## REVISION NOTICE TABLE

|  |  |
| --- | --- |
| DATE | DESCRIPTION OF REVISION |
| 18 March 2025 | Updated channel names & formats in TOB & Loop files. G.G. & S.H. |
| 18 Jan 2023 | Replaced CHL/Phaeo data & flags & comments in CHE files and Loop files. G.G. |

## PROCESSING NOTES

Cruise: 2022-001

Agency: OSD

Location: North-East Pacific

Project: Line P

Chief Scientist: Robert M.

Platform: John P. Tully

Date: 1 March 2022 – 20 March 2022

Processed by: Germaine Gatien

Date of Processing: 30 May 2022 – 19 July 2022

Number of original HEX files: 71 Number of processed CTD files: 71

Number of rosette casts: 38 Number of processed CHE files: 37

Number of original TSG csv files: 2 Number of processed TOB files: 16

# INSTRUMENT SUMMARY

CTD #0550 was mounted in a rosette and attached were 2 Wetlabs CSTAR transmissometer (1185DR & #1883DG), a SBE 43 DO sensor on the primary pump (#997 for events 1-14 and 1119 for events 19-147), SeaPoint Fluorometer on the secondary pump (#3949), 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.

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 decision on the length of waits before bottle firing were based on an assessment of the anticipated vertical gradients of dissolved oxygen and salinity.

* For LINE P STATIONS: Niskin bottles closed from 50 to 150 db (both included) had a wait time of 60 seconds. All other Niskin bottles had a wait time of 30 seconds.
* For COASTAL STATIONS (INCLUDING Haro59 and JF2): Niskin bottles closed from 0 to 150 db (both included) had a wait time of 60 seconds. All other Niskin bottles had a wait time of 30 seconds.

The choice of 50-150db did cover the highest vertical gradients, but gradients were quite high well below that. Most salinity sampling comes from depths where gradients are low. Extending the “60s zone” to 400db for casts with dissolved oxygen sampling, would likely improve calibration of the oxygen sensor. Extending it for all casts would likely bring all samples into better correspondence with ambient conditions at the firing level.

During casts #1 to 27 there were spikes in the dissolved oxygen traces when the CTD was moving but few spikes during bottle stops. Replacing the dissolved oxygen sensor between casts 14 and 19 did not help, but the problem was solved when the Y-cable was replaced before cast #27. Filtering removed most of the spikes in dissolved oxygen; while it smoothed the data, a test of differences caused by the filter suggests they are mostly random in sign except in the higher gradient regions where there could be an effect on the order of 0.02mL/L. Comparisons with upcast bottle samples also suggests that the errors caused by the spiking in dissolved oxygen are small.

There were also problems in the fluorescence and they were more severe because of the spiky nature of that property, making it too difficult to distinguish real spikes from instrumental ones. Filtering left some spikes in deep water that were obviously instrumental, so it is assumed that others remained in shallower water where they could not be distinguished from natural variability. Fluorescence values were likely affected by spikes, so the channel was removed from events #1 to #24.

Fluorescence values were very high in some of the inlets and the fluorometer went off-scale.

Off-scale values were replaced with pad values. There was no extracted chlorophyll sampling

for the affected casts.

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.

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:

±0.40 mL/L from 0-100db except in areas of very large DO gradients

±0.20 mL/L from 100db-400db

±0.05 mL/L below 500db

For events #1 to #24 the quality is considered lower for reasons described above.

There were a number of problems with the thermosalinograph during this cruise.

* The intake thermistor data were bad from the beginning of the cruise until March 8 at 09:28. A proxy called Temperature:Primary was created for the affected files by recalibrating the lab temperature.
* The position data were not available from 03:54 on March 13 until 8:45 on March 16 so no TSG data were processed for that period.
* There were a number of short periods when flow to the TSG and/or fluorometer was stopped; data were padded in affected channels.
* There was a large section during which the flow rates were very noisy and data were clearly affected; temperature, salinity and fluorescence data were padded in that section.

At other times the Thermosalinograph worked well with good detail in temperature salinity and fluorescence traces and few spikes in salinity. TSG intake temperatures and salinity compared well with CTD values from 4m and with loop samples. TSG fluorescence values were about 10% higher than the CTD fluorescence.

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.

The length of waits before bottle firing were:

* For LINE P STATIONS: Niskin bottles closed from 50 to 150 db (both included) had a wait time of 60 seconds. All other Niskin bottles had a wait time of 30 seconds.
* For COASTAL STATIONS (INCLUDING Haro59 and JF2): Niskin bottles closed from 0 to 150 db (both included) had a wait time of 60 seconds. All other Niskin bottles had a wait time of 30 seconds.

##### 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 and salinity data were obtained in QF spreadsheet format from the analysts.
* The cruise summary sheet was completed.
* The histories of the pressure sensor and conductivity and dissolved oxygen sensors were checked. The pressure, temperature and conductivity and dissolved oxygen sensor #997 had been recalibrated at the factory since the last use. Oxygen sensor #1119 had been used on 4 other cruises.
* A few water depth and station names were changed in the raw files.
* An error was fixed in the names of the raw files from first cast.

The configuration files were checked. There was an error in one of the entries for one of transmissometers which was corrected later in the cruise. Two versions of the configuration files were saved as 2022-001-ctd1.xmlcon and 2022-001-ctd2.xmlcon with the only difference being in the dissolved oxygen sensor.

##### BOTTLE FILE PREPARATION

The ROS files were created using files 2022-001-ctd1.xmlcon and 2022-001-ctd2.xmlcon.

The ROS files were converted to IOS format. File #1 was not included as it included no sampling.

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

Temperature and salinity were plotted for all BOT files to check for significant outliers. None were found.

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

A track plot was produced and cast #118 appeared to be on land, but it was in a narrow inlet that is not included in the coastline file.

The BOT files were bin-averaged on bottle number.

