STAR 1998 Endeavor CTD PROCESSING

STAR 1998 CTD data files were collected using a Sea-Bird 911*plus* profiling instrument aboard the UNOLS ship Endeavor (ENDV), operated by the University of Rhode Island Graduate School of Oceanography. The 911*plus* consists of the 9*plus* underwater CTD and 11*plus* V2 Deck Unit, which has high resolution sampling (24Hz) and pump-controlled conductivity and temperature flow-through sensors. Data were collected using Sea-Bird's SeaSave Win32 v. 4.233 and have been processed using Sea-Bird's SBE Data Processing v. 7.26.7. More information regarding the SBE software and recommended data processing procedures can be found online at www.seabird.com.

Each CTD directory on the data server contains two folders named Raw and Data. CTD set-up information, pressure test results, and data collected at sea are stored in the Raw folder. All information and files used in processing are saved in the Data folder, including documentation, configuration files, calibration sheets, intermediate processing steps and final data.

The secondary conductivity sensor was changed on the Endeavor CTD after Leg 1 on STAR 1998. The table below lists the sensors used. There was also a WetStar fluorescence sensor, used to collect data on morning casts only, but those data are not considered here. The owners of the sensors were responsible for their maintenance.

	Casts	Temp 1, 2	Cond 1, 2	Pressure
Leg 1	001-046	T2034, T2107	C1745, C0856	64853
Legs 2-5	047-185	T2034, T2107	C1745, C1749	64853

URI/GSO-owned

STAR 1998 ENDEAVOR CTD SENSOR CALIBRATION

SWFSC MMTD uses Sea-Bird Electronics conductivity, temperature and pressure sensors. Sea-Bird Electronics conductivity sensors drift with usage and time, while temperature and pressure sensors drift primarily over time. Annual calibrations of the conductivity and temperature sensors are necessary to estimate and correct for this drift during data processing. Pre and post-cruise calibration certificates for the sensors used during STAR 1998 on the Endeavor are in the \CON_Files\Calibrations folder.

Conductivity, temperature, and pressure are computed as polynomial functions of the sensor frequencies stored in the raw data file. We follow Sea-Bird recommended procedures for adjusting calibration coefficients for drift between calibrations (Sea-Bird App. Note # 31). Details can be found in the internal document "CTD Calibration Adjustments MMTD.pdf".

The Excel spreadsheet, CTDcalibrations STAR 1998_Endv.xlsx, in the Documentation folder contains the pre and post-cruise calibration information for the conductivity, temperature and pressure sensors. It then derives slope or offset values used to correct the calibration coefficients used in the Data Conversion and Derive modules of Sea-Bird's SBE Data Processing software.

The adjusted configuration files used to process the STAR 1998 Endeavor data are in the \CON_Files folder.

Conductivity Sensor Correction:

The SBE 4C series conductivity sensor has a measurement range of 0.0 to 7.0 Siemens/meter (S/m), which spans the conductivity range of SWFSC MMTD's study areas. The SBE 4C sensor is rated to have an initial accuracy of 0.0003 S/m; with a resolution (at 24Hz) of 0.00004 S/m.

The primary conductivity sensor, C1745, was calibrated on 31 March 1998 and 5 February 1999. The difference between the iSlope values at the start and end of the cruise was less than 0.0003, and the iSlope at the end of the cruise was <0.00015 from 1; consequently, no slope calibration adjustment was needed. Pre-cruise calibration coefficients were used to process the data.

The secondary conductivity sensor, C0856, was calibrated on 3 April 1998 and 3 February 1999. The difference between the iSlope values at the start and end of the cruise was less than 0.0003, and the iSlope at the end of the cruise was <0.00015 from 1; consequently, no slope calibration adjustment was needed. Pre-cruise calibration coefficients were used to process the data.

The replacement secondary conductivity sensor, C1749, was calibrated on 23 July 1996 and 3 February 1999. The difference between the iSlope values at the start and end of the cruise was less than 0.0003, and the iSlope at the end of the cruise was <0.00015 from 1; consequently, no slope calibration adjustment was needed. Post-cruise calibration coefficients were used to process the data, because the pre-cruise calibration was more than 2 years prior to the start of the survey.

