbles in the loop and/or calibration drift. There was a change noted during the previous use so it is possible there was some damage to the conductivity sensor.

5. The TSG intake temperature was higher than the CTD temperature by about 0.006C° which is an excellent result. No recalibration is suggested.

6. The TSG fluorescence values are about 1.4 times those from the CTD and higher than loop CHL samples by a median of 3.5, For the cases where the CHL was <0.5ug/L, the TSG fluorescence was higher than loop samples by a median factor of 3.5 but for the few values between 1 and 2ug/L the TSG fluorescence is close to the CHL values. This is typical of how the CTD fluorometer works with much higher readings than CHL when CHL is very low.

7. The loop salinity samples read higher than those from the rosette by a median of 0.0036psu while the loop chlorophyll was 98% of those from the rosette.

f.) Editing

Time-series plots were examined.

All files required some editing except for those from August 25, September 3 and September 6.

For most casts only a few single-point salinity spikes were removed where differences between points were >0.02psu. The cast from September 5th required more editing to remove fluorescence, temperature, salinity and conductivity data due to flow in the loop being off or low and erratic.

g.) Calibrate

CALIBRATE was used to add 0.346psu to channel Salinity.

ih) Preparing Final Files

REMOVE was used to remove channel Pressure, Temperature:Difference , and record #.

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.

The TSG sensor history was updated.

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

##### Loop File

The Chief Scientist provided file 2021-0008 Loop log.xlsx which included event numbers, sample numbers and what was sampled. Earlier in the processing the loop samples were used to study the TSG calibration. Times were added based on the log entries. The data were copied to file 2021-008-tsg-ctd-loop-rosette-comp.xlsx.

A 6-line header spreadsheet was prepared using a template from previous cruises.

The sampling method column was added and filled with USW.

The columns in the loop-data file were arranged in the order required for the 6-line header used to prepare the loop file.

Date and Time were found in the Loop file in the TSG comparison.

Positions were added based on log entries or for those done during a CTD cast taken from the CTD headers.

Next data from near-surface rosettes were obtained.

The CHE files were put through program DERIVE to obtain sigma-t. (\*.dqt)

Clip was run to choose only data between 0db and 7db. (\*.clip)

Data from those files were exported to file 2021-008-loop.csv. The Oxygen:Dissolved and Oxygen:Dissolved:SBE channel in mass units were included. Draw Temperature was not included since there were no loop DO samples and mass units have already been derived for rosette samples.

The Start Time was used to fill the DATE column and format was set to date (style 2021-05-04).

The times in the files are start times and the samples were actually taken near the end of the cast, so the End Times were calculated from the full files (\*.CLN) and exported to a spreadsheet.

Those times were entered in the spreadsheet – note that there were several records for many casts, so this required some manipulation.

A sample method column was added. ROS was entered for the method.

That data were then added to the 6-line header, sorted on event number, sampling method and pressure.

That file was saved as 2021-008-surface-6linehdr.csv.

The file break column was filled with value 1 so all data will be in a single file when converted.

CONVERT was run to produce an IOS Header file.

CLEAN was run to get start and stop times and positions and to add flag 0 to empty flag cells.

A comment file was prepared which was essentially the same as the one used in preparing CHE files but including a description of the loop system and comments on the CTD data processing.

Header Edit was used to correct channel names and formats and to add comments. The final file was renamed as 2021-008-surface.loop. The track plots look reasonable and plots of temperature and salinity versus event numbers, latitude and longitude look reasonable.

P**articulars - Notes from Daily Science Log and Sampling Notes**

PAR off: 37,39,40,42,44,46,52,57,63,68,70,77,79,81

Casts with bottle fired out of order: 44, 61.

Casts with no Niskin closed: 1 (test cast), 22 (1 bottle fired/didn’t close), 89 (90 has bottle – process both).

Casts with bottles fired but not sampled: 22 (didn’t close)

Wrong depth in headers: 75, 77, 79. (All fixed.)

Header problems (station names or water depths): 39, 55, 57, 59, 77, 79. (All fixed)

Deployment schemes:

CTD to surface, pumps on, down to 10m, 30s wait, up to surface, 30s wait, then cast began.

For most depths there was a wait 30 seconds before closing a bottle except where salinity and dissolved oxygen gradients were large where the soak was for 60s.

1. Test cast cancelled due to faulty pylon.

3. Bottle integrity test. All bottles passed. All bottles fired but only 1 sampled.

8. DICs sampled last.

22. Bottle fired but did not close. No CHE file needed.

23. Repeat at P6 – shallow 1 bottle. Need CTD and CHE files.

37. Odd primary salinity and dissolved oxygen traces – problem started at 1180 on way down. Secondary seems ok. Something stuck in plumbing.

38. Trace Metal cast.

44. Niskin 2 has no sample # - used for bulk water, not needed in CHE file.

46. DO data noisy from 800m on downcast. Cleaned connectors afterwards.

49. Niskin 11 closed at 25m by mistake. Samples from 10m to surface came from Niskins 12-17 instead of 11-16.

51. Niskin 22 added during the cast and not assigned sample # - use 9283 and include in CHE file.

56. Trace Metal cast.

**2021-008**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CTD#** | **Make** | **Model** | **Serial#** | **Used with Rosette?** | **CTD Calibration Sheet Competed?** |
| **1** | **SEABIRD** | **911+** | **0443** | **Yes** | **Yes** |
| **Calibration Information - 0506** |
| **Sensor** | **Pre-Cruise** | **Post Cruise** |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **4700** | **12Dec2020** | **Factory** |  |  |
| **Conductivity** | **3531** | **06Jan2021** | **Factory** |  |  |
| **Secondary Temp.** | **4888** | **12Dec2020** | **Factory** |  |  |
| **Secondary Cond.** | **4513** | **18Dec2020** | **Factory** |  |  |
| **Transmissometer** | **1185DR** | **28Apr2021** | **Factory** |  |  |
| **Transmissometer** | **1883DG** | **28Apr2021** | **Factory** |  |  |
| **SBE 43 DO sensor** | **3791** | **22Dec2020** | **Factory** |  |  |
| **PAR sensor** | **70613** | **24Feb2021** | **Factory** |  |  |
| **SeaPoint Fluor.** | **3950** |  |  |  |  |
| **Pressure Sensor** | **0443** | **07Jan2021** | **Factory** |  |  |
| **Valeport Altimeter** | **76341** | **10Feb2021** | **Factory** |  |  |

**CRUISE SUMMARY – CTD**

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

|  |
| --- |
| **Calibration Information** |
| **Sensor** | **Pre-Cruise** | **Post Cruise** |
| **Name** | **S/N** | **Date** | **Location** | **Date** | **Location** |
| **Temperature** | **0620** | **21Jan20** | **Factory** |  |  |
| **Conductivity** | **0620** | **21Jan20** | **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** |  |  |

 