Continuous underway data series for cruise AMT17 (D299) (15th Oct – 28th Nov, 2005)

Version 1.0 –   October 2008
                18th Dec 2008
                November 2009 (room)

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Introduction

These notes refer to underway data collected during the Discovery cruise (D299) AMT17, between 15th October and 28th November 2005. The underway data end two days before the end of the cruise (26/11/2005 06:00).

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 covered	DSRNCV01	km	
Ship's heading (Glonass compass)	HEADCM01	Degrees true	
Ship's N-S velocity over the ground	APNSGP01	cm s^{-1}	Computed from ship's heading and GPS navigation
Ship's E-W velocity over the ground	APEWGP01	cm s^{-1}	Computed from ship's heading and GPS navigation
Bathymetric depth	MBANCT01	m	
Salinity - calibrated against underway samples	PSALSG01	PSU	Calibrated against bench salinometer samples
Sea temperature from hull sensor - calibrated against CTD temperatures	TEMPHG01	Degrees C	Calibrated against CTD data
Chlorophyll fluorescence - calibrated against extracted chlorophyll-a measurements	CPHLUT01	mg m^{-3}	Calibrated against sample data
Instrument output (voltage) by 25cm path length red light transmissometer	TVLTDR01	Volts	Uncalibrated
Atmospheric pressure	CAPHZZ01	mbar	
Dry bulb air temperature	CDTASS01	Degrees C	
Relative humidity	CRELSS01	%	
Absolute wind speed	EWSBSS01	m s^{-1}	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^{-2}	Corrected for shading effect
Down-welling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere by pyranometer	CSLRR1XS	W m^{-2}	Corrected for shading effect

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 have 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 AMT17. 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
Salinity	PSALSU01	PSU	Uncalibrated
Temperature of conductivity measurement by thermosalinograph	TMESSG01	Degrees C	Uncalibrated
Sea temperature from hull sensor	TEMPHU01	Degrees C	Uncalibrated
Fluorometer output voltage by linear-response chlorophyll fluorometer	FVLTWS01	Volts	Uncalibrated
Chlorophyll fluorescence calibrated using nominal equation provided by manufacturer	CPHLUMTF	mg m^{-3}	Nominal calibration using manufacturer's equation
Relative wind speed	ERWSSS01	m s^{-1}	Relative to ship's movement
Relative wind direction	ERWDSS01	Degrees	Relative to ship's stern
Down-welling light meter - PAR wavelengths – port sensor	DWIRRPSD	W m^{-2}	Manufacturer's calibration applied
Down-welling light meter - PAR wavelengths – starboard sensor	DWIRRSSD	W m^{-2}	Manufacturer's calibration applied
Downwelling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere by port-mounted pyranometer	CSLRRP01	W m^{-2}	Manufacturer's calibration applied
Downwelling vector irradiance as energy (solar (300-3000nm) wavelengths) in the atmosphere by starboard-mounted pyranometer	CSLRRS01	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
CAPHZZ01	Barometer PTB100A	Vaisala	Z4740021	deck
CRELSS01 & CDTASS01	Temp/humidity HMP44L	Vaisala	U1420016	deck
CSLRRS01	TIR CMB6	Kipp & Zonen	07463	deck - starboard
CSLRRP01	TIR CMB6	Kipp & Zonen	07462	deck - port
DWIRRSSD	PAR	SKYE	28557	deck - starboard
DWIRRPSD	PAR	SKYE	28558	deck - port
ERWSSS01	Anemometer WAA	Vaisala		deck
ERWDSS01	Wind vane WAV	Vaisala		deck
TEMPHU01	OTM temperature	FSI	1360	Hull
PSALSU01	OCM conductivity	FSI	1376	Non-toxic supply
TMESSG01	OTM temperature	FSI	1370	Non-toxic supply
FVLTWS01	Fluorometer	Wetlabs	246	Non-toxic supply
TVLTDR01	Transmissometer	Seatech	114R	Non-toxic supply

Originator's data processing

- **Navigation**

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

- **Bathymetry**

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

- **Meteorology**

SurfMet, the UKORS surface water and meteorological suite of instrumentation was run for the duration of the cruise. The data were logged to the RVS format 'surfmet' file.

