Seabird CTD Data 2023 Cookbook

CANADIAN WATERSHED INFORMATION NETWORK (CANWIN)

Document Control

0.1 Version History

Version	Author(s)	Type	Date Modified	Comments
1.0	Kate Yezhova, Janine Hunt, Pascal Guillot	Working Copy	July 2, 2024	

0.2 Document Location

The **original copy** of this document can be found here: https://cwincloud.cc.umanitoba.ca/cj-mundy/southern-hudson-bay-james-bay-expedition/-/tree/master/datasets/2023/Autonomous%20CTD/data/raw?ref_type=heads

Please contact portalco@umanitoba.ca if access is required.

A **public digital copy** of this document can be found here: https://canwin-datahub.ad.umanitoba.ca/data/dataset/shb-jb-ctd-data-2023

0.3 License

Yezhova, K., Hunt, J., Guillot, P(2024). Seabird CTD Data 2023 Cookbook, Version 1.0. Centre for Earth Observation Science. University of Manitoba.

Contents

1 Introduction

1.1 Critical Summary

This document discusses the processing of the autonomous CTD dataset from the 2023 James Bay and Belcher Islands Expedition. The procedure is based on what Janine and Kate were taught by Pascal, and the SBE Data Processing Manual.

2 Seabird CTD Data Workflow

2.0.1 Scripts/Software Used

Software

The SBE Processing Software was used to process the data. The manual can be found **here.** Page 20 outlines the steps for processing data.

Script Location

The CanWIN GitLab and our Data Catalogue both contain the R scripts used in data processing - (to access Gitlab, submit access requests to the data curator).

2.0.2 Environment Setup

1. Create the following folder structure:
    (a) 2023_wk_auto_ctd_sn7783
        i. logbooks
        ii. originals
        iii. r_scripts
        iv. seabird_psa_and_xmlcon
        v. data
            A. 00_raw
            B. 01_datacnv
            C. 02_section
            D. 03_filter
            E. 04_align
            F. 05_ctmass
            G. 06_loopedit
            H. 07_derive

I. 08_binavg

J. 09_split

K. 10_final

2. Into the logbooks folder, place the ship logbook

3. Into the originals folder, place all original data from the field (data files, logbooks, calibration files, etc.); zipped to prevent accidental modification.

   - Transmissometer zeroing test files created by Jens Ehn during the Churchill Field Course are kept in the originals folder but removed from processing folders.

4. Ensure CTD files all follow the same naming structure, and that the names are consistent with the digital logbook

5. The .xml file of the first cast was compared against the .xml file of the last cast, no differences in configuration or calibration values were found. The .xmlcon file was checked against calibration documents to ensure all values were correct. The .xmlcon file was then checked against the first .xml file to ensure consistency; all checked out until volt channels, not sure where the .xml file takes the offset and slope values from for the volt channels. Only one .xmlcon file was used during the cruise so there should not be issues.

2.1 Raw Data Processing

The raw data files are the **.hex** files. They are converted to **.cnv** files, and go through a series of steps before being converted to their final output format: **.csv**

