AMT29 CRUISE REPORT

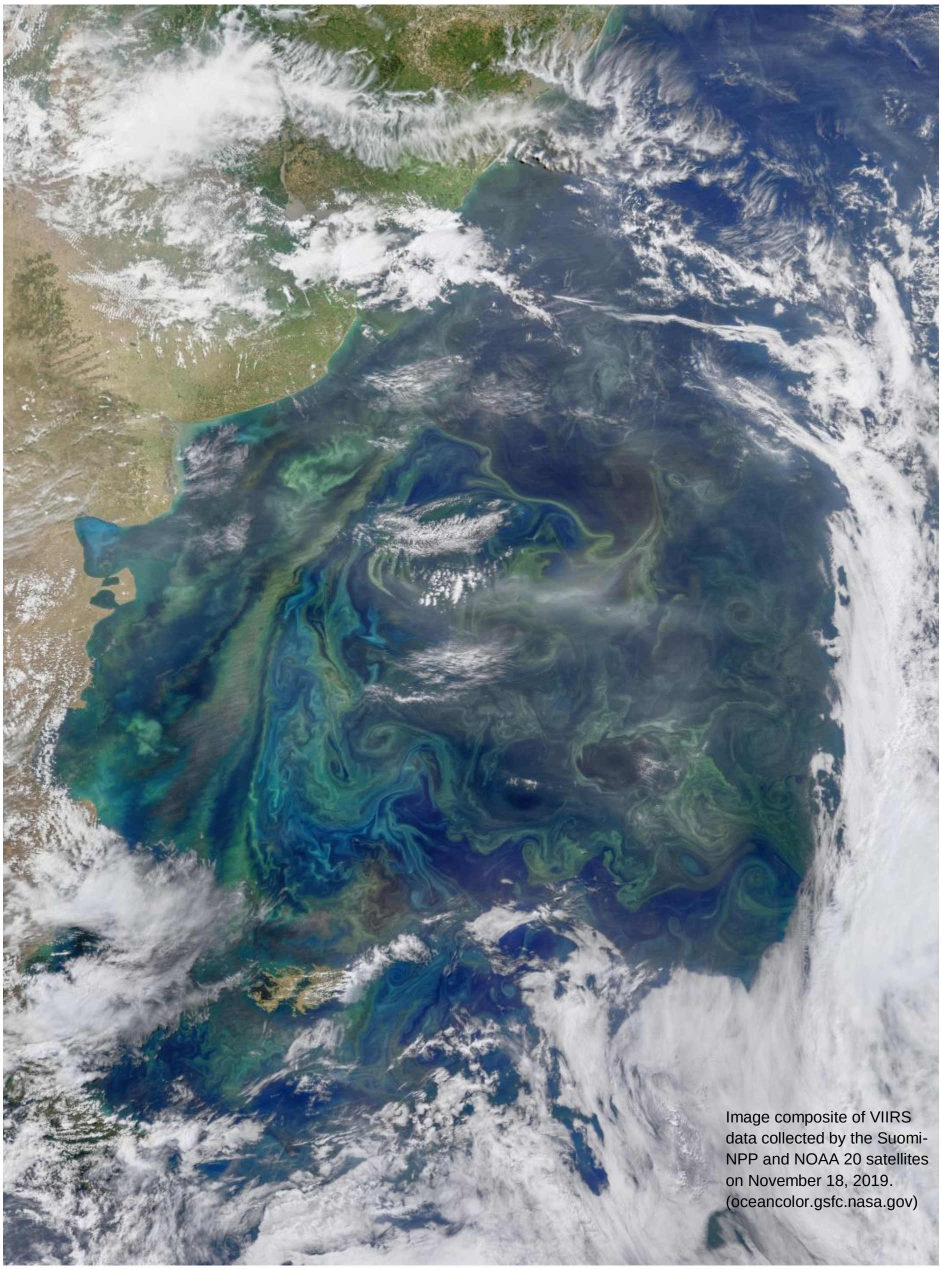

Image composite of VIIRS data collected by the Suomi-NPP and NOAA 20 satellites on November 18, 2019. (oceancolor.gsfc.nasa.gov)

RRS Discovery (DY110)

13 October – 25 November 2019

Chief Scientist: Giorgio Dall'Olmo

Plymouth Marine Laboratory

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The Atlantic Meridional Transect programme

The overall aim of the Atlantic Meridional Transect programme is to quantify key biogeochemical and ecosystem processes and their inherent variability over extended temporal 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 AMT is funded as part of the Natural Environmental Research Council's National Capability. Its specific objectives 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 the export of organic matter and on the 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.
- To provide essential sea-truth validation for current and next generation satellite missions.
- To provide essential data for global ecosystem model development and validation; which in turn provides the world with its climate-change forecasting capability.
- To provide a valuable, highly sought-after and unique training arena for the next generation of UK and international oceanographers.

Acknowledgements

I would like to thank Captain Antonio Gatti, the officers and entire crew for providing us with a safe and efficient place to work, for the friendly environment they welcomed us into as we stepped on the RSS Discovery, for helping up achieve our objectives and for their flexibility with our numerous requests.

John Wynar, Andy Moore, Ian Murdoch and Mike assisted us throughout the voyage and for this I would like to thank them very much.

Paul Strubinger processed and plotted the CTD data every day. Rebecca May and Dan Ford collected discrete oxygen measurements to calibrate the oxygen sensor mounted on the rosette. Dan also plotted daily oxygen calibrations which helped us track the drift of the instrument as well as to adjust the sampling scheme. Many thanks to them for their precious help as well.

A special thank you to the chefs and catering department who spoiled us with some of the best food I have experienced on a ship.

Andy Rees and Glen Tarran kindly helped me lead my first ocean expedition.

I also would like to thank all scientists on board for the warm and friendly atmosphere they fostered through the voyage.

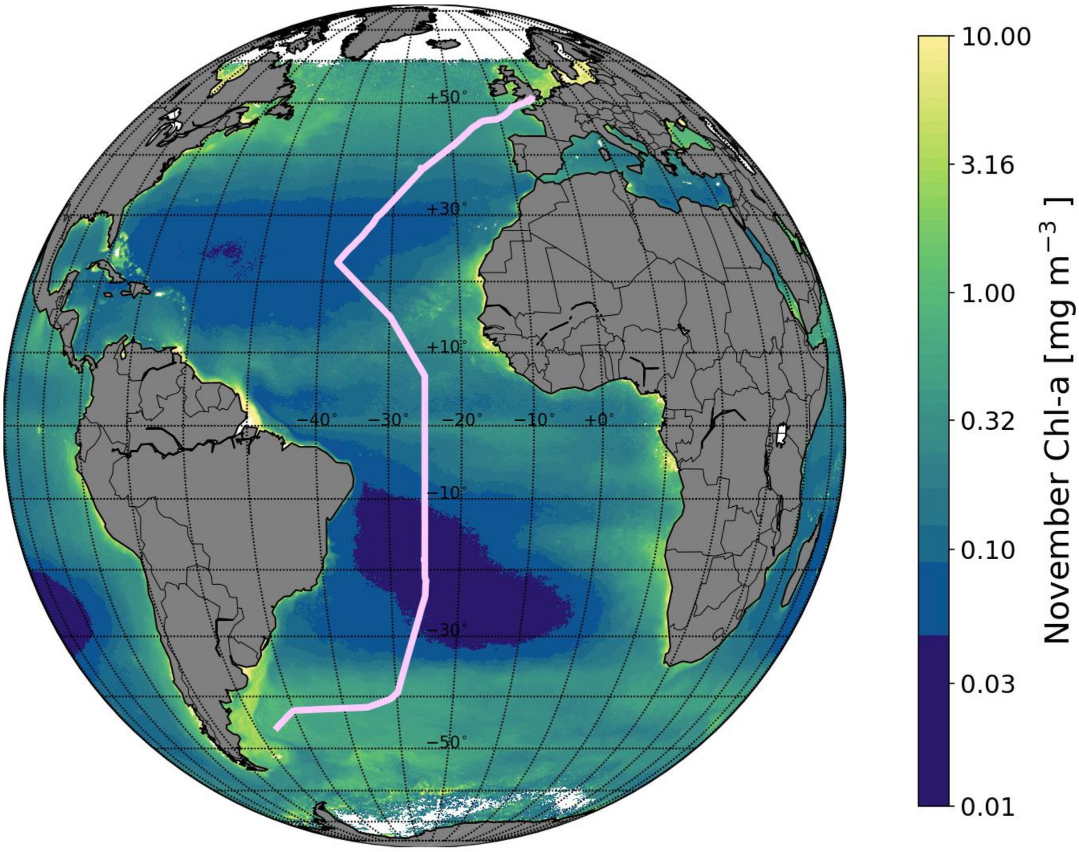
Finally, I would like to acknowledge all the work Christina Devereux put into preparing the cruise and for her support while we were at sea. We would have never made it without her help.

May 1st, 2020

Giorgio Dall'Olmo
Chief Scientist

Cruise overview

The AMT29 research cruise (DY110) set sail from Southampton on October 13th, 2019 aboard the Royal Research Ship Discovery and arrived in Punta Arenas, Chile, on November 25th, 2019. The figure below presents the final cruise track overlaid on the climatological chlorophyll concentration estimate by the OC-CCI product for November.

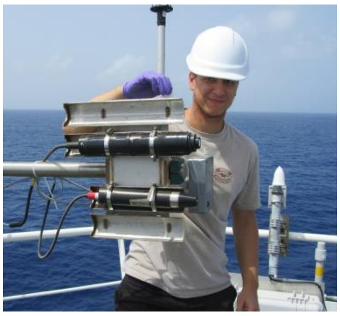
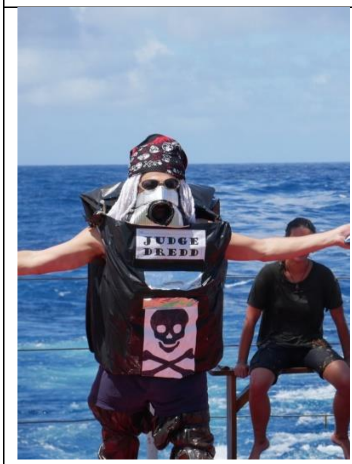


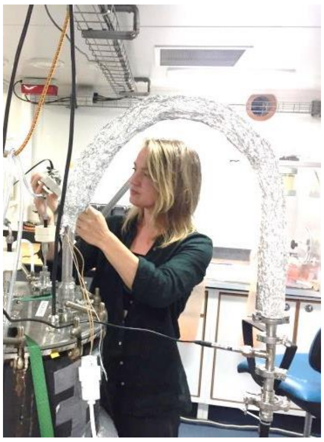
The highlights of AMT29 were as follows:

- 55 CTD profiles measuring key physical and biogeochemical parameters including: temperature, salinity, chlorophyll, oxygen, nutrients, pH, alkalinity, plankton abundance, respiration, genetics and microbial dynamics.
- Daily sampling down to 2000 m in an attempt to resolve the Antarctic Intermediate Waters (AAIW). AAIW is an important water mass is thought to sustain primary production in a large fraction of the ocean. Sampling included measurements of oxygen, nutrients, pH, DIC/TA, REEs, PFAAs, Cr isotopes, flow cytometry and tintinnids.
- Continuous underway temperature, bio-optical and biogeochemical measurements covering an almost 100° range in latitude and vastly contrasting ocean biomes.
- Vertical net hauls to determine the abundance of different species of zooplankton and larger phytoplankton.
- Optics rig deployments to measure optical properties of the upper 500 m of the water column.
- Weather balloon launches.
- Test of two new instruments (new FFRF and new chlorophyll-a meter). AMT as an ideal platform to test instrumentation over a wide range of environments.

- First measurements of depth profiles and sea-spray aerosol enrichment of perfluoroalkyl acids (important to predict environmental transport of contaminants and to understanding the chemical composition of sea-spray aerosol)
- Continuous underway measurements of optical properties, sea-surface temperature, radar backscatter and gas fluxes to validate products from satellite sensors (ESA, JAXA and NASA).
- Collected samples for single-cell phytoplankton stoichiometry at the Atlantic basin scale.
- Incubator experiments to better understand the interactive effect of temperature and nutrients availability in different phytoplankton and bacteria communities along the transect.
- Wide suite of complementary measurements to determine the carbon fluxes (net and gross primary production, net community production, size-fractionated photosynthesis irradiance curves, pigments, etc.) due to phytoplankton and bacteria in the surface sunlit layer.
- New high-resolution meridional cross section of Rare Earth Elements (REE) specifically targeting the water masses of the upper water column to investigate the role of biological features and processes, if any, on the REE distribution. This is important because RREs can be used to investigate processes such as particle scavenging, dust dissolution, river input, pore-water diffusion, etc.
- Flow-cytometry and Coulter-counter measurements as well and sample collection to characterize the distribution and abundance of Archea, bacteria, pico- and nano-eukaryotic phytoplankton, and to investigate the contribution of phytoplankton to the particle size distribution.
- Deployment of six NOAA-PMEL Deep-Argo floats contributing to the regional pilot array in the Brazilian Basin and several additional core Argo floats for the UKMO.
- 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 2018, and the construction and deployment of a new sediment trap mooring at the same location.
- Participation of 20 research scientists from 10 institutes and of 12 different nationalities (Austria, China, France, Germany, India, Italy, Portugal, Russia, Spain, Sweden, UK, Venezuela).

AMT29 participants: science party

			
Anakha Mohan	Andreia Tracana	Bo Sha	Carolina Sa
			
Cristina Fernandez-Gonzales	Dan Ford	Daniel Phillips	Francesco Nencioli
			
Gavin Tilstone	Giorgio Dall'Olmo	Giulia Sent	Glen Tarran

			
Jana Johansson	Nina Schuback	Ophelie Meuriot	Paul Strubinger
			
Polina Lobanova	Rebecca May	Werenfrid Wimmer	Wuchang Zhang

NMF personnel

			
Ian Murdoch	Mike	John wynar	Andy Moore

Science reports

CTD processing and sensor calibrations

Paul Strubinger Sandoval

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Objectives

- To process data output from the CTD casts using Sea-Bird data processing software.
- To obtain profiles of the water column from a range of sensors using Ocean Data view software (ODV).
- To obtain latitudinal section plots from a range of sensors using Ocean Data view software (ODV).

Methods

In total 55 CTD cast deployments, including 1 shakedown, were used to obtain profiles of the water column and section plots along the cruise transect from a range of sensors comprising pressure, temperature, conductivity, oxygen, fluorescence, down-welling and upwelling PAR, turbidity, transmittance, and attenuance. Deployments were conventional profiling casts using 24 x 20L OTE Niskin bottles for sampling water. CTDs were deployed, weather permitting, at pre-dawn between 04:00 and 04:30 am and at solar noon around 12.30 pm ship time each day. Overall, pre-dawn casts consisted of 29 deployments, including 1 of 250 m, 26 of 500 m, 1 of 1000 m, and 1 of 2000 m. Noon casts included 26 deployments, comprising 3 of 1000 m, 22 of 2000 m, and 1 of 5000 m.

For the processing of the data, the Sea-Bird data collsection software Seasave-Win32 were used to record 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.

- DatCnv was used for the conversion of the raw binary Sea-Bird files to 24 Hz ASCII files (CNV) containing data for up and down casts
- Bottle Summary was applied for the generation of bottle firing files which contain the mean values of all the variables at the time of bottle firing events
- WildEdit was applied to the CNV files to remove pressure spikes
- AlignCTD was used to shift, relative to the pressure, the oxygen sensor by 2 seconds, to compensate for the lag in the sensor response time
- CellTM was used to remove the effect of thermal inertia on the conductivity cells.
- SeaPlot was used for the identification of the surface soak for each cast which was removed manually until the cast 40, from the cast 41 onwards LoopEdit was applied
- Derive was used for recalculating salinity and oxygen concentrations values after the corrections for sensor lag and thermal inertia were applied
- BinAverage was used to convert 24 Hz ASCII files into 1 dbar downcast files for calibration and visualisation purposes
- Strip was applied for the removal of the initial salinity and oxygen values produced at the DatCnv stage.

The sensor values obtained at the Bottle Summary stage formed the dataset for calibrating the two CTD salinity sensors and oxygen sensor against discrete bench salinometer measurements and oxygen Winkler titration measurements, respectively. The fluorometer sensor will be calibrated post-cruise using AC-9 data calibrated against HPLC data.

Preliminary Results

- Temperature

There were no independent measurements of temperature made during the cruise and the two CTD temperature sensors on the rig returned consistent values. There was no further calibration of these sensors. Figure 1 and Figure 2 show the section plot along the cruise track of temperature derived from the primary and secondary temperature sensors, respectively.

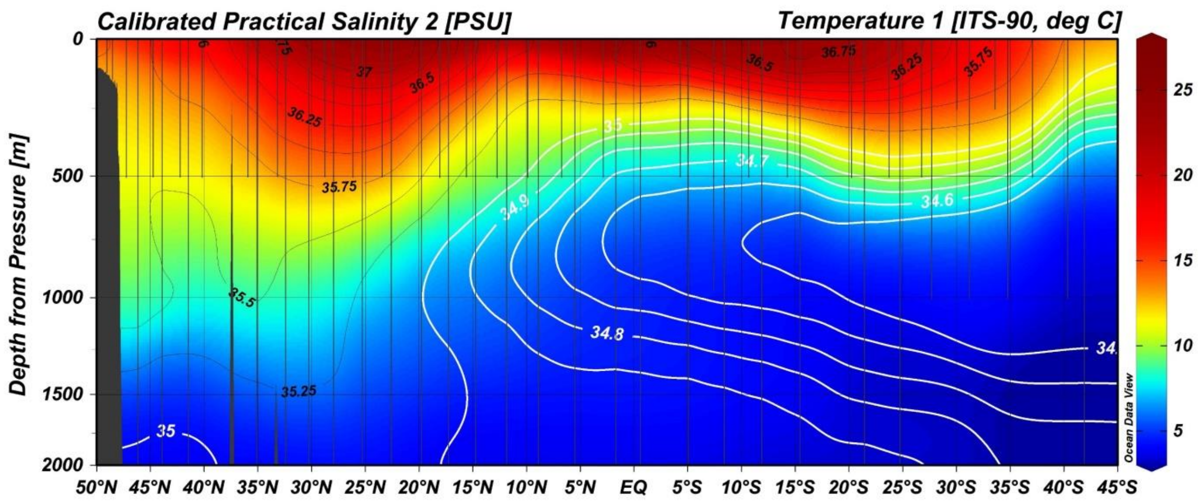

Fig. 1 Section plot along the AMT29/DY110 transect of the temperature versus latitude (50° N – 45° S) from the primary temperature sensor.

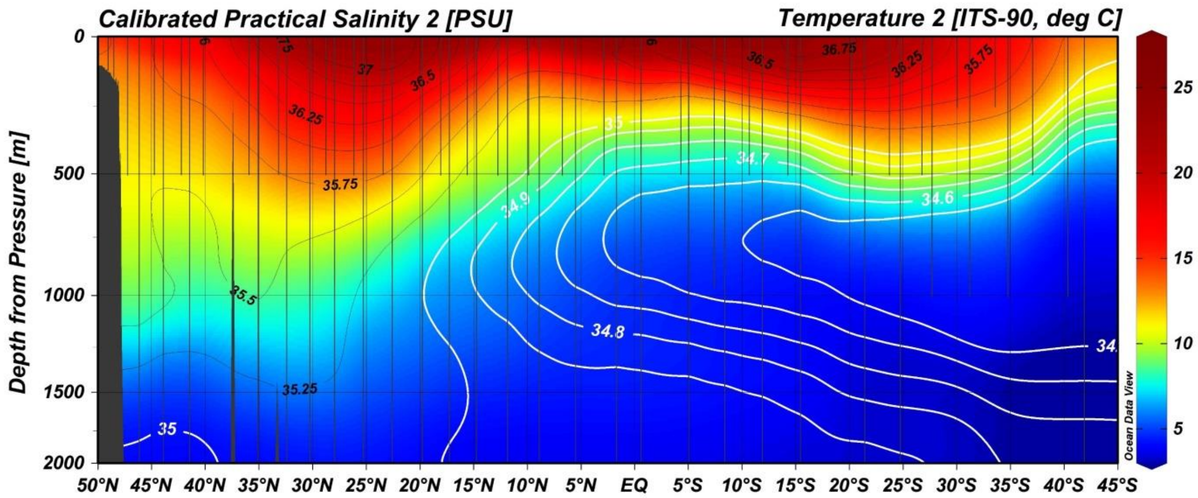

Fig. 2 Section plot along the AMT29/DY110 transect of the temperature versus latitude (50° N – 45° S) from the secondary temperature sensor.

- Salinity

The salinity sensors were calibrated against discrete salinity measurements (autosal) versus corresponding sensor measurements from four samples on average collected from CTD casts every day. Further details of these measurements can be found in the NMF-SS cruise report section.

Preliminary results of the calibrations indicate good agreement between bench salinometer measurements and CTD sensor values (Figure 3), suggesting that there was no significant drift in the sensors. For both sensors, calibration regression parameters were calculated with 95% confidence intervals using a Robust-Regression linear model. Data have been calibrated using the following equation:

$$Salinity_{Calibrated} = intercept + Slope * Salinity_{Uncalibrated}$$

Where:

For primary salinity: Slope = -0.00073 (±0.00020); intercept = 0.0257 (±0.0072)

For secondary salinity: Slope = -0.00164 (±0.00025) ; intercept = 0.0580 (±0.00890)

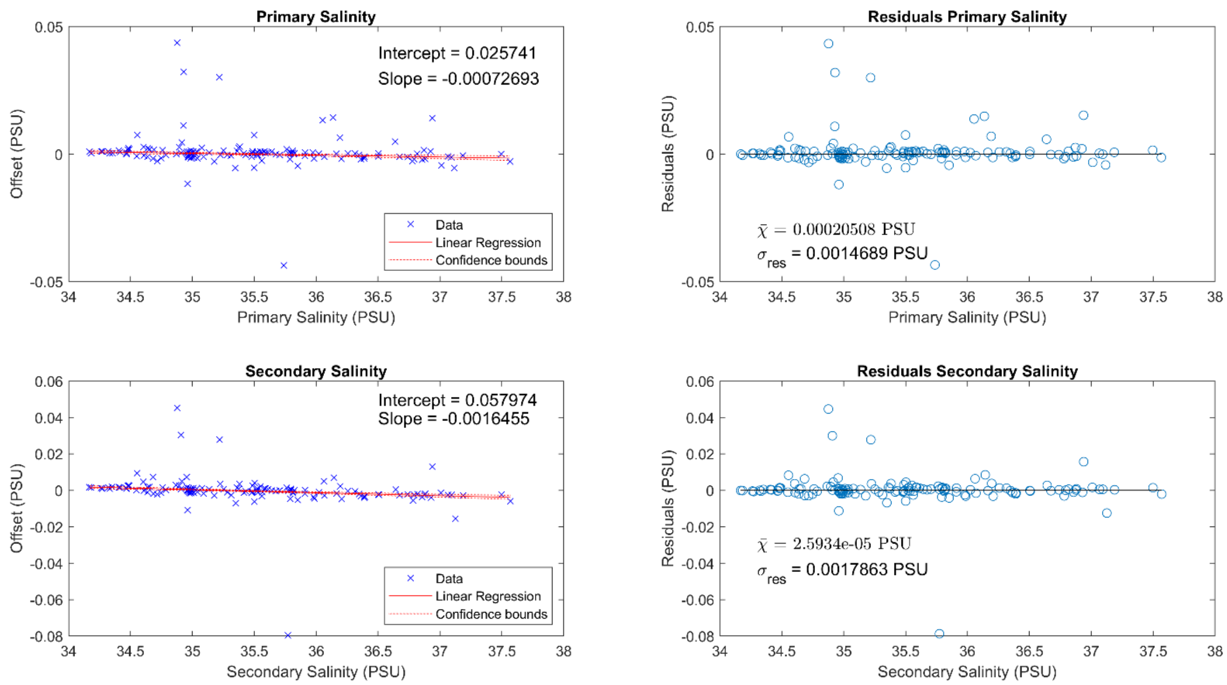

Fig. 3 Regression parameters and salinity offsets (difference between discrete measurements and sensor values) for both sensors against sensor values (left), Residual plot (difference between the predicted value (ŷ) and the observed value) (right).

Figure 4 and Figure 5 show the section plot the along the cruise track of salinity derived from the primary and secondary salinity sensors, respectively.

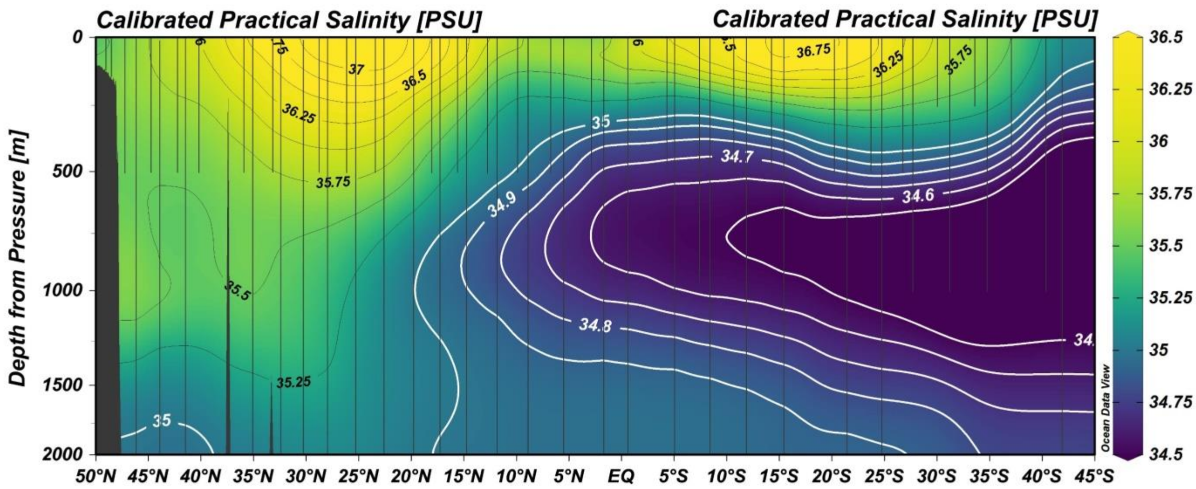

Fig. 4 Section plot along the AMT29/DY110 transect of the salinity versus latitude (50° N – 45° S) from the primary salinity sensor.

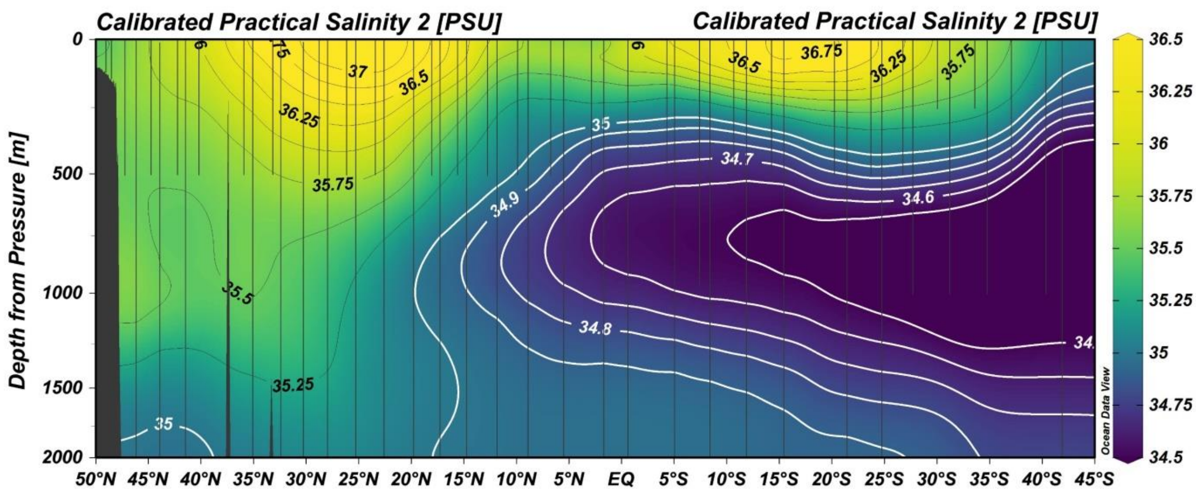

Fig. 5 Section plot along the AMT29/DY110 transect of the salinity versus latitude (50° N – 45° S) from the secondary salinity sensor.

- Oxygen

Calibration of the SBE 43 oxygen (O_2) sensor was performed against discrete oxygen Winkler titration measurements from a minimum of 6 and maximum of 13 depths at both predawn and solar noon CTD stations. More details are available in Rebecca May and Daniel Ford's cruise report.

Calibration regression parameters were calculated for each CTD profile with 95% confidence intervals using a Robust-Regression linear model to identify if any drift in the sensor occurred. The results indicate there was no significant drift in the sensor except at DY110_010. Data was calibrated using the following equation:

$$Corrected_{O2} = 1.027(\pm 0.005) * CTD_{O2} + 1.029\ (\pm 0.936)$$

Preliminary results of the O_2 calibration indicate good agreement between the O_2 concentrations derived by the sensor and Winkler determinations (Figure 6).

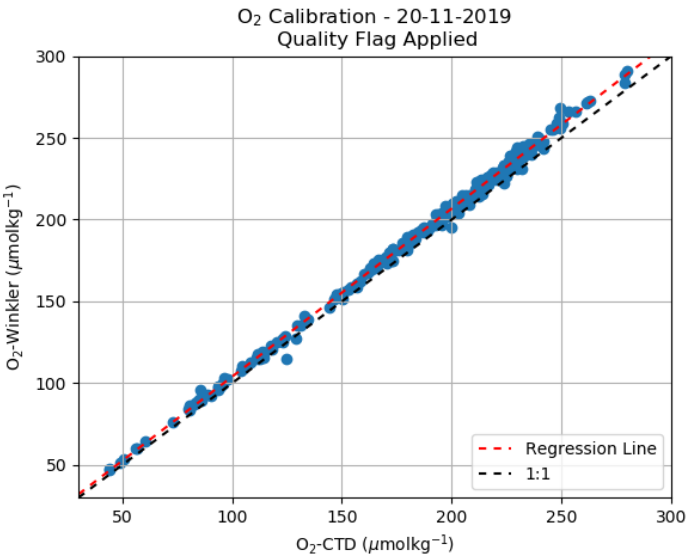

Fig. 6 Regression fit for the O_2 calibrations.

Figure 7 shows the section plot the along the cruise track of O_2 derived from SBE 43 oxygen sensor.

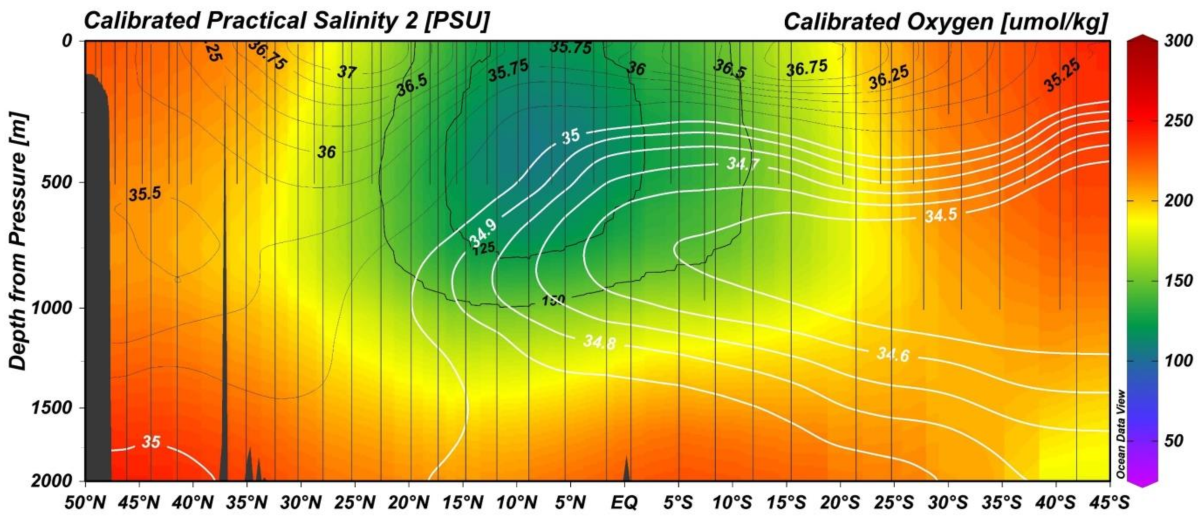

Fig. 7 Section plot along the AMT29/DY110 transect of the O_2 versus latitude (50° N – 45° S) from SBE 43 oxygen sensor.

- Fluorometer

Two fluorometers were used during the cruise. The first one (S/N: 8-2960-163) was used for the first 20 casts. It was replaced, after faulting consecutive on the upcast, by the second one (S/N: 88-2615-126). The wrong calibration file was used to derive fluorescence Chl concentration for the cast DY110_001 to DY110_020, thus, data for these stations must be reprocessed using the corresponding file. However, the voltage values obtained by the first fluorometer were extracted from the original files, and the corresponding calibration equation was applied to obtain the fluorescence Chl concentration. Values can be found in a spreadsheet called “fluorometer_1_to_20.xlsx”. 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 AMT29 cruise track is shown in Figure 8.

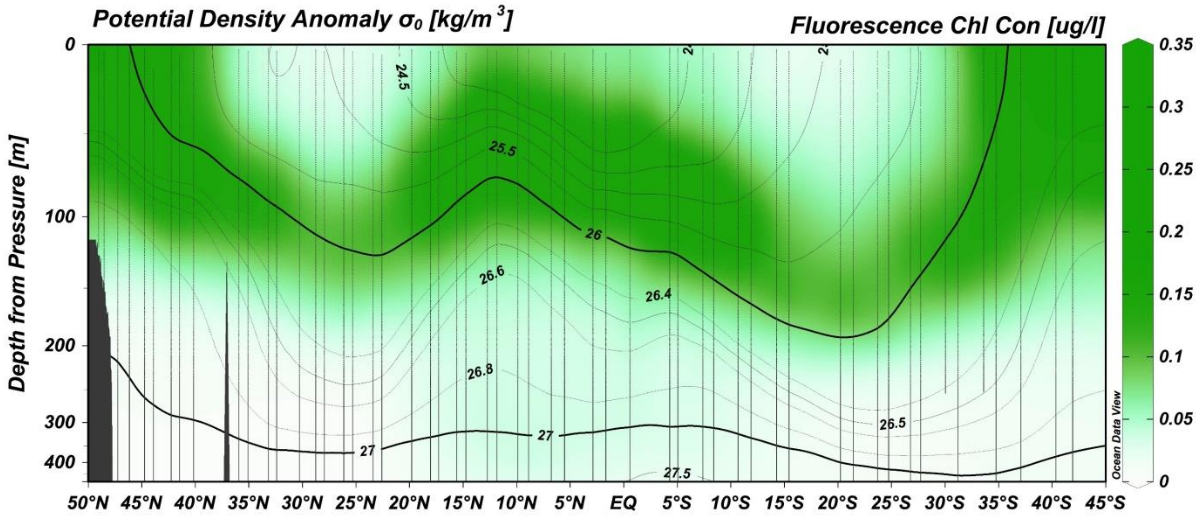

Fig. 8 Section plot along the AMT29/DY110 transect of the fluorescence Chl concentration versus latitude (50^o N – 45^o S).

Dissolved Oxygen Calibration

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Objectives

Dissolved Oxygen (O2) in seawater is produced by photosynthesis and consumed by respiration and photochemical reactions in the surface. Equilibrium between dissolved O2 in seawater and the atmosphere is maintained through air-sea gas exchange. O2 was measured with a sensor mounted on the CTD hydrocast on AMT29. The objective of this work was to calibrate the sensor using discrete samples from Niskin bottles which were analysed by automated Winkler titration.

Methods

Dissolved O_2 concentrations were determined by automated Winkler titration (Williams and Jenkinson, 1982), performed with a Metrohm 916 Ti-Touch with polarimetric end-point detection. Thiosulfate concentration was calibrated every 3 days using a commercial 0.1N KIO3 standard (Sigma-aldrich, FIXANAL).

Water samples were taken at a minimum of 6 and maximum of 15 depths at both predawn (~04:00) and noon (~12:30) CTD stations (Table 1). A single borosilicate glass bottle with a nominal volume of 150mL was filled directly from the CTD rosette Niskin bottle using a silicone tube, before other sampling occurred, at each depth. The bottle was allowed to overfill with 3 times its volume, from the bottom of the bottle to prevent the formation of bubbles. A traceable thermometer was used for measuring the fixing temperature (VWR TD 121, serial number: 92405158). Samples were fixed immediately, and placed underwater at room temperature until analysis within 24 hours of sampling (generally within 2 hours).

In total 435 samples were collected and analysed for calibration of the O_2 sensor. After quality control on the Winkler-determined O_2, 316 samples remained for the calibration.

Preliminary Results

Preliminary results of the O_2 calibration indicate good agreement between Winkler and CTD O_2 concentrations (Figure 1). The results suggest there was no “drift” in the sensor except at DY110_010, after which there was a return to consistent values.

Calibration regression parameters were calculated for each CTD profile with 95% confidence intervals using a Robust Linear Model to address whether any drift in the sensor occurred (Figure 2). The results indicate larger uncertainties at the beginning and end of the cruise, which are attributable to a limited range in O_2 concentrations in these areas. However, the quality-controlled regression line (red line in Figure 2) falls within the uncertainty range for most CTD casts, reinforcing that there was no “drift” in the sensor.

We find the calibration for the CTD O_2 sensor to be of the form, with 95% confidence intervals:

$$Corrected_{O2} = 1.027(\pm 0.005) * CTD_{O2} + 1.029\ (\pm 0.936) \qquad (1)$$

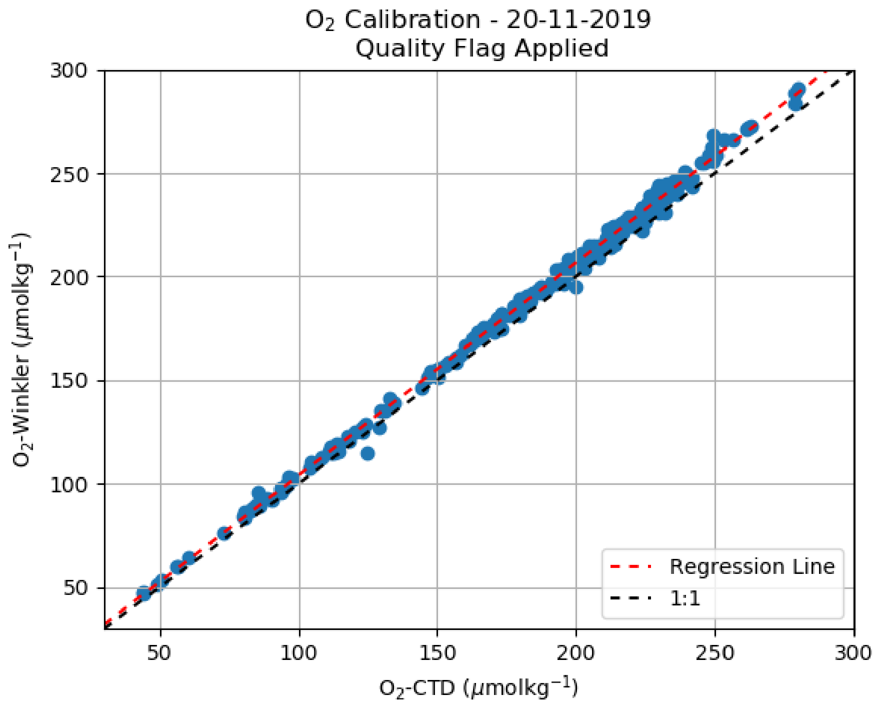

Figure 1 – O_2 calibration of CTD Sensor, using only data flagged as good quality during Winkler Titrations.

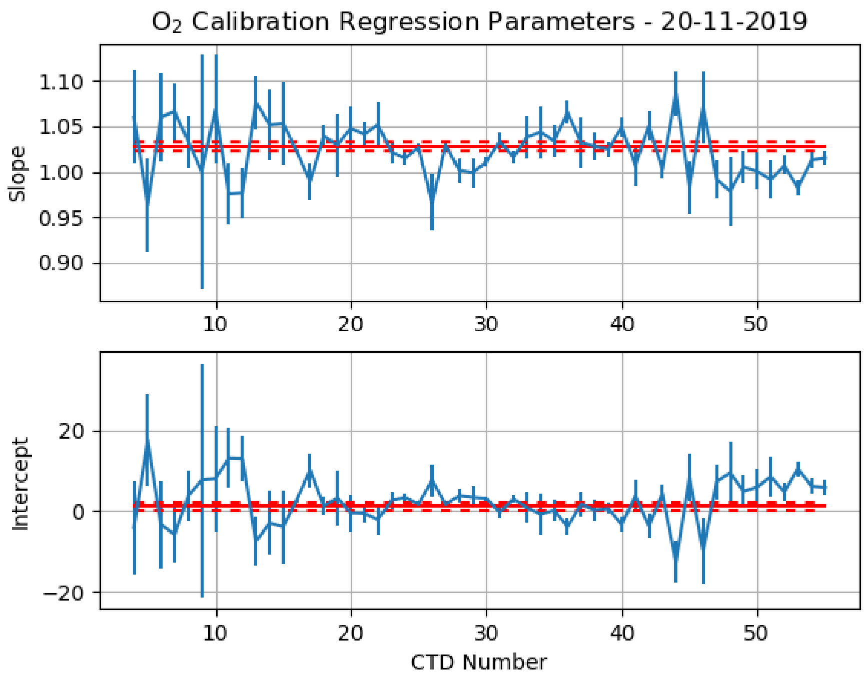

Figure 2 – Regression parameters were computed for each CTD cast from CTD DY110_004 to DY110_054. The slope of the regression (top plot) and the intercept (bottom plot) are plotted in blue, with error bars indicating the 95% confidence interval. The red line indicates the slope and intercept respectively from the Quality Flagged regression (Figure 1). Increased uncertainty at the beginning and end of the cruise was due to the limited range in O_2 concentrations that were observed during these areas.

References

Williams P.J.leB. and Jenkinson N.W., 1982. A transportable microprocessor-controlled precise Winkler titration suitable for field station and shipboard use. Limnology Oceanography 27: 576-584.

