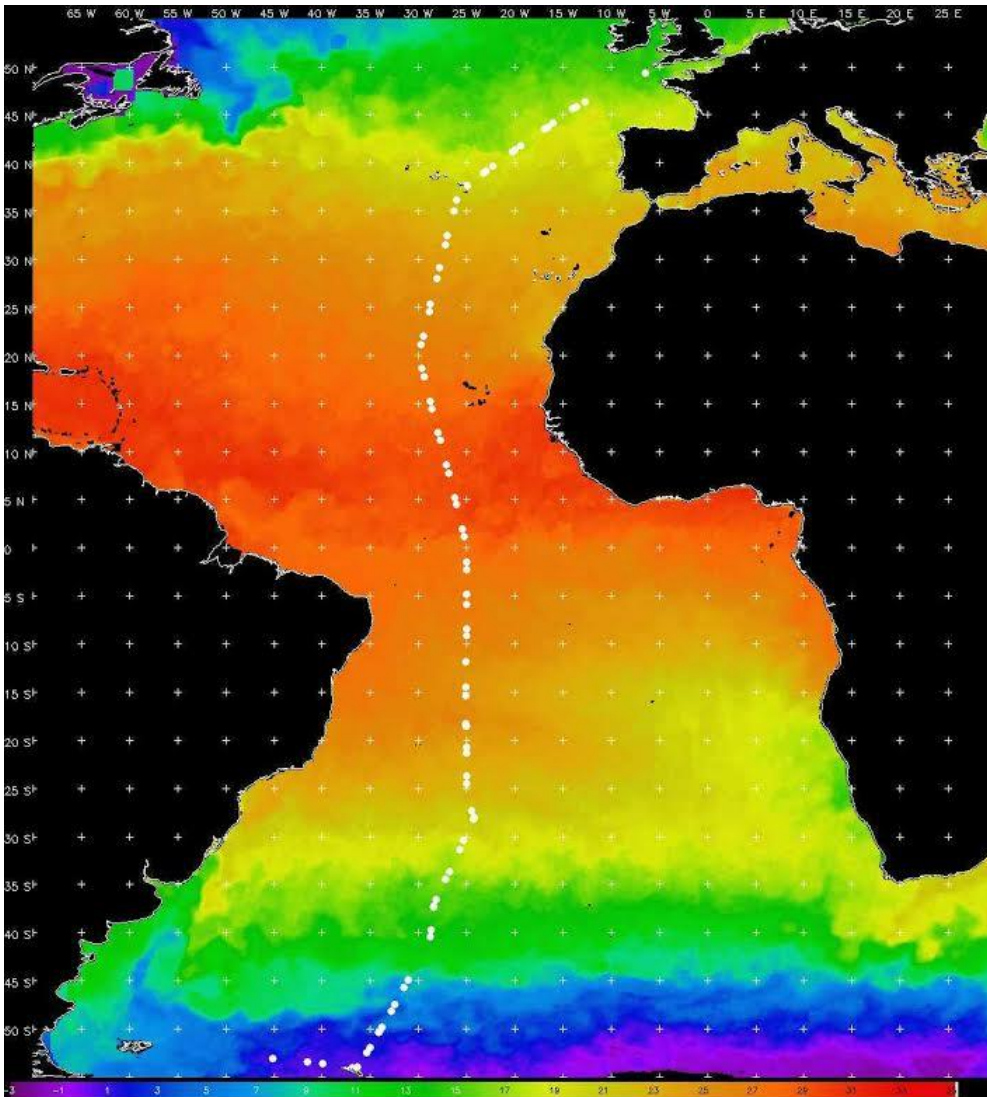


AMT 26 Cruise Report



RRS James Clark Ross JR16001
(20 September – 05 November 2016)
Principal Scientist: Andy Rees
Plymouth Marine Laboratory

PML

Plymouth Marine
Laboratory



**National
Oceanography Centre**
NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC SCIENCE OF THE
ENVIRONMENT

Table of Contents

Overview	3
AMT 26 Scientific cruise participants	5
CTD and underway sensor calibrations	7
Sea Surface Temperature	14
Weather Balloon Deployment.....	21
C-band Radar	24
Dissolved Inorganic Nutrients.....	26
Colour Dissolved Organic Matter.....	30
Dissolved Oxygen.....	34
Carbonate System: Total Alkalinity (AT) and pH.....	37
Dissolved & Atmospheric Greenhouse Gases.....	42
Optical properties and particulate organic carbon and phosphorous	43
Particle size distribution and total suspended matter.....	46
Abundance and Composition of Microbial Plankton Communities by flow cytometry.....	48
Extraction of phytoplankton pigments for High Performance Liquid Chromatography (HPLC) analysis	52
Measurements of optical properties.....	57
Use of SUOMI NPP for derivation of ocean particulate inorganic carbon concentration.....	59
Primary Production and PAB's.....	66
Microplastics and POC sampling with large volume in situ pumps (SAPs).....	70
NOC Underway CO2 System.....	75
Investigation of waterborne microplastic concentrations and zooplankton ingestion of microplastics.....	78
Collection of DOM Samples.....	83
SOG Mooring Recovery and Deployment.....	84
BAS AME (electronics) marine scientific instrumentation support.....	90
Appendix 1: Underway sample log	96
Appendix 2: AMT26 Log of events.....	108

Overview

AMT-26 (JR16001) departed Immingham on the 20th September and arrived in the Falkland Islands on the 3rd November 2016 after travelling 7829 nautical miles via the Azores and South Georgia. Myself and the rest of the scientific party would like to acknowledge the help and support provided by Captain Graham Chapman and his team who were exceptional in their approach to our work. My particular thanks to Glen Tarran and Christina Devereux who assisted in ways too numerous to mention here. Thanks also to Kath Nicholson at BAS and first officer Simon Wallace for their help and guidance in the black art of freight documentation.



The AMT programme maximises on opportunities offered by the regular transit of the RRS James Clark Ross between the UK and the Falkland Islands. Now in its 21st year AMT is a multidisciplinary program which undertakes biological, chemical and physical oceanographic research during an annual voyage throughout the Atlantic Ocean.

AMT objectives have evolved to enable the maintenance of a continuous set of observations, whilst addressing global issues that are raised throughout the most recent IPCC assessment and UK environmental strategy. AMT objectives are to:

- (1) quantify the nature and causes of ecological and biogeochemical variability in planktonic ecosystems;
- (2) quantify the effects of this variability on nutrient cycling, on biogenic export and on air-sea exchange of climate active gases;
- (3) construct a multi-decadal, multidisciplinary ocean time-series which is integrated within a wider "Pole-to-pole" observatory concept;
- (4) provide essential sea-truth validation for current and next generation satellite missions;

- (5) provide essential data for global ecosystem model development and validation and;
- (6) provide a valuable, highly sought after training arena for the next generation of UK and International oceanographers.

An exciting highlight of this AMT cruise is our collaboration with the European Space Agency through their funding of the [AMT4SentinelFRM project](#). This has provided a unique opportunity to obtain high quality fiducial reference measurements for the validation of Sentinel products in a wide range of Atlantic locations.



Dr A.P. Rees

***Plymouth Marine Laboratory
January 2017***

Cruise Participants



Andy Rees
PSO



Carolyn Harris
Nutrients



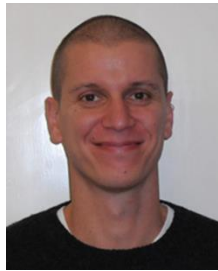
Bob Brewin
Optics, Sentinel 3



Denise Cummings
Primary Production



Emanuele Organelli
Particle distribution



Francesco Nencioli
CDOM, O₂, optics



Giorgio Dall'Olmo
Optics, Sentinel 3



Glen Tarran
Microbial communities



Howard King
Mechanical tech.



James Ayliffe
Data management



Jason Hopkins
NASA PIC



John Wynar
Instrumentation tech.



Katsia Pabortsava
Microplastics, CO₂



Kerri Coombes
CO₂ system, O₂



Madie Steer
Microplastics



Rafael Rasse
POC, POP, PON



Werenfrid Wimmer
Sentinel 3 calibration



Johnnie Edmonston
IT support engineer

Paul Morgan
Instrumentation support

CTD and underway sensor calibrations

James Ayliffe

British Oceanographic Data Centre

CTD profiles

A total of 74 CTD casts were completed during the cruise. All casts were conventional profiling casts with water sampling by OTE Niskin bottles. Originally sampling was carried out with 24 x 20L bottles though bottle 17 was changed for a smaller bottle to ensure all bottles had sufficient space to close properly. A morning cast would be carried out between 03:30 and 05:30 ship time whilst afternoon casts would be carried out between 12:00 and 13:30 unless it was delayed due to operational complications.

CTD casts were recorded using the Sea-Bird data collection software Seasave-Win32. The software outputs were then processed following the BODC recommended guidelines using SBE Data Processing-Win32 v7.26.2.14; the processing routines are named after each stage in brackets < >. The software applied the calibrations as appropriate through the instrument configuration file to the data in engineering units output by the CTD hardware.

An ascii file (CNV) containing the 24 Hz data for up and down casts was generated from the binary Sea-Bird files for each cast <DatCnv>. Files were created for each cast containing the mean values of all the variables at the bottle firing events <Bottle Summary>. Using the CNV files processing routines were applied to remove pressure spikes <WildEdit>, the oxygen sensor was then shifted relative to the pressure by 2 seconds, to compensate for the lag in the sensor response time <AlignCTD> and the effect of thermal 'inertia' on the conductivity cells was removed <CellTM>. The surface soak was identified for each cast, removed and LoopEdit run. Salinity and oxygen concentration were re-derived and density (sigma-theta) values were derived <Derive> after the corrections for sensor lag and thermal 'inertia' had been applied. The CTD files produced from Sea-Bird processing were converted from 24 Hz ascii files into 1 dbar downcast files for calibration and visualisation onboard <BinAverage>. The initial salinity and oxygen channels produced at the DatCnv stage, along with the conductivity, voltage and altimeter channels were removed from the 1 dbar downcast files <Strip>.

The sensor values at bottle firing produced by the Bottle Summary routine were collated and used to generate calibrations for the salinity, oxygen and fluorometer channels. Water samples were collected from each cast for measurement of salinity (bench salinometer), chlorophyll-a (filtration, acetone extraction and fluorometer measurement) and for oxygen (Winkler titration).

The method used for calibration was to generate an offset between the discrete water sample measurement (salinity/oxygen/chl-a) and the nominal value from the sensor at bottle firing. The offsets were then plotted against the discrete sample values and a linear regression applied.

Where the regression was significant the calibration equation was derived by rearranging the regression equation:

$$\text{Offset} = a * \text{Discrete sample} + b$$

Where $\text{offset} = \text{Discrete sample} - \text{Sensor value}$

To give $\text{Calibrated value} = 1/(1-a) * \text{Sensor value} + b/(1-a)$

Where the regression was not significant the mean value of the offset was applied. All calibration datasets are available upon request from BODC post cruise.

- Temperature

There were no independent measurements of temperature made during the cruise and the sensors on the rig returned consistent data. No further calibration of these sensors has been carried out. The

section generated from the primary sensor has been provided in fig. 1.

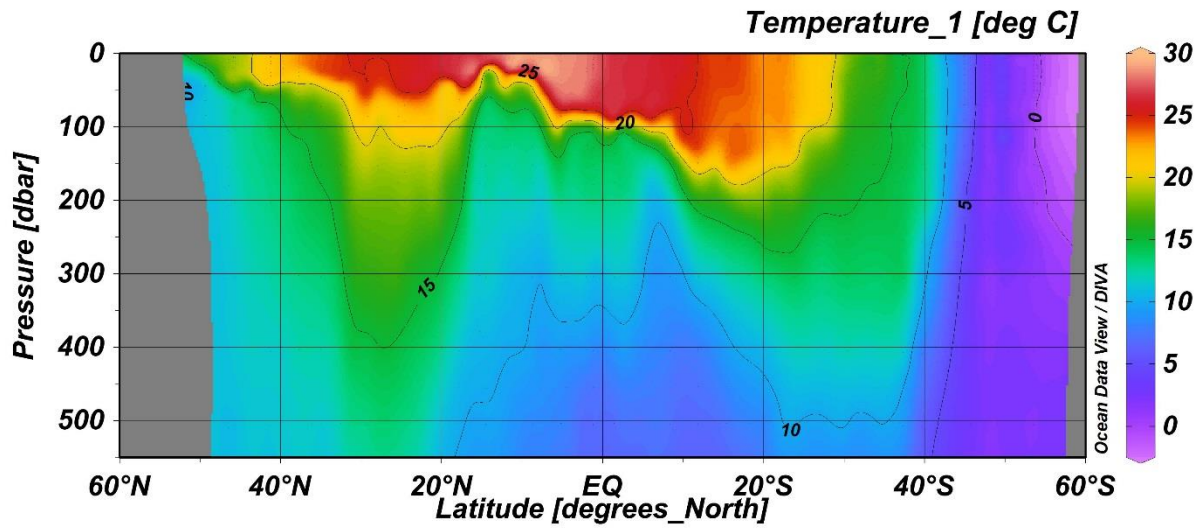


Fig. 1: Temperature section plot along the AMT26 transect by latitude (60 deg N – 60 deg S) from the primary temperature sensor.

- Salinity

The salinity channels were calibrated against bench salinometer measurements from 2 samples collected from most casts. Further details of these measurements can be found in the NMF-SS cruise report section.

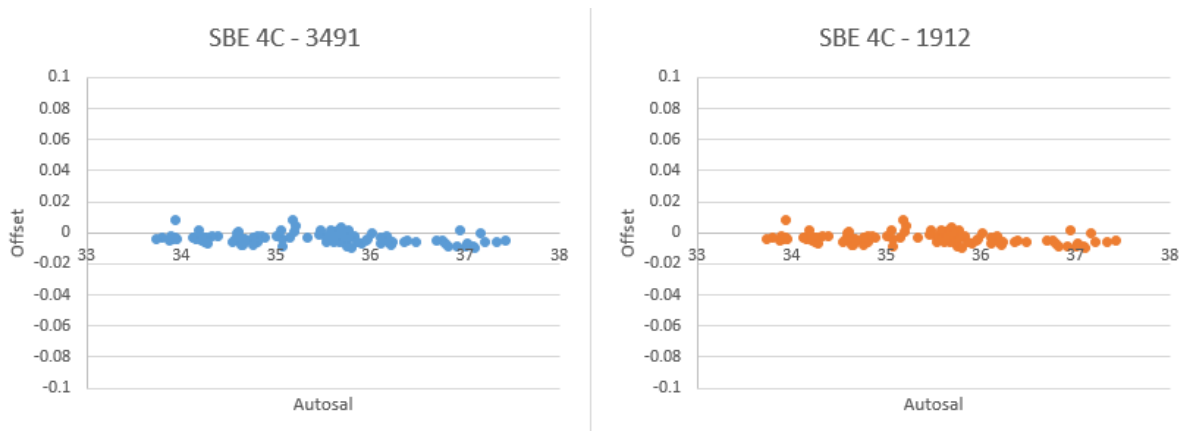


Fig. 2: Salinity offsets for each sensor against discrete sample salinity measured with a bench salinometer.

At the start of the cruise there was some discrepancy between the initial sensors on the CTD set up. The sensors were switched with the spare sensor to determine which may be faulty. Sensors 4C-3491 and 4C-1912 were used for the remainder of the cruise without further problems. The calibration equations for the sensors were:

Sensor SBE 4C-3491 - Calibrated = sensor - 0.0004 (n = 110; $r^2 = 0.0191$; p = 0.1495);

Sensor SBE 4C-1912 - Calibrated = 0.9991 * sensor + 0.0268 (n = 106; $r^2 = 0.0581$; p = 0.0128);

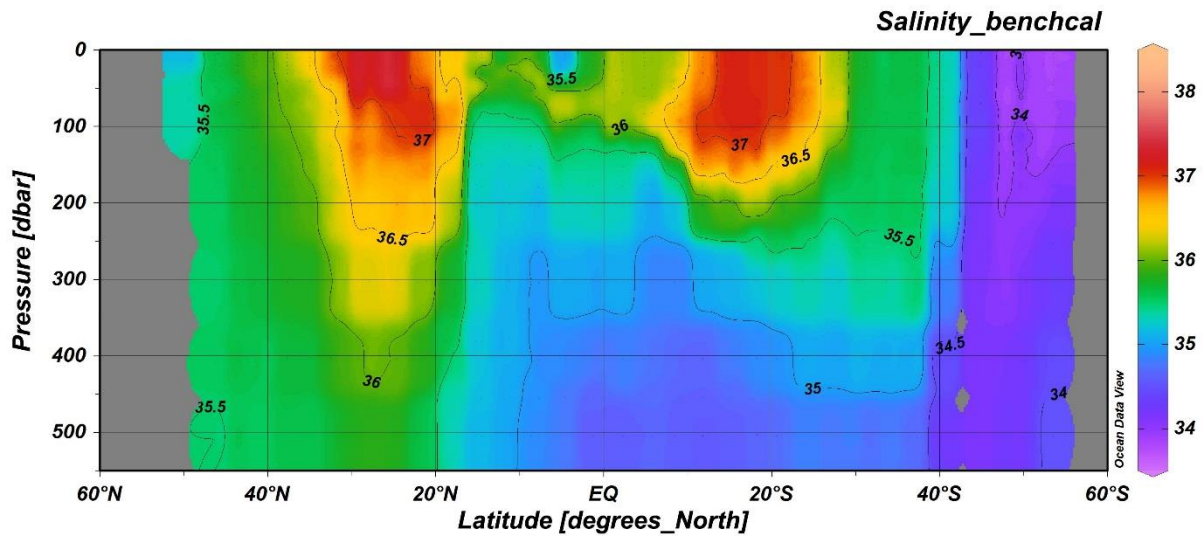


Fig. 3: Salinity section plot along the AMT26 transect by latitude (60 deg N – 60 deg S) from the secondary sensor calibrated against bench salinometer samples.

- Oxygen

The oxygen sensor was calibrated against discrete oxygen sample Winkler titration measurements from over 6 samples collected per CTD. More details can be found in Kerri Coombes' report.

The oxygen sensor had a few issues during the cruise.

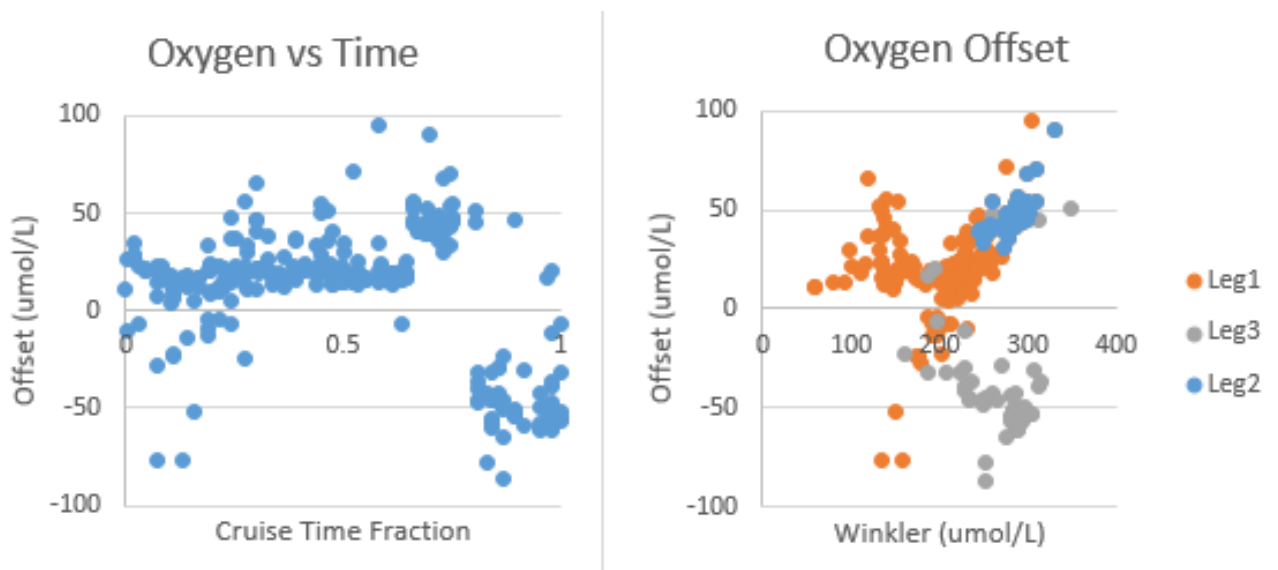


Fig. 4: Oxygen concentration offsets against Time Fraction and Oxygen concentration offsets against Winkler titration measurements from discrete samples.

Two legs were identified for separate calibrations to be applied with data concentration values having a different calibration applied from 25/10/2016 (Time Fraction ~0.8). The calibration equations are:

- (1) $\text{Calibrated } O_2 \text{ (in } \mu\text{mol/l)} = 1.1846 * \text{sensor } O_2 \text{ (in } \mu\text{mol/l)} - 11.435$ (n = 220; $r^2 = 0.314$; $p < 0.001$);
- (2) $\text{Calibrated } O_2 \text{ (in } \mu\text{mol/l)} = 0.8025 * \text{sensor } O_2 \text{ (in } \mu\text{mol/l)} + 15.3272$ (n = 51; $r^2 = 0.4413$; $p < 0.001$);

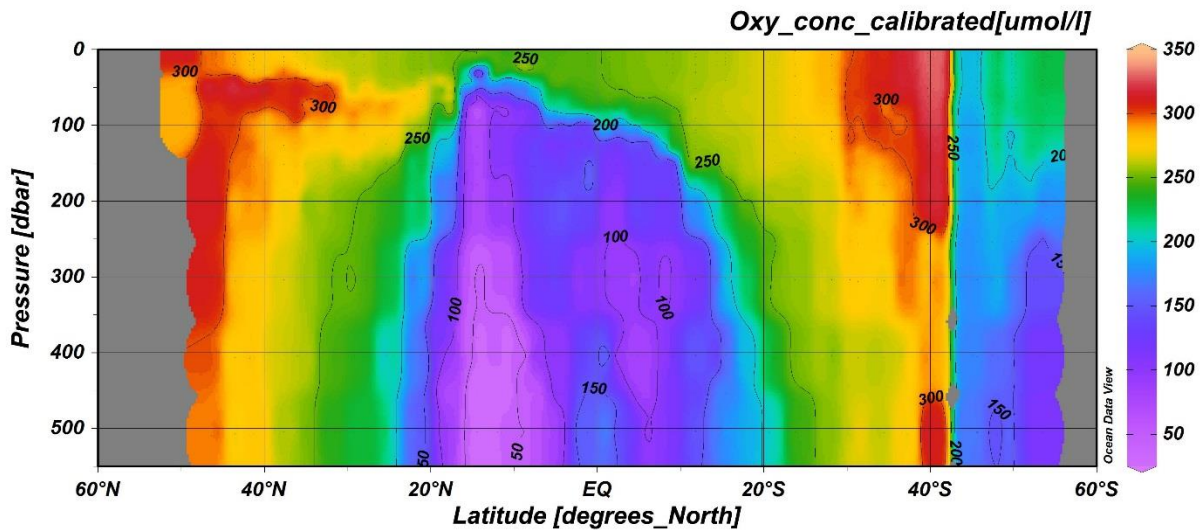


Fig. 5: Oxygen concentration section plot along the AMT26 transect by latitude (60 deg N – 60 deg S) from the SBE43 (s/n: 0620) oxygen sensor calibrated against Winkler titration samples.

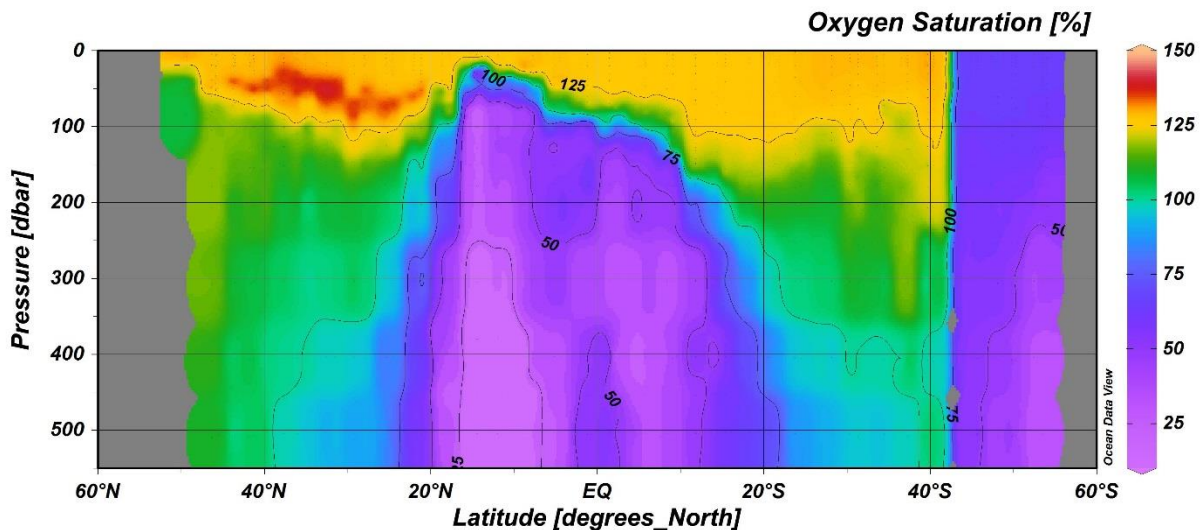


Fig. 6: Oxygen concentration section plot along the AMT26 transect by latitude (60 deg N – 60 deg S) calculated from the SBE43 oxygen sensor calibrated against Winkler titration samples and salinity calibrated against bench salinometer measurements.

- Fluorometer

The CTD fluorometer operated without problem during the cruise. The calibration is to be carried out after the cruise once the fluorometer has been returned to PML for verification of the calibration against known standards.

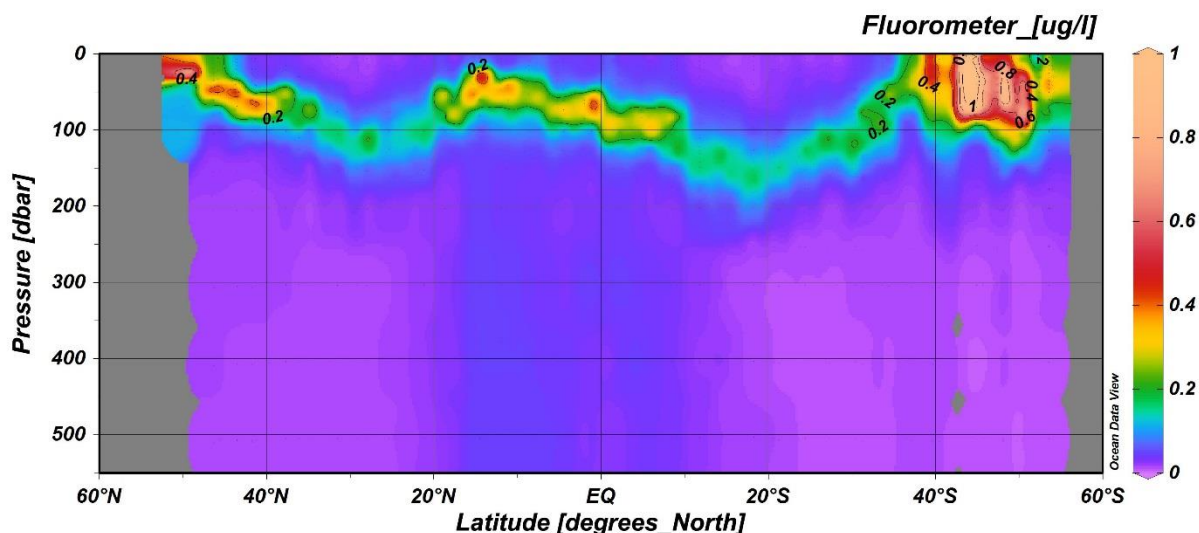


Fig. 7: Fluorometer (nominal calibration) section plot along the AMT26 transect by latitude (60 deg N – 60 deg S).

Underway sensors

The ship's underway meteorological and surface systems were run continuously through the cruise. The sea surface hydrography system started logging from 20/09/2016 and was switched off for brief periods in Portsmouth Harbour (22/09/2016) and South Georgia (29/10/2016) then turned off approaching the Falklands, morning 03/11/2016. Samples were collected to calibrate the TSG and fluorometer connected to the ship's non-toxic flow-through system, which draws water from approximately 7 m below the water line.

- SST – hull mounted sensor

The hull temperature sensor was calibrated against the mean of the CTD temperature sensor values at each station. There was no significant regression of the offset with surface CTD sensor values ($n = 46$; $r^2 = 0.0665$; $p = 0.0837$) but there was significant regression with time ($n = 46$; $r^2 = 0.1532$; $p = 0.0071$).

$$\text{Calibrated sstemp} = 1.037387 * \text{sstemp} + 0.00395$$

The correction will be applied during BODC processing after the cruise before the data is made available online.

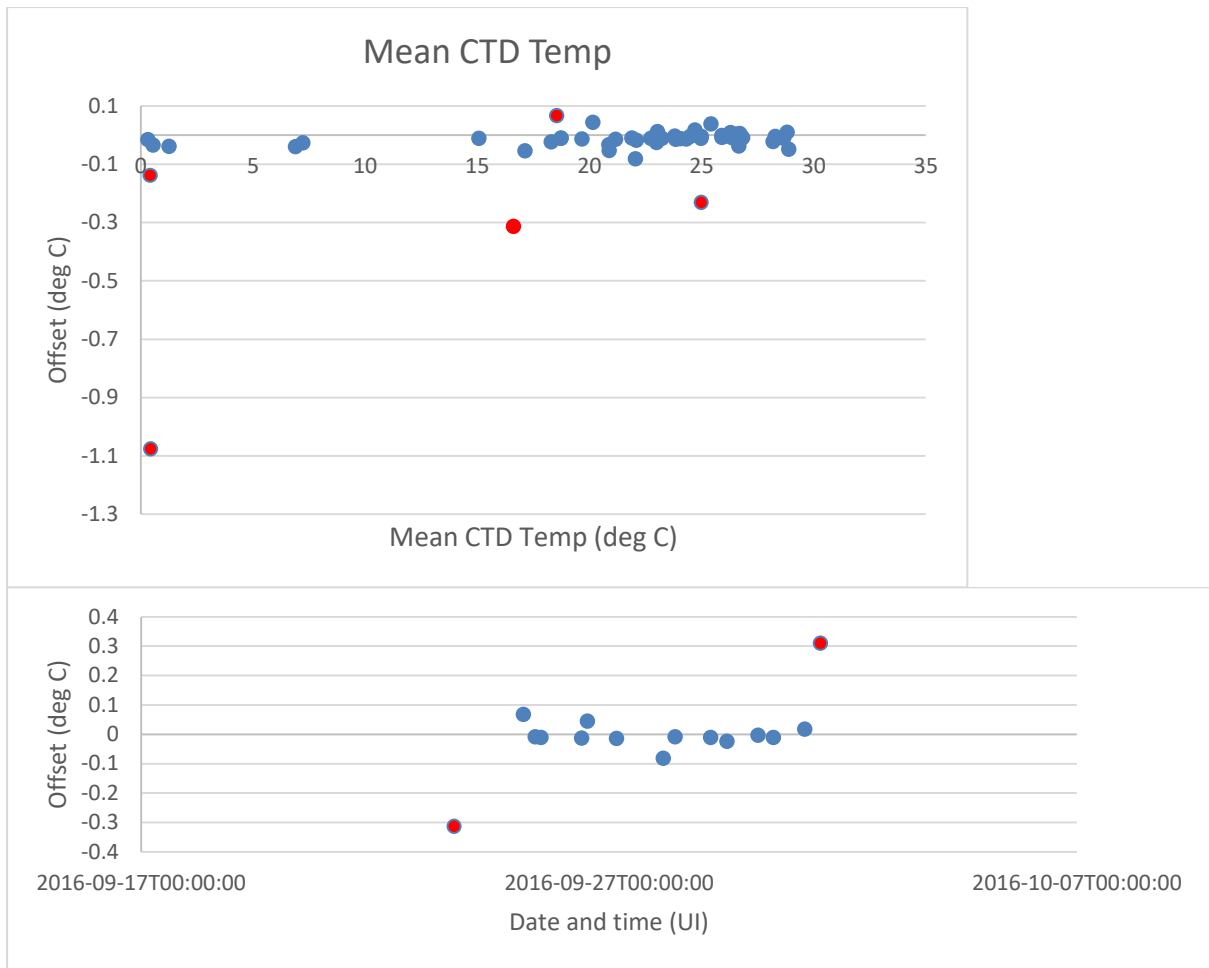


Fig. 8: Hull sensor temperature offsets against surface CTD temperature measurements and date/time.

- Salinity

The TSG sensor salinity data were calibrated against samples collected and analysed with a bench salinometer. Up to five samples were collected each day. There was a significant regression of the offset with bench salinity measurement ($n = 135$; $r^2 = 0.037897$; $p < 0.05$).

$$\text{Calibrated salinity} = 1.0037 * \text{TSG salinity} - 0.1357$$

The correction will be applied during BODC processing after the cruise before the data is made available online.

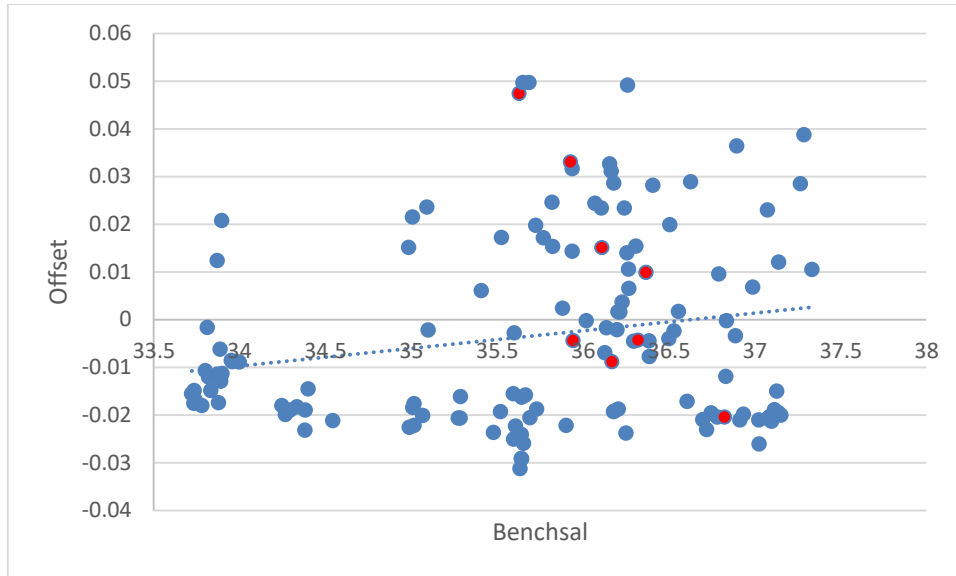


Fig. 9: Salinity offsets against bench salinometer measurements on discrete underway samples.

- Fluorometer

The underway fluorometer did not provide accurate data throughout the cruise. The voltages have been kept though the data are highly suspect. Up to five discrete measurements were collected each day. The calibration is to be carried out after the cruise once the fluorometer has been returned to PML for verification of the calibration against known standards. The correction will be applied during BODC processing after the cruise before the data is made available online.

Sea Surface Temperature – AMT4SentinelIFRM

Werenfrid Wimmer

University of Southampton

Objectives:

Collect SI traceable SSTskin measurements for the validation of SLSTR on the ESA Sentinel 3 satellite. Collect the necessary ancillary measurements for the SSTskin record to help the interpretation of the validation results. Extend the ISAR SSTskin record geographically to cover a wider range of oceanographic regimes.

Collect SSTdepth and met data from the ship underway system for comparison and to complement the SSTskin data set.

Record 6h met observations and bucket temperature measurements to verify the underway data and to provide a SI traceable reference for the SSTdepth measurements.

Automated collection of SSTskin and meteorological data:

SSTskin data was collected by ISAR (Infrared Sea surface temperature Autonomous Radiometer) mounted on the port side of the forward mast at a 45 degree angle relative to the ships center line. The instruments sea viewing angle was checked on 20.09.2016 and 27.09.2016 and determined with 35 deg from nadir. The data was logged with a data logger based in the Mail Room connected to the ships network allowing for frequent data quality checks.

The ancillary sensors, a Kipp and Zonen CM11, a Eppley PIR and a Gill Windmaster were mounted on the bird table in order to be free of obstruction for the Gill Windmaster, and to have a clean view of the sky for the CM11 and the PIR. The CM11 and the PIR were mounted on individual gimbals to ensure that the sensors axis is vertical even when the ship moves. The data were logged with the same logger as the ISAR data. The PIR data is processed as described in Fairall et. al. 1998.

Air temperature and Humidity data were collected with a Vaisala HMP243 sensor on the port side of the monkey island close to the port side JCR met screen with a separate data logger.

SSTdepth (at 4m) data were collected with a Seabird SBE48 in the port side void space. A total of 198963 samples were collected at 20 second intervals.

Meteorological Observations and Bucket temperature samples

To aid the ISAR data interpretation six hourly pressure, air temperature and dew point, sea water temperature, cloud cover and sea state information were collected. Furthermore bucket temperatures were collected at the same time, between 23.09 and 25.09.2016 from the bridge wing, after that the sampling location was under the port life boat. A total of 157 meteorological observations were made and 142 bucket temperature samples collected. The slightly lower number of bucket samples is due to bad weather which made the collection to dangerous. The bucket temperature probe was calibrated against a HART 1504 with a Thermometrics 225 probe in the CASOTS2 water bath on 8.10, 18.10, 24.10 and 28.10.2016 covering a SST range from 1.3 degC to 29 degC and ambient temperatures of 26.4, 22.4, 14.8 and 4.4 degC.

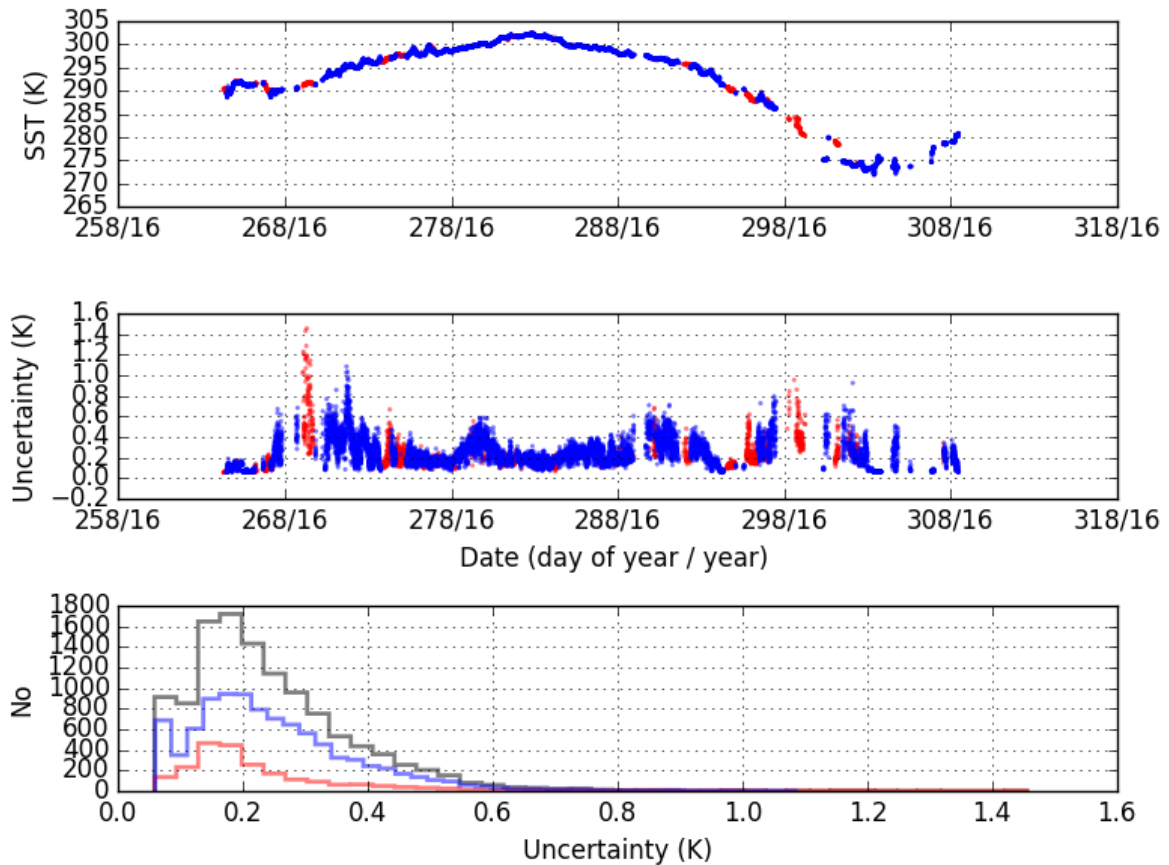


Figure 1: ISAR SST data with associated uncertainties.

Table 1: Metrological observations and bucket temperature collection locations and time. Gray shaded rows are metrological data only, and no bucket temperature was collected because of bad swell conditions on those dates.

No	Date	Time (UTC)	Latitude	N pos	Longitude	W pos
1	22/09/16	18:00	50.5020	N	1.2457	W
2	23/09/16	00:00	50.1667	N	2.9000	W
3	23/09/16	06:00	49.8723	N	4.5583	W
4	23/09/16	12:00	49.5167	N	5.8500	W
5	23/09/16	18:00	49.2500	N	6.6000	W
6	24/09/16	00:00	48.7333	N	7.8833	W
7	24/09/16	06:00	48.4167	N	8.9833	W
8	24/09/16	12:00	48.0333	N	10.0667	W
9	24/09/16	18:00	47.4333	N	11.0167	W
10	25/09/16	00:00	46.7367	N	12.1000	W
11	25/09/16	06:00	46.3000	N	12.8167	W
12	25/09/16	12:00	45.7683	N	13.7400	W
13	25/09/16	18:00	45.2700	N	14.5583	W
14	26/09/16	00:00	0.0000	N	0.0000	W
15	26/09/16	06:00	44.1617	N	16.0533	W

No	Date	Time (UTC)	Latitude	N pos	Longitude	W pos
16	26/09/16	12:00	43.6237	N	16.7970	W
17	26/09/16	18:00	43.0243	N	17.6327	W
18	27/09/16	00:00	42.2495	N	18.7173	W
19	27/09/16	06:00	41.7838	N	19.4118	W
20	27/09/16	12:00	41.2432	N	20.1362	W
21	27/09/16	18:00	40.8705	N	20.6535	W
22	28/09/16	00:00	40.1507	N	21.6478	W
23	28/09/16	06:00	39.6168	N	22.3778	W
24	28/09/16	12:00	39.0762	N	23.1125	W
25	28/09/16	18:00	38.5317	N	23.7157	W
26	29/09/16	00:00	37.7883	N	24.5845	W
27	29/09/16	06:00	37.6697	N	24.8930	W
28	29/09/16	12:00	37.6950	N	24.9267	W
29	29/09/16	18:00	37.6663	N	25.4752	W
30	30/09/16	00:00	36.8985	N	25.5733	W
31	30/09/16	06:00	36.0453	N	26.1010	W
32	30/09/16	12:00	35.0367	N	26.3640	W
33	30/09/16	18:00	34.3318	N	26.4993	W
34	01/10/16	00:00	33.2597	N	26.8022	W
35	01/10/16	06:00	32.5263	N	26.9833	W
36	01/10/16	12:00	31.5470	N	27.2398	W
37	01/10/16	18:00	30.9425	N	27.3817	W
38	02/10/16	00:00	29.9220	N	27.6465	W
39	02/10/16	06:00	29.0620	N	27.8587	W
40	02/10/16	12:00	27.9980	N	28.1193	W
41	02/10/16	18:00	27.3068	N	28.2713	W
42	03/10/16	00:00	26.2948	N	28.5318	W
43	03/10/16	06:00	25.3862	N	28.7445	W
44	03/10/16	12:00	24.6143	N	28.9317	W
45	03/10/16	18:00	23.9973	N	29.0587	W
46	04/10/16	00:00	22.9840	N	29.3127	W
47	04/10/16	06:00	22.0587	N	29.5242	W
48	04/10/16	12:00	21.1642	N	29.7282	W
49	04/10/16	18:00	20.6020	N	29.8622	W
50	05/10/16	00:00	19.5777	N	29.8900	W
51	05/10/16	06:00	18.7003	N	29.6620	W
52	05/10/16	12:00	17.8038	N	29.4327	W
53	05/10/16	18:00	17.1797	N	29.2718	W
54	06/10/16	00:00	16.1617	N	29.0132	W
55	06/10/16	06:00	15.2743	N	28.7842	W
56	06/10/16	12:00	14.5227	N	28.5978	W
57	06/10/16	18:00	13.8825	N	28.4247	W
58	07/10/16	00:00	12.8592	N	28.1795	W

No	Date	Time (UTC)	Latitude	N pos	Longitude	W pos
59	07/10/16	06:00	11.9592	N	27.9595	W
60	07/10/16	12:00	11.2390	N	27.7702	W
61	07/10/16	18:00	10.6128	N	27.6142	W
62	08/10/16	00:00		N		W
63	08/10/16	06:00	8.6975	N	27.1368	W
64	08/10/16	12:00	7.7610	N	26.9052	W
65	08/10/16	18:00	7.1160	N	26.7383	W
66	09/10/16	00:00	6.1363	N	26.5058	W
67	09/10/16	06:00	5.2012	N	26.2748	W
68	09/10/16	12:00	4.4845	N	26.0812	W
69	09/10/16	18:00	3.8000	N	25.9312	W
70	10/10/16	00:00	2.8475	N	25.6975	W
71	10/10/16	06:00	1.9747	N	25.4828	W
72	10/10/16	12:00	1.1817	N	25.2892	W
73	10/10/16	18:00	0.5623	N	25.1257	W
74	11/10/16	00:00	-0.4990	S	25.0025	W
75	11/10/16	06:00	-1.4152	S	25.0047	W
76	11/10/16	12:00	-2.1967	S	25.0123	W
77	11/10/16	18:00	-2.8943	S	25.0103	W
78	12/10/16	00:00	-3.9208	S	25.0208	W
79	12/10/16	06:00	-4.8297	S	25.0210	W
80	12/10/16	12:00	-5.7510	S	25.0308	W
81	12/10/16	18:00	-6.4237	S	25.0343	W
82	13/10/16	00:00	-7.4720	S	25.0398	W
83	13/10/16	06:00	-8.3765	S	25.0408	W
84	13/10/16	12:00	-9.0587	S	25.0440	W
85	13/10/16	18:00	-9.8635	S	25.0535	W
86	14/10/16	00:00	-10.8877	S	25.0595	W
87	14/10/16	06:00	-11.8235	S	25.0633	W
88	14/10/16	12:00	-11.8293	S	25.0523	W
89	14/10/16	18:00	-12.5022	S	25.0633	W
90	15/10/16	00:00	-13.5607	S	25.0728	W
91	15/10/16	06:00	-14.4483	S	25.0758	W
92	15/10/16	12:00	-15.3068	S	25.0825	W
93	15/10/16	18:00	-16.0370	S	25.0852	W
94	16/10/16	00:00	-17.2757	S	25.1117	W
95	16/10/16	06:00	-18.2593	S	25.1198	W
96	16/10/16	12:00	-18.5437	S	25.0947	W
97	16/10/16	18:00	-18.6877	S	25.0015	W
98	17/10/16	00:00	-19.7617	S	25.0068	W
99	17/10/16	06:00	-20.6717	S	25.0103	W
100	17/10/16	12:00	-27.3397	S	25.0130	W
101	17/10/16	18:00	-21.9315	S	25.0175	W

No	Date	Time (UTC)	Latitude	N pos	Longitude	W pos
102	18/10/16	00:00	-22.9870	S	25.0237	W
103	18/10/16	06:00	-23.7222	S	25.0132	W
104	18/10/16	12:00	-24.4652	S	25.0265	W
105	18/10/16	18:00	-25.3622	S	24.9532	W
106	19/10/16	00:00	-26.5007	S	24.6568	W
107	19/10/16	06:00	-27.3453	S	24.4330	W
108	19/10/16	12:00	-28.1035	S	24.2863	W
109	19/10/16	18:00	-28.7250	S	24.5710	W
110	20/10/16	00:00	-29.6987	S	25.0052	W
111	20/10/16	06:00	-30.3932	S	25.3243	W
112	20/10/16	12:00	-31.2290	S	25.6968	W
113	20/10/16	18:00	-31.9043	S	26.0060	W
114	21/10/16	00:00	-32.8923	S	26.4595	W
115	21/10/16	06:00	-33.6157	S	26.7962	W
116	21/10/16	12:00	-33.5710	S	27.1852	W
117	21/10/16	18:00	-34.8357	S	27.4542	W
118	22/10/16	00:00	-35.8308	S	27.8498	W
119	22/10/16	06:00	-35.4652	S	28.1392	W
120	22/10/16	12:00	-37.2575	S	28.4115	W
121	22/10/16	18:00	-37.9245	S	28.5323	W
122	23/10/16	00:00	-38.9597	S	28.5913	W
123	23/10/16	06:00	-39.7563	S	28.6808	W
124	23/10/16	12:00	-40.3957	S	28.7478	W
125	23/10/16	18:00	-41.0735	S	29.0938	W
126	24/10/16	00:00	-41.8492	S	29.4858	W
127	24/10/16	06:00	-42.4532	S	29.7900	W
128	24/10/16	12:00	-42.9705	S	30.0547	W
129	24/10/16	18:00	-43.5808	S	30.3730	W
130	25/10/16	00:00	-44.3390	S	30.7717	W
131	25/10/16	06:00	-44.9573	S	31.1128	W
132	25/10/16	12:00	-45.6655	S	31.4935	W
133	25/10/16	18:00	-46.1187	S	31.7538	W
134	26/10/16	00:00	-46.8948	S	32.1830	W
135	26/10/16	06:00	-47.4520	S	32.4973	W
136	26/10/16	12:00	-48.0810	S	32.8498	W
137	26/10/16	18:00	-48.5512	S	33.1167	W
138	27/10/16	00:00	-49.2942	S	33.5045	W
139	27/10/16	06:00	-49.7805	S	33.7843	W
140	27/10/16	12:00	-50.2652	S	34.0722	W
141	27/10/16	18:00	-50.5758	S	34.2597	W
142	28/10/16	00:00	-51.3463	S	34.7068	W
143	28/10/16	06:00	-51.8580	S	35.0180	W
144	28/10/16	12:00	-52.4437	S	35.3760	W

No	Date	Time (UTC)	Latitude	N pos	Longitude	W pos
145	28/10/16	18:00	-52.8503	S	35.6202	W
146	29/10/16	00:00	-53.4875	S	36.0212	W
147	29/10/16	06:00	-53.9307	S	36.3203	W
148	30/10/16	12:00	-54.1057	S	36.5417	W
149	30/10/16	18:00	-54.0612	S	37.1242	W
150	31/10/16	00:00	-53.7802	S	38.4423	W
151	31/10/16	06:00	-53.5902	S	39.9757	W
152	31/10/16	12:00	-53.4458	S	41.1318	W
153	31/10/16	18:00	-53.3072	S	42.3013	W
154	01/11/16	00:00	-53.1347	S	43.9430	W
155	01/11/16	06:00	-53.0123	S	45.0883	W
156	01/11/16	12:00	-52.8790	S	46.3467	W
157	01/11/16	18:00	-52.7193	S	47.8455	W

References:

Donlon ,CJ., I. Robinson, M. Reynolds, W. Wimmer, G. Fisher, R. Edwards, and T. Nightingale, 2008: An infrared sea surface temperature autonomous radiometer (ISAR) for deployment aboard volunteer observing ships (VOS). *J. Atmos. Oceanic Technol.*, 25, 93–113, doi:10.1175/2007JTECHO505.1.

Donlon ,CJ., W. Wimmer, I. Robinson, G. Fisher, M. Ferlet, T. Nightingale, and B. Bras, 2014: A second-generation blackbody system for the calibration and verification of sea- going infrared radiometers. *J. Atmos. Oceanic Technol.*, 31, 1104–1127, doi:10.1175/JTECH-D-13-00151.1.

Wimmer, W., I. Robinson, and C. Donlon, 2012: Long-term validation of AATSR SST data products using shipborne radiometry in the Bay of Biscay and English Channel. *Remote Sens. Environ.*, 116, 17–31, doi:10.1016/j.rse.2011.03.022.

Wimmer, W., and I. Robinson, 2016: The ISAR instrument uncertainty model. *J. Atmos. Oceanic Technol.* doi:10.1175/JTECH-D-16-0096.1, in press.

Fairall, C. W., Persson, P. O. G., Bradley, E. F., Payne, R. E. and Anderson, S. P. (1998); A newlook at calibration and use of Eppley Precision Infrared Radiometers. PartI: theory and application; *J. Atmos. Oceanic Technol.*; 15: pp. 1229 – 1242.

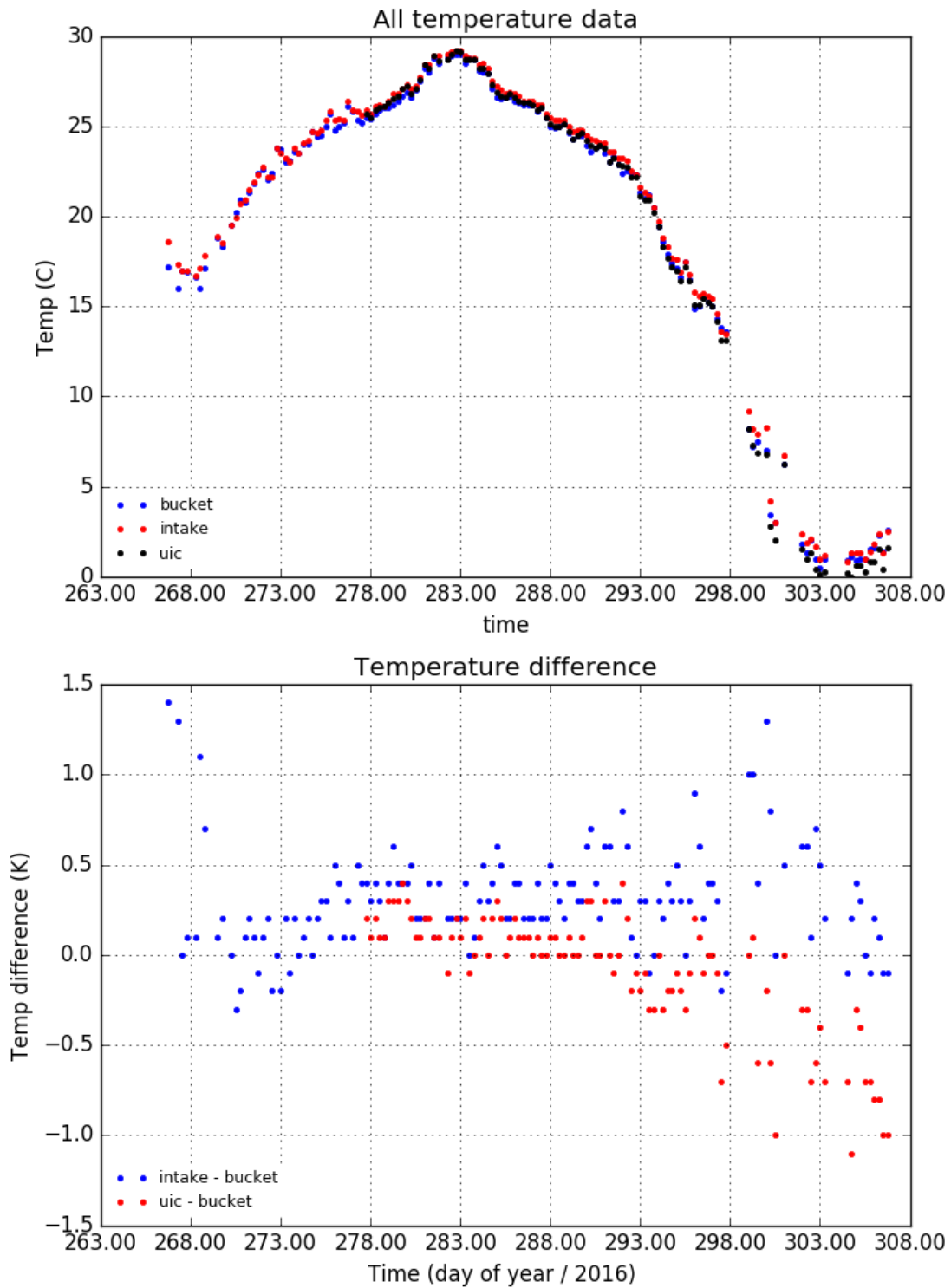


Figure 2: Data plot of the bucket temperatures collected together with the bridge SST temperature (labeled intake) and the underway system temperature (labeled uic). The bottom plot shows the difference between the bucket temperature and the bridge SST in blue and the bucket and the underway SST in red.

Weather balloon – AMT4SentinelFRM

Werenfrid Wimmer and Francesco Nencioli

University of Southampton and PML

Objectives

Collect lower atmosphere profiles to aid the atmospheric radio transfer models of the Sentinel 3 satellite sensors.