Temperature Sensor Correction:

The SBE 3*plus* series temperature sensor has a measurement range of -5.0 to 35 °C, which spans the range of temperatures in SWFSC MMTD's study areas. The SBE 3*plus* sensor is rated to have an initial accuracy of ± 0.001 °C and a resolution (at 24 samples per second) of 0.0003 °C.

The primary temperature sensor, T2034, was calibrated on 31 March 1998 and 3 February 1999. The iOffset at the end of the cruise was less than 2mdeg C; consequently, no calibration adjustment was necessary (offset = 0).

The secondary temperature sensor, T2107, was also calibrated on 31 March 1998 and 3 February 1999. No post-cruise calibration offset is available; since the calibrations were 11 months apart we assume that drift was minimal and no calibration adjustment is needed (offset = 0).

Pressure Sensor Correction:

The SBE Paroscientific Digiquartz pressure sensor is rated to have an initial accuracy of 1.02m (i.e., 0.015% of the full scale range, which is 0 – 6800m). We do not exceed a maximum vertical depth of 1100m. Initial resolution (at 24Hz) is 0.068m (i.e., 0.001% of the full scale range).

We have no calibration sheets for this sensor (Sea-Bird serial number unknown, manufacturer's serial number 64853) and no pressure deck tests were performed. Therefore, we use the pre-cruise calibration coefficients that were entered into the data collection CON files.

Comparison of the Primary and Secondary Sensors

Differences between primary and secondary sensors by cast are summarized in Figure 1. Fortran program COMPSENS.EXE (programmer: Paul Fiedler) calculates the mean difference between the primary and secondary sensors for each profile. The output file, compsens98e.dat, is in \Documentation folder. No bottle salinity analyses were performed. Figure 1 shows that the temperature and conductivity values measured by and salinity values derived from the primary and secondary sensors did not differ by more than the desired accuracy of the sensors, except towards the end of Leg 1. Differences were closer to zero after the secondary conductivity sensor was replaced between Legs 1 and 2. The change in T1-T0 at this time cannot be explained. Data from primary sensors will be used for the final CTD data from all legs.