Table 1 – Samples Collected

Date	Station	CTD	Time in water (GMT)	Lat (+ve °N)	Long (+ve °E)	Niskins sampled	Depths sampled (m)
16/10/2019	01	DY110_001	08:13	49°2.891'	-6°43.927'	3, 6, 9, 16	100, 70, 40, 5
16/10/2019	02	DY110_002	13:20	48°31.309'	-7°12.224'	1, 7, 8, 9, 24	140, 50, 40, 35, 2
17/10/2019	03	DY110_003	04:42	47°14.604'	-9°18.913'	1, 2, 3, 4, 13, 24	500, 400, 300, 200, 35, 5
18/10/2019	04	DY110_004	12:30	46°09.924'	-13°52.933'	1, 3, 5, 7, 10, 14, 24	2000, 1500, 1000, 500, 200, 100, 5
19/10/2019	05	DY110_005	04:34	44°44.635'	-16°10.061'	1, 2, 3, 6, 8, 13, 24	500, 400, 300, 100, 75, 55, 5
19/10/2019	06	DY110_006	12:34	43°54.850'	-17°08.870'	1, 4, 5, 6, 7, 9, 14, 24	2000, 1250, 1000, 750, 500, 250, 90, 10
20/10/2019	07	DY110_007	04:36	42°14.509'	-19°11.766'	1, 3, 5, 6, 12, 13, 24	500, 300, 120, 100, 80, 60, 5
20/10/2019	08	DY110_008	12:24	41°27.928'	-20°11.317'	1, 4, 5, 6, 8, 13, 17, 24	2000, 1250, 1000, 750, 400, 100, 70, 5
21/10/2019	09	DY110_009	04:30	40°10.672'	-21°55.778'	1, 3, 6, 11, 13, 24	500, 300, 100, 65, 55, 2
23/10/2019	10	DY110_010	04:38	35°55.370'	-26°52.760'	1, 3, 5, 7, 12, 13, 14, 24	500, 300, 130, 100, 86, 65, 55, 2
23/10/2019	11	DY110_011	12:24	35°05.480'	-27°37.480'	1, 5, 6, 9, 11, 12, 16, 17, 18, 24	2000, 1000, 750, 300, 150, 120, 90, 60, 50, 5
24/10/2019	12	DY110_012	05:34	33°10.710'	-29°20.090'	1, 3, 6, 8, 13, 14, 15, 24	500, 300, 145, 120, 95, 75, 55, 2
24/10/2019	13	DY110_013	13:18	32°24.116'	-30°01.426'	1, 3, 4, 6, 9, 11, 16, 17, 18, 24	2000, 1500, 1250, 750, 300, 150, 95, 70, 50, 5
25/10/2019	14	DY110_014	13:30	30°16.060'	-31°51.640'	1, 3, 4, 6, 8, 10, 11, 16, 17, 24	2000, 1500, 1250, 750, 400, 200, 150, 115, 80, 10
26/10/2019	15	DY010_015	05:33	28°45.660'	-33°01.776'	1, 3, 4, 6, 11, 13, 24	500, 300, 200, 145, 110, 5
26/10/2019	16	DY110_016	13:27	27°57.252'	-33°41.081'	1, 10, 11, 12, 16, 17, 24	2000, 1000, 500, 200, 125, 80, 5
27/10/2019	17	DY110_017	05:31	26°08.400'	-35°11.690'	1, 3, 6, 7, 12, 13, 24	500, 300, 170, 145, 115, 100, 5
27/10/2019	18	DY110_018	13:17	25°18.030'	-35°54.270'	1, 3, 4, 5, 6, 7, 9, 16, 17, 20	2000, 1500, 1250, 1000, 750, 500, 300, 120, 70, 5
28/10/2019	19	DY110_019	05:22	23°25.198'	-37°31.895'	1, 5, 7, 12, 14, 22	500, 185, 145, 124, 95, 5
28/10/2019	20	DY110_020	13:22	22°35.258'	-37°41.962'	1, 4, 6, 8, 17, 20	2000, 1250, 750, 400, 90, 5
29/10/2019	21	DY110_021	13:23	19°47.920'	-34°46.656'	1, 2, 3, 4, 5, 6, 7, 8, 10, 17, 20	2000, 1750, 1500, 1250, 1000, 750, 500, 400, 200, 60, 5
30/10/2019	22	DY110_022	05:28	18°03.412'	-32°58.394'	1, 5, 7, 12, 14, 24	500, 150, 125, 100, 75, 5
30/10/2019	23	DT110_023	13:18	17°16.736'	-32°09.071'	1, 4, 6, 8, 10, 17	2000, 1250, 850, 400, 200, 60
31/10/2019	24	DY110_024	05:25	15°35.453'	-30°25.580'	1, 3, 5, 7, 14, 24	500, 300, 98, 80, 47, 5
31/10/2019	25	DY110_025	13:20	14°44.299'	-29°41.062'	1, 4, 7, 9, 11, 24	2000, 1250, 700, 400, 170, 5
01/11/2019	26	DY110_026	05:26	12°44.620'	-28°30.090'	2, 5, 6, 8, 14, 24	1, 2, 3, 4, 5, 6, 8, 13, 14, 24
01/11/2019	27	DY110_027	13:19	11°50.693'	-27°57.649'	1, 2, 4, 5, 8, 17	2000, 1750, 1250, 1000, 450, 34
02/11/2019	28	DY110_028	05:24	09°53.018'	-26°47.602'	1, 3, 5, 9, 14, 15	500, 300, 100, 60, 46, 37
02/11/2019	29	DY110_029	13:23	08°53.500'	-26°11.970'	1, 4, 5, 6, 7, 17	2000, 1250, 1000, 850, 500, 35

03/11/2019	30	DY110_030	05:26	06°44.974'	-24°59.969'	1, 3, 4, 9, 14, 16	500, 300, 200, 60, 50, 30
03/11/2019	31	DY110_031	13:13	05°31.302'	-25°00.108'	1, 4, 6, 8, 12, 18	2000, 1250, 800, 400, 80, 30
04/11/2019	32	DY110_032	05:24	02°52.747'	-24°59.677'	1, 3, 4, 7, 8, 14	500, 300, 200, 105, 85, 53
04/11/2019	33	DY110_033	13:16	01°40.604'	-25°0.528'	1, 4, 6, 9, 11, 13	2000, 1250, 800, 300, 90, 76
05/11/2019	34	DY110_034	04:28	-0°34.870'	-24°59.978'	1, 2, 3, 4, 5, 13, 15	2000, 1500, 750, 500, 260, 75, 43
06/11/2019	36	DY110_035	05:25	-04°18.026'	-24°59.930'	1, 3, 4, 7, 8, 10, 14	500, 300, 200, 110, 85, 72, 55
06/11/2019	37	DY110_036	11:08	-05°02.617'	-25°00.090'	1, 2, 3, 4, 5, 6, 7, 9	5000, 2000, 1500, 1000, 730, 400, 250, 85
07/11/2019	39	DY110_037	05:23	-07°23.670'	-25°0.491'	1, 2, 3, 4, 5, 6, 10	500, 400, 300, 200, 160, 120, 90
07/11/2019	40	DY110_038	13:22	-08°24.330'	-24°59.000'	1, 3, 4, 6, 9, 24	2000, 1500, 1250, 800, 300, 2
08/11/2019	42	DY110_039	05:02	-10°40.088'	-25°00.047'	2, 4, 6, 7, 9, 24	400, 200, 152, 120, 100, 2
08/11/2019	43	DY110_040	13:18	-11°52.920'	-25°00.046'	1, 3, 4, 6, 7, 8	2000, 1500, 1250, 800, 500, 400
09/11/2019	44	DY110_041	04:59	-14°16.288'	-24°59.651'	3, 4, 5, 6, 9, 16	300, 250, 200, 180, 150, 64
09/11/2019	45	DY110_042	13:19	-15°26.552'	-25°00.200'	1, 3, 4, 5, 6, 8, 9, 10, 14, 16	2000, 1500, 1250, 1000, 700, 400, 300, 170, 157, 140
11/11/2019	47	DY110_043	04:56	-20°14.780'	-24°59.740'	1, 2, 3, 4, 8, 12, 14, 16, 24	500, 400, 300, 200, 162, 120, 92, 68, 2
11/11/2019	48	DY110_044	13:16	-21°26.246'	-24°50.248'	1, 2, 3, 6, 7, 9, 10, 11, 14, 16	2000, 1750, 1500, 835, 500, 320, 250, 180, 162, 140
12/11/2019	50	DY110_045	04:27	-23°43.547'	-24°55.250'	1, 2, 3, 4, 6, 8, 13, 16, 24	500, 400, 300, 210, 180, 168, 128, 72, 2
12/11/2019	51	DY110_046	12:14	-24°44.102'	-25°12.281'	1, 2, 3, 5, 6, 9, 10, 11, 14, 16	2000, 1750, 1500, 1000, 850, 320, 250, 190, 158, 140
13/11/2019	52	DY110_047	04:24	-26°45.731'	-25°48.404'	1, 2, 3, 4, 5, 7, 11, 12, 15, 24	500, 400, 300, 210, 170, 120, 105, 91, 51, 2
13/11/2019	53	DY110_048	12:19	-27°42.528'	-26°05.105'	1, 2, 3, 4, 5, 6, 8, 11, 15, 24	1000, 800, 500, 400, 300, 200, 160, 125, 100, 2
14/11/2019	54	DY110_049	04:26	-30°01.616'	-26°47.128'	2, 4, 7, 11, 12, 14, 16, 17, 19, 24	250, 180, 110, 100, 84, 63, 38, 26, 14, 2
14/11/2019	55	DY110_050	12:56	-31°12.706'	-27°09.010'	1, 2, 3, 4, 5, 6, 8, 11, 14, 24	1000, 900, 700, 500, 300, 200, 150, 125, 100, 2
15/11/2019	56	DY110_051	04:36	-33°35.932'	-27°53.440'	1, 2, 4, 6, 9, 12, 14, 16, 17, 19, 24	250, 200, 150, 135, 100, 85, 61, 36, 25, 13, 2
15/11/2019	57	DY110_052	12:56	-34°46.624'	-28°15.124'	1, 2, 3, 4, 5, 6, 8, 9, 13, 17, 18, 24	1000, 900, 700, 500, 400, 250, 140, 100, 85, 70, 40, 2
16/11/2019	58	DY110_053	04:38	-37°04.897'	-29°01.019'	1, 2, 4, 6, 9, 12, 14, 16, 17, 19, 24	500, 250, 150, 70, 55, 42, 31, 19, 13, 7, 2
17/11/2019	60	DY110_054	04:05	-40°21.334'	-31°02.357'	1, 2, 3, 4, 5, 6, 8, 10, 14, 16, 17, 24	1000, 800, 600, 400, 200, 100, 55, 40, 23, 17, 9, 3
18/11/2019	62	DY110_055	03:38	-41°54.088'	-35°25.860'	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 17, 18, 19, 24	2000, 1500, 1250, 1000, 800, 600, 400, 250, 100, 40, 20, 15, 10, 5, 2

Dissolved Inorganic Nutrients

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Objectives

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

Methods

Water samples were taken from a 24 x 20 litre bottle stainless steel framed CTD / Rosette system (Seabird). The number of depths sampled from each CTD cast ranged from four to fifteen, capturing the entire available depth profile with a particular interest in sampling along the thermocline. Table 1 lists the samples collected. Water was collected into clean (acid-washed) 60ml HDPE (Nalgene) sample bottles, which were rinsed x3 with sample seawater prior to filling. The bottles were filled to around 75% volume, dried, and placed in a Ziploc bag before being stored at -20°c.

Micro-molar nutrient analysis of the samples will be carried out on return to PML using a 4 channel (nitrate (Brewer & Riley, 1965), nitrite (Grasshoff,K., 1976), phosphate, silicate (Kirkwood, D.S., 1989) Bran & Luebbe AAIII segmented flow, colourimetric auto-analyser.

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Grasshoff, K., 1976. Methods of sea-water analysis, *Verlag Chemie, Weiheim:* pp.317.

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Table 1

Date	Station	CTD	Time in water (GMT)	Lat (+ve °N)	Long (+ve °E)	Niskins sampled	Depths sampled (m)
16/10/2019	01	DY110_001	08:13	49°2.891'	-6°43.927'	1, 7, 9, 13	115, 70, 40, 5
16/10/2019	02	DY110_002	13:20	48°31.309'	-7°12.224'	1, 7, 9, 10, 24	140, 50, 35, 25, 2
17/10/2019	03	DY110_003	04:42	47°14.604'	-9°18.913'	1, 2, 3, 4, 8, 13, 15, 17, 19, 24	500, 400, 300, 200, 50, 35, 20, 12, 5, 5
18/10/2019	04	DY110_004	12:30	46°09.924'	-13°52.933'	1, 3, 5, 7, 11, 14, 15, 18, 19, 24	2000, 1500, 1000, 500, 200, 100, 80, 70, 50, 5
19/10/2019	05	DY110_005	04:34	44°44.635'	-16°10.061'	1, 2, 3, 6, 8, 13, 24	500, 400, 300, 100, 90, 75, 55, 25, 14, 5
19/10/2019	06	DY110_006	12:34	43°54.850'	-17°08.870'	1, 3, 5, 7, 10, 13, 14, 15, 16, 20	2000, 1500, 1000, 500, 200, 100, 90, 80, 70, 10
20/10/2019	07	DY110_007	04:36	42°14.509'	-19°11.766'	1, 2, 3, 5, 6, 7, 12, 13, 17, 24	500, 400, 300, 120, 100, 80, 80, 60, 20, 5
20/10/2019	08	DY110_008	12:24	41°27.928'	-20°11.317'	1, 4, 6, 8, 10, 12, 13, 17, 18, 20	2000, 1250, 750, 400, 200, 120, 100, 70, 60, 5
21/10/2019	09	DY110_009	04:30	40°10.672'	-21°55.778'	1, 2, 3, 5, 6, 7, 11, 13, 17, 24	500, 400, 300, 120, 100, 80, 65, 55, 15, 2

23/10/2019	10	DY110_010	04:38	35°55.370'	-26°52.760'	1, 2, 3, 4, 6, 7, 12, 15, 16, 24	500, 400, 300, 200, 130, 100, 86, 55, 35, 2
23/10/2019	11	DY110_011	12:24	35°05.480'	-27°37.480'	1, 2, 5, 6, 8, 10, 11, 16, 18, 20	2000, 1750, 1000, 750, 400, 200, 150, 90, 50, 5
24/10/2019	12	DY110_012	05:34	33°10.710'	-29°20.090'	1, 2, 4, 5, 6, 13, 14, 15, 16, 24	500, 400, 200, 180, 145, 95, 75, 55, 40, 2
24/10/2019	13	DY110_013	13:18	32°24.116'	-30°01.426'	1, 3, 6, 8, 11, 12, 16, 17, 18, 20	2000, 1500, 750, 400, 150, 120, 95, 70, 50, 5
25/10/2019	14	DY110_014	13:30	30°16.060'	-31°51.640'	1, 3, 6, 8, 10, 12, 16, 17, 18, 19, 20	2000, 1500, 750, 400, 200, 140, 115, 80, 70, 40, 10
26/10/2019	15	DY010_015	05:33	28°45.660'	-33°01.776'	1, 2, 3, 4, 5, 6, 11, 13, 14, 24	500, 400, 300, 200, 170, 145, 110, 90, 70, 50
26/10/2019	16	DY110_016	13:27	27°57.252'	-33°41.081'	1, 10, 12, 13, 14, 17, 18, 19, 20	2000, 1000, 200, 140, 125, 80, 60, 40, 5
27/10/2019	17	DY110_017	05:31	26°08.400'	-35°11.690'	1, 2, 3, 4, 6, 12, 14, 15, 16, 24	500, 400, 300, 200, 170, 115, 100, 77, 57, 5
27/10/2019	18	DY110_018	13:17	25°18.030'	-35°54.270'	1, 3, 5, 6, 8, 11, 16, 17, 18, 20	2000, 1500, 1000, 750, 400, 150, 120, 70, 60, 5
28/10/2019	19	DY110_019	05:22	23°25.198'	-	1, 3, 4, 6, 7, 12,	500, 300, 185, 170, 145, 124,

					37°31.895'	14, 15, 16, 24	95, 70, 55, 5
28/10/2019	20	DY110_020	13:22	22°35.258'	-37°41.962'	1, 3, 5, 6, 8, 11, 16, 17, 18, 20	2000, 1500, 1000, 750, 400, 150, 105, 90, 60, 5
29/10/2019	21	DY110_021	13:23	19°47.920'	-34°46.656'	1, 3, 5, 6, 8, 11, 12, 16, 17, 20	2000, 1250, 1000, 750, 400, 160, 140, 100, 60, 5
30/10/2019	22	DY110_022	05:28	18°03.412'	-32°58.394'	1, 2, 3, 4, 5, 7, 12, 14, 15, 24	500, 400, 300, 200, 150, 125, 100, 75, 55, 5
30/10/2019	23	DT110_023	13:18	17°16.736'	-32°09.071'	1, 3, 6, 8, 10, 11, 12, 16, 17, 20	2000, 1500, 850, 400, 200, 160, 100, 80, 60, 5
31/10/2019	24	DY110_024	05:25	15°35.453'	-30°25.580'	1,2, 3, 4, 5, 7, 12, 14, 15, 24	500, 400, 300, 200, 98, 80, 65, 47, 37, 5
31/10/2019	25	DY110_025	13:20	14°44.299'	-29°41.062'	1, 3, 5, 6, 9, 11, 12, 16, 17, 24	2000, 1500, 1000, 850, 400, 170, 100, 72, 50, 5
01/11/2019	26	DY110_026	05:26	12°44.620'	-28°30.090'	1, 2, 3, 4, 5, 6, 8, 13, 14, 24	500, 400, 300, 200, 100, 58, 45, 39, 29, 2
01/11/2019	27	DY110_027	13:19	11°50.693'	-27°57.649'	1, 3, 6, 8, 10, 11, 12 ,14, 17, 24	2000, 1500, 900, 450, 170, 100, 60, 43, 34, 5
02/11/2019	28	DY110_028	05:24	09°53.018'	-26°47.602'	1, 2, 3, 4, 6, 7, 9, 14, 15, 24	500, 400, 300, 200, 85, 73, 60, 46, 37, 5

02/11/2019	29	DY110_029	13:23	08°53.500'	-26°11.970'	1, 3, 5, 6, 7, 11, 12, 16, 17, 24	2000, 1500, 1000, 850, 500, 120, 70, 58, 35, 2
03/11/2019	30	DY110_030	05:26	06°44.974'	-24°59.969'	1, 2, 4, 6, 7, 8, 9, 14, 16, 24	500, 400, 300, 100, 85, 73, 60, 50, 30, 5
03/11/2019	31	DY110_031	13:13	05°31.302'	-25°00.108'	1, 3, 5, 6, 8, 11, 16, 17, 18, 24	2000, 1500, 1000, 800, 400, 150, 72, 60, 30, 5
04/11/2019	32	DY110_032	05:24	02°52.747'	-24°59.677'	1, 2, 4, 5, 7, 8, 11, 13, 15, 24	500, 400, 200, 150, 105, 85, 70, 53, 40, 2
04/11/2019	33	DY110_033	13:16	01°40.604'	-25°0.528'	1, 3, 5, 6, 8, 9, 10, 15, 16, 24	2000, 1500, 1000, 800, 400, 300, 150, 76, 55, 2
05/11/2019	34	DY110_034	04:28	-0°34.870'	-24°59.978'	1, 2, 3, 4, 5, 7, 8, 13, 14, 19	2000, 1500, 750, 500, 260, 113, 90, 75, 57, 2
06/11/2019	36	DY110_035	05:25	-04°18.026'	-24°59.930'	1, 2, 4, 5, 7, 8, 11, 13, 15, 24	500, 400, 200, 160, 110, 85, 72, 55, 40, 2
06/11/2019	37	DY110_036	11:08	-05°02.617'	-25°00.090'	1, 2, 3, 4, 5, 6, 8, 14, 15, 24	5000, 2000, 1500, 1000, 730, 400, 100, 85, 49, 2
07/11/2019	39	DY110_037	05:23	-07°23.670'	-25°0.491'	1, 2, 3, 4, 5, 6, 7, 10, 12, 24	500, 400, 300, 200, 160, 120, 100, 90, 70, 2
07/11/2019	40	DY110_038	13:22	-08°24.330'	-24°59.000'	1, 3, 5, 6, 7, 9, 10, 11, 15, 16,	2000, 1500, 1000, 800, 500, 300, 200, 120, 100, 76, 2

						24	
08/11/2019	42	DY110_039	05:02	-10°40.088'	-25°00.047'	1, 2, 4, 5, 6, 7, 10, 12, 13, 24	500, 400, 200, 160, 152, 120, 100, 90, 76, 2
08/11/2019	43	DY110_040	13:18	-11°52.920'	-25°00.046'	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 15, 17, 18, 24	2000, 1750, 1500, 1250, 1000, 800, 500, 400, 200, 125, 113, 85, 55, 2
09/11/2019	44	DY110_041	04:59	-14°16.288'	-24°59.651'	1, 2, 3, 4, 5, 6, 10, 12, 13, 15, 16, 17, 24	500, 400, 300, 250, 200, 180, 150, 125, 114, 87, 64, 45, 2
09/11/2019	45	DY110_042	13:19	-15°26.552'	-25°00.200'	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 14, 16, 17, 18, 24	2000, 1750, 1500, 1250, 1000, 700, 500, 400, 300, 170, 157, 140, 85, 55, 2
11/11/2019	47	DY110_043	04:56	-20°14.780'	-24°59.740'	1, 2, 3, 4, 6, 9, 11, 12, 15, 24	500, 400, 300, 200, 180, 162, 140, 120, 92, 2
12/11/2019	50	DY110_045	04:27	-23°43.547'	-24°55.250'	1, 2, 3, 4, 6, 11, 12, 13, 15, 24	500, 400, 300, 210, 180, 168, 140, 128, 97, 2
12/11/2019	51	DY110_046	12:14	-24°44.102'	-25°12.281'	1, 2, 3, 5, 6, 7, 9, 10, 11, 14, 16, 17, 19, 24	2000, 1750, 1500, 1000, 850, 500, 320, 250, 190, 158, 140, 85, 35, 2
13/11/2019	52	DY110_047	04:24	-26°45.731'	-25°48.404'	1, 2, 3, 4, 5, 7, 11, 12, 14, 24	500, 400, 300, 210, 170, 120, 105, 91, 69, 2

13/11/2019	53	DY110_048	12:19	-27°42.528'	-26°05.105'	1, 2, 3, 6, 8, 11, 15, 16, 17, 24	1000, 800, 500, 200, 160, 125, 100, 85, 55, 2
14/11/2019	54	DY110_049	04:26	-30°01.616'	-26°47.128'	2, 4, 7, 11, 12, 14, 16, 17, 19, 24	250, 180, 110, 100, 84, 63, 38, 26, 14, 2
14/11/2019	55	DY110_050	12:56	-31°12.706'	-27°09.010'	1, 2, 3, 4, 5, 6, 8, 11, 14, 24	1000, 900, 700, 500, 300, 200, 150, 125, 100, 2
15/11/2019	56	DY110_051	04:36	-33°35.932'	-27°53.440'	1, 2, 4, 6, 9, 12, 14, 16, 17, 19, 24	250, 200, 150, 135, 100, 85, 61, 36, 25, 13, 2
15/11/2019	57	DY110_052	12:56	-34°46.624'	-28°15.124'	1, 2, 3, 4, 5, 6, 8, 10, 13, 17, 24	1000, 900, 700, 500, 400, 250, 140, 100, 85, 70, 2
16/11/2019	58	DY110_053	04:38	-37°04.897'	-29°01.019'	1, 2, 4, 6, 9, 12, 14, 16, 17, 19, 24	500, 250, 150, 70, 55, 42, 31, 19, 13, 7, 2
17/11/2019	60	DY110_054	04:05	-40°21.334'	-31°02.357'	1, 2, 3, 4, 5, 6, 8, 10, 14, 16, 17, 19, 24	1000, 800, 600, 400, 200, 100, 55, 40, 23, 17, 9, 5, 3
18/11/2019	62	DY110_055	03:38	-41°54.088'	-35°25.860'	1, 3, 4, 5, 7, 8, 9, 10, 11, 15, 17, 18, 24	2000, 1500, 1250, 1000, 600, 400, 250, 100, 40, 20, 15, 10, 2

Carbonate System: Total Alkalinity (AT) and pH

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Objective

- Seawater pH is one of four carbonate system parameters. The other parameters are: pCO2 (CO2 partial pressure- µatm), DIC (Dissolved Inorganic Carbon) and TA (Total Alkalinity - µmol/L or µmol/kg)). If we know any two of the four, we can calculate the remaining two. These measurements will contribute to our understanding of the distribution of C sources and sinks in the Atlantic Ocean and the capacity of the ocean to take up anthropogenic CO2.

Method

Rinse 500 mL sample amber glass bottle 2 times (with sample) and fill directly from Niskin 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). The samples were reding immediately in a spectrophotometric pH system (PML asset number 590) using the m-cresol-purple dye (Dickson et al., 2007). The temperature of the sample was recorded in the spectrophotometer cell.
Every day was made a reference spectrum and the end of each CTD was run MiliQ water.
The calculations and corrections were applied within the R-script. The pH method employed here has typical precision in the low 10-3 to 10-4 pH-unit range. Preliminary results are summarized in Figure 1.

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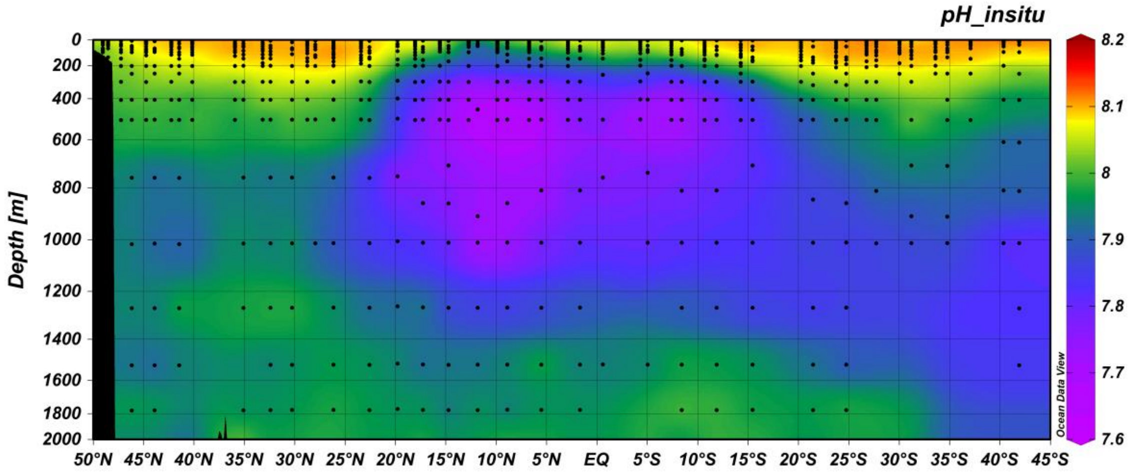

Figure 1. pH profiles along the Atlantic Meridional Transect – 29.

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Samples collected from CTD casts for pH analyses

Date	Time	Station No	CTD Cast No	Lat	Long (W)	Niskin Bottles No	Depths Samples (m)
16/10/2019	0813	1	1	49º 02.891' N	006º 43.927'	3; 4; 5; 7; 9; 10; 11; 16	100; 90; 80; 70; 40; 25; 15; 5
16/10/2019	1320	2	2	48º 31.309' N	007º 12.224'	1; 5; 7; 8; 9; 10; 19; 20; 21; 24	140; 70; 50; 40; 35; 25; 10; 5; 2; 2
17/10/2019	0442	3	3	47º 14.604' N	009º 18.913'	1; 2; 3; 4; 5; 6; 7; 8; 13; 24	500; 400; 300; 150; 100; 80; 50; 35; 5
18/10/2019	1230	4	4	46º 09,924' N	013º 52.933'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 14; 15; 18; 19; 24	2000; 1750; 1500; 1250; 1000; 750; 500; 300; 250; 200; 100; 80; 65; 50; 5
19/10/2019	0434	5	5	44º 44.635' N	016º 10.061'	1; 2; 3; 4; 5; 6; 7; 8; 13; 14; 15; 16; 17; 24	500; 400; 300; 200; 125; 100; 90; 75; 55; 35; 25; 21; 14; 5
19/10/2019	1234	6	6	43º 54, 850'N	017º 08.870'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 12; 14; 15; 16; 20	2000; 1750; 1500; 1250; 1000; 750; 500; 300; 250; 200; 100; 90; 80; 70; 10
20/10/2019	0436	7	7	42º 14,500' N	019º 11,766'	1; 2; 3; 4; 5; 6; 7; 12; 13; 14; 15; 16; 17; 18; 24	500; 400; 300; 200; 120; 100; 80; 80; 60; 45; 35; 30; 20; 10; 5
20/10/2019	1224	8	8	41º 27,928' N	020º 11,317'	1; 3; 4; 5; 6; 7; 8; 9; 10; 12; 13; 17; 18; 19; 20	2000; 1500; 1250; 1000; 750; 500; 300; 250; 200; 120; 100; 70; 60; 30; 5
21/10/2019	0430	9	9	40º 10,672' N	021º 55,778'	1; 2; 3; 4; 5; 6; 7; 11; 13; 14; 15; 16; 17; 18; 24	500; 400; 300; 200; 120; 100; 80; 65; 55; 37; 27; 22; 15; 8; 5
23/10/2019	0439	10	10	35º 55,370' N	026º 52,760'	1; 2; 3; 4; 6; 7; 8; 12; 13; 14; 15; 16; 17; 18; 24	500; 400; 300; 200; 130; 100; 86; 86; 65; 55; 50; 35; 30; 20; 2
23/10/2019	1224	11	11	35º 05,480' N	027º 37,480'	1; 2; 4; 5; 6; 8; 9; 10; 11; 12; 16; 17; 18; 19; 20	2000; 1750; 1250; 1000; 750; 400; 300; 200; 150; 120; 90; 60; 50; 30; 5
24/10/2019	0535	12	12	33º 10.710' N	029º 20.090'	1; 2; 3; 4; 6; 8; 9; 13; 14; 15; 16; 18; 24	500; 400; 300; 200; 180; 145; 120; 92; 92; 75; 55; 40; 23; 2

24/10/2019	1317	13	13	32º 24,116' N	030º 01,426'	1; 2; 4; 5; 6; 8; 9; 10; 11; 12; 16; 17; 18; 19; 20	2000; 1750; 1500; 1250; 1000; 750; 400; 300; 200; 150; 120; 95; 70; 50; 5
25/10/2019	1331	14	14	30º 16,060' N	031º 51,650'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 16; 17; 18; 20	2000; 1750; 1500; 1250; 1000; 750; 500; 400; 300; 200; 115; 80; 70; 20
26/10/2019	0533	15	15	29º 45,660' N	033º 01,776'	1; 2; 3; 4; 5; 6; 11; 13; 14; 15; 16; 17; 18; 24	500; 400; 300; 200; 170; 145; 110; 90; 70; 50; 40; 30; 15; 5
26/10/2019	1327	16	16	27º 57,252' N	033º 41,081'	1; 10; 11; 12; 13; 14; 17; 18; 19; 20	2000; 1000; 500; 200; 140; 125; 80; 60; 40; 5
27/10/2019	0531	17	17	26º 08,400' N	035º 11,690'	1; 2; 3; 4; 6; 7; 12; 14; 15; 16; 17; 18; 19; 24	500; 400; 300; 200; 170; 145; 115; 100; 77; 57; 47; 32; 17; 5
27/10/2019	1317	18	18	25º 18, 030' N	035º 18,030'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 12; 16; 17; 18; 20	2000; 1750; 1500; 1250; 1000; 750; 500; 400; 300; 200; 140; 120; 70; 60; 5
28/10/2019	0530	19	19	23º 25,148' N	037º 31,895'	1; 2; 3; 4; 6; 7; 12; 14; 15; 16; 17; 18; 19; 24	500; 400; 300; 185; 170; 145; 124; 95; 70; 55; 45; 30; 15; 5
28/10/2019	0013	20	20	22º 36,258' N	037º 41,962'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17; 18; 20	2000; 1750; 1500; 1250; 1000; 750; 500; 400; 300; 200; 150; 140; 105; 90; 60; 5
29/10/2019	1324	21	21	19º 47,920' N	034º 46,656'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 16; 17; 18; 20	2000; 1750; 1500; 1250; 1000; 750; 500; 400; 300; 200; 160; 100; 60; 40; 5
30/10/2019	0528	22	22	18º 03,412' N	032º 58,394'	1; 2; 3; 4; 5; 7; 12; 14; 15; 16; 17; 18; 19; 24	500; 400; 300; 200; 150; 125; 100; 75; 55; 45; 35; 25; 15; 5
30/10/2019	1318	23	23	17º 16,736' N	032º 09,071'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17; 20	2000; 1750; 1500; 1250; 1000; 850; 500; 400; 300; 200; 160; 100; 80; 60; 5
31/10/2019	0525	24	24	15º 35,455' N	030º 25,580'	1; 2; 3; 4; 5; 7; 12; 14; 15; 16; 17; 18; 19; 24	500; 400; 300; 200; 98; 80; 65; 47; 37; 27; 22; 15; 8; 5
31/10/2019	1320	25	25	14º 44,299' N	029º 41,062'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17; 24	2000; 1750; 1500; 1250; 1000; 850; 700; 500; 400; 300; 170; 100; 72; 50; 5

01/11/2019	0526	26	26	12º 44,620' N	028º 30,020'	1; 2; 3; 4; 5; 6; 8; 13; 14; 15; 16; 17; 24	500; 400; 300; 200; 100; 58; 45; 39; 29; 22; 16; 8; 5
01/11/2019	1319	27	27	14º 50,693' N	027º 57,649'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 15; 17; 24	2000; 1750; 1500; 1250; 1000; 900; 700; 450; 300; 170; 100; 60; 50; 34; 5
02/11/2019	0524	28	28	09º 53,018' N	026º 47,602'	1; 2; 3; 4; 5; 6; 7; 9; 14; 15; 16; 17; 18; 24	500; 400; 300; 200; 100; 85; 73; 60; 47; 37; 28; 21; 11; 5
02/11/2019	1323	29	29	08º 53,500' N	026º 11,970'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 15; 17; 24	2000; 1750; 1500; 1250; 1000; 850; 500; 400; 300; 170; 120; 70; 58; 35; 24; 5
03/11/2019	0525	30	30	06º 44,974' N	024º 59,969'	1; 2; 3; 4; 5; 6; 8; 13; 14; 15; 16; 17; 24	500; 400; 300; 200; 150; 100; 85; 73; 60; 50; 37; 30; 21; 11; 5
03/11/2019	1313	31	31	05º 31,302' N	025º 00,018'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17; 24	2000; 1750; 1500; 1250; 1000; 800; 500; 400; 300; 200; 150; 80; 69; 55; 5
04/11/2019	0515	32	32	02º 52,747' N	024º 58,677'	1; 2; 3; 4; 5; 7; 8; 11; 14; 15; 17; 18; 24	500; 400; 300; 200; 150; 105; 85; 70; 53; 40; 24; 16; 2
04/11/2019	1316	33	33	01º 40,604' N	025º 00,528'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 15; 16; 24	2000; 1750; 1500; 1250; 1000; 800; 500; 400; 300; 200; 150; 90; 76; 55; 2
05/11/2019	0428	34	34	00º 34,810' S	024º 59,918'	1; 2; 3; 4; 5; 7; 8; 13; 14; 15; 16; 17; 19	2000; 1500; 750; 500; 260; 150; 113; 90; 75; 57; 43; 32; 18; 2
06/11/2019	0525	36	35	04º 18,026' S	024º 59,930'	1; 2; 3; 4; 5; 7; 8; 10; 14; 15; 17; 18; 19; 20	500; 400; 300; 200; 160; 110; 85; 72; 55; 40; 24; 16; 9; 2
06/11/2019	1108	37	36	05º 02,617' S	025º 00,080'	1; 2; 3; 4; 5; 6; 7; 8; 9; 15; 24	5000; 2000; 1500; 730; 400; 250; 100; 85; 90; 49; 2
07/11/2019	0523	39	37	07º 23,670' S	025º 00,491'	1; 2; 3; 4; 5; 6; 7; 10; 13; 14; 16; 17; 24	500; 400; 300; 200; 160; 120; 100; 90; 70; 50; 36; 20; 2
07/11/2019	1322	40	38	08º 24,340' S	024º 59,000'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 15; 17; 24	2000; 1750; 1500; 1250; 1000; 800; 500; 400; 300; 200; 120; 100; 76; 2
08/11/2019	0502	42	39	10º 40,088' S	025º 00,041'	1; 2; 3; 4; 5; 6; 7; 10; 13; 14; 16; 17; 24	500; 400; 300; 200; 160; 152; 120; 100; 90; 76; 58; 43; 24; 2

08/11/2019	1318	43	40	11º 52,920' S	025º 00,462'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 15; 17; 18; 24	2000; 1750; 1500; 1250; 1000; 800; 500; 400; 300; 200; 125; 120; 85; 55; 2
09/11/2019	0459	44	41	14º 16,288' S	024º 59,651'	1; 2; 3; 4; 5; 6; 9; 12; 13; 14; 16; 17; 18; 24	500; 400; 300; 200; 180; 150; 125; 114; 87; 64; 45; 36; 2
09/11/2019	1319	45	42	15º 26,552' S	025º 00,200'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 14; 16; 17; 18; 24	2000; 1750; 1500; 1250; 1000; 700; 500; 400; 170; 157; 140; 85; 55; 2
11/11/2019	0456	47	43	20º 14,780' S	024º 59,740'	1; 2; 3; 4; 6; 8; 11; 12; 14; 16; 17; 18; 19; 24	500; 400; 300; 200; 180; 162; 140; 120; 92; 68; 55; 38; 20; 2
11/11/2019	1316	48	44	21º 26,246' S	024º 50,248'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 14; 16; 18; 24	2000; 1750; 1500; 1250; 1000; 835; 500; 400; 320; 250; 180; 162; 140; 55; 2
12/11/2019	0427	50	45	23º 43,547' S	024º 55,250'	1; 2; 3; 4; 6; 9; 12; 13; 15; 16; 17; 18; 19; 24	500; 400; 300; 210; 180; 168; 140; 128; 97; 72; 59; 40; 21; 2
12/11/2019	1211	51	46	24º 44,102' S	025º 12,281'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 14; 16; 18; 24	2000; 1750; 1500; 1250; 1000; 850; 500; 400; 320; 250; 190; 158; 140; 55; 2
13/11/2019	0424	52	47	26º 45,731' S	025º 48,404'	1; 2; 3; 4; 5; 8; 11; 12; 14; 15; 16; 17; 18; 24	500; 400; 300; 210; 170; 120; 105; 91; 69; 51; 42; 28; 15; 2
13/11/2019	1219	53	48	27º 42,528' S	026º 05,105'	1; 2; 3; 4; 5; 6; 8; 11; 15; 16; 17; 18; 19; 24	1000; 800; 500; 400; 300; 200; 160; 125; 100; 85; 55; 35; 15; 2
14/11/2019	0426	54	49	30º 01,616' S	026º 47,128'	2; 4; 7; 11; 12; 14; 16; 17; 19; 24	250; 180; 110; 100; 84; 63; 38; 26; 14; 2
14/11/2019	1256	55	50	31º 12,706' S	027º 09,010'	1; 2; 3; 4; 5; 6; 7; 11; 14; 16; 17; 18; 19; 24	1000; 800; 500; 400; 300; 200; 160; 125; 100; 85; 55; 35; 15; 2
15/11/2019	0436	56	51	33º 35,935' S	027º 53,440'	1; 2; 4; 6; 9; 12; 14; 16; 17; 19; 24	250; 200; 150;135; 100; 85; 61; 36; 25; 13; 2
15/11/2019	1256	57	52	34º 46,624' S	028º 15,124'	1; 2; 3; 4; 5; 6; 7; 9; 14; 16; 18; 19; 24	1000; 900; 700; 500; 400; 250; 140; 100; 85; 70; 40; 20; 2
16/11/2019	0438	58	53	37º 04,897' S	029º 01,019'	1; 2; 4; 6; 9; 12; 14; 16; 17; 19;	500; 250; 150; 70; 55; 42; 31; 19; 13; 70; 2

						24	
17/11/2019	0405	60	54	40º 21,334' S	031º 02,357'	1; 2; 3; 4; 5; 6; 7; 12; 15; 16; 17; 19	1000; 800; 600; 400; 200; 100; 55; 40; 23; 17; 9; 5
18/11/2019	0338	62	55	41º 54,088' S	035º 25,860'	1; 3; 4; 5; 6; 7; 8; 9; 10; 11; 15; 16; 18; 19; 20	2000; 1500; 1250; 1000; 800; 600; 400; 250; 100; 40; 20; 15; 10; 2

Effects of Saharan dust on coccolithophore communitites

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Objective

- 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, we have collected water samples along the cruise track to study the coccolithophore communities.

Methods

For the coccolithophore analysis, 2 to 4 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 immediately on board through cellulose nitrate filters (47 mm diameter, 0,45 µm pore size) by means of a water jet pump. 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 a Polarising Light- and Scanning Electron Microscopes (SEM).
To relate changes in phytoplankton biomass, N-fixing organisms and coccolithophore species, to eventual variations in amount and composition of dust deposition, contemporary sampling of aerosol were also acquired (check the Dust collector section in this report).

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Seawater sampling from CTD casts for coccolithophore analysis

Date	Time	Station No	CTD Cast No	Lat	Long (W)	Niskin Bottles No	Depths Samples (m)
16/10/2019	0813	1	1	49º 02.891' N	006º 43.927'	6; 9; 12	70; 40; 5
16/10/2019	1320	2	2	48º 31.309' N	007º 12.224'	6; 19; 22	60; 10; 2
17/10/2019	0442	3	3	47º 14.604' N	009º 18.913'	6; 10; 23	100; 35; 5
18/10/2019	1230	4	4	46º 09,924' N	013º 52.933'	14;17; 19; 22	100; 65; 50; 5
19/10/2019	0434	5	5	44º 44.635' N	016º 10.061'	5; 8; 10; 15; 23	125; 75; 55; 25; 5
19/10/2019	1234	6	6	43º 54, 850' N	017º 08.870'	10; 11; 12; 18; 21	200; 150; 100; 50; 10
20/10/2019	0436	7	7	42º 14,500' N	019º 11,766'	4, 5; 9; 13; 23	200; 120; 80; 60; 5
20/10/2019	1224	8	8	41º 27,928' N	020º 11,317'	10; 11; 17; 18; 21	200; 150; 70; 60; 5
21/10/2019	0430	9	9	40º 10,672' N	021º 55,778'	4; 5; 9; 13; 23	200; 120; 65; 55; 2
21/10/2019	0439	10	10	35º 55,370' N	026º 52,760'	4; 6; 10; 14; 24	200; 130; 86; 55; 2
23/10/2019	1224	11	11	35º 05,480' N	027º 37,480'	10; 12; 16; 17; 21	200; 120; 90; 60; 5
24/10/2019	0535	12	12	33º 10.710' N	029º 20.090'	4; 6; 11; 15; 24	200; 145; 92; 55; 2
24/10/2019	1317	13	13	32º 24,116' N	030º 01,426'	10; 11; 16; 18; 21	200; 150; 95; 50; 5
25/10/2019	1331	14	14	30º 16,060' N	031º 51,650'	10; 12; 16; 18; 21	200; 140; 115; 70; 19
26/10/2019	0533	15	15	29º 45,660' N	033º 01,776'	4; 6; 9; 13; 24	200; 145; 110; 90; 5
26/10/2019	1327	16	16	27º 57,252' N	033º 41,081'	12; 13; 14; 17; 21	200; 140; 125; 80; 5
27/10/2019	0531	17	17	26º 08,400' N	035º 11,690'	4; 6; 10; 16; 24	200; 170; 115; 57; 5
27/10/2019	1317	18	18	25º 18, 030' N	035º 18,030'	10; 12; 16; 18; 20	200; 140; 120; 60; 5

28/10/2019	0530	19	19	23º 25,148' N	037º 31,895'	4; 7; 10; 14; 24	185; 145; 124; 95; 5
28/10/2019	1322	20	20	22º 36,258' N	037º 41,962'	10; 12; 16; 17; 21	200; 140; 105; 90; 5
29/10/2019	1324	21	21	19º 47,920' N	034º 46,656'	10; 11; 16; 17; 20	200; 160; 100; 60; 5
30/10/2019	0528	22	22	18º 03,412' N	032º 58,394'	4; 7; 10; 14; 24	200; 125; 100; 75; 5
30/10/2019	1318	23	23	17º 16,736' N	032º 09,071'	10; 12; 16; 17; 21	200; 100; 80; 60; 5
31/10/2019	0525	24	24	15º 35,455' N	030º 25,580'	4; 6; 10; 14; 24	200; 98; 65; 47; 5
31/10/2019	1320	25	25	14º 44,299' N	029º 41,062'	11; 12; 16; 17; 24	170; 100; 72; 50; 5
01/11/2019	0526	26	26	12º 44,620' N	028º 30,020'	5; 7; 11; 14; 24	100; 58; 39; 29; 5
01/11/2019	1319	27	27	14º 50,693' N	027º 57,649'	11; 12; 13; 17; 20	100; 60; 50; 34; 5
02/11/2019	0524	28	28	09º 53,018' N	026º 47,602'	5; 9; 12; 15; 19	100; 60; 44; 37; 5
02/11/2019	1323	29	29	08º 53,500' N	026º 11,970'	11; 12; 16; 17; 24	120; 70; 58; 35; 5
03/11/2019	0525	30	30	06º 44,974' N	024º 59,969'	6; 7; 12; 16; 24	100; 85; 50; 30; 5
03/11/2019	1313	31	31	05º 31,302' N	025º 00,018'	11; 12; 16; 17; 24	150; 80; 69; 55; 5
04/11/2019	0515	32	32	02º 52,747' N	024º 58,677'	5; 6; 11; 13; 24	150; 105; 70; 53; 5
04/11/2019	1316	33	33	01º 40,604' N	025º 00,528'	10; 11; 15; 17; 24	150; 90; 76; 55; 2
05/11/2019	0428	34	34	00º 34,810' S	024º 59,918'	7; 8; 11; 14; 24	113; 90; 75; 57; 2
06/11/2019	0525	36	35	04º 18,026' S	024º 59,930'	5; 6; 11; 13; 24	160; 110; 72; 55; 2
06/11/2019	1108	37	36	05º 02,617' S	025º 00,080'	7; 8; 14; 17; 24	250; 100; 85; 49; 2
07/11/2019	0523	39	37	07º 23,670' S	025º 00,491'	5; 6; 10; 12;	160; 120; 90;

						24	70; 2
07/11/2019	1322	40	38	08º 24,340' S	024º 59,000'	10; 11; 15; 17; 24	200; 120; 100; 76; 2
08/11/2019	0502	42	39	10º 40,088' S	025º 00,041'	4; 7; 10; 12; 24	200; 120; 100; 90; 2
08/11/2019	1318	43	40	11º 52,920' S	025º 00,462'	10; 11; 12; 17; 24	200; 125; 120; 85; 2
09/11/2019	0459	44	41	14º 16,288' S	024º 59,651'	5; 6; 10; 12; 24	200; 180; 150; 125; 2
09/11/2019	1319	45	42	15º 26,552' S	025º 00,200'	9; 10; 11; 16; 24	300; 170; 157; 140; 2
11/11/2019	0456	47	43	20º 14,780' S	024º 59,740'	4; 6; 9; 11; 24	200; 180; 162; 140; 2
11/11/2019	1316	48	44	21º 26,246' S	024º 50,248'	10; 11; 12; 16; 24	250; 180; 162; 140; 2
12/11/2019	0427	50	45	23º 43,547' S	024º 55,250'	4; 6; 9; 14; 24	210; 180; 168; 128; 2
12/11/2019	1211	51	46	24º 44,102' S	025º 12,281'	10; 11; 12; 16; 24	250; 190; 158; 140; 2
13/11/2019	0424	52	47	26º 45,731' S	025º 48,404'	4; 5; 8; 12; 24	210; 170; 120; 91; 2
13/11/2019	1219	53	48	27º 42,528' S	026º 05,105'	6; 7; 9; 14; 23	200; 150; 125; 100; 2
14/11/2019	0426	54	49	30º 01,616' S	026º 47,128'	1; 4; 8; 11; 24	250; 180; 110; 84; 2
14/11/2019	1256	55	50	31º 12,706' S	027º 09,010'	6; 7; 9; 14; 23	200; 150; 125; 100; 2
15/11/2019	0436	56	51	33º 35,935' S	027º 53,440'	2; 6; 10; 13; 24	200; 135; 100; 85;2
15/11/2019	1256	57	52	34º 46,624' S	028º 15,124'	6; 7; 11; 16; 23	250; 140; 85; 70; 2
16/11/2019	0438	58	53	37º 04,897' S	029º 01,019'	3; 5; 10; 13; 23	150; 70; 55; 42; 2
17/11/2019	0405	60	54	40º 21,334' S	031º 02,357'	6; 7; 12; 15; 20	100; 55; 40; 23; 3
18/11/2019	0338	62	55	41º 54,088' S	035º 25,860'	10; 11; 14; 16; 20	100; 40; 20; 15; 2

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

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Objectives

- To assess the phytoplankton pigment composition along the AMT29 transect at the surface and Deep Chlorophyll Maximum (DCM).
- To provide an extensive Chl-*a* dataset for the calibration of the ACS optics instrument.

Method

Seawater samples were collected from the pre-dawn and noon CTD casts, and from the ship's underway system. 8 L polypropylene (PP) carboys - covered in black plastic to protect from light – 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. 2-6 L of seawater were filtered per sample, depending on the extant phytoplankton biomass (e.g. 2 L in more productive waters and 6 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°C freezer.