Method

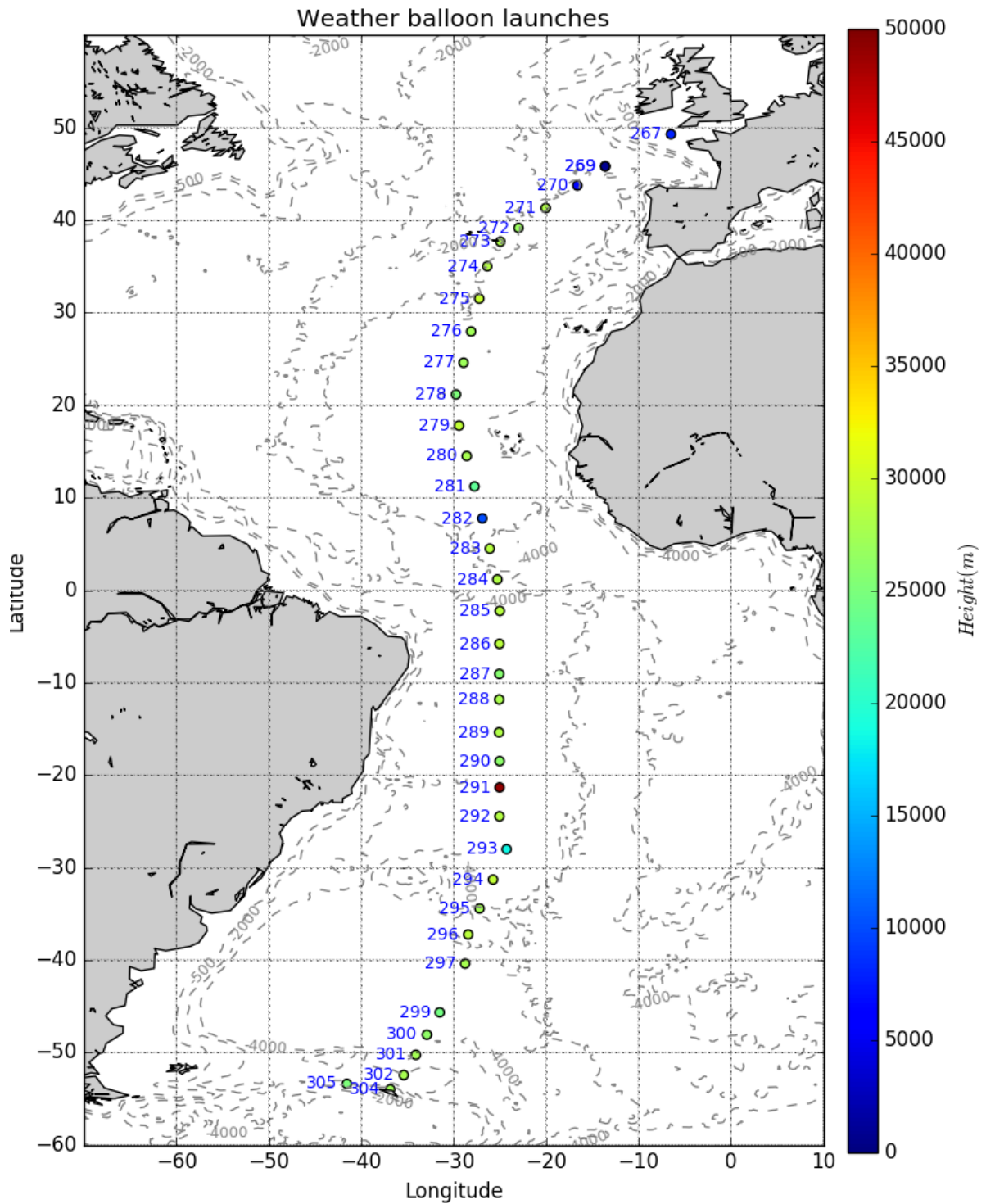
Weather balloons, measuring air pressure, humidity, air temperature, wind speed and direction were launched daily to collect information of the lower atmosphere composition. A total of 37 balloons were launched between 23.09 and 31.10.2016. The radiosondes used are Vaisala RS92, which were reconditioned before launch with the Vaisala GC25. A Vaisala Digicora II MW15 together with a dedicated BAS laptop was used as data receiving and storing device. The Balloons were inflated with He on the bridge deck in a BAS provided balloon cage for approximately 110s at 1bar. The balloons were either launched from the monkey island (4) or the rear end of the bridge deck (33) depending on win direction. Data was emailed post flight to the UK MetOffice with the send_temp_MW15.vi .

No	Date	Time (UTC)	Longitude W pos	Latitude N pos
1	23/09/16	16:00	6.4817	49.3117
2	25/09/16	10:00	13.5917	45.8367
3	25/09/16	10:00	13.5917	45.8367
4	26/09/16	10:00	16.6017	43.7600
5	27/09/16	10:00	20.0250	41.3217
6	28/09/16	10:10	22.9667	39.1717
7	29/09/16	12:46	24.9318	37.6932
8	30/09/16	12:47	26.3497	35.0218
9	01/10/16	12:51	27.2187	31.5267
10	02/10/16	12:58	28.0983	27.9727
11	03/10/16	12:58	28.9158	24.5903
12	04/10/16	12:48	29.7292	21.1657
	05/10/16	13:07	29.4080	17.7923
13	05/10/16	13:21	29.4080	17.7923
14	06/10/16	13:01	28.5697	14.5023
15	07/10/16	12:45	27.7338	11.2150
16	08/10/16	12:48	26.8827	7.7598
17	09/10/16	12:56	26.0800	4.4862
18	10/10/16	12:45	25.2587	1.1585
19	11/10/16	13:06	24.9925	-2.2512

No	Date	Time (UTC)	Longitude W pos	Latitude N pos
20	12/10/16	12:56	25.0268	-5.8110
21	13/10/16	11:46	25.0440	-9.0587
22	14/10/16	11:45	25.0523	-11.8293
23	15/10/16	12:46	25.0763	-15.3793
24	16/10/16	12:42	25.0078	-18.4973
25	17/10/16	11:28	25.0130	-21.3398
26	18/10/16	11:03	25.0265	-24.4652
27	19/10/16	10:55	24.2567	-28.0220
28	20/10/16	12:54	25.7240	-31.3058
29	21/10/16	11:34	27.1852	-34.4290
30	22/10/16	11:14	28.4178	-37.2443
31	23/10/16	10:41	28.7478	-40.3957
32	25/10/16	12:43	31.4945	-45.6657
33	26/10/16	12:51	32.8808	-48.0827
34	27/10/16	10:48	34.0702	-50.2633
35	28/10/16	12:44	35.3760	-52.4437
36	30/10/16	13:48	36.8423	-53.9957
37	31/10/16	13:44	41.5420	-53.3905



photo W. Wimmer



processed 20161102 (c) 2016 ISAR team - v1.0.0

Figure 3: Plot of the Balloon launch positions with day of year labels in blue. The colour of the circle represents the height above sea level at which the balloon burst.

C-band Radar - – AMT4SentinelIFRM

Werenfrid Wimmer

University of Southampton

Objectives

Collect sea state, surface roughness and wave information for the validation of the ESA Sentinel 3 satellite radar altimeter and the synthetic aperture radar on the ESA Sentinel 1 satellite.

Methods

The IFREMER shipborne C-band radar was mounted on the forward mast facing the port side of the ship at an angle of approximately 45 degrees horizontally. The radar's look angle at the sea surface is fixed at approximately 40 degrees. The radar instrument is viewing roughly the same patch of water the ISAR instrument is, but the two instruments have very different fields of view. The radar images have some contamination of the ship's gunwale in them, however this can be removed in post processing. Data were recorded every 20 minutes in the forecastle mail room on a dedicated IFREMER data logging computer. Data quality was checked during the cruise on a regular basis. GPS information was lost 20.10 and restored 21.10.2016 by restarting and powering down the C-band radar and logging system. Together with the C-band radar 480 camera images (over approximately 5 min) were collected every 20 min to help interpret the radar data. A total of

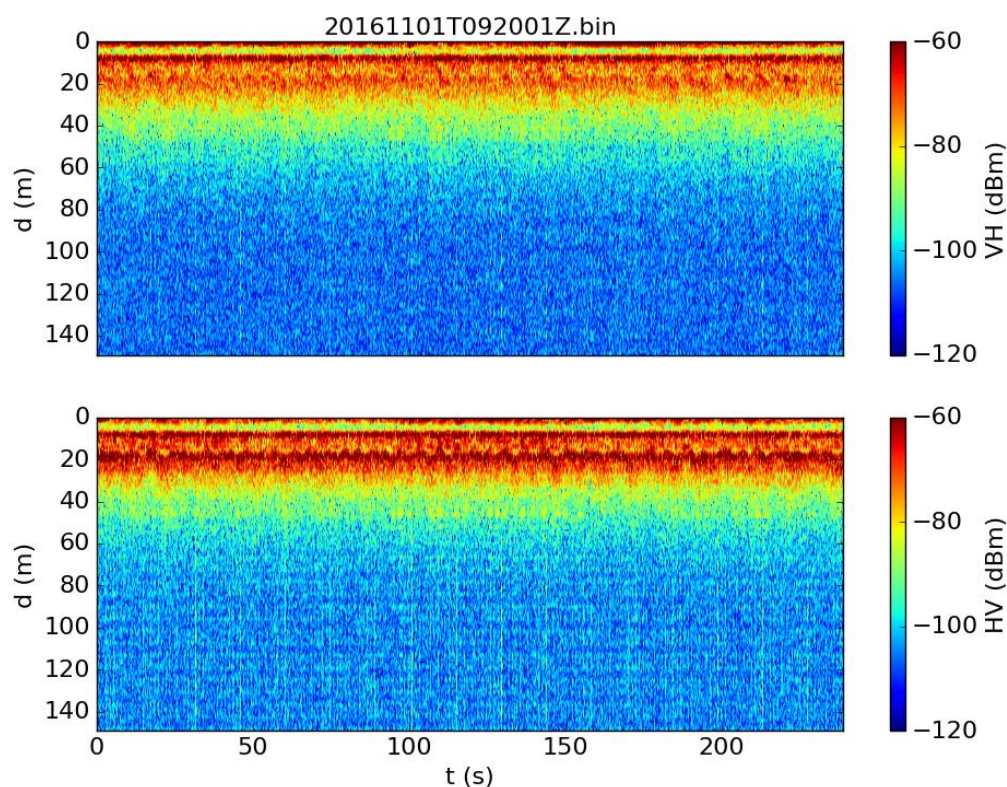


Figure 4: Example radar image from 1.11.2016 showing the vertical horizontal and horizontal vertical polarization data. The strong return at the top is the ship's gunwale.

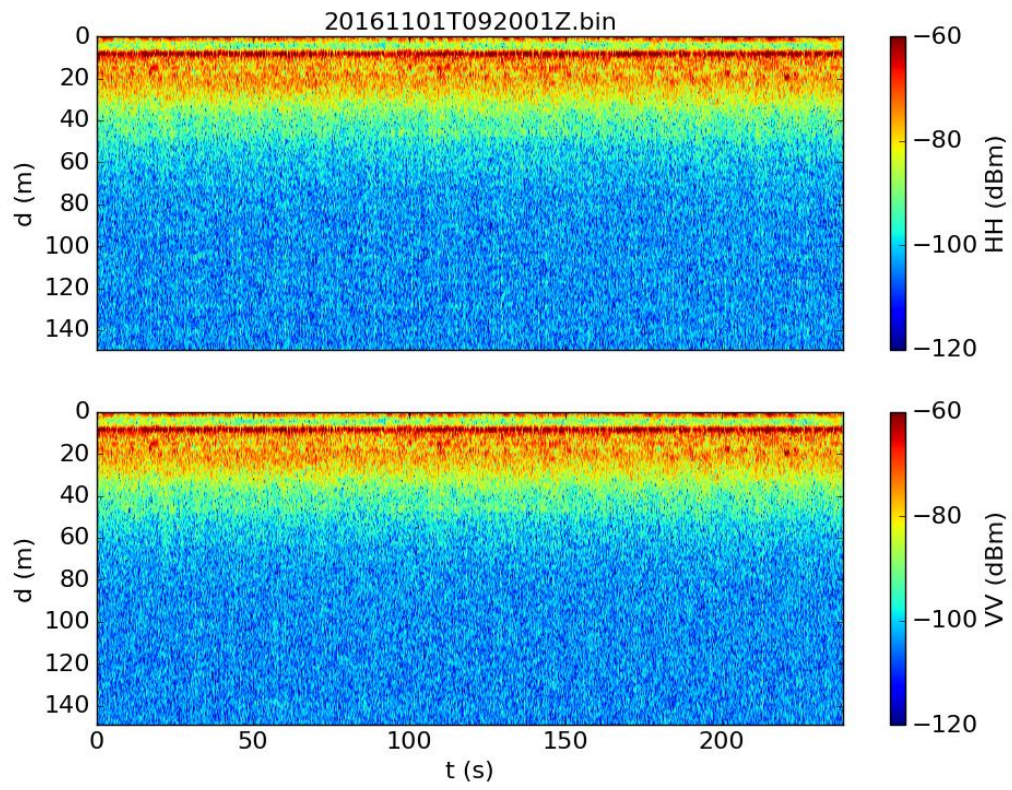


Figure 5: Example radar image from 1.11.2016 showing the vertical vertical and horizontal horizontal polarization data. The strong return at the top is the ships gunwale.

Dissolved Inorganic Nutrients

Carolyn Harris

Plymouth Marine Laboratory

OBJECTIVES:

To investigate the spatial and temporal variations of the micro-molar nutrient species Nitrate, Nitrite, Phosphate, and Silicate during the research cruise along the Atlantic Meridional Transect (AMT) cruise track, departing from Immingham, UK and sailing through the North Atlantic Gyre (NAG), south to the equator, through the South Atlantic Gyre (SAG), before turning south-west to end the cruise at Port Stanley Falkland Islands.

SAMPLING and METHODOLOGY

Micro-molar nutrient analysis was carried out using a 4 channel (nitrate (Brewer & Riley, 1965), nitrite (Grasshoff, K., 1976), phosphate, silicate (Kirkwood, D.S., 1989) . Bran & Luebbe AAll segmented flow, colourimetric, auto-analyser. Established, proven analytical protocols were used.

Water samples were taken from a 24 x 20 litre bottle stainless steel framed CTD / Rosette system (Seabird), typically every unique depth was sampled from each CTD cast. These were sub-sampled into clean (acid-washed) 60ml HDPE (Nalgene) sample bottles, which were rinsed x3 with sample seawater prior to filling.

CTD SAMPLES ANALYSED

A total of 74 vertical profiles were analysed along the axis of the AMT and the niskin bottles sampled and locations are listed detail in the table below.

Table 1: AMT 26 - Station & CTD Sampling Summary

Station	CTD	Lat (°N)	Lon (°W)	Time	Date	Niskin bottles sampled
002	002	46°22.895	12°41.697	04:07	25/09	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,23,24
004	004	45°39.996	13°58.680	13:20	25/09	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
007	007	43°31.454	16°57.704	13.05	26/09	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
008	008	41°47.051	19°23.145	04:00	27/09	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
010	010	41°11.177	20°13.931	13:29	27/09	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,2142,23,24
011	011	39°42.581	22°15.488	04:00	28/09	1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,17,18,19,20,21,22
014	013	37°39.556	24°54.510	04:17	29/09	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
015	014	37°41.594	24°55.908	12:43	29/09	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
016	015	36°7.748	26°4.441	04:29	30/09	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
017	016	35°1.306	26°20.985	12:26	30/9	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
018	017	32°30.823	26°59.323	04:33	01/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
019	018	31°31.604	27°13.119	12:27	01/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24

Station	CTD	Lat (°N)	Lon (°W)	Time	Date	Niskin Bottles sampled
020	019	29°9.625	27°49.922	04:29	02/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
021	020	27°58.356	28°05.904	12:28	02/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
022	021	25°23.168	28°44.668	05:29	03/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
023	022	24°35.423	28°54.933	12:28	03/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
024	023	22°3.518	29°31.453	05:29	04/10	1,2,3,4,5,6,7,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
025	024	21°9.944	29°43.752	12:25	04/10	1,2,3,4,5,6,7,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
026	025	18°42.023	29°39.719	05:27	05/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
027	026	17°47.505	29°24.462	12:30	05/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
028	027	15°16.465	28°47.052	05:32	06/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
029	028	14°30.122	28°34.196	12:28	06/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
030	029	11°57.854	27°57.374	05:29	07/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
031	030	11°12.882	27°44.113	12:29	07/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
032	031	8°41.857	27°8.207	05:24	08/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,22,21,22,23,24,
033	032	7°45.602	26°52.984	12:28	08/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
034	033	5°12.070	26°16.488	05:28	09/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,1,8,19,20,21,22,23,24
035	034	4°29.169	26°4.804	12:29	09/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
036	035	1°58.486	25°28.981	05:24	10/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,,21,22,23,24
037	036	1°9.504	25.15580	12:40	10/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
Station	CTD	Lat (°S)	Lon (°W)	Time	Date	Niskin bottles sampled
038	037	1°24.910	25°0.287	05:24	11/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
039	038	2°15.096	24°59.556	12:34	11/10	7,8,9,10,11,12,15,16,17,18,19,20,21
040	039	4°49.772	25°1.260	05:25	12/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
041	040	5°48.660	25°1.617	12:28	12/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
042	041	8°22.589	25°2.454	05:24	13/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
043	042	9°3.514	25°2.650	11:19	13/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
044	043	11°49.410	25°3.798	05:26	14/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
044	044	11°49.748	25°3.118	12:56	14/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
045	045	14°26.911	25°4.549	05:34	15/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
Station	CTD	Lat (°S)	Lon (°W)	Date	Time	Niskin bottles sampled

046	046	15°22.761	25°4.580	12:31	15/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
047	047	18°15.557	25°7.196	05:25	16/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
050	048	20°40.305	25°0.624	05:21	17/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
051	049	21°20.372	25°0.753	12:40	17/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
052	050	23°43.832	25°1.464	04:24	18/10	1,2,3,4,5,6,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
053	051	24°27.916	25°1.585	11.10	18/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
054	052	27°16.246	24°27.036	04:28	19/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
056	053	28°9.167	24°17.778	12:29	19/10	1,2,3,4,5,6,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
057	054	30°23.076	25°18.758	04:32	20/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
058	055	31°18.241	25°43.567	12:34	20/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
059	056	33°35.038	26°46.954	04:35	21/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
060	057	34°25.737	27°11.115	12:29	21/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
061	058	36°31.513	28°8.950	04:28	22/10	1,2,3,4,5,6,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
063	059	37°19.955	28°26.026	12:35	22/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
064	060	39°42.118	28°40.044	04:27	23/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
065	061	40°23.738	28°44.873	10:47	23/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
066	062	44°54.691	31°4.788	04:33	25/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
067	063	45°39.936	31°.29.66 8	12:26	25/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
068	064	47°26.862	32°29.135	04:25	26/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
069	065	48°4.951	32°52.185	12:55	26/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
070	066	49°46.590	33°46.990	04:48	27/10	1,2,3,4,5,6,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
072	067	50°17.287	34°5.208	13:53	27/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
074	069	52°26.723	35°22.509	12:46	28/10	1,2,3,4,5,6,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
075	070	53°56.232	36°18.156	04:23	29/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
076	071	53°59.781	36°50.459	13:40	30/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
077	072	53°35.417	39°58.542	05:30	31/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
078	073	53°23.515	41°32.365	13:41	31/10	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24
079	074	53°0.738	45°5.298	05:25	01/11	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24

References:

- Brewer & Riley, 1965. The automatic determination of nitrate in seawater. *Deep Sea Research*, 12: 765-772
- Grasshoff, K., 1976. Methods of sea-water analysis, *Verlag Chemie*, Weheim: pp.317.
- Kirkwood, D.S. 1989. Simultaneous determination of selected nutrients in sea-water, *ICES CM* 1989/C:29

Acknowledgements:

I would like to thank colleagues, officers and crew on the RRS James Clarke Ross for making it a pleasant and rewarding trip.

Colour Dissolved Organic Matter

Francesco Nencioli and Giorgio Dall’Olmo

Plymouth Marine Laboratory

Objectives

- To determine horizontal and vertical variability of the absorption spectra of coloured dissolved organic matter (CDOM) along the AMT26 transect from surface to 200 m depth.
- To use the CDOM measurements from discrete water samples as a baseline for correcting the continuous measurements from the Optics Rig and Underway system.
- To assess the quality of the on-board milliQ water through daily comparison with a pure water standard.

Methods

CDOM measurements were collected with a spectrophotometric system which included: a deuterium-halogen light source DH-2000-BAL from Micropak; a 100 cm-pathlength liquid waveguide capillary cell (3000 series) from World Precision Instruments ; a USB 2000+ fiber optic spectrometer from Ocean Optics Inc.; two optical fibers from Ocean Optics Inc. connecting the light source to the waveguide cell and the waveguide cell to the spectrometer. Absorption spectra were collected from 350 to 750 nm in wavelength) with a resolution of roughly 0.3 nm. Water samples were directly collected from the CTD and the underway systems in 0.1 L amber bottles and analysed onboard within few hours from collection. To minimize possible temperature artifacts in the measurements, the samples were kept in a water bath between collection and analysis. CTD samples were generally collected at 5 depths between the surface and 200 m. Underway samples were generally collected twice a day, at the time of the CTD cast and in the evening. For each bottle we analysed 3 samples. Each sample was injected in the waveguide using a 10 mL syringe and a 0.2 µm filter. For each sample, 20 spectra were recorded at a frequency of roughly 1 Hz, and then averaged together. This was necessary since the system showed significant sensitivity due to ship rolling in the visible portion of the spectra.

Our measurements required spectra of pure water and pure seawater to be used as baseline and blank respectively. Spectra of pure water were collected before and after each bottle measurements using the milliQ water produced on board. Its quality was checked on a daily basis by comparison with HPLC grade water from Fisher Scientific at the beginning and at the end of each cycle of analysis. Pure seawater at 36 psu was produced each day before the analysis using 100 mL of milliQ water and 3.6 g of NaCl from Fisher Scientific, previously combusted at 450°C for 4 hours to remove impurities. Pure seawater spectra were collected at the beginning and at the end of each cycle of analysis.

The final spectra were obtained by first smoothing the observed spectra with a Gaussian moving average window with a width of roughly 6 nm. Pure water and seawater spectra were then subtracted to remove instrument drift and salt effects. Finally, any offset in the absolute values of the spectra was removed by setting the absorption at 550 nm to 0.

Table 1. Time and depth of CTD and Underway samples for CDOM measurements on AMT26

Date	Time (UTC)	Type	Number	Depth	Bottle#
2016-10-06	12:28	CTD	28	200	7
	12:28	CTD	28	150	9
	12:28	CTD	28	80	12
	12:28	CTD	28	30	15
	12:28	CTD	28	5	24
	13:22	Und	23	5	--
	16:09	Und	24	5	--
2016-10-07	09:09	Und	25	5	--
	12:29	CTD	30	200	7
	12:29	CTD	30	150	9
	12:29	CTD	30	80	12

Date	Time (UTC)	Type	Number	Depth	Bottle#
	12:29	CTD	30	45	15
	12:29	CTD	30	5	24
	12:54	Und	26	5	--
2016-10-08	12:28	CTD	32	200	7
	12:28	CTD	32	150	9
	12:28	CTD	32	80	12
	12:28	CTD	32	56	14
	12:28	CTD	32	5	24
	13:08	Und	27	5	--
2016-10-09	17:00	Und	28	5	--
	12:29	CTD	34	200	7
	12:29	CTD	34	150	9
	12:29	CTD	34	72	13
	12:29	CTD	34	60	15
	12:29	CTD	34	5	24
2016-10-10	13:17	Und	29	5	--
	18:07	Und	30	5	--
	12:40	CTD	36	200	7
	12:40	CTD	36	150	9
	12:40	CTD	36	67	13
	12:40	CTD	36	60	15
2016-10-11	12:40	CTD	36	5	24
	12:55	Und	31	5	--
	17:05	Und	32	5	--
	06:16	Und	33	5	--
	09:50	Und	34	5	--
	12:05	Und	35	5	--
2016-10-12	12:28	CTD	40	200	7
	12:28	CTD	40	150	9
	12:28	CTD	40	93	12
	12:28	CTD	40	60	15
	12:28	CTD	40	5	24
	13:22	Und	36	5	--
2016-10-13	17:08	Und	37	5	--
	11:19	CTD	42	200	7
	11:19	CTD	42	150	9
	11:19	CTD	42	120	10
	11:19	CTD	42	70	15
	11:19	CTD	42	5	24
2016-10-14	11:47	Und	38	5	--
	16:16	Und	39	5	--
	12:10	Und	40	5	--
	12:56	CTD	44	200	7
	12:56	CTD	44	140	10
	12:56	CTD	44	105	13
2016-10-15	12:56	CTD	44	70	15
	12:56	CTD	44	5	24
	17:03	Und	41	5	--
	12:31	CTD	46	200	7
	12:31	CTD	46	155	10
	12:31	CTD	46	120	13
	12:31	CTD	46	80	15
	12:31	CTD	46	5	24

Date	Time (UTC)	Type	Number	Depth	Bottle#
2016-10-17	13:05	Und	42	5	--
	17:04	Und	43	5	--
	12:37	Und	43b	5	--
	12:40	CTD	49	200	5
	12:40	CTD	49	149	9
	12:40	CTD	49	120	12
2016-10-18	12:40	CTD	49	80	14
	12:40	CTD	49	5	24
	16:45	Und	44	5	--
	10:38	Und	44b	5	--
	11:10	CTD	51	200	7
	11:10	CTD	51	150	9
2016-10-19	11:10	CTD	51	125	10
	11:10	CTD	51	5	24
	16:35	Und	45	5	--
	12:29	CTD	53	200	5
	12:29	CTD	53	135	9
	12:29	CTD	53	117	11
2016-10-20	12:29	CTD	53	90	14
	12:29	CTD	53	5	24
	13:17	Und	46	5	--
	17:02	Und	47	5	--
	12:34	CTD	55	200	7
	12:34	CTD	55	100	10
2016-10-21	12:34	CTD	55	76	13
	12:34	CTD	55	60	15
	12:34	CTD	55	5	24
	13:58	Und	48	5	--
	17:05	Und	49	5	--
	11:45	Und	50	5	--
2016-10-22	12:29	CTD	57	200	5
	12:29	CTD	57	100	10
	12:29	CTD	57	70	12
	12:29	CTD	57	53	14
	12:29	CTD	57	5	24
	12:55	Und	51	5	--
2016-10-23	12:55	Und	52	5	--
	12:55	Und	53	5	--
	17:19	Und	54	5	--
	10:40	Und	55	5	--
	12:35	CTD	59	200	7
	12:35	CTD	59	100	10
2016-10-23	12:35	CTD	59	50	13
	12:35	CTD	59	30	17
	12:35	CTD	59	5	24
	17:05	Und	56	5	--
	17:18	Und	57	5	--
	10:47	CTD	61	200	4
2016-10-23	10:47	CTD	61	100	9
	10:47	CTD	61	60	12
	10:47	CTD	61	50	14
	10:47	CTD	61	5	24
	11:07	Und	58	5	--

Date	Time (UTC)	Type	Number	Depth	Bottle#	
	16:35	Und	59	5	--	
2016-10-25	04:07	Und	60	5	--	
	04:23	Und	61	5	--	
	12:26	CTD	63	200	6	
	12:26	CTD	63	100	9	
	12:26	CTD	63	75	13	
	12:26	CTD	63	30	17	
	12:26	CTD	63	5	24	
	12:58	Und	62	5	--	
	17:09	Und	63	5	--	
	2016-10-26	12:54	CTD	65	200	5
12:54		CTD	65	100	9	
12:54		CTD	65	60	13	
12:54		CTD	65	40	16	
12:54		CTD	65	5	24	
13:32		Und	64	5	--	
17:41		Und	65	5	--	
2016-10-27		11:48	Und	66	5	--
		13:28	Und	67	5	--
		13:53	CTD	67	200	5
	13:53	CTD	67	100	9	
	13:53	CTD	67	75	12	
	13:53	CTD	67	40	16	
	13:53	CTD	67	5	24	
	17:23	Und	68	5	--	
2016-10-28	12:46	CTD	69	200	5	
	12:46	CTD	69	125	9	
	12:46	CTD	69	75	13	
	12:46	CTD	69	40	16	
	12:46	CTD	69	5	24	
	13:13	Und	69	5	--	
	18:23	Und	70	5	--	
	2016-10-30	13:40	CTD	71	150	5
13:40		CTD	71	85	8	
13:40		CTD	71	65	12	
13:40		CTD	71	40	16	
13:40		CTD	71	5	24	
14:01		Und	71	5	--	
22:27		Und	72	5	--	

Dissolved Oxygen

Kerri Coombes

Plymouth Marine Laboratory & University of Plymouth

Background:

Dissolved Oxygen (O₂) in seawater is produced by photosynthesis and consumed by respiration and photochemical reactions in the surface. Equilibrium between dissolved O₂ in seawater and the atmosphere is maintained through air-sea gas exchange. The aim of this work was to calibrate the O₂ sensor on the depth profiler.

Methods:

Dissolved O₂ was determined by automated Winkler titration with photometric end-point detection (Carritt and Carpenter 1966). The concentration of thiosulphate was calibrated every 4-5 days. Gross community production and respiration experiments were carried out according to Robinson et al. (2002).

Seawater samples were collected daily from the afternoon depth profile (2-8 depths), fixed and analysed for O₂ for the calibration of the O₂ sensor on the depth profiler.

Results:

The concentration of O₂ was determined by Winkler titration in 328 discrete samples for the calibration of the O₂ sensor on the depth profiler (Table 1).

Table 2: Samples collected from CTD hydrocast that were analysed.

CTD	DATE	LAT	LONG	NISKINS	DEPTH (m)
JR16001-007	26/09/16	43.52°N	16.96°W	7,12,24	200,68,5
JR16001-008	27/09/16	41.78°N	19.39°W	1,8,12,23	500,100,60,5
JR16001-010	27/09/16	41.19°N	20.23°W	1,18	500,20
JR16001-011	28/09/16	39.71°N	22.26°W	2,6,21	200,100,5
JR16001-013	29/09/16	37.66°N	24.91°W	1,4,8,12,15,23	500,200,100,55,25,5
JR16001-014	29/09/16	37.69°N	24.93°W	1,6	500,200
JR16001-015	30/09/16	36.13°N	26.07°W	1,4,8,15,23	500,200,110,40,5
JR16001-016	30/09/16	35.02°N	26.35°W	1,4,8,15,23	500,200,110,40,5
JR16001-017	01/10/16	32.51°N	26.99°W	1,9,15,23	500,100,45,5
JR16001-018	01/10/16	31.53°N	27.22°W	1,6,11,15,24	500,200,105,30,5
JR16001-019	02/10/16	29.16°N	27.83°W	8,23	126,5
JR16001-020	02/10/16	27.97°N	28.10°W	7,12,24	200,110,5
JR16001-021	03/10/16	25.39°N	28.74°W	1,4,8,13,23	500,200,124,55,5
JR16001-022	03/10/16	24.59°N	28.92°W	6,8,11,15,17,24	200,160,111,30,20,5
JR16001-023	04/10/16	22.06°N	29.52°W	1,4,9,13,23	500,200,100,45,5
JR16001-024	04/10/16	29.73°N	21.17°W	1,12,16,18	500,101,30,20
JR16001-025	05/10/16	18.70°N	29.66°W	3,5,9,14,17,19,24	375,200,125,53,30,20,5
JR16001-026	05/10/16	17.79°N	29.41°W	1,6,14,19	500,200,60,10
JR16001-027	06/10/16	15.27°N	28.78°W	4,7,16,18,24	200,125,30,20,5
JR16001-028	06/10/16	14.50°N	28.57°W	5,7,18,24	300,200,20,5
JR16001-029	07/10/16	11.96°N	27.96°W	1,4,6,10,16,24	500,375,200,100,47,5
JR16001-030	07/10/16	11.21°N	27.74°W	7,9,18,20,24	200,150,30,10,5
JR16001-031	08/10/16	8.70°N	27.14°W	13,16,18,24	52,25,20,5

CTD	DATE	LAT	LONG	NISKINS	DEPTH (m)
JR16001-032	08/10/16	7.76°N	26.88°W	1, 9,18,24	500,150,30,5
JR16001-033	09/10/16	5.20°N	26.27°W	1,4,6,10,19,24	500,40,200,100,25,5
JR16001-034	09/10/16	4.49°N	26.08 °W	7,13,15,20,24	200,72,60,10,5
JR16001-035	10/10/16	1.97°N	25.48 °W	15,18,24	60,20,5
JR16001-036	10/10/16	1.16°N	25.26 °W	5,9,13,15,20,24	300,150,67,60,10,5
JR16001-037	11/10/16	1.42°S	25.005°W	1,4,18,24	500,400,20,5
JR16001-039	12/10/16	4.83°S	25.02°W	11,16,18,24	83,25,15,5
JR16001-040	12/10/16	5.81°S	25.03°W	1,5,7,9,18,20,24	500,300,200,150,20,10,5
JR16001-041	13/10/16	5.38°S	25.04°W	1,4,6,15,24	500,300,175,50,5
JR16001-042	13/10/16	9.06°S	25.04°W	7,15,20,24	200,70,10,5
JR16001-043	14/10/16	11.82°S	25.06°W	3,10,14,18,20,24	400,148,90,30,15,5
JR16001-044	14/10/16	11.83°S	25.05°W	1,5,7,10,20,24	500,300,200,180,10,5
JR16001-045	15/10/16	14.45°S	25.07°W	1,6,10,12,15,19,24	500,180,130,105,70,20,5
JR16001-046	15/10/16	15.38°S	25.08°W	5,7,10,18,20	300,200,155,20,10
JR16001-047	16/10/16	18.26°S	25.12°W	1,4,5,11,15,17,20,24	500,400,300,162,95,55,15,5
JR16001-048	17/10/16	20.67°S	25.01°W	1,3,4,10,15,17,20	500,400,300,152,95,55,15
JR16001-049	17/10/16	21.34°S	25.01°W	1,3,14,17,19,24	300,200,80,20,10,5
JR16001-050	18/10/16	23.73°S	25.02°W	2,5,10,20	400,200,135,15
JR16001-050	18/10/16	23.73°S	25.02°W	2,5,10,20	400,200,135,15
JR16001-051	18/10/16	24.47°S	25.02°W	1,8,11,24	500,175,125,5
JR16001-052	19/10/16	27.27°S	24.45°W	1,3,5,15,17,20	500,300,200,70,50,20
JR16001-053	19/10/16	28.15°S	24.30°W	1,3,5,8,17,24	500,300,200,150,30,5
JR16001-054	20/10/16	30.38°S	25.31°W	2,10,15,20,24	400,117,70,15,5
JR16001-055	20/10/16			1,13,15,19	500,76,60,15
JR16001-056	21/10/16	33.58°S	26.78 °W	2,13,20,24	400,90,15,5
JR16001-057	21/10/16	34.43°S	27.19°W	1,5,8,12,14,24	500,200,150,70,53,5
JR16001-058	22/10/16	36.53°S	28.15°W	3,5,9,11,15,20,24	300,200,100,80,60,15,5
JR16001-059	22/10/16	37.33°S	28.43°W	3,7,8,16,19,20,24	400,200,150,40,15,10,5
JR16001-060	23/10/16	39.70°S	28.67°W	1,3,5,9,11,16	500,300,200,100,80,50
JR16001-061	23/10/16	40.40°S	28.75°W	3,14,19,24	300,50,10,5
JR16001-062	25/10/16	44.91°S	31.08°W	3,17	300,40
JR16001-063	25/10/16	45.67°S	31.49°W	1,4,6,19,24	500,300,200,15,5
JR16001-064	26/10/16	47.45°S	32.49°W	9,11,24	100,70,5
JR16001-065	26/10/16	48.83°S	32.87°W	1,3,5,7,13,17,19	500,300,200,150,60,30,15
JR16001-066	27/10/16	49.78°S	33.78°W	1,3,4,14,17,20	500,400,300,75,40,15
JR16001-067	27/10/16	50.29°S	34.09°W	1,5,17,19,24	500,200,30,15,5
JR16001-069	28/10/16	52.45°S	35.38°W	3,9,11,13,24	300,125,105,75,5
JR16001-070	29/10/16	55.94°S	36.30°W	14,19	60,15
JR16001-071	30/10/16	54.00°S	36.84°W	2,4,12,17,19,24	200,175,65,30,15,5
JR16001-072	31/10/16	53.59°S	39.98°W	1,11,14,20,24	500,80,45,15,5
JR16001-073	31/10/16	53.39°S	41.54°W	1,3,5,12,17,19,24	500,300,200,75,30,15,5
JR16001-074	01/11/16	53.01°S	45.09°W	4,6,14,20,21,24	300,200,50,15,10,5

References:

Carritt, D. E., and J. H. Carpenter. 1966. Comparison and evaluation of currently employed modifications of the Winkler method for determining dissolved oxygen in seawater; a NASCO Report. *J. Mar. Res.* **24**: 286-319.

Carbonate System: Total Alkalinity (A_T) and pH

Kerri Coombes

Plymouth Marine Laboratory & University of Plymouth

Rationale and Method

Dissolved CO_2 reacts with water to form carbonic acid (H_2CO_3). H_2CO_3 dissociates to bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) with the concomitant release of H^+ , causing a reduction in pH. Total alkalinity (A_T) of seawater describes the sum of all ionic charges in seawater, including HCO_3^- , CO_3^{2-} , H^+ , inorganic and organic ions. Samples for the determination of A_T and pH_T (measured on the total scale) were collected in order to constrain the carbonate system along the cruise track. These samples are complemented by underway surface measurements of CO_2 partial pressure (pCO_2) measured with the PML, *Live-pCO₂* system. These measurements will contribute to our understanding of the distribution of C sources and sinks in the Atlantic Ocean and the capacity of the ocean to take up anthropogenic CO_2 .

Table 1 lists cast numbers and Niskin bottle numbers for all pH samples collected and analysed. A_T samples were collected in 250 mL borosilicate glass bottles with glass stoppers (Schott, Duran) and preserved with HgCl_2 until analysis at PML (100 μL of saturated HgCl_2 added). A minimum of two samples per cast were taken at the surface and DCM. The glass stoppers were greased with Apiezon-M grease.

The pH_T method employed here has typical precision in the low 10^{-3} to 10^{-4} pH-unit range. Samples were collected in 500 mL amber glass bottles and placed in a water bath at 25 °C. pH_T was determined spectrophotometrically using the m-cresol-purple dye (Dickson et al., 2007). The dye has two absorbance maxima at 434 nm and 578 nm, the ratio of which is pH-, T- and salinity-dependent. Absorbance measurements of the seawater blank, and following addition of dye (100 μL of a 2 mmol L^{-1} solution), were carried out on a Perkin Elmer, lamda 35 spectrophotometer, using 10 cm cells. The temperature of the sample was recorded in the spectrophotometer cell with a NIST-traceable thermometer. pH_T measurements were corrected for the pH_T change due to the addition of dye according to Dickson et al. (2007). Figure 1 shows preliminary data for pH_T along-track for AMT 24 (JR303) (stations 1-70). Final quality controlled A_T and pH_T data will be submitted to BODC within 12 months.

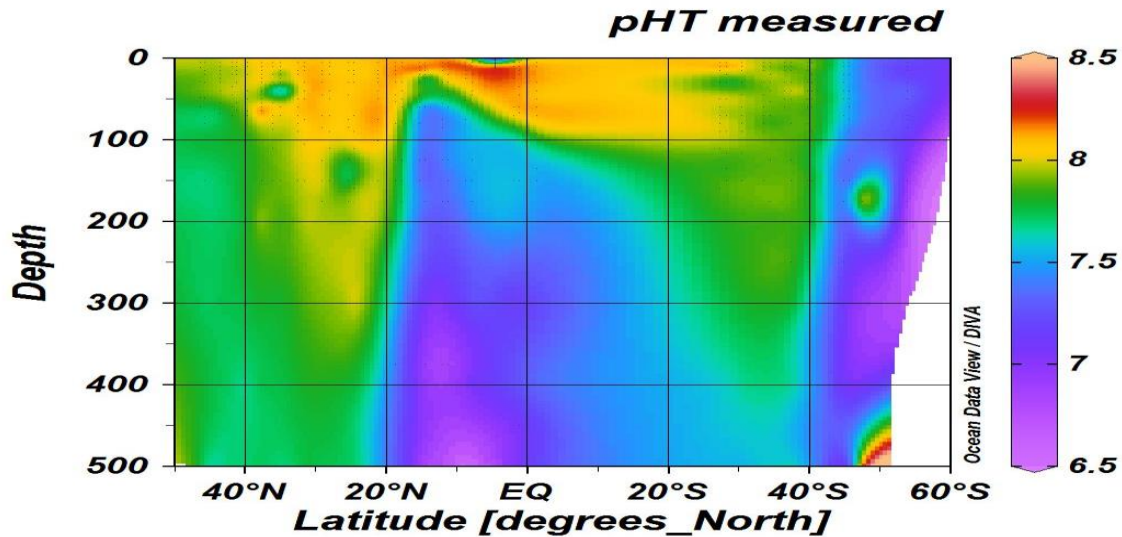


Figure 1: Preliminary pH_T data along-track for AMT 26 (JR16001). Dots show samples location.

Table 3: Samples collected from CTD hydrocast.

CTD	DATE	LAT	LONG	NISKINS	DEPTH
002	25/09/16	46.38°N	12.69°W	1,3,4,5,10,12,16,18,21,23	500,400,300,200,100,60,48,29,12,5
004	25/09/16	46.67°N	13.98°W	1,3,6,8,11,13,16,18,19,20,24	500,300,200,150,80,72,49,30,20,15,5
007	26/09/16	43.52°N	16.96°W	1,4,12,14,15,16,17,18,19,20,24	500,300,68,55,40,30,25,20,15,10,5
008	27/09/16	41.78°N	19.39°W	1,2,3,4,8,10,12,13,14,17,22,23	500,400,300,200,100,70,60,45,35,20,10,5
010	27/09/16	41.19°N	20.23°W	1,4,5,7,10,12,14,16,18,19,20,24	500,400,300,200,100,64,55,30,20,15,10,5
011	28/09/16	39.71°N	22.26°W	1,2,6,8,10,11,12,15,20,21	400,200,100,70,65,50,40,20,10,5
013	29/09/16	37.66°N	24.91°W	1,2,3,4,6,8,10,12,13,14,15,17,20,22,23	500,400,300,200,150,100,65,55,50,30,25,20,15,10,5
014	29/09/16	37.69°N	24.93°W	1,3,4,6,8,9,11,13,14,15,17,18,19,24	500,400,300,200,150,100,60,50,40,30,20,15,10,5
015	30/09/16	36.13°N	26.07°W	1,2,3,4,6,8,10,12,13,14,16,19,21,23	500,400,300,200,150,110,87,80,70,55,30,20,10,5
016	30/09/16	35.02°N	26.35°W	1,4,5,7,9,10,12,14,15,16,17,18,19,20,24	500,400,300,200,150,100,70,60,40,30,25,15,10,5
017	01/10/16	32.51°N	26.99°W	1,2,3,4,6,9,10,11,12,13,14,20,22,23	500,400,300,200,150,100,90,80,70,60,50,20,15,5
018	01/10/16	31.53°N	27.22°W	1,3,4,6,8,9,12,13,14,15,18,19,23	500,400,300,200,150,105,75,50,40,30,15,10,5
019	02/10/16	29.16°N	27.83°W	1,2,4,5,7,8,10,11,12,14,16,18,20,23	500,400,200,175,150,126,100,85,70,45,30,20,15,5
020	02/10/16	27.97°N	28.10°W	1,5,7,9,12,13,14,15,16,18,20,24	500,300,200,150,110,90,70,50,40,20,10,5
021	03/10/16	25.39°N	28.74°W	1,2,3,4,5,6,8,10,11,12,14,16,20,23	500,400,300,200,175,150,124,100,85,75,45,30,15,5
022	03/10/16	24.59°N	28.92°W	1,3,4,6,8,11,12,13,15,17,18,24	500,400,300,200,160,111,90,70,30,20,15,5

CTD	DATE	LAT	LONG	NISKINS	DEPTH
024	04/10/16	29.73°N	21.17°W	1,5,7,9,12,13,14,15,16,17,18,19,24	500,300,200,150,101,75,50,40,30,25,20,15,5
025	05/10/16	18.70°N	29.66°W	1,3,4,5,7,9,10,11,14,15,17,19,20,21,24	500,375,200,150,125,100,80,53,45,30,20,15,10,5
026	05/10/16	17.79°N	29.41°W	1,5,6,7,8,9,10,12,14,15,16,17,19,24	500,300,200,175,150,125,100,78,60,50,40,30,10,5
027	06/10/16	15.27°N	28.78°W	1,3,4,6,7,8,9,10,13,14,16,18,19,20,24	500,300,200,150,125,100,80,60,54,45,30,20,15,10,5
028	06/10/16	14.50°N	28.57°W	1,4,5,7,8,10,13,15,17,18,19,20,24	500,375,300,200,175,125,60,30,25,20,15,10,5
029	07/10/16	11.96°N	27.96°W	1,4,5,6,7,9,10,11,12,13,16,19,20,21,24	500,375,300,200,175,125,100,85,75,55,47,30,15,10,5
030	07/10/16	11.21°N	27.74°W	1,4,5,7,8,9,10,11,13,15,17,18,19,20,24	500,375,300,200,175,150,125,100,60,45,40,30,20,10,5
031	08/10/16	8.70°N	27.14°W	1,3,4,6,8,10,13,16,18,19,20,24	500,300,200,150,100,75,52,25,20,15,10,5
032	08/10/16	7.76°N	26.88°W	1,4,5,7,8,9,10,11,14,16,17,18,19,20,24	500,400,300,200,175,150,125,100,56,45,40,30,20,10,5
034	09/10/16	4.49°N	26.08 °W	1,4,5,7,9,11,13,15,17,18,19,20,24	500,400,300,200,150,100,72,60,35,20,15,10,5
035	10/10/16	1.97°N	25.48 °W	3,5,7,9,10,13,15,18,20,24	300,200,150,100,85,70,60,25,10,5
036	10/10/16	1.16°N	25.26 °W	1,3,4,5,7,9,11,13,15,16,18,19,20,24	500,450,300,200,150,100,67,60,45,35,20,15,10,5
037	11/10/16	1.42°S	25.005°W	1,4,5,6,8,9,10,13,14,15,16,17,18,21,24	500,400,300,200,150,135,100,92,70,60,50,40,30,10
039	12/10/16	4.83°S	25.02°W	1,2,3,4,5,6,7,11,12,13,14,16,18,19,24	500,400,300,200,175,150,125,83,75,60,50,25,15,10,5
040	12/10/16	5.81°S	25.03°W	1,4,5,7,8,9,10,12,14,15,16,17,18,20,24	500,400,300,200,175,150,125,93,80,60,45,35,20,10,5
041	13/10/16	5.38°S	25.04°W	1,3,4,5,6,7,8,9,12,13,14,15,17,20,24	500,400,300,200,175,150,125,105,83,75,65,50,30,10,5
042	13/10/16	9.06°S	25.04°W	2,3,4,5,7,9,10,13,15,16,17,18,19,20,24	500,450,400,300,200,150,120,105,70,50,30,20,15,10,5
043	14/10/16	11.82°S	25.06°W	1,3,5,6,7,10,12,14,15,16,17,18,19,21,24	500,400,300,200,175,148,120,90,65,50,40,30,20,10,5
044	14/10/16	11.83°S	25.05°W	17,18,20,24	30,20,10,5
045	15/10/16	14.45°S	25.07°W	1,3,4,5,6,7,10,12,13,14,15,17,19,20,24	500,400,300,200,180,160,130,105,90,80,70,50,20,15,5
046	15/10/16	15.38°S	25.08°W	1,4,5,7,8,10,12,13,15,16,17,18,20,24	500,400,300,200,185,155,145,120,80,60,40,20,10,5
047	16/10/16	18.26°S	25.12°W	1,4,5,6,7,8,11,15,16,17,20,21,24	500,400,300,250,200,180,162,95,70,20,15,10,5
048	17/10/16	20.67°S	25.01°W	2,4,5,6,7,10,11,13,14,15,16,17,20,21,24	500,300,250,200,180,152,145,120,110,95,70,55,15,10,5

CTD	DATE	LAT	LONG	NISKINS	DEPTH
049	17/10/16	21.34°S	25.01°W	1,2,3,5,7,9,11,12,14, 15,16,17,18,19,24	500,400,300,200,175,149 ,135,120,80,60,40,20,15, 10,5
050	18/10/16	23.73°S	25.02°W	1,2,3,5,10,11,13,14,1 5,16,17,20,21,24	500,400,300,200,135,125 ,105,90,80,60,55,15,10,5
051	18/10/16	24.47°S	25.02°W	1,3,4,6,7,9,11,13,14, 16,17,18,19,20,24	500,400,300,250,200,150 ,125,120,110,80,60,40,20 ,10,5
052	19/10/16	27.27°S	24.45°W	1,2,3,5,7,11,13,14,15 ,16,17,18,20,21,24	500,400,300,200,160,110 ,90,80,70,60,50,30,15,10, 5
053	19/10/16	28.15°S	24.30°W	1,2,3,5,8,9,11,14,15, 16,17,18,19,24	500,400,300,200,150,135 ,117,90,70,50,30,20,10,5
054	20/10/16	30.38°S	25.31°W	1,2,3,5,7,10,13,14,15 ,16,17,18,20,21,24	500,400,300,200,150,117 ,90,80,70,60,45,30,15,10, 5
056	21/10/16	33.58°S	26.78 °W	1,2,3,5,7,9,13,14,15, 16,17,18,20,21,24	500,400,300,200,150,100 ,90,80,70,60,45,30,15,10, 5
057	21/10/16	34.43°S	27.19°W	1,2,4,5,7,9,10,12,14, 16,17,18,19,21	500,400,300,200,175,125 ,100,70,53,40,30,20,10,5
058	22/10/16	36.53°S	28.15°W	1,2,3,5,9,15,16,17,18 ,20,21,24	500,400,300,200,100,60, 50,40,30,15,10,5
059	22/10/16	37.33°S	28.43°W	1,3,4,6,7,8,9,10,11,1 3,16,17,19,20,24	500,400,300,2050,200,15 0,125,100,80,50,40,30,15 ,10,5
060	23/10/16	39.70°S	28.67°W	1,2,3,4,5,7,9,11,13,1 6,17,18,20,21,24	500,400,300,250,200,150 ,100,80,60,50,40,30,15,1 0,5
061	23/10/16	40.40°S	28.75°W	1,2,4,7,9,10,12,14,16 ,17,18,24	500,400,200,150,100,90, 60,50,40,30,20,5
062	25/10/16	44.91°S	31.08°W	1,2,3,4,5,6,7,9,13,16, 17,18,19,21,24	500,400,30,250,175,150, 100,70,50,40,30,20,10,5
063	25/10/16	45.67°S	31.49°W	1,3,4,6,7,8,9,10,13,1 4,15,16,18,20,24	500,400,300,200,150,125 ,100,90,75,60,50,40,20,1 0,5
064	26/10/16	47.45°S	32.49°W	1,2,3,4,5,6,7,10,11,1 3,15,16,18,20,24	500,400,30,250,200,175, 150,85,70,60,50,40,20,10 ,5
065	26/10/16	48.83°S	32.87°W	1,2,3,5,7,8,9,10,11,1 2,15,16,18,20,24	500,400,300,200,150,125 ,100,85,70,60,50,40,20,1 0,5
066	27/10/16	49.78°S	33.78°W	1,3,4,5,6,7,11,14,15, 16,17,19,21,24	500,400,300,250,200,175 ,110,75,60,50,40,20,10,5
067	27/10/16	50.29°S	34.09°W	1,2,3,5,6,7,8,9,10,11, 14,16,18,20,24	500,400,300,200,175,150 ,125,100,85,75,60,40,20, 10,5
069	28/10/16	52.45°S	35.38°W	1,2,3,5,6,11,12,13,14 ,16,18,20,24	500,400,300,200,175,105 ,90,75,60,40,20,10,5
070	29/10/16	55.94°S	36.30°W	1,4,6,7,8,9,10,12,15, 16,17,19,20,24	200,175,150,125,100,85, 75,70,50,40,30,15,10,5
071	30/10/16	54.00°S	36.84°W	1,2,4,5,6,7,8,9,11,14, 15,16,18,20,24	220,200,175,150,125,100 ,85,75,65,60,50,40,20,10,
072	31/10/16	53.59°S	39.98°W	1,3,4,6,8,10,11,12,14 ,16,7,18,21,24	500,400,300,200,150,100 ,80,60,45,40,35,25,10,5
073	31/10/16	53.39°S	41.54°W	1,2,3,5,6,7,8,9,12,14, 15,16,18,20,24	500,400,300,200,175,150 ,125,100,75,60,50,40,20, 10,5

CTD	DATE	LAT	LONG	NISKINS	DEPTH
074	01/11/16	53.01°S	45.09°W	2,3,4,6,7,8,10,12,14, 16,17,19,21,24	500,400,300,200,175,150 ,100,60,50,40,35,20,10,5

Reference

Dickson, A.G., Sabine, C.L. and J.R. Christian (eds.), 2007, Guide to Best Practice for Ocean CO₂ Measurements, PICES Special Publication 3, 191p.

Dissolved & atmospheric Greenhouse Gases (CO₂, N₂O, CH₄)

Andy Rees

Plymouth Marine Laboratory

Rationale

The ocean plays an important role in the global budgets of these three greenhouse gases (carbon dioxide, nitrous oxide and methane), each of which has production and consumption processes active in the marine environment. The latest analysis of observations from the WMO Global Atmosphere Watch (GAW) Programme shows that globally averaged surface mole fractions calculated from this in situ network for CO₂, CH₄ and N₂O reached new highs in 2015, with CO₂ at 400.0±0.1 ppm, CH₄ at 1845±2 ppb(4) and N₂O at 328.0±0.1 ppb. These values constitute, respectively, 144%, 256% and 121% of pre-industrial (before 1750) levels (WMO, 2016).

Here we aim to analyse ocean and atmosphere levels of all 3 gases in order to estimate fluxes between the two to provide analysis of spatial variability throughout the Atlantic Ocean and to add to the decadal database of measurements made throughout the AMT programme.

Methods

An underway pCO₂, pN₂O and pCH₄ analyser was set up in the main laboratory. Gas standards (nominal mixing ratios: 250, 380, 450 ppmv CO₂; 317.4, 406.4, 496.7 ppbv N₂O and 1.009, 2.058, 3.04 ppmv CH₄ in synthetic air; calibrated against NOAA primaries) were located externally for CO₂ and within the laboratory for N₂O and CH₄, an airline for atmospheric measurements was taken externally starboard side to forward of the ships bridge. The system comprises two showerhead equilibrators set at different flow rates for both CO₂/N₂O and CH₄, vented through a second equilibrator and analysed on a Picarro Cavity Ringdown Spectrometer for CO₂, N₂O and CH₄ and on a Li-Cor for CO₂ only. A nafion dryer was used to dry the air flow and associated hardware and electronics controlled the sampling regime.

The system was run in a semi-continuous manner throughout the cruise. Standard daily routine approximated to :

Early a.m. Calibration

Continuous measurement of sea-surface (~06:30 to ~20:00)

Calibration

Continuous measurement of atmosphere (~21:00 to ~04:00)

Reference

World Meteorological Organisation. WMO GREENHOUSE GAS BULLETIN, No. 12, 24 October 2016.

Optical properties and particulate organic carbon and phosphorous

^{1,2}Rafael Rasse and ¹Giorgio Dall’Olmo

¹ Plymouth Marine Laboratory

² Instituto Venezolano de Investigaciones Científicas, Caracas, Venezuela.

Goal

To establish empirical relationships between depth-resolved measurements of optical properties and the concentrations of particulate organic carbon and phosphorous, with particular interest in the oxygen minimum zone.

Methods

- Discrete seawater samples (5-8 l) were collected from the mesopelagic region (5-500 m, Table 1) and filtered through pre-combusted (4 hours at 500 °C) GF/F filters (0.7 µm) under low vacuum (< 10 in Hg) and positive pressure for particulate organic carbon (POC) and phosphorous (POP), respectively. The POC samples were stored in pre-combusted aluminium envelopes, flash frozen in liquid nitrogen and stored at -80 °C (Gardner et al. 2003; Menzel, 1967). Whereas the POP samples were washed with 5 ml of Na₂SO₄ (0.17M), semi-dried with 60 ml of air and stored into pre-combusted 20 ml glass vials at -80 °C (Karl and Tien, 1992; Rimmelin and Moutin. 2005)
- Particulate optical backscattering and attenuation were also determined by instruments (WETLabs BBRTD and C-star, respectively) mounted on the rosette over the upper 500 m of the water column.

Table 1. CTD discrete samples collected.