2.1.1 Data Input

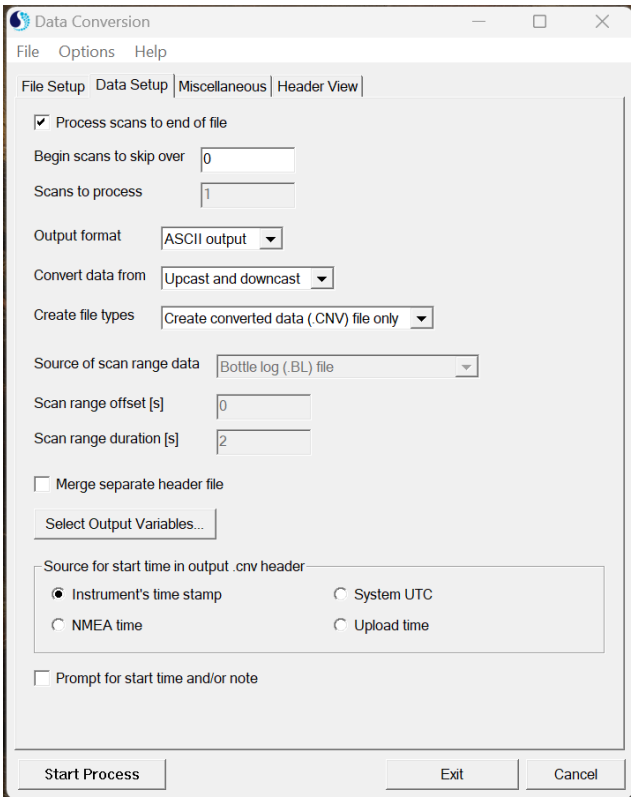
File Type: .hex

File Location: Gitlab location

2.1.2 Steps to Process Raw Data

1. Convert raw .hex files to .cnv files
   (a) SBE Data processing –> **Run** –> **Data Conversion (#1)** –> **File Setup**
      i. Open **01_DatCnv_SN7783_AUTOCTD.psa** file from the ***seabird_psa*** folder
      ii. Under Instrument configuration file, load the ***.xmlcon*** file in the ***00_raw*** folder
      iii. Under Input directory, select all .hex files from “00_raw” folder
      iv. Under Output directory, select “***01_datacnv***” folder
   (b) ... –> Data Setup

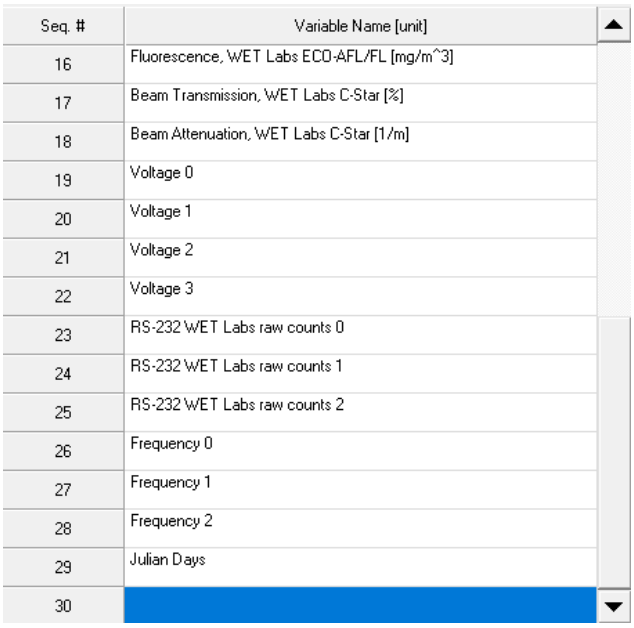
i. *Data Setup Tab*



ii. Click Select Output Variables. . . , and choose the following:

Seq. #	Variable Name [unit]
1	Scan Count
2	Descent Rate [m/s]
3	Pressure, Strain Gauge [db]
4	Depth [salt water, m]
5	Temperature [ITS-90, deg C]
6	Conductivity [mS/cm]
7	Salinity, Practical [PSU]
8	Density [sigma-theta, kg/m^3]
9	Specific Volume Anomaly [10^-8 * m^3/kg]
10	Oxygen raw, SBE 43 [V]
11	Oxygen, SBE 43 [umol/kg]
12	Oxygen, SBE 43 [ml/l]
13	Oxygen, SBE 43 [% saturation]
14	PAR/Irradiance, Biospherical/Licor [umol photons/m^2/sec]
15	Fluorescence, WET Labs CDOM [mg/m^3]

A.



