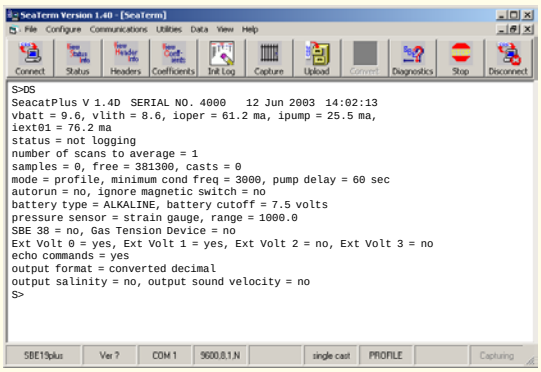
Sea-Bird SEASOFT© Software

SEASOFT©-Win32 is a powerful Windows 95/98/NT/2000/XP modular program for instrument communication and data retrieval, real-time data acquisition and display, and data processing and plotting. An extensive list of seawater parameters can be calculated (using UNESCO equations), dozens of auxiliary sensors are supported, and a variety of color plots can be graphed, printed, and exported in several common graphic file formats. SEASOFT is provided at no charge, and is available for download through our website.

SEASOFT's main components include:
- **SEATERM and SeatermAF** – Terminal programs setup, data retrieval, and diagnostic tests.
- **SEASAVE** – Acquires, converts, and displays real-time or archived raw data.
- **SBE Data Processing** – Converts, edits, processes, and plots data.

The components are discussed in more detail below.

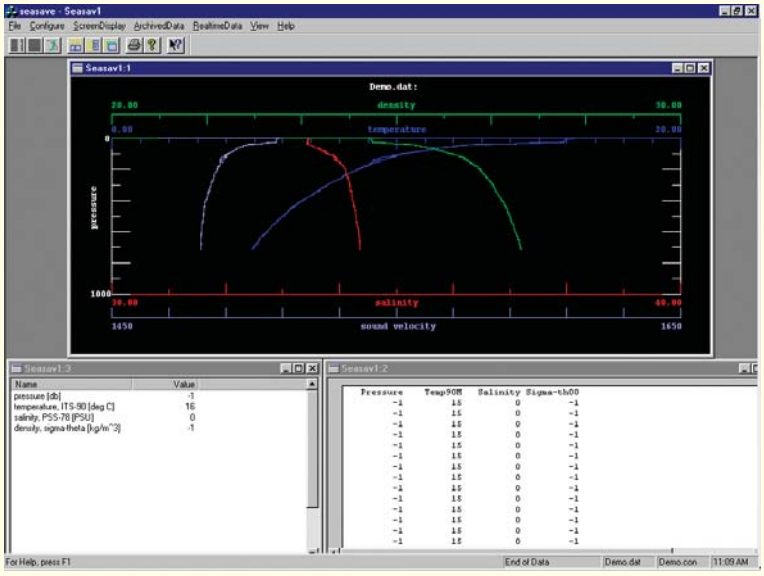


SEATERM and SeatermAF

These terminal programs are designed for interfacing with Sea-Bird instruments, providing setup, data retrieval, and diagnostic tests. Their menus and toolbars contain shortcuts for frequently executed tasks and instrument commands, while their status bars provide information on current instrument selections and communication protocols.
- **SEATERM** – Interfaces with most Sea-Bird instruments.
- **SeatermAF** – Interfaces with instruments that include Auto Fire capability (SBE 17*plus* V2 or Auto Fire Module) for autonomously operating an SBE 32 Carousel Water Sampler on non-conducting cable.

SEASAVE

SEASAVE acquires real-time, raw data (frequencies and voltages) and saves the raw data to the computer for later processing. It also displays selected raw and/or converted (engineering units) real-time data or archived data in text and plot displays. SEASAVE uses an instrument configuration file, which defines the sensors, sensor channels, and calibration coefficients, to convert the real-time, raw data to engineering units for display. This allows you to view meaningful data trends during the cast, and make adjustments to your cast speed as desired to capture interesting features of the water column. Additional SEASAVE features include the ability to:
- Send commands to close water sampler bottles on an SBE 32 Carousel Water Sampler or G.O. 1015 or 1016
- Save NMEA navigation data with the CTD data
- Save a user-input header with the CTD data, providing information that is useful for identifying the data set
- Output converted (engineering units) data to a computer COM port or file
- Output data to a remote display
- Set up alarm parameters
- Mark real-time data to note significant events in a cast



