

# AMT RRS James Cook Cruise JC039 AMT19 Underway Meteorology and Surface Hydrography Document

## Cruise details

<b>Dates</b>	2009-10-13 to 2009-12-01
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<b>Data supplied by</b>	Chris Barnard (NMF-SS)

These notes refer to underway data collected during the RRS James Cook cruise (JC039) AMT19, between 13th October and 1st December 2009. The cruise departed from Falmouth (UK) and finished in Punta Arenas (Chile). All time quoted in this document are UTC.

The data provided to BODC cover the period from 13/10/2009 to 30/11/2009.

00 The data did not fully cover the period of the cruise as the sea surface hydrography sensor suite was not turned on until clear of land at the start of the cruise (17/10/2009 08:15) and turned off prior to entering Argentinean territorial waters (29/11/2009 13:42).

## Content of data series

Parameter	Units	Parameter code	Comments
Latitude	Degrees (+ve N)	ALATGP01	-
Longitude	Degrees (+ve E)	ALONGP01	-
Ship's heading (Gyro)	degrees	HEADCM01	-
Ship's eastward velocity	cm s <sup>-1</sup>	APEWGP01	-
Ship's northward velocity	cm s <sup>-1</sup>	APNSGP01	-
Distance run	km	DSRNCV01	-
Bathymetric depth from GEBCO	m	MBANCT01	Depth generated for position from GEBCO data
Bathymetric depth	m	MBANGBCE	-
Atmospheric pressure	mbar	CAPHTU01	-
Air temperature	°C	CDTASS01	-
Relative humidity	%	CRELSS01	-
PAR irradiance	W m <sup>-2</sup>	DWIRRXMX	-

Total irradiance	W m <sup>-2</sup>	CSLRR1XS	-
Relative wind direction	Degrees	ERWDSS01	-
Relative wind speed	m s <sup>-1</sup>	ERWSSS01	-
Absolute wind direction	Degrees	EWDASS01	Corrected for ship's heading and speed
Absolute wind speed	m s <sup>-1</sup>	EWSBSS01	Corrected for ship's heading and speed
Salinity - calibrated	Dimensionless	PSALSG01	Calibrated against samples
Temperature (sea surface, remote housing at non-toxic seawater supply inlet) - calibrated	°C	TEMPHG01	Calibrated against samples
Temperature (TSG housing)	°C	TMESSG01	-
Fluorometer output: voltage	V	FVLTWS01	-
Chlorophyll fluorescence (calibrated)	mg chl_a m <sup>-3</sup>	CPHLUT01	Calibrated against samples
Beam transmission	%	POPTDR01	-
Beam attenuation	m <sup>-1</sup>	ATTNDR01	-

## Instrumentation

### Navigation and bathymetry (HIPLAT)

Instrument	Type
Ashtech ADU5 GPS based attitude measuring system	GPS
Seapath 200 GPS unit	GPS
Applanix POSMV GPS unit	GPS
DPS116 GPS unit	GPS
CNAV GPS unit	GPS
Ship's Gyrocompass	Gyro compass
Simrad EA600 Precision Echo Sounder	Echosounder

### Meteorology (HIMET)

Sensor	Serial number	Last calibration date	Deployment
Gill Wind sonic (Option 3)	064537	-	Port

Skye Instruments SKE510	28562	2009-04-29	Starboard
Skye Instruments SKE510	28561	2009-04-29	Port
Kipp and Zonen Ltd CMB6	973135	2009-04-20	Starboard
Kipp and Zonen Ltd CMB6	973134	2009-04-20	Port
Vaisala PTB210	U1420016	2009-04-01	Port
Vaisala HMP45A	E1055002	2009-03-15	Port

## Surface hydrography (HIUWAY)

Sensor	Serial number	Last calibration date	Deployment
Sea-Bird SBE38	0489	2009-04-02	Hull inlet to non-toxic supply
Sea-Bird SBE45	0230	2009-02-25	CTD hanger non-toxic supply
Wetlabs C-Star	CST-1132PR	2008-07-14	CTD hanger non-toxic supply
Wetlabs WetStar	WS3S-351P	2009-04-07	CTD hanger non-toxic supply

## Originator's Data Processing

### Navigation and bathymetry (HPPLAT)

During the cruise there was a dual logging system in place on the RRS James Cook. Data from the various instruments were logged to the RVS Level-C system and also as NetCDF (binary) through the Ifremer Techsas data logging system. In addition to the GPS systems the following instruments were logged during the cruise:

- 1) Chernikeef EM speed log (logged to RVS format as log\_chf)
- 2) Ships Gyrocompass (logged to RVS format as gyro)
- 3) Simrad EA600 Precision Echo Sounder (logged to RVS format as ea600m)

The Simrad-EA600 had several issues during the cruise where it lost network connection between the PC and its Transceiver unit which controls, powers and interprets the return signals from the transducer. Kongsberg were contacted and after several days of the unit falling over it was recommended that the software be upgraded. The upgrade featured a GPT Firmware update. This update failed and the Transceiver PIC was damaged. The GPT could not be used again. No useable data were recorded from 17th November 2009 onwards. The EA500 was then used for general echo sounding but the data was not recorded.

