Continuous underway data series for cruise AMT2 (22nd April – 28th May, 1996)

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^{-3}	Calibrated against fluorometric chl-a
Atmospheric pressure	APRES	mbar	
Dry bulb air temperature (Masthead starboard)	SMDBT	Degrees C	
Wind speed	Speed	knots	Caution
Wind direction	Direction	Degrees	Caution
Photosynthetically available radiation	IRRAD	W m^{-2}	
Solar radiation	SOLR	W m^{-2}	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

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 on board ship.

The data from the fluorometer was logged into the JCR Ocean Logger system using the internal A/D converter and range output. The fluorometer had an autoranging capability which maximises the sensitivity of the instrument in areas of different chlorophyll concentrations.

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 22/04/1996 12:10:00 to 22/05/1996 07:17:30, with a sampling interval of 30 seconds.

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 5 speed check failures which were corrected 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**

Temperature and salinity readings from the thermosalinograph were compared with precision reversing thermometers mounted on the CTD frame at the 7m position. The calibration exercise was carried out by Tony Bale (PML), and the results are presented in the AMT2 cruise report. The station at which each comparison was made is provided, but it is not known whether it was carried out during the first or second CTD cast on station, so the data are not present in the database. However, they are presented in the table below.

Station	Thermosalinograph temp	Reversing thermometer temp	Difference (error on thermosalinograph)
114	7.31	7.336	-0.026
115	13.39	12.765	***0.625***
116	19.07	19.097	-0.027
120	20.73	20.72	0.01
121	20.42	20.45	-0.03
122	23.27	23.27	0
123	24.65	24.52	***0.13***
124	25.21	25.17	0.04
125	27.42		
126	28.21	28.13	0.08
127	28.55	28.47	0.08
128	28.6	28.56	0.04
129	28.38	28.35	0.03
130	28.49	28.45	0.04
131	28.62	28.55	0.07
132	26.86	26.74	***0.12***
133	26.17	26.11	0.06

The mean and standard deviation of the offsets, for all samples, are 0.0776 and 0.1538 respectively. If the outlying values are removed (those shown in bold italics), the mean and standard deviation is 0.0282 and 0.0398.

The underway sea temperature channel was also compared with averaged surface values extracted from CTD profiles to 7 metres. The 49 samples gave a small offset of –0.00143˚C between CTD and surface underway data with a standard deviation

0.0310. However, the calibration sample data were derived from averaging several data points; some of these showed a high degree of variability in the underway or CTD data at the time of the calibration point (having a standard deviation of 0.02˚C or greater). When these samples were removed from the data set, the mean offset was 0.000511˚C, with a standard deviation of 0.02366 (N=45). Due to the low offset and relatively high standard deviation of the calibration samples, no correction was required for the original temperature channel.

- **Salinity**

Salinity values from the thermosalinograph were compared with the salinity of samples taken from the non-toxic supply measured on the Autolab precision salinometer. The calibration exercise was carried out by Tony Bale (PML).

The data are presented in the table below (taken from the AMT2 cruise report).

Station	Thermosalinograph salinity (ppt)	Salinometer salinity	Difference (thermosalinograph error)
114	33.986	33.978	0.008
115	34.009	34.022	-0.013
116	35.891	35.904	-0.013
120	36.054	36.055	-0.001
121	35.772	35.796	-0.024
122	36.305	36.358	-0.053
123	36.716	36.659	0.057
124	36.84	36.811	0.029
125	37.36	37.32	0.04
126	37.325	37.26	0.065
127	36.695	36.682	0.013
128	36.406	36.39	0.016
129	35.729	35.724	0.005
130	35.942	35.93	0.012
131	35.403	35.362	0.041
132	35.925	35.942	-0.017
133	36.044	36.039	0.005

The mean and standard deviation of the offset values are 0.01 and 0.03 respectively.

Surface CTD data were also extracted to calibrate the underway salinity. The offset was -0.00293 PSU, with a standard deviation of 0.00996 (N=44). The low offset indicated that the salinity channel required no correction to be applied to the data.

- **Fluorometer**

As the data logged from the fluorometer did not contain corrections for range changes, the exact time and scale of each range change was noted during the screening process at BODC. The data were then adjusted to the same range throughout the cruise, using the correction fluorc = fluor*(31.6/range).

The range used for each section of the cruise is given below.

Start date/time	End date/time	Fluorometer range
22/04/1996 12:10:00	29/04/1996 17:45:00	03.16
29/04/1996 17:45:30	12/05/1996 20:54:30	10.00
12/05/1996 20:55:00	19/05/1996 19:24:00	03.16
19/05/1996 19:24:30	22/05/1996 07:17:30	01.00

After corrections were made for the range changes, the data were compared with fluorometric chlorophyll-a concentrations measured on samples taken from the non-toxic supply. The resulting relationship was used to calibrate the underway fluorometer.

Calibrated chlorophyll-a (mg m^{-3}) = 0.00263 *fluorometer value – 0.0534

(n=255, R2=73.3%)

The effect of quenching was assessed by adding PAR into a multiple regression. There was no improvement in the fit, so no correction for quenching was made.

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. Users can consult the ship's E-W and N-S speed alongside the wind speed and direction.

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.