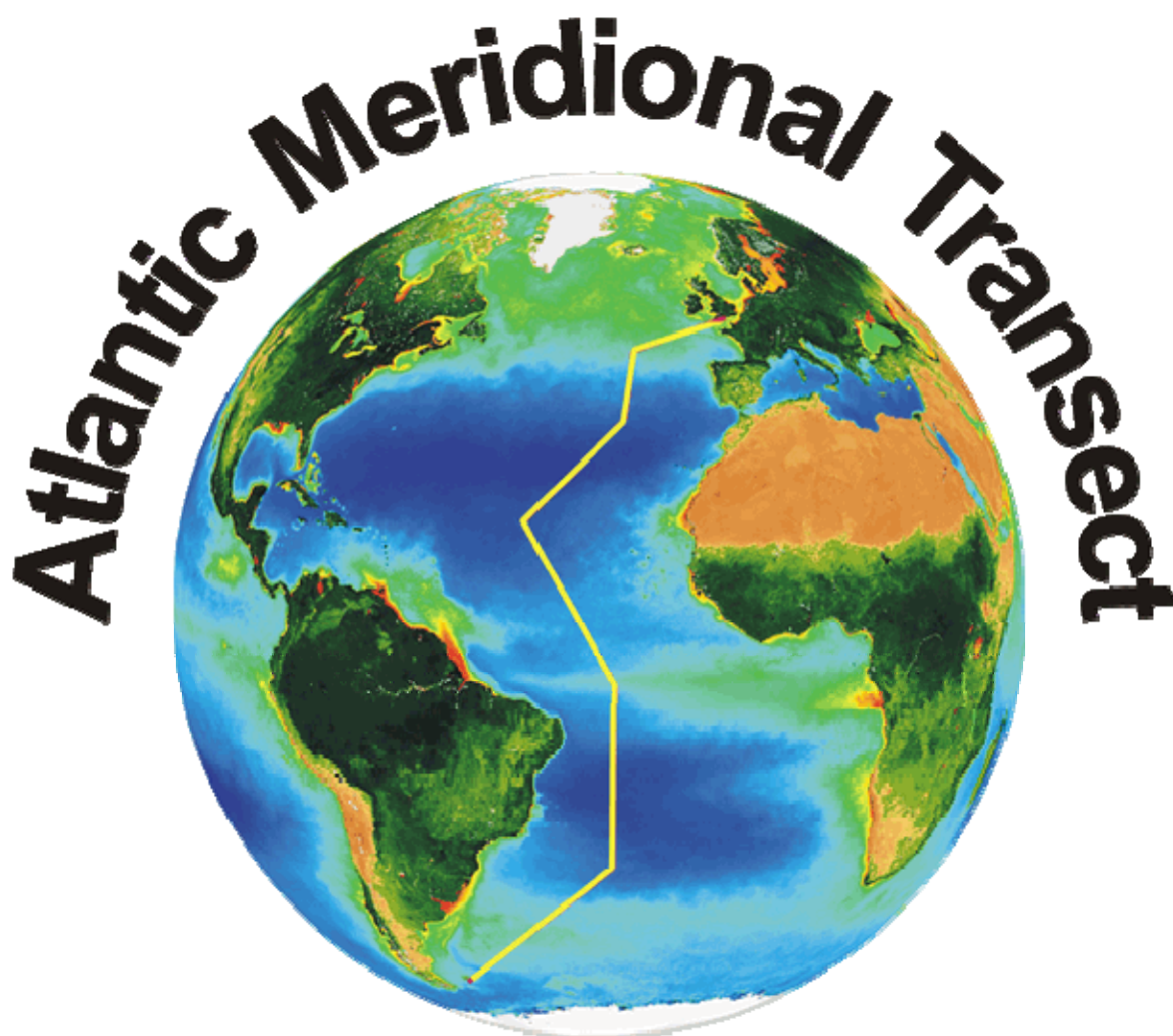


AMT20 Cruise Report



RRS James Cook JC053

(12 October – 25 November 2010)