Processing was carried out using the RVS software suite. The following routines were run on the navigation and bathymetry data channels to produce files named after the routine that generated them:

RELMOV - Relmov is the relative motion file for this cruise. This was generated using the ships gyro and ships Chernikeef Log data to extract a movement in a given direction. This was then used by bestnav when and where necessary to calculate fixes if GPS fixes were not available.

BESTNAV - Bestnav uses all 3 GPS Systems logged and creates a best suite stream by providing an as complete account of the ships track as possible. This is done by reading all 3 GPS streams with gps\_g2 being primary, gps\_4000 as secondary and gps\_ash as tertiary. The system looks for gaps of a certain length in the primary and when it finds those gaps it requests that the next gps down fill in the gaps. If no GPS data is available it asks RELMOV to fill in until data is available again. Then the system calculates back

over itself to ensure that the extrapolated positions are correct using the GPS data available around the gap.

BESTDRF - Bestdrf is a product of bestnav. When run bestnav uses the relmov data which contains a predicted vn and ve based upon direction and speed through the water. The Bestdrf file is the accurate drift velocity of what actually occurred based on the GPS changes between each record.

PRODEP - Prodep is an automated process that accessed the bestnav position fix data and then uses a pre programmed Carter tables of corrections and corrects the echo sounder data for that given location.

Filename	Data type	Start Calendar Day	Start Time	Finish Calendar Day	Finish Time	Data Interval
bestnav	RVS Level-C processed	2009-10-13	12:11:50	2009-11-30	11:06:10	10 seconds
prodep	RVS Level-C processed	2009-10-13	12:30:02	2009-11-17	14:30:02	6-7 seconds

## Meteorology (HPMET)

The meteorology component consisted of a suite of sensors mounted on the foremast at a height of approx 16.4m above the waterline. Parameters measured were wind speed and direction, air temperature, humidity and atmospheric pressure. There was also a pair of optical sensors mounted on gimbals on each side of the ship. These measured total irradiance (TIR) and photo-synthetically active radiation (PAR).

The data from the meteorological sensors were logged by the TECHSAS system during the cruise and combined in the RVS Level-C format to produce the file 'surfmet'. The following instruments were logged during the cruise:

- 1) Gill Wind sonic (Option 3)
- 2) Skye Instruments SKE510 (port and starboard)
- 3) Kipp and Zonen Ltd CMB6 (port and starboard)
- 4) Vaisala PTB100A
- 5) Vaisala HMP45A

No processing was carried out using the RVS software suite on meteorology channels.

Filename	Data type	Start Calendar Day	Start Time	Finish Calendar Day	Finish Time	Interval
surfmet	RVS Level-C raw	2009-10-13	14:26:00	2009-11-29	16:27:00	60 seconds

## Sea surface hydrography (HPUWAY)

The surface water component consisted of a flow through system with a pumped pickup at approx 5 m depth. TSG flow was approx 18 litres per minute whilst fluorometer and transmissometer flow is approx 1.5 litres per minute. Flow to instruments is degassed using a debubbler with 24 litres per minute inflow and 10 litres per minute waste flow. The non-toxic system ran throughout the cruise except when entering within 200 nautical miles of the Azores, Falklands and Argentina.

The data from the non-toxic supply were logged by the TECHSAS system during the cruise and combined in RVS Level-C format to produce the files 'surfmet' and 'sbe45'. The following instruments were logged during the cruise:

- 1) Wetlabs C-star 25 cm pathlength transmissometer (logged to RVS format in surfmet)
- 2) Wetlabs WetStar fluorometer (logged to RVS format in surfmet)

- 3) Seabird SBE38 Temperature sensor (logged to RVS format in sbe45)  
 4) Seabird SBE45 MicroTSG (logged to RVS format in sbe45)

Filename	Data type	Start Calendar Day	Start Time	Finish Calendar Day	Finish Time	Interval
sbe45	RVS Level-C raw	2009-10-17	06:10:02	?	?	1 seconds
surfmet	RVS Level-C raw	2009-10-13	14:26:00	2009-11-29	16:27:00	60 seconds

## BODC Data Processing

Navigation and bathymetry from processed RVS format files, along with meteorological and underway seawater data from the raw 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.

