

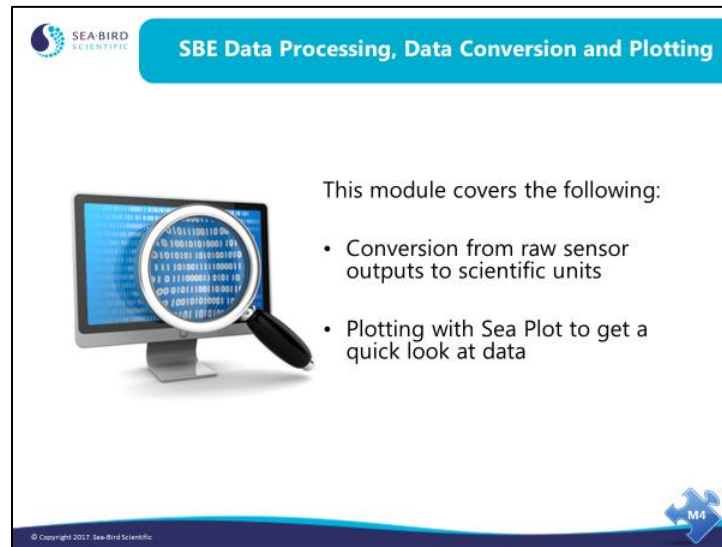


Short Introduction to SBE Data Processing,  
Data Conversion and Plotting

Sea-Bird Scientific University Module 4



## Overview



The slide features the SEA-BIRD SCIENTIFIC logo in the top left corner. The title 'SBE Data Processing, Data Conversion and Plotting' is displayed in a blue header bar. The main content area includes an image of a computer monitor with a magnifying glass over a section of binary code (0s and 1s). To the right of the image, the text reads 'This module covers the following:' followed by two bullet points. The bottom right corner contains a blue puzzle piece icon with 'M4' written on it, and the bottom left corner has a small copyright notice: '© Copyright 2017, Sea-Bird Scientific.'

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### SBE Data Processing, Data Conversion and Plotting

This module covers the following:

- Conversion from raw sensor outputs to scientific units
- Plotting with Sea Plot to get a quick look at data

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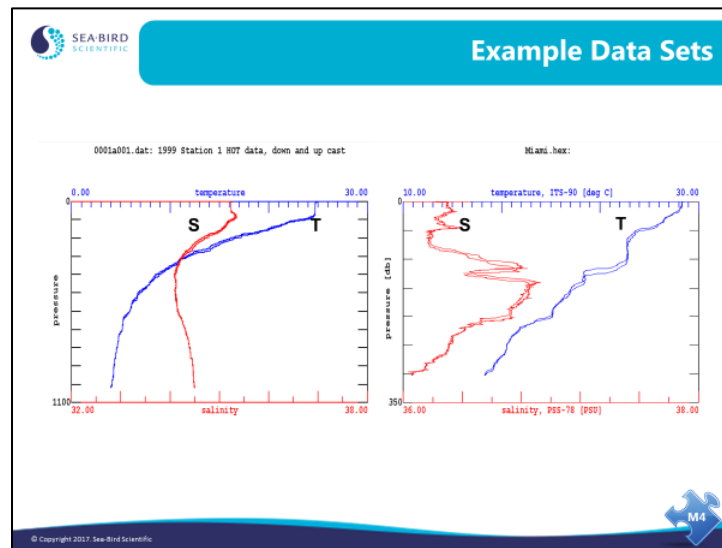
M4

In this module we will cover the data processing basics, no fancy stuff. With this information you can go from raw data file to something you can print or plot.

When we finish this module you should be able to:

- Run *Data Conversion* and convert your raw data to scientific units.
- Run *Sea Plot* to display your work.

## Basic Data Processing: Example Data



Here are Seave plots of some data collected on Hawaii Ocean Time-series cruise 101 and a cruise between Miami and Bimini on a RSMAS vessel.

## Activity: View Example Data in Seasave

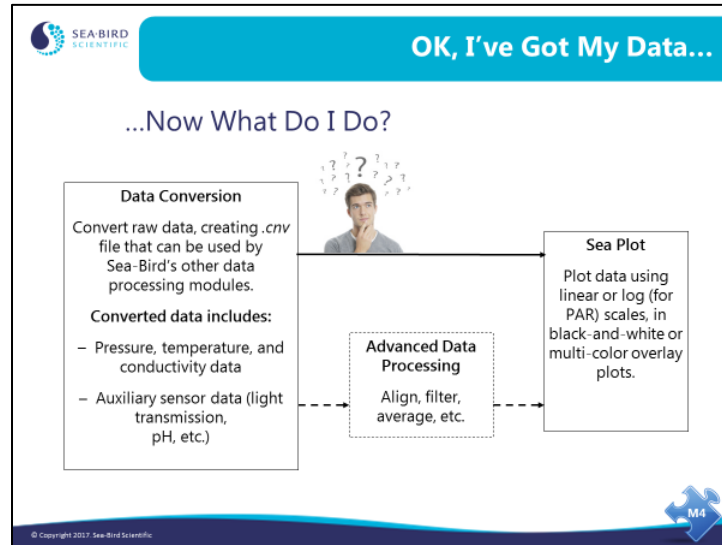
1. Click Start / Programs / Sea-Bird / SeasaveV7.
2. Click *Configure Inputs*, and select 911*plus* configuration file:  
C:\Data\Module3\Hawaii.con
3. Right click on the plot and select *Modify*. Set up the plot with 1 Y and 2 X axes:
  - A. Y Axis: *Pressure, Digiquartz* -> *db*, 0 to 1200 decibars.
  - B. X Axis 1: *Temperature* -> *ITS-90* -> *deg C*, 0 to 30 degrees C.
  - C. X Axis 2: *Salinity, Practical*, 34 to 36 PSU.
  - D. Click *OK*.
4. Click *Archived Data* -> *Start*:
  - A. Click *Select Data File*. Select C:\Data\Module3\Hawaii.dat and click *Open*.  
Note: This data file has a *.dat* extension because it was created with an older version (<6.0) of Seasave; the current version always creates *.hex* files, but it can play back archived *.dat* data
  - B. Click *Start*.
5. Click *Archived Data* -> *No Wait* to speed up the display.