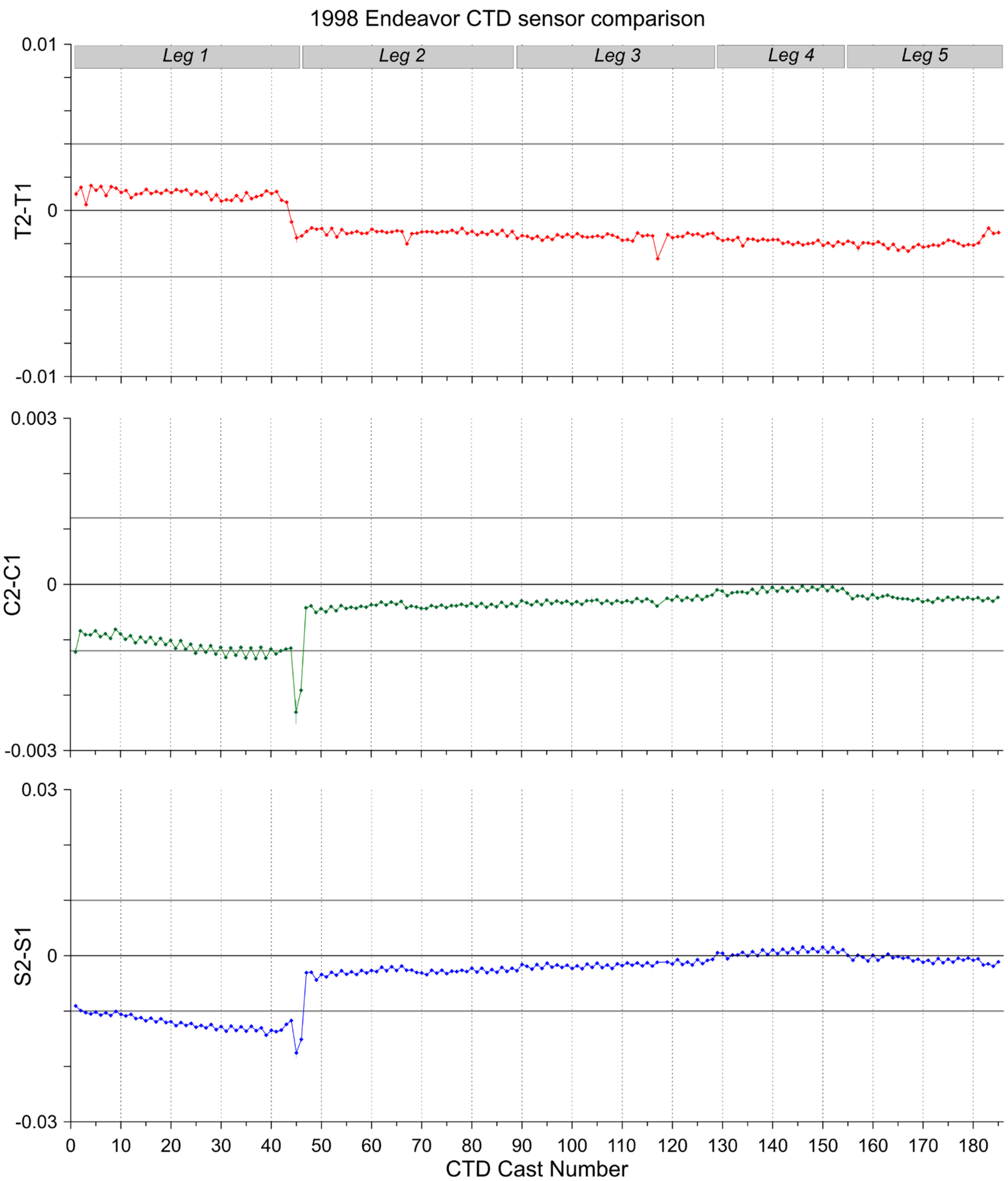


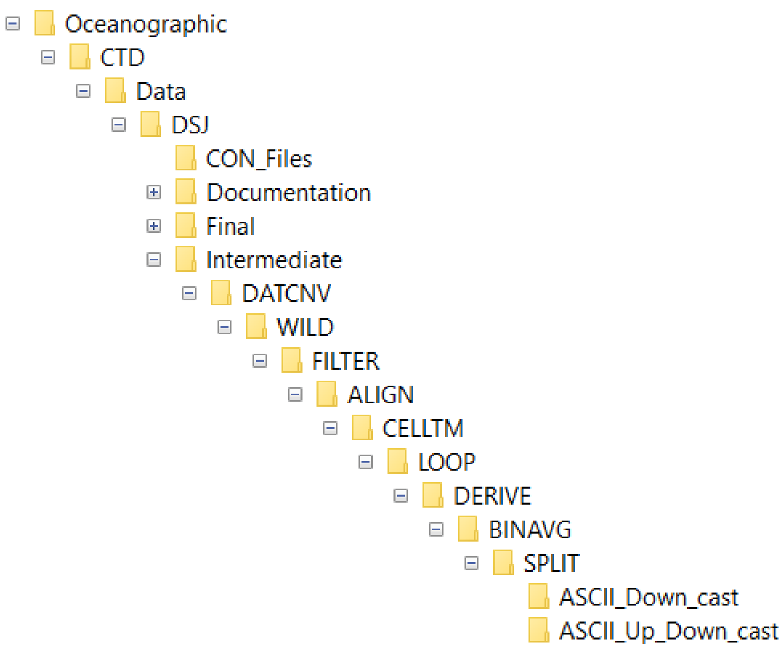
Figure 1. Time series of differences between primary and secondary temperature and conductivity sensors for STAR 1998 Endeavor CTD casts. Each temperature (T2-T1), conductivity (C2-C1), and salinity (S2-S1) difference is a mean of 1m bin-averaged downcast values (excluding the upper 10m and bins with density changes >0.003 σ_t). Gray lines represent desired accuracy (±0.004 ºC, ±0.0012 S/m, ±0.010 psu, which are 4x the specified initial accuracies of the Sea-Bird temperature and conductivity sensors).

