STAR 2003 David Starr Jordan CTD PROCESSING

STAR 2003 CTD data files were collected using a Sea-Bird 911*plus* profiling instrument aboard the NOAA Ship David Starr Jordan (DSJ). 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. 5.28a 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.

Single CTD sensors were used for most of the survey, although a secondary conductivity sensor was added for Legs 5-6. The owners of the sensors were responsible for their maintenance.

	Casts	Temp	Cond 1,2	Pressure
Legs 1-6	001-196	T1448,	C1165, *C1145*	P0311

MMTD-owned, *PRD-owned*

STAR 2003 DSJ 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 sheets for the DSJ sensors used during STAR 2003 are located 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 2003_DSJ.xls, 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 both the "Data Conversion" and "Derive" modules of Sea-Bird's SBE Data Processing procedure. The adjusted configuration files used to process the STAR 2003 DSJ data (Appendix 1) are in the \CON_Files folder. Four different *.con files were necessary to account for the use of a secondary conductivity sensor for casts 123-124, 127-132 and 136-196, and to correct for problems with conductivity sensor C1165. The casts for which each *.con file was used are

included in the file name. Details regarding these problems are provided in the Conductivity Sensor Correction section below.

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.

Sensor C1165 was noted to have failed during cast 113 because conductivity values were low beginning at about 200m on the upcast (Fig. 1), probably due to fouling by large plankton that reduced the volume of the conductivity cell. The cell was cleaned, but when C1165 was sent for post-cruise calibration, Sea-Bird performed an "as received calibration" and concluded that the conductivity cell had failed because of positive drift since the pre-cruise calibration (equivalent to +0.00230 PSU/month, typical drifts are -0.003 PSU/month). They then replaced the conductivity cell and calibrated the sensor "after repair". Casts JD03123 – JD03196, with the exception of casts JD03133 – JD03135, were conducted with an additional conductivity sensor, C1145.There are no notes or photographs of the installation of C1145; it should have been installed with its own pump and CT duct, either without a temperature sensor or alongside temperature sensor T1448 next to C1165. The Trialign results below suggest that C1145 was not paired properly with T1448. For casts conducted using two conductivity sensors, processing was done twice to derive salinity values from both conductivity sensors. The Sea-Bird software only calculates salinity using data from paired conductivity and temperature sensors. To calculate salinity using data from the secondary conductivity sensor, the conductivity column headers in the *.cnv files were switched after the DatCnv module.

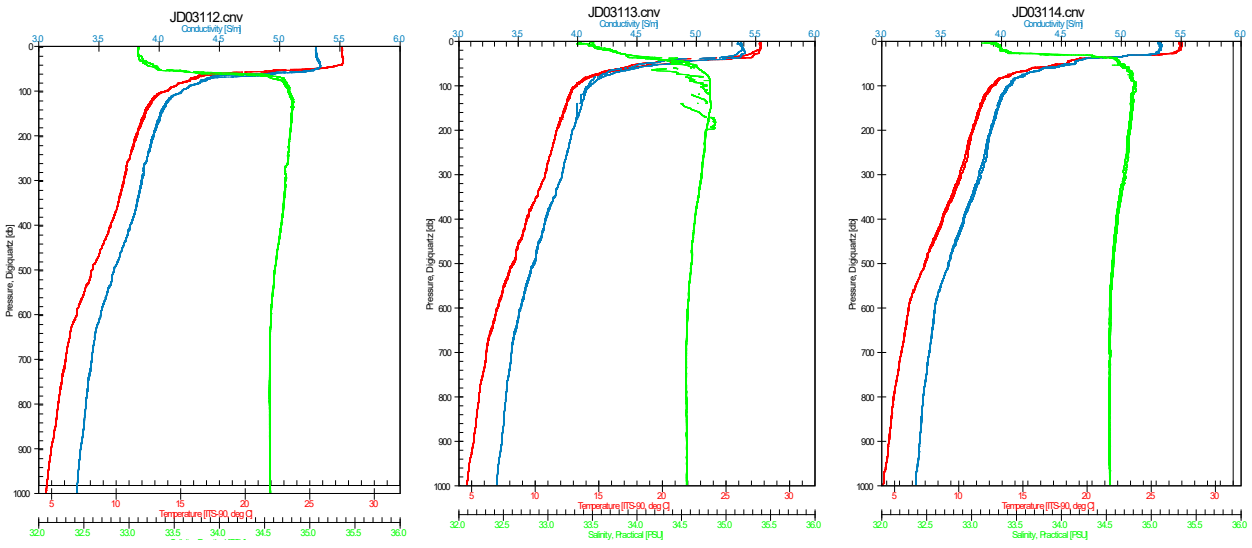


Fig. 1. Plots of casts 112-114, which were derived using the primary conductivity sensor, C1165, with pre-cruise calibration factors. Negative errors in conductivity (blue) and derived salinity (green) are apparent in cast 113 beginning at about 200m on the upcast, probably due to large plankton reducing the volume of the conductivity cell.