---

If you have time, plot SBE 19*plus* data (use C:\Data\Module3\SBE19plus\Miami.hex and C:\Data\Module3\SBE19plus\Miami.con):

- Y axis: *Pressure, Strain Gauge* -> *db*, 0 to 350 decibars
- X axis: *Temperature* -> *ITS-90* -> *deg C*, 10 to 30 degrees C
- X axis: *Salinity, Practical*, 36 to 38 PSU

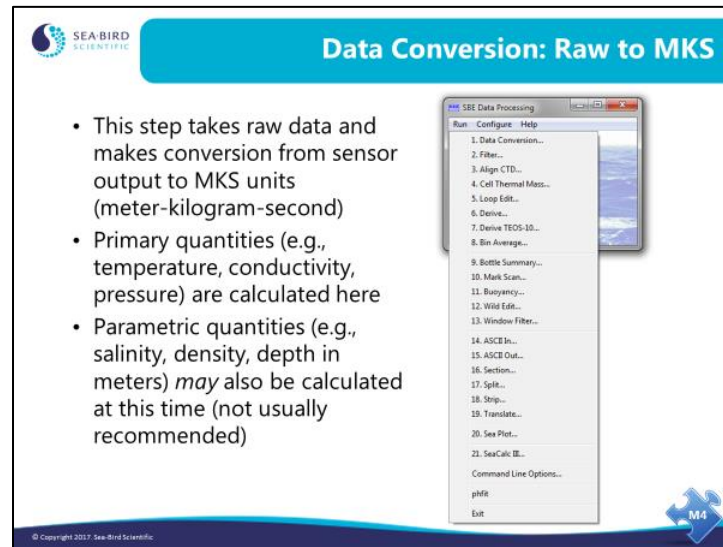
## Data Processing: Flow Chart



Data processing involves operating on your raw data (which came from the sensors attached to the instrument) to convert it from the sensor outputs to scientific units, calculate any additional oceanographic parameters of interest, and reduce the data set to a tractable size. **It is always the best practice to archive your raw data, because there is no going backwards once you have processed it.** Should you discover calibration errors, omit necessary parameters, or make processing errors, it is imperative to return to your raw data set.

Sea-Bird's data processing program, SBE Data Processing, includes a number of modules for processing data. For now, we will only look at Data Conversion and Sea Plot. In Module 9, we will discuss other modules for advanced data processing, including aligning, filtering, remove cell thermal mass errors, removing ship heave errors, and bin averaging data.

## Data Conversion: Software



The screenshot shows the SBE Data Processing software interface. The title bar reads 'SBE Data Processing'. The menu bar includes 'Run', 'Configure', and 'Help'. The 'Run' menu is open, displaying a list of options: 1. Data Conversion..., 2. Filter..., 3. Align CTD..., 4. Cell Thermal Mass..., 5. Loop Edit..., 6. Derive..., 7. Derive TEOS-10..., 8. Bin Average..., 9. Bottle Summary..., 10. Mark Scan..., 11. Buoyancy..., 12. Wild Edit..., 13. Window Filter..., 14. ASCE In..., 15. ASCE Out..., 16. Section..., 17. Split..., 18. Strip..., 19. Translate..., 20. Sea Plot..., 21. SeaCalc II..., Command Line Options..., pH#, and Exit. A blue arrow icon with 'M4' is visible in the bottom right corner of the software window.

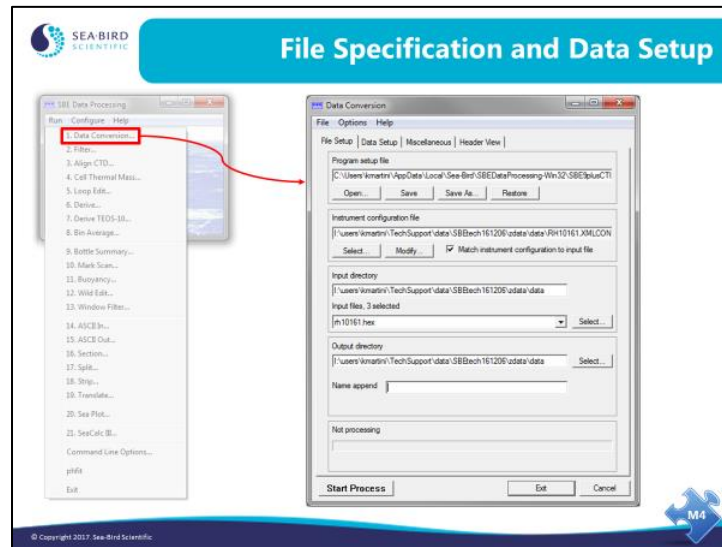
- This step takes raw data and makes conversion from sensor output to MKS units (meter-kilogram-second)
- Primary quantities (e.g., temperature, conductivity, pressure) are calculated here
- Parametric quantities (e.g., salinity, density, depth in meters) *may* also be calculated at this time (not usually recommended)

