

## Continuous underway data series for cruise AMT9 (15<sup>th</sup> September – 12<sup>th</sup> October, 1999)

### Chief Scientist

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### Content of data series

Parameter	Column heading	Units	Comments
Latitude	LAT+VEN	Degrees +ve N	
Longitude	LON+VEE	Degrees +ve E	
Salinity	RPSAL	PSU	
Sea temperature	RTEMP	Degrees C	
Bathymetric depth	DEPTH	m	
Raw Turner Designs fluorometer output	TFLUOR	Nominal units	Range changes
Calibrated fluorometer output.	CPHYL	mg chl-a m <sup>-3</sup>	Poor calibration
Atmospheric pressure	APRES	mbar	
Dry bulb air temperature (Masthead starboard)	SMDBT	Degrees C	
Wind speed	MWS	knots	
Wind direction	MWD	Degrees	
Photosynthetically available radiation	IRRAD	W m <sup>-2</sup>	
Solar radiation	SOLR	W m <sup>-2</sup>	Noisy data
Ship's velocity North-South	VN	Knots +ve N	
Ship's velocity East-West	VE	Knots +ve E	

### Instrumentation and data processing by originator

#### Underway instruments and methodology

Navigation was recorded using a 3D-GPS Trimble Surveyor system using Marine Star differential corrections. Bathymetry was measured using a Simrad EA-500 echo sounder.

The ship was equipped with a pumped "non-toxic" seawater supply system. Water was pumped through a Sea-Bird Electronics (SBE) thermosalinograph system, and a fluorometer.

The fluorometer was a linear response Turner Designs model 10 instrument in flow-through mode. This was placed in line with the SBE thermosalinograph and a flow meter.

The ship also had a scientific meteorological package including the following:

- Wind vane and anemometer
- A photosynthetically available radiation (350 – 700 nm) sensor
- A total irradiance sensor,
- A dry bulb thermometer

It is assumed that the position of the irradiance sensor was the same as for AMT5 and suffered from the same problem of shading by the foremast.

### **Data acquisition and on-board data processing**

Raw data were logged as ADC counts on the ship's computers. They were converted into engineering units using initial manufacturers' calibrations. Conductivity and two temperature channels were produced from the thermosalinograph counts.

The data from the fluorometer was logged into the JCR Ocean Logger system using the internal A/D converter and range output.

The data were submitted to BODC in RVS internal format for post-cruise processing and data banking.

### **BODC post-cruise processing and screening**

#### **Reformatting**

Underway data files were merged into a single binary merge file using time as the primary linking key. The time span of the file was from 15/09/1999 08:06 to 12/10/1999 14:46, with a sampling interval of 1 minute.

Salinity was computed from housing temperature and conductivity using the UNESCO 1978 Practical Salinity Scale (Fofonoff and Millard, 1982).

#### **Screening**

Each data channel was inspected on a graphics workstation and any spikes or periods of dubious data were flagged. The power of the workstation software was used to carry out comparative screening checks between channels by overlaying data channels. A map of the cruise track was simultaneously displayed in order to take account of the oceanographic context.

## Data processing, correction and calibration

- **Navigation**

A program was run which located any null values in the latitude and longitude channels and checked to ensure that the ship's speed did not exceed 15 knots. *The program identified 3 gaps which were filled using linear interpolation.*

- **Meteorology**

Relative wind speed and direction were logged from the meteorological package during the cruise. The ship's speed and heading channels were used with the relative wind data to produce absolute wind speed and direction.

- **Temperature**

The underway sea temperature channel was compared with averaged surface values extracted from CTD profiles up to 7 metres. The 39 samples gave a very small offset of  $-0.01216^{\circ}\text{C}$  between CTD and surface underway data with a standard deviation of 0.0381. As the offset was smaller than the standard deviation, no correction has been applied to the underway data.

- **Salinity**

It was not possible to calibrate the underway salinity channel as there are no available salinity sample data. The CTD salinity channel has itself not been calibrated. However, comparison of the two data sets can be made in order to test the consistency between the two instruments. The offset between CTD sensor 1 and the underway thermosalinograph salinity was 0.0107 PSU, with a standard deviation of 0.0063. This shows good agreement between the CTD and underway data.