The primary conductivity sensor C1165 was calibrated on 24 March 2003 and 27 February 2004. No calibration adjustments were applied for this sensor because of the apparent failure during the cruise. Pre-cruise calibration coefficients were used for casts 1-112 and post-cruise, pre-repair calibration coefficients for casts 113-196.

The secondary conductivity sensor, C1145, was calibrated on 28 January 1999 and 27 February 2004. The post-cruise 2004 calibration coefficients were used during processing because the pre-cruise calibration date occurred too long ago to assume linear drift.

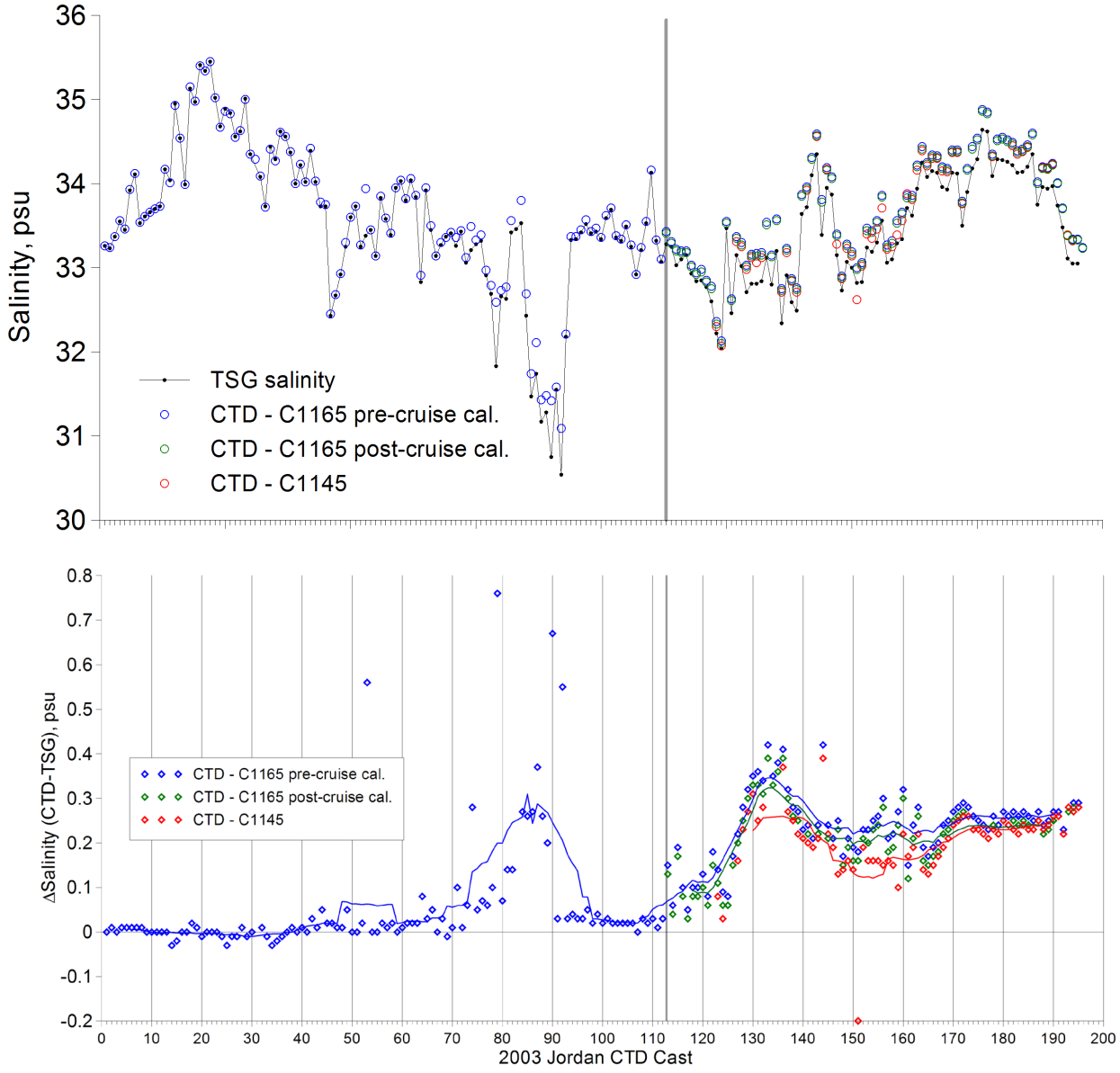


Fig. 2. Time series of salinity values (top) and differences (CTD-TSG, bottom) from the thermosalinograph and from CTD conductivity sensors C1165 and C1145. Colored lines are 11-cast running means. Gray line marks the problem cast (113) for C1165.

Figure 2 compares surface salinity from the thermosalinograph (TSG) to CTD values calculated and derived from C1165 pre-cruise calibration values, C1165 post-cruise calibration values (from cast 113), and C1145 post-cruise calibration values. We interpret the slight increase in salinity differences beginning near cast 113 as TSG error similar to what was observed for casts 70-89; the jump or more pronounced trend beginning at casts 125-126 is a persistent TSG error as explained below. CTD-TSG salinity differences (mean, sd, and range) were as follows:

Casts 1-112	C1165 pre-cruise calibration:	+0.057 ±0.134	-0.03 to +0.76
Casts 113-125	C1165 pre-cruise calibration:	+0.112 ±0.044	+0.05 to +0.19
	C1165 post-cruise calibration:	+0.088 ±0.042	-0.03 to +0.39
Casts 126-196	C1165 pre-cruise calibration:	+0.261 ±0.056	+0.15 to +0.42
	C1165 post-cruise calibration:	+0.240 ±0.057	+0.12 to +0.39
	C1145 post-cruise calibration:	+0.210 ±0.074	-0.20 to +0.39