The output was used to create file ADDSAMP.csv. First, the file was sorted on event number and Bottle Position order. Then sample numbers were added based on the rosette logs.

The ADDSAMP file was then reordered on event # & sample #.

The ADDSAMP file was used to add sample numbers to the BOT files – output \*.SAM.

The SAM files were bin-averaged on bottle # and called SAMAVG.

The addsamp.csv file was converted to CST files, which will form the framework for the bottle files.

Next, each of the analysis spreadsheets were examined to see what comments the analysts wanted included in the header file. These were used to create file 2022-001-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 QF2022-001\_OXY\*.xlsx which includes flags, comments and a precision study. Draw temperatures are available. The spreadsheet page with the final data was simplified and saved as 2022-001oxy.csv. That file was converted into individual \*.OXY files.

The flag on sample #153 was marked “ALL”; so nutrients will also be affected.

EXTRACTED CHLOROPHYLL

Extracted chlorophyll and phaeo-pigment data were obtained in file QF2022-001\_CHL QF\*.xlsx. The file included comments and flags and a precision study. A simplified version of the spreadsheet was prepared and saved as 2022-001chl.csv. The csv file was then converted to individual CHL files.

SALINITY

Salinity analysis was obtained in file QF2022-001\_SAL.xlsx which included a precision study. The analyses were carried out in a temperature-controlled lab 21 to 49 days after collection. The files were simplified and saved as 2022-001sal.csv. That file was then converted to individual SAL files.

NUTRIENTS

The nutrient data were obtained in spreadsheet QF2022-001\_NUTS\*.xlsx. This includes a precision study. The file was simplified, saved as 2022-001nuts.csv. The file was converted to individual NUT files. Sample #153 was flagged “3” due to comment from oxygen analyst.

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

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

The files were then put through CLEAN to reduce the headers to File and Comment sections only.

These files are ordered on sample number, but the SAMAVG files are ordered on bottle number, so one or the other set needs to be reordered in order to merge them. The MRGCLN1 files were reordered on Bottle\_Number and saved as \*. MRGCLN1s.

The MRGCLN1s files were then merged with SAMAVG files using merge channel Bottle\_Number.

The output of the MRG files were exported to a spreadsheet and compared to the rosette log sheets to look for omissions. Many discrepancies were found:

* Event 41 – CHL Samples 177-182 CHL - not on rosette sheet and values make no sense for 2000db.
* Event 43 – CHL Samples 193-197 CHL - not on rosette sheet and values make no sense for 2000db.
* Event 43 – CHL Samples 204-208 not on rosette sheet – reasonable depth for such sampling but values way too high for offshore.
* Event 45 – CHL Samples 224-229 CHL - not on rosette sheet and values make no sense for 2000db.
* Event 68 – Salinity samples 388-390 and nutrient samples 391-392 missing. There is a note “Niskins 1-5 are for carboys not for samples”. The entries are contradictory but it will be assumed no sampling was actually taken for sample #s 388-392.
* Events 82 to 118 are missing the deepest DO values. This is because the event number/sample #s got out of line. Easy fix.
* Event #34 was very confusing – sample #s were not in Niskin # order. This was sorted out and the MRG file was prepared again after fixing the ADDSAMP file and CST and SAM files.

The extra chlorophyll samples were found to have come from a different cruise.

##### Compare

Salinity

Compare was run with pressure as reference channel. A fit was done excluding stops above 100db and cases where the standard deviation in the CTD salinity during the 10s window was >0.0008psu. The primary salinity was lower than bottles by an average of ~0.0013psu (std dev 0.0017psu) and the secondary salinity was high by an average of 0.0014psu (std dev 0.0017psu).

The differences between the 2 fits correspond well with the differences between downcast salinity channels reported in section 9.

The largest outliers were:

* Sample #313, event #56, is an extreme outlier. CTD salinity was very noisy and pressure variation large during the stop. The salinity bottle value is lower than both CTD salinity values; it matches the minimum value seen during the stop. So it could be ok or the bottle could have been late closing.
* Sample #314 in event #56 is somewhat out of line but the standard deviation in the CTD was quite high and the bottle came from a level where the vertical salinity gradient would lead to larger errors due to incomplete flushing.

No quality flags are appropriate for either of those outliers

Analysis was done within 3 to 6 weeks. The bottles from near the end of the offshore section of the cruise are deep and got analyzed within 4 weeks, so any evaporation or desorption effects should be fairly small. The average difference below 2000m from the last 3 deep casts produced differences very close to the difference from the larger comparison when 2 outliers were excluded.

The fits against time for the 2 salinity channels are very close in slope and were low for both..

For full details for the COMPARE run see file 2022-001-sal-comp1.xls.

Dissolved Oxygen

COMPARE was run with pressure as the reference channel.

There was serious spiking in the dissolved oxygen downcast data during casts 3-24. After cast #14 the DO sensor was changed but spiking continued until a Y-cable was replaced before cast #27. The spiking generally stopped during bottle stops.

The standard deviation in the SBE DO is higher than usual below the OMZ. Standard deviation during the 10s window was up to 0.04mL/L at 3000 to 4000db whereas it was ~0.01mL/L during 2021-001. The variability within a bottle stop look to be ±0.01mL/L which agrees with the COMPARE statistics. The noise in deeper water is random, not 2-sided in nature, but does not look like it would introduce a systematic error.

The comparison needs to be done in multiple sections. Casts 3-14 and 17-145 and offshore and inshore.

