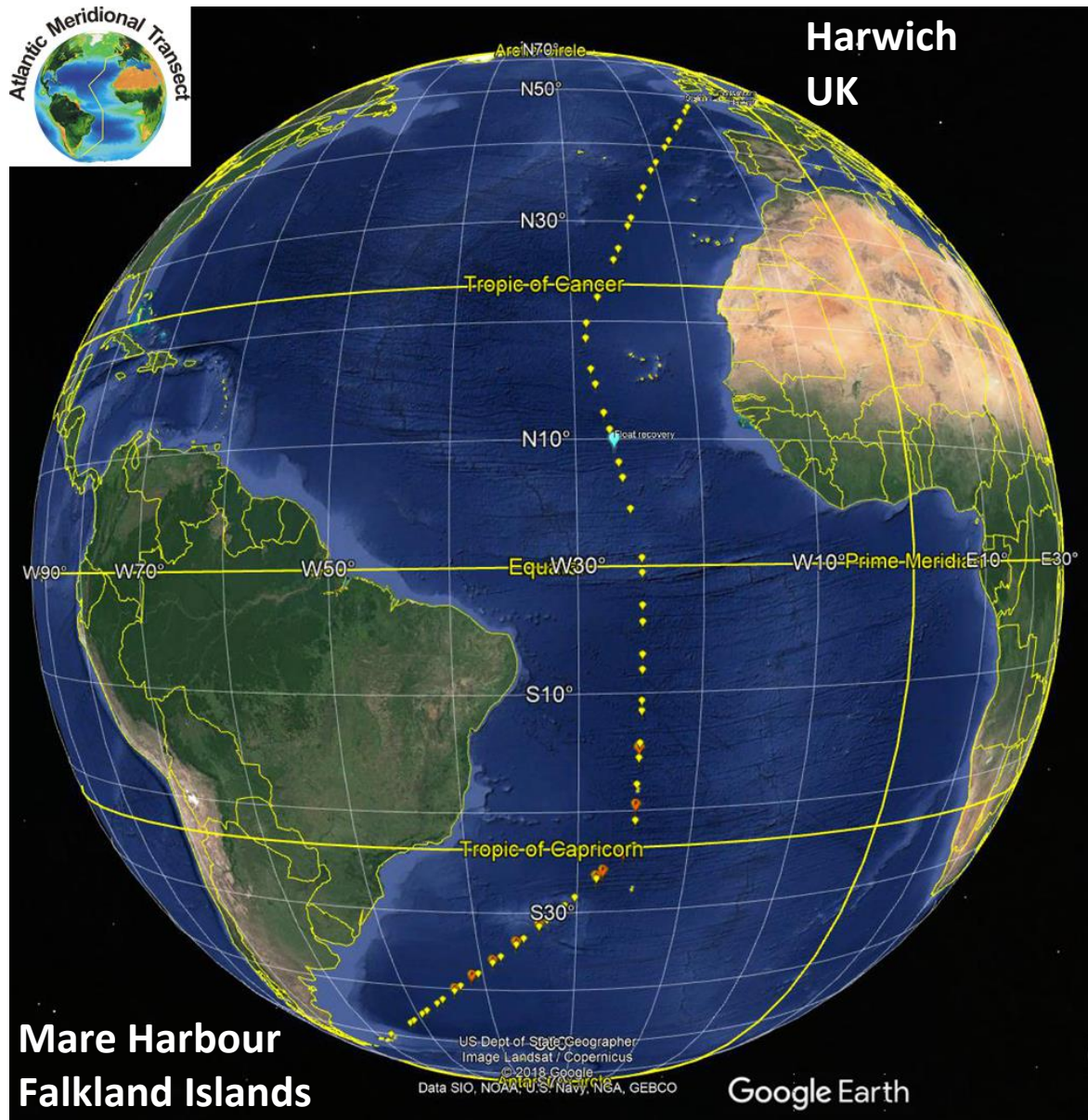


AMT 28 CRUISE REPORT



RRS James Clark Ross (JR18-001)

23 September – 29 October 2018

Chief Scientist – Glen Tarran
Plymouth Marine Laboratory



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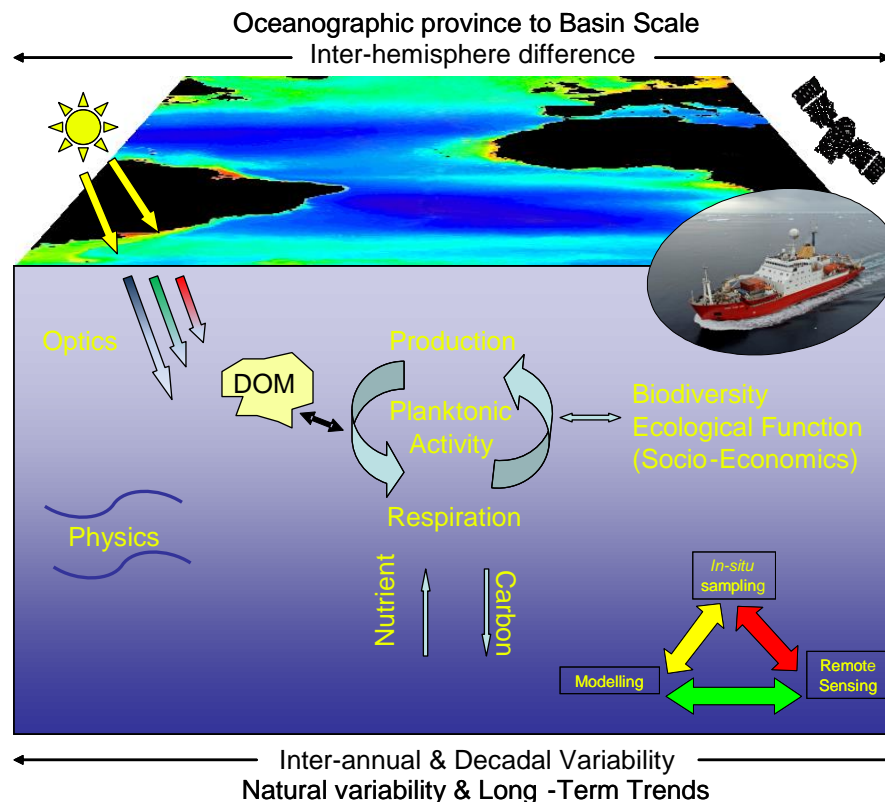
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The Atlantic Meridional Transect programme

The overall aim of the Atlantic Meridional Transect programme is funded as part of the Natural Environmental Research Council's National Capability. It's internationally important remit is to quantify key biogeochemical and ecosystem processes and their inherent variability over extended time and spatial scales in the Atlantic Ocean. This is achieved by executing an annually repeated meridional transect through contrasting oceanic provinces, ranging from oligotrophic deep blue waters, to highly productive shelf seas.

The specific objectives of the AMT are:

- To quantify the nature and causes of ecological and biogeochemical variability in planktonic ecosystems.
- To quantify the effects of this variability on nutrient cycling, on biogenic export and on air-sea exchange of climate active gases.
- To construct multi-decadal, multidisciplinary ocean time-series which are integrated within a wider "Pole-to-pole" observatory concept.
- To provide essential sea-truth validation for current and next generation satellite missions
- To provide a valuable, highly sought after and unique training arena for the next generation of UK and International oceanographers.
- To provide essential data for global ecosystem model development and validation; which in turn provides the world with its climate change forecast capability.



Data sets are publicly available, with CTD profiles and underway surface time series available online at: www.bodc.ac.uk/projects/uk/amt/. The remaining AMT data sets are available on request to BODC or they will advise who to contact for recent data sets.

Cruise Overview

The AMT 28 research cruise (JR18-001) set sail from Harwich on 23rd September, 2018 aboard the Royal Research Ship James Clark Ross, and arrived in Mare Harbour, Falkland Islands on 29th October 2018.



RRS James Clark Ross alongside at Mare Harbour, Falkland Islands

The highlights of AMT28 were as follows:

- Launch of 13 Argo and Biogeochemical-Argo floats, on behalf of the SOCCOM programme, USA, University of Washington, USA and UK Met Office, in the sparsely sampled South Atlantic;
- Recovery of a Bio-Argo float in the tropical Atlantic, following a 4 year deployment.



Bio-Argo float recovered on 7th October

- Recovery of a deep (5000 m) sediment trap mooring in the South Atlantic Oligotrophic Gyre for the National Oceanography Centre, UK, which had previously been deployed in October 2017, and the construction and deployment of a new sediment trap mooring at the same location.

- 63 CTD profiles at stations spaced approximately 200 nM apart, measuring key physical and biogeochemical parameters including: temperature, salinity, chlorophyll, oxygen, nutrients, pH, alkalinity, plankton abundance, respiration, genetics and microbial dynamics.
- 1000s of underway temperature, bio-optical and biogeochemical measurements covering an almost 100° range in latitude and vastly contrasting ocean biomes.
- Continuous acoustic sensor operation to probe positions of marine organisms in the water column.
- 29 vertical net hauls to determine the abundance of different species of zooplankton and larger phytoplankton.
- 28 weather balloon launches.
- 30 optics rig deployments to measure optical properties of the upper 300 m of the water column.
- 63 surface ocean temperature sensor deployments.
- Participation of 19 research scientists from 8 institutes (UK, USA, The Netherlands, France, Spain, Portugal, South Africa).
- Encounters with and circumnavigation of icebergs between 45.5 and 48 °S.



Various aspects of an iceberg circumnavigated on 27th October at 48° S




All the scientists would like to acknowledge the exceptional work of the Officers and crew of the JCR and the NMFSS and AME technical support teams, for making this a successful and highly enjoyable research cruise. I would like to thank Andy Rees and Christina Pardos-Bradley of PML for all of their cruise planning and logistics support.








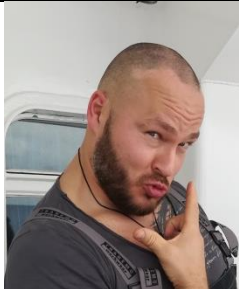



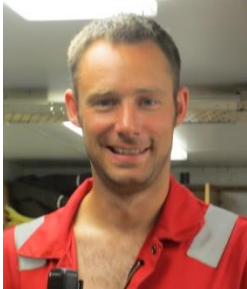









Glen Tarran

Dr Glen. A Tarran, Chief scientist AMT28 (JR18-001).
Plymouth Marine Laboratory. April 2019











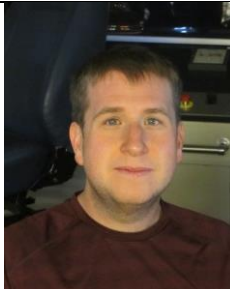




AMT28 Cruise Participants – Scientists

| | | | |
|---|---|--|---|
|  |  |  |  |
| Afonso Ferreira | Alyse Larkin-Swartout | Andrea Tracana | Arwen Bargery |
|  |  |  |  |
| Bob Brewin | Carol Robinson | Cecilia Liszka | Chata Seguro |
|  |  |  |  |
| Fred Wimmer | Giorgio Dall'Olmo | Glen Tarran | Hans Slagter |
|  |  |  |  |
| Ian Murdoch | Igor Fernández | Jenna Lee | John Ballard |
|  |  |  |  |
| Millie Goddard-Dwyer | Natalia Llopis Monferrer | Rebecca May | Wade De Kock |

AMT28 Cruise participants – Ship's personnel

| | | | |
|---|---|--|---|
|  |  |  |  |
| Captain Graham Chapman | 1st officer Georgina Delph | 2 nd officer Dominik Muller-Tolk | 3 rd officer Sam Vargas |
|  |  |  |  |
| 3 rd officer Scott Cramman | Chief engineer Andris Kubulins | 2 nd engineer Chris Donaldson | 3 rd engineer Alek Hardy |
|  |  |  |  |
| 4 th engineer Steve Eady | Deck engineer Rob Sutton | ETO comms Patrick O'Hara | ETO Doug Stevens |
|  |  |  |  |
| Purser Lloyd Sutton | Chief cook Brian Robertson | 2 nd cook Dave Tucker | Snr steward Derek Lee |
|  |  |  | |
| Steward Tom Patterson | Steward Olly Burch | Steward Mick Anderson | |

AMT28 Cruise participants – Ship's personnel

| | | | |
|---|---|--|--|
|  |  |  |  |
| Science bosun Cliff Mullaney | Deck Bosun Chris Littlehales | Bosun's mate John O'Duff | Motorman Carlos Vargas Leon |
|  |  |  |  |
| Motorman Steve Pictor | Seaman Craig Lennon | Seaman Martins Neilands | Seaman Alan Howard |
|  |  |  |  |
| Seaman Chris Devitt | Seaman Paula Munoz Garcia | AME technician Sean Quirk | IT technician Sean Vincent |
|  |  |  | |
| IT technician David Hunter | Lab manager Aisling Smith | Doctor Amber Chadwick | |

Science reports

Sea Surface Temperature – AMT4OceanSatFlux

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's underway system for comparison and to complement the SSTskin data set.

Automated collection of SSTskin and meteorological data:

SSTskin data were collected by ISAR (Infrared Sea surface temperature Autonomous Radiometer, 003) mounted on the port side of the forward mast at a 45 degree angle relative to the ship's centre line. The instruments sea-viewing angle was checked on 24/09/2018 and determined with 35 degrees from nadir (145 degrees in instrument coordinates). The ISAR configuration was set to include three sky angles (25, 35, 45 degrees). The data were logged with a data logger based in the Mail Room connected to the ship's network, allowing for frequent data quality checks. The data logger suffered an SD card failure on reboot on 21/10/2018, which was fixed by replacing the card with a spare card. ISAR 003 suffered intermittent reboot errors, hanging on scan/shutter motor movement, from the 26/10 onwards which were fixed by power cycling the instrument on 26/10 at 13:47 and on 27/10 at 04:30.

A second ISAR (012) was installed on the Monkey island, port side for comparison of SSTskin and uncertainty values with the mast ISAR and to check on the ship's wake influence on the SSTskin measurements. This ISAR was configured with two sea-viewing angles, 35 and 25 from straight downward-looking (145 and 155 instrument coordinates) and 4 sky angles (15, 25, 35, 45). After checking the ship's wake pattern in higher seas on 13/10/2018 an extra sea view at 45 (135 in instrument coordinates) and a 55 degrees sky angle were added. ISAR 012 suffered a 12V supply failure on 25/09/2018 after trying to free a stuck shutter. The instrument was removed and after repair with a spare 12V supply module, was recalibrated and reinstalled on 26/10/2018. To avoid any further issues the shutter was disabled and left open for the rest of the cruise. The rain gauge also failed at the same time as the 12V supply. A spare rain gauge was installed when the instrument was reinstalled. The GPS stopped working after the 12V regulator failure, but no spares were available and the ship's GPS data is used for geolocation information on ISAR 012. The spare rain gauge gave false positive readings and, as no more rain gauges were available, the rain limit was raised to 2.5V and the rain gauge was packed with silica bags. This seemed to work reasonably well to the end of the cruise. The multiple sky and sea view angles were set up to help with the mis-pointing characterization as described by Donlon and Nightingale, 2000 and the changes have no impact on the use of the ISAR data for SLSTR validation.

The ancillary sensors, a Kipp and Zonen CM11, an 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' axes were vertical even when the ship moved. The data were logged with the same logger as the ISAR data. The PIR data was 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 with the ISAR 012 data logger which was located in a computer room just behind the bridge.

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.

Together with the ISAR instruments, time lapse images were recorded at the mast and monkey island of the sea and sky every 10 seconds to aid data interpretation.

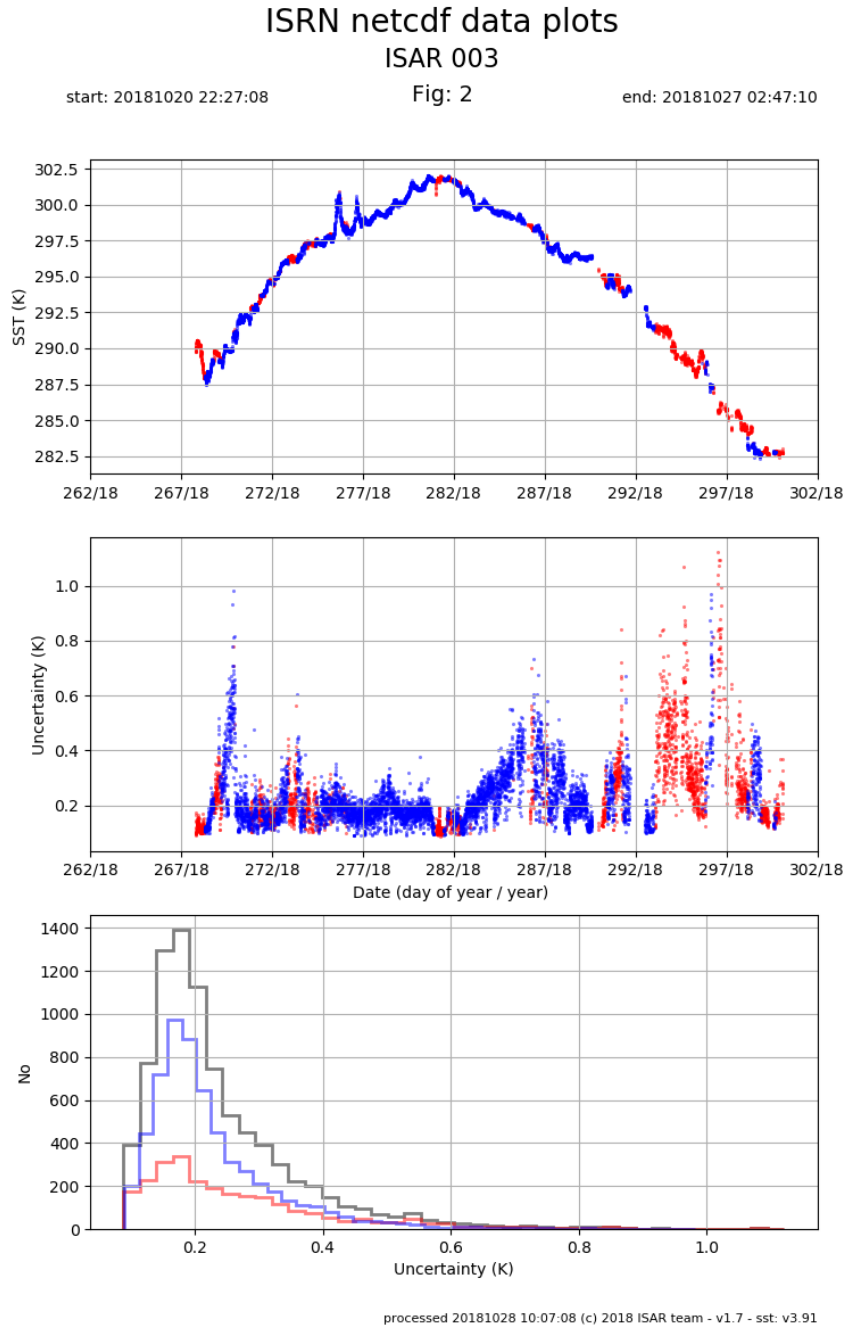


Figure 1: ISAR 003 SST data with corresponding total uncertainty.

Sky Brightness temperature measurements

In order to characterize the mis-pointing uncertainty of the ISAR instrument (Donlon and Nightingale, 2000; Wimmer and Robinson, 2016) and characterize the whole sky, a Heitronics KT 15 was mounted on a three axis motor-driven mount, which also recorded temperature, roll and pitch and GPS date/time and location. A sky BT characterization took approximately 30 min. Together with the KT 15, an all-sky camera was mounted, filming during the KT15 data acquisition in a 1 s time lapse mode. Also, a number of infrared images of the sea and sky were taken with a FLIR E4/8 during each of the KT 15 data acquisitions. A total of 9 Sky brightness temperature characterizations were acquired, mainly at the noon CTD station, with one at the morning CTD station and two at the extended second 1000 m CTD station. Both the KT15 mount and the all-sky camera were mounted on the Monkey island on the port side above the ISAR 012 on top of the two scaffolding poles. The Heitronics KT15 was calibrated with a CASOTS II black body before and after each measurement, with a two point calibration at roughly 290 K and 303 K in the Wet laboratory.



Figure 2: Sky camera and Heitronics KT15 mounted on the monkey island .

Table 1: Sky Brightness Temperature measurements date, time and location.

| No | Date | Time | Lat (+ N) | Lon (E) |
|----|------------|-------|-----------|-----------|
| 1 | 29/09/2018 | 12:40 | 38.63084 | -18.52568 |
| 2 | 30/09/2018 | 13:54 | 35.302 | -20.91522 |
| 3 | 02/10/2018 | 11:50 | 28.60906 | -24.36087 |
| 4 | 04/10/2018 | 13:56 | 21.44719 | -27.74536 |
| 5 | 10/10/2018 | 13:55 | -1.15042 | -24.98211 |
| 6 | 13/10/2018 | 11:45 | -12.08282 | -24.93029 |
| 7 | 14/10/2018 | 13:59 | -16.03239 | -25.02353 |
| 8 | 19/10/2018 | 13:54 | -30.00593 | -31.14971 |
| 9 | 27/10/2018 | 15:42 | -48.19867 | -52.69284 |

References:

Donlon, C. J. and Nightingale, T. J. (2000); Effect of Atmospheric Radiance Errors in Radiometric Sea-Surface Skin Temperature Measurements; *Appl. Opt.*; 39: pp. 2387–2392.

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](https://doi.org/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](https://doi.org/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](https://doi.org/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](https://doi.org/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.

Weather Balloon – AMT4OceanSatFlux

Werenfrid Wimmer and Aisling Smith

University of Southampton and British Antarctic Survey

Objectives

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

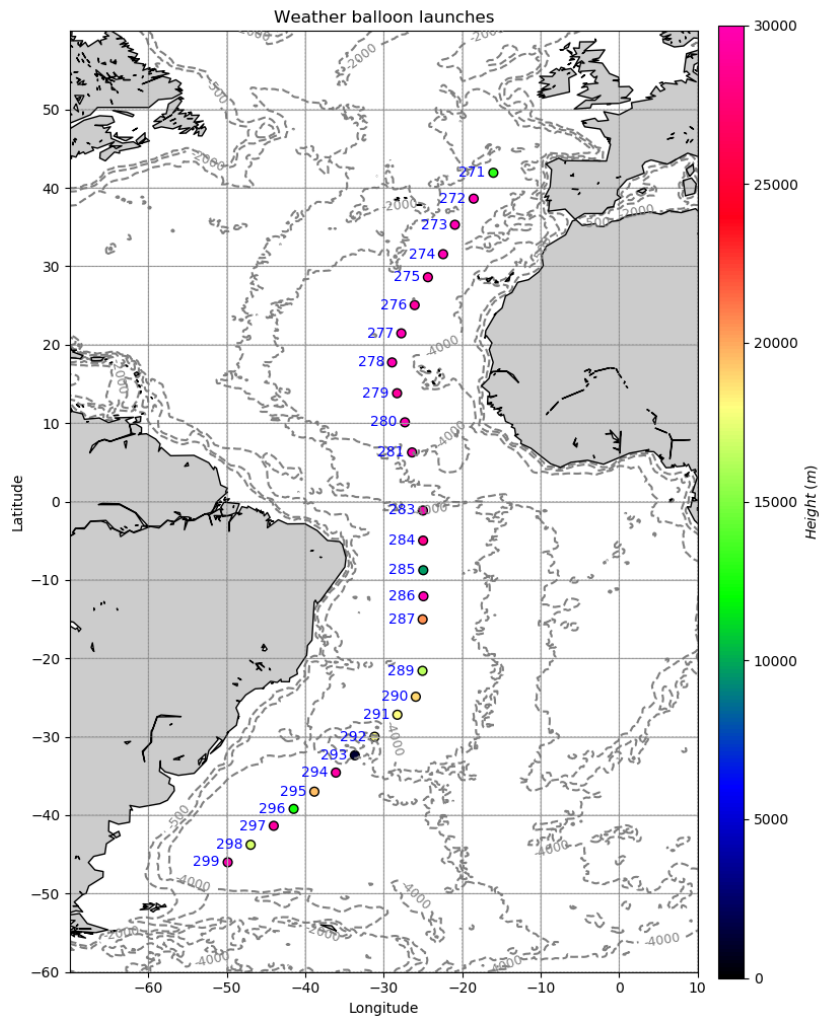
Method

Weather balloons, measuring air pressure, humidity, temperature, wind speed and direction were launched daily to collect information of the lower atmosphere composition. A total of 28 balloons were launched between 28/09/2018 and 26/10/2018. The radiosondes used were Vaisala RS92, which were reconditioned before launch with the Vaisala GC25. A Vaisala Digicora II MW15 together with a

dedicated BAS laptop were used as the data receiving and storing devices. The data receiving and GPS antenna were mounted on the Met platform, the Vaisala GC 25, MW15 and the laptop were located in the UIC. The balloons were inflated with helium, with the helium bottle rack being located behind the bridge, along with a BAS-provided balloon filling cage. The balloons were launched from the rear end of the Bridge deck. Data were emailed post-flight to the UK Met Office with send_temp_MW15.vi .

Table 2: List of radio sonde launch dates and locations.

| No. | Date | Time (UTC) | Lat (+N) | Lon (E) |
|-----|----------|------------|----------|---------|
| 1 | 27/09/18 | 12:26:00 | 45.010 | -13.580 |
| 2 | 28/09/18 | 12:09:00 | 41.930 | -16.020 |
| 3 | 29/09/18 | 12:18:00 | 38.630 | -18.530 |
| 4 | 30/09/18 | 13:20:00 | 35.300 | -20.920 |
| 5 | 01/10/18 | 13:16:00 | 31.550 | -22.420 |
| 6 | 02/10/18 | 13:34:00 | 28.610 | -24.360 |
| 7 | 03/10/18 | 13:10:00 | 25.050 | -26.050 |
| 8 | 04/10/18 | 13:05:00 | 21.450 | -27.750 |
| 9 | 05/10/18 | 13:27:00 | 17.740 | -28.930 |
| 10 | 06/10/18 | 13:20:00 | 13.810 | -28.290 |
| 11 | 07/10/18 | 13:18:00 | 10.100 | -27.290 |
| 12 | 08/10/18 | 13:11:00 | 06.260 | -26.380 |
| 13 | 10/10/18 | 13:15:00 | -1.150 | -24.990 |
| 14 | 11/10/18 | 13:15:00 | -4.985 | -24.970 |
| 15 | 12/10/18 | 13:15:00 | -8.765 | -24.950 |
| 16 | 13/10/18 | 13:20:00 | -12.085 | -24.930 |
| 17 | 14/10/18 | 13:10:00 | -15.035 | -25.030 |
| 18 | 16/10/18 | 13:14:00 | -21.600 | -25.050 |
| 19 | 17/10/18 | 13:19:00 | -24.905 | -25.903 |
| 20 | 18/10/18 | 11:27:00 | -27.200 | -28.250 |
| 21 | 19/10/18 | 13:15:00 | -30.010 | -31.150 |
| 22 | 20/10/18 | 14:15:00 | -32.375 | -33.670 |
| 23 | 21/10/18 | 13:27:00 | -34.580 | -36.090 |
| 24 | 22/10/18 | 13:16:00 | -37.010 | -38.830 |
| 25 | 23/10/18 | 13:38:00 | -39.210 | -41.470 |
| 26 | 24/10/18 | 13:20:00 | -41.370 | -44.010 |
| 27 | 25/10/18 | 14:24:00 | -43.790 | -46.950 |
| 28 | 26/10/18 | 14:38:00 | -46.020 | -49.870 |



processed 20181028 (c) 2018 ISAR team - v1.1

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 – AMT4OceanSatFlux

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 radars 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. Together with the C-band radar 480 camera images (over approximately 5 min) were collected every 20 min to help interpret the radar data.

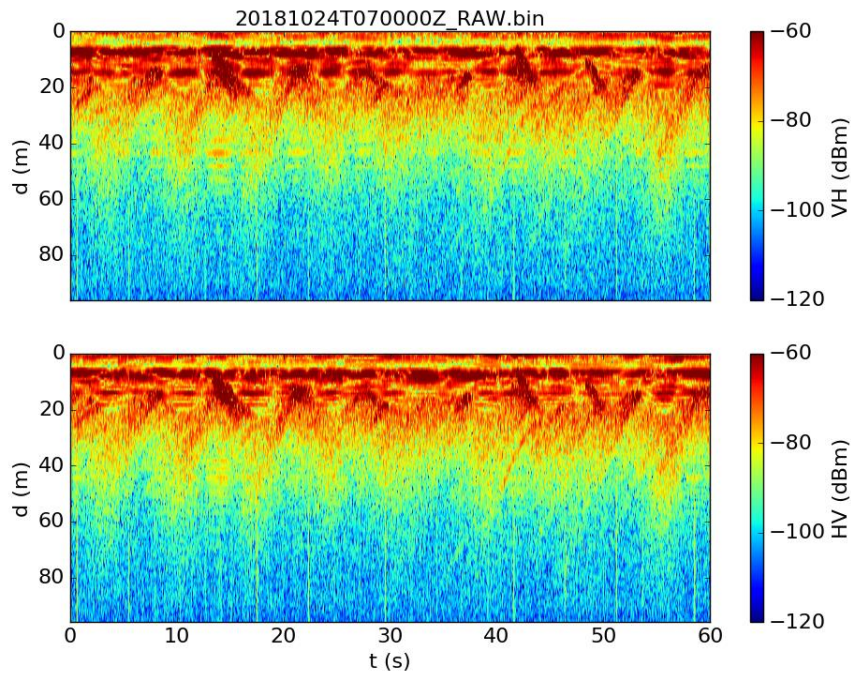


Figure 4: Example radar image from 24/10/2018 showing the vertical horizontal and horizontal vertical polarization data.

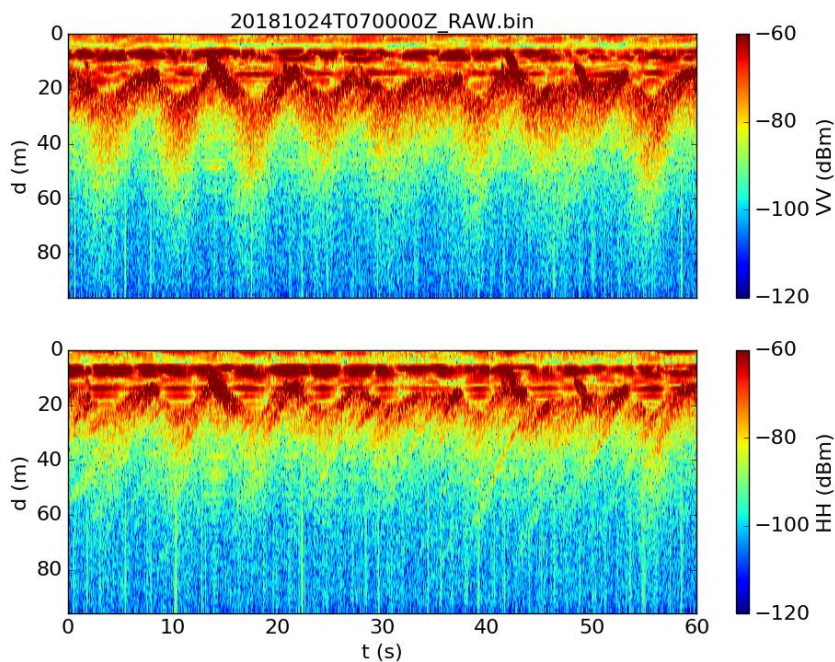


Figure 5: Example radar image from 24/10/2018 showing the vertical vertical and horizontal horizontal polarization data.

Collection of Surface Measurements of Water Temperature using a Small Oceanographic floating Device (SOD)

Bob Brewin¹, Werenfrid Wimmer² & Giorgio Dall'Olmo¹

1. Plymouth Marine Laboratory, UK

2. University of Southampton, UK

Cruise Objectives

There were two objectives to the design, development and operation of the Small Oceanographic floating Device (SOD) on AMT28.

- 1) Test, calibrate and inter-compare a surfboard fin (Smartfin), developed to measure sea surface temperature when surfing, with a suite of other instruments on the JCR designed to measure sea surface temperature, including: the profiling CTD; the underway CTD system; and the Infrared Scanning Autonomous Radiometer (ISAR).
- 2) Characterise the near-surface water temperature profile to test models designed to extrapolate skin temperature measurements, observable via satellite thermal sensors, to deeper depths.

Methods

Two surfboard fins were attached on the underside of a Small Oceanographic floating Device (SOD). The SOD itself is a swimming float with future fin sockets integrated (for attaching the fins) and two bodyboard plugs for attaching rope to either side of the float (see Figure 1). One of the surfboard fins that was attached to the SOD on AMT28 was a Smartfin (<https://smartfin.org/>), designed to record water temperature (at 10 cm depth), GPS and motion. The fin has bluetooth capabilities allowing the transfer of data onto a mobile phone or tablet equipped with the Smartfin app. This data can then be transferred onto the Smartfin data server and is freely accessible.

On the underside of the SOD, a 1 m rope was attached to a plug. Weights were placed to steady the device when in use at the end of the 1 m rope (Figure 1). On the topside, a 10 m rope was attached for lowering the SOD into the water. For the first half of the cruise, two miniature temperature sensors (Tidbit v2 and ibutton with housing) were attached to the end of the 1 m rope (to the weights) to measure water temperature at 1 m, with a white disk used to shelter the sensors from sunlight. On very hot sunny days, these sensors were also covered with tin foil to minimise any additional heating from sunlight. Unfortunately, on one occasion just south of the equator, this attracted a sea predator (or possibly some form of sea monster), which assumed the miniature foil-covered sensors were prey and they were taken from the SOD and not recovered. Subsequent deployments had weights only attached to the 1 m rope.

The SOD was lowered into the water from the starboard side of the JCR using a 10 m rope. At stations where the currents were pushing the SOD into the side of the JCR, a telescopic rod was used to extend the rope further away from the ship (Figure 1). The sensors were launched prior to each deployment and the SOD was operated for 20 minutes at each station, both predawn and solar noon. Once recovered, the data were downloaded onto a laptop and backed-up on the ship's hard drive. Thanks to the help from both the JCR IT technician and the AME technician, the Smartfin data were transferred daily from the mobile phone onto the Smartfin server, through use of a dongle (Ethernet port in the phone) that allowed access to the internet from the phone. All stations were sampled, with only one station that yielded unsatisfactory data (data removed), owing to high gusting winds lifting the SOD into the air. For subsequent deployments in high winds, increased weight was added to the 1 m rope and the SOD operated well.

On four occasions during the cruise the sensors were calibrated against a NIST-traceable temperature probe at two contrasting temperatures in a water bath. Systematic differences between all sensors on the SOD and the NIST-traceable temperature probe were removed to ensure accurate data.

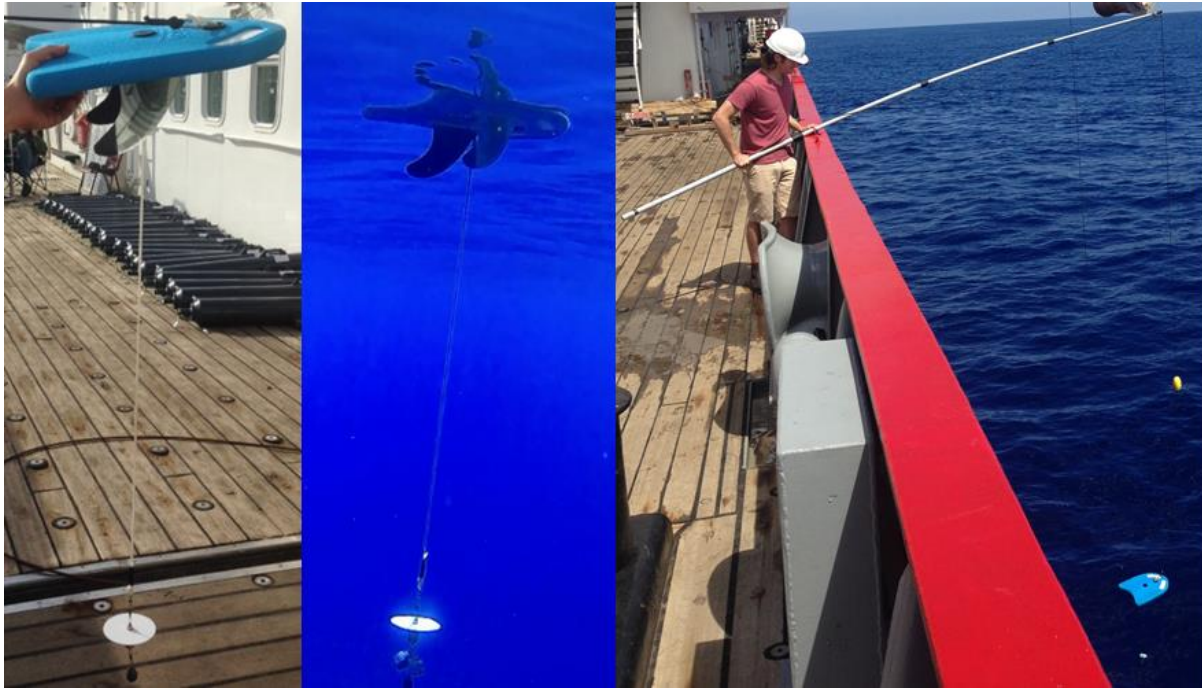


Figure 1. The Small Oceanographic floating Device (SOD). Left on deck prior to deployment, centre underwater shot of the SOD (courtesy of Werenfrid Wimmer) and right, deploying the SOD using a telescopic rod.

Provisional Results

Results from the water bath calibrations are shown in Figure 2. The Smartfin was found to be within 0.003 degrees centigrade of the NIST-traceable temperature probe. The average difference between the probe and the sensors is shown in Figure 2. This difference was removed from each sensor to ensure accurate and consistent measurements. The sensors were found to operate with good stability over the duration of the cruise, with no major drifts between calibrations, as shown in Figure 2.

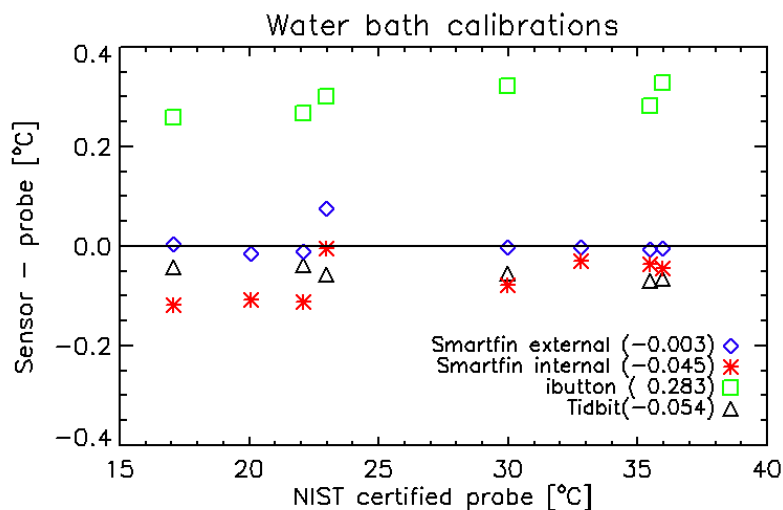


Figure 2. Results from the comparison between SOD sensors and NIST-traceable temperature probe at contrasting temperatures using a temperature controlled water bath.

Figure 3 shows along-track SST as a function of latitude on AMT28 from the underway system, with the Smartfin data overlain. The Smartfin data is shown to track tightly, variations in SST from the underway CTD, suggesting good agreement between the two systems.

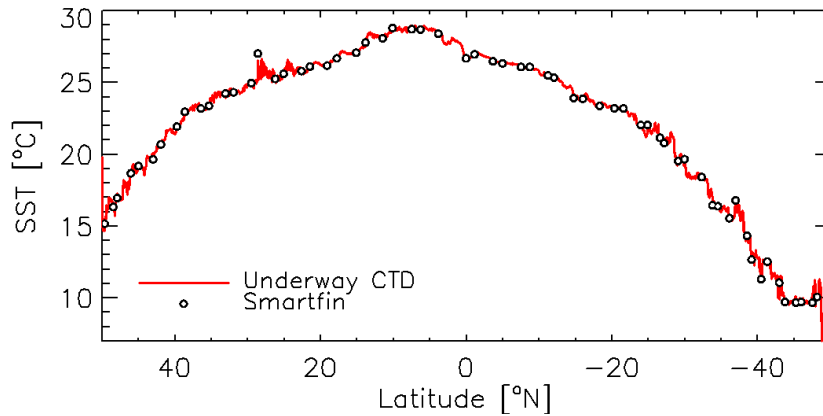


Figure 3. Along-track SST from the JCR underway system with the Smartfin SST data overlain.

Figure 4 shows a histogram of the differences between the Smartfin and the underway SST, as well as the differences between the Smartfin and the ISAR data (preliminary processing), for all the data as well as a partitioning of predawn and noon data. The Smartfin was found to be within <0.05 of the underway (on average) and within <0.1 of the ISAR. Differences within these systems when partitioned into predawn and noon data were consistent with general expectations (Fig. 4), considering the different depths the systems were sampling. Predawn, the expectation (in general and dependant on other environmental conditions) is that the skin temperature from the ISAR (~ 1 mm) would be cooler than the Smartfin (at 10 cm), but that the Smartfin (at 10 cm) would be cooler than the underway (~ 5 m), owing to our understanding of the near-surface temperature profile at night. At noon, there was better agreement between systems in general, though significant deviations were observed on occasion, depending on other environmental conditions (e.g. changes in wind-speed and total solar irradiance).

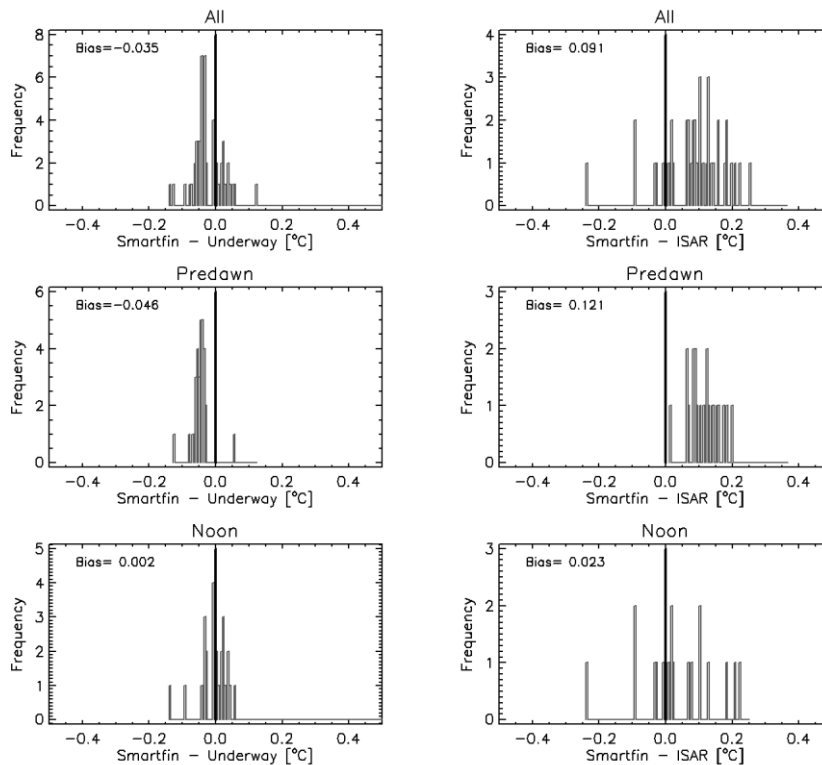


Fig 4. Histograms of the differences between the Smartfin and the underway SST, as well as the differences between the Smartfin and the ISAR data, for all the data as well as a partitioning of predawn and noon data.

Data collected was used to characterise the near-surface water temperature profile for data from the first few mm (from the ISAR) down beyond 100 m depth (CTD). Figure 5 shows two examples of this for two noon stations. The first case (Station 15) where significant surface heating was observed in the upper 10 m, with the temperature significantly higher between 1 mm and 10 cm when compared with data at 1 m and 5 m. In the second case (Station 23), there was excellent agreement between all systems in the upper 10 m. With knowledge of other environmental conditions available from the ship's underway system (e.g. wind speed and irradiance), these data can be used to test models designed to extrapolate skin temperature measurements, observable via satellite thermal sensors, to deeper depths. Table 1 lists locations and times of all SOD deployments.

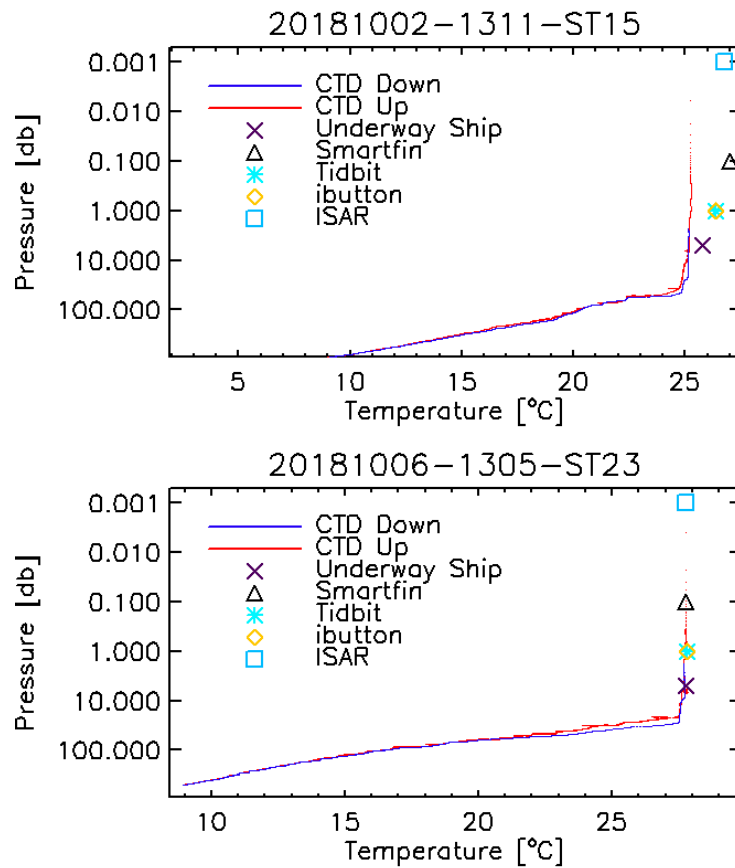


Fig 5. The vertical water temperature profile for data from the first few mm (from the ISAR) to down beyond 100m depth (CTD) for two noon stations during AMT28.

Table 1: SOD deployment times and locations on AMT28

| DATE | TIME (GMT) | Station No. | LAT (degrees N) | LONG (degrees E) |
|------------|------------|-------------|-----------------|------------------|
| 25/09/2018 | 12:49 | 1 | 49.6381 | -5.5016 |
| 26/09/2018 | 03:39 | 2 | 48.4694 | -8.8366 |
| 26/09/2018 | 12:13 | 3 | 47.9012 | -10.3814 |
| 27/09/2018 | 03:32 | 4 | 46.0291 | -12.7325 |
| 27/09/2018 | 12:13 | 5 | 44.9786 | -13.5894 |

| | | | | |
|------------|-------|----|----------|----------|
| 28/09/2018 | 03:42 | 6 | 42.967 | -15.2131 |
| 28/09/2018 | 12:10 | 7 | 41.9117 | -16.0363 |
| 29/09/2018 | 03:35 | 8 | 39.7193 | -17.7161 |
| 29/09/2018 | 12:09 | 9 | 38.6309 | -18.5257 |
| 30/09/2018 | 04:31 | 10 | 36.4139 | -20.1215 |
| 30/09/2018 | 13:05 | 11 | 35.302 | -20.9152 |
| 01/10/2018 | 04:36 | 12 | 33.0469 | -22.1368 |
| 01/10/2018 | 13:13 | 13 | 31.924 | -22.7102 |
| 02/10/2018 | 04:37 | 14 | 29.4883 | -23.9324 |
| 02/10/2018 | 13:11 | 15 | 28.6091 | -24.3608 |
| 03/10/2018 | 04:32 | 16 | 26.2046 | -25.5274 |
| 03/10/2018 | 13:19 | 17 | 25.0577 | -26.0568 |
| 04/10/2018 | 04:33 | 18 | 22.5997 | -27.2133 |
| 04/10/2018 | 13:05 | 19 | 21.4472 | -27.7453 |
| 05/10/2018 | 04:34 | 20 | 19.0777 | -28.8167 |
| 05/10/2018 | 13:04 | 21 | 17.7473 | -28.9302 |
| 06/10/2018 | 04:34 | 22 | 15.0761 | -28.6126 |
| 06/10/2018 | 13:05 | 23 | 13.8122 | -28.2945 |
| 07/10/2018 | 04:35 | 24 | 11.447 | -27.7087 |
| 07/10/2018 | 13:07 | 25 | 10.0982 | -27.2938 |
| 08/10/2018 | 04:36 | 27 | 7.4713 | -26.6501 |
| 08/10/2018 | 13:04 | 28 | 6.256 | -26.3799 |
| 09/10/2018 | 04:36 | 29 | 3.8077 | -25.8358 |
| 10/10/2018 | 04:47 | 30 | 0.0005 | -24.9992 |
| 10/10/2018 | 13:05 | 31 | -1.1518 | -24.9906 |
| 11/10/2018 | 04:38 | 32 | -3.6911 | -24.9782 |
| 11/10/2018 | 13:07 | 33 | -4.9846 | -24.9732 |
| 12/10/2018 | 04:41 | 34 | -7.5487 | -24.9574 |
| 12/10/2018 | 13:06 | 35 | -8.7631 | -24.9484 |
| 13/10/2018 | 04:33 | 36 | -11.2623 | -24.9375 |
| 13/10/2018 | 13:04 | 37 | -12.0828 | -24.9303 |

| | | | | |
|------------|-------|----|----------|----------|
| 14/10/2018 | 04:35 | 38 | -14.7797 | -24.9848 |
| 14/10/2018 | 13:11 | 40 | -16.0324 | -25.0235 |
| 15/10/2018 | 04:37 | 41 | -18.3393 | -25.0857 |
| 16/10/2018 | 04:38 | 43 | -20.3794 | -25.0594 |
| 16/10/2018 | 13:08 | 44 | -21.6037 | -25.0464 |
| 17/10/2018 | 04:33 | 45 | -23.9996 | -24.9994 |
| 17/10/2018 | 13:07 | 46 | -24.9058 | -25.9033 |
| 18/10/2018 | 04:39 | 47 | -26.628 | -27.6553 |
| 18/10/2018 | 11:12 | 48 | -27.2001 | -28.2502 |
| 19/10/2018 | 04:33 | 49 | -29.1276 | -30.2235 |
| 19/10/2018 | 13:06 | 50 | -30.0059 | -31.1497 |
| 20/10/2018 | 13:18 | 52 | -32.3728 | -33.6741 |
| 21/10/2018 | 04:43 | 53 | -33.8316 | -35.2688 |
| 21/10/2018 | 13:16 | 54 | -34.5805 | -36.0914 |
| 22/10/2018 | 04:35 | 55 | -36.1671 | -37.8663 |
| 22/10/2018 | 13:23 | 56 | -37.0121 | -38.8346 |
| 23/10/2018 | 04:41 | 57 | -38.5841 | -40.6551 |
| 23/10/2018 | 13:19 | 58 | -39.2093 | -41.475 |
| 24/10/2018 | 04:43 | 59 | -40.5209 | -43.0829 |
| 24/10/2018 | 13:19 | 60 | -41.3697 | -44.0127 |
| 25/10/2018 | 04:38 | 61 | -43.006 | -45.9817 |
| 25/10/2018 | 14:13 | 62 | -43.7905 | -46.9552 |
| 26/10/2018 | 05:34 | 63 | -45.2975 | -48.8964 |
| 26/10/2018 | 14:16 | 64 | -46.0175 | -49.8723 |
| 27/10/2018 | 06:36 | 65 | -47.5618 | -51.7739 |
| 27/10/2018 | 15:15 | 66 | -48.1989 | -52.6894 |

Measurements of Optical Properties

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Goal

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

Methods & Preliminary results

- 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 and Dall'Olmo et al. 2017. Highly-accurate estimates of chlorophyll concentration can be obtained from the particulate absorption coefficient (Figure 1).
- *In-situ* measurements were also collected by means of a profiling package with a SBE CTD and a WETLABs ACS to determine the particulate absorption and attenuation coefficients over the upper 300 m. The package also included a Secchi disk for measuring Secchi depth and Forel-Ule visual water colour (see Figure 2 for initial processing). The profiling package was deployed once a day, simultaneously with the noon time CTD cast. During this cruise we had numerous problems with the profiling package that will require extensive data processing and may result in data loss.
- 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. These data were processed daily and compared with other continuous underway data collected by the ship (see Figures 3 and 4 for examples of preliminary data processing).

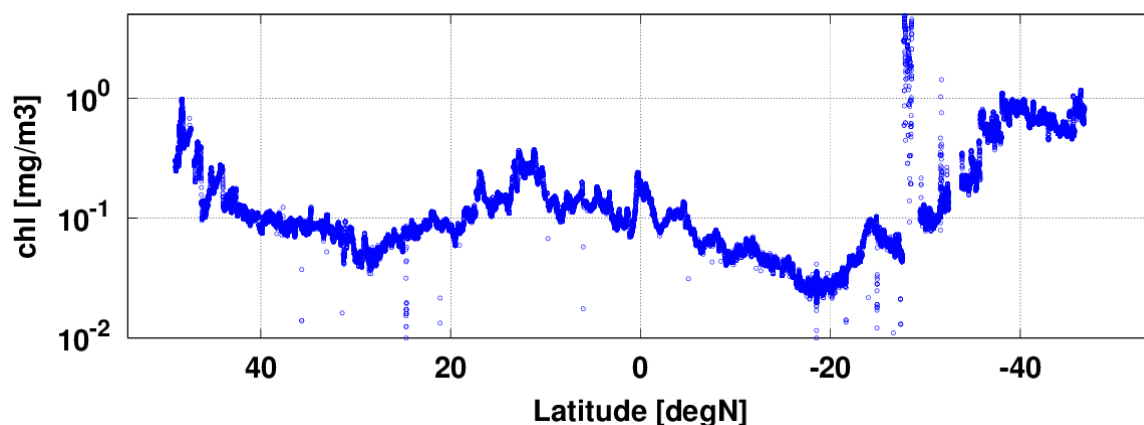


Figure 1. Preliminary surface estimates of chlorophyll concentration obtained from the underway particulate absorption measurements.

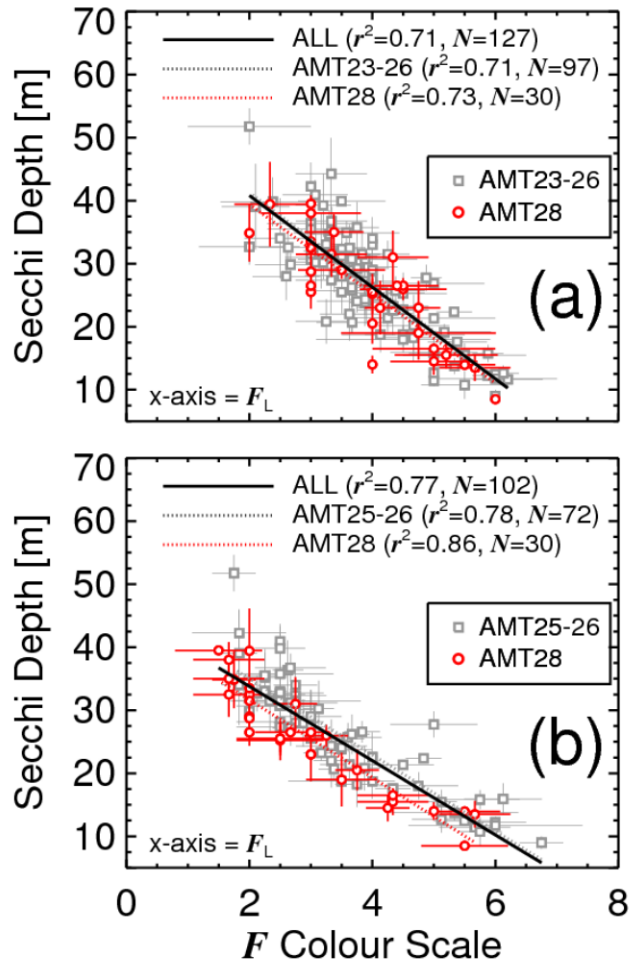


Figure 2. Secchi Depth and Forel-Ule colour measurements collected on AMT28 in red. Grey values are from previous AMT cruises (AMT23, 25 and 26).

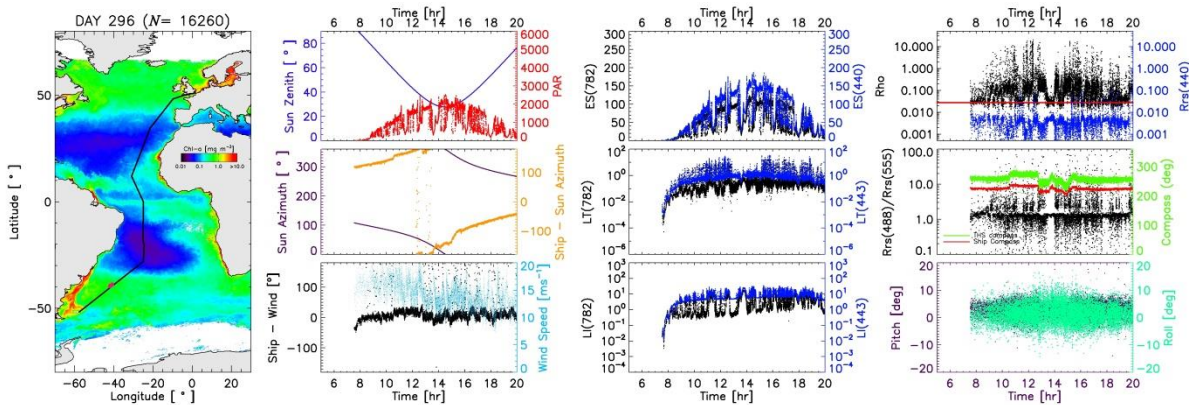


Figure 3. HyperSAS data from 23rd October 2018. This was during a very windy and rough day as we approached the Southern Ocean (see far left plot for location and far bottom right for pitch and roll of ship). All systems appeared to be working well, for example the daily time-series of Es data (spectral downwelling irradiance) was in good agreement with the ship's PAR data.

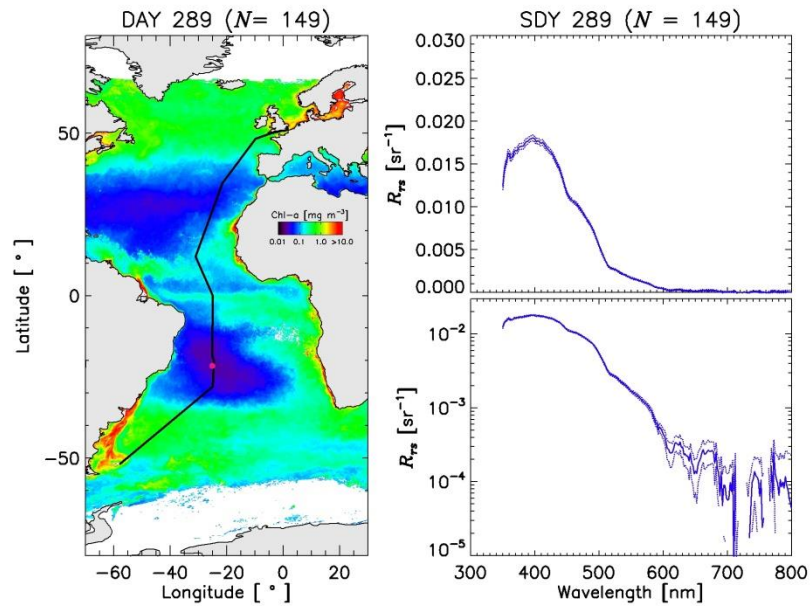


Figure 4. Remote-sensing reflectance spectra for a station in the centre of the South Atlantic Gyre during AMT28 on 16th October 2018.

References

- Dall'Olmo et al. (2009) Significant contribution of large particles to optical backscattering in the open ocean. *Biogeosciences*, 6, 947–967.
- Dall'Olmo et al. (2017) Determination of the absorption coefficient of chromophoric dissolved organic matter from underway spectrophotometry. *Optics Express*, <https://doi.org/10.1364/OE.25.0A1079>

Estimating Phytoplankton Size Distribution Using Flow Cytometry Side-scattering Measurements

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Objective

In order to derive phytoplankton size distributions from flow cytometry data, we investigated the extent to which empirical relationships could be established between the side scatter measured by flow cytometry and the cell diameter determined by a Coulter counter (Grob et al., 2007).

Methodology

1. Water samples (5-14 L) were collected from the rosette at the surface or deep chlorophyll maximum and concentrated in a 0.22 μm Sterivex filter.
2. The concentrated sample was then collected from the filter and analysed using a sorting flow cytometer (FACSort).
3. Distinctive cell populations were sorted based on their fluorescence and scattering properties. The instrument sensitivity was tuned differently for detecting picoplankton and nanoplankton populations ("pico-" and "nano-settings").

4. The sorted cells were collected and analysed in a Beckman Coulter counter (Multisizer 3) using a 20 μm aperture tube.
5. The median diameters and median side scattering of each sorted population were finally used to derive empirical relationships that could allow us to convert side-scattering data into cell diameters.

Provisional results

Similar side-scatter distributions were found between AMT26 and AMT28 (Figure 1) in both the nano- and pico-settings. For the nano-settings, it appears that the side scatter was positively correlated with cell diameter. This positive correlation was not as apparent in the pico setting.

