

# Continuous underway data series for cruise AMT18 (JR20081003) (3<sup>rd</sup> Oct – 10<sup>th</sup> Nov, 2008)

Version 1.0 – 26<sup>th</sup> March 2009 (room)

## Chief Scientist

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## Introduction

These notes refer to underway data collected during the James Clark Ross cruise (JR20081003) AMT18, between 3<sup>rd</sup> October and 10<sup>th</sup> November 2008.

## Content of data series

Parameter	Column heading	Units	Comments
Latitude	ALATGP01	Degrees +ve N	Selected as best quality navigation channel
Longitude	ALONGP01	Degrees +ve E	Selected as best quality navigation channel
Distance covered	DSRNCV01	km	
Ship's heading (Glonass compass)	HEADCM01	Degrees true	
Ship's N-S velocity over the ground	APNSGP01	cm s <sup>-1</sup>	Computed from ship's heading and unspecified GPS system
Ship's E-W velocity over the ground	APEWGP01	cm s <sup>-1</sup>	Computed from ship's heading and unspecified GPS system
Course made good	APDAGP01	Degrees true	
Speed made good	APSAGP01	m s <sup>-1</sup>	
Bathymetric depth	MBANSWCB	m	Depth from the EM120 multibeam swath bathymetry centrebeam
Salinity - calibrated against underway samples	PSALSG01	PSU	Calibrated with samples from Guildline 8400B Laboratory Salinometer
Sea temperature from hull sensor - calibrated against CTD temperatures	TEMPHG01	Degrees C	Calibrated with surface CTD temperatures
Chlorophyll fluorescence calibrated using equation provided by manufacturer	CPHLUMTF	mg m <sup>-3</sup>	Calibrated using manufacturer's equation
Atmospheric pressure	CAPHSL01	mbar	Data from sensor 1 chosen as primary channel
Dry bulb air temperature	CDTASS01	Degrees C	
Relative humidity	CRELSS01	%	
Absolute wind speed	EWSBSS01	m s <sup>-1</sup>	Corrected for ship's speed

Absolute wind direction	EWDASS01	Degrees true	Corrected for ship's heading
Downwelling light meter – PAR wavelengths	IRRDSXS	$\mu\text{E m}^{-2} \text{s}^{-1}$	Maximum value of the 2 sensors
Downwelling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere by pyranometer	CSLRR1XS	$\text{W m}^{-2}$	Maximum value of the 2 sensors

Note: each data channel has a flag column 'f': rows containing an 'N' flag indicate that no data were available for that time interval. An 'M' flag indicates suspect data added during BODC quality control screening procedures.

### Additional channels available on request

The channels listed above are a subset of the channels that have been processed from AMT18. The following additional channels can also be listed if required – please contact BODC if you would like data from any of the channels in the following list.

Parameter	Column heading	Units	Comments
Bathymetric depth	MBANZZ01	m	Channel from Simrad-EA500
Flow rate of flow through system	INFLTF01	$\text{l min}^{-1}$	
Sound velocity in the water column by thermosalinograph	SVELSG01	$\text{m s}^{-1}$	
Conductivity measurement from thermosalinograph	CNDCPR01	$\text{S m}^{-1}$	
Salinity measurement from thermosalinograph	PSALSU01	PSU	Uncalibrated
Temperature of conductivity measurement by thermosalinograph	TMESSG01	Degrees C	Uncalibrated
Sea temperature from hull sensor	TEMPHU01	Degrees C	Uncalibrated
Temperature of seawater at fluorometer	TMESFL01	Degrees C	Uncalibrated
Atmospheric pressure - sensor 2	CAPHSL02	mbar	
Relative wind speed	ERWSS01	$\text{m s}^{-1}$	Relative to ship's movement
Relative wind direction	ERWDSS01	Degrees	Relative to ship's heading
Downwelling light meter – PAR sensor 1	IRRDS01	$\mu\text{E m}^{-2} \text{s}^{-1}$	
Downwelling light meter – PAR sensor 2	IRRDS02	$\mu\text{E m}^{-2} \text{s}^{-1}$	
Downwelling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere by pyranometer – sensor 1	CSLRR101	$\text{W m}^{-2}$	
Downwelling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere by pyranometer – sensor 2	CSLRR102	$\text{W m}^{-2}$	

## Instrumentation

Sensors have been identified where possible from the BAS JCR data dictionary and a list of underway sensors that were present on the JCR at the start of 2008, which have been provided to BODC by BAS.