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Laboratory



**National
Oceanography Centre**

NATURAL ENVIRONMENT RESEARCH COUNCIL

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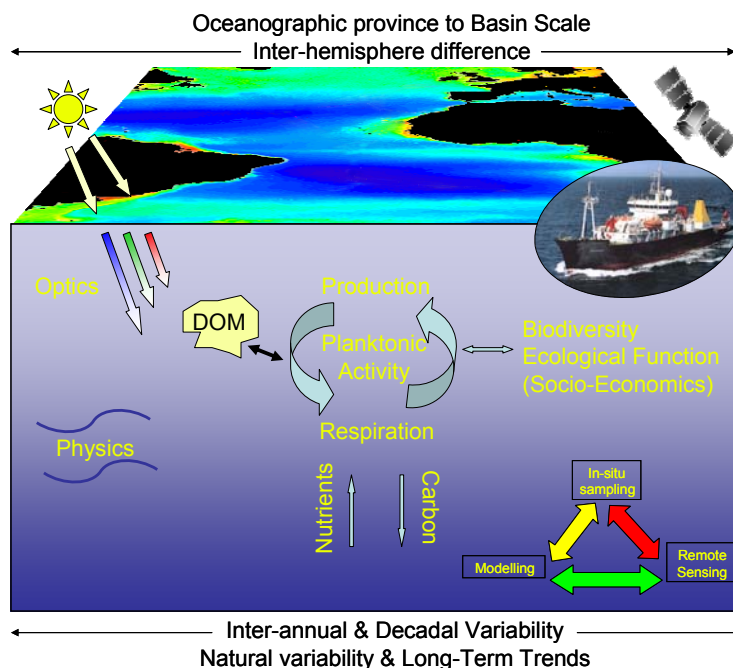
The Atlantic Meridional Transect programme

The Atlantic Meridional Transect – AMT (www.pml.ac.uk/amt) is a multidisciplinary programme which undertakes biological, chemical and physical oceanographic research during an annual voyage between the UK and destinations in the South Atlantic - previously the Falkland Islands and South Africa, and for this cruise Punta Arenas Chile. This transect crosses a range of ecosystems from sub-polar to tropical and from euphotic shelf seas and upwelling systems to oligotrophic mid-ocean gyres.

The programme was established in 1995 and this was the 19th in the series of research cruises which have involved over 200 scientists from 11 countries. AMT has proved to be a long-term multidisciplinary ocean observation programme, which is a platform for national and international scientific collaboration, a training arena for the next generation of oceanographers and an ideal facility for validation of novel technology. AMT continues to contribute to science and policy development including the social and economic understanding of the marine environment and services it delivers.

The main deliverable of AMT is an unique time series (1995-2012) 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. Data sets include:

- Vertical CTD profiles and continuous underway data
- Optical characteristics of the water column
- Biogeochemical measurements on water samples including nutrients, pigments, dissolved gases and particulate carbon and nitrogen
- Primary, new production and respiration measurements



Data sets from 1995-2005 are publicly available, with CTD profiles and underway surface time series available online at: www.bodc.ac.uk/projects/uk/amt/. The remaining AMT data sets are available on request to BODC. The Oceans 2025 data policy has been designed to make the data from 2007 onwards available to the Oceans 2025 community 1 year after a cruise and then, after 2 years to the wider scientific community.

