

# Continuous underway data series for cruise AMT16 (D294) (20<sup>th</sup> May – 29<sup>th</sup> June, 2005)

Version 1.0 – June 2006

Version 2.0 – Oct 2009 – (room)

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## Introduction

These notes refer to underway data collected during the RRS Discovery cruise (D294) AMT16, between 20<sup>th</sup> May and 29<sup>th</sup> June 2005. The underway data end one day before the end of the cruise (28/06/2005 13:00).

## Content of data series

Parameter	Column heading	Units	Comments
Latitude (Trimble navigation)	ALATGP01	Degrees +ve N	Selected as best quality navigation channel
Longitude (Trimble navigation)	ALONGP01	Degrees +ve E	Selected as best quality navigation channel
Distance travelled	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
Bathymetric depth	MBANCT01	m	
Salinity	PSALSG01	PSU	Calibrated against CTD and sample data
Sea temperature from hull sensor - calibrated against CTD temperatures	TEMPHG01	Degrees C	Hull temperature sensor calibrated against CTD data
Fluorometer output voltage	FVLTWS01	Volts	Uncalibrated fluorometer output
Transmissometer output voltage	TVLTDR01	Volts	Uncalibrated transmissometer output
Atmospheric pressure	CAPHZZ01	mbar	
Dry bulb air temperature	CDTASS01	Degrees C	
Relative humidity	CRELSS01	%	
Absolute wind speed	EWSBSS01	m s <sup>-1</sup>	Corrected for ship's movement
Absolute wind direction (Blowing from)	EWDASS01	Degrees true	Corrected for ship's heading
Down-welling light meter - PAR wavelengths	DWIRRXMX	W m <sup>-2</sup>	Maximum value of the 2 sensors

Down-welling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere by pyranometer	CSLRR1XS	$W m^{-2}$	Maximum value of the 2 sensors
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Note: each data channel has a flag column 'F': rows containing an N indicate that no data were available for that time interval. An 'M' flag indicates suspect data from BODC's quality control procedures, an 'L' flag indicates suspect data from the originator's quality control procedures and a 'T' flag indicates data has been interpolated. The full description of BODC flags is included in the associated parameter file.

### Additional channels available on request

The channels listed above are a subset of the channels that have been processed from AMT16. 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
Conductivity - TSG	CNDCSG01	$S m^{-1}$	
Salinity - TSG	PSALSU01	PSU	Uncalibrated
Sea temperature - TSG	TMESG01	Degrees C	Uncalibrated
Sea temperature - Hull sensor	TEMPHU01	Degrees C	Uncalibrated
Relative wind speed	ERWSS01	$m s^{-1}$	Relative to ship's movement
Relative wind direction	ERWDSS01	Degrees	Relative to ship's stern
Down-welling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere – port sensor voltage	CVLTRP01	Volts	Raw data
Down-welling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere – starboard sensor voltage	CVLTRS01	Volts	Raw data
Down-welling light meter - PAR wavelengths – port sensor voltage	DVLTRP01	Volts	Raw data
Down-welling light meter - PAR wavelengths – starboard sensor voltage	DVLTRS01	Volts	Raw data
Down-welling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere by port mounted pyranometer	CSLRRP01	$W m^{-2}$	Manufacturer's calibration applied
Down-welling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere by starboard mounted pyranometer	CSLRSS01	$W m^{-2}$	Manufacturer's calibration applied
Down-welling light meter - PAR wavelengths – port sensor	DWIRRP01	$W m^{-2}$	Manufacturer's calibration applied
Down-welling light meter - PAR wavelengths – starboard sensor	DWIRRSS01	$W m^{-2}$	Manufacturer's calibration applied

## Instrumentation

Details of the instrumentation used and of any data processing undertaken by the originator are summarised from the UKORS Instrumentation Report in the Cruise Report.