For each station, duplicate samples were taken at both surface (2-5 m) and the DCM (ranging between 20-168 m). Three daily samples were also taken using the ship's underway system, one during the pre-dawn station, a second one around 15:45 (ship time) 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

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Table 1. Summary of the CTD casts HPLC samples on AMT29

Date	Time (GMT)	Station	CTD cast	Lat	Lon	Depths (m)
16/10/2019	08:13	001	001	49°2.891'N	6°43.927'W	5
16/10/2019	13:20	002	002	48°31.309'N	7°12.224'W	2
17/10/2019	04:42	003	003	47°14.604'N	9°18.913'W	5, 35

18/10/2019	12:30	004	004	46º 9,924' N	13º 52.933'W	5, 100
19/10/2019	04:30	005	005	44°44.635'N	16°10.061'W	5, 55
19/10/2019	12:34	006	006	43°54.850'N	17°8.870'W	10, 100
20/10/2019	04:38	007	007	42°14.509'N	19°11.766'W	5, 80
20/10/2019	12:24	008	008	41°27.928'N	20°11.317'W	5, 70
21/10/2019	04:30	009	009	40°10.672'N	21°55.778'W	2, 65
23/10/2019	04:38	010	010	35°55.369'N	26°52.756'W	2, 86
23/10/2019	12:24	011	011	35°5.484'N	27°37.477'N	5, 90
24/10/2019	05:35	012	012	33°10.715'N	29°20.056'W	2, 92
24/10/2019	13:17	013	013	32°24.116'N	30°01.426'W	5, 95
25/10/2019	13:31	014	014	30°16.060'N	31°51.650'W	14, 115
26/10/2019	05:33	015	015	28°45.662'N	33°1.777'W	5, 110
26/10/2019	13:27	016	016	27°57.252'N	33°41.081'W	5, 125
27/10/2019	05:30	017	017	26°8.395'N	35°11.687'W	5, 115
27/10/2019	13:17	018	018	25°18.031'N	35°54.263'W	5, 120
28/10/2019	05:35	019	019	24°25.148'N	37°31.895'W	5, 125
28/10/2019	13:20	020	020	22°35.260'N	37°41.963'W	5, 105
29/10/2019	13:24	021	021	19°47.920'N	34°46.657'W	5, 100
30/10/2019	05:26	022	022	18°3.426'N	32°58.386'W	5, 100
30/10/2019	13:18	023	023	17°16.736'N	32°47.159'W	5, 80
31/10/2019	05:25	024	024	15°35.456'N	30°25.579'W	5, 65
31/10/2019	13:10	025	025	14°44.299'N	28°41.062'W	5, 72
01/11/2019	05:26	026	026	12°44.620'N	28°30.090'W	5, 39
01/11/2019	13:19	027	027	11°50.693'N	27°57.650'W	5, 43
02/11/2019	05:25	028	028	9°53.017'N	26°47.602'W	5, 46
02/11/2019	13:23	029	029	8°53.503'N	26°11.970'W	2, 58
03/11/2019	05:25	030	030	6°44.974'N	24°59.969'W	5, 50
03/11/2019	13:15	031	031	5°31.302'N	25°0.108'W	5, 72
04/11/2019	05:15	032	032	2°52.747'N	24°59.677'W	2, 70
04/11/2019	13:16	033	033	01°40.604'N	25°0.528'W	2, 76
05/11/2019	04:28	034	034	0°34.854'S	24°59.893'W	2, 75
06/11/2019	05:24	036	035	4°18.025'S	24°59.930'W	2, 72
06/11/2019	11:08	037	036	5°02.617'S	25°0.080'W	2, 85
07/11/2019	05:21	039	037	7°23.671'S	25°0.492'W	2, 90
07/11/2019	13:20	040	038	8°24.392'S	24°59.936'W	2, 100
08/11/2019	05:02	042	039	10°40.807'S	25°0.047'W	2, 100
08/11/2019	13:18	043	040	11°52.920'S	25°0.463'W	2, 120
09/11/2019	05:00	044	041	14°16.288'S	24°59.651'W	2, 150
09/11/2019	13:19	045	042	15°26.552’S	25º 00,200'W	2, 157
11/11/2019	04:56	047	043	20°14.780’S	24°59.740’W	2, 162
11/11/2019	13:18	048	044	21°26.246'S	24°50.247'W	2, 162
12/11/2019	04:26	050	045	23°43.547'S	24°55.250'W	2, 168
12/11/2019	12:18	051	046	24°44.100'S	25°12.290'W	2, 158
13/11/2019	04:24	052	047	26°45.730'S	25°48.403'W	4, 120
13/11/2019	12:20	053	048	27°42.527'S	26°5.105'W	2, 125
14/11/2019	04:25	054	049	30°1.619'S	26°47.129'W	2, 100
14/11/2019	12:45	055	050	31°12.706'S	27°09.010'W	2, 125
15/11/2019	04:36	056	051	33°35.930'S	27°53.440'W	2, 100
15/11/2019	12:55	057	052	34°46.624'S	28°15.124'W	2, 85
16/11/2019	04:37	058	053	37°4.897'S	29°1.020'W	2, 55
17/11/2019	04:05	060	054	40°21.330'S	31°2.350'W	2, 40
18/11/2019	03:40	062	055	41°54.089'S	35°25.858'W	2, 20

Table 2. Summary of the underway system HPLC samples on AMT29.

Date	Time (GMT)	Station	Lat	Lon	Depth (m)
14/10/2019	12:03	AA	50°29.11' N	2°14.48'W	5
15/10/2019	12:49	AB	50°13.43'N	3°5.65'W	5
15/10/2019	18:20	AC	49°48.98N	4°16.21'W	5
16/10/2019	16:30	AD	48°19.90N	7°30.40W	5
16/10/2019	19:18	AE	48°1.79'N	7°54.64'W	5
17/10/2019	06:48	AF	47°11.73'N	9°26.028'W	5
17/10/2019	12:49	AG	46°45.628'N	10°25.454'W	5
17/10/2019	18:31	AH	46°37.741'N	11°14.406'W	5
18/10/2019	08:39	AI	46°22.760	13°17.998'W	5
18/10/2019	17:17	AJ	45°23'N	14°16.91'W	5
18/10/2019	19:19	AK	45°42.81'N	14°36.90'W	5
19/10/2019	08:21	AL	44°24.555'N	16°32.008'W	5
19/10/2019	16:33	AM	43°43.995'N	17°23.959'W	5
19/10/2019	21:26	AN	43°6.908'N	18°7.099'W	5
20/10/2019	07:16	AO	42°3.530'N	19°24.379'W	5
20/10/2019	15:54	AP	41°19.491'N	20°23.268'W	5
20/10/2019	19:28	AQ	40°57.181'N	20°52.798'W	5
21/10/2019	07:19	AR	39°58.994'N	22°11.370'W	5
23/10/2019	07:54	AS	35°39.083'N	27°7.529'W	5
23/10/2019	15:48	AT	34°55.548'N	27°46.823'W	5
23/10/2019	19:18	AU	34°29.85'N	28°9.591'W	5
24/10/2019	09:21	AV	32°52.077'N	29°37.517'N	5
24/10/2019	15:23	AX	32°17.710'N	30°6.716'W	5
24/10/2019	18:54	AW	31°56.727'N	30°23.497'W	5
25/10/2019	09:21	AY	30°39.008'N	31°31.784'W	5
25/10/2019	17:22	AZ	30°7.881'N	32°3.275'W	5
25/10/2019	19:27	BA	29°55.379'N	32°15.350'W	5
26/10/2019	09:17	BB	28°26.955'N	33°15.079'W	5
26/10/2019	19:25	BC	27°26.162'N	34°5.431'W	5
27/10/2019	09:17	BD	25°48.742'N	35°28.155'W	5
27/10/2019	16:33	BE	25°7.222'N	36°6.233'W	5
27/10/2019	20:35	BF	24°35.490'N	36°35.319'W	5
28/10/2019	09:20	BG	23°3.482'N	37°49.463'W	5
28/10/2019	16:47	BH	22°21.322'N	37°29.753'W	5
28/10/2019	21:27	BI	21°47.740'N	36°52.900'W	5
29/10/2019	09:22	BJ	20°15.428'N	35°16.099'W	5
29/10/2019	17:21	BK	19°31.844'N	34°30.501'W	5
29/10/2019	21:46	BL	18°58.648'N	33°55.923'W	5
30/10/2019	07:55	BM	17°52.521'N	32°47.159'W	5
30/10/2019	17:16	BN	16°59.853'N	31°53.330'W	5
30/10/2019	20:41	BO	16°36.251'N	31°27.62'W	5
31/10/2019	07:56	BP	15°24.611'N	30°14.798'W	5
31/10/2019	16:42	BQ	14°31.342'N	29°33.381'W	5
31/10/2019	19:24	BR	14°7.511'N	29°20.516'W	5
01/11/2019	07:55	BS	12°32.877'N	28°23.021'W	5
01/11/2019	16:48	BT	11°37.647'N	27°50.139'W	5

01/11/2019	20:28	BU	11°8.755'N	27°32.244'W	5
02/11/2019	08:58	BV	9°30.295'N	26°33.740'W	5
02/11/2019	16:18	BX	8°43.580'N	26°6.711'W	5
02/11/2019	16:18	BY	8°43.580'N	26°6.711'W	5
02/11/2019	21:17	BW	7°57.012'N	25°38.606'W	5
03/11/2019	07:36	BZ	6°31.544'N	24°59.915'W	5
03/11/2019	16:55	CA	5°9.101'N	25°0.285'W	5
03/11/2019	21:34	CB	4°18.303'N	25°0.285'W	5
04/11/2019	16:44	CC	1°24.135'N	25°0.328'W	5
05/11/2019	07:54	CD	0°48.798'S	24°59.688'W	5
06/11/2019	07:43	CE	4°31.385'S	25°0.571'W	5
06/11/2019	16:25	CF	5°19.964'S	25°0.070'W	5
06/11/2019	19:43	CG	5°51.921'S	25°0.227'W	5
07/11/2019	07:54	CH	7°34.600'S	24°59.901'W	5
07/11/2019	16:47	CI	8°41.048'S	25°0.505'W	5
07/11/2019	19:45	CJ	9°10.481'S	25°0.105'W	5
08/11/2019	07:20	CK	10°51.688'S	25°0.263'W	5
08/11/2019	16:30	CL	12°7.601'S	25°0.475'W	5
08/11/2019	21:19	CM	12°57.640'S	25°0.04'W	5
09/11/2019	07:40	CN	14°29.538'S	24°59.852'W	5
09/11/2019	17:32	CO	15°52.968'S	25°0.799'W	5
09/11/2019	20:29	CP	16°24.999'S	24°59.797'W	5
10/11/2019	15:34	CQ	18°33.367'S	25°6.380'W	5
10/11/2019	19:57	CR	18°41.226'S	25°1.297'W	5
11/11/2019	07:33	CS	20°28.958'S	24°59.862'W	5
11/11/2019	16:34	CT	21°42.574'S	24°48.811'W	5
11/11/2019	20:20	CU	22°21,286'S	24°52.757'W	5
12/11/2019	08:29	CV	24°7.749'S	25°1.844'W	5
12/11/2019	15:37	CX	24°58.548'S	25°17.274'W	5
12/11/2019	20:22	CY	25°44.013'S	25°31.021'W	5
13/11/2019	06:45	CW	26°56.172'S	25°51.503'W	5
13/11/2019	14:56	CZ	27°54.660'S	26°9.439'W	5
13/11/2019	20:19	DA	28°44.579'S	26°24.129'W	5
14/11/2019	06:25	DB	30°12.392'S	26°50.416'W	5
14/11/2019	19:46	DC	32°10.424'S	27°27.108'W	5
15/11/2019	06:37	DD	33°46.957'S	27°57.013'W	5
15/11/2019	15:39	DE	34°57.397'S	28°18.300'W	5
16/11/2019	06:33	DF	37°12.305'S	29°3.247'W	5
16/11/2019	15:40	DG	38°41.519'S	29°33.312'W	5
16/11/2019	18:53	DH	39°12.405'S	29°43.528'W	5
17/11/2019	06:52	DI	40°27.396'S	31°16.542'W	5
17/11/2019	19:28	DJ	41°19.854'S	33°43.690'S	5
18/11/2019	14:19	DK	41°59.479'S	37°7.399'W	5
18/11/2019	14:19	DL	41°59.479'S	37°7.399'W	5
18/11/2019	18:35	DM	42°0.936'S	37°57.894'W	5
19/11/2019	10:33	DN	42°9.029'S	41°28.076'W	5
19/11/2019	14:36	DO	42°11.787'S	42°18.479'W	5
19/11/2019	20:24	DP	45°15.150'S	43°41.966'W	5
20/11/2019	10:53	DQ	42°22.000'S	47°14.200'W	5

20/11/2019	10:53	DR	42°22.000'S	47°14.200'W	5
20/11/2019	14:36	DS	42°25.066'S	48°2.589'W	5
20/11/2019	20:59	DT	42°27.328'S	49°15.230'W	5
21/11/2019	11:48	DU	43°28.617'S	51°31.972'W	5
21/11/2019	15:48	DV	43°49.756'S	52°6.209'W	5
21/11/2019	20:52	DX	44°19.766'S	52°50.364'W	5
22/11/2019	08:52	DY	45°32.584'S	54°50.247'W	5

Phytoplankton community distribution along the Atlantic

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Objectives

- To study the distribution of phytoplankton communities thriving in the Atlantic Ocean.
- To contribute to the validation of Phytoplankton Size Classes and Phytoplankton Functional Types obtained by remote sensing Ocean Colour with our *in situ* observations.

Method

Seawater samples were collected from the pre-dawn and noon CTD casts for surface and Deep Chlorophyll Maximum (DCM). 180 ml of sample is fixed with lugol's iodine neutral solution (~3mL). Samples will be further analysed with an inverted microscope at MARE-FCUL for estimating the cells' abundance of phytoplankton species (>10 μm). Samples will be analysed by optical microscopy, in Lisbon, following Utermöhl method.

Results from the microscope counts and from the flow cytometer 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

H. Utermöhl 1958. Zur Vervollkommnung der quantitativen Phytoplankton-Methodik. *Mitt. Int. Vereinigung Theor. Angew. Limnol.* 9:1–38.

Funding

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Table 3. Time and location of water sampling on AMT29

Date	Time (UTC)	CDT cast No	Lat (degrees)	Lon (degreese)	Niskin Bottle No	Depth (m)
16/10/2019	08:13	DY001	49°2.891'N	6°43.927'W	16	5
16/10/2019	13:20	DY002	48°31.309'N	7°12.224'W	21	2

17/10/2019	04:42	DY003	47°14.604'N	9°18.913'W	23	5
18/10/2019	12:30	DY004	46º09,924'N	13º52.933'W	23	5
19/10/2019	04:30	DY005	44°44.635'N	16°10.061'W	23, 9	5, 55
19/10/2019	12:34	DY006	43°54.850'N	17°8.870'W	23	10
19/10/2019	12:34	DY006	43°54.850'N	17°8.870'W	23	10
20/10/2019	04:38	DY007	42°14.509'N	19°11.766'W	23, 8	5, 80
20/10/2019	12:24	DY008	41°27.928'N	20°11.317'W	23, 15	5, 70
21/10/2019	04:30	DY009	40°10.672'N	21°55.778'W	23, 8	2, 65
23/10/2019	04:38	DY010	35°55.369'N	26°52.756'W	23, 9	2, 86
23/10/2019	12:24	DY011	35°5.484'N	27°37.477'W	23, 14	5, 90
24/10/2019	05:35	DY012	33°10.715'N	29°20.056'W	23, 10	2, 92
24/10/2019	13:17	DY013	32°24.116'N	30°01.426'W	23, 14	5, 95
25/10/2019	13:31	DY014	30°16.060'N	31°51.650'W	23, 14	14, 115
26/10/2019	05:33	DY015	28°45.662'N	33°1.777'W	23, 8	5, 110
26/10/2019	13:27	DY016	27°57.252'N	33°41.081'W	20, 14	5, 125
27/10/2019	05:30	DY017	26°8.395'N	35°11.687'W	23, 9	5, 115
27/10/2019	13:17	DY018	25°18.031'N	35°54.263'W	23, 16	5, 120
28/10/2019	05:30	DY019	23°25.148'N	37°31.895'W	23, 9	5, 124
28/10/2019	13:20	DY020	22°35.260'N	37°41.963'W	23, 14	5, 105
29/10/2019	13:24	DY021	19°47.920'N	34°46.657'W	23, 14	5, 100
30/10/2019	05:26	DY022	18°3.426'N	32°58.386'W	23, 9	5, 100
30/10/2019	13:28	DY023	17°16.736'N	32°09.071'W	23, 14	5, 80
31/10/2019	05:25	DY024	15°35.456'N	30°25.579'W	23, 9	5, 65
31/10/2019	13:10	DY025	14°44.299'N	28°41.062'W	23, 14	5, 72
01/11/2019	05:26	DY026	12°44.620'N	28°30.090'W	23, 10	2, 39

01/11/2019	13:19	DY027	11°50.693'N	27°57.650'W	22, 15	5, 43
02/11/2019	05:25	DY028	9°53.017'N	26°47.602'W	23, 11	5, 46
02/11/2019	13:23	DY029	8°53.503'N	26°11.970'W	23, 15	2, 58
03/11/2019	05:25	DY030	6°44.974'N	24°59.969'W	23, 11	5, 50
03/11/2019	13:15	DY031	5°31.302'N	25°0.108'W	22, 14	5, 72
04/11/2019	05:15	DY032	2°52.747'N	24°59.677'W	21, 10	2, 70
04/11/2019	13:16	DY033	01°40.604'N	25°0.528'W	22, 14	2, 76
05/11/2019	04:28	DY034	0°34.854'S	24°59.893'W	23, 10	2, 75
06/11/2019	05:24	DY035	4°18.025'S	24°59.930'W	21, 10	2, 72
06/11/2019	11:08	DY036	5°02.617'S	25°00.080'W	22, 13	2, 85
07/11/2019	05:21	DY037	7°23.671'S	25°0.492'W	20, 9	2, 90
07/11/2019	13:20	DY038	8°24.392'S	24°59.936'W	22, 14	2, 100
08/11/2019	05:02	DY039	10°40.087'S	25°0.047'W	20, 9	2, 100
08/11/2019	13:18	DY040	11°52.920'S	25°0.463'W	22, 14	2, 120
09/11/2019	05:00	DY041	14°16.288'S	24°59.651'W	20, 9	2, 150
09/11/2019	13:19	DY042	15°26.552'S	25°0.200'W	22, 13	2, 157
11/11/2019	05:56	DY043	20°14.780'S	24°59.740'W	21, 8	2, 162
11/11/2019	13:18	DY044	21°26.246'S	24°50. 247W	22, 13	2, 162
12/11/2019	04:26	DY045	23°43.547'S	24°55.250'W	20, 8	2, 168
12/11/2019	12:11	DY046	24°44.100'S	25°12.290'W	22, 13	2, 158
13/11/2019	04:24	DY047	26°45.730'S	25°48.403'W	21, 10	4, 120
13/11/2019	12:20	DY048	27°42.527'S	26°5.105'W	20, 10	2, 125
14/11/2019	04:25	DY049	30°1.619'S	26°47.129'W	21, 10	2, 100
14/11/2019	12:45	DY050	31°12.706'S	27°09.010'W	20, 10	2, 125
15/11/2019	04:36	DY051	33°35.930'S	27°53.440'W	21, 7	2, 100

15/11/2019	12:55	DY052	34°46.624'S	28°15.124'W	20, 12	2, 85
16/11/2019	04:37	DY053	37°4,897'S	29°1.020'W	21, 7	2, 55
17/11/2019	04:05	DY054	40°21.330'S	31°2.350'W	24, 12	2, 40
18/11/2019	03:40	DY055	41°54.089'S	35°25.858'W	24, 15	2, 20
18/11/2019	14:19	UW_001	41°59.479'S	37°7.399'W	-	UW
19/11/2019	10:33	UW_002	42°9.029'S	41°28.076'W	-	UW
19/11/2019	14:36	UW_003	42°11.787'S	42°18.479'W	-	UW
20/11/2019	10:53	UW_004	42°22.000'S	47°14.200'W	-	UW
20/11/2019	14:36	UW_005	42°25.066'S	48°2.589'W	-	UW

Aerosol sampling for trace metal and nutrient analysis

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Objectives

- To collect 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 coccolitophores species.

Method

Aerosol 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. For an instrument comparison, a second High-Volume collector was sampling simultaneously.

Funding

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Table 4. Summary of aerosol samples taken along the AMT29 transect.

Sample name	Start date	Start time (GMT)	Start Lat	Start Lon	End date	End time (GMT)	End Lat	End Lon
Motor blank	15/10/2019	10:08	50°27.74'S	2°30.37'W	15/10/2019	10:08	50°27.74'N	2°30.37'W
Exposure blank	15/10/2019	10:36	50°25.48'N	2°36.01'W	16/10/2019	11:30	48°42.80'N	7°1.567'W
Cassette blank	16/10/2019	12:00			17/20/2019	11:30		
AMT29TM01	18/10/2019	18:54	45°45.385'N	14°32.979'W	20/10/2019	08:42	41°53.020'N	19°37.280'W
AMT29TM02	20/10/2019	09:35	41°46.290'N	19°45.395'W	21/10/2019	08:53	39°47.066'N	22°28,033'W
AMT29TM03	21/10/2019	09:17	39°44.104'N	22°32.034'W	23/10/2019	09:16	35°27.858'N	27°17.666'W

AMT29TM04	23/10/2019	09:40	35°24.821'N	27°20.344'W	24/10/2019	10:45	32°39.329'N	29°48.787'W
AMT29TM05	24/10/2019	19:45	31°57.510'N	30°23.010'W	26/10/2019	10:14	28°18.915'N	33°21.924'W
AMT29TM06	26/10/2019	11:30	28°8.25'N	33°31.40'W	28/10/2019	11:10	22°47.719'N	37°56.884'W
AMT29TM07	28/10/2019	11:30	22°46.824'N	37°53.632'W	30/10/2019	09:35	17°40.645'N	32°34.644'W
AMT29TM08	30/10/2019	09:39	17°40.300'N	32°34.282'W	31/10/2019	09:31	15°13.022'N	30°3.310'W
AMT29TM09	31/10/2019	09:34	15°12.666'N	30°2.957'W	01/11/2019	09:24	12°21.07'N	28°15.748'W
AMT29TM10	01/11/2019	09:47	12°17.772'N	28°13.820'W	02/11/2019	09:53	9°22.130'N	26°29.231'W
AMT29TM11	02/11/2019	10:13	9°19.179'N	26°27.612'W	03/11/2019	09:31	6°10.453'N	24°59.887'W
AMT29TM12	03/11/2019	09:45	6°8.081'N	24°59.860'W	04/11/2019	09:29	2°18.285'N	25°0.011'W
AMT29TM13	04/11/2019	09:33	2°17.376'N	25°0.007'W	05/11/2019	09:48	1°7.961'S	24°59.948'W
AMT29TM14	05/11/2019	10:10	1°11.576'S	25°0.017'W	06/11/2019	09:24	4°48.168'S	25°0.261'W
AMT29TM15	06/11/2019	09:35	4°49.909'S	25°0.164'W	07/11/2019	09:59	7°55.371'S	25°0.058'W
AMT29TM16	07/11/2019	10:10	7°57.190'S	25°0.08'W	08/11/2019	09:28	11°14.074'S	25°0.05'W
AMT29TM17	08/11/2019	09:37	11°15.690'S	25°0.059W	09/11/2019	09:30	14°48.384'S	24°59.968'W
AMT29TM18	09/11/2019	09:47	14°51.515'S	25°0.04'W	10/11/2019	11:48	18°32.383'S	25°4.985'W
AMT29TM19	10/11/2019	11:59	18°32.962'S	25°4.973'W	11/11/2019	09:43	20°52.286'S	24°59.894'W
AMT29TM20	11/11/2019	09:52	20°53.824’S	24°59.922’W	13/11/2019	09:30	27°20.266’S	25°58.368’W
AMT29TM21	13/11/2019	09:41	27°21.893’S	25°58.845’W	15/11/2019	09:52	34°18.949’S	28°7.209’W
AMT29TM22	15/11/2019	09:58	34°19.855’S	28°7.485’W	18/11/2019	09:35	41°55.739’S	36°9.771’W
AMT29TM23	18/11/2019	09:54	41°55.977’S	36°13.830’W	20/11/2019	10:28	42°22.873’S	47°6.026’W

Sample collection for Total Alkalinity (TA) and Dissolved Inorganic Carbon (DIC)

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Objectives

- To collect and preserve water samples for the determination of Total Alkalinity (TA) and Dissolved Inorganic Carbon (DIC).

Methods

Seawater samples from the noon CTD casts were collected along the AMT29 transect. The samples were collected in 250 mL borosilicate glass bottles with glass stoppers greased with Apiezon-M grease. The samples were preserved with 50 μL of saturated $HgCl_2$ for latter analysis at PML (Plymouth Marine Laboratory). Table 1 summarise the CTD casts and depth for all samples collected.

References

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

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Table 5. Summary of CTD casts and depth for DIC/TA samples collected.

Date	Time (UTC)	Lat	Lon	CTD	Station	CTD bottle	Depth (m)
16/10/2019	08:13	49°2.891'N	6°43.927'W	DY110_CTD001	STN001	16	5
16/10/2019	13:20	48°31.309'	7°12.224'W	DY110_CTD002	STN002	24	2
17/10/2019	12:30	46º 09,924'N	13º 52.933'W	DY110_CTD004	STN004	24	5
19/10/2019	12:34	43°54.850'N	17°8.870'W	DY110_CTD006	STN006	20	10
20/10/2019	12:24	41°27.928'N	20°11.317'W	DY110_CTD008	STN008	20	5

23/10/2019	12:24	35°5.484'N	27°37.477'W	DY110_CTD011	STN011	20	5
23/10/2019	12:24	35°5.484'N	27°37.477'W	DY110_CTD011	STN011	5	1000
24/10/2019	13:17	32°24.116'N	30°01.426'W	DY110_CTD013	STN013	20	5
25/10/2019	13:31	30°16.060'N	31°51.650'W	DY110_CTD014	STN014	20	10
26/10/2019	13:27	27°57.252'N	33°41.081'W	DY110_CTD016	STN016	20	5
26/10/2019	13:27	27°57.252'N	33°41.081'W	DY110_CTD016	STN016	10	1000
27/10/2019	13:17	25°18.031'N	35°54.263'W	DY110_CTD018	STN018	20	5
27/10/2019	13:17	25°18.031'N	35°54.263'W	DY110_CTD018	STN018	5	1000
28/10/2019	13:20	22°35.260'N	37°41.963'W	DY110_CTD020	STN020	20	5
28/10/2019	13:20	22°35.260'N	37°41.963'W	DY110_CTD020	STN020	5	1000
29/10/2019	13:24	19°47.920'N	34°46.657'W	DY110_CTD021	STN021	20	5
29/10/2019	13:24	19°47.920'N	34°46.657'W	DY110_CTD021	STN021	5	1000
30/10/2019	13:18	17°16.736'N	32°09.071'W	DY110_CTD023	STN023	20	5
30/10/2019	13:18	17°16.736'N	32°09.071'W	DY110_CTD023	STN023	6	850
31/10/2019	13:10	14°44.299'N	28°41.062'W	DY110_CTD025	STN025	24	5
31/10/2019	13:10	14°44.299'N	28°41.062'W	DY110_CTD025	STN025	5	1000
01/11/2019	13:19	11°50.693'N	27°57.650'W	DY110_CTD027	STN027	24	5
02/11/2019	13:23	8°53.503'N	26°11.970'W	DY110_CTD029	STN029	24	2
02/11/2019	13:23	8°53.503'N	26°11.970'W	DY110_CTD029	STN029	5	1000
03/11/2019	13:15	5°31.302'N	25°0.108'W	DY110_CTD031	STN031	24	5
04/11/2019	13:16	1°40.604'N	25°0.528'W	DY110_CTD033	STN033	24	2
06/11/2019	11:08	5°2.617'S	25°00.080'W	DY110_CTD037	STN037	24	2
07/11/2019	13:20	8°24.392'S	24°59.936'W	DY110_CTD038	STN040	24	2
07/11/2019	13:20	8°24.392'S	24°59.936'W	DY110_CTD038	STN040	6	800
08/11/2019	13:18	11°52.920'S	25°0.463'W	DY110_CTD040	STN043	24	2
09/11/2019	13:19	15°26.552'S	25°0.200'W	DY110_CTD042	STN045	24	2

09/11/2019	13:19	15°26.552'S	25°0.200'W	DY110_CTD042	STN045	6	700
11/11/2019	13:18	21°26.246'S	24°50.247'W	DY110_CTD044	STN048	24	2
11/11/2019	13:18	21°26.246'S	24°50.247'W	DY110_CTD044	STN048	6	835
12/11/2019	12:11	24°44.100'S	25°12.290'W	DY110_CTD046	STN051	24	2
13/11/2019	12:20	27°42.527'S	26°5.105'W	DY110_CTD048	STN053	24	2
13/11/2019	12:20	27°42.527'S	26°5.105'W	DY110_CTD048	STN053	2	800
14/11/2019	12:45	31°12.706'S	27°09.010'W	DY110_CTD050	STN055	24	2
14/11/2019	12:45	31°12.706'S	27°09.010'W	DY110_CTD050	STN055	2	900
15/11/2019	12:55	34°46.624'S	28°15.124'W	DY110_CTD052	STN057	24	2
17/11/2019	04:05	40°21.330'S	31°2.320'W	DY110_CTD054	STN060	24	2
17/11/2019	04:05	40°21.330'S	31°2.320'W	DY110_CTD054	STN060	3	600
18/11/2019	04:40	41°54.089'S	35°25.858'W	DY110_CTD055	STN062	24	2

Phytoplankton Photosynthesis, Primary Production and absorption coefficients

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OBJECTIVES.

During AMT29 integrated Primary production measurements were made at 29 stations on three size classes of phytoplankton from measurements taken from six depths. Photosynthesis-irradiance curves and phytoplankton absorption coefficients were made at 32 stations at two depths in the water column (surface and Deep Chlorophyll Maximum). Phytoplankton absorption coefficients and chlorophyll-a concentration were determined at 37 stations. These measurements aim to fulfil the following objectives within:

- *The main deliverable is to provide an unique time series of spatially extensive and internally consistent observations on the structure and biogeochemical properties of planktonic ecosystems in the Atlantic Ocean that are required to validate models addressing questions related to the global carbon cycle. One of the key parameters is phytoplankton production. To this end a continuous long track series of primary production measurements have been made on AMT29 using methods synonymous to those used in previous AMT cruises.*
- *We also assessed the variation in photosynthesis in phytoplankton communities along the Atlantic Meridional transect.*
- *The absorption coefficient of phytoplankton was also measured for satellite algorithm development.*

METHODS.

Primary production. Simulated in situ primary production was measured at 27 stations. Water samples were taken from pre-dawn (03:15-05:15 GMT) deployments of 21 x 10 + 3 x 20l SeaBird CTD rosette sampler on a stainless steel frame from 6 depths in the euphoic zone following the methods described in Tilstone et al. (2009). The samples were transferred from Niskin bottles to black carboys to prevent shock to the photosynthetic lamellae of the phytoplankton cells. Water from each sample was sub sampled into three 75 ml clear polycarbonate bottles and three black polycarbonate bottle; all bottles were pre cleaned following JGOFS protocols (IOC, 1994), to reduce trace metal contamination. Each sample was inoculated with between 185 and 740 kBq (5 - 15 µCi) $NaH^{14}CO_3$ according to the biomass of phytoplankton. The polycarbonate bottles were transferred to an on deck (simulated in situ) incubation system using neutral density and blue filters to simulate subsurface irradiance over depth to 97%, 55%, 33%, 20%, 14%, 7%, 3%, 1% or 0.1% of the surface value and incubated from local dawn to dusk (10 – 16 h). The incubators were maintained at surface temperature by pumping sea water from a depth of ~7 m through the upper light level incubators (97, 55, 33, 14, & 7 %) and from a chiller maintained at ±1°C of in situ temperature for the lower light level incubators (3, 1 & 0.1%). To terminate the incubations, suspended material were filtered sequentially through 0.2μm, 2μm and 10 μm polycarbonate filters to measure the pico, nano and micro-phytoplankton production respectively. The filters were exposed to concentrated HCl fumes for 8-12 h immersed in scintillation cocktail and ^{14}C disintegration time per minute (DPM) was measured on board using a Packard, Tricarb 2900 liquid scintillation counter and the external standard and the channel ratio methods were applied to correct for quenching

Photosynthesis-Irradiance Curves.

Photosynthesis-Irradiance experiments were conducted at 36 stations at two depths in the water column; surface and Chla maxima. The experiments were run in photosynthetrons illuminated by 50 W, 12 V tungsten halogen lamps for the surface waters and LEDs for the Chla maxima following the methods described in Tilstone et al. (2003). Each incubator houses 15 sub-samples in 60 ml polycarbonate bottles which were inoculated with between 185k Bq (5 µCi) and 370 kBq (15 µCi) of ^{14}C labelled bicarbonate. The samples were maintained at *in situ* temperature using the ships non-toxic supply for the surface samples and at ambient temperature at the Chla maxima with a Polyscience chiller. After 1 to 2 h of incubation, the suspended material were filtered onto 0.2μm polycarbonate filters to measure phytoplankton photosynthetic rates. The filters were exposed to concentrated HCl fumes for 8-12 h immersed in scintillation cocktail and ^{14}C disintegration time per minute (DPM) was measured on board using a Packard, Tricarb 2900 liquid scintillation counter and the external standard and the channel ratio methods to correct for quenching. The broadband light-saturated Chla-specific rate of photosynthesis P_m^B [mg C (mg chl a)$^{-1}$ h^{-1}] and the light limited slope α^B [mg C (mg chl a)$^{-1}$ h^{-1} (µmol m^{-2} s^{-1})$^{-1}$] was estimated by fitting the data to the model of Platt *et al.* (Platt et al., 1980).

Phytoplankton Absorption coefficients (a_{ph}).

For the determination of phytoplankton (aph(λ)) and non-algal particle (aNAP(λ)) absorption coefficients, between 6 and 2 L of seawater was filtered at each station for surface and deep chlorophyll maximum samples onto 25 mm, 0.7 µm GF/F filters. The absorbance of the material captured on the filter will then measured from 350 to 750 nm at a 1 nm bandwidth using dual beam 1050 Perkin Elmer spectrophotometer retro-fitted with a 150 mm spectralon coated integrating sphere, following the methods of Kishino et al. (1985). The aNAP (λ) was measured after pigment extraction in methanol.

Determination of Chlorophyll-a concentration (Chl *a*).

Chl *a* was determined by filtering between 1 and 6 L of seawater through onto GFF filters, placing them in 10 ml 90% acetone overnight in a – 20 °C freezer and measuring the extracted Chl a by fluorescence using a Turner Fluorometer according to the method of Welschmeyer (1994).

Initial Results:

Figure 1 shows the variability in primary production along the cruise track in total and the three size fractions. Higher values are associated with both micro- and pico- production in the e equatorial upwelling (360-420 mg C m^{-2} d^{-1}) and the Patagonia shelf region (260-860 mg C m^{-2} d^{-1}), whereas lower values predominantly from pico-production occur in the North Atlantic (160-295 mg C m^{-2} d^{-1}) and South Atlantic Gyres (100-250 mg C m^{-2} d^{-1}).

Figure 2 gives example Photosynthesis-Irradiance curves for CTD018 on 27 October 2019 and CTD 027 on 1 November 2019 in surface waters and at the DCM. In surface waters, both stations show low α^B alp due to adaptation to high light and P_m^B of between 3 and 7 mg C (mg Chl a)$^{-1}$ h^{-1}. At the DCM for CTD018 on 27 October 2019, there is evidence of low light adaptation and consequently high α^B whereas on 1 November 2019 α^B is much lower. At these stations in the DCM P_m^B varies between 1.2 and 3.5 mg C (mg Chl a)$^{-1}$ h^{-1}.

Table 1. Stations at which size fractionated primary production (PP), phytoplankton photosynthesis (PE curves) and Phytoplankton absorption coefficients and Chlorophyll-a ($a_{ph}(\lambda)$) were measured.

Latitude	Longitude	Date	Julian Day	Time	CTD	Measurement
50.4851	-2.2413	14-Oct-19	287	12.03	Uw001	a_{ph}
50.2246	-3.0865	15-Oct-19	288	12.19	Uw002	a_{ph}
49.0482	-6.7322	16-Oct-19	289	08:13	CTD001	PE Curves, a_{ph}
48.5218	-7.2037	16-Oct-19	289	13:20	CTD002	PE Curves, a_{ph}
47.2438	-9.3147	17-Oct-19	290	04:42	CTD003	SIS PP
46.1655	-13.8823	18-Oct-19	291	12:30	CTD004	PE Curves, a_{ph}
44.744	-16.1677	19-Oct-19	292	04:34	CTD005	SIS PP
43.9142	-17.1478	19-Oct-19	292	12:34	CTD006	PE Curves, a_{ph}
42.2418	-19.1962	20-Oct-19	293	04:36	CTD007	SIS PP
41.4655	-20.1885	20-Oct-19	293	12:24	CTD008	PE Curves, a_{ph}
40.1778	-21.9297	21-Oct-19	294	04:30	CTD009	SIS PP
35.9228	-26.8793	23-Oct-19	296	04:38	CTD010	SIS PP
35.0913	-27.6247	23-Oct-19	296	12:24	CTD011	PE Curves, a_{ph}
33.1785	-29.335	24-Oct-19	297	05:34	CTD012	SIS PP
32.402	-30.0238	24-Oct-19	297	13:18	CTD013	PE Curves, a_{ph}

30.9081	-31.3138	25-Oct-19	297	06.46	Uw003	a_{ph}
30.2677	-31.8608	25-Oct-19	298	13:18	CTD014	PE Curves, a_{ph}
28.761	-33.0297	26-Oct-19	299	05:33	CTD015	SIS PP, a_{ph}
27.9542	-33.6847	26-Oct-19	299	13:27	CTD016	PE Curves, a_{ph}
26.1398	-35.1948	27-Oct-19	299	05:31	CTD017	SIS PP, a_{ph}
25.3005	-35.9045	27-Oct-19	300	13:17	CTD018	PE Curves, a_{ph}
23.4192	-37.5315	28-Oct-19	301	05:29	CTD019	SIS PP, a_{ph}
22.5877	-37.6993	28-Oct-19	301	13:22	CTD020	PE Curves, a_{ph}
19.7987	-34.7777	29-Oct-19	302	13:23	CTD021	PE Curves, a_{ph}
20.2666	-35.2786	29-Oct-19	302	09.15	Uw004	a_{ph}
18.0568	-32.9732	30-Oct-19	303	05:28	CTD022	SIS PP, a_{ph}
17.279	-32.1513	30-Oct-19	303	05:28	CTD023	SIS PP, a_{ph}
15.591	-30.4263	31-Oct-19	304	05:25	CTD024	SIS PP, a_{ph}
14.7383	-29.6843	31-Oct-19	304	13:20	CTD025	PE Curves, a_{ph}
12.7437	-28.5015	01-Nov-19	305	05:26	CTD026	SIS PP, a_{ph}
11.844	-27.9602	01-Nov-19	305	13:19	CTD027	PE Curves, a_{ph}
9.8837	-26.7933	02-Nov-19	306	05:24	CTD028	SIS PP, a_{ph}
8.8917	-26.1993	02-Nov-19	306	13:23	CTD029	PE Curves, a_{ph}
6.7495	-24.9995	03-Nov-19	307	05:26	CTD030	SIS PP, a_{ph}
5.5218	-25.0017	03-Nov-19	307	13:13	CTD031	PE Curves, a_{ph}
2.8792	-24.9947	04-Nov-19	308	05:24	CTD032	SIS PP, a_{ph}
1.6767	-25.0088	04-Nov-19	308	13:16	CTD033	PE Curves, a_{ph}
-0.5812	-24.9997	05-Nov-19	309	04:28	CTD034	SIS PP, a_{ph}
-4.3002	-24.9985	06-Nov-19	310	05:25	CTD035	SIS PP, a_{ph}
-5.0437	-25.0015	06-Nov-19	310	11:08	CTD036	PE Curves, a_{ph}
-7.3943	-25.008	07-Nov-19	311	05:23	CTD037	SIS PP, a_{ph}
-8.406	-24.9985	07-Nov-19	311	13:22	CTD038	PE Curves, a_{ph}

-10.6687	-25	08-Nov-19	312	05:02	CTD039	SIS PP, a_{ph}
-11.882	-25.0077	08-Nov-19	312	13:18	CTD040	PE Curves, a_{ph}
-14.2715	-24.9942	09-Nov-19	313	04:59	CTD041	SIS PP, a_{ph}
-15.4425	-25.0033	09-Nov-19	313	13:19	CTD042	PE Curves, a_{ph}
-20.2463	-24.9957	11-Nov-19	314	14:56	CTD043	PE Curves, a_{ph}
-21.4375	-24.8375	11-Nov-19	314	13:16	CTD044	PE Curves, a_{ph}
-23.7258	-24.9208	12-Nov-19	315	04:27	CTD045	SIS PP, a_{ph}
-24.735	-25.2047	12-Nov-19	315	12:14	CTD046	PE Curves, a_{ph}
-26.7622	-25.8067	13-Nov-19	316	04:24	CTD047	SIS PP, a_{ph}
-27.7088	-26.0852	13-Nov-19	316	12:19	CTD048	PE Curves, a_{ph}
-30.027	-26.7855	14-Nov-19	317	4:26	CTD049	SIS PP, a_{ph}
-31.2118	-27.1495	14-Nov-19	317	12:56	CTD050	PE Curves, a_{ph}
-33.5955	-27.8888	15-Nov-19	318	4:36	CTD051	SIS PP, a_{ph}
-34.777	-28.252	15-Nov-19	318	12:56	CTD052	PE Curves, a_{ph}
-37.0817	-29.017	16-Nov-19	319	4:38	CTD053	SIS PP, a_{ph}
-40.3555	-31.0393	17-Nov-19	320	4:05	CTD054	SIS PP, PE Curves, a_{ph}
-41.900	-36.333	18-Nov-19	321	03.40	CTD055	SIS PP, PE Curves, a_{ph}
-41.991	-37.1202	18-Nov-19	321	14.17	Uw005	PE Curves, a_{ph}
-42.150	-41.460	19-Nov-19	322	10.30	Uw006	PE Curves, a_{ph}
-42.1964	-42.307	19-Nov-19	322	14.36	Uw007	PE Curves, a_{ph}
-42.3668	-47.2367	20-Nov-19	323	10.53	Uw008	a_{ph}
-42.417	-48.043	20-Nov-19	323	14.36	Uw009	a_{ph}

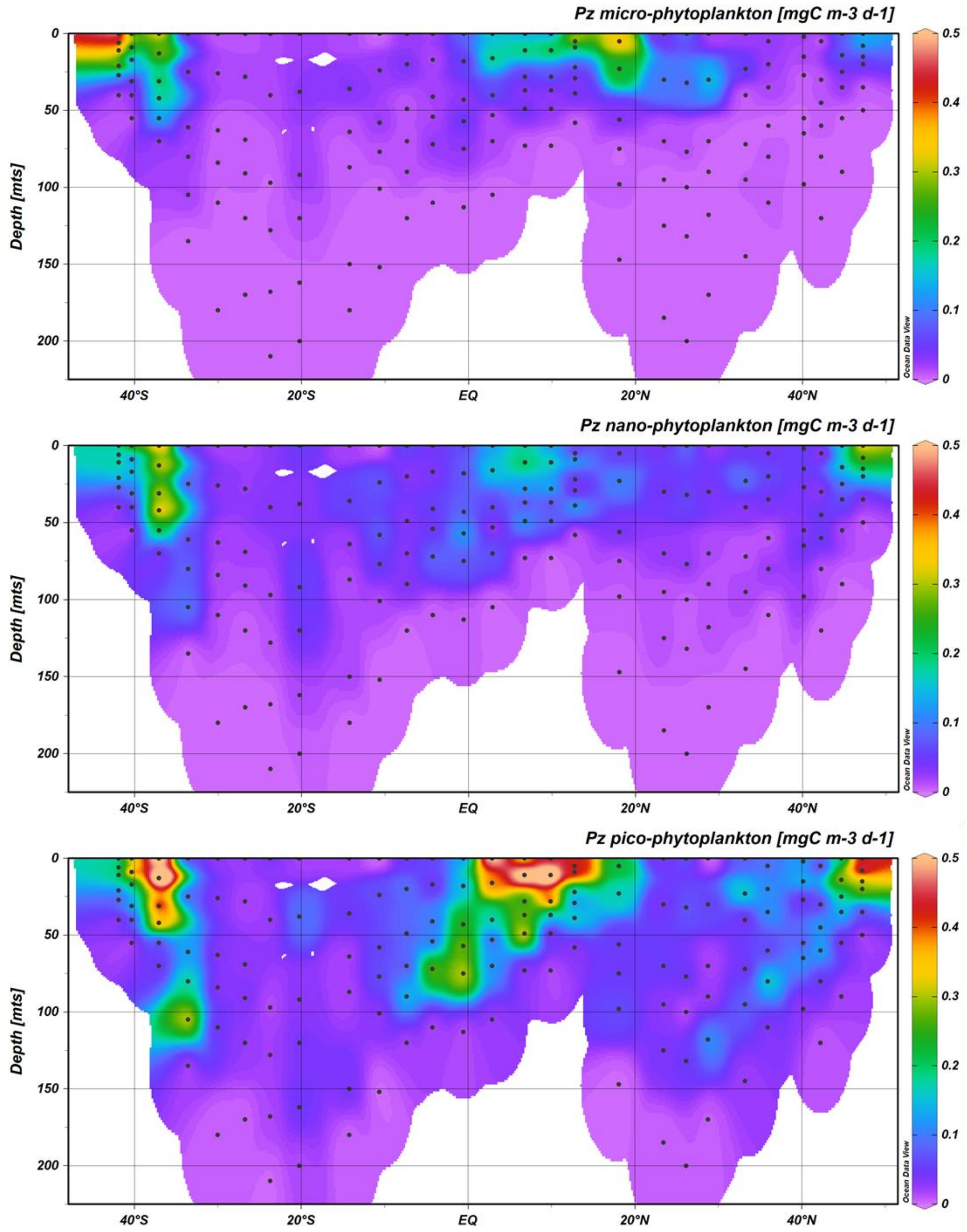
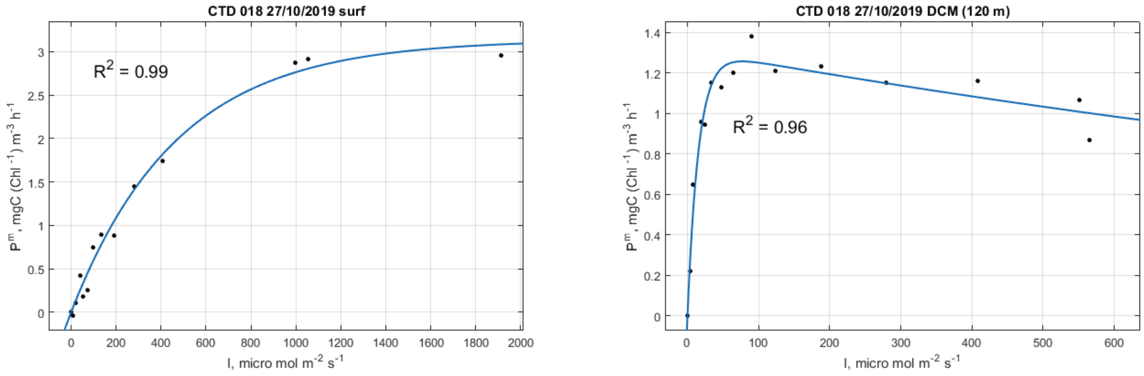
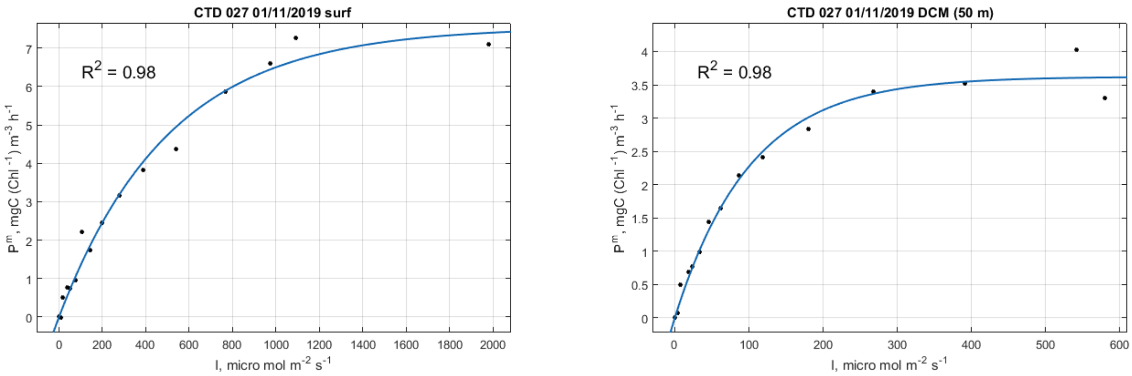


Figure 1. AMT29 Primary production (mg m^{-3} d^{-1}) in total (Pz Total), micro- (Pz >10), nano- (Pz 2-10), pico- (Pz 0.2-2) size fractions.



a)



b)

Figure 2. Example Photosynthesis-Irradiance curves for the surface and Deep Chlorophyll Maximum at CTD018 on 27 October 2019 (a) and CTD 027 on 1 November 2019 (b).