We use pre-cruise calibration coefficients for each sensor when available. Before running the processing modules, it is essential to ensure that the correct sensor configuration coefficients and corrections are loaded into the *.con files used by the SBE Data Processing program. Offset and slope adjustments are obtained from CTDcalibrations STAR 1998_Endv.xlsx in the \Documentation folder. The configuration files for processing data from the sensors used on the Endeavor during STAR 1998 are listed in Appendix 1.

STAR 1998 CTD SBE MODULE PROCESSING

The SBE Data processing modules that were applied to the raw data are listed below. Each SBE module creates a program setup file, named *.psa. The *.psa files are located in the folder preceding their output, i.e. the 'Derive.psa' file is found in the 'LOOP' folder. Output .cnv files are kept in binary format to speed processing and reduce file sizes. The final module – ASCII Out – converts the binary data to ASCII format; if examination of the data is needed during earlier processing steps, the Translate module can be used to convert to the binary data to ASCII.

Modules are run in the following order: Data Conversion, Wild Edit, Filter, Align CTD (as needed), Cell Thermal Mass, Loop Edit, Derive, Bin Average, Split, ASCII Out. The processed data in various stages are in the \Intermediate folder:



1. **Data Conversion Module:**

Data Conversion converts raw SBE 911plus data, which are typically stored as frequencies and voltages in the *.dat file, to engineering units and stores the converted data in a *.cnv file.

The options selected for processing in Data Conversion were as follows:

 # name 0 = prDM: Pressure, Digiquartz [db]
 # name 1 = c0S/m: Conductivity [S/m]
 # name 2 = t090C: Temperature [ITS-90, deg C]
 # name 3 = c1S/m: Conductivity, 2 [S/m]
 # name 4 = t190C: Temperature, 2 [ITS-90, deg C]
 # name 5 = wetStar: Fluorescence, WET Labs WETstar [mg/m^3]
 # name 6 = scan: Scan Count

name 7 = nbf: Bottles Fired (because bottle (.ROS) files were created)
name 8 = flag: 0.000e+00
file_type = ascii

Fortran program SCRDATA (programmer: Paul Fiedler) was used to exclude pressure values <-5.0 or >1200, temperature values <-1.0 or >33, and conductivity values <2.5 or >7.0. The program first checks the range or span of values from the primary and secondary sensors in the header file. If any span exceeds the above limits, the program writes a new file in which each bad value, and the values in the two scans preceding and the two scans succeeding the bad value are replaced with a missing value of -9.990e-29. The original file is renamed with an "x" prefix. For each edited file, the total number of scans, and for each sensor, the number of values that exceeded the limits and the number of entries replaced with a missing value are summarized in the *ScrData.dat* files in the \\Intermediate\DATCNV folder. Of 187 CTD files, 109 had no outliers, 39 and 58 had primary or secondary conductivity outliers, 19 and 72 had primary or secondary temperature outliers, and 52 had pressure outliers.

2. Wild Edit Module:

Wild Edit flags outliers in temperature and conductivity data so that they are not used in further processing. Wild Edit's algorithm requires two passes through the data in blocks of *npoint* scans. The first pass computes the mean and standard deviation and temporarily flags values that differ from the mean by more than *pass1_nstd* standard deviations. The second pass recalculates the mean and standard deviation, excluding values flagged in the first pass. Scans that differ from the mean by more than *pass2_nstd* standard deviations are replaced with a bad data flag. The criteria established by *pass2_nstd* can be overridden using *pass2_mindelta*; specifically, if data are within *pass2_mindelta* of the mean, they are not flagged.

