CTD Data for Challenger 51

Instrumentation

The CTD unit was a Neil Brown Mk. 3 incorporating a pressure sensor, conductivity cell, platinum resistance thermometer and a Beckmann dissolved oxygen sensor. This was mounted vertically in the centre of a protective cage approximately 1.5m square.

Attached to bars of the frame were an Aquatracka logarithmic response fluorometer and a Seatech red light (661 nm) transmissometer with a 25 cm path length.

Above the frame was a General Oceanics rosette sampler fitted with 12, 10 litre water bottles. These comprised a mixture of Niskin, general purpose Go-Flo and ultra-clean teflon lined Go-Flo bottles as dictated by sampling requirements. The base of the bottles were 0.75m above and the tops 1.55m above the pressure head. One bottle was fitted with a holder for twin reversing thermometers mounted 1.38m above the CTD temperature sensor.

Above the rosette was a PML 2-pi PAR (photosynthetically active radiation) sensor pointing upwards to measure downwelling irradiance. A second 2-pi PAR sensor, pointing downwards, was fitted to the bottom of the cage to measure upwelling irradiance. It should be noted that these sensors were vertically separated by 2m with the upwelling sensor 0.2m below the pressure head and the downwelling sensor 1.75m above it.

No account has been taken of rig geometry in the compilation of the CTD data set. However, all water bottle sampling depths have been corrected for rig geometry and represent the true position of the midpoint of the water bottle in the water column.

Operational procedure and data logging

On each cast the CTD was lowered to a depth of approximately 5 metres and held until the oxygen reading stabilised. It was then raised to the surface and lowered continuously at 0.5 to 1 m/s to as close as possible to the sea floor. The upcast was done in stages between the bottle firing depths.

Data were logged by the Research Vessel Services ABC data logging system. The deck unit outputs were sampled at 32 Hz by a microprocessor interface (the Level A) which passed time stamped averaged cycles at 1 Hz to a Sun workstation (the Level C) via a buffering system (the Level B).

Data processing

The raw data comprised ADC counts. These were converted into engineering units (Volts for PAR meters, fluorometer and transmissometer: ml/l for oxygen: mmho/cm for conductivity: C for temperature) by the application of laboratory determined calibrations and salinity was computed using the algorithm in Fofonoff and Millard (1983). The data were submitted to BODC in this form.

Within BODC the data were reformatted on an IBM main-frame. At this stage transmissometer air readings recorded during the cruise were used to correct the transmissometer voltage to the manufacturer's specified voltage by ratio. The voltages were then converted to percentage transmittance (multiplied by 20.0) and dissolved oxygen converted to µM (multiplied by 44.66).

Next the data were loaded onto a Silicon Graphics workstation. A sophisticated interactive screening program was used to delimit the downcast, mark the depth range of water bottle firings and flag any spikes on all of the data channels.

The data were returned to the IBM and the downcasts loaded into a database under the Oracle relational database management system. At this stage percentage transmittance was converted to attenuance to eliminate the influence of instrument path length using the equation:

$$\text{Attenuance} = -4.0 * \log_e (\% \text{ trans}/100)$$

Calibration sample data were merged into the database and files of sample value against CTD reading at the bottle depth were prepared for the Principal Investigators to determine the calibrations. Due allowance was made for rig geometry. Note that CTD downcast values were generally used although the bottles were fired on the upcast. The validity of an assumed static water column for the duration of the cast was checked on the graphics workstation and upcast values substituted if necessary.

Sigma-T values were calculated using the algorithm presented in Fofonoff and Millard (1983). Oxygen saturations were computed using the equation of Weiss (1970).

Calibrations

For each cast the mean pressure reading logged whilst the instrument was in air was determined. The average of these, determined as -1.8 db, was added to each pressure value.

Two digital reversing thermometers were fired at the bottom of each cast. The mean difference, determined for all casts on the cruise, between the averaged calibrated readings and the CTD temperature, 0.007 C, was added to the CTD temperatures.

A sample was taken from the bottom bottle of each cast and salinity was determined using a Guildline Autosal. The mean difference, determined for all casts on the cruise, between the bottle values and the CTD salinity, 0.054 PSU, was added to the CTD salinities.

Extracted chlorophyll values were log transformed and regressed against fluorometer voltages to give the calibration equation:

$$\text{Chlorophyll } (mg/m^3) = \exp (1.141*V - 2.033) \quad (n=235;\ r^2=73.76)$$

Dissolved oxygen was calibrated against Winkler titration data for water bottle samples as a primary standard and calibrated data from the underway Endeco system as a secondary standard.

The resulting calibration equation was:

$$\text{Calibrated oxygen } (\mu M) = \text{Raw oxygen}*1.09 + 31.05$$

Attenuance was regressed against total, organic and inorganic suspended matter determinations to derive the equations below to allow attenuance to be expressed in terms of suspended matter.

$$\text{Total suspended matter } (mg/l) = (\text{Attenuance}-0.787)/0.232 \quad (n=177;\ r^2=79.5\%)$$
$$\text{Inorganic suspended matter } (mg/l) = (\text{Attenuance}-0.935)/0.250 \quad (n=177;\ r^2=71.7\%)$$
$$\text{Organic suspended matter } (mg/l) = (\text{Attenuance}-0.492)/1.092 \quad (n=177;\ r^2=60.5\%)$$

The PAR meters were calibrated using the following laboratory determined calibrations:

$$\text{Upwelling:} \quad \text{PAR } (\mu E/m^2/s) = \exp (-5.151*V + 6.6035) * 0.0375$$
$$\text{Downwelling:} \quad \text{PAR } (\mu E/m^2/s) = \exp (-5.122*V + 6.5739) * 0.0375$$

Warnings

None.

References

Fofonoff, N.P and Millard, R.C. Jr. (1983). Algorithms for the computation of fundamental properties of sea water.

Weiss, R.F. (1970). The solubility of nitrogen, oxygen and argon in water and sea water. Deep Sea Res. 17, 721-735.