Acknowledgements

Once again the “gods” set out to try us with a seemingly never-ending list of trials for us to overcome, but once again the professionalism of the team on board RRS James Cook and on shore ensured successful completion of AMT-20. Diversions into the Azores and to Ascension Island were required which, together with several complications with the ships winch system resulted in a slightly revised cruise track to that originally anticipated. Peter Sarjeant and his officers and crew were resilient in their approach and provided a first class service and I would like to thank them all for the efforts that they put in. Between the NMF-SS technicians and the scientific party there were representatives of 12 different nations which proved to provide a diverse but productive environment with which to deliver our scientific objectives. For me the Kiwi-German interactions everyday at 0400 and the Italian directed crossing the line show were amongst the highlights. Our shore based support included regular updates on oceanographic conditions from the remote sensing team at NEODAAS which provided great insight and context to what we were doing on the ship. Ella Darlington from Education through Expeditions and Rob Thomas from BODC joined us on this cruise and took a huge amount of the pressure from my job in meticulously managing sensor calibrations, log keeping and outreach exercises, which enabled me the luxury of having some of my own science time, for which both are welcome to come again whenever they may wish.

Last and certainly not least, Chris Wing cracked the whip and provided the organisational expertise in getting the scientific party onto the ship and home again, has edited this cruise report and helped me in all other aspects of running the AMT programme for which I am very, very grateful.



Cruise Timetable of events JCO53

RStart		End		Comment
Date	Time	Date	Time	Ship's Time tabulated: +1.0 on UTC departure Southampton; -3.0 on UTC by arrival Punta Arenas
09/10/2010	08:00	09/10/2010	18:00	Mobilising for JC053 @ Southampton; scientific party join v/l
09/10/2010	18:00	10/10/2010	08:00	Port time
10/10/2010	08:00	10/10/2010	18:00	Mobilisation continues
10/10/2010	18:00	11/10/2010	08:00	Port time