- **Sea-surface hydrography**

SurfMet, the UKORS surface water and meteorological suite of instrumentation was run for the duration of the cruise and logged the data to the RVS file 'surfmet'. 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.

BODC post-cruise processing and screening

Reformatting

Data from the full-resolution RVS files were converted to ASCII format and then transferred to BODC's NetCDF format (QXF) under the BODC Underway Data System (BUDS). This transfer involved reducing the data to 60 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**

Navigational data were available from the merged RVS file 'bestnav' and loaded to the QXF file. These formed the primary navigation channels. The velocity channels were converted from knots to 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 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 RVS file 'surfmet'.

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. These channels were converted to Wm^{-2} using the calibration coefficients from the calibration certificates supplied to BODC by UKORS. For the PAR sensors the conversion was 1 mV = 100 Wm^{-2} (conversion x10^5) and for the TIR sensors the conversion was 1 µV = 1 Wm^{-2} (conversion x10^6).

- **Sea-surface hydrography**

The data were loaded from the files 'protsg' and 'surfmet'.

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 PAR data were corrected from the effect of shading by merging the calibrated values from the starboard and port PAR sensors into one channel and taking the maximum values from the two sensors (BODC ICALRF = 6135).

- **Total Irradiance**

The TIR data were corrected from the effect of shading by merging the calibrated values from the starboard and port TIR sensors into one channel and taking the maximum values from the two sensors (BODC ICALRF = 6258).

- **Salinity**

Salinity data from the thermosalinograph were compared with bench salinometer readings for samples taken from the ship's non-toxic pumped sea water supply. A drift in the offset was noticed for the readings from 04/11/2005 18:09 until the end of the cruise and calibration equations for each of three separate periods were derived using a linear interpolation against time. The CTD sensor calibration data had not displayed the same drift and therefore it was felt the drift was in the thermosalinograph not the bench salinometer data. The cruise was split into 3 sections and linear calibrations made for the offset against decimalised time for each period. The first period related to the section until the ship arrived in Ponta Delgada for the second time. The second section ran from the ship leaving Ponta Delgada for the second time until a step in the u/way sensor salinity of 0.2 PSU with no matching jump in temperature (SST or TSG). The final section of the cruise runs from this step in the salinity until the cruise ended.

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

	Uncal. Salinity	Cal. Salinity
Max Offset	-0.050	0.028
Min Offset	-0.191	-0.016
RMS	0.149	0.008

The decrease in the RMS error indicates the calibration improves the match between the bench salinometer and the TSG sensor. Once the calibration was applied the average offset (bench salinometer-calibrated TSG) was -2.5×10^{-5}, with SD = 0.008.

Start	End	Calibration Type	Offset value	N	R^2 (%)	BODC ICALRF
17/10/2005 12:00	25/10/2005 09:58	Linear offset with time	Start = -0.1513 End = -0.1754	8	82.67	6197
27/10/2005 10:45	04/11/2005 18:09	Linear offset with time	Start = -0.1516 End = -0.1976	13	65.98	6198
04/11/2005 18:09	26/11/2005 06:00	Linear offset with time	Start = -0.1961 End = -0.0404	31	96.06	6199

- **Temperature**

The parameter TEMPCU01 was taken from the CTD profiles and TEMPHU01 from the underway files. The data from the CTD profiles were averaged over 5 decibars. Data values with high standard deviations were removed from the calibration set and the offset was calculated from CTD temp – hull sensor temp. The offset was then plotted against time and CTD temperature. There was a significant regression with time but not with CTD temperature. A linear offset was calculated against cruise time and values determined for the offset at 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 was calculated for the comparison of surface temperature from the SeaBird CTD with the uncalibrated TSG temperature and the newly calibrated temperature for the calibration dataset.

	Uncal. Temp	Cal. Temp
Max Offset	-0.003	0.026
Min Offset	-0.088	-0.053
RMS	0.0314	0.0132

The decrease in the RMS error indicates the calibration improves the match between the CTD temperature and the hull temperature sensors. Once the calibration was applied the average offset (CTD-calibrated) was 2×10^{-5} ^{o}C, with SD = 0.01 ^{o}C.