### Navigation and bathymetry (HPPLAT)

The bestnav data were transferred as used as the source for cruise navigation data. A description of the channels present in the files, units, whether they were transferred, BODC parameter code and units, and if a unit conversion was applied during the transfer are detailed in the table below:

bestnav	Channels	Description	Units	BODC Parameter Code	Units	Conversion Factor
	lat	Latitude	Degrees +ve N	ALATGP01	Degrees +ve N	*1
	lon	Longitude	Degrees +ve E	ALONGP01	Degrees +ve E	*1
	vn	northwards velocity	knots	APNSGP01	cm s <sup>-1</sup>	*51.44
	ve	eastwards velocity	knots	APEWGP01	cm s <sup>-1</sup>	*51.44
	mode	mode that the GPS was operating in. 0 indicates an invalid fix, 1 a GPS fix and 2 a DGPS fix	-	not for transfer	-	-
	cmg	Course made good	Degrees True	APDAGP01	Degrees True	*1
	smg	Speed made good	knots	APSAGP01	m s <sup>-1</sup>	*0.514
	dist_run	Distance run	Nautical miles	DSRNCV01	km	*1.852
	Heading	Ship's heading	Degrees true	HEADCM01	Degrees true	*1

prodep	Channels	Description	Units	BODC Parameter Code	Units	Conversion Factor
	uncdepth	Raw depth from echosounder	-	not for transfer	-	-
	cordepth	Depth corrected from Carter's tables	m	MBANCT01	m	*1
	cartarea	Carter's table area from position	-	not for transfer	-	-

Once the data in the RVS navigation file 'bestnav' were transferred 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 (<5 minutes) in the latitude and longitude channels, these were filled using the Matlab program 'navint' to interpolate data to fill the gaps. In addition the 'navcheck' routine checked the vessel's speed over the ground from the navigation data for values that are outside an expected range. There were no warnings indicated. The latitude and longitude channels were screened by plotting the course on to a map of the Atlantic Ocean. There was no further flagging required.

## Meteorology (HPMET) and Sea surface hydrography (HPUWAY)

The 'surfmet' and 'sbe45' files were used as the source data for transfer. A description of the channels present in the files, units, whether they were transferred, BODC parameter code and units, and if a unit conversion was applied during the transfer are detailed in the table below:

surfmet	Channels	Description	Units	BODC Parameter Code	Units	Conversion Factor
	temp_h	TSG housing temperature	-	not for transfer - channel null in file	-	-
	temp_m	Remote temperature at non-toxic inlet	-	not for transfer - channel null in file	-	-
	cond	TSG conductivity	-	not for transfer - channel null in file	-	-
	trans*	Raw fluorometer voltage	V	FVLTWS01	V	*1
	fluo*	Raw transmissometer voltage	mV	TVLTDR01	V	*0.001
	press	Atmospheric pressure at measurement height - no sea level correction	1 hPa	CAPHTU01	1 mbar	*1
		Raw port PAR sensor	-2			-5

	ppar	voltage	10 mV	DVLTRPSD	V	*10
	spar	Raw starboard PAR sensor voltage	10 <sup>-2</sup> mV	DVLTRSSD	V	*10 <sup>-5</sup>
	speed	Relative wind speed	m s <sup>-1</sup>	ERWSS01	m s <sup>-1</sup>	*1
	direct	Relative wind direction	Degrees	ERWDSS01	Degrees	*1
	airtemp	Air temperature	Degrees Celsius	CDTASS01	Degrees Celsius	*1
	humid	Air humidity	Percent	CRELSS01	Percent	*1
	ptir	Raw port TIR sensor voltage	10 <sup>-2</sup> mV	CVLTRP01	V	*10 <sup>-5</sup>
	stir	Raw starboard TIR sensor voltage	10 <sup>-2</sup> mV	CVLTRS01	V	*10 <sup>-5</sup>
<b>sbe45</b>	<b>Channels</b>	<b>Description</b>	<b>Units</b>	<b>BODC Parameter Code</b>	<b>Units</b>	<b>Conversion Factor</b>
	temp_h	TSG housing temperature	Degrees Celsius	TMESSG01	Degrees Celsius	*1
	cond	TSG conductivity	S m <sup>-1</sup>	CNDCSG01	S m <sup>-1</sup>	*1
	salin	Salinity	PSU	PSALSU01	dimensionless	*1
	sndspeer	Velocity of sound in water	m s <sup>-1</sup>	SVELSG01	m s <sup>-1</sup>	*1
	temp_r	Remote temperature at non-toxic inlet	Degrees Celsius	TEMPHU01	Degrees Celsius	*1

\* NMF technician confirmed the fluorometer and transmissometer channels had been reversed during logging.