The options selected for processing in Wild Edit were as follows for all casts:

wildedit_pass1_nstd = 2.0
wildedit_pass2_nstd = 15.0
wildedit_pass2_mindelta = 0.000e+000
wildedit_npoint = 100
wildedit_vars = c0S/m t090C c1S/m t190C wetStar

These options are Sea-Bird defaults, except that *pass2_nstd* was changed from 20.0 to 15.0 to identify more outliers.

3. Filter Module:

The Filter module is run to reduce high-frequency noise in the pressure data, which is caused by counting jitter or other unknown sources. It is important to remove this noise before running the Loop Edit module. Loop Edit flags data that exhibit a change in the CTD velocity. Velocity is calculated using only three successive scans; consequently, noisy pressure data can result in erroneously flagged scans. Filter runs a low-pass filter on the data, which smoothes high frequency (rapidly changing) data. To produce zero phase (i.e., no time shift), the filter is first run forward through the data and then run backward through the data. Pressure data is typically filtered with a time constant equal to four times the CTD scan rate. We run a low-pass filter on the pressure data with time constant = 0.15 seconds, as recommended by Sea-Bird Electronics Inc.

The options selected for processing in Filter were as follows for all CTD casts:

filter_low_pass_tc_A = 0.030
filter_low_pass_tc_B = 0.150
filter_low_pass_A_vars =
filter_low_pass_B_vars = prDM

4. Align CTD Module:

It is essential that all variables derived from the data, such as salinity, density, and sound speed, use measurements of temperature and conductivity from same parcel of water. Logistically, it is practically impossible to instantaneously measure the same parcel of water with all sensors due to the physical location of the sensors on the unit and the different time delays of the sensors. The typical time delay of conductivity relative to temperature, 0.073 seconds, is automatically corrected by the SBE 11plus Deck Unit during data collection. If spikes are observed in the processed salinity profiles, further alignment of conductivity may be necessary. The Align CTD module can be used to align the conductivity data relative to pressure.

Fortran program TRIALIGN (programmer: Paul Fiedler) was run to find the optimum alignment value for conductivity (i.e., the number of scans by which to shift conductivity relative to temperature). TRIALIGN finds the maximum temperature gradient within a 240-scan window using linear regression; TRIALIGN tests for the gradient using only the first 10,000 scans to ensure data are from the downcast and imposes the criteria that depth must change by at least 5m in the 240-scan window. Conductivity alignments are tested within the region of maximum temperature gradient because misalignment of temperature and conductivity often results in excessive salinity spikes when temperature is changing rapidly. Within the window, conductivity is shifted by -24 to +24 scans. For each shift, salinity is derived from the temperature and conductivity data in each scan and a linear regression is fit to the salinity values. The shift that results in the minimum standard deviation of the regression residuals is selected as the optimal value for that cast. Optimal values for all casts are averaged to obtain a single alignment value for the cruise (one scan is 0.042 seconds).

TRIALIGN gave a mean optimum advances of -0.003 sec (SE=0.0032) for primary sensor, C1745, and +0.056 sec (SE=0.0033) for secondary sensors, C0856 and C1749, (see Trialign0.dat and Trialign1.dat in \FILTER, which have the following columns: CTD file name, pressure (db) at the maximum temperature gradient, maximum temperature gradient (deg C/db), optimal advance (scans), and relative standard deviation of residuals).

The options selected for processing in Align CTD were as follows for all casts:

alignctd_adv = c0S/m -0.003, c1S/m 0.056

5. Cell Thermal Mass Module:

Cell Thermal Mass uses a recursive filter to remove conductivity cell thermal mass effects from the measured conductivity. In areas with large temperature gradients, the thermal mass correction is on the order of 0.005 psu. In areas with small temperature gradients, the correction is negligible.