SEASAVE supports these Sea-Bird instruments:
- SBE 911*plus*, 917*plus*, 911, and 911e CTD system
- SBE 16*plus* and 16 SEACAT C-T Recorder
- SBE 19*plus* and 19 SEACAT CTD Profiler
- SBE 21 SEACAT Thermosalinograph
- SBE 25 SEALOGGER CTD
- SBE 31 Multi-Channel Logger
- SBE 45 MicroTSG Thermosalinograph
- SBE 49 FastCAT CTD Sensor

Additionally, SEASAVE supports many auxiliary sensors interfacing with these instruments, including Sea-Bird oxygen, pH, and ORP sensors; and assorted sensors from third party manufacturers (such as altimeter, fluorometer, methane sensor, nepyhelometer, PAR sensor, suspended sediment sensor, and transmissometer). What if you are using an auxiliary sensor that is not directly supported by our software? Auxiliary sensor selection includes a user polynomial, allowing you to define an equation to relate your sensor output voltage to calculated engineering units.

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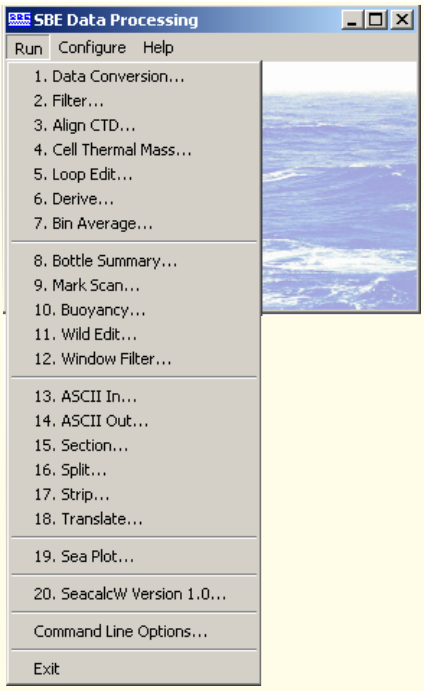
SBE Data Processing



Our data processing software, SBE Data Processing, consists of modular, menu-driven routines to convert, edit, process, and plot oceanographic data acquired with Sea-Bird instruments (CTD data as well as auxiliary sensor data). SBE Data Processing was developed *by* oceanographers, *for* oceanographers, incorporating input from years of collaboration and consultation with customers around the world and applying fundamental principles of oceanography to data analysis. Each module was designed to perform the necessary data manipulation based on our understanding of the real oceanographic features involved, and with sound physical reasons for applying specific corrections to individual types of errors. The software is continuously refined to reflect the latest oceanographic research, as well as to incorporate new auxiliary sensors that can interface with our CTDs.

SBE Data Processing modules fall into five categories:
1. Raw data conversion
2. Data processing
3. File manipulation
4. Data plotting
5. Seawater calculator

1. Raw Data Conversion

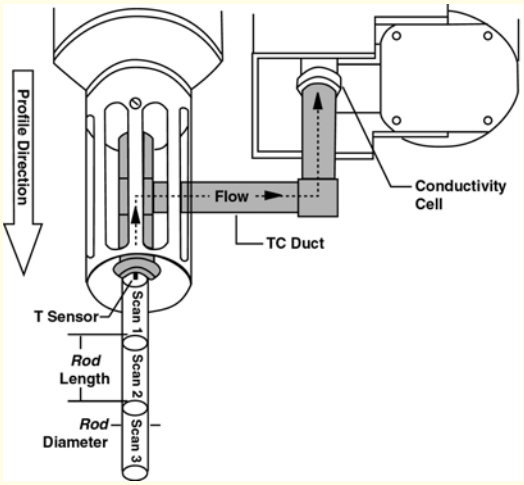
Data Conversion performs the first step in data processing, converting the raw CTD and auxiliary sensor data (typically frequencies and voltages) to engineering units. This raw data can be real-time data obtained via SEASAVE, or data uploaded from the CTD memory via SEATERM or SeatermAF. Data Conversion uses the instrument configuration file (same as used by SEASAVE), which defines sensors, sensor channels, and calibration coefficients, to convert the raw data to engineering units.