The fit for casts 1-14 excluding some outliers based on residuals was:

CTD DO Corrected = CTD DO \* 1.0168 + 0.0437 R2 = 0.68 (Sensor #997)

The fit for casts 21-145 excluding outliers based on residuals was:

CTD DO Corrected = CTD DO \* 1.0153 + 0.0461 R2 = 0.87 (Sensor #1119 - all)

The fit for casts 21-88 excluding outliers based on residuals was:

CTD DO Corrected = CTD DO \* 1.0155 + 0.0457 R2 = 0.88 (Sensor #1119 -offshore)

The fit for casts 103-145 excluding outliers based on residuals was:

CTD DO Corrected = CTD DO \* 1.0144 + 0.0500 R2 = 0.81 (Sensor #1119; inshore)

There are a few issues to consider:

* The fits for the 2 different sensors are remarkably close. Sensor #997 had been recently calibrated while #1119 had been used during 4 other cruises.
* There was no sampling with DO<2mL/L from #997. So having the offset close to that from the other sensor that did sample at low DO is unexpected. With so few bottles, the choice of how many outliers to exclude for the first sensor makes a big difference.
* Bottles from above 50m for cast #118 in Dean Channel were out of line in a way that looks like it is due to poor flushing. The waits were 60s, but presumably that was not enough. Casts #88 and #145 were near shore but not as protected as #118; those cases fell close to the general fit, so longer waits may have helped there.
* Flushing is expected to be good for the offshore casts using sensor #1119. Moreover, any errors associated with poor flushing would be small near the OMZ since vertical gradients are low. So the offset is expected to be reasonably accurate.
* There were problems with the DO sensor early in the cruise that did not go away when the sensor was changed. Eventually a Y-cable was replaced and that ended the spiking problem. Fortunately, spiking was not a big problem during bottle stops.
* Separating the #1119 bottles into inshore and offshore produced little difference, perhaps because of the longer stops for many of the inshore bottles and the exclusion of many bottles from cast #118.

The general fits for #997 and #1119 will be chosen for recalibration.

Outliers:  
File #7 – 20db – Complex profile and large vertical gradients. Distance between bottle and CTD could account for it.

File #118 – 5db - Very high vertical gradient – likely difference due to distance between CTD and bottle.

File #28 – 2000db. This is a mis-sample. Likely from Niskin 13, not Niskin 1. Already flagged 4 by analyst. Change to flag 5 and pad value.

A hysteresis check was run by plotting points below 900db in red. There is no evidence of significant hysteresis.

Finally, plots were made of differences versus file pair number and pressure to make sure there were no further outliers; none were found.

For full details for the COMPARE run see file 2022-001-dox-comp1.xls.

Fluorescence

COMPARE was run with extracted chlorophyll and CTD Fluorescence using pressure as the reference variable. The usual patterns were seen. CTD Fluorescence is higher than CHL when CHL is very low, then drops sharply to a ratio FL/CHL ~ 1 as CHL approaches 0.8ug/L. For CHL>1 fluorescence is about 50% of CHL.

The section with Fluorescence highest compared to CHL comes from stations west of P17. Near-shore the fluorescence is closer to CHL when CHL is low.

For full details for the COMPARE run see file 2022-001-fl-chl-comp1.xls.

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

File 2022-001-ctd1.xmlcon was used to convert files 1-14 and 2022-001-ctd2.xmlcon was used to convert files 17-147. 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, but there are problems in the dissolved oxygen and fluorescence data in casts #2 to 24. The 2 transmissivity channels had similar shapes. The altimetry had a few spikes near the bottom but there is a clear signal.

##### WILDEDIT & DO FILTER

Program WILDEDIT was run to remove spikes from the pressure, depth, conductivity & temperature only in the full cast files (\*.CNV).

Parameters used were: Pass 1 Std Dev = 2 Pass 2 Std Dev = 5 Points per block = 50

The parameter “Keep data within this distance of the mean” was set to 0 so all spikes would be removed.

For events #2 to 24, the dissolved oxygen and fluorescence are very spiky. Fluorescence usually gets filtered later in processing, but since raw oxygen gets converted to concentration before that stage, a

low-pass filter, size 0.3 was applied to channel Oxygen:Raw. This did a good job of removing spikes, though in order to do a good job it may have oversmoothed. To test this, one of the casts with no obvious spiking (#28) was run through the normal steps with and without a filter. The filtered data was smoother but the differences are mostly random in sign; the differences might be significant in the highest vertical gradients where differences of up to 0.02mL/L were seen.

##### 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 improved the alignment and overall looks like a good choice. That value is the one most often chosen for the SBE911s.

ALIGNCTD was run on all casts using +2.5s.

##### CELLTM

The noise in the upcast data makes tests for the best parameters for this routine very difficult to interpret. In the past when upcast data were not so noisy, the default setting of (α = 0.0245, β=9.5) was generally found to be the best choice. A few casts were checked for this cruise and the default setting does improve the data. CELLTM was run using (α = 0.0245, β=9.5) for both the primary and secondary conductivity.

##### DERIVE and Channel Comparisons

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

DERIVE was run a second time on 4 of the deeper casts to find the differences between the pairs of temperature, conductivity and salinity channels.

The conductivity differences were all small.

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

There were some odd shifts in the differences. For example for cast #61 temperature differences shifted around 1500 and then increased from 2500 to 4000db though they were never large. Conductivity shifted slightly to lower differences at 1500 and then higher at 2100db. The shifts are not large, but they seem rather sudden. The descent rates were noisy, so these may just reflect a slight shift in alignment.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cast # | Press | T1-T0 | C1-C0 | S1-S0 | Descent Rate |
| 2022-001-0024 | 1000 | -0.0003 | +0.00013 | 0.0018 | High, XNoisy |
|  | 2000 | -0.0002 | +0.00018 | 0.0024 | “ |
| 2022-001-0050 | 1000 | 0.0000 | +0.00017 | +0.0021 | High,Nosy |
|  | 1950 | +0.0003 | +0.00020 | +0.0023 | “ |
|  | 3000 | -0.0003 | +0.00022 | +0.0029 | “ |
| 2022-001-0061 | 1000 | 0.0000 | +0.00016 | +0.0019 | High, XNoisy |
|  | 2000 | +0.0001 | +0.00018 | +0.0020 | “ |
|  | 3000 | -0.0002 | +0.00022 | +0.0029 | “ |
|  | 4000 | -0.0006 | +0.00022 | +0.0034 | “ |
| 2022-001-0082 | 1000 | -0.0001 | +0.00019 | +0.0023 | High, XNoisy |
|  | 2000 | -0.0001 | +0.00021 | +0.0027 | “ |
|  | 3000 | -0.0003 | +0.00023 | +0.0031 | “ |
|  | 4000 | -0.0007 | +0.00024 | +0.0035 | “ |

