CRUISE REPORT: AU1603

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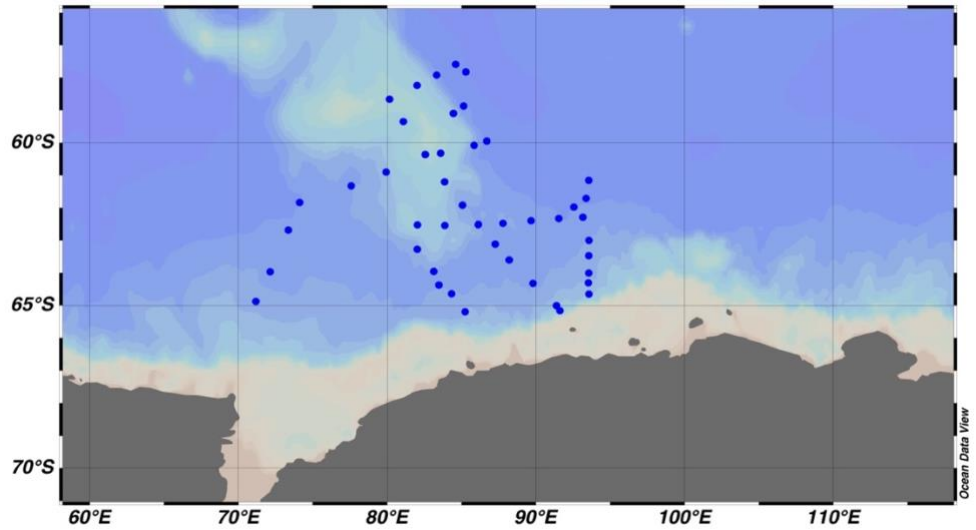

Highlights

Cruise Summary Information

Section Designation	
Expedition Designation (ExpoCode)	**09AR20160111**
Chief Scientist	**Andrew Constable/ University of Tasmania**
Dates	11 January –24 February 2016
Ship	R/V Aurora Australis
Ports of Call	Hobart, Australia Hobart, Australia
Geographic Boundaries	57° 59”S 71° 17”E 93° 56”E 65° 16”S
Stations	47
Floats and Drifters Deployed	5 Apex (Argo) 2 SOCCOM 1 Provor
Moorings Deployed and Recovered	0

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Report assembled by Savannah Lewis

Marine Data Voyage Report 2015/16 Voyage 3

Prepared by: Lloyd Symons

Document Status: **ISSUED**

Document Change Description

Issue	Date	Change Description	By	Approval
1	2016/07/28	First Release	LPS	LPS

1 INTRODUCTION

This is the Marine Data Voyage Report for Voyage 3 2015/16 which took place between the 11th January and the 12th March 2016.

2 PURPOSE OF THIS DOCUMENT

During most Antarctic voyages, the underway data collection system is operated to continuously record navigational, meteorological and water chemistry information. This data collection is performed as part of STS project 3313 whose objective for every voyage is as follows:

- *Science Technical Support including provision of recording scientific data during the voyage for publication from the Australian Antarctic Data Centre (AADC) to the wider scientific community.*
- *Provide meteorological, sea water, bathymetry and navigation information to ship's crew, BOM observers and scientific personnel in real time.*
- *Provide a system for the general use of expeditioners to track the voyage progress and environmental conditions.*

This document is intended to provide a complete description of the underway data recorded on the Voyage. Marine Data Voyage Reports are structured in three parts:

1. A description of the voyage including:

    - Departure and return dates.
    - Purpose of the voyage.
    - Particular activities and events which are relevant to the voyage data set.
    - Any particular instrumentation issues that occurred on the voyage.

2. A description of the instruments installed on the ship for the voyage. Normally this section of the report will remain relatively constant over the course of an Antarctic season but there may be minor changes as instruments occasionally fail or need to be replaced for various reasons.

3. A description of the ship's underway data collection system including the three levels of data that are collected (raw instrument strings, NetCDF files and the final database product that is supplied to the Australian Antarctic Data Centre)

3 VOYAGE DESCRIPTION

3.1 Voyage Objectives

The principal objectives of the voyage were to:

- Conduct the K-Axis Marine Science program.
- Carry out the Mawson resupply,
- Conduct minor cargo operations at Davis and then return to Hobart.

Due to the vessel grounding at Mawson on the 24th February the vessel returned to Fremantle without visiting Davis.

3.2 Timing and locations:

The table below shows the actual voyage schedule:

Location	Time (UTC)	Activity
Hobart	11th January 2016	Departure from Hobart
K-Axis Marine Science	21st January to 19th February	K-Axis marine science program
Mawson	20th February 2016	Arrival at Mawson
Mawson	24th February 2016	Vessel breaks mooring lines and runs aground inside Horseshoe Harbour.
Mawson	26th February 2016	Vessel refloated and departs harbour
Vicinity of Mawson	27th February – 2nd March 2016	Minor cargo operations and vessel checking
Fremantle	12th March 2016	Return to Fremantle

Table 1 - Voyage Schedule

3.3 Ships Track

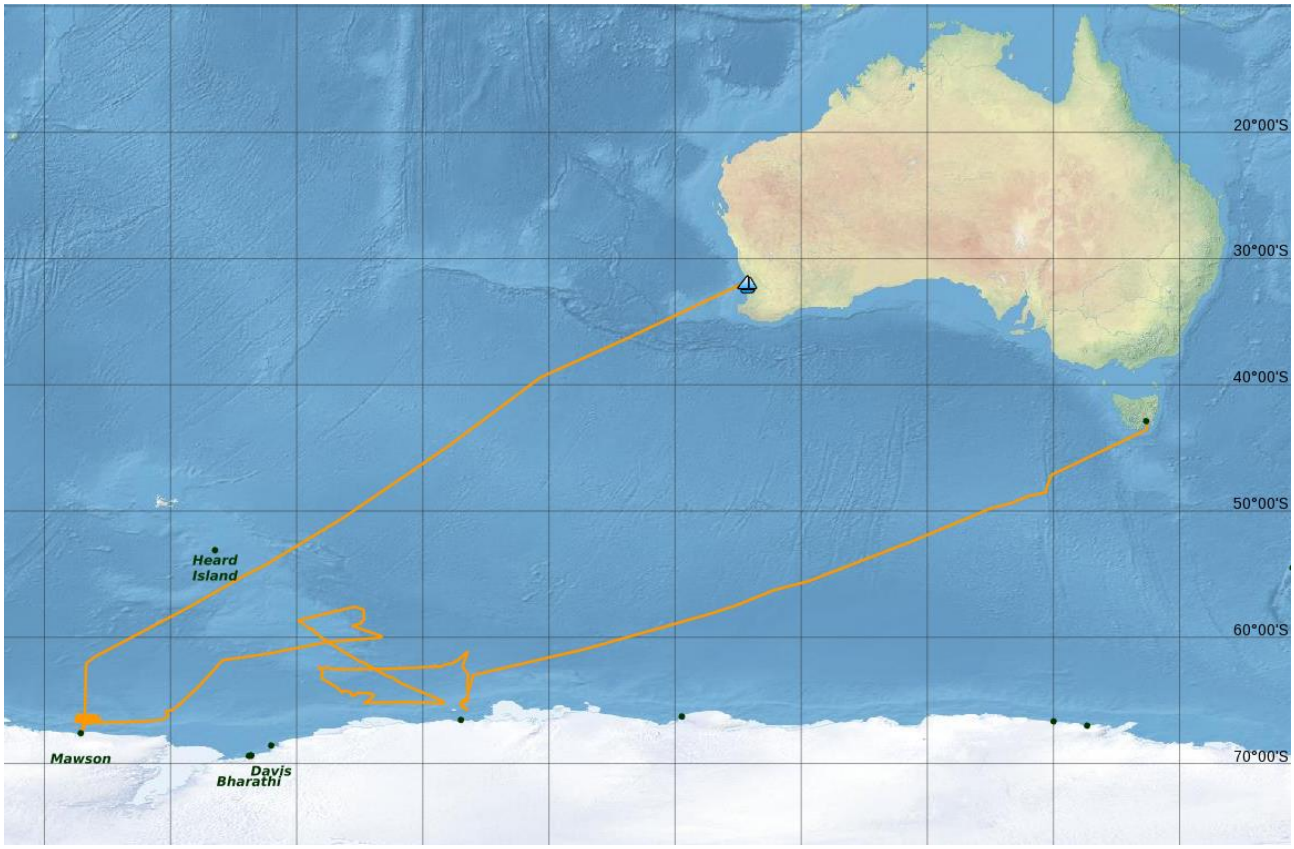


Figure 1 - Ships Track for Voyage 3 - 2015/2016

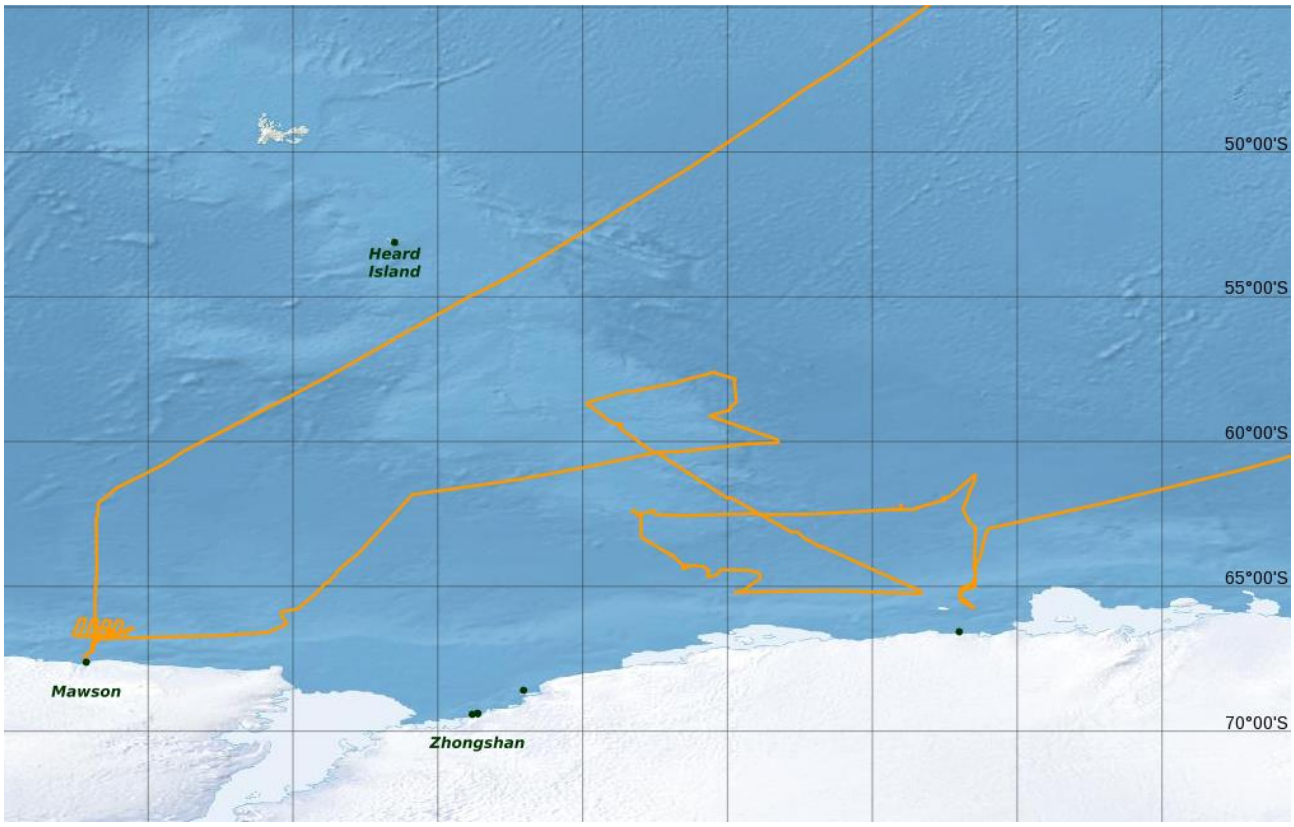


Figure 2 - Ships Track for Voyage 3 - 2015/2016 (Marine Science legs)

3.4 Personnel

To support the K-Axis marine science program, we had three electronics staff on board this voyage except for the return leg from Mawson to Fremantle when we were reduced to one.

3.5 Issues with Instrumentation

During this voyage the following issues were encountered that affected data quality:

3.5.1 Pressure Sensor

There are occasional negative spikes in pressure data. These spikes have been removed from the data. The original data is available from the AADC if required.

3.5.2 Starboard Wind Sensor

After the blizzard at Mawson on the 24th February, there were some observed problems with the starboard wind sensor (it seemed to be sticking at times) however during post voyage data inspection, it is difficult to see any clear evidence of a problem. However caution should be exercised when using this data after the 24th February. The wind sensor did completely fail after arrival back at Fremantle.