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Data Conversion takes your raw data (.dat or .hex) file and, with the information contained in the configuration (.con or .xmlcon) file, converts it to scientific units. The form the converted data takes is set up in the SBE Data Processing Data Conversion dialog. In addition to quantities like temperature and conductivity, parameters that are calculated from these, such as salinity and density, are also available. **If you plan to do more advanced processing of your data, you should wait until the advanced processing is complete before calculating parameters derived from the measured parameters.**

**Reminder about software revisions:** In 2009, Seasave and SBE Data Processing introduced the *.xmlcon* file, written in XML format. The software allows you to open a *.con* **or** *.xmlcon* file, and to save the configuration to a *.con* **or** *.xmlcon* file. We'll use *.con* files for some of the exercises in the class, but *.xmlcon* files provide the same results.

## Data Conversion: Software (*continued*)



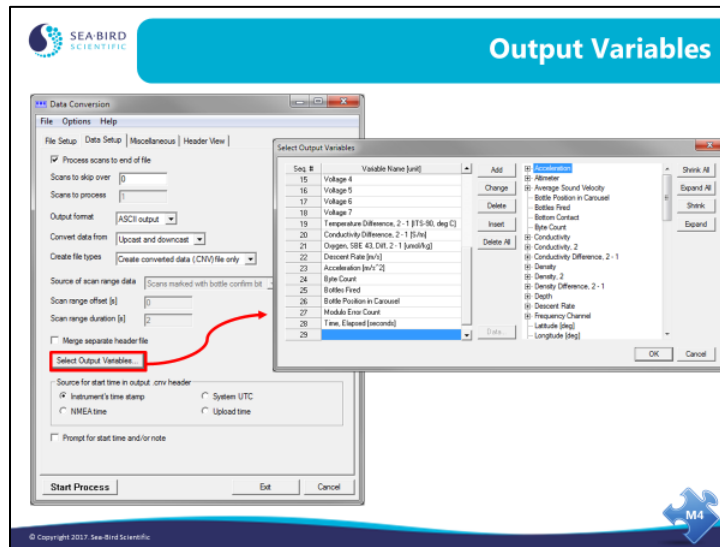
The program setup (.psa) file contains information regarding how the program was set up the last time you used it. This relieves you of the task of choosing the variables and other processing options. In addition, if you have more than one preferred processing protocol, you can store them as separate .psa files. As always, you must select the appropriate .con or .xmlcon file for your instrument. You can select multiple files for processing; a separate .cnv file will be created for each file that is processed.

You can process all or part of the data file and skip the beginning (during the time you were checking your instrument before the cast). You can convert the whole cast or just the downcast. If you collected water samples, you can generate a file containing some CTD scans that were collected while the water bottle was being closed. The means of determining where these scans should come from are:

- If using a CTD with an SBE 32 Carousel or SBE 55 ECO for real-time acquisition and bottle fire control, Seasave writes a .bl file that contains the information required.
- For internally recording instruments with an AFM and SBE 32 Carousel, or internally recording instruments with an SBE 55 ECO, the file uploaded from the AFM or ECO (an .afm file) can be used.
- For the 9plus with 17plus SEARAM and SBE 32 Carousel, or a 9plus with a 11plus Deck Unit and G.O. 1015 water sampler, the data stream is marked with a status bit when the bottle closure occurs.
- A .bsr file can be made from a .mrk file (collected while running Seasave) with the Mark Scan module.

Once you have settled on the source of information for indicating bottle closure times, you have to select the amount of data to be included in the file for each closure. *Scan range offset* is how far back Data Conversion looks in your data stream in seconds and *Scan range duration* is how long it looks, again in seconds. For example, an offset of -5 seconds and duration of 10 seconds means you will get 5 seconds of data before the bottle closure and 5 seconds after the closure, for a total of 10 seconds of data.

## Data Conversion: Software (*continued*)

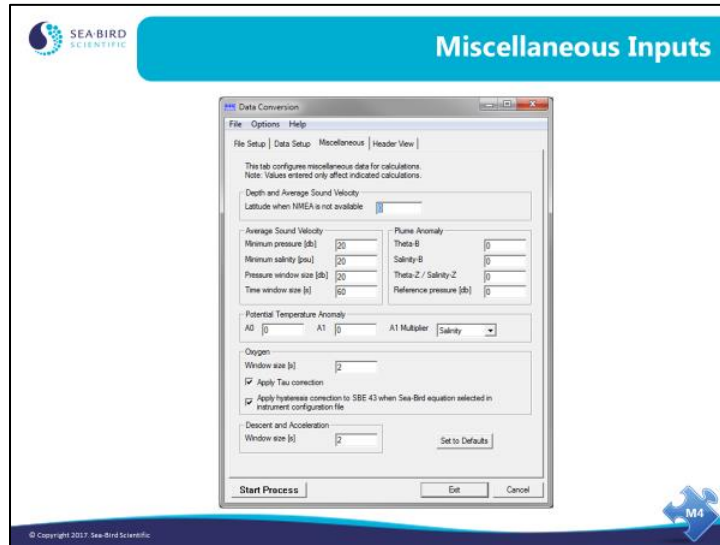


The output variables dialog allows you to select a table of items that will be calculated and the order in which they will be calculated.