Date-Time in	CTD cast	Latitude (N)	Longitude (W)	POC-POP depths (m)
26/09/2016-13:19	4	45° 39.967'	13° 58.678'	500, 300, 200, 100, 54 and 5
27/09/2016-13:05	7	43° 31.454'	16° 57.704'	500, 400, 300, 200, 68 and 5
28/09/2016 -13:29	10	41° 11.177'	20° 13.931'	500x2, 300, 200, 64 and 5
29/09/2016 -12:43	14	37° 41.594'	24° 55.908'	400, 300, 200, 60, and 5x2
30/09/2016-12:26	16	35° 01.307'	26° 20.984'	500x2, 300, 200, 70 and 5
01/10/2016-13:29	18	31° 31.605'	27° 13.121'	400, 300, 200, 105, and 5x2
02/10/2016-12:28	20	27° 58.357'	28° 05.906'	500x2, 300, 200, 110 and 5
03/10/2016 -12:28	22	31° 31.605'	27° 13.121'	400, 300, 200, 111, and 5x2
04/10/2016-12:25	24	31° 31.605'	27° 13.121'	500x2, 300, 200, 100 and 5
05/10/2016 05:18	25	18° 42.021'	29° 39.718'	500, 375x2, 300, 53 and 5
05/10/2016-12:25	26	17° 47.510'	29° 24.255'	500, 400, 450, 300, 78 and 5
06/10/2016-05:32	27	15° 16.482'	28° 47.058'	500, 375, 300, 60, and 5x2
06/10/2016-12:28	28	14° 30.123'	28° 34.196'	500, 450, 375, 300, 30 and 5
07/10/2016-05:29	29	11° 57.854'	27° 57.375'	500, 375x2, 300, 47, 5
07/10/2016-12:22	30	11° 12.896'	27° 44.098'	500, 450, 375, 300, 45 and 5
Date-Time in	CTD	Latitude (N)	Longitude (W)	POC-POP depths (m)

Date-Time in	CTD cast	Latitude (N)	Longitude (W)	POC-POP depths (m)
08/10/2016-05:30	31	8° 41.857'	27° 08.205'	500, 400, 300, 52, and 5x2
08/10/2016-12:28	32	7° 45.601'	26° 52.977'	500, 450, 400, 300, 200, 56 and 5
09/10/2016-05:28	33	5° 12.068'	26° 16.490'	500, 400x2, 300, 70 and 5
09/10/2016-12:29	34	1° 09.370'	25° 15.631'	500, 450, 400, 300, 200, 72 and 5
10/10/2016-05:24	35	1° 58.487'	25° 28.980'	500, 400, 300, 70 and 5x2
10/10/2016-12:40	36	1° 09.370'	25° 15.631'	500, 450, 400, 300, 200, 67 and 5
11/10/2016-05:30	37	-1° 24.910'	25° 00.290'	500, 400x2, 300, 92 and 5
12/10/2016-12:28	40	-5° 48.659'	25° 01.608'	500, 450, 400, 300, 200, 93 and 5
13/10/2016-05:25	41	-8° 22.590'	25° 02.455'	500, 400, 300, 83 and 5x2
13/10/2016-11:15	42	-9° 03.518'	25° 02.646'	500, 450, 400, 300, 200, 120 and 5
14/10/2016-05:25	43	-11° 49.409'	25° 03.798'	500, 400x2, 300, 140 and 5
14/10/2016-12:56	44	-11° 49.782'	25° 03.119'	500, 450, 400, 300, 200, 140 and 5
15/10/2016-05:25	45	-14° 26.911'	25° 04.549'	500, 400, 300, 130 and 5x2
14/10/2016-12:25	46	-15° 22.756'	25° 04.593'	500, 450, 400, 300, 200, 155, and 5
16/10/2016-05:25	47	-18° 15.556'	25° 07.195'	500, 400x2, 300, 162, 5
17/10/2016-12:40	49	-21° 20.370'	25° 00.744'	400, 300, 200, 149 and 5x2
18/10/2016-11:10	51	-24° 27.916'	25° 01.464'	500x2, 300, 200, 125 and 5
19/10/2016-12:24	53	-28° 09. 146'	24° 17.789'	400, 300, 200, 111, and 5x2
20/10/2016-12:34	55	-31° 18.242'	25° 43.548'	500x2, 300, 200, 77, and 5
21/10/2016-12:29	57	-34° 25.738'	27° 11.115'	400, 300, 200, 53, and 5x2
22/10/2016-12:35	59	-37° 19.903'	28° 25.973'	500x2, 300, 200, 44 and 5
23/10/2016-10:42	61	-40° 23.740'	28° 44.872'	400, 300, 200, 50 and 5x2
25/10/2016-12:26	63	-45° 39.936'	31° 29.663'	500x2, 300, 200, 75 and 5
26/10/2016-04:25	64	-47° 26.282'	32° 29.135'	400, 300, 200, 60 and 5x2
26/10/2016-12:55	65	-48° 04.952'	32° 52.185'	500, 400, 300, 200, 60 and 50
27/10/2016-04:48	66	-49° 46.590'	33° 46.286'	500x2, 300, 200, 110 and 5
27/10/2016-13:53	67	-50° 17.287'	34° 05.208'	500, 400, 300, 200, 75 and 5
28/10/2016-12:46	69	-52° 26.723'	35° 22.509'	500, 400, 300, 200, 125 and 5
29/10/2016-04:23	70	-53° 56.232'	36° 18.156'	200, 70 and 5

30/10/2016-12:25	71	-53° 59.742'	36° 50.538'	200, 65 and 5
31/10/2016-05:30	72	-53° 35.417'	39° 58.452'	500x2, 300, 200, 45 and 5
31/10/2016 13:12	73	-53° 23.515'	41° 32.365'	500, 400, 300, 200, 75 and 5
01/11/2016 13:18	74	-53° 00.738'	45° 05.298'	500x2, 300, 200, 50 and 5

References

- Gardner W.D. et al. (2003). Determining true particulate organic carbon: bottles, pumps and methodologies. *Deep Sea Research Part II: Topical Studies in Oceanography* 50(3-4):655-674.
- Menzel, D. W. (1967). Particulate organic carbon in deep sea, *Deep Sea Res.*, 14(2), 229–238, doi:10.1016/0011-7471(67)90008-3.
- Karl D.M. and Tien G. (1992). MAGIC: A sensitive and precise method for measuring dissolved phosphorus in aquatic environments. *Limnol. Oceanogr.* 37(1), 105-116.
- Rimmelin P. and Moutin T. (2005). Re-examination of the MAGIC method to determine low orthophosphate concentration in seawater. *Analytica Chimica Acta* 548(174-182).

Particle size distribution and total suspended matter

Emanuele Organelli* and Giorgio Dall'Olmo

Plymouth Marine Laboratory

Objectives

- To determine particle size distributions (PSD) along the AMT26 transect from surface to the mesopelagic region.
- To determine dry particle mass concentration (TSM) along the AMT26 transect at the sea surface and at 300 m. To assess the individual sample uncertainty.
- To assess relationships of PSD and TSM with respect to in-situ profiles of inherent optical properties (particle light backscattering, attenuation and absorption) and discrete measurements of particulate organic carbon (POC).

Methods

Particle Size Distribution: The PSD was measured with a Coulter Counter Multisizer III (Beckam Coulter) fitted with 20 μm and 100 μm apertures. The measured size ranges were 0.58-12 μm and 2-60 μm for the 20 and 100 μm apertures respectively, each one distributed in 256 logarithmically spaced size bins (Dall'Olmo et al., 2009; Reynolds et al., 2016). Water samples were directly collected from the CTD in 500 mL amber bottles and immediately analysed onboard. Samples were generally collected at 6 depths (5, 150 or 200, 300, 400, 500 m and the depth of the deep chlorophyll maximum). Before analysis, each sample was prepared under a laminar flow hood in order to minimise any external particle contamination. Replicates of each sample (and for each aperture) were measured in order to achieve an overall error <15% in a given size range (Dall'Olmo et al., 2009). Measurements were performed mainly at the noon station. Blank references of 0.1 μm filtered seawater were also recorded for both apertures.

The particle size analyser LISST type B (Sequoia Scientific Inc) was also deployed in the upper 250 m water column in order to get continuous profiles of PSD within the range 1.25-250 μm . The LISST optical path was baffled in order to minimise the influence of ambient light (Reynolds et al., 2016). The LISST was deployed just before the CTD station. MilliQ and 0.2 μm filtered seawater blank measurements were also collected.

Total Suspended Matter: TSM was measured daily at depth of 5 m and (occasionally) 300 m. Water was filtered through pre-ashed and pre-weighed 25 mm GF/F Whatman filters (Van der Linde, 1998). Before filtration, each filter was soaked with MilliQ water (Röttgers et al., 2014). The optimal volume to filter was determined from Table 3 of Neukermans et al. (2012) using estimated TSM concentrations. These TSM concentrations were estimated from particle beam attenuation profiles ($c_p(\lambda)$, WetLabs C-star transmissometer) collected during the CTD cast, converted into particle backscattering coefficients (assuming a backscattering efficiency of 1%) and used as input for the bio-optical model by Reynolds et al. (2016). The optimal volume was scaled for the different size (25 mm instead of 47 mm) of filters used in our study. To assess the uncertainty associated to each sample, two additional samples were collected for each depth by filtering volumes different (by 80% and 120%) from the optimal volume (Röttgers et al., 2014). When the filtration was completed, funnels and filters were rinsed with about 65 mL of MilliQ water. After removing funnels, filter edges were additionally rinsed with 2 mL of MilliQ. Filters were dried at 60°C for 24 h and then sealed until analysis on land. For each station, blank reference filters were also collected.

Funding: PSD and TSM measurements have been performed in the frame of the REOPTIMIZE project which has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 706781.

Table 1. Time and location of Coulter Counter, TSM samples and LISST profiles on AMT26.

Date	CTD Number	Time (GMT)	Longitude (degrees)	Latitude (degrees)	Coulter Counter	LISST	TSM
25/09/2016	003	10:09	-13.58	45.83			X
25/09/2016	004	13:19	-13.97	45.65			X
26/09/2016	006	10:03	-16.60	43.75			X
26/09/2016	007	13:05	-16.95	43.52	X		
27/09/2016	009	10:03	-20.02	41.32			X
27/09/2016	010	13:29	-20.22	41.18	X		X
29/09/2016	014	12:43	-24.92	37.68	X		
30/09/2016	016	12:26	-26.33	35.02	X		X
01/10/2016	018	12:27	-27.22	31.52	X		X
02/10/2016	020	12:28	-28.08	27.97	X		X
03/10/2016	022	12:28	-28.90	24.58	X		X
04/10/2016	024	12:25	-29.72	21.15	X	X	X
05/10/2016	026	12:30	-29.40	17.78	X	X	X
06/10/2016	028	12:28	-28.57	14.50	X	X	X
07/10/2016	030	12:29	-27.73	11.20	X	X	X
08/10/2016	032	12:28	-26.87	7.75	X	X	X
09/10/2016	034	12:29	-26.07	4.48	X	X	X
10/10/2016	036	12:40	-25.25	1.15	X	X	X
11/10/2016	038	12:35	-24.98	-2.25		X	
12/10/2016	040	12:28	-25.02	-5.80	X	X	X
13/10/2016	042	11:19	-25.03	-9.05	X	X	X
14/10/2016	044	12:56	-25.05	-11.82	X	X	X
15/10/2016	046	12:31	-25.07	-15.37	X	X	X
16/10/2016	047	05:25	-25.12	-18.25	X		
17/10/2016	049	12:40	-25.00	-21.33	X	X	X
18/10/2016	051	11:10	-25.02	-24.45	X	X	
19/10/2016	053	12:29	-24.28	-28.15	X	X	X
20/10/2016	055	12:34	-25.71	-31.30	X	X	X
21/10/2016	057	12:29	-27.18	-34.42	X	X	X
22/10/2016	059	12:35	-28.43	-37.32	X	X	X
23/10/2016	061	10:47	-28.73	-40.38		X	X
25/10/2016	063	12:26	-31.48	-45.65		X*	X
26/10/2016	065	12:54	-32.85	-48.07		X	X
27/10/2016	067	13:53	-34.08	-50.28		X*	X
28/10/2016	069	12:46	-35.37	-52.43		X	X
30/10/2016	071	13:40	-36.83	-53.98		X	X
31/10/2016	073	13:41	-41.53	-53.38		X	X

*Additional LISST casts were collected 2 hours before the CTD station.

References

- Dall'Olmo G, Westberry TK, Behrenfeld MJ, Boss E, Slade WH, 2009. Significant contribution of large particles to optical backscattering in the open ocean. *Biogeosciences*, 6, 947-967.
- Neukermans G, Ruddick K, Loisel H, Roose P, 2012. Optimization and quality control of suspended particulate matter concentration measurement using turbidity measurements. *Limnol. Oceanogr. Methods*, 10, 1011-1023.
- Reynolds R, Stramski D, Neukermans G, 2016. Optical backscattering by particles in Arctic seawater and relationships to particle mass concentration, size distribution, and bulk composition. *Limnol. Oceanogr.*, 61, 1869-1890.
- Röttgers R, Heymann K, Krasemann H, 2014. Suspended matter concentrations in coastal waters: Methodological improvements to quantify individual measurement uncertainty. *Estuar. Coast. Shelf Science*, 151, 148-155.
- Van der Linde DW, 1998. Protocol for the determination of Total Suspended Matter in oceans and coastal zones. EU Joint Research Center, Technical Note No I.98.182, 9 pp.

Abundance and Composition of Microbial Plankton Communities by flow cytometry

Glen Tarran

Plymouth Marine Laboratory

Objective

To determine the distribution, abundance and community structure of nano- and picophytoplankton and heterotrophic bacteria from CTD casts by flow cytometry.

Phytoplankton community structure and abundance by flow cytometry.

Fresh seawater samples were collected in clean 250 mL polycarbonate bottles using a Seabird CTD system containing a 24 bottle rosette of 20 L Niskin bottles from 200 m to the surface at predawn and solar noon CTD casts and at variable depths during mid-morning CTD casts. Samples were stored in a refrigerator and analysed within 2 hours of collection. Fresh samples were measured using a Becton Dickinson FACSort flow cytometer which characterised and enumerated *Prochlorococcus* sp. and *Synechococcus* sp. (cyanobacteria) and pico- and eucaryote phytoplankton, based on their light scattering and autofluorescence properties. Data were saved in listmode format and analysed onboard. Table 1 summarises the CTD casts sampled and analysed during the cruise.

Heterotrophic bacteria community structure and abundance by flow cytometry.

Samples for bacteria enumeration were collected in clean 250 mL polycarbonate bottles using a Seabird CTD system containing a 24 bottle rosette of 20 L Niskin bottles from 200 m to the surface at predawn and solar noon CTD casts and at variable depths during mid-morning CTD casts. Samples were fixed with glutaraldehyde solution (Sigma-Aldrich, 50%, Grade 1. 0.5% final concentration, 30 mins at 4°C) within half an hour of surfacing. Samples (see below) were stained for 1 h at room temperature in the dark with the DNA stain SYBR Green I (Thermo-Fisher) in order to separate particles in suspension based on DNA content and light scattering properties. Samples were generally analysed flow cytometrically within 3 hours of surfacing. Stained samples were measured using a Becton Dickinson FACSort flow cytometer. Data were saved in listmode format and analysed onboard.

Additional flow cytometry.

Samples for phytoplankton and bacteria from the ship's non-toxic seawater supply were analysed daily at the time of the solar noon station for Bob Brewin (PML) to compare 1 µm filtered and unfiltered seawater and also to compare the unfiltered non-toxic seawater with seawater from 5 m from the CTD rosette sampler.

Samples for bacteria quantification were analysed for Rafaell Rasse (PML) between 200-500 m from CTDs between approx.. 19° N and 19° S to support work being conducted on the oxygen minimum zone.

Table 1: CTD casts sampled for phytoplankton and heterotrophic bacteria community structure & abundance.

DATE	STATION	CTD	TIME on deck (GMT)	LAT +N, -S	LONG W	DEPTHS/NISKIN BOTTLES
25-Sep	2	2	04:50	46.38	-12.69	5 13 18 25 35 48 60 81 103 128 153 181 200 23 21 20 19 18 15 12 11 10 8 7 6 5
25-Sep	3	3	10:43	45.84	-13.59	4 10 20 33 43 50 12 10 8 6 4 2
25-Sep	4	4	14:06	45.67	-13.98	5 10 15 20 30 49 54 72 78 82 100 150 200 24 21 20 19 18 16 14 13 12 11 9 8 6
26-Sep	6	6	10:35	43.76	-16.60	5 9 20 30 39 50 55 71 101 14 13 11 9 7 5 3 2 1
26-Sep	7	7	13:51	43.52	-16.96	5 11 15 20 25 30 40 55 68 101 150 200 24 20 19 18 17 16 15 14 12 10 9 7

DATE	STATION	CTD	TIME on deck (GMT)	LAT +N, -S	LONG W	DEPTHS/NISKIN BOTTLES
27-Sep	8	8	04:43	41.78	-19.39	5 10 15 20 25 36 45 61 70 90 100 127 152 178 200 23 22 19 17 16 14 13 12 10 9 8 7 6 5 4
27-Sep	9	9	10:33	41.32	-20.03	5 10 20 30 40 50 12 10 8 6 4 2
27-Sep	10	10	14:09	41.19	-20.23	5 10 15 20 25 30 40 55 64 100 152 200 24 20 19 18 17 16 15 14 12 10 9 7
28-Sep	11	11	04:44	39.71	-22.26	5 10 15 20 30 40 50 65 70 90 100 125 150 175 200 21 20 17 15 14 12 11 10 8 7 6 5 4 3 2
29-Sep	14	13		37.66	-24.91	5 10 15 20 25 30 51 55 66 90 100 125 150 175 200 23 22 19 17 16 14 13 12 10 9 8 7 6 5 4
29-Sep	15	14	13:25	37.69	-24.93	5 10 15 20 25 30 40 50 60 100 150 200 24 19 18 17 16 15 14 13 11 9 8 6
30-Sep	16	15	05:09	36.13	-26.07	5 10 20 30 40 55 70 80 87 110 125 150 175 200 23 21 18 16 15 14 13 12 10 8 7 6 5 4
30-Sep	17	16	13:03	35.02	-26.35	5 10 15 20 25 30 40 60 70 100 150 200 24 20 19 8 18 17 16 15 14 12 10 9 7
01-Oct	18	17	05:10	32.51	-26.99	5 15 25 35 45 50 60 70 80 90 100 125 150 175 200 23 22 19 18 16 14 13 12 11 10 9 7 6 5 4
01-Oct	19	18	13:08	31.53	-27.22	5 10 15 20 25 30 40 50 75 105 150 200 24 19 18 17 16 15 14 13 12 9 8 6
02-Oct	20	19	05:06	29.16	-27.83	5 10 15 20 30 45 55 70 85 100 126 150 175 200 22 21 20 18 16 14 13 12 11 10 8 6 5 4
02-Oct	21	20	13:08	27.97	-28.10	5 10 15 20 30 40 50 70 90 110 150 200 24 20 19 18 17 16 15 14 13 10 9 7
03-Oct	22	21	06:08	25.39	-28.74	5 10 15 20 30 40 55 75 85 100 124 150 175 200 21 23 20 18 16 14 13 12 11 10 8 6 5 4
03-Oct	23	22	13:07	24.59	-28.92	5 10 15 20 25 30 50 70 90 111 160 200 24 19 18 17 16 15 14 13 12 11 8 6
04-Oct	24	23	06:07	22.06	-29.52	5 10 15 20 25 35 45 60 80 90 100 125 150 200 23 21 20 18 16 14 13 12 11 10 9 6 5 4
04-Oct	25	24	12:59	21.17	-29.73	5 10 15 20 25 30 40 50 75 101 150 200 24 20 19 18 17 16 15 14 13 12 9 7
05-Oct	26	25	06:07	18.70	-29.66	5 10 15 20 30 40 50 53 80 100 125 150 175 200 24 21 20 19 17 16 15 14 11 10 8 7 6 5
05-Oct	27	26	03:07	17.79	-29.41	5 10 20 30 40 50 60 78 100 125 150 175 200 24 19 18 17 16 15 14 12 10 9 8 7 6
06-Oct	28	27	06:09	15.27	-28.78	10 15 20 30 40 45 54 60 80 100 125 150 175 200 24 20 19 18 17 16 15 14 13 10 9 8 7 6 5 4 3 2 1
06-Oct	29	28	13:09	14.50	-28.57	5 10 15 20 25 30 60 80 100 125 150 175 200 24 20 19 18 17 16 15 13 12 11 10 9 8 7
07-Oct	30	29	06:11	11.96	-27.96	5 10 15 30 40 47 55 75 85 100 125 150 175 200 24 21 19 18 17 16 13 12 11 10 9 8 7 6
07-Oct	31	30	13:07	11.21	-27.74	5 10 20 30 40 45 60 80 100 125 150 175 200 24 20 19 18 17 15 13 12 11 10 9 8 7
08-Oct	32	31	06:03	8.70	-27.14	5 10 15 20 25 35 45 53 75 90 100 125 150 175 200 24 20 19 17 16 15 14 13 10 9 8 7 6 5 4

DATE	STATION	CTD	TIME on deck (GMT)	LAT +N, -S	LONG W	DEPTHS/NISKIN BOTTLES
08-Oct	33	32	13:06	7.76	-26.88	5 10 20 30 40 45 56 80 100 125 150 175 200 24 20 19 18 17 16 14 12 11 10 9 8 7
09-Oct	34	33	06:07	5.20	-26.27	5 10 20 25 35 45 60 65 71 85 100 125 150 175 200 24 21 20 19 18 17 16 15 14 11 10 9 8 7 6
09-Oct	35	34	13:05	4.49	-26.08	5 10 15 20 35 45 60 72 100 125 150 175 200 24 20 19 18 17 16 15 13 11 10 9 8 7
10-Oct	36	35	06:04	1.97	-25.48	5 10 20 25 35 45 60 65 70 85 100 125 150 175 200 24 20 19 18 17 16 15 14 13 10 9 8 7 6 5
10-Oct	37	36	13:16	1.16	-25.26	5 10 15 20 35 45 60 67 100 125 150 175 200 24 20 19 18 17 16 15 13 11 10 9 8 7
11-Oct	38	37	06:01	-1.42	-25.00	5 10 15 20 30 40 50 60 93 70 100 135 150 175 200 24 21 20 19 18 17 16 15 14 13 10 9 8 7 6
11-Oct	39	38	13:07	-2.25	-24.99	5 15 25 40 55 75 95 125 200 24 19 18 17 16 15 13 10 7
12-Oct	40	39	06:07	-4.83	-25.02	5 10 15 20 25 35 50 60 75 83 105 125 150 175 200 24 19 18 17 16 15 14 13 12 11 8 7 6 5 4
12-Oct	41	40	13:06	-5.81	-25.03	5 10 15 20 35 45 60 80 94 125 150 175 200 24 20 19 18 17 16 15 14 12 10 9 8 7
13-Oct	42	41	06:03	-8.38	-25.04	5 10 15 20 30 40 50 65 75 83 105 125 150 175 200 24 20 19 18 17 16 15 14 13 12 9 8 7 6 5
13-Oct	43	42	11:56	-9.06	-25.04	5 10 15 20 30 50 70 90 105 120 150 175 200 24 20 19 18 17 16 15 14 13 11 9 8 7
14-Oct	44	43	06:10	-11.82	-25.06	5 10 15 20 30 40 50 65 90 110 120 130 148 175 200 24 21 20 19 18 17 16 15 14 13 12 10 7 6
14-Oct	44	44	13:30	-11.83	-25.05	5 10 15 20 30 50 70 90 105 125 141 175 200 24 20 19 18 17 16 15 14 13 12 10 8 7
15-Oct	45	45	06:16	-14.45	-25.08	5 15 20 35 50 60 70 80 90 105 120 130 160 180 200 21 20 19 18 17 16 15 14 13 12 11 10 7 6 5
15-Oct	46	46	13:06	-15.38	-25.08	5 10 15 20 40 60 80 100 120 145 155 185 200 24 20 19 18 17 16 15 14 13 12 10 8 7
16-Oct	47	47	06:07	-18.26	-25.12	5 10 15 20 40 55 70 95 125 140 150 163 180 200 24 21 20 19 18 17 16 15 14 13 12 11 8 7
17-Oct	50	48	06:04	-20.67	-25.01	5 10 15 20 40 55 70 95 110 120 130 145 152 180 200 24 21 20 19 18 17 16 15 14 13 12 11 10 7 6
17-Oct	51	49	13:18	-21.34	-25.01	5 10 15 20 40 60 80 100 120 135 148 175 200 24 19 18 17 16 15 14 13 12 11 9 7 5
18-Oct	52	50	05:09	-23.73	-25.02	20 35 55 60 80 90 105 115 125 135 160 180 200 24 20 19 18 17 16 15 14 13 12 11 10 7 6 5
18-Oct	53	51	11:47	-24.47	-25.03	5 10 20 50 60 80 95 110 120 125 150 175 200 24 20 19 18 17 16 15 14 13 11 9 8 7
19-Oct	54	52	05:12	-27.27	-24.45	5 15 20 30 50 60 70 80 90 100 110 140 160 180 200 24 20 19 18 17 16 15 14 13 12 11 8 7 6 5

DATE	STATION	CTD	TIME on deck (GMT)	LAT +N, -S	LONG W	DEPTHS/NISKIN BOTTLES
19-Oct	56	53	13:04	-28.15	-24.30	5 10 20 30 50 70 90 105 117 135 150 200 24 19 18 17 16 15 14 13 11 9 8 5
20-Oct	57	54	05:15	-30.38	-25.31	5 15 20 30 45 60 70 80 90 105 117 125 150 175 200 24 20 19 18 17 16 15 14 13 12 11 8 7 6 5
20-Oct	58	55	13:10	-31.30	-25.73	5 10 15 20 30 45 60 76 90 100 130 160 24 20 19 18 17 16 15 13 11 10 9 8
21-Oct	59	56	05:18	-33.58	-26.78	5 15 20 30 45 60 70 80 90 95 100 125 150 175 200 24 20 19 18 17 16 15 14 13 10 9 8 7 6 5
21-Oct	60	57	13:05	-34.43	-27.19	5 10 20 30 40 53 70 86 103 125 150 175 200 24 19 18 17 16 15 14 12 11 10 9 8 7 5
22-Oct	61	58	05:11	-36.53	-28.15	5 10 15 20 30 40 50 60 70 80 90 100 125 175 200 24 21 20 19 18 17 16 15 12 11 10 9 8 6 5
22-Oct	63	59	13:11	-37.33	-28.43	5 10 15 20 30 40 50 60 80 100 125 150 200 24 20 19 18 17 16 14 12 11 10 9 8 7
23-Oct	64	60	05:11	-39.70	-28.67	5 10 15 20 30 40 50 60 70 80 90 100 125 175 200 24 21 20 19 18 17 16 13 12 11 10 9 8 6 5
23-Oct	65	61	11:26	-40.40	-28.75	5 10 20 30 40 50 60 75 90 100 125 150 175 200 24 19 18 17 16 14 12 11 10 9 8 7 6 4
25-Oct	66	62	05:11	-44.91	-31.08	5 10 15 20 30 40 50 60 70 80 90 100 125 150 200 24 21 20 19 18 17 16 15 14 11 10 9 8 7 5
25-Oct	67	63	13:02	-45.67	-31.49	5 10 15 20 30 40 50 60 75 90 100 125 150 200 24 20 19 18 17 16 15 14 13 10 9 8 7 6
26-Oct	68	64	05:06	-47.45	-32.49	5 10 15 20 30 40 50 60 70 85 100 125 150 175 200 24 20 19 18 17 16 15 13 11 10 9 8 7 6 5
26-Oct	69	65	13:30	-48.08	-32.87	5 10 15 20 30 40 50 60 70 85 100 125 150 175 200 24 20 19 18 17 16 15 14 13 10 9 8 7 5
27-Oct	70	66	05:34	-49.78	-33.78	5 10 15 20 30 40 50 60 75 90 110 125 150 200 24 21 20 19 18 17 16 15 14 13 11 9 8 6
27-Oct	72	67	14:33	-50.29	-34.09	5 10 15 20 30 40 50 60 75 85 100 125 150 200 24 20 19 18 17 16 15 14 12 10 9 8 7 5
28-Oct	74	69	13:22	-52.45	-35.38	5 10 15 20 30 40 50 60 75 90 105 125 175 200 24 20 19 18 17 16 15 14 13 12 11 9 6 5
29-Oct	75	70	04:52	-53.94	-36.30	5 10 15 20 30 40 50 60 70 75 85 100 125 150 200 24 20 19 18 17 16 15 14 12 10 9 8 7 6 1
30-Oct	76	71	14:08	-54.00	-36.84	5 10 20 30 40 50 60 65 75 85 100 125 150 200 24 20 19 18 17 16 15 14 13 9 8 7 6 5 2
31-Oct	77	72	16:16	-53.59	-39.98	15 20 25 35 40 45 60 80 100 125 150 175 200 24 21 20 19 18 17 16 14 12 11 10 9 8 7 6
31-Oct	78	73	14:14	-53.39	-41.54	5 10 15 20 30 40 50 60 75 85 100 125 150 200 24 20 19 18 17 16 15 14 12 10 9 8 7 5
01-Nov	79	74	06:07	-53.01	-45.09	5 10 15 20 25 35 40 50 60 80 100 125 150 175 200 24 21 20 19 18 17 16 14 12 11 10 9 8 7 6

Extraction of phytoplankton pigments for High Performance Liquid Chromatography (HPLC) analysis

Bob Brewin and Giorgio Dall'Olmo
Plymouth Marine Laboratory

Objectives

- To examine the horizontal and vertical phytoplankton pigment composition along the AMT26 transect (at the surface and at the subsurface chlorophyll maximum).
- The continuation of a 21-year spatially extensive and internally consistent time series of observations on the pigment structure of phytoplankton in the Atlantic Ocean.
- Collecting phytoplankton pigment data for the development and validation of remote-sensing algorithms and marine ecosystem models designed to predict and model the phytoplankton biomass and community structure at basin scales.
- Collecting phytoplankton pigment data for the validation of remote-sensing algorithms for estimating phytoplankton pigment concentration on the newly-launched European Space Agency (ESA) Sentinel-3 and Sentinel-2 satellites.

Equipment

- 25 mm glass fibre filters (GF/F)
- 1 and 2 litre measuring cylinders
- Millipore forceps
- Cryovials
- Cryo-pen
- Filtration rig
- Gloves
- Liquid nitrogen for flash freezing.

Methods

Seawater samples were collected from the predawn, 10:00 and noon CTD casts, and from the ship underway system. Seawater was sampled into 9.5 L polypropylene carboys covered in black plastic to keep out light. Using forceps, GF/F filters were placed on the filter rig with the smoother side facing down. Filter papers were fully covered over sintered glass circles such that there were no gaps and water could only pass through GF/F filters. Seawater samples were mixed to avoid issues with sedimentation. 2-4 L samples (depending on phytoplankton biomass, e.g. 2 L in productive waters and 4 L in the oligotrophic gyres) were measured using the rinsed measuring cylinders, and then decanted into rinsed polypropylene bottles with siphon tubes and inverted into a 4 port vacuum filtration rig. Samples were filtered using a low-medium vacuum setting on the vacuum pump. When the last of the water passed through the filter paper, taps on the vacuum pump were closed and the resulting sample filters were folded into 2 mL cryovials and flash frozen in liquid nitrogen and stored in the -80°C freezer. For each station, 2 samples were taken at the surface (~5m), and around the subsurface chlorophyll maximum (which varied between 23m-162m). In addition there were three CTD stations that occurred at 10:00am local time, to coincide with Sentinel-3 overpass, and water was collected at 5 and 20m. Duplicate HPLC measurements were taken at both depths for every station (except the 10:00 stations, and on occasions when a CTD bottle misfired and there was not enough water to do a duplicate). Two daily samples were also taken using the ships underway system around the time of each station (to compare with surface CTD samples and for calibrating the ACS optics instrument). Frozen samples are to be analysed using HPLC methods (see Van Heukelem and Thomas, 2001) at Plymouth Marine Laboratory after the cruise. Table 1 shows the locations and stations of all the HPLC samples.

Table 1: Temporal and spatial locations of HPLC samples on AMT 26.

STATION	CTD	Day of Year	TIME (GMT)	LAT (degrees)	LON (degrees)	SAMPLE DEPTH (m)
1	1	267	17:10:00	49.31107	-6.49057	5 & 23
2	2	269	04:07:00	46.38158	-12.2116	5 & 48
3	3	269	10:09:00	45.00432	-13.5917	5 & 20
4	4	269	13:19:00	45.6661	-13.978	5 & 49
6	6	270	10:03:00	43.75955	-16.6011	5 & 20
7	7	270	13:05:00	43.52423	-16.9617	5 & 68
8	8	271	04:00:00	41.78418	-19.3858	5 & 60
9	9	271	10:03:00	41.53718	-20.0258	5 & 20
10	10	271	13:29:00	41.18628	-20.2322	5 & 64
11	11	272	04:00:00	39.70968	-22.2581	5 & 65
14	13	273	04:17:00	37.65927	-24.9085	5 & 55
15	14	273	12:43:00	37.69323	-24.9318	5 & 60
16	15	274	04:29:00	36.12913	-24.074	5 & 87
17	16	274	12:26:00	35.02177	-26.3497	5 & 70
18	17	275	04:33:00	32.51372	-26.9887	5 & 100
19	18	275	12:27:00	31.52677	-27.2187	5 & 105
20	19	276	04:29:00	29.16042	-27.832	5 & 126
22	21	277	05:29:00	25.75357	-28.7445	5 & 124
23	22	277	12:28:00	24.59038	-28.9159	5 & 111
24	23	278	05:29:00	22.05863	-29.5242	5 & 100
25	24	278	12:25:00	21.16573	-29.7292	5 & 101
26	25	279	05:29:00	18.70038	-29.662	5 & 53
27	26	279	12:36:00	17.79175	-29.4078	5 & 78
28	27	280	05:32:00	15.27442	-28.7842	5 & 54
29	28	280	12:28:00	14.50203	-28.5699	5 & 30
30	29	281	05:29:00	11.96423	-27.9562	5 & 47
31	30	281	12:29:00	11.2147	-27.7352	5 & 45
32	31	282	05:24:00	8.697617	-27.1368	5 & 52
33	32	282	12:28:00	7.760033	-26.8831	5 & 56
34	33	283	05:28:00	5.201167	-26.2748	5 & 70
35	34	283	12:29:00	4.48615	-26.0801	5 & 72
36	35	284	05:24:00	1.974767	-25.483	5 & 70
37	36	284	12:40:00	1.1584	-25.2597	5 & 67
38	37	285	05:24:00	-1.41517	-25.0048	5 & 92
39	38	285	12:35:00	-2.2516	-24.9926	5 & 92
40	39	286	05:25:00	-4.82953	-25.021	5 & 83
41	40	286	12:28:00	-5.811	-25.027	5 & 93
42	41	287	05:25:00	-8.37648	-25.0409	5 & 83
43	42	287	11:19:00	-9.05857	-25.0442	5 & 120
44	43	288	05:26:00	-11.8235	-25.0633	5 & 148
44B	44	288	12:56:00	-11.8291	-25.052	5 & 140

STATION	CTD	Day of Year	TIME (GMT)	LAT (degrees)	LON (degrees)	SAMPLE DEPTH (m)
45	45	289	05:34:00	-14.4485	-25.0758	5 & 130
46	46	289	12:31:00	-15.3794	-25.0763	5 & 155
47	47	290	05:35:00	-18.2593	-25.1199	5 & 162
50	48	291	05:21:00	-20.6717	-25.0104	5 & 152
51	49	291	12:40:00	-21.3395	-25.0126	5 & 149
52	50	292	04:47:00	-23.7305	-25.0044	5 & 135
53	51	292	11:10:00	-24.4653	-25.0244	5 & 125
54	52	293	04:28:00	-23.7305	-25.0044	5 & 110
56	53	293	12:29:00	-28.1528	-24.2963	5 & 117
57	54	294	04:32:00	-30.3846	-25.3126	5 & 117
58	55	294	12:34:00	-31.304	-25.7261	5 & 76
59	56	295	04:35:00	-33.584	-26.7826	5 & 90
60	57	295	12:29:00	-34.429	-27.1853	5 & 53
61	58	296	04:28:00	-36.5252	-28.1492	5 & 60
63	59	296	12:35:00	-37.3326	-28.4338	5 & 40
64	60	297	04:27:00	-39.702	-28.6674	5 & 50
65	61	297	10:47:00	-37.3326	-28.7479	5 & 50
66	62	299	04:33:00	-44.9115	-31.0798	5 & 70
67	63	299	12:26:00	-45.6656	-31.4945	5 & 75
68	64	300	04:33:00	-47.4477	-32.4856	5 & 60
69	65	300	12:55:00	-48.0825	-32.8697	5 & 60
70	66	301	04:48:00	-49.7765	-33.7832	5 & 110
72	67	301	13:53:00	-50.2881	-34.0868	5 & 75
74	69	302	12:46:00	-52.4454	-35.3752	5 & 125
75	70	303	04:23:00	-53.9372	-36.3026	5 & 70
76	71	304	13:40:00	-53.9964	-36.841	5 & 65
77	72	305	05:30:00	-53.5903	-39.9757	5 & 45
78	73	305	13:41:00	-53.3919	-41.5394	5 & 75
79	74	306	05:25:00	-53.0123	-45.0883	5 & 50
Underway	N/A	267	15:00:00	49.3099	-6.49033	5
Underway	N/A	268	09:15:00	48.241	-9.5237	5
Underway	N/A	268	12:18:00	48.033	-10.09681	5
Underway	N/A	269	04:21:00	48.38156	-12.69481	5
Underway	N/A	269	09:53:00	45.84234	-13.57464	5
Underway	N/A	270	04:22:00	44.16155	-16.05389	5
Underway	N/A	270	10:22:00	43.75953	-16.60107	5
Underway	N/A	271	04:28:00	41.78417	-19.38577	5
Underway	N/A	271	04:28:00	41.78417	-19.38577	5
Underway	N/A	271	11:13:00	41.33661	-20.01598	5
Underway	N/A	272	03:43:00	39.7107	-22.24896	5
Underway	N/A	272	10:54:00	39.16737	-22.9713	5
Underway	N/A	272	14:15:00	38.96662	-23.1672	5

STATION	CTD	Day of Year	TIME (GMT)	LAT (degrees)	LON (degrees)	SAMPLE DEPTH (m)
Underway	N/A	273	04:23:00	37.65923	-24.90849	5
Underway	N/A	273	13:55:00	37.69332	-24.9305	5
Underway	N/A	274	04:41:00	36.12913	-26.07402	5
Underway	N/A	274	13:27:00	35.02216	-26.3484	5
Underway	N/A	275	04:45:00	32.51371	-26.98868	5
Underway	N/A	275	13:15:00	31.52678	-27.2185	5
Underway	N/A	276	04:40:00	29.16045	-27.83205	5
Underway	N/A	276	13:18:00	27.97262	-28.09836	5
Underway	N/A	277	04:50:00	25.45214	-28.73421	5
Underway	N/A	277	13:14:00	24.59039	-28.91593	5
Underway	N/A	278	04:43:00	22.1452	-29.50636	5
Underway	N/A	278	13:16:00	21.16579	-29.72914	5
Underway	N/A	279	04:44:00	18.77901	-29.68561	5
Underway	N/A	279	13:17:00	17.79205	-29.40788	5
Underway	N/A	280	04:50:00	15.33899	-28.80141	5
Underway	N/A	279	13:43:00	14.50228	-28.56974	5
Underway	N/A	280	17:19:00	13.95895	-28.43819	5
Underway	N/A	281	04:46:00	12.03669	-27.97602	5
Underway	N/A	281	13:15:00	11.21498	-27.73543	5
Underway	N/A	282	04:46:00	8.77246	-27.15761	5
Underway	N/A	282	13:16:00	7.75997	-26.88272	5
Underway	N/A	283	04:47:00	5.28052	-26.29437	5
Underway	N/A	283	12:48:00	4.48613	-26.08004	5
Underway	N/A	284	04:47:00	2.04548	-25.50099	5
Underway	N/A	284	13:18:00	1.1584	-25.2578	5
Underway	N/A	285	04:42:00	-1.32766	-25.00781	5
Underway	N/A	285	13:19:00	-2.2516	-24.9926	5
Underway	N/A	286	04:45:00	-4.75564	-25.02455	5
Underway	N/A	286	13:19:00	-5.81101	-25.02677	5
Underway	N/A	287	04:46:00	-8.30316	-25.0441	5
Underway	N/A	287	12:17:00	-9.05869	-25.04403	5
Underway	N/A	288	04:46:00	-11.74893	-25.06529	5
Underway	N/A	288	11:22:00	-11.82939	-25.05236	5
Underway	N/A	288	13:17:00	-11.8297	-25.05194	5
Underway	N/A	289	04:02:00	-14.35412	-25.07651	5
Underway	N/A	289	13:15:00	-15.37936	-25.07638	5
Underway	N/A	290	04:48:00	-18.18341	-25.12231	5
Underway	N/A	290	05:55:00	-18.25929	-25.11992	5
Underway	N/A	291	04:42:00	-20.58841	-25.01172	5
Underway	N/A	291	11:22:00	-21.33975	-25.01304	5
Underway	N/A	291	13:14:00	-21.33975	-25.01304	5
Underway	N/A	292	03:47:00	-23.65937	-25.02993	5

STATION	CTD	Day of Year	TIME (GMT)	LAT (degrees)	LON (degrees)	SAMPLE DEPTH (m)
Underway	N/A	292	12:18:00	-24.46521	-25.02643	5
Underway	N/A	293	03:47:00	-27.19466	-24.47805	5
Underway	N/A	293	13:14:00	-28.15228	-24.29661	5
Underway	N/A	294	03:45:00	-30.30737	-25.27338	5
Underway	N/A	294	13:14:00	-31.30473	-25.72514	5
Underway	N/A	295	03:46:00	-33.51125	-26.75054	5
Underway	N/A	295	12:36:00	-34.42892	-27.18528	5
Underway	N/A	296	03:46:00	-36.44542	-28.12025	5
Underway	N/A	296	13:32:00	-37.3329	-28.43409	5
Underway	N/A	297	03:42:00	-39.61231	-28.6515	5
Underway	N/A	297	11:22:00	-40.39566	-28.7479	5
Underway	N/A	298	03:42:00	-42.25143	-29.68811	5
Underway	N/A	298	12:34:00	-43.05729	-30.09568	5
Underway	N/A	299	03:44:00	-44.86615	-31.05415	5
Underway	N/A	299	12:29:00	-45.66559	-31.49445	5
Underway	N/A	300	03:44:00	-47.38935	-32.45323	5
Underway	N/A	300	12:32:00	-48.08196	-32.86244	5
Underway	N/A	301	03:44:00	-49.72042	-33.75509	5
Underway	N/A	301	13:28:00	-50.29004	-34.09502	5
Underway	N/A	302	03:44:00	-51.79873	-34.9781	5
Underway	N/A	302	13:15:00	-52.44775	-35.37427	5
Underway	N/A	303	04:30:00	-53.9372	-36.3026	5
Underway	N/A	304	13:55:00	-53.99566	-36.84222	5
Underway	N/A	305	04:46:00	-53.60508	-39.84963	5
Underway	N/A	305	13:51:00	-53.39045	-41.54209	5
Underway	N/A	306	04:47:00	-53.02229	-44.99486	5
Underway	N/A	306	13:28:00	-52.8354	-46.77509	5
Underway	N/A	307	10:36:00	-52.24727	-52.24422	5

References

Van Heukelem, L. and Thomas, C.S. (2001) Computer-assisted high performance liquid chromatography method development with applications to the isolation and analysis of phytoplankton pigments, *J. Chromatogr. A*, 910, 31–49

Measurements of optical properties

Giorgio Dall'Olmo and Bob Brewin

Plymouth Marine Laboratory

Goal

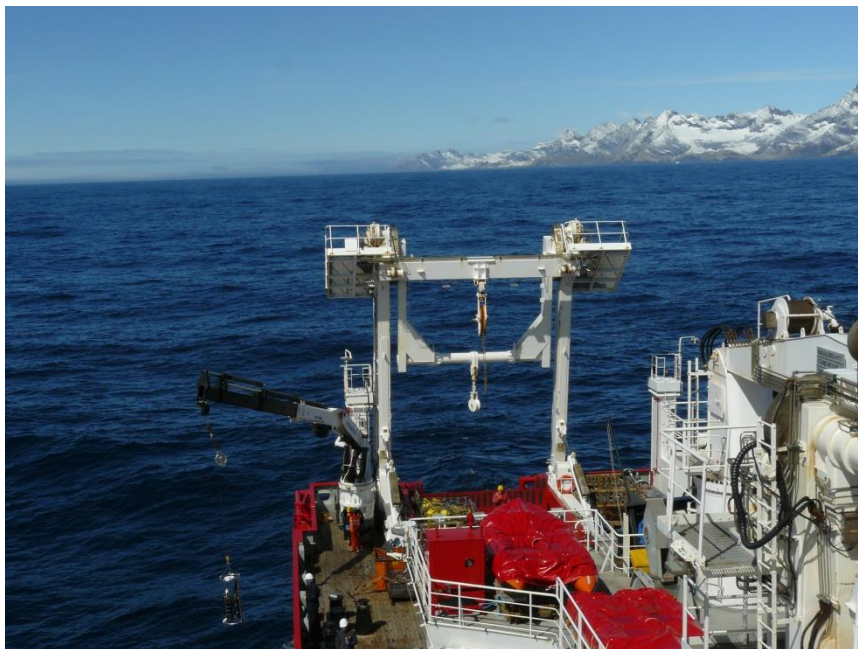
- To determine surface and depth-resolved optical properties along the transect in support of satellite calibration/validation activities.

Methods

- Particulate optical backscattering coefficient (470, 532, 700 nm), beam-attenuation and absorption coefficients (400–750 nm) were determined quasi-continuously from the ship's underway water following methods detailed in Dall'Olmo et al. (2009).
- In-situ optical backscattering measurements were also collected by means of a profiling package mounting a SBE CTD and a WETLabs AC9 to determine the particulate absorption and attenuation coefficients over the upper 250 m. The profiling package was deployed once a day simultaneously with the noon time CTD cast.
- A WETLabs ECO-BB3 sensor (3 channels) and a HobiLabs Hydroscat 6 sensor (6 channels plus chlorophyll fluorescence) were installed on the rosette frame and collected profiles of optical backscattering at all CTD casts in the upper 500 m.
- Above-water radiometric measurements were taken quasi-continuously using a Satlantic HyperSAS system. The HyperSAS optical remote-sensing system provided hyperspectral measurements of spectral water-leaving radiance and downwelling spectral irradiance, from which the above-water remote-sensing reflectance can be computed. The 136-channel HyperOCR radiance and irradiance sensors were mounted onboard the ship to simultaneously view the sea surface and sky.
- Hyperspectral in-water upward radiance measurements were also collected using a TRIOS Ramses radiometer at selected stations. The radiometer was installed on a floating frame that was deployed from the stern of the ship (Table 1).

References

Dall'Olmo et al. (2009) Significant contribution of large particles to optical backscattering in the open ocean. *Biogeosciences*, 6, 947–967.



PML optics rig being recovered with South Georgia in the Background (photo: A. Rees)

Table 4. List of in-water radiometric system deployments.

Day of year 2016	Hour (GMT)	Day of year 2016	Hour (GMT)
271	12:40	289	13:40
271	16:17	290	13:20
272	12:38	291	11:24
272	15:47	291	12:09
273	15:44	292	10:52
274	15:18	292	12:24
275	15:21	293	10:30
275	15:21	293	11:05
276	13:20	293	12:27
277	13:22	293	13:38
278	12:04	294	12:23
278	13:09	294	13:34
279	12:22	295	11:22
279	13:38	295	12:37
280	12:21	296	10:48
280	13:35	296	11:24
281	12:23	296	12:22
281	13:31	296	13:44
282	12:24	297	10:25
282	13:28	297	12:03
283	12:01	299	11:25
283	13:08	299	12:03
284	12:22	299	13:46
284	13:47	300	11:23
285	12:19	300	13:15
285	13:41	301	10:32
286	12:17	301	10:43
286	13:26	301	12:27
287	11:12	302	11:52
287	11:14	302	13:07
287	12:23	304	13:29
288	11:19	304	14:40
288	12:32	305	13:22
289	12:23	305	14:45

Use of SUOMI NPP for derivation of Ocean particulate inorganic carbon concentration

Jason Hopkins (for William Balch)

Bigelow Laboratory for Ocean Sciences

Cruise Objectives

1. Collection of CTD and underway samples for analysis of particulate organic carbon (POC), particulate inorganic carbon (PIC), coccolith enumeration (cell counts), biogenic silica concentration (BSi), and scanning electron microscopy for coccolithophore species identification. The purpose of these samples was to provide an assessment of the inorganic and organic particle concentrations in surface water, provide indices of community composition, and analytical means to calibrate satellite PIC algorithms.

2. Operation of an along-track flow-through system from the ship's non-toxic seawater system to characterize the fine-scale hydrographic and bio-optical variability of the various water masses for satellite development of the NASA PIC algorithm.

3. Water-leaving radiance measurements in the visible and near infrared taken for characterizing the particulate content of the seawater and to provide sea-truth data for NASA's satellite-based radiance measurements.

Underway Sampling

Discrete underway samples were collected from the ship's Surf-Met (underway surface and meteorological data collection) flow system in the prep lab 3 to 4 times per day. Samples for particulate organic carbon (POC), particulate inorganic carbon (PIC), biogenic silica (BSi), and coccolith enumeration were obtained along with chlorophyll and salinity samples taken for fluorometer calibration (chlorophylls measured by James Ayliffe, BODC and salinity measured by John Wynar).

PIC samples were collected on 0.4 μm polycarbonate filters, rinsed with potassium tetraborate buffer, dried and stored in metal free centrifuge tubes. These will be analyzed by ICPOES for particulate calcium.

Coccolith and cell counts were collected on 0.45 μm Millipore HA (nitrocellulose) filters, rinsed with potassium tetraborate buffer, frozen at 20°C, dried, then mounted onto slides using Norland Optical Adhesive. They will later be enumerated by birefringence microscopy.

Biogenic silica (BSi) samples were filtered onto 0.4 μm polycarbonate filters, dried in clean centrifuge tubes, and will be analyzed following the protocol of Brzezinski and Nelson (1989).

POC samples were filtered onto pre-combusted glass fiber filters, rinsed with 0.2 μm filtered seawater, dried, and will later be fumed with concentrated HCl to remove inorganic carbon. They will be analyzed ashore at Bigelow Analytical Services.

Scanning electron microscopy (SEM) samples were collected at select underway stations on 0.4 μm polycarbonate filters, rinsed with potassium tetraborate buffer, dried, and stored in petri dishes for analysis on shore.

Blanks for filtered samples were collected twice weekly.

CTD Sampling

During the pre-dawn CTD eight depths down to 500 m were analyzed for POC, PIC, BSi, coccolith enumeration, and SEM as described above. For the afternoon CTD, eight depths down to 500m were also analyzed for PIC and BSi with only surface samples collected for POC and cell counts. Scanning electron microscopy samples were collected at the DCM and surface for the pre-dawn CTD and at the surface only for the afternoon CTD.

- **Flow-through Bio-optical System**

This system operates semi-continuously with water from the ship's non-toxic sea water supply flowing at a rate of 3-4 liters per minute. Every 5-10 minutes temperature and salinity are measured (with a SeaBird sensor), chlorophyll fluorescence (WETLabs Wet star), total backscattering at 532nm (bb_{tot} ; WETLabs ECO-VSF), acidified backscattering (bb_{acid} ; backscattering of the seawater suspension after the pH has been lowered to dissolve calcite and aragonite), and acid labile backscattering (bb' ; the difference between the bb_{tot} and bb_{acid}).

A WETLabs AC-9 is used to measure absorption and attenuation at 9 visible wavelengths (412, 440, 488, 510, 555, 630, 650, 676, and 715 nm) every 4 minutes and absorption and attenuation at the same wavelengths after the water was routed through a serially-mounted 1 μ m poresize, then 0.2 μ m poresize filter (during the intervening 4 minute segments).

Each morning an AC-9 and bb calibration was performed using 0.2 μ m (absolute) filtered seawater. Once per 7 – 10 days the entire system was disassembled, cleaned, and calibrated using Milli-Q water and also filtered seawater.

- **Above-water Radiance Measurements**

In order to check the PIC algorithm performance, free of atmospheric error, total upwelling radiance, downwelling sky radiance and total downwelling irradiance were measured on the *RRS James Clark Ross* using a Satlantic SeaWiFS Aircraft Simulator (MicroSAS). The same wavelengths are measured with the MicroSAS as are used in the 2-band and 3-band PIC algorithms (except the IR bands which are not needed for the implementation of the ship-derived, three-band algorithm because there is negligible atmospheric correction when measurements are made from ship).

The system consists of a down-looking ocean radiance sensor and an up-looking sky-viewing radiance sensor, both mounted on the meteorological platform. The water-viewing radiance detector was set to view the ocean surface at 40° from nadir and the sky-viewing radiance sensor was set to view the sky 40° from zenith (used in the correction for Fresnel reflectance) as recommended by Mueller et al. (2003b). The downwelling irradiance sensor was mounted at the top of the main mast. Data from these sensors will be used to calculate spectral normalized water-leaving radiance (after filtering out white-caps and high pitch/roll anomalies) for comparison to the satellite estimates of normalized water-leaving radiance.

Sensors were rinsed regularly with Milli-Q water in order to remove salt deposits and any dust. The water radiance sensor was able to view over an azimuth range of ~130° across the ship's heading with no contamination from the ship's deck or wake. The direction of the sensor was adjusted constantly to view the water 120° from the sun's azimuth, to minimize sun glint. This was done using a computer-based system that calculated the sun's azimuth angle relative to the ship's heading and elevation constantly. The system used the ship's gyro-compass to determine the heading of the ship. Depending on the ship's course, the computer controlled a stepper motor that turned the sensors to the proper viewing angle. Protocols for operation and calibration were performed according to Mueller (Mueller et al. 2003a; Mueller et al. 2003b; Mueller et al. 2003c). Data were collected between when the sun was above 20° elevation. Post-cruise, the 16Hz data will be filtered to remove as much residual white cap and glint as possible (we accept the lowest 5% of the data). Calibrations with 10% reflectance plaque were performed several times during the cruise in order to assess the status of the radiometric calibrations. A factory calibration of the radiometers was performed before the cruise.