3.5.3 Uncontaminated Water Flow

All uncontaminated water data should be interpreted with reference to the water flow data.

3.5.4 Eppley PIR

The starboard Eppley PIR fails to track the port sensor during all of January (including the sensor temperature). The reason for this is unknown. It appears to function well during the remainder of the voyage.

3.5.5 Fluorometer Data

There was a significant step change in the fluorometer data on the second day of the voyage. It was on this day that we opened the fluorometer to find that a cleaning cloth had been left in the instrument! It worked much better after this was removed.

3.5.6 Meteorological Data Gap

There is a gap in the meteorological data between the 1700 and 2330 UTC on the 15th January. This was due to a UPS circuit breaker tripping in the met lab.

3.5.7 Missing Biological Echo Sounder Data

The biological echo sounder was turned off after the 24th February due to concerns that the transducer may have been damaged during the grounding event at Mawson. (Turns out that it was not!) Thus there is no biological echo sounder data for the return leg to Fremantle.

3.6 Waypoints

A number of waypoints were maintained in the ships GIS system for this voyage. These are shown in in Section 7, **Table 35 - Voyage Waypoints**.

3.7 Technical Voyage Events

A technical Event Log is maintained by STS staff on every marine science cruise. The contents of this log are found in section 6. This is not to be confused with the scientific event log that was maintained by scientific staff during the voyage.

3.8 Start and End of Voyage

For the purposes of underway data collection, the precise start and end times of any voyage are arbitrarily chosen after the completion of the voyage. The start time is usually chosen to be a few hours before the ship departs its final berth before heading south. The stop time is usually chosen to be a few hours after it has initially berthed after returning from the Southern Ocean.

Some data will have been collected in the days before and after a voyage as the on-board systems are tested in preparation for the voyage. This additional data may be available in the raw format but will not be included in the official voyage processed data set.

Departure Port:	Hobart	**Start Time:**	0000UTC, 11th January 2016
Return	Fremantle	**Stop Time:**	2359 UTC, 12th March 2015

Port:			

Table 2 - Voyage Data Start and Finish Times

3.9 Rectangular Mid-water Trawl (RMT) FSI CTD Data.

A total of 44 routine trawls and 38 target trawls were conducted during the cruise using the Rectangular mid water trawl system.

The RMT system is fitted with a fibre optic cable and at the start of the cruise, we had two high definition cameras with lights mounted on the frame. The lights were only switched on for operational reasons and not during sample trawls.

The data from the RMT is available in the TECHSAS NetCDF files (refer to sections 5.3.16 to 5.3.19) and the high definition video is also available from the AADC. We stopped recording video a couple weeks into the voyage when a flooded housing took out the camera system. Consequently only a limited set of video is available.

3.10 Conductivity, Temperature and Depth (CTD) data.

A total of 42 CTD deployments were undertaken during the voyage. Data was collected and recorded using the seabird system however we also logged the raw data using TECHSAS and this data is available in NetCDF format as part of the underway data set.

All CTD data (in both seabird and NetCDF form) has been submitted to the AADC.

3.11 MIDOC Trawl Data

A total of 40 deep ocean MIDOC trawls were conducted during the voyage. A typical trawl involved deploying the net to 1200 metres and then opening the net at prescribed intervals on the ascent. The cod end was fitted with the CSIRO MIDOC device which allow 6 different cod ends to be switched to the net at time intervals.

MIDOC data was obtained by downloading the unit after every deployment. This data has been submitted to the AADC.

The MIDOC trawl was instrumented using scanmar sensors which were logged by the TECHSAS system and are available in NetCDF format as part of the TECHSAS underway dataset. (Available from the AADC.)

3.12 Acoustic Data

A program of acoustic observations were made throughout the science phase of the voyage using the ships 38, 120 and 200 kHz echo sounders. This observing program was overseen by Dr Martin Cox and all data has been submitted to the AADC.

3.13 Trace Metals Data

A program of Trace metal rosette deployments were made throughout the scientific phase of the voyage. This program was overseen by Dr Christina Schallenberg and the samples will be analysed post voyage.

3.14 UVP data

An Underwater Vision Profiler (UVP) instrument for CNRS (Centre National de la Recherche Scientifique) was fitted to the CTD for some deployments. This program was overseen by Dr Emmanuel Laurenceau-Cornec.

3.15 Other Data Collected

CO2 measurement in surface water: This instrument is maintained by the CSIRO personnel under AAD project 3313 and instrument data is not processed by the AAD.

4 INSTRUMENT DESCRIPTION

4.1 Installed Instruments

During this voyage, the instruments shown in Table 3 were operational.

Calibration certificates are held by the Science Technical Support section at the Australian Antarctic Division and can be made available via queries to the Australian Antarctic Data Centre.

Instrument	**Serial Number**	**Notes**
JRC GPS-112 GPS Receiver (Forward)		
JRC GPS-112 GPS Receiver (Aft)		Not functional during this voyage (is planned for removal)
Ashtech ADU800 GPS Receiver	209130080033	
Sperry Mk-37 Mod D/E Gyrocompass	unknown	Owned by P&O
Simrad 12kHz EK60 GPT	271	
12kHz Transducer, EDO Corporation 323 HP	126-89	Serviced during dry-dock 2013
Simrad 38kHz EK60 GPT	254	
38kHz Transducer, Simrad ES38B	28396	Serviced during dry-dock 2013
Simrad 120kHz EK60 GPT	260	
120kHz Forward Transducer, Simrad ES120-7	29488	Serviced during dry-dock 2013
120kHz Aft Transducer, Simrad ES120-7	29490	Serviced during dry-dock 2013
Simrad 200kHz EK60 GPT	246	
200kHz Transducer, Simrad ES200-7	126	Serviced during dry-dock 2013
RDI OSADCP 150kHz Acoustic Doppler Current Profiler	1667	
ADCP Transducer, Teledyne RD Instruments 71A-1022-00	2133	Serviced during dry-dock 2013
Krohn IFC 020 D Electromagnetic flow meter (TSG)	R08207b	
Krohn IFC 020 D Electromagnetic flow meter (Fluorometer)	R08207a	
Sea-Bird SBE 21 Thermosalinograph (TSG)	2797	Calibrated: June 2015
WetLabs RMA 2948 Wetstar Chlorophyll sensor	FLRTD-013	Calibrated: August 2015
Seabird SBE-38 Water temperature probe	0395	Calibrated: June 2015
Aanderra Optode 3835 Oxygen sensor (owned by AAD)	299	Calibrated: September 2015
Vaisala HMP223 Temperature and Humidity – Port	X0520018	Calibrated: June 2015
Vaisala HMP223 Temperature and Humidity – Starboard	X0520019	Calibrated: June 2015
Vaisala PTB220 Barometer	A3920002	Calibrated: June 2015
RM Young 05103 Wind Anemometer - Port	58616	Serviced January 2013
RM Young 05103 Wind Anemometer - Starboard	37285	Serviced January 2013

Young 50201 Precipitation Gauge	01606	
Middleton SK01-DP2 PAR Sensor – Port	123.1765	Calibrated: June 2015
Middleton SK01-DP2 PAR Sensor – Starboard	123.1766	Calibrated: June 2015
Middleton EQ08 Solar Pyranometer – Port	8409	Calibrated: June 2015
Middleton EQ08 Solar Pyranometer – Starboard	8408	Calibrated: June 2015
Eppley PIR, Precision IR Radiometer – Port	35091F3	Calibrated: June 2015
Eppley PIR, Precision IR Radiometer – Starboard	35092F3	Calibrated: June 2015

Table 3 - Instruments installed and operational during this Voyage

5 UNDERWAY DATA COLLECTION SYSTEM DESCRIPTION

The Underway data system on the Aurora Australis is an autonomous system that logs and distributes data from navigation and scientific instruments in real time during a voyage. The acquisition system is the TECHSAS system which has been developed by IFREMER (French Research Institute for Exploitation of the Sea) and is in use of numerous marine research vessels around the work. To complement the TECHSAS system, AAD uses a CSIRO software package called uwyMerger (underway data merger) which takes the TECHSAS recorded data and further merges it into a synchronised voyage data set containing selected parameters from all instruments and writes it to a single master NetCDF file for the voyage

In summary, data is recorded in three ways:

- All data from received from instruments is time stamped and written to ASCII log files.
- Selected data from the instrument strings is picked by TECHSAS and written to time series NetCDF files (one per day per instrument).
- A master NetCDF file for the voyage is recorded.

During each voyage, summary 1 minute data for the parameters is automatically sent back to the AADC every 60 minutes and is normally available for download within a few hours of the data being collected on board the voyage. This data is available from the Australian Antarctic Data Centre web site.

Sometime after each voyage, the higher time resolution data is generally reprocessed at Head office (using uwyMerger) to produce a final synchronised 5 second time resolution data set. This higher resolution data is then also placed in the Australian Antarctic Data Centre and published.

Not all instruments on the Aurora are connected to the logging system and not all the data from the connected instruments (which is recorded in the raw data text files) is distributed over the network or saved to the database. While only the specific parameters recorded in the database is publicly available from the AADC data centre, both the raw instrument data and the individual instrument NetCDF files are available upon request.

For Marine Science voyages an event log is maintained to record events during the voyage related to data collection and this is included as an appendix to this document when available.

5.1 Quality Control

Very little automatic checking of data is performed, and only gross instrument failures can be detected in some cases. Instrument readings are affected by environmental conditions and meteorological instruments can be affected by ships superstructure and exhaust heat depending on the prevailing weather conditions and the ships heading.

Only the most basic form of quality control has been performed on this data (i.e. some data may have been discarded if it is deemed to be totally worthless or misleading)

Before using any data collected on a voyage you should perform quality checking appropriate to your own needs to ensure that the data sets that you wish to use are valid.

5.2 Underway Parameters published by the AADC

Table 4 lists the parameters are available from the Australian Antarctic Data Centre for download. This does not represent the complete set of data that is collected but is the set of parameters that are transmitted back from the ship in real time (hourly) and made available through the AADC Web Feature Service.

Parameter Name	Description	Units
TIMESTAMP_GPS_UTC	Time	Days since December 30, 1899
LATITUDE_DEGNORTH	Latitude	decimal degrees
LONGITUDE_DEGEAST	Longitude	decimal degrees
TEMP_AIR_PORT_DEGC	Air Temperature (port)	°C
TEMP_AIR_STRBRD_DEGC	Air Temperature (starboard)	°C
REL_HUMIDITY_PORT_PERCENT	Relative Humidity (port)	relative %
REL_HUMIDITY_STRBD_PERCENT	Relative Humidity (starboard)	relative %
ATM_PRESS_HPA	Atmospheric Pressure	hectoPascals
ATM_PRESS_THREE_HR_TREND_HPA	Atmospheric Pressure (3 hour trend)	hPa/ 3 hour
TEMP_SEA_WTR_DEGC	Seawater Temperature	°C
FLOW_RATE_TSG_LPERMIN	Thermosalinograph Flow Rate	litres / minute
FLUOROMTR_FLOW_RATE_LPERMIN	Fluorometer Flow Rate	litres / minute
FLUORESCENCE_NOUNIT	Fluorescence	unitless
CHLOROPHYLL_UGPERL	Chlorophyll Concentration	micrograms / litre
SALINITY_TSG_PSU	Thermosalinograph Salinity	PSU (PSS-78)
OXY_CONCEN_CORR_MMOL	oxygen concentration - corrected	µmol / litre
OXY_CONCEN_UNCORR_MMOL	oxygen concentration - uncorrected	µmol / litre
WTR_TEMP_OPTODE_DEGC	Optode water temperature	°C
SALINITY_OPTODE_PSU	Optode salinity	PSU (PSS-78)
DPHASE_OPTODE_NOUNIT	Optode D Phase	unitless
BPHASE_OPTODE_NOUNIT	Optode Blue Phase	unitless
TEMP_TSG_DEGC	Thermosalinograph water temperature	°C
CONDUCTIVITY_TSG_MSPERCM	Thermosalinograph conductivity	milliSiemens/cm
SHIP_HEADING_GPS_DEG	vessel heading (GPS)	decimal degrees
SHIP_COURSE_OVER_GROUND_DEG	vessel course over ground	decimal degrees
SHIP_HEADING_GYRO_DEG	Vessel heading (gyro)	decimal degrees
SHIP_SPD_OVER_GROUND_KNOT	Vessel speed over ground	knots
WTR_DEPTH_M	Depth from 12 kHz echo-sounder	metres
WTR_DEPTH_BIOMETER_M	Depth from 38kHz echo-sounder	metres
WND_DIR_PORT_CORR_DEG	Wind Direction - true (port)	decimal degrees
WND_DIR_PORT_UNCORR_DEG	Wind Direction - uncorrected	decimal degrees

