# Surface Underway Data for Challenger 59 (23 Aug - 4 Sep 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 a hull-mounted transducer.

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.

## 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 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) |
|---|---|---|---|
| 23/08/1989 13:15 | 26/08/1989 20:32 | -0.12 | 0.13 |
| 26/08/1989 20:32 | 28/08/1989 19:54 | 0.35 | 0.13 |
| 28/08/1989 19:54 | 30/08/1989 10:59 | -0.12 | 0.13 |
| 30/08/1989 10:59 | 31/08/1989 01:13 | 0.00 | 0.13 |
| 31/08/1989 01:13 | 01/09/1989 14:46 | 0.10 | 0.13 |
| 01/09/1989 14:46 | 01/09/1989 19:39 | 0.30 | 0.13 |
| 01/09/1989 19:39 | 02/09/1989 07:33 | 0.44 | 0.13 |
| 02/09/1989 07:33 | 03/09/1989 10:34 | 0.61 | 0.13 |

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-0.5148)/0.4466 ($n=158; r^2=80.0\%$)
Organic suspended matter (mg/l) = (Attenuance-0.3979)/1.4402 ($n=131; r^2=26.2\%$)
Inorganic suspended matter (mg/l) = (Attenuance-0.6857)/0.5088 ($n=131; r^2=81.5\%$)

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

$$\text{Chlorophyll}(mg/m^3) = \exp(2.7240 * \text{fluorometer voltage} - 5.6320) \quad (n=112; r^2=83.0\%)$$

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).

**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.

Salinity data flagged out between 00:00 24 Aug 1989 and 08:30 26 Aug 1989, 21:30 26 Aug 1989 and 20:00 28 Aug 1989 and 13:00 31 Aug 1989 and 10:00 3 Sep 1989, except 12:00-16:00 1 Sep 1989. Data are noisy between 12:00 30 Aug 1989 and 13:00 31 Aug 1989, these data have not been flagged.

Many large spikes in chlorophyll data between 22:00 27 Aug 1989 and 07:00 29 Aug 1989 have been flagged.

Many small spikes flagged in attenuance data.

**Warnings**

***Salinity data should be used with caution. The data are both noisy and proved difficult to calibrate.***

***No PAR (photosynthetically active radiation) data due to a problem with the logging system at medium to high light intensities.***

***The statistics of the organic suspended matter calibration are poor.***

**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.