- **Sampling metrics**

Flow-through optics: 43 days
Above water radiance measurements: 41 days
Underway samples: 110
CTD casts sampled: 67

CTD discrete samples collected

DATE	TIME	CTD CAST	LATITUDE (+ve N)	LONGITUDE (+ve E)	DEPTHS SAMPLED (m)
25/09/2016	0402	002	46.38	-12.69	500, 300, 200, 60, 48, 25, 18, 5
25/09/2016	1008	003	45.85	-13.59	4
25/09/2016	1319	004	45.67	-13.98	500, 300, 200, 80, 49, 30, 15, 5
26/09/2016	1305	007	43.52	-16.96	500, 300, 200, 68, 40, 25, 15, 5
27/09/2016	0402	008	41.78	-19.39	500, 300, 100, 70, 60, 45, 15, 5
27/09/2016	1003	009	41.32	-20.03	5
27/09/2016	1329	010	41.19	-20.23	500, 200, 100, 64, 40, 25, 15, 5
28/09/2016	0400	011	39.71	-22.26	400, 200, 100, 70, 65, 50, 30, 5
29/09/2016	0417	013	37.66	-24.91	500, 200, 100, 65, 55, 50, 30, 5
29/09/2016	1243	014	37.69	-24.93	500, 200, 150, 100, 60, 40, 25, 5
30/09/2016	0429	015	36.13	-26.07	500, 200, 110, 87, 80, 70, 20, 5
30/09/2016	1226	016	35.02	-26.35	500, 200, 100, 70, 40, 25, 15, 5
01/10/2016	0433	017	32.51	-26.99	500, 200, 100, 90, 80, 45, 35, 5
01/10/2016	1227	018	31.53	-27.22	500, 200, 150, 105, 75, 40, 25, 5
02/10/2016	0429	019	29.16	-27.83	500, 200, 126, 100, 85, 70, 30, 5
02/10/2016	1228	020	27.97	-28.10	500, 200, 150, 110, 90, 50, 30, 5
03/10/2016	0529	021	25.39	-28.74	500, 200, 124, 100, 85, 75, 30, 5
03/10/2016	1228	022	24.59	-28.92	500, 200, 160, 111, 90, 50, 25, 5
04/10/2016	0529	023	22.06	-29.52	500, 200, 150, 10, 80, 60, 25, 5
04/10/2016	1225	024	21.17	-29.73	500, 200, 150, 101, 75, 40, 25, 5
05/10/2016	0527	025	18.70	-29.66	500, 200, 125, 100, 53, 40, 20, 5
05/10/2016	1230	026	17.79	-29.41	500, 200, 150, 78, 60, 40, 20, 5
06/10/2016	0532	027	15.27	-28.78	500, 200, 125, 80, 54, 40, 20, 5
06/10/2016	1228	028	14.50	-28.57	500, 200, 175, 60, 30, 25, 15, 5
07/10/2016	0529	029	11.96	-27.96	500, 200, 100, 85, 47, 35, 15, 5
07/10/2016	1229	030	11.21	-27.74	500, 200, 150, 60, 45, 40, 20, 5

DATE	TIME	CTD CAST	LATITUDE (+ve N)	LONGITUDE (+ve E)	DEPTHS SAMPLED (m)
08/10/2016	0524	031	08.70	-27.14	500, 200, 125, 90, 52, 35, 20, 5
08/10/2016	1228	032	07.76	-26.88	500, 200, 150, 80, 56, 40, 20, 5
09/10/2016	0528	033	05.20	-26.27	500, 200, 100, 85, 70, 60, 20, 5
09/10/2016	1229	034	04.49	-26.08	500, 200, 150, 72, 60, 35, 15, 5
10/10/2016	0524	035	01.97	-25.48	500, 200, 100, 85, 70, 60, 20, 5
10/10/2016	1240	036	01.16	-25.26	500, 200, 150, 67, 60, 35, 15, 5
11/10/2016	0524	037	-01.42	-25.00	500, 200, 100, 92, 60, 20, 18, 5
12/10/2016	0525	039	-04.16	-25.02	500, 200, 125, 83, 50, 25, 10, 5
13/10/2016	0524	041	-08.38	-25.04	500, 200, 125, 83, 50, 30, 10, 5
13/10/2016	1119	042	-09.06	-25.04	500, 200, 150, 120, 105, 70, 15, 5
14/10/2016	0526	043	-11.82	-25.06	500, 200, 148, 90, 50, 30, 10, 5
14/10/2016	1256	044	-11.83	-25.05	500, 200, 140, 105, 70, 30, 15, 5
15/10/2016	0534	045	-14.45	-25.08	500, 200, 160, 130, 105, 70, 50, 5
15/10/2016	1231	046	-15.38	-25.08	500, 200, 155, 120, 80, 40, 15, 5
16/10/2016	0525	047	-18.26	-25.12	500, 200, 162, 140, 95, 55, 10, 5
17/10/2016	0521	048	-20.67	-25.01	500, 200, 152, 130, 95, 55, 10, 5
17/10/2016	1240	049	-21.34	-25.01	500, 200, 149, 120, 80, 40, 15, 5
18/10/2016	0427	050	-23.73	-25.02	500, 200, 135, 115, 80, 55, 10, 5
18/10/2016	1110	051	-24.47	-25.02	500, 200, 150, 125, 110, 80, 40, 5
19/10/2016	0428	052	-27.27	-24.45	500, 200, 110, 100, 70, 50, 10, 5
19/10/2016	1229	053	-28.15	-24.30	500, 200, 135, 117, 90, 50, 20, 5
20/10/2016	0432	054	-30.38	-25.31	500, 200, 117, 105, 70, 45, 10, 5
20/10/2016	1234	055	-31.30	-25.73	500, 200, 130, 90, 76, 60, 20, 5
21/10/2016	0435	056	-33.58	-26.78	500, 200, 100, 90, 70, 45, 10, 5
21/10/2016	1229	057	-34.43	-27.19	500, 200, 100, 70, 53, 40, 20, 5
22/10/2016	0428	058	-36.53	-28.15	500, 200, 100, 80, 60, 40, 10, 5
22/10/2016	1235	059	-37.33	-28.43	500, 200, 125, 80, 40, 20, 10, 5

DATE	TIME	CTD CAST	LATITUDE (+ve N)	LONGITUDE (+ve E)	DEPTHS SAMPLED (m)
23/10/2016	0427	060	-39.70	-28.67	500, 200, 100, 80, 50, 40, 10, 5
23/10/2016	10:47	061	-40.40	-28.75	500, 200, 100, 60, 50, 40, 20, 5
25/10/2016	0433	062	-44.91	-31.08	500, 200, 100, 70, 50, 40, 10, 5
25/10/2016	1226	063	-45.67	-31.49	500, 200, 90, 75, 60, 40, 20, 5
26/10/2016	0425	064	-47.45	-32.49	500, 200, 100, 70, 60, 40, 10, 5
26/10/2016	1255	065	-48.08	-32.87	500, 200, 100, 70, 60, 40, 20, 5
27/10/2016	0448	066	-49.78	-33.78	500, 200, 125, 110, 75, 40, 10, 5
27/10/2016	1353	067	-50.29	-34.09	500, 200, 100, 75, 40, 20, 10, 5
28/10/2016	1246	069	-52.45	-35.38	500, 200, 125, 105, 75, 40, 20, 5
29/10/2016	0423	070	-53.94	-36.30	200, 175, 100, 70, 50, 40, 10, 5
30/10/2016	1340	071	-54.00	-36.84	200, 150, 85, 65, 40, 20, 10, 5
31/10/2016	0530	072	-53.59	-39.98	500, 200, 125, 80, 45, 20, 15, 5
31//10/2016	1341	073	-53.39	-41.54	500, 200, 100, 75, 40, 20, 10, 5
01//11//2016	0525	074	-53.01	-45.09	500, 200, 125, 80, 50, 20, 15, 5

Underway discrete samples collected

DATE	TIME	STATION		DATE	TIME	STATION
24/09/2016	1000	AA		12/10/2016	1000	DL
24/09/2016	1200	AB		12/10/2016	1600	DN
24/09/2016	1500	AC		12/10/2016	2000	DO
24/09/2016	1900	AD		13/10/2016	1000	DQ
25/09/2016	1602	AF		13/10/2016	1600	DS
25/09/2016	2000	AG		13/10/2016	2040	DT
26/09/2016	0539	AH		14/10/2016	1000	DV
29/09/2016	1000	AI		14/10/2016	1600	DX
26/09/2016	1600	AL		14/10/2016	2000	DY
26/09/2016	2000	AM		15/10/2016	1002	EA
27/09/2016	1600	AO		15/10/2016	1600	EC
27/09/2016	2000	AP		15/10/2016	2000	ED
28/09/2016	1034	AS		16/10/2016	1000	EF
28/09/2016	1300	AT		16/10/2016	1600	EG

DATE	TIME	STATION		DATE	TIME	STATION
28/09/2016	1600	AU		16/10/2016	2000	EH
28/09/2016	2000	AV		17/10/2016	1000	EJ
29/09/2016	1000	AY		17/10/2016	1600	EL
29/09/2016	1600	BA		17/10/2016	2000	EM
29/09/2016	2000	BB		18/10/2016	1600	EP
30/09/2016	1002	BD		18/10/2016	2000	EQ
30/09/2016	1600	BF		19/10/2016	1000	ES
30/09/2016	2000	BG		19/10/2016	1600	EU
01/10/2016	1000	BI		19/10/2016	2000	EV
01/10/2016	1600	BL		20/10/2016	1000	EX
01/10/2016	2000	BM		20/10/2016	1603	EZ
02/10/2016	1000	BO		20/10/2016	2000	FA
02/10/2016	1600	BQ		21/10/2016	1000	FD
02/10/2016	2000	BR		21/10/2016	1600	FF
03/10/2016	1000	BT		21/10/2016	2000	FG
03/10/2016	1600	BV		22/10/2016	1000	FI
03/10/2016	2000	BW		22/10/2016	2000	FM
04/10/2016	1000	BY		23/10/2016	1000	FO
04/10/2016	1600	CA		23/10/2016	1600	FP
04/10/2016	2000	CB		23/10/2016	2000	FQ
05/10/2016	1000	CD		24/10/2016	0600	FR
05/10/2016	1600	CF		24/10/2016	1000	FS
05/10/2016	2000	CG		24/10/2016	1231	FT
06/10/2016	1002	CI		24/10/2016	1600	FU
06/10/2016	1600	CK		24/10/2016	2000	FV
06/10/2016	2000	CL		25/10/2016	1001	FX
07/10/2016	1001	CN		25/10/2016	1600	FZ
07/10/2016	1600	CP		25/10/2016	2000	GA
07/10/2016	2000	CQ		26/10/2016	1002	GC
08/10/2016	1000	CS		26/10/2016	1600	GE
08/10/2016	1600	CU		26/10/2016	2000	GF
08/10/2016	2000	CV		27/10/2016	1000	GH
09/10/2016	1000	CX		27/10/2016	2000	GJ
09/10/2016	1600	CZ		28/10/2016	0530	GK
09/10/2016	2000	DA		28/10/2016	1000	GL
10/10/2016	1000	DC		28/10/2016	1600	GN

DATE	TIME	STATION		DATE	TIME	STATION
10/10/2016	1600	DE		28/10/2016	2000	GO
10/10/2016	2000	DF		30/10/2016	2000	GS
11/10/2016	1000	DH		31//10/2016	1100	GU
11/10/2016	1230	DI		31//10/2016	1700	GW
11/10/2016	2000	DJ		31/10/2016	2100	GX

References

Brzezinski, M.A., Nelson, D.M., 1989. Seasonal changes in the silicon cycle within a Gulf Stream warm-core ring. *Deep-Sea Research* 36, 1009–1030.

Mueller J.L., Austin R.W., Morel A., Fargion G.S., McClain C.R. 2003a. Ocean optics protocols for satellite ocean color sensor validation, Revision 4, Volume I: Introduction, background, and conventions. Greenbelt, MD: Goddard Space Flight Center. 50 p.

Mueller J.L., Morel A., Frouin R., Davis C., Arnone R., Carder K., Lee Z.P., Steward R.G., Hooker S.B., Mobley C.D., McLean S., Holben B., Miller M., Pietras C., Knobelspiesse K.D., Fargion G.S., Porter J., Voss K. 2003b. Ocean optics protocols for satellite ocean color sensor validation, Revision 4, Volume III: Radiometric measurements and data analysis protocols. Greenbelt, MD: Goddard Space Flight Center. 78 p.

Mueller J.L., Pietras C., Hooker S.B., Austin R.W., Miller M., Knobelspiesse K.D., Frouin R., Holben B., Voss K. 2003c. Ocean optics validation protocols for satellite ocean color sensor validation, Revision 4, Volume II: Instrument specifications, characterisation and calibration. Greenbelt, MD: Goddard Space Flight Center.

Primary Production and PAB's

Denise G. Cummings

Plymouth Marine Laboratory

OBJECTIVES.

During AMT26 integrated Primary production measurements were made at 32 stations on three size classes of phytoplankton from measurements taken from five or six depths. Samples were also taken from the underway and surface from the CTD for PAB's to coincide with the ESA satellite overpass. These measurements aim to fulfil the following objectives within:

- *The main deliverable is to provide an unique time series (1995-2016) of spatially extensive and internally consistent observations on the structure and biogeochemical properties of planktonic ecosystems in the Atlantic Ocean that are required to validate models addressing questions related to the global carbon cycle. One of the key parameters is phytoplankton production. To this end a continuous long track series of primary production measurements have been made on AMT26 using methods synonymous to those used in previous AMT cruises.*

METHODS.

Primary production. Water samples were taken from pre-dawn (03:15-05:15 GMT) deployments of 21 x 10 + 3 x 20l SeaBird CTD rosette sampler on a stainless steel frame from 6 depths in the euphoic zone following the methods described in *Tilstone et al.* (2009). The samples were transferred from Niskin bottles to black carboys to prevent shock to the photosynthetic lamellae of the phytoplankton cells. Water from each sample was sub sampled into three 75 ml clear polycarbonate bottles and three polycarbonate bottles which are then covered in tin foil; all bottles were pre cleaned following JGOFS protocols (IOC, 1994), to reduce trace metal contamination. Each sample was inoculated with between 185 and 370 kBq (5 - 10 μ Ci) $\text{NaH}^{14}\text{CO}_3$ according to the biomass of phytoplankton. The polycarbonate bottles were transferred to an on deck (simulated in situ) incubation system using neutral density and blue filters to simulate subsurface irradiance over depth to 97%, 55%, 33%, 20%, 14%, 7%, 1% or 0.1% of the surface value and incubated from local dawn to dusk (appox.12 h). The incubators were maintained at surface temperature by pumping sea water from a depth of ~7 m through the upper light level incubators (97, 55, 33 & 14%) and from a chiller maintained at $\pm 3^\circ\text{C}$ of in situ temperature for the lower light level incubators (7, 1, 0.1%). To terminate the incubations, suspended material were filtered sequentially through 10 μm , 2 μm and 0.2 μm polycarbonate nucleopore filters to measure the micro, nano and pico-phytoplankton production respectively. The filters were exposed to concentrated HCl fumes for 12 h immersed in scintillation cocktail and ^{14}C disintegration time per minute (DPM) was measured on board using a Perkin Elmer, Tricarb 2910 TR liquid scintillation counter, the external standard and the channel ratio methods were applied to correct for quenching

Table 1. Stations at which size fractionated primary production (PP) measurements were taken

CTD	Date	Time in water	Lat	Long	Depths (m)
2	25-Sep	04:08	46° 22.895' N	12° 41.697' W	5, 12, 18, 29, 48
8	27-Sep	03:58	41° 47.051' N	19° 23.145' W	5, 10, 15, 20, 35, 60
11	28-Sep	03:58	39° 42.581' N	22° 15.488' W	5, 10, 15, 20, 40, 65
13	29-Sep	04:18	37° 39.556' N	24° 54.510' W	5, 10, 15, 20, 30, 55
15	30-Sep	04:30	36° 7.748' N	26° 4.441' W	5, 10, 20, 30, 55, 87
18	01-Oct	04:33	32° 30.823' N	26° 59.323' W	5, 15, 25, 60, 100, 150

CTD	Date	Time	Lat	Long	Depths
19	02-Oct	04:30	29° 9.625' N	27° 49.922' W	5, 15, 30, 70, 126, 175
21	03-Oct	05:29	25° 23.168' N	28° 44.668' W	5, 15, 30, 75, 124, 200
23	04-Oct	05:29	22° 3.518' N	29° 31.453' W	5, 15, 35, 60, 100, 150
25	05-Oct	05:27	18° 42.023' N	29° 39.719' W	5, 10, 15, 40, 53, 100
27	06-Oct	05:30	15° 16.465' N	28° 47.052' W	5, 10, 15, 40, 54, 80
29	07-Oct	05:30	11° 57.854' N	27° 57.374' W	5, 10, 15, 35, 47, 100
31	08-Oct	05:24	8° 41.857' N	27° 8.207' W	5, 10, 20, 35, 52, 90
33	09-Oct	05:29	5° 12.07' N	26° 16.488' W	5, 10, 20, 45, 70, 100
35	10-Oct	05:24	1° 58.486' N	25° 28.981' W	5, 10, 20, 60, 70, 100
39	12-Oct	05:26	04° 40.598' S	25° 1.356' W	5, 10, 20, 50, 83, 150
41	13-Oct	05:25	8° 22.589' S	25° 2.454' W	5, 10, 20, 30, 50, 83
43	14-Oct	05:26	11° 49.41' S	25° 3.798' W	5, 20, 40, 90, 148, 200
45	15-Oct	05:28	14° 26.911' S	25° 4.549' W	5, 20, 35, 80, 130, 200
47	16-Oct	05:26	18° 15.557' S	25° 7.196' W	5, 20, 40, 95, 162, 250
48	17-Oct	05:23	20° 40.304' S	25° 0.624' W	5, 20, 40, 95, 152, 250
50	18-Oct	04:28	23° 43.832' S	25° 1.464' W	5, 20, 35, 80, 135, 200
52	19-Oct	04:28	27° 16.210' S	24° 27.036' W	5, 20, 30, 70, 110, 180
54	20-Oct	04:34	30° 23.076' S	25° 18.758' W	5, 15, 30, 70, 117, 175
56	21-Oct	04:32	33° 35.038' S	26° 46.954' W	5, 15, 30, 70, 90, 150
58	22-Oct	04:29	36° 31.513' S	28° 8.950' W	5, 10, 15, 30, 40, 60
60	23-Oct	04:28	39° 42.118' S	28° 40.044' W	5, 10, 15, 30, 40, 50
62	25-Oct	04:34	44° 54.691' S	31° 4.788' W	5, 10, 20, 40, 50, 70
64	26-Oct	04:26	47° 26.862' S	32° 29.135' W	5, 10, 15, 30, 40, 60
66	27-Oct	04:50	49° 46.59' S	33° 46.990' W	5, 15, 30, 50, 60, 110
70	29-Oct	04:22	53° 56.232' S	36° 18.156' W	5, 10, 20, 30, 40, 70
72	31-Oct	05:30	53° 35.417' S	39° 58.542' W	5, 10, 15, 25, 35, 45

Table 2. Underway and surface CTD Stations where PAB measurements were taken

Date	Event	Lat	Long	Time
25/09/2016	uw			09:31
25/09/2016	uw			10:24
25/09/2016	CTD003	45.8366	-13.5917	10:10
26/09/2016	uw	43.7912	-16.5507	09:32
26/09/2016	uw	43.7595	-16.6011	10:21

Date	Event	Lat	Long	Time
26/09/2016	CTD006	43.7595	-16.6011	09:59
27/09/2016	uw	41.3682	-19.9582	09:21
27/09/2016	uw	41.3218	-20.0257	10:20
27/09/2016	CTD009	41.3218	-20.0258	10:00
28/09/2016	uw	39.1808	-22.9697	09:31
28/09/2016	uw	39.1724	-22.9666	10:26
28/09/2016	CTD012	39.1724	-22.9667	10:02
29/09/2016	uw	37.6952	-24.9217	09:27
29/09/2016	uw	37.6932	-24.9318	12:19
30/09/2016	uw	35.0218	-26.3497	12:19
30/09/2016	CTD016	35.0218	-26.3497	12:26
01/10/2016	uw	31.6582	-27.2105	11:14
01/10/2016	CTD018	31.5268	-27.2187	12:26
02/10/2016	uw	27.9726	-28.0984	12:19
02/10/2016	CTD020	27.9726	-28.0984	12:22
03/10/2016	uw	24.5904	-28.9159	12:22
03/10/2016	CTD022	24.5904	-28.9159	12:25
04/10/2016	uw	21.1657	-29.7292	12:25
04/10/2016	CTD024	21.1657	-29.7292	12:21
05/10/2016	uw	17.7916	-29.4079	12:19
05/10/2016	CTD026	17.7918	-29.4077	12:28
06/10/2016	uw	14.5019	-28.5703	12:16
06/10/2016	CTD028	14.5018	-28.5703	12:22
07/10/2016	uw	11.2131	-27.7364	12:17
07/10/2016	CTD030	11.2145	-27.7355	12:28
08/10/2016	uw	7.7600	-26.8832	12:21
08/10/2016	CTD032	7.7600	-26.8830	12:26
09/10/2016	uw	4.4862	-26.0801	12:20
09/10/2016	CTD034	4.4861	-26.0801	12:27
10/10/2016	uw	1.1565	-25.2606	12:21
10/10/2016	CTD036	1.1584	-25.2597	12:39
11/10/2016	CTD038	-2.2516	-24.9926	12:32
12/10/2016	uw	-5.8110	-25.0271	12:12
12/10/2016	CTD040	-5.8110	-25.0268	12:27
13/10/2016	uw	-9.0587	-25.0440	11:23
13/10/2016	CTD042	-9.0585	-25.0443	11:17
14/10/2016	uw	-11.8297	-25.0520	13:13
14/10/2016	CTD044	-11.8297	-25.0520	12:53
15/10/2016	uw	-15.3792	-25.0768	12:20
15/10/2016	CTD046	-15.3793	-25.0764	12:28
17/10/2016	uw	-21.3395	-25.0124	12:23
17/10/2016	CTD049	-21.3395	-25.0124	12:37

Date	Event	Lat	Long	Time
18/10/2016	uw	-24.4652	-25.0264	11:25
18/10/2016	CTD051	-24.4652	-25.0264	11:08
19/10/2016	uw	-28.0388	-24.2551	11:25
19/10/2016	CTD053	-28.1527	-24.2963	12:27
20/10/2016	uw	-31.3044	-25.7256	12:28
20/10/2016	CTD055	-31.3047	-25.7252	12:33
21/10/2016	uw	-34.4290	-27.1852	12:19
21/10/2016	CTD057	-34.4290	-27.1853	12:23
22/10/2016	uw	-37.3315	-28.4319	12:20
22/10/2016	CTD059	-37.3326	-28.4338	12:36
23/10/2016	uw	-40.3957	-28.7479	11:24
23/10/2016	CTD061	-40.3957	-28.7479	10:45
25/10/2016	uw	-45.6656	-31.4945	12:16
25/10/2016	CTD063	-45.6656	-31.4945	12:24
26/10/2016	uw	-47.9769	-32.8015	10:18
26/10/2016	CTD065	-48.0823	-32.8680	12:52
27/10/2016	uw	-50.2929	-34.1050	13:07
27/10/2016	CTD067	-50.2876	-34.0851	13:20
28/10/2016	uw	-52.4450	-35.3755	12:28
28/10/2016	CTD069	-52.4461	-35.3744	12:44
30/10/2016	uw	-53.9964	-36.8410	12:20
30/10/2016	CTD071	-53.9957	-36.8423	13:39
31/10/2016	uw	-53.3927	-41.5385	13:16
31/10/2016	CTD073	-53.3919	-41.5394	13:41

References:

- Platt, T., Gallegos, C.L. and Harrison, W.G., 1980. Photoinhibition of photosynthesis in natural assemblage of marine phytoplankton. *J Mar Res*, 38: 687-701.
- Tilstone, G.H., Figueiras, F.G., Lorenzo, L.M. and Arbones, B., 2003. Phytoplankton composition, photosynthesis and primary production during different hydrographic conditions at the Northwest Iberian upwelling system. *Marine Ecology-Progress Series*, 252: 89-104.
- Tilstone, G. H., et al. 2004. *REVAMP Protocols; Regional Validation of MERIS chlorophyll products in North Sea coastal waters.*, 77 pp., Working meeting on MERIS and AATSR Calibration and Geophysical Validation (MAVT 2003). European Space Agency, ESRIN, Italy, 20-24 Oct 2004.
- Tilstone, G.H., Smyth, T.J., Poulton, A, Hutson R. 2009. Measured and remotely sensed estimates of primary production in the Atlantic Ocean from 1998 to 2005. *Deep-Sea Research*, 56(15), 918-930.

Microplastics and POC sampling with large volume *in situ* pumps (SAPs)

Katsia Pabortsava

National Oceanography Centre

Microplastics and biogenic particles in the water column were collected with large-volume stand-alone *in situ* pumps (SAPs; Fig. 1A).

The SAPs were deployed at 3 discrete depths collecting particles onto acetone-washed 55 μm stainless steel mesh (pre-filter) and 10% HCl-washed 1 μm NITEX[®] nylon mesh (main filter). Filter loading, sample preparation, and processing were always carried out under the laminar flow hood on board of the ship. The SAPs were set to pump for 50 min (30 min and 40 min for SAPS deployments #1 and #2; Table 1), filtering between 400-1500 L of seawater (Table 1). Upon recovery, the meshes were carefully removed from filter holders, folded and packed into a zip-lock plastic bag (55 μm mesh) and aluminium foil (1 μm mesh) and stored at -20°C until analysis (Fig. 1B-D). For contamination control, 55 μm and 1 μm meshes were prepared as for sampling but not used on a SAP unit.

In total, 30 successful SAPs deployments were carried out, yielding 92 samples for 55 μm size fraction (including 3 blanks) and 86 samples for 1 μm size fraction (including 2 blanks) (Table 1).

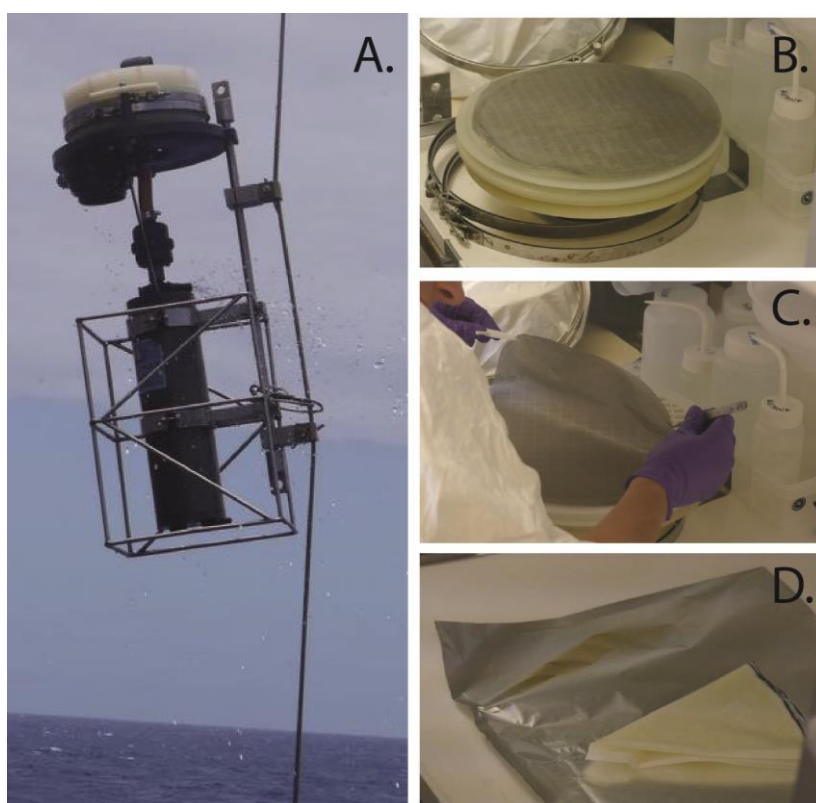


Figure 6: A. Large volume in situ Stand Alone Pump (SAP) used to collect microplastics and marine particles; B-D. Processing SAPs samples under the laminar flow hood (Photos by W. Wimmer).

Table 5: SAPs deployment log. Failed deployments are highlighted in red

Date	ID	Lat (°N)	Lon (°W)	S/N	Depth (m)	Pump time (min)	Mesh size (µm)	Vol filtered (L)
25.09	SAPS-01	45.67	13.64	03-06	10	30	55, 1	27
25.09	SAPS-01	45.67	13.64	03-01	60	30	55, 1	818
25.09	SAPS-01	45.67	13.64	03-07	100	30	55, 1	760
27.09	SAPS-02	41.19	20.22	03-03	10	40	55, 1	898
27.09	SAPS-02	41.19	20.22	03-07	65	40	55, 1	594
27.09	SAPS-02	41.19	20.22	03-01	150	40	55, 1	803
29.09	SAPS-03	37.69	24.93	03-03	10	50	55, 1	870
29.09	SAPS-03	37.69	24.93	03-01	65	50	55, 1	802
29.09	SAPS-03	37.69	24.93	03-07	150	50	55, 1	1240
01.10	SAPS-04	31.53	27.22	03-03	10	50	55, 1	1452
01.10	SAPS-04	31.53	27.22	03-07	100	50	55, 1	1259
01.10	SAPS-04	31.53	27.22	03-01	200	50	55, 1	852
03.10	SAPS-05	24.59	28.92	03-03	10	50	55, 1	1460
03.10	SAPS-05	24.59	28.92	03-01	125	50	55, 1	1017
03.10	SAPS-05	24.59	28.92	03-07	225	50	55, 1	1260
04.10	SAPS-06	21.17	29.73	03-01	10	50	55, 1	1257
04.10	SAPS-06	21.17	29.73	03-03	100	50	55, 1	1425
04.10	SAPS-06	21.17	29.73	03-07	200	50	55, 1	1122
05.10	SAPS-07	17.79	29.41	03-07	10	50	55, 1	1248
05.10	SAPS-07	17.79	29.41	03-01	50	50	55, 1	1129
05.10	SAPS-07	17.79	29.41	03-03	150	50	55, 1	1436
06.10	SAPS-08	14.50	28.57	03-01	10	50	55, 1	1534
06.10	SAPS-08	14.50	28.57	03-03	50	50	55, 1	1423
06.10	SAPS-08	14.50	28.57	03-07	150	50	55, 1	1271
07.10	SAPS-09	11.21	27.74	03-07	10	50	55, 1	1266
07.10	SAPS-09	11.21	27.74	03-03	50	50	55, 1	1370
07.10	SAPS-09	11.21	27.74	03-01	150	50	55, 1	832
08.10	SAPS-10	7.76	26.88	03-07	10	50	55, 1	1283
08.10	SAPS-10	7.76	26.88	03-03	50	50	55, 1	1429
08.10	SAPS-10	7.76	26.88	03-01	150	50	55, 1	1083
09.10	SAPS-11	4.49	26.08	03-07	10	50	55, 1	1262
09.10	SAPS-11	4.49	26.08	03-03	70	50	55, 1	1435
09.10	SAPS-11	4.49	26.08	03-01	170	50	55, 1	926
10.10	SAPS-12	1.16	25.26	03-07	10	50	55, 1	1197
10.10	SAPS-12	1.16	25.26	03-03	70	50	55, 1	1448

Date	ID	Lat (°N)	Lon (°W)	S/N	Depth (m)	Pump time (min)	Mesh size (µm)	Vol filtered (L)
10.10	SAPS-12	1.16	25.26	03-01	170	50	55, 1	703
11.10	SAPS-13	-2.25	24.99	03-07	10	50	55, 1	1263
11.10	SAPS-13	-2.25	24.99	03-03	100	50	55, 1	1478
11.10	SAPS-13	-2.25	24.99	03-01	200	50	55, 1	880
12.10	SAPS-14	-5.81	25.03	03-07	10	50	55, 1	1256
12.10	SAPS-14	-5.81	25.03	03-03	100	50	55, 1	1464
12.10	SAPS-14	-5.81	25.03	03-01	200	50	55, 1	1065
13.10	SAPS-15	-9.06	25.04	03-07	10	50	55, 1	1240
13.10	SAPS-15	-9.06	25.04	03-03	100	50	55, 1	1462
13.10	SAPS-15	-9.06	25.04	03-01	200	50	55, 1	989
14.10	SAPS-16	-11.83	25.05	03-07	10	50	55	1289
14.10	SAPS-16	-11.83	25.05	03-03	150	50	55	1512
14.10	SAPS-16	-11.83	25.05	03-01	250	50	55	1021
15.10	SAPS-17	-15.38	25.08	03-07	10	50	55, 1	1247
15.10	SAPS-17	-15.38	25.08	03-03	140	50	55, 1	1442
15.10	SAPS-17	-15.38	25.08	03-01	240	50	55, 1	931
17.10	SAPS-18	-21.34	25.01	03-07	10	50	55, 1	1253
17.10	SAPS-18	-21.34	25.01	03-03	170	50	55, 1	1453
17.10	SAPS-18	-21.34	25.01	03-01	270	50	55, 1	797
18.10	SAPS-19	-24.47	25.03	03-07	10	50	55, 1	1241
18.10	SAPS-19	-24.47	25.03	03-03	140	50	55, 1	1465
18.10	SAPS-19	-24.47	25.03	03-01	240	50	55, 1	859
19.10	SAPS-20	-28.15	24.30	03-07	10	50	55, 1	1252
19.10	SAPS-20	-28.15	24.30	03-03	110	50	55, 1	1468
19.10	SAPS-20	-28.15	24.30	03-01	210	50	55, 1	858
20.10	SAPS-21	-31.30	25.73	03-07	10	50	55, 1	1257
20.10	SAPS-21	-31.30	25.73	03-03	120	50	55, 1	1476
20.10	SAPS-21	-31.30	25.73	03-01	220	50	55, 1	797
21.10	SAPS-22	-34.43	27.19	03-07	10	50	55	1296
21.10	SAPS-22	-34.43	27.19	03-03	100	50	55	1460
21.10	SAPS-22	-34.43	27.19	03-01	200	50	55	899
22.10	SAPS-23	-37.33	28.43	03-07	10	50	55, 1	1259
22.10	SAPS-23	-37.33	28.43	03-03	100	50	55, 1	1458
22.10	SAPS-23	-37.33	28.43	03-01	200	50	55, 1	507
23.10	SAPS-24	-40.40	28.75	03-07	10	50	55, 1	71
23.10	SAPS-24	-40.40	28.75	03-03	100	50	55, 1	1410

Date	ID	Lat (°N)	Lon (°W)	S/N	Depth (m)	Pump time (min)	Mesh size (µm)	Vol filtered (L)
23.10	SAPS-24	-40.40	28.75	03-01	200	50	55, 1	792
25.10	SAPS-25	-45.67	31.49	03-01	10	50	55, 1	436
25.10	SAPS-25	-45.67	31.49	03-03	100	50	55, 1	1074
25.10	SAPS-25	-45.67	31.49	03-07	200	Pressure test		
26.10	SAPS-26	-48.08	32.86	03-07	10	50	55, 1	452
26.10	SAPS-26	-48.08	32.86	03-03	100	50	55, 1	894
26.10	SAPS-26	-48.08	32.86	03-01	200	50	55, 1	580
27.10	SAPS-27	-50.30	34.11	03-07	10	50	55, 1	508
27.10	SAPS-27	-50.30	34.11	03-03	100	50	55, 1	809
27.10	SAPS-27	-50.30	34.11	03-01	200	50	55, 1	659
28.10	SAPS-28	-52.45	35.37	03-07	10	50	55, 1	675
28.10	SAPS-28	-52.45	35.37	03-03	100	50	55, 1	1185
28.10	SAPS-28	-52.45	35.37	03-01	200	50	55, 1	761
30.10	SAPS-29	-54.00	36.84	03-07	10	50	55, 1	683
30.10	SAPS-29	-54.00	36.84	03-03	100	50	55, 1	1160
30.10	SAPS-29	-54.00	36.84	03-01	200	50	55, 1	778
31.10	SAPS-30	-53.39	41.54	03-07	10	50	55, 1	806
31.10	SAPS-30	-53.39	41.54	03-03	100	50	55, 1	1090
31.10	SAPS-30	-53.39	41.54	03-01	200	50	55	846

SAP 03-06 was flooded during the first deployment on 25.09.2016 (Table 1) and was out of action for the whole cruise. SAP 03-07 was flooded on 23.10.2016 (Table 1). The instrument was successfully repaired and pressure tested at 200 m on 25.10.2016. The clock of the SAP unit was however lagging for ca. 10%. Delay and pumping times had to be adjusted accordingly. Performance of each SAP instrument is shown in Figure 2.

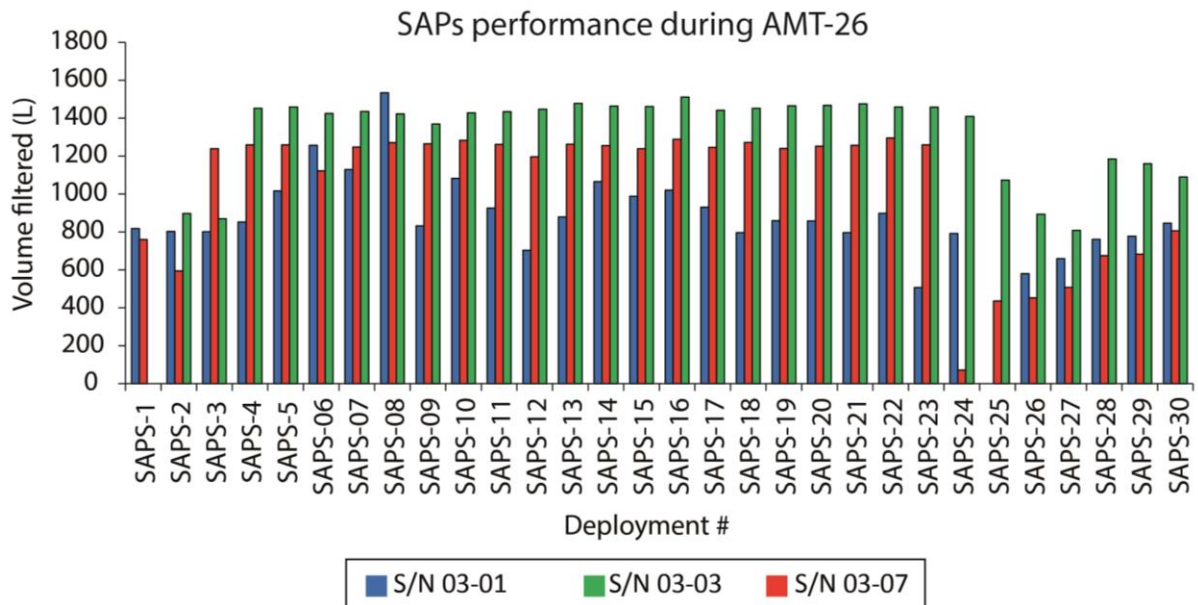


Figure 7: Volume of seawater filtered by individual SAP unit (S/N) during each deployment. See Table 1 for the deployment details.

Acknowledgements

Special thanks to the great SAPs Team: to Jon and Howard for their help with SAPs deployment; to Cliff, Tom and Martyn for the winch work; to the SAPs Ladies Rosie (S/N03-07), Daisy (S/N 03-03) and Camilla (S/N 03-07) for enduring 30 deployments and delivering invaluable samples for the microplastics and POC analyses.

NOC Underway CO₂ System

Katsia Pabortsava

National Oceanography Centre

System overview

The set up for the NOC Underway CO₂ recording system on board of RRS James Clark Ross is shown in Figure 1. The system comprised an 18-litre plastic water tank (Fig. 1A) containing two, open head Pro-Oceanus CO₂-ProCV sensors, two Aanderaa 4330 oxygen optodes, an Aanderaa 4319 conductivity sensor and a Pro-Oceanus GTD-Pro gas tension sensor. These were all connected to an interface box (Fig. 1B) which provides them with 12 V power and passes the RS-232 serial communication signals to a laptop computer with 8 serial ports (Fig. 1C).

The tank containing sensors was secured in a sink by the underway seawater supply (Fig. 1D). The underway was allowed to drain for several hours before being connected to the tank. Sensors in the

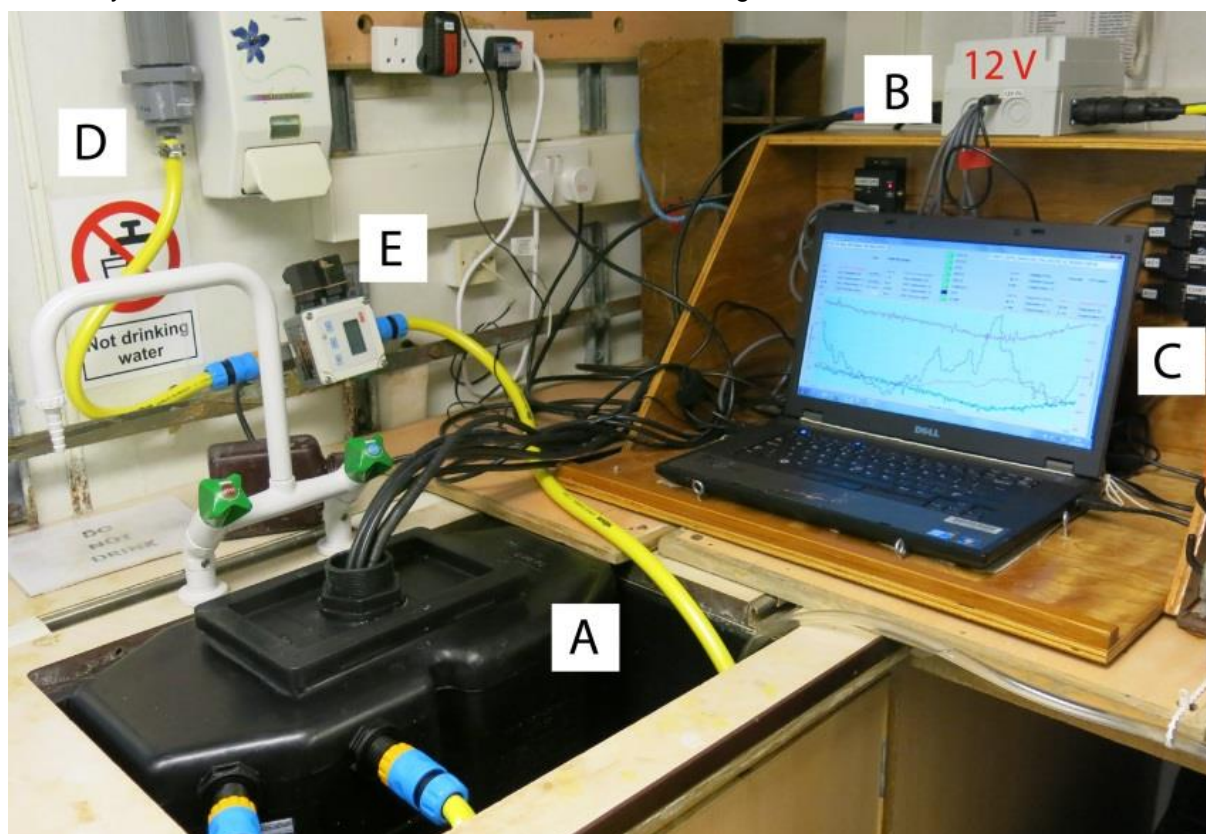


Figure 1: Set up for the NOC Underway CO₂ recording system on board of RRS James Clark Ross. (A) Tank containing sensors; (B) underway supply; (C) flow meter; (D) drain; (E) interface box.

tank were positioned close to the water intake. The SeaBird pump was also fitted into the tank to ensure that the water in the tank is well mixed. The flow meter (Fig. 1E) was linked to underway supply and the sensor tank to regulate the flow of seawater into the tank. During operation, the flow was kept at an approximate rate of 5-7 L min⁻¹.

Daily monitoring and DIC sampling from the ship's underway

The sensor indicator lights were checked to be green (operational mode) and the flow rate was checked to be within 4-9 L min⁻¹ with no leaks from the hoses or connectors.

Seawater from the ship's underway supply was collected for DIC analysis to calibrate the NOC CO₂ sensors. The underway DIC samples were usually taken during the afternoon CTD deployment (Table 1). Immediately after underway sampling, all the system parameters were recorded into a dedicated log sheet (a photo was taken to ensure all parameters are recorded at the same time). For comparison, the 30 min average of CO₂ concentration was recorded from PML system (Picard) at

nearly the same time. Figure 2 shows a good agreement between the NOC and PML Underway CO₂ recording systems (provisional results).

Weekly system restart and data backup

Once a week the logging program and power supply was stopped. The tank was drained fully and rinsed with fresh water. Sensors were also rinsed with fresh water, returned into a clean tank and restarted. The data was backed up onto external device. When necessary, the compute clock was reset to ensure a 30-second proximity to GMT (ship's clock).

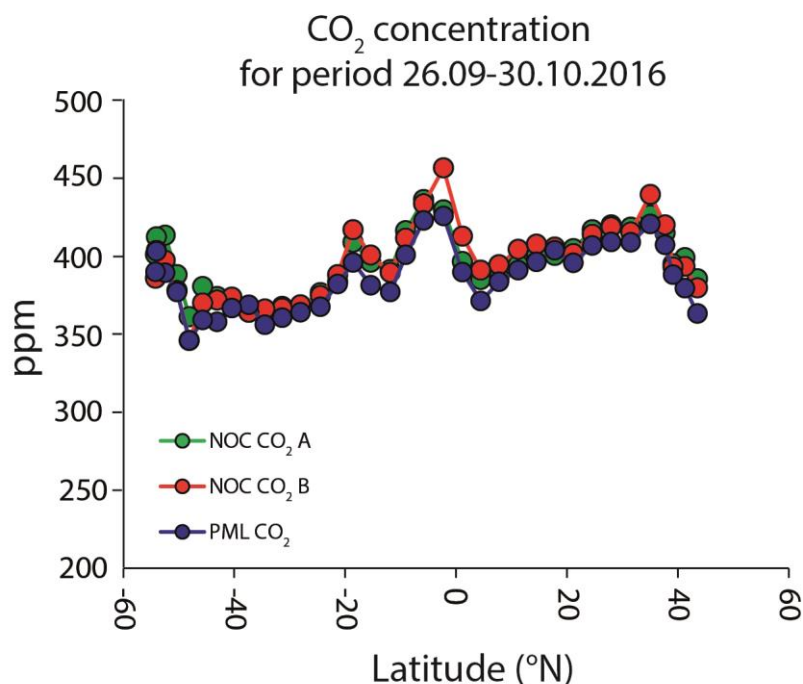


Figure 2: Comparison of CO₂ concentration values recorded by the NOC and PML CO₂ systems between 26.09.2016 and 30.10.2016.

Table 1: The underway DIC sample log

Date	Time (GMT)	Lat (°N)	Long (°W)	Sample ID
25/09/2016	16:15	TBC	TBC	AMT26 25.09.16 16:15 UW DIC-01
26/09/2016	13:04	43.524	16.962	AMT26 26.09.16 13:04 UW DIC-02
27/09/2016	09:51	41.322	20.026	AMT26 27.09.16 09:21 UW DIC-03
28/09/2016	09:51	39.172	22.967	AMT26 28.09.16 09:21 UW DIC-04
29/09/2016	09:46	37.695	24.933	AMT26 29.09.16 09:46 UW DIC-05
30/09/2016	12:23	35.022	26.350	AMT26 30.09.16 12:23 UW DIC-06
01/10/2016	12:44	31.527	27.219	AMT26 01.10.16 12:44 UW DIC-07
02/10/2016	12:21	27.973	28.098	AMT26 02.10.16 12:21 UW DIC-08
03/10/2016	12:39	24.590	28.916	AMT26 03.10.16 12:39 UW DIC-09
04/10/2016	12:29	21.166	29.729	AMT26 04.10.16 12:29 UW DIC-10
05/10/2016	12:30	17.792	29.408	AMT26 05.10.16 12:30 UW DIC-11
06/10/2016	12:30	14.502	28.570	AMT26 06.10.16 12:30 UW DIC-12
07/10/2016	12:43	11.215	27.735	AMT26 07.10.16 12:43 UW DIC-13
08/10/2016	12:24	7.760	26.883	AMT26 08.10.16 12:24 UW DIC-14

Date	Time (GMT)	Lat (°N)	Long (°W)	Sample ID
09/10/2016	12:24	4.486	26.080	AMT26 09.10.16 12:24 UW DIC-15
10/10/2016	12:20	1.158	25.260	AMT26 10.10.16 12:20 UW DIC-16
11/10/2016	12:23	-2.252	24.993	AMT26 11.10.16 12:23 UW DIC-17
12/10/2016	12:23	-5.811	25.027	AMT26 12.10.16 12:23 UW DIC-18
13/10/2016	11:45	-9.059	25.044	AMT26 13.10.16 11:45 UW DIC-19
14/10/2016	11:13	-11.829	25.052	AMT26 14.10.16 11:13 UW DIC-20
15/10/2016	12:29	-15.379	25.076	AMT26 15.10.16 12:29 UW DIC-21
16/10/2016	09:59	-18.545	25.102	AMT26 16.10.16 09:59 UW DIC-22
17/10/2016	11:06	-21.340	25.013	AMT26 17.10.16 11:06 UW DIC-23
18/10/2016	11:16	-24.465	25.026	AMT26 18.10.16 11:16 UW DIC-24
19/10/2016	10:42	-28.022	25.257	AMT26 19.10.16 11:16 UW DIC-25
20/10/2016	12:29	-31.305	25.725	AMT26 20.10.16 12:29 UW DIC-26
21/10/2016	11:13	-34.429	27.185	AMT26 21.10.16 11:13 UW DIC-27
22/10/2016	10:43	-37.333	28.433	AMT26 22.10.16 10:43 UW DIC-28
23/10/2016	11:01	-40.396	28.748	AMT26 23.10.16 11:01 UW DIC-29
24/10/2016	12:33	-43.059	30.096	AMT26 24.10.16 12:33 UW DIC-30
25/10/2016	11:22	-45.665	31.492	AMT26 25.10.16 11:22 UW DIC-31
26/10/2016	11:14	-48.081	32.848	AMT26 26.10.16 11:14 UW DIC-32
27/10/2016	12:36	-50.295	34.114	AMT26 27.10.16 12:36 UW DIC-33
28/10/2016	12:26	-52.446	35.375	AMT26 28.10.16 12:26 UW DIC-34
29/10/2016	07:47	-54.143	36.437	AMT26 29.10.16 07:47 UW DIC-35
30/10/2016	13:26	-53.996	36.842	AMT26 30.10.16 13:26 UW DIC-36
31/10/2016	13:34	-53.390	41.542	AMT26 31.10.16 13:26 UW DIC-37

Investigation of waterborne microplastic concentrations and zooplankton ingestion of microplastics

Madeleine Steer

Plymouth Marine Laboratory

AIMS

The aim of this project is to address the gaps in oceanic field observations for microplastic (< 5 mm) concentrations and investigate the possibility of ingestion of microplastics by zooplankton. Waterborne microplastics will be sampled using 63 μm plankton nets in a vertical and horizontal tow and isolated using enzymatic digestion of bulk plankton samples. Microplastics will be counted, sized and characterised with a sub sample being verified by Fourier Transform Infrared Spectrometry (FT-IR) at Plymouth Marine Laboratory. Microplastic concentrations per cubic meter will thus be calculated at the surface and at depth per station. Zooplankton will be sampled using a 200 μm net towed alongside the 63 μm and assessed for ingestion using an enzymatic digestion technique with any microplastics found also characterised and verified via FT-IR. The ships underway seawater system will also be continuously filtered allowing for microplastic concentrations to be calculated between net stations.

The unique route of the AMT allows for relative fine scale sampling of numerous oceanographic zones on an extensive north-south transect never before assessed for microplastics.

METHODS

Net sample collection

Water borne microplastics were collected using 63 μm nets 57 cm in diameter and 2.5 m in length. Zooplankton was sampled using nets of 200 μm mesh. The vertical tow also included an additional 200 μm net for Plymouth Marine Laboratory AMT zooplankton data series. The vertical triple bongo set up (Fig. 1a) was hauled from 200m at a speed of 12 m/min daily at the pre-dawn station. Surface microplastics and zooplankton were sampled using the same 63 μm and 200 μm nets in a double bongo set up (Fig. 1b) towed for 30 minutes at the surface with an average speed of 1.3 kts through the water, also at the pre-dawn station.

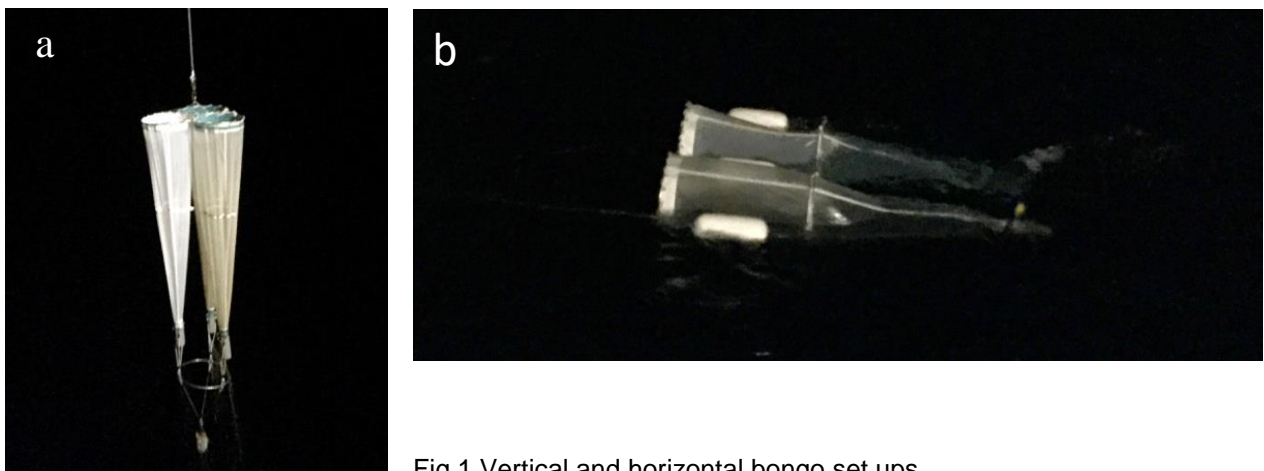


Fig.1 Vertical and horizontal bongo set ups.

Net microplastic processing

Following sampling the 63 μm nets and cod ends were rinsed with seawater into a clean bucket and samples poured through a 63 μm mesh retained in a filtration system (Fig. 2). Subsequently, the mesh was removed from the filtration rig, folded into quarters and stapled closed. Samples were dried in a desiccator for 48 hours on tin foil. Control measures were undertaken on board including control blanks using filtered sea water and samples of boat and crane paint were taken to be assessed by Fourier Transform Infrared Spectroscopy to ensure false positives were avoided in the subsequent plastic counts.

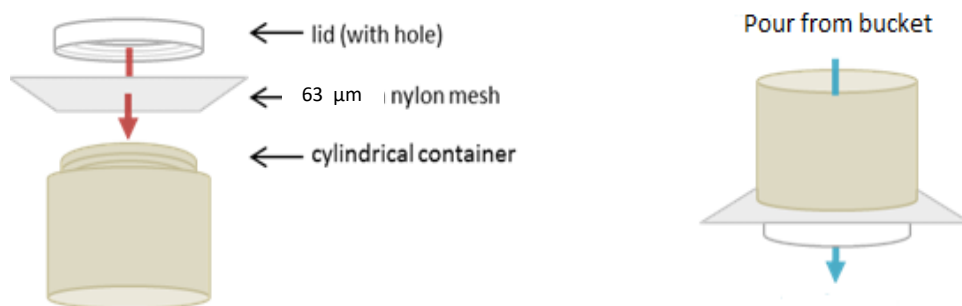


Fig 2. Environmental sample filter system.

Net zooplankton sample processing

Following the trawls, the 200 μm nets and cod ends were rinsed into a large bucket, the contents of which were passed through a 200 μm sieve. If initial assessment suggested individual species weren't abundant enough to be digested for microplastic ingestion analysis they were preserved in 4% formalin and stored for abundance and diversity calculations once back at Plymouth Marine Laboratory. If there was plentiful zooplankton the sieve was placed in a tray of sea water and covered in tin foil to avoid contamination from airborne particles for subsequent zooplankton picking.

Enzyme digestion

The bulk samples from the environmental sampling using the 63 μm net were dried for two days in a desiccator. Once dried the samples were processed using an enzyme digestion protocol adapted from Cole, Webb et al. (2014) using Proteinase K and Cellulase in order to remove as much organic material as possible and retain anthropogenic and inorganic material for inspection and characterisation. In brief; the sample was placed in 30 ml of homogenising solution, physically homogenised and incubated at 50° C for 30 minutes. Following this, 1 ml of 20 mg/ml proteinase K enzyme was added and incubated at 50° C overnight. Further enzymatic digestion of organic material was required with the addition of 1 ml of 40 mg/ml cellulase and the sample refrigerated overnight. Finally 8.5 ml 5 M sodium perchlorate was added; the sample physically homogenised once more and placed in a water bath at 60° C. Each sample was then filtered onto 47 mm 5 μm cyclopore filters under vacuum filtration, rinsing through thoroughly with Milli-Q water, then stored in sealed sterile 50mm Petri dishes for transportation back to Plymouth Marine Laboratory.

Ingestion of microplastics in zooplankton caught in the 200 μm was assessed by picking out 50-100 individuals of abundant species and running a similar enzyme digestion protocol as the bulk samples without the Cellulase. Samples were filtered onto the same cyclopore filters and stored in 50 mm Petri dishes for microscope counts and characterisation. The remainder of each sample was preserved in formalin for future abundance and diversity calculations. Table 1 outlines the samples collected.

Table 1. Net sample dates, location and type (PML 200 is the PML sample, MP is microplastic sample)

Day	Date	Station Location		Vertical			Horizontal	
		Latitude	Longitude	PML 200	MP 200	MP 63	MP 200	MP 63
1	26.09.16	44 09.698 N	016 03.238 W	•	•	•		
2	27.09.16	41 47.048 N	019 24.376 W	•	•	•	•	•
3	28.09.16	39 42.581 N	022 15.488 W	•	•	•		
4	29.09.16	37 41.667 N	024 55.387 W	•	•	•	•	•
5	30.09.16	36 07.771 N	026 04.470 W	•	•	•		
6	01.10.16	15 16.556 N	028 47.103 W	•	•	•	•	•
7	02.10.16	29 10.034 N	027 50.112 W	•	•	•		
8	03.10.16	25 23.162 N	028 44.781 W	•	•	•	•	•
9	04.10.16	22 03.579 N	029 31.568 W	•	•	•		
10	05.10.16	18 42.185 N	029 39.845 W	•	•	•		
11	06.10.16	15 16.556 N	028 47.103 W	•	•	•	•	•
12	07.10.16	11 57.826 N	027 57.339 W	•	•	•	•	•
13	08.10.16	08 42.149 N	027 08.434 W	•	•	•		
14	09.10.16	05 12.875 N	026 16.534 W	•	•	•	•	•
15	10.10.16	01 58.672 N	025 28.996 W	•	•	•	•	•
16	11.10.16	01 24.652 S	025 00.448 W	•	•	•	•	•
17	12.10.16	04 49.737 S	025 01.283 W	•	•	•		
18	13.10.16	08 22.588 S	25 02.4546 W	•	•	•	•	•
19	14.10.16	11 48.561 S	025 03.937 W	•	•	•	•	•
20	15.10.16	14 25.898 S	025 04.553 W	•	•	•		
21	16.10.16	18 15.120 S	025 07.355 W	•	•	•		
22	17.10.16	20 39.973 S	025 00.719 W	•	•	•	•	•
23	18.10.16	23 43.266 S	025 01.671 W	•	•	•	•	•
24	19.10.16	27 15.654 S	024 27.552W	•	•	•		
25	20.10.16	30 23.076 S	025 18.756 W	•	•	•	•	•
26	21.10.16	33 33.495 S	026 46.423 W	•	•	•	•	•
27	22.10.17	36 30.343 S	028 08.445 W	•	•	•	•	•
28	23.10.17	39 42.1182 S	028 40.434 W	•	•	•		
29	24.10.17	CANCELLED						
30	25.10.18	44 54.178 S	31 04.397 W	•	•	•		
31	26.10.18	47 25.654 S	032 28.393 W	•	•	•	•	•
32	27.10.16	CANCELLED						
33	28.10.16	51 51.478 S	35 01.084 W	•	•	•	•	•
34	29.10.16	53 56.231 S	36 18.157 W	•	•	•	•	•
35	30.10.16	53 59.740 S	36 50.538 W				•	•
36	31.10.16	53 35.555 S	39 56.912 W	•	•	•	•	•
37	01.11.16	53 01.028 S	45 03.349 W	•	•	•	•	•

Underway filter system

The ships underway system was continuously filtered (Fig. 2) between the pre-dawn sampling sites at a flow rate of between 5 and 20 L per minute through filters of varying mesh size (both dependent on amount of organic material in water and potential clogging of filters). Filters were washed into clean beakers, the sample sieved and rinsed into a 100 ml bottle before the addition of homogenising solution for transport home (Table 2). The homogenising solution will break down organic material

before final filtering onto 10 µm cyclo pore filters at Plymouth Marine Laboratory. Microplastics will then be counted, sized and characterised and a sub sampled verified by FT-IR.