Data Conversion also outputs separately blocks of data associated with water bottle closures, for easy comparison with lab tests you perform on the collected water samples.

2. Data Processing

Many oceanographic data parameters (e.g., salinity, density, sound velocity) are calculated from a set of temperature, pressure, and conductivity measurements. The highest accuracy in the derived parameters is obtained when the measurements of temperature, pressure, and conductivity are made on the same parcel of seawater. There are two characteristics of *every* CTD (Sea-Bird's as well as any other manufacturer) that must be overcome to get the highest accuracy:
- The temperature sensor and conductivity sensor have different time constants — Sensors do not react infinitely quickly to a new environmental condition. For example, a thermistor is housed in a thin metal sheath; the delay in response to a sharp change in temperature from warm to cold is due to the time required for the heat in the thermistor to diffuse into the environment. For a conductivity cell, there is flushing time of the cell.
- The temperature sensor and conductivity sensor are in physically different places.

Evidence of the mismatch of temperature and conductivity measurements is seen in salinity spikes and density inversions in the processed data.



You can low-pass-filter temperature and conductivity to make their time constants match and you can advance the conductivity data to account for the fact that for a given parcel of water the temperature is measured before the conductivity, *if* you collect your data as a time series of equally spaced measurements. How can you ensure your data is a time series of equally spaced measurements? To ensure that the temperature and conductivity measurements are made on a constrained water sample, we plumb them together with a T-C Duct; the *T-C pair* has water drawn through them with a pump that moves water at a consistent, known speed. One way to visualize this is as a *rod* of water that moves into the duct and flows past the thermometer and into the conductivity cell. Because the water sample is pumped through the duct and conductivity cell, it is not subject to accelerations (sloshing) due to ship heave. Controlling the flow rate of sample water past the sensors assures that the time constants and measurement timing is constant. Filtering and aligning the date is particularly successful for Sea-Bird instruments, because of this technique of constraining the sample as it is measured.

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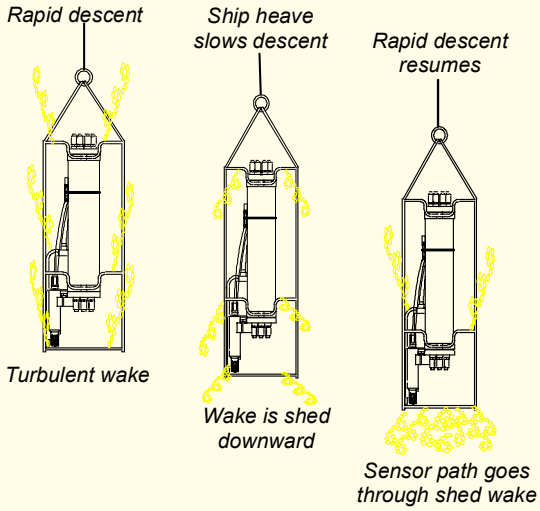
SBE Data Processing includes two modules to ensure that subsequent derived parameters are calculated based on matching temperature and conductivity:

- **Filter** applies a low-pass filter to temperature and conductivity data to make their time constants match.
- **Align CTD** compensates for physical misalignment of sensors in depth, inherent time delay of sensor responses, and water transmit time delays in pumped plumbing. Align CTD aligns data relative to pressure to ensure that later calculations of salinity are made using measurements from the same parcel of water. Align CTD can also be used to align data from auxiliary instruments. For example, for a dissolved oxygen sensor, Align CTD compensates for the time required for the concentration of O_2 near the electrode to equilibrate with the environment; the colder the water that the sensor is working in, the longer it requires to come to a final value.

Conductivity is a function of temperature. The conductivity cell is constructed of glass and plastic, and as such has a thermal mass. When the cell goes from warm water into cold, the water that passes through the cell is warmed slightly as it passes through the cell. Conversely, when the cell goes from cold water into warm, the water that passes through the cell is cooled slightly. This causes the water in the cell to be a different temperature than the thermometer measured before the water reached the conductivity cell. This heat transfer can be modeled and corrected by running **Cell Thermal Mass**.