11/10/2010	08:00	11/10/2010	18:00	Mobilisation continues; Scientific/Technical Safety Briefing & familiarisation tour from 1500hrs
11/10/2010	18:00	12/10/2010	09:18	Port time
12/10/2010	09:18	12/10/2010	10:48	Stand-by Soton Water & W Solent;
12/10/2010	10:48	12/10/2010	16:36	Compass swing & Azi Thruster trials; Emergency & Lifeboat muster stations @ 1610 hrs
12/10/2010	16:36	12/10/2010	17:48	Stand-by period; Clearing W. Solent via Needles Channel
12/10/2010	17:48	12/10/2010	23:59	Channel passage to Start Pt brng 285 deg x 10.6 nm
12/10/2010	23:59	13/10/2010	12:00	Passage to 49 42.7N 006 41.1W; Start-of-cruise meeting @ 0830 hrs; #4 genny load trials in progress from 0900 hrs
13/10/2010	12:00	13/10/2010	15:30	Passage to 49 40.4N 007 38.1W; #4 genny trials completed @ 1440 hrs; commence equipment shakedown deployments
13/10/2010	15:30	13/10/2010	16:30	Stn 1; 49 40.37N 007 41.09W; CTD & Overside Floating Pump (OFP) trial dips
13/10/2010	16:30	13/10/2010	23:59	Passage to 49 30.9N 009 40.4W
13/10/2010	23:59	14/10/2010	04:20	Passage to 49 24.35N 011 09.88W; Clocks retarded 1 hour @ 0200 to UTC
14/10/2010	04:20	14/10/2010	06:20	Stn 2; 49 24.35N 011 09.88W; Events (Es) 2,3,4,5,6: CTD(T); Bongo Nets x3; CTD(S)
14/10/2010	06:20	14/10/2010	12:59	Scientific processing in transit to Stn 3
14/10/2010	12:59	14/10/2010	15:28	Stn 3; 49 16.19N 012 53.04W to 49 16.50N 012 53.04W; Es 7,8,9,10,11,12,13; CTD(S); Optics Rig x2; OFP; 11m Net x3
14/10/2010	15:28	14/10/2010	23:59	Scientific processing in transit; V/l to 49 05.8N 015 16.1W
14/10/2010	23:59	15/10/2010	04:30	Scientific processing in transit to Stn 4
15/10/2010	04:30	15/10/2010	06:30	Stn 4; 49 02.18N 016 25.87W to 49 03.41N 016 25.56W; Es 14,15,16,17,18; CTD(T); Bongo Nest x2; CTD(S); Bongo Net
15/10/2010	06:30	15/10/2010	13:02	Scientific processing in transit to Stn 5; Safety Committee Meeting conducted @ 1030hrs
15/10/2010	13:02	15/10/2010	15:00	Stn 5; 48 06.98N 017 19.46W to 48 07.52N 017 19.52W; Es 19,20,21,22,23,24; CTD(S); Optics x2; 11m Net x2; Towed Net
15/10/2010	15:00	15/10/2010	23:59	Scientific processing in transit; V/l to 46 44.5N 018 33.1W
15/10/2010	23:59	16/10/2010	04:20	Scientific processing in transit to Stn 6
16/10/2010	04:20	16/10/2010	06:30	Stn 6; 46 03.37N 019 11.46W to 46 03.41N 019 12.12W; Es 25,26,27,28,29; Bongo Net; CTD(S); Bongo Net x2; CTD(S)