Fig. 2 Underway filtration rig

Table 2. Filter rig samples

Sample No.	Date	Location		Filter Rig		
		Start	Finish	Course 300	Medium 65	Fine 22
1	23.09.16	49 44.85 N	48 03.5014 N	●	●	●
		005 12.55 W	010 02.2584 W			
2	24.09.16	47 44.4555 N	45 35.4120 N	●	●	●
		010 32.6172 W	014 06.6758 W			
3	25.09.16	45 29.6 N	44 10.5 N	●	●	●
		14 15.2 W	16 01.9 W			
4	26.09.16	43 56.671 N	43 11.519 N	●	●	●
		016 20.188 W	017 24.867 W			
5	27.09.16	41 47.048 N	39 42.581 N	●	●	●
		019 24.376 W	022 15.488 W			
6	28.09.16	39 42.581 N	37 41.667 N	●	●	●
		022 15.488 W	024 55.387 W			
7	29.09.16	37 41.594 N	37 41.667 N	●	●	●
		024 55.910 W	024 55.387 W			
8	30.09.16	35 41.202 N	36 07.771 N	●	●	●
		026 11.631 W	026 04.470 W			
9	01.10.16	31 31.604 N	29 10.034 N	●	●	●
		027 13.121 W	027 50.112 W			
10	02.10.16	27 58.359 N	25 23.162 N	●	●	●
		028 05.898 W	028 44.781 W			
11	03.10.16	24 28.762 N	22 03.578 N	●	●	●
		028 55.419 W	029 31.568 W			
12	04.10.16	21 10.488 N	18 42.185 N	●	●	●
		029 42.542 W	029 39.845 W			
13	05.10.16	17 47.523 N	15 16.556 N	●	●	●
		029 24.473 W	028 47.103 W			
14	06.10.16	14 30.632 N	11 57.826 N	●	●	●
		028 33.663 W	027 57.339 W			

Sample No.	Date	Location		Filter Rig		
		Start	Finish	Course 300	Medium 65	Fine 22
15	08.10.16	7 45.483 N	05 12.875 N	●	●	●
		026 52.242 W	026 16.534 W			
16	09.10.16	04 29. 282 N	1 58.672 N	●	●	●
		026 04.511 W	025 28.996 W			
17	10.10.16	01 09.529 N	01 24.652 S	●	●	●
		025 15.140 W	025 00.448 W			
18	11.10.16	02 17.695 S	04 49.737 S	●	●	●
		024 58.468 W	025 01.283 W			
19	12.10.16	05 48.668 S	08 22.588 S	●	●	●
		025 01.577 W	025 02.4546 W			
20	13.10.16	09 06.660 S	11 48.561 S	●	●	●
		025 01.711 N	025 03.937 W			
21	14.10.16	11 49.853 S	14 25.898 S	●	●	●
		025 03.045 W	025 04.553 W			
22	15.10.16	15 23.213	18 15.120 S	●	●	●
		25 03.940	025 07.355 W			
23	16.10.16	18 32.435 S	20 39.973 S	●	●	●
		025 00.002W	025 00.719 W			
24	17.10.16	21 20.368 S	23 43.266 S	●	●	●
		025 00.744 W	025 01.671 W			
25	18.10.16	24 27.834 S	27 15.654 S	●	●	●
		025 01.596 W	024 27. 552 W			
26	19.10.16	28 09.139 S	30 23.076 S	●	●	●
		024 17.797 W	025 18.756 W			
27	20.10.16	31 22.971 S	33 33.495 S	●	●	●
		025 45.680 W	026 46.423 W			
28	21.10.16	34 25.734 S	36 30.343 S	●	●	●
		027 11.118 W	28 08.445 W			
29	22.10.16	37 19.956 S	39 42.1182 S	●	●	●
		028 25.997 W	028 40.0434 W			
30	23.10.16	40 23.736 S	42 42.712 S	●	●	●
		028 44.927 W	029 54.468 W			
31	24.10.16	43 00.525 S	44 54.178 S	●	●	●
		30 04.227 W	31 04.397 W			
32	25.10.16	45 39.977 S	47 25.654 S	●	●	Clogged
		31 29.807 W	032 28.393 W			
33	26.10.16	48 04.961 S	49 45.188 S	●	●	Clogged
		32 52.774 W	033 46.234 W			
34	27.10.16	50 17.196 S	51 51.478 S	●	●	Clogged
		034 04.904 W	35 01.084 W			
35	28.10.16	52 27.335 S	53 56.231 S	●	●	Clogged
		35 23.467 W	36 18.157 W			
36	29.10.16 @KEP	54 16.986 S	54 16.986 S	●	●	Clogged
		36 29.802 W	36 29.802 W			
37	30.10.16	53 59.740 S	53.35.555 S	●	●	Clogged
		36 50.538 W	39 56.912 W			
38	31.10.16	53 23.244 S	53 01.028 S	●	●	Clogged
		41 32.958 W	45 03.349 W			

Collection of DOM Samples (contribution to NC project LOCATE)

Andy Rees, James Ayliffe

LOCATE is NERC NC project to investigate the transfer of carbon from land to the ocean. The field programme is largely centred on the UK, though takes opportunistic sampling on a global basis. With both South Georgia and the Falkland Islands having extensive peat deposits and significant freshwater inputs to the adjacent ocean, the AMT-26 track provided the chance to collect these additional samples.

Seawaters were collected filtered cleanly using 0.2µm polycarbonate filters into 125 ml HDPE containers from the ships non-toxic seawater supply. These were frozen at -20°C and returned to the UK onboard the ship.

DOM samples collected for LOCATE during AMT26 (JR16001)

Date	Time (z)	Lat	Long	U/W log reference	DOP	DOC
28.10.16	0958	-52° 12.138'	-35° 14.901'	GL	1a	1b
	1348	-52° 26.881'	-35° 22.493'	GM	2a	2b
	1600	-52° 39.756'	-35° 30.314'	GN	3a	3b
	2000	-53° 6.678'	-35° 47.102'	GO	4a	4b
29.10.16	0524	-53° 56.127'	-36° 18.443'	GP	5a	5b
	0934	-54° 17.008'	-36° 50.051'	GQ	6a	6b
30.10.16	1455	-53° 59.672'	-36° 50.672'	GR	7a	7b
	2000	-53° 54.431'	-37° 24.330'	GS	8a	8b
02.11.16	1430	-52° 8.691'	-53° 12.174'	HB	9a	9b
	1802	-52° 4.815'	-53° 48.489'	HC	10a	10b
	2245	-51° 57.227'	-54° 57.113'	HD	11a	11b
03.11.16	0200	-51° 52.492'	-55° 40.909'	HE	12a	12b
	0852	-51° 42.054'	-57° 16.131'	HF	13a	13b

Once samples have been returned to the UK they will be analysed by **Stuart Painter (NOC)** for their fluorescent organic matter spectra and, depending upon sample stability, potentially also for their dissolved organic nutrient content. Excitation-emission matrix spectroscopy will be performed on each sample using a Cary Eclipse Fluorescence Spectrophotometer and a Cary 60 UV-Vis absorbance instrument using protocols (e.g. Coble et al. 2014) that are being used within the NERC LOCATE project. If successful subsequent parallel factor (PARAFAC) analysis (e.g. Stedmon et al 2003) will be undertaken to decompose the fluorescent excitation-emission matrix into classes of organic compounds which will allow for the identification of terrestrial and marine components.

Dissolved organic nitrogen and phosphorous will be determined following UV oxidation of the seawater samples as detailed in Torres-Valdes et al. (2016). Specifically, seawater aliquots will be UV oxidised for 2 hours using 705 Metrohm UV oxidation units before measurement of the total dissolved inorganic N (TDN) or P (TDP) content on a Seal Analytical QuAAtro auto-analyser. Unoxidised aliquots will also be analysed for DIN (NO₃+NO₂, NH₄) or DIP (PO₄) content with final estimates of DON and DOP derived by difference between the TDN/TDP and DIN/DIP measurements. Estimates of DOC content will follow LOCATE procedures with samples analysed at CEH Lancaster.

Sample and data analysis will be undertaken by Stuart Painter (scp@noc.soton.ac.uk)

Coble, P.G., J. Lead, A. Baker, D.M. Reynolds and R.G.M. Spencer (2014). Aquatic Organic Matter Fluorescence, Cambridge University Press.

Stedmon, C.A., S. Markager and R. Bro (2003). Tracing dissolved organic matter in aquatic environments using a new approach to fluorescence spectroscopy. Marine Chemistry 82, 239-254.

Torres-Valdes, S., T. Tsubouchi, E. Davey, I. Yashayaev and S. Bacon (2016). Relevance of dissolved organic nutrients for the Arctic Ocean nutrient budget. Geophysical Research Letters 43, 6418-6426, doi: 6410.6102/2016GL069245.

SOG Mooring Recovery and Deployment

John Wynar

National Oceanography Centre, Southampton

Deployment

All echo sounders were switched off or put in passive mode during acoustic interrogation to avoid interference. All times given are in GMT unless stated otherwise.

The deck unit used throughout was Ixsea TT801, s/n: 140 and respective transducer. The vessel's own dedicated mooring winch was used for recoveries.

The mooring operation began at 08:34 GMT on 16th October 2016 with the deployment of the pick-up float. The mooring was instrumented with two sediment traps, two downward looking current meters and a SBE37 microcat CTD.

Instrument	Serial Number	Time in water
Sediment Trap	12432-06	08:52
AQD Current Meter	9972	
Sediment Trap	12432-02	09:02
AQD Current Meter	9979	
SBE37	9383	10:10
RT661 acoustic Release Window: C446 Release: C485	321	10:23

Anchor release: 10:37

Position of anchor release: 18.54495°S; 25.09791°W (or 18° 32.697'S; 25° 05.875'W)

Water depth: 5261m

The acoustic release was "watched" down to the sea floor until it was deemed to have come to rest safely. A descent speed was calculated as approximately 90m/minute.

The mooring came to rest on the sea bed at 11:36 giving a range of 5298m. A subsequent range of 5301m was obtained at 11:40. Due to the unreliable nature of reception of ranges from the acoustic release it was decided not to attempt to triangulate the mooring's position.

Instrument Set-up

The following shows the set-up of the upper Nortek current meter:

Deployment: SOG_A
Current time: 14/10/2016 14:26:42
Start at: 17/10/2016
Comment:
Underneath trap A

Measurement interval (s): 1800
Average interval (s): 120
Blanking distance (m): 0.35

Measurement load (%): 4
 Power level: HIGH
 Diagnostics interval(min) : 720
 Diagnostics samples: 20
 Compass upd. rate(s): 90
 Coordinate System: ENU
 Speed of sound (m/s): MEASURED
 Salinity(ppt): 35
 Analog input 1: NONE
 Analog input 2: NONE
 Analog input power out: DISABLED
 File wrapping: OFF
 Serial output/TellTale: OFF

Assumed duration (days): 365.0
 Battery utilization (%): 85.0
 Battery level (V): 13.9
 Recorder size (MB): 9
 Recorder free space (MB): 8.972
 Memory required (MB): 1.3
 Vertical vel. prec (cm/s): 1.0
 Horizon. vel. prec (cm/s): 0.7

Instrument ID: AQD 9972
 Head ID: A6L 5310
 Firmware version: 3.37

Aquadopp Version 1.35
 Copyright (C) Nortek AS

The following shows the set-up of the lower Nortek current meter:

Deployment: SOG_B
 Current time: 14/10/2016 14:46:27
 Start at: 17/10/2016
 Comment:
 Underneath trap B

Measurement interval (s): 1800
 Average interval (s): 120
 Blanking distance (m): 0.35
 Measurement load (%): 4
 Power level: HIGH
 Diagnostics interval(min) : 720
 Diagnostics samples: 20
 Compass upd. rate(s): 90
 Coordinate System: ENU
 Speed of sound (m/s): MEASURED
 Salinity(ppt): 35
 Analog input 1: NONE
 Analog input 2: NONE
 Analog input power out: DISABLED
 File wrapping: OFF
 Serial output/TellTale: OFF

Assumed duration (days): 365.0
 Battery utilization (%): 85.0
 Battery level (V): 13.9

Recorder size (MB): 9
Recorder free space (MB): 8.972
Memory required (MB): 1.3
Vertical vel. prec (cm/s): 1.0
Horizon. vel. prec (cm/s): 0.7

Instrument ID: AQD 9979
Head ID: A6L 5309
Firmware version: 3.37

Aquadopp Version 1.35
Copyright (C) Nortek AS

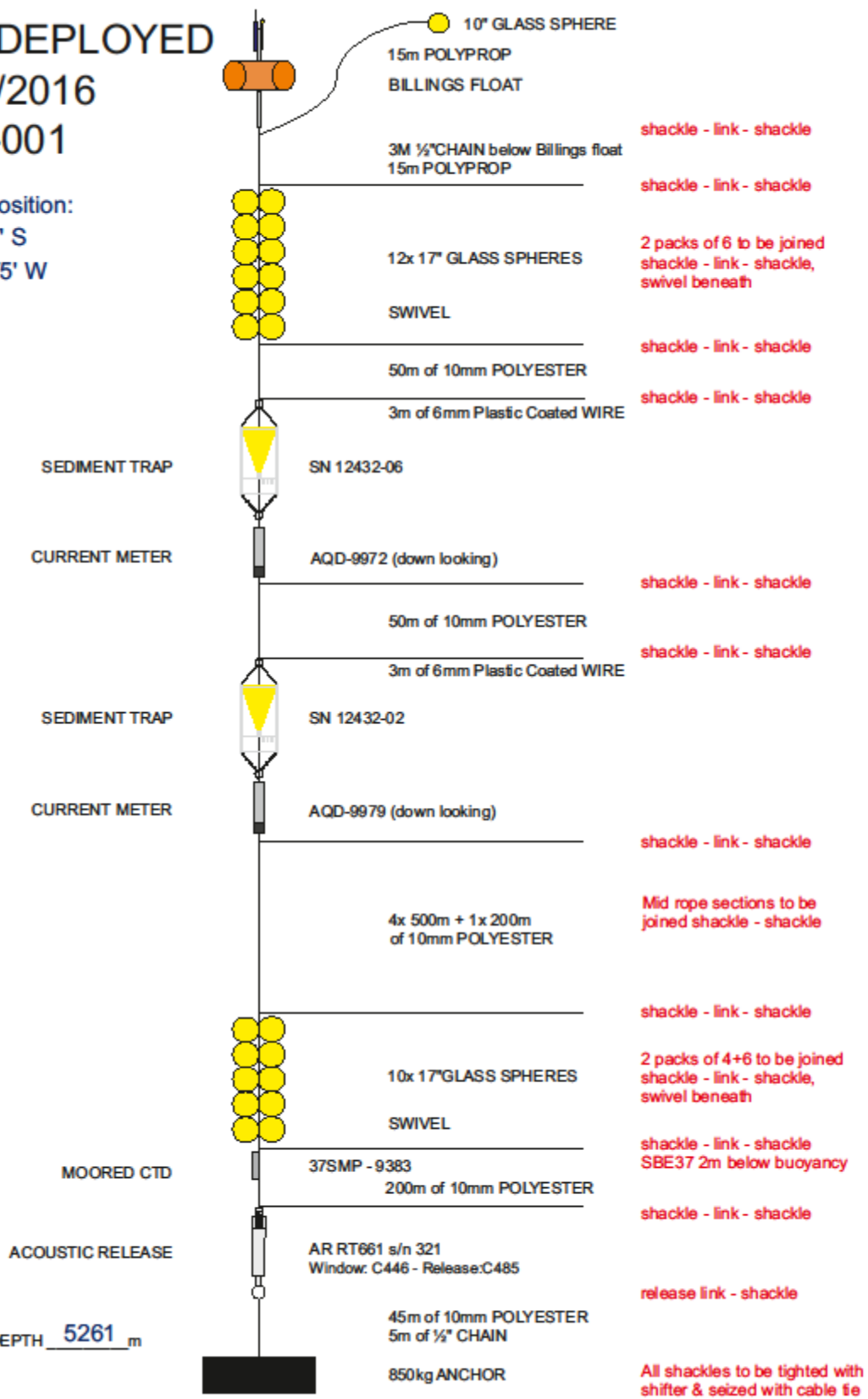
The following is the set-up for the SBE37:

ds
SBE37SM-RS232 v4.1 SERIAL NO. 9383 14 Oct 2016 09:32:56
vMain = 13.20, vLith = 3.22
samplenum = 0, free = 559240
not logging, waiting to start at 17 Oct 2016 00:00:00
sample interval = 30 seconds
data format = converted engineering
output salinity
transmit real-time = no
sync mode = no
pump installed = yes, minimum conductivity frequency = 3320.2
<Executed/>

SOG DEPLOYED
16/10/2016
JR16-001

Release position:
 18°32.697' S
 025°05.875' W

WATER DEPTH 5261 m



Recovery of 2015 Mooring

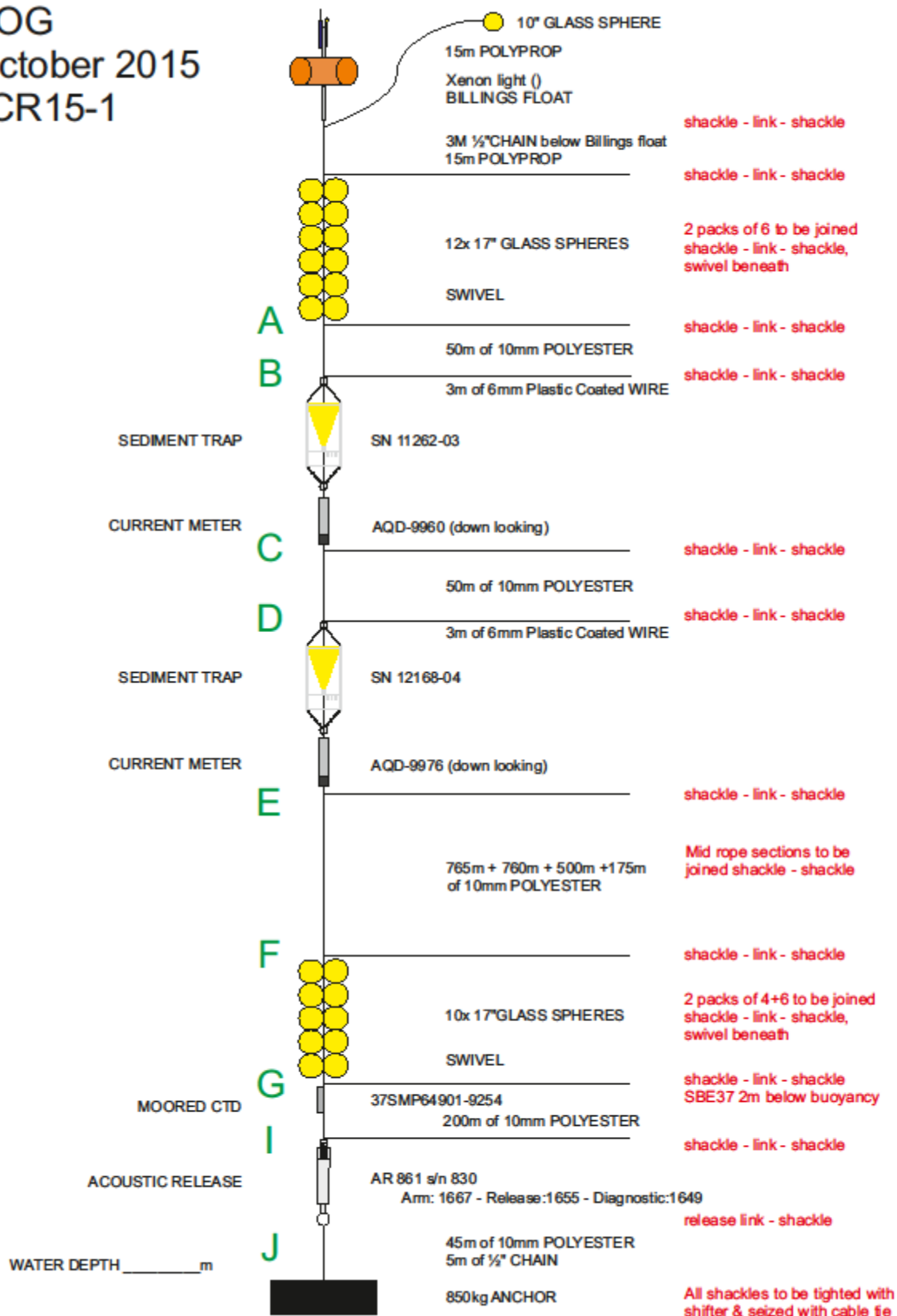
This was begun at 12:30 on the 16/10/16 at position 18.4987°S, 25.0078°W by transmitting the combined Arm/Release signal. A return from the acoustic release (AR861) was received giving a range of 5331m and indicating the release had been executed. A subsequent range of 5130m was received at 12:35 showing that the mooring was indeed rising towards the surface with an initial estimate of ascent speed of 40m/minute. The AR861 was ranged every five to ten minutes to confirm its rate of ascent and to give an estimate of its time on the surface. The Billings float was observed on the surface at 13:15, the ship standing off until all three buoyancy packs were seen. After 45 minutes and further ranging it became apparent that the lower pack was remaining submerged, possibly due to failure of some of the glass spheres, hence the vessel began recovery. As the ship approached the visible buoyancy it was noted that the recovery line was tangled with the upper buoyancy pack. Grappling the line between the latter and the Billings float was the only option and this was achieved at 14:35. The recovery on to the deck began at 14:41, position 18.5021°S; 25.0067°W.

Instrument	Serial Number	Time out of water
Sediment Trap	11262-03	14:59
AQD Current Meter	9960	
Sediment Trap	12168-04	15:12
AQD Current Meter	9976	
SBE37	9254	15:53
AR861 acoustic Release Arm: 1667 Release: 1655	830	15:57

On recovery it was indeed discovered that six out of the ten glass spheres of the lower buoyancy pack had imploded.

Both sediment traps had completed 17 of the 22 scheduled events, the remaining events being programmed after the actual recovery date.

SOG
 October 2015
 JCR15-1



BAS AME (electronics) marine scientific instrumentation support

Paul Morgan

British Antarctic Survey

LAB Instruments

Instrument	S/N Used	Comments
AutoSal	63360	
Scintillation counter	Y	
Magnetometer STCM1	N	
XBT	N	

ACOUSTIC

Instrument	S/N Used	Comments
ADCP	Y	
PES	N	
EM120	N	
TOPAS	N	
EK60	N	
EK80	N	
SSU	Y	
USBL	Y	But only for calibration purposes.
10kHz IOS pinger	N	
Benthos 12kHz pinger S/N 1316 + bracket	N	
Benthos 12kHz pinger S/N 1317 + bracket	N	
MORS 10kHz transponder	N	

OCEANLOGGER

Instrument	S/N Used	Comments
Barometer1(UIC)	5002	
Barometer1(UIC)	5003	
Foremast Sensors		
Air humidity & temp1	3898	
Air humidity & temp2	3896	
TIR1 sensor (pyranometer)	2993	Not working
TIR2 sensor (pyranometer)	2992	Not working
PAR1 sensor	0127	
PAR2 sensor	0126	
prep lab		
Thermosalinograph SBE45	4524698-0018	
Transmissometer	527DR	
Fluorometer (10AU)	1100243	
Flow meter	811950	
Seawater temp 1 SBE38	0601	
Seawater temp 2 SBE38	0599	

CTD (all kept in cage/ sci hold when not in use)

Instrument	S/N Used	Comments
Deck unit 1 SBE11plus	0458	
Underwater unit SBE9plus	0771	
Temp1 sensor SBE3plus	5623	
Temp2 sensor SBE3plus	4874	
Cond1 sensor SBE 4C	3491	
Cond2 sensor SBE 4C	1912	Originally 1913 for CTD casts #1 & #2. I believed the calibration document had a typo s/n 1912, as I did not have a cal document for s/n 1913. However, when I went to change the conductivity sensor I found a sensor with an s/n 1912 which was used instead.
Pump1 SBE5T		
Pump2 SBE5T		
Standards Thermometer SBE35		
Transmissometer C-Star	1505DR	
Oxygen sensor SBE43	0620	
PAR sensor	7274	
Fluorometer Aquatracka	12-8513-0003	Incorrect calibration discovered at the end of the cruise. It had not been updated with the current 2016 calibration. 2016 calibration has been provided for post processing.
Altimeter PA200	163162	
LADCP		
CTD swivel linkage		
Pylon SBE32	0636	
Notes on any other part of CTD e.g. faulty cables, wire drum slip ring, bottles,		NOC 20lt bottles used. Removed at the end of the cruise.

swivel, frame, tubing etc		
---------------------------	--	--

AME UNSUPPORTED INSTRUMENTS BUT LOGGED

Instrument	Working?	Comments
EA600	Y	
Anemometer	Y	
Gyro	Y	
DopplerLog	Y	
EMLog	Y	

Additional notes and recommendations for change / future work

CTD

There have been several terminations for the CTD on this trip due to various reasons. The first was cable management. During the JR15007 cruise work was done on organising the CTD workstation area; the deck unit was wired incorrectly but gave a termination fault. Due to the assumption of the CTD being in a working condition at the end of the last cruise and that the termination was the same, this led to a six-hour fault hunt. The CTD sea cable was re-terminated but it was when I swapped the deck unit I noticed it was plugged incorrectly but gave a cable fault. It has also been discovered that the spare deck unit is faulty. Looking through previous cruise reports I am unable to guess when this broke. As it is the only spare I advise a new one is purchased.

Termination #1 – Cable fault. Sea cable was plugged into the wrong outlet on the deck box.

Termination #2 – Operator error; cable end went through the roller. Inner core had been crushed through the plastic sheath. When re-terminated the cable end was put into a long S shape to highlight how far the CTD can be raised before the roller becomes an issue. Before this it was clamped to the wire making it difficult to see.



Picture showing the damage caused to the termination when trapped in the roller.

Termination #3 – During CTD deployment a fault occurred on the up-cast at 319m. Cause unknown. My best guess would be the tension was eased off, the wire unravelled and when the tension came back on the inner core was caught up.



Picture showing the damage to the sea cable at 319m



Picture showing sea cable at 319m with outer sheathing removed – as can be seen the inner core has done a full turn around the inner sheath.

Termination #4 – Similar to the issue above during CTD deployment a fault occurred at 450m. As the CTD was recovered the sea cable went through the winch system after which the damage was found to be more extensive than is believed to have occurred at 419m.



Picture showing the damaged occurred to the CTD after it had been pulled through the winch system.

The CTD cable has been re-terminated twice due to the state of the cable; be prepared for this to happen more often. Hopefully, it will not but if it happens at a 4am cast it helps if the method for termination has been revised recently.

Calibration Files

During the end of the cruise a request for calibration files that I had not provided was asked by James Ayliffe (BODC Representative). Unfortunately, after double checking the files I had already provided I realised that I had not updated the calibration information for the CTD Fluorometer (Chelsea Aqua Mk III) in error.

James further requested calibration files for the anemometer, x-band radar, seabed radar and gyro. As far as I'm aware I do not know of any calibration documents. I have emailed Neil French and CC's James, should any calibration documents be apparent they will become available.

NavMet

Johnnie has fixed several the issues with the NavMet, he found a 15Gb log file that has appeared to have grown for some time.

Fluorometer

Andy Rees requested that the fluorometer given to BAS was to be fitted before the start of cruise JR16001. He wanted this fitted as the current 10AU (which is part of the underway) has been on the RRS JCR for as long as he can remember and has not provided realistic readings for the last few years. The fluorometer in question was delivered to BAS Cambridge in April 2016. It was supposed to be fitted during refit in Denmark and I was unable to provide Andy with a reason to why this had not happened.

In my attempts to fit the fluorometer in with the current system I requested the help of the JCR ETO (Julian). My own knowledge is lacking in this area and at the time there was no marine support available at BAS Cambridge for the first 2 - 3 weeks of the cruise.

The Fluorometer was installed into the Nudam module beneath the underway in the prep lab. Julian provided the LabView experience and fed the output from the module into the ocean logger that is displayed in the UIC and is logged to the SCS in a raw data format. Unfortunately, the unit was unable to produce acceptable results compared to those produced by the CTD. It became clear as we

journeyed south that the unit did not function correctly as the results changed but not within the expected margins. Fluorometer has been removed at the end of cruise to be returned to Planet Ocean for further investigation.

Wireless Counter

Power supply failed and the batteries are not lasting as long as expected. A 240V to 12V 1A output power supply is being brought South for JR16002 so that this unit can function normally. It has batteries available when the wireless capability is required.

SCS

A request came in through BODC for three file types that can be produced from the SCS. A device configuration (*.xml), and SCS configuration (*.cfg) and a template file (*.tpl). As far as I am aware the SCS can produce these but the system on the RRS JCR is not configured that way. The setup files and configuration information is supplied through the calibration sheets and this report. Old fashioned but it's an old ship.

Appendix 1 – Underway Log

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
	264	20/09/2016 18:00													Underway switched on
AA	268	24/09/2016 09:00	-	-	48.2582	-9.4768	0.4919	35.5378	15.8111	0.71	0.04	-	-	1.90	
AB	268	24/09/2016 12:00	-	-	48.0566	-10.0419	0.5136	35.5512	17.0081	0.71	0.04	-	-	2.33	
AC	268	24/09/2016 15:00	-	-	47.7408	-10.5435	0.6256	35.5617	17.6675	0.70	0.04	-	-	1.54	
AD	268	24/09/2016 19:00	-	-	47.2981	-11.2328	0.6403	35.5790	17.9688	0.70	0.04	-	-	3.25	
AE	269	25/09/2016 10:19	-	-	45.8366	-13.5916	0.5719	35.6398	18.7640	0.71	0.00	5_17	35.74737	1.70	
AF	269	25/09/2016 15:58	-	-	45.5071	-14.2325	0.5792	35.5796	18.6287	0.70	0.00	5_16	35.62702	2.93	
AG	269	25/09/2016 19:59	-	-	45.0086	-14.9226	0.5882	35.6018	18.2832	0.70	0.00	5_01	35.59904	3.09	
AH	269	25/09/2016 05:39	-	-	46.3428	-12.7619	0.6877	35.6498	18.5077	0.71	0.04	5_02	35.73609	1.86	
AI	270	26/09/2016 10:00	-	-	43.7595	-16.6011	0.5135	35.7570	19.7057	0.72	0.00	-	-	-	
AJ	270	26/09/2016 10:15	-	-	43.7595	-16.6011	0.5143	35.7580	19.7046	0.72	0.00	-	-	1.43	
AK	270	26/09/2016 12:54	-	-	43.5243	-16.9617	0.7698	35.8443	20.1396	0.72	0.04	5_18	35.89495	1.20	
AL	270	26/09/2016 16:00	-	-	43.2784	-17.3010	0.6710	36.0451	21.2918	0.73	0.03	5_03	36.06944	0.94	
AM	270	26/09/2016 20:01	-	-	42.7256	-18.0370	0.6548	35.8108	20.4537	0.73	0.03	-	-	1.02	
AN	271	27/09/2016 05:11	-	-	41.7841	-19.3939	0.6321	35.8929	21.1731	0.73	0.03	5_19	35.92596	0.75	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
AO	271	27/09/2016 11:00	-	-	41.3335	-20.0108	0.6357	35.9546	21.5962	0.74	0.03	5_04	36.02208	0.50	
AP	271	27/09/2016 20:00	-	-	40.6113	-21.0231	0.6378	36.0940	22.1842	0.74	0.03	5_13	36.10916	0.18	
AQ	272	28/09/2016 05:20	-	-	39.6769	-22.3001	0.5837	35.9454	22.0917	0.75	0.03	5_20	35.94096	0.50	
AR	272	28/09/2016 08:03	-	-	39.3514	-22.7388	0.5602	35.9227	21.9582	0.75	0.03	5_12	35.937	0.51	
AS	272	28/09/2016 10:34	-	-	39.1725	-22.9666	0.3660	35.9337	21.9441	0.75	0.03	-	-	0.59	
AT	272	28/09/2016 13:00	-	-	38.9695	-23.2161	0.6884	36.0825	22.4225	0.75	0.03	5_21	36.10585	-	
AU	272	28/09/2016 16:00	-	-	38.7504	-23.4292	0.6937	36.3564	23.6887	0.75	0.03	5_06	36.36636	0.63	
AV	272	28/09/2016 19:58	-	-	38.2705	-24.0274	0.6509	36.2420	23.3748	0.75	0.03	5_11	36.25595	0.69	
AW	273	29/09/2016 05:30	-	-	37.6656	-24.8990	0.6044	36.2180	23.2190	0.75	0.03	5_07	36.24133	0.80	
AX	273	29/09/2016 08:08	-	-	37.6908	-24.9268	0.5834	36.2012	22.9260	0.75	0.03	5_08	36.20283	0.88	
AY	273	29/09/2016 10:00	-	-	37.6952	-24.9324	0.5756	36.1969	22.9278	0.75	0.03	-	-	-	
AZ	273	29/09/2016 13:49	-	-	37.6934	-24.9315	0.5340	36.1993	23.0848	0.75	0.03	5_22	36.19717	0.54	
BA	273	29/09/2016 16:00	-	-	37.6791	-25.0529	0.5225	36.2123	23.4147	0.75	0.03	5_10	36.21386	0.76	
BB	273	29/09/2016 20:00	-	-	37.5785	-25.6915	0.5406	36.2930	23.5178	0.75	0.03	5_09	36.30841	0.75	
BC	274	30/09/2016 05:35	-	-	36.1027	-26.0819	0.4724	36.3939	23.8171	0.76	0.03	5_24	36.38609	0.82	
BD	274	30/09/2016 10:02	-	-	35.3380	-26.2848	0.4419	36.4715	23.9836	0.76	0.03	-	-	-	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
BE	274	30/09/2016 13:26	-	-	35.0221	-26.3486	0.4457	36.5044	24.0784	0.76	0.03	5_23	36.50033	0.60	
BF	274	30/09/2016 16:00	-	-	34.6462	-26.4311	0.6933	36.5774	24.6510	0.76	0.03	-	-	0.34	
BG	274	30/09/2016 20:00	-	-	33.9561	-26.6213	0.6487	36.8846	24.7927	0.76	0.03	-	-	0.41	
BH	275	01/10/2016 05:41	-	-	32.5225	-26.9849	0.6527	36.8085	24.6943	0.76	0.03	-	-	0.46	
BI	275	01/10/2016 10:00	-	-	31.8700	-27.1565	0.7049	36.9110	24.6727	0.76	0.00	-	-	-	
BJ	275	01/10/2016 10:18	-	-	31.8191	-27.1700	0.7069	36.9169	24.6727	0.76	0.00	-	-	0.37	
BK	275	01/10/2016 13:34	-	-	31.5279	-27.2157	0.6741	37.0394	24.6727	0.76	0.00	-	-	0.20	
BL	275	01/10/2016 16:00	-	-	31.2459	-27.2771	0.6806	37.1280	24.6727	0.76	0.00	U2_2	37.14001	0.22	
BM	275	01/10/2016 20:00	-	-	30.5790	-27.4817	0.6772	37.0511	24.6727	0.76	0.00	U2_1	37.07403	0.36	
BN	276	02/10/2016 06:13	-	-	29.0029	-27.8729	0.0000	0.0000	0.0000	0.00	0.00	U2_16	37.36248	0.40	
BO	276	02/10/2016 10:00	-	-	28.3253	-28.0391	0.6706	37.2558	24.9451	0.76	0.03	-	-	-	
BP	276	02/10/2016 13:34	-	-	27.9747	-28.0942	0.0000	0.0000	0.0000	0.00	0.00	U2_17	37.24633	0.17	
BQ	276	02/10/2016 16:00	-	-	27.6165	-28.1647	0.0000	0.0000	0.0000	0.00	0.00	U2_15	37.45872	0.48	
BR	276	02/10/2016 20:00	-	-	26.9487	-28.3715	0.0000	0.0000	0.0000	0.00	0.00	U2_18	37.44276	0.28	
BS	277	03/10/2016 06:38	-	-	25.3940	-28.7384	0.0000	0.0000	0.0000	0.00	0.00	U2_03	37.46236	0.76	
BT	277	03/10/2016 10:00	-	-	24.9174	-28.8591	0.6541	37.2469	25.3696	0.76	0.03	U2_14	37.28568	0.66	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
BU	277	03/10/2016 13:32	-	-	24.5911	-28.9149	0.6514	37.2374	25.4024	0.76	0.03	U2_19	37.26587	0.81	
BV	277	03/10/2016 16:00	-	-	24.3032	-28.9734	0.6127	37.3234	25.7366	0.76	0.03	U2_04	37.33386	0.42	
BW	277	03/10/2016 20:00	-	-	23.6374	-29.1624	0.6148	36.9822	25.7371	0.76	0.03	U2_13	36.989	0.60	
BX	278	04/10/2016 06:25	-	-	22.0515	-29.5248	0.5958	36.8912	25.9042	0.76	0.03	U2_20	36.88778	0.72	
BY	278	04/10/2016 10:00	-	-	21.4419	-29.6692	0.6640	36.8354	25.9576	0.76	0.03	U2_05	36.83513	0.99	
BZ	278	04/10/2016 13:21	-	-	21.1661	-29.7287	0.6583	36.7801	26.0418	0.76	0.03	U2_12	36.78963	0.88	
CA	278	04/10/2016 16:00	-	-	20.8874	-29.7919	0.6657	36.8591	26.0612	0.76	0.03	U2_21	36.89549	0.50	
CB	279	05/10/2016 20:00	-	-	16.8120	-29.1790	0.4571	36.3788	27.1574	0.75	0.03	U2_06	36.65698	0.60	
CC	279	05/10/2016 06:41	-	-	18.6625	-29.6524	0.5441	36.3878	26.4838	0.75	0.03	U2_11	36.38331	0.76	
CD	279	05/10/2016 10:00	-	-	18.1110	-29.5114	0.5428	36.4856	26.7897	0.75	0.03	U2_22	36.50544	0.93	
CE	279	05/10/2016 13:33	-	-	17.7922	-29.4080	0.5077	36.5313	26.7107	0.75	0.03	U2_07	36.52886	0.67	
CF	279	05/10/2016 16:00	-	-	17.4817	-29.3455	0.5065	36.5536	26.9827	0.75	0.03	U2_10	36.55532	0.50	
CG	279	05/10/2016 20:00	-	-	16.8120	-29.1790	0.4571	36.3788	27.1574	0.75	0.03	U2_23	36.40692	0.82	
CH	280	06/10/2016 06:41	-	-	15.2831	-28.7766	0.4790	36.1768	26.8141	0.75	0.03	U2_9	36.16803	1.34	
CI	280	06/10/2016 10:04	-	-	14.8167	-28.6723	0.4539	36.1381	26.8488	0.74	0.03	U2_8	36.13636	3.04	
CJ	280	06/10/2016 13:32	-	-	14.5023	-28.5698	0.4938	36.2985	27.1917	0.74	0.03	U2_24	36.29394	2.05	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
CK	280	06/10/2016 16:00	-	-	14.1790	-28.4871	0.4244	36.2609	27.4480	0.74	0.03	5_08	36.2674	1.48	
CL	280	06/10/2016 20:00	-	-	13.5040	-28.3403	-0.0084	0.0000	0.0000	0.00	0.00	5_09	36.2552	1.13	
CM	281	07/10/2016 06:41	-	-	11.9680	-27.9501	0.5614	35.6358	28.3281	0.74	0.03	5_24	35.6855	1.06	
CN	281	07/10/2016 10:00	-	-	11.5158	-27.8399	0.5988	35.7942	28.4183	0.74	0.03	-	-	1.54	
CO	281	07/10/2016 13:35	-	-	11.2151	-27.7348	0.0000	0.0000	0.0000	0.00	0.00	5_10	36.0057	1.13	
CP	281	07/10/2016 15:58	-	-	10.9192	-27.6674	0.5586	35.7046	28.9049	0.74	0.03	5_07	35.7244	1.26	
CQ	281	07/10/2016 20:00	-	-	10.2418	-27.5224	0.5586	35.5999	28.7012	0.74	0.03	5_22	35.6496	1.46	
CR	282	08/10/2016 06:28	-	-	8.6793	-27.1345	0.5718	36.0451	28.8134	0.74	0.03	5_04	35.0908	1.38	
CS	282	08/10/2016 10:00	-	-	8.0935	-26.9890	0.5558	36.0192	28.9087	0.74	0.03	5_06	36.0189	1.56	
CT	282	08/10/2016 13:34	-	-	7.7600	-26.8823	0.5607	35.7948	28.9604	0.74	0.03	5_12	35.8194	2.08	
CU	282	08/10/2016 16:00	-	-	7.4352	-26.7988	0.5302	35.9045	29.0367	0.74	0.03	5_21	35.9361	1.72	
CV	282	08/10/2016 20:01	-	-	6.7570	-26.6601	0.5111	35.5080	29.3271	0.73	0.03	5_00	35.5252	1.00	
CW	283	09/10/2016 06:31	-	-	5.2006	-26.2714	0.5362	34.9841	28.6584	0.73	0.03	5_20	35.0056	0.96	
CX	283	09/10/2016 10:02	-	-	4.7384	-26.1616	0.5638	35.0998	28.6272	0.73	0.03	5_13	35.0976	1.17	
CY	283	09/10/2016 13:26	-	-	4.4865	-26.0790	0.5660	35.0672	28.7826	0.73	0.03	5_04	35.0908	1.12	
CZ	283	09/10/2016 16:00	-	-	4.1615	-26.0055	0.5385	34.9689	28.7720	0.73	0.03	5_19	34.984	0.90	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
DA	283	09/10/2016 20:00	-	-	3.4901	-25.8555	0.5536	35.4016	28.5458	0.73	0.03	5_14	35.4076	0.84	
DB	284	10/10/2016 06:27	-	-	1.9694	-25.4785	0.5660	35.7512	28.1885	0.73	0.03	5_03	35.7683	0.75	
DC	284	10/10/2016 10:00	-	-	1.4658	-25.3589	0.5779	35.8083	28.0996	0.73	0.03	5_18	35.8236	0.91	
DD	284	10/10/2016 13:40	-	-	1.1584	-25.2577	0.5892	35.8779	27.9432	0.73	0.03	5_15	35.8802	0.54	
DE	284	10/10/2016 16:00	-	-	0.8349	-25.1842	0.5690	36.1220	27.3307	0.72	0.03	5_02	36.1546	1.44	
DF	285	11/10/2016 20:00	-	-	-3.2621	-25.0178	0.5858	36.1306	26.6858	0.72	0.03	5_17	36.2003	0.81	
DG	285	11/10/2016 06:24	-	-	-1.4202	-24.9960	0.5604	36.2544	26.6573	0.72	0.03	5_16	36.265	1.19	
DH	285	11/10/2016 10:00	-	-	-1.9205	-25.0101	0.6019	36.1615	26.5803	0.72	0.03	-	-	-	
DI	285	11/10/2016 12:30	-	-	-2.2517	-24.9925	0.5962	36.1510	26.6493	0.72	0.03	5_01	36.1796	1.02	
DJ	285	11/10/2016 20:00	-	-	-3.2621	-25.0178	0.5858	36.1306	26.6858	0.72	0.03	-	-	-	
DK	285	11/10/2016 20:06	-	-	-3.2789	-25.0179	0.5848	36.1302	26.6879	0.72	0.03	-	-	0.59	
DL	286	12/10/2016 10:00	-	-	-5.4545	-25.0286	0.6015	36.1024	26.1787	0.72	0.03	U2_1	36.1793	0.61	
DM	286	12/10/2016 13:30	-	-	-5.8111	-25.0265	0.6119	36.1330	26.3482	0.72	0.03	U2_16	36.1641	0.38	
DN	286	12/10/2016 16:00	-	-	-6.1369	-25.0243	0.5862	36.2239	26.5189	0.72	0.03	U2_17	36.2276	0.69	
DO	286	12/10/2016 20:00	-	-	-6.8094	-25.0365	0.5987	36.2107	26.0827	0.72	0.03	U2_2	36.2598	0.52	
DP	287	13/10/2016 06:30	-	-	-8.3817	-25.0359	0.5622	36.1340	25.8932	0.71	0.03	U2_15	36.127	0.61	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
DQ	287	13/10/2016 10:00	-	-	-8.8872	-25.0475	0.5814	36.2625	25.9687	0.72	0.03	-	-	-	
DR	287	13/10/2016 13:20	-	-	-9.1186	-25.0287	0.5570	36.3244	25.9893	0.71	0.03	U2_3	36.3201	0.73	
DS	287	13/10/2016 16:00	-	-	-9.5690	-25.0516	0.5431	36.6060	25.6128	0.71	0.03	-	-	-	
DT	287	13/10/2016 20:30	-	-	-	10.3493	-25.0566	0.5071	36.5967	25.3424	0.71	U2_14	36.6256	0.31	
DU	288	14/10/2016 06:32	-	-	-	11.8267	-25.0577	0.4975	36.8435	24.9789	0.71	U2_19	36.8316	0.33	
DV	288	14/10/2016 10:00	-	-	-	11.8294	-25.0524	0.5208	36.8439	24.9637	0.71	U2_5	36.8235	0.30	
DW	288	14/10/2016 13:54	-	-	-	11.8301	-25.0517	0.5231	36.8017	25.0655	0.71	U2_4	36.7812	0.44	
DX	288	14/10/2016 16:00	-	-	-	12.1858	-25.0492	0.6197	36.6223	25.3206	0.71	U2_13	36.6051	0.33	
DY	288	14/10/2016 20:00	-	-	-	12.9126	-25.0689	0.6072	37.0770	24.5085	0.71	-	-	0.20	
DZ	289	15/10/2016 06:43	-	-	-	14.4807	-25.0769	0.6282	37.1330	24.2686	0.71	U2_12	37.1141	0.28	
EA	289	15/10/2016 10:00	-	-	-	15.0360	-25.0811	0.6305	37.1564	24.3422	0.71	U2_21	37.1369	0.26	
EB	289	15/10/2016 13:28	-	-	-	15.3793	-25.0763	0.6354	37.1715	24.5195	0.71	U2_6	37.1514	0.35	
EC	289	15/10/2016 16:00	-	-	-	15.7257	-25.0767	0.6260	37.1608	24.5891	0.71	-	-	-	
ED	289	15/10/2016 20:00	-	-	-	16.4883	-25.0884	0.6212	37.1429	24.5448	0.71	U2_11	37.1279	0.28	
EE	290	16/10/2016 06:30	-	-	-	18.2805	-25.1207	0.6477	37.1185	23.8732	0.70	U2_22	37.0972	0.21	
EF	290	16/10/2016 10:00	-	-	-	18.5449	-25.1049	0.6264	37.1010	23.8138	0.70	U2_7	37.0805	0.21	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
EG	290	16/10/2016 16:00	-	-	- 18.5054	-24.9986	0.6324	37.0953	23.8721	0.70	0.03	-	-	-	
EH	290	16/10/2016 20:00	-	-	- 19.0903	-25.0029	0.6145	37.1133	23.7811	0.70	0.03	U2_10	37.093	0.18	
EI	291	17/10/2016 06:34	-	-	- 20.6741	-25.0014	0.6049	37.0453	23.0596	0.70	0.03	U2_23	37.0243	0.43	
EJ	291	17/10/2016 10:00	-	-	- 21.1655	-25.0137	0.6372	37.0518	23.0621	0.70	0.03	U2_24	37.0257	0.56	
EK	291	17/10/2016 13:39	-	-	- 21.3395	-25.0124	0.6177	37.1047	23.2910	0.70	0.03	U2_9	37.0838	0.24	
EL	291	17/10/2016 16:00	-	-	- 21.6514	-24.9953	0.6124	36.9533	23.0078	0.70	0.03	U2_8	36.9335	0.25	
EM	291	17/10/2016 20:00	-	-	- 22.3279	-25.0207	0.5969	36.9134	22.8086	0.70	0.03	-	-	0.29	
EN	292	18/10/2016 05:38	-	-	- 23.7264	-25.0192	0.6024	36.9337	22.7325	0.69	0.03	B_01	36.9126	0.38	
EO	292	18/10/2016 12:10	-	-	- 24.4652	-25.0264	0.6248	36.7192	22.2483	0.69	0.03	B_09	36.6982	0.31	
EP	292	18/10/2016 16:00	-	-	- 25.0402	-25.0252	0.5986	36.7652	22.3698	0.69	0.03	B_17	36.7456	0.29	
EQ	292	18/10/2016 20:00	-	-	- 25.7719	-24.8474	0.6108	36.7427	22.1622	0.69	0.03	B_02	36.7196	0.27	
ER	293	19/10/2016 05:39	-	-	- 27.3054	-24.4411	0.6243	36.2233	20.8623	0.69	0.03	B_10	36.2045	0.34	
ES	293	19/10/2016 10:00	-	-	- 27.9910	-24.2681	0.6126	36.1972	20.7162	0.68	0.03	B_18	36.1778	0.25	
ET	293	19/10/2016 13:24	-	-	- 28.1523	-24.2966	0.6009	36.2035	20.9723	0.68	0.03	B_03	36.1843	0.31	
EU	293	19/10/2016 16:00	-	-	- 28.4597	-24.4386	0.6079	36.2733	21.0255	0.68	0.03	B_11	36.2495	0.25	
EV	293	19/10/2016 20:00	-	-	- 29.0910	-24.7335	0.6184	35.9239	19.9115	0.68	0.03	B_19	35.9017	0.24	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
EW	294	20/10/2016 05:42	-	-	30.3893	-25.3191	0.5899	35.7480	18.2979	0.68	0.03	B_04	35.7292	0.32	
EX	294	20/10/2016 10:00	-	-	30.9707	-25.5791	0.6187	35.6800	17.9123	0.68	0.04	B_12	35.654	0.39	
EY	294	20/10/2016 14:08	-	-	31.3371	-25.7385	0.5859	35.7118	17.8409	0.68	0.03	B_20	35.6912	0.75	
EZ	294	20/10/2016 16:00	-	-	31.6396	-25.8835	0.5903	35.6585	17.4689	0.68	0.04	B_21	35.6422	0.66	
FA	294	20/10/2016 20:00	-	-	32.2734	-26.1755	0.6063	35.5878	16.9623	0.67	0.04	-	-	-	
FB	294	20/10/2016 21:07	-	-	32.4520	-26.2584	0.6019	35.6088	17.1321	0.67	0.04	B_14	35.5932	0.53	
FC	295	21/10/2016 05:43	-	-	33.5887	-26.7818	0.5956	35.5390	16.3631	0.67	0.04	B_05	35.5197	0.68	
FD	295	21/10/2016 10:00	-	-	34.2586	-27.1007	0.5364	35.6291	16.7123	0.66	0.04	B_06	35.6068	1.59	
FE	295	21/10/2016 13:28	-	-	34.4287	-27.1856	0.5204	35.6812	17.2003	0.66	0.04	B_15	35.6654	0.59	
FF	295	21/10/2016 16:00	-	-	34.6172	-27.3230	0.6303	35.6720	16.7810	0.71	0.04	B_07	35.6428	1.05	
FG	295	21/10/2016 20:00	-	-	35.1913	-27.5865	0.6312	35.6213	16.1457	0.71	0.04	B_22	35.5962	1.44	
FH	296	22/10/2016 05:39	-	-	36.5303	-28.1439	0.6036	35.6340	15.0699	0.72	0.04	B_16	35.6093	0.85	
FI	296	22/10/2016 10:00	-	-	37.1418	-28.3892	0.6123	35.6480	15.1244	0.71	0.04	-	-	-	
FJ	296	22/10/2016 10:10	-	-	37.1691	-28.4007	0.6232	35.6640	15.0682	0.71	0.04	B_23	35.6399	1.11	
FK	296	22/10/2016 13:35	-	-	37.3329	-28.4341	0.5696	35.6643	15.5370	0.71	0.04	B_08	35.633	0.97	
FL	296	22/10/2016 16:10	-	-	37.6480	-28.5190	0.5756	35.6689	15.5865	0.71	0.04	B_13	35.6398	1.25	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
							(l)		(deg. C)	(volts)	(volts)				
FM	296	22/10/2016 20:00	-	-	-	-28.5584	0.5679	35.6554	14.8867	0.69	0.05	-	-	-	
FN	297	23/10/2016 05:38	-	-	39.7156	-28.6727	0.6194	35.5010	14.0918	0.69	0.05	B_24	35.4773	3.23	
FO	297	23/10/2016 10:00	-	-	40.3880	-28.7483	0.6152	35.3017	13.0769	0.70	0.05	5_01	35.28556	2.01	
FP	297	23/10/2016 16:00	-	-	40.8618	-28.9859	0.5739	35.3045	13.1156	0.70	0.04	5_02	35.28386	1.62	
FQ	297	23/10/2016 20:00	-	-	41.3796	-29.2453	0.5683	35.2943	13.0792	0.69	0.04	5_03	35.27367	2.91	
FR	298	24/10/2016 06:00	-	-	42.4599	-29.7935	0.5073	35.0387	11.3676	0.69	0.05	5_04	35.01649	2.54	
FS	298	24/10/2016 10:00	-	-	42.8222	-29.9692	0.5563	35.0099	11.1495	0.69	0.05	5_00	-	1.27	
FT	298	24/10/2016 12:30	-	-	43.0517	-30.0925	0.5193	35.0328	11.2938	0.69	0.05	5_06	35.01517	2.20	
FU	298	24/10/2016 16:00	-	-	43.3905	-30.2741	0.5197	35.0859	11.5491	0.69	0.05	5_07	35.06576	2.06	
FV	298	24/10/2016 20:00	-	-	43.8409	-30.5070	0.5340	35.0265	11.2252	0.68	0.05	5_08	35.00808	2.02	
FW	299	25/10/2016 05:44	-	-	44.9261	-31.0959	0.5312	34.4017	7.2409	0.64	0.09	5_16	34.38276	11.11	
FX	299	25/10/2016 10:00	-	-	45.5166	-31.4075	0.5222	34.4030	7.1201	0.65	0.06	-	-	6.46	
FY	299	25/10/2016 13:27	-	-	45.6656	-31.4945	0.5224	34.3527	6.8893	0.64	0.06	5_14	34.33441	5.60	
FZ	299	25/10/2016 16:00	-	-	45.9086	-31.6408	0.5761	34.5635	7.9709	0.65	0.06	5_13	34.54236	3.35	
GA	299	25/10/2016 20:00	-	-	46.4132	-31.9201	0.5940	34.3125	6.7313	0.64	0.07	5_12	34.29356	2.76	
GB	300	26/10/2016 05:32	-	-	47.4498	-32.4911	0.7289	33.8937	2.9096	0.63	0.18	5_11	33.87621	1.27	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
GC	300	26/10/2016 10:03	-	-	47.9424	-32.7814	0.6689	33.8136	1.9502	0.60	0.24	5_10	33.81198	3.89	
GD	300	26/10/2016 13:56	-	-	48.0819	-32.8916	0.6368	33.8116	2.0144	0.56	0.25	5_09	33.80084	0.01	
GE	300	26/10/2016 16:00	-	-	48.3237	-33.0441	0.6518	34.4131	6.7061	0.59	0.19	5_17	34.39856	2.25	
GF	300	26/10/2016 20:00	-	-	48.8314	-33.2400	0.6656	34.2866	5.7430	0.59	0.10	5_18	34.26667	2.93	
GG	301	27/10/2016 06:00	-	-	49.7856	-33.7856	0.6974	34.2643	5.6397	0.59	0.09	5_19	34.24625	2.29	
GH	301	27/10/2016 10:00	-	-	50.2308	-34.0468	0.6544	33.8469	2.2616	0.59	0.11	5_20	33.83197	4.25	
GI	301	27/10/2016 14:56	-	-	50.2874	-34.0816	0.6538	33.8311	1.7450	0.56	0.21	5_21	33.81904	4.35	
GJ	301	27/10/2016 20:00	-	-	50.8786	-34.4311	0.6610	33.8848	1.4593	0.57	0.24	5_22	33.87334	1.99	
GK	302	28/10/2016 05:30	-	-	51.8559	-35.0148	0.6338	33.9654	0.9638	0.57	0.23	5_23	33.95652	3.06	
GL	302	28/10/2016 10:00	1A	1B	52.2053	-35.2495	0.6461	33.8929	1.3599	0.57	0.23	5_24	33.88673	1.47	
GM	302	28/10/2016 13:48	2A	2B	52.4480	-35.3749	0.6197	33.9036	1.3267	0.57	0.22	B_01	33.8906	0.81	
GN	302	28/10/2016 16:00	3A	3B	52.6651	-35.5064	0.5611	33.9081	1.0505	0.52	0.25	B_02	33.8968	16.06	
GO	302	28/10/2016 20:00	4A	4B	53.1116	-35.7851	0.5473	34.0067	-0.1050	0.54	0.23	B_03	33.9978	0.82	
GP	303	29/10/2016 05:24	5A	5B	53.9344	-36.3100	0.5323	33.9594	0.3349	0.54	0.21	B_04	33.9508	1.58	
GQ	303	29/10/2016 09:34	6A	6B	54.2834	-36.5013	0.5689	33.3706	0.8887	0.46	0.24	-	-	10.05	
GR	304	30/10/2016 14:55	7A	7B	53.9946	-36.8444	0.6346	33.8568	0.6247	0.56	0.19	B_05	33.8692	1.16	

Sample ID	JD	Date and time (UT)			Lat (+ve N)	Lon (+ve E)	Flow rate	TSG sal.	SST - hull	Trans.	Fluor	Salinity		Chl-a uncalib	Comments
			DOP/N	DOC/N								Sal_ID	Sal Autosal		
GS	304	30/10/2016 20:00	8A	8B	-	-37.4092	0.6672	33.8747	0.3487	0.56	0.19	B_06	33.8955	2.17	
GT	305	31/10/2016 06:44	-	-	-	-39.9856	0.7267	33.9032	0.5758	0.53	0.22	B_07	33.8914	2.35	
GU	305	31/10/2016 11:00	-	-	-	-40.9293	0.7224	33.7504	0.2018	0.55	0.20	B_08	33.7355	13.16	
GV	305	31/10/2016 14:42	-	-	-	-41.5421	0.6967	33.7550	0.4674	0.55	0.20	B_09	33.7382	2.51	
GW	305	31/10/2016 17:00	-	-	-	-42.1016	0.7017	33.7987	0.6154	0.55	0.19	B_10	33.7806	1.74	
GX	305	31/10/2016 21:00	-	-	-	-43.2090	0.7190	33.7368	0.7041	0.55	0.19	B_11	33.7212	2.22	
GY	306	01/11/2016 06:36	-	-	-	-45.0883	0.7225	33.7507	1.4930	0.54	0.16	B_12	33.7331	2.00	
GZ	306	01/11/2016 11:00	-	-	-	-46.1338	0.7403	33.7496	0.9026	0.53	0.15	-	-	3.09	
HA	306	01/11/2016 14:00	-	-	-	-46.9135	0.7440	33.7785	1.8174	0.54	0.14	-	-	1.63	
HB	307	02/11/2016 14:30	9A	9B	-	-53.1897	0.6383								
HC	307	02/11/2016 18:02	10A	10B	-	-53.7930	0.6340								
HD	307	02/11/2016 22:45	11A	11B	-	-54.9429	0.6461								
HE	308	03/11/2016 02:00	12A	12B	-	-55.6893	0.6429								
HF	308	03/11/2016 08:52	13A	13B	-	-57.2650	0.6391								
	308	03/11/2016 10:00													Underway Switched Off

