Surface Underway Data for Challenger 49 (29 Mar - 10 Apr 1989)

Instrumentation

A suite of parameters were logged from the non-toxic supply, the intake for which was located on the ship's hull, about 2m below the surface.

Navigation was predominantly based on Decca and is hence prone to the inherent weaknesses in this system, particularly at dawn and dusk.

The bathymetric depth was measured using a Simrad echo sounder with the transducer mounted on an overside pole.

Temperature and salinity were measured using an autoranging TSG103 thermosalinograph. Temperature was measured by a thermistor in the non-toxic supply inlet manifold. Conductivity was measured by a unit in the ship's wet laboratory, which included a second thermistor to provide temperature for the computation of salinity.

Optical transmittance was measured using a SeaTech red light (661nm) transmissometer with a 25cm optical path length mounted in a light-tight box on the starboard deck.

Chlorophyll concentrations were measured using an Aquatracka logarithmic response fluorometer mounted in a light-tight box on the starboard deck.

Dissolved oxygen was measured using an Endico type 1125 pulsed dissolved oxygen controller multiplexed with two Endico type 1128 dissolved oxygen probes. The probes were immersed in a perspex cell (approx. 1 litre volume) supplied from the general non-toxic supply via a constant head device at 2 litres/minute.

Photosynthetically active radiation (PAR) was measured using PML 2-pi PAR sensors mounted on gimballed supports on each side of the ship's monkey island, so that when one is in shadow the other is not.

Operational procedure and data logging

Data were logged by the Research Vessels Services ABC data logging system. The data output units were sampled every 30 seconds by a microprocessor interface (the Level A) which passed time stamped data cycles to a Sun workstation (the Level C) via a buffering system (the Level B). Navigation was updated every two minutes and infilled by linear interpolation. Dissolved oxygen and probe temperature were logged at 5 minute intervals by a PC connected to the Endico controller and transferred to the Level C on floppy disk.

Data Processing

The raw data comprised ADC counts. These were converted into engineering units (degrees for latitude/longitude, volts for PAR meters, fluorometer and transmissometer, mmho/cm for conductivity, degC for temperature, metres for bathymetry) by the application of laboratory determined calibrations and salinity was calculated 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 attenuance to eliminate the influence of instrument path length using the equation:

$$\text{Attenuance} = -4.0 * \log_e(\text{voltage}/5.0)$$

Next the data were loaded onto a Silicon Graphics workstation. A sophisticated interactive screening program was used to examine the data and flag any spikes on all of the data channels. The data were then returned to the IBM.

Calibrations

The thermosalinograph was intercalibrated against surface values taken from the calibrated CTD. The corrections applied to the thermosalinograph and the time period for which they are valid are shown below:

Start time	End time	Salinity Correction (PSU)	Temperature Correction (degC)
29/03/1989 11:49	10/04/1989 05:13	-0.08	0.02

Attenuance was regressed against total, organic and inorganic suspended matter determinations to derive the equations below to allow attenuance to be expressed as suspended matter:

Total suspended matter (mg/l) = (Attenuance-0.7340)/0.4561 ($n=89; r^2=94.4\%$)
Organic suspended matter (mg/l) = (Attenuance-0.2065)/3.0761 ($n=82; r^2=87.4\%$)
Inorganic suspended matter (mg/l) = (Attenuance-0.8179)/0.5290 ($n=82; r^2=94.3\%$)

The fluorometer was calibrated by regressing the natural log of chlorophyll concentration against fluorometer voltage. Chlorophyll concentrations were then computed using the equation:

$$\text{Chlorophyll}(mg/m^3) = \exp(0.6157*\text{fluorometer voltage}-0.0433) \quad (n=77;\ r^2=81.3\%)$$

The dissolved oxygen data were corrected for temperature but as the software was unable to cope with salinity variation were computed at zero salinity. At regular intervals triplicate samples were drawn off from the probe outflow into 60 ml borosilicate glass stoppered bottles and analysed for oxygen by Winkler titration.

These values, recomputed to zero salinity, were used to select the most accurately responding of the two electrodes and then calibrate it by linear regression. Once calibrated, the data were recomputed to in-situ salinity using the equations:

$$O_2\ (\text{actual}) = O_2\ (\text{zero salinity}) / \text{Gamma}$$

$$\text{Gamma} = \exp(S*(A6 + A7/T + A8/T^2))$$

where:
S = Salinity (PSU)
T = Absolute temperature (K)
A6 = 0.017674
A7 = -10.754
A8 = 2140.7

Oxygen saturation was computed using the equation of Weiss (1970).

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

Port: PAR ($\mu E/m^2/s$) = exp (-5.247*volts + 6.7806) * 0.0375
Starboard: PAR ($\mu E/m^2/s$) = exp (-5.196*volts + 6.6468) * 0.0375

The PAR data were largely unusable due to a problem with the logging system at medium to high light intensities. Where they are available the data channel is the maximum of the readings from the two sensors, to minimise shading effects.

Data quality comments

Gaps when the Decca system was down or radio reception was too poor were infilled using SatNav fixes plus dead reckoning, based on an em-log below the ship's hull.

The cruise track was validated against digital coastline data and generally shows good agreement, even where the ship passed into the higher reaches of estuaries.

In addition to the true position, tidally corrected navigation is also included. This is the position that the water sampled at a given instant would have been when logging commenced (i.e. the time of the first data cycle). The correction was determined using a numerical model and gives good results in the open sea but is less reliable near the coast where topography dominates the tidal displacement.

Bathymetry data between 30 Mar and 1 Apr 1989 are acceptable but noisy. Between 4-5 Apr 1989, 7-8 Apr 1989, 00:00 - 12:00 9 Apr 1989 and 18:00 9 Apr to the end of the record have been flagged, multiple reflections and a many spikes made it impossible to distinguish the signal from noise.

A noisy section in the temperature and salinity records on 1 Apr 1989 has been flagged.

The PAR sensors recorded acceptable data on 6 Apr 1989, elsewhere most of the data have been flagged.

The attenuance record is noisy in places, spikes due to air bubbles in the system during rough weather have been flagged.

Warnings

Bathymetry data should be treated with caution.

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 Research 17, 721-735.