Parameter	Sensor	Manufacturer	Serial No.	Deployed
TEMPHU01	OTM	FSI	1360	Hull mounted
CNDCSG01	OCM	FSI	1376	Non-toxic supply
PSALSU01	OCM	FSI	1376	Non-toxic supply
TMESSG01	OTM	FSI	1370	Non-toxic supply
TVLTDR01	Transmissometer	Seatech	n/a	Non-toxic supply
FVLTWS01	W3S	Wetlabs	247	Non-toxic supply
ERWSS01	VAA anemometer	Vaisala	P50421	Foremast
ERWDSS01	WAV vane	Vaisala	S21214	Foremast
DWIRRPD	SKE 510 1204	Skye	28557	Port sensor
DWIRRSSD	SKE 510 1204	Skye	28558	Starboard sensor
CSLRRP01	Pyranometer CM6B	Kipp & Zonen Ltd	047462	Port sensor
CSLRRS01	Pyranometer CM6B	Kipp & Zonen Ltd	047463	Starboard sensor
CAPHZZ01	PTB100A	Vaisala	U1420016	n/a
CDTASS01	HMP44L	Vaisala	1850012	n/a
CRELSS01	HMP44L	Vaisala	1850012	n/a

## Originator's data processing

- **Navigation**

Navigation data from a number of different systems on board Discovery were logged in the RVS format during the cruise using the 'bestnav' protocol.

- **Bathymetry**

The bathymetry data were logged to the RVS format file 'prodep'.

- **Meteorology**

Both PAR and TIR sensors were fitted new at the start of AMT16. The data from the meteorological sensors were logged for the duration of the cruise to the RVS format file 'surftmp'.

- **Sea-surface hydrography**

SurfMet, the UKORS surface water and meteorological suite of instrumentation was run for the duration of the cruise. The SurfMet system was controlled via a LabView program running on a desktop PC and logged the data at 30 second intervals to the ship's central data logging (ABC)

System in the RVS format file 'surftmp'. The system was inadvertently stopped from logging mid-cruise resulting in a loss of around 4 hours of data. The temperature and conductivity data were used to calculate the surface salinity and were logged in the RVS file 'protsg'.

The transmissometer and fluorometer flow loop was stopped occasionally to clean the transmissometer lenses and take air and blank readings. After one cleaning event this loop appears to have stalled, even though the flow meter indicated flow. Hence there is bad data logged by the transmissometer and fluorometer between Julian Days 150 and 164 (30<sup>th</sup> May to 13<sup>th</sup> June, 2005).

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

### **Reformatting**

Data 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 to 30 second intervals using averaging. Directional data were reduced by averaging using a unit circle.

### **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 and correction**

- **Navigation**

The navigational data in the 'bestnav' RVS format file were converted to ASCII format and loaded to the QXF file. These formed the primary navigation channels. The velocity channels were converted from knots to  $\text{cm s}^{-1}$  (conversion factor x51.44). 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 speed check failures in the navigation data or gaps. These points were screened again to look for improbable spikes which were flagged as null. The gaps were then filled using linear interpolation and flagged 'T'.

- **Bathymetry**

The bathymetric data was loaded from the RVS file 'prodep'. No further corrections were applied.

- **Meteorology**

The data were loaded from the 'surftmp' RVS file.

Relative wind speed and direction were logged from the meteorological package during the cruise. The anemometer was positioned with 0 degrees at the ship's stern. The ship's speed relative to the ground was calculated at BODC using the ship's navigational information and the ship's heading. The speed and heading were then used to correct the wind data for the effect of the ship's movement. Absolute wind speed and direction channels were created.

The raw voltage channels were transferred for the PAR and TIR sensors and the data were converted to volts from mV (conversion x0.001). The PAR channels were converted to  $\text{Wm}^{-2}$  using the calibration coefficients from the calibration certificates supplied to BODC by UKORS. For the PAR sensors the conversion supplied on the calibration sheets for both sensors was  $1 \text{ mV} = 100 \text{ Wm}^{-2}$  ( $\text{V}$  to  $\text{Wm}^{-2}$  conversion x10<sup>5</sup>).

- **Sea-surface hydrography**

The data were loaded from the RVS files 'protsg' and 'surftmp'.

The raw voltage channels for the fluorometer and transmissometer were transferred and converted from mV to V (conversion factor = x0.001). Data were flagged for periods where the non-toxic supply was turned off and for spikes associated with cleaning operations.

## Calibrations

- **PAR**

The maximum values from the two PAR sensors were merged to produce one channel (BODC ICALRF = 6135).

- **Total Solar Irradiance**

The TIR channels were converted to  $Wm^{-2}$  using the calibration coefficients from the calibration certificates supplied to BODC by UKORS.

$$CSLRRP01 = CVLTRP01 * 94073.377 \text{ (BODC ICALRF = 6364)}$$

$$CSLRRS01 = CVLTRS01 * 84459.459 \text{ (BODC ICALRF = 6365)}$$

The maximum values from the two solar irradiance sensors were merged to produce one channel (BODC ICALRF = 6258).