Note that the list on the right reflects the information in the selected configuration (.con or .xmlcon) file – only data measured by the sensors indicated in the configuration file, and data that can be calculated from those measurements, are available for output. Data that can be calculated from the measurements are included in Data Conversion to allow you to get a quick look at the derived variables. However, if you plan to do more advanced processing of your data, you should wait until the advanced processing is complete before outputting parameters derived from the measured parameters.

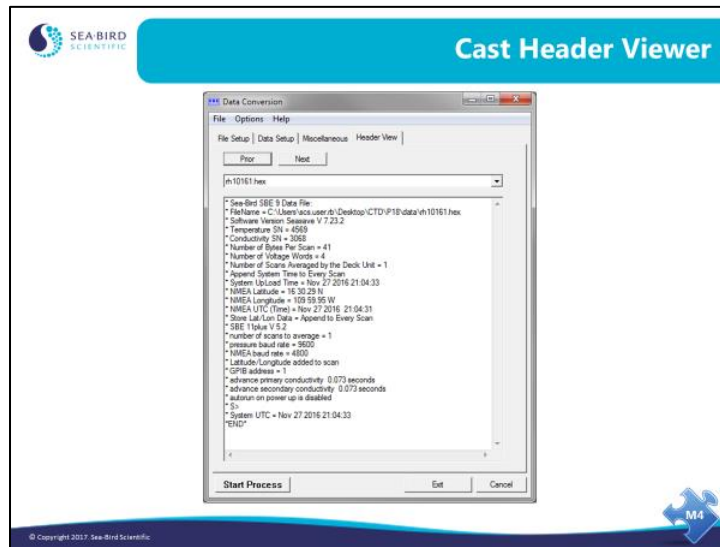


## Data Conversion: Software (continued)




The Miscellaneous tab defines additional parameters required for output of specific variables, such as depth, average sound velocity, and oxygen. Entries on this tab are used only if you are calculating and outputting the associated variables to the .cnv file. For example, if you do not select converted Oxygen (for example, *Oxygen*, *SBE 43*) in the Select Output Variables dialog box, Data Conversion ignores the value entered for Oxygen window size on the Miscellaneous tab.

## Data Conversion: Software (continued)




The header view can reassure you that you are working with the instrumentation you think you are.

## Data Conversion: File Headers Revealed



What's a Header?

- Header is placed at the beginning of each data file
  - Header for internally recorded data is written when the data is uploaded from the instrument
  - Header for real-time data is written before the data is recorded
  - These lines are preceded with an \*
  
- Operator comments are added to the header; these lines are preceded with an \*\*
  
- Headers are updated each time data in the file is manipulated
  - Update contains information relevant to how the data was manipulated
  - These lines are preceded with an #




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```
* Sea-Bird SBE 9 Raw Data File:
* FileName = H:\tests\USERS\mikev\Tau Test 2.hex
* Software Version Seasave Win32 v%s
* Temperature SN = 4022
* Conductivity SN = 4022
* Number of Bytes Per Scan = 14
* Number of Voltage Words = 0
* System UpLoad Time = Jun 11 2001 09:51:47
** Ship: RV TestBath
** Cruise: Tau test
** Station: Bellevue WA
** 11 Jun 01 bath 0 Tau Test with 19plus #2
# nquan = 3
# nvalues = 2596
# units = specified
# name 0 = timeS: Time, Elapsed [seconds]
# name 1 = tv290C: Temperature [ITS-90, deg C]
# name 2 = flag: 0.000e+00
# span 0 = 0.000, 648.750
# span 1 = 1.7905, 6.5876
# span 2 = 0.0000e+00, 0.0000e+00
# interval = seconds: 0.25
# start_time = Jun 11 2001 09:51:47
# bad_flag = -9.990e-29
# sensor 0 = Frequency 0 temperature
# sensor 1 = Frequency 1 conductivity, 4022, 25-Apr-01, cpcor = -9.5700e-08
# sensor 2 = Pressure Voltage
# datcnv_date = Jun 11 2001 10:39:01, 1.00
# datcnv_in = H:\SBE University\data\19p tau test\Tau Test 2.hex H:\SBE
University\data\19p tau test\4022.con
# datcnv_skipover = 0
# file_type = ascii
*END*
```

SBE Data Processing 7.20a and later: Data Conversion now adds calibration coefficient information, in XML format, to header, just above # datcnv lines.

## Data Conversion: What files does the software output?




**Data conversion:  
What files does the software output?**

*The data conversion module outputs human-readable data files and bottle files.*

- .cnv Data Files
  - Contains continuous profile of data.
  - Standard data format for physical and biogeochemical ocean studies.
- .ros Bottle Files
  - Contains segments of data when water sample bottles are triggered.
  - Used for comparing water samples to system sensor data.

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## Data Conversion: Output File Formats

**Data Conversion Output: .cnv Data File**