For casts 1-112, differences between CTD and TSG salinities were not significantly different from zero; the occasional large differences could be due either to CTD or TSG errors. For casts 113-125, the mean C1165 salinity difference doubled, but was not significantly different from what it had been before. However, for casts 126-196, CTD salinities are consistently higher than TSG salinities, no matter what sensor or calibration data are used. It is unlikely that both conductivity sensors would have nearly the same error starting two weeks and a port call after the problem observed with C1165 in cast 113. Pre- and post-cruise calibrations for the TSG conductivity sensor indicate excessive drift; we conclude that the TSG conductivity cell fouled at this time and that the CTD-TSG salinity differences do not represent CTD errors.

Final cast 113-196 salinity profiles use C1165 post-cruise calibration conductivities. The considerations behind this decision are as follows:

1) Surface salinities from the two sensors differ by an average of 0.03±0.46 psu, but there is no way to assess which data are more accurate without good bottle salinities.
2) There are no C1145 data for deriving salinity in casts 113-122 and 133-135.
3) The lag needed to align the C1145 secondary conductivity data with the primary temperature was extreme, probably because it was not properly paired with T1448 (see Align below).
4) C1145 has only 5 outlier conductivity values in two casts (see the discussion of the ScrCond program in the Data Conversion Module) compared to 18,580 outlier values for C1165 in 19 casts from casts 113-196 (the cast 1-112 frequency of outliers was similar). Almost all of these outliers occurred at the surface; if the outliers were not excluded by ScrCond (see Data Conversion below), most would be excluded when the surface soak is removed in the Loop Edit module.

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 temperature sensor, T1448, was calibrated on 15 April 2003 and 27 February 2004. The average iOffset was -0.001812 °C; no offset adjustment was needed.

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).

CTD pressure deck tests are stored in the \Raw\DSJ\Pressure_tests folder.

The digiquartz pressure sensor P0311 was calibrated on 17 June 1993 and 21 October 2005. The iOffset value at the start of the DSJ STAR 2003 cruise was -3.123db.