- **Salinity**

Salinity data from the thermosalinograph have been compared with calibrated surface CTD data to a depth of 7 db and samples collected from the underway system and analysed with a bench salinometer. The analysis showed that there was a drift in the salinity measurement with time during the cruise. This was corrected using a linear offset against time.

The root mean square (RMS) error for the calibration dataset (n = 102) was calculated between the bench salinometer data and both the uncalibrated TSG and calibrated salinity.

	Uncal salinity	Cal Salinity
Max Offset	0.031	0.028
Min Offset	-0.219	-0.048
RMS	0.159	0.009

The decrease in the RMS error indicates the calibration improves the match between the CTD and sample salinities and the TSG sensor. Once the calibration was applied the average offset was  $-9.3 \times 10^{-5}$ , with SD 0.009.

Start	End	Calibration Type	Offset value	N	R <sup>2</sup> (%)	BODC ICALRF
21/05/2005 03:45:00	04/06/2005 03:32:00	Linear offset with time	Start = -0.1689 End = -0.1996	30	61.13	6381
04/06/2005 03:32:01	20/06/2005 00:15:00	Linear offset with time	Start = -0.1996 End = -0.1363	51	91.31	6382
20/06/2005 00:15:01	28/06/2005 13:00:00	Linear offset with time	Start = -0.1093 End = +0.0405	24	86.30	6383

- **Temperature**

Hull mounted temperature sensor data was checked against the CTD temperature measurements averaged over the upper 7db of the water column. Only CTD data points and underway records with a standard deviation lower than 0.01 °C were considered. The offset was calculated from CTD temp – hull sensor temp, which was then plotted against both time and CTD temperature. There was a significant regression with the offset against both time and CTD temp. Since the regression against time explained a greater proportion of the variance a linear offset was determined against cruise time

and values determined for the start and end of the cruise. The BODC calibration system then generated the offset to be added for each time interval in between.

The root mean square (RMS) error for the calibration dataset (n = 46) was calculated between the CTD sensor temperature and both the uncalibrated and calibrated hull sensor temperature.

	Uncal temp	Cal temp
Max Offset	-0.018	0.021
Min Offset	-0.098	-0.049
RMS	0.048	0.014

The decrease in the RMS error indicates the calibration improves the match between the CTD temperature and the hull temperature sensor. Once the calibration was applied the average offset was  $-2.2 \times 10^{-5} \text{ } ^\circ\text{C}$ , with SD 0.014  $^\circ\text{C}$ .

Start	End	Calibration Type	Offset value	N	R <sup>2</sup> (%)	BODC ICALRF
21/05/2005 03:45:00	28/06/2005 13:00:00	Linear offset with time	Start = -0.0176 End = -0.0718	46	51.88	6405

- **Chlorophyll**

Calibration of the fluorometer channel was attempted by comparing the raw fluorometer output voltage with chlorophyll concentration values extracted from samples collected from the ship's non-toxic water supply (n = 138). However the loss of 14 days fluorometer data reduced the calibration samples (n = 86) and reduced coverage during the middle of the cruise. 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.

- **Transmissometer**

There was no record available of the transmissometer serial number and so no calibration sheet can be supplied for this instrument. Despite air and dark readings being taken during the cruise a calibration cannot be reliably applied and the data therefore remain as a voltage.

## Data quality notes & outstanding issues

- **Meteorology**

Air temperature and humidity  
No problem.

Atmospheric pressure  
No problem.

Light sensors

For the PAR and TIR sensors, the port sensor reads slightly lower than the starboard sensor. The pattern of difference between port and starboard is consistent between the PAR and TIR sensors. For the first section of the cruise this maybe due to the westwards track of the ship in the southern hemisphere resulting in minor shading of the port sensors.

Wind data

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

- **Sea-surface hydrography**

The quality of the fluorometer and transmissometer records was affected by the blockage in the flow loop containing these sensors for 14 days in the middle of the cruise (30<sup>th</sup> May to 13<sup>th</sup> June, 2005). These periods were flagged as suspect for both instruments during screening.

Although there were extracted chlorophyll data from samples taken from the non-toxic supply, the decision was taken not to apply calibrations to the highly variable fluorometer data at either end of the cruise track; **instead the extracted chlorophyll dataset should be used for surface chlorophyll data along the cruise track.**