Seq. #	Variable Name [unit]
16	Fluorescence, WET Labs ECO-AFL/FL [mg/m^3]
17	Beam Transmission, WET Labs C-Star [%]
18	Beam Attenuation, WET Labs C-Star [1/m]
19	Voltage 0
20	Voltage 1
21	Voltage 2
22	Voltage 3
23	RS-232 WET Labs raw counts 0
24	RS-232 WET Labs raw counts 1
25	RS-232 WET Labs raw counts 2
26	Frequency 0
27	Frequency 1
28	Frequency 2
29	Julian Days
30	

B.

iii. Click **Start Process**

2. Preparing an Excel sheet for taking notes
   (a) Open the ***01_datacnv*** folder
   (b) Select all files (ctrl+A)
   (c) Hold shift, right click, select copy as path
   (d) Go to excel and paste (Ctrl+V)
   (e) Select **column A**, go to **Find & Select** -> **Replace** -> Type out the beginning of the paths in **find what**, and replace with blank
   (f) Add title row for “cast id, start scan, end scan, notes”
   (g) Save the file, titled “***section.xlsx***”, into the ***logbooks*** folder
3. Plotting casts
   (a) SBE Data Processing –> **Run** –> **Sea Plot (#20)** –> **File Setup**
      i. For Input directory, select all files in ***01_datacnv*** folder
      ii. For Output directory, select any folder (the plots do not get automatically saved)
   (b) –> Plot Setup
      i. Title: datacnv
      ii. For variables, choose the following:
         A. y-axis: pressure
         B. x-axis 1: scan count

C. hide other x-axes

(c) Click **Start Process**

(d) In the plot window select **View** –> **Show Cursor Position**

(e) Record scan # of beginning of downcast (when the CTD comes back up to surface after acclimating at 5̃m depth for 3 minutes), and the end of the upcast (just before the CTD comes out of the water at the end) for each cast in the Excel sheet you created in the previous step.

4. Cutting out soaking period (must go one file at a time)

(a) In SBE Data Processing: **Run** –> **Section (#16)** –> **File Setup**

i. Program setup file: ***03_Section_SN7783_AUTOCTD.psa***

ii. Input: one cast at a time from ***01_datacnv.*** (Definitely not the most time efficient method but the simplest at this point, I am running out of time to test out different MATLAB/R scripts.)

iii. Output: ***02_section*** folder

(b) –> Data Setup

i. Section based on: scan count

ii. Input minimum and maximum value for each cast and click Start Process, one cast at a time

5. Run the ***01_section_check.R*** script to check that the correct values were entered in the Section module and that none of the pressure/depth values ended up being negative (indicating measurements in the air).

6. Run the ***02_pump_check.R*** script to ensure that the pump started working before the downcast began (the pump only starts working once the minimum conductivity frequency is met and the pump delay elapses).

7. Filtering

(a) SBE Data processing –> **Run** –> **Filter (#2)** –> **File Setup**

i. Program setup file: ***04_Filter_SN7783_AUTOCTD.psa***

ii. Input directory: ***02_section*** folder (all casts)

iii. Output directory: ***03_filter*** folder

(b) –> Data Setup

i. Low pass filter A, time constant (s): 1.0

ii. Low pass filter B, time constant (s): 0.5

iii. Specify Filters. . .

A. Clear all

B. Pressure, Strain Gauge (db): Low pass filter A

C. Temperature (ITS-90, deg C): Low pass filter B

D. Conductivity (mS/cm): Low pass filter B

(c) Click **Start Process**

8. Align CTD (advance parameters in time relative to pressure)

(a) SBE Data processing –> **Run** –> **Align CTD (#3)** –> **File Setup**

i. Program setup file: ***05_Align_SN7783_AUTOCTD.psa***

ii. Input directory: ***03_filter*** folder (all casts)