### Wind channels - calculation of absolute values

The BODC Matlab procedure 'wincor' was run using relative wind speed and direction, the ship's north-south and east-west velocities with the vane set to 0 degrees at the bow to generate absolute wind speed (EWSASS01) and direction (EWDASS01).

### Irradiance channels (PAR and TIR) - conversion from voltages using manufacturer's calibrations

The voltages were converted to W m<sup>-2</sup> using the coefficients on the calibration sheets provided. The maximum values from the two PAR sensors were merged to produce one channel.

### Transmissometer - conversion from voltage using manufacturer's calibrations

The coefficients from the calibration sheets provided for the transmissometer were used to generate the calibration equation to convert the raw voltage to transmittance and then to attenuation.

## Sample Calibrations

### Temperature

The hull temperature sensor data were calibrated against the CTD profile temperature. The data from the hull sensor at the CTD start time were compared with the temperature from the CTD averaged over the surface 5 decibars. The temperature offsets (CTD - Hull) were plotted against date/time and CTD sensor temperature and outliers identified and removed from the calibration dataset. The relationships in the offset between sensors were then compared to the date/time and the CTD sensor temperature in separate linear regressions. There was a significant relationship with CTD sensor temperature ( $R^2 = 0.067$ ;  $n = 108$ ;  $F = 7.58$ ;  $p = 0.007$ ) and also a significant regression of offset with date/time ( $R^2 = 0.079$ ;  $n = 108$ ;  $F = 9.09$ ;  $p = 0.003$ ).

Applying the significant regression equation with the greater F ratio, offsets were generated at the date/time when the non-toxic underway system was switched on (17/10/2009 08:11:00 offset = -0.0027) and when switched off at the end of the cruise (29/11/2009 13:41:00 offset = -0.0219). The offset was applied for the period in-between by linear interpolation of these offsets through the BODC BUDS calibration routine (BODC ICALRF 6436).

### Salinity

The SBE45 salinity data were calibrated against bench salinometer data from samples collected from the underway system during the cruise. The data from the SBE45 TSG at the discrete sampling times were compared with the bench salinometer measurements. The salinity offsets (bench - TSG) were plotted against date/time and bench salinity and outliers identified. The relationships in the offset between TSG and bench salinometer were then compared to the date/time and the bench salinity in separate linear regressions. There was a significant relationship of offset with date/time ( $R^2 = 0.060$ ;  $n = 179$ ;  $F = 11.33$ ;  $p = 0.001$ ) and also with bench salinity ( $R^2 = 0.022$ ;  $n = 179$ ;  $F = 4.03$ ;  $p = 0.046$ ).

Applying the significant equation from the date/time regression, the offset was generated at the date/time when the non-toxic underway system was switched on (17/10/2009 08:11:00 offset = 0.0409) and when switched off at the end of the cruise (29/11/2009 13:41:00 offset = 0.0241). The offset was applied for the period in-between by linear interpolation of these offsets through the BODC BUDS calibration routine (BODC ICALRF 6437).

### Fluorescence

The fluorometer voltage data were calibrated against extracted chlorophyll-a data from samples collected from the underway system during the cruise. Samples of seawater collected and extracted chlorophyll-a measurements made following Welschmeyer (1994). Each sample of 250 ml was filtered through a 47 mm 0.2  $\mu\text{m}$  polycarbonate filter. The filters were then placed in a vial with 10 ml 90% acetone and left in a freezer for 24 hours. The samples were then analysed on a pre-calibrated Turner Designs Trilogy fluorometer with a non-acidified chl module (CHL NA #046) fitted. The bench fluorometer calibration was checked against dilutions of pure chlorophyll stock during the cruise and no modifications to the calibration were necessary.

The raw voltage data from the fluorometer were compared with the extracted chlorophyll-a measurements. The offsets (extracted chl-a - voltage) were plotted against date/time and extracted chlorophyll-a and outliers identified. The calibration dataset was split into a number of sections to correct for different periods of drift in the sensor and oceanographic regions. These changes were related to different sections of the cruise where the non-toxic system had been turned off/on and/or cleaned.