##### 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. The only problem found was in the format for the station name P1 which was fixed. There are no negative fluorescence values.
* Surface check was run and the average surface value was 1.5db. This is low for a cruise in the offshore area. However, it was very rough at times, and the variability during the Line P section was large (0.2db to 4.6db) so the CTD was likely bouncing around at the surface after the 10m soak. In the inland section of the cruise values vary less (0.8db to 1.8db) and are not unreasonable in calm waters. Nonetheless, the values do seem low.
* During cast #34 the CTD was left running at the end while in air and pressure ranges from -0.4db to ‑0.5db. During cast #119 archiving started on deck and pressures were in the same range. From another cast it looks like the CTD was in a surface slick at -0.3db. So pressures are likely reading low by ~0.5db. Since there are rarely useful data in the top 0.5db, there is no need to recalibrate before running DELETE, but 0.5db should be added at the CALIBRATE stage.
* 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 0.5 to allow for the fact that altimetry is averaged over the bottom 2m so are likely too high by an average of 1m., while the depth sampled is likely low by 0.5m Where that number was > 5m checks were made to see if the log entry differed from the header entry and whether the altimetry signal at the bottom provided a good header value. No problems were found in the altimetry headers despite 2 casts having spikes at the bottom. Where there was no other explanation and the check value was still >10, a calculated water depth was used. Changes were made to Water Depth header entries as follows:

* The header reading was changed to that found in the log for casts: 14, 110, 120, 145.
* Changes were made based on log entries for other casts at the same site for casts: 21, 82.
* Changes were made based on sum of maximum depth sampled plus altimetry header – 0.5m: 11, 38, 61, 114.

Changes were made to 10 CLN and 7 SAM files; the latter were averaged again after corrections.

##### Shift

Fluorescence

SHIFT was run on the SeaPoint fluorescence channel in all casts using the usual advance of +24 records. Plots show that the fluorescence offset is reasonably close to the temperature offset after this step.

Dissolved Oxygen

The Dissolved Oxygen voltage channel was aligned earlier. A few casts were checked to see if the alignment looked ok, and it did. No further alignment is needed for the DO concentration channel.

Conductivity

Tests were run on a selection of casts to find the alignment shift best for the 2 conductivity sensors into as judged by noise in T-S space. The best choice was -0.7 records for both primary and secondary channels.

SHIFT was run twice on all SBE911 casts using -0.7 records for the primary and -0.7 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: The only warnings came from the end of cast #34 when the CTD was at the surface or out of the water.

##### Other Comparisons

Experience with these sensors since last factory service –

The pressure, temperature, and conductivity sensors have not been used between the last factory service and this cruise.

The dissolved oxygen sensor used for events #1 to #14 had no previous uses since the last factory service, and the sensor used for the rest of the cruise had been used for a few cruises but with no calibration sampling.

Historic ranges – Profile plots were made with 3-standard deviation climatology ranges of T and S superimposed. Local climatology was not available for the inlet section of the cruise. There was only one excursion from the offshore climatology with temperature slightly low between 200 and 250db at P17. There is no indication of problems with calibrations.

Post-Cruise Calibration – None available.

Repeat Casts –Two casts at P26 taken about 80 minutes apart were compared around 950db and differences in temperature were ~0.002C° and in salinity ~0.0002psu along lines of constant density. This is excellent repeatability.

##### DETAILED EDITING

The primary channels were chosen for editing.

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. Most files required some editing. Exceptions were event #s: 107, 114, 131, 136, 138.

Editing in the inlets was limited as unstable features that were not clearly caused by shed wakes might be real.

Notes about editing applied were added to the files.

After editing, T-S plots were examined for all casts. While some unstable features remained, no further was applied as they were from inlets where they may be due to real conditions.

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

The primary salinity was found to be lower than bottles by about 0.0013psu with a standard deviation of ~0.002psu..If there was any evaporation or desorption of samples it is likely that it is actually reading somewhat higher than it appears, but should still be within ±0.003psu. Recalibration will not be applied.

If, in future, it is ever found necessary to use the secondary salinity for some casts, subtract 0.003psu to bring into line with primary.

File 2022-001-recal1.ccf was prepared to add 0.5db to pressure and to apply dissolved oxygen corrections for the 2 sensors:

CTD DO Corrected = CTD DO \* 1.0168 + 0.0437 (Casts 1-14)

CTD DO Corrected = CTD DO \* 1.0153 + 0.0461 (Casts 21-145)

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 0.00009mL/L for the firsts DO sensor and 0.0006mL/L for the 2nd sensor, with standard deviations of 0.0246 and 0.0233mL/L, respectively. See file 2022-001-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 ~0.07mL/L but the standard deviation was 0.16mL/L. The recalibration was obviously effective, but with a lot of noise. The differences are small right at the surface and in deep water where comparisons are expected to be most error-free. When outliers were excluded based on residuals in a fit of differences versus SBE DO, the average differences was 0.03mL/L with standard deviation 0.05mL/L. The differences are larger than expected from a Line P cruise, so a closer examination was made to find what casts and depths had the most outliers. The following casts were studied in more detail:

* Cast #21 at P4 had SBE DO reading lower than bottles between 50 and 100db, which is unusual both in sign and because there was a 60s wait at those levels. These bottles did not stand out as out of line compared to SBE DO during stops. However, there was an unusually large shift in SBE dissolved oxygen during the stop at 100db. The full cast plot shows a reversal in temperature at about 85-120db on the downcast and a little deeper during the upcast. Given that the SBE DO data were put through a filter to smooth the data due to spiking, it is not surprising there is not a good match between bottles and downcast SBE DO data. These records should not be included in the average.
* Casts 50, 61, 82 (P6 to P26) had outliers to the high side between 125m and 400m. Examination of the full casts shows that high vertical gradients were deeper than closer to shore. The longer waits before firing bottles only extended to 150m but the high gradients went down to at least 200db and were fairly high to 400db. So these outliers should also be removed from the analysis of errors in the SBE DO.
* Casts 118 and 145 (DE09 and KC10) were in protected inlets where we expect poor flushing. The comparison does show many of the bottles from the DE09 cast and some from KC10 do show evidence of incomplete flushing of Niskin bottles. The descent rate was particularly smooth at DE09 which is expected to reduce flushing efficiency.

Those outliers were excluded from consideration in making an error estimate for the SBE DO.

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

±0.40 mL/L from 0-100db except in areas of very large DO gradients

±0.20 mL/L from 100db-400db

±0.05 mL/L below 500db

For more detail see file 2022-001-dox-comp3.xls.

##### Fluorescence Processing

There are were some off-scale fluorescence values in the inlet section of this cruise, so CLEAN was rerun on all casts to replace fluorescence values >14.86 with pad values.

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)

For casts #1-24 that had a lot of spikes, the result is reasonably good but some spikes remain. Those at depth are obvious and unlikely to be misinterpreted by researchers; in shallower water the spikes are greatly reduced so that none stand out as obviously wrong.

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

PAR was removed for casts # 38,43,50,55,61,65,82.

Channel Fluorescence was removed from events 1-21.

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. A few unstable features were found in the inlets, but those are likely real. No other problems were found.

The 2 transmissivity values at 4000db were 60.4 %/m and 96.6%/m (compared to 59.7%/m and 94.3%/m in August 2021 and 60.2%/m and 93.5%/m in February 2021.)

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 ~85% to 185%. As usual the Juan de Fuca values were significant lower than 100%. For the P1-P35 casts, all were between 101% and 104% except for P1 which was 109% and P4 which was 100%. Scott2 was 100% and HAK1 ~105%. For the inlet section values were all very high.

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.

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

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

PAR was also removed for casts # 38,43,50,55,61,65,82.

Fluorescence was no removed as there were no spikes observed during the 10s sampling window.

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 2022-001-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.)

A TSG log was available. A few problems will need to be addressed:

* The flow was off to the TSG on March 5 for a while, starting to slow at about 16:26, turned off at 16:38, some repairs were done, and it was back on at 16:45. Positions continued to be recorded, so the file can be left intact, but bad data will need to be padded for that section. This cannot be done at this stage because there appear to have been significant problems before the flow rate slowed, with lab temperatures lower than intake temperatures. That will have to be investigated later.
* Also noted in the log is the fact that on March 16th it was discovered that positions were not updating. In fact that started at 03:53 on March 13th . The file started on March 16 at 8:45 had no flow to the TSG until 9:24 though there was flow registered to the fluorometer. The fluorescence data look reasonable while lab temperatures do not. Some editing will be required but it is not clear which data are usable and which are not. This will be addressed later.
* There are many NAN entries and spikes. These were changed to -99.

The spreadsheets were adjusted as follows:

* 2 lines of headers were added – channel names and units.
* The first 1708 records were removed as there was no flow and no positions.
* 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. The clean water offset value was 0.081. For previous uses of this equipment it was sometimes found necessary to adjust the offset to obtain reasonable values. A quick comparison was made between the fluorescence values in the TSG file and CTD values around 4.5m from a few casts in variable environments. The CTD values were higher than TSG values by about 10% overall but lower where fluorescence<1ug/L. This is reasonable correspondence given different deployment methods and suggests that the TSG fluorescence parameters are appropriate, though recalibration is possible later in processing. The values are rough estimates:

|  |  |  |
| --- | --- | --- |
| CTD | TSG | CTD/TSG |
| 1.5 | 1.1 | 1.4 |
| 3.8 | 3.0 | 1.3 |
| 0.8 | 0.9 | 0.9 |
| 14.0 | 10.8 | 1.3 |
| 0.6 | 0.9 | 0.7 |
| average |  | 1.1 |

* 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 from the beginning of the first file when there was no flow and no positions.
* 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 and that for March 16 which started well after 00:00.

The break between the two files was very large, so they were not combined.

The files were then converted to IOS Header format with header info added. There are 15 IOS files, each covering all or part of 1 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 2021 0:00:00. (Note that this step leads to problems plotting until REORDER is run.)

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

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

a.) Plots

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

Time-series plots were produced.

There are significant problems with most channels due to flow-rate drops on March 5, 6 and 16, and in the fluorescence channel only on March 17. The flow rates were both full of noise (scale ±0.3) for parts of March 5 even when average values were reasonably high.

The salinity traces are mostly spike-free except for March 5th and 6th which have many spikes with some very large ones (up to 0.1psu). There are also some poor values in sections with low flow on March 5, 6 and 16. The spikes are large and one-sided, possibly due to large bubbles in the loop.

All \*.reo files were copied to \*.edt.

b.) Checking Time Channel

The CTD files were thinned to reduce the files to a single point from the downcast at or within 0.5db of 4.5db. These were exported to a spreadsheet which was saved as 2022-001-tsg-ctd-loop-rosette-comp.xlsx. The first 2 CTD casts did not overlap with TSG records and During casts #1 and #3 and from casts #97 to #134 there were no TSG data available. There are 42 points of comparison.