iii. Output directory: ***04_align*** folder

(b) –> Data Setup –> Enter Advanced Values

i. Clear all

ii. Temperature (ITS-90, deg C): +0.5 seconds

- This is the recommended value for SBE19plusV2 in the data processing manual

iii. Conductivity (mS/cm): +0.5 seconds

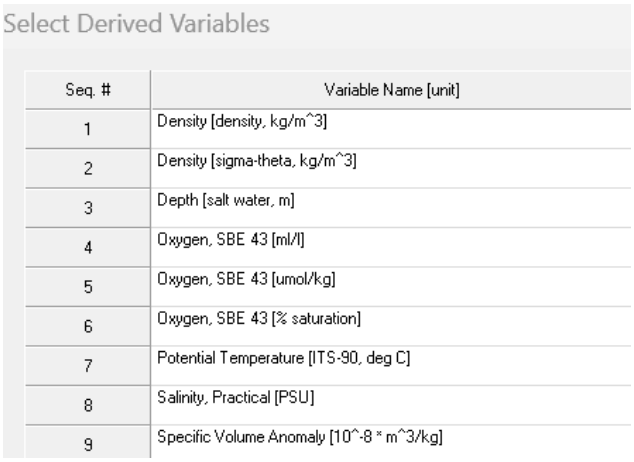
- Note that the manual gives contradicting statements. First statement is: “For an SBE 19plus or 19plus V2 with a standard 2000-rpm pump, do not advance conductivity.” Second statement is: “If temperature is advanced relative to pressure and you do not want to change the relative timing of temperature and conductivity, you must add the same advance to conductivity.”
- Pascal applies a +0.5 second advance to both temperature and conductivity, Pascal’s method will be followed.

iv. Oxygen raw, SBE43 (V): no advance

- The data processing manual suggests +3 to 7 seconds for an SBE19Plus
- Janine noted that this only works if the Oxygen raw, SBE43 (V) variable is being aligned. Janine tried several delays and the 0s delay seemed best for 2021 data.
- Pascal noted that at the beginning, he tried to estimate the right correction. You need to remove the gap between the downcast and upcast because of the long sensor response time. When you are going to apply a correction, you shift all oxygen values X seconds below their original place. Therefore, if you are moving at a speed of 1m/s, a +5 second shift would shift all values 5 m below where they were recorded. For oceanic waters with little variation, this could be okay. But for Arctic waters with chlorophyll maxima and oxygen peaks, this could create a big shift between these two events (SCM and O_2 peak). In Pascal’s opinion, it is scientifically incorrect to create a gap between SCM and O_2 peak. Pascal either does not apply an oxygen correction, or he applies a 0.5s correction (same as for temperature and conductivity).

(c) Click **Start Process**

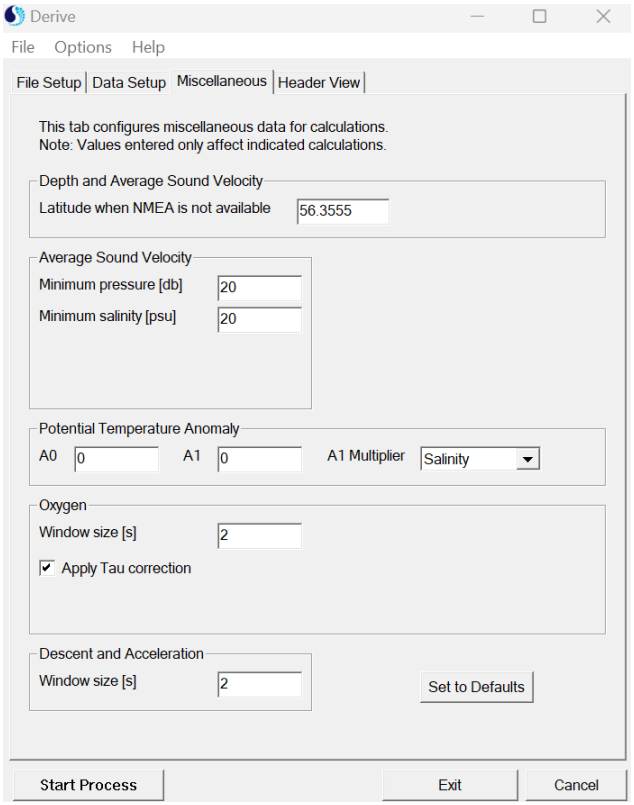
9. Cell Thermal Mass
    (a) As per the data processing manual, “Perform conductivity cell thermal mass correction if salinity accuracy of better than 0.01 PSU is desired in regions with steep gradients. Note: do not use Cell Thermal Mass for freshwater data.”
    (b) SBE Data processing –> **Run** –> **Cell Thermal Mass (#4)** –> **File Setup**
        i. Program setup file: ***06_CTMass_SN7783_AUTOCTD.psa***
        ii. Input directory: ***04_align*** folder (all casts)
        iii. Output directory: ***05_ctmass*** folder
    (c) –> Data setup –> Correct primary conductivity values
        i. Thermal anomaly amplitude (alpha): 0.04
        ii. Thermal anomaly time constant (1/beta) = 8.0
    (d) Click **Start Process**
10. Loop Edit (flags scans with very low and backward velocity)
    (a) SBE Data processing –> **Run** –> **Loop Edit (#5)** –> **File Setup**
        i. Program setup file: ***07_LoopEdit_SN7783_AUTOCTD.psa***
        ii. Input directory: ***05_ctmass*** folder (all casts)
        iii. Output directory: ***06_loopedit*** folder
    (b) –> Data Setup
        i. Minimum velocity type: Fixed minimum velocity
        ii. Minimum CTD velocity (m/s): 0.05. Note that Pascal recommended using velocity < 0.1 m/s (as opposed to the SBE recommended 0.25 m/s).
        iii. Uncheck “Remove surface soak”
        iv. Check “Exclude scans marked bad”
    (c) Click **Start Process**
11. Derive (computes thermodynamic properties based on EOS-80 (practical salinity))
    (a) SBE Data processing –> **Run** –> **Derive (#6)** –> **File Setup**
        i. Program setup file: ***08_Derive_SN7783_AUTOCTD.psa***
        ii. Instrument configuration file: ***AUTO_7783_2023Config.xmlcon***
        iii. Input directory: ***06_loopedit*** folder (all casts)
        iv. Output directory: ***07_derive*** folder
    (b) –> **Data Setup** –> Select **Derived Variables**