	(port)	
WND_DIR_STRBD_CORR_DEG	Wind direction - true (starboard)	decimal degrees
WND_DIR_STRBD_UNCORR_DEG	Wind direction - uncorrected (starboard)	decimal degrees
WND_SPD_PORT_CORR_KNOT	Wind Speed - true (port)	knots
WND_SPD_PORT_UNCORR_KNOT	Wind Speed - uncorrected (port)	knots
WND_SPD_STRBD_CORR_KNOT	Wind Speed - true (starboard)	knots
WND_SPD_STRBD_UNCORR_KNOT	Wind Speed - uncorrected (starboard)	knots
PITCH_TEN_SEC_MIN_DEG	Vessel Pitch (10 second minimum)	decimal degrees
PITCH_TEN_SEC_MAX_DEG	Vessel pitch (10 second maximum)	decimal degrees
PITCH_ONE_MIN_MIN_DEG	Vessel pitch (one minute minimum)	decimal degrees
PITCH_ONE_MIN_MAX_DEG	Vessel pitch (one minute maximum)	decimal degrees
ROLL_TEN_SEC_MIN_DEG	Vessel roll (10 second minimum)	decimal degrees
ROLL_TEN_SEC_MAX_DEG	Vessel roll (10 second maximum)	decimal degrees
ROLL_ONE_MIN_MIN_DEG	Vessel roll (one minute minimum)	decimal degrees
ROLL_ONE_MIN_MAX_DEG	vessel roll (one minute maximum)	decimal degrees
RAD_PAR_PORT_WPERME	photosynthetically active radiation (port)	µmol s-1 m-2
RAD_PAR_STRBRD_WPERME	photosynthetically active radiation (starboard)	µmol s-1 m-2
RAD_SLR_PORT_WPERM2	solar radiation (port)	W m-2
RAD_SLR_STRBRD_WPERM2	Solar radiation (starboard)	W m-2
RAD_INFRRD_PORT_WPERM2	Infrared radiation (port)	W m-2
RAD_INFRRD_STRBRD_WPERM2	Infrared radiation (starboard)	W m-2
TEMP_INFRRD_SNSOR_PORT_DEGC	Temperature of Infrared Sensor (port)	°C
TEMP_INFRRD_SNSOR_STRBRD_DEGC	Temperature of Infrared Sensor (starboard)	°C
RAIN_ACCUM_FOREMST_MM	Accumulated rainfall	millimetres

Table 4 - List of Published Underway Parameters

5.3 Instrument Data Description

The list of instruments included in the underway data collection system is presented in the following summary table. Detailed descriptions of each instrument are provided afterwards.

Instrument	Comment
Ashtech ADU800 GPS	Antenna Array is mounted on the rear gantry
JRC GPS-112 GPS Receiver	Antenna is mounted Forward
Sperry Mk-37 Mod D/E Gyrocompass	Belongs to P&O
Vaisala HMP223 Temperature and Humidity	Mounted Port and Starboard
Vaisala PTB220 Barometer	Located in the Met Lab at bridge level. The intake tube is on the Monkey Deck one level above.
RM Young 05103 Wind Anemometers	Mounted Port and Starboard on topmast
Young 50201 Precipitation Gauge	Mounted on the Port Side
Middleton SK01-DP2 PAR Sensor	Mounted Port and Starboard
Middleton EQ08 Solar Pyranometer	Mounted Port and Starboard
Eppley PIR, Precision IR Radiometer	Mounted Port and Starboard
Krone IFM5020K flow meters	These meters are used to measure water flow rates to the TSG (refer to section 5.3.11) and Fluorometer instruments (refer to section 5.3.12)
Seabird SBE-21 Thermosalinograph (TSG)	These three instruments are located in the Ocean lab and are at the mercy of flow variations in the uncontaminated seawater system (which is why we measure the flow!). The biggest problem occurs when the sea water intakes freeze!
WetLabs RMA 2948 Wetstar Chlorophyll sensor (Fluorometer)	
Aanderra Optode 3835 Oxygen sensor	
Seabird SBE-38 Water temperature probe	Located in the shaft tunnel so as to be as close to the water intake as possible.
Simrad EK60 12 kHz GPT (Bathy)	These transducers are located in the hull.
Simrad 38 kHz, 120 kHz & 200 kHz GPT (Biological)	
Teledyne RD Instruments OS75 150 kHz Acoustic Doppler Current Profiler (ADCP)	

Table 5 - Summary of Installed instruments

The mounting location of any instrument transducer or antenna is shown in Section 5.7

5.3.1 Ashtech ADU800 GPS

In addition to latitude and longitude, this instrument measures vessel pitch and roll. It is also the preferred source of instrument time.

The antennae are mounted on the rear gantry.

Parameters logged from this instrument into separate NetCDF files for vessel position, vessel attitude and satellite information respectively are listed in Table 6, Table 7 and Table 8

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
measureTS	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
lat	Decimal Degrees (North is positive)	Latitudinal position
long	Decimal Degrees (East is positive)	Longitudinal position
alt	metres above mean sea level	Altitude
gndcourse	Decimal degrees (0 to 359.9)	Course over Ground
gndspeed	knots	Speed over Ground
heading	Decimal degrees (0 to 359.9)	Vessel heading
prec		Horizontal position precision code
mode		GPS Mode used to compute fix

Table 6 - Ashtech ADU800 Logged Parameters (position)

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
HDOP	-	Horizontal Dilution of Precision
VDOP	-	Vertical Dilution of Precision
PDOP	-	Dilution of Precision
nbseen	-	number of visible satellites
nbused	-	number of satellites used

Table 7 - Ashtech ADU800 Logged Parameters (Satellite Information)

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
measureTS	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
roll	degrees (-90 to +90)	Vessel Roll
pitch	degrees (-90 to +90)	Vessel Pitch
brms	metres	RMS error
mrms	metres	baseline length RMS error

ROLL_TEN_SEC_MAX_DEG	degrees (-90 to +90)	Vessel Roll (maximum value in last 10 seconds)
ROLL_TEN_SEC_MIN_DEG	degrees (-90 to +90)	Vessel Roll (minimum value in last 10 seconds)
PITCH_TEN_SEC_MAX_DEG	degrees (-90 to +90)	Vessel Pitch (maximum value in last 10 seconds)
PITCH_TEN_SEC_MIN_DEG	degrees (-90 to +90)	Vessel Pitch (minimum value in last 10 seconds)
ROLL_ONE_MIN_MAX_DEG	degrees (-90 to +90)	Vessel Roll (maximum value in last minute)
ROLL_ONE_MIN_MIN_DEG	degrees (-90 to +90)	Vessel Roll (minimum value in last minute)
PITCH_ONE_MIN_MAX_DEG	degrees (-90 to +90)	Vessel Pitch (maximum value in last minute)
PITCH_ONE_MIN_MIN_DEG	degrees (-90 to +90)	Vessel Pitch (minimum value in last minute)
roll_max_15	degrees (-90 to +90)	Vessel Roll (maximum value in last 15 minutes)
roll_min_15	degrees (-90 to +90)	Vessel Roll (minimum value in last 15 minutes)
pitch_max_15	degrees (-90 to +90)	Vessel Pitch (maximum value in last 15 minutes)
pitch_min_15	degrees (-90 to +90)	Vessel Pitch (minimum value in last 15 minutes)

Table 8 - Ashtech ADU800 Logged Parameters (Ship's attitude)

5.3.2 JRC GPS-112 GPS Receiver

There is one JRC mounted on the vessel (Forward) and its primary function is to provide a backup source of vessel position and time.

The TECHSAS logging system will use the Ashtech AD800 as its primary source of ship's position and time but will automatically switch to the JRC units if the Ashtech becomes unavailable. This would cause a slight positional error since the units are located on different parts of the ship. (JRC is about 50 metres forward on the Ashtech)

Parameters logged from this instrument into separate NetCDF files for vessel position and satellite information are listed in Table 9 and Table 10 respectively.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
measureTS	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
latitude	Decimal Degrees (North is positive)	Latitudinal position
longitude	Decimal Degrees (East is positive)	Longitudinal position
alt	metres above mean sea level	Altitude
gndcourse	degrees (0 to 359.9)	Course over Ground

gndspeed	knots	Speed over Ground
heading	Decimal degrees (0 to 359.9)	Vessel Heading
prec		Horizontal position precision code
mode		GPS Mode used to compute fix

Table 9 - JRC GPS-112 GPS Receiver Logged Parameters (Position)

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
HDOP	-	Horizontal Dilution of Precision
VDOP	-	Vertical Dilution of Precision
PDOP	-	Dilution of Precision
nbseen	-	number of visible satellites
nbused	-	number of satellites used

Table 10 - JRC GPS-112 GPS Receiver Logged Parameters (Satellite Information)

5.3.3 Sperry Mk-37 Mod D/E Gyrocompass

This is the ship's gyrocompass. This instrument is owned and managed by the ship operator and we simply take a feed from it.

Parameters logged from this instrument into NetCDF files are listed in Table 11

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
ship_heading	Decimal degrees (0 to 359.9)	Vessel heading
rate_of_turn	Degrees/minute	Vessel Rate Of Turn

Table 11 - Sperry Mk-37 Mod D/E Gyrocompass Logged Parameters

5.3.4 Vaisala HMP223 Temperature and Humidity

A temperature and humidity sensor is mounted on the inboard side of the port side Whale Observers shelter and a second sensor on the inboard side of the starboard Whale Observers shelter on the Monkey Isle.

Depending on the wind direction relative to the ships heading the instruments can be affected by the ships exhaust. When differences between the two instruments are detected the upwind instrument should be used.

Parameters logged from this instrument into NetCDF files are listed in Table 12 and Table 13

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
TEMP_AIR_PORT_DEGC	Temperature in degrees Celsius	Air Temperature (Port Side)
REL_HUMIDITY_PORT_PERCENT	Relative Humidity (%)	Relative Humidity (Port Side)

Table 12 - Vaisala HMP223 Logged Parameters (Port Side)

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
TEMP_AIR_STRBRD_DEGC	Temperature in degrees Celsius	Air Temperature (Starboard Side)
REL_HUMIDITY_STRBRD_PERCENT	Relative Humidity (%)	Relative Humidity (Starboard Side)

Table 13 - Vaisala HMP223 Logged Parameters (Starboard Side)

5.3.5 Vaisala PTB220 Barometer

This instrument measures atmospheric pressure and the 3 hours trend. It is mounted ~16m above sea level on the bridge deck outside the Met lab on the port side with a velocity head.

Parameters logged from this instrument into NetCDF files are listed in Table 14 - Vaisala PTB220 Barometer Logged Parameters.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
pressure1	hPa	Reading of transducer 1
pressure2	hPa	Reading of transducer 2
pressure3	hPa	Reading of transducer 3
ATM_PRESS_HPA	hPa	Atmospheric pressure derived from the previous three values!
ATM_PRESS_THREE_HR_TREND_HPA	hPa / 3 hours	The rate of change in pressure over the previous three hours

Table 14 - Vaisala PTB220 Barometer Logged Parameters

5.3.6 RM Young 05103 Wind Anemometers

Two instruments are installed at the top of the radar mast, approximately 30 meters above the water line.

The instruments can be affected by the mast superstructure and radio domes, and the upwind instrument should be used.

The true wind speed and direction is calculated as a vector from the apparent wind direction and speed from the instrument and the ships speed and course and speed over ground.

Parameters logged from this instrument into NetCDF files are listed in **Table** 15 - RM Young 05103 Wind Anemometers Logged Parameters.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
WND_DIR_PORT_UNCORR_DEG	Decimal degrees (0 to 359.9)	relative wind direction (port)
WND_SPD_PORT_UNCORR_KNOT	knots	relative wind speed (port)
WND_DIR_PORT_CORR_DEG	Decimal degrees (0 to 359.9)	true wind direction (port)
WND_SPD_PORT_CORR_KNOT	knots	true wind speed (port)
WND_DIR_STRBD_UNCORR_DEG	Decimal degrees (0 to 359.9)	relative wind direction (starboard)
WND_SPD_STRBD_UNCORR_KNOT	knots	relative wind speed (starboard)
WND_DIR_STRBD_CORR_DEG	Decimal degrees (0 to 359.9)	true wind direction (starboard)
WND_SPD_STRBD_CORR_KNOT	knots	true wind speed (starboard)
ptruewinddirgusts	Decimal degrees (0 to 359.9)	max true wind dir gusts in 10 min (port)
ptruewindspeedgusts	knots	max true wind speed gusts in 10 min (port)
struewinddirgusts	Decimal degrees (0 to 359.9)	max true wind dir gusts in 10 min (starboard)
struewindspeedgusts	knots	max true wind speed gusts in 10 min (starboard)
minwindsweep	Decimal degrees (0 to 359.9)	min wind dir sweep in 10 min
maxwindsweep	Decimal degrees (0 to 359.9)	max wind dir sweep in 10 min
wnd_spd_port_flag	-	wind quality flag 1
wnd_dir_port_flag	-	wind quality flag 2
wnd_spd_strbd_flag	-	wind quality flag 3
wnd_dir_strbd_flag	-	wind quality flag 4

Table 15 - RM Young 05103 Wind Anemometers Logged Parameters

5.3.7 Young 50201 Precipitation Gauge

Rain gauge data is incorporated into the port radiation instrument. Please refer to section 5.3.8 for details of the logged data.