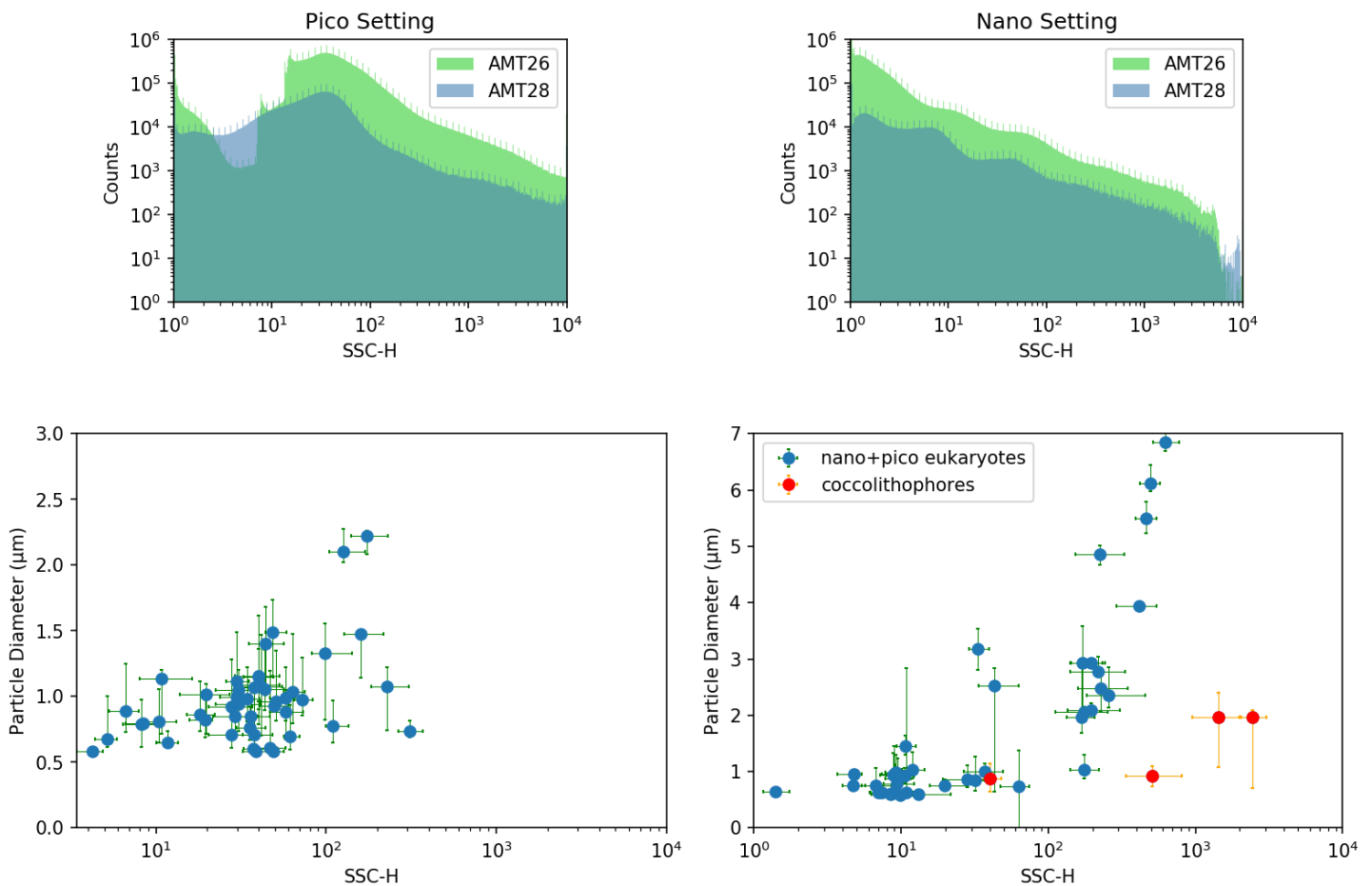


Figure 1: Distributions of side-scatter (SSC-H) for AMT26 (green) and AMT28 (blue) for pico- (left) and nano-settings (right). The scatter plots at the bottom present the relationships between side scatter and cell diameter for the sorted populations.

Table 1: CTD Samples taken for cell sorting analysis during AMT 28

| CTD | Station | Date | Time | Latitude | Longitude | Depth | Niskin | Volume(L) |
|-------|---------|------------|-------|---------------|---------------|---------|--------|-----------|
| CTD01 | STN01 | 2018/09/25 | 12:35 | 49° 38.287' N | 05° 30.096' W | SURFACE | 21 | 5 |
| CTD03 | STN03 | 2018/09/26 | 13:08 | 47° 54.075' N | 10° 22.883' W | DCM | 14 | 5 |
| CTD05 | STN05 | 2018/09/27 | 13:10 | 44° 58.716' N | 13° 35.362' W | DCM | 11 | 5 |
| CTD07 | STN07 | 2018/09/28 | 13:03 | 41° 54.700' N | 16° 02.178' W | DCM | 9 | 5 |
| CTD09 | STN09 | 2018/09/29 | 12:00 | 38° 37.851' N | 18° 31.541' W | DCM | 9 | 5 |
| CTD11 | STN11 | 2018/09/30 | 12:59 | 35° 18.121' N | 20° 54.912' W | DCM | 7 | 5 |
| CTD13 | STN13 | 2018/10/01 | 13:07 | 31° 55.442' N | 22° 42.611' W | DCM | 9 | 5 |
| CTD15 | STN15 | 2018/10/02 | 10:50 | 28° 36.544' N | 24° 21.650' W | DCM | 11 | 5 |
| CTD17 | STN17 | 2018/10/03 | 13:01 | 25° 03.461' N | 26° 03.408' W | SURFACE | 8 | 5 |
| CTD19 | STN19 | 2018/10/04 | 13:01 | 21° 26.830' N | 27° 44.720' W | DCM | 8,9 | 14 |
| CTD21 | STN21 | 2018/10/05 | 13:01 | 17° 44.839' N | 28° 55.814' W | DCM | 9,10 | 14 |
| CTD23 | STN23 | 2018/10/06 | 13:01 | 13° 48.730' N | 28° 17.673' W | DCM | 11,12 | 14 |
| CTD25 | STN25 | 2018/10/07 | 13:00 | 10° 05.894' N | 27° 17.629' W | DCM | 8,9 | 14 |
| CTD27 | STN28 | 2018/10/08 | 13:02 | 06° 15.359' N | 26° 22.796' W | DCM | 11,12 | 14 |
| CTD30 | STN31 | 2018/10/10 | 13:04 | 01° 09.109' S | 24° 59.435' W | DCM | 10,11 | 14 |
| CTD32 | STN33 | 2018/10/11 | 13:02 | 04° 59.077' S | 24° 58.392' W | DCM | 10,11 | 14 |
| CTD34 | STN35 | 2018/10/12 | 13:01 | 08° 45.785' S | 24° 56.904' W | DCM | 10 | 14 |
| CTD36 | STN37 | 2018/10/13 | 10:33 | 12° 04.969' S | 24° 55.818' W | DCM | 13,14 | 10 |
| CTD38 | STN40 | 2018/10/14 | 13:07 | 16° 01.942' S | 25° 01.412' W | DCM | 11 | 14 |
| CTD41 | STN44 | 2018/10/16 | 13:01 | 21° 36.224' S | 25° 02.786' W | DCM | 7 | 14 |
| CTD43 | STN46 | 2018/10/17 | 13:03 | 24° 54.350' S | 25° 54.196' W | DCM | 8 | 14 |
| CTD45 | STN48 | 2018/10/18 | 10:36 | 27° 12.003' S | 28° 15.011' W | DCM | 15 | 5 |
| CTD47 | STN50 | 2018/10/19 | 13:01 | 30° 00.355' S | 31° 08.982' W | DCM | 14,15 | 14 |
| CTD49 | STN52 | 2018/10/20 | 13:12 | 32° 22.371' S | 33° 40.448' W | DCM | 16 | 6 |
| CTD53 | STN56 | 2018/10/22 | 13:15 | 37° 00.723' S | 38° 50.077' W | DCM | 13,14 | 14 |
| CTD59 | STN62 | 2018/10/25 | 14:06 | 43° 47.429' S | 46° 57.313' W | DCM | 14 | 12 |
| CTD61 | STN64 | 2018/10/26 | 14:09 | 46° 01.052' S | 49° 52.339' W | DCM | 13 | 14 |

Underway Samples

Underway samples were taken on days where there were no noon CTDs. Underway samples were also taken when there were shortages in water from the CTD.

Table 2: Underway samples taken for cell sorting analysis during AMT 28

| CTD | Station | Date | Time | Latitude | Longitude | Depth | Niskin | Volume(L) |
|------|----------|------------|-------|---------------|---------------|---------|--------|-----------|
| UND1 | Underway | 2018/10/15 | 8:16 | 18° 32.560' S | 25° 05.395' W | Surface | N/A | 16 |
| UND2 | Underway | 2018/10/21 | 13:25 | 34° 34.831' S | 36° 05.487' W | Surface | N/A | 25 |
| UND3 | Underway | 2018/10/23 | 12:47 | 39° 12.372' S | 41° 28.361' W | Surface | N/A | 12 |
| UND4 | Underway | 2018/10/24 | 12:52 | 41° 22.179' S | 44° 00.764' W | Surface | N/A | 16 |
| UND5 | Underway | 2018/10/27 | 10:45 | 47° 51.198' S | 52° 13.096' W | Surface | N/A | 14 |

References

Grob, C., Ulloa, O., Claustre, H., Huot, Y., Alarcon, G. and Marie, D., 2007. Contribution of picoplankton to the total particulate organic carbon concentration in the eastern South Pacific. *Biogeosciences*, 4(5), pp.837-852.

Dissolved Inorganic Nutrients

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Objectives:

To provide dissolved nitrate, nitrite, phosphate, and silicate analysis of all CTD casts along the AMT28 transect. To provide dissolved nutrient analysis in coordination with SOCCOM float deployments for sensor calibration and contribution to a reference database.

Sampling:

Nutrient samples were drawn into 30 mL polypropylene screw-capped centrifuge tubes. The tubes and caps were cleaned with 10% HCl and rinsed 2-3 times with sample before filling. Samples were either analyzed within 1-3 hours after sample collection or stored overnight in the fridge, allowing sufficient time for all samples to reach room temperature. The centrifuge tubes fit directly onto the sampler.

Methods:

Nutrient analyses (phosphate, silicate, nitrate+nitrite, and nitrite) were performed on a Seal Analytical continuous-flow AutoAnalyzer 3 (AA3). The methods used are described by Gordon et al [Gordon1992] Hager et al. [Hager1972], and Atlas et al. [Atlas1971]. Details of the modification of analytical methods used in this cruise are also compatible with the methods described in the nutrient section of the GO-SHIP repeat hydrography manual (Hydes et al., 2010) [Hydes2010].

Nitrate/Nitrite Analysis

A modification of the Armstrong et al. (1967) [Armstrong1967] procedure was used for the analysis of nitrate and nitrite. For nitrate analysis, a seawater sample was passed through a cadmium column where the nitrate was reduced to nitrite. This nitrite was then diazotized with sulfanilamide and coupled with N-(1-naphthyl)-ethylenediamine to form a red dye. The sample was then passed through a 10 mm flowcell and absorbance measured at 540 nm. The procedure was the same for the nitrite analysis but without the cadmium column.

Phosphate Analysis

Ortho-Phosphate was analyzed using a modification of the Bernhardt and Wilhelms (1967) [Bernhardt1967] method. Acidified ammonium molybdate was added to a seawater sample to produce phosphomolybdic acid, which was then reduced to phosphomolybdous acid (a blue compound) following the addition of dihydrazine sulfate. The sample was passed through a 10 mm flowcell and absorbance measured at 820 nm.

Silicate Analysis

Silicate was analyzed using the basic method of Armstrong et al. (1967). Acidified ammonium molybdate was added to a seawater sample to produce silicomolybdic acid which was then reduced to silicomolybdous acid (a blue compound) following the addition of stannous chloride. The sample was passed through a 10 mm flowcell and absorbance measured at 660 nm.

Data Collection and Processing

Data collection and processing was done with the software ACCE (ver 6.10) provided with the instrument from Seal Analytical. After each run, the charts were reviewed for any problems during the run, any blank was subtracted, and final concentrations (micromoles per litre) were calculated, based

on a linear curve fit. Once the run was reviewed and concentrations calculated, a text file was created. That text file was reviewed for possible problems and then converted to another text file with only sample identifiers and nutrient concentrations that were merged with other bottle data.

Standards and Glassware Calibration

Primary standards for silicate (Na_2SiF_6), nitrate (KNO_3), nitrite (NaNO_2), and phosphate (KH_2PO_4) were obtained from Johnson Matthey Chemical Co. and/or Fisher Scientific. The supplier reports purities of >98%, 99.999%, 97%, and 99.999 respectively. All glass volumetric flasks and pipettes were gravimetrically calibrated prior to the cruise. The primary standards were dried and weighed out to 0.1 mg prior to the cruise. The exact weight was noted for future reference. When primary standards were made, the flask volume at 20 °C, the weight of the powder, and the temperature of the solution were used to buoyancy-correct the weight, calculate the exact concentration of the solution, and determine how much of the primary was needed for the desired concentrations of secondary standard. Primary and secondary standards were made up every 10-14 days. The new standards were compared to the old before use. All the reagent solutions, primary and secondary standards were made with fresh distilled deionized water (DIW). Standardizations were performed at the beginning of each group of analyses with working standards prepared every 10-12 hours from a secondary. Working standards were made up in low nutrient seawater (LNSW). One batch of LNSW was used on the cruise. It was collected and filtered prior to the cruise. The actual concentration of nutrients in this water was empirically determined during the standardization calculations.

Quality Control

All final data is reported in micromoles per kg. NO_3 , PO_4 , and NO_2 are reported to two decimal places and SIL to one. Accuracy is based on the quality of the standards. The levels are:

NO_3 0.05 μM (micromoles per litre)

PO_4 0.004 μM

SIL 2-4 μM

NO_2 0.05 μM

As is standard ODF practice, a deep calibration “check” sample was run with each set of samples to estimate precision within the cruise. This water was collected from station 6, Niskin 1.

Reference materials for nutrients in seawater (RMNS) were also used as a check sample run once a day. The RMNS preparation, verification, and suggested protocol for use of the material are described by [Aoyama2006], [Aoyama2007], [Aoyama2008] and Sato [Sato2010]. RMNS batch CG-1733 was used on this cruise, with each bottle being used once or twice before being discarded and a new one opened.

A total of 63 CTD casts and 925 samples were collected and analyzed for dissolved nutrients. Niskin bottles analyzed are tabulated below:

Table 1: CTD samples analysed for nutrients on AMT28

| Date | Time | Station No | CTD Cast | LAT | LONG (W) | Niskin |
|----------|------|------------|----------|----------------|--------------|------------------------------------|
| 26/09/18 | 334 | 2 | 2 | 48° 28,165' | 8° 50,193' | 1,3,4,6,12,13,15,17,19,20 |
| 26/09/18 | 1210 | 3 | 3 | 47° 54,073 | 10° 23,884 | 1-24 |
| 27/09/18 | 330 | 4 | 4 | 46° 01,745' | 12° 43,950 | 1,3,4,6,12,13,15,17,19,20 |
| 27/09/18 | 1207 | 5 | 5 | 44° 58,715' | 13° 35,363 | 2-17,20-24 |
| 28/09/18 | 333 | 6 | 6 | 42° 58,022 | 15° 12,784 | 1,2,4,5,8,13,14,18,20,21 |
| 28/09/18 | 1201 | 7 | 7 | 41°54,700' | 16°02,179 | 1-17,19-22 |
| 29/09/18 | 334 | 8 | 8 | 39° 43,158 ' | 17° 42,968' | 1,3,4,7,12,13,15,17,19,20 |
| 29/09/18 | 1200 | 9 | 9 | 38° 37,851' | 18° 31,541' | 1-17,19-24 |
| 30/09/18 | 436 | 10 | 10 | 36° 24,836' | 20° 07,287' | 1,3,4,7,12,13,14,16,18,19,21 |
| 30/09/18 | 1259 | 11 | 11 | 35° 18,121' | 20° 54,912' | 1-16,18,20-23 |
| 01/10/18 | 438 | 12 | 12 | 33° 2,816' | 22° 08',206' | 1,3,4,6,10,11,12,13,15,17,19,20,22 |
| 01/10/18 | 1307 | 13 | 13 | 31° 55,442' N | 22° 42,611' | 1-9,11-16,18,20,21,22 |
| 02/10/18 | 435 | 14 | 14 | 29° 29,299'N | 23° 55,948' | 1,4,5,8,13,14,15,17,19-21 |
| 02/10/18 | 1050 | 15 | 15 | 28° 36,544' N | 24° 21,650' | 1-8,10,13-16,18,19,22,23 |
| 03/10/18 | 436 | 16 | 16 | 26° 12,227' N | 25° 31,264' | 1,3,4,7,12,13,15,17,19,20,21 |
| 03/10/18 | 1301 | 17 | 17 | 25° 03,461' N | 26° 03,408' | 1-8,10-16,18,20,21,23 |
| 04/10/18 | 436 | 18 | 18 | 22° 35,980' N | 27° 12,800' | 1,4-7,9,13,14,15,17,19,20,21 |
| 04/10/18 | 1301 | 19 | 19 | 21° 26.830' N | 27° 44.720' | 1-8,10-21,23 |
| 05/10/18 | 438 | 20 | 20 | 19° 04,664' N | 28° 49,004' | 1,3,4,7,11,12,13,16,18,19,21 |
| 05/10/18 | 1301 | 21 | 21 | 17° 44,837' N | 28° 55,814' | 1-10,12-18,20,21,23 |
| 06/10/18 | 438 | 22 | 22 | 15° 04, 566' N | 28° 36,756' | 1-7,9,11,14,15,16,18,19,21,22 |
| 06/10/18 | 1301 | 23 | 23 | 13° 48,630' N | 28° 17,763' | 1,2,3,5,6,7,9,10,11,13-19,21,23 |

| | | | | | | |
|----------|------|----|----|---------------|-------------|---------------------------------------|
| 07/10/18 | 437 | 24 | 24 | 11° 26,819'N | 27° 42,524' | 1,3,4,5,8,12,13,15,17,19,21 |
| 07/10/18 | 1300 | 25 | 25 | 10° 05,894'N | 27° 17,629' | 1-8,10-13 |
| 08/10/18 | 438 | 27 | 26 | 07° 28,277' N | 26° 39,007' | 1,3,4,5,8,12,13,14,16,17,19,21 |
| 08/10/18 | 1302 | 28 | 27 | 06° 15,359' N | 26° 22,796' | 1-11,13-21 |
| 09/10/18 | 439 | 29 | 28 | 03° 48,465' N | 25° 50,148' | 1,3,4,5,8,12,13,14,15,17,19,20,21 |
| 10/10/18 | 446 | 30 | 29 | 00° 00,031' S | 24° 59,953' | 1,3,5,8,12,13,15,17,19,20 |
| 10/10/18 | 1304 | 31 | 30 | 01° 09,109' S | 24° 59,435' | 1-10,12-20 |
| 11/10/18 | 460 | 32 | 31 | 03° 41,467' S | 24° 58,694' | 1,3,4,5,6,9,14,15,17,18,20,21 |
| 11/10/18 | 1302 | 33 | 32 | 04° 59,077' S | 24° 58,392' | 1-10,12-20 |
| 12/10/18 | 439 | 34 | 33 | 07° 32,922' S | 24° 57,444' | 1,4,5,8,12,13,16,18,19,20 |
| 12/10/18 | 1301 | 35 | 34 | 08° 45,785' S | 24° 56,904' | 1-8,11-18,20,21 |
| 13/10/18 | 435 | 36 | 35 | 11° 15,739' S | 24° 56,250' | 1,3,4,7,11,12,13,14,16,17,19,20,21 |
| 13/10/18 | 1033 | 37 | 36 | 12° 04,969' S | 24° 55,818' | 10,11,13,13,15,16,17,19,20,23 |
| 14/10/18 | 435 | 38 | 37 | 14° 46,784' S | 24° 59,086' | 1,4,6,7,12,13,15,17,19,21 |
| 14/10/18 | 1307 | 40 | 38 | 16° 01,942' S | 25° 01,412' | 1-9,12-21 |
| 15/10/18 | 435 | 41 | 39 | 18° 20,357' S | 25° 05,143' | 1,3,4,5,7,11-16,18,19,21,22 |
| 16/10/18 | 449 | 43 | 40 | 20° 22,761' S | 25° 03,565' | 1,4,6,11,12,14,16,18,19,21 |
| 16/10/18 | 1301 | 44 | 41 | 21° 36,224' S | 25° 02,786' | 1-5,8,9,11-21 |
| 17/10/18 | 431 | 45 | 42 | 23° 59,974' S | 24° 59,965' | 1,3,4,5,8,12-15,17,18,20,21 |
| 17/10/18 | 1303 | 46 | 43 | 24° 54,350' S | 25° 54,196' | 1-5,7,9,10,12-18,20,21 |
| 18/10/18 | 443 | 47 | 44 | 26° 37,678' S | 27° 39,321' | 1,4,6,11,12,14,16,18,19,21 |
| 18/10/18 | 1036 | 48 | 45 | 27° 12,003' S | 28° 15,001' | 1-15,17-22 |
| 19/10/18 | 436 | 49 | 46 | 29° 07,655' S | 30° 13,409' | 1,3,4,7,11,12,13,14,16,17,19,20,21,24 |
| 19/10/18 | 1301 | 50 | 47 | 30° 00,355' S | 31° 06,982' | 1-5,7,8,9,13,16-22 |
| 20/10/18 | 444 | 51 | 48 | 31° 37,104' S | 32° 53,058' | 1,4,6,11,12,14,16,18,19,21 |
| 20/10/18 | 1312 | 52 | 49 | 32° 22,371' S | 33° 40,448' | 1-16,18,19,20,21,23 |
| 21/10/18 | 440 | 53 | 50 | 33° 49,894' S | 35° 16,130' | 1,3,4,5,6,9,13,14,15,16,18,20,21 |

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| 21/10/18 | 1310 | 54 | 51 | 34° 34,830' S | 36° 05,486' | 1-17,19-22 |
| 22/10/18 | 445 | 55 | 52 | 36° 10,029' S | 37° 51,980' | 1,4,5,7,12,13,15,17,19,21 |
| 22/10/18 | 1315 | 56 | 53 | 37° 00,723' S | 38° 50,077' | 1-6,8-13,16-20 |
| 23/10/18 | 437 | 57 | 54 | 38° 35,043' S | 40° 39,307' | 1,3,4,5,6,7,10,11,12,13,14,15,17 |
| 23/10/18 | 1311 | 58 | 55 | 39° 12,560' S | 41° 28,505' | 1-19,21,22 |
| 24/10/18 | 441 | 59 | 56 | 40° 31,255' S | 43° 04,973' | 1,4,5,7,12,13,14,17,19,21 |
| 24/10/18 | 1309 | 60 | 57 | 41° 22,179' S | 44° 00,764' | 1-22 |
| 25/10/18 | 540 | 61 | 58 | 43° 00,361' S | 45° 58,902' | 1,3,4,5,6,7,10,14,15,17,18,20,21 |
| 25/10/18 | 1406 | 62 | 59 | 43° 47,429' S | 46° 57,313' | 1-9,11,13,16,17,18,19 |
| 26/10/18 | 538 | 63 | 60 | 45° 17,852' S | 48° 53,785' | 1,3,4,6,11,12,14,16,18,21 |
| 26/10/18 | 1409 | 64 | 61 | 46° 01,052' S | 49° 52,339' | 1,3-12,14,17,18,19 |
| 27/10/18 | 637 | 65 | 62 | 47° 33,709' S | 51° 46,436' | 1,3,4,5,7,8,11,12,14,15,17,19 |
| 27/10/18 | 1503 | 66 | 63 | 48° 11,932' S | 52° 41,362' | 1,2,3,4,5,7,8,9,13,16,17,18 |

References:

- [Armstrong1967] Armstrong, F.A.J., Stearns, C.A., and Strickland, J.D.H., "The measurement of upwelling and subsequent biological processes by means of the Technicon Autoanalyzer and associated equipment," *Deep-Sea Research*, 14, pp.381-389 (1967).
- [Atlas1971] Atlas, E.L., Hager, S.W., Gordon, L.I., and Park, P.K., "A Practical Manual for Use of the Technicon AutoAnalyzer in Seawater Nutrient Analyses Revised," Technical Report 215, Reference 71-22, p.49, Oregon State University, Department of Oceanography (1971).
- [Bernhardt1967] Bernhardt, H., andWilhelms, A., "The continuous determination of low level iron, soluble phosphate and total phosphate with the AutoAnalyzer," *Technicon Symposia*, I,pp.385-389 (1967).
- [Gordon1992] Gordon, L.I., Jennings, J.C., Ross, A.A., Krest, J.M., "A suggested Protocol for Continuous Flow Automated Analysis of Seawater Nutrients in the WOCE Hydrographic Program and the Joint Global Ocean Fluxes Study," Grp. Tech Rpt 92-1, OSU College of Oceanography Descr. Chem Oc. (1992).
- [Hager1972] Hager, S.W., Atlas, E.L., Gordon L.I., Mantyla, A.W., and Park, P.K., " A comparison at sea of manual and autoanalyzer analyses of phosphate, nitrate, and silicate ," *Limnology and Oceanography*, 17,pp.931-937 (1972).
- [Hydes2010] Hydes, D.J., Aoyama, M., Aminot, A., Bakker, K., Becker, S., Coverly, S., Daniel,A.,Dickson,A.G., Grosso, O., Kerouel, R., Ooijen, J. van, Sato, K., Tanhua, T.,Woodward, E.M.S., Zhang, J.Z., 2010. Determination of Dissolved Nutrients (N, P, Si) in Seawater with High Precision and Inter-Comparability Using Gas-Segmented Continuous Flow Analysers, In: GO-SHIP Repeat Hydrography Manual: A Collection of Expert Reports and Guidelines. IOCCP Report No. 14, ICPO Publication Series No 134.

Carbonate System: Total Alkalinity (AT) and pH

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Cruise Objectives

Dissolved CO₂ reacts with water to form carbonic acid (H₂CO₃). H₂CO₃ dissociates to bicarbonate (HCO₃⁻) and carbonate (CO₃²⁻) with the concomitant release of H⁺, causing a reduction in pH. Total alkalinity (AT) of seawater describes the sum of all ionic charges in seawater, including HCO₃⁻, CO₃²⁻, H⁺, inorganic and organic ions. Samples for the determination of AT and pHT (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 CO₂ partial pressure (pCO₂) measured with the PML, Live-pCO₂ system. These measurements will contribute to our understanding of the distribution of carbon sources and sinks in the Atlantic Ocean and the capacity of the ocean to take up anthropogenic CO₂.

Methods

Rinse 500 mL sample amber glass bottle 3 times (with sample) and fill directly from Niskin bottle. Avoid agitating the sample during filling. Place the bottle in a water bath at 25°C (nominal) and allow the sample temperature to equilibrate (30 minutes). Analyse samples immediately in a spectrophotometric pH system (PML asset number 590) using m-cresol-purple dye (Dickson et al., 2007). Whilst samples are equilibrating, run a reference spectrum using Milli-Q water and repeat on completion of sample analysis.

All calculations and corrections were applied using R-script. The pH method employed here has typical precision in the low 10⁻³ to 10⁻⁴ pH-unit range.

References

Clayton, T.D., Byrne, R.H., 1993. Spectrophotometric seawater pH measurements – total hydrogen-ion concentration scale calibration of m-cresol purple and at sea results. *Deep Sea Research Part I: Oceanographic Research Papers* 40, 2115–2129.

Dickson, A.G., Sabine, C.L., Christian, J.R., 2007. Guide to best practices for ocean CO₂ measurements. *PICES Special Publication 3*, PICES Special Publication 3, p. 191.

Table 1: Cast numbers and Niskin bottle numbers for all samples collected

| Date | Time | Statio n. No | CTD Cast | LAT | LONG (W) | Niskin Bottles | Depths Sampled (m) |
|------------|------|--------------|----------|---------------|-------------|--|---|
| 25/09/2018 | 1235 | 01 | 01 | 49° 38,285' N | 5° 30,096' | 1; 3; 7; 10; 13; 15; 20; 21 | 80; 70; 50; 22; 17; 17; 12; 8; 5 |
| 26/09/2018 | 0334 | 02 | 02 | 48° 28,165' N | 8° 50,193' | 1; 3; 4; 6; 12; 13; 15; 17; 19; 20 | 140; 100; 70; 60; 50; 25; 20; 14; 10; 5 |
| 26/09/2018 | 1210 | 03 | 03 | 47° 54,073' N | 10° 23,884' | 1; 2; 3; 5; 6; 7; 8; 9; 10; 12; 13; 16; 17; 19; 20; 21 | 500; 300; 200; 150; 130; 100; 75; 60; 50; 40; 30; 25; 20; 15; 10; 5 |
| 27/09/2018 | 0330 | 04 | 04 | 46° 01,745' N | 12° 43,950' | 1; 3; 4; 6; 12; 13; 15; 17; 19; 20 | 200; 150; 70; 60; 50; 26; 20; 14; 10; 5 |
| 27/09/2018 | 1207 | 05 | 05 | 44° 58,715' N | 13° 35,363' | 2; 4; 6; 7; 8; 10; 11; 14; 15; 16; 17; 20; 21 | 300; 150; 100; 75; 50; 45; 40; 35; 30; 25; 20; 10; 5 |

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| 28/09/2018 | 0333 | 06 | 06 | 42° 58,022' N | 15° 12,784' | 2; 4; 5; 8; 13; 14; 15; 17; 18; 20; 21 | 200; 150; 60; 52; 50; 40; 23; 20; 12; 7; 5 |
| 28/09/2018 | 1201 | 07 | 07 | 41°54,700' N | 16°02,179' | 1; 2; 3; 4; 6 ;7; 8; 9; 12; 14; 15; 16; 17; 20; 21 | 500; 300; 200; 150; 100; 80; 70; 56; 50; 45; 30; 25; 20; 10; 5 |
| 29/09/2018 | 0334 | 08 | 08 | 39° 43,158' N | 17° 42,968' | 1; 2; 3; 4; 6; 7; 8; 11; 12; 14; 15; 16; 17; 20; 21 | 500; 300; 200; 150; 100; 80; 70; 60; 50; 45; 30; 25; 20; 10; 5 |
| 29/09/2018 | 1200 | 09 | 09 | 38° 37,851' N | 18° 31,541' | 1; 3; 4; 7; 12; 13; 14; 16; 18; 19; 21 | 200; 150; 115; 105; 60; 50; 45; 25; 20; 14; 5 |
| 30/09/2018 | 0436 | 10 | 10 | 36° 24,836' N | 20° 07,287' | 1; 2; 3; 4; 6; 7; 10; 11; 13; 15; 16; 18; 20; 21 | 500; 300; 200; 150; 120; 105; 90; 75; 50; 40; 30; 20; 10; 5 |
| 30/09/2018 | 1259 | 11 | 11 | 35° 18,121' N | 20° 54,912' | 1; 3; 4; 6; 7; 10; 11; 13; 15; 17; 19; 20; 22 | 200; 150; 100; 90; 80; 60; 50; 39; 30; 22; 20; 12; 5 |
| 01/10/2018 | 0438 | 12 | 12 | 33° 2,816' N | 22° 08',206' | 1; 2; 3; 4; 6; 7; 8; 11; 13; 15; 16; 18; 20; 21 | 500; 300; 200; 150; 120; 100; 85; 75; 50; 40; 30; 20; 10; 5 |
| 01/10/2018 | 1307 | 13 | 13 | 31° 55,442' N | 22° 42,611' | 1; 4; 5; 8; 13; 14; 17; 18; 19; 20; 21 | 200; 150; 124; 114; 65; 50; 48; 28; 20; 15; 5 |
| 02/10/2018 | 0435 | 14 | 14 | 29° 29,299' N | 23° 55,948' | 7; 8; 10; 13; 14; 15; 16; 18; 19; 20; 5 | 200; 150; 135; 115; 90; 70; 50; 35; 20; 5 |
| 02/10/2018 | 1050 | 15 | 15 | 28° 36,544' N | 24° 21,650' | 7; 8; 10; 13; 14; 15; 16; 18; 19; 22 | 200; 150; 115; 90; 70; 50; 35; 20; 5 |
| 03/10/2018 | 0436 | 16 | 16 | 26° 12,227' N | 25° 31,264' | 1; 3; 7; 11; 12; 13; 14; 15; 17; 19; 20; 21 | 200; 150; 117; 107; 90; 76; 60; 50; 45; 25; 20; 14; 5 |
| 03/10/2018 | 1301 | 17 | 17 | 25° 03,461' N | 26° 03,408' | 1; 2; 3; 4; 5; 7; 10; 11; 13; 15; 16; 18; 20; 21 | 500; 300; 200; 150; 140; 120; 100; 80; 50; 40; 30; 20; 10; 5 |
| 04/10/2018 | 0436 | 18 | 18 | 22° 35,980' N | 27° 12,800' | 1; 4; 5; 6; 7; 9; 13; 14; 15; 17; 19; 20; 21 | 200; 150; 130; 120; 103; 93; 65; 50; ,41; 23; 20; 13; 5 |
| 04/10/2018 | 1301 | 19 | 19 | 21° 26.830' N | 27° 44.720' | 1; 2; 3; 4; 5; 10; 11; 12; 14; 16; 17; 18; 20; 21 | 500; 300; 200; 150; 140; 120; 105; 85; 75; 50; 40; 30; 20; 10; 5 |
| 05/10/2018 | 0438 | 20 | 20 | 19° 04,664' N | 28° 49,004' | 1; 3; 4; 7; 11; 12; 13; 16; 18; 19; 21 | 200; 150; 100; 90; 66; 50; 39; 22; 20; 12; 5 |
| 05/10/2018 | 1301 | 21 | 21 | 17° 44,837' N | 28° 55,814' | 1; 2; 3; 4; 5; 7; 8; 9; 12; 14; 16; 17; 18; 20; 21 | 500; 300; 200; 150; 115; 85; 75; 65; 60; 50; 40; 30; 20; 10; 5 |

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|------------|------|----|----|----------------|-------------|---|--|
| 06/10/2018 | 0438 | 22 | 22 | 15° 04, 566' N | 28° 36,756' | 1; 3;4; 5, 6; 7; 9; 11; 14; 15; 16; 18; 19; 21; 22 | 200; 150; 125; 100; 80; 67; 62; 57; 50; 36; 25; 20, 14; 7; 5 |
| 06/10/2018 | 1301 | 23 | 23 | 13° 48,630' N | 28° 17,763' | 1; 2; 3; 5; 6; 8; 9; 10; 14; 16;17; 18; 19; 20; 21 | 500; 300; 200; 150; 120; 85; 75; 60; 50;45; 40; 30; 20; 10; 5 |
| 07/10/2018 | 0437 | 24 | 24 | 11° 26,819' N | 27° 42,524' | 1; 3; 4; 5; 8; 12; 13; 15; 17; 19; 21 | 200; 150; 100; 60 ;50; 30; 22; 20 12; 7; 5 |
| 07/10/2018 | 1300 | 25 | 25 | 10° 05,894' N | 27° 17,629' | 1; 2; 3; 4; 5; 6; 7; 8; 10; 11; 12; 13; 14; 15 | 200; 150; 100; 70; 70; 50; 40; 40; 35; 30; 20; 5; 5; 5 |
| 08/10/2018 | 0438 | 27 | 26 | 07° 28,277' N | 26° 39,007' | 1; 3; 4; 5; 8; 12; 13; 14; 16; 17; 19; 21 | 200; 150; 100; 82; 72; 50; 40; 30; 20; 17; 9; 5 |
| 08/10/2018 | 1302 | 28 | 27 | 06° 15,359' N | 26° 22,796' | 1; 2; 3; 5; 6; 7; 8; 9; 10; 13; 14; 16; | 500; 300; 200; 150; 120; 10; 85; 70; 64; 54; 50;45;40; 30; 20; 13; 5 |
| 09/10/2018 | 0439 | 29 | 28 | 03° 48,465' N | 25° 50,148' | 1; 3; 4; 5; 8; 12; 13; 14; 15; 17; 19; 20; 21 | 200; 150; 115; 99; 89; 80; 60; 50;39; 22; 20;12; 5 |
| 10/10/2018 | 0446 | 30 | 29 | 00° 00,031' S | 24° 59,953' | 1; 3; 5; 8; 12; 13; 15; 17; 19; 20 | 200; 150;70; 60; 50; 26; 20; 14; 8; 5 |
| 10/10/2018 | 1304 | 31 | 30 | 01° 09,109' S | 24° 59,435' | 1; 2; 3; 4; 5; 6; 7; 8; 9; 12; 14; 15; 16; 17; 18; 19 | 500; 300; 200; 150; 120; 100; 90; 82; 75; 70; 50; 40; 30; 20; 13; 5 |
| 11/10/2018 | 0460 | 32 | 31 | 03° 41,467' S | 24° 58,694' | 1; 3;4;5; 6, 9; 14; 15; 17; 18; 20; 21 | 200; 150; 90; 80; 70; 60; 50; 26; 20; 14; 8; 5 |
| 11/10/2018 | 1302 | 33 | 32 | 04° 59,077' S | 24° 58,392' | 1; 2; 3; 4; 5; 6; 7; 8; 9; 12; 14; 15; 16; 17; 19 | 500; 300; 200; 150; 125; 100; 90; 80; 74; 70; 50; 40; 30; 20; 5 |
| 12/10/2018 | 0439 | 34 | 33 | 07° 32,922' S | 24° 57,444' | 1; 4;5; 8; 12; 13; 16; 18; 19; 20 | 200; 150; 120; 110; 50; 47 ;26; 20; 15; 5 |
| 12/10/2018 | 1301 | 35 | 34 | 08° 45,785' S | 24° 56,904' | 1; 2; 3; 4; 5; 6; 7; 11; 12; 13; 15; 16; 17; 18; 19; 20 | 500; 300; 200; 175; 150; 135; 120; 110; 90; 70; 50; 40; 30; 20; 13; 5 |
| 13/10/2018 | 0435 | 36 | 35 | 11° 15,739' S | 24° 56,250' | 1; 3; 4; 7; 11 ;12; 13; 14; 16; 17; 19; 20; 21 | 200; 150; 132; 122; 110; 100; 80; 53; 50; 30; 20; 16; 5 |
| 13/10/2018 | 1033 | 37 | 36 | 12° 04,969' S | 24° 55,818' | 10; 11; 13; 15; 16; 17; 19; 20; 23 | 200; 150; 111; 100; 70; 50; 35; 20; 5 |
| 14/10/2018 | 0435 | 38 | 37 | 14° 46,784' S | 24° 59,086' | 1; 4; 6; 7; 12; 13; 15; 17; 19; 21 | 200; 155; 150; 145; 100; 62; 55; 35; 20; 5 |

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| 14/10/2018 | 1307 | 40 | 38 | 16° 01,942' S | 25° 01,412' | 1; 2; 3; 4; 5; 6; 8; 12; 14; 15; 16; 17; 18; 19; 20 | 500; 300; 250; 200; 185; 175; 160; 150; 120; 100; 75; 50; 40; 20; 5 |
| 15/10/2018 | 0435 | 41 | 39 | 18° 20,357' S | 25° 05,143' | 1; 3; 4; 5; 7; 11; 12; 13; 14; 15; 16; 18; 19; 21; 22 | 200; 185; 175; 162; 152; 140; 130; 120; 100; 80; 65; 50; 36; 20; 5 |
| 16/10/2018 | 0449 | 43 | 40 | 20° 22,761' S | 25° 03,565' | 1; 4; 6; 11; 12; 14; 16; 18; 19; 21 | 200; 171; 161; ,100; 70; 50; 40; 25; 20; 5 |
| 16/10/2018 | 1301 | 44 | 41 | 21° 36,224' S | 25° 02,786' | 1; 2; 5; 8; 12; 13; 14; 15; 16; 17; 18; 19; 20 | 500; 300; 185; 170; 150; 125; 100; 85; 70; 50; 35; 20; 5 |
| 17/10/2018 | 0431 | 45 | 42 | 23° 59,974' S | 24° 59,965' | 1; 3; 4; 5; 8; 12; 13; 14; 15; 17; 18; 20; 21 | 200; 180; 160; 150; 140; 120; 100; 80; 60; 50; 34; 20; 5 |
| 17/10/2018 | 1303 | 46 | 43 | 24° 54,350' S | 25° 54,196' | 1; 2; 3; 4; 5; 9; 12; 13; 14; 15; 16; 17; 18; 19; 20 | 500; 300; 250; 200; 180; 140; 125; 110; 95; 85; 70; 50; 35; 20; 5 |
| 18/10/2018 | 0443 | 47 | 44 | 26° 37,678' S | 27° 39,321' | 1; 4; 6; 11; 12; 14; 16; 18; 19; 21 | 200; 137; 127; 100; 56; 50; 30; 20; 17; 5 |
| 18/10/2018 | 1036 | 48 | 45 | 27° 12,003' S | 28° 15,001' | 1; 3; 6; 9; 11; 12; 13; 14; 15; 17; 18; 19; 20; 21; 22 | 1500; 1300; 1000; 700; 500; 400; 300; 200; 140; 100; 75; 60; 50; 25; 5 |
| 19/10/2018 | 0436 | 49 | 46 | 29° 07,655' S | 30° 13,409' | 1; 3; 4; 7; 11; 12; 13; 14; 16; 17; 19; 20; 21 | 200; 150; 140; 130; 110; 90; 70; 56; 50; 31; 20; 17; 5 |
| 19/10/2018 | 1301 | 50 | 47 | 30° 00,355' S | 31° 06,982' | 1; 2; 3; 4; 5; 7; 9; 13; 16; 17; 18; 19; 20; 21; 22 | 500; 300; 250; 200; 180; 150; 119; 109; 100; 85; 70; 50; 35; 20; 5 |
| 20/10/2018 | 0444 | 51 | 48 | 31° 37,104' S | 32° 53,058' | 1; 4; 6; 11; 12; 14; 16;18; 19; 21; 24 | 200; 141; 131; 100; 56; 50; 31; 20; 17; 5 |
| 20/10/2018 | 1312 | 52 | 49 | 32° 22,371' S | 33° 40,448' | 1; 3; 6; 9; 11; 12; 13; 14; 15; 16; 18; 19; 20; 21; 22 | 1500; 1300; 1000; 700; 500; 400; 300; 200; 150; 85; 75; 60; 50; 25; 5 |
| 21/10/2018 | 0440 | 53 | 50 | 33° 49,894' S | 35° 16,130' | 1; 3; 4; 5; 6; 9; 13; 14; 15; 16; 18; 20; 21 | 200; 150; 125; 100; 90; 80; 70; 60; 50; 34; 20; 11; 5 |
| 21/10/2018 | 1310 | 54 | 51 | 34° 34,830' S | 36° 05,486' | 2; 3; 5; 9; 12; 13; 14; 15; 16; 17; 19; 20; 21; 22 | 1400; 1300; 1100; 700; 400; 300; 200; 150; 100; 70; 65; 50; 25; 5 |

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| 22/10/2018 | 0445 | 55 | 52 | 36° 10,029' S | 37° 51,980' | 1; 4; 5; 7; 12; 13; 15; 17; 19; 21; 24 | 200; 130; 80; 70; 50; 30; 20; 17; 10; 5 |
| 22/10/2018 | 1315 | 56 | 53 | 37° 00,723' S | 38° 50,077' | 1; 2; 3; 4; 6; 8; 9; 10; 11; 12; 13; 16; 17; 18; 20 | 500; 300; 200; 150; 120; 100; 85; 70; 60; 50; 40; 30; 20; 15; 5 |
| 23/10/2018 | 0437 | 57 | 54 | 38° 35,043' S | 40° 39,307' | 1; 3; 4; 5; 6; 7; 10; 11; 12; 13; 14; 15; 17; 18 | 200; 150; 125; 100; 75; 65; 50; 40; 28; 20; 16; 9; 7 |
| 23/10/2018 | 1311 | 58 | 55 | 39° 12,560' S | 41° 28,505' | 2; 4; 6; 9; 12; 13; 14; 15; 16; 17; 18; 19; 21; 22 | 1400; 1200; 1000; 700; 400; 300; 200; 150; 100; 75; 50; 30; 15; 8 |
| 24/10/2018 | 0441 | 59 | 56 | 40° 31,255' S | 43° 04,973' | 1; 4; 5; 7; 12; 13; 14; 17; 19; 21 | 200; 100; 50; 40; 35; 20; 17; 10; 8; 5 |
| 24/10/2018 | 1309 | 60 | 57 | 41° 22,179' S | 44° 00,764' | 2; 4; 6; 9; 12; 13; 14; 15; 16; 17; 18; 19; 21; 22 | 1400; 1200; 1000; 700; 400; 300; 200; 150; 100; 75; 50; 35; 20; 5 |
| 25/10/2018 | 0540 | 61 | 58 | 43° 00,361' S | 45° 58,902' | 1; 3; 4; 5; 6; 7; 10; 14; 15; 17; 18; 20; 21 | 200; 140; 120; 100; 80; 65; 55; 50; 24; 20; 13; 7; 5 |
| 25/10/2018 | 1406 | 62 | 59 | 43° 47,429' S | 46° 57,313' | 1; 2; 3; 4; 6; 7; 8; 9; 11; 13; 16; 17; 18; 19 | 500; 300; 200; 150; 120; 100; 85; 70; 50; 38; 30; 20; 15; 5 |
| 26/10/2018 | 0538 | 63 | 60 | 45° 17,852' S | 48° 53,785' | 1; 3; 4; 6; 11; 12; 14; 16; 18; 21 | 200; 100; 63; 53; 50; 24; 20; 13; 7; 5 |
| 26/10/2018 | 1409 | 64 | 61 | 46° 01,052' S | 49° 52,339' | 1; 2; 3; 4; 6; 7; 8; 9; 11; 12; 14; 15; 17; 19 | 500; 300; 200; 150; 120; 100; 85; 70; 50; 40; 30; 20; 15; 5 |
| 27/10/2018 | 0637 | 65 | 62 | 47° 33,709' S | 51° 46,436' | 1; 3; 4; 5; 7; 8; 11; 12; 14; 15; 17; 19 | 200; 150; 125; 100; 76; 66; 50; 28; 20; 16; 10; 5 |
| 27/10/2018 | 1503 | 66 | 63 | 48° 11,932' S | 52° 41,362' | 1; 2; 3; 4; 5; 7; 8; 13; 16; 18 | 500; 300; 200; 150; 135; 100; 80; 40; 30; 5 |

Salinity Sample Collection and Analysis

Arwen Bargery

British Oceanographic Data Centre

Cruise Objectives

Collection of CTD and underway seawater samples for salinity analysis and subsequent calibration of the TSG and CTD underway sensors.

Methods

Samples were collected for salinity analysis from both CTD Niskin bottles and the ship's non-toxic underway supply. CTD samples were collected from each pre-dawn and noon CTD cast from five depths, generally collected from around 500 m, 300 m, 150 m, 20 m and 5 m depths from the noon cast, and 200 m or less from the pre-dawn cast.

Samples from the ship's underway supply were collected throughout the cruise. Samples were taken four times each day at approximately 0800, 1200, 1600 and 2000 ship time. In total, 311 CTD samples from 61 CTD casts and 168 underway samples were collected during the cruise. Samples were collected into 130 mL glass bottles pre-labelled with crate number and bottle number, with different crates for underway and CTD samples. Each bottle was filled to the shoulder with water and dried before inserting a plastic stopper and replacing the screw cap. Samples were then stored in the temperature-controlled laboratory for at least 24 hours before analysis on the salinometer.

Two Autosals were used during the cruise which belonged to the British Antarctic Survey. Initially s/n 68533 was used and this was replaced with s/n 65763 as air bubbles were identified in the cell of the former. The instrument used was a Guildline Autosal 8400B salinometer.

From the outset of the cruise there were temperature stability issues within the lab in which the Autosal was situated. To ensure greatest data accuracy, operating guidelines recommend a room temperature of +/-1 degC to which the bath temperature is set with a maximum range of -4/+2 degC. There was difficulty getting the room temperature to stabilise whilst going through the tropics due to fluctuations of the ship's air-conditioning system and additionally the room was used as access between labs. On leaving the tropics the room temperature stabilised at 20 deg C and the cell temperature of the salinometer cell temperature was set at 21 deg C with the temperature of the water samples at 19 deg C.

A standardisation of the Autosal against Standard Seawater P162 (K15=0.99983) was completed for both salinometers prior to analysis of samples and the Autosals were left to stabilise for at least 24 hours after setting the cell temperature.

Table 1: Table showing CTD samples collected for salinity analysis during the cruise.

| Date and Time | CTD | Station | Lat (+ve N) | Lon (+ve E) | Niskin Bottles | Depths |
|------------------|--------|---------|-------------|-------------|------------------|----------------------|
| 25/09/2018 12:35 | CTD001 | 1 | 49.64 | -5.50 | 1, 16, 21, 4, 6 | 80, 12, 5, 70, 50 |
| 26/09/2018 03:34 | CTD002 | 2 | 48.47 | -8.84 | 3, 15, 23, 4, 10 | 100, 20, 5, 70, 60 |
| 26/09/2018 12:10 | CTD003 | 3 | 47.90 | -10.38 | 1, 2, 5, 10, 21 | 500, 300, 150, 50, 5 |
| 27/09/2018 03:30 | CTD004 | 4 | 46.03 | -12.73 | 1, 3, 12, 15, 23 | 200, 150, 50, 20, 5 |
| 27/09/2018 12:07 | CTD005 | 5 | 44.98 | -13.59 | 2, 4, 5, 8, 21 | 300, 150, 125, 50, 5 |
| 28/09/2018 03:33 | CTD006 | 6 | 42.97 | -15.21 | 2, 4, 8, 17, 24 | 200, 150, 52, 20, 5 |
| 28/09/2018 12:01 | CTD007 | 7 | 41.91 | -16.04 | 1, 2, 4, 12, 21 | 500, 30, 150, 50, 5 |
| 29/09/2018 03:34 | CTD008 | 8 | 39.72 | -17.72 | 1, 3, 8, 15, 19 | 200, 150, 71, 20, 9 |
| 29/09/2018 12:00 | CTD009 | 9 | 38.63 | -18.53 | 1, 2, 4, 12, 21 | 500, 300, 150, 50, 5 |

| | | | | | | |
|------------------|--------|----|--------|--------|-----------------------|-------------------------------|
| 30/09/2018 04:34 | CTD010 | 10 | 36.41 | -20.12 | 1, 3, 12, 18, 24 | 200, 150, 60, 20, 5 |
| 30/09/2018 12:59 | CTD011 | 11 | 35.30 | -20.92 | 1, 2, 4, 13, 21 | 500, 300, 150, 50, 5 |
| 01/10/2018 04:38 | CTD012 | 12 | 33.05 | -22.14 | 1, 3, 6, 19, 24 | 200, 150, 90, 20, 5 |
| 01/10/2018 13:07 | CTD013 | 13 | 31.92 | -22.71 | 1, 2, 4, 13, 21 | 500, 300, 150, 50, 5 |
| 02/10/2018 04:37 | CTD014 | 14 | 29.49 | -23.93 | 1, 4, 11, 19, 24 | 200, 150, 14, 20, 24 |
| 02/10/2018 10:50 | CTD015 | 15 | 28.61 | -24.36 | 7, 10, 13, 16, 22 | 200, 135, 115, 50, 5 |
| 03/10/2018 04:37 | CTD016 | 16 | 26.20 | -25.52 | 3, 6, 7, 19, 24 | 150, 117, 107, 20, 5 |
| 03/10/2018 13:01 | CTD017 | 17 | 25.06 | -26.06 | 1, 2, 4, 10, 21 | 500, 300, 150, 100, 5 |
| 04/10/2018 04:27 | CTD018 | 18 | 22.60 | -27.21 | 1, 4, 9, 19, 24 | 200, 150, 93, 20, 5 |
| 04/10/2018 13:01 | CTD019 | 19 | 21.45 | -27.75 | 1, 2, 4, 10, 21 | 500, 300, 150, 105, 5 |
| 05/10/2018 04:38 | CTD020 | 20 | 19.08 | -28.82 | 1, 3, 10, 19, 24 | 200, 150, 90, 12, 5 |
| 05/10/2018 13:01 | CTD021 | 21 | 17.75 | -28.93 | 1, 2, 4, 12, 21 | 500, 300, 150, 60, 5 |
| 06/10/2018 04:38 | CTD022 | 22 | 15.08 | -28.61 | 1, 3, 11, 18, 24 | 200, 150, 57, 29, 5 |
| 06/10/2018 13:01 | CTD023 | 23 | 13.81 | -28.29 | 1, 2, 5, 10, 21 | 500, 300, 150, 60, 5 |
| 07/10/2018 04:37 | CTD024 | 24 | 11.45 | -27.71 | 4, 3, 5, 15, 24 | 150, 100, 60, 20, 5 |
| 07/10/2018 13:00 | CTD025 | 25 | 10.10 | -27.29 | 1, 2, 3, 10, 13 | 200, 150, 100, 35, 5 |
| 08/10/2018 04:38 | CTD026 | 27 | 7.47 | -26.65 | 1, 3, 5, 16, 24 | 200, 150, 82, 20, 5 |
| 08/10/2018 13:02 | CTD027 | 28 | 6.26 | -26.38 | 1, 2, 5, 10, 21 | 500, 300, 150, 64, 5 |
| 09/10/2018 04:39 | CTD028 | 29 | 3.81 | -25.84 | 1, 3, 8, 19, 23 | 200, 150, 89, 20, 5 |
| 10/10/2018 04:46 | CTD029 | 30 | 0.00 | -25.00 | 1, 3, 13, 15, 17 | 200, 150, 26, 20, 14 |
| 10/10/2018 13:04 | CTD030 | 31 | -1.15 | -24.99 | 1, 2, 4, 9, 19 | 500, 300, 150, 75, 5 |
| 11/10/2018 04:30 | CTD031 | 32 | -3.69 | -24.98 | 1, 3, 9, 17, 24 | 200, 150, 60, 20, 5 |
| 11/10/2018 13:02 | CTD032 | 33 | -4.98 | -24.97 | 1, 2, 4, 9, 19 | 500, 300, 150, 74, 5 |
| 12/10/2018 04:39 | CTD033 | 34 | -7.55 | -24.96 | 1, 4, 8, 18, 24 | 200, 150, 110, 20, 5 |
| 12/10/2018 13:01 | CTD034 | 35 | -8.76 | -24.95 | 1, 2, 5, 11, 20 | 500, 300, 150, 110, 5 |
| 13/10/2018 04:35 | CTD035 | 36 | -11.26 | -24.94 | 1, 3, 7, 19, 24 | 200, 150, 122, 20, 5 |
| 13/10/2018 10:33 | CTD036 | 37 | -12.08 | -24.93 | 10, 13, 15, 17, 23 | 200, 111, 100, 50, 5 |
| 14/10/2018 04:35 | CTD037 | 38 | -14.78 | -24.98 | 1, 4, 6, 19, 12 | 200, 155, 150, 100, 20 |
| 14/10/2018 13:07 | CTD038 | 40 | -16.03 | -25.02 | 1, 2, 6, 12, 20 | 500, 300, 175, 150, 5 |
| 15/10/2018 04:35 | CTD039 | 41 | -18.34 | -25.09 | 1, 4, 7, 21, 24 | 200, 175, 152, 20, 5 |
| 16/10/2018 04:39 | CTD040 | 43 | -20.38 | -25.06 | 1, 4, 3, 18, 24 | 200, 171, 200, 25, 5 |
| 16/10/2018 13:01 | CTD041 | 44 | -21.60 | -25.05 | 1, 2, 12, 14, 20 | 500, 300, 150, 100, 5 |
| 17/10/2018 04:31 | CTD042 | 45 | -24.00 | -25.00 | 1, 5, 8, 20, 24 | 200, 150, 140, 20, 5 |
| 17/10/2018 13:03 | CTD043 | 46 | -24.91 | -25.90 | 1, 2, 5, 13, 20 | 500, 300, 180, 110, 5 |
| 18/10/2018 04:43 | CTD044 | 47 | -26.63 | -27.66 | 1, 4, 6, 19, 24 | 200, 137, 127, 17, 5 |
| 18/10/2018 10:36 | CTD045 | 48 | -27.20 | -28.25 | 1, 6, 11, 17, 23 | 1500, 1000, 500, 100, 5 |
| 19/10/2018 04:36 | CTD046 | 49 | -29.13 | -30.22 | 9, 4, 7, 20, 24 | 130, 140, 130, 17, 5 |
| 19/10/2018 13:01 | CTD047 | 50 | -30.01 | -31.15 | 1, 2, 7, 16, 22 | 500, 300, 150, 100, 5 |
| 20/10/2018 04:45 | CTD048 | 51 | -31.62 | -32.88 | 1, 3, 11, 19, 24 | 200, 200, 100, 17, 5 |
| 20/10/2018 13:12 | CTD049 | 52 | -32.37 | -33.67 | 1, 6, 11, 15, 2 | 1500, 1000, 500, 150, 1400 |
| 21/10/2018 04:40 | CTD050 | 53 | -33.83 | -35.27 | 1, 6, 3, 20, 24 | 200, 90, 150, 11, 5 |
| 21/10/2018 13:10 | CTD051 | 54 | -34.58 | -36.09 | 1, 6, 11, 15, 3 | 1500, 1000, 500, 150, 1300 |
| 22/10/2018 04:45 | CTD052 | 55 | -36.17 | -37.87 | 1, 5, 7, 19, 12 | 200, 80, 70, 10, 50 |

| | | | | | | |
|------------------|--------|----|--------|--------|----------------------|---------------------------------|
| 22/10/2018 13:15 | CTD053 | 56 | -37.01 | -38.83 | 1, 2, 4, 8, 20 | 500, 300, 150, 100, 5 |
| 23/10/2018 04:37 | CTD054 | 57 | -38.58 | -40.66 | 1, 3, 6, 15, 18 | 200, 150, 75, 9, 7 |
| 23/10/2018 13:11 | CTD055 | 58 | -39.21 | -41.48 | 1, 6, 8, 10, 11 | 1500, 1000, 800, 600, 500 |
| 24/10/2018 04:41 | CTD056 | 59 | -40.52 | -43.08 | 1, 4, 10, 12, 14 | 200, 100, 40, 35, 17 |
| 24/10/2018 13:09 | CTD057 | 60 | -41.37 | -44.01 | 1, 3, 6, 11, 15 | 1500, 1300, 1000, 500, 150 |
| 25/10/2018 05:40 | CTD058 | 61 | -43.01 | -45.98 | 1, 4, 5, 6, 10 | 200, 120, 100, 80, 55 |
| 25/10/2018 14:06 | CTD059 | 62 | -43.79 | -46.96 | 1, 2, 4, 7, 21 | 500, 300, 150, 100, 5 |
| 26/10/2018 05:38 | CTD060 | 63 | -45.30 | -48.90 | 1, 3, 4, 8, 11 | 200, 100, 63, 53, 50 |
| 26/10/2018 14:09 | CTD061 | 64 | -46.02 | -49.87 | 1, 2, 3, 4, 6, 7, 19 | 500, 300, 200, 150, 120, 100, 5 |

Table 2: Table showing underway sample log for salinity samples collected during the cruise.

| Date and Time (UT) | Julian Day | Lat (+ve N) | Lon (+ve E) | Salinity crate | Salinity bottle | Bench salinity reading | Flow rate (litre/min) | TSG Salinity (PSU) | Temp1 (degC) | Trans (volts) | Chlor (ug/l) | Comments |
|--------------------|------------|-------------|-------------|----------------|-----------------|------------------------|-----------------------|--------------------|--------------|---------------|--------------|---|
| 23/09/2018 11:33 | 266 | 51.8411 | 1.5813 | | | | | | | | | Oceanlogger system switched on after departure from Harwich |
| 25/09/2018 11:41 | 268 | 49.6756 | -5.4176 | U2 | 1 | 35.1985 | 0.5141 | | 14.7740 | | | Ship time is GMT + 1 hour (BST) |
| 25/09/2018 17:39 | 268 | 49.3053 | -6.4879 | U2 | 2 | 35.1201 | 0.5980 | 35.1191 | 16.2595 | | | Broken conductivity sensor was replaced |
| 25/09/2018 18:57 | 268 | 49.1884 | -6.7788 | U2 | 3 | 35.1563 | 0.5869 | 35.1358 | 16.5227 | | | |
| 26/09/2018 08:39 | 269 | 48.1267 | -9.8068 | U2 | 4 | 35.5938 | 0.5540 | 35.5942 | 16.8545 | | | |
| 26/09/2018 13:55 | 269 | 47.8754 | -10.4301 | U2 | 5 | 35.5863 | 0.5579 | 35.5916 | 16.9222 | | | |
| 26/09/2018 15:35 | 269 | 47.7376 | -10.8439 | U2 | 6 | 35.6109 | 0.5524 | 35.6021 | 16.8774 | | | |
| 27/09/2018 04:59 | 270 | 45.9509 | -12.8039 | U2 | 7 | 35.7270 | 0.5022 | 35.7215 | 18.9525 | | | |
| 27/09/2018 06:01 | 270 | 45.7860 | -12.9392 | U2 | 8 | 35.7211 | 0.5090 | 35.7256 | 19.3042 | | | |
| 27/09/2018 10:16 | 270 | 45.2244 | -13.4054 | U2 | 9 | 35.7404 | 0.5058 | 35.7383 | 18.9091 | | | |
| 27/09/2018 13:40 | 270 | 44.9179 | -13.6307 | U2 | 10 | 35.7584 | 0.5063 | 35.7585 | 19.1921 | | | |
| 27/09/2018 15:00 | 270 | 44.7142 | -13.8162 | U2 | 11 | 35.7402 | 0.5059 | 35.7422 | 19.1352 | | | |
| 27/09/2018 17:57 | 270 | 44.2357 | -14.2055 | U2 | 12 | 35.6828 | 0.4966 | 35.6836 | 18.5950 | | | |
| 28/09/2018 05:11 | 271 | 42.8789 | -15.2844 | U2 | 13 | 35.8009 | 0.5108 | 35.8037 | 20.0820 | | | |

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|---------------------|-----|---------|----------|----|----|---------|--------|---------|---------|--|--|--|
| 28/09/2018 08:02 | 271 | 42.4414 | -15.6265 | U2 | 14 | 35.9259 | 0.5219 | 35.9256 | 20.7167 | | | |
| 28/09/2018 08:04 | 271 | 42.4364 | -15.6306 | U2 | 15 | 35.9321 | 0.5224 | 35.9309 | 20.7237 | | | |
| 28/09/2018 09:22 | 271 | 42.2388 | -15.7821 | U2 | 16 | 35.8441 | 0.5167 | 35.8434 | 20.6477 | | | |
| 28/09/2018 09:24 | 271 | 42.2337 | -15.7860 | U2 | 17 | 35.8562 | 0.5174 | 35.8533 | 20.6600 | | | |
| 28/09/2018 10:29 | 271 | 42.1045 | -15.8834 | U2 | 18 | 35.8748 | 0.5187 | 35.8754 | 20.6695 | | | |
| 28/09/2018 10:31 | 271 | 42.1036 | -15.8825 | U2 | 19 | 35.8744 | 0.5158 | 35.8759 | 20.6668 | | | |
| 28/09/2018 11:55 | 271 | 41.9117 | -16.0363 | U2 | 20 | 35.8803 | 0.5213 | 35.8816 | 20.7156 | | | |
| 28/09/2018 11:57 | 271 | 41.9117 | -16.0363 | U2 | 21 | 35.8809 | 0.5194 | 35.8817 | 20.7170 | | | |
| 28/09/2018 13:39 | 271 | 41.8171 | -16.1104 | U2 | 22 | 35.9427 | 0.5253 | 35.9439 | 20.9428 | | | |
| 28/09/2018 13:40 | 271 | 41.8144 | -16.1124 | U2 | 23 | 35.9346 | 0.5235 | 35.9401 | 20.9459 | | | |
| 28/09/2018 15:02 | 271 | 41.6012 | -16.2799 | U2 | 24 | 35.9516 | 0.5071 | 35.9525 | 20.9448 | | | |
| 28/09/2018 07:45 | 271 | 42.4845 | -15.5919 | U3 | 1 | 35.8712 | 0.5157 | 35.8713 | 20.6246 | | | |
| 28/09/2018 07:48 | 271 | 42.4768 | -15.5979 | U3 | 2 | 35.8807 | 0.5183 | 35.8820 | 20.6337 | | | |
| 28/09/2018 07:49 | 271 | 42.4743 | -15.5999 | U3 | 3 | 35.8833 | 0.5182 | 35.8835 | 20.6335 | | | |
| 28/09/2018 07:51 | 271 | 42.4692 | -15.6038 | U3 | 4 | 35.8848 | 0.5177 | 35.8860 | 20.6327 | | | |
| 28/09/2018 07:53 | 271 | 42.4642 | -15.6079 | U3 | 5 | 35.8852 | 0.5176 | 35.8866 | 20.6427 | | | |
| 28/09/2018 07:57 | 271 | 42.4541 | -15.6162 | U3 | 6 | 35.9048 | 0.5173 | 35.9027 | 20.6962 | | | |
| 28/09/2018 09:27 | 271 | 42.2259 | -15.7919 | U3 | 7 | 35.8692 | 0.5161 | 35.8696 | 20.6761 | | | |
| 28/09/2018 09:28 | 271 | 42.2233 | -15.7938 | U3 | 8 | 35.8744 | 0.5177 | 35.8738 | 20.6773 | | | |
| 28/09/2018 09:31 | 271 | 42.2156 | -15.7997 | U3 | 9 | 35.8748 | 0.5159 | 35.8770 | 20.6802 | | | |
| 28/09/2018 10:22 | 271 | 42.1069 | -15.8836 | U3 | 10 | 35.8714 | 0.5203 | 35.8728 | 20.6646 | | | |