In the real world, errors that are completely unrelated to the CTD often creep into the data:

- Ship heave, the rocking motion of the ship, causes errors. Most CTD deployments are made with a small boom or an A-frame that leans out from the ship, giving some distance between the sea cable and the side of the ship. Ship rocking has the effect of pulling up on the sea cable when the ship rocks in one direction and slackening the sea cable when it rocks in the other direction. This heaving action causes the underwater package to decelerate when the sea cable is pulled up and accelerate when it goes slack. As the instrument decelerates, water that is entrained within the package can continue downward past the sensors; this water is of different temperature and conductivity than the water at the bottom of the package, and it causes a sampling error. In cases of radical ship heave, the instrument package can actually *loop* through the water, passing through the same segment of the water column more than once.
- Additional data errors are caused by slip ring noise, other electrical interference, computer data port problems, etc. These errors often result in *wild* data points, which are completely out of range of the expected data values.



SBE Data Processing includes two modules to deal with marking data associated with ship heave and other real world deployment problems:

- **Loop Edit** tests the data for pressure reversals (loops in the instrument's trajectory) and for velocities that fall below a user-defined minimum. It marks scans that fail these tests, so they can be eliminated in later processing steps if desired.
- **Wild Edit** tests for data that falls outside of user-defined limits, specified as standard deviations on a window of data. It marks data that fail this test, so they can be eliminated in later processing steps if desired.

After the corrections have been made to account for the real-world deployment of the CTD, you are ready to calculate parameters derived from the basic measurements of the CTD and auxiliary sensors. **Derive** uses the pressure, temperature, conductivity, and auxiliary sensor data to calculate a large number of parameters, including:

- salinity
- density (density, sigma-theta, sigma-t, sigma-1, sigma-2, sigma-4)
- depth (salt water or fresh water)
- dynamic meters
- sound velocity (Chen-Millero, DelGrosso, Wilson)
- average sound velocity
- descent rate and acceleration
- potential temperature and potential temperature anomaly
- geopeotential anomaly
- specific volume anomaly
- thermosteric anomaly
- oxygen

Often, the last step in processing data is to average the data, to reduce the data set to a usable size. **Bin Average** makes a statistical estimate of data values at user-defined intervals based on pressure range, depth range, scan number range, or time range.

SBE Data Processing includes a few more data processing modules for specialized applications:

- **Buoyancy** computes Brunt Väisälä buoyancy and stability frequency.
- **Window Filter** filters data with a triangle, cosine, boxcar, Gaussian, or median window to smooth data.

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3. File Manipulation

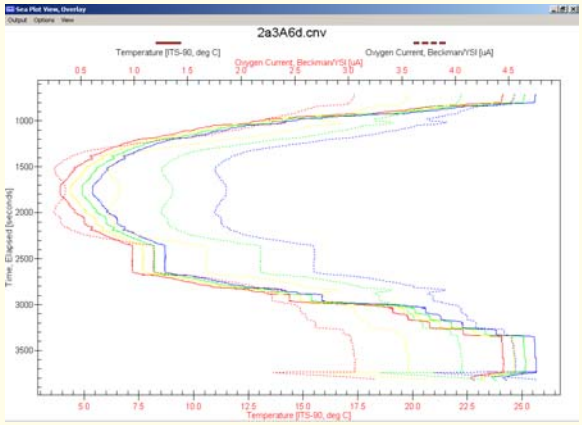
File manipulation modules can be used to add descriptive information to a file or easily extract the desired information from the data:

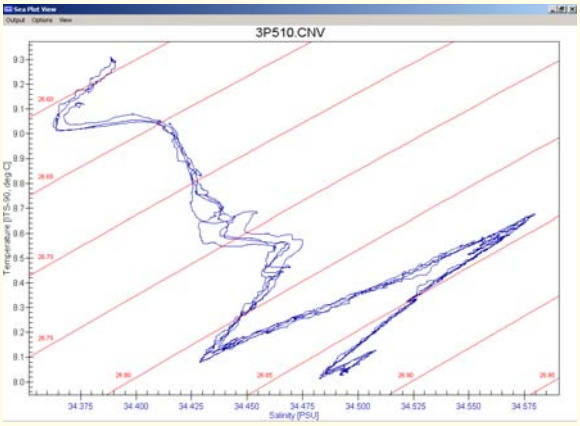
- **ASCII In** adds header information to an ASCII data file. It is useful for preparing a data file that was generated by other (non-Sea-Bird) software for further processing or plotting by SBE Data Processing.
- **ASCII Out** outputs data and/or header from a converted data file to an ASCII file. It is useful for exporting converted data for processing by non-Sea-Bird software.
- **Section** extracts rows of data from a converted data file.
- **Split** splits data in a converted data file into upcast and downcast files.
- **Strip** extracts columns of data from a converted data file.
- **Translate** converts data in a converted data file from ASCII to binary, or vice versa.