Parameter	Sensor	Manufacturer	Serial No.	Deployed
TEMPHU01	n/a	n/a	n/a	Hull mounted
INFLTF01	PMDQRCIL, Transmitter 45SNVCE	Litre Meter Ltd	45/59462	Non-toxic supply
SVELSG01	SBE45 thermosalinograph	SeaBird Electronics Inc	4538936-0130	Non-toxic supply
CNDCSG01	SBE45 thermosalinograph	SeaBird Electronics Inc	4538936-0130	Non-toxic supply
PSALSU01	SBE45 thermosalinograph	SeaBird Electronics Inc	4538936-0130	Non-toxic supply
TMESSG01	SBE45 thermosalinograph	SeaBird Electronics Inc	4538936-0130	Non-toxic supply
TMESFL01	Turners Instruments 10- AU-005-CE Fluorometer	Turners Instruments	n/a	Non-toxic supply
CPHLUMFT	Turners Instruments 10- AU-005-CE Fluorometer	Turners Instruments	n/a	Non-toxic supply
ERWSS01	Ultrasonic anemometer	Solent Meteorological	n/a	Foremast
ERWDSS01	Ultrasonic anemometer	Solent Meteorological	n/a	Foremast
IRRDSS01	PAR sensor Quantum PAR LITE 0348900	Kipp & Zonen Ltd	990069	Foremast
IRRDSS02	PAR LITE 0348900	Kipp & Zonen Ltd	990070	Foremast
CSLRR101	Pyranometer SP LITE 0339-900	Kipp & Zonen Ltd	990684	Foremast
CSLRR201	SP LITE 0339-900	Kipp & Zonen Ltd	990685	Foremast
CAPHSL01	Digital barometer PTB210 Class B	Vaisala	V145002	Logger rack
CAPHSL02	PTB210 B1A2B (Class B)	Vaisala	V145003	Logger rack
CDTASS01	Meteorology probe with air humidity and temperature sensors MP103A-CG030-W4W	Rotronic Instruments (UK) Ltd	43124 014	Foremast
CRELSS01	Meteorology probe with air humidity and temperature sensors MP103A-CG030-W4W	Rotronic Instruments (UK) Ltd	43124 014	On deck

## Originator's data processing

- **Navigation**

Navigational data were available from different GPS systems (Glonass, Ashtec, etc) on the James Clark Ross. These were processed on board and the ship's best determined position was calculated by the NMF process 'bestnav' to produce a 30 second average ship's position. The 'bestnav' data stream represents the combined output from several sensors to ensure the continuous navigation information in the event of one sensor failing. The main source of data was the ship's GPS SeaTex system, which is regarded to provide the most accurate position. The 'bestnav' data stream was transferred daily into

the PSTAR absolute navigation file 'abnv2181' for use in PSTAR processing during the cruise. It was noted that the navigation data stopped before the ship reached its destination port. Last record in file was on 2008/11/09 15:30:00.

- **Sea-surface hydrography**

The non-toxic supply draws water from a depth 6 m below the surface. The hull sensor is mounted just inside the inlet. The thermosalinograph is situated in the lab with the fluorometer downstream. The data from the non-toxic supply and atmospheric sensors were logged by the RVS Surfmet system during the cruise. The processing of the underway data was completed daily using two PSTAR routines. The first 'oceanlog0' converted the RVS format data into PSTAR format. Then 'oceanlog1' set the unrealistic values of variables to absent, converted conductivity into mS/cm and merged time, lat, lon and distance run into the file from the Bestnav navigation (abnv2181). The daily processed data was saved to as a file 'olg.218xx' and the file 'olg.master' was appended with the data each day of the cruise.