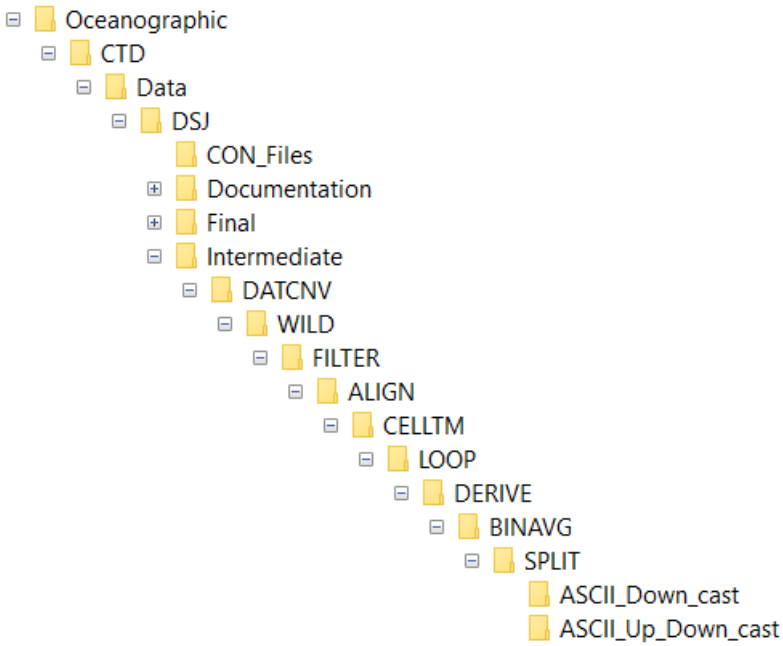
Five deck tests were conducted on the DSJ during STAR 2003 resulting in offsets of -3.37, -3.67, -3.69, -3.70, -3.42 db; the results of these tests were consistent. Therefore, the average deck test offset of -3.568 db was used in the *.con file.

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 2003_DSJ.xlsx in the \Documentation folder. Configuration files for the sensors used on the DSJ during STAR 2006 are listed in Appendix 1.

STAR 2003 CTD SBE MODULE PROCESSING

The SBE Data processing modules that were applied to the raw STAR 2003 DSJ data are listed below. Each SBE module creates 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 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 this module are as follows for all casts:

Output Format = ASCII
name 0 = prDM: Pressure, Digiquartz [db]
name 1 = c0S/m: Conductivity [S/m]
name 2 = t090C: Temperature [ITS-90, deg C]
name 3 = flag: 0.000e+00

For all casts after JD030123 the following were added:

name 3 = c1S/m: Conductivity, 2 [S/m]
name 4 = flag: 0.000e+00 [flag converts to # name 4]

Fortran program SCRDATA 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 196 files, 132 had no outliers, 2 had pressure outliers, 61 had primary conductivity outliers, and 3 had secondary conductivity 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 temporarily flagged values. Scans that differ from the mean by more than *pass2_nstd* standard deviations are replaced with a flag signaling that they are bad data. 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 this module are as follows for all casts:

```
# wildedit_pass1_nstd = 2.0
# wildedit_pass2_nstd = 15.0
# wildedit_pass2_mindelta = 0.000e+000
# wildedit_npoint = 100
```