The following Sea-Bird Electronics Inc. recommendations for Cell Thermal Mass when processing SBE 9plus data, with TC duct, were used:

    # celltm_alpha = 0.0300, 0.0300
    # celltm_tau = 7.0000, 7.0000
    # celltm_temp_sensor_use_for_cond = primary, secondary

6. Loop Edit Module:

Loop Edit flags data that exhibit a change in the mean CTD ascent or descent rate (e.g., pressure reversals or slowdowns). Such changes in ascent or descent rates are usually created by ship heave as the CTD unit is lowered or raised, and indicate unreliable data. Data that have been flagged are documented in the *.cnv header. In this module, we remove any scans that were flagged as bad during data collection. Surface soak was removed in case data collection was started before the CTD had been returned to near the surface after the 10m surface soak.

The options selected for processing in Loop Edit follow the recommendations of Sea-Bird Electronics Inc. for casts:

    # loopedit_minVelocity = 0.250
    # loopedit_surfaceSoak: minDepth = 5.0, maxDepth = 20, useDeckPress = 0
    # loopedit_excl_bad_scans = no

7. Derive Module:

Derive uses pressure, temperature, and conductivity from the input *.cnv file to compute the following oceanographic variables, some of which are routinely used in the assessment of protected species (other variables are available upon request):

- Salinity
- Density (density, sigma-theta, sigma-t, sigma-1, sigma-2, sigma-4)
- Depth (salt water, fresh water)
- Sound velocity (which can be calculated using the Chen-Millero, DelGrosso or Wilson equation)
- Average sound velocity (the harmonic mean from the surface to the current CTD depth, which is calculated on the downcast only)

The following derived variables were calculated in this module for all CTD casts:

name 6 = depSM: Depth [salt water, m], lat = 26.7172
name 7 = potemp090C: Potential Temperature [ITS-90, deg C]

name 8 = sal00: Salinity, Practical [PSU]
name 9 = sigma-é00: Density [sigma-theta, kg/m^3]
name 10 = svCM: Sound Velocity [Chen-Millero, m/s]
name 11 = avgsvCM: Average Sound Velocity [Chen-Millero, m/s], minP = 2, minS = 20
name 12 = svCM1: Sound Velocity, 2 [Chen-Millero, m/s]
name 13 = potemp190C: Potential Temperature, 2 [ITS-90, deg C]
name 14 = sal11: Salinity, Practical, 2 [PSU]
name 15 = sigma-é11: Density, 2 [sigma-theta, kg/m^3]

To calculate average sound velocity, the following values were used:

minimum pressure = 2 db [average depth of the acoustic array]
minimum salinity = 20 psu [recommended Sea-Bird Electronics Inc.]
Latitude = 10 °N [this value is used only if NMEA latitude is not available in the header]

The profiles output by the Derive module were inspected by the Senior Oceanographer for bad data caused by sensor failure, temperature inversions, low surface salinity measurements (likely the result of rain), and spikes in salinity. Comments about each cast are in “STAR 1998 Endeavor CTD Cast info.xlsx” in the \Documentation folder. Comment codes are:

A – acceptable
R – reject cast

8. Bin Average Module:

The bin average module averages temperature, conductivity, pressure, and derived variables in user-selected intervals; the intervals may be defined using pressure, depth, scan number, or time range. We use 1m bins, with no surface bin. In this module, we exclude scans that were flagged as bad in previous modules.

The following processing options were selected in this module for all casts:

binavg_bintype = meters
binavg_binsize = 1
binavg_excl_bad_scans = yes
binavg_surface_bin = no, min = 0.000, max = 0.000, value = 0.000

9. Split Module:

Split separates the data from an input *.cnv file into upcast (pressure decreasing) and downcast (pressure increasing) *.cnv files. Downcast only files are output because they do not contain the data collected when the bottles are fired (e.g., repetitive sampling at the same pressure). Consequently, they are used to derive variables such as thermocline depth and strength.

The following options were selected in this module for all casts:

- # split_excl_bad_scans = no
- # output the downcast only (into the \Split folder). This command adds a ‘d’ at the beginning of the filenames.

10. ASCII Out Module:

ASCII Out outputs the header and/or the data from a binary data file (*.cnv). Data are written to an ASCII file (*.asc), while the header information, which lists each processing module and the variables applied, is written to a separate ASCII file (*.hdr).