i.

(c) –> Miscellaneous

i. Latitude when NMEA is not available: average starting latitude of all casts



(d) Click **Start Process**

(e) Optional step that was not done: Use Derive TEOS-10 (absolute salinity) module to derive variables based on TEOS-10.

12. Bin Average

(a) SBE Data processing –> **Run** –> **Bin Average (#8)** –> **File Setup**

i. Program setup file: ***09_BinAvg_SN7783_AUTOCTD.psa***

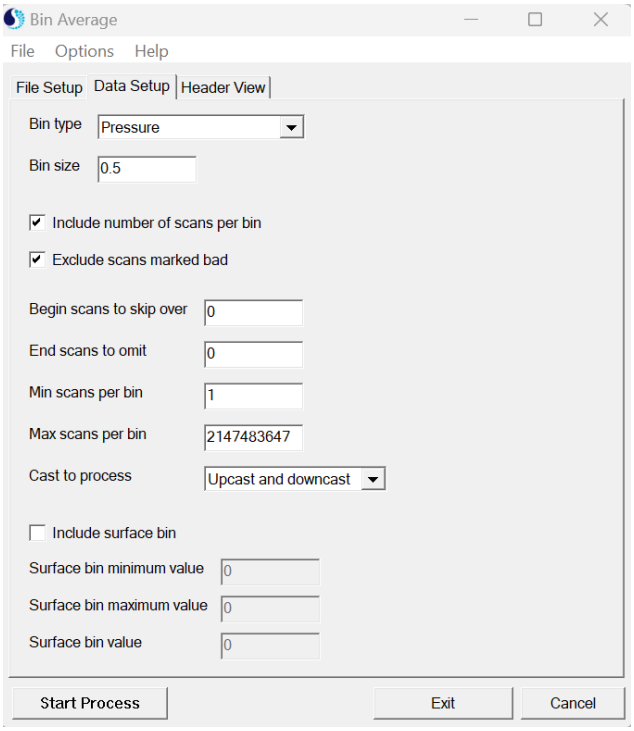
ii. Input directory: ***07_derive*** folder (all casts)

iii. Output directory: ***08_binavg*** folder

(b) –> Data Setup

i. Bin type: Pressure

ii. Bin size = 0.5



(c) Click **Start Process**

13. Split (splitting the downcast from upcast)

(a) SBE Data processing –> **Run** –> **Split (#17)** –> **File Setup**

i. Program setup file: ***10_Split_SN7783_AUTOCTD.psa***

ii. Input directory: ***08_binavg*** folder (all casts)

iii. Output directory: ***09_split*** folder

(b) –> Data Setup

i. Output files: upcast and downcast (it will rename each file for downcast with a “d” and upcast with a “u” in front of the file name)

ii. Check “Exclude scans marked bad”