4. Data Plotting

SeaPlot plots up to 5 variables, with 1 X axis and up to 4 Y axes or 1 Y axis and up to 4 X axes, using linear and/or logarithmic scales. It can create contour plots, generating density or thermosteric anomaly contours on temperature-salinity (TS) plots. Overlay plots allow the user to view multiple data sets at the same time; each file can be offset to create a *waterfall* plot. Plots can be sent to a printer, saved to the clipboard for insertion in another program (such as Microsoft Word), or saved as graphic files in bitmap, metafile, or JPEG format.

X-Y Overlay Waterfall Plot

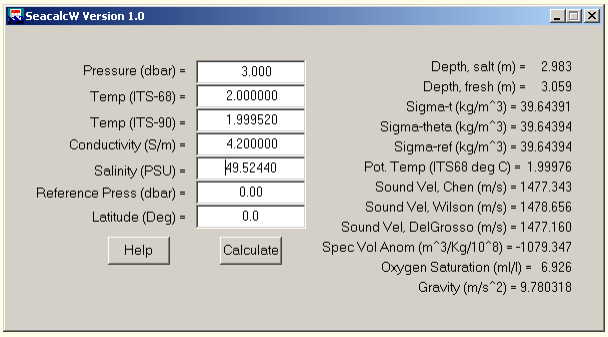




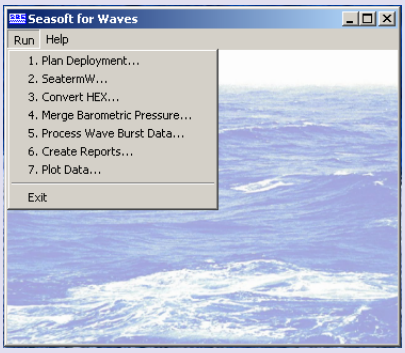
TS Contour Plot

5. Sea Water Calculator

SeacalcW is a seawater calculator that computes depth (salt and fresh water, density (sigma-1, sigma-theta, sigma-ref), potential temperature, sound velocity (Chen, Wilson, and DelGrosso), specific volume anomaly, and oxygen saturation from *one* user-input scan of temperature, pressure, conductivity *or* salinity, reference pressure, and latitude. SeacalcW can be used as a quick check on the expected range of derived data, as well as evaluation of the sensitivity of the derived parameters to small changes in the basic measurements.



SEASOFT for Waves©-Win32 is a powerful modular program for use with the **SBE 26*plus* (or older SBE 26) SEAGAUGE Wave and Tide Recorder** or **SBE 53 BPR Bottom Pressure Recorder**. It includes:



- **Plan Deployment** (SBE 26/26*plus* only) – Calculates and plots pressure attenuation ratio and predicts surface wave analysis parameters for user-input wave sampling scheme.
- **Battery and Memory Endurance Calculator** – Calculates nominal battery and memory endurance for user-input sampling scheme.
- **SeatermW** – Communicates with instrument, providing setup, data retrieval, and diagnostic tests.
- **Convert Hex** – Converts uploaded data into separate wave and tide files (for SBE 26/26*plus*) or tide and reference frequency files (for SBE 53), with data in engineering units.
- **Merge Barometric Pressure** – Removes barometric pressure from tide data.
- **Process Wave Burst Data** (SBE 26/26*plus* only) – Calculates wave statistics.
- **Create Reports** (SBE 26/26*plus* only) – Calculates surface wave time series and/or wave burst auto-spectrum statistics for each wave burst.
- **Plot Data** – Plots data.

09/05

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