This module was run twice. First, to convert the complete cast; second, to convert the downcast-only files created with the SPLIT module.

The following options were selected in this module for all casts:

- # Output Header and Data files
- # Label Column at top of the file
- # Column separator = space

FINAL PRODUCT

ASCII Out outputs the header and/or the data from a binary data file (*.cnv). Data are written to an ASCII file (*.asc), while the header information, which lists each processing module and the variables applied, is written to a separate ASCII file (*.hdr).

ASCII down-cast output files, containing only data recorded by the secondary sensors and no error flags, can be found in the \Final\ASCII_Down_cast folder.

The file headers have been saved separately from the final ASCII data files in both directories. The header files contain time in two separate fields: “System UpLoad Time” and “NMEA UTC (Time)”. The time in the “System UpLoad Time” field is taken from the PC used to the collect the data and may not be accurate (e.g., this field may be recorded in local time, rather than Coordinated Universal Time, and may not have been adjusted for local time zone changes). The Coordinated Universal Time in the “NMEA UTC (Time)” field is taken from the GPS unit and is accurate as long as the GPS functioned properly.

The downcast profile is used to derive variables commonly used in protected species assessments, such as thermocline depth and strength. Plots of complete casts show hysteresis, or depth offsets, of 5-8 m. The error in the depth, as indicated by the offsets, are expected to occur primarily in the upcasts due to “package wake” (i.e., the “shadowing” of the sensors by the rosette and frame as the CTD is pulled up through the water column). Additionally, the upcasts include repetitive sampling of the same depth when bottles are fired to collect water samples.

In total, 184 CTD casts were conducted during STAR 1998 on the Endeavor (not including cast 118). The format of the downcast output files is shown below.

```
  PrDM     C0S/m    T090C  DepSM Potemp090C   Sal00 Sigma-é00    SvCM  AvgsvCM Nbin
 2.011  5.364927  27.6538  2.000   27.6533  33.4438  21.3371  1538.95  1538.95  11
 3.017  5.365673  27.6570  3.000   27.6563  33.4465  21.3381  1538.98  1538.95  24
 4.023  5.365637  27.6561  4.000   27.6551  33.4466  21.3386  1538.99  1538.96  47
 5.028  5.365699  27.6565  5.000   27.6553  33.4465  21.3385  1539.01  1538.97  50
```

The columns are:
PrDM = Digiquartz pressure in decibars (db)
C0S/m = Primary conductivity in Siemens per meter (S/m)
T090C = Primary temperature, in degrees Celsius (ºC), calculated using the ITS-90 standard
DepSM = Salt water depth in meters (m)
Potemp090C = Potential temperature, in degrees Celsius (ºC), calculated using ITS-90
Sal00 = Salinity, in practical salinity units (psu), derived from the primary temperature and conductivity sensors
Sigma-é00 = Density [sigma-theta], in kilograms per cubic meter (kg/m^3), calculated from the temperature sensor and derived salinity
SvCM = Chen-Millero’s sound velocity in meters per second (m/s) calculated from the temperature sensor and derived salinity
AvgsvCM = Chen-Millero’s average sound velocity in meters per second (m/s) calculated from the temperature sensor and derived salinity
Nbin = number of scans per bin

Perl program CTDPositionCheck (programmer: Dan Prosperi) was used to check the CTD cast date/times and positions recorded in the header files against the edited TSG file for the survey. 183 of 184 files had matching TSG records; corrections were mad in 2 files as detailed in \Files_With_Errors_ReadMe.txt.

Paul Fiedler, 25 June 2021

Appendix 1. STAR 1998 Endeavor SBE CTD configuration files used for data processing.