```
# datcnv_date = Jun 25 2001 10:21:54, 5.2
# datcnv_in = HOT101\0001a001.dat HOT101\S1C1\0001a001.con
# datcnv_skipover = 12000
# file_type = ascii
*END*
10.115  24.7800  5.3146  0.000e+00
10.178  24.7799  5.3142  0.000e+00
10.170  24.7798  5.3143  0.000e+00
10.115  24.7799  5.3144  0.000e+00
```

↑ P (db)   
 ↑ T (°C)   
 ↑ C (S/m)   
 ↑ Error flag

M4

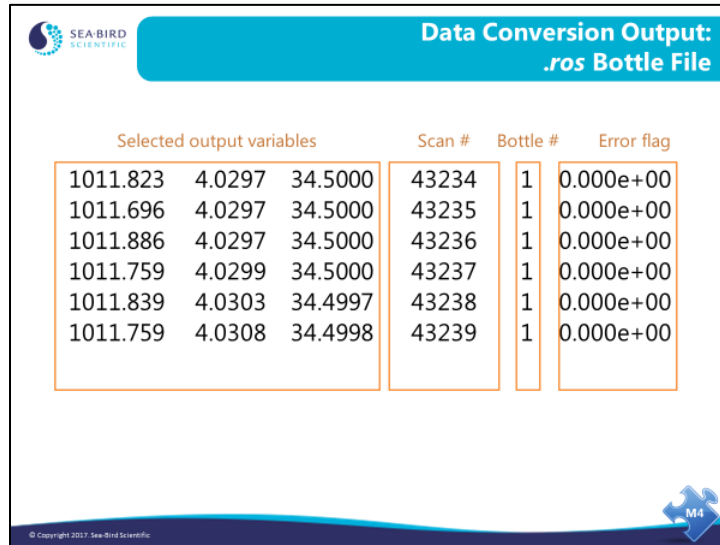
```
* Sea-Bird SBE 9 Raw Data File:
* FileName = D:34-8.DAT
* Software Version 4.0.b.g
* Temperature SN = 1123
* Conductivity SN = 915
* Pressure SN = 43440
* Number of Bytes Per Scan = 15
* System UpLoad Time = January 24, 1992 3:39:09 pm
** Ship: R/V Poseidon
** Cruise: 189-1a
** Station: 34
** Cast: 8
** Latitude: 35 22.00' N
** Longitude: 12 43.36' W
** Second set of CTD trials, station 34 cast 8, SBE Mk3 Mk5a Mk5b.
# nquan = 5
# nvalues = 77205
# units = metric
# name 0 = depS: depth, salt water [m]
# name 1 = t068: temperature, IPTS-68 [deg C]
# name 2 = c0S/m: conductivity [S/m]
# name 3 = flag: 0.000e+00
# span 0 = 1.519, 3555.084
# span 1 = 2.4822, 17.1124
# span 2 = 3.257845, 4.669567
# span 3 = 0.0000e+00, 0.0000e+00
# interval = seconds: 0.0416667
# start_time = Jan 24 1992 15:39:09
# bad_flag = -9.990e-29
# sensor 0 = Frequency 0 temperature, 1123
# sensor 1 = Frequency 1 conductivity, 915, cpcor = -9.5700e-08
# sensor 2 = Frequency 2 pressure, 43440
# sensor 3 = Extrl Volt 0 oxygen, current, 130259
# sensor 4 = Extrl Volt 1 oxygen, temperature, 130259
# datcnv_date = Jun 22 2001 16:19:48, 4.249
# datcnv_in = 34-8.DAT 34-8.CON
# datcnv_skipover = 0
# file_type = ascii
*END*
1.636  16.9770  4.654863  36.4699  0.000e+00
1.691  16.9784  4.655062  36.4703  0.000e+00
```

Selected output variables / headings for columns of data below (error flag column added automatically by Data Conversion).

Note: If you plan to process the data with other modules, select only the primary variables to be converted in Data Conversion, then process data with other modules, and then use Derive to compute derived parameters such as salinity, density, sound velocity, oxygen, etc.

SBE Data Processing 7.20a and later: Data Conversion now adds calibration coefficient information, in XML format, to header, just above # datcnv lines.

## Data Conversion: Output File Formats (*continued*)



Selected output variables	Scan #	Bottle #	Error flag
1011.823 4.0297 34.5000	43234	1	0.000e+00
1011.696 4.0297 34.5000	43235	1	0.000e+00
1011.886 4.0297 34.5000	43236	1	0.000e+00
1011.759 4.0299 34.5000	43237	1	0.000e+00