(c) Click **Start Process**

14. Merging with logbook (using R)
    (a) Run the ***03_final_file.R*** script to merge CTD data with the logbook and output Excel and ODV files.

2.2 Final Output Data

2.2.1 File Details

File Type: .csv

Data Level: 1

File Location: The processed files are located here:

- CanWIN Gitlab

- CanWIN Data Catalogue (under **Data**)

A Reference Tables

A.1 Data Levels

Level 0 – Raw data: unprocessed data and data products that have not undergone quality control. Depending on the data type and data transmission system, raw data may be available within seconds or minutes after real-time. Examples include real-time precipitation, streamflow, and water quality measurements

Level 0.1 – First pass QC: A first quality control pass has been performed to remove out of range and obviously erroneous values. These values are deleted from the record. E.g: Online Environment Canada stream-flow data, laboratory data

Level 1 – Quality Controlled Data: Data that have passed quality assurance procedures such as Level 0.1 and have been further quality controlled by data provider before being submitted to CanWIN (e.g. Idronaut data with only downwelling (upwelling data removed) data included.

Level 1.5 – Advanced Quality Controlled Data: Data have undergone complete data provenance (i.e. standardized) in CanWIN. Metadata includes links to protocols and methods, sample collection details, incorporates CanWIN's or another standardized vocabulary, and has analytical units standardized. Note: Process still under development in CanWIN (as of May 13, 2020).

Level 2 – Derived Products: Derived products require scientific and technical interpretation and can include multiple data types. E.g.: watershed average stream runoff derived from stream-flow gauges using an interpolation procedure.

Level 3 – Interpreted Products: These products require researcher (PI) driven analysis and interpretation and/or model-based interpretation using other data and/or strong prior assumptions. E.g.: watershed average stream runoff and flow using streamflow gauges and radarsat imagery

Level 4 – Knowledge Products: These products require researcher (PI) driven scientific interpretation and multidisciplinary data integration and include model-based interpretation using other data and/or strong prior assumptions. E.g.: watershed average nutrient runoff concentrations derived from the combination of stream-flow gauges and nutrient values.

Content retrieved from https://canwin-datahub.ad.umanitoba.ca/content/dataset-level.

A.2 Result Value Qualifiers

ADL	Above Detection Limit
BDL	Below Detection Limit
FD	Field Duplicate
LD	Lab Duplicate
$	Incorrect sample container
EFAI	Equipment failure, sample lost
FEF	Field equipment failed
FEQ	Field Equipment Questionable
FFB	Failed. Field blank not acceptable
FFD	Failed. Field Duplicate
FFS	Failed. Field spike not acceptable
H	Holding time exceeded
ISP	Improper sample preservation
ITNA	Incubation time not attained
ITNM	Incubation temperature not maintained
JCW	Sample container damaged, sample lost
NaN	Value is missing and reason is not known
NC	Not collected
ND	Not detected
NR	Sample taken/measured on site but information in this field not recorded
NS	Sample collected but not submitted
OC	Master Coordinate List Used
P	Analysis requested and result pending
prob_good	probably good value. Data value that is probably consistent with real phenomena but this is unconfirmed or data value forming part of a malfunction that is considered too small to affect the overall quality of the data object of which it is a part
prob_bad	probably bad value. Data value recognised as unusual during quality control that forms part of a feature that is probably inconsistent with real phenomena
Interpolated	This value has been derived by interpolation from other values in the data object
Q	Below limit of quantification (LOQ). The value was below the LOQ of the analytical method. The value in the result field is the limit of quantification (limit of detection) for the method