RStart		End		Comment
16/10/2010	06:30	16/10/2010	12:58	Scientific processing in transit to Stn 7
16/10/2010	12:58	16/10/2010	15:03	Stn 7; 45 11.81N 019 56.02W to 45 12.07N 019 55.76W; Es 30,31,32,33,34,35; CTD(S); Optics x2; 11m Net x2; Towed Net
16/10/2010	15:03	16/10/2010	23:59	Scientific processing in transit; V/I to 44 05.0N 020 54.9W
16/10/2010	23:59	17/10/2010	04:17	Scientific processing in transit to Stn 8
17/10/2010	04:17	17/10/2010	06:46	Stn 8; 43 32.97N 021 21.85W; Es 36,37,38,39,40,41; CTD(T); Bongo Net x4; CTD(S)
17/10/2010	06:46	17/10/2010	13:02	Scientific processing in transit to Stn 9
17/10/2010	13:02	17/10/2010	15:11	Stn 9; 42 46.02N 022 02.07W to 42 46.80N 022 02.57W; Es 42,43,44,45,46,47; CTD(S); Optics x2; 11m Net x2; Towed Net
17/10/2010	15:11	17/10/2010	23:59	Scientific processing in transit; V/I to 41 37.0N 022 58.0W
17/10/2010	23:59	18/10/2010	04:25	Scientific processing in transit to Stn 10
18/10/2010	04:25	18/10/2010	06:50	Stn 10; 40 59.65N 023 28.76W to 40 59.90N 023 28.6W; Es 48,49,50,51,52,53; CTD(T); Bongo Net x3; CTD(S); Towed Net
18/10/2010	06:50	18/10/2010	13:01	Scientific processing in transit to Stn 11; Emergency exercise & safety quiz conducted @ 1030 hrs
18/10/2010	13:01	18/10/2010	15:07	Stn 11; 40 07.59N 024 11.57W to 40 07.93N 024 11.44W; Es 54,55,56,57,58,59; CTD(S); Optics x2; 11m Net x2; Towed Net
18/10/2010	15:07	18/10/2010	23:59	Scientific processing in transit; V/I to 38 53.0N 025 11.2W
18/10/2010	23:59	19/10/2010	04:20	Scientific processing in transit to Stn 12
19/10/2010	04:20	19/10/2010	07:00	Stn 12; 38 16.88N 025 38.74W; Es 60,61,62,63,64,65; CTD(T); Bongo Net x4; CTD(S)
19/10/2010	07:00	19/10/2010	12:00	Scientific processing in transit; V/I noon position 37 41.7N 025 43.4W
19/10/2010	12:00	19/10/2010	13:36	Approaching Ponta Delgada; critical instrument tests; awaiting pilot; B'water brng 318 deg x 1.86 nm @ 1336 hrs
19/10/2010	13:36	19/10/2010	14:15	Pilotage to berth, Ponta Delgada
19/10/2010	14:15	19/10/2010	19:51	Taking fresh water and receiving spares
19/10/2010	19:51	19/10/2010	20:18	Berth to Full away, resuming passage
19/10/2010	20:18	19/10/2010	23:59	Passage to 37 11.7N 026 17.5W; Invalid Dip Clear prevents resumption of science
19/10/2010	23:59	20/10/2010	12:00	Passage to 35 20.0N 028 29.0W; Clocks retarded 1 hr to UTC -1 @ 0200hrs
20/10/2010	12:00	20/10/2010	15:18	Passage to Stn 13; v/I clearing into International Waters, 35 00N 028 52W, @ 1420 hrs (Ship's time)
20/10/2010	15:18	20/10/2010	16:38	Stn 13; 34 56.39N 028 56.62W; Events #s 66,67,68,69,70; CTD(S), Optics x2; Plankton Net x2
20/10/2010	16:38	20/10/2010	23:59	Scientific processing in transit; V/I passage to 34 28.8N 029 27.5W
20/10/2010	23:59	21/10/2010	04:23	Scientific processing in transit to Stn 14
21/10/2010	04:23	21/10/2010	06:25	Stn 14; 34 13.09N 029 45.70W to 34 12.59N 029 44.57W; Es 71,72,73,74,75; CTD(T); Bongo Nets x 4
21/10/2010	06:25	21/10/2010	12:58	Scientific processing in transit to Stn 15
21/10/2010	12:58	21/10/2010	15:05	Stn 15; 33 50.55N 030 12.21W to 33 50.76N 030 12.11W; Es 76,77,78,79,80,81,82; CTD(S); Optics x2; 11m Net x3; Towed Net