1011.839 4.0303 34.4997	43238	1	0.000e+00
1011.759 4.0308 34.4998	43239	1	0.000e+00

The data conversion process also writes a file with data collected while water bottles were being closed. You choose the time window of data you want written to the file. For example, you might select to have all scans collected starting 5 seconds before the bottle closes and ending 5 seconds after the bottle closure written to the file. The .ros file contains the selected output variables as well as the scan number and associated bottle number for the output scans. Like the .cnv file, the .ros file also contains an error flag column.

We will discuss the use of this data in correction of CTD conductivity data in the advanced data processing topics.

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## Activity: Convert Example Data in SBE Data Processing

1. Click Start / Programs / Sea-Bird / SBEDataProcessing-Win32.
2. In SBE Data Processing, select *Run -> 1. Data Conversion*.
3. On File Setup tab:
  - A. *Instrument configuration file*: Click *Select*. Navigate to C:\Data\Module3\Hawaii.con and click *Open*.
  - B. *Input file (data file)*: Click *Select*. Navigate to C:\Data\Module3\Hawaii.dat and click *Open*.
4. On Data Setup tab:
  - A. Select *Process scans to end of file*.
  - B. *Skip over 0 scans*.
  - C. Select *output format ascii*.
  - D. *Convert data from upcast and downcast*.
  - E. Select *Create .cnv file only*.
  - F. Click *Select Output Variables* button  
Click 1st Variable Name. Select *Pressure, Digiquartz -> db*. Click *Add* or *Change*.  
Click 2nd Variable Name. Select *Temperature -> ITS-90 -> deg C*. Click *Add* or *Change*.  
Click 3rd Variable Name. Select *Conductivity -> S/m*. Click *Add* or *Change*.  
Click OK.
5. On File Setup tab, for Program setup file click *Save As . . .*, and save file as C:\Data\Module3\HawaiiDatCnv.psa.
6. Click *Start Process*.
7. Open the .cnv file in Notepad or Wordpad, and take a look at the header and data.

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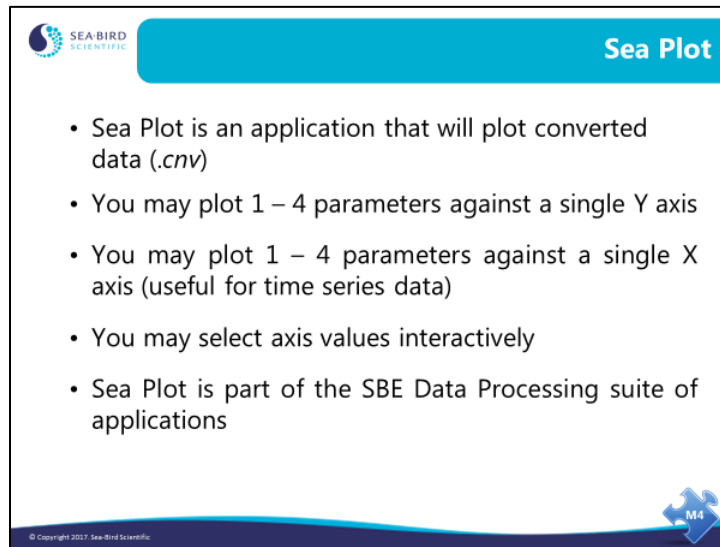
If you have time, convert SBE 19plus data (use C:\Data\Module3\SBE19plus\Miami.con and C:\Data\Module3\SBE19plus\Miami.hex):

- *Pressure, Strain Gauge -> db*
- *Temperature -> ITS90 -> deg C*
- *Conductivity -> S/m*

---

*We thank the Hawaii Ocean Time Series program and the Rosenstiel School of Marine and Atmospheric Science for sharing this data with us.*

## Sea Plot: Display Converted Data



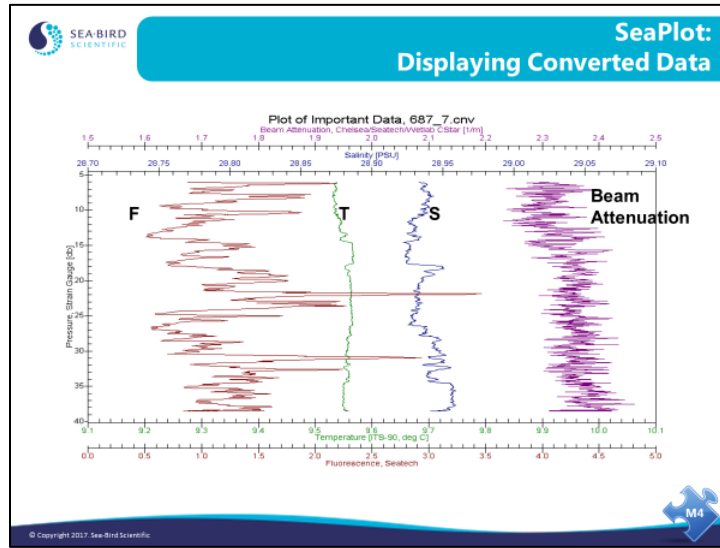