Appendix 2 – AMT26 Log of events

Time	Bridge EVENT	Science EVENT	Lat	Lon	Comment
23/09/2016 14:30:00	Test Station	001 Station	49.32017	-6.45798	Commence Slowing Down
23/09/2016 14:36:00	Test Station	001 Station	49.31213	-6.48233	VSL on DP
23/09/2016 14:44:00	Test Station HB001	001 HB001	49.31232	-6.48246	Commence Deploying Horizontal Tow Net
23/09/2016 14:59:00	Test Station HB001	001 HB001	49.31074	-6.48757	Commence Recovering Horizontal Tow Net
23/09/2016 15:04:00	Test Station HB001	001 HB001	49.31003	-6.48987	Net Recovered to Deck
23/09/2016 15:24:00	Test Station RA002	001 RA001	49.30989	-6.49038	Radiometer deployed astern
23/09/2016 15:33:00	Test Station RA002	001 RA001	49.30992	-6.49037	Commence Recovery
23/09/2016 15:34:00	Test Station RA002	001 RA001	49.30991	-6.49037	Radiometer Recovered to Deck
23/09/2016 16:26:00	Test Station RS003	001 RS001	49.31073	-6.49056	Weather balloon launched
23/09/2016 16:33:00	Test Station CTD004	001 CTD001	49.31074	-6.49056	CTD Deployed
23/09/2016 16:55:00	Test Station CTD004	001 CTD001	49.31073	-6.49057	CTD Veering to 100m
23/09/2016 16:58:00	Test Station CTD004	001 CTD001	49.31073	-6.49057	CTD Stopped at 100m
23/09/2016 17:12:00	Test Station CTD004	001 CTD001	49.31073	-6.49057	CTD Recovered
23/09/2016 17:24:00	Test Station	001 Station	49.31071	-6.49054	Vessel Off DP
23/09/2016 17:30:00	Test Station	001 Station	49.3092	-6.49253	On Passage
25/09/2016 03:12:00	1	002 Station	46.36902	-12.6704	Commence Slowing Down
25/09/2016 03:42:00	1	002 Station	46.38081	-12.6952	Vsl on DP
25/09/2016 04:08:00	001 CTD005	002 CTD002	46.38158	-12.6949	CTD Deployed
25/09/2016 04:11:00	001 CTD005	002 CTD002	46.38158	-12.6949	CTD Veering to 500m
25/09/2016 04:19:00	001 CTD005	002 CTD002	46.38154	-12.6948	CTD Stopped at 500m
25/09/2016 04:52:00	001 CTD005	002 CTD002	46.38153	-12.6948	CTD Recovered
25/09/2016 05:12:00	1	002 Station	46.38174	-12.6954	Vessel Off DP
25/09/2016 05:18:00	1	002 Station	46.38291	-12.6994	Vessel On Passge
25/09/2016 09:56:00	2	003 Station	45.83657	-13.5842	Commence slowing down for station
25/09/2016 10:02:00	2	003 Station	45.83661	-13.5912	Vessel on DP
25/09/2016 10:10:00	002 CTD006	003 CTD003	45.83656	-13.5917	CTD deployed
25/09/2016 10:13:00	002 CTD006	003 CTD003	45.83655	-13.5917	CTD veering to 500m
25/09/2016 10:17:00	002 RS007	003 RS002	45.83657	-13.5917	Weather balloon deployed
25/09/2016 10:22:00	002 CTD006	003 CTD003	45.8366	-13.5917	CTD stopped at 500m
25/09/2016 10:43:00	002 CTD006	003 CTD003	45.83656	-13.5917	CTD recovered to deck
25/09/2016 10:47:00	002 RS008	003 RS003	45.83658	-13.5917	2nd weather balloon launched
25/09/2016 10:55:00	2	003 Station	45.83657	-13.5917	Vessel off DP
25/09/2016 11:02:00	2	003 Station	45.83545	-13.5981	Vessel on passage
25/09/2016 12:54:00	3	004 Station	45.66545	-13.9743	Commence Slowing Down
25/09/2016 13:00:00	3	004 Station	45.6661	-13.978	Vsl on DP
25/09/2016 13:07:00	003 SAP009	004 SAP001	45.66613	-13.978	Commence Deploying SAPS
25/09/2016 13:10:00	003 CTD010	004 CTD004	45.6661	-13.978	Commence Deploying CTD
25/09/2016 13:18:00	003 SAP009	004 SAP001	45.66609	-13.978	1st Pump in the Water

25/09/2016 13:19:00	003 CTD010	004 CTD004	45.66611	-13.978	CTD in the Water
25/09/2016 13:23:00	003 SAP009	004 SAP001	45.66661	-13.978	2nd Pump in the Water
25/09/2016 13:24:00	003 CTD010	004 CTD004	45.66608	-13.978	CTD veering to 500m
25/09/2016 13:27:00	003 SAP009	004 SAP001	45.66661	-13.978	3rd Pump in the Water
25/09/2016 13:28:00	003 SAP009	004 SAP001	45.66661	-13.978	SAPS at Depth (10, 60 and 100m)
25/09/2016 13:33:00	003 CTD010	004 CTD004	45.66607	-13.978	CTD stopped at 500m, EA600 Depth 4781m
25/09/2016 14:06:00	003 CTD010	004 CTD004	45.66606	-13.978	CTD Recovered to Deck
25/09/2016 14:19:00	003 SAP009	004 SAP001	45.66607	-13.978	Commence SAPS Recovery
25/09/2016 14:22:00	003 SAP009	004 SAP001	45.66606	-13.978	3rd Pump Recovered
25/09/2016 14:25:00	003 SAP009	004 SAP001	45.66607	-13.978	1st Pump and Weight recovered to Deck
25/09/2016 14:30:00	3	004 Station	45.66661	-13.978	Vsl off DP
25/09/2016 14:42:00	3	004 Station	45.66386	-13.9979	Full Away on Passage Commence Slowing down for Station
26/09/2016 03:42:00	4	005 Station	44.1672	-16.0423	Station
26/09/2016 04:00:00	4	005 Station	44.1615	-16.0538	Vessel On DP
26/09/2016 04:04:00	004 CTD011	005 CTD005	44.16157	-16.0539	Performing load test on CTD
26/09/2016 04:30:00	004 CTD011	005 CTD005	44.16156	-16.0539	Load test complete
26/09/2016 04:40:00	004 VB012	005 VB001	44.16152	-16.054	Net Deployed
26/09/2016 04:43:00	004 VB012	005 VB001	44.16154	-16.054	Veering to 200m
26/09/2016 04:53:00	004 VB012	005 VB001	44.16155	-16.0539	Net Stopped at 200m
26/09/2016 04:58:00	004 CTD011	005 CTD005	44.16153	-16.0539	CTD Deployed
26/09/2016 05:02:00	004 CTD011	005 CTD005	44.16154	-16.0539	Veering to 500m
26/09/2016 05:04:00	004 CTD011	005 CTD005	44.16153	-16.0539	CTD Stopped at 70m, recovery required
26/09/2016 05:06:00	004 CTD011	005 CTD005	44.16155	-16.0539	CTD Recovered to deck
26/09/2016 05:12:00	004 VB012	005 VB001	44.16154	-16.0539	Bongo Net recovered
26/09/2016 06:24:00	4	005 Station	44.16162	-16.0539	Vessel Off DP
26/09/2016 06:30:00	4	005 Station	44.1594	-16.0556	Vessel On Passage Vessel slowing down onto station
26/09/2016 09:48:00	5	006 Station	43.75964	-16.593	station
26/09/2016 09:54:00	5	006 Station	43.75958	-16.6006	Vessel on DP
26/09/2016 09:59:00	005 CTD013	006 CTD006	43.75954	-16.6011	Commence deploying CTD
26/09/2016 10:06:00	005 CTD013	006 CTD006	43.75956	-16.6011	CTD veering to 500m
26/09/2016 10:13:00	005 RS014	006 RS004	43.75953	-16.6011	Weather balloon launched
26/09/2016 10:16:00	005 CTD013	006 CTD006	43.75951	-16.6011	CTD stopped at 500m
26/09/2016 10:36:00	005 CTD013	006 CTD006	43.75951	-16.601	CTD recovered to deck
26/09/2016 10:42:00	5	006 Station	43.75953	-16.6011	Vessel off DP
26/09/2016 10:54:00	5	006 Station	43.75128	-16.6157	Vessel on passage Commence Turning on to Station
26/09/2016 12:36:00	6	007 Station	43.52808	-16.9254	Station
26/09/2016 12:54:00	6	007 Station	43.52427	-16.9617	VSL on DP
26/09/2016 12:59:00	006 CTD015	007 CTD007	43.52424	-16.9617	Commence Deploying CTD
26/09/2016 13:05:00	006 CTD015	007 CTD007	43.52424	-16.9617	CTD in the Water
26/09/2016 13:07:00	006 RA016	007 RA002	43.52427	-16.9618	Commence Deploying Radiometer
26/09/2016 13:10:00	006 CTD015	007 CTD007	43.52428	-16.962	CTD veering to 500m, EA600 Depth 3634m

26/09/2016 13:13:00	006 RA016	007 RA002	43.52428	-16.9622	Radiometer Recovered to Deck
26/09/2016 13:19:00	006 CTD015	007 CTD007	43.52426	-16.9622	CTD stopped at 500m, Commence Hauling
26/09/2016 13:52:00	006 CTD015	007 CTD007	43.52427	-16.9622	CTD Recovered to Deck
26/09/2016 14:00:00	6	007 Station	43.52424	-16.9622	VSL off DP
26/09/2016 14:12:00	6	007 Station	43.51723	-16.9737	On Passage
27/09/2016 03:42:00	7	008 Station	41.78409	-19.3809	Commence Slowing Down
27/09/2016 03:48:00	7	008 Station	41.78416	-19.3858	VSL on DP
27/09/2016 03:58:00	007 CTD017	008 CTD008	41.78417	-19.3858	Commence Deploying CTD
27/09/2016 03:59:00	007 VB018	008 VB002	41.78417	-19.3858	Commence Deploying Vertical Bongo Nets
27/09/2016 04:00:00	007 VB018	008 VB002	41.78416	-19.3858	Veering to 200m
27/09/2016 04:07:00	007 CTD017	008 CTD008	41.78419	-19.3858	Veering to 500m
27/09/2016 04:16:00	007 CTD017	008 CTD008	41.78418	-19.3858	Stopped at 500m
27/09/2016 04:27:00	007 VB018	008 VB002	41.78418	-19.3858	Nets recovered
27/09/2016 04:44:00	007 CTD017	008 CTD008	41.78416	-19.3857	CTD Recovered
27/09/2016 04:56:00	007 HB019	008 HB002	41.78419	-19.3859	Nets Deployed
27/09/2016 05:38:00	007 HB019	008 HB002	41.78416	-19.4085	Nets recovered
27/09/2016 05:54:00	7	008 Station	41.78398	-19.4118	Vessel Off DP
27/09/2016 06:00:00	7	008 Station	41.78022	-19.4173	Vessel On Passage
27/09/2016 09:42:00	8	009 Station	41.3277	-20.0155	Commence slowing down for station
27/09/2016 09:54:00	8	009 Station	41.32181	-20.0257	Vessel on DP
27/09/2016 10:00:00	008 CTD020	009 CTD009	41.32182	-20.0258	Commence deployment of CTD
27/09/2016 10:03:00	008 CTD020	009 CTD009	41.32182	-20.0258	CTD in water
27/09/2016 10:05:00	008 CTD020	009 CTD009	41.32182	-20.0258	CTD veering to 500m
27/09/2016 10:10:00	008 OR021	009 OR001	41.32182	-20.0258	Commence deploying optics rig
27/09/2016 10:12:00	008 OR021	009 OR001	41.32182	-20.0258	Optics rig in water. Veering to 50m
27/09/2016 10:14:00	008 CTD020	009 CTD009	41.32181	-20.0258	CTD at 500m
27/09/2016 10:15:00	008 RS022	009 RS005	41.32181	-20.0257	Balloon launched
27/09/2016 10:21:00	008 OR021	009 OR001	41.32181	-20.0258	Optics rig hauled out of water
27/09/2016 10:23:00	008 OR021	009 OR001	41.32181	-20.0258	Optics rig in water. Veering to 50m
27/09/2016 10:33:00	008 OR021	009 OR001	41.32181	-20.0258	Optics rig recovered to deck
27/09/2016 10:36:00	008 CTD020	009 CTD009	41.32179	-20.0257	CTD recovered to deck
27/09/2016 10:39:00	008 RA023	009 RA003	41.32181	-20.0258	RA deployed
27/09/2016 10:46:00	008 RA023	009 RA003	41.32211	-20.0254	RA recovered to deck
27/09/2016 10:48:00	8	009 Station	41.32224	-20.0253	Vessel off DP
27/09/2016 10:54:00	8	009 Station	41.32293	-20.0243	Vessel on passage
27/09/2016 12:36:00	9	010 Station	41.17171	-20.2304	Turning to come on station
27/09/2016 12:54:00	9	010 Station	41.18616	-20.2322	VSL on DP
27/09/2016 12:59:00	009 SAP024	010 SAP002	41.18629	-20.2322	Commence Deploying SAPS
27/09/2016 13:02:00	009 OR025	010 OR002	41.1863	-20.2322	Commence Deploying Optics Rig
27/09/2016 13:03:00	009 OR025	010 OR002	41.1863	-20.2322	Optics Rig Deployed - Issue with Camera
27/09/2016 13:13:00	009 OR025	010 OR002	41.18628	-20.2322	Optics Rig - all okay, veering

27/09/2016 13:14:00	009 SAP024	010 SAP002	41.18628	-20.2322	1st Pump in the Water
27/09/2016 13:18:00	009 SAP024	010 SAP002	41.18627	-20.2322	2nd Pump in the Water
27/09/2016 13:19:00	009 OR025	010 OR002	41.18628	-20.2322	Optics Rig at 250m, Commence Hauling
27/09/2016 13:22:00	009 SAP024	010 SAP002	41.18628	-20.2322	3rd Pump in the Water
27/09/2016 13:23:00	009 SAP024	010 SAP002	41.18629	-20.2322	SAPS Fully Deployed at 10m, 65m and 150m
27/09/2016 13:30:00	009 CTD026	010 CTD010	41.18628	-20.2322	Commence Deploying CTD
27/09/2016 13:33:00	009 CTD026	010 CTD010	41.18627	-20.2322	CTD veering to 500m
27/09/2016 13:35:00	009 OR025	010 OR002	41.18625	-20.2322	Optics Rig at ships side, Commence Redeploying
27/09/2016 13:40:00	009 OR027	010 OR003	41.18625	-20.2322	Optics Rig at 250m, Commence Hauling
27/09/2016 13:42:00	009 CTD026	010 CTD010	41.18627	-20.2322	CTD at 500m, Commence Hauling
27/09/2016 13:59:00	009 OR027	010 OR003	41.18626	-20.2322	Optics Rig Recovered to Deck
27/09/2016 14:10:00	009 CTD026	010 CTD010	41.18627	-20.2322	CTD recovered to deck
27/09/2016 14:11:00	009 RA028	010 RA004	41.18628	-20.2322	Commence Deploying Radiometer
27/09/2016 14:23:00	009 RA028	010 RA004	41.18691	-20.2301	Radiometer Recovered to deck
27/09/2016 14:25:00	009 SAP024	010 SAP002	41.18704	-20.2297	Commence recovering SAPS
27/09/2016 14:29:00	009 SAP024	010 SAP002	41.18712	-20.2294	2nd Pump Recovered to Deck
27/09/2016 14:36:00	009 SAP024	010 SAP002	41.18712	-20.2294	SAPS Fully Recovered to Deck
27/09/2016 14:42:00	9	010 Station	41.18712	-20.2294	VSL off DP
27/09/2016 14:50:00	9	010 Station	41.18578	-20.2213	VSL running with sun on Beam
27/09/2016 14:55:00	9	010 Station	41.18003	-20.2046	Completed 5 minute run
27/09/2016 15:00:00	9	010 Station	41.17145	-20.1888	On passage
28/09/2016 03:42:00	10	011 Station	39.71235	-22.2471	Commence Slowing Down
28/09/2016 03:48:00	10	011 Station	39.70969	-22.2569	Vsl on DP
28/09/2016 03:58:00	010 CTD029	011 CTD011	39.70968	-22.2582	Commence Deploying CTD
28/09/2016 04:00:00	010 CTD029	011 CTD011	39.70967	-22.2581	CTD in the Water
28/09/2016 04:00:00	010 VB030	011 VB003	39.70967	-22.2581	Commence Deploying Bongo Nets
28/09/2016 04:02:00	010 CTD029	011 CTD011	39.70967	-22.2581	CTD veering to 500m
28/09/2016 04:14:00	010 CTD029	011 CTD011	39.70966	-22.2581	CTD Stopped at 500m
28/09/2016 04:32:00	010 VB030	011 VB003	39.70966	-22.2581	Nets Recovered
28/09/2016 04:45:00	010 CTD029	011 CTD011	39.70966	-22.2581	CTD Recovered
28/09/2016 05:00:00	10	011 Station	39.70961	-22.2583	Vessel Off DP
28/09/2016 05:06:00	10	011 Station	39.70496	-22.2643	Vessel On Passage
28/09/2016 09:42:00	11	012 Station	39.16228	-22.9885	Vessel turned for 5 minute run with sun on starboard beam.
28/09/2016 09:48:00	11	012 Station	39.16859	-22.9758	Slowing down to come on station
28/09/2016 09:54:00	11	012 Station	39.17213	-22.9671	Vessel on DP
28/09/2016 09:59:00	011 OR031	012 OR004	39.17239	-22.9667	Commence deploying optic rig
28/09/2016 10:00:00	011 OR031	012 OR004	39.17239	-22.9666	Optic rig in water. Veering to 50m
28/09/2016 10:02:00	011 CTD032	012 CTD012	39.17238	-22.9667	Commence deploying CTD
28/09/2016 10:03:00	011 CTD032	012 CTD012	39.17238	-22.9667	CTD in water
28/09/2016 10:05:00	011 OR031	012 OR004	39.17238	-22.9667	Optic rig hauled out of water

28/09/2016 10:06:00	011 OR031	012 OR004	39.17239	-22.9667	Optic rig in water veering to 50m
28/09/2016 10:06:00	011 CTD032	012 CTD012	39.17239	-22.9667	CTD veering to 500m
28/09/2016 10:10:00	011 RS033	012 RS006	39.17239	-22.9666	Balloon launched
28/09/2016 10:13:00	011 OR031	012 OR004	39.17236	-22.9666	Optic rig recovered to deck
28/09/2016 10:15:00	011 CTD032	012 CTD012	39.17237	-22.9667	CTD stopped at 500m
28/09/2016 10:23:00	011 CTD032	012 CTD012	39.17238	-22.9666	Problem with CTD? Hauling to deck
28/09/2016 10:32:00	011 CTD032	012 CTD012	39.17243	-22.9666	CTD recovered to deck
28/09/2016 10:36:00	011 RA034	012 RA005	39.1725	-22.9666	RA deployed
28/09/2016 10:45:00	011 RA034	012 RA005	39.17301	-22.9662	RA recovered to deck
28/09/2016 10:48:00	11	012 Station	39.17332	-22.9661	Vessel off DP
28/09/2016 10:54:00	11	012 Station	39.168	-22.9699	Vessel on passage
28/09/2016 12:36:00	12	013 Station	38.97985	-23.2402	Commence Turning onto Station
28/09/2016 12:40:00	12	013 Station	38.97186	-23.2409	Steaming for 5mins with sun on beam
28/09/2016 12:50:00	12	013 Station	38.96966	-23.2172	End of 5mins steam
28/09/2016 12:54:00	12	013 Station	38.96953	-23.2161	Vsl on DP
28/09/2016 12:55:00	CASIUS TRIAL	Casius Trial	38.96952	-23.2161	Sonardyne pole deployed
28/09/2016 12:56:00	012 OR035	013 OR005	38.96953	-23.2161	Optics Rig in the Water
28/09/2016 13:02:00	012 OR035	013 OR005	38.96952	-23.2161	Optics rig a 250m Commence Hauling
28/09/2016 13:05:00	CASIUS TRIAL	Casius Trial	38.96952	-23.2161	Sonardyne beacon in the water
28/09/2016 13:17:00	012 OR035	013 OR005	38.96952	-23.2161	Optics Rig recovered to Bulwark and redeployed
28/09/2016 13:22:00	CASIUS TRIAL	Casius Trial	38.96952	-23.2161	Sonardyne beacon recovered to deck
28/09/2016 13:30:00	012 OR036	013 OR006	38.96951	-23.2161	Optics rig a 250m Commence Hauling
28/09/2016 13:36:00	CASIUS TRIAL	Casius Trial	38.96954	-23.2161	Sonardyne Pole Recovered
28/09/2016 13:41:00	012 OR036	013 OR006	38.96953	-23.2161	Optics Rig Recovered to Deck
28/09/2016 13:46:00	012 RA037	013 RA006	38.96955	-23.216	Radiometer deployed
28/09/2016 13:55:00	012 RA037	013 RA006	38.96963	-23.2148	Radiometer Recovered to Deck
28/09/2016 14:00:00	12	013 Station	38.96953	-23.2113	VSL off DP
28/09/2016 14:04:00	12	013 Station	38.96945	-23.2009	Steaming for 5mins with sun on beam
28/09/2016 14:10:00	12	013 Station	38.96968	-23.1787	End of 5mins steam
28/09/2016 14:12:00	12	013 Station	38.96936	-23.1718	VSL on Passage
28/09/2016 23:42:00	CASIUS TRIAL	Casius Trial	37.80285	-24.5423	Commence Swath Survey
29/09/2016 03:18:00	CASIUS TRIAL	Casius Trial	37.65731	-24.9189	End of Swath Survey - commence slowing down
29/09/2016 03:24:00	13	014 Station	37.65915	-24.9087	VSL on DP
29/09/2016 03:40:00	13	014 Station	37.65927	-24.9085	Commence load testing CTD termination
29/09/2016 03:51:00	13	014 Station	37.65926	-24.9085	Load Test Completed
29/09/2016 04:16:00	013 VB038	014 VB004	37.65925	-24.9085	Bongo Net deployed, veering to 200m
29/09/2016 04:18:00	013 CTD039	014 CTD013	37.65926	-24.9085	CTD Deployed
29/09/2016 04:20:00	013 VB038	014 VB004	37.65925	-24.9085	Net stopped at 200m

29/09/2016 04:21:00	013 CTD039	014 CTD013	37.65925	-24.9085	CTD Veering to 500m
29/09/2016 04:30:00	013 CTD039	014 CTD013	37.65926	-24.9085	CTD Stopped at 500m
29/09/2016 04:42:00	013 VB038	014 VB004	37.65926	-24.9085	Net Recovered
29/09/2016 04:58:00	013 CTD039	014 CTD013	37.65927	-24.9085	CTD Recovered
29/09/2016 05:14:00	013 HB040	014 HB003	37.66086	-24.9061	Horizontal net deployed
29/09/2016 05:45:00	013 HB040	014 HB003	37.66966	-24.893	Net Recovered
29/09/2016 06:00:00	Casius Trial	Casius Trial	37.66974	-24.893	Vessel Off DP, Commence Swathe survey for Casius
29/09/2016 06:36:00	Casius Trial	Casius Trial	37.69551	-24.9262	Vessel On DP for Casius Calibration. Depth EA600: 2577.7m
29/09/2016 06:52:00	Casius Trial	Casius Trial	37.69544	-24.9265	Commence Casius Deployment
29/09/2016 06:55:00	Casius Trial	Casius Trial	37.69545	-24.9264	Beacon in the water
29/09/2016 06:59:00	Casius Trial	Casius Trial	37.69544	-24.9265	Beacon Released
29/09/2016 07:25:00	Casius Trial	Casius Trial	37.69524	-24.9267	Beacon on the seabed, Depth 2562m, Commencing calibration
29/09/2016 12:10:00	Casius Trial	Casius Trial	37.69212	-24.9305	Callibration complete
29/09/2016 12:20:00	014 OR041	015 OR007	37.69323	-24.9318	Optics Rig in the water
29/09/2016 12:23:00	014 SAP042	015 SAP003	37.69324	-24.9318	1st pump in the water
29/09/2016 12:30:00	014 OR041	015 OR007	37.69324	-24.9318	Optics Rig at 250m, Commence Recovery
29/09/2016 12:31:00	014 SAP042	015 SAP003	37.69324	-24.9318	3rd pump in the water
29/09/2016 12:34:00	014 SAP042	015 SAP003	37.69324	-24.9318	SAPS Fully Deployed at 80, 135 and 150m
29/09/2016 12:39:00	014 CTD043	015 CTD014	37.69323	-24.9318	Commence Deploying CTD
29/09/2016 12:43:00	014 CTD043	015 CTD014	37.69323	-24.9318	CTD in the water
29/09/2016 12:45:00	014 OR041	015 OR007	37.69322	-24.9318	Optics Rig at the surface, redeploying
29/09/2016 12:46:00	014 RS044	015 RS007	37.69376	-24.9273	Weather Ballon Launched
29/09/2016 12:50:00	014 CTD043	015 CTD014	37.69324	-24.9318	CTD veering to 500m
29/09/2016 12:55:00	014 OR045	015 OR008	37.69325	-24.9318	Optics Rig at 250m, Commence Hauling
29/09/2016 12:59:00	014 CTD043	015 CTD014	37.69323	-24.9318	CTD at 500m, Commence Hauling
29/09/2016 13:09:00	014 OR045	015 OR008	37.69323	-24.9318	Optics Rig Recovered to deck
29/09/2016 13:29:00	014 CTD043	015 CTD014	37.69321	-24.9318	CTD Recovered to Deck
29/09/2016 13:38:00	014 SAP042	015 SAP003	37.6932	-24.9318	Commence Recovering SAPS
29/09/2016 13:44:00	014 RA045	015 RA007	37.6932	-24.9318	Radiometer Deployed
29/09/2016 13:44:00	014 SAP042	015 SAP003	37.6932	-24.9318	SAPS Fully Recovered to Deck
29/09/2016 13:54:00	014 RA045	015 RA007	37.69331	-24.9307	Radiometer Recovered to Deck
29/09/2016 14:19:00	CASIUS TRIAL	Casius Trial	37.69378	-24.9273	Beacon Released from the Seabed
29/09/2016 14:54:00	CASIUS TRIAL	Casius Trial	37.6947	-24.9274	Beacon on the Surface and Sighted
29/09/2016 14:55:00	CASIUS TRIAL	Casius Trial	37.69472	-24.9274	Sonardyne Pole Recovered
29/09/2016 15:07:00	CASIUS TRIAL	Casius Trial	37.6949	-24.9241	Beacon Hooked
29/09/2016 15:09:00	CASIUS TRIAL	Casius Trial	37.69467	-24.9236	Beacon Recovered to Deck
29/09/2016 15:18:00	CASIUS TRIAL	Casius Trial	37.69461	-24.9236	VSL off DP

29/09/2016 15:24:00	CASIUS TRIAL	Casius Trial	37.6944	-24.9302	On Passage
30/09/2016 04:12:00	15	016 Station	36.13488	-26.0757	Commence Slowing Down
30/09/2016 04:18:00	15	016 Station	36.12927	-26.0742	Vessel On DP
30/09/2016 04:29:00	015 VB046	016 VB005	36.12912	-26.074	Bongo Net Deployed
30/09/2016 04:30:00	015 CTD047	016 CTD015	36.12912	-26.074	CTD Deployed
30/09/2016 04:32:00	015 CTD047	016 CTD015	36.12911	-26.074	CTD Veering to 500m
30/09/2016 04:33:00	015 VB046	016 VB005	36.12912	-26.074	Nets at 200m, Hauling
30/09/2016 04:42:00	015 CTD047	016 CTD015	36.12913	-26.074	CTD stopped at 500m
30/09/2016 04:52:00	015 VB046	016 VB005	36.12913	-26.074	Nets Recovered
30/09/2016 05:12:00	015 CTD047	016 CTD015	36.12913	-26.074	CTD Recovered
30/09/2016 05:18:00	15	016 Station	36.12913	-26.074	Vessel Off DP
30/09/2016 05:24:00	15	016 Station	36.12816	-26.073	Vessel On Passage
30/09/2016 12:00:00	16	017 Station	35.00717	-26.3703	Commence Turning on to Station
30/09/2016 12:03:00	16	017 Station	35.00869	-26.365	Running for 5 mins with sun on beam
30/09/2016 12:08:00	16	017 Station	35.01708	-26.3553	End of 5 mins Steaming
30/09/2016 12:12:00	16	017 Station	35.02141	-26.3502	VSL on DP
30/09/2016 12:25:00	016 OR048	017 OR009	35.02177	-26.3497	Optics Rig in the Water
30/09/2016 12:26:00	016 CTD049	017 CTD016	35.02177	-26.3497	Commence Deploying CTD
30/09/2016 12:27:00	016 CTD049	017 CTD016	35.02178	-26.3497	CTD in the Water
30/09/2016 12:30:00	016 CTD049	017 CTD016	35.02178	-26.3497	CTD veering to 500m
30/09/2016 12:34:00	016 OR048	017 OR009	35.02175	-26.3497	Optics Rig at 250m, Commence Hauling
30/09/2016 12:38:00	016 CTD049	017 CTD016	35.02176	-26.3497	CTD at 500m, Commence Hauling
30/09/2016 12:47:00	016 RA050	017 RS008	35.02178	-26.3497	Weather Ballon Launched
30/09/2016 12:48:00	016 OR048	017 OR009	35.02179	-26.3497	Optics Rig recovered to Bulwark, Redeploying
30/09/2016 12:59:00	016 OR051	017 OR010	35.02177	-26.3497	Optics Rig at 250m, Commence Hauling
30/09/2016 13:03:00	016 CTD049	017 CTD016	35.02176	-26.3497	CTD Recovered to Deck
30/09/2016 13:15:00	016 OR051	017 OR010	35.02177	-26.3497	Optics Rig Recovered to Deck
30/09/2016 13:18:00	016 RA052	017 RA008	35.02182	-26.3496	Radiometer in the Water
30/09/2016 13:26:00	016 RA052	017 RA008	35.02209	-26.3486	Radiometer Recovered to Deck
30/09/2016 13:30:00	16	017 Station	35.02217	-26.3476	VSL off DP
30/09/2016 13:36:00	16	017 Station	35.02522	-26.3366	Running for 5 mins with sun on beam
30/09/2016 13:41:00	16	017 Station	35.0293	-26.3228	End of 5 min Steaming
30/09/2016 13:48:00	16	017 Station	35.01875	-26.3183	On passage
01/10/2016 04:12:00	17	018 Station	32.51732	-26.9919	Vessel Slowing down
01/10/2016 04:18:00	17	018 Station	32.51408	-26.9887	Vessel On DP
01/10/2016 04:32:00	017 VB053	018 VB006	32.51371	-26.9887	VB Deployed
01/10/2016 04:33:00	017 CTD054	018 CTD017	32.51372	-26.9887	CTD Deployed
01/10/2016 04:36:00	017 CTD054	018 CTD017	32.5137	-26.9887	CTD Veering to 500m
01/10/2016 04:38:00	017 VB053	018 VB006	32.5137	-26.9887	VB at 200m, commenced hauling
01/10/2016 04:45:00	017 CTD054	018 CTD017	32.51371	-26.9887	CTD stopped at 500m
01/10/2016 04:56:00	017 VB053	018 VB006	32.51371	-26.9887	VB Recovered to deck

01/10/2016 05:12:00	017 CTD054	018 CTD017	32.51372	-26.9887	CTD Recovered
01/10/2016 05:20:00	017 HB055	018 HB004	32.51469	-26.9883	HB Deployed
01/10/2016 05:54:00	017 HB055	018 HB004	32.52635	-26.9833	HB Recovered
01/10/2016 06:06:00	17	018 Station	32.52635	-26.9833	Vessel Off DP
01/10/2016 06:12:00	17	018 Station	32.52512	-26.9817	Vessel On passage
01/10/2016 12:00:00	18	019 Station	31.5236	-27.2453	Commence Turning onto Station
01/10/2016 12:04:00	18	019 Station	31.51891	-27.2395	Running for 5 mins with sun on beam
01/10/2016 12:09:00	18	019 Station	31.52436	-27.2251	End of 5mins Steaming
01/10/2016 12:18:00	18	019 Station	31.52673	-27.2187	VSL on DP
01/10/2016 12:21:00	018 OR056	019 OR011	31.52674	-27.2187	Optics Rig in the Water
01/10/2016 12:26:00	018 CTD057	019 CTD018	31.52676	-27.2187	Commence Deploying CTD
01/10/2016 12:26:00	018 SAP058	019 SAP004	31.47992	-27.2053	Commence Deploying SAPS, 1st Pump in the Water
01/10/2016 12:27:00	018 CTD057	019 CTD018	31.52676	-27.2187	CTD in the Water
01/10/2016 12:29:00	018 OR056	019 OR011	31.52676	-27.2187	Optics Rig at 250m, Commence Hauling
01/10/2016 12:30:00	018 CTD057	019 CTD018	31.52676	-27.2187	CTD veering to approx 500m
01/10/2016 12:34:00	018 SAP058	019 SAP004	31.52785	-27.2157	2nd Pump in the Water
01/10/2016 12:38:00	018 SAP058	019 SAP004	31.52675	-27.2187	3rd Pump in the Water
01/10/2016 12:39:00	018 CTD057	019 CTD018	31.52676	-27.2187	CTD Stopped at 500m, Commence Hauling
01/10/2016 12:39:00	018 SAP058	019 SAP004	31.52676	-27.2187	SAPS Fully Deployed at 200, 100 and 10m
01/10/2016 12:44:00	018 OR056	019 OR011	31.52676	-27.2187	Optics Rig at the Bulwark, Redeploying
01/10/2016 12:51:00	018 RS059	019 RS009	31.52675	-27.2187	Weather Ballon Launched
01/10/2016 12:52:00	018 OR060	019 OR012	31.52675	-27.2187	Optics Rig at 250m, Commence Hauling
01/10/2016 13:08:00	018 OR060	019 OR012	31.52672	-27.2187	Optics Rig Recovered to Deck
01/10/2016 13:10:00	018 CTD057	019 CTD018	31.52673	-27.2187	CTD Recovered to Deck
01/10/2016 13:18:00	018 RA061	019 RA009	31.52693	-27.2181	Radiometer in the Water
01/10/2016 13:28:00	018 RA061	019 RA009	31.52759	-27.2164	Radiometer Recovered to Deck
01/10/2016 13:50:00	018 SAP058	019 SAP004	31.52788	-27.2157	Commence Recovering SAPS
01/10/2016 14:01:00	018 SAP058	019 SAP004	31.52786	-27.2158	SAPS Fully Recovered to Deck
01/10/2016 14:06:00	18	019 Station	31.52787	-27.2157	VSL off DP
01/10/2016 14:12:00	18	019 Station	31.53061	-27.2077	Running for 5 mins with sun on beam
01/10/2016 14:17:00	18	019 Station	31.53561	-27.1936	End of 5 mins Steaming
01/10/2016 14:18:00	18	019 Station	31.53607	-27.1905	On Passage
02/10/2016 04:12:00	19	020 Station	29.16633	-27.8354	Vessel slowing down
02/10/2016 04:18:00	19	020 Station	29.16052	-27.8323	Vessel On DP
02/10/2016 04:29:00	019 VB062	020 VB007	29.16042	-27.832	VB Deployed
02/10/2016 04:30:00	019 CTD063	020 CTD019	29.16043	-27.8321	CTD Deployed
02/10/2016 04:30:00	019 VB062	020 VB007	29.16043	-27.832	VB veering to 200m
02/10/2016 04:32:00	019 CTD063	020 CTD019	29.16043	-27.8321	CTD Veering to 500m
02/10/2016 04:34:00	019 VB062	020 VB007	29.16043	-27.8321	VB at 200m hauling
02/10/2016 04:41:00	019 CTD063	020 CTD019	29.16045	-27.8321	CTD stopped at 500m

02/10/2016 04:52:00	019 VB062	020 VB007	29.16047	-27.8321	Nets recovered
02/10/2016 05:06:00	019 CTD063	020 CTD019	29.16047	-27.8321	CTD Recovered
02/10/2016 05:12:00	19	020 Station	29.16048	-27.8321	Vessel Off DP
02/10/2016 05:18:00	19	020 Station	29.15974	-27.831	Vessel on passage
02/10/2016 12:00:00	20	021 Station	27.96715	-28.1269	Commence Turning onto Station
02/10/2016 12:05:00	20	021 Station	27.95965	-28.1225	Running for 5 mins with sun on beam
02/10/2016 12:11:00	20	021 Station	27.9683	-28.107	End of 5 mins Steaming
02/10/2016 12:18:00	20	021 Station	27.97256	-28.0985	VSL on DP
02/10/2016 12:20:00	020 OR064	021 OR013	27.97259	-28.0984	Commence Deploying Optics Rig
02/10/2016 12:22:00	020 OR064	021 OR013	27.97262	-28.0984	Optics Rig in the Water
02/10/2016 12:22:00	020 CTD065	021 CTD020	27.97262	-28.0984	Commence Deploying CTD
02/10/2016 12:28:00	020 CTD065	021 CTD020	27.97262	-28.0984	CTD in the Water
02/10/2016 12:31:00	020 OR064	021 OR013	27.97261	-28.0984	Optics Rig at 250m, Commence Hauling
02/10/2016 12:31:00	020 CTD065	021 CTD020	27.97261	-28.0984	CTD Veering to 500m
02/10/2016 12:41:00	020 CTD065	021 CTD020	27.9726	-28.0984	CTD Stopped at 500m, Commence Hauling
02/10/2016 12:45:00	020 OR064	021 OR013	27.9726	-28.0984	Optics Rig at Bulwark, Redeploying
02/10/2016 12:57:00	020 OR066	021 OR014	27.97263	-28.0984	Optics Rig at 250m, Commence Hauling
02/10/2016 12:58:00	020 RS067	021 RS010	27.97264	-28.0984	Weather Balloon Launched
02/10/2016 13:08:00	020 CTD065	021 CTD020	27.97266	-28.0983	CTD Recovered to Deck
02/10/2016 13:10:00	020 OR066	021 OR014	27.97266	-28.0983	Optics Rig Recovered to Deck
02/10/2016 13:19:00	020 RA068	021 RA010	27.97263	-28.0984	Radiometer in the Water
02/10/2016 13:29:00	020 RA068	021 RA010	27.97301	-28.0978	Radiometer Recovered to Deck
02/10/2016 13:30:00	20	021 Station	27.97305	-28.0977	VSL off DP
02/10/2016 13:34:00	20	021 Station	27.97427	-28.095	Running for 5 mins with sun on beam
02/10/2016 13:39:00	20	021 Station	27.98154	-28.0767	End of 5 mins Steaming
02/10/2016 13:42:00	20	021 Station	27.98154	-28.0767	On Passage
03/10/2016 05:12:00	21	022 Station	25.39133	-28.7465	Vessel Slowing Down
03/10/2016 05:18:00	21	022 Station	25.38624	-28.7445	Vessel On DP
03/10/2016 05:27:00	021 VB069	022 VB008	25.38614	-28.7445	VB Deployed
03/10/2016 05:29:00	021 CTD070	022 CTD021	25.38614	-28.7445	CTD Deployed
03/10/2016 05:32:00	021 VB069	022 VB008	25.38614	-28.7445	Nets at 200m, Hauling
03/10/2016 05:33:00	021 CTD070	022 CTD021	25.38614	-28.7445	CTD Veering to 500m
03/10/2016 05:41:00	021 CTD070	022 CTD021	25.38614	-28.7445	CTD stopped at 500m
03/10/2016 05:52:00	021 VB069	022 VB008	25.38616	-28.7445	VB Recovered
03/10/2016 06:09:00	021 CTD070	022 CTD021	25.38616	-28.7444	CTD Recovered
03/10/2016 06:16:00	021 HB071	022 HB005	25.38699	-28.7438	HB Deployed
03/10/2016 06:48:00	021 HB071	022 HB005	25.39676	-28.7363	HB Recovered
03/10/2016 07:00:00	21	022 Station	25.39676	-28.7363	Vessel Off DP
03/10/2016 07:06:00	21	022 Station	25.39699	-28.7363	Vessel on passage
03/10/2016 12:00:00	22	023 Station	24.58297	-28.9382	Commence Turning onto Station
03/10/2016 12:04:00	22	023 Station	24.57847	-28.9343	Running for 5 mins with sun on

					beam
03/10/2016 12:09:00	22	023 Station	24.58537	-28.9232	End of 5 mins Steaming
03/10/2016 12:18:00	22	023 Station	24.59039	-28.9159	VSL on DP
03/10/2016 12:19:00	022 OR072	023 OR015	24.59039	-28.9159	Commence deploying Optics Rig
03/10/2016 12:19:00	022 SAP073	023 SAP005	24.59039	-28.9159	Commence Deploying SAPS
03/10/2016 12:21:00	022 OR072	023 OR015	24.59038	-28.9159	Optics Rig in the Water
03/10/2016 12:25:00	022 CTD074	023 CTD022	24.59038	-28.9159	Commence Deploying CTD
03/10/2016 12:29:00	022 CTD074	023 CTD022	24.59039	-28.9159	CTD in the Water
03/10/2016 12:30:00	022 OR072	023 OR015	24.59039	-28.9159	Optics Rig at 250m, Commence Hauling
03/10/2016 12:31:00	022 SAP073	023 SAP005	24.5904	-28.9159	2nd Pump in the Water
03/10/2016 12:32:00	022 CTD074	023 CTD022	24.5904	-28.9159	CTD Veering to 500m
03/10/2016 12:34:00	022 SAP073	023 SAP005	24.5904	-28.9159	SAPS fully deployed at 225, 125 and 10m
03/10/2016 12:40:00	022 CTD074	023 CTD022	24.59039	-28.9159	CTD Stopped at 500m, Commence Hauling
03/10/2016 12:46:00	022 OR072	023 OR015	24.59038	-28.9159	Optics Rig at the Ship Side, Redeploying
03/10/2016 12:56:00	022 OR075	023 OR016	24.59037	-28.9159	Optics Rig at 250m, Commence Hauling
03/10/2016 12:58:00	022 RS076	023 RS011	24.59038	-28.9159	Weather Balloon Launched
03/10/2016 13:09:00	022 CTD074	023 CTD022	24.5904	-28.9159	CTD Recovered to Deck
03/10/2016 13:11:00	022 OR075	023 OR016	24.59039	-28.9159	Optics Rig Recovered to Deck
03/10/2016 13:21:00	022 RA077	023 RA011	24.59047	-28.9158	Radiometer Deployed
03/10/2016 13:29:00	022 RA077	023 RA011	24.59099	-28.915	Radiometer Recovered to Deck
03/10/2016 13:42:00	022 SAP073	023 SAP005	24.5911	-28.9149	Commence Recovering SAPS
03/10/2016 13:47:00	022 SAP073	023 SAP005	24.5911	-28.9149	2nd Pump Recovered
03/10/2016 13:53:00	022 SAP073	023 SAP005	24.5911	-28.9149	SAPS Fully Recoverd to Deck
03/10/2016 14:00:00	22	023 Station	24.59109	-28.9149	VSL off DP
03/10/2016 14:04:00	22	023 Station	24.59293	-28.9117	Running for 5 mins with sun on beam
03/10/2016 14:09:00	22	023 Station	24.59975	-28.9017	End of 5 mins Steaming
03/10/2016 14:12:00	22	023 Station	24.60082	-28.8942	On Passage
04/10/2016 05:12:00	23	024 Station	22.06115	-29.5266	Vessel Slowing down
04/10/2016 05:18:00	23	024 Station	22.0587	-29.5242	Vessel On DP
04/10/2016 05:26:00	023 VB078	024 VB009	22.05865	-29.5242	VB Deployed
04/10/2016 05:29:00	023 CTD079	024 CTD023	22.05865	-29.5242	CTD Deployed
04/10/2016 05:32:00	023 CTD079	024 CTD023	22.05865	-29.5242	CTD Veering to 500m
04/10/2016 05:41:00	023 CTD079	024 CTD023	22.05865	-29.5242	CTD Stopped at 500m
04/10/2016 05:54:00	023 VB078	024 VB009	22.05864	-29.5242	VB Recovered
04/10/2016 06:08:00	023 CTD079	024 CTD023	22.05865	-29.5242	CTD Recovered
04/10/2016 06:18:00	23	024 Station	22.05863	-29.5242	Vessel Off DP
04/10/2016 06:24:00	23	024 Station	22.05409	-29.5237	Vessel On passage
04/10/2016 11:42:00	24	025 Station	21.15786	-29.7351	Running for 5 mins with sun on beam
04/10/2016 11:48:00	24	025 Station	21.15894	-29.731	Vessel slowing onto station
04/10/2016 11:54:00	24	025 Station	21.16446	-29.7284	Vessel on DP
04/10/2016 12:02:00	024 RA080	025 RA012	21.16537	-29.7295	Radiometer Deployed

04/10/2016 12:12:00	024 RA080	025 RA012	21.16563	-29.7293	Radiometer Recovered to Deck
04/10/2016 12:16:00	024 OR081	025 OR017	21.16574	-29.7292	Commence Deploying Optics Rig
04/10/2016 12:16:00	024 SAP082	025 SAP006	21.16574	-29.7292	Commence Deploying SAPS
04/10/2016 12:19:00	024 OR081	025 OR017	21.16575	-29.7292	Optics Rig in the Water
04/10/2016 12:21:00	024 CTD083	025 CTD024	21.16573	-29.7292	Commence Deploying CTD
04/10/2016 12:25:00	024 CTD083	025 CTD024	21.16572	-29.7292	CTD in the Water
04/10/2016 12:27:00	024 CTD083	025 CTD024	21.16572	-29.7292	CTD Veering to 500m
04/10/2016 12:28:00	024 OR081	025 OR017	21.16572	-29.7292	Optics Rig at 250m, Commence Hauling
04/10/2016 12:29:00	024 SAP082	025 SAP006	21.16572	-29.7292	2nd Pump in the Water
04/10/2016 12:36:00	024 CTD083	025 CTD024	21.16573	-29.7292	CTD at 500m, Commence Hauling
04/10/2016 12:37:00	024 SAP082	025 SAP006	21.16572	-29.7292	SAPS Fully Deployed at 200, 100 and 10m
04/10/2016 12:41:00	024 OR081	025 OR017	21.1661	-29.7287	Optics Rig recovered to the Bulwark, Redeploying
04/10/2016 12:48:00	024 RS084	025 RS012	21.16572	-29.7292	Weather Balloon Launched
04/10/2016 12:50:00	024 OR085	025 OR018	21.16571	-29.7292	Optics Rig at 250m, Commence Hauling
04/10/2016 12:59:00	024 CTD083	025 CTD024	21.16575	-29.7292	CTD Recovered to Deck
04/10/2016 13:05:00	024 OR085	025 OR018	21.16574	-29.7292	Optics Rig Recovered to Deck
04/10/2016 13:08:00	024 RA086	025 RA013	21.16578	-29.7292	Radiometer Deployed
04/10/2016 13:17:00	024 RA086	025 RA013	21.16607	-29.7287	Radiometer Recovered to Deck
04/10/2016 13:42:00	024 SAP082	025 SAP006	21.16609	-29.7287	Commence Recovering SAPS
04/10/2016 13:51:00	024 SAP082	025 SAP006	21.16611	-29.7287	SAPS Fully Recovered to Deck
04/10/2016 14:00:00	24	025 Station	21.16663	-29.7284	VSL off DP
04/10/2016 14:03:00	24	025 Station	21.16869	-29.726	Running for 5 mins with sun on beam
04/10/2016 14:08:00	24	025 Station	21.17473	-29.7166	End of 5 mins Steaming
04/10/2016 14:12:00	24	025 Station	21.17459	-29.709	On Passage
05/10/2016 05:12:00	25	026 Station	18.7014	-29.6636	Vessel slowing down
05/10/2016 05:18:00	25	026 Station	18.70011	-29.6614	Vessel On DP
05/10/2016 05:26:00	025 VB087	026 VB010	18.70039	-29.662	VB Deployed
05/10/2016 05:27:00	025 CTD088	026 CTD025	18.70037	-29.662	CTD Deployed
05/10/2016 05:31:00	025 CTD088	026 CTD025	18.70035	-29.662	CTD Veering to 500m
05/10/2016 05:40:00	025 CTD088	026 CTD025	18.70036	-29.662	CTD Stopped at 500m
05/10/2016 05:47:00	025 VB087	026 VB010	18.70034	-29.662	VB Recovered
05/10/2016 06:08:00	025 CTD088	026 CTD025	18.70036	-29.662	CTD Recovered
05/10/2016 06:24:00	25	026 Station	18.70017	-29.6615	Vessel Off DP
05/10/2016 06:30:00	25	026 Station	18.69206	-29.6588	Vessel On Passage
05/10/2016 12:00:00	26	027 Station	17.78416	-29.4278	Commence Turning onto Sation
05/10/2016 12:03:00	26	027 Station	17.77919	-29.4236	Running for 5 mins with sun on beam
05/10/2016 12:08:00	26	027 Station	17.7854	-29.4149	End of 5 mins Steaming
05/10/2016 12:18:00	26	027 Station	17.79171	-29.4075	VSL on DP
05/10/2016 12:21:00	026 RA089	027 RA014	17.79157	-29.4081	Radiometer in the Water
05/10/2016 12:28:00	026 CTD090	027 CTD026	17.79176	-29.4077	Commence Deploying CTD

05/10/2016 12:30:00	026 CTD090	027 CTD026	17.79181	-29.4076	CTD in the Water
05/10/2016 12:30:00	026 SAP091	027 SAP007	17.79181	-29.4076	Commence Deploying SAPS
05/10/2016 12:31:00	026 RA089	027 RA014	17.79184	-29.4076	Radiometer Recovered to Deck
05/10/2016 12:33:00	026 CTD090	027 CTD026	17.79185	-29.4076	CTD Veering to 500m
05/10/2016 12:34:00	026 OR092	027 OR019	17.79185	-29.4076	Commence Deploying Optics Rig
05/10/2016 12:36:00	026 OR092	027 OR019	17.79182	-29.4076	Optics Rig in the Water
05/10/2016 12:38:00	026 SAP091	027 SAP007	17.79183	-29.4076	SAPS Fully Deployed at 150, 50, and 10m
05/10/2016 12:42:00	026 CTD090	027 CTD026	17.7918	-29.4077	CTD at 500m, Commence Hauling
05/10/2016 12:45:00	026 OR092	027 OR019	17.79181	-29.4077	Optics Rig at 250m, Commence Hauling
05/10/2016 13:03:00	026 OR092	027 OR019	17.79181	-29.4078	Optics Rig at the Bulwark, Redeploying
05/10/2016 13:07:00	026 CTD090	027 CTD026	17.79181	-29.4078	CTD Recovered to Deck
05/10/2016 13:07:00	026 RS093	027 RS013	17.79181	-29.4078	Weather Balloon Deployment Failed
05/10/2016 13:15:00	026 OR094	027 OR020	17.79204	-29.4079	Optics Rig at 250m, Commence Hauling
05/10/2016 13:21:00	026 RS095	027 RS014	17.79206	-29.4079	Weather Balloon Deployed
05/10/2016 13:35:00	026 OR094	027 OR020	17.79227	-29.408	Optics Rig Recovered to Deck
05/10/2016 13:37:00	026 RA096	027 RA015	17.79233	-29.408	Radiometer in the Water
05/10/2016 13:45:00	026 SAP091	027 SAP007	17.79247	-29.4075	Commence Recovering SAPS
05/10/2016 13:48:00	026 RA096	027 RA015	17.79254	-29.4073	Radiometer Recovered to Deck
05/10/2016 13:57:00	026 SAP091	027 SAP007	17.79253	-29.4073	SAPS Fully Recovered to Deck
05/10/2016 14:00:00	26	027 Station	17.79253	-29.4073	VSL off DP
05/10/2016 14:05:00	26	027 Station	17.7926	-29.4066	Running for 5 mins with sun on beam
05/10/2016 14:10:00	26	027 Station	17.79475	-29.4012	End of 5 mins Steaming
05/10/2016 14:12:00	26	027 Station	17.79496	-29.3974	On Passage
06/10/2016 05:12:00	27	028 Station	15.2769	-28.7865	Vessel slowing down
06/10/2016 05:18:00	27	028 Station	15.2757	-28.7835	Vessel On DP
06/10/2016 05:29:00	027 VB097	028 VB011	15.27443	-28.7842	VB Deployed
06/10/2016 05:30:00	027 CTD 098	028 CTD027	15.27444	-28.7842	CTD Deployed
06/10/2016 05:35:00	027 CTD098	028 CTD027	15.27445	-28.7842	CTD Veering to 500m
06/10/2016 05:44:00	027 CTD098	028 CTD027	15.27443	-28.7842	CTD all stopped at 500m
06/10/2016 05:58:00	027 VB097	028 VB011	15.27443	-28.7842	VB Recovered
06/10/2016 06:09:00	027 CTD098	028 CTD027	15.27445	-28.7842	CTD Recovered
06/10/2016 06:18:00	027 HB099	028 HB006	15.27509	-28.7837	Horizontal Nets Deployed
06/10/2016 06:53:00	027 HB099	028 HB006	15.28657	-28.7737	HB Recovered
06/10/2016 07:06:00	27	028 Station	15.28656	-28.7737	Vessel Off DP
06/10/2016 07:12:00	27	028 Station	15.28651	-28.772	Vessel On Passage
06/10/2016 12:00:00	28	029 Station	14.49745	-28.5914	Commence Turning on to Station
06/10/2016 12:03:00	28	029 Station	14.4933	-28.5869	Running for 5 mins with sun on beam
06/10/2016 12:08:00	28	029 Station	14.49854	-28.5769	End of 5 mins Steaming
06/10/2016 12:18:00	28	029 Station	14.5018	-28.5704	VSL on DP

06/10/2016 12:21:00	028 RA100	029 RA016	14.50172	-28.5703	Radiometer in the Water
06/10/2016 12:22:00	028 CTD102	029 CTD028	14.5018	-28.5703	Commence Deploying CTD
06/10/2016 12:22:00	028 SAP101	029 SAP008	14.5018	-28.5703	Commence Deploying SAPS
06/10/2016 12:24:00	028 SAP101	029 SAP008	14.50188	-28.5702	1st Pump in the Water
06/10/2016 12:27:00	028 CTD102	029 CTD028	14.50199	-28.57	CTD in the Water
06/10/2016 12:28:00	028 RA100	029 RA016	14.50204	-28.57	Radiometer Recovered to Deck
06/10/2016 12:29:00	028 OR103	029 OR021	14.50207	-28.5699	Commence Deploying Optics Rig
06/10/2016 12:29:00	028 SAP101	029 SAP008	14.50207	-28.5699	2nd Pump in the Water
06/10/2016 12:30:00	028 OR103	029 OR021	14.50211	-28.5699	Optics Rig in the Water
06/10/2016 12:31:00	028 CTD102	029 CTD028	14.50216	-28.5698	CTD Veering to 500m
06/10/2016 12:34:00	028 SAP101	029 SAP008	14.50227	-28.5697	SAPS Fully Deployed at 150, 50, 10m
06/10/2016 12:40:00	028 CTD102	029 CTD028	14.50227	-28.5697	CTD Stopped at 500m, Commence Hauling
06/10/2016 12:42:00	028 OR103	029 OR021	14.50228	-28.5697	Optics Rig at 250m, Commence Hauling
06/10/2016 12:55:00	028 OR103	029 OR021	14.50226	-28.5698	Optics Rig at the Bulwark, Redeploying
06/10/2016 13:01:00	028 RS104	029 RS015	14.50229	-28.5698	Weather Balloon Launched
06/10/2016 13:06:00	028 OR105	029 OR022	14.50228	-28.5698	Optics Rig at 250m, Commence Hauling
06/10/2016 13:09:00	028 CTD102	029 CTD028	14.50227	-28.5697	CTD Recovered to Deck
06/10/2016 13:23:00	028 OR105	029 OR022	14.50226	-28.5698	Optics Rig Recovered to Deck
06/10/2016 13:34:00	028 RA106	029 RA017	14.50231	-28.5698	Radiometer in the Water
06/10/2016 13:37:00	028 SAP101	029 SAP008	14.50238	-28.5696	Commence Recovering SAPS
06/10/2016 13:42:00	028 RA106	029 RA017	14.50258	-28.5694	Radiometer Recovered to Deck
06/10/2016 13:47:00	028 SAP101	029 SAP008	14.5026	-28.5694	SAPS Fully Recovered to Deck
06/10/2016 13:48:00	28	029 Station	14.5026	-28.5694	VSL off DP
06/10/2016 13:55:00	28	029 Station	14.5056	-28.5664	Running for 5 mins with sun on beam
06/10/2016 14:00:00	28	029 Station	14.51233	-28.5584	End of 5 mins Steaming
06/10/2016 14:06:00	28	029 Station	14.50213	-28.5522	On Passage
07/10/2016 05:12:00	29	030 Station	11.96614	-27.959	Vessel slowing down
07/10/2016 05:18:00	29	030 Station	11.96414	-27.9557	Vessel On DP
07/10/2016 05:30:00	029 CTD107	030 CTD029	11.96424	-27.9562	CTD Deployed
07/10/2016 05:32:00	029 CTD107	030 CTD029	11.96423	-27.9562	CTD Veering to 500m
07/10/2016 05:34:00	029 VB108	030 VB012	11.96422	-27.9562	VB Deployed
07/10/2016 05:41:00	029 CTD107	030 CTD029	11.96423	-27.9563	CTD Stopped at 500m
07/10/2016 06:00:00	029 VB108	030 VB012	11.96414	-27.9564	VB Recovered
07/10/2016 06:12:00	029 CTD107	030 CTD029	11.96415	-27.9564	CTD Recovered
07/10/2016 06:22:00	029 HB109	030 HB007	11.96457	-27.9557	HB Deployed
07/10/2016 06:54:00	029 HB109	030 HB007	11.96976	-27.9467	HB Recovered
07/10/2016 07:06:00	29	030 Station	11.96971	-27.9466	Vessel Off DP
07/10/2016 07:12:00	29	030 Station	11.96587	-27.9441	Vessel On Passage
07/10/2016 12:00:00	30	031 Station	11.19223	-27.7585	Commence Turning onto Station
07/10/2016 12:04:00	30	031 Station	11.19225	-27.7526	Running for 5 mins with sun on beam