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Gross primary production (GPP), dark community respiration (CR) and net community production (NCP)

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Background

Dissolved oxygen (O_2) in seawater is produced and consumed in the oceans by the plankton community. The balance of gross primary production (GPP) and the community respiration (CR) determines the net community production (NCP; NCP = GPP – CR). NCP indicates the contribution of the plankton community to the carbon cycle, through export of organic matter to the deep ocean, and the biologically driven exchange of carbon dioxide (CO_2) from the oceans.

In areas of positive NCP (autotrophic, GPP > CR) it would be suggested these regions would act as a greater sink to CO_2 due to phytoplankton carbon fixation, where the reverse would occur for negative NCP (heterotrophic, GPP < CR) in which heterotrophs respire CO_2.

The AMT provides the opportunity to measure NCP, GPP and CR across both unproductive oligotrophic ocean gyres and productive regions, with coincident measurements of primary production and CO_2 fluxes.

The aims of this work are:

- To determine the depth and spatial distribution of net community production (NCP); or the balance of gross primary production (GPP) and community respiration (CR), along the AMT track from Southampton, UK to Punta Arenas, Chile.
- To test and refine empirical models to predict NCP from remote sensing estimates of primary production (PP).
- To test relationships between coincident CO_2 concentration measurements and NCP

Methods

NCP, GPP and CR were determined at a minimum of 4, and maximum of 6 depths at dawn (~04:00) CTD stations (Table 1) using in vitro changes in dissolved O_2 concentrations after 24 hour light and dark incubations. Measurements of dissolved O_2 was measured by automated Winkler titration (Williams and Jenkinson, 1982), performed with a Metrohm 916 Ti-Touch with polarimetric end point detection. Thiosulfate concentration was calibrated every 3 days.

Water samples were collected at depths equivalent to percentages of surface irradiance, generally 97%, 33%, 7%, 3%, 1% and 0.1%, and collected from the rosette Niskin bottles into carboys before siphoning into ~125 ml borosilicate glass bottles. Four zero time replicate bottles were fixed immediately, and two further sets were incubated in surface water cooled simulated *in situ* (SIS) deck incubators. One set were incubated in the light of equivalent irradiance to that found *in situ*, with a second set in the dark by covering in aluminium foil and placed in the same on deck incubators for 24 hours. Opaque screens were placed over the incubators during night hours to minimise artefacts from the ships on deck lights.

NCP was determined as the difference between the means of the light and zero replicates, CR the difference between dark and zero and GPP the difference between light and dark. NCP, GPP and CR were integrated to the 1% light level using trapezoidal integration to be comparable to previous AMT cruises. Integration to the 0.1% light level was conducted separately.

NCP, GPP and CR were sampled at 29 CTD casts (Table 1), with a total of 27 stations where these parameters were computed. CTD numbers DY110_001 had samples taken however samples were incubated for daylight hours only as a test incubation. DY110_003 samples were taken but no NCP calculated.

Preliminary Results

GPP, CR and NCP analysis were performed on board, and preliminary processing of the data on board is shown in Figure 1. Integrated NCP indicated highly heterotrophic communities in the North Atlantic, before the equatorial upwelling zone. Over the equator, autotrophic communities prevailed, until the South Atlantic where a mix of communities existed. Below 25° S communities became autotrophic, indication of increased primary production in the austral spring.

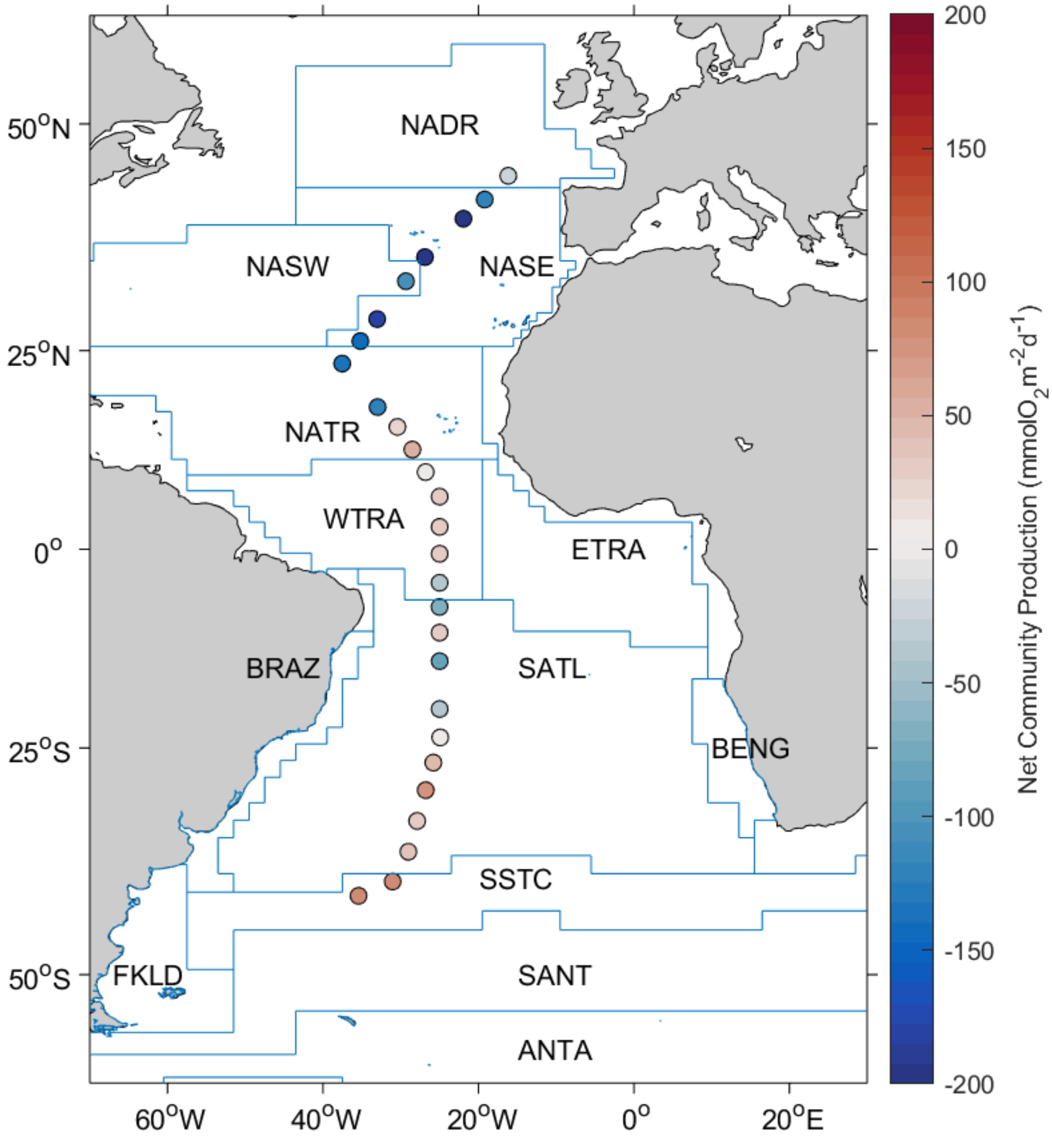

Figure 1 – Integrated NCP to the 1% light level for all stations sampled on AMT 29. Longhurst biogeochemical provinces (Longhurst, 1995) are shown to display the different regions the AMT covers, where the cruise covered: NADR – North Atlantic Drift Region, NASE – North Atlantic Subtropical East, NASW – North Atlantic Subtropical West, NATR – North Atlantic Tropical Gyre, WTRA – Western Tropical Atlantic, SATL – South Atlantic Gyre, SSTC – Sub Tropical Convergence

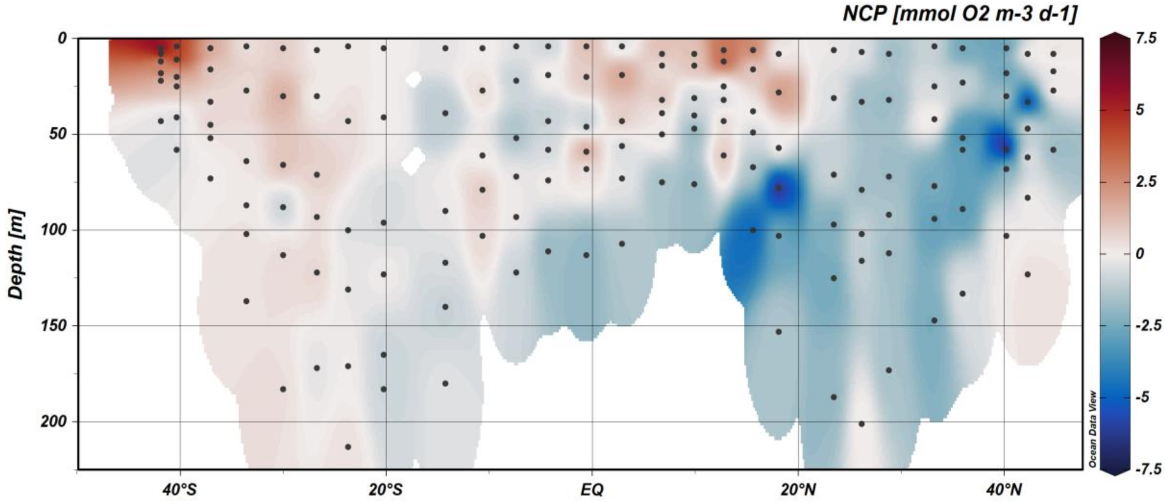

Figure 2 – Depth section of NCP from the UK (right) to Chile (left) where black points indicate the sampling locations.

References

Williams P.J.leB. and Jenkinson N.W., 1982. A transportable microprocessor-controlled precise Winkler titration suitable for field station and shipboard use. Limnology Oceanography 27: 576-584.

Longhurst A, Sathyendranath S, Platt T and Caverhill C. 1995. An estimate of global primary production in the ocean from satellite radiometer data. Journal Plankton Research 17: 1245 – 1271.

Funding

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Table 1 – Samples Collected

CTD Number	Date	Time (GMT)	Latitude	Longitude	Niskin Bottles	Sample Depth (m)	Light Depth (%)
001	16/10/2019	08:13	49° 2.891’ N	6° 43.927’ W	8, 11, 15	44, 18, 9	1, 33, 97
003	17/10/2019	04:42	47° 14.604’ N	9° 18.913’ W	12, 16, 18, 24	37, 17, 10, 8	1, 14, 33, 97
005	19/10/2019	04:34	44° 44.635’ N	16° 10.061’ W	12, 15, 17, 19	58, 27, 17, 8	1, 14, 33, 97
007	20/10/2019	04:36	42° 14.509’ N	19° 11.766’ W	5, 12, 13, 14, 16, 19	123, 83, 62, 47, 33, 8	.1, 1, 3, 7, 20, 97
009	21/10/2019	04:30	40° 10.672’ N	21° 55.778’ W	6, 11, 12, 15, 17, 20	103, 68, 58, 30, 18, 5	.1, 1, 3, 14, 33, 97
010	23/10/2019	04:38	35° 55.370’ N	26° 52.760’ W	5, 12, 14, 15,	133, 89, 58, 52, 23,	.1, 1, 3, 7,

					18, 20	5	33, 97
012	24/10/2019	05:34	33° 10.710’ N	29° 20.090’ W	7, 13, 14, 16, 18, 20	147, 94, 77, 42, 25, 4	.1, 1, 3, 14, 33, 97
015	26/10/2019	05:33	28° 45.660’ N	33° 1.776’ W	5, 7, 12, 14, 17, 20	173, 112, 92, 72, 32, 8	.1, 1, 3, 7, 33, 97
017	27/10/2019	05:31	26° 08.400’ N	35° 11.690’ W	5, 8, 13, 15, 18, 20	201, 116, 102, 79, 33, 7	.1, 1, 3, 7, 33, 97
019	28/10/2019	05:28	23° 25.198’ N	37° 31.895’ W	5, 8, 13, 15, 18, 20	187, 125, 97, 71, 31, 6	.1, 1, 3, 7, 33, 97
022	30/10/2019	05:28	18° 03.412’ N	32°.58.394’ W	6, 8, 13, 15, 18, 20	153, 103, 78, 57, 28, 8	.1, 1, 3, 7, 33, 97
024	31/10/2019	05:25	15° 35.422’ N	30° 25.580’ W	6, 12, 13, 15, 18, 20	100, 67, 49, 38, 16, 6	.1, 1, 3, 7, 33, 97
026	01/11/2019	05:26	12° 44.620’ N	28° 30.020’ W	7, 13, 14, 15, 17, 20	61, 43, 32, 25, 12, 6	.1, 1, 3, 7, 33, 97
028	02/11/2019	05:24	9° 53.018’ N	26° 47.602’ W	8, 14, 15, 16, 18, 20	76, 47, 40, 31, 14, 8	.1, 1, 3, 7, 33, 97
030	03/11/2019	05:26	6° 44.974’ N	24° 59.969’ W	8, 14, 15, 17, 19, 20	75, 50, 39, 32, 14, 8	.1, 1, 3, 7, 33, 97
032	04/11/2019	05:24	2° 52.747’ N	24° 59.677’ W	6, 9, 13, 16, 18, 23	107, 73, 56, 43, 19, 4	.1, 1, 3, 7, 33, 97
034	05/11/2019	04:38	0° 34.870’ S	24° 59.978’ W	7, 13, 14, 15, 17, 20	113, 68, 59, 46, 20, 4	.1, 1, 3, 7, 33, 97
035	06/11/2019	05:25	4° 18.026’ S	24° 59.930’ W	6, 9, 13, 16, 18, 23	111, 74, 58, 43, 19, 4	.1, 1, 3, 7, 33, 97
037	07/11/2019	05:23	7° 23.679’ S	25° 0.491’ W	6, 8, 12, 15, 17, 23	122, 93, 72, 52, 22, 4	.1, 1, 3, 7, 33, 97
039	08/11/2019	05:02	10° 40.088’ S	25° 0.047’ W	6, 8, 13. 16. 18. 23	156, 103, 79, 61, 27, 5	.1, 1, 3, 7, 33, 97
041	09/11/2019	04:59	14° 16.288’ S	24° 59.651’ W	7, 8, 13, 15, 18, 23	183, 140, 117, 90, 39, 5	.1, 1, 3, 7, 33, 97
043	11/11/2019	04:56	20° 14.780’ S	24° 59.740’W	5, 7, 12, 15, 18, 23	183, 165, 123, 96, 41, 5	.1, 1, 3, 7, 33, 97
045	12/11/2019	04:27	23° 43.547’ S	24° 55.250’ W	5, 7, 14, 15, 18, 23	213, 171, 131, 100, 43, 4	.1, 1, 3, 7, 33, 97
047	13/11/2019	04:24	26° 45.731’ S	25° 48.404’ W	5, 6, 13, 14, 17, 23	172, 122, 93, 71, 30, 6	.1, 1, 3, 7, 33, 97
049	14/11/2019	04:26	30° 1.616’ S	26° 47.128’ W	3, 6, 13, 15, 18, 23	183, 113, 88, 66, 30, 5	.1, 1, 3, 7, 33, 97
051	15/11/2019	04:36	33° 35.932’ S	27° 53.440’ W	5, 8, 13, 15, 18, 23	137, 102, 87, 64, 27, 4	.1, 1, 3, 7, 33, 97
053	16/11/2019	04:38	37° 4.894’ S	29° 1.019’ W	5, 8, 13, 15, 18, 23	73, 52, 45, 33, 16, 5	.1, 1, 3, 7, 33, 97
054	17/11/2019	04:05	40° 21.334’ S	31° 2.351’ W	8, 10, 15, 16, 18, 22	58, 41, 25, 20, 11, 4	.1, 1, 3, 14, 33, 97
055	18/11/2019	03:38	41° 54.088’ S	35° 25.860’ W	11, 13, 17, 18, 19, 22	43, 22, 18, 12, 8, 5	.1, 1, 3, 14, 33, 97

Abundance, Composition and Size Structure of Microbial Plankton Communities by flow cytometry

Glen Tarran, *Plymouth Marine Laboratory, Plymouth UK*

Objectives

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 PML. 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 all depths at predawn (500 m) and solar noon (2000 m) CTD casts. 0.5 mL samples were fixed with glutaraldehyde solution (Sigma-Aldrich, 50%, Grade 1. 0.5% final concentration, 30 mins at 4^{o}C) within half an hour of surfacing. Samples (see below) were stained for 1 h at room temperature in the dark with the DNA stain SYBR Green I (Thermo-Fisher) in order to separate particles in suspension based on DNA content and light scattering properties. This enabled bacteria to be discriminated from other particles and enumerated. In addition to bacteria, the settings used will enable discrimination of algal viruses to provide relative abundance along the transect in support of a US-led CBIOMES project on viruses and enumeration of a cluster of cells that could possibly be Archaea, in support of a PML project investigating the identification, distribution and abundance of Archaea in the Atlantic and Arctic Oceans (see section on Archaea further on in this report). Samples were 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 PML. Table 1 summarises the CTD casts sampled and analysed during the cruise.

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

DATE	STATION	CTD	TIME on deck (GMT)	LAT +N, -S	LONG E	DEPTHS (**numbers in bold, bacteria analyses only**) *NISKIN BOTTLES.*
16-Oct	1	1	08:54	49.05	-6.73	5 15 25 40 70 80 90 100 110 120 *13 11 10 9 6 5 4 3 2 1*
16-Oct	2	2	13:55	48.52	-7.20	2 5 10 25 35 40 50 60 80 100 140 *22 20 19 10 9 8 7 6 4 3 1*

17-Oct	3	3	05:47	47.24	-9.32	5 8 12 15 20 35 50 80 100 150 200 **300 400 500** *24 18 17 16 15 12 8 7 6 5 4 3 2 1*
18-Oct	4	4	14:21	46.17	-13.88	5 50 65 80 100 200 **250 400 500 750 1000 1250 1500 1750 2000** *23 19 18 15 12 11 9 8 7 6 5 4 3 2 1*
19-Oct	5	5	05:38	44.74	-16.17	5 7 14 21 25 35 55 75 90 100 125 200 **300 400 500** *24 18 17 16 15 14 12 8 7 6 5 4 3 2 1*
19-Oct	6	6	14:31	43.91	-17.15	10 25 50 70 80 90 100 150 200 **250 400 500 750 1000 1250 1500 1750 2000** *23 19 18 16 15 14 13 11 10 9 8 7 6 5 4 3 2 1*
20-Oct	7	7	05:35	42.24	-19.20	5 10 20 30 35 45 60 80 100 120 200 **300 400 500** *23 18 17 16 15 14 13 9 6 5 4 3 2 1*
20-Oct	8	8	14:02	41.47	-20.19	5 30 60 70 100 120 150 200 **250 400 500 750 1000 1250 1500 1750 2000** *21 19 18 14 13 12 11 10 9 8 7 6 5 4 3 2 1*
21-Oct	9	9	05:28	40.18	-21.93	2 8 15 22 27 37 55 65 80 100 120 200 **300 400 500** *23 18 17 16 15 14 13 11 7 6 5 4 3 2 1*
23-Oct	10	10	05:36	35.89	-26.88	2 10 20 30 35 50 55 65 86 100 130 200 **300 400 500** *22 19 18 17 16 15 14 13 8 7 6 4 3 2 1*
23-Oct	11	11	14:04	35.09	-27.62	5 30 50 60 90 120 150 200 **300 400 500 750 1000 1250 1500 1750 2000** *21 19 18 17 13 12 11 109 8 7 6 5 4 3 2 1*
24-Oct	12	12	06:38	33.18	-29.33	2 12 23 33 40 55 75 95 120 145 180 **200 300 400 500** *22 19 18 17 16 15 14 9 8 6 5 4 3 2 1*
24-Oct	13	13	15:04	32.35	-0.02	5 30 50 60 90 120 150 200 **300 400 500 750 1000 1250 1500 1750 2000** *21 19 18 17 13 12 11 10 9 8 7 6 5 4 3 2 1*
25-Oct	14	14	15.:20	30.27	-31.86	19 40 70 80 115 140 150 200 **300 400 500 750 1000 1250 1500 1750 2000** *21 19 18 17 13 12 11 10 9 8 7 6 5 4 3 2 1*
26-Oct	15	15	06:34	28.76	-33.03	5 15 30 40 50 70 90 110 145 170 200 **300 400 500** *22 18 17 16 15 14 12 9 6 5 4 3 2 1*
26-Oct	16	16	15:11	27.95	-33.68	5 40 60 80 125 140 200 **500 1000** *21 19 18 17 14 13 12 11 10*
27-Oct	17	17	06:32	26.14	-35.19	5 17 32 47 57 77 100 115 145 170 200 **300 400 500** *22 19 18 17 16 15 14 10 7 6 4 3 2 1*
27-Oct	18	18	14:50	25.30	-35.90	5 25 60 70 120 140 150 200 **300 400 500 750 1000 1250 1500 1750 2000** *21 19 18 17 13 12 11 10 9 8 7 6 5 4 3 2 1*
28-Oct	19	19	06:25	23.42	-37.53	5 15 30 45 55 70 95 124 170 185 **300 400 500** *22 19 18 17 16 15 14 10 7 6 4 3 2 1*
28-Oct	20	20	14:54	22.59	-37.70	5 25 60 90 105 140 150 200 **300 400 500 750 1000 1250 1500 1750 2000** *21 19 18 17 13 12 11 10 9 8 7 6 5 4 3 2 1*
29-Oct	21	21	14:59	19.80	-34.78	5 25 40 60 100 140 160 200 **300 400 500 750 1000 1250 1500 1750 2000** *21 19 18 17 13 12 11 10 9 8 7 6 5 4 3 2 1*

30-Oct	22	22	06:19	18.06	-32.97	5 15 25 35 45 55 75 100 125 150 200 **300 400 500** *22 19 18 17 16 15 14 10 7 5 4 3 2 1*
30-Oct	23	23	14:49	17.28	-32.15	5 25 40 60 80 100 160 200 **300 400 500 850 1000 1250 1500 1750 2000** *21 19 18 17 13 12 11 10 9 8 7 6 5 4 3 2 1*
31-Oct	24	24	06:18	15.59	-30.43	5 8 15 22 27 37 47 65 80 98 200 **300 400 500** *23 19 18 17 16 15 14 10 7 5 4 3 2 1*
31-Oct	25	25	14:56	14.74	-29.68	9 17 30 50 72 100 170 **300 400 500 700 850 1000 1250 1500 1750 2000** *20 19 18 17 15 12 11 10 9 8 7 6 5 4 3 2 1*
01-Nov	26	26	06:20	12.74	-28.50	2 5 9 16 22 29 39 45 58 100 200 **300 400 500** 24 18 17 16 15 14 11 8 6 5 4 3 2 1
01-Nov	27	27	14:57	11.84	-27.96	5 11 34 50 60 100 170 **300 450 700 900 1000 1250 1500 1750 2000** *20 19 18 17 14 12 11 10 9 8 7 6 5 4 3 2 1*
02-Nov	28	28	16:16	9.88	-26.79	5 11 21 28 37 46 60 73 85 100 200 **300 400 500** *19 18 17 16 15 12 9 7 6 5 4 3 2 1*
02-Nov	29	29	14:56	8.89	-26.20	2 7 14 24 35 58 70 120 170 **300 400 500 850 1000 1250 1500 1750 2000** *23 21 19 17 14 12 11 10 9 8 7 6 5 4 3 2 1*
03-Nov	30	30	16:17	6.75	-25.00	5 11 21 30 37 50 60 73 85 100 150 200 **300 400 500** *22 19 18 17 15 12 9 8 7 6 5 4 3 2 1*
03-Nov	31	31	14:46	5.52	-25.00	5 9 17 30 60 80 150 200 **300 400 500 800 1000 1250 1500 1750 2000** *23 20 19 18 17 15 12 11 10 9 8 7 6 5 4 3 2 1*
04-Nov	32	32	06:14	2.88	-24.99	2 9 16 24 40 53 70 85 105 150 200 **300 400 500** *21 19 18 17 15 14 10 8 7 5 4 3 2 1*
04-Nov	33	33	14:47	1.68	-25.01	2 9 18 32 55 76 90 150 **300 400 500 800 1000 1250 1500 1750 2000** *22 20 19 18 17 15 11 10 9 8 7 6 5 4 3 2 1*
05-Nov	34	34	06:24	-0.01	-25.00	2 9 18 32 43 57 75 90 113 150 **260 500 750 1500 2000** *24 18 17 16 15 14 11 8 7 6 5 4 3 2 1*
06-Nov	36	35	06:15	-4.30	-25.00	2 9 16 24 40 55 72 85 110 160 200 **300 400 500** *22 19 18 17 15 14 9 8 7 5 4 3 2 1*
06-Nov	37	36	14:29	-5.04	-25.00	2 11 20 36 49 85 **100 250 400 730 1000 1500 2000 5000** *22 20 19 18 17 9 8 7 6 5 4 3 2 1*
07-Nov	39	37	06:41	-7.39	-25.01	2 11 20 36 50 70 90 100 120 160 200 **300 400 500** *21 18 17 16 14 13 8 7 6 5 4 3 2 1*
07-Nov	40	38	14:55	-8.41	-24.98	2 13 24 43 76 100 120 200 **300 400 500 800 1000 1250 1500 1750 2000** *22 20 19 18 17 15 11 10 9 8 7 6 5 4 3 2 1*
08-Nov	42	39	06:03	-10.67	-25.00	2 13 24 43 58 76 90 100 120 152 160 200 **300 400 500** *21 19 18 17 15 14 12 8 7 6 5 4 3 2 1*
08-Nov	43	40	14:55	-11.88	-25.00	2 15 30 55 83 120 125 200 **300 400 500 800 1000 1250 1500 1750 2000** *22 20 19 18 17 12 11 10 9 8 7 6 5 4 3 2 1*

09-Nov	44	41	06:07	-14.27	-24.99	2 19 36 45 64 87 114 125 150 180 200 **300 400 500** *21 19 18 17 16 14 13 12 8 7 5 4 3 2 1*
09-Nov	45	42	14:52	-15.44	-25.00	2 15 30 55 85 140 157 170 **300 400 500 700 1000 1250 1500 1750 2000** *22 20 19 18 17 16 14 10 9 8 7 6 5 4 3 2 1*
11-Nov	47	43	06:01	-20.25	-25.00	2 20 38 55 68 92 105 120 140 162 180 200 **300 400 500** *21 19 18 17 16 14 13 12 11 7 6 5 3 2 1*
11-Nov	48	44	14:48	-21.44	-24.84	5 15 30 55 85 140 162 180 **250 320 400 500 835 1000 1250 1500 1750 2000** *22 20 19 18 17 16 12 11 10 9 8 7 6 5 4 3 2 1*
12-Nov	50	45	05:42	-23.73	-24.92	2 21 40 59 72 97 128 140 168 180 210 **300 400 500** *21 19 18 17 16 15 13 12 7 6 5 3 2 1*
12-Nov	51	46	14:00	-24.74	-25.20	2 15 35 55 85 140 158 190 **250 320 400 500 850 1000 1250 1500 1750 2000** *22 20 19 18 17 16 12 11 10 9 8 7 6 5 4 3 2 1*
13-Nov	52	47	05:24	-26.76	-25.81	4 15 28 42 51 69 91 105 120 170 **210 300 400 500** *21 18 17 16 15 14 13 11 8 5 4 3 2 1*
14-Nov	54	49	05:08	-30.03	-26.79	2 14 26 38 63 84 100 110 180 **250** *21 19 18 16 15 13 10 8 3 1*
14-Nov	55	50	14:00	-31.21	-27.15	2 15 35 55 85 100 125 150 200 **300 500 700 900 1000** *23 19 18 17 16 14 13 7 6 5 4 3 2 1*
15-Nov	56	51	05:21	-33.60	-27.89	2 13 25 36 61 85 100 135 150 200 **250** *22 19 18 16 15 13 10 5 3 2 1*
15-Nov	57	52	13:58	-34.78	-28.25	4 20 40 70 85 100 140 **250 400 500 700 900 1000** 23 19 18 17 11 10 8 6 5 4 3 2 1
16-Nov	58	53	05:30	-37.08	-29.02	2 7 13 19 31 42 55 70 150 **250 500** 22 19 18 16 15 13 10 5 3 2 1
17-Nov	60	54	05:25	-40.36	-31.04	3 5 9 17 23 40 55 100 200 **400 600 800 1000** *22 19 18 16 14 11 7 6 5 4 3 2 1*
18-Nov	62	55	06:07	-41.90	-35.43	2 5 10 15 20 40 100 **250 400 600 800 1000 1250 1500 1750 2000** *22 19 18 17 15 11 10 9 8 7 6 5 4 3 2 1*

Size structure of pico- and nanophytoplankton and bacteria communities

Simons Foundation project, CBIOMES (Computational Biogeochemical Modeling of Marine Ecosystems), Ocean Colour and Ocean Biogeochemistry, led by Prof. Shubha Sathyendranath is developing and improving novel satellite-based products, including phytoplankton functional types, particulate organic carbon, photosynthesis-irradiance parameters and phytoplankton carbon. These products, along with more standard products such as chlorophyll concentration and marine primary production, will form part of the CBIOMES data atlas. They will be used for comparison with ecosystem model outputs, and in data assimilation. With specific reference to phytoplankton carbon, one of the key parameters needed to better quantify phytoplankton carbon accurately is to measure the sizes of different components of phytoplankton communities in contrasting ocean waters. To achieve this a size fractionation approach, combined with flow cytometry, was used to estimate the median cell sizes of *Synechococcus* sp. and *Prochlorococcus* sp. cyanobacteria and pico- and nanoeukaryote phytoplankton in contrasting waters, both in terms of oceanic provinces and depth, along the AMT transect. In addition, median cell sizes of heterotrophic bacteria were also estimated using the same approach. The approach involved passing samples of seawater through a series of membrane filters (Table 2) and analysing the resulting filtrates by flow cytometry. The percentage of cells remaining in each filtrate, relative to those in unfiltered water were plotted against filter pore size to produce curves as shown in the example in Figure 1. For each plankton group, a line was drawn across from the 50% mark on the Y axis. Where it intersected with the curve a vertical line was drawn down to the X axis and the point of intersection with the X axis was recorded as the median cell size for that group. In the southern hemisphere, filtration was conducted by Carolina Sà, University of Lisbon. Filters used were Whatman Nuclepore™ polycarbonate filters of 47 mm diameter. Filters were placed in in-line polycarbonate filter housings clamped onto a burette stand with a 5 mL flow cytometry tube below to collect the filtrate. Filters were pre-wetted with 0.2 µm filtered seawater before placing them in the filter housing. 3.1 mL of sample seawater was pipetted into the filter housing for phytoplankton samples and 1.6 mL for bacteria samples (bacteria samples were live-stained for 1 h with Sybr Green I DNA stain at room temperature in the dark). Experiments were conducted daily using water collected from predawn CTDs. Experiments alternated every other day between samples from the deep chlorophyll maximum and the mixed layer.

***Table 2*: Membrane filter pore sizes used for size fractionation experiments and samples analysed per experiment.**

Filter pore size/ Sample (µm)	Eukaryote phytoplankton	Prokaryote phytoplankton	Bacteria
0.2		✓	✓
0.4		✓	✓
0.6		✓	✓
0.8		✓	✓
1	✓	✓	✓
2	✓	✓	✓
3	✓	✓	
5	✓	✓	
8	✓		
10	✓		
Unfiltered	✓	✓	✓

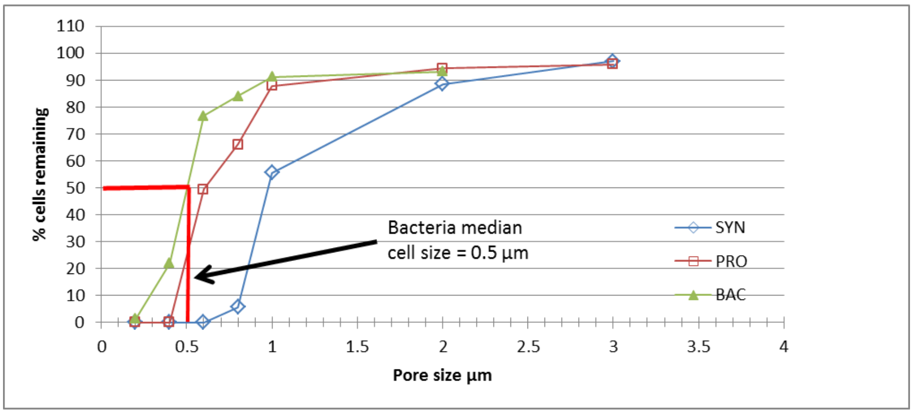

***Figure 1*: Example size fractionation plot for estimating prokaryoplankton group median cell size.**
Water from 100 m (deep chlorophyll maximum), 21 October 2019

Additional flow cytometry.

Enumeration of picophytoplankton and bacteria in collaboration with Cristina Fernandez-Gonzalez and Emilio Marañon. University of Vigo, Spain

Seawater samples (6 mL) were provided daily from incubation experiments being run by Cristina in an on-deck incubator. See relevant section in this report for summary of incubation experiments. 0.5 mL sub-samples were fixed with glutaraldehyde, stained with Sybr Green I, and analysed by flow cytometry to enumerate bacteria, as described in the previous section. Picophytoplankton samples were analysed live as described in the first section of this report.

Particle size distribution analyses in collaboration with Carolina Sà, University of Lisbon, Portugal and Giorgio Dall'Olmo, PML

As part of a collaboration studying particle size distributions (PSD) (see Carolina's cruise report for details), daily samples from solar noon CTD casts were filtered through Whatman Nuclepore™ membrane filters and analysed, in parallel with unfiltered samples by flow cytometry and using a Multisizer III Coulter Counter (Beckman Coulter). Flow cytometric analyses were triggered using light scatter (side scatter) as the thresholding parameter to tie in better with the Multisizer measurements. The objective of the analyses was to be able to apportion the contribution of plankton groups to the overall particle size distribution. Table 3 summarises the PSD sample details.

***Table 3*: Details of sampling for parallel flow cytometry: Coulter Counter PSD analyses**

DATE	STN	CTD	TIME on deck (GMT)	LAT +N, -S	LON E	Depth (m)	Filtrate µm	Unfiltered sample
03-Nov	31	31	14:46	5.52	-25.00	72	2	✓
04-Nov	33	33	14:47	1.68	-25.01	76	1	✓
05-Nov	34	34	06:24	-0.01	-25.00	75	1	✓
06-Nov	37	36	14:29	-5.04	-25.00	85	1	✓
07-Nov	40	38	14:55	-8.41	-24.98	100	0.8	✓
08-Nov	43	40	14:55	-11.88	-25.00	113	2	✓
09-Nov	45	42	14:52	-15.44	-25.00	157	0.6	✓
11-Nov	48	44	14:48	-21.44	-24.84	162	0.6	✓
12-Nov	51	46	14:00	-24.74	-25.20	158	2	✓
13-Nov	53	48	13:24	-27.71	-26.09	125	0.8	
14-Nov	55	50	14:00	-31.21	-27.15	125	1	

15-Nov	57	52	13:58	-34.78	-28.25	85	2	
17-Nov	60	54	05:25	-40.36	-31.04	40	3	
18-Nov	62	55	06:07	-41.90	-35.43	20	3	

Mesoplankton Community Size Structure and abundance

Glen Tarran, *Plymouth Marine Laboratory, Plymouth UK*

Methods:

Vertical net hauls were conducted each day at the pre-dawn stations for the collection of mesozooplankton samples (Table 4). A bongo (double) net frame was deployed from the Discovery's aft starboard quarter using one of the ship's cranes and a Romica general purpose winch with 8 mm steel wire. The nets used had 0.57 m diameter openings with 200 µm nylon mesh, fitted with cod ends with 200 µm mesh windows. Nets were deployed to a depth of 200 m and then hauled at a rate of 11-12 m min^{-1}, providing duplicate samples, integrated between 200 m and the surface. Nets were washed with seawater whilst still outboard and then brought on board where the cod ends containing the samples were collected into buckets. Nets were then washed down with fresh water before stowing. The duplicate samples were then passed through a 200 µm sieve and the material retained on the sieve was then washed into a 100 mL plastic bottle using fresh seawater. Samples then had 10 mL of 37% borax-buffered formaldehyde (4% final concentration) added and were gently inverted 10 times to mix in the formaldehyde. Samples were then stored at 4-6^{o}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 4*: Details of bongo WP-2 net vertical deployments**

DATE	Day of year	STATION	TIME on deck (GMT)	Duration (mins)	LAT +N, -S	LON E	Preserved sample names
21-Oct	1	9	05:02	17	40.18	-21.93	A29_009_1 and 2
23-Oct	2	10	04:44	17	35.89	-26.88	A29_010_1 and 2
24-Oct	3	12	05:47	18	33.18	-29.33	A29_012_1 and 2
27-Oct	4	17	05:46	17	26.14	-35.19	A29_017_1 and 2
28-Oct	5	19	05:44	17	23.42	-37.53	A29_019_1 and 2
30-Oct	6	22	05:51	20	18.06	-32.97	A29_022_1 and 2
31-Oct	7	24	05:46	17	15.59	-30.43	A29_024_1 and 2
01-Nov	8	26	05:52	18	12.74	-28.50	A29_026_1 and 2

02-Nov	9	28	05:44	17	9.88	-26.79	A29_028_1 and 2
03-Nov	10	30	05:45	17	6.75	-25.00	A29_030_1 and 2
04-Nov	11	32	05:43	18	2.88	-24.99	A29_032_1 and 2
05-Nov	12	34	04:46	14	-0.01	-25.00	A29_034_1 and 2
06-Nov	13	35	05:45	17	-4.30	-25.00	A29_035_1 and 2
08-Nov	14	39	05:20	16	-10.67	-25.00	A29_039_1 and 2
09-Nov	15	41	05:20	17	-14.27	-24.99	A29_041_1 and 2
11-Nov	16	47	05:17	17	-20.25	-25.00	A29_047_1 and 2
12-Nov	17	50	04:43	17	-23.73	-24.92	A29_050_1 and 2
14-Nov	18	54	04:44	18	-30.03	-26.79	A29_054_1 and 2
15-Nov	19	56	04:59	19	-33.60	-27.89	A29_056_1 and 2
17-Nov	20	60	04:20	13	-40.36	-31.04	A29_060_1 and 2
18-Nov	21	62	04:00	18	-41.90	-35.43	A29_062_1 and 2

Sample collection for molecular identification and quantification of Archaea

Glen Tarran *Plymouth Marine Laboratory, Plymouth UK*

Methods:

Seawater samples were collected, preserved and stored from solar noon CTDs as part of a project to study the distribution and abundance of Archaea from the Arctic and through the Atlantic Ocean with Karen Tait and Patrick Downes from PML. Archaea are a relatively newly discovered domain of prokaryotes, older than bacteria, which were first discovered in 1977. They were thought to only exist in extreme environments such as hot springs but have recently been reported in other environments such, as the ocean.

Using the samples collected for flow cytometry, 1.7 mL sub-samples from the surface down to 1000 m were pipetted into 2 mL cryovials, along with 15 µL glutaraldehyde solution (Sigma-Aldrich, 50%, Grade 1. 0.4% final concentration) for 1 hour at 4^{o}C. Cryovials were then flash-frozen with liquid nitrogen and transferred to a -80^{o}C freezer. Samples will be transported back to the UK on the ship, transferred to the lab. in a liquid nitrogen dry shipper and a combination of flow-sorting and molecular probes used to isolate and identify Archaea. It is possible that the Archaea can be discriminated from bacteria in the standard flow cytometry plots used for AMT analyses. If this is the case, it will be possible to reanalyse historical AMT bacteria data files to create a time series of Archaea abundance through the water column in the Atlantic Ocean. Table 5 provides details of samples collected for Archaea studies.

***Table 5*: Details of sampling for Archaea studies**

DATE	STATION	CTD	TIME on deck (GMT)	LAT +N, -S	LON E	DEPTHS/*NISKIN BOTTLES*
18-Oct	4	4	14:21	46.17	-13.88	5 50 80 100 200 250 400 500 750 1000 *23 19 15 12 11 9 8 6 5*
19-Oct	6	6	14:31	43.91	-17.15	10 50 100 150 200 250 400 500 750 1000 *23 18 13 11 10 9 8 7 6 5*
20-Oct	8	8	14:02	41.47	-20.19	5 60 100 150 200 250 400 500 750 1000 *21 18 13 11 10 9 8 7 6 5*
23-Oct	11	11	14:04	35.09	-27.62	5 60 90 150 200 300 400 500 750 1000 *22 17 14 11 10 9 8 7 6 5*
24-Oct	13	13	15:04	32.35	-0.02	5 50 95 150 200 300 400 500 750 1000 *21 18 13 11 10 9 8 7 6 5*
25-Oct	14	14	15.:20	30.27	-31.86	5 50 95 150 200 300 400 500 750 1000 *21 18 13 11 10 9 8 7 6 5*
26-Oct	16	16	15:11	27.95	-33.68	5 80 125 140 200 500 1000 *21 17 14 13 12 11 10*
27-Oct	18	18	14:50	25.30	-35.90	5 60 120 150 200 300 400 500 750 1000 *21 18 13 11 10 9 8 7 6 5*

28-Oct	20	20	14:54	22.59	-37.70	5 60 105 150 200 300 400 500 750 1000 *21 18 13 11 10 9 8 7 6 5*
29-Oct	21	21	14:59	19.80	-34.78	5 60 100 160 200 300 400 500 750 1000 *21 17 13 11 10 9 8 7 6 5*
30-Oct	23	23	14:49	17.28	-32.15	5 60 100 160 200 300 400 500 750 1000 *21 17 12 11 10 9 8 7 6 5*
31-Oct	25	25	14:56	14.74	-29.68	9 72 100 170 300 400 500 700 850 1000 *20 15 12 11 10 9 8 7 6 5*
01-Nov	27	27	14:57	11.84	-27.96	5 43 60 100 170 300 450 700 900 1000 *20 14 12 11 10 9 8 7 6 5*
02-Nov	29	29	14:56	8.89	-26.20	2 58 70 120 170 300 400 500 850 1000 *23 14 12 11 10 9 8 7 6 5*
03-Nov	31	31	14:46	5.52	-25.00	5 72 80 150 200 300 400 500 800 1000 *23 15 12 11 10 9 8 7 6 5*
04-Nov	33	33	14:47	1.68	-25.01	2 55 76 90 150 300 400 500 800 1000 *22 16 15 11 10 9 8 7 6 5*
06-Nov	37	36	14:29	-5.04	-25.00	2 36 85 100 250 400 730 5000 *21 18 9 8 7 9 5 1*
07-Nov	40	38	14:55	-8.41	-24.98	2 43 100 200 300 400 500 800 1000 *22 18 15 10 9 8 7 6 5*
08-Nov	43	40	14:55	-11.88	-25.00	2 55 120 200 300 400 500 800 1000 *22 18 12 10 9 8 7 6 5*
09-Nov	45	42	14:52	-15.44	-25.00	2 85 157 170 300 400 500 700 1000 *22 17 14 10 9 8 7 6 5*
11-Nov	48	44	14:48	-21.44	-24.84	2 85 162 250 320 400 500 835 1000 *22 17 12 10 9 8 7 6 5*
12-Nov	51	46	14:00	-24.74	-25.20	2 85 158 250 320 400 500 850 1000 *22 17 12 10 9 8 7 6 5*
13-Nov	53	48	13:24	-27.71	-26.09	5 55 125 200 300 400 500 800 1000 *22 17 13 6 5 4 3 2 1*
14-Nov	55	50	14:00	-31.21	-27.15	2 55 125 200 300 500 700 900 1000 *22 17 13 6 5 4 3 2 1*
15-Nov	57	52	13:58	-34.78	-28.25	2 40 85 250 400 500 700 900 1000 *23 18 11 6 5 4 3 2 1*
17-Nov	60	54	05:25	-40.36	-31.04	9 100 200 400 600 800 1000 *17 6 5 4 3 2 1*
18-Nov	62	55	06:07	-41.90	-35.43	2 20 100 250 400 600 800 1000 *22 13 10 9 8 7 6 5*

Single cell stoichiometry

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Objective

- To generate the first measurements of single-cell phytoplankton stoichiometry obtained in open ocean over basin-wide scales.

Method

Samples from surface and DCM were collected along the transect. 9L of seawater were filtering in a peristaltic pump in two steps. First, the higher size fraction of the natural community, >20 µm, was concentrated by reverse filtering in 200ml of sample. Then, this 200ml were filtered throughout a 10 µm PC filter and flash frozen. The remaining 8.8L were filtering again into a cell-trap where small cells, <20 µm, were retained and then eluted into a cryovial and flash frozen. Both size fractions were store at -80ºC.

The elemental composition of cells will be measured using X-ray microanalysis (XRMA) on land following Segura-Noguera et al. 2012. This single-cell method provides more accurate data than the bulk seston samples technique because it allows to avoid the interference of non-phytoplankton material.

Funding

Responses of marine phytoplankton to environmental variability across levels of biological organization (POLARIS). Funding agency: Spanish Ministry of Science and Innovation (grant PGC2018-094553-B-I00)

Tropical and South Atlantic: climate-based marine ecosystem prediction for sustainable management (TRIATLAS). Funding agency: EU H2020 Programme (Call H2020-BG-2018-2, Project 8175)

References

Segura-Noguera M., Blasco D., and Fortuño J.M. 2012. An improved energy-dispersive X-ray microanalysis for analysing simultaneously carbon, nitrogen, oxygen, phosphorous, sulphur, and other cation and anion concentrations in single natural marine microplankton cells. Limn. Oceanogr.: Methods 10, 666-680

Table 1. Time and location of water sampling on AMT29.