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

### **Reformatting**

Navigation, meteorological and underway seawater data from processed PSTAR format files, along with wind measurements and bathymetry (em120 and sim500) from the full-resolution RVS files were transferred to BODC's NetCDF format (QXF) under the BODC Underway Data System (BUDS). This transfer involved reducing the data by averaging to 60 second intervals. Directional data were reduced by averaging using a unit circle.

### **Screening**

Each data channel was inspected on a graphics workstation using BODC screening software EDSERPLO and any spikes or periods of dubious data were flagged using BODC quality control flag system ('M' for suspect value). Impossible values were checked carefully and flagged null only if believed to be genuine missing or bad data. EDSERPLO 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 and correction**

- **Navigation**

Once the PSTAR navigation files compiled after from the 'bestnav' files were converted to the BODC QXF format, a Matlab program ('navcheck') 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. There were a few small gaps (<15 minutes) in the latitude and longitude channels, these were filled using the Matlab program 'navint' to interpolate data to fill the gaps. In addition there were a few speed check failures in the navigation data, where speed over ground was higher than might be expected. This occurred at the start of the cruise and could well be possible given a flood tide at departure. Once the cruise report is received BODC will be able to investigate further.

- **Bathymetry**

Bathymetric data was loaded from two RVS files em120.rvs and sim500.rvs. These contained the logged output from the EM120 multibeam swath bathymetry centrebeam depth (em120) and the Simrad-ea500 depth measurement (sim500). As part of the screening process a channel was added for the bathymetry derived from GEBCO. This data is often of lower resolution than that available along the cruise track from on board sensors but provided a background bathymetry with which to screen the channels recorded during the cruise for unrealistic data values.

- **Meteorology**

The logged measurements from the ship's atmospheric sensors (pressure, temperature, humidity and solar irradiance – total and PAR) were loaded from the PSTAR files generated from the RVS Surfmet system. BODC were advised by the data processors that the file 'olg.master' was appended with the

data each day of the cruise, with the exception of the last day's data and this data was loaded from the daily file 'olg.21837'. At BODC after loading the 'olg.master' and 'olg.21837' files and screening the input, data from 10/10/2008 was found to be missing and was subsequently loaded from the daily file 'olg.21808'.

Relative wind speed and direction were logged from the meteorological package during the cruise and saved in RVS format in the file 'anemom'. The anemometer was positioned with 0 degrees at the ship's bow. The ship's speed relative to the ground was calculated during the 'bestnav' processing using the ship's navigational information and the ship's heading. At BODC after screening of the navigation channels was completed the speed over ground and heading data were then used to correct the wind channels for the effect of the ship's movement using a BODC MATLAB program ('wincor') and absolute wind speed and direction channels were created.

- **Sea-surface hydrography**

The logged measurements from the ship's non-toxic underway system (SST, salinity, chl-a) were loaded from the PSTAR files generated from the RVS Surfmet system. BODC were advised by the data processors that the file 'olg.master' was appended with the data each day of the cruise, with the exception of the last day's data and this data was loaded from the daily file 'olg.21837'. At BODC after loading the 'olg.master' and 'olg.21837' files and screening the input, data from 10/10/2008 was found to be missing and was subsequently loaded from the daily file 'olg.21808'.

### Calibrations

- **PAR**

The maximum values from the two PAR sensors were merged to produce one channel.

- **Total Solar Irradiance**

The maximum values from the two solar irradiance sensors were merged to produce one channel.

- **Salinity**

Salinity data from the thermosalinograph (TSG) were compared with bench salinometer readings from samples taken from the ship's non-toxic pump supply. An offset between the bench salinometer and the TSG data was calculated. A regression between the offset and decimalised time was carried out, which was found to be significant. This indicates a slight drift in the TSG sensor over time. The calibration equation relating the offset to decimalised time was used to generate the offset at the start and end of the underway data and applied through the BODC calibration database.

The root mean square (RMS) error was calculated for the comparison of bench salinometer salinity with uncalibrated TSG salinity and the newly calibrated salinity.