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|---------------------|-----|---------|----------|----|----|---------|--------|---------|---------|--|--|---|
| 28/09/2018 10:24 | 271 | 42.1063 | -15.8834 | U3 | 11 | 35.8716 | 0.5201 | 35.8736 | 20.6651 | | | |
| 28/09/2018 10:26 | 271 | 42.1057 | -15.8833 | U3 | 12 | 35.8734 | 0.5206 | 35.8745 | 20.6663 | | | |
| 28/09/2018 11:59 | 271 | 41.9117 | -16.0363 | U3 | 13 | 35.8801 | 0.5191 | 35.8816 | 20.7177 | | | |
| 28/09/2018 12:00 | 271 | 41.9117 | -16.0363 | U3 | 14 | 35.8807 | 0.5215 | 35.8817 | 20.7178 | | | |
| 28/09/2018 12:02 | 271 | 41.9117 | -16.0363 | U3 | 15 | 35.8813 | 0.5239 | 35.8815 | 20.7191 | | | |
| 28/09/2018 13:35 | 271 | 41.8279 | -16.1028 | U3 | 16 | 35.9394 | 0.5227 | 35.9396 | 20.9389 | | | |
| 28/09/2018 13:37 | 271 | 41.8225 | -16.1065 | U3 | 17 | 35.9439 | 0.5221 | 35.9432 | 20.9490 | | | |
| 28/09/2018 17:53 | 271 | 41.1565 | -16.6211 | U3 | 18 | 36.1381 | 0.5057 | 36.1428 | 21.6245 | | | |
| 28/09/2018 17:56 | 271 | 41.1487 | -16.6271 | U3 | 19 | 36.1246 | 0.5058 | 36.1269 | 21.5856 | | | |
| 28/09/2018 17:57 | 271 | 41.1461 | -16.6291 | U3 | 20 | 36.1128 | 0.5104 | 36.1167 | 21.5764 | | | |
| 29/09/2018 05:09 | 272 | 39.6183 | -17.7851 | U3 | 21 | 36.0782 | 0.5198 | 36.0793 | 21.9119 | | | |
| 29/09/2018 05:12 | 272 | 39.6105 | -17.7908 | U3 | 22 | 36.0831 | 0.5181 | 36.0822 | 21.9195 | | | |
| 29/09/2018 07:54 | 272 | 39.2078 | -18.0977 | U3 | 23 | 36.2030 | 0.5534 | 36.2039 | 22.2964 | | | |
| 29/09/2018 08:07 | 272 | 39.1744 | -18.1223 | U3 | 24 | 36.2050 | 0.5594 | 36.2060 | 22.3158 | | | |
| 29/09/2018 10:51 | 272 | 38.7653 | -18.4225 | U4 | 1 | 36.3104 | 0.5531 | 36.3138 | 22.6663 | | | |
| 29/09/2018 14:14 | 272 | 38.4697 | -18.6440 | U4 | 2 | 36.4151 | 0.5546 | 36.4206 | 22.9573 | | | |
| 29/09/2018 15:24 | 272 | 38.2981 | -18.7581 | U4 | 3 | 36.4294 | 0.5558 | 36.4401 | 23.0085 | | | |
| 29/09/2018 17:54 | 272 | 37.9406 | -19.0252 | U4 | 4 | 36.3288 | 0.5512 | 36.3204 | 23.1744 | | | |
| 30/09/2018 08:04 | 273 | 36.0298 | -20.4050 | U4 | 5 | 36.5779 | 0.5537 | 36.5788 | 23.2769 | | | Ships time back 1 hour to GMT on 30/09/2018. |
| 30/09/2018 11:02 | 273 | 35.5739 | -20.7280 | U4 | 6 | 36.6855 | 0.5936 | 36.6886 | 23.3993 | | | |

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|---------------------|-----|---------|----------|----|----|---------|--------|---------|---------|--------|--------|---|
| 30/09/2018 15:35 | 273 | 35.0731 | -21.0720 | U4 | 7 | 36.6813 | 0.5914 | 36.6839 | 23.9070 | | | |
| 30/09/2018 17:50 | 273 | 34.7199 | -21.2740 | U4 | 8 | 36.7886 | 0.5933 | 36.4285 | 23.6480 | | | |
| 01/10/2018 07:05 | 274 | 32.8381 | -22.2499 | U4 | 9 | 36.6936 | 0.5869 | 36.7011 | 24.3915 | | | |
| 01/10/2018 09:05 | 274 | 32.5263 | -22.4088 | U4 | 10 | 36.6557 | 0.5891 | 36.6401 | 24.1910 | | | |
| 01/10/2018 14:56 | 274 | 31.8313 | -22.7381 | U4 | 11 | 36.7669 | 0.5798 | 36.7683 | 24.3469 | | | Transmittance and fluorometer sensors were wrong way round. |
| 01/10/2018 16:56 | 274 | 31.5072 | -22.9344 | U4 | 12 | 36.9096 | 0.5782 | 36.9137 | 24.3752 | | | Transmitter and fluorometer fixed on 01/10/2018 19:40 |
| 01/10/2018 20:22 | 274 | 30.9174 | -23.2224 | U4 | 13 | 36.9390 | 0.7157 | 36.9362 | 24.3384 | 0.8609 | 0.0996 | |
| 02/10/2018 06:22 | 275 | 29.3537 | -23.9978 | U4 | 14 | 37.0379 | 0.7429 | 37.0345 | 24.7918 | 0.8626 | 0.0499 | |
| 02/10/2018 08:01 | 275 | 29.0586 | -24.1426 | U4 | 15 | 37.4066 | 0.7158 | 37.4031 | 24.9492 | 0.8621 | 0.0971 | |
| 02/10/2018 11:06 | 275 | 28.6090 | -24.3609 | U4 | 16 | 37.4168 | 0.7315 | 37.4139 | 25.5337 | 0.8638 | 0.0436 | |
| 02/10/2018 14:21 | 275 | 28.5303 | -24.3960 | U4 | 17 | 37.3994 | 0.7122 | 37.3957 | 25.2916 | 0.8639 | 0.0282 | |
| 02/10/2018 15:30 | 275 | 28.3364 | -24.4884 | U4 | 18 | 37.2649 | 0.7116 | 37.4172 | 25.6740 | 0.8626 | 0.0309 | |
| 02/10/2018 19:48 | 275 | 27.6743 | -24.8165 | U4 | 19 | 37.2656 | 0.7157 | 37.2667 | 25.8150 | 0.8593 | 0.0584 | |
| 03/10/2018 05:26 | 276 | 26.2038 | -25.5211 | U4 | 20 | 37.2632 | 0.7229 | 37.2674 | 25.1468 | 0.8608 | 0.0802 | |
| 03/10/2018 08:14 | 276 | 25.7222 | -25.7487 | U4 | 21 | 37.2497 | 0.7268 | 37.2429 | 25.1983 | 0.8612 | 0.0857 | |
| 03/10/2018 13:46 | 276 | 25.0577 | -26.0568 | U4 | 22 | 37.3435 | 0.6786 | 37.3413 | 25.8196 | 0.8622 | 0.0447 | |
| 04/10/2018 06:23 | 277 | 22.4769 | -27.2651 | U4 | 23 | 37.0670 | 0.6687 | 37.1338 | 25.7257 | 0.8617 | 0.0686 | |

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|---------------------|-----|---------|----------|----|----|---------|--------|---------|---------|--------|--------|--|
| 04/10/2018 06:25 | 277 | 22.4715 | -27.2680 | U4 | 24 | 37.0362 | 0.6718 | 37.0936 | 25.6477 | 0.8616 | 0.0814 | |
| 04/10/2018 08:07 | 277 | 22.1941 | -27.4031 | U2 | 1 | 37.0616 | 0.6696 | 37.0577 | 25.7633 | 0.8622 | 0.0902 | |
| 04/10/2018 13:42 | 277 | 21.4472 | -27.7453 | U2 | 2 | 37.0906 | 0.6659 | 37.0914 | 26.0723 | 0.8607 | 0.0644 | |
| 04/10/2018 15:51 | 277 | 21.1459 | -27.8808 | U2 | 3 | 36.8754 | 0.7299 | 36.8973 | 26.1878 | 0.8609 | 0.0516 | |
| 04/10/2018 17:07 | 277 | 20.9315 | -27.9846 | U2 | 4 | 36.6375 | 0.7630 | 36.6548 | 26.3363 | 0.8606 | 0.0499 | |
| 04/10/2018 19:43 | 277 | 20.5018 | -28.1810 | U2 | 5 | 36.5769 | 0.7658 | 36.5820 | 26.3820 | 0.8608 | 0.0787 | |
| 05/10/2018 06:17 | 278 | 18.9982 | -28.8176 | U2 | 6 | 36.8020 | 0.7640 | 36.8061 | 26.2292 | 0.8615 | 0.0759 | |
| 05/10/2018 07:58 | 278 | 18.7069 | -28.8489 | U2 | 7 | 36.6929 | 0.7550 | 36.7126 | 26.4600 | 0.8629 | 0.0556 | |
| 05/10/2018 11:55 | 278 | 17.9234 | -28.9188 | U2 | 8 | 36.4880 | 0.7616 | 36.4918 | 26.5568 | 0.8610 | 0.0450 | |
| 05/10/2018 15:58 | 278 | 17.3861 | -28.9968 | U2 | 9 | 36.5486 | 0.7545 | 36.5215 | 26.9696 | 0.8609 | 0.0417 | |
| 05/10/2018 19:51 | 278 | 16.6555 | -28.9686 | U2 | 10 | 36.3693 | 0.7122 | 36.3718 | 27.1234 | 0.8533 | 0.1373 | |
| 06/10/2018 05:05 | 279 | 15.0761 | -28.6126 | U2 | 11 | 36.3214 | 0.7151 | 36.3242 | 27.0825 | 0.8571 | 0.1164 | |
| 06/10/2018 07:59 | 279 | 14.6806 | -28.5210 | U2 | 12 | 36.3397 | 0.7182 | 36.3431 | 27.2682 | 0.8579 | 0.0940 | |
| 06/10/2018 11:57 | 279 | 13.9633 | -28.3395 | U2 | 13 | 36.3342 | 0.7099 | 36.3431 | 27.5525 | 0.8592 | 0.0324 | |
| 06/10/2018 16:24 | 279 | 13.3723 | -28.1923 | U2 | 14 | 36.0636 | 0.7103 | 36.0694 | 28.3907 | 0.8451 | 0.0883 | |
| 06/10/2018 20:30 | 279 | 12.6121 | -28.0005 | U2 | 15 | 36.0559 | 0.7242 | 36.0470 | 28.2557 | 0.8341 | 0.2105 | |
| 07/10/2018 06:08 | 280 | 11.3457 | -27.6811 | U2 | 16 | 35.8788 | 0.7451 | 35.8810 | 28.2084 | 0.8454 | 0.1102 | |
| 07/10/2018 08:00 | 280 | 11.0054 | -27.5980 | U2 | 17 | 35.8097 | 0.7286 | 35.8107 | 28.2258 | 0.8458 | 0.1425 | |
| 07/10/2018 11:04 | 280 | 10.4303 | -27.4085 | U2 | 18 | 35.9887 | 0.7260 | 35.9895 | 28.4477 | 0.8451 | 0.0730 | |
| 07/10/2018 12:54 | 280 | 10.0983 | -27.2939 | U2 | 19 | 35.9051 | 0.7302 | 35.9057 | 28.7398 | 0.8486 | 0.0326 | |
| 07/10/2018 15:40 | 280 | 9.6893 | -27.1731 | U2 | 20 | 35.8442 | 0.7233 | 35.8504 | 28.7917 | 0.8480 | 0.0425 | |

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|---------------------|-----|----------|----------|----|----|---------|--------|---------|---------|--------|--------|--|
| 07/10/2018 20:01 | 280 | 8.8686 | -26.9638 | U2 | 21 | 35.3798 | 0.7265 | 35.3796 | 28.6450 | 0.8443 | 0.0698 | |
| 08/10/2018 07:59 | 281 | 7.0923 | -26.5582 | U2 | 22 | 34.8784 | 0.7371 | 34.8847 | 28.9103 | 0.8445 | 0.0703 | |
| 08/10/2018 12:39 | 281 | 6.2805 | -26.3814 | U2 | 23 | 34.9181 | 0.7091 | 34.9219 | 28.7110 | 0.8448 | 0.0794 | |
| 08/10/2018 16:04 | 281 | 5.9145 | -26.2960 | U2 | 24 | 35.0132 | 0.7032 | 35.0152 | 28.8087 | 0.8415 | 0.0423 | |
| 09/10/2018 08:05 | 282 | 3.4092 | -25.7470 | U3 | 1 | 35.3180 | 0.7247 | 35.3180 | 28.3596 | 0.8379 | 0.0732 | |
| 09/10/2018 12:00 | 282 | 2.7481 | -25.6035 | U3 | 2 | 35.7218 | 0.7256 | 35.7245 | 27.6485 | 0.8397 | 0.0203 | |
| 09/10/2018 16:21 | 282 | 2.0007 | -25.4384 | U3 | 3 | 35.7955 | 0.7321 | 35.7978 | 28.0331 | 0.8376 | 0.0208 | |
| 09/10/2018 20:06 | 282 | 1.3427 | -25.2940 | U3 | 4 | 35.7896 | 0.7399 | 35.7918 | 27.9078 | 0.8348 | 0.0781 | |
| 10/10/2018 07:58 | 283 | -0.3665 | -24.9980 | U3 | 5 | 36.0007 | 0.7346 | 36.0024 | 26.7527 | 0.8305 | 0.2973 | |
| 10/10/2018 12:33 | 283 | -1.1207 | -24.9959 | U3 | 6 | 35.9953 | 0.7335 | 35.9932 | 26.9246 | 0.8276 | 0.0686 | |
| 10/10/2018 16:03 | 283 | -1.4830 | -24.9910 | U3 | 7 | 36.0182 | 0.7240 | 36.0160 | 27.0711 | 0.8288 | 0.0556 | |
| 10/10/2018 19:47 | 283 | -2.1356 | -24.9894 | U3 | 8 | 36.1232 | 0.7139 | 36.1236 | 26.9117 | 0.8285 | 0.0729 | |
| 11/10/2018 08:02 | 284 | -4.1334 | -24.9823 | U3 | 9 | 36.1926 | 0.7108 | 36.1908 | 26.4517 | 0.8277 | 0.1034 | |
| 11/10/2018 11:59 | 284 | -4.8381 | -24.9776 | U3 | 10 | 36.1055 | 0.7077 | 36.1051 | 26.3238 | 0.8282 | 0.0442 | |
| 11/10/2018 16:05 | 284 | -5.3458 | -24.9718 | U3 | 11 | 36.0355 | 0.7159 | 36.0394 | 26.4162 | 0.8263 | 0.0335 | |
| 11/10/2018 20:02 | 284 | -6.0593 | -24.9682 | U3 | 12 | 36.1031 | 0.7178 | 36.1041 | 26.2985 | 0.8255 | 0.0741 | |
| 12/10/2018 08:01 | 285 | -7.9621 | -24.9586 | U3 | 13 | 36.2911 | 0.7153 | 36.2975 | 26.0503 | 0.8281 | 0.0858 | |
| 12/10/2018 12:03 | 285 | -8.6368 | -24.9539 | U3 | 14 | 36.3649 | 0.7217 | 36.3574 | 26.0299 | 0.8275 | 0.0380 | |
| 12/10/2018 16:08 | 285 | -9.1035 | -24.9539 | U3 | 15 | 36.4655 | 0.7307 | 36.4608 | 25.9938 | 0.8277 | 0.0241 | |
| 12/10/2018 20:22 | 285 | -9.8434 | -24.9461 | U3 | 16 | 36.4307 | 0.7315 | 36.4297 | 25.8567 | 0.8260 | 0.0524 | |
| 13/10/2018 08:00 | 286 | -11.6867 | -24.9339 | U3 | 17 | 36.6536 | 0.7276 | 36.6503 | 25.2649 | 0.8268 | 0.0589 | |

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|---------------------|-----|----------|----------|----|----|---------|--------|---------|---------|--------|-------------|--|
| 13/10/2018 11:58 | 286 | -12.0828 | -24.9303 | U3 | 18 | 36.6514 | 0.7334 | 36.6533 | 25.3121 | 0.8252 | 0.0446 | |
| 13/10/2018 16:00 | 286 | -12.4776 | -24.9797 | U3 | 19 | 36.6675 | 0.7378 | 36.6644 | 25.3553 | 0.8245 | 0.0350 | |
| 13/10/2018 20:05 | 286 | -13.2489 | -24.9552 | U3 | 20 | 36.8635 | 0.7340 | 36.8615 | 24.8418 | 0.8246 | 0.0537 | |
| 14/10/2018 08:02 | 287 | -15.2512 | -25.0023 | U3 | 21 | 37.1007 | 0.7192 | 37.0955 | 24.0269 | 0.8251 | 0.0618 | |
| 14/10/2018 12:00 | 287 | -15.8933 | -25.0224 | U3 | 22 | 37.1199 | 0.7154 | 37.1156 | 23.8760 | 0.8252 | 0.0165 | |
| 14/10/2018 16:00 | 287 | -16.3475 | -25.0416 | U3 | 23 | 37.1788 | 0.7129 | 37.1728 | 24.1333 | 0.8253 | 0.0345 | |
| 14/10/2018 21:01 | 287 | -17.1636 | -25.0609 | U3 | 24 | 37.0144 | 0.7083 | 37.0096 | 23.7360 | 0.8263 | 0.0432 | |
| 15/10/2018 07:57 | 288 | -18.5528 | -25.0896 | U2 | 1 | 36.8699 | 0.7070 | 36.8673 | 23.3344 | 0.8257 | 0.0278 | |
| 15/10/2018 12:31 | 288 | -18.5784 | -25.0864 | U2 | 2 | 36.8751 | 0.7077 | 36.8709 | 23.4776 | 0.8245 | 0.0034 | |
| 15/10/2018 16:19 | 288 | -18.5451 | -25.0801 | U2 | 3 | 36.8731 | 0.7076 | 36.8707 | 23.4656 | 0.8241 | 0.0134 | |
| 15/10/2018 19:59 | 288 | -18.9719 | -25.0841 | U2 | 4 | 36.9133 | 0.7220 | 36.9096 | 23.5107 | 0.8234 | 0.0295 | |
| 16/10/2018 08:01 | 289 | -20.7784 | -25.0582 | U2 | 5 | 36.9211 | 0.7262 | 36.9136 | 23.1652 | 0.8227 | 0.0273 | |
| 16/10/2018 16:05 | 289 | -21.9372 | -25.0362 | U2 | 6 | 36.9750 | 0.7073 | 36.9733 | 23.1765 | 0.8222 | 0.0472 | |
| 16/10/2018 11:54 | 289 | -21.4502 | -25.0467 | U2 | 7 | 37.0048 | 0.7125 | 37.0002 | 23.2550 | 0.8217 | 0.0146 | |
| 16/10/2018 20:03 | 289 | -22.6194 | -25.0248 | U2 | 8 | 36.8972 | 0.7132 | 36.8974 | 22.8468 | 0.8233 | 0.0497 | |
| 17/10/2018 09:04 | 290 | -24.4548 | -25.4560 | U2 | 9 | 36.6402 | 0.7211 | 36.6360 | 21.6467 | 0.8244 | 0.0463 | |
| 17/10/2018 12:10 | 290 | -24.8225 | -25.8288 | U2 | 10 | 36.6017 | 0.7225 | 36.5932 | 21.5015 | 0.8274 | 0.0082 | |
| 17/10/2018 16:03 | 290 | -25.1363 | -26.1514 | U2 | 11 | 36.6826 | 0.7236 | 36.6804 | 21.9907 | 0.8346 | 0.0086 | |
| 17/10/2018 20:03 | 290 | -25.5437 | -26.5810 | U2 | 12 | 36.6343 | 0.7215 | 36.6283 | 21.6430 | 0.8384 | 0.0475 | |
| 18/10/2018 08:00 | 291 | -26.9173 | -27.9595 | U2 | 13 | 36.4904 | 0.7056 | 36.4853 | 20.6687 | 0.8535 | 0.0454 | |
| 18/10/2018 14:51 | 291 | -27.4687 | -28.5123 | U2 | 14 | 36.5036 | 0.7013 | 36.4989 | 21.0866 | 0.8663 | - 0.0040 | |

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|---------------------|-----|----------|----------|----|----|---------|--------|---------|---------|--------|-------------|--|
| 18/10/2018 16:06 | 291 | -27.6195 | -28.6510 | U2 | 15 | 36.4936 | 0.7155 | 36.4825 | 21.1752 | 0.8693 | - 0.0008 | |
| 18/10/2018 20:12 | 291 | -28.1110 | -29.1727 | U2 | 16 | 36.6045 | 0.7188 | 36.5995 | 21.5497 | 0.8728 | 0.0530 | |
| 19/10/2018 08:00 | 292 | -29.4284 | -30.5460 | U2 | 17 | 36.1133 | 0.7231 | 36.1069 | 19.9159 | 0.8816 | 0.0302 | |
| 19/10/2018 11:55 | 292 | -29.9062 | -31.0355 | U2 | 18 | 36.0105 | 0.7034 | 35.9995 | 19.5397 | 0.8745 | - 0.0030 | |
| 19/10/2018 16:00 | 292 | -30.2526 | -31.4035 | U2 | 19 | 35.8282 | 0.7113 | 35.8213 | 18.4733 | 0.8785 | 0.0397 | |
| 19/10/2018 20:10 | 292 | -30.7737 | -31.9644 | U2 | 20 | 35.8592 | 0.6995 | 35.8540 | 18.3953 | 0.8833 | 0.0270 | |
| 20/10/2018 08:01 | 293 | -31.7971 | -33.0624 | U2 | 21 | 35.9898 | 0.7148 | 35.9829 | 18.6744 | 0.8884 | 0.0904 | |
| 20/10/2018 12:00 | 293 | -32.2647 | -33.5617 | U2 | 22 | 35.9731 | 0.7057 | 35.9665 | 18.4406 | 0.8924 | - 0.0100 | |
| 20/10/2018 16:22 | 293 | -32.4856 | -33.7993 | U2 | 23 | 35.9767 | 0.7213 | 35.9695 | 18.5317 | 0.8918 | 0.0289 | |
| 20/10/2018 20:26 | 293 | -32.9769 | -34.3333 | U2 | 24 | 35.9622 | 0.6779 | 35.9554 | 18.2119 | 0.8957 | 0.1067 | |
| 21/10/2018 08:00 | 294 | -34.0505 | -35.5071 | U4 | 1 | 35.6411 | 0.6707 | 35.6522 | 16.5897 | 0.8987 | 0.1187 | |
| 21/10/2018 11:56 | 294 | -34.4789 | -35.9826 | U4 | 2 | 35.5944 | 0.6605 | 35.6066 | 16.3900 | 0.8997 | 0.0675 | |
| 21/10/2018 16:06 | 294 | -34.7042 | -36.2234 | U4 | 3 | 35.5992 | 0.6704 | 35.6095 | 16.4365 | 0.8971 | 0.0503 | |
| 21/10/2018 20:15 | 294 | -35.2068 | -36.7904 | U4 | 4 | 35.6113 | 0.6694 | 35.6207 | 16.3062 | 0.8970 | 0.3535 | |
| 22/10/2018 07:59 | 295 | -36.4319 | -38.1683 | U4 | 5 | 35.7201 | 0.6802 | 35.7291 | 15.4925 | 0.9012 | 0.6536 | |
| 22/10/2018 14:51 | 295 | -37.0475 | -38.8733 | U4 | 6 | 35.9097 | 0.6765 | 35.9207 | 16.7386 | 0.9021 | 0.2174 | |
| 22/10/2018 16:02 | 295 | -37.1852 | -39.0323 | U4 | 7 | 35.8961 | 0.6801 | 35.8994 | 16.4385 | 0.8988 | 0.4562 | |
| 22/10/2018 20:04 | 295 | -37.6776 | -39.5941 | U4 | 8 | 35.5856 | 0.6786 | 35.5931 | 15.4148 | 0.8843 | 1.1328 | |
| 23/10/2018 07:57 | 296 | -38.8187 | -40.9184 | U4 | 9 | 35.3736 | 0.6774 | 35.3810 | 14.1150 | 0.8843 | 1.2555 | |
| 23/10/2018 11:55 | 296 | -39.1554 | -41.3745 | U4 | 10 | 34.9845 | 0.6602 | 34.9925 | 12.7197 | 0.8753 | 0.6917 | |
| 23/10/2018 17:01 | 296 | -39.3853 | -41.6987 | U4 | 11 | 35.1057 | 0.6652 | 35.1127 | 13.1057 | 0.8779 | 0.6910 | |

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|---------------------|-----|----------|----------|----|----|---------|--------|---------|---------|--------|--------|--|
| 23/10/2018 19:43 | 296 | -39.6435 | -42.0145 | U4 | 12 | 35.0934 | 0.6625 | 35.0994 | 12.9800 | 0.8812 | 1.1046 | |
| 24/10/2018 08:00 | 297 | -40.7748 | -43.3661 | U4 | 13 | 35.0194 | 0.6678 | 35.0266 | 12.5914 | 0.8816 | 1.2462 | |
| 24/10/2018 11:55 | 297 | -41.2626 | -43.8967 | U4 | 14 | 34.9761 | 0.6592 | 34.9829 | 12.2789 | 0.8846 | 0.4644 | |
| 24/10/2018 16:12 | 297 | -41.5104 | -44.1794 | U4 | 15 | 34.9959 | 0.6626 | 35.0020 | 12.4576 | 0.8794 | 0.5473 | |
| 24/10/2018 20:01 | 297 | -41.9631 | -44.7160 | U4 | 16 | 34.6795 | 0.6646 | 34.6846 | 11.4685 | 0.8772 | 1.2429 | |
| 25/10/2018 08:57 | 298 | -43.2541 | -46.2859 | U4 | 17 | 34.7681 | 0.6563 | 34.7732 | 11.5129 | 0.8795 | 0.9511 | Ships time back one hour to GMT -1 hour |
| 25/10/2018 14:38 | 298 | -43.7905 | -46.9552 | U4 | 18 | 34.4959 | 0.6540 | 34.5002 | 9.7928 | 0.8683 | 0.6321 | |
| 25/10/2018 17:08 | 298 | -43.9978 | -47.2235 | U4 | 19 | 34.5242 | 0.6565 | 34.5271 | 9.8341 | 0.8703 | 0.2902 | |
| 25/10/2018 21:09 | 298 | -44.4217 | -47.7643 | U4 | 20 | 34.5058 | 0.6662 | 34.5149 | 9.6933 | 0.8659 | 0.9911 | |
| 26/10/2018 09:09 | 299 | -45.5346 | -49.3118 | U4 | 21 | 34.5307 | 0.6563 | 34.5505 | 9.7903 | 0.8690 | 1.0273 | |
| 26/10/2018 14:15 | 299 | -46.0176 | -49.8723 | U4 | 22 | 34.6651 | 0.6430 | 34.6696 | 9.7062 | 0.8506 | 0.6221 | |
| 26/10/2018 16:54 | 299 | -46.1886 | -50.0671 | U4 | 23 | 34.6743 | 0.6464 | 34.6802 | 9.7931 | 0.8504 | 0.6270 | |
| 26/10/2018 20:37 | 299 | -46.5984 | -50.5160 | U4 | 24 | 34.6763 | 0.6420 | 34.6829 | 9.6555 | 0.8573 | 1.0374 | |
| 27/10/2018 | 300 | | | | | | | | | | | Underway system switched off |

Extraction of Algal Pigments for High Performance Liquid Chromatography (HPLC) Analysis

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Cruise Objectives

- Assess the phytoplankton pigment composition along the AMT28 transect at the surface and subsurface chlorophyll maximum.
- Ensure the continuation of a consistent and spatially extensive 23-year time series of phytoplankton pigment structure data along the Atlantic Ocean.
- Contribute, by providing extensive phytoplankton pigment data, to the development and validation of remote sensing algorithms and marine ecosystem models designed to predict and model phytoplankton biomass and community structure.

Methods

Seawater samples were collected from the pre-dawn and noon CTD casts, and from the ship’s underway system. 9.5 L polypropylene (PP) carboys - covered in black plastic to keep light out – were used to sample the seawater. Seawater samples were primarily mixed to avoid sedimentation and subsequently filtered through Fisher Scientific GF/F 25 mm ø glass fibre filters. The GF/F filters were always placed on the filtration rig with its smoother side facing down. 2-4 L of seawater were filtered per sample, depending on the extant phytoplankton biomass (e.g. 2 L in more productive waters and 4 L in the oligotrophic gyres). Samples were filtered using a low-to-medium vacuum setting on the vacuum pump. Resulting sample filters were folded into cryovials, flash-frozen in liquid nitrogen and stored in the -80° freezer.

For each station, duplicate samples were taken at both surface (5 m) and the subsurface chlorophyll maximum (ranging between 12-170 m). Two daily samples were also taken using the ship’s underway system, one during the noon station and another at night (around 20:00 ship time), in order to compare with surface CTD samples and towards calibrating the ACS optics instrument). Frozen samples are to be analysed following the proceedings of Van Heukelem & Thomas (2001). Tables 1 and 2 show the location, station and details from the CTD and underway system samples, respectively.

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

Table 1 – Summary of the CTD casts HPLC samples on AMT28.

| Date | Time (GMT) | Station | CTD Cast | Lat | Lon | Depths sampled (m) |
|-------------|-------------------|----------------|-----------------|----------------|----------------|---------------------------|
| 25/09/2018 | 1235 | 1 | 002 | 49° 38,285' N | 5° 30,096' W | 5, 12 |
| 26/09/2018 | 0334 | 2 | 003 | 48° 28,165' N | 8° 50,193' W | 5, 60 |
| 26/09/2018 | 1210 | 3 | 004 | 47° 54,073' N | 10° 23,884' W | 5, 30 |
| 27/09/2018 | 0330 | 4 | 004 | 46° 01,745' N | 12° 43,950' W | 5, 60 |
| 27/09/2018 | 1207 | 5 | 005 | 44° 58,715' N | 13° 35,363' W | 5, 40 |
| 28/09/2018 | 0333 | 6 | 006 | 42° 58,022' N | 15° 12,784' W | 5, 52 |
| 28/09/2018 | 1201 | 7 | 007 | 41°54,700' N | 16°02,179' W | 5, 52 |
| 29/09/2018 | 0334 | 8 | 008 | 39° 43,158 ' N | 17° 42,968' W | 5, 71 |
| 29/09/2018 | 1200 | 9 | 009 | 38° 37,851' N | 18° 31,541' W | 5, 70 |
| 30/09/2018 | 0434 | 10 | 010 | 36° 24,836' N | 20° 07,287' W | 5, 105 |
| 30/09/2018 | 1259 | 11 | 011 | 35° 18,121' N | 20° 54,912' W | 5, 105 |
| 01/10/2018 | 0438 | 12 | 012 | 33° 2,816' N | 22° 08',206' W | 5, 90 |
| 01/10/2018 | 1307 | 13 | 013 | 31° 55,442' N | 22° 42,611' W | 5, 85 |
| 02/10/2018 | 0437 | 14 | 014 | 29° 29,299' N | 23° 55,948' W | 5, 114 |
| 02/10/2018 | 1050 | 15 | 015 | 28° 36,544' N | 24° 21,650' W | 5, 135 |
| 03/10/2018 | 0437 | 16 | 016 | 26° 12,227' N | 25° 31,264' W | 5, 107 |
| 03/10/2018 | 1301 | 17 | 017 | 25° 03,461' N | 26° 03,408' W | 5, 120 |
| 04/10/2018 | 0437 | 18 | 018 | 22° 35,980' N | 27° 12,800' W | 5, 93 |
| 04/10/2018 | 1301 | 19 | 019 | 21° 26.830' N | 27° 44.720' W | 5, 120 |
| 05/10/2018 | 0438 | 20 | 020 | 19° 04,664' N | 28° 49,004' W | 5, 93 |
| 05/10/2018 | 1301 | 21 | 021 | 17° 44,837' N | 28° 55,814' W | 5, 65 |
| 06/10/2018 | 0438 | 22 | 022 | 15° 04, 566' N | 28° 36,756' W | 5, 57 |
| 06/10/2018 | 1301 | 23 | 023 | 13° 48,630' N | 28° 17,763' W | 5, 60 |
| 07/10/2018 | 0437 | 24 | 024 | 11° 26,819' N | 27° 42,524' W | 5, 50 |
| 07/10/2018 | 1300 | 25 | 025 | 10° 05,894' N | 27° 17,629' W | 5, 40 |

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|------------|------|----|-----|---------------|---------------|--------|
| 08/10/2018 | 0438 | 27 | 026 | 07° 28,277' N | 26° 39,007' W | 5, 72 |
| 08/10/2018 | 1302 | 28 | 027 | 06° 15,359' N | 26° 22,796' W | 5, 64 |
| 09/10/2018 | 0439 | 29 | 028 | 03° 48,465' N | 25° 50,148' W | 5, 89 |
| 10/10/2018 | 0446 | 30 | 029 | 00° 00,031' S | 24° 59,953' W | 5, 60 |
| 10/10/2018 | 1304 | 31 | 030 | 01° 09,109' S | 24° 59,435' W | 5, 75 |
| 11/10/2018 | 0430 | 32 | 031 | 03° 41,467' S | 24° 58,694' W | 5, 60 |
| 11/10/2018 | 1302 | 33 | 032 | 04° 59,077' S | 24° 58,392' W | 5, 74 |
| 12/10/2018 | 0439 | 34 | 033 | 07° 32,922' S | 24° 57,444' W | 5, 110 |
| 12/10/2018 | 1301 | 35 | 034 | 08° 45,785' S | 24° 56,904' W | 5, 120 |
| 13/10/2018 | 0435 | 36 | 035 | 11° 15,739' S | 24° 56,250' W | 5, 122 |
| 13/10/2018 | 1033 | 37 | 036 | 12° 04,969' S | 24° 55,818' W | 5, 111 |
| 14/10/2018 | 0435 | 38 | 037 | 14° 46,784' S | 24° 59,086' W | 5, 145 |
| 14/10/2018 | 1307 | 40 | 038 | 16° 01,942' S | 25° 01,412' W | 5, 160 |
| 15/10/2018 | 0435 | 41 | 039 | 18° 20,357' S | 25° 05,143' W | 5, 152 |
| 16/10/2018 | 0449 | 43 | 040 | 20° 22,761' S | 25° 03,565' W | 5, 161 |
| 16/10/2018 | 1301 | 44 | 041 | 21° 36,224' S | 25° 02,786' W | 5, 170 |
| 17/10/2018 | 0431 | 45 | 042 | 23° 59,974' S | 24° 59,965' W | 5, 140 |
| 17/10/2018 | 1303 | 46 | 043 | 24° 54,350' S | 25° 54,196' W | 5, 140 |
| 18/10/2018 | 0443 | 47 | 044 | 26° 37,678' S | 27° 39,321' W | 5, 127 |
| 18/10/2018 | 1036 | 48 | 045 | 27° 12,003' S | 28° 15,001' W | 5, 140 |
| 19/10/2018 | 0436 | 49 | 046 | 29° 07,655' S | 30° 13,409' W | 5, 130 |
| 19/10/2018 | 1301 | 50 | 047 | 30° 00,355' S | 31° 06,982' W | 5, 109 |
| 20/10/2018 | 0445 | 51 | 048 | 31° 37,104' S | 32° 53,058' W | 5, 131 |
| 20/10/2018 | 1312 | 52 | 049 | 32° 22,371' S | 33° 40,448' W | 5, 85 |
| 21/10/2018 | 0440 | 53 | 050 | 33° 49,894' S | 35° 16,130' W | 5, 80 |
| 21/10/2018 | 1310 | 54 | 051 | 34° 34,830' S | 36° 05,486' W | 5, 70 |
| 22/10/2018 | 0445 | 55 | 052 | 36° 10,029' S | 37° 51,980' W | 5, 70 |
| 22/10/2018 | 1315 | 56 | 053 | 37° 00,723' S | 38° 50,077' W | 5, 40 |

| | | | | | | |
|------------|------|----|-----|---------------|---------------|-------|
| 23/10/2018 | 0437 | 57 | 054 | 38° 35,043' S | 40° 39,307' W | 7, 65 |
| 23/10/2018 | 1311 | 58 | 055 | 39° 12,560' S | 41° 28,505' W | 8, 30 |
| 24/10/2018 | 0441 | 59 | 056 | 40° 31,255' S | 43° 04,973' W | 5, 40 |
| 24/10/2018 | 1309 | 60 | 057 | 41° 22,179' S | 44° 00,764' W | 5, 35 |
| 25/10/2018 | 0540 | 61 | 058 | 43° 00,361' S | 45° 58,902' W | 5, 55 |
| 25/10/2018 | 1406 | 62 | 059 | 43° 47,429' S | 46° 57,313' W | 5, 38 |
| 26/10/2018 | 0538 | 63 | 060 | 45° 17,852' S | 48° 53,785' W | 5, 53 |
| 26/10/2018 | 1409 | 64 | 061 | 46° 01,052' S | 49° 52,339' W | 5, 30 |
| 27/10/2018 | 0637 | 65 | 062 | 47° 33,709' S | 51° 46,436' W | 5, 66 |
| 27/10/2018 | 1503 | 66 | 063 | 48° 11,932' S | 52° 41,362' W | 5, 40 |

Table 2 – Summary of the underway system HPLC samples on AMT28.

| Date | Time (GMT) | Station | Lat | Lon | Depths sampled (m) |
|------------|------------|---------|-------------|-------------|--------------------|
| 26/09/2018 | 1250 | AA | 47°54.074'N | 10°22.885'W | 5 |
| 26/09/2018 | 1853 | AB | 47°21.610'N | 11°37.041'W | 5 |
| 27/09/2018 | 1252 | AC | 44°58.715'N | 13°35.36'W | 5 |
| 27/09/2018 | 1925 | AD | 43°51.548'N | 14°30.508'W | 5 |
| 28/09/2018 | 1227 | AE | 41°54.700'N | 16°02.179'W | 5 |
| 28/09/2018 | 1935 | AF | 40°47.320'N | 16°54.317'W | 5 |
| 29/09/2018 | 1225 | AG | 38°37.851'N | 18°31.541'W | 5 |
| 29/09/2018 | 1937 | AH | 37°45.555'N | 19°09.603'W | 5 |
| 30/09/2018 | 1334 | AI | 35°18.121'N | 20°54.912'W | 5 |
| 30/09/2018 | 1945 | AJ | 34°27.315'N | 21°24.378'W | 5 |
| 01/10/2018 | 1343 | AK | 31°55.442'N | 22°42.611'W | 5 |
| 01/10/2018 | 2040 | AL | 30°47.574'N | 23°17.178'W | 5 |
| 02/10/2018 | 1343 | AM | 28°36.544'N | 24°21.650'W | 5 |
| 02/10/2018 | 2042 | AN | 27°45.850'N | 24°46.320'W | 5 |
| 03/10/2018 | 1340 | AO | 25°3.461'N | 26°3.408'W | 5 |
| 03/10/2018 | 2043 | AP | 23°57.279'N | 26°35.125'W | 5 |

| | | | | | |
|------------|------|----|-------------|-------------|---|
| 04/10/2018 | 1340 | AQ | 21°26.830'N | 27°44.720'W | 5 |
| 04/10/2018 | 2015 | AR | 20°31.965'N | 28°10.032'W | 5 |
| 05/10/2018 | 1348 | AS | 17°44.839'N | 28°55.814'W | 5 |
| 05/10/2018 | 2015 | AT | 16°35.861'N | 28°57.739'W | 5 |
| 06/10/2018 | 1343 | AU | 13°48.730'N | 28°17.673'W | 5 |
| 06/10/2018 | 2053 | AV | 12°30.818'N | 27°58.420'W | 5 |
| 07/10/2018 | 1328 | AX | 10°5.894'N | 27°17.629'W | 5 |
| 07/10/2018 | 2015 | AW | 08°42.729'N | 26°55.857'W | 5 |
| 08/10/2018 | 1340 | AY | 06°15.359'N | 26°22.796'W | 5 |
| 08/10/2018 | 2023 | AZ | 05°12.009'N | 26°08.523'W | 5 |
| 09/10/2018 | 2040 | BA | 01°12.138'N | 24°59.435'W | 5 |
| 10/10/2018 | 1343 | BB | 01°9.109'S | 24°59.435'W | 5 |
| 10/10/2018 | 2115 | BC | 02°27.508'S | 24°59.245'W | 5 |
| 11/10/2018 | 1342 | BD | 04°59.077'S | 24°58.392'W | 5 |
| 11/10/2018 | 2043 | BE | 06°11.458'S | 24°58.009'W | 5 |
| 12/10/2018 | 1338 | BF | 08°45.785'S | 24°56.904'W | 5 |
| 12/10/2018 | 2053 | BG | 09°57.476'S | 24°56.730'W | 5 |
| 13/10/2018 | 1331 | BH | 12°4.969'S | 24°55.818'W | 5 |
| 13/10/2018 | 1943 | BI | 13°13.998'S | 24°57.294'W | 5 |
| 14/10/2018 | 1347 | BJ | 16°1.942'S | 25°1.412'W | 5 |
| 14/10/2018 | 1956 | BK | 17°0.989'S | 25°3.417'W | 5 |
| 15/10/2018 | 1343 | BL | 18°34.708'S | 25°5.185'W | 5 |
| 15/10/2018 | 1958 | BM | 19°01.466'S | 25°5.046'W | 5 |
| 16/10/2018 | 1338 | BN | 21°36.224'S | 25°2.786'W | 5 |
| 16/10/2018 | 1957 | BO | 22°48.540'S | 25°1.441'W | 5 |
| 17/10/2018 | 1338 | BP | 24°54.35'S | 25°54.196'W | 5 |
| 17/10/2018 | 2044 | BQ | 25°38.621'S | 26°40.649'W | 5 |
| 18/10/2018 | 1230 | BR | 27°12.003'S | 28°15.011'W | 5 |
| 18/10/2018 | 2030 | BS | 28°09.559'S | 29°13.664'W | 5 |

| | | | | | |
|------------|------|----|-------------|-------------|---|
| 19/10/2018 | 1344 | BT | 30°0.355'S | 31°8.982'W | 5 |
| 19/10/2018 | 2014 | BU | 30°46.447'S | 31°57.894'W | 5 |
| 20/10/2018 | 1515 | BV | 32°22.371'S | 33°40.448'W | 5 |
| 20/10/2018 | 2126 | BX | 33°05.817'S | 34°27.761'W | 5 |
| 21/10/2018 | 1555 | BW | 34°34.830'S | 36°5.486'W | 5 |
| 21/10/2018 | 2025 | BY | 35°19.405'S | 36°55.129'W | 5 |
| 22/10/2018 | 1354 | BZ | 37°0.723'S | 38°50.077'W | 5 |
| 22/10/2018 | 2020 | CA | 37°44.161'S | 39°39.648'W | 5 |
| 23/10/2018 | 1457 | CB | 39°12.560'S | 41°28.501'W | 5 |
| 23/10/2018 | 2019 | CC | 39°42.036'S | 42°05.176'W | 5 |
| 24/10/2018 | 1455 | CD | 41°22.179'S | 44°0.764'W | 5 |
| 24/10/2018 | 1958 | CE | 41°58.384'S | 44°43.668'W | 5 |
| 25/10/2018 | 1451 | CF | 43°47.429'S | 46°57.313'W | 5 |
| 25/10/2018 | 2051 | CG | 44°24.629'S | 47°45.020'W | 5 |
| 26/10/2018 | 1522 | CH | 46°01.052'S | 49°52.339'W | 5 |
| 26/10/2018 | 2050 | CI | 46°37.986'S | 50°33.285'W | 5 |
| 27/10/2018 | 1551 | CJ | 48°11.932'S | 52°41.362'W | 5 |

Effects of Saharan Dust on Coccolithophore Communities

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Cruise Objectives

Explore the potential role of Saharan dust as a nutrient fertilizer for marine phytoplankton in the Atlantic Ocean, particularly on the biogeochemically important coccolithophores. To that aim, the following samples were collected: (a) plankton samples for the study of the coccolithophore communities, and (b) aerosol samples to quantify the amount and composition of dust deposited in the ocean and investigate their link to changes in phytoplankton biomass, N-fixing organisms and coccolithophore species.

Methods

For the coccolithophore analysis, 2 to 5 L of water was taken directly from the Niskin bottles of the CTD-rosette, sampled at discrete water depths from the surface to the base of the photic layer. The samples were then filtered through cellulose nitrate filters (47 mm diameter, 0.45 µm pore size) by means of a water jet pump immediately on board. After filtering, the filters were washed with a solution of Na₂CO₃ + NaHCO₃, dried at room temperature and stored in petri dishes.

Species composition and abundance will be further determined at MARE-FCUL by taxonomic identification and counting on measured filter transects, using Polarising Light- and Scanning Electron Microscopes (SEM).

For the dust analysis, samples were collected using an Anderson high-volume dust collector, which sucks air through an air filter, covered with a rain cover. The dust collector was mounted on the deck above the bridge of the ship. Cellulose acetate filters were used to collect the dust by placing them on the dust collector for 24-48 h, depending on the aerosol deposition (e.g. 24 h in areas with higher depositions, 48 h if aerosol deposition was noticeably low after 24 h). The dust collector was equipped with a logger to monitor the volume of air collected and increase the suction when the filter got loaded with material, so that the air flow was kept constant. The filter cassette was taken from the dust collector, and the filter unloaded and replaced safely under a laminar flow cabinet in the laboratory. Resulting filters were stored in the ship's -20°C freezer and will later be analysed for trace elements, as well as dust particle-size and bulk-composition.

References

- Baker, A.R., French, M., Linge, K.L. 2006. Trends in aerosol nutrient solubility along a west-east transect of the Saharan dust plume. *Geophysical Research Letters* 33(7), L07805.
- Baker, A.R., Jickells, T.D. 2016. Atmospheric deposition of soluble trace elements along the Atlantic Meridional Transect (AMT). *Progress in Oceanography* 158, 41-51.
- Guerreiro, C., Oliveira, A., De Stigter, H., Cachao, M., Sa, C., Borges, C., Cros, L., Quaresma, L., Santos, A.I., Fortunato, J.M., Rodrigues, A. 2013. Late winter coccolithophore bloom off central Portugal in response to river discharge and upwelling. *Continental Shelf Research* 59, 65 - 83.
- McIntyre, A., Bé, A. 1967. Modern coccolithophoridae of the atlantic ocean—I. Placoliths and cyrtoliths. *Deep-Sea Research* 14, 561–597.
- Winter, A., Siesser, W.G., 1994. *Coccolithophores*. Cambridge University Press, New York, 242 PP. ISBN 0-521-38050-2

Table 1: Seawater sampling from CTD casts for coccolithophore analysis

| Date | Time | Station No | CTD Cast | Lat | Lon (W) | Depths Sampled (m) |
|------------|------|------------|----------|---------------|-------------|--------------------|
| 25/09/2018 | 1235 | 01 | 01 | 49° 38,285' N | 5° 30,096' | 80; 60; 22; 12; 5 |
| 26/09/2018 | 0334 | 02 | 02 | 48° 28,165' N | 8° 50,193' | 100; 60; 20; 10; 5 |
| 26/09/2018 | 1210 | 03 | 03 | 47° 54,073' N | 10° 23,884' | 150; 50; 30; 20; 5 |
| 27/09/2018 | 0330 | 04 | 04 | 46° 01,745' N | 12° 43,950' | 150; 70; 20; 10; 5 |
| 27/09/2018 | 1207 | 05 | 05 | 44° 58,715' N | 13° 35,363' | 150; 50; 40; 20; 5 |
| 28/09/2018 | 0333 | 06 | 06 | 42° 58,022' N | 15° 12,784' | 150; 60; 52; 20; 5 |
| 28/09/2018 | 1201 | 07 | 07 | 41°54,700' N | 16°02,179' | 150; 56; 50; 20; 5 |

| | | | | | | |
|------------|------|----|----|----------------|--------------|-----------------------|
| 29/09/2018 | 0334 | 08 | 08 | 39° 43,158' N | 17° 42,968' | 150; 81; 71; 20; 5 |
| 29/09/2018 | 1200 | 09 | 09 | 38° 37,851' N | 18° 31,541' | 150; 70; 50; 20; 5 |
| 30/09/2018 | 0436 | 10 | 10 | 36° 24,836' N | 20° 07,287' | 150; 115; 105; 20; 5 |
| 30/09/2018 | 1259 | 11 | 11 | 35° 18,121' N | 20° 54,912' | 150; 105; 50; 20; 5 |
| 01/10/2018 | 0438 | 12 | 12 | 33° 2,816' N | 22° 08',206' | 150; 100; 90; 50; 5 |
| 01/10/2018 | 1307 | 13 | 13 | 31° 55,442' N | 22° 42,611' | 150; 120; 85; 50; 5 |
| 02/10/2018 | 0435 | 14 | 14 | 29° 29,299' N | 23° 55,948' | 200; 150; 114; 50; 5 |
| 02/10/2018 | 1050 | 15 | 15 | 28° 36,544' N | 24° 21,650' | 200; 150; 135; 50; 5 |
| 03/10/2018 | 0436 | 16 | 16 | 26° 12,227' N | 25° 31,264' | 200; 150; 107; 50; 5 |
| 03/10/2018 | 1301 | 17 | 17 | 25° 03,461' N | 26° 03,408' | 200; 140; 120; 50; 5 |
| 04/10/2018 | 0436 | 18 | 18 | 22° 35,980' N | 27° 12,800' | 200; 150; 93; 50; 5 |
| 04/10/2018 | 1301 | 19 | 19 | 21° 26,830' N | 27° 44,720' | 200; 140; 120; 50; 5 |
| 05/10/2018 | 0438 | 20 | 20 | 19° 04,664' N | 28° 49,004' | 200; 150; 90; 50; 5 |
| 05/10/2018 | 1301 | 21 | 21 | 17° 44,837' N | 28° 55,814' | 200; 100; 65; 50; 5 |
| 06/10/2018 | 0438 | 22 | 22 | 15° 04, 566' N | 28° 36,756' | 150; 100; 57; 20; 5 |
| 06/10/2018 | 1301 | 23 | 23 | 13° 48,630' N | 28° 17,763' | 150; 85; 60; 50; 5 |
| 07/10/2018 | 0437 | 24 | 24 | 11° 26,819' N | 27° 42,524' | 150; 100; 50; 20; 5 |
| 07/10/2018 | 1300 | 25 | 25 | 10° 05,894' N | 27° 17,629' | 150; 70; 40; 20; 5 |
| 08/10/2018 | 0438 | 27 | 26 | 07° 28,277' N | 26° 39,007' | 150; 100; 72; 50; 5 |
| 08/10/2018 | 1302 | 28 | 27 | 06° 15,359' N | 26° 22,796' | 150; 85; 64; 30; 5 |
| 09/10/2018 | 0439 | 29 | 28 | 03° 48,465' N | 25° 50,148' | 200; 150; 89; 50; 5 |
| 10/10/2018 | 0446 | 30 | 29 | 00° 00,031' S | 24° 59,953' | 150; 70; 60; 50; 5 |
| 10/10/2018 | 1304 | 31 | 30 | 01° 09,109' S | 24° 59,435' | 120; 90; 75; 30; 5 |
| 11/10/2018 | 0460 | 32 | 31 | 03° 41,467' S | 24° 58,694' | 150; 90; 60; 50; 5 |
| 11/10/2018 | 1302 | 33 | 32 | 04° 59,077' S | 24° 58,392' | 125; 90; 74; 50; 5 |
| 12/10/2018 | 0439 | 34 | 33 | 07° 32,922' S | 24° 57,444' | 200; 150; 110; 50; 5 |
| 12/10/2018 | 1301 | 35 | 34 | 08° 45,785' S | 24° 56,904' | 175; 135; 120; 65; 5 |
| 13/10/2018 | 0435 | 36 | 35 | 11° 15,739' S | 24° 56,250' | 200; 150; 122; 110; 5 |
| 13/10/2018 | 1033 | 37 | 36 | 12° 04,969' S | 24° 55,818' | 200; 150; 111; 50; 5 |

| | | | | | | |
|------------|------|----|----|---------------|-------------|-----------------------|
| 14/10/2018 | 0435 | 38 | 37 | 14° 46,784' S | 24° 59,086' | 200; 150; 145; 55; 5 |
| 14/10/2018 | 1307 | 40 | 38 | 16° 01,942' S | 25° 01,412' | 250; 185; 160; 75; 5 |
| 15/10/2018 | 0435 | 41 | 39 | 18° 20,357' S | 25° 05,143' | 200; 152; 100; 50; 5 |
| 16/10/2018 | 0449 | 43 | 40 | 20° 22,761' S | 25° 03,565' | 200; 161; 100; 50; 5 |
| 16/10/2018 | 1301 | 44 | 41 | 21° 36,224' S | 25° 02,786' | 250; 185; 170; 125; 5 |
| 17/10/2018 | 0431 | 45 | 42 | 23° 59,974' S | 24° 59,965' | 200; 140; 100; 50; 5 |
| 17/10/2018 | 1303 | 46 | 43 | 24° 54,350' S | 25° 54,196' | 250; 180; 140; 50; 5 |
| 18/10/2018 | 0443 | 47 | 44 | 26° 37,678' S | 27° 39,321' | 200; 127; 100; 50; 5 |
| 18/10/2018 | 1036 | 48 | 45 | 27° 12,003' S | 28° 15,001' | 300; 200; 140; 100; 5 |
| 19/10/2018 | 0436 | 49 | 46 | 29° 07,655' S | 30° 13,409' | 200; 150; 130; 50; 5 |
| 19/10/2018 | 1301 | 50 | 47 | 30° 00,355' S | 31° 06,982' | 250; 150; 109; 50; 5 |
| 20/10/2018 | 0444 | 51 | 48 | 31° 37,104' S | 32° 53,058' | 200; 131; 100; 50; 5 |
| 20/10/2018 | 1312 | 52 | 49 | 32° 22,371' S | 33° 40,448' | 200; 150; 85; 50; 5 |
| 21/10/2018 | 0440 | 53 | 50 | 33° 49,894' S | 35° 16,130' | 200; 150; 80; 50; 5 |
| 21/10/2018 | 1310 | 54 | 51 | 34° 34,830' S | 36° 05,486' | 150; 100; 70; 50; 5 |
| 22/10/2018 | 0445 | 55 | 52 | 36° 10,029' S | 37° 51,980' | 200; 130; 70; 20; 5 |
| 22/10/2018 | 1315 | 56 | 53 | 37° 00,723' S | 38° 50,077' | 120; 70; 40; 15; 5 |
| 23/10/2018 | 0437 | 57 | 54 | 38° 35,043' S | 40° 39,307' | 200; 100; 65; 20; 7 |
| 23/10/2018 | 1311 | 58 | 55 | 39° 12,560' S | 41° 28,505' | 200; 75; 30; 15; 8 |
| 24/10/2018 | 0441 | 59 | 56 | 40° 31,255' S | 43° 04,973' | 200; 100; 40; 20; 5 |
| 24/10/2018 | 1309 | 60 | 57 | 41° 22,179' S | 44° 00,764' | 200; 100; 75; 20; 5 |
| 25/10/2018 | 0540 | 61 | 58 | 43° 00,361' S | 45° 58,902' | 200; 140; 55; 20; 5 |
| 25/10/2018 | 1406 | 62 | 59 | 43° 47,429' S | 46° 57,313' | 135; 70; 38; 15; 5 |
| 26/10/2018 | 1409 | 63 | 61 | 46° 01,052' S | 49° 52,339' | 200; 135; 50; 30; 5 |
| 27/10/2018 | 0637 | 64 | 62 | 47° 33,709' S | 51° 46,436' | 200; 100; 66; 20; 5 |
| 27/10/2018 | 1503 | 65 | 63 | 48° 11,932' S | 52° 41,362' | 200; 100; 40; 20; 5 |

Table 2: Summary of the aerosol samples during AMT28. Date, time, latitude and longitude shown for each sample correspond to the start of the sampling.

| Sample | Date (start) | Time (start) (GMT) | Lat (start) | Lon (start) |
|---------------|---------------------|-------------------------------|--------------------|--------------------|
| AA | 23/09/2018 | 1858 | 50°45.810'N | 0°54.968'E |
| AB | 24/09/2018 | 0745 | 50°48.424'N | 1°06.640'W |
| AC | 25/09/2018 | 0817 | 49°59.534'N | 4°29.717'W |
| AD | 26/09/2018 | 1900 | 47°21.610'N | 11°37.041'W |
| AE | 28/09/2018 | 1904 | 40°58.446'N | 16°45.727'W |
| AF | 29/09/2018 | 1915 | 37°45.555'N | 19°09.603'W |
| AG | 30/09/2018 | 1927 | 34°27.315'N | 21°24.378'W |
| AH | 01/10/2018 | 1911 | 31°07.699'N | 23°07.130'W |
| AI | 02/10/2018 | 1923 | 27°45.850'N | 24°46.320'W |
| AJ | 03/10/2018 | 2046 | 23°57.279'N | 26°35.125'W |
| AK | 04/10/2018 | 1933 | 20°31.965'N | 28°10.032'W |
| AL | 05/10/2018 | 1917 | 16°45.869'N | 28°58.861'W |
| AM | 06/10/2018 | 1927 | 12°30.818'N | 27°58.420'W |
| NA | 07/10/2018 | 1917 | 8°54.555'N | 26°58.226'W |
| AO | 08/10/2018 | 2011 | 5°12.009'N | 26°08.523'W |
| AP | 09/10/2018 | 1927 | 1°27.480'N | 25°19.188'W |
| AQ | 10/10/2018 | 1941 | 2°07.049'S | 24°59.338'W |
| AR | 11/10/2018 | 1925 | 5°56.540'S | 24°58.092'W |
| AS | 12/10/2018 | 1918 | 9°38.772'S | 24°56.849'W |
| AT | 13/10/2018 | 1917 | 13°05.586'S | 24°57.088'W |
| AU | 14/10/2018 | 1918 | 16°52.862'S | 25°03.196'W |
| AV | 15/10/2018 | 1921 | 18°51.593'S | 25°05.058'W |
| AW | 16/10/2018 | 1920 | 22°28.529'S | 25°01.663'W |
| AX | 18/10/2018 | 1930 | 28°00.886'S | 29°04.087'W |
| AY | 20/10/2018 | 1855 | 32°47.563'S | 34°08.144'W |
| AZ | 22/10/2018 | 1914 | 37°34.490'S | 39°28.578'W |
| BA | 24/10/2018 | 1931 | 41°54.363'S | 44°38.907'W |

Distribution of Phytoplankton Communities in the Atlantic Ocean

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Cruise Objectives

The main goal is to understand the ecology and distribution of phytoplankton communities thriving in the Atlantic Ocean. Furthermore, we would like to contribute to the validation of Phytoplankton Size Classes (PSCs) and Phytoplankton Functional Types (PFTs) obtained by remote sensing ocean colour with our *in situ* observations.

Methods

0.3 L of seawater was collected from Niskin bottles from each cast CTD at the surface and the deep chlorophyll *a* maximum (DCM). 150 mL samples were taken and subsequently fixed with acid Lugol's iodine solution (~7,5 mL) in brown-glass flasks and stored in a cool place. Samples will be further analysed with an inverted microscope in the lab at MARE-FCUL for estimating cells abundance and phytoplankton species composition (>10 µm). Samples will be analysed by optical microscopy, in the University of Lisbon, following the proceedings of Utermöhl (1958). Results from the microscope counts and from the flow cytometer (see next report) will be treated jointly (estimating biovolume and carbon per cell content), in order to get a complete survey of phytoplankton groups, from picoplankton cells to diatoms, dinoflagellates and coccolithophores.

References

Utermöhl, H. 1958. Zur Vervollkommnung der quantitativen Phytoplankton- Methodik. Mitt. Int. Ver. Limnol. 9, 1-38.