Start	End	Calibration Type	Offset value	N	R^2 (%)	BODC ICALRF
16/10/2005 08:00	26/11/2005 08:00	Linear offset with time	Start = -0.0107 End = -0.0426	44	21.2	6203

- **Chlorophyll**

The fluorometer channel (FVLTWS01) was calibrated by converting the voltage to a nominal chlorophyll concentration (CPHLUMTF) using the calibration equation provided by UKORS.

CPHLUMTF = 13.1 * FVLTWS01 – 1.0349 (BODC ICALRF = 6207)

The nominal chlorophyll concentration values were compared to discrete chlorophyll concentrations, which were extracted after samples from the ship's non-toxic water supply, filtered and then dissolved in acetone and analysed against known chlorophyll-a standards with a bench fluorometer. The cruise was broken up into 5 sections based on changes in the fluorometer readings before and after the ship had been alongside for repairs and the presence of 'steps' in the fluorometer readings. The first and last sections had offsets that were significantly related to the extracted chlorophyll data and in for these periods a calibration equation was applied. The three middle sections showed a significant linear regression between the offset and time. In these cases offset values were generated for the start and end of each period and the BODC calibration form applied the appropriate offset for the period in between. The calibrations and the periods for which they have been applied are given in the table below. These adjustments were made to generate the final calibrated channel (CPHLUT01).

Start	End	Calibration Type	N	R^2 (%)	BODC ICALRF
16/10/2005 08:00	25/10/2005 07:00	CPHLUT01 = 0.1696 * CPHLUMTF + 0.2448	28	61.24	6406
17/11/2005 04:30	26/11/2005 06:00	CPHLUT01 = 0.1815 * CPHLUMTF + 0.1651	46	68.27	6407

Start	End	Calibration Type	Offset value	N	R^2 (%)	BODC ICALRF
27/10/2005 09:00	01/11/2005 07:05	Linear offset with time	Start = 0.5868 End = 0.6818	23	36.3	6208
01/11/2005 07:10	04/11/2005 15:55	Linear offset with time	Start = 0.4870 End = 0.6228	13	85.3	6209
04/11/2005 15:55	16/11/2005 21:15	Linear offset with time	Start = 0.4723 End = 0.7074	51	68.6	6210

The root mean square (RMS) error for the calibration dataset was calculated for offset between the discrete extracted samples and both the nominal fluorometer values and the newly calibrated fluorometer values.

	Nominal calibration	Sample calibration
Max Offset	0.774	0.644
Min Offset	-1.411	-0.138
RMS	0.596	0.064

The decrease in the RMS error indicates the calibration improves the match between the extracted chlorophyll values and the fluorometer values. Once the calibration was applied the average offset (Extracted chl-a – calibrated fluorometer) was 0.0004 mg m^{-3}, with SD = 0.064 mg m^{-3}.

Data quality notes & outstanding issues

Two unusually large gaps in all meteorological and surface hydrography data streams occurred at the beginning of the cruise on 15/10/2005 between 08:40 and 16:00 and on 16/10/2005 between 11:48 and 15:41 GMT. These gaps are not mentioned in the cruise report. UKORS technical cruise report does mention that a new logging PC and device manager were being tried and this may explain the unusual problems.

- **Meteorology**

Light sensors
The port TIR and PAR sensors read slightly lower (50-60 Wm^{-2} and 10-20 Wm^{-2} respectively) than the starboard sensors for a large portion of the cruise, however the trends were consistent.

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 the ship's structure.

- **Sea-surface hydrography**

The fluorometer output fluctuated at the start and end of the cruise and it is during these periods there is the greatest scatter in the calibration residuals. There were many lower level (< 0.2 μg l^{-1}) readings but fewer high level (> 0.4 μg l^{-1}) extracted chlorophyll samples which may limit the accuracy of the calibrations at higher concentrations at the start and end of the cruise.

The output voltage from the transmissometer still needs to have a calibration applied to generate the underway attenuance. No calibration equation provided for transmissometer. Open and blank voltage sheet for the cruise duration has been provided to BODC.