The image shows a slide titled "Sea Plot" from the SEA-BIRD SCIENTIFIC suite. The slide contains a list of bullet points describing the application's capabilities. The slide has a blue header with the SEA-BIRD SCIENTIFIC logo and the title "Sea Plot". The footer includes a copyright notice and a blue puzzle piece icon labeled "M4".

- Sea Plot is an application that will plot converted data (.cnv)
- You may plot 1 – 4 parameters against a single Y axis
- You may plot 1 – 4 parameters against a single X axis (useful for time series data)
- You may select axis values interactively
- Sea Plot is part of the SBE Data Processing suite of applications

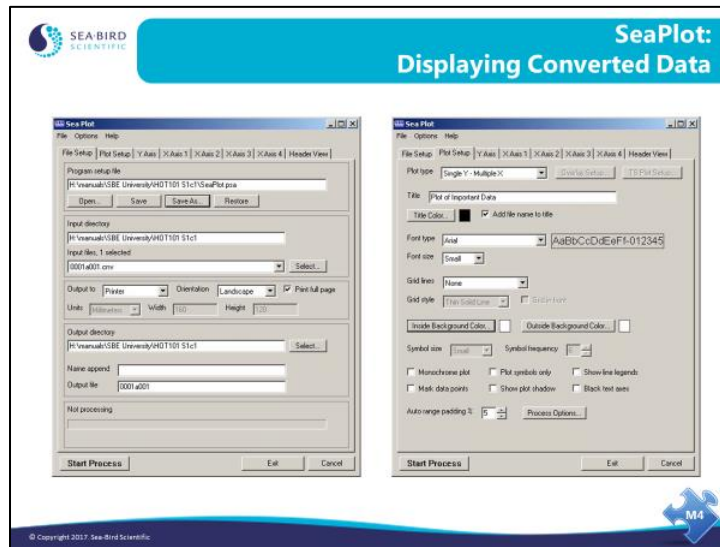
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## Sea Plot: Display Converted Data (continued)



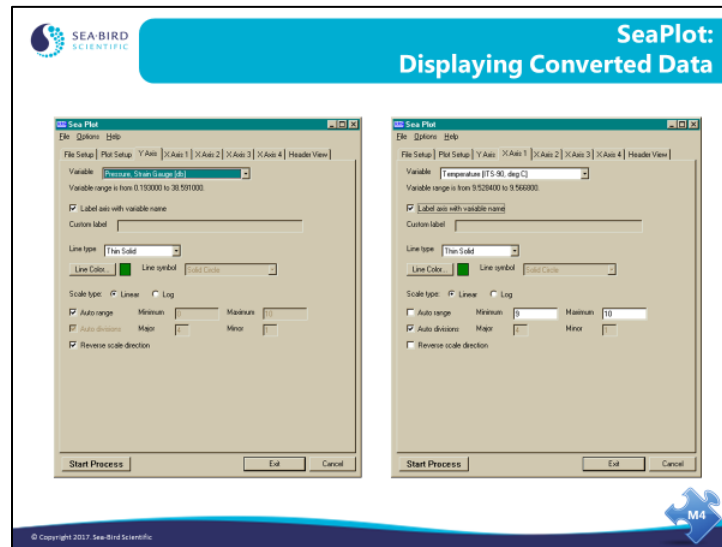
## Sea Plot: Display Converted Data (continued)



The file setup dialog includes an entry for the program setup file or *.psa*. This allows you to store your plot setup for reuse. Output directory settings are included for batch processing.

Plot Setup allows you to choose the plot type (single Y, multiple X or single X, multiple Y), fonts, titles, and color schemes. Symbols are also specified here; if you are plotting to a black and white printer, symbols are very useful. The auto range padding entry sets the amount beyond the range of the data that the minimum and maximum axis values extend.

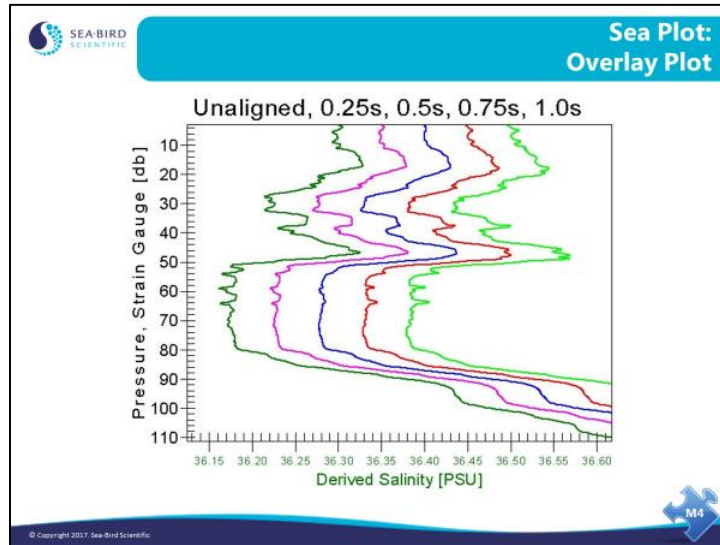
## Sea Plot: Display Converted Data (*continued*)



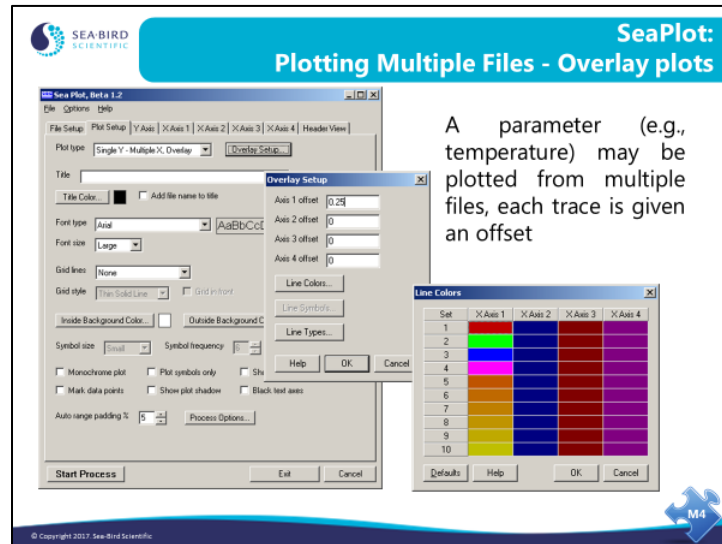
The axis setup tabs allow selection of variable, line type, and color. Plot range and scale direction are also specified here.

Note that the list of variables reflects the information in the selected .cnv file – only variables in the .cnv file are available for plotting, with the following exception. Sea Plot can calculate and plot salinity and/or density *on the fly*, if conductivity, temperature, and pressure data are in the .cnv file. This allows you to skip running the Derive module if you want a quick look at salinity and density before performing other processing steps.

## Sea Plot: Plotting Multiple Files with Overlay Plots



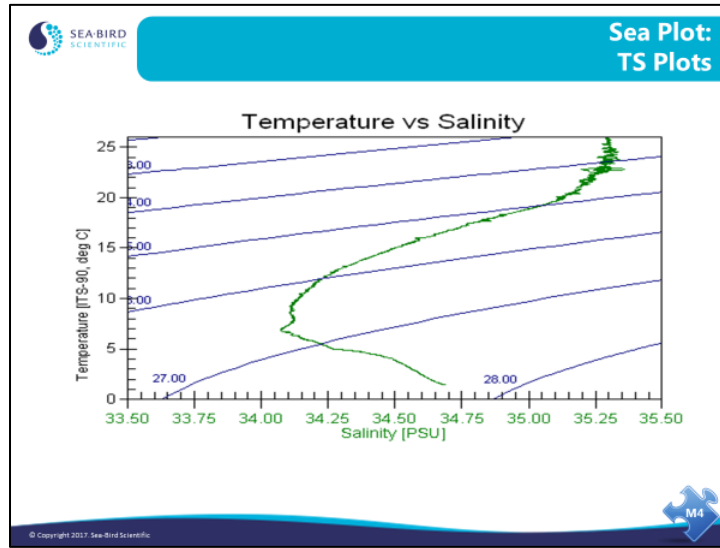
## SeaPlot: Plotting Multiple Files with Overlay Plots (continued)



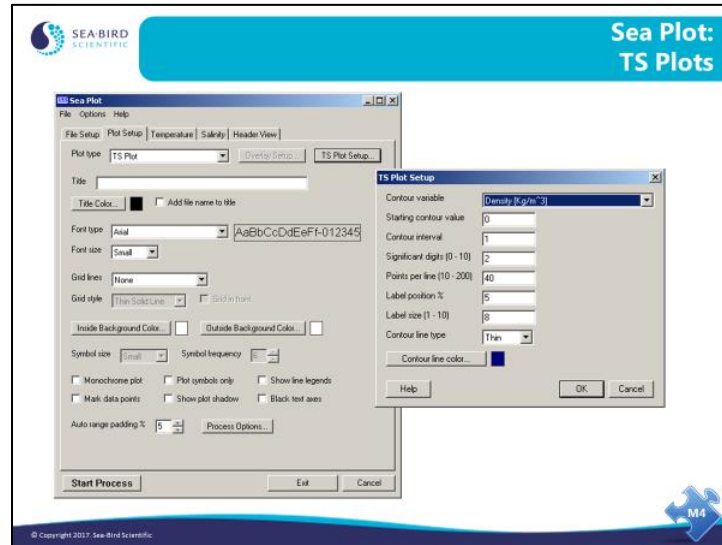