21/10/2010	15:05	21/10/2010	23:59	Scientific processing in transit; V/I to 32 54.2N 031 15.8W
RStart		End		Comment
21/10/2010	23:59	22/10/2010	04:27	Scientific processing in transit to Stn 16
22/10/2010	04:27	22/10/2010	06:44	Stn 16; 32 25.54N 031 48.01W to 32 25.79N 031 48.42W; Es 83,84,85,86,87; CTD(T); Bongo Nets x3; CTD(S)
22/10/2010	06:44	22/10/2010	13:03	Scientific processing in transit to Stn 17
22/10/2010	13:03	22/10/2010	15:05	Stn 17; 31 43.79N 032 33.76W to 31 43.99N 032 33.61W; Es 88,89,90,91,92,93; CTD(S); Optics x2; 11m Net x2; Towed Net
22/10/2010	15:05	22/10/2010	23:59	Scientific processing in transit; V/I to 30 45.4N 033 40.0W
22/10/2010	23:59	23/10/2010	04:25	Scientific processing in transit to Stn 18
23/10/2010	04:25	23/10/2010	06:45	Stn 18; 30 17.09N 034 10.74W to 30 18.12N 034 10.81W; Es 94,95,96,97,98,99,100; CTD(T); Bongo Nets x4; CTD(S); Towed Net
23/10/2010	06:45	23/10/2010	12:55	Scientific processing in transit to Stn 19; Survival suit demonstration & exercise
23/10/2010	12:55	23/10/2010	14:55	Stn 19; 29 36.60N 034 54.08W to 29 36.75N 034 53.82W; Es 101 to 107 incl; Bucket; CTD(S); Optics x2; 11m Net x2; Towed Net
23/10/2010	14:55	23/10/2010	23:59	Scientific processing in transit; V/I to 28 36.0N 036 00.0W; Sample review of Scientific RAs conducted
23/10/2010	23:59	24/10/2010	04:18	Scientific processing in transit to Stn 20
24/10/2010	04:18	24/10/2010	06:50	Stn 20; 28 06.73N 036 30.97W to 28 06.76N 036 30.49W; Es 108 to 112 incl; CTD(T); Bongo Nets x3; CTD(S)
24/10/2010	06:50	24/10/2010	12:59	Scientific processing in transit to Stn 21
24/10/2010	12:59	24/10/2010	15:15	Stn 21; 27 27.10N 037 14.00W to 27 27.19N 037 13.93W; Es 113 to 120 incl; CTD(S) x2; Optics x2; Bucket; 11m Net x2; Twd Net
24/10/2010	15:15	24/10/2010	23:59	Scientific processing in transit; V/I to 26 28.3N 038 16.6W
24/10/2010	23:59	25/10/2010	04:17	Scientific processing in transit to Stn 22
25/10/2010	04:17	25/10/2010	06:30	Stn 22; 25 59.01N 038 46.98W to 25 59.07N 038 47.00W; Es 121 to 126 incl; CTD(T); Bongo Nets x3; CTD(S); 4th Bongo Net
25/10/2010	06:30	25/10/2010	12:59	Scientific processing in transit to Stn 23
25/10/2010	12:59	25/10/2010	14:37	Stn 23; 25 16.19N 039 31.81W to 25 16.43N 039 31.61W; Es 127 to 131 incl; CTD(S); Optics; Bucket; Optics; Towed Net
25/10/2010	14:37	25/10/2010	23:59	Scientific processing in transit; V/I to 24 13.6N 040 37.0W
25/10/2010	23:59	26/10/2010	04:20	Scientific processing in transit to Stn 24
26/10/2010	04:20	26/10/2010	06:36	Stn 24; 23 46.26N 041 06.46W to 23 45.90N 041 06.44W; Es 132 to 136 incl; CTD(T); Bongo Nets x3; CTD(S)
26/10/2010	06:36	26/10/2010	12:58	Scientific processing in transit to Stn 25; Emergency exercise (Crew) & Security DVD (Sci/Techs) @ 1030hrs
26/10/2010	12:58	26/10/2010	15:01	Stn 25; 22 57.81N 040 31.92W to 22 57.71N 040 31.56W; Es 137 to 143 incl; CTD(S); Bucket; Optics x2; 11m Net x2; Towed Net
26/10/2010	15:01	26/10/2010	23:59	Scientific processing in transit; V/I to 21 45.8N 039 40.6W