Date	Hour (UTC)	Station No	CTD Cast No	Latitude (degrees)	Longitude (degrees)	Niskin Bottle No	Depth (m)
17/10/2019	0445	3	DY003	47º 14.60334N	9º 18.91134W	11,20,22	35, 5
19/10/2019	0430	5	DY005	44º 44.63586N	16º 10.06074W	11, 24	55,5
20/10/2019	0436	7	DY007	42º 14.51034N	19º 11.76294W	11,21	80,5
21/10/2019	0430	9	DY009	40ºN 10.67166N	21º 55.77894W	11,22,21	65,2
23/10/2019	0438	10	DY010	35º 55.36854N	26º 52.7566W	11,22,21	86,2

24/10/2019	0535	12	DY012	33º 10.71468N	29º 20.09574W	10,21,22	92,2
26/10/2019	0533	15	DY015	29º 45.660N	33º 1.776 W	8,21,22	118,5
27/10/2019	0530	17	DY017	26º 08.400 N	35º 11.690W	9,22,21	115,5
28/10/2019	0530	18	DY018	23º 25.14762N	37º 31.89432W	9,21,22	124,5
30/10/2019	0530	22	DY022	18º 3.42690N	32º 58.38542W	9,20,22	100,5
31/10/2019	0525	24	DY024	15º 35.45658N	30º 25.58088W	9,21,22	65,5
31/10/2019	1315	25	DY025	14º 49.299N	29º 41062W	13,21,24	72,5
01/11/2019	0526	26	DY026	12º 44.61744N	28º 30.00910W	10,21,22	39,2
01/11/2019	1319	27	DY027	11º 50.69170N	27 57.64914W	13,21	43,5
02/11/2019	0525	28	DY028	9º 53.01390N	26º 47.60622W	11,22	46,,5
02/11/2019	1323	29	DY029	8º 53.50290N	26º 11.97030W	13,22	58,2
03/11/2019	0525	30	DY030	6º 44.974N	24º 59.969W	13,21	50,5
03/11/2019	1315	31	DY031	5º 31.30104N	25º 0.10006W	13,23	72,5
04/11/2019	0515	32	DY032	2º 52.747N	24º 58.677W	10,19	70,2
04//11/19	1316	33	DY033	1º 40.60368N	25º 0.52836W	12,21	76,2
05/11/2019	0428	34	DY034	0º 34.857005 N	24º 59.93214W	10,22	75,2
06/11/2019	0525	36	DY035	4º 18.026N	24º 59.940W	10,22	72,2
06/11/2019	1130	37	DY036	5º 2.617 S	25º 0.08W	10,22	85,11
07/11/2019	0521	39	DY037	7º 23.67132S	25º 0.49086	9,22	80,2
07/11/2019	1315	40	DY038	8º 24.340S	24º 59.000W	12,21,	100,2
08/11/2019	0502	42	DY039	10º 40.00780N	25º 0.04644W	9,22	100,2
09/11/2019	0500	44	DY041	14º 16.28802S	24º 59.65185W	9,22	140,2
10/11/2019	0456	47	DY043	20º 14.77632 S	24º 59.73702 W	8,22	162,2
11/11/2019	0426	50	DY045	23º 43.54686 S	25.25064 W	8,22	168,2
12/11/2019	0426	50	DY045	23º 43.54686 S	25.25064 W	8,10,21,22	168,2
13/11/2019	0424	52	DY047	26º 45.72936 S	25º 48.40362 W	7,9,20,21	120,2
14/11/2019	0426	54	DY049	30º 1.61826 S	26º 47.12856 W	7,9,20,22	110,2
15/11/2019	0436	56	DY051	33º 35.9325 S	27º 53.440 W	9,11,20,22	100,2
16/11/2019	0437	58	DY053	37º 4.89714 S	29º 1.01964 W	10,11,20,22	55,2

17/11/2019	0405	60	DY054	40º 21.334S	31º 02.357 W	9,13,14,16,18,19,21,22	40,23,17,9,5,2
18/11/2019	0340	62	DY055	41º 54.08730S	35º 25.85790 W	12,15,17,18,19,21,22	27,16,11,6,2

Viscosity and transparent exopolymeric particles (TEP)

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Objective

- To characterise both the viscous heterogeneity at the microscale and its ecological effects.
- To formulate a new conceptual framework for the microbial oceanic landscape that includes viscosity.

Method

Seawater samples for the determination of viscosity and TEP, which have an influence on seawater viscosity, are collected from 6 different depths in the euphotic zone, including surface and deep chlorophyll maximum. Viscosity was analysed on board with a µVisc (Rheosense), and TEP samples were fixed with formaldehyde 37% (final concentration 7%) and stored at room temperature until analysis on land following Passow & Alldredge (1995).

Funding

Slowing Down at Small Scales: Microscale Viscosity Gradients in the Sea. Gordon & Betty Moore Foundation, GBMF6852, Nov. 2017, $965,532, PI: Drs. Stuart Humphries (University of Lincoln, UK) & Jules Jaffe (Scripps Institution of Oceanography, USA).

Responses of marine phytoplankton to environmental variability across levels of biological organization (POLARIS). Funding agency: Spanish Ministry of Science and Innovation (grant PGC2018-094553-B-I00)

Tropical and South Atlantic: climate-based marine ecosystem prediction for sustainable management (TRIATLAS). Funding agency: EU H2020 Programme (Call H2020-BG-2018-2, Project 8175)

References

Passow U. and A.L. Alldredge (1995), A dye-binding assay for the spectrophotometric measurement of transparent exopolymer particles (TEP). Limnol. Oceanogr., 40(7): 1326 – 1335.

Table 1. Time and location of water sampling on AMT29.

Date	Hour (UTC)	Station No	CTD Cast No	Latitude	Longitude	Niskin Bottle No	Depth (m)
17/10/2019	0445	3	DY003	47º 14.60334N	9º 18.91134W	11,12,16,17,18,20,22	35, 15 12, 8, 5
19/10/2019	0430	5	DY005	44º 44.63586N	16º 10.06074W	11,12,16,17,18,20,21,24	55,25,21,14,7,5
20/10/2019	0436	7	DY007	42º 14.51034N	19º 11.76294W	11,10,15,16,17,18,22,21	80,35,30,20,10,5
21/10/2019	0430	9	DY009	40ºN 10.67166N	21º 55.77894W	11,10,15,16,17,18,22,2	65,27,22,15,8,2

						1	
23/10/2019	0438	10	DY010	35º 55.36854N	26º 52.7566W	11,9,16,17,18,19,22,21	86,35,30,20,10,2
24/10/2019	0535	12	DY012	33º 10.71468N	29º 20.09574W	10,12,16,17,18,19,22,21	92,40,33,23,12,2
26/10/2019	0533	15	DY015	29º 45.660N	33º 1.776 W	8,10,15,16,17,18,19,21,22	118,50,40,30,15,5
27/10/2019	0530	17	DY017	26º 08.400 N	35º 11.690W	9,11,16,17,18,19,22,21	115,57,47,32,17,5
28/10/2019	0530	18	DY018	23º 25.14762N	37º 31.89432W	9,11,16,17,18,19,21,22	124,54,45,30,15,5
30/10/2019	0530	22	DY022	18º 3.42690N	32º 58.38542W	9,11,16,17,18,19,20,22	100,45,35,25,15,5
31/10/2019	0525	24	DY024	15º 35.45658N	30º 25.58088W	9,11,16,17,18,19,21,22	65,27,22,15,8,5
31/10/2019	1315	25	DY025	14º 49.299N	29º 41062W	13,16,17,18,19,20,21,24	72,50,30,17,9,5
01/11/2019	0526	26	DY026	12º 44.61744N	28º 30.00910W	10,12,15,16,17,18,19,21,22	39,22,16,9,5,2
01/11/2019	1319	27	DY027	11º 50.69170N	27 57.64914W	13,16,17,18,19,20,21	43,34,20,11,5
02/11/2019	0525	28	DY028	9º 53.01390N	26º 47.60622W	11,13,16,17,18,21,22	46,28,21,11,5
02/11/2019	1323	29	DY029	8º 53.50290N	26º 11.97030W	13,16,17,19,20,21,22,24	58,35,24,14,7,2
03/11/2019	0525	30	DY030	6º 44.974N	24º 59.969W	13,17,18,19,21	50,30,21,11,5
03/11/2019	1315	31	DY031	5º 31.30104N	25º 0.10006W	13,16,17,18,19,20,21,23	72,60,30,17,9,5
04/11/2019	0515	32	DY032	2º 52.747N	24º 58.677W	10,12,16,17,18,19	70,40,24,16,9,2
04//11/19	1316	33	DY033	1º 40.60368N	25º 0.52836W	12,17,18,19,20,21	76,55,32,18,3,2
05/11/2019	0428	34	DY034	0º 34.857005 N	24º 59.93214W	10,12,15,16,17,18,21,22	75,43,32,18,9,2
06/11/2	0525	36	DY035	4º 18.026N	24º 59.940W	10,12,1	72,40,2

019						6,17,18,19,20,22	4,16,9,2
06/11/2019	1130	37	DY036	5º 2.617 S	25º 0.08W	10,14,17,18,19,20,21,22	85,49,36,20,11
07/11/2019	0521	39	DY037	7º 23.67132S	25º 0.49086	9,11,15,16,17,18,19,21,22	80,50,36,20,11,2
07/11/2019	1315	40	DY038	8º 24.340S	24º 59.000W	12,17,18,19,20,21,	100,76,43,24,13,2
08/11/2019	0502	42	DY039	10º 40.00780N	25º 0.04644W	9,11,16,17,18,19,21,22	100,58,43,24,13,2
09/11/2019	0500	44	DY041	14º 16.28802S	24º 59.65185W	9,11,14,16,18,19,21,22	140,87.64.36.19,2
11/11/2019	0456	47	DY043	20º 14.77632 S	24º 59.73702 W	8,10,14,16,18,19,21,22	162,92,68,38,20,2
12/11/2019	0426	50	DY045	23º 43.54686 S	25.25064 W	8,10,15,17,18,19,21,22	168,97,59,40,21,2
13/11/2019	0424	52	DY047	26º 45.72936 S	25º 48.40362 W	7,9,14,16,17,18,19,20,21	120,69,42,28,15,2
14/11/2019	0426	54	DY049	30º 1.61826 S	26º 47.12856 W	7,9,15,16,17,19,20,22	110,63,28,26,14,2
15/11/2019	0436	56	DY051	33º 35.9325 S	27º 53.440 W	9,11,15,16,17,19,20,22	100,61,36,25,13,2
16/11/2019	0437	58	DY053	37º 4.89714 S	29º 1.01964 W	10,11,15,16,18,19,20,22	55,31,19,13,7,2
17/11/2019	0405	60	DY054	40º 21.334S	31º 02.357 W	9,13,14,16,18,19,21,22	40,23,17,9,5,2
18/11/2019	0340	62	DY055	41º 54.08730S	35º 25.85790 W	12,15,17,18,19,21,22	27,16,11,6,2

Cytosense and Flow Cam analyses

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Objective

- To measure the abundance and biovolume of natural phytoplankton communities along the transect.

Method

Along the transect samples for measuring the abundance of pico, nano and microphytoplankton were collected. Samples for measuring with Flow Cam were fixed with buffered formaldehyde 10% and stored at room temperature while samples for measuring with the flow cytometer “Cytosense” were fixed with Paraformaldehyde at 2% final concentration, kept in the fridge for 30 minutes and stored at -80ºC. Both will be analysing on land.

Funding

Responses of marine phytoplankton to environmental variability across levels of biological organization (POLARIS). Funding agency: Spanish Ministry of Science and Innovation (grant PGC2018-094553-B-I00)

Tropical and South Atlantic: climate-based marine ecosystem prediction for sustainable management (TRIATLAS). Funding agency: EU H2020 Programme (Call H2020-BG-2018-2, Project 8175)

Table 1. Time and location of water sampling on AMT29.

Date	Hour (UTC)	Station No	CTD Cast No	Latitude	Longitude	Niskin Bottle No	Depth (m)
17/10/2019	0445	3	DY003	47º 14.60334N	9º 18.91134W	11,18,22	35,8,5
19/10/2019	0430	5	DY005	44º 44.63586N	16º 10.06074W	12,17,20,21	55,14,5
20/10/2019	0436	7	DY007	42º 14.51034N	19º 11.76294W	10,17,21	80,20,5
21/10/2019	0430	9	DY009	40ºN 10.67166N	21º 55.77894W	10,17,21	65,15,2
23/10/2019	0438	10	DY010	35º 55.36854N	26º 52.7566W	11,18,21	86,18,2
24/10/2019	0535	12	DY012	33º 10.71468N	29º 20.09574W	12,18,21	92,23,2
26/10/2019	0533	15	DY015	29º 45.660N	33º 1.776 W	10,17,19,21	118,30,5
27/10/2019	0530	17	DY017	26º 08.400 N	35º 11.690W	11,18,21	115,32,5
28/10/2019	0530	18	DY018	23º 25.14762N	37º 31.89432W	11,18,21	124,30,5
30/10/2019	0530	22	DY022	18º 3.42690N	32º 58.38542W	11,18,20	100,25,5
31/10/2019	0525	24	DY024	15º 35.45658N	30º 25.58088W	11,18,21	65,15,5
31/10/2	1315	25	DY025	14º	29º 41062W	13,19,2	72,17,5

019				49.299N		1	
01/11/2019	0526	26	DY026	12º 44.61744N	28º 30.00910W	12,17,19,21	39,9,2
01/11/2019	1319	27	DY027	11º 50.69170N	27 57.64914W	13,19,21	43,11,5
02/11/2019	0525	28	DY028	9º 53.01390N	26º 47.60622W	13,18,22	46,11,5
02/11/2019	1323	29	DY029	8º 53.50290N	26º 11.97030W	13,20,22	58,14,2
03/11/2019	0525	30	DY030	6º 44.974N	24º 59.969W	13,19,21	50,11,5
03/11/2019	1315	31	DY031	5º 31.30104N	25º 0.10006W	13,19,21	72,17,5
04/11/2019	0515	32	DY032	2º 52.747N	24º 58.677W	12,18,20	70,16,2
04//11/19	1316	33	DY033	1º 40.60368N	25º 0.52836W	12,19,21	76,18,2
05/11/2019	0428	34	DY034	0º 34.857005N	24º 59.93214W	12,17,21	75,18,2
06/11/2019	0525	36	DY035	4º 18.026N	24º 59.940W	12,18,20	72,16,2
06/11/2019	1130	37	DY036	5º 2.617 S	25º 0.08W	10,19,21	85,20,5?
07/11/2019	0521	39	DY037	7º 23.67132S	25º 0.49086	11,17,19	80,20,2
07/11/2019	1315	40	DY038	8º 24.340S	24º 59.000W	12,19,21	100,24,2
08/11/2019	0502	42	DY039	10º 40.00780N	25º 0.04644W	11,18,22	100,24,2
09/11/2019	0500	44	DY041	14º 16.28802S	24º 59.65185W	9,11,18,21,22	140,36,2
11/11/2019	0456	47	DY043	20º 14.77632 S	24º 59.73702 W	8,10,18,21,22	162,38,2
12/11/2019	0426	50	DY045	23º 43.54686 S	25.25064 W	8,10,18,21,22	168,40,2
13/11/2019	0424	52	DY047	26º 45.72936 S	25º 48.40362 W	7,9,17,20,21	120,28,2
14/11/2019	0426	54	DY049	30º 1.61826 S	26º 47.12856 W	7,9,17,20,22	110,26,2
15/11/2019	0436	56	DY051	33º 35.9325 S	27º 53.440 W	9,11,17,22	100,25,2
16/11/2019	0437	58	DY053	37º 4.89714 S	29º 1.01964 W	10,11,18,20,22	55,13,2
17/11/2019	0405	60	DY054	40º 21.334S	31º 02.357 W	9,13,18,21,22	40,9,2
18/11/2019	0340	62	DY055	41º 54.08730S	35º 25.85790 W	12,15,19,21,22	27,6,2

Temperature-Nutrient Incubations on deck

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Objective

- To improve our understanding about the interactive effect of temperature and nutrients availability in different phytoplankton and bacteria communities along the transect.

Method

Along the transect we set up five temperature controlled incubations on deck of 96 hours. For each experiment, we set up 3 treatments of temperature, the *in situ* temperature at the moment when samples were taken, 3 degrees below and 3 degrees above that. In addition, for each temperature we set up two nutrient treatments, a control without any addition and an addition of nitrate and phosphate to get a final concentration of 1 µmol/L and 0.2 µmol/L, respectively. All of them per triplicate.

Every day, samples for measuring abundance of picoeucaryotes, cynobacteria and bacteria were taken. These samples were measuring aboard in a flow cytometer by Glenn Tarran. Every day, samples for measuring some photosynthetic parameter such us In vivo fluorescence, photosynthetic quantum yield or the absorption cross section of PSII were taken as well and measured on board in a FRRF by Nina Schuback. Moreover, at day 0 and at d4 samples for measuring Chlorophyll *a* concentration and abundance of microzooplankton were taken. Chlorophyll a concentration was measured on board at the end of experiments using a Turner Fluorimeter and samples for microzooplankton were fixed with Buffered 10% Formaldehyde and will be measured in land with a Flow Cam. At day 0 samples for measuring nutrient concentration were also taken.

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Table 1. Time and location of water sampling on AMT29.

Date	Hour (UTC)	Station No	CTD Cast No	Latitude	Longitude	Niskin Bottle No	Depth (m)
19/10/2019	0430	5	DY005	44º 44.63586N	16º 10.06074W	20, 21	5
26/10/19	0533	15	DY015	29º 45.660N	33º 1.776 W	19, 21	5
01/11/19	0526	26	DY026	12º 44.61744N	28º 30.00910W	19, 21	2
07/11/2019	0521	39	DY037	7º 23.67132S	25º 0.49086W	19, 22	2
13/11/2019	0430	52	DY047	26º 45.72936 S	25º 48.40362W	19,20	2

Chromium concentration, speciation and isotopic composition

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Objective

- Collect samples to be analysed for chromium concentration, speciation, and isotopic composition across a range of productivity regimes.

Method

Samples for [Cr(tot)] and d53Cr(tot) were collected by filtering 1 L samples through a 0.2 µm ACROPAK cartridge filter.

Samples for analysis of the concentration of Cr(III) were collected as triplicated 14 ml samples by filtration through a 0.2 µm ACROPAK cartridge filter. Samples were precipitated by addition of 40 µl NH4 and centrifuged to obtain a precipitate pellet. The pellet was washed 2x with pH adjusted MQ and re-suspended in 1.5 ml HNO3 (1M).

Samples for analysis of d53Cr(III) were collected as 5 L samples by filtration through 0.2 µm ACROPAK cartridge filters. Samples were precipitated by addition of 10-15 ml NH4. Precipitate was collected by filtration onto 0.5 µm PC filter and resuspended in 10 ml HNO3 (1M).

References

Table 1. Chromium samples taken during AMT29.

Date	Stn	CTD	Lat	Long	[Cr(tot)]	d53Cr(tot)	[Cr(III)]	d53Cr(III)	Niskin	Depth
17/10/2019	3	3	47° 14.604	9° 19.913	x	x	x		22	8
17/10/2019	3	3	47° 14.604	9° 19.913	x	x	x		16	17
17/10/2019	3	3	47° 14.604	9° 19.913	x	x	x		15	22
17/10/2019	3	3	47° 14.604	9° 19.913	x	x	x		13	37
17/10/2019	3	3	47° 14.604	9° 19.913	x	x	x		8	52
17/10/2019	3	3	47° 14.604	9° 19.913	x	x	x		7	83
17/10/2019	3	3	47° 14.604	9° 19.913	x	x	x		6	103
17/10/2019	3	3	47° 14.604	9° 19.913	x	x	x		5	152
17/10/2019	3	3	47° 14.604	9° 19.913	x	x	x		3	304
17/10/2019	3	3	47° 14.604	9° 19.913	x	x	x		1	508
20/10/2019	7	7	42° 14.509	19° 11.766	x	x	x		22	8
20/10/2019	7	7	42° 14.509	19° 11.766	x	x	x		18	13

20/10/2019	7	7	42° 14.509	19° 11.766	x	x	x		15	38
20/10/2019	7	7	42° 14.509	19° 11.766	x	x	x		14	47
20/10/2019	7	7	42° 14.509	19° 11.766	x	x	x		7	83
20/10/2019	7	7	42° 14.509	19° 11.766	x	x	x		6	103
20/10/2019	7	7	42° 14.509	19° 11.766	x	x	x		5	123
20/10/2019	7	7	42° 14.509	19° 11.766	x	x	x		4	204
20/10/2019	7	7	42° 14.509	19° 11.766	x	x	x		3	304
20/10/2019	7	7	42° 14.509	19° 11.766	x	x	x		1	508
23/10/2019	10	10	35° 55.370	26° 52.756	x	x	x		22	5
23/10/2019	10	10	35° 55.370	26° 52.756	x	x	x		**16**	38
23/10/2019	10	10	35° 55.370	26° 52.756	x	x	x		**15**	53
23/10/2019	10	10	35° 55.370	26° 52.756	x	x	x		**8**	89
23/10/2019	10	10	35° 55.370	26° 52.756	x	x	x		6	133
23/10/2019	10	10	35° 55.370	26° 52.756	x	x	x		4	204
23/10/2019	10	10	35° 55.370	26° 52.756	x	x	x		3	305
23/10/2019	10	10	35° 55.370	26° 52.756	x	x	x		1	507
27/10/2019	17	17	26° 08.400	35° 11.690	x	x	x		22	7
27/10/2019	17	17	26° 08.400	35° 11.690	x	x	x		16	59
27/10/2019	17	17	26° 08.400	35° 11.690	x	x	x		15	79
27/10/2019	17	17	26° 08.400	35° 11.690	x	x	x		8	116
27/10/2019	17	17	26° 08.400	35° 11.690	x	x	x		6	173
27/10/2019	17	17	26° 08.400	35° 11.690	x	x	x		4	201
27/10/2019	17	17	26° 08.400	35° 11.690	x	x	x		3	304
27/10/2019	17	17	26° 08.400	35° 11.690	x	x	x		1	506
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		20	8
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		18	42
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		17	62
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		16	81
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		12	102
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		11	162
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		10	202
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		8	404
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		6	860
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		5	1012
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		3	1518
30/10/2019	23	23	17° 16.736	32° 09.071	x	x	x		1	2030
01/11/2019	26	26	12° 44.620	28° 30.090	x	x	x	x	24	5
01/11/2019	26	26	12° 44.620	28° 30.090	x	x	x		15	25
01/11/2019	26	26	12° 44.620	28° 30.090	x	x	x	[x]	9	43
01/11/2019	26	26	12° 44.620	28° 30.090	x	x	x		8	48
01/11/2019	26	26	12° 44.620	28° 30.090	x	x	x	x	6	62
01/11/2019	26	26	12° 44.620	28° 30.090	x	x	x	x	5	103
01/11/2019	26	26	12° 44.620	28° 30.090	x	x	x		4	204
01/11/2019	26	26	12° 44.620	28° 30.090	x	x	x	x	3	305
01/11/2019	26	26	12° 44.620	28° 30.090	x	x	x	[x]	1	508
04/11/2019	33	33	01° 40.604	25° 00.528	x	x	x		24	4
04/11/2019	33	33	01° 40.604	25° 00.528	x	x	x		18	34
04/11/2019	33	33	01° 40.604	25° 00.528	x	x	x		17	57
04/11/2019	33	33	01° 40.604	25° 00.528	x	x	x		13	78
04/11/2019	33	33	01° 40.604	25° 00.528	x	x	x		10	152
04/11/2019	33	33	01° 40.604	25° 00.528	x	x	x		9	303
04/11/2019	33	33	01° 40.604	25° 00.528	x	x	x		8	405
04/11/2019	33	33	01° 40.604	25° 00.528	x	x	x		6	810
04/11/2019	33	33	01° 40.604	25° 00.528	x	x	x		3	1519
04/11/2019	33	33	01° 40.604	25° 00.528	x	x	x		1	2030
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		24	5
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		18	46
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		17	79
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		13	102
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		10	203
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		9	304
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		8	405
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		7	507
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		6	811
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		4	1266
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		3	1519
07/11/2019	40	38	08° 24.340 S	24° 59.00	x	x	x		1	2031

09/11/2019	45	42	10° 40.088 S	25° 0.470	x	x	x		24	4
09/11/2019	45	42	10° 40.088 S	25° 0.470	x	x	x		19	32
09/11/2019	45	42	10° 40.088 S	25° 0.470	x	x	x		18	57
09/11/2019	45	42	10° 40.088 S	25° 0.470	x	x	x		17	87
09/11/2019	45	42	10° 40.088 S	25° 0.470	x	x	x		12	162
09/11/2019	45	42	10° 40.088 S	25° 0.470	x	x	x		9	303
09/11/2019	45	42	10° 40.088 S	25° 0.470	x	x	x		8	405
09/11/2019	45	42	10° 40.088 S	25° 0.470	x	x	x		6	710
09/11/2019	45	42	10° 40.088 S	25° 0.470	x	x	x		3	1519
09/11/2019	45	42	10° 40.088 S	25° 0.470	x	x	x		1	2031
11/11/2019	50	45	23° 43.547 S	24° 55.250	x	x	x	x	24	4
11/11/2019	50	45	23° 43.547 S	24° 55.250	x	x	x	x	17	61
11/11/2019	50	45	23° 43.547 S	24° 55.250	x	x	x	x	14	131
11/11/2019	50	45	23° 43.547 S	24° 55.250	x	x	x	x	9	171
11/11/2019	50	45	23° 43.547 S	24° 55.250	x	x	x	x	5	213
11/11/2019	50	45	23° 43.547 S	24° 55.250	x	x	x	x	3	304
11/11/2019	50	45	23° 43.547 S	24° 55.250	x	x	x		2	405
11/11/2019	50	45	23° 43.547 S	24° 55.250	x	x	x		1	508
17/11/2019	60	54	40° 21.334 S	31° 2.357	x	x	x		22	4
17/11/2019	60	54	40° 21.334 S	31° 2.357	x	x	x		14	26
17/11/2019	60	54	40° 21.334 S	31° 2.357	x	x	x		10	41
17/11/2019	60	54	40° 21.334 S	31° 2.357	x	x	x		6	102
17/11/2019	60	54	40° 21.334 S	31° 2.357	x	x	x		5	202
17/11/2019	60	54	40° 21.334 S	31° 2.357	x	x	x		4	405
17/11/2019	60	54	40° 21.334 S	31° 2.357	x	x	x		3	609
17/11/2019	60	54	40° 21.334 S	31° 2.357	x	x	x		1	1013
18/11/2019	62	55	41° 54.087 S	35° 25.858	x	x	x	x	**24**	5
18/11/2019	62	55	41° 54.087 S	35° 25.858	x	x	x	x	**16**	18
18/11/2019	62	55	41° 54.087 S	35° 25.858	x	x	x	[x]	13	22
18/11/2019	62	55	41° 54.087 S	35° 25.858	x	x	x	x	**10**	103
18/11/2019	62	55	41° 54.087 S	35° 25.858	x	x	x	[x]	9	255
18/11/2019	62	55	41° 54.087 S	35° 25.858	x	x	x	x	**8**	407
18/11/2019	62	55	41° 54.087 S	35° 25.858	x	x	x		7	611
18/11/2019	62	55	41° 54.087 S	35° 25.858	x	x	x		5	1013
18/11/2019	62	55	41° 54.087 S	35° 25.858	x	x	x		2	1778
18/11/2019	62	55	41° 54.087 S	35° 25.858	x	x	x		1	2034

Continuous single turn-over active fluorescence (STAF)

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Objective

- Test LabSTAF running fluorescence light curves autonomoulsy sampling from the underway water supply
- Test run photochemical excitation profiles (fluorescence excitation spectra with 8 wavelengths resolution
- Test dual wavelengths correction approach (proxy for packaging / fluorescence reabsorbtion from Fv680nm / Fv730nm)

Method

A novel LabSTAF instrument was connected to the continuous seawater supply and automatically exchanged the sample and acquired fluorescence light curves (FLCs) in approximately 30 min intervals.

The ratio of variable fluorescence detected at 680nm and 730nm, which has potential to be developed as a proxy for pigment packaging (Boatman et al., 2019), was measured before each FLC.

Additionally, variable fluorescence at 8 different excitation wavelengths was measured at one pre-dawn sample from the underway and from size fractionated samples (all, >10um, >2um) from noon CTD casts (DCM and 5m) in order to derive photochemical excitation profiles (PEP).

MilliQ and filtrate blanks were run each day.

References

Boatman, T. G., Geider, R. J. and Oxborough, K.: Improving the Accuracy of Single Turnover Active Fluorometry (STAF) for the Estimation of Phytoplankton Primary Productivity (PhytoPP), Front. Mar. Sci., 6, doi:10.3389/fmars.2019.00319, 2019.

FastOcean active fluorometry (CTD)

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Objective

- To assess photophysiology of size fractionated phytoplankton communities along the transect and compare absolute values and light dependence of electron transport in photosystem II (ETR) with absolute values and light dependence of ^{14}C-uptake.

Method

Samples for analysis by fast repetition rate fluorometry (FRRF, FastOcean, Chelsea Instruments) were collected at noon CTDs from the DCM and surface. Immediatedly after sampling, samples were size fractionated by gravity filtration through 10 um and 2 um PC filter, avoiding exposure to direct light. All samples kept in opaque bottles in a water-bath until processing, water was circulated through the waterjacket of the FRRF between measurements to control temperature in the measurement chamber. Only blue excitation LED was used for all measurements. Fluorescence light curves (FLC) were kept as short as possible, to allow sampling many samples fast. Light steps of FLC were 0, 25, 62, 118, 202, 328, 517, 800 µmol quanta m^{-2} s^{-1} provided by white LED for 60 s each, with a low light (12 µmol quanta m^{-2} s^{-1}) pre-acclimation time of 120 s and a final dark step of 60 s. Single-tunrover induction protocols were run with a saturation phase of 100 flashlets at a 2 us pitch and a relaxation phase of 40 flashlets at a 60 µs pitch. Twenty-four induction curves were run per acquisition (55 at very low biomass). Intensity of the excitation LED was adjusted manually to achieve best saturation of induction curves throughout the FLC. Gain was adjusted automatically.

One MQ blank was run before each set of measurements. Blanks of 0.2 µm filtrate were run for each sampling depths and values were substracted from samples.

Table 1. Log of FLC measurements made on the FastOcean using CTD samples (x: FLC acquired, nm: sample not measured as signal too low, qc: data removed after first round of qc)

Date	Station	CTD	Lat	Long	depths	Niskin	all	>10	>2
19-Oct	6	6	43° 54.850	17° 08.870	10	23	x	x	x
	6	6	43° 54.850	17° 08.870	50	18	x	x	x
20-Oct	8	8	41° 27.928	20° 11.317	5	23	x	x	x
	8	8	41° 27.928	20° 11.317	70	16	x	x	x
23-Oct	11	11	35° 05.480	27° 37.480	5	23	x	x	qc

	11	11	35^{o} 05.480	27^{o} 37.480	90	15	x	x	x
24-Oct	13	13	32^{o} 24.116	30^{o} 01.426	5	23	x	qc	nm
	13	13	32^{o} 24.116	30^{o} 01.426	96	15	x	x	x
25-Oct	14	14	30^{o} 16.060	31^{o} 51.640	10	24	x	x	nm
	14	14	30^{o} 16.060	31^{o} 51.640	115	15	x	x	x
26-Oct	16	16	27^{o} 57.2530	33^{o} 41.081	5	24	x	x	qc
	16	16	27^{o} 57.2530	33^{o} 41.081	125	16	x	x	x
27-Oct	18	18	25^{o} 18.039	35^{o} 54.262	5	24	x	x	nm
	18	18	25^{o} 18.039	35^{o} 54.262	120	15	x	x	x
28-Oct	20	20	22^{o} 35.259	37^{o} 41.962			nm	nm	nm
	20	20	22^{o} 35.259	37^{o} 41.962	105	15	x	x	x
29-Oct	21	21	19^{o} 47.920	34^{o} 46.656	5	24	qc	qc	qc
	21	21	19^{o} 47.920	34^{o} 46.656	100	15	x	x	x
31-Oct	25	25	14^{o} 44.299	29^{o} 41.062			nm	nm	nm
	25	25	14^{o} 44.299	29^{o} 41.062	72	15	x	x	x
2-Nov	29	29	08^{o} 53.500	26^{o} 11.970			nm	nm	nm
	29	29	08^{o} 53.500	26^{o} 11.970	58	16	x	x	x
3-Nov	31	31	05^{o} 31.302	25^{o} 00.108	30	18	x	x	x
	31	31	05^{o} 31.302	25^{o} 00.108	72	14	x	x	x
6-Nov	36	37	05^{o} 02.617 S	25^{o} 00.090	49	15	qc	qc	qc
	36	37	05^{o} 02.617 S	25^{o} 00.090	85	11	x	x	x
8-Nov	43	40	11^{o} 52.920 S	25^{o} 0.460			nm	nm	nm
	43	40	11^{o} 52.920 S	25^{o} 0.460	120	16	x	x	x
11-Nov	48	44	21^{o} 26.246 S	24^{o} 50.247			nm	nm	nm
	48	44	21^{o} 26.246 S	24^{o} 50.247	162	12	x	x	x
13-Nov	53	48	27^{o} 42.528 S	26^{o} 05.105			nm	nm	nm
	53	48	27^{o} 42.528 S	26^{o} 05.105	125	12	x	x	x
15-Nov	55	50	31^{o} 12.706 S	27^{o} 9.0108	55	17	x	nm	nm
	55	50	31^{o} 12.706 S	27^{o} 9.0108	125	13	x	x	x

FastOcean active fluorometry (incubation)

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Objective

- To improve our understanding about the interactive effect of temperature and nutrients availability on photophysiology in different phytoplankton communities along the transect.

Method

For a detailed description of the set up of the incubation experiment, please see cruise report by Cristina Fernández González.

Samples for analysis by fast repetition rate fluorometry (FRRF, FastOcean, Chelsea Instruments) were collected before sunrise, and avoiding exposure to direct light. All samples kept in opaque bottles in water-bath at SST of initial sampling time until processing, water was circulated through the waterjacket between measurements to control temperature in measurement chamber. From each 15 ml sub-sample, 5 ml were used to rinse the cuvette and 10 ml to acquire a fluorescence light curve (FLC). After E2D3 samples of triplicate bottles were pooled and measured together to reduce the time needed to get through all samples. Only blue excitation LED was used for all measurements. FLC was kept as short as possible, to allow sampling many samples fast. Light steps of FLC were 0, 26, 64, 118, 196, 308, 469, 700 µmol quanta m^{-2} s^{-1} provided by White LED for 40 s each, with a low light (12 µmol quanta m^{-2} s^{-1}) pre-acclimation time of 60 s and a final dark step of 60 s. Single-tunrover induction protocols were run with a saturation phase of 100 flashlets at a 2 us pitch and a relaxation phase of 40 flashlets at a 60 µs pitch. Twenty-four induction curves were run per acquisition (55 at very low biomass). Intensity of the excitation LED was adjusted manually to achieve best saturation of induction curves throughout the FLC. Gain was adjusted automatically.

Blanks were run for a subset of triplicates (pooled sample) after gentle filtration through 0.02µm acro-discs and on a MQ sample every day. The MQ sample blank remained constant at 0.05 and this constant instrument blank value was applied to all samples. The filtrate minus MQ blank was always <5% of the sample Fm and therefore considered negligible.

Table 1. Log of FLC measurements made on the FastOcean using incubation samples .

date	experiment	day	# samples
19-Oct	1	0	3

20-Oct	1	1	18
21-Oct	1	2	18
22-Oct	1	3	18
23-Oct	1	4	18
26-Oct	2	0	3
27-Oct	2	1	18
28-Oct	2	2	18
29-Oct	2	3	6
30-Oct	2	4	6
01-Nov	3	0	3
02-Nov	3	1	6
03-Nov	3	2	6
04-Nov	3	3	6
05-Nov	3	4	18
07-Nov	4	0	0
08-Nov	4	1	6
09-Nov	4	2	6
10-Nov	4	3	6
11-Nov	4	4	18
13-Nov	5	0	3
14-Nov	5	1	6
15-Nov	5	2	6
16-Nov	5	3	6
17-Nov	5	4	18

Measurements of optical properties

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Objective

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

Methods

- Particulate optical backscattering coefficient (470, 532, 700 nm), beam-attenuation and absorption coefficients (400–750 nm) were determined quasi-continuously from the ship's underway water following methods detailed in Dall'Olmo et al. 2009 and Dall'Olmo et al. 2017. Highly-accurate estimates of chlorophyll concentration can be obtained from the particulate absorption coefficient.
- In-situ measurements were also collected by means of a profiling package with a SBE CTD, a WETLABs ACS and a Hobilabs Hydroscat-6P to determine the particulate absorption, attenuation coefficients and backscattering over the upper 500 m. The package also included a Secchi disk for measuring Secchi depth. The profiling package was deployed once a day, simultaneously with the noon time CTD cast. At various times during the cruise we some problems with the profiling package that 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.

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

Table 1. Time and location of casts with the optics profiling package on AMT29.

Date	Station No	CTD Cast No	Hour (UTC)	Latitude (degrees)	Longitude (degrees)	Depth (m)
16/10/2019	02	DY110_002	13:20	48°31.309'	-7°12.224'	500
20/10/2019	08	DY110_008	12:24	41°27.928'	-20°11.317'	500
23/10/2019	11	DY110_011	12:24	35°05.480'	-27°37.480'	500
24/10/2019	13	DY110_013	13:18	32°24.116'	-30°01.426'	500
26/10/2019	16	DY110_016	13:27	27°57.252'	-33°41.081'	500
27/10/2019	18	DY110_018	13:17	25°18.030'	-35°54.270'	500

29/10/2019	21	DY110_021	13:23	19°47.920'	-34°46.656'	500
30/10/2019	23	DT110_023	13:18	17°16.736'	-32°09.071'	500
31/10/2019	25	DY110_025	13:20	14°44.299'	-29°41.062'	500
01/11/2019	27	DY110_027	13:19	11°50.693'	-27°57.649'	500
02/11/2019	29	DY110_029	13:23	08°53.500'	-26°11.970'	500
03/11/2019	31	DY110_031	13:13	05°31.302'	-25°00.108'	500
04/11/2019	33	DY110_033	13:16	01°40.604'	-25°0.528'	500
06/11/2019	37	DY110_036	11:08	-05°02.617'	-25°00.090'	500
07/11/2019	40	DY110_038	13:22	-08°24.330'	-24°59.000'	500
08/11/2019	43	DY110_040	13:18	-11°52.920'	-25°00.046'	500
09/11/2019	45	DY110_042	13:19	-15°26.552'	-25°00.200'	500
11/11/2019	48	DY110_044	13:16	-21°26.246'	-24°50.248'	500
12/11/2019	51	DY110_046	12:14	-24°44.102'	-25°12.281'	500
13/11/2019	53	DY110_048	12:19	-27°42.528'	-26°05.105'	500
14/11/2019	55	DY110_050	12:56	-31°12.706'	-27°09.010'	500
15/11/2019	57	DY110_052	12:56	-34°46.624'	-28°15.124'	500
18/11/2019	62	DY110_055	04:00	-41°54.088'	-35°25.860'	500

Atmospheric ozone and seawater uptake

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Objective

- To measure concentrations of ozone in the marine boundary layer.
- To measure ozone uptake to the ocean surface.
- To measure surface iodide/iodate (key reactant in ozone uptake).

Method

Atmosphere was sampled from the meteorological platform and pumped to the meteorological laboratory for ozone concentration measurement (10 s) using a 2B-tech 202 ozone monitor. Approximately 30 m of ¼ in OD PTFE tubing was used to transport the sample air.

Ozone uptake was measured by comparing the concentration of ozone from a generator to the concentration after interaction with the underway water. Ozone was generated from artificial air (BTCA 178) using a corona discharge and diluted to maintain desired concentrations. A total gas flow rate of 200 mL min^{-1} was controlled using mass flow controllers. Underway water was flushed into a glass bottle, from which peristaltic pumps drew the water into a segmented flow coil equilibrator (SFCE). The water flow was routinely measured and the peristatic power varied to maintain a flow of 100 mL min^{-1}. The underway water and ozone containing air were mixed and then separated for measurement using a 2B-tech 205 ozone monitor (10 s). The generator and coil exit output was alternated using a three-way solenoid valve every 5 minutes. All tubing, unions and valves were made from PTFE. The peristaltic pump tubing was 9 cm x ¼ in ID silicone.

The SFCE was based of the design of Wohl *et. al* (2019).

Measurements were continuous, however occasionally noon CTD waters were measured for comparison with surface measurements (see Table 6).

Table 6: Coordinates and depths for sampled CTD water.

Date	Time	Lat	Long	Niskin Bottles No	Depths Samples (m)
16/10/2019	1320	48º 31.309'	-007º 12.224'	5	DCM
18/10/2019	1230	46º 09.924'	-013º 52.933'	5	1000
19/10/2019	1234	43º 54.850'	-017º 08.870'	16	DCM
20/10/2019	1224	41º 27.928'	-020º 11.317'	5	1000
23/10/2019	1224	35º 05.480'	-027º 37.480'	5, 16	DCM, 1000
24/10/2019	1317	32º 24.116'	-030º 01.426'	5	1000
25/10/2019	1331	30º 16.060'	-031º 51.650'	16	DCM
27/10/2019	1317	25º 18.030'	-035º 18.030'	5, 16	DCM, 1000
29/10/2019	1324	19º 47.920'	-034º 46.656'	5, 16	DCM, 1000
30/10/2019	1318	17º 16.736'	-032º 09.071'	5, 16	DCM, 1000
01/11/2019	1319	14º 50.693'	-027º 57.649'	5, 14	DCM, 1000
03/11/2019	1313	05º 31.302'	-025º 00.018'	5, 16	DCM, 1000
06/11/2019	1108	-05º 02.617'	-025º 00.080'	2, 4	DCM, 1000
08/11/2019	1318	-11º 52.920'	-025º 00.462'	1	2000
11/11/2019	1316	-21º 26.246'	-024º 50.248'	1, 12/14	DCM, 2000
13/11/2019	1219	-27º 42.528'	-026º 05.105'	1	1000
15/11/2019	1256	-34º 46.624'	-028º 15.124'	1	1000

Everyday underway water was sampled, filtered and frozen for iodide/iodate analysis during the CTD (see Table 7). Samples were filtered through GF/F filter paper and stored in 50 mL plastic tubes.

Table 7: Coordinates for underway iodide/iodide samples.

Time	Lat	Long
14/10/2019 14:28	50.445	-2.451
15/10/2019 12:15	50.279	-2.963
16/10/2019 12:50	48.554	-7.171
17/10/2019 13:04	46.745	-10.466
18/10/2019 13:00	46.165	-13.882
19/10/2019 12:35	43.914	-17.148
20/10/2019 14:45	41.469	-20.215
21/10/2019 13:40	39.246	-23.182
23/10/2019 12:55	35.091	-27.625
24/10/2019 14:00	32.402	-30.024
25/10/2019 13:35	30.268	-31.861
26/10/2019 14:15	27.954	-33.685
27/10/2019 13:45	25.301	-35.904
28/10/2019 14:20	22.588	-37.699
29/10/2019 14:00	19.799	-34.778
30/10/2019 13:45	17.279	-32.151
31/10/2019 14:00	14.738	-29.684
01/11/2019 14:00	11.845	-27.961
02/11/2019 14:15	8.892	-26.200
03/11/2019 13:40	5.522	-25.002
04/11/2019 13:50	1.677	-25.009
06/11/2019 15:55	-2.121	-24.998
07/11/2019 13:30	-8.406	-24.999
08/11/2019 13:45	-11.882	-25.008
09/11/2019 13:40	-15.443	-25.003
10/11/2019 14:40	-18.559	-25.103
11/11/2019 13:20	-21.437	-24.837
12/11/2019 13:10	-24.735	-25.205
13/11/2019 13:00	-27.709	-26.085
14/11/2019 13:30	-31.212	-27.150
15/11/2019 13:10	-34.777	-28.252
16/11/2019 14:40	-38.534	-29.499
17/11/2019 15:05	-41.007	-32.849
18/11/2019 12:45	-41.973	-36.811
19/11/2019 13:00	-42.166	-41.972
20/11/2019 13:55	-42.412	-47.893
21/11/2019 14:05	-43.669	-51.830

Funding

PhD studentship.

References

Wohl, C., Capelle, D., Jones, A., Sturges, W. T., Nightingale, P. D., Else, B. G. T., and Yang, M.: Segmented flow coil equilibrator coupled to a proton-transfer-reaction mass spectrometer for measurements of a broad range of volatile organic compounds in seawater, Ocean Sci., 15, 925–940, https://doi.org/10.5194/os-15-925-2019, 2019.

Seawater pCO_2 and pCO_2 transfer resistance

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Objective

- To measure the resistance of CO_2 for air-sea gas transfer.

Method

pCO_2 transfer resistance was measured by comparing the concentration of CO_2 after full and partial equilibration into CO2 free air (BTCA 178) from underway water. A gas flow rate of 25 mL min^{-1} per equilibrator was controlled using mass flow controllers. Underway water was flushed into a glass bottle, from which peristaltic pumps drew the water into two segmented flow coil equilibrators (SFCE). The water flows were routinely measured and the peristatic power varied to maintain a flow of 100 mL min^{-1}. The underway water and CO_2 free air were mixed and then separated for measurement using a LI-7000 CO_2 analyser. CO_2 free air was used as the LI-7000 reference gas. pCO2 was measured from a 15 m coil (high residence time, approx. 4.5 min), which was maintained at underway temperature using an overflowing bucket, whilst partial equilibration was from a 20 cm coil (very short residence time, approx. 5 s). The equilibrator exit outputs were alternated using a three-way solenoid valve every 5 minutes. All tubing, unions and valves were made from PTFE. The peristaltic pump tubing was 9 cm x ¼ in ID silicone. A nafion counter-flow drier was used to remove water vapour before measurement.

The SFCE was based of the design of Wohl *et. al* (2019).

Measurements were generally continuous, however occasionally noon CTD waters were measured for comparison with surface measurements (see Table 8).

Table 8: Coordinates and depths for sampled CTD water.

Date	Time	Lat	Long	Niskin Bottles No	Depths Samples (m)
16/10/2019	1320	48º 31.309'	-007º 12.224'	5	DCM
18/10/2019	1230	46º 09.924'	-013º 52.933'	5	1000
19/10/2019	1234	43º 54.850'	-017º 08.870'	16	DCM
20/10/2019	1224	41º 27.928'	-020º 11.317'	5	1000
24/10/2019	1317	32º 24.116'	-030º 01.426'	5	1000
26/10/2019	1327	27º 57.252'	-033º 41.081'	10, 14	DCM, 1000
28/10/2019	0013	22º 36.258'	-037º 41.962'	5, 16	DCM, 1000
30/10/2019	1318	17º 16.736'	-032º 09.071'	5, 16	DCM, 1000
31/10/2019	1320	14º 44.299'	-029º 41.062'	4, 14	DCM, 1000
02/11/2019	1323	08º 53.500'	-026º 11.970'	5, 16	DCM, 1000
04/11/2019	1316	01º 40.604'	-025º 00.528'	4, 5	1000, 1250
07/11/2019	1322	-08º 24.340'	-024º 59.000'	1, 16	DCM, 2000
09/11/2019	1319	-15º 26.552'	-025º 00.200'	1, 2	1750, 2000
12/11/2019	1211	-24º 44.102'	-025º 12.281'	1, 12/14	DCM, 1000
14/11/2019	1256	-31º 12.706'	-027º 09.010'	1	1000

References

Wohl, C., Capelle, D., Jones, A., Sturges, W. T., Nightingale, P. D., Else, B. G. T., and Yang, M.: Segmented flow coil equilibrator coupled to a proton-transfer-reaction mass spectrometer for measurements of a broad range of volatile organic compounds in seawater, Ocean Sci., 15, 925–940, https://doi.org/10.5194/os-15-925-2019, 2019.

DNA sample collection

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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 approximately 5 litres of seawater into sampling carboys. The precise volumes of the carboys were measured at the beginning of the cruise. Two depths were sampled from each CTD cast, with seawater samples collected from Niskin bottles fired at both the surface (generally 2-5m) and the Deep Chlorophyll Maximum (DCM). In total 107 samples were collected during the cruise, from 55 CTD casts, as shown in Table 1.