5.3.8 Port Radiation Sensors (incorporating the Rain Gauge)

The solar radiation sensors are mounted on the top of the port side Whale Observers shelter and the starboard Whale Observers shelter on the Monkey Isle. The instruments are mounted in a gimbal tray that allows sideways movement to keep the instruments vertical as the ship rolls. The mounts do not allow forward to aft movement. These optical instruments can be affected by atmospheric conditions, snow, ice and dirt occluding the sensor and shading from the ships superstructure.

Voltages are measured from the instruments and converted to "real" units according to the manufacturer's data sheet and supplied calibration constants which are re-established at the beginning of each season. Both raw voltages and derived quantities are logged. (The Eppley PIR data is corrected for dome temperature.)

5.3.8.1 Middleton SK01-DP2 PAR Sensor

Two Middleton PAR sensors are installed, on the port and starboard whale observer shelters. The PAR sensors measure photo synthetically active radiation in the 400-700nm band.

5.3.8.2 Middleton EQ08 Solar Pyranometer

Two Middleton solar radiation sensors are installed, on the port and starboard whale observer shelters. These sensors measure total downward solar radiation in the 300-3000nm band.

5.3.8.3 Eppley PIR, Precision IR Radiometer

The logged parameters are: Port and Starboard infrared radiation in the 3.5 to 50nm band and instrument temperature.

5.3.8.4 RM Young 50201 Precipitation Gauge

This instrument measures accumulated precipitation. It is mounted on the port side of the monkey rail. The instrument accumulates to 50mm, then resets to zero and starts to accumulate again.

5.3.8.5 Logged Parameters

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
rawMIPyrano	mV	raw Middleton Pyranometer voltage
rawEPPIR	mV	raw Eppley PIR voltage
rawEPPIRCaseTemp	mV	raw Eppley PIR case temperature voltage
rawEPPIRDomeTemp	mV	raw Eppley PIR dome temperature voltage
rawMIPAR	mV	raw Middleton PAR voltage
RAD_SLR_PORT_WPERM2	W/m^2	Middleton Pyranometer (port)
RAD_INFRRD_PORT_WPERM2	W/m^2	Eppley Pyranometer (port)
TEMP_INFRRD_SNSOR_PORT_DEGC	°C	Eppley PIR case temperature (port)
RAD_PAR_PORT_WPERME	$umol/s/m^2$	Middleton PAR (port)
RAIN_ACCUM_FOREMST_MM	mm	RM Young precipitation gauge

Table 16 - Port Radiation Sensors Logged Parameters

5.3.9 Starboard Radiation Sensors

With a single exception (the absence of precipitation) starboard radiation data is identical in terms of the quantities measured by the Port Radiation Sensors. The parameters are named differently to reflect the difference between port and starboard.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
rawMIPyrano	mV	raw Middleton Pyranometer voltage
rawEPPIR	mV	raw Eppley PIR voltage
rawEPPIRCaseTemp	mV	raw Eppley PIR case temperature voltage
rawEPPIRDomeTemp	mV	raw Eppley PIR dome temperature voltage
rawMIPAR	mV	raw Middleton PAR voltage
	W/m^2	Middleton Pyranometer (starboard)
RAD_INFRRD_STRBRD_WPERM2	W/m^2	Eppley Pyranometer (starboard)
TEMP_INFRRD_SNSOR_STRBRD_DEGC	°C	Eppley PIR Case Temperature (starboard)
RAD_PAR_STRBRD_WPERME	$umol/s/m^2$	Middleton PAR (starboard)

Table 17 - Starboard Radiation Sensors Logged Parameters

5.3.10 Krone IFM5020K flow meters

These meters are used to measure water flow rates to the TSG (refer to section 5.3.11) and Fluorometer instruments (refer to section 5.3.12)

Due to the sampling rate of the interface for these units they can sample slightly longer than the 10 second sample rate used to record flow rates in the dataset. This causes approximately a 10% data loss in the data set at the usual 10 second interval rate, however this is not seen as significant as it extrapolates to only 1 record lost every 100 seconds and flow rates should be constant over this period.

Water flow is manually stopped when the instruments or de-bubblers are cleaned.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
FLOW_RATE_TSG_LPERMIN	litres / minute	Rate of water flow to TSG instrument

Table 18 – TSG Flow Sensor Logged Parameters

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
FLUOROMTR_FLOW_RATE_LPERMIN	litres / minute	Rate of water flow to Fluorometer instrument

Table 19 – Fluorometer Flow Sensor Logged Parameters

5.3.11 Seabird SBE-21 Thermosalinograph (TSG)

This instrument is used to measure the salinity and conductivity of the sea water.

(For more details on the Uncontaminated Water sampling system, refer to Section 5.6)

Before data from this instrument is used the appropriate flow rate parameter should be check to ensure that there is water flow through the uncontaminated sea water system.

Other useful checks would be to compare the TSG Water Temperature with the uncontaminated water temperature which it should match to within 1 degree. It is usually warmer as the sea water warms up slightly as it travels from the water inlet to the TSG instrument through the ships pipe work.

The sea water is stopped whenever cleaning is done and this can result in inaccurate results. (This is another good reason to have flow sensors!)

Data from the TSG is logged in two files described in the following tables. The hydrology file contains the most useful data while an auxiliary file contains the value measured by the 4 A/D channels (not normally connected to anything – but they might be one day! Consequently they are included here for completeness.)

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
SALINITY_TSG_PSU	PSU (PSS-78)	Water salinity
density	kg/m^3	water density derived from measurements
TEMP_TSG_DEGC	°C	water temperature
sndspeed	metres / second	water sound speed derived from measurements
CONDUCTIVITY_TSG_MSPERCM	milliSiemens/cm	conductivity of water
intaketemp	°C	temperature of water measured at the intake

Table 20 –TSG Hydrology Sensor Logged Parameters

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
ChannelA	-	ChannelA Value
ChannelB	-	ChannelB Value
ChannelC	-	ChannelC Value
ChannelD	-	ChannelD Value

Table 21 –TSG External A/D Sensor Logged Parameters

5.3.12 WetLabs RMA 2948 Wetstar Chlorophyll sensor (Fluorometer)

The Fluorometer is used to measure the fluorescence of the sea water. This gives an indication of the amount of biological material in the water. The instrument is (usually) periodically cleaned which results in significant spikes in the data.

This instrument measures chlorophyll concentration which can be converted to provide a unit-less measure of fluorescence. Considerable care should be taken when interpreting this data.

(For more details on the Uncontaminated Water sampling system, refer to Section 5.6)

Before data from this instrument is used the appropriate flow rate parameter should be check to ensure that there is water flow through the uncontaminated sea water system.

Data from the Chlorophyll sensor is logged in NetCDF files described in the following tables.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
FLUORESCENCE_NOUNIT	unit-less	Fluorescence
CHLOROPHYLL_UGPERL	micrograms / litre	Chlorophyll Concentration
value1	-	Not Defined
value2	-	Not Defined

Table 22 – WetLabs RMA 2948 Wetstar Chlorophyll Sensor Logged Parameters

5.3.12.1 Calculations

The Chlorophyll concentration is derived from the FLUORESCENCE_NOUNIT value with calibration coefficients Scale Factor (SF) and Dark Counts applied according to the following equation:

$$CHL(\mu g/l) = Scale\ Factor \times (Fluorescence - Dark\ Counts)$$

The calibration coefficients are taken from the latest calibration sheets as described in **Table 3 - Instruments installed and operational during this Voyage**

5.3.13 Aanderra Optode 3835 Oxygen sensor

This instrument is mounted in the same housing as the Fluorometer and measures the dissolved oxygen concentration. The salinity is obtained from the SBE-21Thermosalinograph and is used to calculate a corrected value.

(For more details on the Uncontaminated Water sampling system, refer to Section 5.6)

Before data from this instrument is used the appropriate flow rate parameter should be check to ensure that there is water flow through the uncontaminated sea water system.

The temperature and salinity can also be cross referenced to the SBE-21 TSG and SBE-38 temperature. The Optode water temperature can be higher than both the SBE-38 & SBE-21 readings due to the lower flow rates and longer piping required.

This instrument samples at 1 minute intervals. The 5 second data comes in the published data set comes from interpolation provided by the uwyMerger software.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
OXY_CONCEN_CORR_MMOL	micromoles/litre	oxygen concentration (corrected)
serialnb	-	serial number
BPot	-	Blue light plot
WTR_TEMP_OPTODE_DEGC	°C	optode water temperature
DPHASE_OPTODE_NOUNIT	-	optode calibrated phase
RAmp	-	Red light amplitude
RawTemp	-	Temperature raw value
SALINITY_OPTODE_PSU	PSU (PSS-78)	optode salinity
BAmp	-	Blue light amplitude
OXY_CONCEN_UNCORR_MMOL	micromoles/litre	optode oxygen concentration (uncorrected)
modelnb	-	Model Number
airSat	100*Pa/Pa	air saturation
RPhase	-	Red light phase
BPHASE_OPTODE_NOUNIT	-	optode blue light phase

Table 23 – Seabird SBE-38 Water Temperature Sensor Logged Parameters

5.3.13.1 Calculations

The OXY_CONCEN_CORR_MMOL (oxygen concentration - corrected) is derived from the OXY_CONCEN_UNCORR_MMOL (oxygen concentration - uncorrected) value with calibration coefficients applied according to the following calculations

The O2-concentration sensed by the Optode is in fact the O2-concentration in the sensing foil. Since this foil is only permeable to gas and not water, the Optode cannot sense the effect of salt dissolved in the water, hence the Optode always measures as if immersed in fresh water. Therefore the O2-concentration must be compensated for the salinity variations in the uncontaminated seawater system.

The TECHSAS driver calculates and outputs the corrected oxygen concentration using the following equations, based on information from CSIRO. The driver shall also use the real-time salinity values measured by the SBE21 Thermosalinograph in this calculation. If no salinity is available (i.e. bad data or instrument offline) an assumed constant salinity value of 34.0 PSS-78 is used by default.

Freshwater oxygen concentration:

$$O_2\,fresh = \frac{\left(\frac{C_4 + C_5 T}{C_6 + C_7 P}\right) - 1}{C_1 + C_2 T + C_3 T^2}$$

Where: C1, C2, C3, C4, C5, C6 & C7 are calibration coefficients obtained from the current calibration sheet for the instrument. (**Refer to Table 3 - Instruments installed and operational during this Voyage**)

T is the Optode temperature measurement, and,

P is the Optode blue light phase raw value (BPhase).

Scaled temperature:

$$T_S = \ln\left(\frac{298.15 - T}{273.15 + T}\right)$$

Where: T is the Optode temperature measurement.

Oxygen concentration scaling factor:

$$f = \exp\left[S_{TSG}\left(B_0 + B_1 T_S + B_2 {T_S}^2 + B_3 {T_S}^3\right) + C_0 {S_{TSG}}^2\right]$$

Where: STSG is the salinity measurement from the SBE21 Thermosalinograph,
TS is the scaled Optode temperature,
B0 = -6.24097 E-03,
B1 = -6.93498 E-03,
B2 = -6.90358 E-03,
B3 = -4.29155 E-03, and,
C0 = -3.11680 E-07.

Compensated oxygen concentration:

$$O_2 compensated = f \times O_2 fresh$$

Where: f is the oxygen concentration scaling factor, and,
O2fresh is the freshwater concentration.

Pure water density, from UNESCO 1983 equation 14 (page 17):

$$\rho_W = a_0 + a_1 T + a_2 T^2 + a_3 T^3 + a_4 T^4 + a_5 T^5$$

Where: T is the Optode temperature measurement,
a0 = 999.842594,
a1 = 6.793952 E-02,
a2 = -9.095290 E-03,
a3 = 1.001685 E-04,
a4 = -1.120083 E-06, and,
a5 = 6.536332 E-09.

Seawater density, from UNESCO 1983 equation 13 (page 17):

$$\rho_{SW} = \rho_W + \left(b_0 + b_1 T + b_2 T^2 + b_3 T^3 + b_4 T^4\right) S_{TSG} + (c_0 + c_1 T + c_2 T^2) {S_{TSG}}^{3/2} + d_0 {S_{TSG}}^2$$

Where: S_{TSG} is the salinity measurement from the SBE21 Thermosalinograph,

T is the Optode temperature measurement,

ρ_W is the pure water density,

b0 = 8.24493 E-01,

b1 = -4.0899 E-03,

b2 = 7.6438 E-05,

b3 = 8.2467 E-07,

b4 = 5.3875 E-09,

c0 = -5.72466 E-03,

c1 = 1.0227 E-04,

c2 = -1.6546 E-06, and,

d0 = 4.8314 E-04.