Table 1: Summary of the CTD casts phytoplankton samples.

| Date | Time | Station No | CTD Cast | Lat | Lon (W) | Depths Sampled (m) |
|------------|------|------------|----------|--------------|-------------|--------------------|
| 25/09/2018 | 1235 | 01 | 01 | 49° 38,285' | 5° 30,096' | 5 |
| 26/09/2018 | 0334 | 02 | 02 | 48° 28,165' | 8° 50,193' | 5, 60 |
| 26/09/2018 | 1210 | 03 | 03 | 47° 54,073 | 10° 23,884 | 5; 30 |
| 27/09/2018 | 0330 | 04 | 04 | 46° 01,745' | 12° 43,950 | 5; 60 |
| 27/09/2018 | 1207 | 05 | 05 | 44° 58,715' | 13° 35,363 | 5; 40 |
| 28/09/2018 | 0333 | 06 | 06 | 42° 58,022 | 15° 12,784 | 5; 52 |
| 28/09/2018 | 1201 | 07 | 07 | 41°54,700' | 16°02,179 | 5; 56 |
| 29/09/2018 | 0334 | 08 | 08 | 39° 43,158 ' | 17° 42,968' | 5; 71 |
| 29/09/2018 | 1200 | 09 | 09 | 38° 37,851' | 18° 31,541' | 5; 70 |
| 30/09/2018 | 0436 | 10 | 10 | 36° 24,836' | 20° 07,287' | 5; 105 |

| | | | | | | |
|------------|------|----|----|----------------|--------------|--------|
| 30/09/2018 | 1259 | 11 | 11 | 35° 18,121' | 20° 54,912' | 5; 105 |
| 01/10/2018 | 0438 | 12 | 12 | 33° 2,816' | 22° 08',206' | 5; 90 |
| 01/10/2018 | 1307 | 13 | 13 | 31° 55,442' N | 22° 42,611' | 5; 85 |
| 02/10/2018 | 0435 | 14 | 14 | 29° 29,299'N | 23° 55,948' | 5; 114 |
| 02/10/2018 | 1050 | 15 | 15 | 28° 36,544' N | 24° 21,650' | 5; 135 |
| 03/10/2018 | 0436 | 16 | 16 | 26° 12,227' N | 25° 31,264' | 5; 107 |
| 03/10/2018 | 1301 | 17 | 17 | 25° 03,461' N | 26° 03,408' | 5; 120 |
| 04/10/2018 | 0436 | 18 | 18 | 22° 35,980' N | 27° 12,800' | 5; 93 |
| 04/10/2018 | 1301 | 19 | 19 | 21° 26,830' N | 27° 44,720' | 5; 120 |
| 05/10/2018 | 0438 | 20 | 20 | 19° 04,664' N | 28° 49,004' | 5; 90 |
| 05/10/2018 | 1301 | 21 | 21 | 17° 44,837' N | 28° 55,814' | 5; 65 |
| 06/10/2018 | 0438 | 22 | 22 | 15° 04, 566' N | 28° 36,756' | 5; 57 |
| 06/10/2018 | 1301 | 23 | 23 | 13° 48,630' N | 28° 17,763' | 5;60 |
| 07/10/2018 | 0437 | 24 | 24 | 11° 26,819'N | 27° 42,524' | 5; 50 |
| 07/10/2018 | 1300 | 25 | 25 | 10° 05,894'N | 27° 17,629' | 5; 40 |
| 08/10/2018 | 0438 | 27 | 26 | 07° 28,277' N | 26° 39,007' | 5; 72 |
| 08/10/2018 | 1302 | 28 | 27 | 06° 15,359' N | 26° 22,796' | 5; 64 |
| 09/10/2018 | 0439 | 29 | 28 | 03° 48,465' N | 25° 50,148' | 5; 89 |
| 10/10/2018 | 0446 | 30 | 29 | 00° 00,031' S | 24° 59,953' | 5; 60 |
| 10/10/2018 | 1304 | 31 | 30 | 01° 09,109' S | 24° 59,435' | 5; 75 |
| 11/10/2018 | 0460 | 32 | 31 | 03° 41,467' S | 24° 58,694' | 5; 60 |
| 11/10/2018 | 1302 | 33 | 32 | 04° 59,077' S | 24° 58,392' | 5; 74 |
| 12/10/2018 | 0439 | 34 | 33 | 07° 32,922' S | 24° 57,444' | 5; 120 |
| 12/10/2018 | 1301 | 35 | 34 | 08° 45,785' S | 24° 56,904' | 5; 120 |
| 13/10/2018 | 0435 | 36 | 35 | 11° 15,739' S | 24° 56,250' | 5; 122 |
| 13/10/2018 | 1033 | 37 | 36 | 12° 04,969' S | 24° 55,818' | 5; 111 |
| 14/10/2018 | 0435 | 38 | 37 | 14° 46,784' S | 24° 59,086' | 5; 145 |
| 14/10/2018 | 1307 | 40 | 38 | 16° 01,942' S | 25° 01,412' | 5; 160 |
| 15/10/2018 | 0435 | 41 | 39 | 18° 20,357' S | 25° 05,143' | 5; 150 |

| | | | | | | |
|-------------|-------------|-------------------|-----------------|---------------|-----------------|---------------------------|
| 16/10/2018 | 0449 | 43 | 40 | 20° 22,761' S | 25° 03,565' | 5; 161 |
| 16/10/2018 | 1301 | 44 | 41 | 21° 36,224' S | 25° 02,786' | 5; 170 |
| 17/10/2018 | 0431 | 45 | 42 | 23° 59,974' S | 24° 59,965' | 5; 140 |
| 17/10/2018 | 1303 | 46 | 43 | 24° 54,350' S | 25° 54,196' | 5; 140 |
| 18/10/2018 | 0443 | 47 | 44 | 26° 37,678' S | 27° 39,321' | 5; 127 |
| 18/10/2018 | 1036 | 48 | 45 | 27° 12,003' S | 28° 15,001' | 5; 140 |
| 19/10/2018 | 0436 | 49 | 46 | 29° 07,655' S | 30° 13,409' | 5; 130 |
| 19/10/2018 | 1301 | 50 | 47 | 30° 00,355' S | 31° 06,982' | 5; 109 |
| 20/10/2018 | 0444 | 51 | 48 | 31° 37,104' S | 32° 53,058' | 5; 131 |
| 20/10/2018 | 1312 | 52 | 49 | 32° 22,371' S | 33° 40,448' | 5; 85 |
| 21/10/2018 | 0440 | 53 | 50 | 33° 49,894' S | 35° 16,130' | 5; 80 |
| 21/10/2018 | 1310 | 54 | 51 | 34° 34,830' S | 36° 05,486' | 5; 70 |
| 22/10/2018 | 0445 | 55 | 52 | 36° 10,029' S | 37° 51,980' | 5; 70 |
| 22/10/2018 | 1315 | 56 | 53 | 37° 00,723' S | 38° 50,077' | 5; 40 |
| 23/10/2018 | 0437 | 57 | 54 | 38° 35,043' S | 40° 39,307' | 5; 65 |
| 23/10/2018 | 1311 | 58 | 55 | 39° 12,560' S | 41° 28,505' | 5; 30 |
| 24/10/2018 | 0441 | 59 | 56 | 40° 31,255' S | 43° 04,973' | 5; 40 |
| 24/10/2018 | 1309 | 60 | 57 | 41° 22,179' S | 44° 00,764' | 5; 35 |
| 25/10/2018 | 0540 | 61 | 58 | 43° 00,361' S | 45° 58,902' | 5; 55 |
| 25/10/2018 | 1406 | 62 | 59 | 43° 47,429' S | 46° 57,313' | 5; 38 |
| 26/10/2018 | 0538 | 63 | 60 | 45° 17,852' S | 48° 53,785' | 5; 53 |
| 26/10/2018 | 1409 | 64 | 61 | 46° 01,052' S | 49° 52,339' | 5; 30 |
| 27/10/2018 | 0637 | 64 | 61 | 47° 33,709' S | 51° 46,436' | 5; 66 |
| Date | Time | Station No | CTD Cast | LAT | LONG (W) | Depths Sampled (m) |
| 27/10/2018 | 1503 | 64 | 61 | 48° 11,932' S | 52° 41,362' | 5; 40 |

Abundance and Composition of Microbial Plankton Communities by Flow Cytometry

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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. 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 eukaryote phytoplankton, based on their light scattering and autofluorescence properties. Data were saved in listmode format and will be analysed back at the laboratory. 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. Samples were fixed with glutaraldehyde solution (Sigma-Aldrich, 50%, Grade 1. 0.5% final concentration, 30 mins at 4°C) within 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. This enabled bacteria to be discriminated from other particles and enumerated. 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 will be analysed back at the laboratory.

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

| Date | Station no. | CTD cast | Time in water (GMT) | LAT (+ve N) | LON (+ve E) | Niskins sampled | Depths sampled (m) |
|----------|-------------|----------|---------------------|-------------|--------------|--|---|
| 25/09/18 | 01 | CTD01 | 12:25 | 49° 38.287' | -5° 30.096' | 1, 3, 5, 6, 9, 10, 13, 16, 20, 21 | 80, 70, 60, 50, 35, 22, 17, 12, 8, 5 |
| 26/09/18 | 02 | CTD02 | 03:34 | 48° 28.162' | -8° 50.195' | 1, 3, 4, 6, 12, 13, 15, 17, 19, 20 | 140, 100, 70, 60, 50, 25, 20, 14, 10, 5 |
| 26/09/18 | 03 | CTD03 | 12:10 | 47° 54.074' | -10° 22.885' | 3, 5, 6, 7, 8, 9, 10, 13, 16, 17, 19, 20, 21 | 200, 150, 130, 100, 75, 60, 50, 30, 25, 20, 15, 10, 5 |
| 27/09/18 | 04 | CTD04 | 03:30 | 46° 01.745' | -12° 43.951' | 1, 3, 4, 6, 12, 13, 15, 17, 19, 20 | 200, 150, 70, 60, 50, 26, 20, 14, 10, 5 |
| 27/09/18 | 05 | CTD05 | 12:07 | 44° 58.715' | -13° 35.364' | 3, 4, 5, 6, 7, 8, 10, 11, 14, | 200, 150, 125, 100, 75, |

| | | | | | | | |
|----------|----|-------|-------|-------------|--------------|---|---|
| | | | | | | 15, 16, 17, 20, 21 | 50, 45, 40, 35, 30, 25, 20, 10, 5 |
| 28/09/18 | 06 | CTD06 | 03:33 | 42° 58.022' | -15° 12.784' | 2, 4, 5, 8, 13, 14, 15, 17, 18, 20, 21 | 200, 150, 60, 52, 50, 40, 23, 20, 12, 7, 5 |
| 28/09/18 | 07 | CTD07 | 12:01 | 41° 54.700' | -16° 02.179' | 3, 4, 5, 6, 7, 8, 9, 12, 14, 15, 16, 17, 19, 20, 21 | 200, 150, 125, 100, 80, 70, 56, 50, 45, 30, 25, 20, 15, 10, 5 |
| 29/09/18 | 08 | CTD08 | 03:34 | 39° 43.158' | -17° 42.968' | 1, 3, 4, 8, 12, 13, 15, 17, 19, 20 | 200, 150, 81, 71, 50, 30, 20, 17, 9, 5 |
| 29/09/18 | 09 | CTD09 | 12:00 | 38° 37.851' | -18° 31.541' | 3, 4, 5, 6, 7, 8, 11, 12, 14, 15, 16, 17, 19, 20, 21 | 200, 150, 125, 100, 80, 70, 60, 50, 45, 30, 25, 20, 15, 10, 5 |
| 30/09/18 | 10 | CTD10 | 04:34 | 36° 24.836' | -20° 07.287' | 1, 3, 4, 7, 12, 13, 14, 16, 18, 19, 21 | 200, 150, 115, 105, 60, 50, 45, 25, 20, 14, 5 |
| 30/09/18 | 11 | CTD11 | 12:59 | 35° 18.121' | -20° 54.912' | 3, 4, 5, 6, 7, 10, 11, 12, 13, 15, 16, 18, 20, 21 | 200, 150, 130, 120, 105, 90, 75, 60, 50, 40, 30, 20, 10, 5 |
| 01/10/18 | 12 | CTD12 | 04:38 | 33° 02.816' | -22° 08.206' | 1, 3, 4, 6, 10, 11, 12, 13, 15, 17, 19, 20, 22 | 200, 150, 100, 90, 80, 60, 50, 39, 30, 22, 20, 12, 5 |
| 01/10/18 | 13 | CTD13 | 13:07 | 31° 55.442' | -22° 42.611' | 3, 4, 5, 6, 7, 8, 11, 12, 13, 15, 16, 18, 20, 21 | 200, 150, 130, 120, 100, 85, 75, 60, 50, 40, 30, 20, 10, 5 |
| 02/10/18 | 14 | CTD14 | 04:37 | 29° 29.300' | -23° 55.947' | 1, 4, 5, 8, 13, 14, 15, 17, 19, 20, 21 | 200, 150, 124, 114, 65, 50, 48, 28, 20, 15, 5 |
| 02/10/18 | 15 | CTD15 | 10:50 | 28° 36.544' | -24° 21.650' | 7, 8, 10, 13, 14, 15, 16, 18, 19, 22 | 200, 150, 135, 115, 90, 70, 50, 35, 20, 5 |
| 03/10/18 | 16 | CTD16 | 04:37 | 26° 12.277' | -25° 31.264' | 1, 3, 4, 7, 11, 12, 13, 14, 15, 17, 19, 20, 21 | 200, 150, 117, 107, 90, 76, 60, 50, 45, 25, 20, 14, 5 |
| 03/10/18 | 17 | CTD17 | 13:01 | 25° 3.461' | -26° 3.408' | 3, 4, 5, 6, 7, 10, 11, 12, 13, 15, 16, 18, 20, 21 | 200, 150, 130, 120, 103, 93, 65, 50, 41, 23, 20, 13, 5 |
| 04/10/18 | 18 | CTD18 | 04:37 | 22° 35.980' | -27° 12.800' | 1, 4, 5, 6, 7, 9, 13, 14, 15, 17, 19, 20, 21 | 200, 150, 130, 120, 103, 93, 65, 50, 41, 23, 20, 13, 5 |
| 04/10/18 | 19 | CTD19 | 13:01 | 21° 26.830' | -27° 44.720' | 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 16, | 200, 150, 140, 130, 120, 105, 85, |

| | | | | | | | |
|------------|----|-------|-------|--------------|--------------|--|---|
| | | | | | | 17, 18, 20, 21 | 75, 65, 50, 40, 30, 20, 10, 5 |
| 05/10/18 | 20 | CTD20 | 04:38 | 19° 04.664' | -28° 49.004' | 1, 3, 4, 10, 11, 12, 13, 16, 19, 21 | 200, 150, 100, 90, 66, 50, 39, 22, 12, 5 |
| 05/10/18 | 21 | CTD21 | 13:01 | 17° 44.839'N | -28° 55.814' | 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 16, 17, 18, 20, 21 | 200, 150, 115, 100, 85, 75, 65, 60, 55, 50, 40, 30, 20, 10, 5 |
| 06/10/18 | 22 | CTD22 | 04:38 | 15° 04.566' | -28° 36.756' | 2, 3, 4, 5, 6, 7, 9, 11, 14, 15, 16, 18, 19, 21, 22 | 200, 150, 125, 100, 80, 67, 62, 57, 50, 36, 25, 20, 14, 7, 5 |
| 06/10/2018 | 23 | CTD23 | 13:01 | 13° 48.730' | -28° 17.673' | 3, 5, 6, 7, 8, 9, 10, 13, 14, 16, 17, 18, 19, 20, 21 | 200, 150, 120, 100, 85, 75, 60, 55, 50, 45, 40, 30, 20, 10, 5 |
| 07/10/18 | 24 | CTD24 | 04:37 | 11° 26.819' | -27° 42.524' | 1, 3, 4, 5, 8, 12, 13, 15, 17, 19, 21 | 200, 150, 100, 60, 50, 30, 22, 20, 12, 7, 5 |
| 07/10/18 | 25 | CTD25 | 13:00 | 10° 05.894' | -27° 17.629' | 1, 2, 3, 4, 6, 7, 10, 11, 12, 13 | 200, 150, 100, 70, 50, 40, 35, 30, 20, 5 |
| 08/10/18 | 27 | CTD26 | 04:38 | 07° 28.277' | -26° 39.007' | 1, 3, 4, 5, 8, 12, 13, 14, 16, 17, 19, 24 | 200, 150, 100, 82, 72, 50, 40, 30, 20, 17, 9, 5 |
| 08/10/18 | 28 | CTD27 | 13:02 | 06° 15.359' | -26° 22.796' | 3, 5, 6, 7, 8, 9, 10, 13, 14, 16, 17, 18, 19, 20, 21 | 200, 150, 120, 100, 85, 70, 64, 54, 50, 45, 40, 30, 20, 13, 5 |
| 09/10/18 | 29 | CTD28 | 04:39 | 03° 48.465' | -25° 50.148' | 1, 3, 4, 5, 8, 12, 13, 14, 15, 17, 19, 20, 21 | 200, 150, 115, 99, 89, 80, 60, 50, 39, 22, 20, 12, 5 |
| 10/10/18 | 30 | CTD29 | 04:46 | 00° 00.031' | -24° 59.952' | 1, 3, 5, 8, 12, 13, 15, 17, 19, 20 | 200, 150, 70, 60, 50, 26, 20, 14, 8, 5 |
| 10/10/18 | 31 | CTD30 | 13:04 | -01° 09.109' | -24° 59.435' | 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 17, 18, 19 | 200, 150, 120, 100, 90, 82, 75, 70, 63, 50, 40, 30, 20, 13, 5 |
| 11/10/18 | 32 | CTD31 | 04:30 | -03° 41.467' | -24° 58.694' | 1, 3, 4, 5, 6, 9, 14, 15, 17, 18, 20, 21 | 200, 150, 90, 80, 70, 60, 50, 26, 20, 14, 8, 5 |
| 11/10/18 | 33 | CTD32 | 13:02 | -04° 59.077' | -24° 58.392' | 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 17, 18, 19 | 200, 150, 125, 100, 90, 82, 74, 70, 65, 50, 40, 30, 20, 13, 5 |
| 12/10/18 | 34 | CTD33 | 04:39 | -07° 32.922' | -24° 57.444' | 1, 4, 5, 8, 12, 13, 16, 18, 19, 20 | 200, 150, 120, 110, 50, 47, 26, 20, 15, 5 |

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|----------|----|-------|-------|--------------|--------------|---|---|
| 12/10/18 | 35 | CTD34 | 13:01 | -08° 45.785' | -24° 56.904' | 3, 4, 5, 6, 7, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 | 200, 175, 150, 135, 120, 110, 90, 70, 65, 50, 40, 30, 20, 13, 5 |
| 13/10/18 | 36 | CTD35 | 04:35 | -11° 15.739' | -24° 56.250' | 1, 3, 4, 7, 11, 12, 13, 14, 16, 17, 19, 20, 21 | 200, 150, 132, 122, 110, 100, 80, 53, 50, 30, 20, 16, 5 |
| 13/10/18 | 37 | CTD36 | 10:33 | -12° 4.969' | -24° 55.818' | 10, 11, 13, 15, 16, 17, 19, 20, 23 | 200, 150, 111, 100, 70, 50, 35, 20, 5 |
| 14/10/18 | 38 | CTD37 | 04:35 | -14° 46.784' | -24° 59.086' | 1, 4, 6, 7, 12, 13, 15, 17, 19, 21 | 200, 155, 150, 145, 100, 62, 55, 35, 20, 5 |
| 14/10/18 | 40 | CTD38 | 13:06 | -16° 01.942' | -25° 01.412' | 4, 5, 6, 8, 12, 13, 14, 15, 16, 17, 18, 19, 20 | 200, 185, 175, 160, 150, 135, 120, 100, 75, 50, 40, 20, 5 |
| 15/10/18 | 41 | CTD39 | 04:35 | -18° 20.357' | -25° 05.143' | 1, 3, 4, 5, 7, 11, 12, 13, 14, 15, 16, 18, 19, 21, 22 | 200, 185, 175, 162, 152, 145, 135, 120, 100, 80, 65, 50, 36, 20, 5 |
| 16/10/18 | 43 | CTD40 | 04:38 | -20° 22.761' | -25° 03.565' | 1, 4, 9, 11, 12, 14, 16, 18, 19, 21 | 200, 171, 161, 100, 70, 50, 40, 25, 20, 5 |
| 16/10/18 | 44 | CTD41 | 13:01 | -21° 36.224' | -25° 2.786' | 4, 5, 8, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 | 200, 185, 170, 160, 150, 125, 100, 85, 70, 50, 35, 20, 5 |
| 17/10/18 | 45 | CTD42 | 04:31 | -23° 59.974' | -24° 59.965' | 1, 3, 4, 5, 8, 12, 13, 14, 15, 17, 18, 20, 21 | 200, 180, 160, 150, 140, 120, 100, 75, 60, 50, 34, 20, 5 |
| 17/10/18 | 46 | CTD43 | 13:03 | -24° 54.35' | -25° 54.196' | 4, 5, 7, 9, 12, 13, 14, 15, 16, 17, 18, 20, 24 | 200, 180, 160, 140, 125, 110, 95, 85, 70, 50, 35, 20, 5 |
| 18/10/18 | 47 | CTD44 | 04:43 | -26° 37.675' | -27° 39.321' | 1, 4, 6, 11, 12, 14, 16, 18, 19, 21 | 200, 137, 127, 100, 56, 50, 30, 20, 17, 5 |
| 18/10/18 | 48 | CTD45 | 10:36 | -27° 12.003' | -28° 15.011' | 14, 15, 17, 18, 19, 20, 21, 23 | 200, 140, 100, 75, 60, 50, 25, 5 |
| 19/10/18 | 49 | CTD46 | 04:36 | -29° 07.655' | 30° 13.409' | 1, 3, 4, 7, 11, 12, 13, 14, 16, 17, 19, 20, 21 | 200, 150, 140, 130, 110, 90, 70, 56, 50, 31, 20, 17, 5 |
| 19/10/18 | 50 | CTD47 | 13:01 | -30° 0.355' | -31° 8.982' | 4, 5, 7, 8, 9, 13, 16, 17, 18, 19, 20, 21, 22 | 200, 180, 150, 135, 119, 109, 100, 85, 70, 50, 35, 20, 5 |

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| 20/10/18 | 51 | CTD48 | 04:45 | -31° 37.104' | -32° 53.058' | 1, 4, 6, 11, 12, 14, 16, 18, 19, 21 | 200, 141, 131, 100, 56, 50, 31, 20, 17, 5 |
| 20/10/18 | 52 | CTD49 | 13:12 | -32° 22.371' | -33° 40.448' | 14, 15, 16, 18, 19, 20, 21, 24 | 200, 150, 85, 75, 60, 50, 25, 5 |
| 21/10/18 | 53 | CTD50 | 04:40 | -33° 49.894' | -35° 16.130' | 1, 3, 4, 5, 6, 9, 13, 14, 15, 16, 18, 20, 21 | 200, 150, 125, 100, 90, 80, 70, 60, 50, 34, 20, 11, 5 |
| 21/10/18 | 54 | CTD51 | 13:10 | -34° 34.830' | -36° 5.486' | 14, 15, 16, 17, 19, 20, 21, 23 | 200, 150, 100, 70, 65, 50, 25, 5 |
| 22/10/18 | 55 | CTD52 | 04:45 | -36° 10.029' | -37° 51.980' | 1, 4, 5, 7, 12, 13, 15, 17, 19, 21 | 200, 130, 80, 70, 50, 30, 20, 17, 10, 5 |
| 22/10/18 | 56 | CTD53 | 13:15 | -37° 0.723' | -38° 50.077' | 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20 | 200, 150, 130, 120, 100, 85, 70, 60, 50, 40, 30, 20, 15, 10, 5 |
| 23/10/18 | 57 | CTD54 | 04:37 | -38° 35.043' | -40° 39.307' | 1, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 17 | 200, 150, 125, 100, 75, 65, 50, 40, 28, 20, 16, 9, 7 |
| 23/10/18 | 58 | CTD55 | 13:11 | -39° 12.560' | -41° 28.501' | 14, 15, 16, 17, 18, 19, 21, 23 | 200, 150, 100, 75, 50, 30, 15, 8 |
| 24/10/18 | 59 | CTD56 | 04:41 | -40° 31.255' | -43° 04.973' | 1, 4, 5, 7, 12, 13, 14, 17, 19, 21 | 200, 100, 50, 40, 35, 20, 17, 10, 8, 5 |
| 24/10/18 | 60 | CTD57 | 13:09 | -41° 22.179' | -44° 0.764' | 14, 15, 16, 17, 18, 19, 21, 23 | 200, 150, 100, 75, 50, 35, 20, 5 |
| 25/10/18 | 61 | CTD58 | 05:40 | -43°00.361' | -45° 58.902' | 1, 3, 4, 5, 6, 7, 10, 14, 15, 17, 18, 20, 21 | 200, 140, 120, 100, 80, 65, 55, 50, 24, 20, 15, 7, 5 |
| 25/10/18 | 62 | CTD59 | 14:06 | -43° 47.429' | -46° 57.313' | 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 16, 17, 18, 19 | 200, 150, 135, 120, 100, 85, 70, 60, 50, 38, 30, 20, 15, 5 |
| 26/10/18 | 63 | CTD60 | 05:38 | -45° 17.852' | -48° 53.783' | 1, 3, 4, 6, 11, 12, 14, 16, 18, 21 | 200, 100, 63, 53, 50, 24, 20, 13, 7, 5 |
| 26/10/18 | 64 | CTD61 | 14:09 | -46° 01.052' | -49° 52.339' | 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 17, 18, 19 | 200, 150, 135, 120, 100, 85, 70, 60, 50, 40, 30, 20, 15, 5 |
| 27/10/18 | 65 | CTD62 | 06:37 | -47° 33.709' | -51° 46.436' | 1, 3, 4, 5, 7, 8, 11, 12, 14, 15, 17, 19 | 200, 150, 125, 100, 76, 66, 50, 28, 20, 16, 10, 5 |
| 27/10/18 | 63 | CTD63 | 15:03 | -48° 11.932' | -52° 41.362' | 3, 4, 7, 8, 9, 10, 13, 16, 17, 18 | 200, 150, 100, 80, 65, 50, 40, 30, 20, 5 |

Mesoplankton Community Size Structure and abundance

Glen Tarran¹, Igor Fernández²

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Methods:

Vertical net hauls were conducted each day at the pre-dawn stations for the collection of mesozooplankton samples (Table 1). A bongo (double) net frame was deployed from the JCR's forward crane and a general purpose winch with 8 mm steel wire. The nets used had 0.57m diameter openings and carried 2 WP-2 nets; one with a 200 µm nylon mesh and a 200 µm mesh cod end and the other with 120 µm mesh and a 63 µm cod end to collect Rhizaria. Nets were generally deployed to a depth of 200-250 m, once off the European continental shelf and then hauled at a rate of 11-12 m min⁻¹, integrated between the depth of deployment and the surface. Nets were washed with seawater whilst still outboard and then brought onboard where the cod ends containing the samples were collected into buckets. Nets were then washed down with fresh water before stowing. The Rhizaria samples were used by Natalia Llopis-Monferrer. The 200 µm sample was passed through a 200 µm sieve and the material retained on the sieve was then washed into a 100 mL plastic bottle containing 10 mL of 37% borax-buffered formaldehyde (4% final concentration) using Milli-Q water. Samples were then stored at 4°C for analysis on return to the UK. Back in the UK, samples will be analysed using a combination of microscopy and FlowCAM to provide information on taxonomic composition, size distribution and abundance.

Table 1: Details of bongo WP-2 net vertical deployments

| Date | STN | Event no. | Deploy depth (m) | TIME in water (GMT) | TIME on deck (GMT) | Duration (mins) | LAT +N, -S | LON E | Preserved sample name |
|----------|-----|-----------|------------------|---------------------|--------------------|-----------------|------------|--------|-----------------------|
| 26-09-18 | 2 | 5 | 130 | 03:37 | 03:51 | 00:11 | 48.47 | -8.84 | Bongo 01 |
| 27-09-18 | 4 | 10 | 200 | 03:28 | 03:50 | 00:17 | 46.03 | -12.73 | Bongo 02 |
| 28-09-18 | 6 | 18 | 200 | 03:39 | 04:02 | 00:16 | 42.97 | -15.21 | Bongo 03 |
| 29-09-18 | 8 | 25 | 200 | 03:31 | 03:53 | 00:17 | 39.72 | -17.72 | Bongo 04 |
| 30-09-18 | 10 | 32 | 200 | 04:28 | 04:51 | 00:17 | 36.41 | -20.12 | Bongo 05 |
| 01-10-18 | 12 | 40 | 200 | 04:29 | 04:52 | 00:17 | 33.05 | -22.14 | Bongo 06 |
| 02-10-18 | 14 | 47 | 200 | 04:34 | 04:56 | 00:16 | 28.61 | -24.36 | Bongo 07 |
| 03-10-18 | 16 | 55 | 200 | 04:30 | 04:51 | 00:16 | 26.20 | -25.52 | Bongo 08 |
| 04-10-18 | 18 | 62 | 200 | 04:29 | 04:53 | 00:17 | 22.60 | -27.21 | Bongo 09 |
| 05-10-18 | 20 | 69 | 200 | 04:30 | 04:52 | 00:16 | 19.08 | -28.82 | Bongo 10 |
| 06-10-18 | 22 | 76 | 200 | 04:31 | 04:53 | 00:17 | 15.08 | -28.61 | Bongo 11 |
| 07-10-18 | 24 | 83 | 200 | 04:32 | 04:53 | 00:16 | 11.45 | -27.71 | Bongo 12 |
| 08-10-18 | 27 | 91 | 200 | 04:32 | 04:54 | 00:16 | 7.47 | -26.65 | Bongo 13 |
| 09-10-18 | 29 | 96 | 200 | 04:33 | 04:54 | 00:17 | 3.81 | -25.84 | Bongo 14 |
| 10-10-18 | 30 | 102 | 200 | 04:45 | 05:14 | 00:16 | 0.00 | -25.00 | Bongo 15 |
| 11-10-18 | 32 | 109 | 200 | 04:33 | 04:56 | 00:17 | -3.69 | -24.98 | Bongo 16 |

| | | | | | | | | | |
|----------|-------------------|-----|---------------------|-------------|-------|-------|--------|--------|----------|
| 12-10-18 | 34 | 116 | 200 | 04:36 | 05:01 | 00:16 | -7.55 | -24.96 | Bongo 17 |
| 13-10-18 | 36 | 123 | 200 | 04:30 | 04:53 | 00:16 | -11.26 | -24.94 | Bongo 18 |
| 14-10-18 | 38 | 131 | 250 | 04:29 | 04:56 | 00:20 | -14.78 | -24.98 | Bongo 19 |
| 15-10-18 | 41 | 141 | 250 | 04:34 | 05:00 | 00:20 | -18.34 | -25.09 | Bongo 20 |
| 16-10-18 | 43 | 146 | 250 | 04:35 | 05:02 | 00:20 | -18.34 | -25.09 | Bongo 21 |
| 17-10-18 | 45 | 153 | 250 | 04:28 | 04:54 | 00:20 | -24.00 | -25.00 | Bongo 22 |
| 18-10-18 | 47 | 162 | 250 | 04:37 | 05:05 | 00:21 | -26.56 | -27.66 | Bongo 23 |
| 19-10-18 | 49 | 172 | 250 | 04:30 | 04:57 | 00:21 | -29.13 | -30.22 | Bongo 24 |
| 20-10-18 | 51 | 180 | 200 | 04:39 | 05:05 | 00:17 | -31.62 | -32.88 | Bongo 25 |
| 21-10-18 | NO | NET | Wind 26-30 knots at | | | 04:00 | | | |
| 22-10-18 | 56 | 196 | 200 | 04:32 | 04:56 | 00:16 | -36.17 | -37.86 | Bongo 26 |
| 23-10-18 | NO NET. Wind F5-6 | | | Large waves | | | | | |
| 24-10-18 | NO NET. Wind F5-6 | | | Large waves | | | | | |
| 25-10-18 | 61 | 217 | 200 | 05:36 | 06:07 | 00:18 | -43.00 | -45.98 | Bongo 27 |
| 26-10-18 | 63 | 223 | 200 | 05:31 | 05:55 | 00:17 | -45.30 | -48.90 | Bongo 28 |
| 27-10-18 | 65 | 231 | 200 | 06:34 | 06:58 | 00:17 | -47.56 | -51.77 | Bongo 29 |

| | | | | | | | | | | |
|----------|---|--|--|--|--|--|--|--|--|--|
| NOTES | | | | | | | | | | |
| Date | | | | | | | | | | |
| 26-09-18 | Net going under ship. Recovered and redeployed. Deployment to 130m. | | | | | | | | | |
| | Water column 148m. Hooching with salps and Nitzschia. Training, Igor/Natalia. | | | | | | | | | |
| | 1 x 200 µm net and 1 x 120 µm net with a 63 µm cod end | | | | | | | | | |
| 27-09-18 | Training, Igor/Natalia. | | | | | | | | | |
| 28-09-18 | Net done by Igor and me and will be from now on | | | | | | | | | |
| 29-09-18 | | | | | | | | | | |
| 30-09-18 | | | | | | | | | | |
| 01-10-18 | | | | | | | | | | |
| 02-10-18 | | | | | | | | | | |
| 03-10-18 | | | | | | | | | | |
| 04-10-18 | | | | | | | | | | |
| 05-10-18 | | | | | | | | | | |
| 06-10-18 | Phosphorescence. Squid, flying fish | | | | | | | | | |
| 07-10-18 | Just N of equatorial counter current. Lots of Trichodesmium | | | | | | | | | |
| 08-10-18 | Sargassum, lots. Pyrosome. 12 x 2.5 cm. Returned to sea | | | | | | | | | |
| 09-10-18 | | | | | | | | | | |
| 10-10-18 | EQUATOR. Wire under ship. Held at 200m for 8 mins | | | | | | | | | |
| 11-10-18 | | | | | | | | | | |
| 12-10-18 | | | | | | | | | | |
| 13-10-18 | Wire going slack. Swell. | | | | | | | | | |

| | | | | | | | | |
|----------|---|--|--|--|--|--|--|--|
| 14-10-18 | DEPLOYED TO 250 m. Puffer fish attacking the bongo wire | | | | | | | |
| 15-10-18 | DEPLOYED TO 250m | | | | | | | |
| 16-10-18 | DEPLOYED TO 250m | | | | | | | |
| 17-10-18 | DEPLOYED TO 250m | | | | | | | |
| 18-10-18 | DEPLOYED TO 250m | | | | | | | |
| 19-10-18 | | | | | | | | |
| 20-10-18 | Broke 200µm net. Replaced. Wind got up. Gusting 30 knots, large swell | | | | | | | |
| 21-10-18 | | | | | | | | |
| 22-10-18 | | | | | | | | |
| 23-10-18 | | | | | | | | |
| 24-10-18 | | | | | | | | |
| 25-10-18 | Issues with spooling/level wind | | | | | | | |
| 26-10-18 | | | | | | | | |
| 27-10-18 | | | | | | | | |

Bacterial respiration and production; Dissolved Organic Matter

Hans Slagter and Millie Goddard-Dwyer

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Objectives and methods

In order to help elucidate oceanic carbon cycling, bacterial production was studied during AMT28 using radiolabelled leucine in production and respiration assays. Additionally, samples were collected for analysis of DOM in the home lab.

Samples were taken from pre-dawn CTD rosette sampler deployments at the surface, the deep chlorophyll maximum (DCM), and the point of 33% light penetration, starting with carboys for DOM using no tubes and avoiding contact with the CTD frame to minimize the risk of contamination; followed by carboys for bacterial production and respiration assays. All materials were acid-cleaned overnight and rinsed just before sampling.

Bacterial production was measured via the rate of ³H-Leucine incorporation after Hill, Warwick, & Zubkov (2013). In short, samples were portioned into subsamples and received ³H-Leucine additions of 0.2, 0.4, 0.6, 0.8 and 1.0 nM and were left to incubate for 10, 20, 30 and 40 minutes, with the experiment halted by the addition of paraformaldehyde (PFA) to a final concentration of 1%. After adding the fixative, samples were brought onto 0.2 µm polycarbonate filters which were suspended in 3-5 mL scintillation cocktail (Goldstar) to be measured with the on-board liquid scintillation counter the next day. Samples were saved for optional later reanalysis on more sensitive equipment.

Respiration of ¹⁴C-Leucine was also measured after Hill et al., 2013. For these assays 0.4 nM ¹⁴C-Leucine was added to 6-8 70 mL subsample replicates in gas-tight borosilicate glass bottles. These were allowed to respire in a dark incubator, which was set to either the sea surface temperature when all depths were sampled, or the DCM temperature where only the DCM was sampled. Respiration was halted at regular intervals between 6-12 hours via the addition of 1 mL HCl 10% v/v. Typically, the next day, samples were harvested by passing through CO₂-scrubbed air and trapping the respired ¹⁴CO₂ in 4 mL sorbent (Carbo-Sorb E) in a scintillation vial. 15 mL of scintillation cocktail was added to

the sorbent, and samples were counted on-board the next day, and saved for optional reanalysis at the home lab.

Samples for DOM were collected at the same time and depths as respiration and production samples, as well as from two deep casts in the North Atlantic Gyre and the South Atlantic Gyre. Regular pre-dawn CTD samples were filtered (~1500 mL) over ashed GF/F filters using HCl-washed equipment concurrently with the bacterial production and respiration assays. The filtrate (1 L) was acidified to a pH of 2 using concentrated HCl (Suprapur grade, Merck) and stored at 4 °C in the dark until extraction. Deep cast samples were filtered in concurrent batches of 3 depths (7-8 L each depth), prioritising surface samples with waiting samples stored at 4 °C in the dark, which were similarly acidified and extracted directly after.

All filters were saved, flash-frozen in liquid nitrogen and stored at -80 °C. Solid phase extraction was performed using 200 mg Bond Elut columns (Agilent) for the regular predawn CTD samples and 1 g columns for the high volume samples from the deep casts. The acidified samples were pulled through the cartridges which were subsequently eluted with 1-3 mL methanol, collected in glass vials and stored at -20 °C, with long-term storage northbound at -80 °C.

Concurrently with the above main assays and extractions, abundance samples were taken from our carboys immediately after sampling the CTD: duplicates of 1 mL fixed with 0.5% glutaraldehyde and 1% PFA (4 samples per depth). Samples for molecular analysis (1.6 mL) were also collected immediately, two non-fixed and two fixed with 1% PFA. All samples were flash-frozen in liquid nitrogen and stored at -80 °C.

Reference

Hill, P. G., Warwick, P. E., & Zubkov, M. V. (2013). Low microbial respiration of leucine at ambient oceanic concentration in the mixed layer of the central Atlantic Ocean. *Limnology and Oceanography*, 58(5), 1597–1604. <https://doi.org/10.4319/lo.2013.58.5.1597>

Table 1: Samples collected from CTD rosette sampler

Properties listed:

P bacterial production
 R bacterial respiration
 D dissolved organic matter
 C enumeration
 M molecular

| Date | Time | Station No. | CTD cast | Lat (+ve N) | Lon (+ve E) | Depths sampled (m) | Properties |
|------------|------|-------------|----------|-------------|-------------|--|------------|
| 27/09/2018 | 0334 | 2 | 002 | 48.51 | -8.89 | 5, 20, 60 | P, R, D, C |
| 28/09/2018 | 0337 | 6 | 006 | 42.98 | -15.22 | 52 | P, R, D, C |
| 29/09/2018 | 0334 | 8 | 008 | 37.76 | -17.97 | 5, 17, 71 | P, R, D, C |
| 30/09/2018 | 0337 | 10 | 010 | 36.63 | -20.20 | 105 | P, R, D, C |
| 01/10/2018 | 0338 | 12 | 012 | 33.26 | -22.19 | 5, 22, 90 | P, R, D, C |
| 02/10/2018 | 0338 | 14 | 014 | 29.57 | -24.18 | 114 | P, R, D, C |
| 02/10/2018 | 1050 | 15 | 015 | 28.62 | -24.37 | 5, 50, 135, 250, 500, 1000, 2000, 3000, 4000 | D, C, M |

| | | | | | | | |
|------------|------|----|-----|--------|--------|--|---------------|
| 05/10/2018 | 0428 | 20 | 020 | 19.25 | -28.48 | 5, 22, 90 | P, R, D, C, M |
| 06/10/2018 | 0438 | 22 | 022 | 15.22 | -28.81 | 57 | P, R, D, C, M |
| 07/10/2018 | 0437 | 24 | 024 | 11.66 | -27.85 | 5, 12, 50 | P, R, D, C, M |
| 08/10/2018 | 0438 | 27 | 026 | 7.21 | -26.65 | 72 | P, R, D, C, M |
| 09/10/2018 | 0439 | 29 | 028 | 3.93 | -25.87 | 89 | P, R, D, C, M |
| 10/10/2018 | 0446 | 30 | 029 | 0.01 | -25.25 | 5, 14, 60 | P, R, D, C, M |
| 11/10/2018 | 0430 | 32 | 031 | -3.81 | -25.16 | 60 | P, R, D, C, M |
| 12/10/2018 | 0439 | 34 | 033 | -7.79 | -25.07 | 5, 26, 110 | P, R, D, C, M |
| 13/10/2018 | 0435 | 36 | 035 | -11.46 | -25.00 | 122 | P, D, C, M |
| 13/10/2018 | 1033 | 37 | 036 | -12.09 | -24.94 | 5, 50, 111, 250, 500, 1000, 2000, 3000, 4000 | D, C, M |
| 14/10/2018 | 0435 | 38 | 037 | -14.78 | -24.99 | 5, 35, 145 | D, C, M |
| 16/10/2018 | 0419 | 43 | 040 | -20.58 | -24.21 | 5, 40, 161 | P, R, D, C, M |
| 17/10/2018 | 0435 | 45 | 042 | -24.25 | -25.25 | 140 | P, R, D, C, M |
| 18/10/2018 | 0443 | 47 | 044 | -26.81 | -27.73 | 5, 30, 127 | P, R, D, C, M |
| 19/10/2018 | 0436 | 49 | 046 | -29.30 | -30.33 | 130 | P, R, D, C, M |
| 20/10/2018 | 0445 | 51 | 048 | -31.65 | -32.90 | 5, 31, 131 | P, R, D, C, M |
| 21/10/2018 | 0440 | 53 | 050 | -34.07 | -35.30 | 80 | P, R, D, C, M |
| 22/10/2018 | 0445 | 55 | 052 | -36.18 | -38.12 | 5, 17, 70 | P, R, D, C, M |
| 24/10/2018 | 0440 | 59 | 056 | -40.59 | -43.34 | 5, 10, 40 | P, R, D, C, M |
| 25/10/2018 | 0540 | 61 | 058 | -43.10 | -46.22 | 55 | P, R, D, C, M |
| 26/10/2018 | 0538 | 63 | 060 | -45.52 | -49.10 | 5, 13, 53 | P, R, D, C, M |

REMINERALISATION OF ORGANIC CARBON BY MARINE BACTERIOPLANKTON (REMAIN) – REDUCING THE KNOWN UNKNOWN



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Cruise Objectives

1. To determine the relationship between plankton respiration derived from dissolved oxygen consumption (CR_{O_2}) and the reduction of a tetrazolium salt (2-para(indophenol)-3(nitrophenyl)-5(phenyl) tetrazolium chloride-INT) (INT_R) across a range of plankton communities and environmental conditions
2. To determine the influence of plankton community structure and the stoichiometry of dissolved organic matter (DOM) on the relationship between CR_{O_2} and INT_R
3. To determine the proportion of plankton community respiration attributable to the 0.1-0.8 μm and 0.8-2.0 μm size classes using INT_R and ETS and assess how this is influenced by environmental conditions
4. To determine size fractionated plankton respiration for the first time using both the classical ETS method and a new enzyme kinetic model (EKM) incorporating pyridine nucleotide concentrations
5. To determine zooplankton respiration
6. To compare our 4 methods of measuring plankton respiration with the ^{14}C -leucine technique used by project partner Claire Evans' group (NOC)
7. In collaboration with the NOC group, derive bacterial growth efficiencies and assess any influence of DOM stoichiometry
8. Measure dissolved oxygen in order to calibrate the CTD oxygen sensor
9. To communicate the importance of plankton respiration, and especially bacterioplankton respiration, to the general public via social media (cruise blog, twitter, SWAY), articles in popular magazines and through contribution to the 2018 Global Science Opera (<http://globalscienceopera.com/>) on the ocean

Methods

Community respiration derived from *in vitro* changes in dissolved oxygen concentration (CR_{O_2})

CR_{O_2} was determined as the decrease in dissolved oxygen concentration of a water sample incubated in the dark for 24 h (Robinson et al., 2002; Serret et al., 2015). Water samples were collected into 10 L carboys from each of six depths from the pre-dawn CTD cast (~04:30 GMT) corresponding to 5 m, the depth at which irradiance is 33% of surface irradiance, the depth of 14% of surface irradiance, the depth of the deep chlorophyll maximum (DCM), 10 m below the DCM and 200 m. Ten gravimetrically calibrated ~55 mL glass bottles were carefully filled with water from each depth. Five bottles were fixed at the start of the incubation (“zero time samples”) with 0.5 mL of manganese sulphate and 0.5 mL of a solution of sodium iodide/sodium hydroxide. The other five bottles were placed in water temperature controlled incubators for 24 hours (“dark samples”). The incubation temperatures were ± 1 °C of the *in situ* temperature. Bottles were removed from the incubators after 24 hours and fixed with $MnSO_4$ and $NaI/NaOH$. Dissolved oxygen concentration was measured by automated precision Winkler titration using a Metrohm 765 Dosimat titrator to a photometric end point (Carritt & Carpenter, 1966). All bottles were analysed within 36 hours. Plankton community respiration was calculated as the difference in oxygen concentration between the means of the “zero” and “dark” measurements. 25 profiles were completed as detailed in Table 1 below.

Community and size fractionated respiration derived from the reduction of INT (INT_R).

Water samples were collected from the same six depths as CR_{O_2} . Five dark glass bottles were filled with 240 mL from each 10 L carboy. Two replicates were fixed immediately by adding 6 mL of formaldehyde (2% w/v final concentration) and used as killed controls. Twenty minutes later all five replicates were inoculated with 6 mL of a sterile solution of 7.9 mM 2-(p-iodophenyl)-3-(p-nitrophenyl)-5-phenyl tetrazolium salt (INT) to give a final concentration of 0.2 mM. The solution was freshly prepared for each experiment using Milli-Q water. Samples were incubated in the same temperature-controlled water baths as for CR_{O_2} for between 30 minutes and 3 hours and then fixed by adding formaldehyde, as for the killed controls. After 20 minutes, the samples were sequentially filtered through 2.0, 0.8 and onto 0.1 μm pore size polycarbonate filters. The filters were then stored frozen in 1.5 mL cryovials at $-80^\circ C$ until return to UEA. The CR_{INT} (i.e. the sum of respiration of the $>2.0 \mu m$, 0.8 – 1.0 μm and 0.1-0.8 μm fractions) and BR_{INT} (considered as the respiration of the 0.1-0.8 μm fraction) will be measured following Martínez-García et al. (2009).

Time-course experiments were carried out in each biogeochemical province in order to know the optimal incubation time range for the experiments in that province. Samples were also collected for flow cytometric analysis from the surface (5 m depth), DCM and 200 m. The analysis of the communities in the experimental size fractions was undertaken by Rebecca May (Plymouth Marine Laboratory). See Table 1 of samples collected.

Community and size fractionated respiration measured with the classical ETS method

Water samples were collected into 10 L carboys from Niskin bottles fired at the same six depths (surface, 33% light, 14% light, deep chlorophyll maximum, 10 m below the DCM and 200 m) as CR_{O_2} and INT_R . The carboys were flushed twice with the sample seawater and immediately placed in the 4 °C constant temperature room. Approximately 10 L of seawater from each depth was filtered through 3 pore size filters (2.0 μm , 0.8 μm and 0.1 μm), thus allowing the estimation of the contribution of each component of the plankton community to the total respiration. Once the filtration was completed, the volume was measured with a 2 L measuring cylinder. The filters were snap-frozen in liquid nitrogen ($-196^\circ C$) and stored at $-80^\circ C$. Samples will be shipped by dry shipper to Concepción for subsequent kinetic analyses of the electron transport activity (ETS) following the Owens and King (1975) protocol. See Table 1 for a list of samples collected.

Community and size fractionated respiration derived from pyridine nucleotide concentrations and an enzyme kinetic model.

The same procedure as that described for the classical ETS method was followed. In this case, however, the filters will be analysed for the intracellular concentration of pyridine nucleotides (Wagner and Scott, 1994) in order to apply a kinetic model that uses the potential respiratory activity (ETS), kinetic enzymatic constants and the concentration of intracellular substrates to estimate actual respiratory rates. See Table 1 for a list of samples collected.

Zooplankton respiration

Zooplankton were collected at pre-dawn by vertical tows with a Bongo net (57 cm diameter ring, fitted with 120 μm and 200 μm mesh sizes) either from 200 or 250 m to the surface. The hauling speed was about 0.2–0.3 m s^{-1} , as recommended for physiological studies of live zooplankton. The samples from the 120 μm mesh size were split by the beaker technique; one half was fractionated for incubation experiments (Llopis-Monferrer et al., this cruise), while the other was carefully fractionated into 100–500 μm , 500–2000 μm and >2000 μm size categories, and immediately frozen in liquid nitrogen before being stored in the freezer ($-80\text{ }^{\circ}\text{C}$) for subsequent enzymatic (classical ETS) and stable isotope (C and N) analyses. Organisms collected by the 200 μm mesh size net were stored in plastic bottles filled with buffered formaldehyde for taxonomic analysis (Tarran et al., this cruise). See Table 2 for a list of nets sampled.

Particulate organic carbon and nitrogen and isotopic analysis

~20 L of surface seawater was collected at predawn from the underway non toxic seawater system for analysis of POC and PON concentrations, as well as the isotopic signatures (^{13}C and ^{15}N) in seston as a baseline for zooplankton values. Accordingly, all underway samples were taken at the same stations as those for zooplankton (see Table 2). 5 L was filtered through GF/F filters for POM concentration; 15 L was filtered through 0.8 μm polycarbonate filters for specific isotopic measurements of amino acids.

Dissolved organic carbon, total dissolved nitrogen and dissolved organic phosphorus (DOC, TDN & DOP)

Water for dissolved organic carbon, nitrogen and phosphorous (DOC/N/P) was collected from four depths at all pre-dawn CTDs where CR_{O_2} and INT_{R} were measured (see Table 1) and filtered according to the protocol described in Margolin et al. (2015). The depths corresponded to the surface (5 m), Deep Chlorophyll Maximum (DCM), 10 m below the DCM and 200 m. Collection bottles were rinsed with sample water and 1 litre of water was subsequently collected from each depth and stored at 4°C until filtering. All bottles and filtration equipment were acid-washed in a 10% HCl bath for at least 6 hours, rinsed thoroughly (at least 3 times) in Milli-Q and left to air dry in a clean fume hood. Water was filtered through a 0.45 μm pre-combusted GF/F and stored in labelled bottles at $-20\text{ }^{\circ}\text{C}$ until return to UEA.

Chlorophyll concentration

Chlorophyll-a (chl-a) was measured as an indicator of phytoplankton biomass. 1 L of seawater was collected at the predawn cast at all stations where either CR_{O_2} , INT_{R} or ETS samples were collected (see Table 1). Between 250 and 500 mL of seawater was filtered through the 0.2 μm polycarbonate filters depending on the productivity of the system. The filters were first stored at $-20\text{ }^{\circ}\text{C}$ before pigment extraction. Pigments were then extracted in acetone for 24 h, and their concentration was determined onboard using their fluorescence properties as described by Yentsch and Menzel (1963).

16S and 18S rRNA

Water samples were collected from all CTDs where CR_{O_2} and INT_R were measured (see Table 1) at two depths corresponding to the surface (5 m) and the DCM. Four litres of water were collected into pre-rinsed carboys and filtered within ~1 hour through a 0.22 μm Sterivex filter connected between the carboy and peristaltic pump with silicone tubing. To minimise degradation of the material, the water was filtered in the 2-4 °C controlled temperature room. Between 1 and 4 litres of water were filtered, depending on the productivity of the region. At the end of filtering, the Sterivex was sealed at both ends with Parafilm and stored in the -80 °C freezer until return to UEA.

Microscopy

Water samples were collected for plankton analysis in two ways. Firstly, 200 mL water was collected directly from the CTD from two depths corresponding to the surface (5 m) and the DCM. This was fixed immediately with Lugol's iodine solution using a concentration of 2 mL Lugol's per 100 mL sample. Secondly, 11 litres of water were collected from the same two depths and reverse-filtered through a 20 μm mesh in order to retain a concentrated sample of ~200 mL with plankton >20 μm . This was fixed with Lugol's iodine solution using a concentration of 3 mL per 100 mL sample. The bottles were sealed with parafilm and stored in the cool stow until return to the UK and analysis by project partner Claire Widdicombe at Plymouth Marine Laboratory.

Calibration of the CTD oxygen sensor

Samples were collected from 6 depths (surface, 33% light depth, 14% light depth, depth of the deep chlorophyll maximum (DCM), 10 m below the DCM and 200 m) on the pre-dawn CTD. Additional samples were taken when available at the oxygen minimum and below 200 m. One or two 55 mL glass bottles were filled directly from the Niskin bottle following Langdon, 2010. Samples were fixed immediately with $MnSO_4$ and $NaI/NaOH$ and analysed within 36 hours. Measurements of dissolved oxygen were made using an automated Winkler titration system to a photometric endpoint (Williams and Jenkinson, 1982). The sodium thiosulphate titrant was calibrated every second day before the analysis of the samples and the coefficient of variation of the calibration was always <0.3% (Langdon, 2010). In total, 36 profiles were analysed for the oxygen sensor calibration covering a concentration range between 66 and 294 μmol per L.

Provisional results

Calibration of the CTD oxygen sensor

Winkler oxygen data will be used to calibrate the SBE oxygen sensor on the CTD. Provisional data show a good relationship between the sensor and Winkler titrations. All data above 200 m are shown in Figure 1. The offset between the two varied with time (CTD number) and oxygen concentration (Figure 2). Samples collected below 200 m will be used to assess whether the relationship varies with depth (pressure).

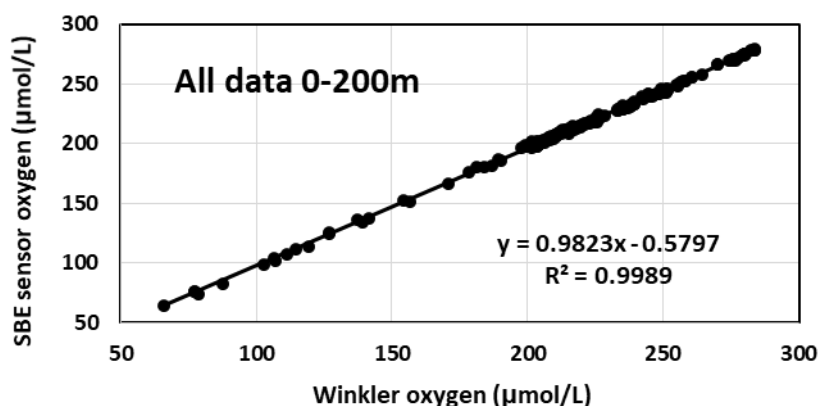


Figure 1 Regression between SBE sensor oxygen and Winkler oxygen

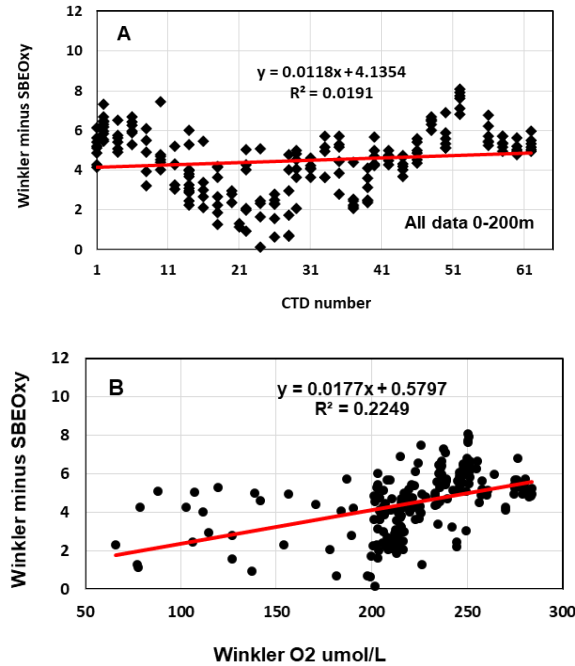


Figure 2 The offset ($\mu\text{mol/L}$) between the SBE sensor and Winkler oxygen varied with time (A) and oxygen concentration (B)

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References

- Carritt, D.E. and Carpenter, J.H., 1966. Comparison and evaluation of currently employed modifications of the Winkler method for determining dissolved oxygen in seawater; a NASCO Report. *Journal of Marine Research*, 24, 286-319.
- García-Martín, E.E., Aranguren-Gassis, M., Karl, D.M., Martínez-García, S., Robinson, C., Serret, P., Teira, E. Validation of the in vivo iodo-nitro-tetrazolium (INT) salt reduction method as a proxy for plankton respiration. *Frontiers in Marine Science*. In review.
- García-Martín, E.E., Aranguren-Gassis, M., Hartmann, M., Zubkov, M.V., Serret, P. 2016. Contribution of bacterial respiration to plankton respiration from 50°N to 44°S in the Atlantic Ocean *Progress in Oceanography*
- Langdon, C. 2010 Determination of dissolved oxygen in seawater by Winkler titration using the amperometric technique. The GO-SHIP Repeat Hydrography Manual: A collection of expert reports and guidelines. IOCCP Rport No. 14, ICPO Publication Series No. 134, Version 1.
- Margolin, A. R., Chen, W., Custals, L. & Hansell, D. A. 2015. Sampling guide for determination of dissolved organic carbon and total dissolved nitrogen in seawater. University of Miami: University of Miami, Rosenstiel School of Marine and Atmospheric Science

- Martínez-García, S., Fernández, E., Aranguren-Gassis, M., Teira, E., 2009. *In vivo* electron transport system activity: a method to estimate respiration in natural marine microbial planktonic communities. *Limnology and Oceanography Methods* 7, 459-469
- Owens, T.G., King, F.D., 1975. The measurement of respiratory electron-transport-system activity in marine zooplankton. *Marine Biology* 30 (1), 27–36.
- Robinson, C., Serret, P., Tilson, G., Teira, E., Zubkov, M.V., Rees, A.P., Woodward, E.M.S. 2002. Plankton respiration in the Eastern Atlantic Ocean. *Deep-Sea Research* 49, 787-813.
- Serret, P., Robinson, C., Aranguren-Gassis, M., García-Martín, E.E., Gist, N., Kitidis, V., Lozano, J., Stephens, J., Harris, C., Thomas, R. 2015. Both respiration and photosynthesis determine the scaling of plankton metabolism in the oligotrophic ocean. *Nature Communications* doi: 10.1038/ncomms7961
- Yentsch, C.S., Menzel, D.W., 1963. A method for the determination of phytoplankton chlorophyll and phaeophytin by fluorescence. *Deep Sea Research* 221–231.
- Wagner TC, Scott MD (1994) Single extraction method for the spectrophotometric quantification of oxidized and reduced pyridine nucleotides in erythrocytes. *Anal Biochem* 222, 417–426
- Williams, P.J.leB. and Jenkinson, N.W. 1982. A transportable micro-processor controlled precise Winkler titration suitable for field station and shipboard use. *Limnology and Oceanography*, 27, 576.