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 0.5mL of RNA Later 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	Station	CTD	Time in water (GMT)	Niskin	Depth	Volume filtered	Lat (+ve °N)	Long (+ve °E)
16/10/2019	01	DY110_001	08:13	15	5m	5800mL	49°2.891'	-6°43.927'
16/10/2019	01	DY110_001	08:13	4	90m	5760mL	49°2.891'	-6°43.927'
16/10/2019	02	DY110_002	13:20	23	2m	5800mL	48°31.309'	-7°12.224'
16/10/2019	02	DY110_002	13:20	10	25m	5760mL	48°31.309'	-7°12.224'
17/10/2019	03	DY110_003	04:42	23	5m	5800mL	47°14.604'	-9°18.913'
17/10/2019	03	DY110_003	04:42	10	35m	5760mL	47°14.604'	-9°18.913'
18/10/2019	04	DY110_004	12:30	21	5m	5800mL	46°09.924'	-13°52.933'
18/10/2019	04	DY110_004	12:30	16	70m	5760mL	46°09.924'	-13°52.933'
19/10/2019	05	DY110_005	04:34	22	5m	5800mL	44°44.635'	-16°10.061'
19/10/2019	05	DY110_005	04:34	10	55m	5760mL	44°44.635'	-16°10.061'
19/10/2019	06	DY110_006	12:34	21	10m	5800mL	43°54.850'	-17°08.870'
19/10/2019	06	DY110_006	12:34	16	70m	5760mL	43°54.850'	-17°08.870'
20/10/2019	07	DY110_007	04:36	22	5m	5360mL	42°14.509'	-19°11.766'
20/10/2019	07	DY110_007	04:36	9	80m	5760mL	42°14.509'	-19°11.766'
20/10/2019	08	DY110_008	12:24	21	5m	5800mL	41°27.928'	-20°11.317'
20/10/2019	08	DY110_008	12:24	14	70m	5760mL	41°27.928'	-20°11.317'
21/10/2019	09	DY110_009	04:30	22	2m	5800mL	40°10.672'	-21°55.778'

21/10/2019	09	DY110_009	04:30	9	65m	5760mL	40°10.672'	-21°55.778'
23/10/2019	10	DY110_010	04:38	22	2m	5800mL	35°55.370'	-26°52.760'
23/10/2019	10	DY110_010	04:38	10	86m	5760mL	35°55.370'	-26°52.760'
23/10/2019	11	DY110_011	12:24	21	5m	5800mL	35°05.480'	-27°37.480'
23/10/2019	11	DY110_011	12:24	13	90m	5760mL	35°05.480'	-27°37.480'
24/10/2019	12	DY110_012	05:34	22	2m	5800mL	33°10.710'	-29°20.090'
24/10/2019	12	DY110_012	05:34	11	95m	5760mL	33°10.710'	-29°20.090'
24/10/2019	13	DY110_013	13:18	21	5m	5800mL	32°24.116'	-30°01.426'
24/10/2019	13	DY110_013	13:18	13	95m	5760mL	32°24.116'	-30°01.426'
25/10/2019	14	DY110_014	13:30	21	10m	5800mL	30°16.060'	-31°51.640'
25/10/2019	14	DY110_014	13:30	13	115m	5760mL	30°16.060'	-31°51.640'
26/10/2019	15	DY110_015	05:33	22	5m	5800mL	28°45.660'	-33°01.776'
26/10/2019	15	DY110_015	05:33	9	110m	5760mL	28°45.660'	-33°01.776'
26/10/2019	16	DY110_016	13:27	21	5m	5800mL	27°57.252'	-33°41.081'
27/10/2019	17	DY110_017	05:31	22	5m	5800mL	26°08.400'	-35°11.690'
27/10/2019	17	DY110_017	05:31	10	115m	5760mL	26°08.400'	-35°11.690'
27/10/2019	18	DY110_018	13:17	21	5m	5800mL	25°18.030'	-35°54.270'
27/10/2019	18	DY110_018	13:17	13	120m	5760mL	25°18.030'	-35°54.270'
28/10/2019	19	DY110_019	05:22	22	5m	5800mL	23°25.198'	-37°31.895'
28/10/2019	19	DY110_019	05:22	10	124m	5760mL	23°25.198'	-37°31.895'
28/10/2019	20	DY110_020	13:22	21	5m	5800mL	22°35.258'	-37°41.962'
28/10/2019	20	DY110_020	13:22	13	105m	5760mL	22°35.258'	-37°41.962'
29/10/2019	21	DY110_021	13:23	21	5m	5800mL	19°47.920'	-34°46.656'
29/10/2019	21	DY110_021	13:23	13	100m	5760mL	19°47.920'	-34°46.656'
30/10/2019	22	DY110_022	05:28	22	5m	5800mL	18°03.412'	-32°58.394'
30/10/2019	22	DY110_022	05:28	10	100m	5760mL	18°03.412'	-32°58.394'
30/10/2019	23	DT110_023	13:18	21	5m	5800mL	17°16.736'	-32°09.071'
30/10/2019	23	DT110_023	13:18	13	80m	5760mL	17°16.736'	-32°09.071'
31/10/2019	24	DY110_024	05:25	22	5m	5800mL	15°35.453'	-30°25.580'
31/10/2019	24	DY110_024	05:25	10	65m	5760mL	15°35.453'	-30°25.580'
31/10/2019	25	DY110_025	13:20	23	5m	3480mL	14°44.299'	-29°41.062'
31/10/2019	25	DY110_025	13:20	15	72m	5760mL	14°44.299'	-29°41.062'
01/11/2019	26	DY110_026	05:26	22	2m	5800mL	12°44.620'	-28°30.090'
01/11/2019	26	DY110_026	05:26	11	39m	5760mL	12°44.620'	-28°30.090'
01/11/2019	27	DY110_027	13:19	23	5m	5800mL	11°50.693'	-27°57.649'
02/11/2019	28	DY110_028	05:24	22	5m	5800mL	09°53.018'	-26°47.602'
02/11/2019	28	DY110_028	05:24	12	46m	5760mL	09°53.018'	-26°47.602'
02/11/2019	29	DY110_029	13:23	23	2m	5800mL	08°53.500'	-26°11.970'

03/11/2019	30	DY110_030	05:26	22	5m	5800mL	06°44.974'	-24°59.969'
03/11/2019	30	DY110_030	05:26	12	50m	5760mL	06°44.974'	-24°59.969'
03/11/2019	31	DY110_031	13:13	23	5m	5800mL	05°31.302'	-25°00.108'
03/11/2019	31	DY110_031	13:13	15	72m	5760mL	05°31.302'	-25°00.108'
04/11/2019	32	DY110_032	05:24	22	2m	5800mL	02°52.747'	-24°59.677'
04/11/2019	32	DY110_032	05:24	11	70m	5760mL	02°52.747'	-24°59.677'
04/11/2019	33	DY110_033	13:16	23	2m	5800mL	01°40.604'	-25°0.528'
04/11/2019	33	DY110_033	13:16	14	76m	5760mL	01°40.604'	-25°0.528'
05/11/2019	34	DY110_034	04:28	22	2m	5800mL	-0°34.870'	-24°59.978'
05/11/2019	34	DY110_034	04:28	11	75m	5760mL	-0°34.870'	-24°59.978'
06/11/2019	36	DY110_035	05:25	22	2m	5800mL	-04°18.026'	-24°59.930'
06/11/2019	36	DY110_035	05:25	11	72m	5760mL	-04°18.026'	-24°59.930'
06/11/2019	37	DY110_036	11:08	23	2m	5800mL	-05°02.617'	-25°00.090'
06/11/2019	37	DY110_036	11:08	13	85m	5760mL	-05°02.617'	-25°00.090'
07/11/2019	39	DY110_037	05:23	21	2m	5800mL	-07°23.670'	-25°00.491'
07/11/2019	39	DY110_037	05:23	10	90m	5760mL	-07°23.670'	-25°00.491'
07/11/2019	40	DY110_038	13:22	23	2m	5800mL	-08°24.330'	-24°59.000'
07/11/2019	40	DY110_038	13:22	14	100m	5760mL	-08°24.330'	-24°59.000'
08/11/2019	42	DY110_039	05:02	21	2m	5800mL	-10°40.088'	-25°00.047'
08/11/2019	42	DY110_039	05:02	10	100m	5760mL	-10°40.088'	-25°00.047'
08/11/2019	43	DY110_040	13:18	23	2m	5800mL	-11°52.920'	-25°00.046'
08/11/2019	43	DY110_040	13:18	12	120m	5760mL	-11°52.920'	-25°00.046'
09/11/2019	44	DY110_041	04:59	21	2m	5800mL	-14°16.288'	-24°59.651'
09/11/2019	44	DY110_041	04:59	10	150m	5760mL	-14°16.288'	-24°59.651'
09/11/2019	45	DY110_042	13:19	23	2m	5800mL	-15°26.552'	-25°00.200'
09/11/2019	45	DY110_042	13:19	11	157m	5760mL	-15°26.552'	-25°00.200'
11/11/2019	47	DY110_043	04:56	20	2m	5800mL	-20°14.780'	-24°59.740'
11/11/2019	47	DY110_043	04:56	9	162m	5760mL	-20°14.780'	-24°59.740'
11/11/2019	48	DY110_044	13:16	23	2m	5800mL	-21°26.246'	-24°50.248'
11/11/2019	48	DY110_044	13:16	12	162m	5760mL	-21°26.246'	-24°50.248'
12/11/2019	50	DY110_045	04:27	21	2m	5800mL	-23°43.547'	-24°55.250'
12/11/2019	50	DY110_045	04:27	9	168m	5760mL	-23°43.547'	-24°55.250'
12/11/2019	51	DY110_046	12:14	23	2m	5800mL	-24°44.102'	-25°12.281'
12/11/2019	51	DY110_046	12:14	12	158m	5760mL	-24°44.102'	-25°12.281'
13/11/2019	52	DY110_047	04:24	21	2m	5800mL	-26°45.731'	-25°48.404'
13/11/2019	52	DY110_047	04:24	8	120m	5760mL	-26°45.731'	-25°48.404'
13/11/2019	53	DY110_048	12:19	22	2m	5800mL	-27°42.528'	-26°05.105'
13/11/2019	53	DY110_048	12:19	9	125m	5760mL	-27°42.528'	-26°05.105'

14/11/2019	54	DY110_049	04:26	22	2m	5800mL	-30°01.616'	-26°47.128'
14/11/2019	54	DY110_049	04:26	8	110m	5760mL	-30°01.616'	-26°47.128'
14/11/2019	55	DY110_050	12:56	22	2m	5800mL	-31°12.706'	-27°09.010'
14/11/2019	55	DY110_050	12:56	9	125m	5760mL	-31°12.706'	-27°09.010'
15/11/2019	56	DY110_051	04:36	22	2m	5800mL	-33°35.932'	-27°53.440'
15/11/2019	56	DY110_051	04:36	10	100m	5760mL	-33°35.932'	-27°53.440'
15/11/2019	57	DY110_052	12:56	22	2m	5800mL	-34°46.624'	-28°15.124'
15/11/2019	57	DY110_052	12:56	11	85m	5760mL	-34°46.624'	-28°15.124'
16/11/2019	58	DY110_053	04:38	22	2m	5800mL	-37°04.897'	-29°01.019'
16/11/2019	58	DY110_053	04:38	10	55m	5760mL	-37°04.897'	-29°01.019'
17/11/2019	60	DY110_054	04:05	23	3m	4800mL	-40°21.334'	-31°02.357'
17/11/2019	60	DY110_054	04:05	11	40m	5760mL	-40°21.334'	-31°02.357'
18/11/2019	62	DY110_055	03:38	23	2m	5800mL	-41°54.088'	-35°25.860'
18/11/2019	62	DY110_055	03:38	14	20m	5760mL	-41°54.088'	-35°25.860'

DNA and virus sample collection

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Cruise Objectives

Collection of CTD seawater samples for determination of DNA and viruses for the University of Southern California.

Methods

Samples were collected for DNA and virus analysis by collecting ~1.1L of seawater from a Niskin bottle fired at the surface (generally 2-5m) from each pre-dawn and noon CTD cast. The water was collected into a clean (Milli-Q rinsed) Nalgene bottle, marked to indicate volume. A peristaltic pump was used to flush a small volume (~100mL) of sample through an acid-washed peristaltic tube. When 1L of seawater remained in the sampling bottle, the pump was switched off and a sterile 0.2µm Sterivex filter was attached to the tube. A sterile 0.02µm Anotop filter was attached to the outlet of the Sterivex filter. The seawater was then pumped slowly through the Sterivex filter, before passing through the smaller Anotop filter. When the entire sample had been filtered, filters were removed and separated. A syringe was used to gently push the last drops of sample through the filters. 0.5mL RNA Later Solution (Invitrogen by Thermo Fisher Scientific) was added to the Sterivex filter only, for the preservation of the sample. Both filters were sealed with Parafilm, placed together in a sealed Whirlpak bag and stored immediately at -80°c until return to the University of Southern California for analysis.

A total of 110 samples were collected from 55 CTD casts, as seen in Table 1.

Table 1: Samples collected for DNA and virus analysis during AMT29

Date	Station	CTD	Time in water (GMT)	Niskin	Depth	Vol. filtered ANOTOP	Vol. filtered STERVIEX	Lat (+ve °N)	Long (+ve °E)
16/10/2019	001	DY110_001	08:13	15	5m	950mL	950mL	49°2.891'	-6°43.927'
16/10/2019	002	DY110_002	13:20	23	2m	1000mL	1000mL	48°31.309'	-7°12.224'
17/10/2019	003	DY110_003	04:42	23	5m	1000mL	1000mL	47°14.604'	-9°18.913'
18/10/2019	004	DY110_004	12:30	21	5m	1000mL	1000mL	46°09.924'	-13°52.933'
19/10/2019	005	DY110_005	04:34	22	5m	1000mL	1000mL	44°44.635'	-16°10.061'
19/10/2019	006	DY110_006	12:34	21	10m	1000mL	1000mL	43°54.850'	-17°08.870'
20/10/2019	007	DY110_007	04:36	22	5m	1000mL	1000mL	42°14.509'	-19°11.766'
20/10/2019	008	DY110_008	12:24	21	5m	1000mL	1000mL	41°27.928'	-20°11.317'
21/10/2019	009	DY110_009	04:30	22	2m	1000mL	1000mL	40°10.672'	-21°55.778'
23/10/2019	010	DY110_010	04:38	22	2m	1000mL	1000mL	35°55.370'	-26°52.760'
23/10/2019	011	DY110_011	12:24	21	5m	1000mL	1000mL	35°05.480'	-27°37.480'
24/10/2019	012	DY110_012	05:34	22	2m	1000mL	1000mL	33°10.710'	-29°20.090'
24/10/2019	013	DY110_013	13:18	21	5m	1000mL	1000mL	32°24.116'	-30°01.426'
25/10/2019	014	DY110_014	13:30	21	10m	1000mL	1000mL	30°16.060'	-31°51.640'
26/10/2019	015	DY110_015	05:33	22	5m	1000mL	1000mL	28°45.660'	-33°01.776'
26/10/2019	016	DY110_016	13:27	21	5m	1000mL	1000mL	27°57.252'	-33°41.081'
27/10/2019	017	DY110_017	05:31	22	5m	1000mL	1000mL	26°08.400'	-35°11.690'

27/10/2019	018	DY110_018	13:17	21	5m	1000mL	1000mL	25°18.030'	-35°54.270'
28/10/2019	019	DY110_019	05:22	22	5m	1000mL	1000mL	23°25.198'	-37°31.895'
28/10/2019	020	DY110_020	13:22	21	5m	1000mL	1000mL	22°35.258'	-37°41.962'
29/10/2019	021	DY110_021	13:23	21	5m	1000mL	1000mL	19°47.920'	-34°46.656'
30/10/2019	022	DY110_022	05:28	22	5m	1000mL	1000mL	18°03.412'	-32°58.394'
30/10/2019	023	DT110_023	13:18	21	5m	1000mL	1000mL	17°16.736'	-32°09.071'
31/10/2019	024	DY110_024	05:25	22	5m	1000mL	1000mL	15°35.453'	-30°25.580'
31/10/2019	025	DY110_025	13:20	23	5m	1000mL	1000mL	14°44.299'	-29°41.062'
01/11/2019	026	DY110_026	05:26	22	2m	1000mL	1000mL	12°44.620'	-28°30.090'
01/11/2019	027	DY110_027	13:19	23	5m	1000mL	1000mL	11°50.693'	-27°57.649'
02/11/2019	028	DY110_028	05:24	22	5m	1000mL	1000mL	09°53.018'	-26°47.602'
02/11/2019	029	DY110_029	13:23	23	2m	1000mL	1000mL	08°53.500'	-26°11.970'
03/11/2019	030	DY110_030	05:26	22	5m	1000mL	1000mL	06°44.974'	-24°59.969'
03/11/2019	031	DY110_031	13:13	23	5m	1000mL	1000mL	05°31.302'	-25°00.108'
04/11/2019	032	DY110_032	05:24	22	2m	1000mL	1000mL	02°52.747'	-24°59.677'
04/11/2019	033	DY110_033	13:16	23	2m	1000mL	1000mL	01°40.604'	-25°0.528'
05/11/2019	034	DY110_034	04:28	22	2m	1000mL	1000mL	-0°34.870'	-24°59.978'
06/11/2019	036	DY110_035	05:25	22	2m	975mL	975mL	-04°18.026'	-24°59.930'
06/11/2019	037	DY110_036	11:08	23	2m	1000mL	1000mL	-05°02.617'	-25°00.090'
07/11/2019	039	DY110_037	05:23	21	2m	1000mL	1000mL	-07°23.670'	-25°0.491'
07/11/2019	040	DY110_038	13:22	23	2m	1000mL	1000mL	-08°24.330'	-24°59.000'
08/11/2019	042	DY110_039	05:02	21	2m	1000mL	1000mL	-10°40.088'	-25°00.047'
08/11/2019	043	DY110_040	13:18	23	2m	1000mL	1000mL	-11°52.920'	-25°00.046'
09/11/2019	044	DY110_041	04:59	21	2m	1000mL	1000mL	-14°16.288'	-24°59.651'
09/11/2019	045	DY110_042	13:19	23	2m	1000mL	1000mL	-15°26.552'	-25°00.200'
11/11/2019	047	DY110_043	04:56	20	2m	1000mL	1000mL	-20°14.780'	-24°59.740'
11/11/2019	048	DY110_044	13:16	23	2m	1000mL	1000mL	-21°26.246'	-24°50.248'
12/11/2019	050	DY110_045	04:27	21	2m	1000mL	1000mL	-23°43.547'	-24°55.250'
12/11/2019	051	DY110_046	12:14	23	2m	1000mL	1000mL	-24°44.102'	-25°12.281'
13/11/2019	052	DY110_047	04:24	21	2m	1000mL	1000mL	-26°45.731'	-25°48.404'
13/11/2019	053	DY110_048	12:19	22	2m	1000mL	1000mL	-27°42.528'	-26°05.105'
14/11/2019	054	DY110_049	04:26	22	2m	1000mL	1000mL	-30°01.616'	-26°47.128'
14/11/2019	055	DY110_050	12:56	22	2m	1000mL	1000mL	-31°12.706'	-27°09.010'
15/11/2019	056	DY110_051	04:36	22	2m	1000mL	1000mL	-33°35.932'	-27°53.440'
15/11/2019	057	DY110_052	12:56	22	2m	1000mL	1000mL	-34°46.624'	-28°15.124'
16/11/2019	058	DY110_053	04:38	22	2m	1000mL	1000mL	-37°04.897'	-29°01.019'
17/11/2019	060	DY110_054	04:05	23	3m	1000mL	1000mL	-40°21.334'	-31°02.357'
18/11/2019	062	DY110_055	03:38	23	2m	1000mL	1000mL	-41°54.088'	-35°25.860'

Particle Size Distribution

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Objective

- To measure particle size distributions (PSD) of surface and deep-chlorophyll maximum (DCM) samples collected along the AMT29 transect using a Coulter counter.
- To progress the analysis of the empirical relationship between the size of particles and the side-scattering data obtained from the flow cytometry (Grob et al., 2007).

Method

Samples from surface, DCM and ~1750 m ("deep") were collected in 500 mL dark bottles directly from the noon CTD along the transect (Table 1). The deep sample was used as blank reference after x5 sterivex filtration (0.22 µm). For the DCM, a sub-sample was also filtered with a variable size filter (e.g. 0.6, 0.8, 1, 2 or 3 µm) in order to isolate specific size peaks from the sample which were further analysed by flow cytometry (see Glen Tarran's report). The PSD was measured with a Coulter Counter Multisizer III (Beckam Coulter) using both a 20-µm and a 100-µm aperture, measuring between ~0.8-10 µm and 2-60 µm, respectively, in 256 logarithmically spaced size bins (Dall'Olmo et al., 2009). All samples were analysed in both apertures and preparation of samples and diluent (i.e. filtered surface water) was conducted under a laminar flow hood to minimize contamination. Occasionaly, when the noon CTD was not performed, a surface sample was taken from the underway system (Table 2).

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References

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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.

Table 1. CTD samples taken for PSD analysis during AMT29.

Date	Hour (UTC)	Station No	CTD Cast No	Latitude (degrees)	Longitude (degrees)	Niskin Bottle No	Depth (m)	Size filter for DCM (µm)
19/10/2019	1229	006	006	43.9142	-17.1478	1;12; 23	2000; 100; 10	-

20/10/2019	1221	008	008	41.4655	-20.1885	2; 15, 23	1750; 75; 5	-
24/10/2019	1312	013	013	32.4020	-30.0238	2;15;22	1750; 92; 2	-
25/10/2019	1325	014	014	30.2677	-31.8608	2;15; 20	1750; 115; 10	-
26/10/2019	1323	016	016	27.9542	-33.6847	2;14; 20	1000; 125; 5	-
27/10/2019	1309	018	018	25.3005	-35.9045	2;13; 21	1750; 120; 5	-
28/10/2019	1314	020	020	22.5877	-37.6993	2;13; 21	1750; 105; 5	-
29/10/2019	1316	021	021	19.7987	-34.7777	2;13; 21	1750; 100; 5	-
31/10/2019	1321	25	025	14.7483	-29.6843	2;15; 21	1750; 72; 5	-
01/11/2019	1311	27	027	11.8440	-27.9602	2;15; 23	1750; 50; 5	-
02/11/2019	0518	28	028	9.8837	-26.7933	11	46	0.8; 1.0; 2.0 (only for 20 um aperture)
02/11/2019	1320	29	029	8.8917	-26.1993	2;16; 23	1750; 58; 2	
03/11/2019	0520	30	030	6.7495	-24.9995		21	2.0 only for 100 um aperture)
03/11/2019	1308	31	031	5.5218	-25.0017	2;15; 23	1750; 72; 5	2.0
04//11/19	1307	33	033	1.6767	-25.0088	2;14; 23	1750; 76; 2	1.0
05/11/2019	0504	34	034	-0.58	-24.9997	1;10; 23	2000; 75; 2	1.0
06/11/2019	1101	37	036	-5.0437	-25.0015	3;13; 23	1500; 85; 2	1.0
07/11/2019	1312	40	038	-8.4060	-24.9985	2;14; 23	1750; 100; 2	0.8
08/11/2019	1312	43	040	-11.8820	-25.0077	2;14; 23	1750; 120;2	2.0
09/11/2019	1314	45	042	-15.4425	-25.0033	2;13; 23	1750; 157; 2	0.6
11/11/2019	1312	48	044	-21.4375	-24.8375	2;13; 23	1750; 162; 2	0.6
12/11/2019	1210	51	046	-24.7350	-25.2047	2;13; 23	1750; 158; 2	2.0
13/11/2019	1215	53	048	-27.7088	-26.0852	1;13; 23	1000; 125; 2	0.8
14/11/2019	1249	55	050	-31.2118	-27.1495	1;13; 23	1000; 125; 2	1.0
15/11/2019	1252	57	052	-34.7770	-28.2520	1;15; 23	1000; 85; 2	2.0
17/11/2019	0401	60	054	-40.3555	-31.0393	1;11; 23	1000; 40; 2	3.0
18/11/2019	0331	62	055	-41.9013	-35.4305	2;14; 23	1750; 19; 2	3.0

Table 2. Underway samples taken for PSD analysis during AMT29.

Date	**Hour (UTC)**	**Station No**	**CTD Cast**	**Latitude**	**Longitude**	**Niskin Bottle**	**Depth (m)**	**Size filter for**

			No	(degrees)	(degrees)	No		DCM (µm)
16/11/2019	15:10:18	underway	U01	To be extracted from the ship’s underway data		-	5	-
19/11/2019	14:33:56	underway	U02			-	5	-

Aerosol Optical Depth – Microtops II sunphotometer

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Objective

- Take aerosol optical depth (AOD) measurements using a Microtops II sun photometer and contribute for the Maritime aerosol network (MAN) database (Smirnov et al. 2009).

Method

Whenever conditions allowed (i.e. clear sky conditions) measurements were taken with a Microtops II sun photometer configured to acquired data at five channels 380, 440, 675, 870 and 936 nm. Microtops was connected to a GPS for accurate time and location logging, and while targeting the Sun, 6-10 scans were taken. Procedure was repeated with 2 min interval. Data were downloaded and sent to the MAN for processing and dissemination. Data collected during the campaign are available at: https://aeronet.gsfc.nasa.gov/new_web/cruises_new/Discovery_19_0.html.

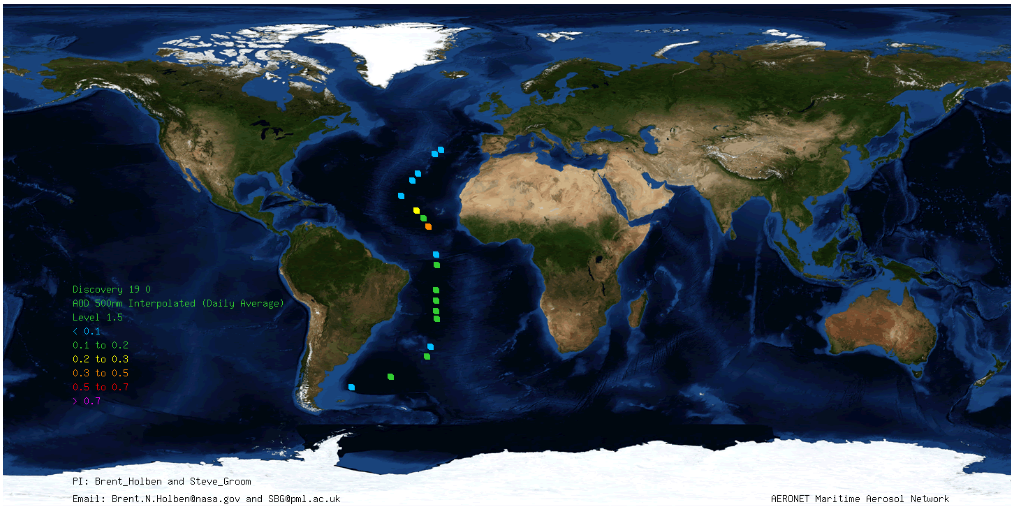

Figure 1. Aerosol optical depth at 500 nm (interpolated and daily average). Data processed by MAN and available at https://aeronet.gsfc.nasa.gov/new_web/cruises_new/Discovery_19_0.html.

References

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Rare Earth Elements (REEs)

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Objective

The REEs, or lanthanides, are a group of 14 metals with atomic number 57 to 71. Some REEs, such as Cerium (58) and Neodymium (60), have received substantial attention recently owing for their use as paleo-proxies. The REEs, however, are most interesting when considered as a group. The stability of the chemical bonds they form evolves along the series due to a slight decrease in atomic radius with increasing atomic number (the lanthanide contraction – a unique feature of the period table). This unique chemical behaviour means that the dissolved amount of each REE relative to the abundance of the other REEs in the sequence (i.e. the REE pattern) is modified in specific ways by specific processes such as particle scavenging, dust dissolution, river input, pore-water diffusion, etc. Monitoring the spatiotemporal evolution of the REE patterns can be used to infer the importance of specific biogeochemical processes and trace these processes spatially. The value of REEs as oceanographic tracers is not yet fully realised, as only limited data exist. Recent progress in analytical techniques now allow for quasi-routine measurements to be made on a large number of small water volumes (<30 ml for all REE, Hathorne et al., 2012)

The main goals for this study are (1) to make new high-resolution measurements in the Atlantic to produce a full meridional cross section specifically targeting the water masses of the upper water column, (2) to investigate the role of biological features and processes, if any, on the REE distribution and (3) to constrain the influence of the main dust plumes in the Atlantic.

A total of 619 60ml REE samples were taken across 40 stations during AMT29.

Methods

Samples were drawn from Niskins with acid-cleaned (3M HCl) 60ml PP syringes and ¼ inch acid-cleaned silicone tubing equipped with a PP Luer slip syringe fitting. New syringes and filters were used for every 4-5 samples to reduce cross-contamination and due to syringe deterioration. After flushing the tubing for a few seconds, a ~30ml aliquot was taken into the syringe. The plunger was then fully opened and the syringe was shaken before ejecting 25ml from the syringe. A 0.45um PP Whatman Puradisc filter (25mm) was connected to the syringe and the remaining 5ml were used to sample-rinse the filter. After this systematic sample rinse, 60ml were drawn into the syringe and syringe-filtered into prelabelled acid-cleaned 60ml LDPE bottles. Additional unfiltered samples were taken to use as a comparison (around 3 bottles per station). Bottles were dried with a Kimwipe and the stopper sealed with Parafilm. All samples were then stored in Ziploc bags in the dark at room temperature.
To minimise contamination, all sampling material was kept in plastic bags until sampling and nitrile gloves were worn at all times when manipulating REE equipment. Samples were collected either directly after pH or after nutrients. The lab workbench was covered in plastic, which was cleaned regularly. Anything left on the counter was stored in a plastic bag, which was taped to the wall and tied shut, opened only to access content.

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<u>Samples collected from CTD casts for REE analyses</u>

Date	Time	Station No	CTD Cast No	Lat	Long (W)	Niskin Bottles No	Depths Samples (m)
16/10/2019	0813	1	1	49º 02.891' N	006º 43.927'	3; 4; 7; 16	100; 90; 70; 5
18/10/2019	1230	4	4	46º 09,924' N	013º 52.933'	2; 4; 5; 6; 7; 8; 9; 12; 15; 18; 19; 24	1750; 1250; 1000; 750; 500; 400; 250; 100; 80; 70; 50; 5
19/10/2019	1234	6	6	43º 54, 850'N	017º 08.870'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 12; 14; 15; 16; 18; 19; 20	2000; 1750; 1500; 1250; 1000; 750; 500; 300; 250; 200; 100; 90; 80; 70;50; 25; 10
20/10/2019	1224	8	8	41º 27,928' N	020º 11,317'	1;2; 3; 4; 5; 6; 7; 8; 9; 10;11; 13; 17; 18; 19; 24	2000; 1750; 1500; 1250; 1000; 750; 500; 300; 250; 200; 150; 100; 70; 60; 30; 5
23/10/2019	0439	10	10	35º 55,370' N	026º 52,760'	1; 4; 6; 7; 12; 14; 17; 24	500; 200; 130; 100; 86; 86; 55; 30; 2
23/10/2019	1224	11	11	35º 05,480' N	027º 37,480'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17; 18; 19; 24	2000; 1750; 1500; 1250; 1000; 750; 500; 400; 300; 200; 150; 120; 90; 60; 50; 30; 5
24/10/2019	0535	12	12	33º 10.710' N	029º 20.090'	1; 4; 6; 8; 13; 14; 17; 24	500; 200; 145; 120; 95; 75; 33; 2
24/10/2019	1317	13	13	32º 24,116' N	030º 01,426'	1; 2; 4; 5; 6; 8; 9; 10; 12; 16; 17; 18; 19; 24	2000; 1750; 1500; 1250; 1000; 750; 400; 300; 200; 120; 95; 70; 50;30; 5
25/10/2019	1331	14	14	30º 16,060' N	031º 51,650'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17; 19; 24	2000; 1750; 1500; 1250; 1000; 750; 500; 400; 300; 200; 150; 140; 115; 80; 40; 10
26/10/2019	0533	15	15	29º 45,660' N	033º 01,776'	1; 2; 3; 6; 11; 13; 15; 24	500; 400; 300; 145; 118; 90; 50; 5
26/10/2019	1327	16	16	27º 57,252' N	033º 41,081'	1; 10; 11; 12; 13; 14; 17; 18; 19; 20	2000; 1000; 500; 200; 140; 125; 80; 60; 40; 5
27/10/2019	0531	17	17	26º 08,400' N	035º 11,690'	1; 2; 3; 4; 7; 12; 14; 18; 24	500; 400; 300; 200; 145; 115; 100; 32; 5
27/10/2019	1317	18	18	25º 18, 030' N	035º 18,030'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 12; 16; 17; 19; 20	2000; 1750; 1500; 1250; 1000; 750; 500; 400; 300; 200; 140; 120; 70; 25; 5
28/10/2019	0530	19	19	23º 25,148' N	037º 31,895'	1; 2; 3; 7; 12; 14; 17; 24	500; 400; 300; 145; 124; 95 ;45; 5
28/10/2019	0013	20	20	22º 36,258' N	037º 41,962'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 12; 16; 17; 18; 19; 20	2000; 1750; 1500; 1250; 1000; 750; 500; 400; 300; 200; 140; 105; 90; 60;2 5; 5

29/10/2019	1324	21	21	19º 47,920' N	034º 46,656'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11;12; 16; 17; 19; 20	2000; 1750; 1500; 1250; 1000; 750; 500; 400; 300; 200; 160; 140; 100; 60; 25; 5
30/10/2019	0528	22	22	18º 03,412' N	032º 58,394'	2; 4; 7; 12; 14; 15; 17; 19; 24	400; 200; 125; 100; 75; 55; 35; 15; 5
30/10/2019	1318	23	23	17º 16,736' N	032º 09,071'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17; 18; 19; 20	2000; 1750; 1500; 1250; 1000; 850; 500; 400; 300; 200; 160; 100; 80; 60; 40; 25; 5
31/10/2019	0525	24	24	15º 35,455' N	030º 25,580'	1; 2; 3; 7; 12; 14; 16; 17; 24	500; 400; 300; 80; 65; 47; 27; 5
31/10/2019	1320	25	25	14º 44,299' N	029º 41,062'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17;18;19 24	2000; 1750; 1500; 1250; 1000; 850; 700; 500; 400; 300; 170; 100; 72; 50; 30; 17; 5
01/11/2019	0526	26	26	12º 44,620' N	028º 30,020'	1; 2; 4; 6; 8; 13; 14; 18	500; 400; 200; 58; 45; 39; 29; 5
01/11/2019	1319	27	27	14º 50,693' N	027º 57,649'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17; 18; 19; 24	2000; 1750; 1500; 1250; 1000; 900; 700; 450; 300; 170; 100; 60; 43; 34; 20; 11; 5
02/11/2019	0524	28	28	09º 53,018' N	026º 47,602'	1; 3; 5; 7; 9; 14; 15; 17; 18; 24	500; 300; 100; 73; 60; 44; 37; 21; 5
02/11/2019	1323	29	29	08º 53,500' N	026º 11,970'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17; 19; 21; 23	2000; 1750; 1500; 1250; 1000; 850; 500; 400; 300; 170; 120; 70; 58; 35; 24;7; 2
03/11/2019	0525	30	30	06º 44,974' N	024º 59,969'	2; 3; 4; 5; 6; 9; 14; 15; 17; 24	400; 300; 200; 100; 60; 50; 30; 5
03/11/2019	1313	31	31	05º 31,302' N	025º 00,018'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 16; 17; 18; 19; 24	2000; 1750; 1500; 1250; 1000; 800; 500; 400; 300; 200; 150; 80; 69; 55;30; 17; 5
04/11/2019	0515	32	32	02º 52,747' N	024º 58,677'	1; 2; 3; 8; 11; 14; 17; 24	500; 400; 300; 85; 70; 53; 24; 2
04/11/2019	1316	33	33	01º 40,604' N	025º 00,528'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 15; 17; 18; 19; 20; 24	2000; 1750; 1500; 1250; 1000; 800; 500; 400; 300; 200; 150; 90; 76; 55; 32; 18; 9; 2
05/11/2019	0428	34	34	00º 34,810' S	024º 59,918'	1; 2; 3; 4; 5; 8; 13; 14; 24	2000; 1500; 750; 500; 260; 90; 75; 57; 2
06/11/2019	1108	37	36	05º 02,617' S	025º 00,080'	1; 2; 3; 4; 5; 6; 7; 8; 9; 17; 18; 19; 24	5000; 2000; 1500; 730; 400; 250; 100; 85; 90; 49; 36; 20; 2
07/11/2019	1322	40	38	08º 24,340' S	024º 59,000'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 15; 17; 18; 19; 20; 24	2000; 1750; 1500; 1250; 1000; 800; 500; 400; 300; 200; 120; 100; 76; 43; 24; 13; 2

08/11/2019	1318	43	40	11º 52,920' S	025º 00,462'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 15; 17; 18; 19; 20; 24	2000; 1750; 1500; 1250; 1000; 800; 500; 400; 300; 200; 125; 120; 85; 55; 30; 15; 2
09/11/2019	1319	45	42	15º 26,552' S	025º 00,200'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 14; 16; 17; 18; 24	2000; 1750; 1500; 1250; 1000; 700; 500; 400; 170; 157; 140; 85; 55; 2
11/11/2019	1316	48	44	21º 26,246' S	024º 50,248'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 14; 16; 18; 20; 24	2000; 1750; 1500; 1250; 1000; 835; 500; 400; 320; 250; 180; 162; 140; 55; 15; 2
12/11/2019	1211	51	46	24º 44,102' S	025º 12,281'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 14; 16; 17; 18; 20; 24	2000; 1750; 1500; 1250; 1000; 850; 500; 400; 320; 250; 190; 158; 140; 85;55;15; 2
13/11/2019	1219	53	48	27º 42,528' S	026º 05,105'	1; 2; 3; 4; 5; 6; 8; 11; 15; 16; 17; 18; 19; 24	1000; 800; 500; 400; 300; 200; 160; 125; 100; 85; 55; 35; 15; 2
15/11/2019	1256	57	52	34º 46,624' S	028º 15,124'	1; 2; 3; 4; 5; 6; 7; 10; 13; 17; 18; 19; 24	1000; 900; 700; 500; 400; 250; 140; 100; 85; 70; 40; 20; 2
16/11/2019	0438	58	53	37º 04,897' S	029º 01,019'	1; 2; 4; 6; 9; 12; 14; 16; 18; 19; 24	500; 250; 150; 70; 55; 42; 31; 19; 13; 70; 2
17/11/2019	0405	60	54	40º 21,334' S	031º 02,357'	1; 2; 3; 4; 5; 6; 8; 11; 14; 16; 18; 19; 24	1000; 800; 600; 400; 200; 100; 55; 40; 23; 17; 9; 5; 2
18/11/2019	0338	62	55	41º 54,088' S	035º 25,860'	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 14; 17; 18; 19; 24	2000; 1750; 1500; 1250; 1000; 800; 600; 400; 250; 100; 40; 20; 15; 10; 6; 2

Tintinnid community variation in relation to gyres and DCM depth

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Cruise Objectives

Tintinnid is planktonic ciliate with a lorica, which could be used as taxonomic identification criteria. Biogeographically, oceanic tintinnid genera were divided into polar (Arctic and Antarctic) and warm water groups. Due to their lorica, they are the model plankton species which could be identified at species level with abundance high enough to take water samples instead of net towing sampling, which has difficulty in assigning its vertical position.

Up to now, the spatial heterogeneity of tintinnid assemblage (or community) is not clear at the basin scale. We do not know the dominant (or abundant) species and species richness in different areas. My study objective is to analyse the tintinnid assemblage variation along the AMT transect which encompasses tropical to sub-Antarctic areas and several water masses.

Methods

1, Filtration
Tintinnid was collected by pouring the water through a 10 micron pore-size net. The waters in the cod end were collected, fixed with Lugol's solution and concentrated into 10 ml after sedimentation (for about 12 hours) and siphoning out the supernatant.

2, Depth selection and water volumes in CTD water sampling
The depth selection of CTD water samples were based on the DCM (Deep Chlorophyll Maximum) and AAIW (Antarctic Intermediate Water).
At each station, surface water and DCM water were sampled. One or two depths between surface and DCM, and/or one layer below DCM were sampled.

For the study of tintinnids in AAIW, three layers were taken: in the middle of AAIW, and two layers above and below AAIW, respectively.

About 10-16 L water from each layer was filtered.

3 Underway tintinnid sampling
Tintinnids were collected using the underway water system 3 times per day: 4:30 Am (corresponding to the morning CTD), 12:15 Pm (corresponding to the noon CTD) and 9:00 Pm. A total of 50 L surface water was filtered and concentrated into 10 ml for each sample.

References

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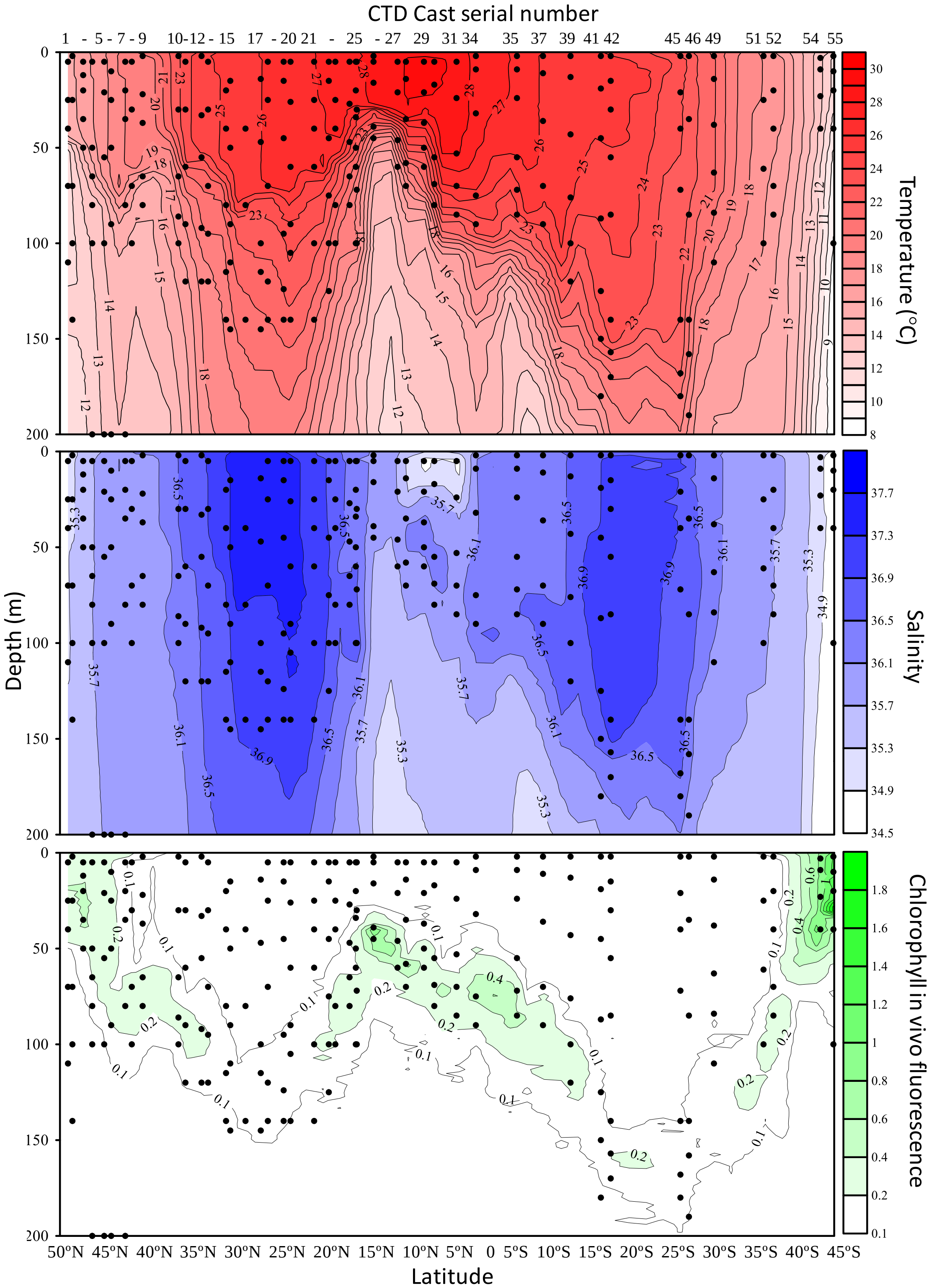

Fig. 1 Tintinnid sampling points from CTD casts and their relationship with temperature, salinity and chlorophyll in vivo fluorescence in the upper 200 m along the AMT29 transect.

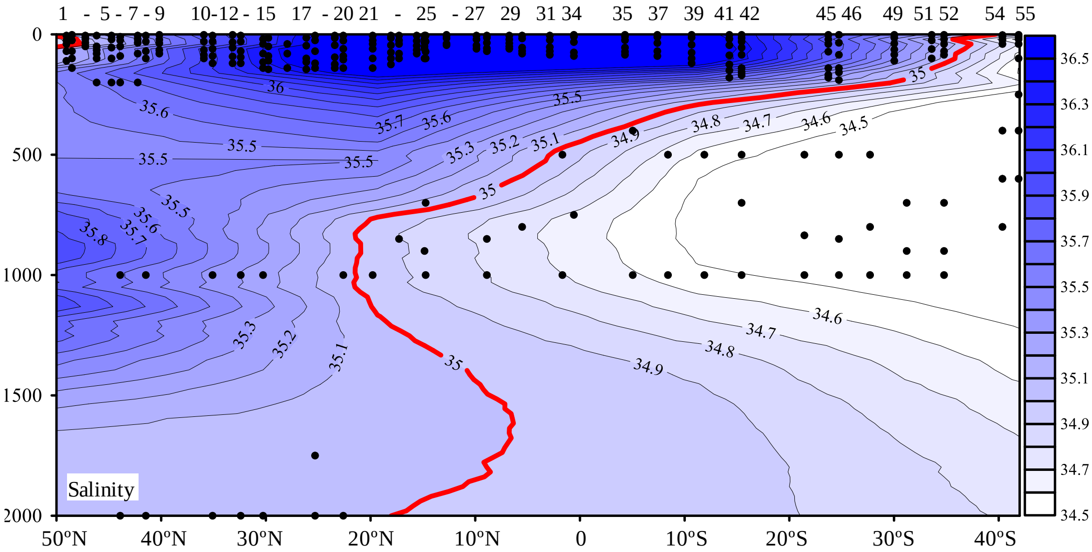

Fig. 2 Tintinnid sampling points from CTD casts and their relationship with salinity in the upper 2000 m along the AMT29 transect. This figure is to highlight the sampling points in the AAIW (Antarctic Intermediate Water, salinity lower than 35 in the depth about 500-1000 m).

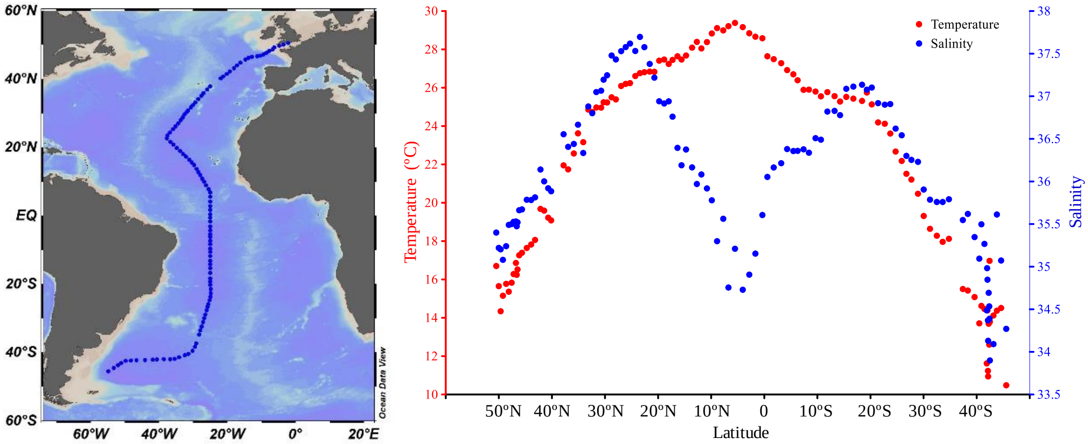

Fig. 3 Underway surface water tintinnid sampling positions (left) and variations of temperature and salinity along the sampling trajectory (right).