Corrected oxygen concentration:

$$O_2 corrected = \frac{O_2 compensated \times 1000}{\rho_{SW}}$$

Where: $O_{2compensated}$ is the oxygen concentration compensated for salinity, and,

ρ_{SW} is the density of seawater.

The calibration coefficients are taken from the latest calibration sheets as described in **Table 3 - Instruments installed and operational during this Voyage.**

5.3.14 Seabird SBE-38 Water Temperature Sensor

This instrument is mounted ~4m below surface in the uncontaminated seas water suction inlet, port side of the shaft tunnel towards the stern of the ship and gives an accurate water temperature reading.

(For more details on the Uncontaminated Water sampling system, refer to Section 5.6)

Before data from this instrument is used the appropriate flow rate parameter should be check to ensure that there is water flow through the uncontaminated sea water system.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
TEMP_SEA_WTR_DEGC	°C	Sea water temperature

Table 24 – Seabird SBE-38 Water Temperature Sensor Logged Parameters

5.3.15 Seabird 911+ CTD

The data from the seabird CTD is primarily logged by the seabird software but each scan of the processed data is output via a serial port and recorded by the TECHSAS system so that the CTD status can be broadcast around the vessel. This means that it is also logged in TECHSAS as NetCDF files. The format is this file is given in the following table.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
scancount	Unit-less	Number of the scan
primCond	S/m	Primary Conductivity
primTemp	°C	Primary Temperature
pressure	***Good Question!*** (see note below)	Pressure
secCond	S/m	Secondary Conductivity
secTemp	°C	Secondary Temperature
oxygen	µmol/l	Oxygen
par	Unit-less	Photosynthetically active radiation
altitude1	metres	Altimeter 1
altitude2	metres	Altimeter 2
transmis	Unit-less	transmissivity
fluo	Unit-less	fluorometer
rate	metres/second	Rate of ascent
salinity	PSU	Salinity

Table 25 – Seabird 911+ CTD Logged Parameters

Note that there has been some confusion with regard to the pressure units put out by the CTD over the last few years up to and including 2015/16. The seabird unit puts out pressure in deci-bars and TECHSAS has been wrongly interpreting this data as bars and so multiplying these numbers by 10 before storing the data. This bug has now been fixed but the bottom line is that all Seabird 911 CTD pressure data recorded in NetCDF format up to and including 2015/16 is probably in "centi-bars" and needs to be divided by 10 to restore it to deci-bars. The data recorded by the Seabird system (which most people prefer to use) is unaffected by this fault.

5.3.16 Rectangular Midwater Trawl - Attitude Sensor

The attitude sensor measures the attitude of the RMT. This data is logged in TECHSAS as NetCDF files. The format is this file is given in the following table.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
fault	integer	Fault code
pitch	degrees	pitch
roll	degrees	roll
yaw	degrees	yaw

accel_z		Acceleration – Z- Axis
pressure	bars (really)	
depth	metres	

Table 26 – RMT Attitude Logged Parameters

5.3.17 Rectangular Midwater Trawl – Power Supply Unit

The RMT PSU returns various status information including voltages and currents. It is used to monitor the RMT system performance.

This data is logged in TECHSAS as NetCDF files. The format is this file is given in the following table.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
volts	Volts	Volts at submerged end
amp	Amperes	Current at submerged end
watts	Watts	Power at submerged end
hs_temp	°C	Power supply temperature
v36	integer	
v24	integer	

Table 27 – RMT Power Supply Unit Logged Parameters

5.3.18 RMT Flow Meter

The Flow meter measures water flow.

This data is logged in TECHSAS as NetCDF files. The format is this file is given in the following table.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
flow_speed	metres/second	Water flow speed
hertz	Hz	Frequency from counter
edge_events	integer	Edge event count
time	seconds	Elapsed time in seconds

Table 28 – RMT Flow Meter Logged Parameters

5.3.19 Teledyne RDI CTD NV

A Teledyne RDI CTD is mounted on the Rectangular Midwater trawl for all deployments to provide accurate CTD data.

This data is logged in TECHSAS as NetCDF files. The format is this file is given in the following table.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file

conductivity	mS/cm	Seawater conductivity
temp	°C	°C
pressure	deci-bars	Seawater pressure
salinity	PSU	Salinity
soundvel	metres/second	Speed Of Sound
Aux1	Volts	Space Channel
chlorophyll	µg/litre	Chlorophyll concentration
battvoltage	Volts	Battery Voltage
Aux4	Volts	Spare channel

Table 29 – Teledyne RDI CTD NV Logged Parameters

5.3.20 Scanmar Net Sensors

Scanmar net sensors are used on a variety of nets to record and transmit acoustically information about the equipment. This data is collected by the TECHSAS system by decoding the NMEA data stream from the scan mate system in the Aft Control room so that it can be recorded and disseminated around the vessel

. This means that it is also logged in TECHSAS as NetCDF files. The format is this file is given in the following table.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
trawl_door_spread	Unit-less	Trawl Door Spread
trawl_depth	S/m	Depth of the trawl
trawl_temperature	°C	Water temperature
trawl_fish_density	Unit-less	A number from 0 to 9
trawl_opening	metres	Opening of the trawl net
trawl_clearance	metres	Clearance of the trawl net
trawl_height	metres	Height of the trawl net
trawl_speed_x	knots	Speed through the water (x component)
trawl_speed_y	knots	Speed through the water (y component)

Table 30 –Scanmar Logged Parameters

5.4 TECHSAS Virtual Instruments

TECHSAS has the capability of maintaining “virtual instruments” which can act as a convenient collection point for several streams of data from other “real” instruments.

5.4.1 Ships Navigation

Ship navigational information comes from a variety of sources and it is useful to have a "one stop shop" for this data in some applications (especially where the data may have to come from alternative sources (i.e. if a GPS fails and another one has to take over)

The parameters stored in the daily NetCDF files are shown in Table 31 – Ships Navigation Virtual Instrument Logged Parameters

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
surfspeed	knots	Vessel speed over the surface
SHIP_SPD_OVER_GROUND_KNOT	knots	Speed over Ground
driftspeed	knots	Estimated drift speed of the vessel
TIMESTAMP_GPS_UTC	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
surfcourse	degrees (0 to 359.9)	Vessel course over the surface
draught	metres	Distance from the water surface to the bottom of the keel
SHIP_COURSE_OVER_GROUND_DEG	degrees (0 to 359.9)	vessel course over ground
driftcourse	degrees (0 to 359.9)	Estimated drift course of the vessel
depth	metres	Depth of water under the keel
LATITUDE	Decimal Degrees (North is positive)	Latitudinal position
roll	degrees (-90 to +90)	Vessel Roll
alt	metres above mean sea level	Altitude
heave	metres	Not recorded
SHIP_HEADING_GYRO_DEG	knots	Vessel Heading (from gyro)
LONGITUDE	Decimal Degrees (East is positive)	Longitudinal position
pitch	degrees (-90 to +90)	Vessel pitch

Table 31 – Ships Navigation Virtual Instrument Logged Parameters

5.5 Acoustic Instruments

The acoustic instruments record the bottom depth and profile, biological activity in the water column and currents at various depths. Primary depth calculated from the Simrad 12 kHz sounder interface is processed by the underway logging system. This season the Simrad 38 kHz acoustic sounder is being tested as a second source of depth information for waters less than 1600m in depth.

A Teledyne RD Instruments OS75 150kHz Acoustic Doppler Current Profiler (ADCP) is used to measure water currents under the vessel.

All data from these instruments is recorded on computer hard disk and transferred to the AADC at the end of the voyage.

The Bio acoustic sounders were calibrated in the river Derwent off White Rock, Tasmania during September 2014 by a team from the CSIRO. The Bathy 12 kHz sounder is not calibrated and uses the default configuration values as supplied by Simrad.

5.5.1 Simrad EK60 12 kHz GPT (Bathy)

The Simrad 12kHz GPT acoustic sounder is used to measure the backscatter coefficient (Sv) and other data to a depth of 5000m. The Simrad ER60 software interface also calculates the depth and this value is send to the underway data system for display and recording. The raw data for this instrument is transferred to the AADC at the end of the voyage.

A dedicated computer runs the Simrad ER60 and Echolog software to record the raw data generated by this instrument. Further processing can be performed with the Echoview software package.

The depth calculation is affected by any sea ice or turbulence under the hull that may be present during ice breaking or rough weather. The operation of the ships thrusters which are used to maintain a stationary position also affects the reliability of the depth calculation. It is a common occurrence during ice breaking or thrusters operations that the bottom depth cannot be determined by the software and a random value (usually very deep) or zero is recorded. The algorithm used to calculate depth for the 12 kHz sensor is poor in shallow waters as the instrument configuration is set to allow deep water measurement and any readings less than 200m might be suspect. Better bathymetry can be obtained by post-processing the raw acoustic data that was collected on the acoustics computer system. This is usually not done on a voyage.

If accurate values are required the raw data must be manually reprocessed and the depth recalculated. The depth parameters transferred to the AADC are not quality checked. Please check with the AADC for further information regarding the status of collected depth information for specific voyages.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file
WTR_DEPTH_M	metres	Water Depth

Table 32 –12kHz Depth Sounder Logged Parameters

5.5.2 Simrad 38 kHz, 120 kHz & 200 kHz GPT (Bio)

These three sounders are used to profile the backscatter coefficient (Sv) and other data in the water column. The higher the frequency of the transducer the more resolution can be obtained, but the beam absorption is higher so less depth can be sampled. The backscatter (or visibility) of objects varies with the frequency. The raw data from these instruments are transferred to the AADC at the completion of the voyage.

A similar setup to the Simrad 12 kHz sounder with a dedicated computer running the Simrad ER60 and Echolog software is used to record the raw data generated by this instrument. Further processing can be performed with the Echoview software package.

The 38 kHz depth data estimation from the Simrad ER60 software is been displayed and recorded as part of the voyage data

As the 38kHz sounder is set for a maximum depth of 1600m the instrument and ER60 software depth algorithms perform better in shallow water and should give better results than the 12kHz sounder for water less than 200 metres in depth. Water depths greater than 1600 metres cannot be measured with this instrument.

Name	Unit	Description
time	Days since 1899-12-30T00:00:00 UTC	The timestamp for each data point in the NetCDF file

WTR_DEPTH_BIOMETER_M	metres	Water Depth

Table 33 –38kHz Depth Sensor Logged Parameters

5.5.3 Teledyne RD Instruments OS75 150 kHz Acoustic Doppler Current Profiler (ADCP)

The Teledyne RD Instruments OS75 150kHz Acoustic Doppler Current Profiler (ADCP) determines currents at different depths. It uses the pitch and roll information from the Ashtech GPS unit to compensate for the ships movement when calculating current profiles.

No data from the ADCP is fed into the TECHSAS system.

The raw data is transferred to the AADC at the completion of the voyage.

5.6 Uncontaminated Seawater Flow

The Uncontaminated seawater (UCS) system supplies UCS to most laboratories, the aquarium, TSG, Fluorometer and Optode in the Ocean Lab etc. The system consists of the following stages:

- Uncontaminated saltwater is pumped from an intake that is located in the propeller shaft tunnel approximately 4m below the waterline & 10m forward of the stern gland on the port side of the vessel.
- Pumped by a Grundfos CRN15 – 96485668 Vertical, non-self-priming, multistage, in-line, centrifugal pump (approximately 300 l/minute, 7 bar) …
- Through a 36.3mm ID Stainless Steel main pipe run.

Most water goes to the oceanographic lab where it goes to the TSG, Fluorometer and Optode instruments.

- The water temperature is measured by a Seabird Electronics SBE38 temperature sensor that is located approximately 150mm inboard from the intake. The temperature rise from the intake to the ocean lab is approximately 0.6C.
- The pressure at the pressure relieving overboard discharge valve us approximately 6.5 bar,
- Note that other side branches take the water to the other labs prior to the Oceanographic (OG) lab (except for Lab 1 which is fed from OG lab.)
- Small ice fragments can partially block the water intake which can result in reduced or erratic flows. This is especially prevalent during ice breaking.

5.7 Instrument and Transducer Locations

The SBE 21 TSG, Krone flow meters, Fluorometer and Aanderra O2 sensors are located in the Ocean Laboratory.

The external meteorological sensor positions are shown on the drawing on the following page.

The square 12 kHz transducer sea chest is positioned between ribs 101 and 102 and to the port side of the keel, with the starboard edge of the sea chest touching the keel centreline.

The circular 38 kHz transducer sea chest is positioned between ribs 103 and 104 and to the port side of the keel, with the starboard side of the sea chest approximately 10cm from the keel centreline.

The circular 120fwd/200 transducer sea chest is positioned between ribs 103 and 104 and to the starboard side of the keel, with the port side of the sea chest approximately 10cm from the keel centreline.

The circular 120aft transducer sea chest is positioned across rib 98 and to the port side of the keel, with the starboard side of the sea chest approximately 10cm from the keel centreline.