The TSG files were averaged over 12 records (1 minute) 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 2022-001-tsg-ctd-loop-rosette-comp.xlsx.. The same file was thinned to the closest times to loop files and added to the TSG-Loop comparison. There were 28 loop samples that overlapped with TSG records. (In one case there was a TSG record but all data were padded.)

A comparison was made of positions for the CTD and TSG data 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 median differences were 0.0000º for latitude and 0.0003º for longitude. There were a number of differences> 0.001º with the largest being a difference of 0.0058º in longitude which is unusually large; this occurred in an inlet. The position in the CTD file corresponds to a position in the TSG record from about 5 minutes earlier. There was a change in how position data were downloaded during the latter part of the cruise which may explain the difference. It is not large.

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 had a very large differences:

* TSG Salinity was much lower than that from the CTD for events 136-142 (stations Bur1-Bur6). Differences in Juan de Fuca Strait are fairly large as well. When only the stations from the Line P section were used, the differences are closer to the range expected. The largest differences came from all the sites likely to have large vertical salinity gradients so that slight mismatches in depth of TSG and CTD observations lead to large differences. There is a lot of salinity scatter in the early Line P section as well, which is likely related to the very noisy TSG salinity data on March 5th. This was likely due to a flow problem as the flow rate is very noisy. Shortly after the noisiest section the flow did stop and the water was very rusty on start-up. There may have been some blockage earlier. On March 6th salinity was also noisy until the noise in the flow rate stopped. When only the 15 casts with the lowest standard deviation in the TSG salinity over 1 minute were included, the TSG salinity is lower than the CTD by a median of 0.003psu with a standard deviation of 0.012psu.
* Temperature differences were also out of line until after station P16 with the worst results in the P8-P16 section. This was clearly due to a problem with the intake temperature. The intake temperature was much higher than the CTD temperature and between P8 and P16 it was even higher than the lab temperature. The comparison of the lab temperature to the CTD was in a reasonable range.

When only Line P casts were used excluding P8-P16, the differences were somewhat lower, but still out of line. Finally the 14 casts from P17 to P35 were used and the results were:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Tint-Tctd | Stsg-Sctd | FLtsg/FLctd |
| average | 0.0140 | -0.0039 | 1.22 |
| stdev | 0.0054 | 0.0025 | 0.37 |
| median | 0.0137 | -0.0033 | 1.06 |

Before P17 the intake temperature is clearly not useful and salinity looks out of line in some sections, particularly on March 5th . A look at loop samples may offer clearer answers about salinity. For the casts in the inlets, there is a lot of variability but that is to be expected and the last 2 casts as the ship left the inlets look fairly close to the differences before then. Fluorescence data may be ok.

Heating in the loop usually reduces as temperatures increase. That pattern is seen in the P17 to P35 section but the intake temperature doesn’t change much so the trend is slight.

* Fluorescence was about 10% higher from the TSG than from the CTD for most casts. The two were closer on average in the inlets where CHL was higher, but there was great variability.
* Comparisons of Loop samples and TSG data

There were 29 loop Salinity and Chlorophyll samples of which 11 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 3 for the samples with CHL < 1ug/L. It dropped sharply as CHL increased. It was close to CHL for the few samples in the range 0.8ug/L<CHL<2ug/L and about 30% of CHL for the 2 samples with CHL>5ug/L. This pattern is typical for this type of instrument.

The TSG salinity was lower than the loop samples by a median of 0.0075psu (std dev 0.0213psu). When only P17 to P35 are used it is low by a median of 0.0057 (std dev 0.0028psu). For the underway samples the median is -0.0065psu (std dev 0.0269) and stopped it is -0.0075psu (std dev 0.0038). The difference between the two sets is slight except that the standard deviation is higher while in motion, which is not surprising.

* Comparison of 5m Rosette samples and Loop samples

There were 11 salinity and 9 extracted chlorophyll loop samples taken during rosette casts. There was excellent agreement between the two with the ratio of Loop to Rosette CHL being 0.99ug/L (std dev 0.07) and Loop Salinity being lower than rosette salinity by an average of 0.0009psu (std dev 0.002psu.) The samples all came from between P5 and P35. Loops are clearly useful for comparison with TSG data.

d.) Calibration History

The TSG was serviced and recalibrated shortly before cruise 2022-001; only the 2nd dissolved oxygen sensor and fluorometer has any history available.

* During 2021-001 the TSG fluorescence values were about 32% of fluorescence from the CTD and 74% of the loop CHL samples and loop chlorophyll was about 75% of that from the rosette.
* During 2021-006 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 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.
* During 2021-069 TSG fluorescence values were reasonably close to those from the CTD fluorometer and about 50% of rosette CHL samples when CHL>4ug/L.
* During 2021-008 the TSG fluorescence values were 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.

e.) Conclusions re TSG

1. The TSG clock worked well and position information was available and reliable in the offshore, though there were some larger differences in the inlets which may be related in a change in how positions were recorded late in the cruise.

2. Both flow rates were mostly in a good range, but there were some dropouts and a large section with very noisy signals. There were many large spikes in salinity during that period and fluorescence is noisier than usual. Data look unreliable in that section.

3. The TSG salinity was remarkably close to that from the loops and CTD during the P17 to P35 section. The differences were large in the inlets, as expected due to strong vertical gradients, and fairly high in Juan de Fuca Strait and near the coast. They were also high on March 5 and part of March 6 when the flow rate was noisy. Between P17 and P35, the TSG salinity was lower than the CTD salinity by a median of 0.0033psu and lower than loop salinity by a median of 0.0057psu. There was little difference between comparisons with loops while stopped or underway. The differences from loops are somewhat larger when all data are included. The differences from CTD salinity is 0.0056 if all of Line P is included and by 0.0098psu for P8 to P16, the area where intake temperature was very poor. The intake temperature should not affect the salinity, but P8 to P10 were from the section with noisy flow and if they are excluded the median difference is 0.0071. TSG salinity is expected to read lower than loops or TSG due to bubbles in the loop. There is little evidence of bubbles except in the area with noisy flow rates, but there are likely some and they would lower the TSG salinity. No recalibration is justified.