	Uncal salinity	'Cal salinity'
Max Residual	0.410	0.349
Min Residual	-0.064	-0.116
RMS error	0.0849	0.0690

The decrease in the residual range and the RMS error is small but indicates the calibration equation improves the match between the bench salinometer and the TSG sensor.

Start	End	Calibration Type	Offset value	N	R <sup>2</sup> (%)	BODC ICALRF
04/10/2008 07:39	09/11/2008 15:30	Linear offset	Start = 0.0820 End = 0.0263	177	99.34	6249

- **Temperature**

The temperature from the hull sensor in the BUDS file was compared with the surface temperatures recorded by the CTD sensor. The data from the CTD profiles were averaged over 7 decibars at the

surface. Data values with high standard deviations were removed from the calibration set and an offset calculated between CTD and hull sensor temperature. The offset was then plotted against time and CTD temperature. There was a significant regression with CTD temperature and the regression against time was not significant. The calibration equation was derived from the regression of the offset against CTD temperature.

The root mean square (RMS) error was calculated for the comparison of surface temperature from SeaBird CTD with the uncalibrated TSG temperature and the newly calibrated temperature.

	Uncal temp	'Cal temp'
Max Residual	-0.350	0.0753
Min Residual	-0.601	-0.1482
RMS error	0.449921	0.037687

The decrease in the residual range and the RMS error indicates the calibration equation improves the match between the CTD temperature and the hull temperature sensors.

Calibration Equation	N	R <sup>2</sup> (%)	BODC ICALRF
TEMPHG01 = 0.9958 * TEMPHU01 – 0.3505	80	99.99	6248

- **Chlorophyll**

Once the underway fluorometer readings were compared with the extracted chlorophyll samples collected during the cruise it was observed that the fluorometer showed limited response to changes in surface chlorophyll levels in oceanic regions. Therefore the fluorometer data have not been calibrated and BODC recommends the use of the underway sampled extracted chlorophyll dataset, which provides good coverage along the cruise track.

### Data quality notes & outstanding issues

- **Meteorology**

Air temperature and humidity

A number of short-lasting drops in air temperature (about 0.2 degree per minute followed by slow recovery at about ½ the rate) were noted, most notably on the 13-14/10/2008 and 19-26/10/2008. They were often associated with increases in relative humidity. Interference from the ship's operations or instrument malfunction or contamination was first suspected but after investigation no satisfactory explanation could be found other than natural causes and the data were left unflagged.

Atmospheric pressure

No problem. Good agreement between the two sensors.

Light sensors

Good agreement between the two total solar irradiance sensors. For the two PAR sensors, one of them (01) reads slightly lower (about 40 μE m<sup>-2</sup> s<sup>-1</sup>) at noon than the other. Both judged OK to merge into one channel.

Wind data

The absolute wind speed is noisy but looks OK in terms of range and variations. Wind direction very variable too, but there was no obvious systematic interference with ship's structure.

- **Sea-surface hydrography**

The flow rate through the non-toxic supply was very unstable and varied erratically throughout the cruise. This affected the quality of some of the measurements from the non-toxic water supply system and notably salinity.

The salinity record has a large amount of noise throughout the cruise. This was due to many small increasing and decreasing “steps” in its signal of the order of 0.2-0.3 PSU which were generally coincident with irregularities in the flow rate and which could not be corrected for through the calibration.

The quality of the sea surface temperature from the hull mounted sensor did not seem to have suffered from this problem of flow rate.

On the other hand the temperature measurements from the non-toxic water supply available for this cruise (temperature of the conductivity measurements and temperature from the fluorometer) seemed to be affected by the problem in flow rate and should therefore be used with caution. The fluorometer temperature in particular is of poor quality.

The quality of the fluorometer record was also affected by the variation in flow rate probably due to bubbles being formed and interfering with the sensor. These periods were initially flagged as suspect during screening. However when the fluorometer data were compared with concentration of chlorophyll extracted from samples taken every 4-5 hours for the duration of the cruise, it became clear that the fluorometer was not responding to changes in chlorophyll levels at the equator and in the northern and southern gyre regions. The decision was taken to flag the entire channel as suspect; **the extracted chlorophyll dataset should be used for surface chlorophyll data along the cruise track.**