07/10/2016 12:09:00	30	031 Station	11.20326	-27.7437	End of 5 mins Steaming
07/10/2016 12:18:00	30	031 Station	11.21336	-27.7363	On Passage
07/10/2016 12:22:00	030 RA110	031 RA018	11.21389	-27.7362	Radiometer in the Water
07/10/2016 12:28:00	030 CTD111	031 CTD030	11.21448	-27.7355	Commence Deploying CTD
07/10/2016 12:28:00	030 SAP112	031 SAP009	11.21448	-27.7355	Commence Deploying SAPS
07/10/2016 12:29:00	030 CTD111	031 CTD030	11.2146	-27.7354	CTD in the Water
07/10/2016 12:31:00	030 RA110	031 RA018	11.21482	-27.7351	Radiometer Recovered to Deck
07/10/2016 12:32:00	030 OR113	031 OR023	11.2149	-27.735	Commence Deploying Optics Rig
07/10/2016 12:32:00	030 CTD111	031 CTD030	11.2149	-27.735	CTD Veering to 500m
07/10/2016 12:33:00	030 OR113	031 OR023	11.21492	-27.735	Optics Rig in the Water
07/10/2016 12:33:00	030 SAP112	031 SAP009	11.21492	-27.735	2nd Pump in the Water
07/10/2016 12:37:00	030 SAP112	031 SAP009	11.2149	-27.7351	SAPS Fully Deployed at 150, 50 and 10m
07/10/2016 12:41:00	030 CTD111	031 CTD030	11.2149	-27.7352	CTD Stopped at 500m, Commence Hauling
07/10/2016 12:43:00	030 OR113	031 OR023	11.2149	-27.7352	Optics Rig at 250m, Commence Hauling
07/10/2016 12:45:00	030 RS114	031 RS016	11.21491	-27.7352	Weather Balloon Launched
07/10/2016 12:58:00	030 OR113	031 OR023	11.21501	-27.7355	Optics Rig at the Bulwark, Redeploying
07/10/2016 13:02:00	030 OR115	031 OR024	11.21502	-27.7354	Optics Rig Veering
07/10/2016 13:08:00	030 CTD111	031 CTD030	11.215	-27.7354	CTD Recovered to Deck
07/10/2016 13:09:00	030 OR115	031 OR024	11.21499	-27.7354	Optics Rig at 250m, Commence Hauling
07/10/2016 13:26:00	030 OR115	031 OR024	11.21503	-27.7354	Optics Rig Recovered to Deck
07/10/2016 13:30:00	030 RA116	031 RA019	11.21502	-27.7354	Radiometer in the Water
07/10/2016 13:37:00	030 SAP112	031 SAP009	11.2151	-27.7346	Commence Recovering SAPS
07/10/2016 13:40:00	030 RA116	031 RA019	11.21512	-27.7343	Radiometer Recovered to Deck
07/10/2016 13:45:00	030 SAP112	031 SAP009	11.21516	-27.7338	SAPS Recovered to Deck
07/10/2016 14:06:00	30	031 Station	11.21525	-27.7335	VSL off DP
07/10/2016 14:12:00	30	031 Station	11.21379	-27.7274	On Passage
08/10/2016 05:12:00	31	032 Station	8.69976	-27.1399	Vessel slowing down
08/10/2016 05:18:00	31	032 Station	8.69768	-27.1368	Vessel On DP
08/10/2016 05:24:00	031 CTD117	032 CTD031	8.69763	-27.1368	CTD Deployed
08/10/2016 05:26:00	031 VB118	032 VB013	8.6976	-27.1368	VB Deployed
08/10/2016 05:27:00	031 CTD117	032 CTD031	8.69759	-27.1368	CTD Veering to 500m
08/10/2016 05:37:00	031 CTD117	032 CTD031	8.6976	-27.1368	CTD stopped at 500m
08/10/2016 05:51:00	031 VB118	032 VB013	8.69758	-27.1368	VB Recovered
08/10/2016 06:04:00	031 CTD117	032 CTD031	8.69758	-27.1368	CTD Recovered
08/10/2016 06:12:00	31	032 Station	8.69756	-27.1368	Vessel Off DP
08/10/2016 06:18:00	31	032 Station	8.69634	-27.1369	Vessel On passage
08/10/2016 12:00:00	32	033 Station	7.76891	-26.9083	Commence Turning onto Station
08/10/2016 12:04:00	32	033 Station	7.76049	-26.9037	Running for 5 mins with sun on beam
08/10/2016 12:09:00	32	033 Station	7.76018	-26.8914	End of 5 mins Steaming
08/10/2016 12:18:00	32	033 Station	7.76004	-26.8831	VSL on DP
08/10/2016 12:24:00	032 RA119	033 RA020	7.76003	-26.8831	Radiometer in the Water

08/10/2016 12:26:00	032 CTD121	033 CTD032	7.76003	-26.883	Commence Deploying CTD
08/10/2016 12:26:00	032 SAP120	033 SAP010	7.76003	-26.883	Commence Deploying SAPS
08/10/2016 12:29:00	032 CTD121	033 CTD032	7.76	-26.8828	CTD in the Water
08/10/2016 12:32:00	032 OR122	033 OR025	7.75999	-26.8827	Commence Deploying Optics Rig
08/10/2016 12:32:00	032 CTD121	033 CTD032	7.75999	-26.8827	CTD Veering to 500m
08/10/2016 12:34:00	032 RA119	033 RA020	7.75998	-26.8828	Radiometer Recovered to Deck
08/10/2016 12:36:00	032 SAP120	033 SAP010	7.75996	-26.8828	SAPS Fully Deployed at 150, 50 and 10m
08/10/2016 12:41:00	032 CTD121	033 CTD032	7.75994	-26.8827	CTD Stopped at 500m, Commence Hauling
08/10/2016 12:43:00	032 OR122	033 OR025	7.75996	-26.8827	Optics Rig Stopped at 250m, Commence Hauling
08/10/2016 12:57:00	032 OR122	033 OR025	7.75996	-26.8827	Optics Rig at the Bulwark, Redeploying
08/10/2016 12:58:00	032 RS123	033 RS017	7.75996	-26.8827	Weather Balloon Launched
08/10/2016 13:07:00	032 CTD121	033 CTD032	7.75997	-26.8827	CTD Recovered to Deck
08/10/2016 13:08:00	032 OR124	033 OR026	7.75998	-26.8827	Optics Rig Stopped at 250m, Commence Hauling
08/10/2016 13:27:00	032 OR124	033 OR026	7.75998	-26.8827	Optics Rig Recovered to Deck
08/10/2016 13:28:00	032 RA125	033 RA021	7.76	-26.8827	Radiometer in the Water
08/10/2016 13:36:00	032 SAP120	033 SAP010	7.75995	-26.8822	Commence Recovering SAPS
08/10/2016 13:38:00	032 RA125	033 RA021	7.75992	-26.8821	Radiometer Recovered to Deck
08/10/2016 13:43:00	032 SAP120	033 SAP010	7.75992	-26.882	SAPS Fully Recovered to Deck
08/10/2016 13:48:00	32	033 Station	7.75992	-26.882	VSL off DP
08/10/2016 13:54:00	32	033 Station	7.75974	-26.8812	Running for 5 mins with sun on beam
08/10/2016 13:59:00	32	033 Station	7.75992	-26.8754	End of 5 mins Steaming
08/10/2016 14:06:00	32	033 Station	7.7496	-26.8686	On Passage
09/10/2016 05:12:00	33	034 Station	5.2122	-26.2749	Vessel Slowing down
09/10/2016 05:18:00	33	034 Station	5.20192	-26.273	Vessel On DP
09/10/2016 05:29:00	033 CTD126	034 CTD033	5.20115	-26.2748	CTD deployed
09/10/2016 05:30:00	033 VB127	034 VB014	5.20115	-26.2748	VB Deployed
09/10/2016 05:32:00	033 CTD126	034 CTD033	5.20117	-26.2748	CTD Veering to 500m
09/10/2016 05:41:00	033 CTD126	034 CTD033	5.20118	-26.2748	CTD Stopped at 500m
09/10/2016 05:53:00	033 VB127	034 VB014	5.20117	-26.2748	VB Recovered
09/10/2016 06:06:00	033 CTD126	034 CTD033	5.20118	-26.2748	CTD Recovered
09/10/2016 06:15:00	033 HB128	034 HB008	5.20106	-26.2741	HB deployed
09/10/2016 06:51:00	033 HB128	034 HB008	5.20012	-26.2687	HB Recovered
09/10/2016 07:06:00	33	034 Station	5.19998	-26.2687	Vessel Off DP
09/10/2016 07:12:00	33	034 Station	5.19249	-26.268	Vessel on passage
09/10/2016 11:36:00	34	035 Station	4.48194	-26.0988	Commence Turning onto Station
09/10/2016 11:41:00	34	035 Station	4.47354	-26.0937	Vessel running with sun on beam for 5 minutes
09/10/2016 11:46:00	34	035 Station	4.48122	-26.0858	End of 5 minute steaming
09/10/2016 11:54:00	34	035 Station	4.48523	-26.0807	Vessel on DP
09/10/2016 12:00:00	034 RA129	035 RA022	4.48536	-26.0808	Radiometer in the Water
09/10/2016 12:09:00	034 RA129	035 RA022	4.48607	-26.0801	Radiometer Recovered to Deck

09/10/2016 12:10:00	034 OR131	035 OR027	4.48611	-26.0801	Optics Rig in the Water
09/10/2016 12:10:00	034 SAP130	035 SAP011	4.48611	-26.0801	Commence Deploying SAPS
09/10/2016 12:20:00	034 SAP130	035 SAP011	4.48614	-26.0801	SAPS Fully Deployed at 170, 70 and 10m
09/10/2016 12:21:00	034 OR131	035 OR027	4.48613	-26.08	Optics Rig Stopped at 250m, Commence Hauling
09/10/2016 12:27:00	034 CTD132	035 CTD034	4.48614	-26.0801	Commence Deploying CTD
09/10/2016 12:28:00	034 CTD132	035 CTD034	4.48616	-26.0801	CTD in the Water
09/10/2016 12:31:00	034 CTD132	035 CTD034	4.48616	-26.0801	CTD Veering to 500m
09/10/2016 12:35:00	034 OR131	035 OR027	4.48614	-26.0801	Optics Rig at the Bulwark, Redeploying
09/10/2016 12:40:00	034 CTD132	035 CTD034	4.48615	-26.0801	CTD Stopped at 500m, Commence Hauling
09/10/2016 12:46:00	034 OR133	035 OR028	4.48612	-26.08	Optics Rig Stopped at 250m, Commence Hauling
09/10/2016 12:56:00	034 RS134	035 RS018	4.48613	-26.08	Weather Balloon Launched
09/10/2016 13:05:00	034 OR133	035 OR028	4.48612	-26.08	Optics Rig Recovered to Deck
09/10/2016 13:06:00	034 CTD132	035 CTD034	4.48611	-26.08	CTD Recovered to Deck
09/10/2016 13:08:00	034 RA135	035 RA023	4.48614	-26.08	Radiometer in the Water
09/10/2016 13:18:00	034 RA135	035 RA023	4.48646	-26.0791	Radiometer Recovered to deck
09/10/2016 13:36:00	034 SAP130	035 SAP011	4.4865	-26.079	Commence Recovering SAPS
09/10/2016 13:45:00	034 SAP130	035 SAP011	4.48653	-26.079	SAPS Fully Recovered to Deck
09/10/2016 13:54:00	34	035 Station	4.48707	-26.0781	VSL off DP
09/10/2016 13:56:00	34	035 Station	4.48777	-26.0759	Running for 5 mins with sun on beam
09/10/2016 14:01:00	34	035 Station	4.49152	-26.0658	End of 5 mins Steaming
09/10/2016 14:06:00	34	035 Station	4.48355	-26.0599	On Passage
10/10/2016 05:12:00	35	036 Station	1.98007	-25.4838	Vessel slowing down
10/10/2016 05:18:00	35	036 Station	1.9749	-25.4829	Vessel On DP
10/10/2016 05:24:00	035 CTD136	036 CTD035	1.97475	-25.4831	CTD Deployed
10/10/2016 05:25:00	035 VB137	036 VB015	1.97476	-25.483	VB Deployed
10/10/2016 05:27:00	035 CTD136	036 CTD035	1.97479	-25.483	CTD veering to 500m
10/10/2016 05:37:00	035 CTD136	036 CTD035	1.9748	-25.483	CTD stopped at 500m
10/10/2016 05:50:00	035 VB137	036 VB015	1.97479	-25.483	VB Recovered
10/10/2016 06:05:00	035 CTD136	036 CTD035	1.97478	-25.483	CTD recovered
10/10/2016 06:10:00	035 HB138	036 HB009	1.97442	-25.4827	HB Deployed
10/10/2016 06:41:00	035 HB138	036 HB009	1.96538	-25.4752	HB Recovered
10/10/2016 06:54:00	35	036 Station	1.96536	-25.4752	Vessel Off DP
10/10/2016 07:00:00	35	036 Station	1.96367	-25.4741	Vessel On Passage
10/10/2016 12:00:00	36	037 Station	1.13714	-25.2787	Commence Turning onto Station
10/10/2016 12:04:00	36	037 Station	1.13514	-25.2726	Vessel running with sun on beam for 5 minutes
10/10/2016 12:09:00	36	037 Station	1.14722	-25.2662	End of 5 mins Steaming
10/10/2016 12:18:00	36	037 Station	1.15602	-25.2606	VSL on DP
10/10/2016 12:21:00	036 RA139	037 RA024	1.15654	-25.2606	Radiometer in the Water
10/10/2016 12:23:00	036 SAP140	037 SAP012	1.15674	-25.2606	Commence Deploying SAPS
10/10/2016 12:32:00	036 RA139	037 RA024	1.15821	-25.2599	Radiometer Recovered to Deck

10/10/2016 12:33:00	036 SAP140	037 SAP012	1.15834	-25.2598	SAPS Fully deployed at 170, 70 and 10m
10/10/2016 12:39:00	036 CTD141	037 CTD036	1.15841	-25.2597	Commence Deploying CTD
10/10/2016 12:40:00	036 CTD141	037 CTD036	1.15842	-25.2597	CTD in the Water
10/10/2016 12:41:00	036 OR142	037 OR029	1.15842	-25.2596	Commence Deploying Optics rig
10/10/2016 12:42:00	036 OR142	037 OR029	1.1584	-25.2596	Optics Rig in the Water
10/10/2016 12:43:00	036 CTD141	037 CTD036	1.1584	-25.2596	CTD Veering to 500m
10/10/2016 12:45:00	036 RS143	037 RS019	1.1584	-25.2596	Weather Balloon Launched
10/10/2016 12:52:00	036 OR142	037 OR029	1.15842	-25.2595	Optics Rig Stopped at 250m, Commence Hauling
10/10/2016 12:52:00	036 CTD141	037 CTD036	1.15842	-25.2595	CTD Stopped at 500m, Commence Hauling
10/10/2016 13:06:00	036 OR142	037 OR029	1.15842	-25.2585	Optics Rig at the Bulwark, Redeploying
10/10/2016 13:18:00	036 CTD141	037 CTD036	1.1584	-25.2578	CTD Recovered to Deck
10/10/2016 13:20:00	036 OR144	037 OR030	1.15841	-25.2577	Optics Rig Stopped at 250m, Commence Hauling
10/10/2016 13:35:00	036 SAP140	037 SAP012	1.15842	-25.2577	Commence Recovering SAPS
10/10/2016 13:37:00	036 OR144	037 OR030	1.15843	-25.2578	Optics Rig Recovered to Deck
10/10/2016 13:45:00	036 SAP140	037 SAP012	1.1584	-25.2578	SAPS Fully Recovered to Deck
10/10/2016 13:46:00	036 RA145	037 RA025	1.15842	-25.2577	Radiometer in the Water
10/10/2016 13:58:00	036 RA145	037 RA025	1.15842	-25.2571	Radiometer Recovered to Deck
10/10/2016 14:00:00	36	037 Station	1.1585	-25.2567	VSL off DP
10/10/2016 14:03:00	36	037 Station	1.15882	-25.2538	Running for 5 mins with sun on beam
10/10/2016 14:08:00	36	037 Station	1.15836	-25.2421	End of 5 mins Steaming
10/10/2016 14:12:00	36	037 Station	1.15059	-25.2362	On Passage
11/10/2016 05:12:00	37	038 Station	-1.41243	-25.0066	Vessel slowing down
11/10/2016 05:18:00	37	038 Station	-1.41518	-25.0048	Vessel On DP
11/10/2016 05:24:00	037 CTD146	038 CTD037	-1.41515	-25.0048	CTD Deployed
11/10/2016 05:26:00	037 VB147	038 VB016	-1.41516	-25.0048	VB Deployed
11/10/2016 05:28:00	037 CTD146	038 CTD037	-1.41515	-25.0048	CTD Veering to 500m
11/10/2016 05:37:00	037 CTD146	038 CTD037	-1.41516	-25.0048	CTD Stopped at 500m
11/10/2016 05:48:00	037 VB147	038 VB016	-1.41516	-25.0048	VB Recovered
11/10/2016 06:04:00	037 CTD146	038 CTD037	-1.41515	-25.0048	CTD Recovered
11/10/2016 06:08:00	037 HB148	038 HB010	-1.41551	-25.0042	HB Deployed
11/10/2016 06:42:00	037 HB148	038 HB010	-1.42547	-24.987	HB Recovered
11/10/2016 06:54:00	37	038 Station	-1.4255	-24.987	Vessel Off DP
11/10/2016 07:00:00	37	038 Station	-1.42718	-24.9869	Vessel on passage
11/10/2016 12:00:00	38	039 Station	-2.26034	-25.0121	Commence Turning onto Station
11/10/2016 12:03:00	38	039 Station	-2.26399	-25.0083	Running for 5 mins with sun on beam
11/10/2016 12:08:00	38	039 Station	-2.25494	-24.9996	End of 5 mins steaming
11/10/2016 12:12:00	38	039 Station	-2.25292	-24.9946	VSL on DP
11/10/2016 12:18:00	038 RA148	039 RA026	-2.253	-24.9935	Radiometer in the Water
11/10/2016 12:26:00	038 RA148	039 RA026	-2.25222	-24.9925	Radiometer Recovered to Deck
11/10/2016 12:32:00	038 OR149	039 OR031	-2.2516	-24.9926	Commence Deploying Optics Rig

11/10/2016 12:32:00	038 CTD150	039 CTD038	-2.2516	-24.9926	Commence Deploying CTD
11/10/2016 12:32:00	038 SAP149	039 SAP013	-2.2516	-24.9926	Commence Deploying SAPS
11/10/2016 12:34:00	038 OR149	039 OR031	-2.25159	-24.9926	Optics Rig in the Water
11/10/2016 12:34:00	038 CTD150	039 CTD038	-2.25159	-24.9926	CTD in the Water
11/10/2016 12:38:00	038 CTD150	039 CTD038	-2.25159	-24.9926	CTD Veering to 500m
11/10/2016 12:42:00	038 SAP149	039 SAP013	-2.25158	-24.9926	SAPS Fully deployed at 200, 100 and 10m
11/10/2016 12:46:00	038 OR149	039 OR031	-2.25159	-24.9926	Optics Rig Stopped at 250m, Commence Hauling
11/10/2016 12:47:00	038 CTD150	039 CTD038	-2.25159	-24.9926	CTD Stopped at 500m, Commence Hauling
11/10/2016 13:00:00	038 OR149	039 OR031	-2.25159	-24.9926	Optics Rig at the Bulwark, Redeploying
11/10/2016 13:06:00	038 RS151	039 RS020	-2.2516	-24.9926	Weather Balloon Launched
11/10/2016 13:09:00	038 CTD150	039 CTD038	-2.25159	-24.9926	CTD Recovered to Deck
11/10/2016 13:12:00	038 OR152	039 OR032	-2.2516	-24.9926	Optics Rig Stopped at 250m, Commence Hauling
11/10/2016 13:30:00	038 OR152	039 OR032	-2.2516	-24.9926	Optics Rig Recovered to Deck
11/10/2016 13:37:00	038 SAP149	039 SAP013	-2.25159	-24.9926	Commence Recovering SAPS
11/10/2016 13:40:00	038 RA153	039 RA027	-2.2516	-24.9926	Radiometer in the Water
11/10/2016 13:47:00	038 SAP149	039 SAP013	-2.2516	-24.9926	SAPS Fully Recovered to Deck
11/10/2016 13:50:00	038 RA153	039 RA027	-2.25159	-24.9926	Radiometer Recovered to Deck
11/10/2016 13:54:00	38	039 Station	-2.25154	-24.9925	VSL off DP
11/10/2016 13:57:00	38	039 Station	-2.25157	-24.9898	Running for 5 mins with sun on beam
11/10/2016 14:02:00	38	039 Station	-2.25312	-24.9786	End of 5 mins Steaming
11/10/2016 14:06:00	38	039 Station	-2.25829	-24.9718	On Passage
12/10/2016 05:12:00	39	040 Station	-4.82763	-25.023	Vessel slowing down
12/10/2016 05:18:00	39	040 Station	-4.82959	-25.021	Vessel On DP
12/10/2016 05:26:00	039 CTD154	040 CTD039	-4.82954	-25.021	CTD Deployed
12/10/2016 05:27:00	039 VB155	040 VB017	-4.82954	-25.021	VB Deployed
12/10/2016 05:28:00	039 CTD154	040 CTD039	-4.82955	-25.021	CTD Veering to 500m
12/10/2016 05:38:00	039 CTD154	040 CTD039	-4.82955	-25.021	CTD Stopped at 500m
12/10/2016 05:49:00	039 VB155	040 VB017	-4.82962	-25.021	VB Recovered
12/10/2016 06:04:00	039 CTD154	040 CTD039	-4.82959	-25.021	CTD Recovered
12/10/2016 06:06:00	39	040 Station	-4.8296	-25.021	Vessel off DP
12/10/2016 06:12:00	39	040 Station	-4.8296	-25.021	Vessel On passage
12/10/2016 12:06:00	40	041 Station	-5.80573	-25.0311	Commence Slowing Down (No 5 min run as sun was already on beam)
12/10/2016 12:12:00	40	041 Station	-5.81123	-25.0279	VSL on DP
12/10/2016 12:16:00	040 RA156	041 RA028	-5.81099	-25.0275	Radiometer in the Water
12/10/2016 12:18:00	040 SAP157	041 SAP014	-5.81099	-25.0274	Commence Deploying SAPS
12/10/2016 12:24:00	040 RA156	041 RA028	-5.81099	-25.0269	Radiometer Recovered to Deck
12/10/2016 12:27:00	040 OR159	041 OR033	-5.81099	-25.0268	Commence Deploying Optics Rig
12/10/2016 12:27:00	040 CTD158	041 CTD040	-5.81099	-25.0268	Commence Deploying CTD
12/10/2016 12:27:00	040 SAP157	041 SAP014	-5.81099	-25.0268	SAPS Fully deployed at 200, 100 and 10m

12/10/2016 12:28:00	040 CTD158	041 CTD040	-5.81099	-25.0268	CTD in the Water
12/10/2016 12:29:00	040 OR159	041 OR033	-5.81099	-25.0268	Optics Rig in the Water
12/10/2016 12:31:00	040 CTD158	041 CTD040	-5.81099	-25.0268	CTD Veering to 500m
12/10/2016 12:40:00	040 OR159	041 OR033	-5.811	-25.0268	Optics Rig Stopped at 250m, Commence Hauling
12/10/2016 12:40:00	040 CTD158	041 CTD040	-5.811	-25.0268	CTD Stopped at 500m, Commence Hauling
12/10/2016 12:54:00	040 OR159	041 OR033	-5.81103	-25.0268	Optics Rig at the Bulwark, Redeploying
12/10/2016 12:56:00	040 RS160	041 RS021	-5.81103	-25.0268	Weather Balloon Launched
12/10/2016 13:07:00	040 OR161	041 OR034	-5.81102	-25.0268	Optics Rig Stopped at 250m, Commence Hauling
12/10/2016 13:07:00	040 CTD158	041 CTD040	-5.81102	-25.0268	CTD Recovered to Deck
12/10/2016 13:23:00	040 OR161	041 OR034	-5.81101	-25.0268	Optics Rig Recovered to Deck
12/10/2016 13:25:00	040 RA162	041 RA029	-5.81101	-25.0268	Radiometer in the Water
12/10/2016 13:34:00	040 RA162	041 RA029	-5.81114	-25.0263	Radiometer Recovered to Deck
12/10/2016 13:36:00	040 SAP157	041 SAP014	-5.81114	-25.0263	Commence Recovering SAPS
12/10/2016 13:43:00	040 SAP157	041 SAP014	-5.81114	-25.0263	SAPS Fully Recovered to Deck
12/10/2016 14:00:00	40	041 Station	-5.81091	-25.0243	VSL off DP
12/10/2016 14:01:00	40	041 Station	-5.81104	-25.0229	Running for 5 mins with sun on beam
12/10/2016 14:06:00	40	041 Station	-5.81284	-25.0123	End of 5 mins Steaming
12/10/2016 14:12:00	40	041 Station	-5.82567	-25.009	On Passage
13/10/2016 05:12:00	41	042 Station	-8.37533	-25.0446	Vessel slowing down
13/10/2016 05:18:00	41	042 Station	-8.37676	-25.041	Vessel On DP
13/10/2016 05:25:00	041 CTD163	042 CTD041	-8.37648	-25.0409	CTD Deployed
13/10/2016 05:26:00	041 VB164	042 VB018	-8.37648	-25.0409	VB Deployed
13/10/2016 05:28:00	041 CTD163	042 CTD041	-8.37651	-25.0409	CTD Veering to 500m
13/10/2016 05:37:00	041 CTD163	042 CTD041	-8.37648	-25.0409	CTD stopped at 500m
13/10/2016 05:48:00	041 VB164	042 VB018	-8.37647	-25.0409	VB Recovered
13/10/2016 06:04:00	041 CTD163	042 CTD041	-8.37648	-25.0409	CTD recovered
13/10/2016 06:12:00	041 HB165	042 HB011	-8.37671	-25.0406	HB Deployed
13/10/2016 06:43:00	041 HB165	042 HB011	-8.38471	-25.0329	HB Recovered
13/10/2016 06:54:00	41	042 Station	-8.38471	-25.0329	Vessel Off DP
13/10/2016 07:00:00	41	042 Station	-8.3874	-25.0337	Vessel On Passage
13/10/2016 11:00:00	42	043 Station	-9.05411	-25.0492	Commence slow down onto station (sun already on beam)
13/10/2016 11:06:00	42	043 Station	-9.05835	-25.0445	Vessel on DP
13/10/2016 11:11:00	042 RA166	043 RA030	-9.05824	-25.0446	RA deployed
13/10/2016 11:13:00	042 RA166	043 RA030	-9.05831	-25.0445	RA recovered to deck
13/10/2016 11:14:00	042 RA166	043 RA030	-9.05834	-25.0444	RA redeployed
13/10/2016 11:17:00	042 CTD167	043 CTD042	-9.05846	-25.0443	Commence deploying CTD
13/10/2016 11:18:00	042 SAP168	043 SAP015	-9.05851	-25.0443	Commence deploying SAPS
13/10/2016 11:19:00	042 CTD167	043 CTD042	-9.05854	-25.0442	CTD in water
13/10/2016 11:22:00	042 CTD167	043 CTD042	-9.05865	-25.0441	CTD veering to 500m
13/10/2016 11:22:00	042 RA166	043 RA030	-9.05865	-25.0441	RA recovered to deck
13/10/2016 11:24:00	042 OR169	043 OR035	-9.05871	-25.044	Commence deploying optics rig

13/10/2016 11:25:00	042 OR169	043 OR035	-9.05869	-25.044	Optics rig in water. Veering to 250m
13/10/2016 11:26:00	042 SAP168	043 SAP015	-9.05869	-25.044	SAPS deployed to 200m, 100m, and 10m
13/10/2016 11:30:00	042 CTD167	043 CTD042	-9.0587	-25.0441	CTD stopped at 500m
13/10/2016 11:46:00	042 RS170	043 RS022	-9.05869	-25.0441	Weather balloon launched
13/10/2016 11:50:00	042 OR169	043 OR035	-9.05869	-25.044	Optics rig hauled out of water
13/10/2016 11:52:00	042 OR171	043 OR036	-9.0587	-25.044	Optics rig in water. Veering to 250m
13/10/2016 11:57:00	042 CTD167	043 CTD042	-9.0587	-25.044	CTD recovered to deck
13/10/2016 12:03:00	042 OR171	043 OR036	-9.0587	-25.044	Optics Rig Stopped at 250m, Commence Hauling
13/10/2016 12:19:00	042 OR171	043 OR036	-9.05869	-25.044	Optics Rig Recovered to Deck
13/10/2016 12:23:00	042 RA172	043 RA031	-9.05875	-25.044	Radiometer in the Water
13/10/2016 12:36:00	042 SAP168	043 SAP015	-9.05922	-25.0434	Commence Recovering SAPS
13/10/2016 12:37:00	042 RA172	043 RA031	-9.05925	-25.0434	Radiometer Recovered to Deck
13/10/2016 12:47:00	042 SAP168	043 SAP015	-9.0596	-25.0429	SAPS Fully Recovered to Deck
13/10/2016 12:48:00	42	043 Station	-9.05963	-25.0429	VSL off DP
13/10/2016 12:56:00	42	043 Station	-9.063	-25.0392	Running for 5 mins with sun on beam
13/10/2016 13:01:00	42	043 Station	-9.06953	-25.0308	End of 5 mins Steaming
13/10/2016 13:06:00	42	043 Station	-9.08093	-25.0281	On Passage
14/10/2016 05:12:00	43	044 Station	-11.8207	-25.0656	Vessel slowing down
14/10/2016 05:18:00	43	044 Station	-11.8235	-25.0632	Vessel On DP
14/10/2016 05:26:00	043 CTD173	044 CTD043	-11.8235	-25.0633	CTD Deployed
14/10/2016 05:27:00	043 VB174	044 VB019	-11.8235	-25.0633	VB Deployed
14/10/2016 05:30:00	043 CTD173	044 CTD043	-11.8235	-25.0633	CTD veering to 500m
14/10/2016 05:40:00	043 CTD173	044 CTD043	-11.8235	-25.0633	CTD Stopped at 500m
14/10/2016 05:49:00	043 VB174	044 VB019	-11.8235	-25.0633	VB Recovered
14/10/2016 06:08:00	043 CTD173	044 CTD043	-11.8235	-25.0633	CTD Recovered
14/10/2016 06:16:00	043 HB175	044 HB012	-11.8236	-25.0632	HB Deployed
14/10/2016 06:50:00	043 HB175	044 HB012	-11.8299	-25.052	HB Recovered
14/10/2016 06:54:00	43	044 Station	-11.8299	-25.052	Vessel staying on station for release wire testing
14/10/2016 07:00:00	043 RELEASE TEST	044 Release Test	-11.8299	-25.052	Commence Release Wire Test Operations
14/10/2016 07:22:00	043 RELEASE TEST	044 Release Test	-11.8299	-25.052	Release wire deployed
14/10/2016 07:24:00	043 RELEASE TEST	044 Release Test	-11.8299	-25.052	Release Wire Veering to approx 5000m
14/10/2016 08:55:00	043 RELEASE TEST	044 Release Test	-11.8299	-25.052	Release wire stopped at 5200m
14/10/2016 08:58:00	043 RELEASE TEST	044 Release Test	-11.8299	-25.052	Hydrophone deployed
14/10/2016 09:20:00	043 RELEASE TEST	044 Release Test	-11.8298	-25.0522	Hydrophone recovered
14/10/2016 09:25:00	043 RELEASE	044 Release Test	-11.8294	-25.0524	Commence recovery of release wire

TEST					
14/10/2016 09:52:00	043 RELEASE TEST	044 Release Test	-11.8294	-25.0524	Hydrophone deployed
14/10/2016 09:58:00	043 RELEASE TEST	044 Release Test	-11.8294	-25.0524	Release wire stopped at 3284m
14/10/2016 10:02:00	043 RELEASE TEST	044 Release Test	-11.8294	-25.0524	Release wire veering to approx 5000m
14/10/2016 10:13:00	043 RELEASE TEST	044 Release Test	-11.8294	-25.0524	Release wire stopped at 3946m
14/10/2016 10:19:00	043 RELEASE TEST	044 Release Test	-11.8294	-25.0524	Release wire veering to 4500m
14/10/2016 10:29:00	043 RELEASE TEST	044 Release Test	-11.8294	-25.0524	Release wire stopped at 4500m
14/10/2016 10:32:00	043 RELEASE TEST	044 Release Test	-11.8294	-25.0524	Commence recovery of release wire
14/10/2016 11:18:00	043 RA176	044 RA032	-11.8294	-25.0524	Radiometer deployed
14/10/2016 11:27:00	043 RA176	044 RA032	-11.8294	-25.0524	Radiometer recovered to deck
14/10/2016 11:31:00	043 OR177	044 OR037	-11.8294	-25.0524	Commence deploying optics rig
14/10/2016 11:32:00	043 OR177	044 OR037	-11.8294	-25.0524	Optics rig in water. Veering to 250m
14/10/2016 11:45:00	043 RS178	044 RS023	-11.8294	-25.0524	Weather balloon launched
14/10/2016 12:00:00	043 OR179	044 OR038	-11.8294	-25.0524	Optics rig in water. Veering to 250m
14/10/2016 12:09:00	043 OR179	044 OR038	-11.8294	-25.0524	Optics Rig Stopped at 250m, Commence Hauling
14/10/2016 12:24:00	043 RELEASE TEST	044 Release Test	-11.8294	-25.0524	Weight and Release Recovered to Deck
14/10/2016 12:27:00	043 OR179	044 OR038	-11.8294	-25.0524	Optics Rig Recovered to Deck
14/10/2016 12:32:00	043 RA180	044 RA033	-11.8295	-25.0524	Radiometer in the Water
14/10/2016 12:34:00	043 SAP181	044 SAP016	-11.8295	-25.0523	Commence Deploying SAPS
14/10/2016 12:40:00	043 RA180	044 RA033	-11.8297	-25.052	Radiometer Recovered to Deck
14/10/2016 12:43:00	043 SAP181	044 SAP016	-11.8297	-25.052	SAPS Fully Deployed to 250, 150 and 10m
14/10/2016 12:53:00	043 CTD182	044 CTD044	-11.8297	-25.052	Commence Deploying CTD
14/10/2016 12:56:00	043 CTD182	044 CTD044	-11.8297	-25.052	CTD in the water
14/10/2016 12:57:00	043 CTD182	044 CTD044	-11.8297	-25.052	CTD Veering to 500m
14/10/2016 13:07:00	043 CTD182	044 CTD044	-11.8297	-25.052	CTD Stopped at 500m, Commence Hauling
14/10/2016 13:31:00	043 CTD182	044 CTD044	-11.8297	-25.0519	CTD Recovered to Deck
14/10/2016 13:40:00	043 SAP181	044 SAP016	-11.8297	-25.052	Commence Recovering SAPS
14/10/2016 13:44:00	043 SAP181	044 SAP016	-11.8297	-25.052	SAPS Fully Recovered to Deck
14/10/2016 13:54:00	43	044 Station	-11.8299	-25.0519	VSL off DP
14/10/2016 13:56:00	43	044 Station	-11.8308	-25.051	Running for 5 mins with sun on beam
14/10/2016 14:01:00	43	044 Station	-11.8354	-25.0429	End of 5 mins Steaming
14/10/2016 14:06:00	43	044 Station	-11.8453	-25.0392	On Passage
15/10/2016 05:12:00	44	045 Station	-14.441	-25.0759	Vessel slowing down

15/10/2016 05:18:00	44	045 Station	-14.4482	-25.0756	Vessel On DP
15/10/2016 05:25:00	044 VB183	045 VB020	-14.4485	-25.0758	VB Deployed
15/10/2016 05:28:00	044 CTD184	045 CTD045	-14.4485	-25.0758	CTD Deployed
15/10/2016 05:32:00	044 CTD184	045 CTD045	-14.4485	-25.0758	CTD Recovered to deck for component inspection
15/10/2016 05:34:00	044 CTD184	045 CTD045	-14.4485	-25.0758	CTD Re-deployed
15/10/2016 05:39:00	044 CTD184	045 CTD045	-14.4485	-25.0758	CTD Veering to 500m
15/10/2016 05:47:00	044 CTD184	045 CTD045	-14.4485	-25.0758	CTD Stopped at 500m
15/10/2016 05:48:00	044 VB183	045 VB020	-14.4485	-25.0758	VB Recovered
15/10/2016 06:18:00	044 CTD184	045 CTD045	-14.4485	-25.0758	CTD Recovered
15/10/2016 06:24:00	44	045 Station	-14.4485	-25.0758	Vessel Off DP
15/10/2016 06:30:00	44	045 Station	-14.4513	-25.0763	Vessel On Passage
15/10/2016 06:30:00	44	045 Station	-14.4513	-25.0763	Vessel On Passage
15/10/2016 12:06:00	45	046 Station	-15.3719	-25.0827	Commence Slowing Down (No 5 min run as sun was already on beam)
15/10/2016 12:18:00	45	046 Station	-15.3791	-25.0769	VSL on DP
15/10/2016 12:21:00	045 RA185	046 RA034	-15.3792	-25.0768	Radiometer in the Water
15/10/2016 12:24:00	045 SAP186	046 SAP017	-15.3792	-25.0766	Commence Deploying SAPS
15/10/2016 12:28:00	045 CTD187	046 CTD046	-15.3793	-25.0764	Commence Deploying CTD
15/10/2016 12:29:00	045 RA185	046 RA034	-15.3794	-25.0764	Radiometer Recovered to Deck (SOG 0.2Knts)
15/10/2016 12:31:00	045 CTD187	046 CTD046	-15.3794	-25.0763	CTD in the Water
15/10/2016 12:32:00	045 OR188	046 OR040	-15.3794	-25.0763	Commence Deploying Optics Rig
15/10/2016 12:33:00	045 SAP186	046 SAP017	-15.3794	-25.0763	SAPS deployed to 240m, 140m, and 10m
15/10/2016 12:34:00	045 OR188	046 OR040	-15.3794	-25.0764	Optics Rig in the Water
15/10/2016 12:35:00	045 CTD187	046 CTD046	-15.3794	-25.0764	CTD Veering to 500m
15/10/2016 12:44:00	045 CTD187	046 CTD046	-15.3794	-25.0763	CTD Stopped at 500m, Commence Hauling
15/10/2016 12:47:00	045 OR188	046 OR040	-15.3793	-25.0763	Optics Rig Stopped at 250m, Commence Hauling
15/10/2016 12:47:00	045 RS189	046 RS024	-15.3793	-25.0763	Weather Balloon Launched
15/10/2016 13:03:00	045 OR188	046 OR040	-15.3794	-25.0764	Optics Rig at the Bulwark, Redeploying
15/10/2016 13:08:00	045 CTD187	046 CTD046	-15.3794	-25.0764	CTD Recovered to Deck
15/10/2016 13:20:00	045 OR190	046 OR039	-15.3794	-25.0764	Optics Rig Stopped at 250m, Commence Hauling
15/10/2016 13:36:00	045 OR190	046 OR039	-15.3794	-25.0764	Optics Rig Recovered to Deck
15/10/2016 13:37:00	045 SAP186	046 SAP017	-15.3794	-25.0764	Commence Recovering SAPS
15/10/2016 13:40:00	045 RA191	046 RA035	-15.3794	-25.0763	Radiometer in the Water
15/10/2016 13:46:00	045 SAP186	046 SAP017	-15.3795	-25.076	SAPS Fully Recovered to Deck
15/10/2016 13:48:00	045 RA191	046 RA035	-15.3796	-25.0759	Radiometer Recovered to Deck (SOG 0.2Knts)
15/10/2016 13:49:00	045 ARGO192	046 ARGO001	-15.3796	-25.0759	ARGO Float Deployed (APEX 7587)
15/10/2016 14:00:00	45	046 Station	-15.3807	-25.0748	VSL off DP
15/10/2016 14:01:00	45	046 Station	-15.3814	-25.0744	Running for 5 mins on Station Heading
15/10/2016 14:06:00	45	046 Station	-15.3841	-25.0677	End of 5 mins Steaming
15/10/2016 14:12:00	45	046 Station	-15.3961	-25.0662	On Passage

16/10/2016 05:12:00	46	047 Station	-18.2574	-25.1223	Vessel Slowing Down
16/10/2016 05:18:00	46	047 Station	-18.2593	-25.1199	Vessel On DP
16/10/2016 05:24:00	046 VB 193	047 VB021	-18.2593	-25.1199	VB Deployed
16/10/2016 05:26:00	046 CTD194	047 CTD047	-18.2593	-25.1199	CTD Deployed
16/10/2016 05:30:00	046 CTD194	047 CTD047	-18.2593	-25.1199	CTD Veering to 500m
16/10/2016 05:38:00	046 CTD194	047 CTD047	-18.2593	-25.1199	CTD Stopped at 500m
16/10/2016 05:45:00	046 VB 193	047 VB021	-18.2593	-25.1199	VB Recovered
16/10/2016 06:10:00	046 CTD194	047 CTD047	-18.2593	-25.1199	CTD Recovered
16/10/2016 06:18:00	46	047 Station	-18.2595	-25.1197	Vessel Off DP
16/10/2016 06:24:00	46	047 Station	-18.2661	-25.1203	Vessel On Passage
16/10/2016 07:48:00	47	048 Station	-18.5281	-25.1285	Vessel Slowing down
16/10/2016 07:54:00	47	048 Station	-18.5436	-25.1305	Vessel On DP
16/10/2016 08:34:00	47	048 Station	-18.5445	-25.1284	Commence deployment of mooring
16/10/2016 08:35:00	047 MOOR195	048 MOOR001	-18.5445	-25.1283	Billings float and 10" sphere deployed
16/10/2016 08:37:00	047 MOOR195	048 MOOR001	-18.5445	-25.1279	12 x 17
16/10/2016 08:53:00	047 MOOR195	048 MOOR001	-18.5445	-25.1258	1st sediment trap and current meter deployed
16/10/2016 09:03:00	047 MOOR195	048 MOOR001	-18.5446	-25.1242	2nd sediment trap and current meter deployed
16/10/2016 10:11:00	047 MOOR195	048 MOOR001	-18.5449	-25.103	10 x 17
16/10/2016 10:23:00	047 MOOR195	048 MOOR001	-18.5449	-25.1007	Acoustic release deployed
16/10/2016 10:38:00	047 MOOR195	048 MOOR001	-18.545	-25.0979	Anchor deployed. 5261m depth
16/10/2016 11:41:00	47	048 Station	-18.545	-25.0975	Anchor on seabed. Ranging 5301m
16/10/2016 11:42:00	47	048 Station	-18.545	-25.0975	vessel off DP
16/10/2016 11:48:00	47	048 Station	-18.5434	-25.0942	Vessel on passage to next mooring position
16/10/2016 12:18:00	48	049 Station	-18.5023	-25.0171	Commence Slowing Down
16/10/2016 12:24:00	48	049 Station	-18.4987	-25.0085	VSL on DP at Mooring Site
16/10/2016 12:29:00	048 MOOR196	049 MOOR002	-18.4987	-25.0079	Hydrophone in the Water
16/10/2016 12:31:00	048 MOOR196	049 MOOR002	-18.4987	-25.0078	Release Signal Sent
16/10/2016 12:42:00	048 RS197	049 RS025	-18.4981	-25.0079	Weather Balloon Deployed
16/10/2016 13:19:00	048 RA198	049 RA036	-18.4951	-25.0079	Radiometer in the Water
16/10/2016 13:21:00	048 MOOR196	049 MOOR002	-18.4951	-25.0079	Top Set of Floats at the Surface - Sighted
16/10/2016 13:24:00	048 RA198	049 RA036	-18.4951	-25.0079	Radiometer Recovered to Deck
16/10/2016 13:36:00	048 MOOR196	049 MOOR002	-18.4951	-25.0079	Hydrophone Recovered to Deck
16/10/2016 13:36:00	48	049 Station	-18.4951	-25.0079	VSL off DP
16/10/2016 14:06:00	48	049 Station	-18.4996	-25.0095	047 MOOR196
16/10/2016 14:08:00	048 MOOR196	049 MOOR002	-18.4996	-25.0094	Hydrophone in the Water
16/10/2016 14:17:00	048 MOOR196	049 MOOR002	-18.4996	-25.0094	Hydrophone Recovered to Deck
16/10/2016 14:18:00	48	049 Station	-18.4997	-25.0093	VSL off DP
16/10/2016 14:24:00	48	049 Station	-18.5014	-25.0074	VSL on DP

16/10/2016 14:35:00	048 MOOR196	049 MOOR002	-18.5021	-25.0067	Mooring Grappled - Transferring to Stern Gantry
16/10/2016 14:41:00	048 MOOR196	049 MOOR002	-18.5024	-25.0063	Commence Mooring Recovery
16/10/2016 14:47:00	048 MOOR196	049 MOOR002	-18.5027	-25.0057	Top Set of Floats Recovered to Deck
16/10/2016 14:59:00	048 MOOR196	049 MOOR002	-18.5033	-25.0044	1st Sediment Trap and Current Meter Recovered to Deck
16/10/2016 15:12:00	048 MOOR196	049 MOOR002	-18.5038	-25.003	2nd Sediment Trap and Current Meter Recovered to Deck
16/10/2016 15:53:00	048 MOOR196	049 MOOR002	-18.5053	-24.9989	Second Set of Floats Recovered to Deck
16/10/2016 15:57:00	048 MOOR196	049 MOOR002	-18.5054	-24.9987	Release Recovered to Deck, Stern Door Shut
16/10/2016 16:30:00	48	049 Station	-18.5075	-24.9993	Vessel Off DP
16/10/2016 16:36:00	48	049 Station	-18.5184	-25	Vessel On Passage
17/10/2016 05:12:00	49	050 Station	-20.6714	-25.0108	Vessel Slowing Down
17/10/2016 05:18:00	49	050 Station	-20.6719	-25.0104	Vessel On DP
17/10/2016 05:23:00	049 CTD199	050 CTD048	-20.6717	-25.0104	CTD Deployed
17/10/2016 05:24:00	049 VB 200	050 VB022	-20.6717	-25.0104	Vertical net deployed
17/10/2016 05:25:00	049 CTD199	050 CTD048	-20.6718	-25.0104	CTD Veering to 500m
17/10/2016 05:35:00	049 CTD199	050 CTD048	-20.6718	-25.0104	CTD Stopped at 500m
17/10/2016 05:46:00	049 VB 200	050 VB022	-20.6718	-25.0104	VB Recovered
17/10/2016 06:04:00	049 CTD199	050 CTD048	-20.6718	-25.0104	CTD Recovered
17/10/2016 06:12:00	049 HB201	050 HB013	-20.672	-25.0096	HB Deployed
17/10/2016 06:50:00	049 HB201	050 HB013	-20.6754	-24.9959	HB Recovered, Average speed of tow = 1.4kts
17/10/2016 06:53:00	049 BA202	050 BA001	-20.6755	-24.9954	Commenced Argo Deployment
17/10/2016 06:55:00	049 BA202	050 BA001	-20.6756	-24.9951	Argo Float Released
17/10/2016 07:06:00	49	050 Station	-20.6777	-24.9912	Vessel Off DP
17/10/2016 07:12:00	49	050 Station	-20.6885	-24.9912	Vessel On Passage
17/10/2016 11:00:00	50	051 Station	-21.335	-25.0151	Slowing down onto station (sun already on port beam)
17/10/2016 11:06:00	50	051 Station	-21.3396	-25.0126	Vessel on DP
17/10/2016 11:23:00	050 RA203	051 RA037	-21.3397	-25.013	Radiometer deployed
17/10/2016 11:28:00	050 RS204	051 RS026	-21.3398	-25.013	Weather balloon launched
17/10/2016 11:33:00	050 RA203	051 RA037	-21.3398	-25.013	Radiometer recovered to deck
17/10/2016 11:36:00	050 OR205	051 OR041	-21.3397	-25.013	Commence deploying Optics Rig
17/10/2016 11:37:00	050 OR205	051 OR041	-21.3398	-25.013	Optics rig in water. Veering to 250m
17/10/2016 12:01:00	050 OR205	051 OR041	-21.3398	-25.013	Optics rig hauled out of water
17/10/2016 12:03:00	050 OR205	051 OR041	-21.3398	-25.013	Optics rig in water. Veering to 250m
17/10/2016 12:07:00	050 RA206	051 RA038	-21.3397	-25.0129	Radiometer in the Water
17/10/2016 12:13:00	050 SAP207	051 SAP018	-21.3395	-25.0126	Commence Deploying SAPS
17/10/2016 12:14:00	050 OR205	051 OR041	-21.3395	-25.0125	Optics Rig Stopped at 250m, Commence Hauling
17/10/2016 12:15:00	050 RA206	051 RA038	-21.3395	-25.0124	Radiometer Recovered to Deck
17/10/2016 12:26:00	050 SAP207	051 SAP018	-21.3394	-25.0124	SAPS Fully Deployed at 270, 170 and 10m
17/10/2016 12:33:00	050 OR205	051 OR041	-21.3395	-25.0124	Optics Rig Recovered to Deck

17/10/2016 12:37:00	050 CTD208	051 CTD049	-21.3395	-25.0124	Commence Deploying CTD
17/10/2016 12:40:00	050 CTD208	051 CTD049	-21.3395	-25.0124	CTD in the Water
17/10/2016 12:42:00	050 CTD208	051 CTD049	-21.3395	-25.0124	CTD Veering to 500m
17/10/2016 12:51:00	050 CTD208	051 CTD049	-21.3395	-25.0124	CTD Stopped at 500m, Commence Hauling
17/10/2016 13:19:00	050 CTD208	051 CTD049	-21.3395	-25.0124	CTD Recovered to Deck
17/10/2016 13:37:00	050 SAP207	051 SAP018	-21.3395	-25.0124	Commence Recovering SAPS
17/10/2016 13:47:00	050 SAP207	051 SAP018	-21.3395	-25.0124	SAPS Fully Recovered to Deck
17/10/2016 13:50:00	050 ARGO209	051 ARGO002	-21.3395	-25.0124	Apex Float Deployed (#7588)
17/10/2016 13:54:00	50	051 Station	-21.3395	-25.0119	VSL off DP
17/10/2016 14:00:00	50	051 Station	-21.3385	-25.0093	Running for 5 mins with sun on beam
17/10/2016 14:06:00	50	051 Station	-21.3329	-24.9968	End of 5 mins Steaming
17/10/2016 14:12:00	50	051 Station	-21.3462	-24.9919	On Passage
18/10/2016 04:12:00	51	052 Station	-23.7278	-25.0261	Vessel Slowing down
18/10/2016 04:18:00	51	052 Station	-23.7294	-25.0239	Vessel On DP
18/10/2016 04:26:00	051 VB 210	052 VB023	-23.7305	-25.0244	VB Deployed
18/10/2016 04:28:00	051 CTD211	052 CTD050	-23.7305	-25.0244	CTD Deployed
18/10/2016 04:28:00	051 VB 210	052 VB023	-23.7305	-25.0244	Nets Veering to 200m
18/10/2016 04:30:00	051 CTD211	052 CTD050	-23.7305	-25.0244	CTD Veering to 500m
18/10/2016 04:31:00	051 VB 210	052 VB023	-23.7305	-25.0244	VB at 200m,Hauling
18/10/2016 04:40:00	051 CTD211	052 CTD050	-23.7305	-25.0244	CTD stopped at 500m
18/10/2016 04:48:00	051 VB 210	052 VB023	-23.7305	-25.0244	VB Recovered
18/10/2016 05:08:00	051 CTD211	052 CTD050	-23.7305	-25.0244	CTD Recovered
18/10/2016 05:26:00	051 HB212	052 HB014	-23.7296	-25.0232	HB Deployed
18/10/2016 05:58:00	051 HB212	052 HB014	-23.722	-25.0129	HB Recovered, Average speed of tow = 1.3Kts
18/10/2016 06:12:00	51	052 Station	-23.7218	-25.0126	Vessel Off DP
18/10/2016 06:18:00	51	052 Station	-23.7296	-25.0128	Vessel On Passage
18/10/2016 10:36:00	52	053 Station	-24.4669	-25.0284	Commence slowing onto station. (sun already on port beam)
18/10/2016 10:42:00	52	053 Station	-24.4657	-25.0265	Vessel on DP
18/10/2016 10:49:00	052 RA213	053 RA039	-24.4657	-25.0267	Radiometer deployed
18/10/2016 11:03:00	052 RA213	053 RA039	-24.4652	-25.0264	Radiometer recovered
18/10/2016 11:03:00	052 RS214	053 RS027	-24.4652	-25.0264	Weather balloon launched
18/10/2016 11:07:00	052 SAP215	053 SAP019	-24.4652	-25.0264	Commence deploying SAPS
18/10/2016 11:08:00	052 CTD216	053 CTD051	-24.4652	-25.0264	Commence deploying CTD
18/10/2016 11:11:00	052 CTD216	053 CTD051	-24.4652	-25.0264	CTD in water
18/10/2016 11:14:00	052 CTD216	053 CTD051	-24.4652	-25.0264	CTD veering to 500m
18/10/2016 11:14:00	052 OR217	053 OR042	-24.4652	-25.0264	Commence deploying optics rig
18/10/2016 11:15:00	052 OR217	053 OR042	-24.4652	-25.0264	Optics rig in water. Veering to 250m
18/10/2016 11:15:00	052 SAP215	053 SAP019	-24.4652	-25.0264	SAPS deployed. 240m, 140, 10m
18/10/2016 11:23:00	052 CTD216	053 CTD051	-24.4652	-25.0264	CTD stopped at 500m
18/10/2016 11:39:00	052 OR217	053 OR042	-24.4652	-25.0264	Optics rig hauled out of water
18/10/2016 11:40:00	052 OR218	053 OR043	-24.4652	-25.0264	Optics rig in water. Veering to

					250m
18/10/2016 11:48:00	052 CTD216	053 CTD051	-24.4652	-25.0264	CTD recovered to deck
18/10/2016 12:06:00	052 SAP215	053 SAP019	-24.4652	-25.0264	Commence Recovering SAPS
18/10/2016 12:13:00	052 OR218	053 OR043	-24.4652	-25.0264	Optics Rig Recovered to Deck
18/10/2016 12:16:00	052 SAP215	053 SAP019	-24.4652	-25.0265	SAPS Fully Recovered to Deck
18/10/2016 12:22:00	052 RA219	053 RA040	-24.4648	-25.0264	Radiometer in the Water
18/10/2016 12:31:00	052 RA219	053 RA040	-24.4639	-25.0266	Radiometer Recovered to Deck
18/10/2016 12:36:00	52	053 Station	-24.4636	-25.0276	VSL off DP
18/10/2016 12:42:00	52	053 Station	-24.4685	-25.0277	Running for 5 mins with sun on beam
18/10/2016 12:47:00	52	053 Station	-24.4792	-25.0207	End of 5 mins Steaming
18/10/2016 12:48:00	52	053 Station	-24.4816	-25.0191	On Passage
19/10/2016 04:12:00	53	054 Station	-27.2683	-24.4571	Vessel Slowing down
19/10/2016 04:18:00	53	054 Station	-27.2702	-24.4507	Vessel On DP
19/10/2016 04:24:00	053 VB220	054 VB024	-27.2702	-24.4506	VB Deployed
19/10/2016 04:28:00	053 CTD221	054 CTD052	-27.2702	-24.4506	CTD Deployed
19/10/2016 04:31:00	053 VB220	054 VB024	-27.2702	-24.4506	VB stopped at 200m, Hauling
19/10/2016 04:32:00	053 CTD221	054 CTD052	-27.2702	-24.4506	CTD Veering to 500m
19/10/2016 04:42:00	053 CTD221	054 CTD052	-27.2702	-24.4506	CTD Stopped at 500m
19/10/2016 04:48:00	053 VB220	054 VB024	-27.2701	-24.4506	VB Recovered
19/10/2016 05:14:00	053 CTD221	054 CTD052	-27.2702	-24.4506	CTD Recovered
19/10/2016 05:24:00	53	054 Station	-27.2699	-24.4494	Vessel Off DP
19/10/2016 05:30:00	53	054 Station	-27.2797	-24.4463	Vessel On Passage
19/10/2016 10:12:00	54	055 Station	-28.0177	-24.2611	Commence slowing onto station. (Sun already on port beam)
19/10/2016 10:24:00	54	055 Station	-28.0227	-24.2564	Vessel on DP
19/10/2016 10:29:00	054 RA222	055 RA041	-28.0226	-24.2565	Radiometer deployed
19/10/2016 10:38:00	054 RA222	055 RA041	-28.0221	-24.2566	Radiometer recovered
19/10/2016 10:40:00	054 OR223	055 OR044	-28.022	-24.2567	Commence deploying optics rig
19/10/2016 10:41:00	054 OR223	055 OR044	-28.022	-24.2567	Optics rig deployed
19/10/2016 10:45:00	054 OR223	055 OR044	-28.022	-24.2566	Optics rig veering to 50m
19/10/2016 10:48:00	054 OR223	055 OR044	-28.022	-24.2566	Optics rig stopped at 50m
19/10/2016 10:50:00	054 OR223	055 OR044	-28.022	-24.2567	Optics rig hauled out of water
19/10/2016 10:52:00	054 OR223	055 OR044	-28.022	-24.2567	Optics rig redeployed
19/10/2016 10:55:00	054 RS224	055 RS028	-28.022	-24.2567	Weather balloon launched
19/10/2016 10:56:00	054 OR223	055 OR044	-28.022	-24.2567	Optics rig veering to 50m
19/10/2016 10:58:00	054 OR223	055 OR044	-28.022	-24.2567	Optics rig stopped at 50m
19/10/2016 11:03:00	054 OR223	055 OR044	-28.022	-24.2567	Optics rig recovered to deck
19/10/2016 11:04:00	054 RA222	055 RA041	-28.022	-24.2567	Radiometer redeployed
19/10/2016 11:12:00	54	055 Station	-28.0218	-24.2567	Vessel off DP
19/10/2016 11:12:00	054 RA222	055 RA041	-28.0218	-24.2567	Radiometer recovered
19/10/2016 11:18:00	54	055 Station	-28.0212	-24.2581	Steaming for 5 mins with sun on port beam
19/10/2016 11:23:00	54	055 Station	-28.0314	-24.2563	End of 5 minutes steaming
19/10/2016 11:24:00	54	055 Station	-28.0342	-24.2555	Vessel on passage

