CTD Data for Cruise Discovery 209

(3 August - 22 August 1994)

1) Introduction

The cruise Discovery 209, as reported by Herring (1994), formed part of the UKs contribution to WOCE. The cruise was a biological and physical study of the oxygen minimum and other hydrographic features of the Arabian Sea at 19° N 59° W during the southwest monsoon. The scientists concerned had already worked up the data received and BODC was mainly concerned with the checking of the data. Derived oceanographic variables were computed using the standard algorithms of Fofonoff and Millard (1983).

2) Instrumentation

The CTD profiles were taken with an RVS Neil Brown Systems Mk3B CTD incorporating a pressure sensor, conductivity cell, platinum resistance thermometer and a Beckman dissolved oxygen sensor. The CTD unit was mounted vertically in the centre of a protective cage approximately 1.5 m square. Attached to the bars of the frame was a Chelsea Instruments Aquatracka fluorometer and a SeaTech red light (661 nm) transmissometer with a 100 cm path length.

A General Oceanics rosette sampler fitted with 24 10-litre Niskin bottles was mounted above the frame. The bases of the bottles were 0.75 m above the pressure head with their tops 1.55 m above it. Up to three digital reversing thermometers were attached to the multisampler. These were mounted 1.38 m above the CTD temperature sensor.

Lowering rates were generally in the range of 0.5-1.0 m/s but could be up to 1.5 m/s.

3) Data Acquisition and Processing

The CTD sampled at a frequency of 32 Hz. These data were reduced in real time to a 1-second time series by the RVS Level A microcomputer system. These data were logged as raw counts on the Level C workstation via a Level B data buffer. The raw data were transferred to the P-EXEC system running on a Sun workstation. Manufacturer's calibrations for the sensors were applied. Downcast data were extracted, sorted on pressure and then averaged to 2 dbar intervals.

The CTD pressure, temperature and salinity data have been worked up to WOCE standards on board ship with further refinements to the calibrations back at the laboratory. The CTD processing scheme is well documented (Saunders *et al.* 1993, Dickson *et al.* 1993).

3.1) Pressure Calibration

The laboratory calibration of the pressure sensor was adjusted by -2.6 dbar after noting the deck pressure offset during the first few casts. This remained consistent (within +/- 1 dbar) throughout the cruise.

3.2) Temperature Calibration

The CTD temperature was checked against the digital reversing thermometers.

3.3) Salinity Calibration

The CTD salinity was calibrated against the salinity samples drawn from the rosette bottles. For each CTD cast the differences between the CTD and bottle salinities were averaged and the mean subtracted from the CTD values. The general offset applied to the sensor data did not change by more than about 0.003 psu throughout the cruise. The worst differences between the upcast and downcast data after being matched on pressure, except for a few outliers, were 0.006 psu (+/- 0.002 psu in the more stable deep water).

3.4) Oxygen Calibration

A comparison of CTD oxygen with measurements from bottle samples showed poor agreement, which varied significantly with depth. This was attributed to the effect on the sensors of a sudden drop from near saturation in surface waters to virtually nothing in the oxygen minimum, and a lack of experience in calibrating CTD oxygen data. The scientists concentrated on calibrating the upcasts only and no downcast oxygen data were made available.

3.5) Chlorophyll Calibration

The CTD fluorescence data was calibrated against extracted chlorophyll from the bottle samples.

3.6) Transmittance Calibration

No further information is available on the transmissometer calibration. Usual SOC practice incorporates source decay (through air voltage checks) and refractive index corrections.

4) Bottle Samples

4.1) Salinity

Salinity samples were analysed using an IOS Autosal salinometer (Model 53718).

4.2) Oxygen

Samples were drawn into clear, wide necked calibrated glass bottles and fixed immediately with Winkler reagents dispensed using Anachem dispensers. Samples were shaken for half a minute on deck and then again in the laboratory about 30 mins after collection. Temperatures of oxygen fixation were taken using a hand held electronic thermometer probe.

Dissolved oxygen was analysed using a Metrohm automated Winkler titration system with amperometric endpoint detection, as described by Culberson and Huang (1987). The analysis procedure for dissolved oxygen and computations were in accordance with the WOCE guidelines given by Culberson (1991).

4.3) Chlorophyll

Analysis of chlorophyll-a and phaeopigments were carried out on a Turner Designs Model 10000R fluorometer. 100 ml (sometimes 200 ml) of seawater were filtered onto 25 mm GFF glassfibre filters and the pigments extracted by adding 20 ml 90% Analar acetone for a minimum of 15 hours. The chlorophyll fluorescence was measured before and after adding 0.1 M hydrochloric acid. A pure chlorophyll-a standard was used to calibrate the fluorometer. The concentration of this standard had been determined by spectrophotometry before leaving the UK.

4.4) Reversing Thermometers

Temperature was measured using SIS digital reversing thermometers.

5) BODC CTD Data Processing

5.1) Reformatting

BODC received processed, fully calibrated 2 dbar averaged down cast CTD data. The data were converted into the BODC internal format (PXF) to allow the use of in-house software tools, notable the workstation graphics editor. In addition to reformatting, the transfer program applied the following modifications to the data:

The chlorophyll was converted from mg/m^3 to a nominal voltage (V) by taking it's natural log. Note that this was to make the data compatible with BODC's CTD handling system. The transform was automatically reversed on data retrieval.

Potential attenuance (poat) was converted to attenuance (atten) using the algorithms:

$$\text{atten} = \exp(-\text{poat})$$
$$\text{atten} = \text{atten} / (1.0 - \ln(\text{atten}) \times \text{pressure} / 215800)$$
$$\text{atten} = -\ln(\text{atten})$$

5.2) Editing

Using a custom in-house graphics editor, the downcasts were manually flagged. Spikes on any of the channels were flagged 'suspect' by modification of the associated quality control flag. In this way none of the original data values were edited or deleted during quality control.

Chlorophyll: the fluorometer did not work properly for stations 66103, 66201, and 66202, no data are available.

5.3) Calibration

The CTD data were compared with the bottle data to check that the data were up to WOCE standards. No calibrations, other than those done by the scientists concerned, have been applied by BODC.

6) Bibliography

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