Table 1: CTD samples collected

| Date | Time (GMT) | CTD Cast | LAT (+ve N) | LON (+ve E) | Niskins sampled | Parameters |
|------------|------------|----------|-------------|-------------|----------------------|--|
| 25/09/2018 | 12:32 | 1 | 49.6381 | -5.50158 | 21 | INT _R time series plus flow cytometric analysis of size fractions |
| 25/09/2018 | 12:32 | 1 | 49.6381 | -5.50158 | 1, 10, 16, 21 | Dissolved O ₂ , DOC, DON, DOP |
| 25/09/2018 | 12:32 | 1 | 49.6381 | -5.50158 | 2, 8, 12, 15, 18, 23 | ETS |
| 25/09/2018 | 12:32 | 1 | 49.6381 | -5.50158 | 1, 7, 11, 14, 17, 22 | Chl |
| 25/09/2018 | 12:32 | 1 | 49.6381 | -5.50158 | 17, 22 | RNA |
| 25/09/2018 | 12:32 | 1 | 49.6381 | -5.50158 | 17, 22 | Lugols |
| 26/09/2018 | 03:34 | 2 | 48.46939 | -8.83656 | 1, 4, 6, 13, 17, 20 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 26/09/2018 | 03:34 | 2 | 48.46939 | -8.83656 | 2, 5, 8, 14, 18, 21 | ETS, EKM |
| 26/09/2018 | 03:34 | 2 | 48.46939 | -8.83656 | 1, 4, 6, 20 | DOC, DON, DOP |
| 26/09/2018 | 03:34 | 2 | 48.46939 | -8.83656 | 6, 20 | RNA |
| 26/09/2018 | 03:34 | 2 | 48.46939 | -8.83656 | 9, 20, 23 | Lugols |
| 27/09/2018 | 03:30 | 4 | 46.0291 | -12.73255 | 1, 4, 6, 13, 17, 20 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 27/09/2018 | 03:30 | 4 | 46.0291 | -12.73255 | 20 | INT _R time series plus flow cytometric analysis of size fractions |
| 27/09/2018 | 03:30 | 4 | 46.0291 | -12.73255 | 2, 5, 8, 14, 17, 21 | ETS, EKM |
| 27/09/2018 | 03:30 | 4 | 46.0291 | -12.73255 | 1, 4, 6, 20 | DOC, DON, DOP |

| | | | | | | |
|------------|-------|----|----------|-----------|---------------------|---|
| 27/09/2018 | 03:30 | 4 | 46.0291 | -12.73255 | 6, 20 | RNA |
| 27/09/2018 | 03:30 | 4 | 46.0291 | -12.73255 | 9, 23 | Lugols |
| 28/09/2018 | 03:33 | 6 | 42.96752 | -15.21344 | 2, 5, 8, 15, 18, 21 | Dissolved O ₂ |
| 28/09/2018 | 03:33 | 6 | 42.96752 | -15.21344 | 3, 6, 9, 16, 19, 22 | ETS, Chl |
| 29/09/2018 | 03:29 | 8 | 39.71934 | -17.71619 | 1, 4, 7, 13, 17, 20 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 29/09/2018 | 03:29 | 8 | 39.71934 | -17.71619 | 2, 5, 8, 14, 18, 21 | ETS, EKM |
| 29/09/2018 | 03:29 | 8 | 39.71934 | -17.71619 | 1, 4, 7, 20 | DOC, DON, DOP |
| 29/09/2018 | 03:29 | 8 | 39.71934 | -17.71619 | 7, 20 | RNA |
| 29/09/2018 | 03:29 | 8 | 39.71934 | -17.71619 | 9, 23 | Lugols |
| 30/09/2018 | 04:27 | 10 | 36.41392 | -20.12145 | 1, 4, 7, 14, 16, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 30/09/2018 | 04:27 | 10 | 36.41392 | -20.12145 | 20, 21 | INT _R time series plus flow cytometric analysis of size fractions |
| 30/09/2018 | 04:27 | 10 | 36.41392 | -20.12145 | 2, 5, 8, 15, 17, 22 | ETS, EKM |
| 30/09/2018 | 04:27 | 10 | 36.41392 | -20.12145 | 1, 4, 7, 21 | DOC, DON, DOP |
| 30/09/2018 | 04:27 | 10 | 36.41392 | -20.12145 | 7, 21 | RNA |
| 30/09/2018 | 04:27 | 10 | 36.41392 | -20.12145 | 9, 23 | Lugols |
| 01/10/2018 | 04:30 | 12 | 33.04696 | -22.13676 | 1, 4, 6, 13, 17, 22 | Dissolved O ₂ |
| 01/10/2018 | 04:30 | 12 | 33.04696 | -22.13676 | 2, 5, 7, 14, 18, 23 | ETS, Chl |
| 02/10/2018 | 04:34 | 14 | 29.48832 | -23.93246 | 1, 5, 8, 15, 17, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 02/10/2018 | 04:34 | 14 | 29.48832 | -23.93246 | 2, 6, 9, 16, 18, 22 | ETS, EKM |
| 02/10/2018 | 04:34 | 14 | 29.48832 | -23.93246 | 1, 5, 8, 21 | DOC, DON, DOP |
| 02/10/2018 | 04:34 | 14 | 29.48832 | -23.93246 | 8, 21 | RNA |
| 02/10/2018 | 04:34 | 14 | 29.48832 | -23.93246 | 10, 23 | Lugols |
| 03/10/2018 | 04:32 | 16 | 26.20378 | -25.52107 | 1, 4, 7, 15, 17, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 03/10/2018 | 04:32 | 16 | 26.20378 | -25.52107 | 2, 5, 8, 16, 18, 22 | ETS, EKM |
| 03/10/2018 | 04:32 | 16 | 26.20378 | -25.52107 | 1, 4, 7, 21 | DOC, DON, DOP |
| 03/10/2018 | 04:32 | 16 | 26.20378 | -25.52107 | 7, 21 | RNA |
| 03/10/2018 | 04:32 | 16 | 26.20378 | -25.52107 | 9, 23 | Lugols |

| | | | | | | |
|------------|-------|----|----------|-----------|----------------------|---|
| 04/10/2018 | 04:34 | 18 | 22.59968 | -27.21334 | 1, 7, 9, 15, 17, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 04/10/2018 | 04:34 | 18 | 22.59968 | -27.21334 | 2, 8, 10, 16, 18, 22 | ETS, EKM |
| 04/10/2018 | 04:34 | 18 | 22.59968 | -27.21334 | 1, 7, 9, 21 | DOC, DON, DOP |
| 04/10/2018 | 04:34 | 18 | 22.59968 | -27.21334 | 9, 21 | RNA |
| 04/10/2018 | 04:34 | 18 | 22.59968 | -27.21334 | 11, 23 | Lugols |
| 05/10/2018 | 04:36 | 20 | 19.07775 | -28.81675 | 1, 4, 7, 13, 16, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 05/10/2018 | 04:36 | 20 | 19.07775 | -28.81675 | 21 | INT _R time series plus flow cytometric analysis of size fractions |
| 05/10/2018 | 04:36 | 20 | 19.07775 | -28.81675 | 2, 4, 8, 14, 17, 22 | ETS, EKM |
| 05/10/2018 | 04:36 | 20 | 19.07775 | -28.81675 | 1, 4, 7, 21 | DOC, DON, DOP |
| 05/10/2018 | 04:36 | 20 | 19.07775 | -28.81675 | 7, 21 | RNA |
| 05/10/2018 | 04:36 | 20 | 19.07775 | -28.81675 | 9, 23 | Lugols |
| 06/10/2018 | 04:37 | 22 | 15.07608 | -28.61262 | 1, 7, 11, 16, 19, 22 | Dissolved O ₂ |
| 06/10/2018 | 04:37 | 22 | 15.07608 | -28.61262 | 2, 8, 12, 17, 20, 23 | ETS, Chl |
| 07/10/2018 | 04:35 | 24 | 11.44698 | -27.70872 | 1, 5, 8, 13, 17, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 07/10/2018 | 04:35 | 24 | 11.44698 | -27.70872 | 2, 6, 9, 14, 18, 22 | ETS, EKM |
| 07/10/2018 | 04:35 | 24 | 11.44698 | -27.70872 | 1, 5, 8, 21 | DOC, DON, DOP |
| 07/10/2018 | 04:35 | 24 | 11.44698 | -27.70872 | 8, 21 | RNA |
| 07/10/2018 | 04:35 | 24 | 11.44698 | -27.70872 | 10, 23 | Lugols |
| 08/10/2018 | 04:36 | 26 | 7.47128 | -26.65012 | 1, 5, 8, 14, 17, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 08/10/2018 | 04:36 | 26 | 7.47128 | -26.65012 | 20, 21 | INT _R time series plus flow cytometric analysis of size fractions |
| 08/10/2018 | 04:36 | 26 | 7.47128 | -26.65012 | 2, 6, 9, 15, 18, 22 | ETS, EKM |
| 08/10/2018 | 04:36 | 26 | 7.47128 | -26.65012 | 1, 5, 8, 21 | DOC, DON, DOP |
| 08/10/2018 | 04:36 | 26 | 7.47128 | -26.65012 | 8, 21 | RNA |
| 08/10/2018 | 04:36 | 26 | 7.47128 | -26.65012 | 10, 23 | Lugols |
| 09/10/2018 | 04:38 | 28 | 3.80776 | -25.8358 | 1, 5, 8, 15, 17, 21 | Dissolved O ₂ |
| 09/10/2018 | 04:38 | 28 | 3.80776 | -25.8358 | 2, 6, 9, 16, 18, 22 | ETS, Chl |

| | | | | | | |
|------------|-------|----|-----------|-----------|----------------------|---|
| 10/10/2018 | 04:42 | 29 | 0.00056 | -24.99909 | 1, 5, 8, 13, 17, 20 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 10/10/2018 | 04:42 | 29 | 0.00056 | -24.99909 | 2, 6, 9, 14, 18, 21 | ETS, EKM |
| 10/10/2018 | 04:42 | 29 | 0.00056 | -24.99909 | 1, 5, 8, 20 | DOC, DON, DOP |
| 10/10/2018 | 04:42 | 29 | 0.00056 | -24.99909 | 8, 20 | RNA |
| 10/10/2018 | 04:42 | 29 | 0.00056 | -24.99909 | 10, 23 | Lugols |
| 11/10/2018 | 04:37 | 31 | -3.69158 | -24.97764 | 1, 6, 9, 15, 18, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 11/10/2018 | 04:37 | 31 | -3.69158 | -24.97764 | 2, 7, 10, 16, 19, 22 | ETS, EKM |
| 11/10/2018 | 04:37 | 31 | -3.69158 | -24.97764 | 1, 6, 9, 21 | DOC, DON, DOP |
| 11/10/2018 | 04:37 | 31 | -3.69158 | -24.97764 | 9, 21 | RNA |
| 11/10/2018 | 04:37 | 31 | -3.69158 | -24.97764 | 11, 21, 23 | Lugols |
| 12/10/2018 | 04:37 | 33 | -7.54874 | -24.95725 | 1, 5, 8, 13, 16, 20 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 12/10/2018 | 04:37 | 33 | -7.54874 | -24.95725 | 8 | INT _R time series plus flow cytometric analysis of size fractions |
| 12/10/2018 | 04:37 | 33 | -7.54874 | -24.95725 | 2, 6, 9, 14, 17, 22 | ETS, EKM |
| 12/10/2018 | 04:37 | 33 | -7.54874 | -24.95725 | 1, 5, 8, 20 | DOC, DON, DOP |
| 12/10/2018 | 04:37 | 33 | -7.54874 | -24.95725 | 8, 20 | RNA |
| 12/10/2018 | 04:37 | 33 | -7.54874 | -24.95725 | 10, 20, 23 | Lugols |
| 13/10/2018 | 04:33 | 35 | -11.26239 | -24.9374 | 1, 4, 7, 14, 17, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 13/10/2018 | 04:33 | 35 | -11.26239 | -24.9374 | 2, 5, 8, 15, 18, 22 | ETS, EKM |
| 13/10/2018 | 04:33 | 35 | -11.26239 | -24.9374 | 1, 4, 7, 21 | DOC, DON, DOP |
| 13/10/2018 | 04:33 | 35 | -11.26239 | -24.9374 | 7, 21 | RNA |
| 13/10/2018 | 04:33 | 35 | -11.26239 | -24.9374 | 9, 21, 23 | Lugols |
| 14/10/2018 | 04:33 | 37 | -14.77977 | -24.98475 | 1, 4, 7, 13, 17, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 14/10/2018 | 04:33 | 37 | -14.77977 | -24.98475 | 20, 21 | INT _R time series plus flow cytometric analysis of size fractions |
| 14/10/2018 | 04:33 | 37 | -14.77977 | -24.98475 | 2, 5, 8, 14, 18, 22 | ETS, EKM |
| 14/10/2018 | 04:33 | 37 | -14.77977 | -24.98475 | 1, 4, 7, 21 | DOC, DON, DOP |
| 14/10/2018 | 04:33 | 37 | -14.77977 | -24.98475 | 7, 21 | RNA |

| | | | | | | |
|------------|-------|----|-----------|-----------|---------------------|---|
| 14/10/2018 | 04:33 | 37 | -14.77977 | -24.98475 | 9, 21, 23 | Lugols |
| 15/10/2018 | 04:33 | 39 | -18.33931 | -25.08566 | 1, 5, 7, 16, 19, 22 | Dissolved O ₂ |
| 15/10/2018 | 04:33 | 39 | -18.33931 | -25.08566 | 2, 6, 8, 17, 20, 23 | ETS, Chl |
| 16/10/2018 | 04:37 | 40 | -20.37933 | -25.05943 | 1, 4, 6, 12, 16, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 16/10/2018 | 04:37 | 40 | -20.37933 | -25.05943 | 6 | INT _R time series plus flow cytometric analysis of size fractions |
| 16/10/2018 | 04:37 | 40 | -20.37933 | -25.05943 | 2, 5, 7, 13, 17, 22 | ETS, EKM |
| 16/10/2018 | 04:37 | 40 | -20.37933 | -25.05943 | 1, 4, 6, 21 | DOC, DON, DOP |
| 16/10/2018 | 04:37 | 40 | -20.37933 | -25.05943 | 6, 21 | RNA |
| 16/10/2018 | 04:37 | 40 | -20.37933 | -25.05943 | 8, 21, 23 | Lugols |
| 17/10/2018 | 04:28 | 42 | -23.99954 | -24.99934 | 1, 5, 8, 15, 18, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 17/10/2018 | 04:28 | 42 | -23.99954 | -24.99934 | 2, 6, 9, 16, 19, 22 | ETS, EKM |
| 17/10/2018 | 04:28 | 42 | -23.99954 | -24.99934 | 1, 5, 8, 21 | DOC, DON, DOP |
| 17/10/2018 | 04:28 | 42 | -23.99954 | -24.99934 | 8, 21 | RNA |
| 17/10/2018 | 04:28 | 42 | -23.99954 | -24.99934 | 10, 21, 23 | Lugols |
| 18/10/2018 | 04:40 | 44 | -26.62798 | -27.65536 | 1, 4, 6, 12, 16, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 18/10/2018 | 04:40 | 44 | -26.62798 | -27.65536 | 2, 5, 7, 13, 17, 22 | ETS, EKM |
| 18/10/2018 | 04:40 | 44 | -26.62798 | -27.65536 | 1, 4, 6, 21 | DOC, DON, DOP |
| 18/10/2018 | 04:40 | 44 | -26.62798 | -27.65536 | 6, 21 | RNA |
| 18/10/2018 | 04:40 | 44 | -26.62798 | -27.65536 | 8, 21, 23 | Lugols |
| 19/10/2018 | 04:34 | 46 | -29.1276 | -30.22349 | 1, 4, 7, 14, 17, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 19/10/2018 | 04:34 | 46 | -29.1276 | -30.22349 | 2, 5, 8, 15, 18, 22 | ETS, EKM |
| 19/10/2018 | 04:34 | 46 | -29.1276 | -30.22349 | 1, 4, 7, 21 | DOC, DON, DOP |
| 19/10/2018 | 04:34 | 46 | -29.1276 | -30.22349 | 7, 21 | RNA |
| 19/10/2018 | 04:34 | 46 | -29.1276 | -30.22349 | 9, 21, 23 | Lugols |
| 20/10/2018 | 04:40 | 48 | -31.61847 | -32.88412 | 1, 4, 6, 12, 16, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 20/10/2018 | 04:40 | 48 | -31.61847 | -32.88412 | 2, 5, 7, 13, 17, 22 | ETS, EKM |
| 20/10/2018 | 04:40 | 48 | -31.61847 | -32.88412 | 1, 4, 6, 21 | DOC, DON, DOP |

| | | | | | | |
|------------|-------|----|-----------|-----------|-------------------------------|---|
| 20/10/2018 | 04:40 | 48 | -31.61847 | -32.88412 | 6, 21 | RNA |
| 20/10/2018 | 04:40 | 48 | -31.61847 | -32.88412 | 8, 21, 23 | Lugols |
| 21/10/2018 | 04:36 | 50 | -33.83179 | -35.26906 | 1, 6, 9, 16, 18, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 21/10/2018 | 04:36 | 50 | -33.83179 | -35.26906 | 2, 7, 10, 17, 19, 22 | ETS, EKM |
| 21/10/2018 | 04:36 | 50 | -33.83179 | -35.26906 | 1, 6, 9, 21 | DOC, DON, DOP |
| 21/10/2018 | 04:36 | 50 | -33.83179 | -35.26906 | 9, 21 | RNA |
| 21/10/2018 | 04:36 | 50 | -33.83179 | -35.26906 | 11, 21, 23 | Lugols |
| 21/10/2018 | 13:07 | 51 | -34.58054 | -36.09145 | 1, 6, 8, 11 | Dissolved O ₂ |
| 22/10/2018 | 04:40 | 52 | -36.16738 | -37.86655 | 1, 5, 7, 13, 17, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 22/10/2018 | 04:40 | 52 | -36.16738 | -37.86655 | 21, 24 | INT _R time series plus flow cytometric analysis of size fractions |
| 22/10/2018 | 04:40 | 52 | -36.16738 | -37.86655 | 2, 6, 8, 14, 18, 22 | ETS, EKM |
| 22/10/2018 | 04:40 | 52 | -36.16738 | -37.86655 | 1, 5, 7, 21 | DOC, DON, DOP |
| 22/10/2018 | 04:40 | 52 | -36.16738 | -37.86655 | 7, 21 | RNA |
| 22/10/2018 | 04:40 | 52 | -36.16738 | -37.86655 | 9, 21, 23 | Lugols |
| 23/10/2018 | 13:06 | 55 | -39.2093 | -41.47502 | 1, 3, 6, 9, 11, 12, 13, 14 | Dissolved O ₂ |
| 24/10/2018 | 04:36 | 56 | -40.521 | -43.0831 | 1, 5, 7, 14, 17, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 24/10/2018 | 04:36 | 56 | -40.521 | -43.0831 | 2, 6, 8, 15, 18, 22 | ETS, EKM |
| 24/10/2018 | 04:36 | 56 | -40.521 | -43.0831 | 1, 5, 7, 21 | DOC, DON, DOP |
| 24/10/2018 | 04:36 | 56 | -40.521 | -43.0831 | 7, 21 | RNA |
| 24/10/2018 | 04:36 | 56 | -40.521 | -43.0831 | 9, 21, 23 | Lugols |
| 24/10/2018 | 13:02 | 57 | -40.521 | -43.0831 | 1, 3, 6, 9, 11, 14 | Dissolved O ₂ |
| 25/10/2018 | 05:37 | 58 | -43.006 | -45.9817 | 1, 7, 10, 15, 18, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |
| 25/10/2018 | 05:37 | 58 | -43.006 | -45.9817 | 2, 8, 11, 16, 19, 22 | ETS, EKM |
| 25/10/2018 | 05:37 | 58 | -43.006 | -45.9817 | 1, 7, 10, 21 | DOC, DON, DOP |
| 25/10/2018 | 05:37 | 58 | -43.006 | -45.9817 | 10, 21 | RNA |
| 25/10/2018 | 05:37 | 58 | -43.006 | -45.9817 | 12, 21, 23 | Lugols |
| 26/10/2018 | 05:35 | 60 | -46.0176 | -49.8723 | 1, 4, 6, 12, 16, 21 | Dissolved O ₂ , CR _{O2} , INT _R , Chl |

| | | | | | | |
|------------|-------|----|-----------|-----------|---------------------|---|
| 26/10/2018 | 05:35 | 60 | -46.0176 | -49.8723 | 19 | INT _R time series plus flow cytometric analysis of size fractions |
| 26/10/2018 | 05:35 | 60 | -46.0176 | -49.8723 | 2, 5, 7, 13, 17, 22 | ETS, EKM |
| 26/10/2018 | 05:35 | 60 | -46.0176 | -49.8723 | 1, 4, 6, 21 | DOC, DON, DOP |
| 26/10/2018 | 05:35 | 60 | -46.0176 | -49.8723 | 6, 21 | RNA |
| 26/10/2018 | 05:35 | 60 | -46.0176 | -49.8723 | 8, 21, 23 | Lugols |
| 27/10/2018 | 06:37 | 62 | -47.56184 | -51.77396 | 2, 6, 9, 13, 16, 18 | Dissolved O ₂ |

Table 2 Net samples collected

| Station | Event | START date/time | Lat | Lon | Depth |
|---------|---------|-----------------|-----------|-----------|-------|
| 2 | BONGO01 | 26/9/18 3:38 | 48.46937 | -8.83657 | 130 |
| 4 | BONGO02 | 27/9/18 3:29 | 46.02911 | -12.73254 | 200 |
| 6 | BONGO03 | 28/9/18 3:35 | 42.93067 | -15.24096 | 200 |
| 8 | BONGO04 | 29/9/18 3:30 | 39.71934 | -17.71618 | 200 |
| 10 | BONGO05 | 30/9/18 4:27 | 36.41393 | -20.12146 | 200 |
| 12 | BONGO06 | 1/10/18 4:27 | 33.04687 | -22.13684 | 200 |
| 14 | BONGO07 | 2/10/18 4:34 | 29.48831 | -23.93245 | 200 |
| 16 | BONGO08 | 3/10/18 4:29 | 26.20378 | -25.52106 | 200 |
| 18 | BONGO09 | 4/10/18 4:27 | 22.52602 | -27.23756 | 200 |
| 20 | BONGO10 | 5/10/18 4:32 | 19.07778 | -28.81673 | 200 |
| 22 | BONGO11 | 6/10/18 4:30 | 15.07608 | -28.61265 | 200 |
| 24 | BONGO12 | 7/10/18 4:31 | 11.44697 | -27.7087 | 200 |
| 27 | BONGO13 | 8/10/18 4:30 | 7.47128 | -26.65011 | 200 |
| 29 | BONGO14 | 9/10/18 4:33 | 3.80777 | -25.83581 | 200 |
| 30 | BONGO15 | 10/10/18 4:44 | 0.00195 | -24.99564 | 200 |
| 32 | BONGO16 | 11/10/18 4:33 | -3.6894 | -24.97921 | 200 |
| 34 | BONGO17 | 12/10/18 4:36 | -7.54858 | -24.9588 | 200 |
| 36 | BONGO18 | 13/10/18 4:30 | -11.26192 | -24.93874 | 200 |
| 38 | BONGO19 | 14/10/18 4:30 | -14.77903 | -24.98561 | 250 |
| 41 | BONGO20 | 15/10/18 4:33 | -18.33901 | -25.08716 | 250 |
| 43 | BONGO21 | 16/10/18 4:36 | -20.3803 | -25.05914 | 250 |
| 45 | BONGO22 | 17/10/18 4:28 | -24.00001 | -24.99993 | 250 |
| 47 | BONGO23 | 18/10/18 4:34 | -26.62795 | -27.65536 | 250 |
| 49 | BONGO24 | 19/10/18 4:30 | -29.12759 | -30.22349 | 200 |
| 51 | BONGO25 | 20/10/18 4:39 | -31.61683 | -32.88554 | 200 |
| 55 | BONGO26 | 22/10/18 4:29 | -36.16649 | -37.86574 | 200 |
| 61 | BONGO27 | 25/10/18 5:34 | -43.00398 | -45.98262 | 200 |
| 63 | BONGO28 | 26/10/18 5:31 | -45.29729 | -48.89553 | 200 |
| 65 | BONGO29 | 27/10/18 6:34 | -47.56557 | -51.77405 | 200 |

References

- MARGOLIN, A. R., CHEN, W., CUSTALS, L. & HANSELL, D. A. 2015. Sampling guide for determination of dissolved organic carbon and total dissolved nitrogen in seawater. University of Miami: University of Miami, Rosenstiel School of Marine and Atmospheric Science.
- MARTÍNEZ-GARCÍA, S., FERNÁNDEZ, E., ARANGUREN-GASSIS, M. & TEIRA, E. 2009. In vivo electron transport system activity: a method to estimate respiration in natural marine microbial planktonic communities *Limnology and oceanography: methods*, 7, 459-469.

Silicon Uptake Rates and Silica Content of Rhizaria

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Cruise Objectives

Polycystinean radiolarians and phaeodarians are open-ocean planktonic protozoa which are typified by complex siliceous skeletons. These organisms are distributed worldwide and they can be found from the surface to the abyssal regions. Rhizarians have been extensively studied as a paleoenvironmental tool, however, their physiology and ecology has not been sufficiently investigated because they are hard to cultivate.

The aim of this project is to address the gaps in oceanic field observations and investigate the role of siliceous Rhizaria in the oceanic silica cycle. Herein we collect samples of living Rhizaria to obtain estimates of silica, as well as production rates, from a wide variety of pelagic ecosystems along the Atlantic Ocean transect, to better quantify the contribution of these organisms to the world ocean silica cycle.

Methods

Niskin bottles

Sea water samples were collected every other day at six different depths using Niskin bottles. Silicic acid concentration, particulate organic carbon, nitrogen and biogenic silica content was collected for all depths, while only 3 depths were used for production/incubations.

At each sampling station water was filtered onto a 0.4 µm GF/F filter for organic carbon and nitrogen analyses or onto a 0.8 µm polycarbonate (PC) membrane filter for biogenic silica determination. GF/F filters were frozen at -20°C and PC membranes were stored at room temperature in mini petri dishes until off site analysis.

Net hauls

Plankton samples are collected daily at predawn using a WP-2 bongo (120 µm mesh size/ 63 µm cod-end) vertical haul from 200 m or 250 m to the surface. The sample was divided into 2 subsamples by the beaker technique. One half was frozen for enzymatic analyses (Fernández-Urruzola) and the other half was subsequently split into 4 subsamples.

1. Ethanol fixation for single cell isolation. Sample was sieved through a 44 µm sieve and recovered in a Falcon tube.
2. Acidic lugol fixation for FlowCAM processing. Sample was sieved through a 44 µm sieve and recovered in a glass flask.
3. DNA analysis to be analysed at the SBR (Station Biologique de Roscoff). Sample was quickly filtered through 2 x 47 mm 10 µm PC filters (ca 250 mL each filter). Once filtration was over or whenever it clogged, filters were recovered with cleaned tweezers into two separate 2 mL cryovials.

Samples were immediately flash-frozen in liquid nitrogen and stored at -80 °C until further analysis in the lab.

4. Observation for single cell isolation to be used in the production experiments. Small cells were observed under an inverted microscope while largest cells were observed using a stereomicroscope. Siliceous Rhizaria were handpicked and isolated with the aid of a Pasteur pipette and deposited in a 20 mL glass vial with filtered sea water. Cells were sorted according to a few targeted taxonomic groups (Figure 1). Glass vials containing between 1 to 50 cells of the same taxonomic group were incubated on deck, after isolation, for 24h in a flowing-seawater incubator to maintain constant water temperature.. A series of neutral density screens was used to simulate *in situ* light intensity. After incubation, isotope samples were filtered by gentle (<150mmHg) vacuum filtration onto 47mm diameter, 0.6 µm pore-size polycarbonate membrane filters (Nuclepore) and rinsed twice with filtered seawater to wash away non-particulate ³²Si. Each filter was then placed in a clean 20 mL polypropylene liquid scintillation vial and the vial was capped loosely to permit the sample to dry at room temperature for 48 h. The vials were then capped tightly and returned to UBO laboratories for counting using the Cerenkov method. Once the counting is done, digestion will be performed to measure the particulate biogenic silica contained in the filters (BSi).

Provisional Results

The samples taken from the Bongo (zooplankton) and the rosette (seawater) will be analysed back at UBO (France).

References

- Tréguer, P., Bowler, C., Moriceau B., Dutkiewicz S., Gehlen M., Aumont O., Bittner, L., Dugdale R., Finkel Z., Iudicone D., Jahn O., Guidi L., Lasbleiz, M., Leblanc K., Levy M., Pondaven P., 2017. Influence of diatom diversity on the ocean biological carbon pump. *Nature Geoscience*. doi:10.1038/s41561-017-0028-x
- Biard, T., Stemmann, L., Picheral, M., Mayot, N., Vandromme, P., Hauss, H., Gorsky, G., Guidi, L., Kiko, R., Not, F., 2016. In situ imaging reveals the biomass of giant protists in the global ocean. *Nature* 532(7600), 504–507. doi:10.1038/nature17652 (<http://www.nature.com/nature/journal/v532/n7600/full/nature17652.html>)
- Tréguer, P. and De la Rocha C., 2013. The world ocean Silica cycle. *Annu. Rev. Mar. Sci.*
- RogersJ, & De Dekker, P, 2011. Environmental reconstructions of the upper 500 m of the southern Indian Ocean over the last 40 ka using Radiolarian (Protista) proxies. *Quaternary Sci. Rev.* doi.org/10.1016/j.quascirev.2011.01.006
- Lampitt, R.S., Salter, I., Johns, D., 2009. Radiolaria: Major exporters of organic carbon to the deep ocean. *Global Biogeochem. Cycles* 23, 1–9. doi:10.1029/2008GB003221
- Tréguer, P., Lindner, L., van Bennekom, A.J., Leynaert, A., Panouse, M., Jacques, G. 1991. Production of biogenic silica in the Weddell-Scotia Seas measured with ³²Si. *Limnology & Oceanography*, doi: 10.4319/lo.1991.36.6.1217

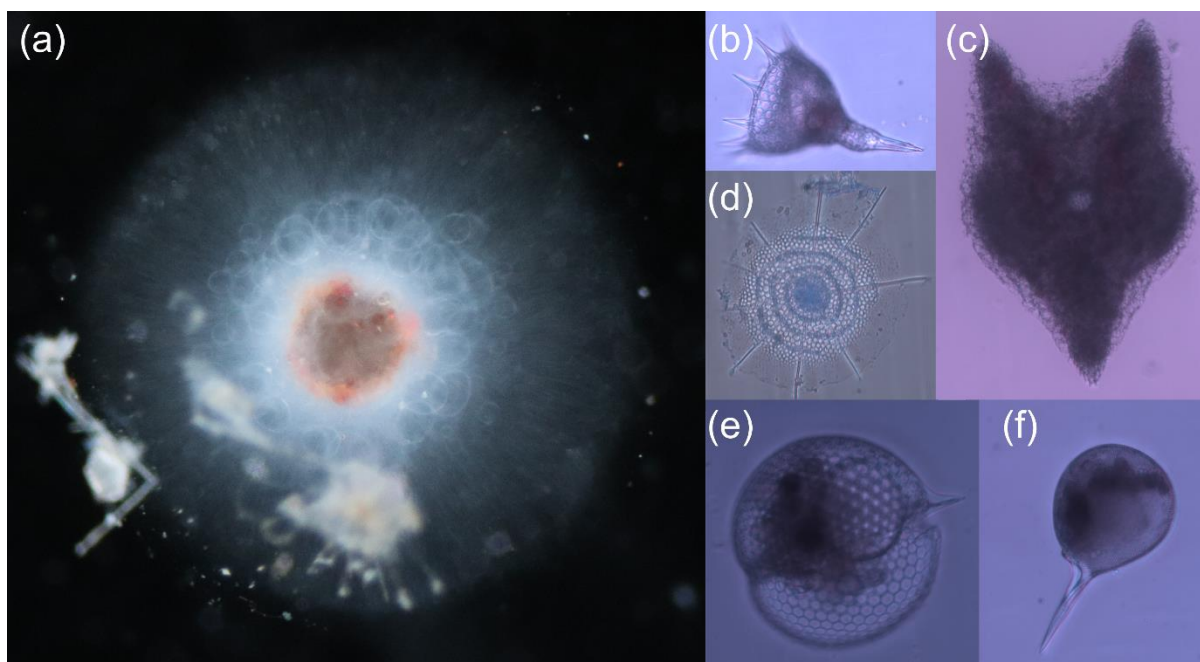


Figure 1. Pictures of the different taxonomic groups taken during the AMT28. (a) Collodaria (*Thalassicolla* sp.), (b) Nassellaria, (c) and (d) Spumellaria, (e) Phaeoconchida and (f) Phaeogromida

Table 1: AMT28 – CTD samples

| Date | Time (GMT) | Station No. | CTD Cast | LAT (+ve N) | LON (+ve E) | Depths sampled (m) |
|------------|------------|-------------|----------|-------------|-------------|--------------------------|
| 26/09/2018 | 0334 | 2 | 002 | 48.47 | -8.84 | 140, 70, 60, 25, 10, 5 |
| 28/09/2018 | 0333 | 6 | 006 | 42.97 | -15.21 | 200, 60, 52, 23, 7, 5 |
| 30/09/2018 | 0427 | 10 | 010 | 36.41 | -20.12 | 200, 115, 105, 45, 14, 5 |
| 02/10/2018 | 0434 | 14 | 014 | 29.49 | -23.93 | 200, 124, 114, 45, 15, 5 |
| 04/10/2018 | 0434 | 18 | 018 | 22.60 | -27.21 | 200, 103, 93, 41, 13, 5 |
| 06/10/2018 | 0437 | 22 | 022 | 15.08 | -28.61 | 200, 67, 57, 25, 7, 5 |
| 08/10/2018 | 0436 | 27 | 026 | 7.47 | -26.65 | 200, 82, 72, 30, 9, 5 |
| 10/10/2018 | 0442 | 30 | 029 | 0.00 | -24.00 | 200, 70, 60, 26, 8, 5 |
| 12/10/2018 | 0437 | 34 | 033 | -7.55 | -24.96 | 200, 120, 110, 47, 15, 5 |
| 14/10/2018 | 0433 | 38 | 037 | -14.78 | -24.98 | 200, 155, 145, 62, 20, 5 |
| 16/10/2018 | 0437 | 43 | 040 | -20.39 | -25.06 | 200, 171, 161, 70, 25, 5 |
| 18/10/2018 | 0440 | 47 | 044 | -26.63 | -27.66 | 200, 137, 127, 56, 17, 5 |
| 20/10/2018 | 0530 | 51 | 048 | -31.62 | -32.88 | 200, 141, 131, 56, 17, 5 |
| 22/10/2018 | 0440 | 55 | 052 | -33.17 | -37.87 | 200, 80, 70, 30, 10, 5 |
| 24/10/2018 | 0436 | 59 | 056 | -40.52 | -43.08 | 200, 50, 40, 17, 8, 5 |
| 26/10/2018 | 0535 | 63 | 060 | -45.30 | -48.90 | 200, 63, 53, 24, 7, 5 |

Table 2: AMT28 - Zooplankton samples

| Date | Station No. | Bongo No. | Depth sampled (m) | LAT (+ve N) | LON (+ve E) |
|-------------|--------------------|------------------|--------------------------|--------------------|--------------------|
| 26/09/2018 | 2 | BONGO01 | 130 | 48,47 | -8,84 |
| 27/09/2018 | 4 | BONGO02 | 200 | 46,03 | -12,73 |
| 28/09/2018 | 6 | BONGO03 | 200 | 42,97 | -15,21 |
| 29/09/2018 | 8 | BONGO04 | 200 | 39,72 | -17,72 |
| 30/09/2018 | 10 | BONGO05 | 200 | 36,41 | -20,12 |
| 01/10/2018 | 12 | BONGO06 | 200 | 33,05 | -22,14 |
| 02/10/2018 | 14 | BONGO07 | 200 | 29,49 | -23,93 |
| 03/10/2018 | 16 | BONGO08 | 200 | 26,20 | -25,52 |
| 04/10/2018 | 18 | BONGO09 | 200 | 22,60 | -27,21 |
| 05/10/2018 | 20 | BONGO10 | 200 | 19,08 | -28,82 |
| 06/10/2018 | 22 | BONGO11 | 200 | 15,08 | -28,61 |
| 07/10/2018 | 24 | BONGO12 | 200 | 11,45 | -27,71 |
| 08/10/2018 | 27 | BONGO13 | 200 | 7,47 | -26,65 |
| 09/10/2018 | 29 | BONGO14 | 200 | 3,81 | -25,84 |
| 10/10/2018 | 30 | BONGO15 | 200 | 0,00 | -25,00 |
| 11/10/2018 | 32 | BONGO16 | 200 | -3,69 | -24,98 |
| 12/10/2018 | 34 | BONGO17 | 200 | -7,55 | -24,96 |
| 13/10/2018 | 36 | BONGO18 | 200 | -11,26 | -24,94 |
| 14/10/2018 | 38 | BONGO19 | 250 | -14,78 | -24,98 |
| 15/10/2018 | 41 | BONGO20 | 250 | -18,34 | -25,09 |
| 16/10/2018 | 43 | BONGO21 | 250 | -20,38 | -25,06 |
| 17/10/2018 | 45 | BONGO22 | 250 | -24,00 | -25,00 |
| 18/10/2018 | 47 | BONGO23 | 250 | -26,63 | -27,66 |
| 19/10/2018 | 49 | BONGO24 | 200 | -29,13 | -30,22 |
| 20/10/2018 | 51 | BONGO25 | 200 | -31,62 | -32,88 |
| 22/10/2018 | 55 | BONGO26 | 200 | -36,17 | -37,87 |
| 25/10/2018 | 61 | BONGO27 | 200 | -43,01 | -45,98 |
| 26/10/2018 | 63 | BONGO28 | 200 | -45,30 | -48,90 |
| 27/10/2018 | 65 | BONGO29 | 200 | -47,56 | -51,77 |

Genetics, Proteomics and Particulate Organic Matter

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Cruise Objectives

The goal of our work is to link patterns in microbial community structure and growth to nutrient availability and the cycling of organic matter. We propose the following hypotheses:

- I. Changes in inorganic nutrient supply and temperature cause C:N:P:O ratios to differ across oceanographic biomes
- II. Ambient nutrient conditions significantly influence differences in the population-level genomic structure of microbial communities across the Atlantic Ocean
- III. Diel and regional taxa-specific growth rates are highly correlated with particulate organic carbon fluxes

To test these hypotheses, we collected hourly particulate organic matter (POM) samples from the underway system, as well as surface and 50 m genetics samples from CTD casts, along the AMT 28 transect. Additionally, proteomics samples were taken every other day from the underway, concurrent with the pre-dawn CTD cast. The data produced by this research will be analysed using novel quantitative genomics and biogeochemical techniques. Future analyses will compare this data to genomics data generated by our lab from the other three ocean gyres.

Methods

Genetics

Seawater samples were collected approximately every degree of latitude at predawn and solar noon casts, which used a Seabird CTD system containing a 24-bottle rosette of 20 L Niskin bottles, in clean 2 L polycarbonate bottles from 5 m and 50 m depths. A total of 2 L per depth was collected at all stations except the 5 m depth at CTD cast 59 and both depths at CTD cast 62, where 1 L was collected. Water was filtered immediately after collection through a Sterivex 0.22 μ m filter using a peristaltic pump at a low speed. Once all water was pumped through the Sterivex cartridge, one end was sealed with Crito-seal putty, 1620 μ L of sterile ultrapure buffer was pipetted into the filter cartridge, and the other end was sealed with a luer-lok cap. The filters were placed in separate Ziplok bags and preserved frozen at -80°C until shipment to the Dr. Adam Martiny lab at University of California Irvine for further analysis. Final filtration volume was recorded for all samples. Gloves were worn during all steps, and were also used by all samplers at the rosette for the surface bottle 24. A total of 126 genetics samples were collected on the cruise

Prior to the cruise, all silicone tubing, Omnifit caps and cubitainers were cleaned in soapy water, 10% HCL, and Milli-Q water. Once a week 10% bleach solution was run through the tubing for 1 hour, then the tubing was soaked in Milli-Q for 3 hours to sterilize. Between sample collections, the tubing and sample containers were rinsed 4x with Milli-Q water.

Proteomics

Underway seawater samples were collected every other day at 04:30 concurrent with the pre-dawn CTD cast in clean 2 L polycarbonate bottles from a nominal depth of ~5 m. A total of 8 L was collected. Water was filtered immediately after collection through a Sterivex 0.22 μ m filter using a peristaltic pump at a low speed. Filtration continued until the filter clogged and the final volume was recorded. Once water was pumped through the Sterivex cartridge, one end was sealed with Crito-seal putty, 1620 μ L of RNAlater buffer was pipetted into the filter cartridge, and the other end was sealed with a luer-lok cap. The filters were placed in separate Ziplok bags and preserved frozen at -80°C until shipment to the Dr. Mak Saito lab at the Woods Hole Oceanographic Institute for further analysis.

Gloves were worn during all steps. Sterilization of equipment was the same as for the genetics samples. A total of 16 proteomics samples were collected on the cruise

Particulate Organic Matter

Particulate organic matter (POM) samples were collected from the underway seawater system for particulate organic carbon (POC), nitrogen (PON), phosphorous (POP) and chemical oxygen demand (COD). The underway seawater system was chosen to increase water volumes and replication. Each sample was pre-filtered through a 30 µm nylon mesh and passed through a GF/F filter (nominal pore size 0.7 µm). An aspirator pump was used to pull water through the filters at a vacuum setting of -0.08 to -0.1 MPa. Between latitudes 49° 38.286' N at 14:00 and 48° 11.921' S at 14:00, a total of 777 underway stations were sampled on the hour. At each station, three carboys were filled with 3-8 L of water (volume biomass-dependent) and designated as POP, POC/PON, or COD. At noon, triplicates of each type of sample were collected. South of 28°N an additional set of samples was collected without a pre-filter. The 13:00 hour and occasionally the 11:00 hour were skipped to allow for noon station set-up and filtration. POP filters were rinsed with 3 mL of buffer to remove traces of dissolved organic phosphorous at the end of filtration. Filters were folded and stored frozen at -20°C in pre-combusted foil squares.

All carboys were rinsed 2x with sample water before collection. GF/F filters and foil squares were pre-combusted at 500°C for 4.5 hours. Prior to the cruise, all silicone tubing, filter holders, and carboys were cleaned in soapy water, 10% HCL, and Milli-Q water. The 30 µm nylon mesh was rinsed with filtered seawater between sample collections. All filters will be shipped frozen and analyzed by the Martiny lab at UC Irvine. Gloves were used for all steps mentioned above.

Table 1 – CTD casts sampled for microbial community genomic analyses

| Date | TIME (GMT) | Station No. | CTD Cast | Lat | Lon (W) | Depths sampled (m) |
|------------|------------|-------------|----------|----------------|--------------|--------------------|
| 25/09/2018 | 1235 | 01 | 01 | 49° 38.285' N | 5° 30.096' | 50; 5 |
| 26/09/2018 | 0334 | 02 | 02 | 48° 28.165' N | 8° 50.193' | 50; 5 |
| 26/09/2018 | 1210 | 03 | 03 | 47° 54.073 N | 10° 23.884 | 50; 5 |
| 27/09/2018 | 0330 | 04 | 04 | 46° 01.745' N | 12° 43.950 | 50; 5 |
| 27/09/2018 | 1207 | 05 | 05 | 44° 58.715' N | 13° 35.363 | 50; 5 |
| 28/09/2018 | 0333 | 06 | 06 | 42° 58.022 N | 15° 12.784 | 50; 5 |
| 28/09/2018 | 1201 | 07 | 07 | 41°54.700' N | 16°02.179 | 50; 5 |
| 29/09/2018 | 0334 | 08 | 08 | 39° 43.158 ' N | 17° 42.968' | 50; 5 |
| 29/09/2018 | 1200 | 09 | 09 | 38° 37.851' N | 18° 31.541' | 50; 5 |
| 30/09/2018 | 0436 | 10 | 10 | 36° 24.836' N | 20° 07.287' | 50; 5 |
| 30/09/2018 | 1259 | 11 | 11 | 35° 18.121' N | 20° 54.912' | 50; 5 |
| 01/10/2018 | 0438 | 12 | 12 | 33° 2.816' N | 22° 08'.206' | 50; 5 |
| 01/10/2018 | 1307 | 13 | 13 | 31° 55.442' N | 22° 42.611' | 50; 5 |

| | | | | | | |
|------------|------|----|----|----------------|-------------|-------|
| 02/10/2018 | 0435 | 14 | 14 | 29° 29.299' N | 23° 55.948' | 50; 5 |
| 02/10/2018 | 1050 | 15 | 15 | 28° 36.544' N | 24° 21.650' | 50; 5 |
| 03/10/2018 | 0436 | 16 | 16 | 26° 12.227' N | 25° 31.264' | 50; 5 |
| 03/10/2018 | 1301 | 17 | 17 | 25° 03.461' N | 26° 03.408' | 50; 5 |
| 04/10/2018 | 0436 | 18 | 18 | 22° 35.980' N | 27° 12.800' | 50; 5 |
| 04/10/2018 | 1301 | 19 | 19 | 21° 26.830' N | 27° 44.720' | 50; 5 |
| 05/10/2018 | 0438 | 20 | 20 | 19° 04.664' N | 28° 49.004' | 50; 5 |
| 05/10/2018 | 1301 | 21 | 21 | 17° 44.837' N | 28° 55.814' | 50; 5 |
| 06/10/2018 | 0438 | 22 | 22 | 15° 04. 566' N | 28° 36.756' | 50; 5 |
| 06/10/2018 | 1301 | 23 | 23 | 13° 48.630' N | 28° 17.763' | 50; 5 |
| 07/10/2018 | 0437 | 24 | 24 | 11° 26.819' N | 27° 42.524' | 50; 5 |
| 07/10/2018 | 1300 | 25 | 25 | 10° 05.894' N | 27° 17.629' | 50; 5 |
| 08/10/2018 | 0438 | 27 | 26 | 07° 28.277' N | 26° 39.007' | 50; 5 |
| 08/10/2018 | 1302 | 28 | 27 | 06° 15.359' N | 26° 22.796' | 50; 5 |
| 09/10/2018 | 0439 | 29 | 28 | 03° 48.465' N | 25° 50.148' | 50; 5 |
| 10/10/2018 | 0446 | 30 | 29 | 00° 00.031' S | 24° 59.953' | 50; 5 |
| 10/10/2018 | 1304 | 31 | 30 | 01° 09.109' S | 24° 59.435' | 50; 5 |
| 11/10/2018 | 0460 | 32 | 31 | 03° 41.467' S | 24° 58.694' | 50; 5 |
| 11/10/2018 | 1302 | 33 | 32 | 04° 59.077' S | 24° 58.392' | 50; 5 |
| 12/10/2018 | 0439 | 34 | 33 | 07° 32.922' S | 24° 57.444' | 50; 5 |
| 12/10/2018 | 1301 | 35 | 34 | 08° 45.785' S | 24° 56.904' | 50; 5 |
| 13/10/2018 | 0435 | 36 | 35 | 11° 15.739' S | 24° 56.250' | 50; 5 |
| 13/10/2018 | 1033 | 37 | 36 | 12° 04.969' S | 24° 55.818' | 50; 5 |
| 14/10/2018 | 0435 | 38 | 37 | 14° 46.784' S | 24° 59.086' | 50; 5 |
| 14/10/2018 | 1307 | 40 | 38 | 16° 01.942' S | 25° 01.412' | 50; 5 |
| 15/10/2018 | 0435 | 41 | 39 | 18° 20.357' S | 25° 05.143' | 50; 5 |
| 16/10/2018 | 0449 | 43 | 40 | 20° 22.761' S | 25° 03.565' | 50; 5 |
| 16/10/2018 | 1301 | 44 | 41 | 21° 36.224' S | 25° 02.786' | 50; 5 |

| | | | | | | |
|------------|------|----|----|---------------|-------------|-------|
| 17/10/2018 | 0431 | 45 | 42 | 23° 59.974' S | 24° 59.965' | 50; 5 |
| 17/10/2018 | 1303 | 46 | 43 | 24° 54.350' S | 25° 54.196' | 50; 5 |
| 18/10/2018 | 0443 | 47 | 44 | 26° 37.678' S | 27° 39.321' | 50; 5 |
| 18/10/2018 | 1036 | 48 | 45 | 27° 12.003' S | 28° 15.001' | 50; 5 |
| 19/10/2018 | 0436 | 49 | 46 | 29° 07.655' S | 30° 13.409' | 50; 5 |
| 19/10/2018 | 1301 | 50 | 47 | 30° 00.355' S | 31° 06.982' | 50; 5 |
| 20/10/2018 | 0444 | 51 | 48 | 31° 37.104' S | 32° 53.058' | 50; 5 |
| 20/10/2018 | 1312 | 52 | 49 | 32° 22.371' S | 33° 40.448' | 50; 5 |
| 21/10/2018 | 0440 | 53 | 50 | 33° 49.894' S | 35° 16.130' | 50; 5 |
| 21/10/2018 | 1310 | 54 | 51 | 34° 34.830' S | 36° 05.486' | 50; 5 |
| 22/10/2018 | 0445 | 55 | 52 | 36° 10.029' S | 37° 51.980' | 50; 5 |
| 22/10/2018 | 1315 | 56 | 53 | 37° 00.723' S | 38° 50.077' | 50; 5 |
| 23/10/2018 | 0437 | 57 | 54 | 38° 35.043' S | 40° 39.307' | 50; 7 |
| 23/10/2018 | 1311 | 58 | 55 | 39° 12.560' S | 41° 28.505' | 50; 8 |
| 24/10/2018 | 0441 | 59 | 56 | 40° 31.255' S | 43° 04.973' | 50; 5 |
| 24/10/2018 | 1309 | 60 | 57 | 41° 22.179' S | 44° 00.764' | 50; 5 |
| 25/10/2018 | 0540 | 61 | 58 | 43° 00.361' S | 45° 58.902' | 50; 5 |
| 25/10/2018 | 1406 | 62 | 59 | 43° 47.429' S | 46° 57.313' | 50; 5 |
| 26/10/2018 | 0538 | 63 | 60 | 45° 17.852' S | 48° 53.783' | 50; 5 |
| 26/10/2018 | 1409 | 64 | 61 | 46° 01.052' S | 49° 52.339' | 50; 5 |
| 27/10/2018 | 0637 | 65 | 62 | 47° 33.709' S | 51° 46.436' | 66; 5 |
| 27/10/2018 | 1503 | 66 | 63 | 48° 11.932' S | 52° 41.362' | 40; 5 |

Table 2: Underway discrete samples collected for microbial proteomic analyses

| DATE | TIME | AMT Station No. | Sample No. | Lat | LONG (W) |
|------------|------|-----------------|------------|----------------|--------------|
| 27/09/2018 | 0330 | 04 | 001 | 46° 01.745' N | 12° 43.950' |
| 29/09/2018 | 0330 | 08 | 002 | 39° 43.158 ' N | 17° 42.968' |
| 01/10/2018 | 0430 | 12 | 003 | 33° 2.816' N | 22° 08'.206' |

| | | | | | |
|------------|------|----|-----|---------------|-------------|
| 03/10/2018 | 0430 | 16 | 004 | 26° 12.227' N | 25° 31.264' |
| 05/10/2018 | 0430 | 20 | 005 | 19° 04.664' N | 28° 49.004' |
| 07/10/2018 | 0430 | 24 | 006 | 11° 26.819' N | 27° 42.524' |
| 09/10/2018 | 0430 | 29 | 007 | 03° 48.465' N | 25° 50.148' |
| 11/10/2018 | 0430 | 32 | 008 | 03° 41.467' S | 24° 58.694' |
| 13/10/2018 | 0430 | 36 | 009 | 11° 15.739' S | 24° 56.250' |
| 15/10/2018 | 0430 | 41 | 010 | 18° 20.357' S | 25° 05.143' |
| 17/10/2018 | 0430 | 45 | 011 | 23° 59.974' S | 24° 59.965' |
| 19/10/2018 | 0430 | 49 | 012 | 29° 07.655' S | 30° 13.409' |
| 21/10/2018 | 0430 | 53 | 013 | 33° 49.894' S | 35° 16.130' |
| 23/10/2018 | 0430 | 57 | 014 | 38° 35.043' S | 40° 39.307' |
| 25/10/2018 | 0530 | 61 | 015 | 43° 00.361' S | 45° 58.902' |
| 27/10/2018 | 0630 | 65 | 016 | 47° 33.709' S | 51° 46.436' |

DNA Sample Collection

Arwen Bargery¹ for Andy Rees²

1: British Oceanographic Data Centre, 2: Plymouth Marine Laboratory

Cruise Objectives

Collection of CTD seawater samples for determination of DNA, collected for DNA archives.

Methods

Each pre-dawn and noon CTD cast was sampled for DNA analysis by collecting 5 litres of seawater into sampling carboys. Two depths were sampled from each CTD cast, with seawater samples collected from Niskin bottles fired at both the surface (5m) and the Deep Chlorophyll Maximum (DCM). In total, 122 samples were collected during the cruise, from 62 CTD casts.

Seawater samples were filtered through Sterivex-GP, 0.22 µm sterile vented filter units (SVGP01050) by using a ColePalmer-MasterFlex L/S Economy Drive Multichannel Pump (Model 7535-08). Where carboys were not full, the volume filtered was measured. After filtration, the Sterivex filters were preserved by adding 1mL of RNAlater Solution (Invitrogen by Thermo fisher scientific). Afterwards, all Sterivex units were sealed with Cole-Parmer Male Luer integral lock ring plugs and Chase Instruments Cha-seal, then stored at -80°C in a freezer until return to Plymouth Marine Laboratory for analysis.

Table 1: Table showing CTD samples collected during the cruise for DNA analysis.

| Date and Time | Station Number | CTD Cast | Lat (+ve N) | Lon (+ve E) | Niskin Bottles Sampled | Depths Sampled (m) |
|----------------------|-----------------------|-----------------|--------------------|--------------------|-------------------------------|---------------------------|
| 26/09/2018 03:34 | 2 | CTD002 | 48.469 | -8.837 | 9, 22 | 60, 5 |
| 26/09/2018 12:10 | 3 | CTD003 | 47.901 | -10.381 | 14, 22 | 30, 5 |
| 27/09/2018 03:30 | 4 | CTD004 | 46.029 | -12.733 | 9, 22 | 60, 5 |
| 27/09/2018 12:07 | 5 | CTD005 | 44.979 | -13.589 | 12, 22 | 40, 5 |
| 28/09/2018 03:33 | 6 | CTD006 | 42.967 | -15.213 | 10, 22 | 52, 5 |
| 28/09/2018 12:01 | 7 | CTD007 | 41.912 | -16.036 | 10, 22 | 56, 5 |
| 29/09/2018 03:34 | 8 | CTD008 | 39.719 | -17.716 | 9, 22 | 71, 5 |
| 29/09/2018 12:00 | 9 | CTD009 | 38.631 | -18.526 | 9, 22 | 70, 5 |
| 30/09/2018 04:34 | 10 | CTD010 | 36.414 | -20.122 | 9, 23 | 105, 5 |
| 30/09/2018 12.59 | 11 | CTD011 | 35.302 | -20.915 | 8, 22 | 105, 5 |
| 01/10/2018 04:38 | 12 | CTD012 | 33.047 | -22.137 | 6, 22 | 90, 5 |
| 01/10/2018 13:07 | 13 | CTD013 | 31.924 | -22.710 | 9, 22 | 85, 5 |
| 02/10/2018 04:37 | 14 | CTD014 | 29.488 | -23.933 | 10, 23 | 114, 5 |
| 02/10/2018 10:50 | 15 | CTD015 | 28.609 | -24.361 | 10, 23 | 135, 5 |
| 03/10/2018 04:37 | 16 | CTD016 | 26.204 | -25.521 | 9, 23 | 107, 5 |
| 03/10/2018 13:01 | 17 | CTD017 | 25.058 | -26.057 | 8, 22 | 120, 5 |
| 04/10/2018 04:27 | 18 | CTD018 | 22.600 | -27.213 | 11, 23 | 93, 5 |
| 04/10/2018 13:01 | 19 | CTD019 | 21.447 | -27.745 | 8, 22 | 120, 5 |
| 05/10/2018 04:38 | 20 | CTD020 | 19.078 | -28.817 | 9, 23 | 90, 5 |
| 05/10/2018 13:01 | 21 | CTD021 | 17.747 | -28.930 | 10, 22 | 65, 5 |
| 06/10/2018 04:38 | 22 | CTD022 | 15.076 | -28.613 | 13, 22 | 57, 5 |
| 06/10/2018 13:01 | 23 | CTD023 | 13.812 | -28.295 | 11, 22 | 60, 5 |
| 07/10/2018 04:37 | 24 | CTD024 | 11.447 | -27.709 | 10, 23 | 50, 5 |
| 07/10/2018 13:00 | 25 | CTD025 | 10.098 | -27.294 | 8, 14 | 40, 5 |
| 08/10/2018 04:38 | 27 | CTD026 | 7.471 | -26.650 | 10, 23 | 72, 5 |
| 08/10/2018 13:02 | 28 | CTD027 | 6.256 | -26.380 | 11, 22 | 64, 5 |
| 09/10/2018 04:39 | 29 | CTD028 | 3.808 | -25.836 | 10, 23 | 89, 5 |
| 10/10/2018 04:46 | 30 | CTD029 | 0.001 | -24.999 | 10, 23 | 60, 5 |
| 10/10/2018 13:04 | 31 | CTD030 | -1.152 | -24.991 | 10, 20 | 75, 5 |
| 11/10/2018 04:30 | 32 | CTD031 | -3.691 | -24.978 | 11, 23 | 60, 5 |
| 11/10/2018 13:02 | 33 | CTD032 | -4.985 | -24.973 | 10, 20 | 74, 5 |
| 12/10/2018 04:39 | 34 | CTD033 | -7.549 | -24.957 | 10, 23 | 110, 5 |
| 12/10/2018 13:01 | 35 | CTD034 | -8.763 | -24.949 | 8, 21 | 120, 5 |
| 13/10/2018 04:35 | 36 | CTD035 | -11.262 | -24.938 | 9, 23 | 122, 5 |
| 13/10/2018 10:33 | 37 | CTD036 | -12.083 | -24.930 | 13, 23 | 111, 5 |

| | | | | | | |
|------------------|----|--------|---------|---------|--------|--------|
| 14/10/2018 04:35 | 38 | CTD037 | -14.780 | -24.985 | 9, 23 | 145, 5 |
| 14/10/2018 13:07 | 40 | CTD038 | -16.032 | -25.024 | 9, 21 | 160, 5 |
| 15/10/2018 04:35 | 41 | CTD039 | -18.339 | -25.086 | 7, 22 | 152, 5 |
| 16/10/2018 04:39 | 43 | CTD040 | -20.379 | -25.060 | 8, 23 | 161, 5 |
| 16/10/2018 13:01 | 44 | CTD041 | -21.604 | -25.047 | 9, 21 | 170, 5 |
| 17/10/2018 04:31 | 45 | CTD042 | -24.000 | -24.999 | 10, 23 | 140, 5 |
| 17/10/2018 13:03 | 46 | CTD043 | -24.906 | -25.903 | 10, 21 | 140, 5 |
| 18/10/2018 04:43 | 47 | CTD044 | -26.628 | -27.655 | 8, 23 | 127, 5 |
| 18/10/2018 10:36 | 48 | CTD045 | -27.200 | -28.250 | 15, 23 | 140, 5 |
| 19/10/2018 04:36 | 49 | CTD046 | -29.128 | -30.224 | 9, 23 | 130, 5 |
| 19/10/2018 13:01 | 50 | CTD047 | -30.006 | -31.150 | 14, 24 | 109, 5 |
| 20/10/2018 04:45 | 51 | CTD048 | -31.619 | -32.884 | 8, 23 | 131, 5 |
| 20/10/2018 13:12 | 52 | CTD049 | -32.373 | -33.674 | 16, 24 | 85, 5 |
| 21/10/2018 04:40 | 53 | CTD050 | -33.832 | -35.269 | 11, 23 | 80, 5 |
| 21/10/2018 13:10 | 54 | CTD051 | -34.581 | -36.092 | 17, 23 | 70, 5 |
| 22/10/2018 04:45 | 55 | CTD052 | -36.167 | -37.866 | 9, 23 | 70, 5 |
| 22/10/2018 13:15 | 56 | CTD053 | -37.012 | -38.835 | 14, 22 | 40, 5 |
| 23/10/2018 04:37 | 57 | CTD054 | -38.584 | -40.655 | 7, 17 | 65, 7 |
| 23/10/2018 13:11 | 58 | CTD055 | -39.209 | -41.475 | 19, 23 | 30, 8 |
| 24/10/2018 04:41 | 59 | CTD056 | -40.521 | -43.083 | 9, 23 | 40, 5 |
| 24/10/2018 13:09 | 60 | CTD057 | -41.370 | -44.013 | 19, 23 | 35, 5 |
| 25/10/2018 05:40 | 61 | CTD058 | -43.006 | -45.982 | 12, 23 | 55, 5 |
| 25/10/2018 14:06 | 62 | CTD059 | -43.791 | -46.955 | 21 | 5 |
| 26/10/2018 05:38 | 63 | CTD060 | -45.298 | -48.896 | 23 | 5 |
| 26/10/2018 14:09 | 64 | CTD061 | -46.018 | -49.872 | 15, 21 | 30, 5 |
| 27/10/2018 06:57 | 65 | CTD062 | -47.562 | -51.774 | 10, 18 | 66, 5 |
| 27/10/2018 15:03 | 66 | CTD063 | -48.199 | -52.689 | 14,20 | 40, 5 |

SOCCOM and ARGO floats

John Ballard

UCSD - Scripps Institution of Oceanography

Objectives

Deploy Southern Ocean Carbon and Climate Observations and Modelling Programme (SOCCOM. <https://soccom.princeton.edu/>) floats and University of Washington ARGO floats at specific desired coordinates along the AMT28 cruise track. Collect and analyze parameters important for SOCCOM sensor calibration, validation, and reference database. These parameters include fluorescence, backscatter, POC, pH/TA, salinity, dissolved inorganic nutrients, and oxygen. The six SOCCOM floats deployed on the cruise were adopted by schools in the USA and were graffitied before being deployed (Figure 1).



SOCCOM

Unlocking the mysteries
of the Southern Ocean

Figure 1: SOCCOM floats adopted by schools in the USA and graffitied on board prior to deployment

Deployments

**Table 1: 3 Argo and 6 SOCCOM float deployment details for AMT28
(For a table of all float deployments, refer to next report):**

| UTC time | UTC date | Station | CTD | Lat (N) | Lon (E) | Float ID | Float type |
|----------|----------|---------|-----|-----------|-----------|----------|------------|
| 08:57 | 14/10/18 | 39 | n/a | -15.40784 | -25.00084 | 12691 | SOS (CF) |
| 05:35 | 16/10/18 | 43 | 40 | -20.37916 | -25.05984 | 12632 | ARGO (AI) |
| 12:59 | 17/10/18 | 46 | 43 | -24.9059 | -25.90328 | 12776 | SOS (CF) |
| 12:21 | 18/10/18 | 48 | 45 | -27.20013 | -28.25005 | 12696 | BGC (CF) |
| 12:26 | 18/10/18 | 48 | 45 | -27.20081 | -28.2498 | 12883 | BGC (CF) |
| 15:08 | 20/10/18 | 52 | 49 | -32.37702 | -33.67523 | 12881 | BGC (CF) |
| 14:51 | 21/10/18 | 54 | 51 | -34.58331 | -36.09178 | 12700 | BGC (CF) |
| 14:56 | 23/10/18 | 58 | 55 | -39.20996 | -41.47501 | 12747 | BGC (CF) |
| 14:52 | 24/10/18 | 60 | 57 | -41.37037 | -44.01361 | 12778 | BGC (CF) |

All 3 Argo floats and SOCCOM floats 12696 and 12883 were lowered by hand line on the aft starboard corner of the ship. Due to increased sea state and geometry of the ship's hull, SOCCOM floats 12881, 12700, 12747, and 12778 were deployed with the starboard crane and quick release pin.

Table 2: SOCCOM float IDs and their adopted schools

| Float ID | School |
|----------|---|
| 12696 | Mount San Antonio College, California |
| 12883 | North Bay elementary School, Oregon |
| 12881 | Forest Park High School, Virginia |
| 12700 | Marjory Stoneman Douglas High School, Parkland, Florida |
| 12747 | Curtis Inge Middle School, Oklahoma |
| 12778 | Brooksville Elementary School, Florida |

POC/HPLC

For the CTD casts immediately before SOCCOM deployments, Niskin bottles at the chlorophyll maximum and surface were sampled for POC/HPLC filtration. 1-2 L per samples were filtered under vacuum and flash-frozen in liquid nitrogen. The filters were preserved in the -80°C freezer for future analysis on land.

Table 3: Niskin bottles sampled for POC/HPLC analysis

| UTC time | UTC date | Station | CTD | Lat (N) | Lon (E) | POC/HPLC niskins |
|----------|----------|---------|-----|-----------|-----------|------------------|
| 12:21 | 18/10/18 | 48 | 45 | -27.20013 | -28.25005 | 16, 22 |
| 15:08 | 20/10/18 | 52 | 49 | -32.37702 | -33.67523 | 17, 24 |
| 14:51 | 21/10/18 | 54 | 51 | -34.58331 | -36.09178 | 17, 22 |
| 14:56 | 23/10/18 | 58 | 55 | -39.20996 | -41.47501 | 20, 22 |
| 14:52 | 24/10/18 | 60 | 57 | -41.37037 | -44.01361 | 20, 22 |

pH/Total Alkalinity

For the CTD casts immediately before SOCCOM deployments, 500 mL from each depth was pickled with mercuric chloride and sealed with a greased ground glass stopper. Two duplicates from the same Niskin bottle were taken for each cast at random depths. Samples will be analyzed by Andrew Dickson's lab at a future date.

Table 4: Niskin bottles sampled for pH/total alkalinity

| UTC time | UTC date | Station | CTD | Lat (N +ve) | Lon (E +ve) | pH/TA Niskins |
|----------|----------|---------|-----|-------------|-------------|------------------------|
| 12:21 | 18/10/18 | 48 | 45 | -27.20013 | -28.25005 | 1-15,17,18,19,20,21,22 |
| 15:08 | 20/10/18 | 52 | 49 | -32.37702 | -33.67523 | 1-21,23 |
| 14:51 | 21/10/18 | 54 | 51 | -34.58331 | -36.09178 | 1-17,19,21,22 |
| 14:56 | 23/10/18 | 58 | 55 | -39.20996 | -41.47501 | 1-19,21,22 |
| 14:52 | 24/10/18 | 60 | 57 | -41.37037 | -44.01361 | 1-19,21,22 |

FLBB

A Wet Labs FLBB-RTD sensor was mounted on the CTD at the beginning of the AMT28 cruise for the purpose of comparison to the FLBB sensors on each SOCCOM float deployed. A custom cable was fabricated on board to mate to the CTD. The cable failed with a ground short on Station 44 (CTD 41). The cable was repaired and mounted back on the rosette for Station 46 (CTD 43). A dark cast, where the detectors are taped over for the cast, was performed at stations 7, 46, and 65 (CTD 7, 46, and 62).