19/10/2016 12:00:00	55	056 Station	-28.1256	-24.2979	Commence Turning on to Station
19/10/2016 12:04:00	55	056 Station	-28.136	-24.3003	Running for 5 mins with sun on beam
19/10/2016 12:09:00	55	056 Station	-28.1479	-24.2929	End of 5 mins Steaming
19/10/2016 12:18:00	55	056 Station	-28.1528	-24.2961	VSL on DP
19/10/2016 12:19:00	055 SAP225	056 SAP020	-28.1528	-24.2961	Commence Deploying SAPS
19/10/2016 12:25:00	055 RA226	056 RA042	-28.1527	-24.2962	Radiometer in the Water
19/10/2016 12:27:00	055 CTD227	056 CTD053	-28.1527	-24.2963	Commence Deploying CTD
19/10/2016 12:27:00	055 SAP225	056 SAP020	-28.1527	-24.2963	SAPS Fully Deployed at 210, 110 and 10m
19/10/2016 12:29:00	055 CTD227	056 CTD053	-28.1526	-24.2963	CTD in the Water
19/10/2016 12:31:00	055 CTD227	056 CTD053	-28.1525	-24.2964	CTD Veering to 500m
19/10/2016 12:35:00	055 RA226	056 RA042	-28.1523	-24.2966	Radiometer Recovered to Deck
19/10/2016 12:36:00	055 OR228	056 OR045	-28.1523	-24.2966	Commence Deploying Optics Rig
19/10/2016 12:41:00	055 CTD227	056 CTD053	-28.1523	-24.2966	CTD Stopped at 500m, Commence Hauling
19/10/2016 13:02:00	055 OR228	056 OR045	-28.1523	-24.2966	Optics Rig at the Bulwark, Redeploying
19/10/2016 13:04:00	055 CTD227	056 CTD053	-28.1523	-24.2966	CTD Recovered to Deck
19/10/2016 13:35:00	055 OR229	056 OR046	-28.1523	-24.2966	Optics Rig Recovered to Deck
19/10/2016 13:37:00	055 SAP225	056 SAP020	-28.1523	-24.2966	Commence Recovering SAPS
19/10/2016 13:38:00	055 RA230	056 RA043	-28.1523	-24.2967	Radiometer in the Water
19/10/2016 13:46:00	055 RA230	056 RA043	-28.1519	-24.297	Radiometer Recovered to Deck
19/10/2016 13:46:00	055 SAP225	056 SAP020	-28.1519	-24.297	SAPS Fully Recovered to Deck
19/10/2016 14:00:00	55	056 Station	-28.1512	-24.2978	VSL off DP
19/10/2016 14:04:00	55	056 Station	-28.1534	-24.3002	Running for 5 mins with sun on beam
19/10/2016 14:09:00	55	056 Station	-28.1605	-24.3084	End of 5 mins Steaming
19/10/2016 14:12:00	55	056 Station	-28.1675	-24.3138	On Passage
20/10/2016 04:12:00	56	057 Station	-30.3787	-25.31	Vessel Slowing Down
20/10/2016 04:18:00	56	057 Station	-30.3845	-25.313	Vessel On DP
20/10/2016 04:26:00	056 VB231	057 VB025	-30.3846	-25.3126	VB Deployed
20/10/2016 04:30:00	056 VB231	057 VB025	-30.3846	-25.3126	VB stopped at 200m, Hauling
20/10/2016 04:34:00	056 CTD232	057 CTD054	-30.3846	-25.3127	CTD Deployed
20/10/2016 04:37:00	056 CTD232	057 CTD054	-30.3846	-25.3126	CTD Veering to 500m
20/10/2016 04:46:00	056 CTD232	057 CTD054	-30.3846	-25.3127	CTD Stopped at 500m
20/10/2016 04:51:00	056 VB231	057 VB025	-30.3846	-25.3127	VB Recovered
20/10/2016 05:18:00	056 CTD232	057 CTD054	-30.3846	-25.3126	CTD Recovered
20/10/2016 05:26:00	056 HB233	057 HB015	-30.3851	-25.3133	HB Deployed
20/10/2016 06:02:00	056 HB233	057 HB015	-30.3938	-25.3253	HB Recovered, Average speed of tow = 1.5Kts
20/10/2016 06:18:00	56	057 Station	-30.3938	-25.3253	Vessel Off DP
20/10/2016 06:24:00	56	057 Station	-30.3989	-25.3279	Vessel On Passage
20/10/2016 12:12:00	57	058 Station	-31.2982	-25.7281	Commence Slowing Down to Come on Station
20/10/2016 12:18:00	57	058 Station	-31.304	-25.7261	VSL on DP
20/10/2016 12:19:00	057 SAP234	058 SAP021	-31.304	-25.7261	Commence Deploying SAPS

20/10/2016 12:23:00	057 RA235	058 RA044	-31.304	-25.726	Radiometer in the Water
20/10/2016 12:28:00	057 SAP234	058 SAP021	-31.3044	-25.7256	SAPS Fully Deployed at 220, 120 and 10m
20/10/2016 12:32:00	057 RA235	058 RA044	-31.3047	-25.7252	Radiometer Recovered to Deck (Speed 0.4knts)
20/10/2016 12:33:00	057 CTD236	058 CTD055	-31.3047	-25.7252	Commence Deploying CTD
20/10/2016 12:34:00	057 CTD236	058 CTD055	-31.3047	-25.7252	CTD in the Water
20/10/2016 12:35:00	057 OR237	058 OR047	-31.3049	-25.725	Commence Deploying Optics Rig
20/10/2016 12:37:00	057 CTD236	058 CTD055	-31.3047	-25.7252	CTD Veering to 500m
20/10/2016 12:37:00	057 OR237	058 OR047	-31.3047	-25.7252	Optics Rig in the Water
20/10/2016 12:45:00	057 OR237	058 OR047	-31.3048	-25.7252	Optics Rig Stopped at 250m, Commence Hauling
20/10/2016 12:47:00	057 CTD236	058 CTD055	-31.3047	-25.7252	CTD Stopped at 500m, Commence Hauling
20/10/2016 12:54:00	057 RS238	058 RS029	-31.3047	-25.7252	Weather Balloon Launched
20/10/2016 13:01:00	057 OR237	058 OR047	-31.3047	-25.7251	Optics Rig at the Bulwark, Redeploying
20/10/2016 13:11:00	057 CTD236	058 CTD055	-31.3047	-25.7251	CTD Recovered to Deck
20/10/2016 13:32:00	057 OR239	058 OR048	-31.3048	-25.7251	Optics Rig Recovered to Deck
20/10/2016 13:33:00	057 RA240	058 RA045	-31.3048	-25.7251	Radiometer in the Water
20/10/2016 13:37:00	057 SAP234	058 SAP021	-31.3051	-25.7248	Commence Recovering SAPS
20/10/2016 13:46:00	057 RA240	058 RA045	-31.3057	-25.724	Radiometer Recovered to Deck (Speed 0.4knts)
20/10/2016 13:47:00	057 SAP234	058 SAP021	-31.3057	-25.724	SAPS Fully Recovered to Deck
20/10/2016 13:54:00	57	058 Station	-31.3059	-25.724	VSL off DP
20/10/2016 14:00:00	57	058 Station	-31.3151	-25.728	On Passage
21/10/2016 04:12:00	58	059 Station	-33.5797	-26.7836	Vessel slowing down
21/10/2016 04:18:00	58	059 Station	-33.5836	-26.7822	Vessel On DP
21/10/2016 04:24:00	058 VB241	059 VB026	-33.584	-26.7826	VB Deployed
21/10/2016 04:28:00	058 VB241	059 VB026	-33.584	-26.7826	VB Stopped at 200m, hauling
21/10/2016 04:32:00	058 CTD242	059 CTD056	-33.584	-26.7825	CTD Deployed
21/10/2016 04:39:00	058 CTD242	059 CTD056	-33.584	-26.7826	CTD Veering to 500m
21/10/2016 04:48:00	058 CTD242	059 CTD056	-33.584	-26.7825	CTD Stopped at 500m
21/10/2016 04:48:00	058 VB241	059 VB026	-33.584	-26.7825	VB Recovered
21/10/2016 05:19:00	058 CTD242	059 CTD056	-33.584	-26.7825	CTD Recovered
21/10/2016 05:42:00	58	059 Station	-33.5865	-26.7809	Vessel Off DP
21/10/2016 05:48:00	58	059 Station	-33.5989	-26.7869	Vessel On Passage
21/10/2016 11:06:00	59	060 Station	-34.4278	-27.1817	Vessel slowing down onto station
21/10/2016 11:12:00	59	060 Station	-34.4293	-27.1848	Vessel On DP
21/10/2016 11:21:00	059 RA243	060 RA046	-34.4293	-27.185	Radiometer deployed
21/10/2016 11:29:00	059 RA243	060 RA046	-34.429	-27.1852	Radiometer recovered
21/10/2016 11:33:00	059 OR244	060 OR049	-34.429	-27.1852	Commence deploying optics rig
21/10/2016 11:35:00	059 OR244	060 OR049	-34.429	-27.1852	Optics rig deployed
21/10/2016 11:37:00	059 RS245	060 RS030	-34.429	-27.1852	Weather balloon launched
21/10/2016 11:40:00	059 OR244	060 OR049	-34.429	-27.1852	Optics rig veering to 250m
21/10/2016 11:47:00	059 OR244	060 OR049	-34.429	-27.1852	Optics rig stopped at 250m
21/10/2016 12:02:00	059 OR244	060 OR049	-34.429	-27.1853	Optics Rig at the Bulwark,

						Redeploying
21/10/2016 12:12:00	059 SAP245	060 SAP022	-34.429	-27.1852	Commence Deploying SAPS	
21/10/2016 12:19:00	059 OR246	060 OR050	-34.429	-27.1852	Optics Rig Stopped at 250m, Commence Hauling	
21/10/2016 12:23:00	059 CTD247	060 CTD057	-34.429	-27.1853	Commence Deploying CTD	
21/10/2016 12:24:00	059 SAP245	060 SAP022	-34.4289	-27.1852	SAPS Fully Deployed at 200, 100 and 10m	
21/10/2016 12:29:00	059 CTD247	060 CTD057	-34.4289	-27.1853	CTD in the Water	
21/10/2016 12:32:00	059 CTD247	060 CTD057	-34.429	-27.1853	CTD Veering to 500m	
21/10/2016 12:35:00	059 OR246	060 OR050	-34.4289	-27.1853	Optics Rig Recovered to Deck	
21/10/2016 12:36:00	059 RA248	060 RA047	-34.4289	-27.1853	Radiometer in the Water	
21/10/2016 12:42:00	059 CTD247	060 CTD057	-34.4288	-27.1856	CTD Stopped at 500m, Commence Hauling	
21/10/2016 12:43:00	059 RA248	060 RA047	-34.4287	-27.1856	Radiometer Recovered to Deck (Speed 0.2knts)	
21/10/2016 13:06:00	059 CTD247	060 CTD057	-34.4287	-27.1857	CTD Recovered to Deck	
21/10/2016 13:36:00	059 SAP245	060 SAP022	-34.4287	-27.1856	Commence Recovering SAPS	
21/10/2016 13:46:00	059 SAP245	060 SAP022	-34.4287	-27.1856	SAPS Fully Recovered to Deck	
21/10/2016 13:52:00	059 HB249	060 HB016	-34.4286	-27.1858	Horizontal Bongo Nets in the Water	
21/10/2016 14:10:00	059 BA250	060 BA002	-34.4248	-27.1913	Bio Argo Float in the Water	
21/10/2016 14:13:00	059 BA250	060 BA002	-34.424	-27.1924	Bio Argo Float LOVBIO106 Released and Floating Clear	
21/10/2016 14:24:00	059 HB249	060 HB016	-34.4211	-27.1962	Commence Recovering Horizontal Bongo Nets (Towed at 1.4knts)	
21/10/2016 14:26:00	059 HB249	060 HB016	-34.4206	-27.1969	Horizontal Bongo Nets Recovered to Deck	
21/10/2016 14:35:00	59	060 Station	-34.4182	-27.2	VSL off DP	
21/10/2016 14:42:00	59	060 Station	-34.4181	-27.2095	On Passage	
22/10/2016 04:12:00	60	061 Station	-36.5189	-28.1453	Vessel Slowing Down	
22/10/2016 04:18:00	60	061 Station	-36.5253	-28.1491	Vessel On DP	
22/10/2016 04:25:00	060 VB251	061 VB027	-36.5252	-28.1491	VB Deployed	
22/10/2016 04:29:00	060 CTD252	061 CTD058	-36.5252	-28.1492	CTD Deployed	
22/10/2016 04:32:00	060 CTD252	061 CTD058	-36.5252	-28.1491	CTD Veering to 500m	
22/10/2016 04:32:00	060 VB251	061 VB027	-36.5252	-28.1491	VB stopped at 200m, Hauling	
22/10/2016 04:43:00	060 CTD252	061 CTD058	-36.5252	-28.1492	CTD all stopped at 500m	
22/10/2016 04:52:00	060 VB251	061 VB027	-36.5252	-28.1492	VB Recovered	
22/10/2016 05:16:00	060 CTD252	061 CTD058	-36.5252	-28.1491	CTD Recovered	
22/10/2016 05:24:00	060 HB253	061 HB017	-36.5257	-28.1487	HB Deployed	
22/10/2016 05:55:00	060 HB253	061 HB017	-36.5348	-28.1392	HB Recovered, Average speed of tow 1.5Kts	
22/10/2016 06:00:00	060 Float254	061 ARGO003	-36.5352	-28.1388	Commence Deployment of Float 7583	
22/10/2016 06:02:00	060 Float254	061 ARGO003	-36.5355	-28.1385	Float 7583 Deployed Astern, Vessel moving ahead at 0.5Kts	
22/10/2016 06:12:00	60	061 Station	-36.5373	-28.1368	Vessel Off DP	
22/10/2016 06:18:00	60	061 Station	-36.5455	-28.1393	Vessel On Passage	
22/10/2016 10:30:00	61	062 Station	-37.2217	-28.4228	Commence 5 min steam with sun on port beam	
22/10/2016 10:35:00	61	062 Station	-37.2339	-28.4207	End of 5 min steam	

22/10/2016 10:36:00	61	062 Station	-37.2365	-28.42	Commence slowing onto station
22/10/2016 10:42:00	61	062 Station	-37.2437	-28.4181	Vessel on DP
22/10/2016 10:47:00	061 RA255	062 RA048	-37.2439	-28.418	Radiometer deployed
22/10/2016 10:58:00	061 RA255	062 RA048	-37.2443	-28.4179	Radiometer recovered
22/10/2016 11:01:00	061 OR256	062 OR051	-37.2443	-28.4179	Commence deploying optics rig
22/10/2016 11:02:00	061 OR256	062 OR051	-37.2443	-28.4179	Optics rig deployed
22/10/2016 11:04:00	061 OR256	062 OR051	-37.2443	-28.4179	Optics rig veering to 50m
22/10/2016 11:06:00	061 OR256	062 OR051	-37.2443	-28.4179	Optics rig stopped at 50m
22/10/2016 11:08:00	061 OR256	062 OR051	-37.2443	-28.4179	Optics rig hauled out of water
22/10/2016 11:10:00	061 OR256	062 OR051	-37.2443	-28.4179	Optics rig redeployed
22/10/2016 11:14:00	061 RS257	062 RS031	-37.2443	-28.4179	Weather balloon launched
22/10/2016 11:15:00	061 OR256	062 OR051	-37.2443	-28.4179	Optics rig veering to 50m
22/10/2016 11:17:00	061 OR256	062 OR051	-37.2443	-28.4179	Optics rig stopped at 50m
22/10/2016 11:23:00	061 OR256	062 OR051	-37.2443	-28.4179	Optics rig recovered to deck
22/10/2016 11:24:00	061 RA255	062 RA048	-37.2443	-28.4179	Radiometer redeployed
22/10/2016 11:32:00	061 RA255	062 RA048	-37.2444	-28.4179	Radiometer recovered
22/10/2016 11:36:00	61	062 Station	-37.2457	-28.4172	Vessel off DP. Commence 5 min steam with sun on port beam
22/10/2016 11:41:00	61	062 Station	-37.2547	-28.4128	End of 5 min steam
22/10/2016 11:42:00	61	062 Station	-37.2568	-28.4118	Vessel on passage
22/10/2016 12:00:00	62	063 Station	-37.3028	-28.4311	Commence Turning onto Station
22/10/2016 12:03:00	62	063 Station	-37.3111	-28.4347	Running for 5 mins with sun on beam
22/10/2016 12:08:00	62	063 Station	-37.3236	-28.4276	End of 5 mins Steaming
22/10/2016 12:18:00	62	063 Station	-37.3315	-28.4317	VSL on DP
22/10/2016 12:19:00	062 SAP255	063 SAP023	-37.3315	-28.4319	Commence Deploying SAPS
22/10/2016 12:21:00	062 RA256	063 RA049	-37.3315	-28.432	Radiometer in the Water
22/10/2016 12:32:00	062 SAP255	063 SAP023	-37.3322	-28.4334	SAPS Fully Deployed at 200, 100 and 10m
22/10/2016 12:33:00	062 RA256	063 RA049	-37.3324	-28.4335	Radiometer Recovered to Deck (Speed 0.5knts)
22/10/2016 12:33:00	062 CTD257	063 CTD059	-37.3324	-28.4335	Commence Deploying CTD
22/10/2016 12:35:00	062 OR258	063 OR052	-37.3325	-28.4337	Commence Deploying Optics Rig
22/10/2016 12:36:00	062 CTD257	063 CTD059	-37.3326	-28.4338	CTD in the Water
22/10/2016 12:36:00	062 OR258	063 OR052	-37.3326	-28.4338	Optics Rig in the Water
22/10/2016 12:38:00	062 CTD257	063 CTD059	-37.3327	-28.4339	CTD Veering to 500m
22/10/2016 12:47:00	062 CTD257	063 CTD059	-37.3329	-28.4341	CTD Stopped at 500m, Commence Hauling
22/10/2016 13:00:00	062 OR258	063 OR052	-37.3329	-28.4341	Optics Rig at the Bulwark, Redeploying
22/10/2016 13:12:00	062 OR259	063 OR053	-37.3329	-28.4341	Optics Rig Stopped at 250m, Commence Hauling
22/10/2016 13:13:00	062 CTD257	063 CTD059	-37.3329	-28.4341	CTD Recovered to Deck
22/10/2016 13:30:00	062 OR259	063 OR053	-37.3329	-28.4341	Optics Rig Recovered to Deck
22/10/2016 13:36:00	062 SAP255	063 SAP023	-37.3329	-28.4341	Commence Recovering SAPS
22/10/2016 13:44:00	062 RA260	063 RA050	-37.3327	-28.4338	Radiometer in the Water
22/10/2016 13:47:00	062 SAP255	063 SAP023	-37.3327	-28.4336	SAPS Fully Recovered to

					Deck
22/10/2016 13:53:00	062 RA260	063 RA050	-37.3326	-28.4332	Radiometer Recovered to Deck (Speed 0.2knts)
22/10/2016 13:54:00	62	063 Station	-37.3325	-28.4331	VSL off DP
22/10/2016 13:58:00	62	063 Station	-37.3303	-28.427	Running for 5 mins with sun on beam
22/10/2016 14:03:00	62	063 Station	-37.3246	-28.4109	End of 5 mins Steaming
22/10/2016 14:12:00	62	063 Station	-37.3324	-28.4156	On Passage
23/10/2016 04:12:00	63	064 Station	-39.6948	-28.6636	Vessel Slowing down
23/10/2016 04:18:00	63	064 Station	-39.7019	-28.6674	Vessel On DP
23/10/2016 04:25:00	063 VB261	064 VB028	-39.7019	-28.6674	VB Deployed
23/10/2016 04:28:00	063 CTD262	064 CTD060	-39.702	-28.6674	CTD Deployed
23/10/2016 04:31:00	063 VB261	064 VB028	-39.702	-28.6674	VB stopped at 200m, Hauling
23/10/2016 04:32:00	063 CTD262	064 CTD060	-39.702	-28.6674	CTD Veering to 500m
23/10/2016 04:41:00	063 CTD262	064 CTD060	-39.702	-28.6674	CTD Stopped at 500m
23/10/2016 04:50:00	063 VB261	064 VB028	-39.702	-28.6674	VB Recovered
23/10/2016 05:12:00	063 CTD262	064 CTD060	-39.702	-28.6674	CTD Recovered
23/10/2016 05:30:00	63	064 Station	-39.703	-28.6671	Vessel Off DP
23/10/2016 05:36:00	63	064 Station	-39.7112	-28.6705	Vessel On Passage
23/10/2016 09:55:00	64	065 Station	-40.3747	-28.7512	Commence 5 minute steam with sun on port beam
23/10/2016 10:00:00	64	065 Station	-40.3869	-28.7487	5 minute steam complete. Slowing onto station
23/10/2016 10:12:00	64	065 Station	-40.3958	-28.7478	Vessel on DP
23/10/2016 10:24:00	064 RA263	065 RA051	-40.3956	-28.7474	Radiometer deployed
23/10/2016 10:32:00	064 RA263	065 RA051	-40.3956	-28.7478	Radiometer recovered
23/10/2016 10:36:00	064 OR264	065 OR054	-40.3957	-28.7479	Optics rig deployed
23/10/2016 10:41:00	064 OR264	065 OR054	-40.3956	-28.7479	Optics rig veering to 250m
23/10/2016 10:41:00	064 RS265	065 RS032	-40.3956	-28.7479	Weather balloon launched
23/10/2016 10:44:00	064 SAP266	065 SAP024	-40.3957	-28.7479	Commence deploying SAPS
23/10/2016 10:45:00	064 CTD267	065 CTD061	-40.3957	-28.7479	Commence deploying CTD
23/10/2016 10:50:00	064 CTD267	065 CTD061	-40.3957	-28.7479	CTD deployed
23/10/2016 10:52:00	064 CTD267	065 CTD061	-40.3957	-28.7478	CTD veering to 500m
23/10/2016 10:54:00	064 SAP266	065 SAP024	-40.3957	-28.7479	SAPS deployed to 200m, 100m and 10m
23/10/2016 10:56:00	064 OR264	065 OR054	-40.3957	-28.7479	Optics rig stopped at 250m
23/10/2016 11:03:00	064 CTD267	065 CTD061	-40.3956	-28.7479	CTD at 500m
23/10/2016 11:10:00	064 OR264	065 OR054	-40.3956	-28.7479	Optics rig hauled out of water
23/10/2016 11:12:00	064 OR264	065 OR054	-40.3956	-28.7479	Optics rig redeployed
23/10/2016 11:16:00	064 OR264	065 OR054	-40.3957	-28.7479	Optics rig veering to 250m
23/10/2016 11:27:00	064 CTD267	065 CTD061	-40.3957	-28.7479	CTD recovered to deck
23/10/2016 11:31:00	064 OR264	065 OR054	-40.3956	-28.7479	Optics rig stopped at 250m
23/10/2016 11:47:00	064 OR264	065 OR054	-40.3956	-28.7479	Optics rig recovered to deck
23/10/2016 12:01:00	064 SAP266	065 SAP024	-40.3956	-28.7479	SAPS recovered to deck
23/10/2016 12:03:00	064 RA263	065 RA051	-40.3956	-28.748	Radiometer redeployed
23/10/2016 12:11:00	064 RA263	065 RA051	-40.3956	-28.7492	Radiometer recovered
23/10/2016 12:12:00	64	065 Station	-40.3956	-28.7493	Vessel off DP
23/10/2016 12:22:00	64	065 Station	-40.3956	-28.7563	Commence 5 minute steam

					with sun on beam
23/10/2016 12:27:00	64	065 Station	-40.394	-28.7647	End of 5 minute steam
23/10/2016 12:30:00	64	065 Station	-40.391	-28.7787	Vessel on passage
25/10/2016 04:06:00	65	066 Station	-44.9127	-31.08	Vessel slowing down for station
25/10/2016 04:12:00	65	066 Station	-44.9119	-31.0798	Vessel on DP
25/10/2016 04:28:00	065 VB268	066 VB029	-44.9116	-31.0798	VB deployed
25/10/2016 04:34:00	065 CTD269	066 CTD062	-44.9115	-31.0798	CTD Deployed
25/10/2016 04:38:00	065 CTD269	066 CTD062	-44.9115	-31.0798	CTD Veering to 500m
25/10/2016 04:47:00	065 CTD269	066 CTD062	-44.9115	-31.0798	CTD at 500m
25/10/2016 04:52:00	065 VB268	066 VB029	-44.9115	-31.0798	VB recovered
25/10/2016 05:16:00	065 CTD269	066 CTD062	-44.9115	-31.0798	CTD Recovered
25/10/2016 05:26:00	065 ARGO270	066 ARGO004	-44.9117	-31.0801	Commence deployment of Met Float 7584, Vessel moving ahead at 0.5kts
25/10/2016 05:29:00	065 ARGO270	066 ARGO004	-44.9119	-31.0808	Met Float 7584 Deployed
25/10/2016 05:30:00	65	066 Station	-44.9121	-31.0811	Vessel Off DP
25/10/2016 05:36:00	65	066 Station	-44.9137	-31.0847	Vessel On Passage
25/10/2016 11:00:00	66	067 Station	-45.655	-31.4819	Commence slowing onto station
25/10/2016 11:12:00	66	067 Station	-45.6652	-31.4926	Vessel on DP
25/10/2016 11:24:00	066 RA271	067 RA052	-45.6654	-31.4928	Radiometer deployed
25/10/2016 11:33:00	066 RA271	067 RA052	-45.6655	-31.4935	Radiometer recovered
25/10/2016 11:35:00	066 OR272	067 OR055	-45.6655	-31.4935	Commence deploying optics rig
25/10/2016 11:36:00	066 OR272	067 OR055	-45.6655	-31.4936	Optics rig deployed
25/10/2016 11:40:00	066 OR272	067 OR055	-45.6655	-31.4935	Optics rig veering to 50m
25/10/2016 11:43:00	066 OR272	067 OR055	-45.6655	-31.4935	Optics rig stopped at 50m
25/10/2016 11:46:00	066 OR272	067 OR055	-45.6655	-31.4935	Optics rig hauled out of water
25/10/2016 11:47:00	066 OR273	067 OR056	-45.6655	-31.4936	Optics rig redeployed
25/10/2016 11:51:00	066 OR273	067 OR056	-45.6655	-31.4936	Optics rig veering to 50m
25/10/2016 11:54:00	066 OR273	067 OR056	-45.6655	-31.4935	Optics rig stopped at 50m
25/10/2016 12:00:00	066 OR273	067 OR056	-45.6655	-31.4935	Optics rig recovered to deck
25/10/2016 12:03:00	066 RA274	067 RA053	-45.6655	-31.4938	Radiometer in the Water
25/10/2016 12:10:00	066 RA274	067 RA053	-45.6656	-31.4944	Radiometer Recovered to Deck (Speed 0.2knts)
25/10/2016 12:15:00	066 SAP275	067 SAP025	-45.6656	-31.4944	Commence Deploying SAPS
25/10/2016 12:16:00	066 OR276	067 OR057	-45.6656	-31.4945	Commence Deploying Optics Rig
25/10/2016 12:17:00	066 OR276	067 OR057	-45.6656	-31.4945	Optics Rig in the Water
25/10/2016 12:23:00	066 SAP275	067 SAP025	-45.6656	-31.4945	SAPS deployed to 200m (for Pressure Test), 100m and 10m
25/10/2016 12:24:00	066 CTD277	067 CTD063	-45.6656	-31.4945	Commence Deploying CTD
25/10/2016 12:27:00	066 CTD277	067 CTD063	-45.6656	-31.4945	CTD in the Water
25/10/2016 12:29:00	066 CTD277	067 CTD063	-45.6656	-31.4945	CTD Veering to 500m
25/10/2016 12:34:00	066 OR276	067 OR057	-45.6656	-31.4945	Optics Rig Stopped at 250m, Commence Hauling
25/10/2016 12:40:00	066 CTD277	067 CTD063	-45.6656	-31.4945	CTD Stopped at 500m, Commence Hauling

25/10/2016 12:43:00	066 RS278	067 RS033	-45.6656	-31.4945	Weather Balloon Launched
25/10/2016 12:49:00	066 OR276	067 OR057	-45.6656	-31.4945	Optics Rig at the Bulwark, Redeploying
25/10/2016 13:03:00	066 OR279	067 OR058	-45.6656	-31.4945	Optics Rig Stopped at 250m, Commence Hauling
25/10/2016 13:09:00	066 CTD277	067 CTD063	-45.6656	-31.4944	CTD Recovered to Deck
25/10/2016 13:25:00	066 OR279	067 OR058	-45.6656	-31.4945	Optics Rig Recovered to Deck
25/10/2016 13:37:00	066 SAP275	067 SAP025	-45.6656	-31.4944	Commence Recovering SAPS
25/10/2016 13:45:00	066 SAP275	067 SAP025	-45.6656	-31.4945	SAPS Fully Recovered to Deck
25/10/2016 13:46:00	066 RA280	067 RA054	-45.6656	-31.4946	Radiometer in the Water
25/10/2016 13:55:00	066 RA280	067 RA054	-45.6658	-31.4956	Radiometer Recovered to Deck (Speed 0.2knts)
25/10/2016 14:00:00	66	067 Station	-45.6659	-31.4962	VSL off DP
25/10/2016 14:06:00	66	067 Station	-45.6672	-31.4992	Running for 5 mins with sun on beam
25/10/2016 14:11:00	66	067 Station	-45.6697	-31.5091	End of 5 minute steam
25/10/2016 14:12:00	66	067 Station	-45.6705	-31.5113	On Passage
26/10/2016 04:12:00	67	068 Station	-47.4484	-32.4858	Vessel Slowing down
26/10/2016 04:18:00	67	068 Station	-47.4478	-32.4856	Vessel On DP
26/10/2016 04:24:00	067 VB281	068 VB030	-47.4477	-32.4856	VB Deployed
26/10/2016 04:26:00	067 CTD282	068 CTD064	-47.4477	-32.4856	CTD Deployed
26/10/2016 04:28:00	067 CTD282	068 CTD064	-47.4477	-32.4856	CTD Veering to 500m
26/10/2016 04:39:00	067 CTD282	068 CTD064	-47.4477	-32.4856	CTD Stopped at 500m
26/10/2016 04:48:00	067 VB281	068 VB030	-47.4477	-32.4856	VB Recovered
26/10/2016 05:07:00	067 CTD282	068 CTD064	-47.4477	-32.4856	CTD Recovered
26/10/2016 05:12:00	067 ARGO283	068 ARGO005	-47.4478	-32.4858	Commence Argo float '7585' deployment, Vessel moving ahead at 0.5kts
26/10/2016 05:14:00	067 ARGO283	068 ARGO005	-47.4479	-32.486	ARGO float 7585 deployed
26/10/2016 05:18:00	067 HB284	068 HB018	-47.4481	-32.4866	HB Deployed
26/10/2016 05:54:00	067 HB284	068 HB018	-47.452	-32.4974	HB Recovered, Average speed of tow = 1.3Kts
26/10/2016 06:06:00	67	068 Station	-47.4523	-32.498	Vessel Off DP
26/10/2016 06:12:00	67	068 Station	-47.4548	-32.5043	Vessel On Passage
26/10/2016 11:00:00	68	069 Station	-48.0686	-32.8434	Commence 5 min steam with sun on port beam
26/10/2016 11:05:00	68	069 Station	-48.0793	-32.8459	End of 5 minute steam
26/10/2016 11:06:00	68	069 Station	-48.0803	-32.8471	Slowing onto station
26/10/2016 11:12:00	68	069 Station	-48.0811	-32.8487	Vessel on DP
26/10/2016 11:22:00	068 RA285	069 RA055	-48.0812	-32.8488	Radiometer deployed
26/10/2016 11:33:00	068 RA285	069 RA055	-48.0811	-32.8497	Radiometer recovered
26/10/2016 11:36:00	068 OR286	069 OR060	-48.081	-32.8497	Commence deploying optics rig
26/10/2016 11:37:00	068 OR286	069 OR060	-48.0811	-32.8497	Optics rig deployed
26/10/2016 11:45:00	068 OR286	069 OR060	-48.0811	-32.8497	Optics rig veering to 250m
26/10/2016 12:17:00	068 SAP287	069 SAP026	-48.0817	-32.8586	Commence Deploying SAPS
26/10/2016 12:17:00	068 OR286	069 OR060	-48.0817	-32.8586	Optics Rig Recovered to Deck
26/10/2016 12:22:00	068 OR288	069 OR061	-48.0818	-32.8607	Commence Deploying Optics Rig
26/10/2016 12:23:00	068 OR288	069 OR061	-48.0818	-32.861	Optics Rig in the Water

26/10/2016 12:29:00	068 SAP287	069 SAP026	-48.0819	-32.862	SAPS deployed to 200m, 100m and 10m
26/10/2016 12:46:00	068 OR288	069 OR061	-48.0821	-32.8657	Optics Rig Stopped at 250m, Commence Hauling
26/10/2016 12:51:00	068 RS289	069 RS034	-48.0823	-32.8676	Weather Balloon Launched
26/10/2016 12:52:00	068 CTD290	069 CTD065	-48.0823	-32.868	Commence Deploying CTD
26/10/2016 12:55:00	068 CTD290	069 CTD065	-48.0825	-32.8692	CTD in the Water
26/10/2016 12:58:00	068 CTD290	069 CTD065	-48.0826	-32.8704	CTD Veering to 500m
26/10/2016 13:02:00	068 OR288	069 OR061	-48.0828	-32.8721	Optics Rig Recovered to Deck
26/10/2016 13:08:00	068 CTD290	069 CTD065	-48.083	-32.8734	CTD Stopped at 500m, Commence Hauling
26/10/2016 13:15:00	068 RA291	069 RA056	-48.0828	-32.876	Radiometer in the Water
26/10/2016 13:23:00	068 RA291	069 RA056	-48.0827	-32.879	Radiometer Recovered to Deck (Speed 0.8knts)
26/10/2016 13:30:00	068 CTD290	069 CTD065	-48.0826	-32.8816	CTD Recovered to Deck
26/10/2016 13:36:00	068 SAP287	069 SAP026	-48.0825	-32.8838	Commence Recovering SAPS
26/10/2016 13:43:00	068 SAP287	069 SAP026	-48.0823	-32.8865	SAPS Fully Recovered to Deck
26/10/2016 13:54:00	68	069 Station	-48.0822	-32.8881	VSL off DP
26/10/2016 13:58:00	68	069 Station	-48.0819	-32.8946	Running for 5 mins with sun on beam
26/10/2016 14:03:00	68	069 Station	-48.0812	-32.9087	End of 5 minute Steam
26/10/2016 14:06:00	68	069 Station	-48.0824	-32.9162	On Passage
27/10/2016 04:12:00	69	070 Station	-49.772	-33.7811	Vessel slowing down
27/10/2016 04:18:00	69	070 Station	-49.7755	-33.7838	Vessel On DP Assessing conditions
27/10/2016 04:50:00	069 CTD292	070 CTD066	-49.7765	-33.7832	CTD Deployed
27/10/2016 04:52:00	069 CTD292	070 CTD066	-49.7765	-33.7832	CTD Veering to 500m
27/10/2016 05:07:00	069 CTD292	070 CTD066	-49.7765	-33.7832	CTD Stopped at 500m
27/10/2016 05:31:00	069 CTD292	070 CTD066	-49.7765	-33.7832	CTD at surface
27/10/2016 05:35:00	069 CTD292	070 CTD066	-49.7765	-33.7832	CTD Recovered
27/10/2016 05:48:00	69	070 Station	-49.7765	-33.7833	Vessel Off DP
27/10/2016 05:54:00	69	070 Station	-49.778	-33.7842	Vessel On Passage
27/10/2016 10:18:00	70	071 Station	-50.2623	-34.0672	Commence slowing onto station
27/10/2016 10:24:00	70	071 Station	-50.2634	-34.0701	Vessel on DP
27/10/2016 10:32:00	070 RA293	071 RA057	-50.2635	-34.0704	Radiometer deployed
27/10/2016 10:41:00	070 RA293	071 RA057	-50.2635	-34.0705	Radiometer recovered
27/10/2016 10:43:00	070 RA293	071 RA057	-50.2635	-34.0705	Radiometer redeployed
27/10/2016 10:47:00	070 RA293	071 RA057	-50.2635	-34.0704	Radiometer recovered
27/10/2016 10:48:00	070 RS294	071 RS035	-50.2635	-34.0703	Weather balloon launched
27/10/2016 10:53:00	070 OR295	071 OR062	-50.2635	-34.0703	Commence deploying optics rig
27/10/2016 10:54:00	070 OR295	071 OR062	-50.2634	-34.0703	Optics rig deployed
27/10/2016 10:56:00	070 OR295	071 OR062	-50.2634	-34.0702	Optics rig veering to 30m
27/10/2016 10:58:00	070 OR295	071 OR062	-50.2634	-34.07	Optics rig stopped at 30m
27/10/2016 11:00:00	070 OR295	071 OR062	-50.2635	-34.0698	Optics rig hauled out of water
27/10/2016 11:02:00	070 OR295	071 OR062	-50.2635	-34.0695	Optics rig redeployed
27/10/2016 11:07:00	070 OR295	071 OR062	-50.2635	-34.0688	Optics rig veering to 30m
27/10/2016 11:10:00	070 OR295	071 OR062	-50.2635	-34.0684	Optics rig stopped at 30m

27/10/2016 11:14:00	070 OR295	071 OR062	-50.2637	-34.068	Optics rig recovered to deck
27/10/2016 11:23:00	070 ARGO296	071 ARGO006	-50.2638	-34.0681	ARGO float 7586 deployed
27/10/2016 11:30:00	70	071 Station	-50.2639	-34.0684	Vessel off DP
27/10/2016 11:38:00	70	071 Station	-50.2651	-34.0733	Commence 5 minute steam with sun on beam
27/10/2016 11:43:00	70	071 Station	-50.2629	-34.0852	End of 5 minute steam
27/10/2016 11:48:00	70	071 Station	-50.2687	-34.0898	Vessel on passage
27/10/2016 12:00:00	71	072 Station	-50.2914	-34.0953	Commence Turning onto Station
27/10/2016 12:03:00	71	072 Station	-50.2947	-34.0982	Running for 5 mins Heading 265
27/10/2016 12:08:00	71	072 Station	-50.2954	-34.1103	End of 5 minute Steam
27/10/2016 12:18:00	71	072 Station	-50.2966	-34.1177	VSL on DP
27/10/2016 12:27:00	071 RA297	072 RA058	-50.2966	-34.1178	Radiometer in the Water
27/10/2016 12:28:00	071 SAP298	072 SAP027	-50.2967	-34.1178	Commence Deploying SAPS
27/10/2016 12:32:00	071 RA297	072 RA058	-50.2967	-34.118	Radiometer Recovered to Deck
27/10/2016 12:40:00	071 OR299	072 OR063	-50.2962	-34.1166	Commence Deploying Optics Rig
27/10/2016 12:41:00	071 SAP298	072 SAP027	-50.296	-34.1162	SAPS deployed to 200m, 100m and 10m
27/10/2016 12:42:00	071 OR299	072 OR063	-50.2959	-34.1159	Optics Rig in the Water
27/10/2016 13:01:00	071 OR299	072 OR063	-50.2935	-34.108	Optics Rig Stopped at 250m, Commence Hauling
27/10/2016 13:16:00	071 OR299	072 OR063	-50.2917	-34.1007	Optics Rig at the Bulwark, Redeploying
27/10/2016 13:35:00	071 SAP298	072 SAP027	-50.2893	-34.0917	Commence Recovering SAPS
27/10/2016 13:37:00	071 OR300	072 OR064	-50.2891	-34.0907	Optics Rig Stopped at 250m, Commence Hauling
27/10/2016 13:43:00	071 SAP298	072 SAP027	-50.2884	-34.0878	SAPS Fully Recovered to Deck
27/10/2016 13:49:00	071 CTD301	072 CTD067	-50.2876	-34.0851	Commence Deploying CTD
27/10/2016 13:52:00	071 OR300	072 OR064	-50.2873	-34.0841	Optics Rig Recovered to Deck
27/10/2016 13:54:00	071 CTD301	072 CTD067	-50.2871	-34.0835	CTD in the Water
27/10/2016 13:55:00	071 CTD301	072 CTD067	-50.287	-34.0832	CTD Veering to 500m
27/10/2016 14:09:00	071 CTD301	072 CTD067	-50.2855	-34.078	CTD Stopped at 500m, Commence Hauling
27/10/2016 14:36:00	071 CTD301	072 CTD067	-50.2823	-34.0673	CTD Recovered to Deck
27/10/2016 14:42:00	71	072 Station	-50.2822	-34.0669	VSL off DP
27/10/2016 14:48:00	71	072 Station	-50.2823	-34.0681	Running for 5 mins with sun on beam
27/10/2016 14:53:00	71	072 Station	-50.2841	-34.077	End of 5 minute Steam
27/10/2016 14:54:00	71	072 Station	-50.2845	-34.0792	On Passage
28/10/2016 04:12:00	72	073 Station	-51.8544	-35.0117	Vessel Slowing down
28/10/2016 04:18:00	72	073 Station	-51.8563	-35.0152	Vessel On DP
28/10/2016 04:28:00	072 CTD302	073 CTD068	-51.8562	-35.0153	CTD Deployed
28/10/2016 04:32:00	072 CTD302	073 CTD068	-51.8562	-35.0153	CTD Veering to 500m
28/10/2016 04:33:00	072 VB303	073 VB031	-51.8562	-35.0153	VB Deployed
28/10/2016 04:38:00	072 VB303	073 VB031	-51.8562	-35.0153	VB stopped at 200m, Hauling
28/10/2016 04:44:00	072 CTD302	073 CTD068	-51.8556	-35.0143	CTD Stopped at 500m
28/10/2016 04:50:00	072 CTD302	073 CTD068	-51.8547	-35.013	CTD experiencing technical issue, commenced recovery

28/10/2016 04:58:00	072 VB303	073 VB031	-51.8538	-35.0114	VB Recovered
28/10/2016 04:59:00	072 CTD302	073 CTD068	-51.8537	-35.0112	CTD Recovered
28/10/2016 05:15:00	072 HB304	073 HB019	-51.8541	-35.0119	HB Deployed
28/10/2016 05:54:00	072 HB304	073 HB019	-51.8579	-35.0181	HB recovered, Average speed of tow = 1.3 Kts
28/10/2016 07:30:00	72	073 Station	-51.858	-35.0181	Vessel Off DP
28/10/2016 07:36:00	72	073 Station	-51.8597	-35.0187	Vessel on passage
28/10/2016 11:30:00	73	074 Station	-52.4367	-35.3676	Commence slowing onto station
28/10/2016 11:36:00	73	074 Station	-52.4437	-35.3762	Vessel on DP
28/10/2016 11:51:00	073 RA305	074 RA059	-52.4438	-35.3763	Radiometer deployed
28/10/2016 11:59:00	073 RA305	074 RA059	-52.444	-35.3768	Radiometer recovered
28/10/2016 12:00:00	073 LOAD TEST	074 LOAD067	-52.444	-35.3769	Commence Load Testing CTD Wire
28/10/2016 12:03:00	073 OR306	074 OR065	-52.444	-35.377	Commence Deploying Optics Rig
28/10/2016 12:05:00	073 OR306	074 OR065	-52.444	-35.377	Optics Rig in the Water
28/10/2016 12:13:00	073 LOAD TEST	074 LOAD067	-52.4441	-35.3769	Load Test Completed
28/10/2016 12:16:00	073 SAP307	074 SAP028	-52.4443	-35.3766	Commence Deploying SAPS
28/10/2016 12:26:00	073 SAP307	074 SAP028	-52.4449	-35.3757	SAPS Deployed to 200m, 100m and 10m
28/10/2016 12:29:00	073 OR306	074 OR065	-52.4451	-35.3755	Optics Rig at the Bulwark, Redeploying
28/10/2016 12:42:00	073 OR308	074 OR066	-52.446	-35.3746	Optics Rig Stopped at 250m, Commence Hauling
28/10/2016 12:44:00	073 CTD309	074 CTD069	-52.4461	-35.3744	Commence Deploying CTD
28/10/2016 12:44:00	073 RS310	074 RS036	-52.4461	-35.3744	Weather Balloon Launched
28/10/2016 12:46:00	073 CTD309	074 CTD069	-52.4463	-35.3743	CTD in the Water
28/10/2016 12:48:00	073 CTD309	074 CTD069	-52.4464	-35.3742	CTD Veering to 500m
28/10/2016 12:59:00	073 OR308	074 OR066	-52.4473	-35.3735	Optics Rig Recovered to Deck
28/10/2016 13:00:00	073 CTD309	074 CTD069	-52.4473	-35.3734	CTD Stopped at 500m, Commence Hauling
28/10/2016 13:07:00	073 RA311	074 RA060	-52.4475	-35.3737	Radiometer in the Water
28/10/2016 13:16:00	073 RA311	074 RA060	-52.4479	-35.3747	Radiometer Recovered to Deck
28/10/2016 13:24:00	073 CTD309	074 CTD069	-52.448	-35.3749	CTD Recovered to Deck
28/10/2016 13:36:00	073 SAP307	074 SAP028	-52.448	-35.375	Commence Recovering SAPS
28/10/2016 13:46:00	073 SAP307	074 SAP028	-52.448	-35.3749	SAPS Fully Recovered to Deck
28/10/2016 14:00:00	73	074 Station	-52.4481	-35.3754	VSL off DP
28/10/2016 14:02:00	73	074 Station	-52.4493	-35.3779	Running for 5 mins with sun on beam
28/10/2016 14:07:00	73	074 Station	-52.4545	-35.3891	End of 5 minute Steam
28/10/2016 14:12:00	73	074 Station	-52.4634	-35.395	On Passage
29/10/2016 04:00:00	74	075 Station	-53.9372	-36.3026	VSL on DP
29/10/2016 04:22:00	074 CTD312	075 CTD070	-53.9372	-36.3026	Commence Deploying CTD
29/10/2016 04:23:00	074 CTD312	075 CTD070	-53.9372	-36.3026	CTD in the Water
29/10/2016 04:25:00	074 VB313	075 VB032	-53.9372	-36.3026	Commence Deploying Vertical Bongo's
29/10/2016 04:27:00	074 CTD312	075 CTD070	-53.9372	-36.3026	CTD Veering to Approx 200m, EA600 Depth 242m
29/10/2016 04:32:00	074 CTD312	075 CTD070	-53.9372	-36.3026	CTD Stopped at 225m, Commence Hauling

29/10/2016 04:32:00	074 VB313	075 VB032	-53.9372	-36.3026	Vertical Bongos at 200m, Commence Hauling
29/10/2016 04:52:00	074 VB313	075 VB032	-53.9372	-36.3026	VB recovered
29/10/2016 04:54:00	074 CTD312	075 CTD070	-53.9372	-36.3026	CTD Recovered
29/10/2016 05:08:00	074 HB314	075 HB020	-53.9372	-36.3026	HB Deployed
29/10/2016 05:44:00	074 HB314	075 HB020	-53.9307	-36.3202	HB Recovered, Average speed of tow = 1.4Kts
29/10/2016 06:00:00	74	075 Station	-53.9308	-36.3202	Vessel Off DP
29/10/2016 06:06:00	74	075 Station	-53.9319	-36.323	Vessel on Passage
30/10/2016 13:06:00	75	076 Station	-53.9991	-36.8348	Commence Slowing Down
30/10/2016 13:12:00	75	076 Station	-53.9964	-36.8398	VSL on DP
30/10/2016 13:16:00	075 SAP315	076 SAP029	-53.9963	-36.841	Commence Deploying SAPS
30/10/2016 13:27:00	075 RA316	076 RA061	-53.9963	-36.841	Radiometer in the Water
30/10/2016 13:27:00	075 SAP315	076 SAP029	-53.9963	-36.841	SAPS Deployed to 200m, 100m and 10m
30/10/2016 13:35:00	075 RA316	076 RA061	-53.9959	-36.8419	Radiometer Recovered to Deck (Speed 0.4knts)
30/10/2016 13:39:00	075 CTD317	076 CTD071	-53.9957	-36.8423	Commence Deploying CTD
30/10/2016 13:41:00	075 CTD317	076 CTD071	-53.9957	-36.8423	CTD in the Water
30/10/2016 13:42:00	075 CTD317	076 CTD071	-53.9957	-36.8423	CTD Veering to 200m, EA600 Depth 234m
30/10/2016 13:42:00	075 OR318	076 OR067	-53.9957	-36.8423	Commence Deploying Optics Rig
30/10/2016 13:44:00	075 OR318	076 OR067	-53.9957	-36.8423	Optics Rig in the Water
30/10/2016 13:46:00	075 CTD317	076 CTD071	-53.9957	-36.8423	CTD Stopped at 200m, Commence Hauling
30/10/2016 13:47:00	075 OR318	076 OR067	-53.9957	-36.8423	Optics Rig Recovered to Deck
30/10/2016 13:47:00	075 RS319	076 RS037	-53.9957	-36.8423	Weather Balloon Launched
30/10/2016 13:49:00	075 OR320	076 OR068	-53.9957	-36.8423	Optics Rig in the Water
30/10/2016 13:58:00	075 OR320	076 OR068	-53.9957	-36.8423	Optics Rig Stopped at 200m, Commence Hauling
30/10/2016 14:09:00	075 CTD317	076 CTD071	-53.9957	-36.8423	CTD Recovered to Deck
30/10/2016 14:11:00	075 OR320	076 OR068	-53.9957	-36.8423	Optics Rig at the Bulwark, Redeploying
30/10/2016 14:22:00	075 OR321	076 OR069	-53.9957	-36.8423	Optics Rig Stopped at 200m, Commence Hauling
30/10/2016 14:36:00	075 OR321	076 OR069	-53.9957	-36.8423	Optics Rig Recovered to Deck
30/10/2016 14:36:00	075 SAP315	076 SAP029	-53.9957	-36.8423	Commence Recovering SAPS
30/10/2016 14:40:00	075 RA322	076 RA062	-53.9955	-36.8426	Radiometer in the Water
30/10/2016 14:47:00	075 RA322	076 RA062	-53.9949	-36.8439	Radiometer Recovered to Deck (Speed 0.4knts)
30/10/2016 14:47:00	075 SAP315	076 SAP029	-53.9949	-36.8439	SAPS Fully Recovered to Deck
30/10/2016 14:55:00	075 HB323	076 HB021	-53.9946	-36.8444	Commence Deploying Horizontal Bongo Nets
30/10/2016 15:02:00	075 HB323	076 HB021	-53.9944	-36.8449	Horizontal Bongo Nets in the Water
30/10/2016 15:34:00	075 HB323	076 HB021	-53.985	-36.864	Commence Recovering Horizontal Bongo Nets (Speed 1.7knts)
30/10/2016 15:39:00	075 HB323	076 HB021	-53.9837	-36.8666	Horizontal Bongo Net Recovered to Deck
30/10/2016 15:42:00	75	076 Station	-53.9833	-36.8676	VSL off DP
30/10/2016 15:48:00	75	076 Station	-53.9833	-36.8767	On Passage
31/10/2016 05:12:00	76	077 Station	-53.5902	-39.9675	Vessel slowing down

31/10/2016 05:18:00	76	077 Station	-53.5903	-39.9756	Vessel on DP
31/10/2016 05:27:00	076 VB324	077 VB033	-53.5903	-39.9757	VB Deployed
31/10/2016 05:30:00	076 CTD325	077 CTD072	-53.5903	-39.9757	CTD Deployed
31/10/2016 05:32:00	076 VB324	077 VB033	-53.5903	-39.9757	VB stopped at 200m, hauling
31/10/2016 05:34:00	076 CTD325	077 CTD072	-53.5903	-39.9757	CTD Veering to 500m
31/10/2016 05:45:00	076 CTD325	077 CTD072	-53.5903	-39.9757	CTD Stopped at 500m
31/10/2016 05:51:00	076 VB324	077 VB033	-53.5903	-39.9757	VB Recovered
31/10/2016 06:18:00	076 CTD325	077 CTD072	-53.5903	-39.9757	CTD Recovered
31/10/2016 06:28:00	076 HB326	077 HB022	-53.5904	-39.9761	HB Deployed
31/10/2016 07:04:00	076 HB326	077 HB022	-53.5955	-39.9956	HB Recovered, average speed of tow 1.4Kts
31/10/2016 07:18:00	76	077 Station	-53.5955	-39.9956	Vessel Off DP
31/10/2016 07:24:00	76	077 Station	-53.5955	-39.9956	Vessel On passage
31/10/2016 13:12:00	77	078 Station	-53.3957	-41.5288	Commence Slowing Down
31/10/2016 13:18:00	77	078 Station	-53.3921	-41.539	VSL on DP
31/10/2016 13:21:00	077 RA327	078 RA063	-53.3919	-41.5395	Radiometer in the Water
31/10/2016 13:29:00	077 RA327	078 RA063	-53.3908	-41.5415	Radiometer Recovered to Deck (Speed 0.8knts)
31/10/2016 13:29:00	077 SAP328	078 SAP030	-53.3908	-41.5415	Commence Deploying SAPS
31/10/2016 13:32:00	077 OR329	078 OR070	-53.3905	-41.5421	Commence Deploying Optics Rig
31/10/2016 13:33:00	077 OR329	078 OR070	-53.3905	-41.5421	Optics Rig in the Water
31/10/2016 13:39:00	077 SAP328	078 SAP030	-53.3905	-41.5421	SAPS Deployed to 200m, 100m and 10m
31/10/2016 13:39:00	077 CTD330	078 CTD073	-53.3905	-41.5421	Commence Deploying CTD
31/10/2016 13:42:00	077 CTD330	078 CTD073	-53.3905	-41.5421	CTD in the Water
31/10/2016 13:44:00	077 CTD330	078 CTD073	-53.3905	-41.5421	CTD Veering to 500m
31/10/2016 13:46:00	077 OR329	078 OR070	-53.3905	-41.5421	Optics Rig Stopped at 250m, Commence Hauling
31/10/2016 13:53:00	077 CTD330	078 CTD073	-53.3905	-41.5421	CTD Stopped at 500m, Commence Hauling
31/10/2016 13:54:00	077 RS331	078 RS038	-53.3905	-41.5421	Weather Balloon Launched
31/10/2016 14:01:00	077 OR329	078 OR070	-53.3905	-41.5421	Optics Rig at the Bulwark, Redeploying
31/10/2016 14:15:00	077 CTD330	078 CTD073	-53.3905	-41.5421	CTD Recovered to Deck
31/10/2016 14:15:00	077 OR332	078 OR071	-53.3905	-41.5421	Optics Rig Stopped at 250m, Commence Hauling
31/10/2016 14:31:00	077 OR332	078 OR071	-53.3905	-41.5421	Optics Rig Recovered to Deck
31/10/2016 14:35:00	077 SAP328	078 SAP030	-53.3905	-41.5421	Commence Recovering SAPS
31/10/2016 14:43:00	077 SAP328	078 SAP030	-53.3904	-41.5422	SAPS Fully Recovered to Deck
31/10/2016 14:44:00	077 RA333	078 RA063	-53.3903	-41.5425	Radiometer in the Water
31/10/2016 14:53:00	077 RA333	078 RA063	-53.3889	-41.545	Radiometer Recovered to Deck (Speed 0.8knts)
31/10/2016 15:00:00	77	078 Station	-53.3874	-41.5493	VSL off DP
31/10/2016 15:06:00	77	078 Station	-53.3853	-41.5645	On Passage
01/11/2016 05:12:00	78	079 Station	-53.0145	-45.0839	Vessel slowing down
01/11/2016 05:18:00	78	079 Station	-53.0121	-45.0884	Vessel On DP
01/11/2016 05:22:00	078 VB334	079 VB034	-53.0123	-45.0882	VB Deployed
01/11/2016 05:24:00	078 CTD335	079 CTD074	-53.0123	-45.0883	CTD Deployed
01/11/2016 05:40:00	078 CTD335	079 CTD074	-53.0123	-45.0883	CTD stopped at 500m

01/11/2016 05:46:00	078 VB334	079 VB034	-53.0123	-45.0883	VB recovered
01/11/2016 06:10:00	078 CTD335	079 CTD074	-53.0123	-45.0883	CTD recovered
01/11/2016 06:20:00	078 HB336	079 HB023	-53.0118	-45.0883	HB Deployed
01/11/2016 06:54:00	078 HB336	079 HB023	-52.9992	-45.0884	HB recovered, Average speed of tow 1.4Kts
01/11/2016 07:06:00	78	079 Station	-52.999	-45.0897	Vessel Off DP
01/11/2016 07:12:00	78	079 Station	-52.9993	-45.0884	Vessel on passage



RRS James Clark Ross alongside at King Edward Point, South Georgia 29 October 2016 (photo: A. Rees)