Table 1 Samples collected from CTD casts for tintinnid analyses.

Date	Time	Station No	CTD Cast No	Lat	Long (W)	Niskin Bottles No	Depths Samples (m)
16/10/2019	0813	1	1	49º 02.891' N	006º 43.927'	No record	110; 70; 40; 25; 5
16/10/2019	1320	2	2	48º 31.309' N	007º 12.224'	No record	140; 100; 70; 25; 2
17/10/2019	0442	3	3	47º 14.604' N	009º 18.913'	No record	50; 35; 20; 12; 5
18/10/2019	1230	4	4	46º 09,924' N	013º 52.933'	No record	200; 100; 80; 65; 50; 5
19/10/2019	0434	5	5	44º 44.635' N	016º 10.061'	No record	200;100; 55; 21; 5
19/10/2019	1234	6	6	43º 54, 850'N	017º 08.870'	No record	1000-2000; 200; 90; 50; 25; 10
20/10/2019	0436	7	7	42º 14,500' N	019º 11,766'	No record	200; 80; 35; 20; 5
20/10/2019	1224	8	8	41º 27,928' N	020º 11,317'	No record	1000-2000; 100; 70; 30; 5
21/10/2019	0430	9	9	40º 10,672' N	021º 55,778'	No record	80; 65; 37; 22; 5
23/10/2019	0439	10	10	35º 55,370' N	026º 52,760'	No record	100; 86; 65; 30; 2
23/10/2019	1224	11	11	35º 05,480' N	027º 37,480'	No record	1000-2000; 120; 90; 60; 30; 5
24/10/2019	0535	12	12	33º 10.710' N	029º 20.090'	8; 9-11; 15; 17; 20,22	120; 92; 55; 33; 2
24/10/2019	1317	13	13	32º 24,116' N	030º 01,426'	1-5; 12; 13-16; 17; 19; 20	1000-2000; 120; 95; 70; 30; 5
25/10/2019	1331	14	14	30º 16,060' N	031º 51,650'	1-5; 12; 13-16; 17; 19; 20	1000-2000; 140;115; 80; 40; 20
26/10/2019	0533	15	15	29º 45,660' N	033º 01,776'	6; 11; 12-13; 15; 18	145; 110; 90; 50; 15
26/10/2019	1327	16	16	27º 57,252' N	033º 41,081'	13; 17; 19	140; 80; 40

27/10/2019	0531	17	17	26º 08,400' N	035º 11,690'	7; 10,12; 14; 17; 19	145; 115; 100; 47; 14
27/10/2019	1317	18	18	25º 18, 030' N	035º 18,030'	1-2; 11-12; 13,16; 17; 19; 20-21	1750-2000;140; 120; 70; 25; 5
28/10/2019	0530	19	19	23º 25,148' N	037º 31,895'	7; 12; 13-14; 17; 19; 24	145; 124; 95; 45; 15; 5
28/10/2019	0013	20	20	22º 36,258' N	037º 41,962'	1-5; 12; 13-16; 17; 18; 19	1000-2000; 140; 105; 90; 60; 26; 5
29/10/2019	1324	21	21	19º 47,920' N	034º 46,656'	5; 12; 13-16; 17; 18; 19; 20-21	1000; 140; 100; 60; 40; 25; 5
30/10/2019	0528	22	22	18º 03,412' N	032º 58,394'	7; 12; 13-14; 16; 19; 22, 24	125; 100; 75; 45; 15; 5
30/10/2019	1318	23	23	17º 16,736' N	032º 09,071'	6; 12; 13-16; 18; 19; 20, 24	850; 100; 80; 40; 25; 5
31/10/2019	0525	24	24	15º 35,455' N	030º 25,580'	7; 8, 10, 11; 13-14; 16; 22, 24	80; 65; 47; 27; 5
31/10/2019	1320	25	25	14º 44,299' N	029º 41,062'	5-7; 12; 13-16; 18; 24	700-1000; 100; 72; 30; 5
01/11/2019	0526	26	26	12º 44,620' N	028º 30,020'	8; 9, 11; 16; 18; 22, 24	45; 39; 16; 5; 2
01/11/2019	1319	27	27	14º 50,693' N	027º 57,649'	6; 11; 12; 15; 17; 18; 23-24	900; 100; 60; 50; 34; 20; 5
02/11/2019	0524	28	28	09º 53,018' N	026º 47,602'	9; 11-12; 17; 20, 24	60; 46; 21; 5
02/11/2019	1323	29	29	08º 53,500' N	026º 11,970'	5, 6; 12; 16; 17; 20; 24	850-1000; 70; 58; 35; 14; 5
03/11/2019	0525	30	30	06º 44,974' N	024º 59,969'	9; 11; 15; 18; 22-24	60; 50; 37; 21; 5
03/11/2019	1313	31	31	05º 31,302' N	025º 00,018'	6; 12; 13,16; 17; 19; 23,24	800; 80; 69; 55; 17; 5
04/11/2019	0515	32	32	02º 52,747' N	024º 58,677'	8; 9-11; 14; 17; 23-24	85; 70; 53; 24; 2
04/11/2019	1316	33	33	01º 40,604' N	025º 00,528'	5-7	500-1000

05/11/2019	0428	34	34	00º 34,810' S	024º 59,918'	3; 8; 9-11; 16; 18; 19,24	750; 90; 75; 32; 9; 2
06/11/2019	0525	36	35	04º 18,026' S	024º 59,930'	8; 9-11; 14; 17; 19; 23-24	85; 72; 55; 24; 9; 2
06/11/2019	1108	37	36	05º 02,617' S	025º 00,080'	4-6	400-1000
07/11/2019	0523	39	37	07º 23,670' S	025º 00,491'	8-10; 13; 16; 18; 21,24	90; 70; 36; 11; 2
07/11/2019	1322	40	38	08º 24,340' S	024º 59,000'	5-7	500-1000
08/11/2019	0502	42	39	10º 40,088' S	025º 00,041'	7; 8-10; 14; 17; 19; 22-24	120; 100; 76; 43; 13; 2
08/11/2019	1318	43	40	11º 52,920' S	025º 00,462'	5-7	500-1000
09/11/2019	0459	44	41	14º 16,288' S	024º 59,651'	6-7; 8-11; 12; 14-15; 17; 19; 23-24	180; 150; 125; 87; 45; 19; 2
09/11/2019	1319	45	42	15º 26,552' S	025º 00,200'	5-7; 10; 12; 16; 17; 18; 19; 20; 21-24	500-1000; 170; 157; 140; 85; 55; 30; 15; 2
11/11/2019	0456	47	43	20º 14,780' S	024º 59,740'		No tintinnid sampling
11/11/2019	1316	48	44	21º 26,246' S	024º 50,248'	5-7	500-1000
12/11/2019	0427	50	45	23º 43,547' S	024º 55,250'	6; 8-9; 12; 16; 18; 19; 21,24	180; 168; 140; 72; 40; 21; 2
12/11/2019	1211	51	46	24º 44,102' S	025º 12,281'	5-7; 11; 12-15; 16; 17; 19; 23-24	500-1000; 190; 158; 140; 85; 35; 2
13/11/2019	0424	52	47	26º 45,731' S	025º 48,404'		No tintinnid sampling
13/11/2019	1219	53	48	27º 42,528' S	026º 05,105'	1-3	500-1000
14/11/2019	0426	54	49	30º 01,616' S	026º 47,128'	5; 12; 14; 16; 19; 22-24	110; 84; 63; 38; 14; 2
14/11/2019	1256	55	50	31º 12,706' S	027º 09,010'	1-3	700-1000

15/11/2019	0436	56	51	33º 35,935' S	027º 53,440'	9; 14; 17-18; 22-24	100; 61; 25; 2
15/11/2019	1256	57	52	34º 46,624' S	028º 15,124'	1-3;11-13; 16-17; 18; 19; 22-24	700-1000; 85; 70; 40; 20; 2
16/11/2019	0438	58	53	37º 04,897' S	029º 01,019'		No tintinnid sampling
17/11/2019	0405	60	54	40º 21,334' S	031º 02,357'	2-4; 12-13; 14-15; 17-18; 22-23	400-800; 40; 23; 9; 3
18/11/2019	0338	62	55	41º 54,088' S	035º 25,860'	7-9; 10; 11; 13-15; 18; 22-24	250-600; 100; 40; 20; 10; 2

Table 2 Underway surface water tintinnid sampling time, position, temperature (T) and salinity (S).

Serial No.	Date	Time	Latitude N	Longitude W	T °C	S
1	13-Oct	16:42	50.49	2.22	16.7	35.4
2	15	15:45	50.01	3.59	15.65	35.22
3		21:45	49.66	4.76	14.34	35.203
4	16	4:30	49.23	6.24	15.15	35.08
5		12:00	48.63	6.75	15.77	35.24
6		18:00	48.13	7.79	15.36	35.49
7		23:30	47.59	8.62	15.83	35.5
8	17	6:00	47.22	9.39	16.28	35.526
9		12:00	46.78	10.37	16.86	35.53
10		18:00	46.63	11.22	16.24	35.474
11	18	5:00	46.48	12.83	16.52	35.52
12		12:00	46.17	13.87	17.26	35.662
13		20:00	45.64	14.72	17.39	35.672
14	19	6:00	44.74	16.17	17.64	35.785
15		14:00	43.91	17.15	17.82	35.782
16		21:00	43.18	18.04	18.06	35.813
17	20	6:00	42.16	19.29	19.68	36.14
18		12:00	41.47	20.19	19.59	36.001
19		21:30	40.71	21.21	19.22	35.92
20	21	6:00	40.15	21.97	19.08	35.885
21	22	6:00	37.80	25.02	21.95	36.554
22		21:00	36.94	25.93	21.74	36.406
23	23	4:30	35.87	26.93	22.57	36.44
24		12:00	35.09	27.62	23.62	36.666
25		22:00	34.10	28.52	23.16	36.334
26	24	4:30	33.15	29.37	24.86	36.88
27		12:00	32.40	30.02	24.73	36.801
28		22:00	31.64	30.68	24.97	37.049
29	25	7:00	30.73	31.46	24.96	37.065
30		13:00	30.27	31.86	25.24	37.194
31		21:30	29.60	32.56	25.23	37.246
32	26	5:00	28.76	33.03	25.5	37.478
33		12:15	27.95	33.68	25.39	37.432
34		21:30	26.96	34.42	26.09	37.529
35	27	5:00	26.11	35.23	26.2	37.577
36		14:00	25.29	35.92	26.24	37.618
37		21:30	24.30	36.83	26.61	37.531
38	28	5:00	23.42	37.53	26.76	37.696
39		13:30	22.59	37.70	26.81	37.576
40		21:30	21.59	36.67	26.84	37.379
41	29	4:30	20.71	35.74	26.83	37.218
42		13:30	19.80	34.78	27.41	36.941
43		21:30	18.86	33.80	27.47	36.915
44	30	4:30	18.01	32.93	27.24	36.94
45		13:30	17.28	32.15	27.45	36.76
46		21:30	16.35	31.20	27.64	36.394
47	31	4:30	15.59	30.43	27.47	36.19
48		13:30	14.74	29.69	27.68	36.375
49		21:30	13.60	29.01	28.09	36.165
50	1 Nov.	4:30	12.70	28.47	28.39	35.97
51		12:15	11.84	27.96	28.05	36.082
52		21:30	10.80	27.34	28.38	35.918

53	2	4:30	9.88	26.79	28.83	35.779
54		14:00	8.89	26.20	29.11	35.299
55		21:30	7.73	25.52	28.99	35.562
56	3	4:30	6.75	25.00	29.21	34.755
57		13:30	5.52	25.00	29.38	35.21
58		21:30	4.06	25.00	29.16	34.729
59	4	4:30	2.83	24.99	28.84	34.906
60		13:30	1.68	25.01	28.66	35.153
61		21:30	0.36	25.00	28.58	35.606
62	5	5:00	-0.58	25.00	27.64	36.053
63		12:15	-1.77	25.00	27.49	36.164
64		21:30	-3.18	25.00	27.28	36.214
65	6	5:00	-4.30	25.00	26.92	36.38
66		16:00	-5.47	25.00	26.7	36.357
67		21:30	-6.28	25.00	26.39	36.359
68	7	5:00	-7.39	25.01	25.89	36.377
69		13:30	-8.41	25.00	25.9	36.337
70		21:30	-9.65	25.00	25.8	36.508
71	8	5:00	-10.67	25.00	25.55	36.49
72		13:30	-11.88	25.01	25.77	36.82
73		21:30	-13.24	25.01	25.56	36.828
74	9	5:00	-14.27	24.99	25.28	36.778
75		13:30	-15.44	25.00	25.52	37.087
76		21:30	-16.78	25.00	25.43	37.113
77	10	6:00	-18.41	25.04	25.31	37.135
78		10:30	-19.32	25.01	25.75	37.077
79	11	4:30	-20.25	25.00	25.13	37.102
80		13:30	-21.44	24.84	24.19	36.919
81		21:00	-22.70	24.88	24.12	36.901
82	12	4:30	-23.73	24.92	23.61	36.908
83		13:30	-24.74	25.20	22.67	36.62
84		21:00	-25.88	25.56	22.18	36.542
85	13	4:30	-26.76	25.81	21.51	36.3
86		12:15	-27.71	26.09	21.21	36.253
87		21:30	-28.95	26.46	20.47	36.23
88	14	4:30	-30.03	26.79	19.31	35.905
89		13:30	-31.21	27.15	18.64	35.786
90		21:30	-32.50	27.54	18.28	35.759
91	15	4:30	-33.60	27.89	17.96	35.759
92		14:00	-34.78	28.25	18.12	35.791
93	16	7:30	-37.40	29.12	15.5	35.547
94		13:00	-38.34	29.44	15.42	35.619
95		22:00	-39.61	30.17	15.08	35.347
96	17	7:30	-40.49	31.37	13.71	35.094
97		13:00	-40.89	32.47	14.62	35.497
98		21:00	-41.46	34.13	14.46	35.267
99	18	5:00	-41.90	35.43	11.62	34.487
100		12:30	-41.97	36.77	14.39	34.982
101		21:30	-42.04	38.61	14.39	34.847
102	19	6:30	-42.12	40.59	11.23	34.369
103		12:00	-42.16	41.86	10.94	34.13
104		9:45	-42.27	44.07	13.69	34.693
105	20	7:00	-42.37	46.59	12.6	34.534
106		14:30	-42.43	48.25	16.97	34.389
107		22:00	-42.49	49.74	13.79	33.899
108	21	6:45	-43.17	51.05	14.12	34.091
109		14:00	-43.81	52.07	14.37	35.612
110		22:30	-44.60	53.28	14.51	35.072

111	22	7:00	-45.57	54.88	10.48	34.27

Sea Surface Temperature – AMT4OceanSatFlux

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Objectives:

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

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

Automated collection of SSTskin and meteorological data:

SSTskin data was collected by ISAR (Infrared Sea surface temperature Autonomous Radiometer, 003) mounted on the port side of the forward mast at a 90 degree angle relative to the ships center line. The instruments sea viewing angle was checked on 12.10.2019 and determined with 25 deg from nadir (155 degrees in instrument coordinates). The ISAR configuration was set to include three sky angles (15, 25, 35 degrees). The data was logged with a data logger based in the Met Laboratory connected to the ships network allowing for frequent data quality checks.

A second ISAR (007) was installed next to ISAR 003 for comparison of SSTskin and uncertainty values. This ISAR was configured with three sea viewing angles, 45, 35 and 25 from straight downward looking (135, 145 and 155 instrument coordinates) and 5 sky angles (15, 25, 35, 45, 55). After checking the ships 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. The multiple sky and sea view angles were set up to help with the miss pointing characterization as described by Donlon and Nightingale, 2000 and the changes have a no impact on the use of the ISAR data for SLSTR validation.

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

Air temperature and Humidity data were collected with a Vaisala HMP243 sensor on the port side of the monkey island with a data logger which was located in the science junction box on the bridge.

SSTdepth (at 4m) data were collected with a Seabird SBE48 bow thruster room on the starboard side. A total of 187312 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.

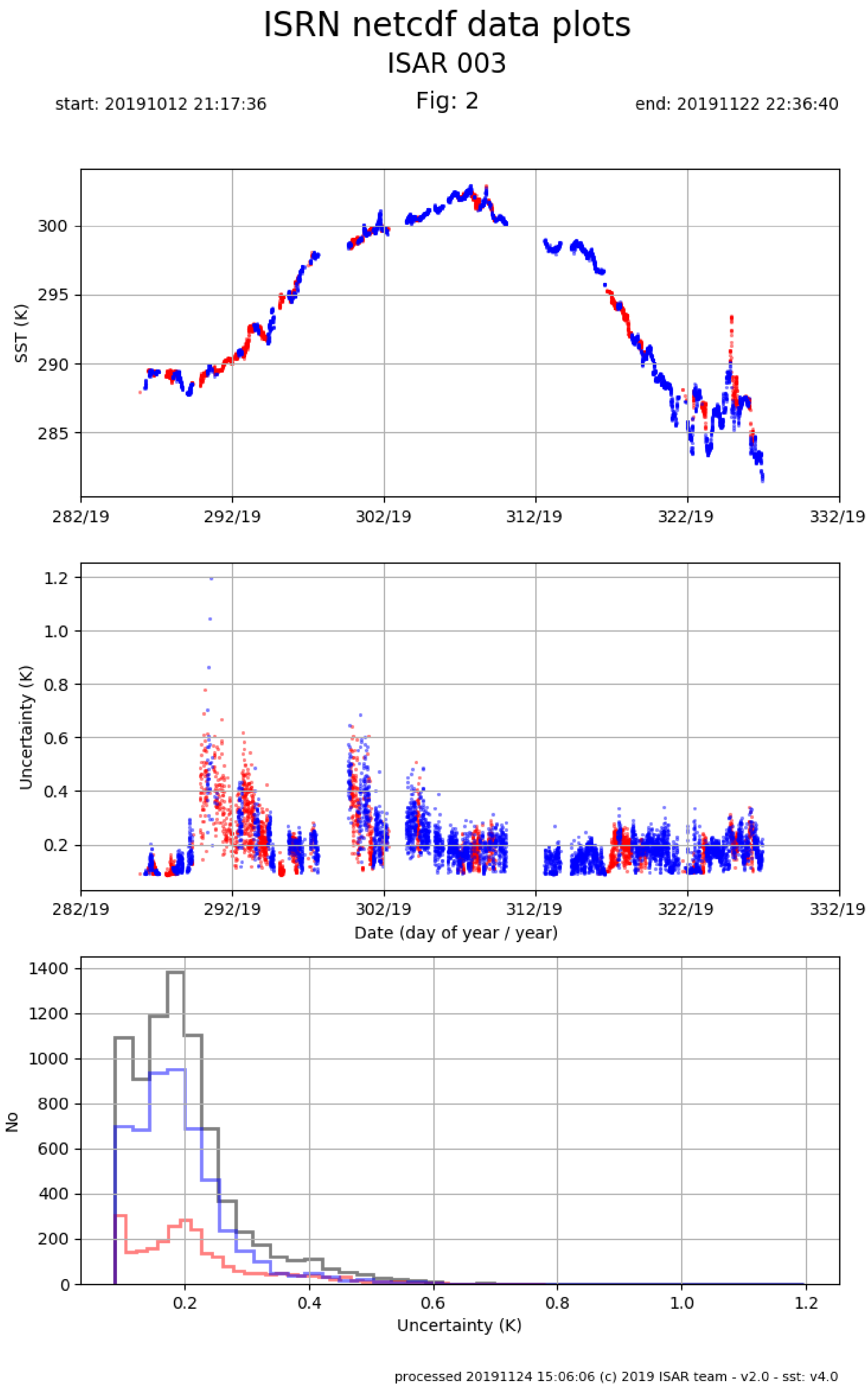

Figure 1: ISAR 003 SST data with corresponding total uncertainty.

Sky Brightness temperature measurements

In order to characterize the miss pointing uncertainty of the ISAR instrument (Donlon and Nightingale, 2000; Wimmer and Robinson, 2016) and characterize the whole sky two infrared (IR) cameras were installed on the forward mast next to the ISAR. Each camera was mounted at 45 degree from vertical and has a view angle of 110 x 75 degrees. The IR cameras have 32x24 pixel and are sampled every 2 seconds. The IR cameras were calibrated with a CASOTS II black body with a two point calibration at roughly 290 K and 303 K in the Met laboratory.

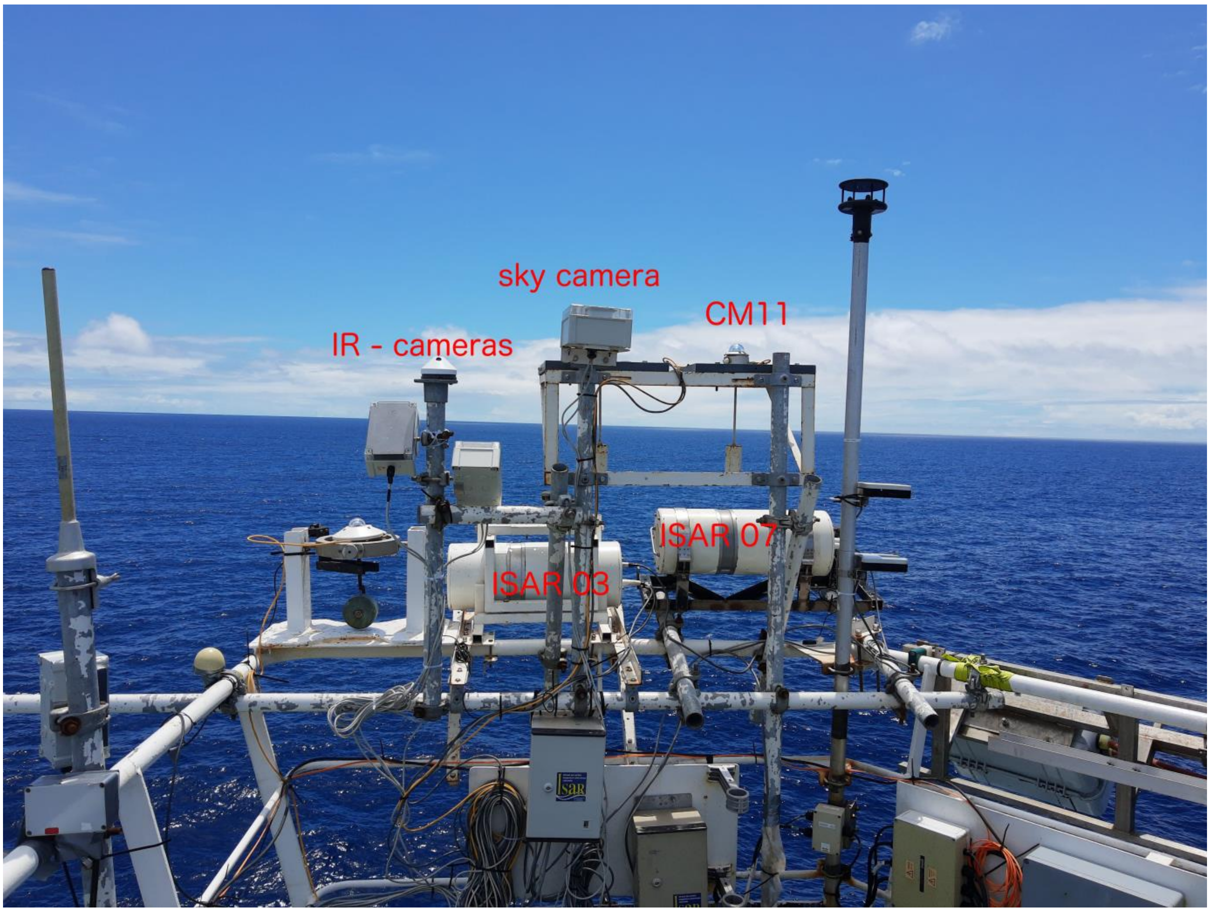

Figure 2: Sky camera and Heitronics KT15 mounted on the monkey island .

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Weather balloon – AMT4OceanSatFlux

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Objectives

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

Method

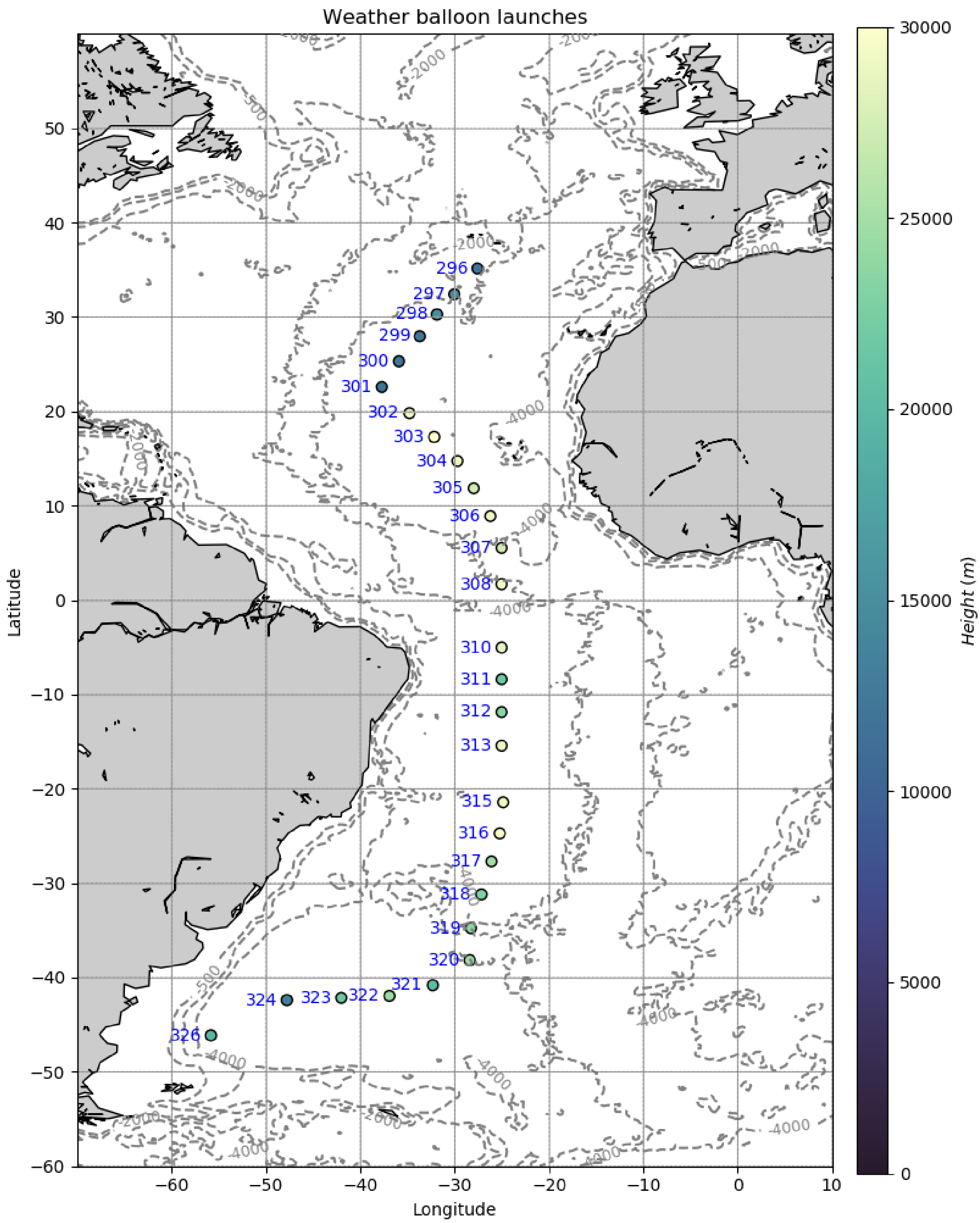
Weather balloons, measuring air pressure, humidity, air temperature, wind speed and direction were launched daily to collect information of the lower atmosphere composition. A total of 28 balloons were launched between 23.10 and 22.11.2019. The radiosondes used are Vaisala RS41, which were reconditioned before launch with the Vaisala GC25. A Vaisala Digicora MW41 together with a dedicated NCAS laptop was used as data receiving and storing device. The data receiving and GPS antenna were mounted on the Met Platform, the Vasiala GC 25, MW41 and the laptop were located in the Met laboratory. The Balloons were inflated with He, with the He bottle rack being located on the Hangar roof the bridge, were also a BAS provided balloon cage was located for filling the balloons. The balloons were launched from rear end of the Hangar roof deck. Data was emailed post flight to the UK MetOffcie.

Table 9: List of radio sonde launch dates and locations.

No	Date	Time (UTC)	Latitude	Longitude
			N pos	W pos
1	23/10/2019	12:36:00	35.14476	27.57800
2	24/10/2019	13:26:00	32.40931	30.01903
3	25/10/2019	14:00:00	30.26740	31.86132
4	26/10/2019	13:37:00	27.95457	33.68530
5	27/10/2019	13:17:00	25.30602	35.89122
6	28/10/2019	13:13:00	22.58795	37.69883
7	29/10/2019	13:53:00	19.79878	34.77700

8	30/10/2019	13:46:00	17.27944	32.15088
9	31/10/2019	13:58:00	14.73872	29.68392
10	01/11/2019	13:57:00	11.84518	27.96033
11	02/11/2019	14:01:00	8.89213	26.19911
12	03/11/2019	13:42:00	5.52128	25.00138
13	04/11/2019	13:50:00	1.67693	25.00935
14	06/11/2019	13:39:00	-5.04399	25.00105
15	07/11/2019	13:50:00	-8.40748	25.00014
16	08/11/2019	13:40:00	-11.88047	25.00659
17	09/11/2019	13:46:00	-15.44247	25.00276
18	11/11/2019	13:49:00	-21.43789	24.83740
19	12/11/2019	12:57:00	-24.73558	25.20490
20	13/11/2019	13:05:00	-27.70936	26.08458
21	14/11/2019	13:13:00	-31.20465	27.14572
22	15/11/2019	13:19:00	-34.77743	28.25117
23	16/11/2019	13:08:00	-38.17635	28.38505
24	17/11/2019	12:57:00	-40.82737	32.30067
25	18/11/2019	12:47:00	-41.96405	36.89694
26	19/11/2019	13:43:00	-42.16802	42.00417
27	20/11/2019	13:54:00	-42.40801	47.76791
28	22/11/2019	14:58:00	-46.15226	55.81991

20191023 12:36:00 to to 20191122 14:57:59



processed 20191122 (c) 2019 ISAR team - v1.2

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

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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 and 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. Data were recorded every 20 minutes in the Met Laboratory 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.

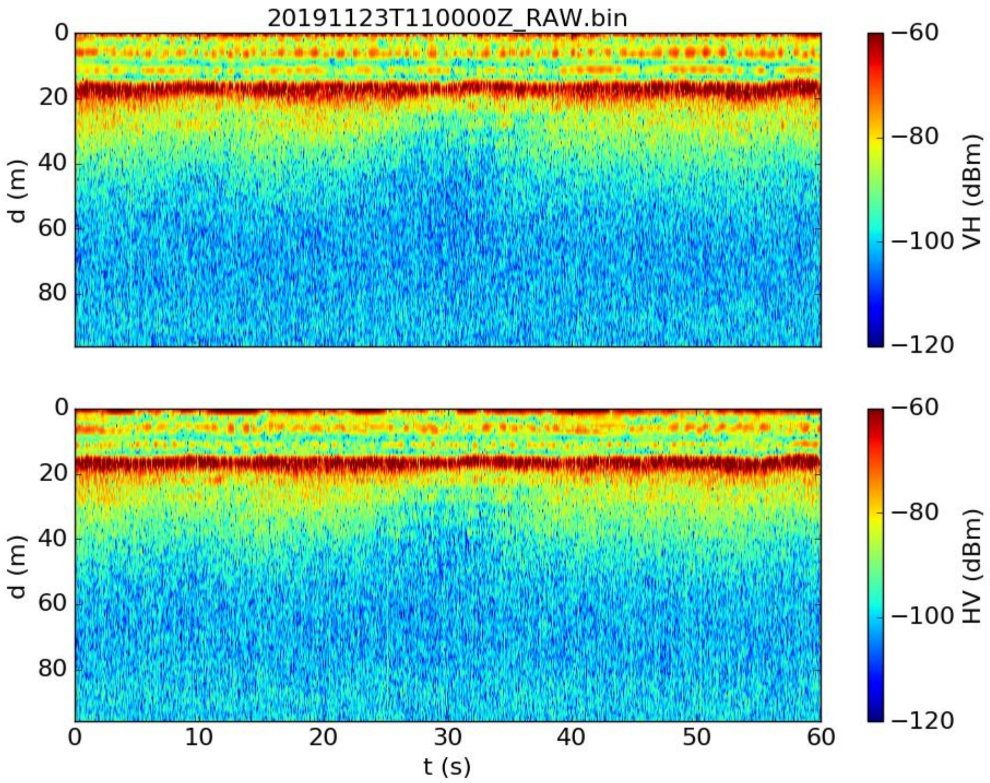

Figure 4: Example radar image from 23.11.2019 showing the vertical horizontal and horizontal vertical polarization data.

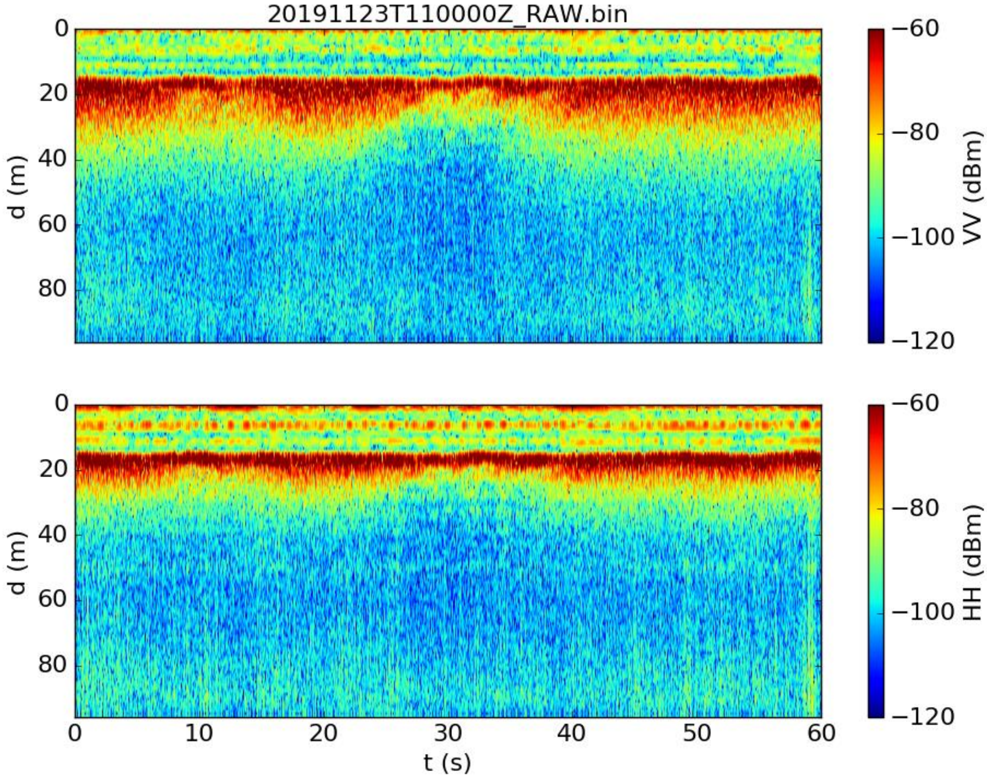

Figure 5: Example radar image from 23.11.2019 showing the vertical vertical and horizontal horizontal polarization data.

Depth profiles and sea spray aerosol enrichment of perfluoroalkyl acids (and other organics)

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Objective

Perfluorinated alkyl acids (PFAAs) are anthropogenic performance chemicals which have been manufactured since the 1950s. Although these substances do not occur naturally they are present in humans and biota globally, as well as in remote environments and throughout the global oceans. This is worrysome as several of the PFAAs have demonstrated cancerogenic and endocrine disruptive effects in humans. We have previously demonstrated that these surfactants are enriched in laboratory-generated sea spray aerosol (SSA) by up to a factor of 60 000 and that the highest enrichment occurs in aerosols known to have long-range transport potential (<1.6 µm). Emissions of PFAAs from the global oceans, modelled using these laboratory-derived enrichment factors (EFs), are in line with or exceed published emission estimates for other potential sources (Johansson et al., 2018). However, the modelled emissions are associated with a high uncertainty, partly because the EFs were determined using artificial seawater at an elevated PFAA concentration and partly because published seawater concentration data for the open ocean is very limited and variable. On AMT29, we have therefore performed experiments to measure field-based SSA EFs for PFAAs at a range of conditions representative for the global oceans. The samples will also be analysed using a non-targeted method to identify previously unkown organic substances that are enriched in SSA. Our findings will aid prediction of environmental transport of contaminants and further understanding of the chemical composition of SSA (which is relevant for e.g. cloud formation).

An additional objective is to analyse depth profiles of PFAAs along the transect. This data will be a valuable addition to a recent debate regarding whether these involatile and non-degradable substances stay in the global surface oceans over decadal scales or are rapidly mixed into the deeper oceans.

Method

The experiments were performed by generating SSA in a chamber designed for this purpose and using underway seawater continuously pumped through the system. The water in the chamber was sampled on solid phase extraction cartridges. The generated SSA was sampled both using an impactor and using bulk aerosol samplers. Each datapoint represents SSA and water sampled over the course of 30 hours. The samples are analysed for sodium using inductively coupled plasma mass spectrometry. Targeted analysis of perfluoroalkyl acids and non-targeted analysis of other organic substances enriched in SSA is performed using liquid chromatography high-resolution mass spectrometry.

CTD seawater samples were collected from 7 depths daily. These samples were concentrated on solid phase extraction cartridges and analysed for PFAAs via liquid chromatography mass spectrometry.

Funding

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The Swedish Research Council Vetenskapsrådet

Stockholm University

References

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Table 1. Time and location of CTD seawater sampling on AMT29.

Date	Hour (UTC)	Station No	CTD Cast No	Lat (degrees)	Lon (degrees)	Niskin Bottle No.	Depth (m)
2019-10-16	1316	2	DY002	48.52183	-7.20367	1, 2, 3, 5, 9, 20, 24	140m, 120m, 100m, 70m, 35m, 5m, 2m
2019-10-18	1224	4	DY004	46.16550	-13.88232	1, 3, 5, 7, 11, 17, 24	2000m, 1500m, 1000m, 500m, 200m, 70m, 5m
2019-10-19	1229	6	DY006	43.91417	-17.14783	1, 3, 5, 7, 10, 14, 24	2000m, 1500m, 1000m, 500m, 200m, 90m, 5m
2019-10-20	1221	8	DY008	41.46550	-20.18851	1, 3, 5, 7, 10, 14, 24	2000m, 1500m, 1000m, 500m, 200m, 70m, 5m
2019-10-23	1219	11	DY011	35.09133	-27.62466	1, 3, 5, 7, 10, 13, 24	2000m, 1500m, 1000m, 500m, 200m, 90m, 5m
2019-10-24	1312	13	DY013	32.40200	-30.02383	1, 3, 5, 7, 10, 13, 24	2000m, 1500m, 1000m, 500m, 200m, 95m, 5m
2019-10-25	1325	14	DY014	30.26767	-31.86084	1, 3, 5, 7, 10, 13, 24	2000m, 1500m, 1000m, 500m, 200m, 115m, 5m
2019-10-26	1323	16	DY016	27.95417	-33.68466	1, 10, 11, 12, 14, 24	2000m, 1000m, 500m, 200m, 120m, 5m
2019-10-27	1317	18	DY018	26.13983	-35.19482	1, 3, 5, 7, 10, 13, 24	2000m, 1500m, 1000m, 500m, 200m, 120m, 5m
2019-10-28	1314	20	DY020	22.58767	-37.69934	1, 3, 5, 7, 10, 13, 24	2000m, 1500m, 1000m, 500m, 200m, 105m, 5m
2019-10-29	1316	21	DY021	19.79867	-34.77768	1, 3, 5, 7, 10, 13, 24	2000m, 1500m, 1000m, 500m, 200m, 95m, 5m
2019-10-30	1308	23	DY023	17.27900	-32.15134	1, 3, 6, 7, 10, 13, 24	2000m, 1500m, 850m, 500m, 200m, 80m, 5m
2019-10-31	1321	25	DY025	14.73833	-29.68433	1, 3, 6, 8, 11, 16, 24	2000m, 1500m, 850m, 500m, 170m, 72m, 5m
2019-11-01	1311	27	DY027	11.84400	-27.96017	1, 3, 6, 8, 10, 16, 24	2000m, 1500m, 900m, 450m, 170m, 50m, 5m
2019-11-02	1320	29	DY029	8.89167	-26.19934	1, 3, 6, 7, 10, 12, 24	2000m, 1500m, 850m, 500m, 170m, 70m, 2m
2019-11-03	1308	31	DY031	5.52183	-25.00168	1, 3, 6, 7, 10, 16, 23	2000m, 1500m, 800m, 500m, 200m, 72m, 2m

2019-11-04	1307	33	DY033	1.67667	-25.00882	1, 3, 6, 7, 9, 15, 23	2000m, 1500m, 800m, 500m, 300m, 76m, 2m
2019-11-05	0421	34	DY034	-0.58117	-24.99966	1, 2, 3, 4, 5, 9, 19	2000m, 1500m, 750m, 500m, 260m, 75m, 2m
2019-11-06	1101	36	DY036	-5.04367	-25.00150	1, 2, 4, 5, 6, 14, 23	5000m, 2000m, 1000m, 730m, 400m, 85m, 2m
2019-11-07	1312	38	DY038	-8.40600	-24.99850	1, 3, 6, 7, 9, 15, 23	2000m, 1500m, 800m, 500m, 300m, 100m, 2m
2019-11-08	1312	40	DY040	-11.88200	-25.00766	1, 3, 6, 7, 9, 15, 23	2000m, 1500m, 800m, 500m, 300m, 120m, 2m
2019-11-09	1314	42	DY042	-15.44250	-25.00333	1, 3, 6, 7, 9, 14, 23	2000m, 1500m, 700m, 500m, 300m, 120m, 2m
2019-11-11	1312	44	DY044	-21.43750	-24.83749	1, 3, 6, 7, 9, 14, 23	2000m, 1500m, 835m, 500m, 320m, 162m, 2m
2019-11-12	1210	46	DY046	-24.73500	-25.20465	1, 3, 6, 7, 9, 14, 23	2000m, 1500m, 850m, 500m, 320m, 158m, 2m
2019-11-13	1215	48	DY048	-27.70883	-26.08517	1, 2, 3, 5, 6, 13, 23	1000m, 800m, 500m, 300m, 200m, 125m, 2m
2019-11-14	1249	50	DY050	-31.21183	-27.14951	1, 2, 3, 5, 6, 13, 23	1000m, 800m, 500m, 300m, 200m, 125m, 2m
2019-11-15	1252	52	DY052	-34.77700	-28.25201	1, 2, 3, 5, 7, 15, 23	1000m, 900m, 700m, 400m, 140m, 85m, 2m
2019-11-17	0401	54	DY054	-40.35550	-31.03934	1, 2, 3, 4, 5, 13, 23	1000m, 800m, 600m, 400m, 200m, 40m, 2m
2019-11-18	0331	55	DY055	-41.90133	-35.43050	1, 3, 5, 8, 9, 15, 13	2000m, 1500m, 1000m, 400m, 200m, 20m, 2m

Table 2. Time and location of sea spray experiments (underway seawater sampling) on AMT29.

No.	Start time (UTC)		End time (UTC)		Duration	Start location		End location	
	Date	Time	Date	Time		Lat	Lon	Lat	Lon
1	2019-10-14	0831	2019-10-15	1433	30.0	50.5177	-2.2013	49.3903	-4.6122
2	2019-10-16	0950	2019-10-17	1609	30.3	48.9471	-6.8135	46.6522	-10.9356
3	2019-10-18	0910	2019-10-19	1516	30.1	46.3588	-13.3769	43.9142	-17.1478
4	2019-10-20	1005	2019-10-21	1610	30.1	41.7113	-19.8383	39.0655	-23.4119
5	2019-10-23	0904	2019-10-24	1507	30.0	35.4893	-27.2705	32.4019	-30.0237
6	2019-10-25	1213	2019-10-26	1916	30.0	30.3619	-31.7840	27.4711	-34.0686
7	2019-10-27	1104	2019-10-28	1810	30.1	25.5555	-35.6753	22.1487	-37.2802
8	2019-10-29	1035	2019-10-30	1631	29.9	20.0999	-35.0990	17.0773	-31.9715
9	2019-10-31	1010	2019-11-01	1609	30.0	15.1376	-29.9757	11.7241	-27.8931
10	2019-11-02	1008	2019-11-03	1602	29.9	9.3551	-26.4803	5.2711	-25.0050
11	2019-11-04	1027	2019-11-05	1633	30.1	2.0931	-24.9991	-2.3409	-24.9970
12	2019-11-06	1019	2019-11-07	1626	30.1	-4.9439	-24.9997	-8.6321	-25.0072
13	2019-11-08	1010	2019-11-09	1610	30.0	-11.3673	-25.0006	-16.0582	-25.0089
14	2019-11-10	1011	2019-11-11	1605	29.9	-18.5040	-25.1077	-21.8664	-24.8443
15	2019-11-12	0913	2019-11-13	1507	29.9	-24.2602	-25.0701	-28.1147	-26.2165
16	2019-11-14	0917	2019-11-15	1513	29.9	-30.6933	-26.9831	-35.2012	-28.4083
17	2019-11-16	1232	2019-11-17	1829	29.95	-38.6923	-29.5553	-41.2308	-33.446712
18	2019-11-18	0843	2019-11-19	1436	29.88	-41.9013	-35.4305	-42.1962	-42.3514
19	2019-11-20	0952	2019-11-21	1605	30.22	-42.3797	-46.9931	-43.9576	-52.2896

DY110 NMF CTD Operations Report

PSO: Dr G Dall'Olmo

13th October – 25th November 2019

JOHN WYNAR

Sensors & Moorings Group

National Marine Facilities Division

National Oceanography Centre, Southampton

CTD System Configuration

See separate Sensor Information document.

CTD Operations

There were 55 CTD casts made all using the stainless steel (s/s) system. Log sheets were scanned and included with the data from this cruise. 20L water samplers were used throughout. During cast 36 rosette positions 12 & 16 were used for acoustic release testing.

Owing to sensor changes several configuration files were used and included in the Appendix at the end of this report.

CTD1 was used for all casts. The wire was terminated several times during the voyage giving an insulation figure of 2.6GΩ o/c and a s/c value of 70Ω after the last cast. MDS swivel s/n: 1246-1 was used for all casts with no issues.

Total number of casts: 55

Casts deeper than 2000m: 1

Deepest cast: 5000m

Sensor Changes

The PSO requested that the PML-owned backscatter sensor BBRTD-849 be installed on the s/s frame, the initial 'config' file being:

DY110_1182_SS.xmlcon.