Summary of all Float Deployments on AMT 28

Table 1: Summary of all floats deployed on AMT28

| Organisation | Organisation deployment number | AMT28 deployment number | Float type | Serial no./ Apfid | DEPLOYMENT DETAILS | | | |
|------------------|--------------------------------|-------------------------|------------|-------------------|--------------------|------------|----------|----------|
| | | | | | Date in 2018 | Time (GMT) | Lat S | Lon W |
| Univ. Washington | 1 | Argo 01 | SOS (CF) | 12691 | Sun 14 Oct | 08:57 | 15.40768 | 25.00007 |
| UK Met Office | 1 | Argo 02 | ARGO | 7001 | Sun 14 Oct | 08:59 | 15.40784 | 25.00084 |
| Univ. Washington | 2 | Argo 03 | ARGO (AL) | 12632 | Tue 16 Oct | 05:35 | 20.37916 | 25.05984 |
| Univ. Washington | 3 | Argo 04 | SOS (CF) | 12776 | Wed 17 Oct | 14:02 | 24.90627 | 25.90277 |
| UK Met Office | 2 | Argo 05 | ARGO | 7589 | Thu 18 Oct | 05:39 | 26.62794 | 27.65496 |
| SOCCOM | 1 | Argo 06 | BGC (CF) | 12696 | Thu 18 Oct | 12:22 | 27.20025 | 28.24999 |
| SOCCOM | 2 | Argo 07 | BGC (CF) | 12883 | Thu 18 Oct | 12:28 | 27.20098 | 28.24975 |
| SOCCOM | 3 | Argo 08 | BGC (CF) | 12881 | Sat 20 Oct | 15:09 | 32.37702 | 33.67523 |
| UK Met Office | 3 | Argo 09 | ARGO | 8064 | Sun 21 Oct | 14:44 | 34.58132 | 36.09154 |
| SOCCOM | 4 | Argo 10 | BGC (CF) | 12700 | Sun 21 Oct | 14:51 | 34.58331 | 36.09178 |
| UK Met Office | 4 | Argo 11 | ARGO | 8065 | Mon 22 Oct | 14:25 | 37.01203 | 38.83492 |
| SOCCOM | 5 | Argo 12 | BGC (CF) | 12747 | Tue 23 Oct | 14:56 | 39.20996 | 41.47501 |
| SOCCOM | 6 | Argo 13 | BGC (AL) | 12778 | Wed 24 Oct | 14:52 | 41.36965 | 44.01273 |

Ship's systems Reports

CTD and underway sensor calibrations

Arwen Bargery

British Oceanographic Data Centre

Cruise Objectives

In total, 63 CTD casts along the cruise transect were deployed to obtain profiles of the water column from a range of sensors. All casts were conventional profiling casts with 24 x 20 L Ocean Test Equipment (OTE) Niskin bottles for sampling water. CTDs were deployed pre-dawn at ~04:30 and noon ~13:00 ship time each day, from 25th September 2018 until 27th October 2018. Profiles were generally down to 500 metres depth twice a day, with 2 CTDs above 150 m on the European continental shelf, five CTDs to 1500 m, a CTD to 4000 m and a CTD to 4200 m. Sensors on the CTD included pressure, temperature, conductivity, oxygen, fluorescence, PAR, turbidity, transmittance and attenuation.

Methods

The Sea-Bird data collection software Seasave-Win32 recorded the raw data output from the CTD casts. Processing the raw data occurred daily, following the BODC recommended guidelines using SBE Data Processing-Win32 v7.26.7. Outlined below are the processing routines used to convert the raw CTD data into CNV files, each routine is named after each stage in brackets < >.

Conversion of the raw binary Sea-Bird files to ASCII files (CNV) containing the 24 Hz data for up and down casts <DatCnv>. Generation of bottle files for each cast containing the mean values of all the variables at the time of bottle firing events <Bottle Summary>. Using the CNV files, processing routines were applied to remove pressure spikes <WildEdit>. Following this 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 for each cast was identified using <SeaPlot> and removed manually using a text editor. LoopEdit was run to mark scans with a bad flag wherever there was a pressure slowdown or reversal. 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 on-board <BinAverage>. Removal of the initial salinity and oxygen channels produced at the DatCnv stage, along with the conductivity, voltage and altimeter channels from the 1-dbar downcast files <Strip>.

Collation of the sensor values at bottle firing generated by the Bottle Summary routine formed the dataset for calibrating the two CTD salinity sensors and oxygen sensor against discrete bench salinometer measurements and oxygen Winkler measurements, respectively. The fluorometer sensor will be calibrated post-cruise using AC-9 data calibrated against HPLC data.

To generate a calibration, an offset between the discrete water sample measurement (salinity/oxygen) and the nominal value from the sensor at bottle firing was calculated. Outliers were identified using plots of offset against the discrete sample values and a linear regression was applied.

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

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

Where offset = Discrete sample – Sensor value

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

Where the regression was not significant or did not improve the dataset, the mean value of the offset was applied.

All provisional calibration datasets will be checked and confirmed once back at BODC. Calibration datasets are available upon request from BODC post cruise.

Provisional Results

- Temperature

There were no independent measurements of temperature made during the cruise and the two CTD temperature sensors on the rig returned consistent data. There was no further calibration of these sensors. Figure 1 below shows the section plot of the primary temperature sensor along the cruise track.

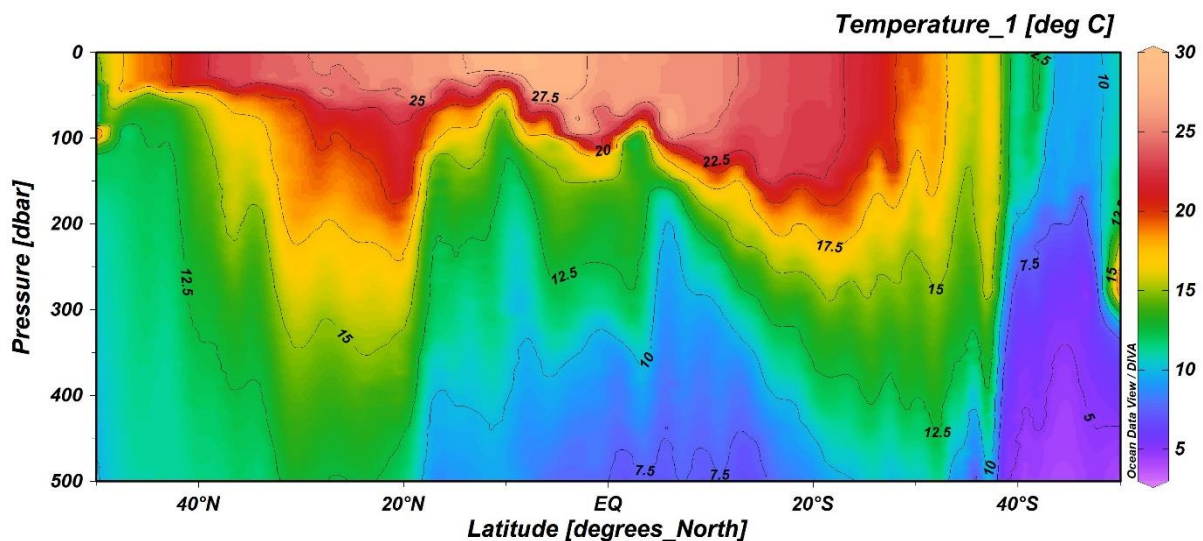


Figure 1: Temperature section plot along the AMT28 transect by latitude (50 deg N – 50 deg S) from the primary temperature sensor, located on the CTD vane.

- Salinity

The salinity channels were calibrated against bench salinometer measurements from five samples collected from each CTD cast. Further details of these measurements can be found in the salinity sampling cruise report section.

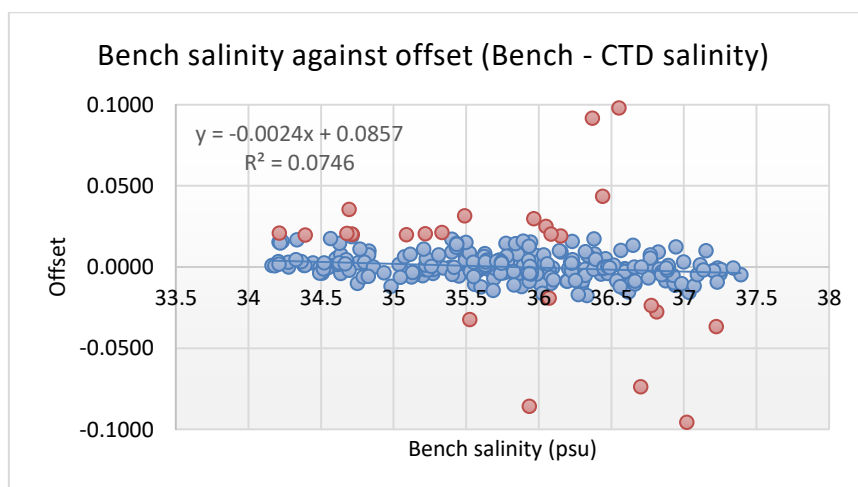


Figure 2: Salinity offsets for the primary salinity sensor against discrete sample salinity measured with a bench salinometer.

For salinity sensor 1, there was a weak but significant relationship between bench salinity and offset ($n = 281$; $r^2 = 0.0746$; $p < 0.001$). However, applying a regression did not improve the dataset so the mean offset was applied.

Calibrated primary salinity = uncalibrated salinity + 0.0000177

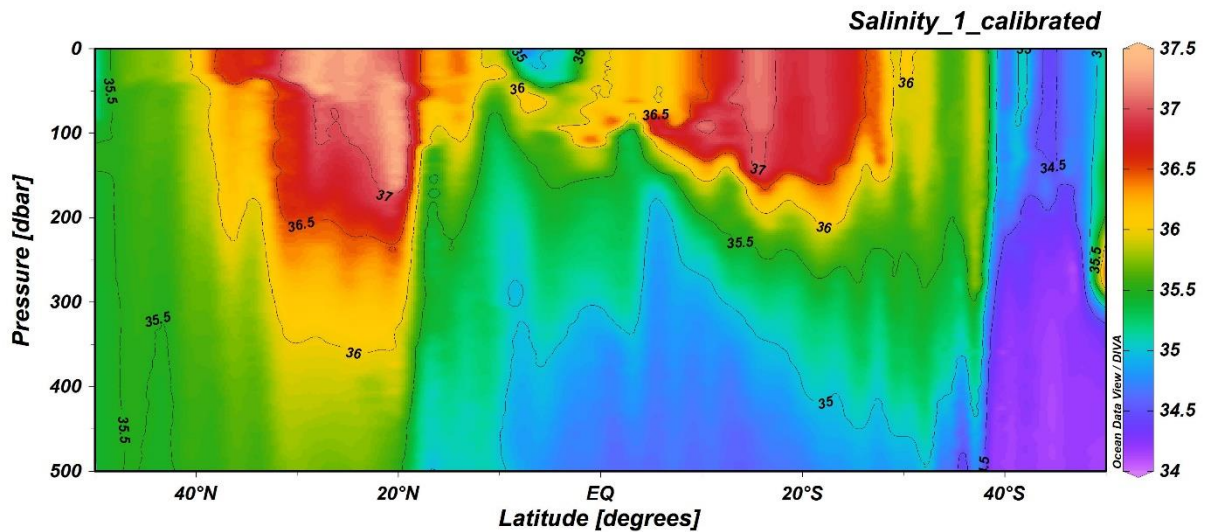


Figure 3: Salinity section plot along the AMT28 transect by latitude (50 deg N – 50 deg S) from the primary salinity sensor.

The secondary CTD salinity sensor was calibrated against discrete salinity measurements. Again, there was a weak but significant relationship between bench salinity and offset ($n = 284$; $r^2 = 0.0938$; $p < 0.001$). Applying a regression did not improve the dataset so the mean offset was applied.

Calibrated secondary salinity = uncalibrated salinity - 0.000156

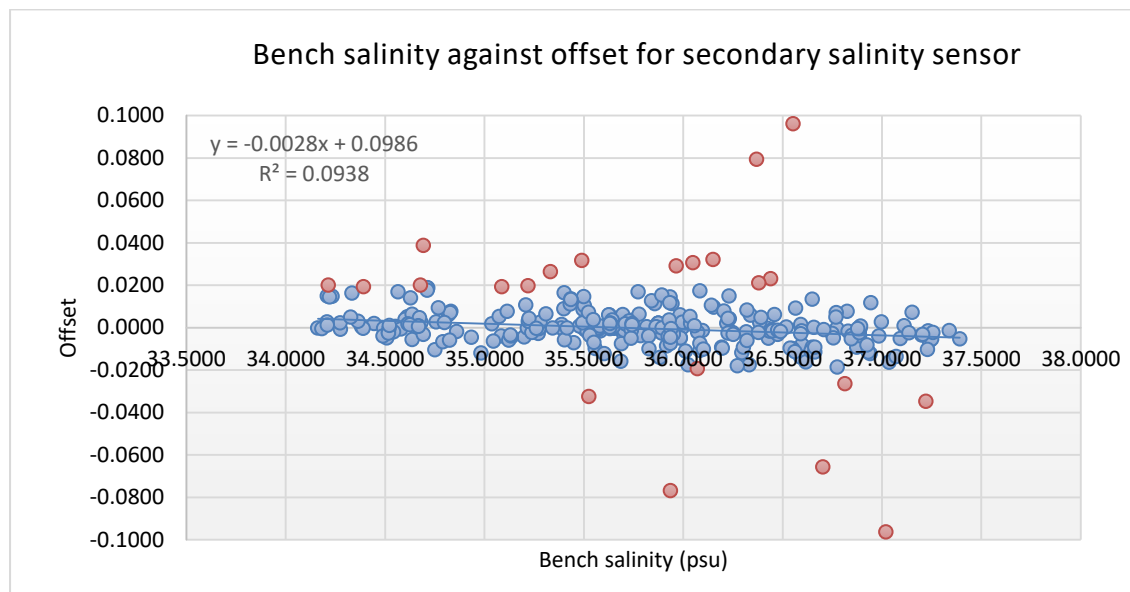


Figure 4: Salinity offsets for the secondary salinity sensor against discrete sample salinity measured with a bench salinometer.

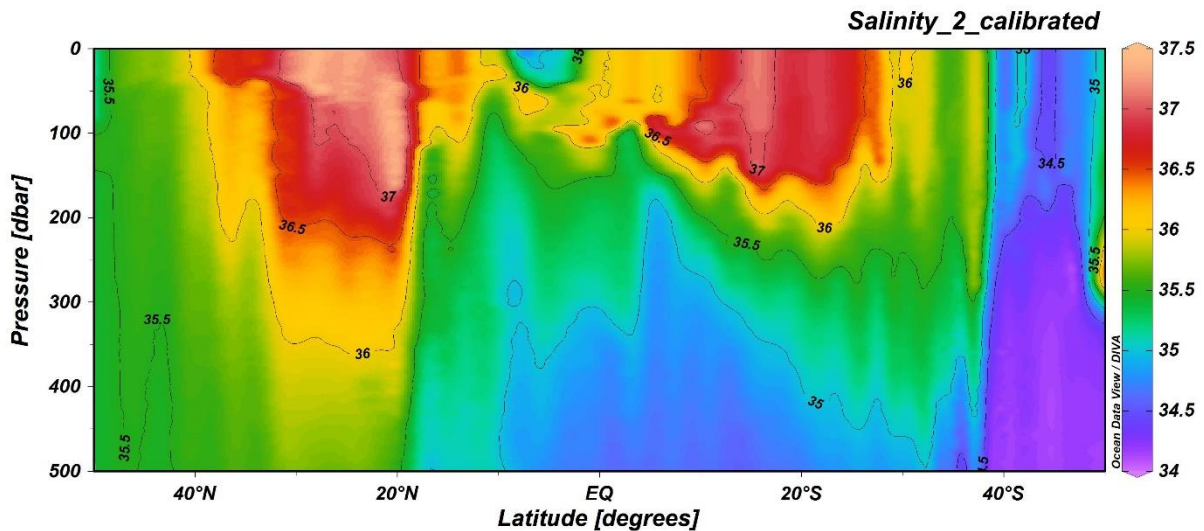


Figure 5: Salinity section plot along the AMT28 transect by latitude (50 deg N – 50 deg S) from the secondary salinity sensor calibrated against bench salinity samples.

- Oxygen

Calibration of the SBE 43 oxygen sensor against discrete oxygen Winkler titration measurements used five depths collected from the pre-dawn and noon CTDs. More details are available in Carol Robinsons' cruise report. The oxygen sensor operated without problem throughout the remainder of the cruise. Several data points did not fit the pattern observed with the data from the other casts and so were excluded from the calibration data set. There was a strong, significant relationship between the offset and the discrete oxygen data, so that the trend below was applied to the CTD oxygen data.

The calibration equation:

$$\text{Calibrated O}_2 \text{ (in } \mu\text{mol/l)} = 1.01804 * \text{sensor O}_2 \text{ (in } \mu\text{mol/l)} + 0.590175 \quad (n = 199; r^2 = 0.2249; p < 0.001);$$

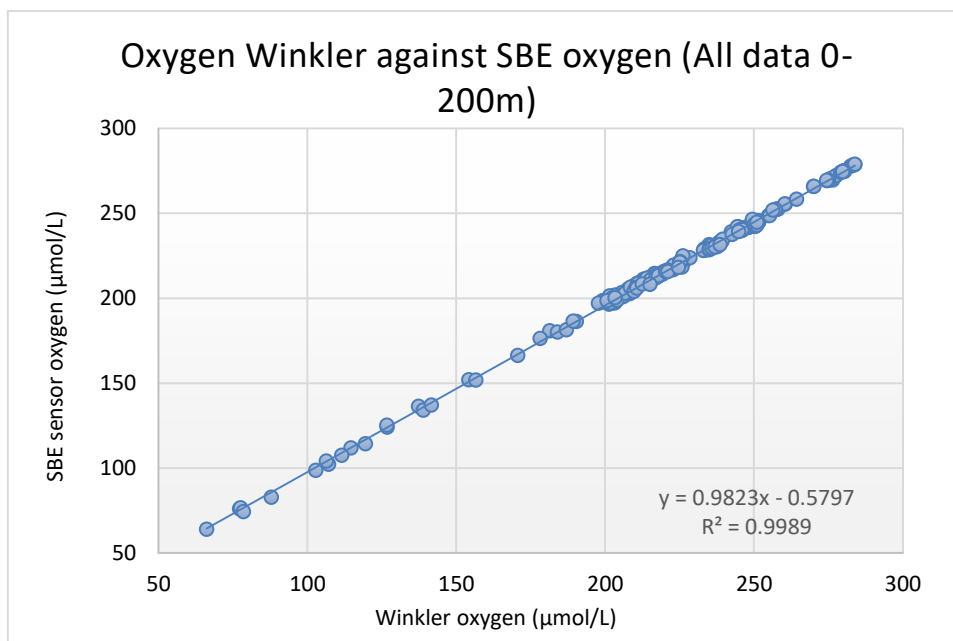


Figure 6: Oxygen concentration offsets against SBE CTD oxygen sensor measurements.

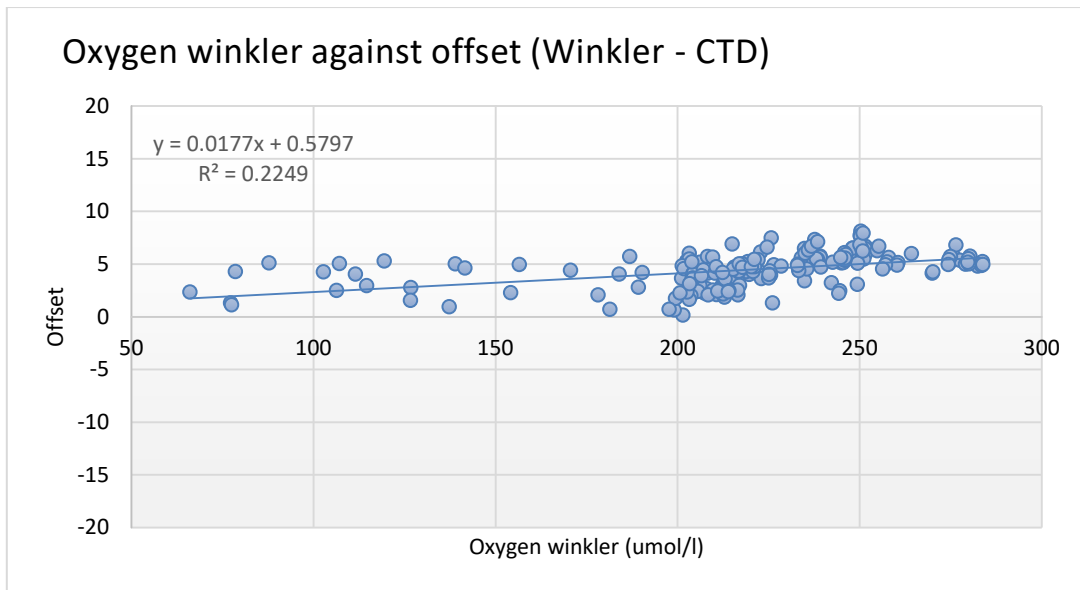


Figure 7: Oxygen concentration offsets against Winkler titration measurements from discrete samples.

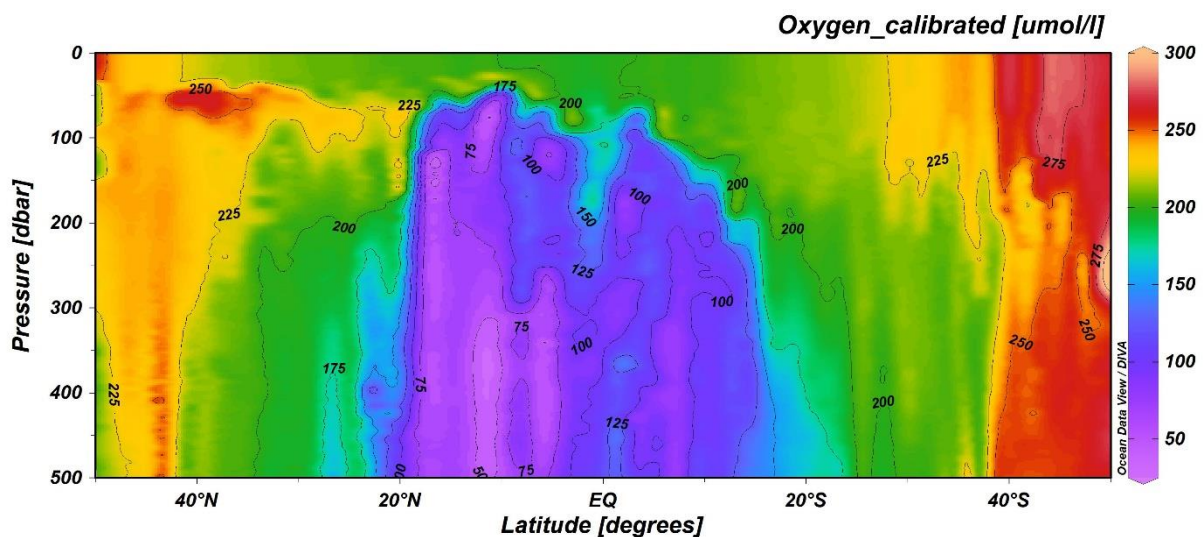


Figure 8: Oxygen concentration section plot along the AMT28 transect by latitude (50 deg N – 50 deg S) from the SBE43 oxygen sensor calibrated against Winkler titration samples.

- Fluorometer

The CTD fluorometer operated without problem during the cruise. Calibration of the CTD fluorometer sensor against sample data will be carried out after the cruise against AC-9 and HPLC data. A section plot of the fluorescence data along the AMT28 cruise track is shown below.

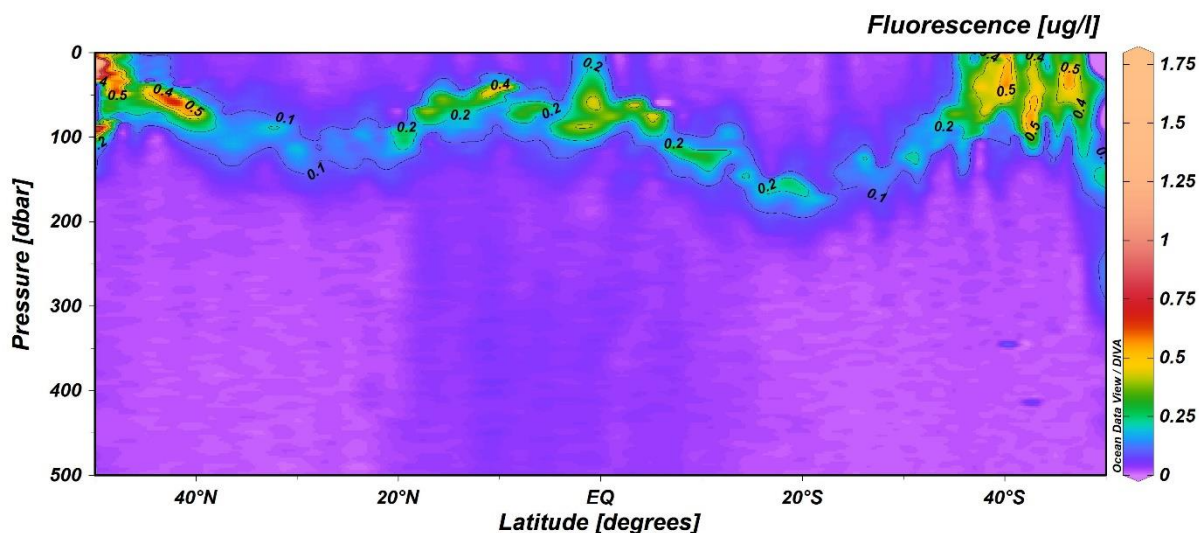


Figure 9: Fluorometer section plot along the AMT28 transect by latitude (50 deg N – 50 deg S).

Underway sensors

The ship's underway meteorological and surface systems were run continuously throughout the cruise. The sea surface hydrography system started logging from 23/09/2018 11:33 (UT) and was switched off prior to arrival at the Falklands on 28/10/2018. Samples were collected to calibrate the TSG connected to the ship's non-toxic flow-through system, which draws water from approximately 5.5 m below the water line on the RRS James Clark Ross.

Sea Surface Temperature Hull sensor (oceanlogger-sstemp)

The primary hull temperature sensor was calibrated against the mean of the primary and secondary CTD temperature sensor values from each CTD at 5.5 dbar. The isosurface temperature values at 5.5 dbar were calculated in Ocean Data View, by using the available temperature values to obtain a linearly interpolated value on the isosurface. Several values were excluded from the regression where the surface value was anomalous.

A regression analysis was performed on the offset (CTD temperature – underway temperature) against cruise day and offset against CTD temperature. Two trends were identified in the data: there was a strong and significant regression of the offset with surface CTD sensor values ($n = 51$; $r^2 = 0.2194$; $p < 0.05$) and a weak but significant relationship of offset with cruise day ($n=51$; $r^2 = 0.153$; $p < 0.05$). The stronger relationship was adjusted for by applying the regression equation for the trend with CTD temperature.

Calibrated underway temperature = $1.001 * \text{uncalibrated temp} - 0.0369$

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

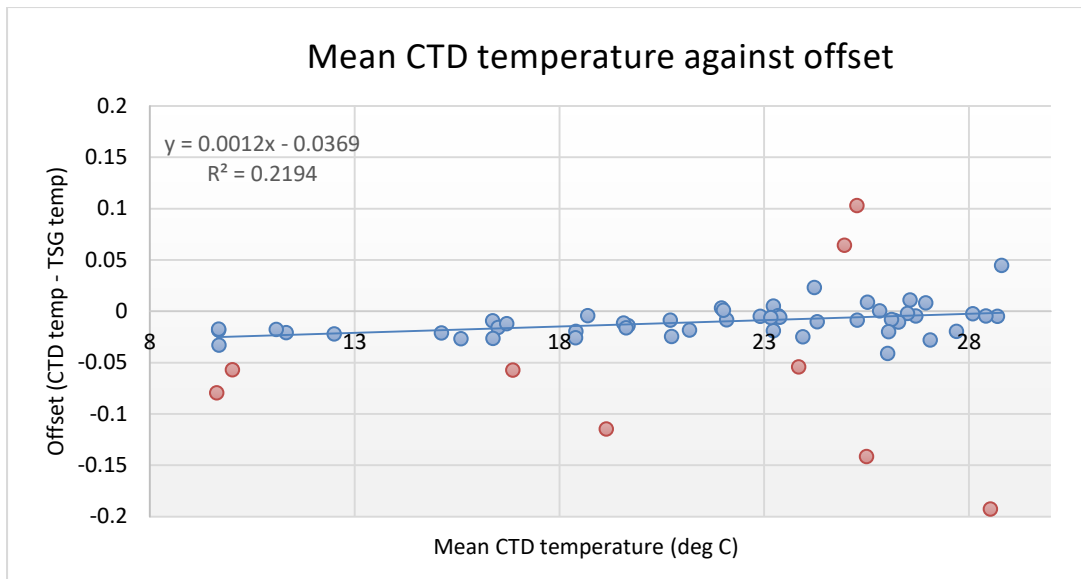


Figure 10: Hull sensor temperature offsets against surface CTD temperature measurements.

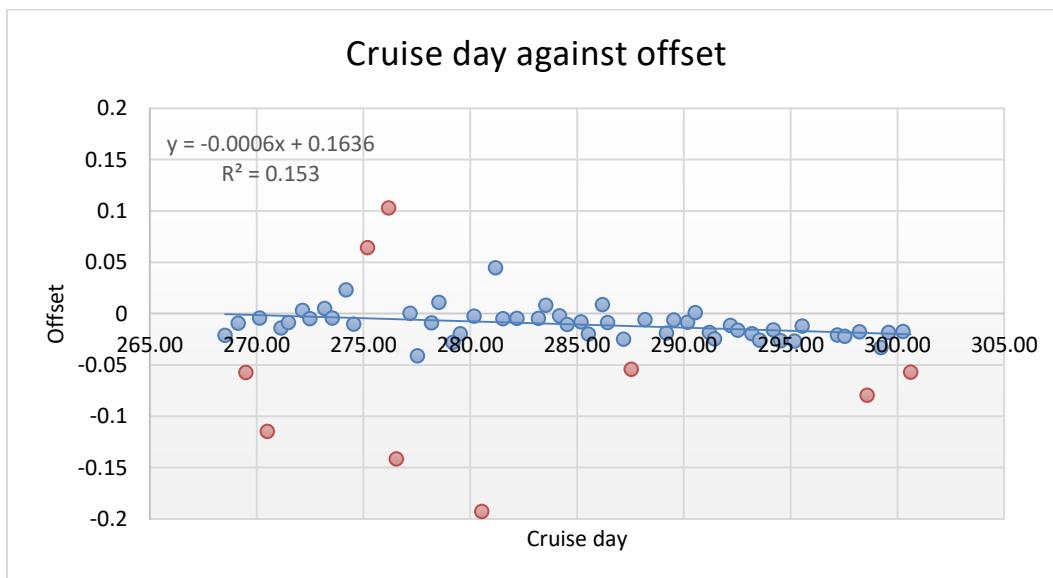


Figure 11: Hull sensor temperature offsets against cruise day.

Salinity

The TSG sensor salinity data were calibrated against samples collected and analysed with a bench salinometer. Up to four samples were collected each day at approximately 08:00, 12:00, 16:00 and 20:00, ship's time. The offset between bench salinity and underway TSG salinity sensor value was calculated. Several outliers were identified when plotting offset against bench salinity and cruise day, which were excluded from the calibration dataset. There was not a significant regression of the offset with bench salinity measurement ($n = 116$; $r^2 = 0.0018$; $p > 0.05$) and the regression between cruise day and offset was also not significant ($n = 116$; $r^2 = 0.01425$; $p > 0.05$) so the mean offset was applied to the TSG data.

Calibrated salinity = TSG salinity + 0.0076

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

Fluorometer

The underway fluorometer data will be calibrated against AC-9 and HPLC data generated during the cruise back at PML. The correction will be applied during BODC processing after the cruise before the data are made available online.

AME Scientific Ship Systems Report

Sean Quirk, Ship Science Engineer. seairk@bas.ac.uk

British Antarctic Survey, Cambridge, UK

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1 Cruise Summary

| Cruise | Departure | Arrival | AME Engineer(s) |
|---------|---------------------|---------------------|-------------------------------|
| JR18001 | 23/09/18 Harwich UK | 03/11/18 Stanley FI | Sean Quirk (seairk@bas.ac.uk) |

This cruise is part of the AMT science programme, with 2 stations per day; one pre dawn 04:30 and the other at normally at 13:00. The stations include CTD, Plankton nets, Optics Rig, SOD deployment, weather balloon and float deployment.

2 Instrumentation

2.1 Systems used on cruise

| Instrument | #SN if Used | Make and Model | Comments |
|------------------------|--------------|-----------------------------|----------|
| Lab Instruments | | | |
| AutoSal | 68533/65753 | OSIL 8400B | |
| Scintillation counter | SGTC20150612 | PERKINELMER TRI-CARB 2910TR | |
| XBT | No | | |
| Acoustic | | | |
| ADCP | Yes | | |
| EM122 | Yes | | |
| TOPAS | Yes | | |
| EK60/80 | Yes | | |
| K-Sync | Yes | | |
| SSU | No | | |

| | | | |
|---------------------------|---------------|-------------------------------|--|
| USBL | Yes | Sonardyne Ranger 1 | |
| 10kHz IOS Pinger | No | | |
| Benthos 12kHz Pinger | No | | |
| Benthos 14kHz Pinger | No | | |
| Mors 10kHz Transponder | No | | |
| EA600 | Yes | | Bridge Equipment but logged |
| Oceanlogger | | | |
| Barometer1 | V145002 | VAISALA PTB210B1A2B | Inside the UIC |
| Barometer2 | V145003 | VAISALA PTB210B1A2B | Inside the UIC |
| Air humidity & temp1 | 61019333 | Rotronic Hygroclip 2 | On Foremast Port not checked changed at end of JR17007 |
| Air humidity & temp2 | 61019251 | Rotronic Hygroclip 2 | On Foremast Stbd not checked changed at end of JR17007 |
| TIR1 sensor (pyranometer) | 172882 | Kipp & Zonen Sp Lite2 | On Foremast S/N not checked assumed from JR17007 |
| TIR2 sensor (pyranometer) | 172883 | Kipp & Zonen Sp Lite2 | On Foremast S/N not checked assumed from JR17007 |
| PAR1 sensor | 160959 | Kipp & Zonen PQS-1 | On Foremast S/N not checked assumed from JR17007 |
| PAR2 sensor | 160960 | Kipp & Zonen PQS-1 | On Foremast S/N not checked assumed from JR17007 |
| Thermosalinograph | 0072 and 0018 | SBE45 | PrepLab SN 0072 has a faulty conductivity sensor |
| Transmissometer | 1497DR | CST-846DR | PrepLab |
| Fluorometer | 1498 | WSCHL-1498 | PrepLab |
| Flow meter | 05/811950 | LitreMeter F112-P-HC-AP-OR-PP | PrepLab |
| Seawater temp 1 | 0765 | SBE38 | Sea Inlet |
| Seawater temp 2 | 0771 | SBE38 | Sea Inlet |
| CTD | | | |
| Deck unit 1 | 0458 | SBE11plus | |
| Underwater ACD/Depth | 1225 | SBE9plus | |
| Temp1 | 5645 | SBE3plus | |
| Temp2 | 2191 | SBE3plus | |
| Cond1 | 3248 | SBE 4C | |
| Cond2 | 4126 | SBE 4C | |
| Pump1 | 1807 | SBE5T | |
| Pump2 | 7966 | SBE5T | |

| | | | |
|--|--------------|--------------------------|--|
| Standards Thermometer | 0061 | SBE35 0024 | |
| Transmissometer | 527DR | C-Star | |
| Oxygen sensor | 0620 | SBE43 | |
| PAR sensor | 70442 | QCP2350 | |
| Fluorometer | 12.8513-001 | CTG Aqua Tracker MkIII | |
| Altimeter | 10127.244739 | Tritech | |
| CTD swivel linkage | 1961018 | Focal Technologies Group | |
| LADCP Master Down | 14443 | TeleDyne WHM300 | |
| LADCP Slave Up | No | TeleDyne WHM300 | |
| Pylon | 0636 | SBE32 | |
| Other ship's systems (non-AME) | | | |
| Anemometer | Yes | | Bridge Equipment, logged |
| Ships Gyro | Yes | | Bridge Equipment, logged |
| System(s) brought by science team (non-AME) | | | |
| Fluorometer + Backscatter | 4795 | Seabird Eco FLBBRTD | University of Washington provided by J.Ballard |

2.2 Notes for Heading and Course Instruments

2.2.1 *Seatex*

The Seatech was calibrated before the beginning of the cruise by Oceanfix Limited (RPS Energy) whilst alongside at Harwich. The antenna position has moved and the heading changed since the last offset survey was completed by Parker in 2014. The antenna position has been updated in the software. The gyros have also been calibrated and new C-O values need to be applied to the system. This was not done at the time due to imminent departure and substantial mobilisation work was still to be completed.

2.2.2 *Ships Gyro*

The vessel gyros were changed during the recent refit and again recalibrated as per the above. Again, the values have not been added to the system at this time.

2.3 Notes for Lab Instruments used

2.3.1 *AutoSal*

2.3.1.1 Autosal S/N 65833

Upon installation of Autosal SN 68533 it was noted that the internal tubing on the end of the cell was disconnected see below images in Figure 6 and Figure 7.

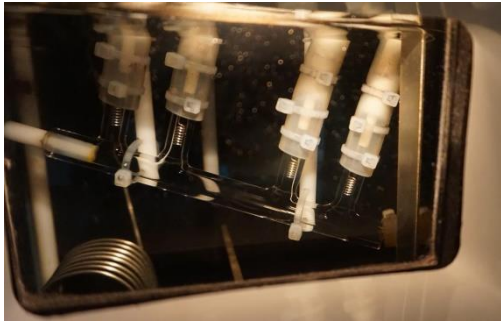


Figure 6:- Autosol S/N 65833 Cell Tubing Fault

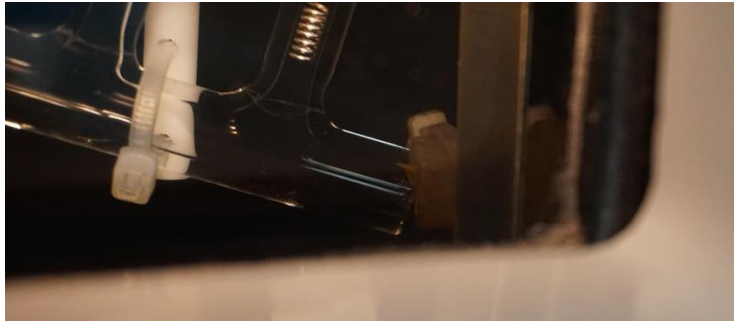


Figure 7- Autosol S/N 65833 Cell Tubing Fault

During this repair it was noted that the seawater inlet hosing into the conductivity cell was badly kinked this was also repaired.

Once the Autosol was initially repaired it only appeared to be working with the pumps on continuously. If the pumps were switched off then the conductivity reading dropped substantially. It was also noted that when with the cell was full of sample an air pocket would develop within the cell when the pumps were switched off. This was investigated and it was discovered that the air flushing manifold had a leak due to a missing cable tie when compared to the spare unit. This was replaced but there were further issues with air pockets developing. This was tracked down to a loose air line into the silicone bung at the air flushing manifold. This was repaired, with some extra silicone placed around the air line see below image in Figure 8.

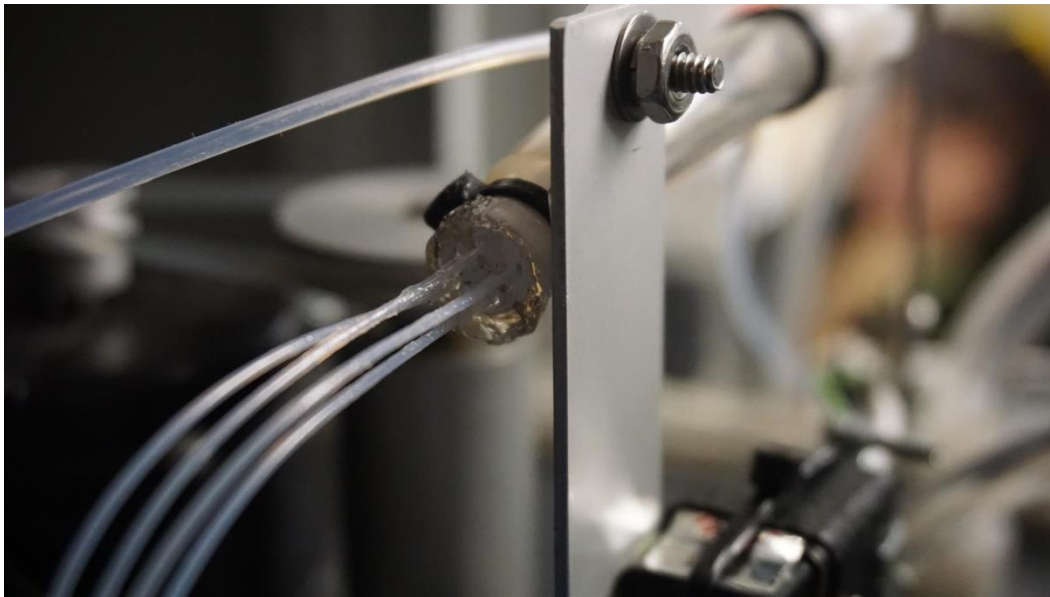


Figure 8:- Autosol S/N 65833 Air Flushing Manifold Repair

During the investigation into the air pocket the heating lamp was disconnected and the crimp terminals pulled off with no force being applied this was also repaired see below image in Figure 9.

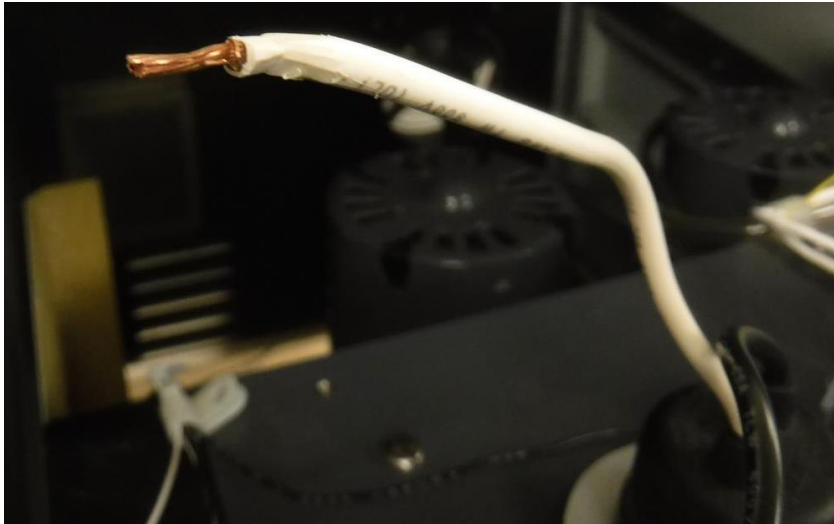


Figure 9:- Autosal S/N 65833 Broken heating lamp wire

Once these further repairs were carried out the Autosal would not give a consistent reading. It was discovered that the connection of the cell wires onto the connector was held on by 2 strands this came loose with a simple movement as shown in Figure 10.

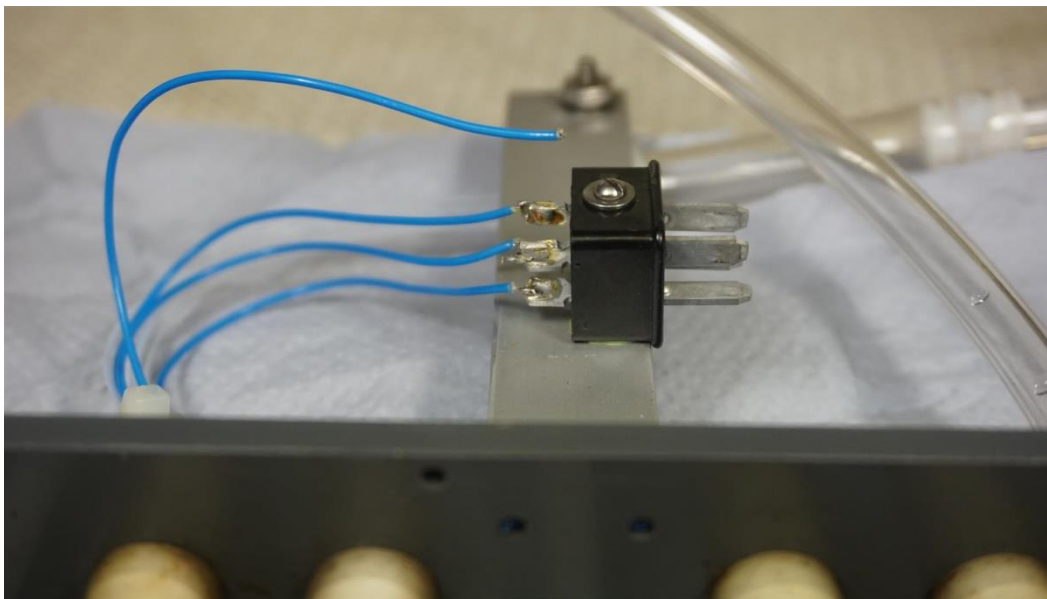


Figure 10:- Autosal S/N 68533 Broken cell wire

Once these repairs were complete cleaning of the cell was performed by making a mixture of methanol, Decon90 and Milli-Q water. This was left for 24 hours in the cell under recommendation from Becky Childs at OSIL.

The unit is currently still not functioning correctly with a continuous slow drift on the reading. This is still under discussion with technical support at OSIL.

In addition to this it is also noted that the sample inlet tubing is missing a metal pipe from the cell when compared to the spare Autosal. OSIL have confirmed that this is a design feature difference between models. However, design severely bends the inflow tubing, possibly restricting flow to the cell.

It is suspected a new conductivity cell will be required and the Autosal recalibrated.

Overall, the servicing of the Autosol is very poor and this needs to be addressed with the provider.

Diagnosis and repair unlikely without return of unit to manufacturer or service personnel attending the vessel.

2.3.1.2 Autosol S/N 65763

When Autosol SN 65763 was brought up from the hold it was noted that the lamp for the bath was extremely hot. This was replaced with the lamp from the other Autosol. After a day it was noted that the heating lamps were not flashing on and off to regulate the bath temperature. This was investigated and the heat exhaust fan on the back of the unit was not plugged in as shown in Figure 11.



Figure 11:- Autosol S/N 65753 Disconnected Exhaust Fan

This was connected and the unit was operational.

It is noted that there is drift in the seawater standards from the start and end of a run which could cause issues on future cruises where higher accuracy salinity measurements are required.

Again, the quality of the servicing needs to be addressed with the provider.

2.3.1.3 Other Issues

In addition to this there are issues with keeping the temperature constant in the bio lab where the units are located and they have been set to run at 27 degrees C and require constant monitoring. This should be a consideration for future cruises through the tropics.

It was noted that temperature probes within the room were positioned close to the ceiling giving a false reading of the water temperatures of the samples. It is suggested that the temperature of sample or stock seawater is recorded to better assess whether samples should be run.

2.3.1.4 Manufacturer Recommendations

While fault finding on the Autosol units a phone call was made to OSIL by Aisling Smith (Lab Manager) to discuss the issues we were seeing on board with regard to the standards drifting at the start and end of the run. In short, the main fluctuation point is in the temperature which is hard to

maintain in the bio lab while going through the tropics. It is suggested that at cruise planning stage that this difficulty is raised to the PSO. It is recommended to install a temperature sensor inside the water bath to monitor temperature changes. This was looked into and there is a spare port on the Pico Temperature Data Logger although a higher accuracy immersion temperature probe would need to be purchased.

See below transcription of the call.

/*****/

Discussion with Westley from OSIL 17/10/2018

Email: seawater.chemist@osil.com

Tel: +44 2392 488240

Bath temperature

Ideally you want the bath temperature to be the same temperature as the sample. Ignore the manual stating that -2 to +4 is ok.

If it is not possible to have samples the same temperature it is better to have the bath 1 degree warmer than the sample temperature.

Look at the LTA cooling module-check this. You will need to check bath temperature at the start and end of runs. A change of 0.1 to 0.2 degree is a large change in temperature.

Changes within the bath of more than +/- 0.02 degree is enough to cause the instrument to drift and misreport.

The 'temperature' for the bath temp is a set point only. It is not the actual temp of the bath. Bath temp should be within 20 milli-degrees of the set point. If it is outside of this it will not report the correct conductivity.

Bulbs flashing: if it's struggling to maintain temp the bulbs will turn off for quite a period, rather than regular occasional sporadic flash.

If ptfе tubing is too close to any heating lamps it will cause sample to heat leading to a mis-read.

Tips from OSIL

Standardise at the start of each run.

A drift of 30 units over the course of a run is not ideal for high precision work. Advice would be to stop run.

Recommended that you record the start and end run bath temp. Also record the R value (the standardisation dial)

Bulbs flashing: if it is struggling to maintain temp the bulbs will turn off for quite a period, rather than regular occasional sporadic flash.

The instruments range of accuracy is +/- 0.02 psu, which is about 6 units.

Cleaning:

Ethanol decon mix is fine to use instead of methanol decon mix

OSIL fill the cell and then put it into an ultrasonic bath for at least 24 hours.

OSIL say that the cell is removed and cleaned at every service.

Using compressed air to blast it is fine. It won't damage cell.

Mechanical checks suggested:

Insert temperature probe into bath to be able to monitor over the duration of the run

Check that the LTA cooling module-check this.

Can use silicone to block for the flush manifold.

Metal section as the tubing (PTFE) enters the cell may be missing. This is not a mistake this is a new design.

Send a photo of the connection of the tube to OSIL.

Track the drain valve to cell to make sure there are no kinks on this, this can cause a pressure issue

If you want to make sure the ptfе is not leaking could you empty the cell and see if it refills with water from the bath

Is there a new edition of the manual? No there is only the 1970s manual available.

*/*****/*

2.3.2 Scintillation Counter

The Scintillation Counter had 2 engineers visit while alongside in Harwich for repairs. The unit is operational and has been used successfully throughout the cruise. There is a test procedure in place written by David Goodger under advice from the Perkin Elmer Engineers.

2.4 Notes for Acoustic Systems used

2.4.1 ADCP

The ADCP had issues with maintaining comms and would be stuck in the initialisation loop. This was fixed by IT and is being monitored.

2.4.2 EM122

The EM122 was used opportunistically for the cruise to provide a more reliable depth reading.

2.4.3 EK60/80

The EK60/80 was used opportunistically for the duration of the cruise and appears to have functioned correctly

2.4.4 K-Sync

K-Sync was used and appears to have functioned correctly

2.4.5 USBL

The USBL system was used for the duration of the cruise with a beacon being attached to the CTD and working well with a successful cast to 4000m with the exception of the security dongle for around 1 week. The issue with the security dongle was an expired time. This was investigated by IT. The problem was almost certainly caused by FusionUSBL being run with the PC date set in the past, which caused the security key to reset its start date. The date was incorrect because the USBL PC was rebooted with a flat CMOS battery and K9 was failing to sync the date\time. The IT tech replaced the CMOS battery, rebuilt the PC using a back-up image (to resolve K9 issue) and the security dongle was updated (by Sonardyne) with an expiration date of 01/12/2026. While the issues with the main dongle were ongoing the red emergency dongle was not easy to locate. The red dongle is stored in drawer 901 labelled AME - USBL manuals. It is also noted that there is no longer a hot swap spare for the USBL. This needs to be rectified.

2.4.6 EA600

The EA 600 was used and appears to have functioned correctly.

2.5 Notes about the Oceanlogger

There was a few issues with the Oceanlogger during the cruise.

2.5.1 *Transmissometer End Brackets*

Upon installation of the Transmissometer into the oceanlogger system it was noted that there was a leak on the water flow tubing end bracket. This was shown to be small cracks in the casing see below images in Figure 12 and Figure 13 and an additional bracket had a cracked end as shown in Figure 14. In addition to this another 2 broken end brackets were found.

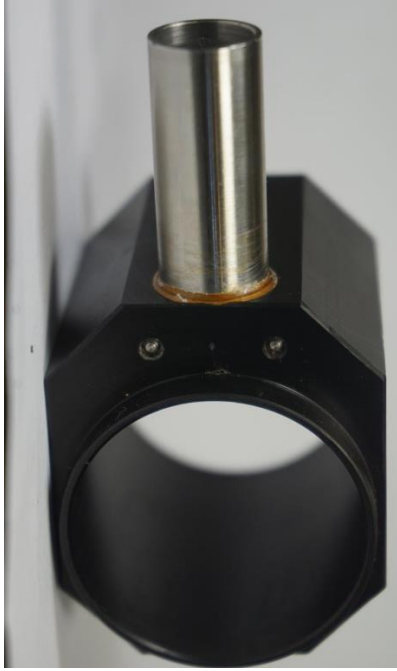


Figure 12:- Transmissometer end bracket hairline crack



Figure 13:- Transmissometer end bracket hairline crack



Figure 14:- Transmissometer bracket damaged end

2.5.2 SBE 45

On the 25/09/2018 it was noted that the SBE 45 SN 0072 was giving an incorrect salinity reading. This was investigated further and it was discovered the Conductivity sensor was giving incorrect readings when compared with calibration sheet. This was replaced with spare SBE 45 SN 0018 on the 25/09/2018 although this unit did not have the tubing connectors installed. These fittings were taken from the broken SBE 45. This resolved the issue.

2.5.3 Connection Issues

On the 01/10/2018 it was noted that the Chlorophyll values were giving incorrect readings. This was investigated and it was discovered that the Transmissometer and Fluorometer were connected into the wrong channels of the ocean logger this was correct at 19:40. To avoid this happening in the future the connectors have been labelled. In addition to this a suggestion would be to have “normal” values printed or added to the wiki to show what to expect which should highlight obviously erroneous values.

2.5.4 Fluorometer

During the investigation into the connection issues the Fluorometer was given a thorough clean and was noted that there was some growth within the sensor.

Notes about the CTD

Table 3:- CTD Cast Statistics

| | | | |
|--------------------|------|------------------------------------|----------------------|
| Basic Stats | | | |
| Number Of Casts | 63 | | |
| Max Depth | 4200 | Min Depth | 81 |
| Cable Removed (m) | 0 | Number of Re-terminations (elect.) | Only on mobilisation |

The CTD wire that has been in use has been cut and returned to the drum. A new CTD wire will be installed in the Falklands and will require re-termination on sailing.

2.5.5 CTD Deployment Procedure

Prior to deployment all bottles are cocked and the deionised water is vented from the T/C sensors. Pre-deployment technical tests are carried out on the LADCPs and are logged. The LADCP is then activated and starts logging. Once the deck crew and winch operator are ready, the CTD is lifted into the water and lowered to 10 m, where power is started and logging begins. It is held here until the operator sees the difference between T1 and T2 stabilize. This can take some time, especially if the air temperature and sea temperature are far apart. In some circumstances (mainly turbulent surface waters) it can be necessary to lower the CTD to 20 m or further, where the temperature is more stable. This is at the operator’s discretion. Once stable, the CTD is lifted to as near to the surface as the winch operator deems safe, then is lowered to the required depth or bottom without stopping. The bottom depth is an approximation from the best echo sounder available, commonly the EM122. If bottom depth is required then the altimeter will start working within 100 m of the sea bed and is used to stop approximately 10 m from the sea bed. From here some adjustment can be made to get closer, this is done at the operator’s discretion. Once the down-cast is complete, bottles are fired at requested depths, in order, deepest first. When each bottle is fired, 30 seconds are given to ensure that the independent standards thermometer has time to take a reading. Once on the surface the CTD is returned to the vessel and the C/T sensors are filled with deionised water to avoid damage. All data are backed up as soon as possible.

2.5.6 CTD Bottles

There were several issues with the 20 L bottles on this cruise.

2.5.6.1 Mobilisation

It was decided to use the new 20 L bottles that have been purchased for the SDA. This required substantially more time to setup than anticipated and very nearly caused there to be a major delay to the science programme due to not being setup on time. If this happens in the future the condition of these bottles needs to be communicated to the oncoming engineer to ensure sufficient time is allowed for setup. Also, the delivery of the bottles needs to be prioritised as they did not arrive on board until 1

day before sailing. In addition to this there is no spares package (O rings, stopcock drainage valves, and internal rubber springs) and only 2 spare 20 L bottles.

This shows some serious lack of planning when performing the mobilisation for the season.

2.5.6.2 Power Cord Tightening

The bottles themselves have a rubber power cord which has caused a great many leaks on the bottom end cap. This got to the point where there was not enough water left in the bottles for the scientists to collect. The bottles were tightened under advice from Ocean Test Equipment although this was not done properly due to not having the equipment to do so. It is advised to purchase a small spring balance to measure up to 36lbs to allow the force to be measured. The force that should be applied is 26-28 lbs. All bottles were adjusted over the course of the cruise as the internal springs failed to seal effectively. The manufacturer also recommended using a small amount of silicone when tying the new knot in the power cord this was not followed due to potential contamination issues within the bottle. This is something that may need to be discussed with the scientists at Cambridge.

Chief Scientist's notes: On occasion, more than half the rosette of 24 bottles leaked on the same cast. Basically, the rubber power cord used was not strong enough to keep the end caps in position with a 20 kg load of sweater above them, once the vent cap had been opened.

2.5.6.3 Manufacturer Recommendation

During conversation with the manufacturer it is recommended to replace the power cords at least yearly if not more frequently, therefore we need a good supply of spares on-board. It is also recommended to use stainless steel springs instead of the power cord as this minimises the chance of leaks which would be more important when performing dissolved gas sampling.

2.5.7 Frame Modifications

During the refit the BAS CTD frame was modified to allow the addition of 20 L bottles by increasing the height of the frame to allow the bottles to clear. Due to the extra length of the new 20 L bottles there were 2 bottles contacting the frame and not closing properly. See below images in Figure 15.

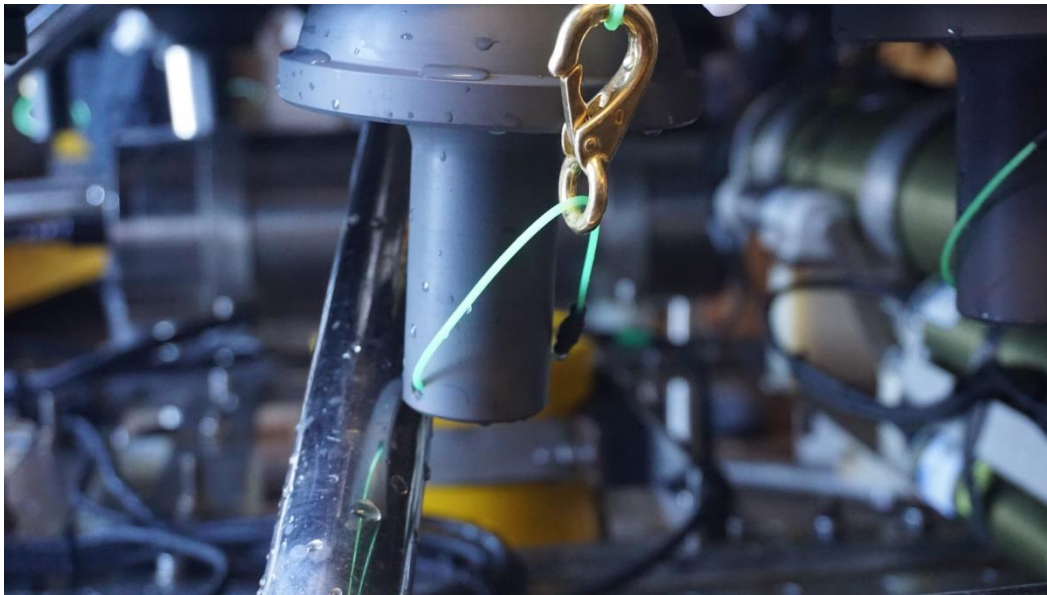


Figure 15:- 20 L CTD bottle contacting stainless steel frame strut

After discussions with Cambridge it was decided to install the spare CTD isolation washer which connects between the stainless steel frame and the aluminium rosette holder see below images in Figure 16 and Figure 17



Figure 16:- Installation of additional CTD isolation washer



Figure 17:- 20 L CTD bottle clearing stainless steel frame

This resolved the issue but leaves the spare frame without the isolation washer.

2.5.8 Additional Sensor Installation

2.5.8.1 Seabird ECO Fluorometer and Back Scatter (FLBB)

John Ballard from the University of San Diego provided a Seabird ECO Fluorometer and Back Scatter (FLBB) sensor to be installed on the CTD. The wrong cable was provided with the system but, fortunately there were sufficient tails available to make a subsea cable to connect the sensor. In addition to this no brackets were provided. This was manufactured on board see below images.



Figure 18:- Seabird Eco-FLBB installation



Figure 19:- Seabird Eco-FLBB installation

The sensor stopped giving data at 75 m on cast 041. This was investigated and an insulation fault was found on the short tail which could be causing it to short under pressure. This was replaced with another tail and worked for the remainder of the cruise. The tail has been kept to use as a deck test lead. It is clearly labelled.

2.5.8.2 Ixsea Acoustic Releases

For the deep cast to 4200m on cast 036, 2 x Ixsea Acoustic releases were attached to the CTD frame. This required removing bottles 5 and 21 and using some shackles and cable ties to attach.

2.6 Notes on Cable Counters

During the cruise the cable counter was running unreliably. This was investigated.

2.6.1 TX2 Fault

A faulty transmitter, TX2 S/N 50467 was found to have a range of maximum 27 m and average of 6 m compared to the 200 m expected range. It is suspected that the battery is on the way out. This unit is to be sent back to STR for investigation as the battery should last in excess of 6 years.

2.6.2 DTD 254 and antenna fault

In addition to the faulty transmitter there was also found to be an issue with one of the receivers. The combination of DTD 254 S/N 50591-TC and antenna STR-ANT1-418 S/N 50604-TC, when combined with the fully operational transmitter only produced a range of 37 m when compared to the other unit which achieved a range of 90 m (maximum we could achieve on-board). As the ranges normally used are less than 37 m it was decided this should be sufficient for this season, although this may need replacing if it continues to degrade in range.

2.6.3 Battery Charging of handheld counter in white box

During the investigation into the cable counters there were questions as to how well the handheld readers were getting charged on the dedicated chargers. After discussions with Cambridge it was decided to take the connector off the dedicated charger and connect it directly to the bench supply at 14.9V for charging to ensure that it was completely charged.

3 Additional work completed on cruise

3.1 PML Optics Rig

3.1.1 Subsea cables

During mobilisation two cables were required to be made for the optics rig. One tail was found to have a hairline crack in the connector which would have caused a fault. This was replaced with a spare CTD tail.

3.1.2 Chelsea battery pack

There were several problems with the Chelsea battery packs

3.1.2.1 Chelsea battery pack S/N 182042

This battery pack was not taking any charge. It was opened to investigate and the batteries were found to be flooded as shown in Figure 20. These were removed and disposed of.



Figure 20:- Chelsea Battery Pack S/N 182042 flooded internals with corroded batteries



Figure 21:- Chelsea Battery Pack S/N 182042 Replacement charging components

3.1.2.2 Chelsea battery pack S/N 180241

The Chelsea battery pack provided was not taking a full charge and the unit was only working at the start of the optics cast. This was investigated and it was found to be several factors.

3.1.2.2.1 Charging Cable

The charging cable provided had previous salt water ingress and was badly corroded on the inside. This was replaced with a new one.

3.1.2.2.2 Battery pack

On one unit the battery pack PCB was receiving the correct voltage from the PSU but was not regulating the voltage to the batteries for charging. This was replaced with 6 diodes (IN5404) to allow safe charging of the batteries from a bench power supply set to 17.8V as shown in **Error! Reference source not found.** A new charging cable was provided with a DC power plug and socket.

3.1.3 SBE 5T Pump

In the initial deployments the data were not as expected. It was traced down to a faulty pump. A spare CTD SBE 5T pump was provided and a subsea cable manufactured for this.

3.2 PML Picarro installed in the mail room

During the cruise through the tropics the temperature in the mail room was approximately 50°C with the instrumentation running up to 60°C, although the equipment is only rated to 40°C. Three rack fans were provided for cooling and this assisted the situation as shown in Figure 22. They are still currently installed and should be reclaimed at the end of the season on demobilisation.