STAR 1998 ENDV 001-046.CON

```
Frequency channels suppressed : 0
Voltage words suppressed      : 3
Computer interface            : RS-232C
Deck unit                     : SBE11plus
Firmware Version >= 5.0
Scans to average              : 1
NMEA position data added      : Yes
NMEA depth data added         : No
NMEA time added               : No
NMEA device connected to      : deck unit
Surface PAR voltage added     : No
Scan time added               : No

1) Frequency 0, Temperature

   Serial number : 2034
   Calibrated on : 31-Mar-98
   G             : 4.12863341e-003
   H             : 6.26898058e-004
   I             : 2.00739673e-005
   J             : 1.96910533e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency 1, Conductivity

   Serial number : 1745
   Calibrated on : 31-Mar-98s
   G             : -4.18267136e+000
   H             : 4.62582344e-001
   I             : -6.74723920e-004
   J             : 5.52297180e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 64853
   Calibrated on : 08-21-96
   C1            : -5.378517e+004
   C2            : -3.498580e-001
   C3            : 1.648580e-002
   D1            : 4.036100e-002
   D2            : 0.000000e+000
   T1            : 2.984744e+001
   T2            : -3.538190e-004
   T3            : 3.972770e-006
   T4            : 2.922330e-009
   T5            : 0.000000e+000
   Slope         : 1.00000000
   Offset        : 0.00000
   AD590M        : 1.125800e-002
   AD590B        : -8.763492e+000

4) Frequency 3, Temperature, 2

   Serial number : 2107
   Calibrated on : 31-Mar-98s
   G             : 4.14738713e-003
   H             : 6.27827312e-004
   I             : 2.09539084e-005
   J             : 2.13916549e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

5) Frequency 4, Conductivity, 2

   Serial number : 0856
   Calibrated on : 03-Apr-98s
   G             : -4.50497624e+000
   H             : 5.44007154e-001
   I             : -1.99267519e-004
   J             : 3.49136426e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

6) A/D voltage 0, Fluorometer, WET Labs
WETstar

   Serial number : WS3S-132
   Calibrated on : 6-11-98
   Blank output  : 0.000
   Scale factor  : 1.000

7) A/D voltage 1, Free

Scan length                   : 28
```

STAR 1998 ENDV 047-185.CON

```
Frequency channels suppressed : 0
Voltage words suppressed      : 3
Computer interface            : RS-232C
Deck unit                     : SBE11plus
Firmware Version >= 5.0
Scans to average              : 1
NMEA position data added      : Yes
NMEA depth data added         : No
NMEA time added               : No
NMEA device connected to      : deck unit
Surface PAR voltage added     : No
Scan time added               : No

1) Frequency 0, Temperature

   Serial number : 2034
   Calibrated on : 31-Mar-98
   G             : 4.12863341e-003
   H             : 6.26898058e-004
   I             : 2.00739673e-005
   J             : 1.96910533e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency 1, Conductivity

   Serial number : 1745
   Calibrated on : 31-Mar-98s
   G             : -4.18267136e+000
   H             : 4.62582344e-001
   I             : -6.74723920e-004
   J             : 5.52297180e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 64853
   Calibrated on : 08-21-96
   C1            : -5.378517e+004
   C2            : -3.498580e-001
   C3            : 1.648580e-002
   D1            : 4.036100e-002
   D2            : 0.000000e+000
   T1            : 2.984744e+001
   T2            : -3.538190e-004
   T3            : 3.972770e-006
   T4            : 2.922330e-009
   T5            : 0.000000e+000
   Slope         : 1.00000000
   Offset        : 0.00000
   AD590M        : 1.125800e-002
   AD590B        : -8.763492e+000

4) Frequency 3, Temperature, 2

   Serial number : 2107
   Calibrated on : 31-Mar-98s
   G             : 4.14738713e-003
   H             : 6.27827312e-004
   I             : 2.09539084e-005
   J             : 2.13916549e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

5) Frequency 4, Conductivity, 2

   Serial number : 1749
   Calibrated on : 03-Feb-99s
   G             : -4.21954197e+000
   H             : 5.32582024e-001
   I             : -6.43045774e-004
   J             : 5.95157506e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

6) A/D voltage 0, Fluorometer, WET Labs
WETstar

   Serial number : WS3S-132
   Calibrated on : 6-11-98
   Blank output  : 0.000
   Scale factor  : 1.000

7) A/D voltage 1, Free

Scan length                   : 28
```