26/10/2010	23:59	27/10/2010	04:20		Scientific processing in transit to Stn 26
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RStart		End		Comment
27/10/2010	04:20	27/10/2010	06:55	Stn 26; 21 12.71N 039 17.58W to 21 12.52N 039 17.13W; Es 144 to 150 inc; CTD(T); Bongo Net x3; CTD(S); 4th Bongo & Twd Net
27/10/2010	06:55	27/10/2010	13:01	Scientific processing in transit to Stn 27
27/10/2010	13:01	27/10/2010	14:57	Stn 27; 20 25.86N 038 44.34W to 20 25.77N 038 44.05W; Es 151 to 158 incl; Bucket; CTD(S); Optics x2; 11m Net x3; Towed Net
27/10/2010	14:57	27/10/2010	23:59	Scientific processing in transit; V/I to 19 15.7N 037 56.0W
27/10/2010	23:59	28/10/2010	04:20	Scientific processing in transit to Stn 28
28/10/2010	04:20	28/10/2010	06:50	Stn 28; 18 41.45N 037 31.37W; Es 159 to 163 incl; CTD(T); Bongo x3; CTD(S)
28/10/2010	06:50	28/10/2010	13:00	Scientific processing in transit to Stn 29
28/10/2010	13:00	28/10/2010	14:54	Stn 29; 17 54.77N 036 59.03W to 17 55.12N 036 58.82W; Es 164 to 170 incl; CTD(S); Bucket; Optics x2; 11m Net x2; Towed Net
28/10/2010	14:54	28/10/2010	23:59	Scientific processing in transit; V/I to 16 44.5N 036 11.2W
28/10/2010	23:59	29/10/2010	04:20	Scientific processing in transit to Stn 30
29/10/2010	04:20	29/10/2010	06:50	Stn 30; 16 11.43N 035 48.37W to 16 11.37N 035 48.08W; Es 171 to 177 incl; CTD(T); Bongo Net x3; CTD(S); 4th Bongo; Towed Net
29/10/2010	06:50	29/10/2010	12:57	Scientific processing in transit to Stn 31
29/10/2010	12:57	29/10/2010	14:57	Stn 31; 15 25.43N 035 17.13W to 15 25.74N 035 16.82W; Es 178 to 184 incl; Bucket; CTD(S); Optics x2; 11m Net x2; Towed Net
29/10/2010	14:57	29/10/2010	23:59	Scientific processing in transit; V/I to 14 05.6N 034 23.4W
29/10/2010	23:59	30/10/2010	04:20	Scientific processing in transit to Stn 32
30/10/2010	04:20	30/10/2010	06:40	Stn 32; 13 27.77N 033 57.02W to 13 29.94N 033 57.23W; Es 185 to 189 incl; CTD(T); Bongo Net x3; CTD(S)
30/10/2010	06:40	30/10/2010	13:00	Scientific processing in transit to Stn 33
30/10/2010	13:00	30/10/2010	15:01	Stn 33; 12 32.73N 033 19.73W to 12 32.95N 033 19.57W; Es 190 to 196 incl; Bucket; CTD(S); Optics x2; 11m Net x2; Towed Net
30/10/2010	15:01	30/10/2010	23:59	Scientific processing in transit; V/I to 11 11.0N 032 25.0W
30/10/2010	23:59	31/10/2010	04:20	Scientific processing in transit to Stn 34
31/10/2010	04:20	31/10/2010	07:27	Stn 34; 10 34.00N 031 59.70W to 10 34.40N 031 59.68W; Es 197 to 203 inc; CTD(T); Bongo Net x4; CTD(S); Twd Net; 30 min delay
31/10/2010	07:27	31/10/2010	12:56	Scientific processing in transit to Stn 35
31/10/2010	12:56	31/10/2010	15:13	Stn 35; 09 45.06N 031 27.45W to 09 45.10N 031 27.05W; Es 204 to 210 inc; CTD(S); Bucket; Optics x2; 11m Net x2; Towed Net
31/10/2010	15:13	31/10/2010	23:59	Scientific processing in transit; V/I to 08 26.0N 030 35.2W
31/10/2010	23:59	01/11/2010	04:25	Scientific processing in transit to Stn 36
01/11/2010	04:25	01/11/2010	06:27	Stn 36; 07 48.84N 030 09.57W to 07 49.03N 030 09.59W; Es 211 to 215 inc; CTD(T); Bongo Net x3; CTD(S)