You can plot up to 4 parameters from multiple files by selecting the *overlay* plot type. To use this option you must specify the files in the order (left to right) you want them to appear. You must also enter an *offset* amount; this is amount of space between traces. For example, you might want to space temperature traces from casts taken at hour intervals at the same location by 0.2 degrees. You can also select the colors that each file will be plotted in. There is a color wheel that will allow selection of a graded set of line colors that is available by double clicking the axis identifier.

Note: When doing an overlay plot, all the files must have the same parameters.

## Sea Plot: TS Plots



## Sea Plot: TS Plots (*continued*)



Temperature *versus* salinity plots are useful for discerning water masses. It is helpful if contours of constant density are placed on the plot as well. Sea Plot's TS plotting format allows you to do this. The file and axis menus above are as expected for Sea Plot. In addition you may define the density contours that are most useful for your application.

## Activity: Plot Example Data in SBE Data Processing with Sea Plot

1. Click Start / Programs / Sea-Bird / SBEDataProcessing-Win32.
2. In SBE Data Processing, select *Run -> 20. Sea Plot*.
3. On File Setup tab:
  - Input file: Click *Select*. Navigate to data that you converted (C:\Data\Module3\Hawaii.cnv) and click *Open*.
4. On Plot Setup tab:
  - Select a *Plot type* of *Single Y - Multiple X*.
5. On Y Axis tab:
  - For *Variable*, select *Pressure, Digiquartz [db]*.
  - Check *Auto range*.
6. On X Axis 1 tab:
  - For *Variable*, select *Temperature [ITS-90, deg C]*.
  - **Uncheck** *Auto range*. Enter a *Minimum* of 0, a *Maximum* of 30.
7. On X Axis 2 tab:
  - Check *Include axis*.
  - For *Variable*, select *Derived Salinity, Practical [PSU]*.
  - **Uncheck** *Auto range*. Enter a *Minimum* of 34, a *Maximum* of 36.
8. On File Setup tab:
  - For Program setup file click *Save As . . .*, and save file as C:\Data\Module3\HawaiiSeaPlot.psa.
9. Click *Start Process*.

Note that we were able to have Sea Plot calculate Salinity *on the fly*, because conductivity, temperature, and pressure were in the input .cnv file. This allows us to get a quick look at salinity before more advanced processing, even though the .cnv file does not contain a salinity column of data yet.

---

If you converted 19*plus* data in the previous activity and have time, plot that data (C:\Data\Module3\SBE19plus\Miami.cnv). Use same ranges as above for pressure and temperature, but change the Derived Salinity range to 35 - 37.