Figure 22:- Installation of additional fans to assist cooling of mail room Picarro

3.3 University of East Anglia particle vacuum

The UEA particle vacuum pump developed a faulty motor. The unit was opened. Some damage was observed on the capacitor wire and the mounting plate was bent. See below images in Figure 23 and Figure 24. This was replaced with a spare motor.

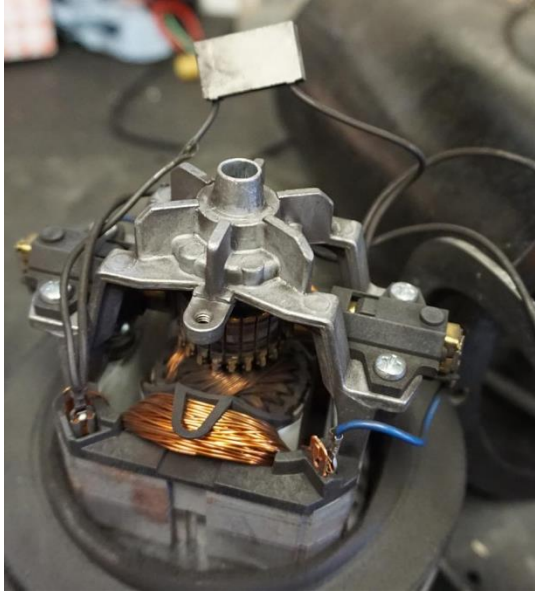


Figure 23:- UEA vacuum motor



Figure 24:- UEA damaged capacitor wire

4 Workshop Equipment

4.1 Oscilloscopes

During the cruise a dual channel oscilloscope was required to perform some testing on the Autosal units. This was not available in the workshop as both oscilloscopes are not functioning correctly.

4.1.1 Tektronix TDS 3012B

The Tektronix oscilloscope only has 1 functional channel (2). Channel 1 does not work correctly. This should be repaired/replaced.

4.1.2 Fluke scope meter 190-062

The Fluke scope meter was out of battery and the charger could not be located. A replacement charger has been requested.

4.2 Drills

A new drill was purchased for the season. It is located on the floor by the door.

5 AME Department notes

5.1 Pre-cruise tasks

| Task | Status |
|---|--------|
| Download AME_Eng/Platform_Specific/JCR | N |
| Check cruise planning meeting notes | N |
| Number of hours hand over with previous ship's AME Engineer | N |

5.2 Daily & weekly tasks

| Task | Frequency | Status |
|--|-----------|--------|
| Sanity check the Oceanlogger data | Daily | N |
| Check the Following Fans: Oceanlogger Acoustic Rack Seapath EM122 (Tween) Topas (Tween) | Daily | Y |
| Mega test CTD cable | Weekly | Y |
| Clean Underway System | Weekly | N |

5.3 End of cruise checks

| Task | Status |
|---|--------|
| XBT left in cage, in a suitable state | Y |
| The salinity bottles have been cleaned, if used | Y |
| CTD left in suitable state - Ducts cleaned with Triton and deionised water, blanking plugs installed and system washed with water | Y |
| CTD slip rings have been cleaned | Y/N |
| Office is tidy, with manuals and files returned and items stowed for sea | Y |
| Clean the following fans: Oceanlogger Acoustic Rack Seapath EM122 (Tween) Topas (Tween) | Y |

5.4 Items to be purchased

| Supplier | Item | Quantity | Use |
|----------------------|--|----------|----------------------------------|
| RS | TE Connectivity Cable Sleeve Kit Refill CGAT Series, 3:1 Shrink Ratio, 1 piece | 3 | Cable repairs and lanyard making |
| RS | ON Semi 1N5404G Diode, 400V 3A, 2-Pin DO-201AD | 10 | Diodes used for power regulation |
| Ocean Test Equipment | Niskin 20L bottles stopcocks with O'Rings | 26 | Spare for bottles onboard |
| Ocean Test Equipment | Niskin 20L bottles Natural Rubber Internal Spring | 26 | Spare for bottles onboard |
| Ocean Test Equipment | <u>Niskin 20L bottles End Cap O'Rings</u> | 52 | Spare for bottles onboard |

| | | | |
|---------------|---|---|--|
| BAS Cambridge | SBE 45 | 1 | Spare for onboard |
| OSIL | Autosal 8400B light bulb for chamber | 1 | Spare for onboard |
| Planet Ocean? | Impulse 2 pin female with locator pin tail 2m length | 2 | Spare for seabird pump used 2 to make cables |
| Planet Ocean? | Impulse 6 pin female tail 2m length | 4 | |
| RS | RS Pro Black 3:1, Heat Shrink Tubing 19mm Sleeve Dia. x 1.2m Length | 2 | Cable repairs |
| RS | RS Pro Black Nylon Cable Tie, 300mm x 4.8 mm | 2 | Cable management |
| RS | RS Pro Black Nylon Cable Tie, 150mm x 3.6 mm | 2 | Cable management |
| | Fluke Scopemeter 190-062 charger | 1 | |

5.5 Additional notes and changes/future work

The CTD wire is to be changed over to a new one in Stanley. Therefore, a complete mechanical and electrical re-termination will be required during mobilisation/sailing.

The red T Count Transmitter S/N 50467-TC is to be returned to STR for investigation once the replacement unit has reached the vessel.

SOG Mooring Recovery and Deployment

Ian Murdoch

Ocean Engineering Group, National Marine Facilities, UK

Recovery of 2017 SOG Mooring

Release Position:

18° 32.700' S

25° 04.800' W

Monday 15th October at 06.30 GMT, recovery operations of 2017 SOG Mooring began. When the ship was in position all echo sounders were switched off or put into passive mode to prevent interference when using deck unit and transducer IXSEA TT801. With an instant response back from the acoustic release I had a range of 5271.0m at 07:16. When the mooring was released, it was ranged whilst climbing through the water column at 1 minute intervals to determine a rate of ascent and estimated surface time. The mooring climbed at a rate of 25 m per minute. This rate is very slow for the amount of buoyancy deployed on the mooring. At this point I assumed that some of the buoyancy spheres might have imploded at depth. The mooring was ranged every five minutes thereafter and continued to rise at a slow rate increasing to 30 m per minute.

The mooring was first sighted by the bridge at 09:04, the bridge observed two packages on the surface at a range of 1000 m off the bow at position 18° 32.15' S, 025° 05.3' W

At this point it was obvious that the deeper buoyancy spheres had imploded.

Once the hydrophone transducer was inboard the ship moved into position ready to grapple the top recovery line. The recovery buoy was removed and mooring winch rope attached at 09:31am. Whilst the ship slowly moved ahead the slack rope was heaved until the mooring line towed aft. The Billings float was recovered to the deck at 09:42. The two sediment traps came to the surface in good condition with no signs of damage and samples all attached. Mooring recovery went very smoothly using a combination of JCR deck mooring winch, aft gantry and articulating arm. The recovery was complete, with the acoustic release on deck at 11:09, in position 18° 32.15' S – 025° 05.5' W. Instruments were fresh water-rinsed and stowed safely until a convenient time to stop data logging.

Table 1: Components of the 2017 SOG mooring with times recovered

| Instrument | Serial Number | Recovery Time (GMT) |
|------------------------|----------------------|----------------------------|
| Novatech Light & Argos | A08-015 / A02-017 | 09:42 |
| AQD Current Meter | 13585 | 10:02 |
| Parflux Sediment Trap | 11804-04 | 10:02 |
| AQD Current Meter | 13569 | 10:09 |
| Parflux Sediment Trap | 12168-02 | 10:09 |
| SBE Moored CTD | 13244 | 11:00 |
| Acoustic Release AR861 | 1469 | 11:09 |

SOG AS DEPLOYED 2017

Release Position:
18°32.700' S
25°04.800' W

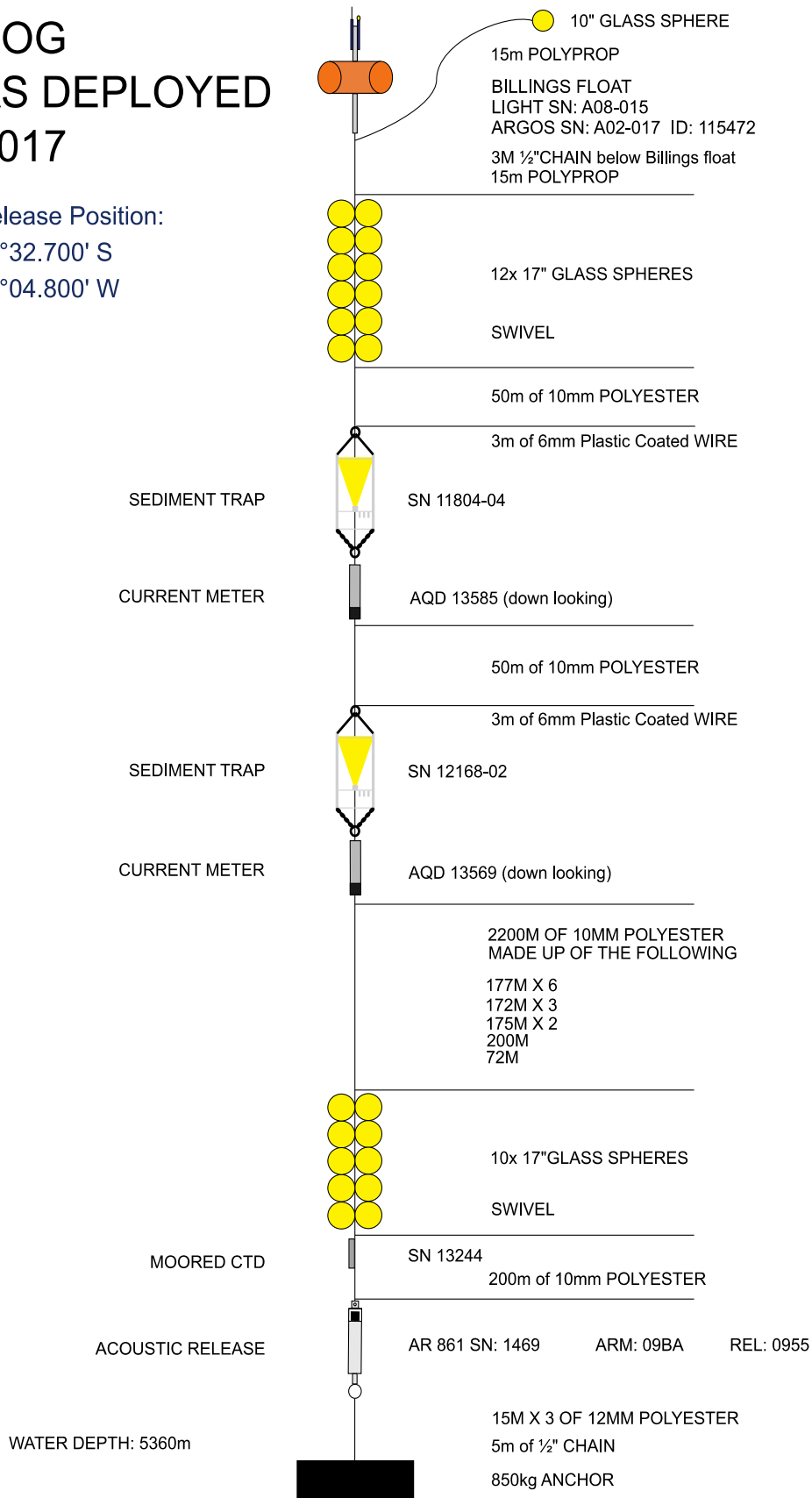


Figure 1: SOG mooring as deployed in 2017



Figure 2: Billings Float Recovered.



Figure 3: Sediment Trap Recovery.



Figure 4: Imploded buoyancy spheres.

Deployment of 2018 SOG Mooring

All mooring ropes, links and shackles were wound onto the JCR mooring winch with the bottom ropes first, finishing with the top. A rope reeling stand was used to support reels whilst winding. Buoyancy spheres, sediment traps, instruments and the acoustic release were made ready. Deployment of the 2018 mooring began at 14:25 in position 18° 34.75' S, 025° 05.1' W. Slowly moving ahead, the mooring recovery Billings float was streamed aft and tension gradually increased to allow the top pack of buoyancy floats to be deployed. The ship's aft Gilson Winch held a sea catch on a wire through the aft gantry's center sheave, connected through the lifting bridal to safely and effectively deploy the sediment traps and Nortek current meters in a vertical position. The lower buoyancy was changed on AMT28 in comparison to previous years. On this deployment, to prevent imploding buoyancy spheres at the deeper depths a 40 inch diameter Syntactic Buoy was used.

Table 2 : Components of the 2018 SOG mooring with times that they entered the water

| Instrument | Serial Number | Time in the water (GMT) |
|------------------------|----------------------|--------------------------------|
| Light & Argos | Y01-015 / CO2-048 | 14:25 |
| Parflux Sediment Trap | 12432-04 (SOG-A) | 14:40 |
| AQD Current Meter | 11990 | 14:40 |
| Parflux Sediment Trap | 12432-03 (SOG-B) | 15:00 |
| AQD Current Trap | 11992 | 15:00 |
| 40" Syntactic Buoyancy | J18048-003 | 16:12 |
| SBE 37 CTD | 13242 | 16:12 |
| Acoustic Release AR861 | 2253 | 16:20 |

Anchor released: 16:32

Position: 18° 32.70' S, 025° 04.81' W

EA600 Depth: 5289m

The Mooring fell to the seabed at an average rate of 100 m per minute. The releases came to a stop and depth stabilized at 17:19 at 5310 m Depth.

Table 3: Instrument set up details

| | |
|-------------------------------------|-------------------------------------|
| Deployment : SOG_B | Deployment : SOG_A |
| Current time : 15/10/2018 11:58:42 | Current time : 15/10/2018 11:54:50 |
| Start at : 15/10/2018 18:00:00 | Start at : 15/10/2018 18:00:00 |
| Comment: | Comment: |
| SOG_B CM BELOW TRAP B | SOG_A CM BELOW TRAP A |
| ----- | |
| Measurement interval (s) : 1800 | Measurement interval (s) : 1800 |
| Average interval (s) : 60 | Average interval (s) : 60 |
| Blanking distance (m) : 0.50 | Blanking distance (m) : 0.50 |
| Measurement load (%) : 4 | Measurement load (%) : 4 |
| Power level : HIGH | Power level : HIGH |
| Diagnostics interval(min) : 720:00 | Diagnostics interval(min) : 720:00 |
| Diagnostics samples : 20 | Diagnostics samples : 20 |
| Compass upd. rate (s) : 1 | Compass upd. rate (s) : 1 |
| Coordinate System : ENU | Coordinate System : ENU |
| Speed of sound (m/s) : MEASURED | Speed of sound (m/s) : MEASURED |
| Salinity (ppt) : 35 | Salinity (ppt) : 35 |
| Analog input 1 : NONE | Analog input 1 : NONE |
| Analog input 2 : NONE | Analog input 2 : NONE |
| Analog input power out : DISABLED | Analog input power out : DISABLED |
| Raw magnetometer out : OFF | Raw magnetometer out : OFF |
| File wrapping : OFF | File wrapping : OFF |
| TellTale : OFF | TellTale : OFF |
| AcousticModem : OFF | AcousticModem : OFF |
| Serial output : OFF | Serial output : OFF |
| Baud rate : 9600 | Baud rate : 9600 |
| ----- | |
| Assumed duration (days) : 550.0 | Assumed duration (days) : 550.0 |
| Battery utilization (%) : 89.0 | Battery utilization (%) : 89.0 |
| Battery level (V) : 13.7 | Battery level (V) : 13.7 |
| Recorder size (MB) : 9 | Recorder size (MB) : 9 |
| Recorder free space (MB) : 8.973 | Recorder free space (MB) : 8.973 |
| Memory required (MB) : 2.0 | Memory required (MB) : 2.0 |
| Vertical vel. prec (cm/s) : 1.4 | Vertical vel. prec (cm/s) : 1.4 |
| Horizon. vel. prec (cm/s) : 0.9 | Horizon. vel. prec (cm/s) : 0.9 |
| ----- | |
| Instrument ID : AQD11992 | Instrument ID : AQD11990 |
| Head ID : A6L 6934 | Head ID : A6L 6931 |
| Firmware version : 3.37 | Firmware version : 3.37 |
| ----- | |
| Aquadopp Deep Water Version 1.40.16 | Aquadopp Deep Water Version 1.40.16 |

**SOG MOORING
DEPLOYED
AMT-28
2018**

Release position:
18° 32.70 S
025° 04.81 W

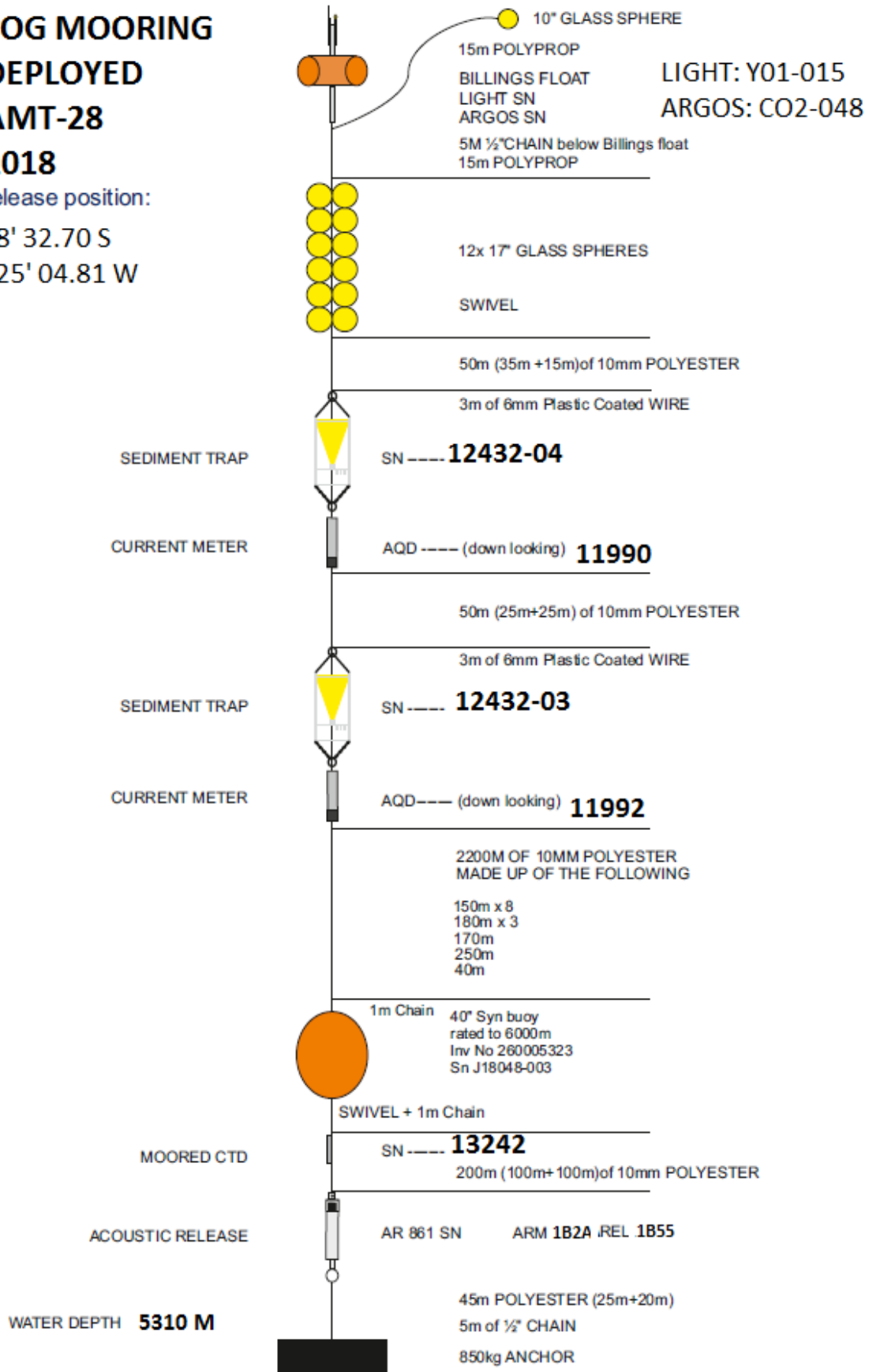


Figure 5: SOG mooring as deployed on AMT28 in 2018

Appendix 1: Non-toxic Seawater Supply System Log

| Date | Time (GMT) | Pump | Filter in use | Probe position | Event | Remarks |
|----------|------------|------|---------------|----------------|------------------------------------|----------------------------|
| 25-09-18 | 0700 | Fwd | 2 | Mid | Started System | |
| 27-09-18 | 0700 | Fwd | 1 | Mid | Swapped strainers | One small fish in strainer |
| 29-09-18 | 0700 | Fwd | 2 | Mid | Swapped strainers | |
| 01-10-18 | 1600 | Fwd | 1 | Mid | Swapped strainers | |
| 04-10-18 | 1600 | Fwd | 2 | Mid | Swapped strainers | |
| 08-10-18 | 0900 | Fwd | 1 | Mid | Swapped strainers | Kelp in strainer |
| 12-10-18 | 1100 | Fwd | 2 | Mid | Swapped strainers | Kelp in strainer |
| 16-10-18 | 0900 | Fwd | 1 | Mid | Swapped strainers | |
| 19-10-18 | 0900 | Aft | 2 | Down | Swapped strainers, lowered probe | Low flow rate in chem lab |
| 23-10-18 | 0800 | Aft | 1 | Down | Swapped strainers | |
| 26-10-18 | 0900 | Aft | 1 | Mid | Lifted probe to Mid position | |
| 26-10-18 | 1400 | Aft | 2 | Mid | Swapped strainers | |
| 28-10-18 | 2115 | Aft | 2 | Up | Turned off system and closed valve | |

Appendix 2: AMT28 Log of Events.

* Lat and Lon coordinate reference system is WGS 84 throughout this report

| Start date and time (GMT) | End date and time (GMT) | Gear | Activity | Station | Event No. | Start *Lat (+ve N) | Start *Lon (+ve E) | End Lat (+ve N) | End Lon (+ve E) | Comments |
|---------------------------|-------------------------|------------|------------|---------|-----------|--------------------|--------------------|-----------------|-----------------|----------------------------|
| 25/09/2018 12:32 | 25/09/2018 13:06 | CTD | CTD001 | 1 | 1 | 49.6381 | -5.5016 | 49.6381 | -5.5016 | Ship's time is GMT+1 (BST) |
| 25/09/2018 12:42 | 25/09/2018 13:05 | OPTICS RIG | OPTICS 001 | 1 | 2 | 49.6381 | -5.5016 | 49.6381 | -5.5016 | |
| 25/09/2018 12:49 | 25/09/2018 13:02 | SODS FLOAT | SODS001 | 1 | 3 | 49.6381 | -5.5016 | 49.4498 | -6.0478 | |
| 26/09/2018 03:34 | 26/09/2018 04:07 | CTD | CTD002 | 2 | 4 | 48.4694 | -8.8366 | 48.4694 | -8.8366 | |
| 26/09/2018 03:38 | 26/09/2018 03:57 | BONGO NET | BONGO 001 | 2 | 5 | 48.4694 | -8.8366 | 48.4694 | -8.8366 | |
| 26/09/2018 03:39 | 26/09/2018 04:00 | SODS FLOAT | SODS002 | 2 | 6 | 48.4694 | -8.8366 | 48.4694 | -8.8366 | |
| 26/09/2018 12:07 | 26/09/2018 12:43 | OPTICS RIG | OPTICS 002 | 3 | 7 | 47.9013 | -10.3814 | 47.9012 | -10.3814 | |
| 26/09/2018 12:10 | 26/09/2018 12:55 | CTD | CTD003 | 3 | 8 | 47.9013 | -10.3814 | 47.9012 | -10.3814 | |
| 26/09/2018 | 26/09/2018 | SODS | SODS003 | 3 | 9 | 47.9013 | -10.3814 | 47.9012 | -10.3814 | |

| | | | | | | | | | | |
|-------------------------|-------------------------|---------------|----------------|---|----|---------|----------|---------|----------|--|
| 2018 12:12 | 2018 12:34 | FLOAT | | | | | | | | |
| 27/09/ 2018 03:29 | 27/09/ 2018 03:53 | BONGO NET | BONGO 002 | 4 | 10 | 46.0291 | -12.7325 | 46.0291 | -12.7325 | |
| 27/09/ 2018 03:30 | 27/09/ 2018 04:16 | CTD | CTD004 | 4 | 11 | 46.0291 | -12.7326 | 46.0291 | -12.7325 | |
| 27/09/ 2018 03:30 | 27/09/ 2018 03:53 | SODS FLOAT | SODS004 | 4 | 12 | 45.9832 | -12.7747 | 46.0291 | -12.7325 | |
| 27/09/ 2018 12:04 | 27/09/ 2018 12:57 | CTD | CTD005 | 5 | 13 | 44.9786 | -13.5894 | 44.9786 | -13.5894 | |
| 27/09/ 2018 12:06 | 27/09/ 2018 12:42 | OPTICS RIG | OPTICS 003 | 5 | 14 | 44.9786 | -13.5894 | 44.9786 | -13.5894 | |
| 27/09/ 2018 12:12 | 27/09/ 2018 12:34 | SODS FLOAT | SODS005 | 5 | 15 | 44.9786 | -13.5894 | 44.9786 | -13.5894 | |
| 27/09/ 2018 12:26 | N/A | BALLOON | BALLOON 001 | 5 | 16 | 44.9786 | -13.5894 | N/A | N/A | |
| 28/09/ 2018 03:33 | 28/09/ 2018 04:21 | CTD | CTD006 | 6 | 17 | 42.9675 | -15.2134 | 42.9647 | -15.2116 | |
| 28/09/ 2018 03:35 | 28/09/ 2018 04:08 | BONGO NET | BONGO 003 | 6 | 18 | 42.9666 | -15.2128 | 42.9307 | -15.2410 | |
| 28/09/ 2018 03:40 | 28/09/ 2018 04:03 | SODS FLOAT | SODS006 | 6 | 19 | 42.9656 | -15.2122 | 42.9647 | -15.2116 | |

| | | | | | | | | | | |
|-------------------------|-------------------------|---------------|----------------|---|----|---------|----------|---------|----------|--|
| 28/09/ 2018 12:00 | 28/09/ 2018 12:40 | OPTICS RIG | OPTICS 004 | 7 | 20 | 41.9117 | -16.0363 | 41.9117 | -16.0363 | |
| 28/09/ 2018 12:02 | 28/09/ 2018 12:50 | CTD | CTD007 | 7 | 21 | 41.9117 | -16.0363 | 41.6448 | -16.2476 | |
| 28/09/ 2018 12:09 | N/A | BALLOON | BALLOON 002 | 7 | 22 | 41.9117 | -16.0363 | N/A | N/A | |
| 28/09/ 2018 12:10 | 28/09/ 2018 12:31 | SODS FLOAT | SODS007 | 7 | 23 | 41.9117 | -16.0363 | 41.9117 | -16.0363 | |
| 29/09/ 2018 03:29 | 29/09/ 2018 04:22 | CTD | CTD008 | 8 | 24 | 39.7193 | -17.7162 | 39.6845 | -17.7375 | |
| 29/09/ 2018 03:30 | 29/09/ 2018 03:56 | BONGO NET | BONGO 004 | 8 | 25 | 39.7193 | -17.7161 | 39.7193 | -17.7162 | |
| 29/09/ 2018 03:36 | 29/09/ 2018 03:56 | SODS FLOAT | SODS008 | 8 | 26 | 39.7193 | -17.7161 | 39.7193 | -17.7162 | |
| 29/09/ 2018 11:57 | 29/09/ 2018 12:37 | OPTICS RIG | OPTICS 005 | 9 | 27 | 38.6309 | -18.5257 | 38.6309 | -18.5257 | |
| 29/09/ 2018 12:00 | 29/09/ 2018 12:52 | CTD | CTD009 | 9 | 28 | 38.6309 | -18.5257 | 38.6308 | -18.5257 | |
| 29/09/ 2018 12:08 | 29/09/ 2018 12:31 | SODS FLOAT | SODS009 | 9 | 29 | 38.6309 | -18.5257 | 38.6309 | -18.5257 | |
| 29/09/ 2018 | N/A | BALLOON | BALLOON 003 | 9 | 30 | 38.6308 | -18.5257 | N/A | N/A | |

| | | | | | | | | | | |
|---------------------|---------------------|------------|-------------|----|----|---------|----------|---------|----------|--|
| 12:14 | | | | | | | | | | |
| 29/09/2018 12:40 | N/A | SKY PAN | SKY001 | 9 | 31 | 38.6308 | -18.5257 | N/A | N/A | |
| 30/09/2018 04:27 | 30/09/2018 04:55 | BONGO NET | BONGO 005 | 10 | 32 | 36.4139 | -20.1215 | 36.4139 | -20.1215 | Ships time is GMT (clocks back 1 hour) |
| 30/09/2018 04:27 | 30/09/2018 05:20 | CTD | CTD010 | 10 | 33 | 36.4139 | -20.1215 | 36.4139 | -20.1214 | |
| 30/09/2018 04:30 | 30/09/2018 04:52 | SODS FLOAT | SODS010 | 10 | 34 | 36.4139 | -20.1215 | 36.4139 | -20.1215 | |
| 30/09/2018 12:55 | 30/09/2018 13:35 | OPTICS RIG | OPTICS 006 | 11 | 35 | 35.3020 | -20.9152 | 35.3020 | -20.9152 | |
| 30/09/2018 13:01 | 30/09/2018 13:50 | CTD | CTD011 | 11 | 36 | 35.3020 | -20.9152 | 35.3020 | -20.9152 | |
| 30/09/2018 13:06 | 30/09/2018 13:29 | SODS FLOAT | SODS011 | 11 | 37 | 35.3020 | -20.9152 | 35.3020 | -20.9152 | |
| 30/09/2018 13:18 | N/A | BALLOON | BALLOON 004 | 11 | 38 | 35.3020 | -20.9152 | N/A | N/A | |
| 30/09/2018 13:54 | N/A | SKY PAN | SKY002 | 11 | 39 | 35.3020 | -20.9152 | N/A | N/A | |
| 01/10/2018 04:27 | 01/10/2018 04:54 | BONGO NET | BONGO 006 | 12 | 40 | 33.0469 | -22.1368 | 33.0469 | -22.1368 | |

| | | | | | | | | | | |
|-------------------------|-------------------------|---------------|----------------|----|----|---------|----------|---------|----------|--|
| 01/10/ 2018 04:30 | 01/10/ 2018 05:27 | CTD | CTD012 | 12 | 41 | 33.0470 | -22.1368 | 33.0469 | -22.1368 | |
| 01/10/ 2018 04:37 | 01/10/ 2018 04:57 | SODS FLOAT | SODS012 | 12 | 42 | 33.0469 | -22.1368 | 33.0469 | -22.1368 | |
| 01/10/ 2018 13:02 | 01/10/ 2018 13:41 | OPTICS RIG | OPTICS 007 | 13 | 43 | 31.9240 | -22.7102 | 31.9240 | -22.7102 | |
| 01/10/ 2018 13:04 | 01/10/ 2018 14:01 | CTD | CTD013 | 13 | 44 | 31.9240 | -22.7102 | 31.9240 | -22.7102 | |
| 01/10/ 2018 13:12 | 01/10/ 2018 13:36 | SODS FLOAT | SODS013 | 13 | 45 | 31.8140 | -22.7469 | 31.9240 | -22.7102 | |
| 01/10/ 2018 13:16 | N/A | BALLOON | BALLOON 005 | 13 | 46 | 31.9240 | -22.7102 | N/A | N/A | |
| 02/10/ 2018 04:34 | 02/10/ 2018 05:00 | BONGO NET | BONGO 007 | 14 | 47 | 29.4883 | -23.9325 | 29.4883 | -23.9325 | |
| 02/10/ 2018 04:34 | 02/10/ 2018 05:27 | CTD | CTD014 | 14 | 48 | 29.4883 | -23.9325 | 29.4883 | -23.9324 | |
| 02/10/ 2018 04:36 | 02/10/ 2018 05:00 | SODS FLOAT | SODS014 | 14 | 49 | 29.4883 | -23.9325 | 29.4883 | -23.9325 | |
| 02/10/ 2018 10:51 | 02/10/ 2018 13:39 | CTD | CTD015 | 15 | 50 | 28.6091 | -24.3609 | 28.6091 | -24.3609 | |
| 02/10/ 2018 | N/A | SKY PAN | SKY003 | 15 | 51 | 28.6091 | -24.3609 | N/A | N/A | |

| | | | | | | | | | | |
|-------------------------|-------------------------|---------------|----------------|----|----|---------|----------|---------|----------|--|
| 11:50 | | | | | | | | | | |
| 02/10/ 2018 12:54 | 02/10/ 2018 13:35 | OPTICS RIG | OPTICS 008 | 15 | 52 | 28.6091 | -24.3608 | 28.6091 | -24.3609 | |
| 02/10/ 2018 13:08 | 02/10/ 2018 13:30 | SODS FLOAT | SODS015 | 15 | 53 | 28.6091 | -24.3609 | 28.6091 | -24.3609 | |
| 02/10/ 2018 13:34 | N/A | BALLOON | BALLOON 006 | 15 | 54 | 28.6091 | -24.3609 | N/A | N/A | |
| 03/10/ 2018 04:29 | 03/10/ 2018 04:54 | BONGO NET | BONGO 008 | 16 | 55 | 26.2038 | -25.5211 | 26.2038 | -25.5211 | |
| 03/10/ 2018 04:31 | 03/10/ 2018 04:54 | SODS FLOAT | SODS016 | 16 | 56 | 26.2038 | -25.5211 | 26.2038 | -25.5211 | |
| 03/10/ 2018 04:32 | 03/10/ 2018 05:27 | CTD | CTD016 | 16 | 57 | 26.2038 | -25.5211 | 26.2038 | -25.5211 | |
| 03/10/ 2018 12:59 | 03/10/ 2018 13:52 | CTD | CTD017 | 17 | 58 | 25.0577 | -26.0568 | 25.0577 | -26.0568 | |
| 03/10/ 2018 13:04 | 03/10/ 2018 13:42 | OPTICS RIG | OPTICS 009 | 17 | 59 | 25.0577 | -26.0568 | 25.0577 | -26.0568 | |
| 03/10/ 2018 13:11 | N/A | BALLOON | BALLOON 007 | 17 | 60 | 25.0577 | -26.0568 | N/A | N/A | |
| 03/10/ 2018 13:17 | 03/10/ 2018 13:43 | SODS FLOAT | SODS017 | 17 | 61 | 25.0577 | -26.0568 | 25.0577 | -26.0568 | |
| 04/10/ | 04/10/ | BONGO | BONGO | 18 | 62 | 22.5997 | -27.2134 | 22.5260 | -27.2376 | |

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|-------------------------|-------------------------|---------------|----------------|----|-----|---------|----------|---------|----------|--|
| 2018 04:27 | 2018 04:56 | NET | 009 | | | | | | | |
| 04/10/ 2018 04:32 | 04/10/ 2018 04:57 | SODS FLOAT | SODS018 | 18 | 63 | 22.5997 | -27.2134 | 22.5997 | -27.2134 | |
| 04/10/ 2018 04:34 | 04/10/ 2018 05:27 | CTD | CTD018 | 18 | 64 | 22.5997 | -27.2133 | 22.5997 | -27.2134 | |
| 04/10/ 2018 12:55 | 04/10/ 2018 13:32 | OPTICS RIG | OPTICS 010 | 19 | 65 | 21.4472 | -27.7454 | 21.4472 | -27.7453 | |
| 04/10/ 2018 13:00 | 04/10/ 2018 13:49 | CTD | CTD019 | 19 | 66 | 21.4472 | -27.7453 | 21.4472 | -27.7454 | |
| 04/10/ 2018 13:05 | 04/10/ 2018 13:27 | SODS FLOAT | SODS019 | 19 | 67 | 21.4472 | -27.7453 | 21.4472 | -27.7453 | |
| 04/10/ 2018 13:06 | N/A | BALLOON | BALLOON 008 | 19 | 68 | 21.4472 | -27.7453 | N/A | N/A | |
| 04/10/ 2018 13:56 | N/A | SKY PAN | SKY004 | 19 | 68B | 21.4472 | -27.7454 | N/A | N/A | |
| 05/10/ 2018 04:32 | 05/10/ 2018 04:55 | BONGO NET | BONGO 010 | 20 | 69 | 19.0778 | -28.8168 | 19.0778 | -28.8167 | |
| 05/10/ 2018 04:34 | 05/10/ 2018 04:56 | SODS FLOAT | SODS020 | 20 | 70 | 19.0778 | -28.8168 | 19.0778 | -28.8168 | |
| 05/10/ 2018 04:36 | 05/10/ 2018 05:22 | CTD | CTD020 | 20 | 71 | 19.0778 | -28.8168 | 18.8081 | -28.8392 | |

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| 05/10/ 2018 12:54 | 05/10/ 2018 13:32 | OPTICS RIG | OPTICS 011 | 21 | 72 | 17.7473 | -28.9303 | 17.7474 | -28.9302 | |
| 05/10/ 2018 13:00 | 05/10/ 2018 13:53 | CTD | CTD021 | 21 | 73 | 17.7473 | -28.9302 | 17.7474 | -28.9302 | |
| 05/10/ 2018 13:04 | 05/10/ 2018 13:26 | SODS FLOAT | SODS021 | 21 | 74 | 17.7473 | -28.9302 | 17.7473 | -28.9302 | |
| 05/10/ 2018 13:27 | N/A | BALLOON | BALLOON 009 | 21 | 75 | 17.7473 | -28.9302 | N/A | N/A | |
| 06/10/ 2018 04:30 | 06/10/ 2018 04:56 | BONGO NET | BONGO0 11 | 22 | 76 | 15.0761 | -28.6126 | 15.0761 | -28.6127 | |
| 06/10/ 2018 04:32 | 06/10/ 2018 04:56 | SODS FLOAT | SODS022 | 22 | 77 | 15.0761 | -28.6126 | 15.0761 | -28.6127 | |
| 06/10/ 2018 04:37 | 06/10/ 2018 05:32 | CTD | CTD022 | 22 | 78 | 15.0761 | -28.6126 | 15.0761 | -28.6127 | |
| 06/10/ 2018 12:56 | 06/10/ 2018 13:32 | OPTICS RIG | OPTICS 012 | 23 | 79 | 13.8122 | -28.2946 | 13.8122 | -28.2946 | |
| 06/10/ 2018 13:00 | 06/10/ 2018 13:49 | CTD | CTD023 | 23 | 80 | 13.8122 | -28.2946 | 13.8122 | -28.2946 | |
| 06/10/ 2018 13:05 | 06/10/ 2018 13:27 | SODS FLOAT | SODS 023 | 23 | 81 | 13.8122 | -28.2946 | 13.8122 | -28.2946 | |
| 06/10/ 2018 | N/A | BALLOON | BALLOON 010 | 23 | 82 | 13.8122 | -28.2945 | N/A | N/A | |

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| 13:11 | | | | | | | | | | |
| 07/10/ 2018 04:31 | 07/10/ 2018 04:56 | BONGO NET | BONGO 012 | 24 | 83 | 11.4470 | -27.7087 | 11.4470 | -27.7087 | |
| 07/10/ 2018 04:34 | 07/10/ 2018 04:57 | SODS FLOAT | SODS024 | 24 | 84 | 11.4470 | -27.7087 | 11.4470 | -27.7087 | |
| 07/10/ 2018 04:35 | 07/10/ 2018 05:20 | CTD | CTD024 | 24 | 85 | 11.4470 | -27.7087 | 11.4470 | -27.7087 | |
| 07/10/ 2018 12:55 | 07/10/ 2018 13:30 | OPTICS RIG | OPTICS 013 | 25 | 86 | 10.0983 | -27.2939 | 10.0983 | -27.2938 | |
| 07/10/ 2018 12:58 | 07/10/ 2018 13:34 | CTD | CTD025 | 25 | 87 | 10.0982 | -27.2938 | 10.0983 | -27.2938 | |
| 07/10/ 2018 13:06 | 07/10/ 2018 13:27 | SODS FLOAT | SODS025 | 25 | 88 | 10.0982 | -27.2938 | 10.0983 | -27.2938 | |
| 07/10/ 2018 13:17 | N/A | BALLOON | BALLOON 011 | 25 | 89 | 10.0983 | -27.2938 | N/A | N/A | |
| 07/10/ 2018 19:49 | 07/10/ 2018 19:54 | ARGO FLOAT RECOVERY | ARGO RECOVER 001 | 26 | 90 | 8.8703 | -26.9641 | 8.8701 | -26.9639 | |
| 08/10/ 2018 04:30 | 08/10/ 2018 04:58 | BONGO NET | BONGO 013 | 27 | 91 | 7.4713 | -26.6501 | 7.4713 | -26.6501 | |
| 08/10/ 2018 04:33 | 08/10/ 2018 04:58 | SODS FLOAT | SODS026 | 27 | 92 | 7.4713 | -26.6501 | 7.4713 | -26.6501 | |

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| 08/10/ 2018 04:36 | 08/10/ 2018 05:25 | CTD | CTD026 | 27 | 93 | 7.4713 | -26.6501 | 7.4713 | -26.6501 | |
| 08/10/ 2018 12:56 | 08/10/ 2018 13:34 | OPTICS RIG | OPTICS 014 | 28 | 94 | 6.2561 | -26.3800 | 6.2560 | -26.3800 | |
| 08/10/ 2018 13:00 | 08/10/ 2018 13:50 | CTD | CTD027 | 28 | 95 | 6.2560 | -26.3800 | 6.2560 | -26.3800 | |
| 08/10/ 2018 13:04 | 08/10/ 2018 13:25 | SODS FLOAT | SODS027 | 28 | 96 | 6.2560 | -26.3799 | 6.2560 | -26.3800 | |
| 08/10/ 2018 13:10 | N/A | BALLOON | BALLOON 012 | 28 | 97 | 6.2560 | -26.3800 | N/A | N/A | |
| 09/10/ 2018 04:33 | 09/10/ 2018 04:58 | BONGO NET | BONGO 014 | 29 | 98 | 3.8078 | -25.8358 | 3.8078 | -25.8358 | |
| 09/10/ 2018 04:37 | 09/10/ 2018 04:58 | SODS FLOAT | SODS028 | 29 | 99 | 3.8078 | -25.8358 | 3.8078 | -25.8358 | |
| 09/10/ 2018 04:38 | 09/10/ 2018 05:28 | CTD | CTD028 | 29 | 100 | 3.8078 | -25.8358 | 3.8077 | -25.8358 | |
| 10/10/ 2018 04:42 | 10/10/ 2018 05:38 | CTD | CTD029 | 30 | 101 | 0.0006 | -24.9991 | 0.0020 | -24.9925 | |
| 10/10/ 2018 04:44 | 10/10/ 2018 05:15 | BONGO NET | BONGO 015 | 30 | 102 | 0.0005 | -24.9992 | 0.0020 | -24.9956 | |
| 10/10/ 2018 | 10/10/ 2018 | SODS FLOAT | SODS029 | 30 | 103 | 0.0005 | -24.9992 | 0.0013 | -24.9973 | |

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| 04:45 | 05:07 | | | | | | | | | |
| 10/10/ 2018 12:57 | 10/10/ 2018 13:33 | OPTICS RIG | OPTICS 015 | 31 | 104 | -1.1518 | -24.9906 | -1.1508 | -24.9857 | |
| 10/10/ 2018 13:00 | 10/10/ 2018 13:53 | CTD | CTD030 | 31 | 105 | -1.1518 | -24.9906 | -1.1505 | -24.9824 | |
| 10/10/ 2018 13:05 | 10/10/ 2018 13:28 | SODS FLOAT | SODS030 | 31 | 106 | -1.1518 | -24.9906 | -1.1509 | -24.9865 | |
| 10/10/ 2018 13:15 | N/A | BALLOON | BALLOON 013 | 31 | 107 | -1.1512 | -24.9888 | N/A | N/A | |
| 10/10/ 2018 13:55 | N/A | SKY PAN | SKY005 | 31 | 108 | -1.1504 | -24.9821 | N/A | N/A | |
| 11/10/ 2018 04:33 | 11/10/ 2018 05:00 | BONGO NET | BONGO 016 | 32 | 109 | -3.6918 | -24.9774 | -3.6894 | -24.9792 | |
| 11/10/ 2018 04:34 | 11/10/ 2018 05:00 | SODS FLOAT | SODS031 | 32 | 110 | -3.6918 | -24.9774 | -3.6894 | -24.9792 | |
| 11/10/ 2018 04:37 | 11/10/ 2018 05:27 | CTD | CTD031 | 32 | 111 | -3.6916 | -24.9776 | -3.6876 | -24.9809 | |
| 11/10/ 2018 12:57 | 11/10/ 2018 13:55 | CTD | CTD032 | 33 | 112 | -5.2562 | -24.9714 | -4.9846 | -24.9732 | |
| 11/10/ 2018 12:59 | 11/10/ 2018 13:36 | OPTICS RIG | OPTICS 016 | 33 | 113 | -4.9846 | -24.9732 | -4.9846 | -24.9732 | |
| 11/10/ | 11/10/ | SODS | SODS032 | 33 | 114 | -4.9846 | -24.9732 | -4.9846 | -24.9732 | |

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| 2018 13:05 | 2018 13:27 | FLOAT | | | | | | | | |
| 11/10/ 2018 13:15 | N/A | BALLOON | BALLOON 014 | 33 | 115 | -4.9847 | -24.9732 | N/A | N/A | |
| 12/10/ 2018 04:36 | 12/10/ 2018 05:05 | BONGO NET | BONGO 017 | 34 | 116 | -7.5488 | -24.9572 | -7.5486 | -24.9588 | |
| 12/10/ 2018 04:37 | 12/10/ 2018 05:29 | CTD | CTD033 | 34 | 117 | -7.5487 | -24.9573 | -7.5488 | -24.9601 | |
| 12/10/ 2018 04:42 | 12/10/ 2018 05:06 | SODS FLOAT | SODS033 | 34 | 118 | -7.5487 | -24.9575 | -7.5486 | -24.9589 | |
| 12/10/ 2018 12:56 | 12/10/ 2018 13:34 | OPTICS RIG | OPTICS 017 | 35 | 119 | -8.7631 | -24.9484 | -8.7631 | -24.9484 | |
| 12/10/ 2018 12:59 | 12/10/ 2018 13:53 | CTD | CTD034 | 35 | 120 | -8.7631 | -24.9484 | -8.7631 | -24.9484 | |
| 12/10/ 2018 13:05 | 12/10/ 2018 13:28 | SODS FLOAT | SODS034 | 35 | 121 | -8.7631 | -24.9484 | -8.7631 | -24.9484 | |
| 12/10/ 2018 13:15 | N/A | BALLOON | BALLOON 015 | 35 | 122 | -8.7631 | -24.9484 | N/A | N/A | |
| 13/10/ 2018 04:30 | 13/10/ 2018 04:58 | BONGO NET | BONGO 018 | 36 | 123 | -11.2623 | -24.9374 | -11.2619 | -24.9387 | |
| 13/10/ 2018 04:33 | 13/10/ 2018 05:22 | CTD | CTD035 | 36 | 124 | -11.2624 | -24.9374 | -11.2616 | -24.9400 | |

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| 13/10/ 2018 04:33 | 13/10/ 2018 04:53 | SODS FLOAT | SODS035 | 36 | 125 | -11.2624 | -24.9374 | -11.2620 | -24.9385 | |
| 13/10/ 2018 10:31 | 13/10/ 2018 13:40 | CTD | CTD036 | 37 | 126 | -12.0828 | -24.9303 | -12.0828 | -24.9303 | |
| 13/10/ 2018 11:45 | N/A | SKY PAN | SKY006 | 37 | 127 | -12.0828 | -24.9303 | N/A | N/A | |
| 13/10/ 2018 12:55 | 13/10/ 2018 13:32 | OPTICS RIG | OPTICS 018 | 37 | 128 | -12.0828 | -24.9303 | -12.0828 | -24.9303 | |
| 13/10/ 2018 13:04 | 13/10/ 2018 13:29 | SODS FLOAT | SODS036 | 37 | 129 | -12.0828 | -24.9303 | -12.0828 | -24.9303 | |
| 13/10/ 2018 13:19 | N/A | BALLOON | BALLOON 016 | 37 | 130 | -12.0828 | -24.9303 | N/A | N/A | |
| 14/10/ 2018 04:30 | 14/10/ 2018 05:00 | BONGO NET | BONGO 019 | 38 | 131 | -14.7798 | -24.9847 | -14.7790 | -24.9856 | |
| 14/10/ 2018 04:32 | 14/10/ 2018 04:56 | SODS FLOAT | SODS037 | 38 | 132 | -14.7798 | -24.9847 | -14.7792 | -24.9855 | |
| 14/10/ 2018 04:33 | 14/10/ 2018 05:24 | CTD | CTD037 | 38 | 133 | -14.7798 | -24.9848 | -14.7783 | -24.9868 | |
| 14/10/ 2018 08:57 | N/A | ARGO FLOAT | ARGO001 | 39 | 134 | -15.4078 | -25.0008 | N/A | N/A | Argo float No. 12691 |
| 14/10/ 2018 | N/A | ARGO FLOAT | ARGO002 | 39 | 135 | -15.4077 | -25.0001 | N/A | N/A | Argo float No. 7001 |

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| 08:59 | | | | | | | | | | |
| 14/10/ 2018 13:02 | 14/10/ 2018 13:39 | OPTICS RIG | OPTICS 019 | 40 | 136 | -16.0324 | -25.0235 | -16.0324 | -25.0235 | |
| 14/10/ 2018 13:05 | 14/10/ 2018 13:55 | CTD | CTD038 | 40 | 137 | -16.0324 | -25.0235 | -16.0324 | -25.0235 | |
| 14/10/ 2018 13:08 | 14/10/ 2018 13:33 | SODS FLOAT | SODS038 | 40 | 138 | -16.0324 | -25.0235 | -16.0324 | -25.0235 | |
| 14/10/ 2018 13:10 | N/A | BALLOON | BALLOON 017 | 40 | 139 | -16.0324 | -25.0235 | N/A | N/A | |
| 14/10/ 2018 13:59 | N/A | SKY PAN | SKY007 | 40 | 140 | -16.0324 | -25.0235 | N/A | N/A | |
| 15/10/ 2018 04:33 | 15/10/ 2018 05:03 | BONGO NET | BONGO 020 | 41 | 141 | -18.3393 | -25.0857 | -18.3390 | -25.0872 | |
| 15/10/ 2018 04:33 | 15/10/ 2018 05:25 | CTD | CTD039 | 41 | 142 | -18.3393 | -25.0857 | -18.3390 | -25.0871 | |
| 15/10/ 2018 04:36 | 15/10/ 2018 05:00 | SODS FLOAT | SODS039 | 41 | 143 | -18.3393 | -25.0857 | -18.3391 | -25.0871 | |
| 15/10/ 2018 07:10 | 15/10/ 2018 11:09 | MOORING RECOVERY | MOORING RECOVER 001 | 42 | 144 | -18.5506 | -25.0874 | -18.5354 | -25.0919 | |
| 15/10/ 2018 14:25 | 15/10/ 2018 17:20 | MOORING DEPLOYME NT | MOORING DEPLOY 001 | 42 | 145 | -18.5785 | -25.0864 | -18.5443 | -25.0799 | |

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| 16/10/ 2018 04:36 | 16/10/ 2018 05:06 | BONGO NET | BONGO 021 | 43 | 146 | -20.3793 | -25.0594 | -20.3803 | -25.0591 | |
| 16/10/ 2018 04:37 | 16/10/ 2018 05:23 | CTD | CTD040 | 43 | 147 | -20.3793 | -25.0594 | -20.3803 | -25.0591 | |
| 16/10/ 2018 04:38 | 16/10/ 2018 05:00 | SODS FLOAT | SODS040 | 43 | 148 | -20.3794 | -25.0594 | -20.3802 | -25.0592 | |
| 16/10/ 2018 05:35 | N/A | ARGO FLOAT | ARGO003 | 43 | 149 | -20.3792 | -25.0598 | N/A | N/A | University of Washington ARGO (AL) Float No. 12632 |
| 16/10/ 2018 12:58 | 16/10/ 2018 13:55 | CTD | CTD041 | 44 | 150 | -21.6038 | -25.0464 | -21.6037 | -25.0465 | |
| 16/10/ 2018 12:59 | 16/10/ 2018 13:37 | OPTICS RIG | OPTICS 020 | 44 | 151 | -21.6037 | -25.0465 | -21.6037 | -25.0464 | |
| 16/10/ 2018 13:03 | 16/10/ 2018 13:30 | SODS FLOAT | SODS041 | 44 | 152 | -21.6037 | -25.0464 | -21.6038 | -25.0464 | |
| 16/10/ 2018 13:14 | N/A | BALLOON | BALLOON 018 | 44 | 153 | -21.6037 | -25.0464 | N/A | N/A | |
| 17/10/ 2018 04:28 | 17/10/ 2018 04:56 | BONGO NET | BONGO 022 | 45 | 154 | -23.9995 | -24.9993 | -24.0000 | -24.9999 | |
| 17/10/ 2018 04:28 | 17/10/ 2018 05:23 | CTD | CTD042 | 45 | 155 | -23.9995 | -24.9993 | -24.0000 | -25.0000 | |
| 17/10/ 2018 | 17/10/ 2018 | SODS FLOAT | SODS042 | 45 | 156 | -23.9996 | -24.9994 | -24.0000 | -24.9999 | |

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| 04:30 | 04:54 | | | | | | | | | |
| 17/10/ 2018 12:56 | 17/10/ 2018 13:35 | OPTICS RIG | OPTICS 021 | 46 | 157 | -24.9059 | -25.9033 | -24.9059 | -25.9033 | |
| 17/10/ 2018 12:59 | 17/10/ 2018 13:55 | CTD | CTD043 | 46 | 158 | -24.9059 | -25.9033 | -24.9059 | -25.9033 | |
| 17/10/ 2018 13:05 | 17/10/ 2018 13:29 | SODS FLOAT | SODS043 | 46 | 159 | -24.9059 | -25.9033 | -24.9059 | -25.9033 | |
| 17/10/ 2018 13:19 | N/A | BALLOON | BALLOON 019 | 46 | 160 | -24.9059 | -25.9033 | N/A | N/A | |
| 17/10/ 2018 14:00 | N/A | ARGO FLOAT | ARGO004 | 46 | 161 | -24.9059 | -25.9033 | N/A | N/A | ARGO Float No. 12776 |
| 18/10/ 2018 04:34 | 18/10/ 2018 05:08 | BONGO NET | BONGO 023 | 47 | 162 | -26.6280 | -27.6554 | -26.6280 | -27.6554 | |
| 18/10/ 2018 04:35 | 18/10/ 2018 05:00 | SODS FLOAT | SODS044 | 47 | 163 | -26.6280 | -27.6554 | -26.6280 | -27.6554 | |
| 18/10/ 2018 04:40 | 18/10/ 2018 05:33 | CTD | CTD044 | 47 | 164 | -26.6280 | -27.6554 | -26.6280 | -27.6554 | |
| 18/10/ 2018 05:40 | N/A | ARGO FLOAT | ARGO005 | 47 | 165 | -26.6279 | -27.6550 | N/A | N/A | |
| 18/10/ 2018 10:36 | 18/10/ 2018 12:06 | CTD | CTD045 | 48 | 166 | -27.2001 | -28.2502 | -27.2000 | -28.2501 | |
| 18/10/ | 18/10/ | OPTICS RIG | OPTICS | 48 | 167 | -27.2000 | -28.2501 | -27.2000 | -28.2501 | |

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| 2018 11:00 | 2018 11:43 | | 022 | | | | | | | |
| 18/10/ 2018 11:12 | 18/10/ 2018 11:32 | SODS FLOAT | SODS045 | 48 | 168 | -27.2000 | -28.2501 | -27.2000 | -28.2501 | |
| 18/10/ 2018 11:26 | N/A | BALLOON | BALLOON 020 | 48 | 169 | -27.2000 | -28.2501 | N/A | N/A | |
| 18/10/ 2018 12:21 | N/A | ARGO FLOAT | ARGO006 | 48 | 170 | -27.2001 | -28.2501 | N/A | N/A | SOCCOM float No.12696 |
| 18/10/ 2018 12:26 | N/A | ARGO FLOAT | ARGO007 | 48 | 171 | -27.2008 | -28.2498 | N/A | N/A | SOCCOM float No.12883 |
| 19/10/ 2018 04:30 | 19/10/ 2018 05:00 | BONGO NET | BONGO 024 | 49 | 172 | -29.1276 | -30.2235 | -29.1276 | -30.2235 | |
| 19/10/ 2018 04:33 | 19/10/ 2018 04:54 | SODS FLOAT | SODS046 | 49 | 173 | -29.1276 | -30.2235 | -29.1276 | -30.2235 | |
| 19/10/ 2018 04:34 | 19/10/ 2018 05:27 | CTD | CTD046 | 49 | 174 | -29.1276 | -30.2235 | -29.1276 | -30.2235 | |
| 19/10/ 2018 12:56 | 19/10/ 2018 13:35 | OPTICS RIG | OPTICS 023 | 50 | 175 | -30.0059 | -31.1497 | -30.0059 | -31.1497 | |
| 19/10/ 2018 13:00 | 19/10/ 2018 13:50 | CTD | CTD047 | 50 | 176 | -30.0059 | -31.1497 | -30.0059 | -31.1497 | |
| 19/10/ 2018 13:05 | 19/10/ 2018 13:30 | SODS FLOAT | SODS047 | 50 | 177 | -30.0059 | -31.1497 | -30.0059 | -31.1497 | |

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| 19/10/ 2018 13:15 | N/A | BALLOON | BALLOON 021 | 50 | 178 | -30.0059 | -31.1497 | N/A | N/A | |
| 19/10/ 2018 13:54 | N/A | SKY PAN | SKY008 | 50 | 179 | -30.0059 | -31.1497 | N/A | N/A | |
| 20/10/ 2018 04:39 | 20/10/ 2018 05:06 | BONGO NET | BONGO 025 | 51 | 180 | -31.6171 | -32.8809 | -31.6168 | -32.8855 | |
| 20/10/ 2018 04:40 | 20/10/ 2018 05:30 | CTD | CTD048 | 51 | 181 | -31.6185 | -32.8841 | -31.6135 | -32.8881 | |
| 20/10/ 2018 04:45 | 20/10/ 2018 04:52 | SODS FLOAT | SODS048 | 51 | 182 | -31.6184 | -32.8843 | -31.6180 | -32.8846 | |
| 20/10/ 2018 13:04 | 20/10/ 2018 14:41 | CTD | CTD049 | 52 | 183 | -32.3729 | -33.6742 | -32.3729 | -33.6741 | |
| 20/10/ 2018 13:09 | 20/10/ 2018 13:58 | OPTICS RIG | OPTICS 024 | 52 | 184 | -32.3729 | -33.6742 | -32.3729 | -33.6741 | |
| 20/10/ 2018 13:17 | 20/10/ 2018 13:45 | SODS FLOAT | SODS049 | 52 | 185 | -32.3729 | -33.6741 | -32.3729 | -33.6742 | |
| 20/10/ 2018 14:10 | N/A | BALLOON | BALLOON 022 | 52 | 186 | -32.4331 | -33.7360 | N/A | N/A | |
| 20/10/ 2018 15:08 | N/A | ARGO FLOAT | ARGO008 | 52 | 187 | -32.3770 | -33.6752 | N/A | N/A | SOCCOM Float No. 12881 |
| 21/10/ 2018 | 21/10/ 2018 | CTD | CTD050 | 53 | 188 | -33.8318 | -35.2691 | -33.8292 | -35.2665 | |

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|-------------------------|-------------------------|---------------|----------------|----|-----|----------|----------|----------|----------|-------------------------|
| 04:36 | 05:35 | | | | | | | | | |
| 21/10/ 2018 04:40 | 21/10/ 2018 05:05 | SODS FLOAT | SODS050 | 53 | 189 | -33.8316 | -35.2689 | -33.8306 | -35.2678 | |
| 21/10/ 2018 13:07 | 21/10/ 2018 14:37 | CTD | CTD051 | 54 | 190 | -34.5805 | -36.0915 | -34.5806 | -36.0914 | |
| 21/10/ 2018 13:09 | 21/10/ 2018 14:05 | OPTICS RIG | OPTICS 025 | 54 | 191 | -34.5805 | -36.0914 | -34.5806 | -36.0915 | |
| 21/10/ 2018 13:14 | 21/10/ 2018 13:37 | SODS FLOAT | SODS051 | 54 | 192 | -34.5805 | -36.0915 | -34.5806 | -36.0914 | |
| 21/10/ 2018 13:27 | N/A | BALLOON | BALLOON 023 | 54 | 193 | -34.5806 | -36.0914 | N/A | N/A | |
| 21/10/ 2018 14:45 | N/A | ARGO FLOAT | ARGO009 | 54 | 194 | -34.5813 | -36.0915 | N/A | N/A | Float No. 8064 |
| 21/10/ 2018 14:51 | N/A | ARGO FLOAT | ARGO010 | 54 | 195 | -34.5833 | -36.0918 | N/A | N/A | SOC COM Float no. 12700 |
| 22/10/ 2018 04:29 | 22/10/ 2018 05:00 | BONGO NET | BONGO 026 | 55 | 196 | -36.1677 | -37.8669 | -36.1665 | -37.8657 | |
| 22/10/ 2018 04:35 | 22/10/ 2018 04:56 | SODS FLOAT | SODS052 | 55 | 197 | -36.1676 | -37.8668 | -36.1667 | -37.8659 | |
| 22/10/ 2018 04:40 | 22/10/ 2018 05:30 | CTD | CTD052 | 55 | 198 | -36.1674 | -37.8666 | -36.1652 | -37.8646 | |
| 22/10/ | 22/10/ | CTD | CTD053 | 56 | 199 | -37.0121 | -38.8346 | -37.0121 | -38.8346 | |

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|-------------------------|-------------------------|---------------|----------------|----|-----|----------|----------|----------|----------|--|
| 2018 13:10 | 2018 14:11 | | | | | | | | | |
| 22/10/ 2018 13:14 | 22/10/ 2018 13:54 | OPTICS RIG | OPTICS 026 | 56 | 200 | -37.0121 | -38.8346 | -37.0121 | -38.8346 | |
| 22/10/ 2018 13:16 | N/A | BALLOON | BALLOON 024 | 56 | 201 | -37.0121 | -38.8346 | N/A | N/A | |
| 22/10/ 2018 13:20 | 22/10/ 2018 13:45 | SODS FLOAT | SODS053 | 56 | 202 | -37.0121 | -38.8346 | -37.0121 | -38.8346 | |
| 22/10/ 2018 14:25 | N/A | ARGO FLOAT | ARGO011 | 56 | 203 | -37.0120 | -38.8349 | N/A | N/A | |
| 23/10/ 2018 04:28 | 23/10/ 2018 05:28 | CTD | CTD054 | 57 | 204 | -38.5841 | -40.6551 | -38.5838 | -40.6533 | |
| 23/10/ 2018 04:42 | 23/10/ 2018 05:02 | SODS FLOAT | SODS054 | 57 | 205 | -38.5840 | -40.6550 | -38.5839 | -40.6542 | |
| 23/10/ 2018 13:06 | 23/10/ 2018 14:41 | CTD | CTD055 | 58 | 206 | -39.2093 | -41.4750 | -39.2094 | -41.4750 | |
| 23/10/ 2018 13:18 | 23/10/ 2018 13:35 | SODS FLOAT | SODS055 | 58 | 207 | -39.2093 | -41.4750 | -39.2291 | -41.4954 | |
| 23/10/ 2018 13:39 | N/A | BALLOON | BALLOON 025 | 58 | 208 | -39.2094 | -41.4749 | N/A | N/A | |
| 23/10/ 2018 14:56 | N/A | ARGO FLOAT | ARGO012 | 58 | 209 | -39.2100 | -41.4750 | N/A | N/A | |

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|-------------------------|-------------------------|---------------|----------------|----|-----|----------|----------|----------|----------|-------------------------------------|
| 24/10/ 2018 04:36 | 24/10/ 2018 05:32 | CTD | CTD056 | 59 | 210 | -40.5210 | -43.0831 | -40.5184 | -43.0805 | |
| 24/10/ 2018 04:44 | 24/10/ 2018 05:01 | SODS FLOAT | SODS056 | 59 | 211 | -40.5209 | -43.0829 | -40.5205 | -43.0824 | |
| 24/10/ 2018 13:02 | 24/10/ 2018 14:45 | CTD | CTD057 | 59 | 212 | -41.3697 | -44.0127 | -41.3697 | -44.0127 | |
| 24/10/ 2018 13:10 | 24/10/ 2018 14:00 | OPTICS RIG | OPTICS 027 | 59 | 213 | -41.3697 | -44.0127 | -41.4358 | -44.0906 | |
| 24/10/ 2018 13:17 | 24/10/ 2018 13:40 | SODS FLOAT | SODS057 | 59 | 214 | -41.3697 | -44.0127 | -41.3697 | -44.0127 | |
| 24/10/ 2018 13:20 | N/A | BALLOON | BALLOON 026 | 59 | 215 | -41.3697 | -44.0127 | N/A | N/A | |
| 24/10/ 2018 14:52 | N/A | ARGO FLOAT | ARGO013 | 59 | 216 | -41.3704 | -44.0136 | N/A | N/A | SOCCOM float 12778 |
| 25/10/ 2018 05:34 | 25/10/ 2018 06:10 | BONGO NET | BONGO 027 | 61 | 217 | -43.0060 | -45.9817 | -43.0040 | -45.9826 | Ships time back 1 hour to GMT -1 |
| 25/10/ 2018 05:37 | 25/10/ 2018 06:33 | CTD | CTD058 | 61 | 218 | -43.0060 | -45.9817 | -43.0023 | -45.9838 | |
| 25/10/ 2018 05:38 | 25/10/ 2018 06:01 | SODS FLOAT | SODS058 | 61 | 219 | -43.0059 | -45.9817 | -43.0045 | -45.9822 | |
| 25/10/ 2018 | 25/10/ 2018 | CTD | CTD059 | 62 | 220 | -43.7905 | -46.9552 | -43.7905 | -46.9552 | |

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|-------------------------|-------------------------|---------------|----------------|----|-----|----------|----------|----------|----------|---------------------------|
| 14:05 | 14:53 | | | | | | | | | |
| 25/10/ 2018 14:08 | 25/10/ 2018 14:47 | OPTICS RIG | OPTICS 028 | 62 | 221 | -43.7905 | -46.9552 | -43.7905 | -46.9552 | |
| 25/10/ 2018 14:12 | 25/10/ 2018 14:35 | SODS FLOAT | SODS059 | 62 | 222 | -43.7905 | -46.9552 | -43.7905 | -46.9552 | |
| 25/10/ 2018 14:24 | N/A | BALLOON | BALLOON 027 | 63 | 223 | -43.7905 | -46.9552 | N/A | N/A | |
| 26/10/ 2018 05:31 | 26/10/ 2018 06:01 | BONGO NET | BONGO 028 | 63 | 224 | -45.2976 | -48.8965 | -45.2973 | -48.8955 | |
| 26/10/ 2018 05:34 | 26/10/ 2018 05:58 | SODS FLOAT | SODS060 | 63 | 225 | -45.2976 | -48.8965 | -45.2973 | -48.8957 | |
| 26/10/ 2018 05:35 | 26/10/ 2018 06:23 | CTD | CTD060 | 63 | 226 | -45.2976 | -48.8965 | -45.2971 | -48.8947 | |
| 26/10/ 2018 14:07 | 26/10/ 2018 15:04 | CTD | CTD061 | 64 | 227 | -46.0176 | -49.8723 | -46.0175 | -49.8723 | |
| 26/10/ 2018 14:10 | 26/10/ 2018 14:49 | OPTICS RIG | OPTICS 029 | 64 | 228 | -46.0176 | -49.8723 | -46.0175 | -49.8723 | |
| 26/10/ 2018 14:15 | 26/10/ 2018 14:36 | SODS FLOAT | SODS061 | 64 | 229 | -46.0176 | -49.8723 | -46.0176 | -49.8723 | |
| 26/10/ 2018 14:37 | N/A | BALLOON | BALLOON 028 | 64 | 230 | -46.0176 | -49.8723 | N/A | N/A | |
| 27/10/ | 27/10/ | BONGO | BONGO | 65 | 231 | -47.5618 | -51.7740 | -47.5656 | -51.7741 | Ships time back 1 hour to |

| | | | | | | | | | | |
|-------------------------|-------------------------|---------------|---------------|----|-----|----------|----------|----------|----------|--------|
| 2018 06:34 | 2018 07:02 | NET | 029 | | | | | | | GMT -2 |
| 27/10/ 2018 06:35 | 27/10/ 2018 07:25 | CTD | CTD062 | 65 | 232 | -47.5618 | -51.7740 | -47.5691 | -51.7723 | |
| 27/10/ 2018 06:37 | 27/10/ 2018 06:58 | SODS FLOAT | SODS062 | 65 | 233 | -47.5618 | -51.7739 | -47.5648 | -51.7740 | |
| 27/10/ 2018 15:02 | 27/10/ 2018 15:50 | CTD | CTD063 | 66 | 234 | -48.1989 | -52.6894 | -48.1986 | -52.6942 | |
| 27/10/ 2018 15:06 | 27/10/ 2018 15:44 | OPTICS RIG | OPTICS 030 | 66 | 235 | -48.1989 | -52.6894 | -48.1986 | -52.6932 | |
| 27/10/ 2018 15:10 | 27/10/ 2018 15:38 | SODS FLOAT | SODS063 | 66 | 236 | -48.1989 | -52.6893 | -48.1987 | -52.6922 | |
| 27/10/ 2018 15:42 | N/A | SKY PAN | SKY009 | 66 | 237 | -48.1987 | -52.6928 | N/A | N/A | |

Appendix 3: Chief Scientist's Notes

20 September – Travel to Harwich

Depart PML 0645. 2 vehicles. Vehicle 1 – Me Bob, Andreia Tracana, Afonso Ferreira; vehicle 2 – Becca, Malcolm, Giorgio, Wade De Kock. Also met up with Natalia Llopis Monferrer and Aude Leynaert from UBO in the PML car park. Natalia and Aude followed my vehicle. They had a Renault Kangoo. Travelled A38, M5, M5, M25, off at J28 onto A12 at Brentwood, A120.