4. The intake temperature looks poor up to P8 and then gets much worse. At about 9:30 on March 8 the intake temperature dropped suddenly and was higher than the CTD temperature by about 0.014C° between P17 and P35, which is a reasonable result. No recalibration is justified.

5. TSG fluorescence values are close to those from the CTD when fluorescence is >1ug/L; the TSG values are higher than the CTD at the low end of the range. TSG fluorescence was higher than Extracted CHL by up to a factor of 3 for the samples with CHL < 1ug/L and dropped sharply for CHL>0.5ug/L. There were only 2 samples with CHL>5ug/L and TSG fluorescence was about 30% of CHL for those. This is typical performance for this type of sensor.

6. The TSG lab temperature read higher than the TSG intake temperature by a median of 0.685C° degrees and 0.70C° higher than the CTD between P17 and P35; the standard deviation was 0.050C°. Using data from the whole cruise it is somewhat higher at 0.741C°. The larger differences come from the near-shore and inlet casts. Using 0.7C° looks like a reasonable choice

7. The change in intake temperature was very sudden. Looking at the file in detail around that time shows that the ship was slowing down about 10 minutes before the CTD cast at station P17. Intake temperature fell by 1C° in 5s and 1.9C° in 25s. The salinity and lab temperatures dropped slightly at the same time but that was in line with a steady decrease before and after the change in intake temperature. Perhaps the ship slowing or changing direction cleared some debris at the intake.

Routine Fracture was run to split the \*..reo file for March 8 into two parts:

20220308-000000.reo

20220308-092814.reo

Both files were copied to \*.EDT.

f.) Editing

Time-series plots were examined.

Editing was applied to the following files:

20220305 – removed a lot of data where flow was off or very noisy. Salinity was cleaned.

20220306 – removed data when flow was off or “recovering”. Salinity was cleaned.

20220316 - removed data when flow was off or “recovering”.

20220317 – removed fluorescence data when flow to fluorometer off.

20220319 – clean large spike in fluorescence

Two cast lists were prepared – one for the section with bad intake temperature and one for the rest of the cruise.

g.) Calibrate

For the data up to March 8 at 9:28 the following steps were run to create a proxy for the intake temperature:

* ADD CHANNEL was run to add channel Temperature:Primary with the channel values set equal to Temperature:Lab.
* CALIBRATE was applied using file 2022-001-recal-tsg.ccf to subtract 0.70C degrees from channel Temperature:Primary based on the comparison with offshore CTD casts described above.
* REMOVE was run to remove channels Pressure, Temperature:Intake, Temperature:Difference and record #.

For the files from March 8 at 9:28 to the end of the cruise the following step was run:

* REMOVE was run to remove channels Pressure, Temperature:Difference and record #.

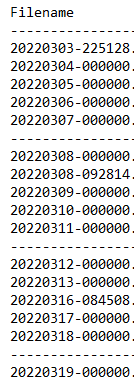
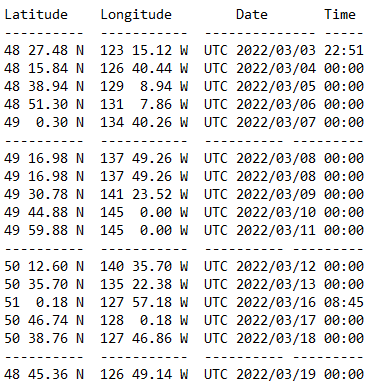
h) Preparing Final Files

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

The TSG sensor history was updated.

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

A cross-reference list was prepared – see below\*.

The cruise # was later added as a prefix to the TSG file names shown above.

Example: 2022-001-20220304-225128.tob

##### Loop File

The Chief Scientist provided file 2022-001 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 2022-001-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; for those done during a CTD cast the time was taken from the end of the cast.

Next data from near-surface rosettes were obtained from the Chief Scientist.

The times were changed to match the end of casts rather than the beginning.

Draw temperature was not included in the file and is not important for this purpose.

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 2022-001-surface-6linehdr.csv.

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

The date formats from the underway loops and rosette samples could not be reconciled. A separate column was created with an Excel date that had to be faked for the loop samples. The file was sorted on that date plus time. The times were often 1 second different between the loops and ROS samples where both were available; the loop times were adjusted to match the ROS times.

CONVERT was run to produce an IOS Header file.

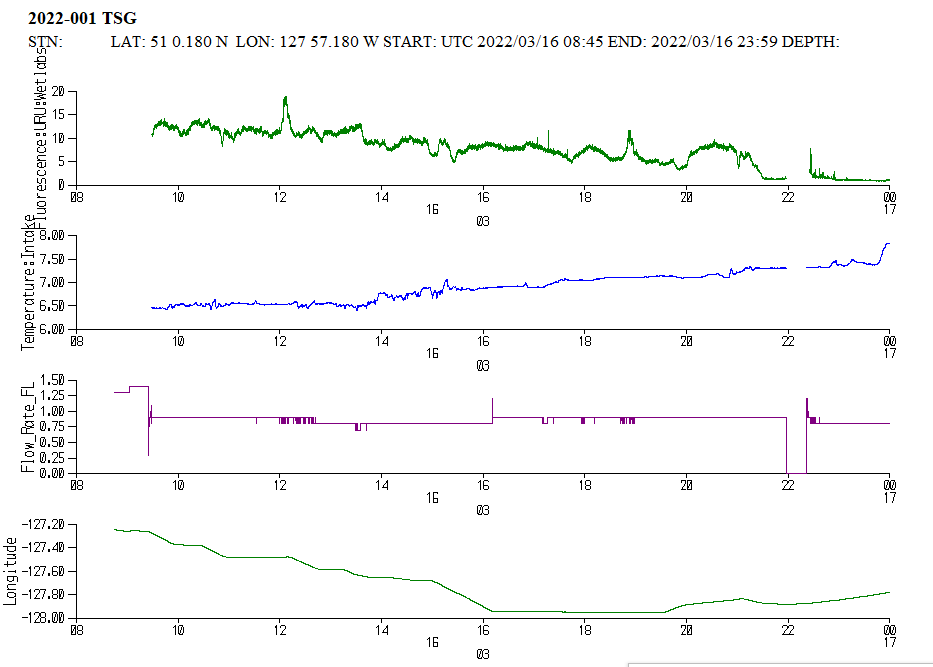
CLEAN was run to get start and stop times and to add flag 0 to empty flag cells.