The 200 kHz transducer is mounted in the same sea chest as the 120fwd channel.

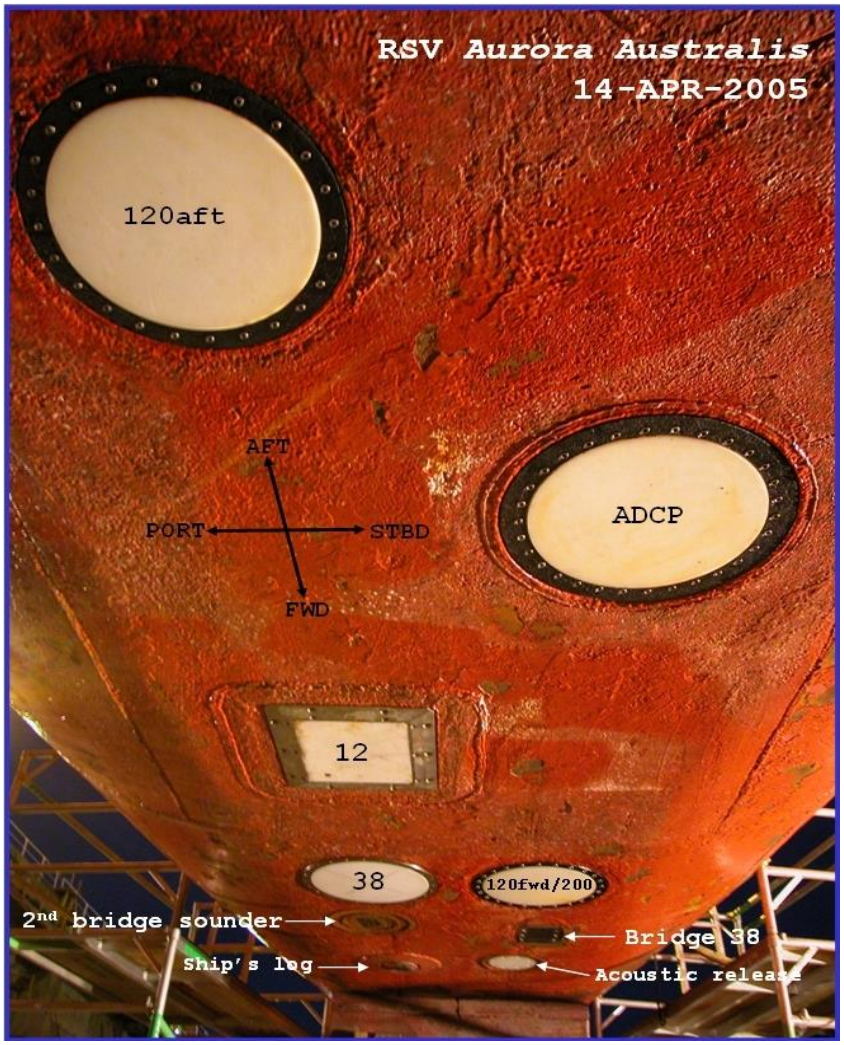
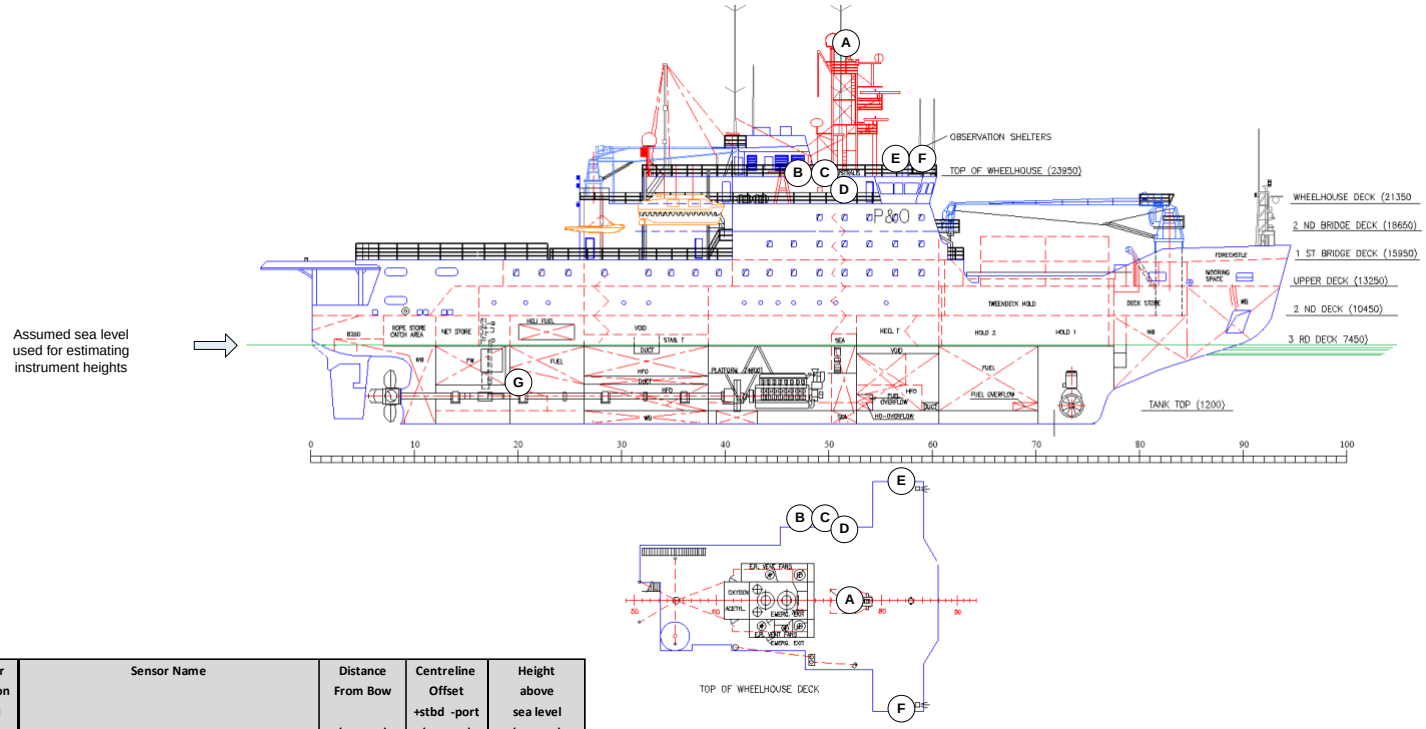


Figure 3 - Location of Acoustic Transducers



Assumed sea level used for estimating instrument heights

Sensor Location Label	Sensor Name	Distance From Bow (metres)	Centreline Offset +stbd -port (metres)	Height above sea level (metres)
A	Anemometer (port)	42.5	-1	30
A	Anemometer (starboard)	42.5	1	30
B	Precipitation - RM Young (port)	48	-8	17
C	Precipitation - OSI OWI-430 (port)	47	-8	17
D	Atm. Pressure - Vaisala HMP223 (port)	43	-7	16
E	Air Temp and Humidity - Vaisala PTB220 (port)	37.5	-10.5	18.5
F	Air Temp and Humidity - Vaisala PTB220 (starboard)	37.5	10.5	18.5
E	Eppley PIR (port)	37.5	-10.5	18.5
F	Eppley PIR (starboard)	37.5	10.5	18.5
E	Middleton EQ08 (port)	37.5	-10.5	18.5
F	Middleton EQ08 (starboard)	37.5	10.5	18.5
E	Middleton SK01-DP2 (port)	37.5	-10.5	18.5
F	Middleton SK01-DP2 (starboard)	37.5	10.5	18.5
G	Uncontaminated Seawater Intake[Note 3]	75	-2	-4

Note 1: All instrument locations are estimated from ship's drawings and not directly measured. (accuracy is estimated to be no better than +-2 metres)

Note 2: Height above sea level depends on ship draft and is necessarily variable even taking into account Note 1!

Note 3: Uncontaminated seawater inlet is on the port side, ship's discharge outlets are on the starboard side.

Issue	Issue Date	Description of Change	Approval	Drawn
02	02/03/2011	Added uncontaminated seawater inlet and note 3.	LPS	LPS
01	06/01/2011	Initial	LPS	LPS

Aurora Australis Underway Sensor Locations.

Science Technical Support
Australian Antarctic Division
Channel Highway
Kingston, Tasmania, 7050

Dwg No. 07011-VSD-0001-02
Filename visiodocument

Sheet 1 of 1 A3

6 EVENT LOG

During the voyage, STS personnel maintain a Voyage Event Log which records deployments and technical issues encountered throughout the voyage. This is not to be confused with the Scientific Event Log which was maintained by scientists on board during the voyage and seeks to achieve other objectives.

id	time	message
413	2016-01-11 06:00:00	Departed Hobart at 5pm local time. Lloyd Symons
415	2016-01-12 23:28:33	Fluorometer readings were identified as suspect. Upon inspection a foreign object (small cleaning rag) was discovered and removed. The Fluorometer face was cleaned at the same time. Lloyd Symons
414	2016-01-13 00:50:00	Trial MIDOC deployment at approximately S47 53; E139 34 MIDOC Start Time: 00:50:00; 2016-01-13 First interval: 105 minutes. Remaining Intervals are 30 minutes. We didn't quite get to 1000 metres due to winch issues but we managed to get to 789m by the time that the first cod end fired. All other cod ends were within 25 m of the target depth. Lloyd Symons
416	2016-01-15 23:10:00	A power failure/disruption in the Met Lab took out the wind and pressure data between 1650UTC - 2310UTC. The problem was eventually resolved by cycling power on the Met Lab Perle Terminal Server and then rerunning the "init_barometer" script on the TECHSAS server to kick start the barometer transmissions. Lloyd Symons
417	2016-01-16 03:36:00	Fluorometer cleaned at 0330UTC. Lloyd Symons
418	2016-01-17 19:17:53	CPR Tow Summary Tow #1 Start 12/1/16 02:45 UTC 45 20.021 S 143 44.962 E End 13/1/16 00:10 UTC 48 07.643 S 139 27.596 E Tow #2 Start 07:34 13/1/16 48 26.980 S 139 28.126 E End 15/1/16 09:53 51 51.743 S 129 56.016 E Tow #3 Start 15/1/16 10:03; 51 52.290 S 129 55.355 E End 17/1/16 06:52 55 43.399 S 119 50.276 E 91 at top of tunnel. Cassette # 2 Tow #4 Start 17/1/16 06:59 55 43.581 S 119 48.973 E Cassette #3 course 250 End 19/1/16 07:57 59 16.884 S 108 46.157 E Tow #5 Start 19/1/16 08:05 59 17.550 S 108 43.870 E End 20/1/16 21:51 62 25.492 S 96 35.007 E Ongoing Received from Rob King
419	2016-01-18 00:30:07	Just played with the 12 kHz echo sounder to see if we can pick up the bottom correctly. It has been picking up the bottom at about 2250m for quite a few days now which is clearly wrong. In the end; I altered the echogram backscatter to PR (no TVG) (was SV -

		20LogTVG). That didn't work so I doubled the pulse length. Now it seems to be working. We are now picking up the bottom correctly at about 4500m. Lloyd Symons
420	2016-01-18 12:51:14	For the second time today; an earth leakage fault has taken out the met lab rack. This means gaps in wind and pressure data. Firstly we unplugged the ships camera system from this circuit but then it tripped again. Now we have unplugged the METLAB DIP and screen. Note: You have to power cycle the Perle terminal server in the Met Lab rack to get the wind data flowing again. And then you need to reinitialise the barometer by running the ""init_barometer"" script on the TECHSAS server desktop (bottom left) Lloyd Symons
421	2016-01-19 16:00:00	The ships track ran almost directly over a large sea mount at S57 48; E107 06 A temporary spike in chlorophyll was picked up for a few hours as we passed over. Lloyd Symons
422	2016-01-20 02:20:02	We put an argo float in at 0336UTC. I need to get the details from Stuart Lloyd Symons
423	2016-01-21 02:56:56	CTD - K00 Test Deployment to 300m 62deg 41.82' S 95deg 21.85' E
424	2016-01-22 04:30:00	RMT Test deployment to 200m. K-Axis Marine Science Log event 96 LAT LONG Net Open signal sent at approximately 26m. Observed on camera the shackles were still caught on the net release. The winch operator gave a sharp upward tug and the cable was successfully freed and deployed to 200m. The net stayed open and was brought back up to 10m before being closed and recovered. At 10m depth; the image was clearer without lights; and the net closing could be confirmed. Brian McGlashan
425	2016-01-23 00:30:00	CTD - K00 Deployment in approx. 3200m Station KX03 Event K03 64deg 00.059 S 93deg 33.086' E Brian McGlashan
426	2016-01-23 06:12:20	CTD - K00 Deployment in approx. 3175m Station KX04 Event K04 63deg 28.232S 93deg 32.673E Brian McGlashan
427	2016-01-23 10:42:36	Completed RMT oblique tow.
428	2016-01-23 18:00:06	Completed RMT oblique tow.
429	2016-01-23 22:11:25	CTD Deployment in approx. 3960m Station KX06 Event K06 62deg 16.953S 93deg 09.533E Brian McGlashan
430	2016-01-24 04:20:23	RMT Target Trawl to 150m Video on 2 cameras. No lights used. 61degE52.1 93degE19.3 Flow Meter final reading 106364 Brian McGlashan
431	2016-01-24 05:38:28	CTD Deployment to 300m Station KX07 Event K07 61deg 42.55 S 93deg 22.050' E Brian McGlashan
432	2016-01-24 14:22:48	MIDOC - KX08 Deployed 2016-01-24 10:52z Retrieved 2016-01-24 14:52z Data downloaded to laptop. Scanmar TS0024 failed to send info. Others very intermittent. Check charge level. Tom Luttrell
433	2016-01-24 16:38:27	CTD - K08 wp 0212 Deployed to 300m 61deg 09.124'S 093deg 32.997'E Tom Luttrell
434	2016-01-24 19:03:23	RMTR - R04 In water 18:43:12z; 61deg 8.058 S; 93deg 33.723 E Open 18:43:33z; 61deg 8.050 S; 93deg 33.725 E; 10m; down at 0.8m/s; up at 0.3m/s Closed 19:01:00; 61deg 7.649 S; 93deg 33.877 E; 10m; RMT screens failed to switch. RMT Control GUI latitude showing West instead of East. Tom Luttrell.
435	2016-01-25 04:54:23	MIDOC K09 In water 00:30UTC 61deg 58.2 S; 92deg 33.6 E on completion Cable length were mismatched by 550m on completion of trawl. Scanmar Depth data was unreliable throughout the trawl. Brian McGlashan