Arrived 1345.

No containers onboard because port cranes won't operate above 25 knots. No chems onboard either.

Only gear loaded by end of day – UBO and UEA.

Organised for PML container to be brought alongside on 21st and unstuffed on dockside. Use ship's crane to load gear onto ship.

Evening – Train into Harwich Town. There's a train in the dock because of Harwich International ferry terminal. 2 stops, 4-5 mins into town.

21 September

Alyse, Jenna and Ian Murdoch arrived

Fran Pitt dropped off gear.

There was an electrical blackout at approx. 0745. Power restored at 0810.

Today – Meeting of BAS, NMFOps and Harwich Port to discuss future of using Harwich as the mob port for the SDA.

Unloaded Orchestra/Andrex II boxes from the PML container (on the dockside) to the explosives locker. Operation ended 0950. Decision was then made to bring the PML container onboard and unstuff. To achieve this, needed to raise gangway to allow the port's massive crane on rails to do the job. In addition to the PML container, the 2 RN containers were also loaded. Finished around 1130. PML container unloading then commenced unstuffing. Stopped for lunch at 1200 and then finished unloading between 1230 – 1300.

Informed by the captain – shipside still had a lot to load on 22nd. Would have to work an 0800 – 2000 shift. Hoped to leave Harwich at 1000 on 23rd.

Mid-afternoon –Discovered the new 20L Niskin bottles were not ready to use i.e. no lanyards/snap hooks.

Also, issues with 2 PSTs: 1 simply not here, 1 is a photocopy. Captain looking into the source of photocopy as the scientist has said that is all they were issued with by the company. Missing PST – FedEx original from the USA to arrive in Portsmouth on Monday where we will pick up bunkers and AVCAT fuel.

22 September, Saturday

Up at 0550 – Emptied cabin boxes. UIC – rapidly emptied boxes and stowed gear before anyone else around. Got fixing bits for FCMs, MIll and fridge ready for Becca and Wade to deal with. When they arrived, they were helped by Afonso. I taught them how to fix things down.

During the course of the day – finished FCMs, MIII and fridge. Turned B0264 transformer on (Wade's).

Routed pH system waste line from pH system , along bench to knee-hole under the Autosol for Andreia, plus, provided a waste drum.

Set up Arwen with peristaltic pump, adjusted tubing etc. so Sterivex would be in sink. Too short to begin with. If the Sterivex had come off the tube it would have flooded the bench.

Helped Afonso secure dust collector on monkey island.

Put waste containers in the hold for easier access. Hold basically empty in comparison to previous years.

Sorted out locations for gas cylinders (AMT and Andrex 2). Charel's - outside the UIC in the gallery. 2 large and 1 smaller.

3 x CO2 standards, Ian's, Boat deck, stbd side.

5 x helium cylinders on Bridge deck for weather balloons

Sorted container for empty boxes and accessible gear, particularly Hans and Millie.

Made sure Alyse and Jenna OK. Alyse gave me UCI Anteater college team insulated mug and socks.

All JR18001 chems are OK, except John Ballard's box with a Class, 5, 6 and 8; all tiny amounts – Were air freighted, so OK for IATA?

Things to do before sailing:

Tidy last few things in lab

Print AFC log sheets

Cruise intro presentation – scientists, AME, IT, lab manager – Time - Sunday 1600?

- Discuss water budget, especially predawn, Underway – on all the time to minimise flow fluctuations, Issues so far?, changes to scientists' original science plans, meal times at sea – same as in port (0730, 1200, 1800)

Cruise intro presentation - crew

See Aisling – lab induction – format and time.

115V supply from main lab – circuits tripped

Check water budgets

23 September – cruise departure

0900 – safety briefing. Scientists = SPP = special purpose personnel, hours of rest, cabin/lab inspections – Sunday mornings.

NOTE – NO VSAT communication – everything has been checked, so hope all will work when we leave Harwich. Other ships have experienced the same problem.

Went through donning of immersion suits. Several people put them on.

Cruise photos – put on shared drive

1300 – Muster and drill

1330 – Lab management intro

1700 – Science meeting

Ask for chairs to be moved out of UIC.

HORRIBLE weather – cast off 1042

Note –luggage locker for large cases – f's'cstle deck opposite to saloon entrance

1340 – Lab induction presentation in the bar.

Accidents and near misses – no blame culture. Labelling for chem lockers and in labs

Aisling proposed using a colour coding system. I proposed using the GHS symbols – I have a set of stickers.

Lone working e.g. Natalia – set up plan with the PSO

Haz waste – Aisling proposed a consignment workshop to train people.

Waste – into UN-approved containers

Lab coats – to be worn at all times, regardless of temperature. Includes officers on their rounds. Temperature will be monitored.

Had to sign documents saying we'd read our own H and S documentation.

Went and saw ETO re. Alyse's power issue. Her voltage regulator was tripping the 240V circuit.

He told me that the 115V circuit breakers had a message on them saying, "Do not use". Doug went away and found the chief engineer who said that the message tags had probably been left on after refit because they were not being used. The ETO then turned on the circuits and tested them with an AVO meter – All OK. Ran an extension lead from the main lab., through a gland and around the trunking in the wet lab to the kit on the bench under the window.

Science meeting 1700.

Igor – zooplankton metabolism. On A28 will be focussing on bacterial respiration/production + DOM.

BAS IT. David Hunter – first cruise. Sean Vincent – second cruise.

Alyse and Jenna – bacteria metagenomics

John Ballard – Question – When to do nutrient measurements? He will combine 2 CTDs into a single run. Natalia wants nitrate results 2-3h after CTD. Therefore run samples after predawn CTD.

Arwen – told everyone about data processing from CTD and underway.

People using the underway

Alyse/Jenna, HPLC, salinity, Giorgio and Bob.

Work/shared drive for the cruise – Legwork and Legdata. Also a media drive.

Note: Main anemometer doesn't work at the moment. Fred has one installed and Tom/Ming (PML, not onboard) have one installed for underway atmospheric sampling.

The NavMET system – <http://www> – JCR homepage, select NavMET near bottom of page.

Water requirements

Andreia – 125 m – go to 150 m. surface essential. 5 depths total predawn and noon – surface, base of ML where chl just increasing, DCM, mid-way along lower side of chl peak, just below chl peak.

Allyse – spread of 5 depths. Select from surface, 20, 50, DCM, DCM+10, 150 predawn and noon

Fran – the dregs in the NAG above 50 m. Noon CTD OK, therefore can have whole bottles.

UEA – predawn only, approx. ½ volume available on the CTD rosette. O₂ and DOM – different bottles.

DNA/Sterivex – predawn and noon.

NOTE: Find light table

Arrange meeting with bridge team

Passage – ETA Tuesday noon and Wed 0430 – Territorial waters issue? – No

When first clock change?

Frequency of drills?

Make sure FCMs running

Chat with Carol about taking on the predawn CTD so I can train Igor/Natalia to use the bongo net.

Plan for officers and crew.

Water table for Tuesday

Put GHS stickers up in the UIC

Rejig water budget. Check last year's first couple of casts to gauge water column depth.

Hours of rest – Purser placing current month on shared drive?

Distribute science plans to crew

Construct bongo net

Distribute PML mugs to crew

24 September – Portsmouth – Sunny

Informed original PST had arrived at purser's house so scientist was fine to sail.

Photocopy PST – Captain satisfied it is genuine. Scientist fine to sail.

Natalia – lab chair.

Alyse and Jenna – not enough 1mL tips for original science plans. Have obtained some tips from Natalia but have decided to scale back operations on the CTD to 2 depths – surface and 50 m at predawn and noon stations.

AVCAT/bunkers – Barge (Teesdale) only operating at 100 cubes per hour. Hopefully finish 1830 and sail 1930.

Distributed science skeleton and initial science schedule to bridge, Mackem (Cliff) and crew bar.

Concentrating cruise info in the UIC on the side of the server cabinet.

Set Cecilia up with reverse filtration gear and gave her a lesson.

Found Lugol's dispenser in one of Wade's drawers

We left Portsmouth this evening about 19:20 and hope to have our first station tomorrow around 13:00.

25 September. Sunny and calm

To Do:

Check with Sean – CTD bottles ready?

Confirm time for CTD and distribute.

Crew presentation – Check time and place with Cliff

Make net – 1 x 200 μm , 1 x 120 μm . Igor, glue 63 μm mesh in one cod end.

Wrap birthday present, distribute 5 x cards (inc. group cards)

Hours of rest – check with purser

Bob's Temperature float (SOFD, SOD) – RA to captain and 1st officer.

Optics rig and sun position relative to ship at noon station

Silvia Pardo – EO email.

2nd bit of tubing for Cecilia

See purser – birthday cake

Deck incubators – See Rob (DeckEng)

Overside equipment deployment meeting, aft deck 1100

Build incubators

0730 – Directly south of Newton Ferrers. ETA at E1 0845

Wet lab, left sink – Possible to get a piece of matting in the bottom to stop empty plastic bottles from floating around? Possible to shorten tubing on underway outlet to between 5 and 10"? – Yes

Funnel – Arwen, for salinometer waste collection.

Crew presentation 1430 – Bar

Purser– list of bond items

After lunch – load test CTD wire.

1300 - Test CTD. 10 depths. 5, 8, 12, 17, 22, 30, 50, 60, 70, 80. 12 m = DCM. Water column 87 m

Everyone treated it as a guaranteed serious CTD. Water was tight.

Bottles 7 and 19 – bottoms not closed because too close to the central frame. Bottles 14 and 23 leaked. 8 was a misfire.

Also deployed the optics rig to check the convoluted route around the RN container – All OK

Also deployed the temperature float (SOD).

Alyse/Jenna working pattern – Alyse 1500 – 1800 and 0300 – 1200, Jenna 1200-1500 and 1800-0300.

Discussed Natalia's lone working in container. Approx 0500 – 1600. Doing microscopy so will need regular breaks. Plenty of other people around during the day. Also said I would look in on her.

26 September

Deck incubators – Set up with Ian and Rob

Noon CTD sheet

Laptop – to CTD

Notice – location of CTD data on shared drive – Legwork/data_management

Talked with captain. He reckoned current ETA in Falklands – 0500 30 October. Also told me location of weather info. Media drive/jcr/0weather/PassageWeather

Hours of rest notice – location on shared drive

Logs – Bongo, Progress

Fred – no weather balloon today. Gavin had underestimated the number of balloons he thought he'd packed. Not enough for every day. Only 28 instead of 40. Fred had found a couple in the BAS balloon box but still not quite enough.

Check event log for time on station

Issue with prop motors – don't know what is causing them to stop. Assessing.

Post 6x science schedules. Bridge, bar, Mackem, UIC, Main/wet lab door, duty mess door

CTD03 – Sunny, choppy. DCM 25-46 m, DCM1 – 30 m. 02 max 0-25 m, surf. Flor 0.39, salinity 35.59, ML 49 m.

Predawn net - trained Igor and Natalia in the ways of the AMT bongo deployments. Igor's done plenty before, so that's good. We were only in 148 m of water, so I wouldn't normally have done a net. Now I know why. Full of salps. I've used 3 sample pots already. Things are beginning to slot into place now as the number of 'start of cruise' tasks diminishes. Got the deck incubators up and running this morning with Ian Murdoch and the deck eng., Rob.

Email to Andy Rees, PML - Graham's (Captain) current calculation for getting to Stanley (minus SAG mooring turnaround) at 10 knots and 4 h sampling per day is 05:00 on 30 October. If we keep shaving off the odd hour here and there, we should be OK to do the deeper casts when we deploy the SOCCOM floats. Lunchtime CTD was a breeze. People only need just over 100 L of water. Looks like I'll be growing a beard. I've definitely forgotten my razor's charge lead. Doh. There will be more hair on my chin than on the top of my head by the end.

Carol's in charge again tomorrow at the predawn whilst I let Igor and Natalia show me how they do the net.

CTD bottles - a couple won't close as they catch on the frame. Turns out the new bottles are slightly different in that their mounting apparatus is slightly higher up on the bottle, meaning that the bottle sits lower on the frame. We are using the BAS frame, which has been properly straightened and has had about 2.5 inches added to its height. Ian Murdoch reckons the NMF frame will have the same problem. Our current solution is to add an additional plastic ring, which holds up the central carousel and bottle mounting ring to increase the height of everything so it should clear the frame. The extra ring is part of the spares inventory. If this works, we won't have to use 2 x 12 L bottles on the rosette, which is a pain for the predawn cast. Email end.

Plan for 27th – After predawn CTD Sean and Ian will take all bottles off the CTD. At 0800 the ship will stop. The central section of the CTD will be unbolted and the and the 10T crane will lift the central section out. An additional/spare white plastic ring will be placed on top of the existing plastic ring which separates the carousel/bottle holding apparatus from the rest of the frame and the CTD put back together again. This will enable the Niskin bottles to sit higher on the frame and hopefully stop the bottoms of bottles 7 and 19 from getting fouled on the frame.

27 September

Cloudy here today. Here being 45 degs 23 N, 13 degs 16 W.

Carol running predawn CTD – Print off light table.

2 birthdays. Alyse is 30, David Hunter (BAS IT) is 25.

Start Bongo log, CTD log/summary, Progress log.

Check event log board.

Make a waste log – Aisling

CTD – Noted bottles 4 and 5 leak once the vent is opened. Question – Rubber connecting end caps a bit slack? Mentioned to Sean

Predawn CTD future – Have passed the predawn CTD baton to Carol. I will do the net with Igor

John – wants 10L from 500m at noon CTD for nuts.

0815 – Added ring to CTD. Bottles raised by 10-12 mm. Lower end caps of bottles 7 and 19 are now clear of the angled part of the frame.

Underway system – started 0800 25/9/18. Giorgio's underway system started approx. 2100 25/9/18. Wasn't on before this due to issues with wires/cables/non-connectivity. Miscommunication between different people in the optics group as to what was required.

Rob has a log of underway system events and can provide at the end of the cruise.

Radiometry (Bob) – HyperSAS running since Harwich.

Noon CTD (005) – At same latitude as Bordeaux

Note: Adding the white plastic ring to the CTD worked.

Email to Andy Rees, PML - Today is a double birthday. Alyse from University of California, Irvine turns 30 and David Hunter, BAS IT is 25. Massive sponge cakes covered in cream at dinner. Very tasty.

The ship's underway was switched on the morning after we left Portsmouth. To be precise; 0800 (BST) on Tuesday 25 September.

Bob's HyperSAS has been running since Harwich

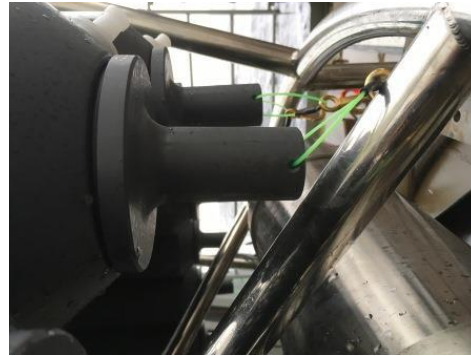
Giorgio's underway has been running since about 2100 (BST) on 25 September. There were various cabling issues that needed sorting

Aisling will be Fred's balloon launching buddy and she was at the CTD yesterday with Alyse/Jenna's bottles.

Have hopefully sorted the problem with 2 bottles getting fouled on the CTD frame and not closing at the bottom. All the bottles were taken off, the middle of the CTD raised with the CTD gantry and an additional plastic ring inserted to increase the height of the carousel and bottle mounting ring by 10-12 mm. The bottles are now clear of the angled bit of the frame that runs from the centre out to the frame edge.

Just a few random shots. There's a shot of Wade at the CTD, one of Wade, Andreia and Afonso. One of Alyse sampling at the CTD today on her birthday. Then there are a couple of pics relating to raising the centre of the CTD frame to add an extra white plastic ring under the bottle attachment ring to raise the bottles up by 10-12 mm, so the bottles don't get fouled on the frame - This was done after breakfast and tested at the noon CTD - It worked





Email end

28 September - Cloudy

Hours of rest notice tomorrow

Salinometer – Potential issue. Arwen has done a couple of samples and thinks the results aren't right. She will run some standard seawater and check. If there is a problem there is a spare salinometer in the hold.

Noon CTD – At the same latitude as the northern Portugal/Spain border.

John – using this CTD as a dark cast for his FLBB (fluorescence and backscatter meter). I.e. the sensor window has a piece of insulation tape stuck over it.

I was asked by the captain when to retard the clocks. I checked my old notebook from last year. We retarded the clocks when we left the Azores. Do the same this year.

At 1800 the captain came to see me with a faxed document in Portuguese. Turned out to be DipClear for Portuguese waters. Afonso translated it with me and the captain got someone at BAS to do the same. For now the captain just needs to file our noon position each day with 2 Portuguese authorities. Need to send cruise report and data link (BODC) within 6 months

Want photos of all the crew.

Email to Andy Rees, PML - Cloudy here. Currently at approx. 42.5 N, 15.5 W. Doing just over 10 knots. 6 CTDs under our belts now. This morning's was the first with no misfires. The bottles are hopefully bedding in. Carol is happy to continue running the predawn CTD, so I'm netting with Igor.

Bob's 'child's toy' is entered into the event log as the SOD; surface oceanographic device. Bob's original name for it was surface floating oceanographic device, but the F seems to have got dropped off.

Having issues with the PCO₂ system but Aisling is in contact with Ian. I took a look last night but couldn't see anything. I suggested she took pictures and sent them to Ian, which she did. Currently one alarm won't go away - Water in reservoir. Ian is aware.

Noon CTD – At the same latitude as the border between northern Portugal and Spain.

Early evening – Informed by the captain that we have received diplomatic clearance for working in Portuguese waters as we transit between the Azores and Madeira.

29 September – Cloudy (Saturday)

Clocks back 1 hour tonight

Hours of rest notice

Inspection notice for tomorrow. Labs/cabins

Photo of event log board

Crew photos –Carol will do.

Email from Carol – Possible to have O rings handy near the CTD? She had pushed a Niskin tap all the way in. I showed her what had happened and how to prevent it happening in future i.e be careful when putting tubing on the tap so that it doesn't cover the O ring. If this happens, the O ring is pulled off and the tap will then become unseated.

She also enquired if it was possible to open the outside door from the wet lab as Chata had been unable to open it. I showed them how to open it.

Emailed Vas – pH system issues. See email to Andy below.

Notice -20 °C chems

Print cabin list

Carol – requested 0400 call if she wasn't already up

Noon CTD – At least 12 bottles started leaking from the bottom cap once the vent had been opened. Asked Sean to tighten the rubber tubing attached to the caps.

Email to Andy Rees, PML All well. 8 CTDs, 4 nets, 4 optics rigs, 2 weather balloons and 8 temperature float/child's toy/SOD deployments under our belts now. Currently taking about 3 hours a day to go from full speed to stationary, to doing stations and then back to full speed, so I'm looking at doing a deep CTD to 4000 metres in the NAG in about 5 day's time for the Claire Evans group. Should take about 3 hours, all being well.

Had a couple of issues with the new pH system. One was Blue Tac related (The flow cell was fixed in place with Blue Tac and had worked loose. Added some new.), the other was fixed with blue tac (circlip holding the main lamp in place had disengaged and was not doing a good job so the lamp was firmly stuck in place with a generous amount of Blue Tac)

30 September

We are now on GMT. The clocks were retarded one hour last night. I don't think anyone was caught out by it, which may be a first.

NavMet system – Very unreliable. Keeps freezing.

Deep CTD for DOM – Hans/Millie. Ideal position would be 30°N, 25°W. Ask Dom (2nd Mate) for updated ETA at WP17 – 26° 46' N, 25° 15' W AND check depth. Checked AMT23 stations as the track was similar and all stations between 31.3N, 22.67 W and 24.22 N, 26.26 W were >5000 m.

Painting notice

Note – Underway system in UIC, chlorophyll is reading 4 µg L⁻¹. Pattern looks OK. Calibration issue? Check with Sean.

Arwen is now happy that the salinometer is working properly

01 October (Monday) Raining, lightning during the night

Natalia – note about sampling requirements

David – Note about Navmet system resetting – He will be getting it to reset automatically every hour, 5 minutes before the hour so it will be less likely to freeze.

Crossing the Line list

Ian – sending email to Paul Provost re. the fact that the max depth we can reach with the CTD wire is 4200 m – Is this deep enough to test the acoustic releases for the mooring?

Ian – problem with Hans/Millie's RN container's air-con. Keeps on tripping as soon as it starts because it is too hot.

Email Fran – Storage of full carboys in wet lab, rather than cool spec room, transport of carboys back to UK.

Email to Andy Rees, PML. Still cloudy here. Plenty of lightning and rain last night. Showery this morning. Planning to do 4000m CTD Tuesday morning at 1045. 12 CTDs, 12 SODs, 6 Bongos, 4 weather balloons and 6 optics rigs so far. All going well. We've now had 2 Beer O'clocks at 1730 on the starboard side between the CTD and the winch cab. Cloudy but over 20 C, so pleasant. Having forgotten my razor charger, I'm now sporting the beginnings of my fourth ever beard.

Just finished the list for crossing the line and there are 16 scientists and techs who haven't crossed the equator before. Let the planning for the fun commence.

Giorgio came to see me about the possibility of recovering 1-2 floats with non-working sensors, originally deployed on AMT24, which are currently very close to our track. If we can make it, it will be in about a week's time. Not sure best way to recover it/them. Rescue boat? Email end

02 October – Clear, sunny, sea - glassy

Transmittance and chl on underway plugged in the wrong way round since cruise beginning. OK now. Told Arwen

Georgina asked if it would be OK to make CTD wire thickness measurements at bottle firing depths during the deep CTD – Fine.

Had a chat with Ian. Air-con in RN container is fixed. Paul Provost says 4200 m to test the acoustic release is fine.

Noon station, deep CTD to 4000 m – Fred is going to launch a tethered weather balloon to approx.. 100m with a camera on, take pics, bring back down and then launch the balloon as normal, with a radiosonde on it. captain said OK as windspeed at only 1 knot.

Swimming pool put up on aft deck.

Late afternoon – recovered life ring from MV Sana of Valetta (crude oil tanker). Later found out the ship was operating off the east coast of the USA, so life ring must have just have been lost.

Email to Andy Rees, PML. Begins with: Email from BAS: - received before breakfast.

Morning Graham and Glen,

I would like to enquire of you both if it would be possible to get in a day earlier than currently planned? If you ran at higher speeds between stations Graham would this be possible? and Glen would you still be able to accomplish your science objectives?

We need to have a bit more time for the DASH to get the cargo from the JCR to Rothera.

Best Randy

I'm pretty relaxed about it. The increased speed, particularly as the request has come relatively early, isn't too bad.

We hit the jackpot today. 1045 CTD to 4000 m. On deck 40 minutes ago. Our first truly glorious day. Sun, glassy deep blue ocean, wind speed 1-2 knots. Fred said the steel on the deck on the monkey island was up to 60 C. CTD went well (2 h 50 mins) and now we are trundling along at just below 11 knots. The increase in speed might mean a couple fewer stations, but if we are still able to work until the 27th, that's still another 50 stations and we've racked up 15 already, so we will still be fine in terms of total stations. Yes, I know, don't count your chickens, but at the moment we are still in a healthy position. Fred launched a weather balloon at the noon station with a 100 m tether and a video camera attached to it to take aerial footage above the ship. Lots of spinning footage but Fred hopes to get some reasonable still shots of the ship.

We now have a pool in the aft deck, 8 feet diameter. Big enough for 7-8 people to cool down when the sun's beating down.

Late afternoon. A life ring from the MV Sana of Valetta was recovered from the sea. It later turned out the vessel was operating happily off the coast of the USA, so the life ring must have been accidentally lost overboard. Email ends

3 October

Talked to Bob about the underway system's chl and transmittance being plugged in the wrong way round until 1920 on 1/10/18. He said he and Giorgio had an underway system that measured absorbance at 656 nm and compared it to zero (filtered seawater) at <1 minute intervals (binned to 1 min intervals) that provided [chl] estimates to within 10% of HPLC. Could actually be more accurate because there was no sample manipulation.

MOB drill for crew at 1030. Ship slowed and turned. MOB boat was deployed. Drill ended approx. 1115.

Approx. 1200 – Oil spill on aft deck, starboard quarter. Bio oil in the airgun boom leaked on the deck (4-5 L) during routine maintenance. Deck hosed down and oil tank refilled.

Metering block for the optics rig Kevlar rope not working. Probably batteries out of power (12V). Sean investigating.

Chata came to see me to let me know the CT lab temperature had increased from 4 to 9°C. Checked shortly afterwards and temperature was back at 4°C. It had probably been on a defrost cycle. Chata said she had heard a noise like falling ice.

Email to Andy Rees, PML. This morning was absolutely flat calm and starry – NO wind.

Mid-morning, the crew performed a man overboard drill. This involved slowing and turning the ship through 180 degrees and then launching the rescue boat. Pic attached.



First flying fish sighted this afternoon.

Evening BBQ to celebrate Tom the steward's birthday on the after deck Email ends

4 October – Starry, a few clouds

First predawn CTD with squid and flying fish. Flying fish also seen yesterday.

0800 – More clouds, still plenty of blue sky.

Air-con in Hans/Millie's container not working. Turned off last night during the BBQ due to smoke. Air temperature hot this morning. Air-con kept tripping out as soon as it was started. Went and got the portable air-con unit from the gym to try and cool the anteroom with the air-con unit in it. Also went

and got both of my fans to create better circulation AND a large bucket of ice to lower air flowing onto air-con unit. Once temperature went below 26°C the unit started and kept going. For the future – Keep the air-con on all the time. If/when there is another BBQ Hans/Millie will either organise work so they are not in the container or the BBQ will move to the f'c'stle.

Recovery of one of Giorgio's floats looking promising. It is only 40-50 miles off our intended track. The second float is over 350 miles off-track, so we will focus just on the nearest one. Cliff, the science bosun, says there is a cradle on board for recovering gliders, which would be ideal. Current ETA at the last known position of the float, 18:00 on 7 October.

5 October – Starry, a few clouds

Natalia has asked for both microscopes to be moved out of the RN container due to vibration issues. Have agreed with Sean Vincent to move Natalia's microscopes from her RN container up to the computer room, just in on the left.

After predawn station – noticed we were only doing 1.5 – 2 knots. Moving at 12 knots again by 0645. The captain came to see me at 0800. Definitely prop motor issues. Ship stationary a couple of times. Might have to make a decision about going into Cabo Verde.

Had a chat with the 1st officer re. chems. Still outstanding issues. Not just with our cruise but subsequent cruises too. One problem is that she is not working with the final version of the PML manifest. Another problem is that she has simply been overloaded. She is only about half way through the complete DG manifest for the ship.

John – Says there is a potential issue with bottle 4 – It's had lower nutrients than expected at several stations (compared to bottles either side), especially PO₄ and NO₃. Will fire bottles 4 and 5 at the same depth at the noon CTD. Let Sean know.

Alyse said she and Jenna had finished sampling for Fran.

Note: Alyse and Jenna filter approx. ½ a tonne of water a day.

6 October

Phosphorescence, squid and flying fish at the net station near the bow of the ship.

Prop motor issues a couple of times during the morning. Approx 1040, prop motors cut out. All was reset and we were underway again after about 10 mins. The captain told me that, yesterday they could only manage 800 kW of power, which is not enough, particularly if there is any heavy weather. They are still waiting for a response from the manufacturers about the main fault encountered. Seriously considering options wrt pulling into Cabo Verde. Motors cut out again at 1120

7 October

Prop motors a major issue during the night. Stationary for approx. 1.5 hours. Engineers and ETO working hard on the problem. Talked with captain about possible float recovery. On the edge of feasibility. ETA currently 19:30-19:45 today.

Noon station time reduced to 40 mins, ship speed all afternoon 13.5 knots. Got to float site approx. 19:20; float sighted approx. 19:30; float recovered at dusk. See 8 October entry sent to Andy Rees for a summary of the weekend and details of the float recovery.

Aisling came and found me and asked if I would be happy for her to contact BAS Cambridge to ask if the lab coat policy could be relaxed because of the high temperatures in the labs.

08 October – Monday Stars and clouds predawn. 0915 onwards, rain

Should arrive Falklands 3 weeks today

Steaming at 10 knots. Much cooler with clouds and rain. Noon station – Raining hard.

NOC group RN container leaking through the main door.....again, now it's raining. Ian showed me a video of water coming in through the door seal. Solution – needs some kind of gutter above the door

Email to Andy Rees, PML.

It's been an interesting weekend out on the briney.

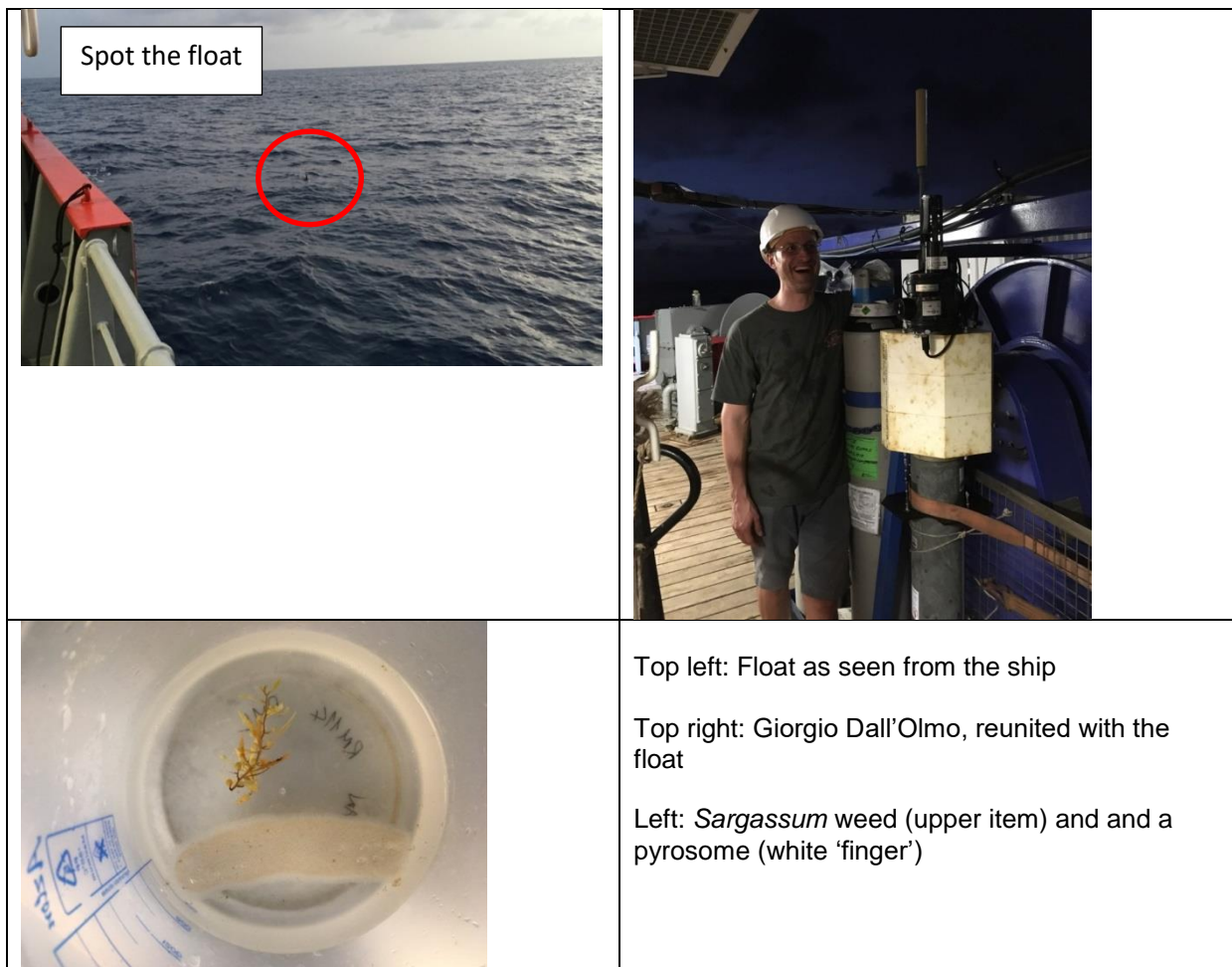
Saturday and into Sunday morning we had serious issues with prop motors failing. When this happened the ship would basically come to a standstill. I think the worst period was early Sunday morning before the station. The ship was stationary for about 1.5 hours whilst the engineers did everything they could to remedy the situation. There were serious considerations about whether we could safely continue or whether we would have to call in to Cabo Verde to resolve the issue as it was the closest and last port of call before venturing out into the south Atlantic. I am pleased to say that, for the moment at any rate, we are continuing on our way and we have now had no obvious problem for 24 h.

The great success of the weekend has been the recovery of a BGC float deployed by Giorgio on AMT 24, on 10 October 2014. Giorgio had been to see me a few days before to tell me there were 2 floats really close to our intended track that had failed sensors on them, which had been measuring backscatter, fluorescence and irradiance. So, the question was, could we recover one/both of them? One of them was several 100 miles off our track so that was unlikely, but the other was probably only 40-50 miles off track, slightly to the east of our planned track. I had a chat with the captain, he did the sums in terms of time available and likely time of arrival in the vicinity of the float (estimated at about 18:00 on the 7th Oct) and decided that it was worth a try. That was before the latest issues with the prop motors (ongoing for over a week), which ate into the ETA. We got the predawn station done yesterday morning, redid the timings and it was really touch and go as the ETA was between 1930 and 1945, with sundown being 1935. I decided to shorten the noon CTD station. We only went to 300 m with the CTD, only sampled 10 depths and only fired 16 bottles, meaning the CTD only took 36 mins. How many onlys? The optics rig took about the same time. That tipped the balance, as far as the captain was concerned and we steamed at 13 knots towards the float with an ETA of 1915 - 1930.

The float had been ordered to go into "End of Life" mode, whereby it comes to the surface and periodically sends out its position AND says "Help". During the afternoon it sent its position every hour, which was received by Giorgio via email. At 1640 the frequency of position updates was increased to every 10 mins. The float had been travelling SSE with the equatorial counter current at up to 0.8 knots but as we got closer it started swinging west. After dinner I found Giorgio up on the bridge with his laptop, relaying the floats position to the captain. An added complication was a container ship travelling SE which looked like it might be on a collision course with the float but eventually passed to the south of it. There were teams of people looking out on the bow and on the bridge and a further recovery team on the starboard side with a glider recovery cradle with long strops attached to the 10T crane and a long pole with wire lasso. The float was actually sighted at approx. 1930, which was no mean feat, given that very little of it was above the surface. We were really lucky with the sea state. The captain manoeuvred the ship so the float came down the starboard side about 20 feet from the ship's side. We couldn't quite get it with the cradle but we were able to lasso it, tighten the noose and then guide the float into the cradle. It was then craned on board and removed

from the cradle to a loud round of applause. The float looked in excellent shape but was definitely covered in a slimy biofilm. Giorgio took swabs from the main body and sensor windows, put them into vials and then added RNA-later for genetic analysis back at UCI. The only visible issue with the float was that one of the stainless steel rods connecting the buoyancy foam and the deployment ring had disintegrated. Another thing that Giorgio discovered was that, when he touched the antenna with his thumb and forefinger it unscrewed easily, so may already have been loose. I have included a picture of Giorgio beaming happily after being reunited with the float after 4 years (minus 3 days).

A great success and a massive team effort. A heartfelt thank you to all concerned. A really slick operation. Float recovery position: 8.8701° N, 26.9639° W at 19:54 GMT.



Overnight we have been travelling at a more sedate 10 knots. We are into *Sargassum* and Pyrosome territory now. We started seeing lots of *Sargassum* yesterday afternoon and there was masses of *Trichodesmium* in the nets yesterday morning. I have included a picture of a pyrosome from this morning's net and some *Sargassum* that got caught on the net's winch wire. The pyrosome was about 12 x 2.5 cm in size.

Raining hard at lunchtime. Much cooler (3 °C lower than previous days).

9 October – Starry, no clouds, sunny day

Crossing the Line Day

Saw Purser. Current plan for Stanley – 3rd officer arriving 25th Oct. Will be on ship as soon as we arrive. Fred share with me. All off ship 1500 on 31/10/18.

Email to Andy Rees, PML.

Crossing the Line ceremony today. 19 Pollywogs in total. Preparations are at fever pitch. Pretty certain the pollywogs are up to something. Mind you, if I was part of a group of 19 and there were only 10 police coming to find you all, I'd be preparing means of repelling borders as well.

Briefing for pollywogs: 1140

1315: Captain welcomes King Neptune, Queen Amphitrite and their entourage on board. Pollywogs go and hide. Police find them and bring them before the Court of King Neptune to answer charges relating to crimes committed prior to and whilst being on the ship. If found guilty (a done deal) sentence is then carried out. This is where a barrel of food slops and a ladle come in handy. Then it's get hosed down to get rid of the worst of the slops, have a shower, possibly have another shower and then back out on deck to have crossing the line certificates presented by the captain.



At the BBQ, Mackem mentioned how impressed he'd been with the complete team effort involved in recovering the float; from down in the bowels (maintaining 13.5 knots) to lookouts and steerage on the bridge.

10 October

Predawn station AT the equator. – Equator pics, get.

Time 06:22 GMT

Position: 0 degs N/S, 25 degs W. Predawn station at the equator

Heading 180

Speed 10.4 knots

Sea state 3-4

Sky starry

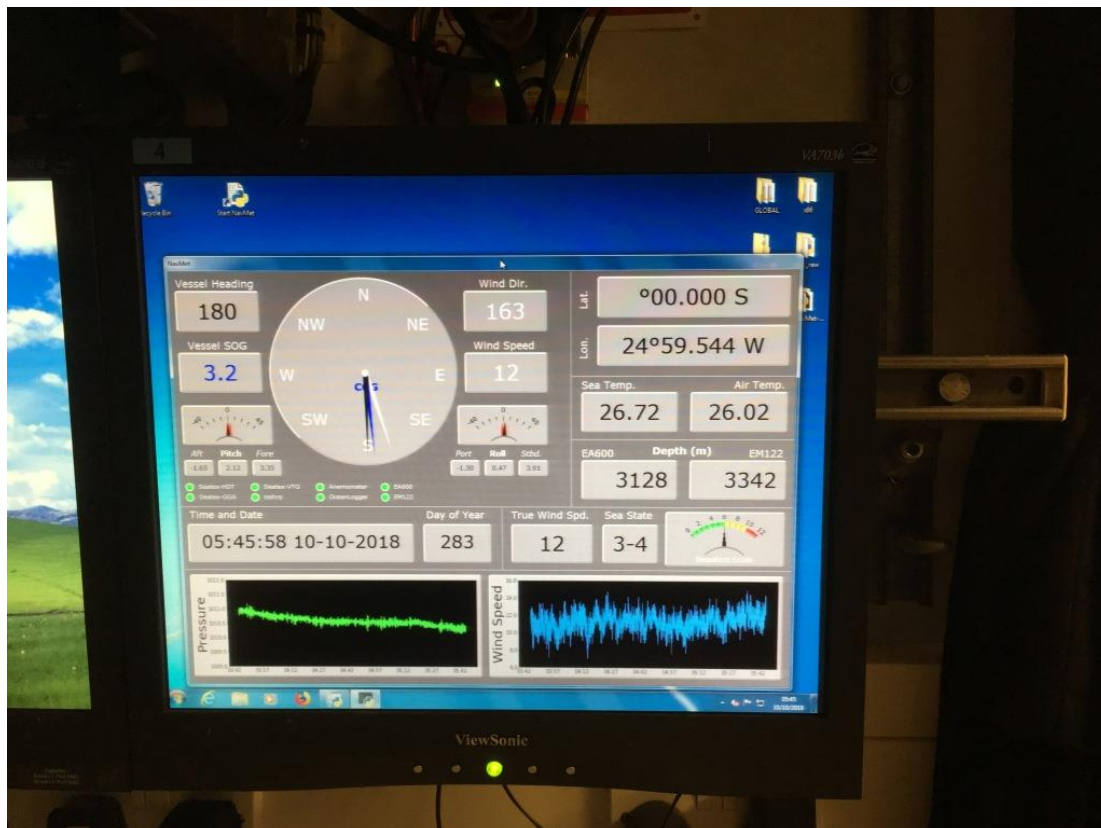
Email people re. float deployments – Lynne Talley, Fiona Carse

Deal with group pics from crossing the line

Next deep CTD planning -Down to 4200 m to test acoustic releases for mooring. Need to make sure station is in deep enough water. Also, needs to be in the southern gyre i.e. south of 9°S. From current lat., at a speed of 10knots = 21h 15 mins = 213 nmi. $213/60 \sim 3.5^\circ$ a day. 10.5°S. Deep CTD time will be noon on 13th Oct. Start station at 1030.

Deploy first float at noon on 14th Oct.

Note: Portuguese man o' war seen at the noon CTD station



11 October – Starry, a few clouds

Today = 18 days into the cruise and 18 days to go = Halfway Haribo day.

1230 – Met with John re. float deployments

He wants approx. 22 bottles from 1500-1600m and the surface. John to provide a list of all depths.

At each depth: nuts, pH (1 L, pickled samples, HgCl₂), also a duplicate depth for pH

At surface and DCM: POC (7 L), HPLC (7 L)

O₂ – Would like approx. 6 depths for calibration – John to ask Carol

After all deployments completed, would like another FLBB deployment to 500 m.

ALL floats are pressure activated.

All SOCCOM floats are sponsored by schools.

Looks like deployments will have to be limited to noon because nowhere near enough water/bottles at the predawn station.

Bob – Suspended temperature sensor. Covered it in foil. At the noon CTD deployment it appears to have been eaten by a fish/squid. Sean tried to locate a new sensor but couldn't find anything that was stand-alone. Only had wired sensors. Bob will use his spare fin.

1st officer is looking for gas cylinders. Ian – 2x OFN, Charel, 4 cylinders. Both sets of cylinders are for JR18005/Andrex II.

12 October- Starry, a few clouds

Carlos caught a squid whilst the CTD was in the water.

Send a copy of Charel's manifest to 1st officer.

Question from 1st officer – What's the weight of the batteries in the floats? Found the answer in the UW (SOCCOM) float manifest.

Helped Ian get acoustic releases up and running and 'talking'

13 October – Cloudy, Rain. Lumpy F5-6

Get Daz's carboys ready for today's CTD to 4200 m at 1030.

0100 – prop motor failure. Reset straight away without further issues.

Tomorrow – Net. Go to 250 m to collect more material for Natalia.

Float plan to Fred. He will help with float deployments, along with me.

Today, position of CTD was 12°S. Position of SAG mooring is 18.5°S = 6.5° difference

On station 3.25 h = 1345.

Ship speed approx. 10.5 knots

ETA at 15°S = 180/10.5 ~17 h = 0645, + predawn station of approx. 1.25 h = 0800 at 15°S.

Position at 0430 ~ 14.6°S. Suggest slowing ship to 1 knot at 0900 to deploy UW float s/n 12691 and Met Office float s/n 7001.

Notice – No bones, T bags into slops bin because macerator can't cope.

Send CTD36 bottle file to Daz

4200 m CTD – Nice and sunny, F4. In water at 1033 GMT

Got to 4200m at 1147 GMT.

Ian successfully pinged both acoustic releases. 1 returned a depth of 4185 m, the other returned a depth of 4187 m.

CTD out of water at 1338 GMT. Total of 3 h 5 mins.

Daz's samples – All of bottles 1 and 2. Both at 4200 m. Did a single rinse on both bottles of between 0.5 – 0.75 L, then filled.

14 October – Starry F3-4

Bongo to 250m to try and get more plankton for Natalia. Also ask Igor to be gentler with the hose.

Get tools and shackle bucket ready for mooring.

Send boxlist to Becca and Wade for end of cruise packing.

15 October – SAG mooring Day.

Had a meeting on aft deck for all people involved with the mooring. Mooring first pinged at 0713. Range given as 5270 m. Ian sent release command, received OK message. Didn't realise bridge had not authorised release. Protocol – Range it and then choose a safe distance for the ship. Bridge estimated vessel position from mooring of approx. 300 m. ship slowly moved backwards until 800-900 m from likely position of mooring. When vessel was stationary, repinged the mooring (at 0816). Reading of 3790 m. $5270 - 3760 = 1480$ m in approx. 1 hour.

Approx mooring ascent speed = $1480/60 = 24.67$ m per minute. This value was very slow. Lower floats probably imploded. With total mooring length in the region of 3000 m, top of mooring surfaced at 0905 GMT. Mooring all recovered approx. 1130. All lower set of floats had imploded. Mooring deployment began at 1200.

Anchor chain dropped at 1632 in location 18° 32.7016'S, 25° 4.8100'W.

Kept on pinging the mooring on the way down until got 3 constant readings. Did not carry out triangulation of mooring to confirm final position.

1736 – ship back on passage.


Helped Ian collect samples from the sediment traps. 21 bottles per trap. First, tested pH with strips. pH varied from 7.0 – 8.5. Then, parafilm placed on top of bottle and then lid screwed on. Bottles were put into small Mailboxes with lots of blue roll and then placed in the CT lab at 4°C.

16 October – Starry. Cloudy by 0800

Deployed UW float s/n 12632 at 0535 (GMT).

Next floats at 25°S and 26.5°S

Question – Will get to southern turn at 24°S on 17/10/18 at approx. 0430 ship time?

After this, distance from 24°S to 25°S is approx.. 85 nmi (Pythagoras) . Sides = 60 nmi, squares = 7200, hypotenuse = square root of 7200 = ~ 85 = 8.5 hours travel time.

26.5°S is approx. 206 nmi from 24°S. Went to verify with Dominik at 1430 (ship). Correct.

Oven in prep lab has not been working. ETO has checked it out, replaced 2 fuses and it is now working again.

17 October – Mix of clouds and stars

Station at southern turn, 24°S, 25°W.

Still an issue with Niskins not sealing and it is getting worse, according to Carol.

The best thing to do would be to replace the rubber tubing with spring and rope/cat gut lanyards. Basically, the rubber tubing is nowhere near strong enough to hold the end cap in place with 20 kg of water above it, once the vent has been opened and atmospheric pressure comes into play. Sean reckons the problem gets worse as the tubing gets older as it gets 'tired'. I checked with a few people and it turns out there are too many leakers to count, but the worst offenders are 5, 9, 16, 21. 16 also has a tap which is difficult to open/close. Leakage gets even worse as the ship rolls. Told Sean – He will tighten the 4 worst offenders and will swap out 23 and 24 with spares for the noon CTD that have had the rubber tubing replaced with springs.

Approx. distance from southern turn to Port Stanley. Port Stanley is at 51° 42'S, 57° 51'W. Google maps gives the distance as 2235 nmi. At a speed of 10 knots, that's approx. 10 days. Add in 10 day's-worth of science at 2.75 h d⁻¹ and 6 SOCCOM floats at 30 mins each you get an additional 30.5 h. Total = 11 days 6.5 hours.

18 October - Starry

Deployed Met Office float s/n 7589 at 0539 GMT

1030 – “Noon” station at 27.2°S to allow for 1500 m CTD and deployment of first 2 SOCCOM floats. s/n 12696 and 12883. Need to be deployed in the right location to hopefully get into the Brazil Current. Needs to be >2000 m deep and before the Rio Grande Rise.

Distance from 27.2 to 33°S = 431 nmi. Leave 27.2°S at approx. 1230. 431 nmi at 10 knots = 43.1 h = 1 day 19 h, plus 3 stations, totalling approx.. 6 h. Therefore, time to get to 33°S will be approx. 2 days = approx. ETA of 1230 on 20 Oct. Next SOCCOM float deployment will therefore be 1300 (ship) on Sat 20 Oct.

Next Met Office float, at 34.5°S will be at the noon station on 21 Oct.

Note: 3 prop motor failures during the night

Note: at the 1030 station there were 3 large black petrels at the stern of the ship.

Gear returning to the UK.

PML Container – Me, Becca, Wade, Giorgio, Bob, Andreia, Afonso, Arwen, Natalia – 18-19 cubic metres

NMF storage container – Ian, Hans, Millie, Carol, Chata, Cecilia, Igor, Fred, John, Alyse, Jenna. Scientists' kit, approx. 12 cubic metres. NMF kit ???

Check people's onward travel. Igor and John are both flying LATAM.

19 October – rain, followed by stars

UEA – 2 x dry shippers going to be couriered to Concepcion, Chile, probably on the same flight as Igor. He is arranging their pickup from the ship by the courier. Will have lots of frozen samples to leave on board. Lugol's samples will go in the PML container.

Alyse/Jenna – Yeti cooler. Will take back on the flight with them.

Make sure lab will be open when we return on Saturday 3 Nov.

Book minibus travel.

1st officer said that each container will need a container packing certificate. Blank form on the shared drive in the cargo paperwork folder. Containers = PML, NMF storage, 2 x RN container.

As the containers leave the ship they will be weighed via load cell. All containers will be non-haz.

The RN containers will require decontamination certificates. Again blank copy on the shared drive.

Hans/Mille will have rad samples for cool stow – Use my fridge? (not used in the end)

Waste – Class 7 will go in no. 1 hold, Other waste in No. 2 hold.

Current demob plan.

Containers off forward, then 2 containers out of forward hold. Everything out of the port wing and then the stbd wing to get equipment out for transport to Rothera. (Foremast equipment off in bird cage at some point). Then, containers off the aft deck. 3 containers from forward then go on the aft deck, 2 containers back in the forward hold and 1 on the hatch. And, also, at some point, demob AMT28.

Gear off monkey island

PML gas stillage – HazBol – 5 x He, 2 x OFN from NOC.

Foremast – Fred/Bob need to be ready to dismantle gear immediately, if necessary.

Class3 chems will go into 10' container outside the UIC and stay until the UK.

EtOH needs to be classed as waste to avoid duty being charged on arrival in the UK.

BOL numbers – Use the Visiting Scientists section in the Assigned Bol numbers excel file.

Note: Good possibility we will have to berth at Mare Harbour instead of Port Stanley.

20 October - Cloudy and windy. F5-6.

By end of predawn station, wind at +30 knots.

The SOD was more like a kite.

200 µm net – net parted company with the canvas at the opening over 1/3 of the circumference.

Will need a new net for next year.

At end of station we were stationary for over ½ an hour.

Find out about end of cruise data. Arwen will take a complete copy. She will ask SeanV or David to do it.

RN container decon. Certificates. Signed by the captain. Originals to NMF. Copies to captain and BAS H & S advisor, Jenny Forster-Davidson.

Noon CTD – 2 humpback whales around the ship until we left station. Possible mother and calf.

Note: Possibly rough Mon/Tue.

21 October – Stars and clouds

0400 – Wind 26-30 knots – cancelled net.

Clocks – 3 hours to go back. retard on 24, 26 and 28 Oct.

PCA – ship downtime, AINMEs – ask captain for details, Other downtime – cruise shortened by 1 day to enable equipment transfer to Rothera. PCA v1 written.

an Brown – BOL, gases

Met Office float 8065.

22 October – Cloudy

Email Jez to let him know about possible/probable demob at Mare Harbour.

Container numbers.

PML – PSSU 336650 3

NMF RN1 (Hans/Millie) – NMFU 200225 2

NMF RN2 (Natalia) - NMFU 200224 7

NMF storage container – TCIU 452968 1

Drill 1030 – Into lifeboats. Video on liferafts.

Noon station – Should arrive at 37°S. Next Met Office float nominal deployment latitude is 38°S. Decided with Fred to deploy at this station because of poor weather forecast. Float s/n 8065.

23 October - Cloudy, F5-6

Managed predawn CTD and SOD. No net. At start of station sea state was F5-6 by the end we were at F6-7, wind speed getting up to 35-45 knots. Position 38° 36' S, 40° 41' W.

At 0730, approx. 1063 nmi to go. 6 days at 177 nmi per day. Perfect timing, if all goes well.

1215 – Large 4-5 m waves, sea F6-7, gusting 30-39 knots. If can't do CTD and deploy float, do additional CTD tomorrow?

Potential programme: 0430 (1.5h), 0830 to 1500 m (2h), 1300 (1.5h).

Currently travelling at 7.5 knots. 24 h = 180 nmi, approx. 2 degrees of latitude. If stopped at 0830 we would be approx. 30 nmi short of 40° 50'S. If didn't do this and went to 0430 next day, looking at a further 20h at say 9 knots = a further 2 degrees of latitude = 42° 50'S.

24 October – Rain, cloud, moon and stars.

Clocks to back to GMT-1 hour tonight

No net. Still large swell. Wind 30 knots at 0410. Wind dropped off on station

John – working late on SOCCOM float days.

Andreia – Unused Lugol's boxes?. Lugol's samples back to UK in container.

Bob – Question – space for an extra cryobox of AFC samples in his cardboard box to be left in the -80C freezer until back in the UK? Yes. Box: 43 x 26x x26 cm.

Check PML container Tare

Safety meeting – 1030, 24/10/18, conference room.

Correct labelling on chems, end of cruise rad things.

Aisling asked how I know 0.5% glut was non-reg wrt IMDG. Told her I'd just Googled it and gave her an MSDS for 2.5% glut used as a disinfectant, which was non-reg. Aisling said that 1st officer had been given an Excel spreadsheet for calculating whether a certain concentration of HgCl₂ was hazardous or non-reg. (Got it from 1st officer. Had been created by Marie Jose Messias, Exeter Uni).

Asked Aisling for details of waste drums so far, with their locations.

25 October

Northbound BOLs – Ask 1st officer that the port of discharge will be. Answer – TBC

Let 1st officer know about the courier coming to pick up Igor's dry shippers.

Send PCA draft to captain and ask for AINME details

End of cruise scientists' meeting – Sunday 1030

Giorgio – BGC float return. Use the double UW float box. 206 x 56 x 43 cm. Weight 114 – 40 = 74 kg.

Class 7 DGNs for waste (Didn't need them in the end because non-haz). No-one at PML. ?Claire Evans? – Yes

Cruise picture for ship – Artwork – Millie and Jenna.

26 October – Cloudy

Went close to icebergs! One at 0930 and one at 1000 Approx location – 45.5°S, 49.4°W.

Noon station – Andreia came to let me know she would not be sampling on 27 Oct. When I asked why she said it was because she only had 3 filters left for coccolithophore filtration. Using 47 mm 0.45 µm cellulose nitrate filters. I gave her a pack of filters and a pack of 55 mm petri dishes. Arwen and Wade also told me they only had 1 Sterivex left each. I gave Arwen 5 extra and Wade an additional 1 Sterivex.

Comms blackouts during the morning. Phone and internet.

27 October – Partly cloudy, nice and calm

Last day of science. Predawn and noon stations.

Do end of science presentation

Do cabin packing

Incubators – dismantle

FCMs – Once all sampled analysed, Decon for 30 mins and then 30 mins MQ.

Download AFC data.

Download Legwork shared drive

Lead weights – bring aft

Bongo log – send to Igor and Natalia

Sort out samples remaining on board – cool stow. +4C, -20C, -80C

Laminate cylinder BOLs for Ian's OFN on the boat deck.

BOL list – 1st officer

JR18005 – Manifests and gas BOLs

ICEBERG approx.. 0950 – 1030

Circumnavigated it twice, just a few 100 yards off so that Bob could get underway measurements in the wake of the berg as other studies have indicated that bergs fertilise the ocean as they go.

Met with Aisling to deal with waste and unused chems. She is happy to deal with it all.

Arrange to meet with everyone who has unused chems at 1400 on Sunday to move all chems into the science hold to pack them.

Got results regarding the ³²Si source: activity 87330 Bq – Exempt. Not even classed as radioactive in France.

28 October

See Mackem – access to hold

See 1st officer – dry shipper courier

See Rob – turning off underway after lunch and underway event log.

Cabin inspection 1530

29 October

Arrival Mare Harbour – after breakfast.

Samples onboard - PML, NOC

Natalia – 1 cryovial box – in with PML sample box in -80C freezer. 2 boxes of glass vials and 1 UN box of 15 mL Falcon tubes containing samples pickled in EtOH, both in -20C freezer.

UEA – Lots of boxes in -20 and -80C freezer including dust filters.

Hans/Millie – 1 box at -80C and 2 stacks of boxes at -20C

John – 6 large blue boxes containing TA samples pickled with HgCl₂. Consigning to someone on JR18005

Igor's samples.