Start	End	Calibration	N	R	ICALRF
17/10/2009 08:00	21/10/2009 19:30	CPHLUT01 = 1.9493 * FVLTWS01 - 0.0503	70	0.951	6440
21/10/2009 19:30	25/10/2009 20:25	CPHLUT01 = 6.6667 * FVLTWS01 - 0.4586	20	0.983	6439
25/10/2009 20:25	28/10/2009 13:10	CPHLUT01 = 8.9286 * FVLTWS01 - 0.6429	11	0.946	6432
28/10/2009 13:10	30/10/2009 11:15	Start offset = -0.1513 End offset = 0.0429	5	0.752	6438
30/10/2009 11:15	10/11/2009 00:00	CPHLUT01 = 1.9493 * FVLTWS01 - 0.0503	70	0.951	6440
10/11/2009 00:00	14/11/2009 20:00	Start offset = 0.0340 End offset = -0.3278	18	0.986	6430
14/11/2009 20:00	21/11/2009 20:25	CPHLUT01 = 4.6512 * FVLTWS01 - 0.2270	31	0.973	6431
21/11/2009 20:25	29/11/2009 13:30	CPHLUT01 = 1.9493 * FVLTWS01 - 0.0503	70	0.951	6440

## References

**Welschmeyer N.A., 1994.** Fluorometric analysis of chlorophyll-a in the presence of chlorophyll-b and phaeopigments. *Limnology and Oceanography*, 39:1985-1992.

## 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. 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 quality report

### Navigation and bathymetry (HQPLAT)

The navigation data have been through BODC quality control screening. The gaps of less than ten minutes have been filled by interpolation. Overall the navigation data for the cruise duration appear good. There were 2 periods (6+ hrs) of missing positional data in the RVS bestnav file provided in the Post-Cruise archive. No further recovery of navigation data has been possible for these periods and they have been filled by interpolation. Both these periods appear to be while the vessel was steaming between stations and it could be considered that the interpolated values should be reasonable for use with the underway meteorology and hydrography data.

The connectivity problems between the logging PC and the transducer resulted in a very noisy stream of bathymetry data. The MBANCT01 channel has been flagged to remove the most obvious suspect data but for many periods the variation was large and frequent. There is no depth data available from 17th

November 2009 12:00. BODC advises the use of the depth data created from the GEBCO bathymetric data along side the data recorded by the Simrad-EA600.

## Meteorology (HQMET)

The meteorology data have been through BODC quality control screening. Some intermittent flagging of data have been made. Overall the data for the cruise duration appear good. Additional notes are provided from the NMF technicians' report where anomalies in the data were apparent due to problems with the sensors during the cruise.

**Irradiance channels:** Good agreement between the two total PAR sensors. For the two total solar irradiance sensors, one of them (starboard) reads slightly higher (about 70 - 80 W m<sup>-2</sup>) at noon than the other. Both judged OK to merge into one channel.

The data in the TIR and PAR channels did not require further flagging as it is unclear whether the variation is due to changing cloud cover etc.

## Sea surface hydrography (HQUWAY)

The underway log sheets were used as a guide to the times when the non-toxic flow was switched off, dropped low or was adjusted during the cruise. Where there was noise in the channel at these times the data were flagged suspect. If there was no noise or spiking the data remain unflagged.

The sample calibrations applied to the TSG salinity and hull sensor temperature channels appear reasonable and did not produce suspect data in the calibrated channels.

**Fluorometer:** The data for period from 28/10/2009 12:00 to 31/10/2010 12:00 should be considered suspect. There was a step up in sensor values at 28/10/2009 12:00, which decreased back to values before the step over the next 2-3 days. The calibration appeared to correct for some of this drift but users should be aware that the calibrated data may still not be reliable for this period as the number of discrete samples were small for this period. The first diel station (29/10/2009 03:59 - 30/10/2009 11:15) coincides with this period and the data show little variation for this period as might be anticipated since the vessel is not underway. There appeared to be drift in the sensor for the period 10/11/2009 19:00 to 14/11/2009 19:56, possibly from not being cleaned for a number of days however the calibration was able to correct for this drift.

The calibrated fluorometer data exhibit large amounts of variability towards the end of the cruise in the southern Atlantic Ocean. The calibration in this area is not as closely matched to the sample data for this reason. Users should keep this in mind when using the sample calibrated fluorometer data.

**Attenuance and transmittance:** Throughout the cruise track there was intermittent noise in the transmissometer channels. It is possible bubbles were becoming trapped in the transmissometer and building up to a point before being flushed past the lens. There are also a few steps in the data of which users should be aware. Users should use caution when interpreting the attenuance and transmittance channels.

## Problem report

### Navigation and bathymetry

Not applicable.

### Meteorology

Not applicable.

## **Sea surface hydrography**

Not applicable.