436	2016-01-25 06:19:19	CTD Event - K09 Station - KX09 to 300m 61deg 58.2 S; 92deg 33.6 E Brian McGlashan
437	2016-01-25 07:45:33	RMT Target Trawl to 150m Video on 2 cameras. No lights used. 61degS58.85 92degE33.6 Brian McGlashan
438	2016-01-25 09:55:38	RMT - T06 Target to 140m Open 09:32:43; 62deg 1.131 S; 92deg 26.543 E Close 09:47:49; 62deg 1.341 S; 92deg 27.206 E 2x Video recorded. Lights used momentarily to determine if net opened. Tom Luttrell
439	2016-01-25 15:19:00	MIDOC03 - KX10 Deployed 2016-01-25 11:39z Retrieved 2016-01-24 15:49z Scanmar data settled down once Robbie got the net straight using winch pressure readings rather than wire length. Data downloaded to laptop and transferred to K:\MIDOC\2016-01-25\data\ Scanmar sensors recharged. MIDOC recharged. Tom Luttrell
440	2016-01-25 21:39:11	CTD - K10 wp 0302 Deployed in approx. 4040m 62deg 17.400'S 091deg 31.99200'E
441	2016-01-26 00:37:30	RMT - Regular Oblique to 200m Lost RMT Net Control GUI prior to opening - Returned in tiime to open atl 26.6m Net closed at 9m Video on 2 cameras. No lights used. 62degS18.224 91degE31.2 Brian McGlashan
442	2016-01-26 15:22:54	MIDOC04 - KX11 Deployed 2016-01-26 08:10z Retrieved 2016-01-26 12:20z Incorrect Scanmar trawl speed sensor mounted. Tom Luttrell.
443	2016-01-26 15:23:59	CTD - K11 wp0303 Deployed in approx. 4165m 62deg 23.673'S 089deg 39.365'E Tom Luttrell
444	2016-01-26 18:11:53	RMTR - R06 Oblique to 200m Open 18:24:35; 62deg 23.520 S 89deg 39.536 E pause at 115m (winch problems). Close 18:53:59; 62deg 22.940 S 89deg 37.855 E No video recorded. Lights used momentarily to determine if net opened. No Scanmar trawl speed data received. Instrument DIP not working. Used load cell DIP instead. Tom Luttrell
445	2016-01-26 18:57:52	RMTT - T06 Target Trawl to 40m; then to 25m at 0.3m/s. No video recorded (too dark; lights not able to be used). Open 19:40:38; 62deg 23.568 S 89deg 39.729 E Close 19:48:44; 62deg 23.762 S 89deg 40.196 E RMT net control GUI crashed when net closed. LINE RESISTANCE DROPPED TO 38K OHM AND ALARMED. Cleaned sea connector; resistance = 127k Ohm. Tom Luttrell
446	2016-01-27 01:04:00	CTD - Event K12 Station KX12 wp0304 Deployed in approx. 3500m 62deg 28.237'S 087deg 47.772'E Brian McGlashan
447	2016-01-27 14:04:37	MIDOC05 - KX13 wp0305 Deployed 2016 /01/27 09:40z Retrieved 2016 /01/27 13:50z Tom Luttrell
448	2016-01-27 14:57:34	CTD - K13 wp0305 Deployed in approx. 3939m 62deg 30.861'S 086deg 06.820'E Tom Luttrell
449	2016-01-27 22:07:30	RMTR - R09 Oblique to 200m 62deg 29S 86deg54 E
450	2016-01-27 22:09:46	Cleaned Fluorometer face in Oceanography Lab Brian McGlashan
451	2016-01-28 03:03:47	RMT Target Trawl 25m Event T07 Station KX13 - 14 62deg 31.2'S 084deg 64.2'E Brian McGlashan
452	2016-01-28 03:29:47	CTD in approx. 2600m Event CTD14 Station KX14 62deg 31.2'S 084deg 64.2'E Brian McGlashan
453	2016-01-28 09:07:23	RMT Target Trawl 30-40m Event T08 Open 09:21:06 62deg 31.614'S 083deg 33.989'E Close 09:40:12 62deg 32.138'S 083deg 33.973'E Tom Luttrell
454	2016-01-28 17:24:04	MIDOC06 - KX15 wp0307 Deployed 2016/01/28 12:14z Retrieved 2016/01/28 16:24z" No Scanmar data. Had to wiggle Scanmar acoustic receive cable to get data. Inspected

		(ok) and cleaned connector. Scanmar trawl speed sensor unresponsive then gave negative data. Could have flipped on net. Tom Luttrell
455	2016-01-28 18:43:32	Lost power to Met rack again. Put isolation transformer in line with Met power supply. Removed comms PC from essential power. Restarted Perle serial server. Ran init_optode.py Ran init_barometer.py Tom Luttrell.
456	2016-01-28 18:56:52	CTD - K15 wp0307 Deployed in approx. 2000m 62deg 31.321'S 082deg 01.483'E Tom Luttrell
457	2016-01-29 00:54:47	RMT - Regular Event - R11 Station - KX15 Oblique to 200m Line Insulation prior to deployment 161K Back on deck on completion 31.9K Net closed at 10m Video only from 1 camera. 62degS31.32 81degE59.57 Brian McGlashan
458	2016-01-29 05:54:44	1 Whale Buoy Recovered, 1 Whale Buoy Deployed Brian McGlashan
459	2016-01-29 10:01:53	MIDOC07 - KX16 wp0401 Deployed 2016/01/29 10:12z Retrieved 2016/01/29 14:22z Hydrophone cable replaced. Intermittent reception problem persisted. PC board visually checked; no faults found. Re-seated inter-board connectors. Tom Luttrell
460	2016-01-29 15:34:03	CTD - K16 wp0401 Deployed in approx. 3000m 63deg 16.213'S 082deg 01.147'E Chief engineer had to disconnect charger before running out the gantry. Tom Luttrell
461	2016-01-29 20:49:04	RMT - Regular Event - R12 Station - KX16 Oblique to 200m Scanmar working. Cable resistance. Before 111K After 31K Brian McGlashan
462	2016-01-30 03:35:20	MIDOC8 Station KX17 63deg 45.566'S 082deg 48.729'E Nets failed to open - mechanical fault - repaired now Brian McGlashan
463	2016-01-30 06:26:58	CTD017 Station - KX17 63deg 57.109'S 083deg 08.476'E Brian McGlashan
464	2016-01-30 11:08:08	RMT - Regular Event - R13 Station - KX17 Oblique to 200m Lost contact with BeagleBone on the way up. Cable failed on lift from water. HV supply short to chassis. Rewired aft control room power supply to use one HV return as HV supply. Disconnected and isolated both HV supply lines. Tom Luttrell
465	2016-01-30 14:42:14	MIDOC9 Station KX17 63deg 48.327'S 082deg 53.769'E 200 - 0m net didn't open. Re-shot with net open. Tom Luttrell
466	2016-01-30 19:12:28	MIDOC10 Station KX17 63deg 56.3'S 083deg 7.331'E Net shot open 0 - 200 - 0m (~40 minutes) as last shot did not open Tom Luttrell
467	2016-01-30 21:38:08	MIDOC11 Station KX18 64deg 10.77'S 083deg 21.719'E Brian McGlashan
468	2016-01-31 13:44:32	MIDOC12 deployed Station KX19 64deg 18.52'S 84deg11.00 'E MIDOC initiated at 1342UTC Net 6 failed to open (200 to 0m). Re-shot Lloyd Symons and Tom Luttrell
469	2016-01-31 18:55:20	MIDOC13 deployed Station KX19 64deg 26.63'S 84deg 21.82 'E 0 - 200 - 0m re-shoot of MIDOC12 because net failed to open. Shot at 18:54z; resurface at 19:36z Tom Luttrell
470	2016-01-31 21:55:01	CTD019 Station - KX19 64deg 38.26'S 084deg 19.47'E Brian McGlashan
471	2016-02-01 05:30:33	RMT - Regular Station - KX19 Oblique to 200m 64deg 24.595'S 84deg 46.13 'E Brian McGlashan
472	2016-02-01 06:06:23	RMT - Target Trawl to 23m 64deg 25.278'S 84deg 47.154 'E Brian McGlashan
473	2016-02-01	MIDOC14 - KX20 wp0405

	19:35:38	
474	2016-02-01 19:36:10	CTD - K30 wp0405A Deployed in approximately 3200m
475	2016-02-01 22:32:30	RMT - Regular Event - R16 Station - KX20 Oblique to 200m 65deg 10.32'S 85deg 19.78 'E Brian McGlashan
476	2016-02-01 22:55:14	RMT - Target Event - T10 To 30m 65deg 09.96 'S 85deg 46.14 'E Brian McGlashan
477	2016-02-02 13:13:20	MIDOC15 - KX21 Start 2016-02-02 12:06z Finish 2016-02-02 16:06z Tom Luttrell
478	2016-02-02 17:14:33	CTD - K21 Deployed in approximately 1200m 65deg 09.391'S 091deg 37.110'E Tom Luttrell
479	2016-02-02 21:03:10	RMT Event - R17 Station - KX21 Oblique to 200m depth. Net failed to open - Mechanical Failure Repairs carried out on deck and successfully completed on second attempt. 65deg 06.62'S 091deg 33.53'E Brian McGlashan
480	2016-02-02 21:50:00	RMTR - R18 KX21 - KX22 Start 2016/02/02 21:50z 65deg 02.5 S; 91deg 22.4 E End 2016/02/02 22:14z 65deg 02.4 S; 91deg 31.4 E Tom Luttrell
481	2016-02-02 23:04:00	CTD - KX22 Start 2016/02/02 23:04z 65deg 00.2 S; 91deg 23.1 E
482	2016-02-03 05:17:00	MIDOC 16 - KX23 Start 2016/02/03 05:17z 65deg 29.0 S; 91deg 10.8 E
483	2016-02-03 09:52:00	CTD 23 Start 2016/02/03 09:52z 64deg 18.96 S; 89deg 47.86 E
484	2016-02-03 14:26:40	RMTR - R19 Oblique to 200m Open 14:12:50 64deg 19.071 S 89deg 50.431 E Close 14:33:31 64deg 19.648 S 89deg 51.553 E
485	2016-02-03 15:00:37	RMTT - T15 Target trawl to 20m / 5 minutes Open 14:48 64.34 S 89.88 E Close 14:53:27 64deg 20.201 S 89deg 52.690 E
486	2016-02-03 17:41:58	RMTT - T16 Target trawl to 25m Open 17:35:56 63deg 59.203 S 89deg 7.421 E Close 17:38:56 63deg 59.297 S 89deg 7.655 E
487	2016-02-03 20:06:56	MIDOC17 Deployed 2016/02/03 20:02z 63deg 45.881 S 88deg 35.462 E
488	2016-02-04 02:22:22	CTD 24 wp0601
489	2016-02-04 02:00:00	RMTR to 200m
490	2016-02-04 21:41:54	CTD25 - to 300m wp0603
491	2016-02-04 22:47:56	RMTR - 22 Oblique to 200m
492	2016-02-04 23:26:00	RMTT - T17 Target trawl to 30m 62deg 25.9 S 86deg 2.5 E
494	2016-02-04 21:21:00	CTD 26 wp0604
493	2016-02-05 01:50:00	CTD 27 wp0604
495	2016-02-05 11:15:00	RMTR - R23
496	2016-02-05 15:16:00	MIDOC - MIDOC20
497	2016-02-05 21:26:45	CTD28 - to approx. 2500m wp0605
498	2016-02-05 07:20:44	Ethanol - Water Mix Changed in RMT Mechanical Flow Meter. Brian McGlashan