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 2022-001-surface.loop. The track plots look reasonable and plots of temperature and salinity versus event numbers, latitude and longitude look reasonable.

A question arose about the very high CHL values for Loops 5132 and 5137, especially as they had been flagged 3 due to one rep having not been diluted and the value being out of range. But CTD fluorescence went off-scale at several sites in that area, sometimes to a depth of 7 or 8m. Since the CTD and TSG fluorometers generally read about 25 to 50% of CHL when CHL>5ug/L, it does not seem impossible that CHL values were really as high as 40ug/L.

The plot below shows TSG data from early on March 16th. Unfortunately, the TSG was not running when Loop 5132 was taken, but Loop 5137 was at about 10:34 UTC on March 16th; TSG fluorescence was about 12ug/L at that time. It reached ~19ug/L at about 12:06 on March 16th.



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

PAR off: 38, 43, 50, 55, 61, 65, 82

Casts with bottle fired out of order: 19, 28, 34, 46, 65, 80

Casts with no Niskin closed: 27 and most casts after Line P.

Casts with bottles fired but not sampled: 1

Deployment schemes:

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 LINE P STATIONS:

Niskin bottles closed from 50 to 150 db (both included) had a wait time of 60 seconds

All other Niskin bottles had a wait time of 30 seconds.

For COASTAL STATIONS (INCLUDING Haro59 and JF2):

Niskin bottles closed from 0 to 150 db (both included) had a wait time of 60 seconds

All other Niskin bottles had a wait time of 30 seconds.

TSG notes

16:38 March 5 – TSG stopped. Running again 16:50. Pump or blockage. Very rusty on startup.

04:00 March 13 – record stops and no data found until March 16.

Around 10:00 on March 16 discovered TSG not running. Closed and opened TSG instance on GPSGate. Solved problem.

14:58 – 15:25 March 16 – TSG stopped for repair of hose bib on aft deck saltwater hose.

21:08 March 17 – Fluorometer cleaned.

CTD notes

1 - 14. DO sensor 997

1. Test cast – bottles closed but no sampling. No CHE file required.

1. Niskin #19 top cap leaking. Adjusted and leak stopped. Replaced O-ring on Niskin #24 due to leak.

11. Before this cast a minor primary plumbing issue was fixed in effort to fix problems in DO signals.

12. Wrong depth in header – should be 118. Fixed.

17. Changed to DO sensor 1119. Did not fix problem with DO signal.

27. Before this cast noted that FL also noisy; replaced Y-cable to oxygen sensor and fluorometer and that improved data greatly.

33. Near-tube-lock – Rosette brought out of water by mistake.

34. Niskin 13 closed instead of 7.

34. Left acquisition on at end of cast to get pressure data.

34 & 38. Wrong depth in header, should be ~3235. Fixed.

45. Trans #1185DR parameters corrected in con file.

80. Wrong station name in header should be P26. Fixed.

114. Saved as event #113. Log says 114. Fixed.

116. Forgot to hit “start archive” – sent back to surface and restarted cast.

119. Started archiving while on deck for pressure reference.

120. Surface soak for 1 minute.

**2022-001**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CTD#** | **Make** | **Model** | | **Serial#** | | **Used with Rosette?** | | **CTD Calibration Sheet Competed?** | | |
| **1** | **SEABIRD** | **911+** | | **0550** | | **Yes** | | **Yes** | | |
| **Calibration Information - 0506** | | | | | | | | | | | |
| **Sensor** | | | | | **Pre-Cruise** | | | | **Post Cruise** | | |
| **Name** | | | **S/N** | | **Date** | | **Location** | | **Date** | **Location** | |
| **Temperature** | | | **2106** | | **16Aug2021** | | **Factory** | |  |  | |
| **Conductivity** | | | **2280** | | **20Aug2021** | | **Factory** | |  |  | |
| **Secondary Temp.** | | | **2663** | | **16Aug2021** | | **Factory** | |  |  | |
| **Secondary Cond.** | | | **2754** | | **3Sep2021** | | **Factory** | |  |  | |
| **Transmissometer** | | | **1185DR** | | **28Apr2021** | | **Factory** | |  |  | |
| **Transmissometer** | | | **1883DG** | | **28Apr2021** | | **Factory** | |  |  | |
| **SBE 43 DO sensor** | | | **997** | | **15Oct2021** | | **Factory** | |  |  | |
| **SBE 43 DO sensor** | | | **1119** | | **5Feb2021** | | **Factory** | |  |  | |
| **PAR sensor** | | | **70613** | | **24Feb2021** | | **Factory** | |  |  | |
| **SeaPoint Fluor.** | | | **3949** | |  | |  | |  |  | |
| **Pressure Sensor** | | | **0550** | | **11Oct2021** | | **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** | **12Jan22** | **Factory** |  |  |
| **Conductivity** | **0620** | **12Jan22** | **Factory** |  |  |
| **Wetlabs WETStar Fluor.**  For depths deeper than, and including, 125 dbar, we would wait 30 seconds before closing a bottle. For depths shallower than, and including, 100 dbar, we would wait 60 seconds before closing a bottle. | **1656** | **12Mar2021** | **Factory** |  |  |