- **Fluorometer**

The Turner Designs fluorometer operated on different range settings throughout the cruise. The points at which the range setting changed were identified during screening by looking for abrupt jumps in the signal with a magnitude of approximately 3. The data were then adjusted to a constant range for the whole cruise. For AMT9, the following corrections were applied.

Section start	Section end	Scaling factor
15/09/1999 10:14:30	15/09/1999 12:21:30	3.16
15/09/1999 12:21:30	19/09/1999 08:01:30	31.6
19/09/1999 08:01:30	19/09/1999 13:09:30	10.0
19/09/1999 13:09:30	19/09/1999 16:48:30	31.6
19/09/1999 16:48:30	20/09/1999 12:21:30	10.0
20/09/1999 12:21:30	20/09/1999 22:09:30	31.6
20/09/1999 22:09:30	21/09/1999 08:00:30	10.0
21/09/1999 08:00:30	27/09/1999 12:00:30	31.6
27/09/1999 12:00:30	28/09/1999 09:54:30	10.0
28/09/1999 09:54:30	10/10/1999 21:06:30	31.6
10/10/1999 21:06:30	12/10/1999 13:49:30	10.0

The fluorometer voltage channel was compared with data obtained from fluorometric assays on acetone extracts from discrete underway samples throughout the cruise. This exercise showed a very inconsistent relationship between the two data sets. It is likely that the response of the instrument was affected by the very different oceanographic regimes encountered throughout the whole cruise. The data were examined carefully and split into different sections where the best relationships could be identified. Calibrations were then applied to different sections of the cruise. The relationship was of the form

$$\text{Chlorophyll concentration (mg m}^{-3}\text{)} = \text{fluorometer signal} * \text{coeffA} + \text{coeffB}.$$

The effect of varying PAR was considered but no quenching effect could be identified.

Section start	Section end	coeffA	coeffB	R <sup>2</sup>	No.samples
15/09/1999 08:06:30	18/09/1999 22:00:30	1.78	-1.620	0.586	8
18/09/1999 22:01:30	20/09/1999 21:00:30	0.219	0.0645	0.158	18
20/09/1999 21:01:30	26/06/1999 03:00:30	0.549	-0.38	0.951	54
26/09/1999 03:01:30	28/09/1999 09:53:30	2.03	-1.58	0.966	21
28/09/1999 09:54:30	12/10/1999 14:46:30	0.281	-0.0311	0.702	120

### Comments on data quality:

Users should be cautious when using ship-borne wind measurements. Although the relative wind data have been corrected for ship's heading and speed, they are still sensitive to shielding effects. On AMT9, there was a slight reduction in wind speed when the ship's heading was in the NNW direction.

The air temperature data displayed problems during periods of bad weather, possibly due to wetting of the sensor. The periods of poor quality correspond to periods of high wind speed.

The position of the solar radiation and PAR sensors on the ship were unknown. The PAR data included periods that appeared to be affected by the ship's heading, suggesting that shielding of the sensor was a problem. The solar radiation did not appear to be affected by the shielding, but, like the air temperature channel, was affected during windy periods.

Due to the changing nature of the relationship between fluorometer output and chlorophyll-a concentrations, the data were split into different sections for the purposes of the calibration exercise. It is believed that this is the best way to produce an accurate representation of chlorophyll-a concentration throughout the cruise, but people who need accurate concentrations should use the extracted chlorophyll-a dataset directly. Note that the section from 18/09/1999 22:01 to 20/09/1999 21:00 was very poorly correlated with chlorophyll-a concentrations. Please consult Alison Fairclough ([ajfa@bodc.ac.uk](mailto:ajfa@bodc.ac.uk)) for more details.

## Reference

Fofonoff N.P. and Millard Jr., R.C. 1982. Algorithms for Computation of Fundamental Properties of Seawater. *UNESCO Technical Papers in Marine Science* 44.