Documentation of CTD Data from Saga Kanya Cruise No. 87

1.0 Investigator / Data Provider

The data were kindly provided by:
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The data were collected and processed as described in the JGOFS protocols, the following part of this documentation is an extract from these protocols, known as JGOFS Report No. 19, June 1996.

2.0 Apparatus

The SeaBird CTD instrument package is mounted on a 12 or 24 position General Oceanics Model 1015 rosette that is typically equipped with 12 l Niskin bottles. The package can be deployed on a single conductor hydrowire.

2.1 The Seabird CTD system consists of an SBE 9 underwater CTD unit and an SBE 11 deck unit. There are four principal components: A pressure sensor, a temperature sensor, a flow-through conductivity sensor and a pump for the conductivity cell and oxygen electrode. The temperature and conductivity sensors are connected through a standard Seabird ”TC-Duct”. The duct ensures that the same parcel of water is sam-pled by both sensors which improves the accuracy of the computed salinity. The pump used in this system ensures constant sensor responses since it maintains a constant flow through the ”TC-Duct”. The pressure sensor is insulated by standard Sea-Bird methods which reduces thermal errors in this signal.

2.1.1 *Pressure:* SeaBird model 410K-023 digiquartz pressure sensor with 12-bit A/D temperature compensation. Range: 0–7000 dBar. Depth resolution: 0.004% full scale. Response time: 0.001 s.
2.1.2 *Temperature:* SBE 3–02/F. Range: -5 to 35°C. Accuracy ±0.003°C over a 6 month period. Resolution: 0.0003°C. Response time: 0.082 s at a drop rate of 0.5 m/sec.
2.1.3 *Conductivity:* (flow-through cell): SBE 4-02/0. Range 0-7 Siemens/meter. Accuracy ±0.003 S/m per year. Resolution: 5×10^{-5} S/m. Response time: 0.084 s at a 0.5 m/s drop rate with the pump.
2.1.4 *Pump:* SBE 5-02. Typical flow rate for the BBSR system is approx. 15 ml/s. (The pump is used to control the flow through the conductivity cell to match the response time to the temperature sensor. It is also used to pull water through the dissolved oxygen sensor.)

3.0 Data Collection

The CTD package is operated as per SeaBird's suggested methods. The data from the package pass through a SeaBird deck unit and a General Oceanics deck unit before being stored on the hard disk of a PC-compatible portable computer. The CTD is powered with a single conducting electro-mechanical cable. This single conductor is unable to maintain power to the CTD during bottle fires. During this time, the CTD is kept at the desired depth for 90-120

seconds, after which time a software bottle marker is created. Following the mark, the bottle is immediately fired, which takes approximately 20 seconds during which time the CTD is depowered. Once power has returned to the CTD, the package is further maintained at depth for 120 seconds. After this period, the CTD sensors are found to be stable which permits the continuation of the upcast. The data acquisition rate is 24 samples per second (Hz). The SeaBird deck unit averages these data to 2 Hz in real time. Averaging in the time-domain helps reduce salinity spiking.
The 2 Hz data are subsequently stored on the PC. After each cast, a CTD log sheet is completely filled out (Figure 1). The ship's position is recorded directly from the GPS and Loran system. We use the Loran TD values rather than the Loran unit's calculated position which is not usually current. Relevant information such as weather conditions are added in the notes section.

After the cast is complete, these four files are immediately backed up onto floppy disks. SeaBird data acquisition and processing software are used during the cruise for preliminary observations of raw data.

The programs are:
SEASAVE: Display, recording and playback of data.
SEACON: Entry of calibration coefficients and recording of the configuration.
SPLITCTD: Split file into separate up and down casts.
BINAVG: Bin averages existing SEASAVE data files and converts to ASCII text.

In addition, the matrix manipulation program Matlab (The Math Works, Inc., 21 Elliot Street South Natick, MA 01760 USA) is used for post-cruise calibration of data with the discrete samples.

4.0 Data Processing

The raw 2 Hz data are first converted to an ASCII format. At this stage, a pressure filter is applied which effectively eliminates all scans for which the CTD speed through the water column is less than 0.25 ms $^{-1}$. Each profile is then plotted and visually examined for bad data and spikes which are removed. The salinity and dissolved oxygen data are then passed through a 7 point median filter to systematically eliminate spikes. The oxygen data are further smoothed by the application of a 17 point running mean. The necessary sensor corrections are then applied to obtain a calibrated 2 Hz data stream (see below). Finally, for data submission and distribution, the data are bin averaged to 2 dbar resolution.

4.1 *Temperature Corrections*: The SeaBird temperature sensors (SBE 3-O2/F) are found to have characteristic drift rates. The drift is a linear function of time with a depen-dency on temperature. For each cruise the calibration history of the sensor is used to determine an offset and slope value.

4.2 *Salt Corrections*: The salinity calculated from the conductivity sensor is calibrated using the discrete salinity measurements collected from the Niskin bottles on the rosette. The samples from the entire cruise are combined to give an ensemble of 36 samples in the depth range 0-4200 m. The bottle salinity samples from the upcast are mapped to the downcast CTD salinity trace, at the temperature of the Niskin closure.
These matched pairs from all associated casts are grouped together and used to determine a specific salinity correction. The deviation between the bottle salinity and CTD values is

regressed against pressure, temperature and the uncorrected CTD salinity using a polynomial relationship.