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 smooths 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 this module are as follows for all casts:

```
# filter_low_pass_tc_A =
# 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).

Inspection of the DSJ 2003 CTD profiles suggested that no further alignment of the primary conductivity sensor C1165 was necessary. Nevertheless, C1165 was aligned with a delay of 0.003 seconds (# alignctd_adv = c0S/m -0.003, TRIALIGN gave a mean optimum advance of -0.003 sec, SE=0.0027, see Trialign0.dat in /FILTER, which has 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 secondary conductivity sensor, C1145, was aligned with a delay of 0.718 seconds (# alignctd_adv = c1S/m -0.718, TRIALIGN gave a mean optimum advance of -0.718 sec, SE=0.0065, see Trialign1.dat in /FILTER). This is an excessive delay, because C1145 was not paired with a secondary temperature sensor; the primary temperature sensor was paired with C1165.

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 steep temperature gradients, the thermal mass correction is on the order of 0.005 psu. In areas with shallow temperature gradients, the correction is negligible.

The following Sea-Bird Electronics Inc. recommendations for module selections when processing SBE 9plus, with TC duct, data were used for all casts:

celltm_temp_sensor_use_for_cond = primary
celltm_alpha = 0.0300, 0.0000
celltm_tau = 7.0000, 0.0000

For all casts after JD030123 the following were added:
celltm_temp_sensor_use_for_cond = secondary

celltm_alpha = 0.0300, 0.0000
celltm_tau = 7.0000, 0.0000

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 the 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.

The options selected for processing in this module follow the recommendations of Sea-Bird Electronics Inc. for all casts:
loopedit_minVelocity = 0.250
loopedit_surfaceSoak: minDepth = 1.0, maxDepth = 5, useDeckPress = 0
loopedit_excl_bad_scans = yes

7. Derive Module:

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

- Depth
  Potential temperature
  Salinity
- Density
- Sound velocity
- Average sound velocity (harmonic mean from surface to current depth on the downcast)

The following processing options were selected in this module for all casts:
name 3 = depSM: Depth [salt water, m], lat = 10
name 4 = potemp090C: Potential Temperature [ITS-90, deg C]
name 5 = sal00: Salinity, Practical [PSU]
name 6 = sigma-é00: Density [sigma-theta, kg/m^3]
name 7 = svCM: Sound Velocity [Chen-Millero, m/s]
name 8 = avgsvCM: Average Sound Velocity [Chen-Millero, m/s]

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 by 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 \Documentation\ DSJ_2003_CTD_cast_comments.xls. Comment codes are:

A – acceptable
inv – temperature inversion
R – reject cast

An additional spreadsheet containing detailed comments about casts and sampling is in \Raw\Survey_Prep\Documents\CTDcastinfo03.xls.

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 we 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_skipover = 0
binavg_omit = 0
binavg_min_scans_bin = 1
binavg_max_scans_bin = 2147483647
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 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, 196 CTD casts were conducted during STAR 2003 on the DSJ. The format of the output files containing one conductivity sensor is shown below.

PrDM	C0S/m	T090C	DepSM	Potemp090C	Sal00	Sigma-é00	SvCM	AvgsvCM	Nbin
1.006	4.432587	18.4894	1.000	18.4892	33.2600	23.8196	1515.26	-443.31	24
2.011	4.436674	18.5321	2.000	18.5317	33.2595	23.8086	1515.40	873.90	41
3.017	4.432737	18.4908	3.000	18.4902	33.2595	23.8189	1515.29	1533.11	54
4.023	4.432556	18.4882	4.000	18.4875	33.2597	23.8197	1515.30	1515.27	41

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
Sal00 = Salinity, in practical salinity units (psu), derived from the primary temperature and conductivity sensors

DepSM = Salt water depth in meters (m)
Sigma-é00 = Density [sigma-theta], in kilograms per cubic meter (kg/m^3), calculated from the primary temperature sensor and derived salinity
SvCM = Chen-Millero's sound velocity in meters per second (m/s) calculated from the primary temperature sensor and derived salinity
AvgsvCM = Chen-Millero's average sound velocity in meters per second (m/s) calculated from the primary temperature sensor and derived salinity
Nbin = Scans averaged 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. 194 of 196 files had matching TSG records; no corrections were necessary.

Paul Fiedler, 17 June 2021

Appendix 1. STAR 2003 DSJ SBE CTD configuration files used for data processing.

STAR 2003 DSJ Cast 1-112.con

```
Frequency channels suppressed : 2
Voltage words suppressed      : 4
Computer interface            : RS-232C
Deck unit                     : SBE11plus
       Firmware Version >= 5.0
Scans to average              : 1
NMEA position data added      : No
NMEA depth data added         : No
NMEA time added               : No
Surface PAR voltage added     : No
Scan time added               : No

1) Frequency 0, Temperature

   Serial number : 1448
   Calibrated on : 15-Apr-03
   G             : 4.82378400e-003
   H             : 6.72078279e-004
   I             : 2.58845731e-005
   J             : 2.06298431e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0018

2) Frequency 1, Conductivity

   Serial number : 1165
   Calibrated on : 24-Mar-03
   G             : -4.15172983e+000
   H             : 5.71081691e-001
   I             : 1.10668858e-003
   J             : -2.75060266e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 53561
   Calibrated on : 06-17-1993
   C1            : -4.123560e+004
   C2            : 1.043267e+000
   C3            : 1.330030e-002
   D1            : 4.018400e-002
   D2            : 0.000000e+000
   T1            : 3.020637e+001
   T2            : 4.924132e-005
   T3            : 3.833950e-006
   T4            : 6.451910e-009
   T5            : 0.000000e+000
   Slope         : 1.00000000
   Offset        : -3.56820
   AD590M        : 1.167000e-002
   AD590B        : -8.165620e+000
```

STAR 2003 DSJ Cast 113-122_133-135.con

```
Frequency channels suppressed : 2
Voltage words suppressed      : 4
Computer interface            : RS-232C
Deck unit                     : SBE11plus
       Firmware Version >= 5.0
Scans to average              : 1
NMEA position data added      : No
NMEA depth data added         : No
NMEA time added               : No
Surface PAR voltage added     : No
Scan time added               : No