499	2016-02-06 13:27:32	RMTR - R25 Oblique to 200m
500	2016-02-06 14:00:53	RMTT - T18 140m target trawl
501	2016-02-06 15:34:19	RMTT - T19 220m target trawl. FOTS tested to 365m (accidentally).
502	2016-02-06 18:30:00	RMTT - T20 Target trawl to 220m. HV cable resistance dropped to 80kR at depth; recovered to 160kR. Removing pressure housing HV coupling made no difference.
503	2016-02-07 01:00:00	MIDOC 22 - Station KX30 wp00607
504	2016-02-07 07:10:00	CTD30
505	2016-02-07 09:14:00	RMTR - R26
506	2016-02-07 13:13:00	MIDOC23 Replaced Scanmar PC after trawl.
507	2016-02-07 17:43:42	CTD31
508	2016-02-07 21:00:00	RMT R 27 Station KX31
509	2016-02-08 02:00:00	MIDOC 24 Station KX 32
510	2016-02-08 07:00:00	CTD 32 Station KX32
511	2016-02-08 09:43:19	RMTT - T21
512	2016-02-08 10:19:00	RMTR - R28
513	2016-02-08 13:55:00	MIDOC - MIDOC25 Updated Scanmar trawl sounder #2 channel parameters.
514	2016-02-08 19:00:25	CTD - K33
515	2016-02-08 21:47:00	RMT R29 - K33
516	2016-02-09 00:56:00	MIDOC 26 - KX34 wp0702
517	2016-02-09 06:20:00	CTD 34 - KX34 wp00703
521	2016-02-09 10:05:00	RMTR - R30 KX34
522	2016-02-09 12:25:00	MIDOC27 - KX35
523	2016-02-09 17:45:00	CTD35 - KX35
524	2016-02-09 19:02:00	RMTR - R31 KX35
525	2016-02-09 23:00:00	RMT T22 - KX36
526	2016-02-10 01:18:00	MIDOC 28 - KX38
527	2016-02-10 06:47:00	CTD 36 - KX38
528	2016-02-10 07:23:00	RMTT T23 - KX36
529	2016-02-10 07:57:00	RMTR R32 - KX36

530	2016-02-10 10:10:00	MIDOC29 - KX37
531	2016-02-10 15:36:48	CTD K37 - KX37 wp0802
532	2016-02-10 16:17:17	RMTR R33 KX37 Net failed to open.
533	2016-02-10 16:46:05	RMTR R34 KX37
534	2016-02-10 23:37:00	MIDOC 30 - KX38
535	2016-02-11 07:21:29	CTD 38 - KX38
536	2016-02-11 10:19:00	RMTT - T24 KX38
537	2016-02-11 10:34:00	RMTR - R35 KX38 1.1M to 120K Ohm
538	2016-02-11 12:37:00	MIDOC31 KX39 wp0803
539	2016-02-11 18:05:23	CTD39 - KX39 wp0901
540	2016-02-11 23:54:00	RMT R36 - KX39 Prior to deployment; insulation reading 1.2MOhm min. observed 170kOhm Rubber Tape may have improved insulation. Level has remained at 171kOhm despite RMT being back on deck... suspect seawater is not able to drain as quickly.
541	2016-02-12 05:11:02	RMT Insulation dropped from 800kOhm prior to deployment to 140kOhm. Suspect cable retaining water due to rubber tape. Removed tape to avoid frozen water causing further damage.
542	2016-02-12 07:26:00	MIDOC32 - KX40
543	2016-02-12 12:41:00	RMTT - T26 KX40
544	2016-02-12 14:27:15	RMTR - R37 KX40
545	2016-02-12 15:20:17	CTD40 - KX40 wp0902 Waypoint was incorrect in Viasge. Was: 60deg 7.74 S 83deg 34.57 E Changed to: 60deg 19.002 S 83deg 35.360 E Voyage route needs updating.
546	2016-02-12 21:45:00	CTD41 - KX41 wp0903
547	2016-02-13 05:33:00	MIDOC33 - KX42 Retrieved and re-deployed due to twisted line.
548	2016-02-13 06:23:00	MIDOC34 - KX42
549	2016-02-13 10:54:00	CTD42 - K42 KX42 wp0904
550	2016-02-13 15:04:00	RMTR - R38 KX42 850K to 160K
551	2016-02-13 21:25:00	MIDOC35 KX43
552	2016-02-14 01:58:00	CTD43 KX43 wp0905
553	2016-02-14 06:39:00	RMTT T27 KX43
554	2016-02-14 07:10:00	RMTT T28 KX43
555	2016-02-14 07:29:00	RMTT T29 KX43
556	2016-02-14 08:26:00	RMTR R39 KX43

557	2016-02-14 15:12:00	MIDOC36 KX44
558	2016-02-14 20:04:04	CTD44 K44 wp0906
559	2016-02-15 01:28:00	RMTR R40 KX44
560	2016-02-15 04:46:00	MIDOC37 KX45
561	2016-02-15 09:45:05	CTD45 KX45 wp1001
562	2016-02-15 10:15:00	RMTR R41 KX45 Net failed to open.
563	2016-02-15 10:46:00	RMTR R42 KX45
564	2016-02-15 14:50:00	RMTT T30
565	2016-02-15 16:47:50	MIDOC38 KX46
568	2016-02-15 22:14:00	RMTR R43 KX46
569	2016-02-16 01:34:00	MIDOC39 KX47
570	2016-02-16 06:48:00	CTD47 KX47 WP1003
571	2016-02-16 07:51:00	RMTR R44 KX47
567	2016-02-16 12:31:00	MIDOC40 KX48
573	2016-02-18 06:25:00	RMT T31
574	2016-02-18 08:47:00	RMT T32
575	2016-02-18 16:31:00	RMT T33
576	2016-02-18 17:51:00	RMT T34
577	2016-02-18 18:24:00	RMT T35
578	2016-02-18 19:11:00	RMT T36
579	2016-02-18 23:56:00	RMT T37
572	2016-02-19 04:22:00	RMT Target T38
580	2016-02-22 03:39:29	Had another power failure in the Met lab possibly due to the 60+ knot blizzard currently going on causing blizz static via the physics instruments on the Monkey deck. We reset the breaker and it quickly tripped again. So I have pulled out every cable to these experiments and restarted the rack. Lloyd Symons
581	2016-02-24 03:55:00	Ship got loose from mooring lines and ran aground at West Arm; Horseshoe harbour
582	2016-02-26 00:00:00	Ship was floated off the rocks and exited the harbour at 1:42pm Mawson time
583	2016-03-05 07:34:48	Just checking oceanographic lab to find that the TSG was running dry. I upped the flow rate. Also cleaned the fluorometer. Lloyd Symons

584	2016-03-06 10:30:00	Found the fluorometer running dry so I adjusted flows once more. TSG data appears less spikey as a result Lloyd Symons
585	2016-03-07 04:14:29	Just found the fluorometer bubbler running dry and the TSG bubbler working perfectly (the reverse of yesterday's situation) so I increased the flow rate into the fluoro slightly and it started to fill. This system seems extraordinarily touchy... Especially given that there are no scientists on board trying to take water from the system via other means. Lloyd Symons
586	2016-03-12 05:30:22	As we are approaching Fremantle; I have shut down the sea water instruments so that the engineers can shut down the sea water intakes. Lloyd Symons

Table 34 - Voyage Event Log (Technical)

7 WAYPOINTS

A number of waypoints were maintained in the ships scientific GIS system (known as Visage) for planning purposes. Note that these waypoints do not record the actual location of deployments but were used for planning purposes. The ships track data contained in the underway data is the best record of where deployments were actually conducted.

ID	Label	Latitude	Longitude	Comment
576	W-GRIBB	S62° 22.80'	E81° 47.81'	whale_recorders
577	W-DAVIS	S66° 34.47'	E77° 38.97'	whale_recorders
675	wp0101	S42° 54.50'	E147° 22.03'	k-axis
676	wp0102	S62° 41.34'	E99° 14.33'	k-axis
677	wp0103	S63° 59.66'	E93° 35.47'	k-axis
678	wp0104	S64° 51.00'	E93° 33.00'	k-axis
679	wp0201	S64° 49.80'	E93° 32.40'	k-axis
680	wp0202	S64° 48.60'	E93° 33.60'	k-axis
681	wp0203	S64° 46.80'	E93° 33.60'	k-axis
682	wp0204	S64° 43.80'	E93° 34.20'	k-axis
683	wp0205	S64° 17.40'	E93° 33.60'	k-axis
684	wp0206	S64° 0.00'	E93° 33.60'	k-axis
685	wp0207	S63° 30.00'	E93° 33.60'	k-axis
686	wp0208	S63° 0.00'	E93° 34.20'	k-axis
687	wp0209	S62° 16.80'	E93° 9.00'	k-axis
688	wp0210	S61° 57.73'	E93° 15.65'	k-axis
689	wp0211	S61° 42.38'	E93° 22.51'	k-axis
690	wp0301	S61° 57.91'	E92° 33.67'	k-axis
691	wp0302	S62° 17.40'	E91° 31.20'	k-axis
692	wp0303	S62° 23.56'	E89° 40.42'	k-axis
693	wp0304	S62° 28.09'	E87° 47.77'	k-axis
694	wp0305	S62° 30.67'	E86° 7.42'	k-axis
695	wp0306	S62° 32.00'	E83° 51.57'	k-axis
696	wp0307	S62° 31.25'	E82° 0.97'	k-axis
697	wp0401	S63° 15.56'	E82° 0.69'	k-axis
698	wp0402	S63° 56.74'	E83° 7.88'	k-axis

699	wp0403	S64° 24.75'	E83° 32.70'	k-axis
700	wp0404	S64° 39.93'	E84° 18.67'	k-axis
701	wp0405	S65° 10.03'	E84° 18.72'	k-axis
702	wp0406	S65° 31.43'	E84° 28.87'	k-axis
703	wp0407	S65° 42.81'	E84° 26.96'	k-axis
704	wp0408	S65° 46.09'	E84° 31.67'	k-axis
705	wp0409	S65° 48.65'	E84° 33.01'	k-axis
706	wp0501	S64° 55.19'	E88° 40.19'	k-axis
707	wp0601	S63° 35.39'	E88° 13.05'	k-axis
708	wp0602	S63° 6.58'	E87° 15.40'	k-axis
709	wp0603	S62° 30.67'	E86° 7.42'	k-axis
710	wp0604	S61° 55.39'	E85° 4.42'	k-axis
711	wp0605	S61° 12.10'	E83° 51.77'	k-axis
712	wp0606	S60° 21.70'	E82° 32.90'	k-axis
713	wp0607	S59° 21.76'	E81° 6.20'	k-axis
714	wp0608	S58° 39.47'	E80° 9.13'	k-axis
715	wp0701	S58° 14.34'	E82° 0.04'	k-axis
716	wp0702	S57° 54.59'	E83° 20.06'	k-axis
717	wp0703	S57° 34.73'	E84° 35.33'	k-axis
718	wp0704	S57° 20.70'	E85° 25.76'	k-axis
719	wp0801	S57° 41.13'	E85° 33.70'	k-axis
720	wp0802	S58° 49.64'	E86° 1.57'	k-axis
721	wp0803	S59° 26.98'	E86° 17.65'	k-axis
722	wp0901	S59° 40.78'	E85° 24.96'	k-axis
723	wp0902	S60° 7.74'	E83° 34.57'	k-axis
724	wp0903	S60° 21.71'	E82° 32.91'	k-axis
725	wp0904	S60° 54.02'	E79° 55.41'	k-axis
726	wp0905	S61° 19.03'	E77° 34.92'	k-axis
727	wp0906	S61° 50.03'	E74° 5.77'	k-axis
728	wp1001	S62° 41.00'	E73° 21.20'	k-axis
729	wp1002	S63° 57.74'	E72° 7.76'	k-axis
730	wp1003	S64° 52.61'	E71° 10.19'	k-axis
731	wp1004	S65° 57.38'	E69° 56.69'	k-axis
732	wp1005	S66° 37.59'	E69° 7.22'	k-axis
733	wp1006	S66° 54.22'	E68° 45.53'	k-axis
734	wp1101	S66° 51.70'	E66° 13.61'	k-axis
735	wp1102	S66° 47.15'	E63° 56.93'	k-axis
736	wp1201	S67° 36.22'	E62° 52.37'	k-axis

Table 35 - Voyage Waypoints