After cast 5 this was removed and the NOC unit BBRTD-5466 fitted using the'config' file: DY110_1182_SS_0.xmlcon.

A problem developed with the fluorometer s/n: 88-163 when it intermittently produced step changes in output. It was swapped for unit 88-126 after cast 20 and using 'config' file:

DY110_1182_SS_1.xmlcon.

During casts 46 to 49 inc., the backscatter sensor was replaced with BBRTD-758R in order to investigate a problem with the s/s system. 'Config' changed to:

DY110_1182_SS_2.xmlcon.

For casts 50 to 55 the backscatter sensor reverted to BBRTD-5466 and used the 'config' file: DY110_1182_SS_1.xmlcon.

Incidentally, for casts 52 to 55 the BBRTD was moved from its usual position clamped to the underside of the frame in a downward looking orientation, to being fitted horizontally to the vane looking away from the frame. This resulted in removing the offset which was observed in the data between the downcast and the upcast.

Data Processing

Basic post-processing of the CTD cast data was done to guidelines established with BODC (ref. Moncoiffe 7th July 2010).

Salinity measurement

A Guildline Autosal 8400B salinometer, s/n: 65764, was used for salinity measurements. The salinometer was sited in the Salinometer lab. Initially, the bath temperature was set at 21°C, the ambient temperature being approximately 20°C. The salinometer was standardized at the beginning of the first set of samples, and checked with an additional standard analysed prior to setting the RS. Once standardized the Autosal was not adjusted for the duration of sampling. A standard was analysed after each crate of samples to monitor & record drift (second standard analysed after sample 24, third standard analysed after sample 48, etc). Standards were recorded in the spreadsheet as '0' and had a standard salinity value of 34.994. Standard deviation was set to 0.00002.

A bespoke program written in Labview called "Autosal" was used as the data recording program for salinity values.

Salinity samples were taken and analysed from most casts and the results tabulated in a spreadsheet SALFORM_SS.xlsx.

APPENDIX

***Configuration files used for the stainless system*:**

Instrument configuration file: C:\Users\sandm\Documents\Cruises\DY110\Seasave setup files\DY110_1182_SS.xmlcon

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0

Voltage words suppressed : 0

Computer interface : RS-232C

Deck unit : SBE11plus Firmware Version < 5.0

Scans to average : 1

NMEA position data added : Yes

NMEA depth data added : No

NMEA time added : No

NMEA device connected to : PC

Surface PAR voltage added : No

Scan time added : Yes

1) Frequency 0, Temperature

Serial number : 03P-4383

Calibrated on : 11 July 2018

G : 4.39862417e-003

H : 6.55304958e-004

I : 2.41428164e-005

J : 1.98844984e-006

F0 : 1000.000

Slope : 1.00000000

Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-2580

Calibrated on : 11 July 2018

G : -1.04804926e+001

H : 1.54201240e+000

I : -2.36431999e-004

J : 1.01511916e-004

CTcor : 3.2500e-006

CPcor : -9.57000000e-008

Slope : 1.00000000

Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 129735

Calibrated on : 3 November 2017

C1 : -6.064446e+004

C2 : 6.966022e-002

C3 : 1.971200e-002

D1 : 2.882500e-002

D2 : 0.000000e+000

T1 : 3.029594e+001

T2 : -6.713680e-005

T3 : 4.165390e-006

T4 : 0.000000e+000

T5 : 0.000000e+000

Slope : 0.99982000

Offset : -1.48930

AD590M : 1.279180e-002

AD590B : -8.821250e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-4381

Calibrated on : 25 July 2018

G : 4.42359439e-003

H : 6.44950441e-004

I : 2.26922968e-005

J : 1.98186505e-006

F0 : 1000.000

Slope : 1.00000000

Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-2450

Calibrated on : 14 June 2018

G : -1.04375764e+001

H : 1.66338115e+000

I : -1.95407131e-003

J : 2.78452913e-004

CTcor : 3.2500e-006

CPcor : -9.57000000e-008

Slope : 1.00000000

Offset : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

Serial number : 43-1940

Calibrated on : 21 July 2018

Equation : Sea-Bird

Soc : 5.30300e-001

Offset : -4.97000e-001

A : -3.46500e-003

B : 1.95130e-004

C : -3.33540e-006

E : 3.60000e-002

Tau20 : 1.33000e+000

D1 : 1.92634e-004

D2 : -4.64803e-002

H1 : -3.30000e-002

H2 : 5.00000e+003

H3 : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, Fluorometer, Chelsea Aqua 3

Serial number : 88-2960-163

Calibrated on : 16 August 2018

VB : 0.237930

V1 : 2.021270

Vacetone : 0.441380

Scale factor : 1.000000

Slope : 1.000000

Offset : 0.000000

9) A/D voltage 3, Altimeter

Serial number : 59494

Calibrated on : 25 March 2013

Scale factor : 15.000

Offset : 0.000

10) A/D voltage 4, PAR/Irradiance, Biospherical/Licor

Serial number : 70510

Calibrated on : 27 June 2019

M : 1.00000000

B : 0.00000000

Calibration constant : 20300000000.00000000

Multiplier : 1.00000000

Offset : -0.05009162

11) A/D voltage 5, PAR/Irradiance, Biospherical/Licor, 2

Serial number : 70520

Calibrated on : 27 June 2019

M : 1.00000000

B : 0.00000000

Calibration constant : 19900000000.00000000

Multiplier : 1.00000000

Offset : -0.05148773

12) A/D voltage 6, Transmissometer, WET Labs C-Star

Serial number : CST-1654DR

Calibrated on : 7 April 2017

M : 21.1627

B : -0.1550

Path length : 0.250

13) A/D voltage 7, OBS, WET Labs, ECO-BB

Serial number : BBRTD-849

Calibrated on : 16 July 2014

ScaleFactor : 0.002112

Dark output : 0.047400

Scan length : 41

Pump Control

This setting is only applicable to a custom build of the SBE 9plus.

Enable pump on / pump off commands: NO

Data Acquisition:

Archive data: YES

Delay archiving: NO

Data archive: C:\Users\sandm\Documents\Cruises\DY110\CTD Raw Data\DY110_055.hex

Timeout (seconds) at startup: 60

Timeout (seconds) between scans: 20

Instrument port configuration:

Port = COM4

Baud rate = 19200

Parity = N

Data bits = 8

Stop bits = 1

Water Sampler Data:

Water Sampler Type: SBE Carousel

Number of bottles: 36

Port: COM5

Enable remote firing: NO

Firing sequence: User input

Tone for bottle fire confirmation uses PC sound card.

Header information:

Header Choice = Prompt for Header Information

prompt 0 = Ship: RRS Discovery

prompt 1 = Cruise: DY110

prompt 2 = Cast:

prompt 3 = Station:

prompt 4 = Julian Day:

prompt 5 = Date:

prompt 6 = Time (GMT):

prompt 7 = Latitude:

prompt 8 = Longitude:

prompt 9 = Depth (uncorrected m):

prompt 10 = Principal Scientist: G. Dall'Olmo

prompt 11 = Operator: J. Wynar

TCP/IP - port numbers:

Data acquisition:

Data port: 49163

Status port: 49165

Command port: 49164

Remote bottle firing:

Command port: 49167

Status port: 49168

Remote data publishing:

Converted data port: 49161

Raw data port: 49160

Miscellaneous data for calculations

Depth, Average Sound Velocity, and TEOS-10

Latitude when NMEA is not available: 55.000000

Longitude when NMEA is not available: 0.000000

Average Sound Velocity

Minimum pressure [db]: 20.000000

Minimum salinity [psu]: 20.000000

Pressure window size [db]: 20.000000

Time window size [s]: 60.000000

Descent and Acceleration

Window size [s]: 2.000000

Plume Anomaly

Theta-B: 0.000000

Salinity-B 0.000000

Theta-Z / Salinity-Z 0.000000

Reference pressure [db] 0.000000

Oxygen

Window size [s]: 2.000000

Apply hysteresis correction: 0

Apply Tau correction: 1

Potential Temperature Anomaly

A0: 0.000000

A1: 0.000000

A1 Multiplier: Salinity

Serial Data Output:

Output data to serial port: NO

Mark Variables:

No variables are selected.

Shared File Output:

Output data to shared file: NO

TCP/IP Output:

Raw data:

Output raw data to socket: NO

XML wrapper and settings: NO

Seconds between raw data updates: 0.000000

Converted data:

Output converted data to socket: NO

XML format: NO

SBE 11plus Deck Unit Alarms

Enable minimum pressure alarm: NO

Enable maximum pressure alarm: NO

Enable altimeter alarm: NO

SBE 14 Remote Display

Enable SBE 14 Remote Display: NO

PC Alarms

Enable minimum pressure alarm: NO

Enable maximum pressure alarm: NO

Enable altimeter alarm: NO

Enable bottom contact alarm: NO

Alarm uses PC sound card.

Options:

Prompt to save program setup changes: YES

Automatically save program setup changes on exit: NO

Confirm instrument configuration change: YES

Confirm display setup changes: YES

Confirm output file overwrite: YES

Check scan length: YES

Compare serial numbers: YES

Maximized plot may cover Seasave: NO

Config file used for casts 6 to 20 (only the change is shown here):

Instrument configuration file: C:\Users\sandm\Documents\Cruises\DY110\Seasave setup files\DY110_1182_SS_0.xmlcon

13) A/D voltage 7, OBS, WET Labs, ECO-BB

Serial number : BBRTD-5466

Calibrated on : 4 February 2019

ScaleFactor : 0.003307

Dark output : 0.051000

Config file used for casts 21 to 45 and 50 to 55 (only the change is shown here):

Instrument configuration file: C:\Users\sandm\Documents\Cruises\DY110\Seasave setup files\DY110_1182_SS_1.xmlcon

8) A/D voltage 2, Fluorometer, Chelsea Aqua 3

Serial number : 88-2615-126

Calibrated on : 16 August 2018

VB : 0.593340

V1 : 2.105980

Vacetone : 0.756140

Scale factor : 1.000000

Slope : 1.000000

Offset : 0.000000

Config file used for casts 46 to 49 (only the change is shown here):

Instrument configuration file: C:\Users\sandm\Documents\Cruises\DY110\Seasave setup files\DY110_1182_SS_2.xmlcon

13) A/D voltage 7, OBS, WET Labs, ECO-BB

Serial number : BBRTD-758R

Calibrated on : 30 August 2019

ScaleFactor : 0.004284

Dark output : 0.054400

SOG Mooring Recovery/Deployment

Cruise DY110

RRS Discovery

10th November 2019

Technical Report

Compiled by: John Wynar

Sensors and Moorings

Sensors and Moorings Group

National Oceanography Centre

European Way

Southampton

Mooring Operations

Main objectives

1. To recover the Southern Ocean Gyre sediment trap mooring deployed in 2018.

2. To deploy a replacement SOG sediment trap mooring with refurbished instruments and new hardware.

Passive mode was selected for all echo sounders and the ship's thrusters disabled during acoustic interrogation to avoid interference.

The deck unit used was Ixsea TT801, s/n: 010 and the ship's mooring transducer located in the drop keel.

All times given below are in UTC unless stated otherwise

Acoustic Releases Test

A test of two AR861 releases for potential use in the mooring was carried out during CTD cast 36 on the 6th November and at a depth of 5000m. This was approximately the pressure that the mooring would be subjected to. The results were as follows:

s/n: 1499;	Release:	range: 4999m; release OK
	Release:	range: 4995m; release OK
	Diagnostic:	range: 4994m; 9V, vertical
s/n: 1751;	Release:	range: 4995m; release OK
	Release:	range: 4995m; release OK
	Diagnostic:	range: 4994m; 12.5V, vertical

Mooring Recovery

The vessel arrived on station about 500m from the way point around 08:00 and echo sounders were disabled. The AR861 acoustic release (s/n: 2253) was interrogated and gave a range of 4778m initially. The bridge OOW was informed acoustic contact had been made with the mooring and gave the go-ahead for release. The release code was transmitted and at 08:46 and ranges of 7070m and 7591m, release OK were received.

This range seemed a little large and subsequent ranges (5792m, 7589m, 5877m) were inconsistent. The OOW was asked if the vessels thrusters could be disabled for a period to allow better communication with the AR861. This was done and then the following ranges were received:

08:55 7283m

08:56 7200m

08:57 7119m

08:58 7041m

Hence this gave an approximate ascent rate of 80m/min. and a time at the surface around 10:05.

By 10:30 there was still no sign of the mooring at the surface and acoustic communication with the AR861 had been lost. It was then realised that we were not at the mooring release position but nearly 3 nautical miles away! The ship re-positioned and the mooring was sighted on the surface at 11:30.

Recovery timings and summary:

12:15 Recovery buoy inboard

12:19 Billings float i/b (initially tangled underneath the 12 glass buoyancy)*

12:22 12 glass buoyancy i/b

12:28 Sediment trap A (s/n: 12432-04) & current meter A (s/n: AQD11990) i/b

12:34 Sediment trap B (s/n: 12432-03) & current meter B (s/n: AQD11992) i/b

13:04 SBE 37 (s/n: 13242) i/b

13:08 40” syntactic float i/b

13:15 AR861 (s/n: 2253) i/b

*Hence why there were no Argos transmissions as it was underwater

Current meter A stopped and data retrieved at 14:14:00 on 10th November

Current meter B stopped and data retrieved at 14:23:30 on 10th November

CTD SBE37 stopped and data retrieved on 10th November

Configuration of Instruments to Deploy

Sediment Trap A (S/N: ML11804-07)

McLane Research Laboratories, USA

ParFlux 21-Cup Sediment Trap

Version: pst-21_1.c S/N: ML11804-07

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º Main Menu º

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Tue Sep 24 11:03:37 2019

<1> Set Time <5> Create Schedule

<2> Diagnostics <6> Deploy System

<3> Fill Containers <7> Offload Data

<4> Sleep <8> Contacting McLane

Selection ? 6

Is the rotator aligned to the

open hole (Yes/No) [N] ? y

Clock reads 09/24/2019 11:04:05

Change time & date (Yes/No) [N] ? n

Existing deployment data file will be

erased. Continue (Yes/No) [N] ? y

Enter new deployment schedule (Yes/No) [N] ? n

Schedule Verification

Event   1 of 22 = 11/17/2019 12:00:00

Event   2 of 22 = 12/15/2019 12:00:00

Event   3 of 22 = 01/12/2020 12:00:00

Event   4 of 22 = 02/09/2020 12:00:00

Event   5 of 22 = 03/08/2020 12:00:00

Event   6 of 22 = 04/05/2020 12:00:00

Event   7 of 22 = 05/03/2020 12:00:00

Event   8 of 22 = 05/31/2020 12:00:00

Event   9 of 22 = 06/28/2020 12:00:00

Event 10 of 22 = 07/26/2020 12:00:00

Event 11 of 22 = 08/23/2020 12:00:00

Event 12 of 22 = 09/20/2020 12:00:00

Event 13 of 22 = 10/18/2020 12:00:00

Event 14 of 22 = 11/15/2020 12:00:00

Event 15 of 22 = 12/13/2020 12:00:00

Event 16 of 22 = 01/10/2021 12:00:00

Press any key to continue.

Event 17 of 22 = 02/07/2021 12:00:00

Event 18 of 22 = 03/07/2021 12:00:00

Event 19 of 22 = 04/04/2021 12:00:00

Event 20 of 22 = 05/02/2021 12:00:00

Event 21 of 22 = 05/30/2021 12:00:00

Event 22 of 22 = 06/27/2021 12:00:00

Modify an event (Yes/No) [N] ? n

C

odify an event (Yes/No) [N] ? n

Current Header reads:

Do you want a different header (Yes/No) [N] ? y

Enter new header (three lines, 80 characters/line)

> LXXXV_A SOG

> SOG 2019_2021

> TRAP A 3000M

Current Header reads:

LXXXV_A SOG

SOG 2019_2021

TRAP A 3000M

Do you want a different header (Yes/No) [N] ? N

System status:

09/24/2019 11:07:47   21.4 Vb   23 øC aligned

Caution: Deployment will overwrite the

EEPROM data backup cache.

Proceed with the deployment (Yes/No) [N] ? Y

>>> Remove communication cable and <<<

>>> attach dummy plug. <<<

>>> Sediment trap is ready to deploy. <<<

<09/24/2019 11:07:53> Waiting for Event 01 of 22 @ 11/17/2019 12:00:00

<09/24/2019 11:07:55> Sleeping . . .

Sediment Trap B (S/N: ML12283-02)

McLane Research Laboratories, USA

ParFlux 21-Cup Sediment Trap

Version: PST-21_3.c   S/N: ML12283-02

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º   Main Menu   º

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Tue Sep 24 11:22:39 2019

<1> Set Time <5> Create Schedule

<2> Diagnostics <6> Deploy System

<3> Fill Containers <7> Offload Data

<4> Sleep <8> Contacting McLane

Selection ? 6

Is the rotator aligned to the

open hole (Yes/No) [N] ? Y

Clock reads 09/24/2019 11:23:02

Change time & date (Yes/No) [N] ? N

Existing deployment data file will be

erased. Continue (Yes/No) [N] ? Y

Enter new deployment schedule (Yes/No) [N] ? N

Schedule Verification

Event 1 of 22 = 11/17/2019 12:00:00

Event 2 of 22 = 12/15/2019 12:00:00

Event 3 of 22 = 01/12/2020 12:00:00

Event 4 of 22 = 02/09/2020 12:00:00

Event 5 of 22 = 03/08/2020 12:00:00

Event 6 of 22 = 04/05/2020 12:00:00

Event 7 of 22 = 05/03/2020 12:00:00

Event 8 of 22 = 05/31/2020 12:00:00

Event 9 of 22 = 06/28/2020 12:00:00

Event 10 of 22 = 07/26/2020 12:00:00

Event 11 of 22 = 08/23/2020 12:00:00

Event 12 of 22 = 09/20/2020 12:00:00

Event 13 of 22 = 10/18/2020 12:00:00

Event 14 of 22 = 11/15/2020 12:00:00

Event 15 of 22 = 12/13/2020 12:00:00

Event 16 of 22 = 01/10/2021 12:00:00

Press any key to continue.

Event 17 of 22 = 02/07/2021 12:00:00

Event 18 of 22 = 03/07/2021 12:00:00

Event 19 of 22 = 04/04/2021 12:00:00

Event 20 of 22 = 05/02/2021 12:00:00

Event 21 of 22 = 05/30/2021 12:00:00

Event 22 of 22 = 06/27/2021 12:00:00

Modify an event (Yes/No) [N] ? N

Current Header reads:

Do you want a different header (Yes/No) [N] ? Y

Enter new header (three lines, 80 characters/line)

> LXXXV_B SOG

```
> SOG 2019_2021

> TRAP B 3000M

 Current Header reads:


 LXXXV_B SOG

 SOG 2019_2021

 TRAP B 3000M


 Do you want a different header (Yes/No) [N] ? N


 System status:

  09/24/2019 11:25:50   21.5 Vb    21 øC  aligned


Caution:  Deployment will overwrite the

          EEPROM data backup cache.


 Proceed with the deployment (Yes/No) [N] ? Y


  >>> Remove communication cable and <<<

       >>> attach dummy plug. <<<

 >>> Sediment trap is ready to deploy. <<<


<09/24/2019 11:25:57> Waiting for Event 01 of 22 @ 11/17/2019 12:00:00


 09/24/2019 11:25:59 Sleeping . . .
```

CTD; SBE 37 (s/n: 9388)

ds

SBE37SM-RS232 v4.1 SERIAL NO. 9388 09 Nov 2019 15:15:41

vMain = 13.36, vLith = 3.00

samplenumber = 1, free = 559239

not logging, waiting to start at 11 Nov 2019 00:00:00

sample interval = 3600 seconds

data format = converted engineering

output salinity

transmit real-time = yes

sync mode = no

pump installed = yes, minimum conductivity frequency = 3300.9

<Executed/>

Current Meter A; Nortek (s/n:AQD12123)

==

Deployment   : SOG_A

Current time : 09/11/2019 15:30:42

Start at   : 11/11/2019

Comment:

SOG_A CM under Trap A

Measurement interval (s) : 3600

Average interval   (s) : 60

Blanking distance   (m) : 0.50

Measurement load   (%) : 4

Power level   : HIGH

Diagnostics interval(min) : 720:00

Diagnostics samples : 20

Compass upd. rate (s) : 1

Coordinate System : ENU

Speed of sound (m/s) : MEASURED

Salinity (ppt) : 35

Analog input 1 : NONE

Analog input 2 : NONE

Analog input power out : DISABLED

Raw magnetometer out : OFF

File wrapping : OFF

TellTale : OFF

AcousticModem : OFF

Serial output : OFF

Baud rate : 9600

Assumed duration (days) : 550.0

Battery utilization (%) : 59.0

Battery level (V) : 13.8

Recorder size (MB) : 9

Recorder free space (MB) : 8.973

Memory required (MB) : 1.4

Vertical vel. prec (cm/s) : 1.4

Horizon. vel. prec (cm/s) : 0.9

Instrument ID : AQD12123

Head ID : A6L 6954

Firmware version : 3.37

Aquadopp Deep Water Version 1.40.16

Copyright (C) Nortek AS

Current Meter B; Nortek (s/n:AQD12033)

==

Deployment : SOG_B

Current time : 09/11/2019 15:23:51

Start at : 11/11/2019

Comment:

SOG_B CM under Trap B

Measurement interval (s) : 3600

Average interval (s) : 60

Blanking distance (m) : 0.50

Measurement load (%) : 4

Power level : HIGH

Diagnostics interval(min) : 720:00

Diagnostics samples : 20

Compass upd. rate (s) : 1

Coordinate System : ENU

Speed of sound (m/s) : MEASURED

Salinity (ppt) : 35

Analog input 1 : NONE

Analog input 2 : NONE

Analog input power out : DISABLED

Raw magnetometer out : OFF

File wrapping : OFF

TellTale : OFF

AcousticModem : OFF

Serial output : OFF

Baud rate : 9600

Assumed duration (days) : 550.0

Battery utilization (%) : 59.0

Battery level (V) : 13.8

Recorder size (MB) : 9

Recorder free space (MB) : 8.973

Memory required (MB) : 1.4

Vertical vel. prec (cm/s) : 1.4

Horizon. vel. prec (cm/s) : 0.9

Instrument ID : AQD12033

Head ID : A6L 6945

Firmware version : 3.37

Aquadopp Deep Water Version 1.40.16

Copyright (C) Nortek AS

AR861 acoustic release: s/n:1499

Arm: 09DA

Diagnostic: Arm & 0949

Release: Arm & 0955

Mooring Deployment Summary

Start time: 15:56 on 10th November 2019

Start position: 18° 33.14’S; 25° 06.40’W

Anchor drop: 18° 32.59’S; 25° 03.86’W

Time: 17:59

Depth: 5200m

The AR861 was ranged on while it was falling to the sea-bed and gave a descent rate of approximately 100m/min. At 18:48 a range of 5069m was received with successive ranges giving 5069m and 5070m. At 18:51 the mooring was deemed to be securely on the sea floor and the vessel departed the area.

Event log AMT29-DY110

Log of the sampling events happened during the cruise. This information is taken from the BRIDGE LOG and cruise annotations.

DATE	START TIME (GMT)	END TIME (GMT)	START LAT (+ve N)	START LON (+ve W)	STATION	EQUIPMENT	ACTIVITY/ COMMENTS
16/10/19	08:13	08:55	49° 2.891	6° 43.927	01 Shakedown	Stainless- steel frame Rosette (CTD)	CTD_001, Station Shakedown, Water depth = 130 m, Cast depth = 120 m, 16 bottles fired, mixed layer depth = 41 m.
16/10/19	13:20	13:55	48° 31.309	7° 12.224	02 (Shelf)	Stainless- steel frame Rosette (CTD)	CTD_002, Station on the shelf, Water depth = 156 m, Cast depth = 150 m, 24 bottles fired. All information as last cast
16/10/19	13:20	13:55	48° 31.309	7° 12.224	02 (Shelf)	Optics Rig	Depth could not be determined by the winch. Depth measured in function of speed. Time :4.37 minutes, Depth: 126 m
17/10/19	04:42	05:46	47° 14.604	9° 19.913	03	Stainless- steel frame Rosette (CTD)	CTD_003, Water depth = 4459 m, Cast depth = 500 m, 24 bottles fired. All information as last cast
17/10/19	12:15	-	46° 48.316	10° 18.273	-	Stainless- steel frame Rosette (CTD)/ optics rig	scheduled deployments canceled (sea state)
18/10/19	04:30	-	46° 30.588	12° 39.724	-	Stainless- steel frame Rosette (CTD)/ Nets	scheduled deployments canceled (sea state)
18/10/19	12:15	-	46° 09.924	13° 52.933	-	Optics Rig	scheduled deployment canceled (sea state)
18/10/19	12:30	14:21	46° 09.924	13° 52.933	04	Stainless- steel frame Rosette (CTD)	CTD_004, Water depth = 4786m, Cast depth = 2000 m, 24 bottles fired. O2

							min at 1000 m, O2 max at surface (70 m). All information as last cast
18/10/19	-	-	-	-	-	Dust collectors	They started to work after an update of the software.

19/10/19	04:34	05:36	44° 44.635	16° 10.06	05	Stainless-steel frame Rosette (CTD)	CTD_005, Water depth = 3077m, Cast depth = 500 m, 24 bottles fired. DCM at 55 m. All information as last cast./ scheduled net deployment canceled (sea state)
19/10/19	12:30	14:21	43° 54.850	17° 08.870	06	Stainless-steel frame Rosette (CTD)	CTD_006, Water depth = 3876 m , Cast depth = 2000 m, 24 bottles fired. Backscatter sensor was changed, new serial number BBRTD – 5466. Optics rig deployments cancelled.
20/10/19	04:36	05:35	42° 14.509	19° 11.766	07	Stainless-steel frame Rosette (CTD)	CTD_007, Water depth = 4300 m, Cast depth = 500 m, 24 bottles fired. All information as last cast./ scheduled net deployment canceled (sea state)
20/10/19	12:24	14:02	41° 27.928	20° 11.317	08	Stainless-steel frame Rosette (CTD)	CTD_008, Water depth = 2866 m , Cast depth = 2000 m, 24 bottles fired.
20/10/19	12:24	13:10	41° 27.928	20° 11.317	08	Optics Rig	
21/10/19	04:30	05:28	40° 10.670	21° 55.778	09	Stainless-steel frame Rosette (CTD)	CTD_009, Water depth = 4437 m , Cast depth = 500 m, 24 bottles fired. No sampling board picture.
21/10/19	04:39	05:02	40° 10.670	21° 55.778	09	Bongo Nets	First time deployment. Vertical deployment. Size

							of net 200 µm.
22/10/19	08:00	16:39	37^{o} 39.2557	25^{o} 39.073	-	Underway system/Non-Toxic	Non-Toxic was off while in Azores.
23/10/19	04:23	04:44	35^{o} 55.370	26^{o} 52.756	10	Bongo Nets	Second station.
23/10/19	04:38	5:36	35^{o} 55.370	26^{o} 52.756	10	Stainless-steel frame Rosette (CTD)	CTD_010, Water depth = 3770 m , Cast depth = 500 m, 24 bottles fired.
23/10/19	12:24	14:03	35^{o} 05.480	27^{o} 37.480	11	Stainless-steel frame Rosette (CTD)	CTD_011, Water depth = 2591 m , Cast depth = 2000 m, 24 bottles fired.
23/10/19			35^{o} 05.480	27^{o} 37.480	11	Optics Rig	
23/10/19					11	Atmospheric Balloon	First time deployment
24/10/19	05:34	06:38	33^{o} 10.710	29^{o} 20.090	12	Stainless-steel frame Rosette (CTD)	CTD_012, Water depth = 3770 m , Cast depth = 500 m, 24 bottles fired.
21/10/19	04:39	05:02	33^{o} 10.710	29^{o} 20.090	12	Bongo Nets	second deployment. Vertical deployment. Size of net 200 µm.
24/10/19	13:18	14:59	32^{o} 24.116	30^{o} 01.426	13	Stainless-steel frame Rosette (CTD)	CTD_013, Water depth = 3491 m , Cast depth = 2000 m, 24 bottles fired.
24/10/19			32^{o} 24.116	30^{o} 01.426	13	Atmospheric Balloon	
24/10/19	13:21	14:00	32^{o} 24.116	30^{o} 01.426	13	Optics Rig	
25/10/19	04:30	-			-	Stainless-steel frame Rosette (CTD)/ Nets	scheduled deployments canceled (sea state)
25/10/19	13:30	15:18	30^{o} 16.060	31^{o} 51.640	14	Stainless-steel frame Rosette (CTD)	CTD_014, Water depth = 4257 m , Cast depth = 2000 m, 24 bottles fired. The last 5 bottles were fired on the fly.
25/10/19			30^{o} 16.060	31^{o} 51.640	14	Atmospheric Balloon	
25/10/19	-	-	30^{o} 16.060	31^{o} 51.640	14	Optics Rig	scheduled deployment canceled (sea state)
26/10/19	05:33	06:34	28^{o} 45.662	33^{o} 01.776	15	Stainless-steel frame Rosette (CTD)	CTD_015, Water depth = 4708 m , Cast depth = 500 m, 24 bottles fired.
26/10/19	-	-	28^{o} 45.662	33^{o} 01.776	15	Bongo Nets	scheduled deployment canceled (sea state)

26/10/19	13:27		27^{o} 57.2530	33^{o} 41.081	16	Stainless-steel frame Rosette (CTD)	CTD_016, Water depth = 4923 m , Cast depth = 2000 m, 15 bottles fired, 6 bottles remained open. Problems with confirmation of bottles fired. See CTD log sheet and sampling board pictures
26/10/19	13:30	14:10	27^{o} 57.2530	33^{o} 41.081	16	Optics Rig	
26/10/19	13:20		27^{o} 57.2530	33^{o} 41.081	16	Atmospheric Balloon	
27/10/19	05:31	06:30	26^{o} 08.400	35^{o} 11.690	17	Stainless-steel frame Rosette (CTD)	CTD_017, Water depth = 5484 m, Cast depth = 500 m, 24 bottles.
27/10/19	05:29	05:46	26^{o} 08.400	35^{o} 11.690	17	Bongo Nets	.
27/10/19	06:35		26^{o} 08.400	35^{o} 11.690	17	Core-Argo Float (8573)	Deployment of the first core-Argo float.
27/10/19	13:17	14:49	25^{o} 18.039	35^{o} 54.262	18	Stainless-steel frame Rosette (CTD)	CTD_018, Water depth = 5084 m , Cast depth = 2000 m, 24 bottles fired. Fluorometer fault at 800 m on upcast only
27/10/19	13:19	14:00	25^{o} 18.039	35^{o} 54.262	18	Optics Rig	
27/10/19	13:20		25^{o} 18.039	35^{o} 54.262	18	Atmospheric Balloon	
28/10/19	05:29	06:25	23^{o} 25.148	37^{o} 31.895	19	Stainless-steel frame Rosette (CTD)	CTD_019, Water depth = 5685 m , Cast depth = 500 m, 24 bottles fired.
28/10/19	05:22	05:44	23^{o} 25.148	37^{o} 31.895	19	Bongo Nets	
28/10/19	13:22	14:54	22^{o} 35.259	37^{o} 41.962	20	Stainless-steel frame Rosette (CTD)	CTD_020, Water depth = 6401 m , Cast depth = 2000 m, 24 bottles fired. Fluorometer fault again at 750 m on upcast only
28/10/19	-	-	22^{o} 35.259	37^{o} 41.962	20	Optics Rig	Scheduled deployment canceled (the cable used in the flow control was flooded in the previous cast. It has been repair by Andy.
28/10/19	13:30		22^{o} 35.259	37^{o} 41.962	20	Atmospheric Balloon	
29/10/19	04:30	-	-	-	-	Stainless-steel frame Rosette	scheduled deployments canceled

						(CTD)/ Nets	
29/10/19	13:23	14:58	19^o 47.920	34^o 46.656	21	Stainless-steel frame Rosette (CTD)	CTD_021, Water depth = 5267 m , Cast depth = 2000 m, 24 bottles fired. Fluorometer was changed (serial number 88-2615-126). John realized that the configuration file for the fluorometer was wrong for the station 1 to 20, He used the file for the instrument with serial number 88-2615-126) rather that serial number 88-2960-163. Data for those stations must be reprocessed again for fluorescence.
29/10/19	-	-	19^o 47.920	34^o 46.656	21	Optics Rig	Scheduled deployment was aborted (the winch did not work).
29/10/19	13:30		19^o 47.920	34^o 46.656	21	Atmospheric Balloon	
30/10/19	05:28	06:17	18^o 03.412	32^o 58.394	22	Stainless-steel frame Rosette (CTD)	CTD_022, Water depth = 5045 m , Cast depth = 500 m, 24 bottles fired.
30/10/19	05:24	05:51	18^o 03.412	32^o 58.394	22	Bongo Nets	
30/10/19	13:18	14:49	17^o 16.736	32^o 09.071	23	Stainless-steel frame Rosette (CTD)	CTD_023, Water depth = 4921 m , Cast depth = 2000 m, 24 bottles fired.
30/10/19	13:19	14:00	17^o 16.736	32^o 09.071	23	Optics Rig	
30/10/19	13:30		17^o 16.736	32^o 09.071	23	Atmospheric Balloon	
30/10/19	13:30		17^o 16.736	32^o 09.071	23	Radiometers	The radiometers located at the Met platform were cover with dust, probably from Sahara/Sahel Region.
31/10/19	05:25	06:16	15^o 35.455	30^o 25.580	24	Stainless-steel frame Rosette (CTD)	CTD_024, Water depth = 5375 m , Cast depth = 500 m, 24 bottles fired.

31/10/19	05:24	05:46	15^{o} 35.455	30^{o} 25.580	24	Bongo Nets	
31/10/19	13:20	14:54	14^{o} 44.299	29^{o} 41.062	25	Stainless-steel frame Rosette (CTD)	CTD_025, Water depth = 5424 m , Cast depth = 2000 m, 24 bottles fired.
31/10/19	13:30	14:40	14^{o} 44.299	29^{o} 41.062	25	Optics Rig	Two casts, the first one was suspended because the winch was not working properly
30/10/19	13:30		14^{o} 44.299	29^{o} 41.062	25	Atmospheric Balloon	
01/11/19	05:26	06:19	12^{o} 44.620	28^{o} 30.090	26	Stainless-steel frame Rosette (CTD)	CTD_026, Water depth = 5467 m , Cast depth = 500 m, 24 bottles fired.
01/11/19	05:27	05:52	12^{o} 44.620	28^{o} 30.090	26	Bongo Nets	
01/10/19	13:19	14:57	11^{o} 50.693	27^{o} 57.649	27	Stainless-steel frame Rosette (CTD)	CTD_027, Water depth = 5598 m , Cast depth = 2000 m, 22 bottles fired. Bottles 14 and 16 did not close.
31/10/19	13:20	14:00	11^{o} 50.693	27^{o} 57.649	27	Optics Rig	
30/10/19	13:30		11^{o} 50.693	27^{o} 57.649	27	Atmospheric Balloon	
02/11/19	05:24	06:15	09^{o} 53.018	26^{o} 47.620	28	Stainless-steel frame Rosette (CTD)	CTD_028, Water depth = 5498 m , Cast depth = 500 m, 24 bottles fired.
02/11/19	05:21	05:44	09^{o} 53.018	26^{o} 47.620	28	Bongo Nets	
02/11/19	13:23	14:55	08^{o} 53.500	26^{o} 11.970	29	Stainless-steel frame Rosette (CTD)	CTD_029, Water depth = 4988 m , Cast depth = 2000 m, 23 bottles fired. Bottle 14 did not close.
02/11/19	13:40	14:20	08^{o} 53.500	26^{o} 11.970	29	Optics Rig	
02/11/19	13:50		08^{o} 53.500	26^{o} 11.970	29	Atmospheric Balloon	
03/11/19	05:26	06:16	06^{o} 44.970	24^{o} 59.969	30	Stainless-steel frame Rosette (CTD)	CTD_030, Water depth = 4415 m , Cast depth = 500 m, 24 bottles fired.
03/11/19	05:23	05:45	06^{o} 44.970	24^{o} 59.969	30	Bongo Nets	
03/11/19	13:13	14:45	05^{o} 31.302	25^{o} 00.108	31	Stainless-steel frame Rosette (CTD)	CTD_031, Water depth = 4088 m , Cast depth = 2000 m, 24 bottles fired
03/11/19	13:20	14:15	05^{o} 31.302	25^{o} 00.108	31	Optics Rig	
03/11/19	13:50		05^{o} 31.302	25^{o} 00.108	31	Atmospheric Balloon	
04/11/19	05:24	06:12	02^{o} 52.747	24^{o} 59.677	32	Stainless-steel frame Rosette (CTD)	CTD_032, Water depth = 4276 m , Cast depth = 500

							m, 24 bottles fired.
04/11/19	05:20	05:43	02° 52.747	24° 59.677	32	Bongo Nets	
04/11/19	13:16	14:46	01° 40.604	25° 00.528	33	Stainless-steel frame Rosette (CTD)	CTD_031, Water depth = 3837 m , Cast depth = 2000 m, 24 bottles fired
04/11/19	13:30	14:15	01° 40.604	25° 00.528	33	Optics Rig	
04/11/19	13:45		01° 40.604	25° 00.528	33	Atmospheric Balloon	
05/11/19	04:28	06:23	0° 34.810 S	24° 59.918	34	Stainless-steel frame Rosette (CTD)	CTD_034, Water depth = 3015 m , Cast depth = 2000 m, 24 bottles fired.
05/11/19	04:26	04:46	0° 34.810 S	24° 59.918	34	Bongo Nets	
05/11/19	13:00		1° 42.065 S	25° 00.00	35	Deep-Argo Float (12012)	Deployment of the first deep-Argo float.
06/11/19	05:25	06:18	04° 18.025 S	24° 59.930	36	Stainless-steel frame Rosette (CTD)	CTD_035, Water depth = 5035.6 m , Cast depth = 500 m, 24 bottles fired.
06/11/19	05:23	05:45	04° 18.025 S	24° 59.930	36	Bongo Nets	
06/11/19	11:08	14:29	05° 02.617 S	25° 00.090	37	Stainless-steel frame Rosette (CTD)	CTD_036, Water depth = 5576 m, Cast depth = 5000 m, 22 bottles fired. Bottles 12 and 16 were removed from the rosette to allocate the acoustics releasers.
06/11/19	13:15	13:50	05° 02.617 S	25° 00.090	37	Optics Rig	
06/11/19	13:25		05° 02.617 S	25° 00.090	37	Atmospheric Balloon	
06/11/19	20:36		05° 59.845 S	25° 00.103	38	Deep-Argo Float (12030)	Deployment of the second deep-Argo float.
07/11/19	05:23	06:41	07° 23.670 S	25° 0.491	39	Stainless-steel frame Rosette (CTD)	CTD_037, Water depth = 5665 m , Cast depth = 500 m, 24 bottles fired. The rosette was to 1000 m depth for winch wire crossover rectification
07/11/19					39	Bongo Nets	Scheduled deployment was aborted
07/11/19	13:22	14:54	08° 24.340 S	24° 59.00	40	Stainless-steel frame Rosette (CTD)	CTD_038, Water depth = 5693 m, Cast depth = 2000 m, 24 bottles fired.
07/11/19	13:20	14:00	08° 24.340 S	24° 59.00	40	Optics Rig	
07/11/19	13:35		08° 24.340 S	24° 59.00	40	Atmospheric Balloon	

07/11/19	20:57		09° 21.881 S	24° 59.973	41	Deep-Argo Float (12015)	Deployment of the third deep-Argo float.
08/11/19	05:02	06:02	10° 40.088 S	25° 0.470	42	Stainless-steel frame Rosette (CTD)	CTD_039, Water depth = 5035 m , Cast depth = 500 m, 24 bottles fired.
08/11/19	05:00	05:25	10° 40.088 S	25° 0.470	42	Bongo Nets	
08/11/19	13:18	14:55	11° 52.920 S	25° 0.460	43	Stainless-steel frame Rosette (CTD)	CTD_038, Water depth = 5801 m, Cast depth = 2000 m, 24 bottles fired.
08/11/19	13:30	14:10	11° 52.920 S	25° 0.460	43	Optics Rig	
08/11/19	13:35		11° 52.920 S	25° 0.460	43	Atmospheric Balloon	
09/11/19	04:59	06:06	14° 16.288 S	24° 59.651	44	Stainless-steel frame Rosette (CTD)	CTD_041, Water depth = 4835 m , Cast depth = 500 m, 24 bottles fired.
09/11/19	04:58	05:20	14° 16.288 S	24° 59.651	44	Bongo Nets	
09/11/19	06:20		14° 16.288 S	24° 59.651	44	Deep-Argo Float (12032)	Deployment of the third deep-Argo float.
09/11/19	13:19	14:51	15° 26.552 S	25° 0.200	45	Stainless-steel frame Rosette (CTD)	CTD_042, Water depth = 5100 m, Cast depth = 2000 m, 24 bottles fired.
08/11/19	13:20	14:00	15° 26.552 S	25° 0.200	45	Optics Rig	
08/11/19	13:35		15° 26.552 S	25° 0.200	45	Atmospheric Balloon	
10/11/19	10:00	18:00	18° 32.584 S	25° 3.807	46	Sediment Traps	Recovery and deployment of sediment traps
11/11/19	04:56	06:00	20° 14.780 S	24° 59.740	47	Stainless-steel frame Rosette (CTD)	CTD_043, Water depth = 5179 m , Cast depth = 500 m, 24 bottles fired.
11/11/19	04:56	05:17	20° 14.780 S	24° 59.740	47	Bongo Nets	
11/11/19	06:10		20° 14.780 S	24° 59.740	47	Core-Argo Float (8475)	Deployment of the second core-Argo float.
11/11/19	13:16	14:48	21° 26.246 S	24° 50.247	48	Stainless-steel frame Rosette (CTD)	CTD_044, Water depth = 5196 m, Cast depth = 2000 m, 24 bottles fired.
11/11/19	13:25	14:05	21° 26.246 S	24° 50.247	48	Optics Rig	
11/11/19	13:40		21° 26.246 S	24° 50.247	48	Atmospheric Balloon	
11/11/19	18:06		21° 43.574 S	24° 55.555	49	Deep-Argo Float (12013)	Deployment of the fourth deep-Argo float.
12/11/19	04:27	05:41	23° 43.547 S	24° 55.250	50	Stainless-steel frame Rosette (CTD)	CTD_045, Water depth = 5217 m , Cast depth = 500 m, 24 bottles fired.

12/11/19	04:22	04:43	23° 43.547 S	24° 55.250	50	Bongo Nets	
12/11/19	05:55		23° 43.547 S	24° 55.250	50	Core-Argo Float (8476)	Deployment of the third core-Argo float.
12/11/19	12:14	13:59	24° 44.102 S	25° 12.281	51	Stainless-steel frame Rosette (CTD)	CTD_046, Water depth = 5074 m, Cast depth = 2000 m, 24 bottles fired.
12/11/19	12:20	13:00	24° 44.102 S	25° 12.281	51	Optics Rig	
12/11/19	13:40		24° 44.102 S	25° 12.281	51	Atmospheric Balloon	
12/11/19	04:24	05:22	26° 45.731 S	25° 48.406	52	Stainless-steel frame Rosette (CTD)	CTD_047, Water depth = 5130 m , Cast depth = 500 m, 23 bottles fired. Bottle 22 did not close.
12/11/19			26° 45.731 S	25° 48.406	52	Bongo Nets	Scheduled deployment was aborted
13/11/19	12:19	13:24	27° 42.528 S	26° 05.105	53	Stainless-steel frame Rosette (CTD)	CTD_048, Water depth = 4500 m, Cast depth = 1000 m, 24 bottles fired.
13/11/19	12:15	13:00	27° 42.528 S	26° 05.105	53	Optics Rig	
13/11/19	13:40		27° 42.528 S	26° 05.105	53	Atmospheric Balloon	
14/11/19	04:26	05:07	30° 1.618 S	26° 47.128	54	Stainless-steel frame Rosette (CTD)	CTD_049, Water depth = 4928 m, Cast depth = 250 m, 24 bottles fired.
14/11/19	04:26	04:44	30° 1.618 S	26° 47.128	54	Bongo Nets	Scheduled deployment was aborted
14/11/19	12:56	13:59	31° 12.706 S	27° 9.0108	55	Stainless-steel frame Rosette (CTD)	CTD_050, Water depth = 3005 m, Cast depth = 1000 m, 22 Bottles 22 and 15 did not close.
14/11/19	12:55	13:59	31° 12.706 S	27° 9.0108	55	Optics Rig	
14/11/19	13:10		31° 12.706 S	27° 9.0108	55	Atmospheric Balloon	
15/11/19	04:36	05:20	33° 35.932 S	27° 53.440	56	Stainless-steel frame Rosette (CTD)	CTD_051, Water depth = 4516 m, Cast depth = 250 m, 24 bottles fired.
14/11/19	04:35	04:59	33° 35.932 S	27° 53.440	56	Bongo Nets	
15/11/19	12:56	13:57	34° 46.624 S	28° 15.124	57	Stainless-steel frame Rosette (CTD)	CTD_052, Water depth = 4100 m, Cast depth = 1000 m, 24 bottles fired.
14/11/19	12:50	13:30	34° 46.624 S	28° 15.124	57	Optics Rig	
14/11/19	13:15		34° 46.624 S	28° 15.124	57	Atmospheric Balloon	
16/11/19	04:38	05:30	37° 4.897 S	29° 1.019	58	Stainless-steel frame	CTD_053, Water depth = 4481 m,

						Rosette (CTD)	Cast depth = 500 m, 24 bottles fired.
16/11/19			37° 4.897 S	29° 1.019	58	Bongo Nets	Scheduled deployment was aborted
16/11/19	05:40		37° 4.897 S	29° 1.019	58	Core-Argo Float (8577)	Deployment of the fourth core-Argo float.
16/11/19	13:15				59	Atmospheric Balloon	
17/11/19	04:05	05:25	40° 21.334 S	31° 2.357	60	Stainless-steel frame Rosette (CTD)	CTD_054, Water depth = 4542 m, Cast depth = 1000 m, 24 bottles fired.
17/11/19			40° 21.334 S	31° 2.357	60	Bongo Nets	Scheduled deployment was aborted
17/11/19	13:15				61	Atmospheric Balloon	
18/11/19	03:38	06:06	41° 54.087 S	35° 25.858	62	Stainless-steel frame Rosette (CTD)	CTD_055, Water depth = 5050 m, Cast depth = 2000 m, 24 bottles fired. Clam Problem. Stopped at 400m. Restarted at 05:42.
18/11/19	3:38	3:42	41° 54.087 S	35° 25.858	62	Bongo Nets	
18/11/19	04:10	04:50	41° 54.087 S	35° 25.858	62	Optics Rig	
18/11/19	06:15		41° 54.087 S	35° 25.858	62	Core-Argo Float (8578)	Deployment of the fifth core-Argo float.
18/11/19	12:50		41° 58.546 S	36° 50.799	63	Atmospheric Balloon	
19/11/19	12:50				64	Atmospheric Balloon	
20/11/19	12:50				65	Atmospheric Balloon	
21/11/19	18:00		41° 2.7897 S	52° 23.440	66	Core-Argo Float (8477)	Deployment of the sixth core-Argo float.