1) Frequency 0, Temperature

   Serial number : 1448
   Calibrated on : 15-Apr-03
   G             : 4.82378400e-003
   H             : 6.72078279e-004
   I             : 2.58845731e-005
   J             : 2.06298431e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0018

2) Frequency 1, Conductivity

   Serial number : 1165
   Calibrated on : 24-Mar-03
   G             : -4.15172983e+000
   H             : 5.71081691e-001
   I             : 1.10668858e-003
   J             : -2.75060266e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 53561
   Calibrated on : 06-17-1993
   C1            : -4.123560e+004
   C2            : 1.043267e+000
   C3            : 1.330030e-002
   D1            : 4.018400e-002
   D2            : 0.000000e+000
   T1            : 3.020637e+001
   T2            : 4.924132e-005
   T3            : 3.833950e-006
   T4            : 6.451910e-009
   T5            : 0.000000e+000
   Slope         : 1.00000000
   Offset        : -3.56820
   AD590M        : 1.167000e-002
   AD590B        : -8.165620e+000
```

STAR 2003 DSJ Cast 125-126.con

```
Frequency channels suppressed : 2
Voltage words suppressed      : 4
Computer interface            : RS-232C
Deck unit                     : SBE11plus
       Firmware Version >= 5.0
Scans to average              : 1
NMEA position data added      : No
NMEA depth data added         : No
NMEA time added               : No
Surface PAR voltage added     : No
Scan time added               : No

1) Frequency 0, Temperature

   Serial number : 1448
   Calibrated on : 15-Apr-03
   G             : 4.82378400e-003
   H             : 6.72078279e-004
   I             : 2.58845731e-005
   J             : 2.06298431e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0018

2) Frequency 1, Conductivity

   Serial number : 1165
   Calibrated on : 24-Mar-03
   G             : -4.15172983e+000
   H             : 5.71081691e-001
   I             : 1.10668858e-003
   J             : -2.75060266e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 53561
   Calibrated on : 06-17-1993
   C1            : -4.123560e+004
   C2            : 1.043267e+000
   C3            : 1.330030e-002
   D1            : 4.018400e-002
   D2            : 0.000000e+000
   T1            : 3.020637e+001
   T2            : 4.924132e-005
   T3            : 3.833950e-006
   T4            : 6.451910e-009
   T5            : 0.000000e+000
   Slope         : 1.00000000
   Offset        : -3.56820
   AD590M        : 1.167000e-002
   AD590B        : -8.165620e+000
```

STAR 2003 DSJ Cast 123-124_127-132_136-196.con

```
Frequency channels suppressed : 0
Voltage words suppressed      : 4
Computer interface            : RS-232C
Deck unit                     : SBE11plus
       Firmware Version >= 5.0
Scans to average              : 1
NMEA position data added      : No
NMEA depth data added         : No
NMEA time added               : No
Surface PAR voltage added     : No
Scan time added               : No

1) Frequency 0, Temperature

   Serial number : 1448
   Calibrated on : 15-Apr-03
   G             : 4.82378400e-003
   H             : 6.72078279e-004
   I             : 2.58845731e-005
   J             : 2.06298431e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0018

2) Frequency 1, Conductivity

   Serial number : 1165
   Calibrated on : 27-Feb-04
   G             : -4.14764854e+000
   H             : 5.66657987e-001
   I             : 2.18629692e-003
   J             : -9.49195130e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 53561
   Calibrated on : 06-17-1993
   C1            : -4.123560e+004
   C2            : 1.043267e+000
   C3            : 1.330030e-002
   D1            : 4.018400e-002
   D2            : 0.000000e+000
   T1            : 3.020637e+001
   T2            : 4.924132e-005
   T3            : 3.833950e-006
   T4            : 6.451910e-009
   T5            : 0.000000e+000
   Slope         : 1.00000000
   Offset        : -3.56820
   AD590M        : 1.167000e-002
   AD590B        : -8.165620e+000

4) Frequency 3, Free

5) Frequency 4, Conductivity, 2

   Serial number : 1145
   Calibrated on : 27-Feb-04
   G             : -4.20591883e+000
   H             : 4.64704892e-001
   I             : -1.52341574e-004
   J             : 3.02146382e-005
```

```
CTcor          : 3.2500e-006
 CPcor         : -9.57000000e-008
 Slope         : 1.00000000
 Offset        : 0.00000
```