RStart		End		Comment
01/11/2010	06:27	01/11/2010	13:06	Scientific processing in transit to Stn 37
01/11/2010	13:06	01/11/2010	14:58	Stn 37; 06 47.24N 029 29.04W to 06 47.36N 029 29.03W; Es 216 to 222 inc; Optics; Bucket; CTD(S); Optics; 11m Net x2; Twd Net
01/11/2010	14:58	01/11/2010	23:59	Scientific processing in transit; V/I to 05 19.49N 028 30.81W
01/11/2010	23:59	02/11/2010	04:29	Scientific processing in transit to Stn 38; Clocks advanced 1 hr to GMT @ 0200hrs
02/11/2010	04:29	02/11/2010	07:01	Stn 38; 04 48.24N 028 09.95W to 04 48.00N 028 09.40W; Es 223 to 229 inc; CTD(T); Bongo x3; CTD(S); 4th Bongo; Towed Net
02/11/2010	07:01	02/11/2010	13:00	x2
02/11/2010	13:00	02/11/2010	15:12	Stn 39; 03 53.14N 027 33.89W to 03 53.30N 027 33.85W; Es 230 to 236 inc; Optics; Bucket; CTD(S); Optics; 11m Net x2; Twd Net
02/11/2010	15:12	02/11/2010	23:59	Scientific processing in transit; V/I to 02 37.0N 026 42.0W
02/11/2010	23:59	03/11/2010	04:32	Scientific processing in transit to Stn 40
03/11/2010	04:32	03/11/2010	06:00	Stn 40; 01 57.75N 026 17.95W to 026 17.81W; Es 237 to 240 inc; CTD(T) - not deployed, wire damage; Bongo Nets x3
03/11/2010	06:00	03/11/2010	11:56	Scientific processing in transit to Stn 41
03/11/2010	11:56	03/11/2010	13:50	Stn 41; 01 01.86N 025 44.99W to 01 08.42N 025 45.06W; Es 241 to 245 inc; Optics x2; 11m Net x2; Towed Net
03/11/2010	13:50	03/11/2010	23:59	Scientific processing in transit; V/I in transit to 00 25.2S 025 00.3W; {A/c @ 2140 hrs to 180(T); V/I posn. 00 01.2S 025 00.2W}
03/11/2010	23:59	04/11/2010	04:32	Scientific processing in transit to Stn 42
04/11/2010	04:32	04/11/2010	05:41	Stn 42; 01 10.31S 025 00.04W to 01 10.16S 024 59.89W; Es 246a,b&c; CTD(T) profile; Bongo to 150m (fouled CTD); Bucket
04/11/2010	05:41	04/11/2010	06:52	Downtime: running CTD wire out to 500m to inspect for damage
04/11/2010	06:52	04/11/2010	09:00	Scientific processing in transit; V/I to 01 19.0S 025 00.0W
04/11/2010	09:00	04/11/2010	11:50	Stn 43; 01 19.94S 024 59.92W; E 247; Acoustic release test to 4,600m via trawl wire {Precursor to Mooring operations @ SAG}
04/11/2010	11:50	04/11/2010	13:07	Scientific processing in transit towards Stn 44
04/11/2010	13:07	04/11/2010	14:14	Stn 44; 01 28.78S 025 00.49W to 01 28.69S 025 00.00W; Es 248, 249a, 249b; Optics; CTD(S) (profile only); 2nd Optics
04/11/2010	14:14	04/11/2010	15:18	CTD recovery time; comms followed by scrolling problems
04/11/2010	15:18	04/11/2010	23:59	Scientific processing in transit; V/I to 03 04.6S 025 00.9W
04/11/2010	23:59	05/11/2010	04:25	Scientific processing in transit to Stn 45
05/11/2010	04:25	05/11/2010	07:06	Stn 45; 03 51.09S 025 01.06W to 03 50.86S 025 00.59W; Es 249c to 255 inc; Bongo; CTD(T); Bongo x2; CTD(S); Bongo; Twd Net
05/11/2010	07:06	05/11/2010	13:03	Scientific processing in transit to Stn 46; Emergency exercises with Utility Party @ 0930hrs: hoses; foam branch; SCBA; vents
05/11/2010	13:03	05/11/2010	14:54	Stn 46; 04 53.44S 025 01.77W to 04 53.52S 025 01.59W; Es 256 to 262 inc; Optics; Bucket; CTD(S); Optics; 11m Net x2; Twd Net

RStart		End		Comment
05/11/2010	14:54	05/11/2010	20:42	Scientific processing in transit; V/I to 05 48.4S 025 01.7W; V/I diversion @ 2042hrs towards Ascension Is for compassionate evac.
05/11/2010	20:42	05/11/2010	23:59	Scientific processing in transit; V/I to 05 55.0S 024 28.6W
05/11/2010	23:59	06/11/2010	04:30	Scientific processing in transit towards Stn 47
06/11/2010	04:30	06/11/2010	06:36	Stn 47; 06 03.44S 023 45.77W to 06 03.24S 023 45.60W; Es 263 to 267 inc; CTD(T); Bongo x3; CTD(S)
06/11/2010	06:36	06/11/2010	13:07	Scientific processing in transit towards Stn 48
06/11/2010	13:07	06/11/2010	14:01	Stn 48; 06 16.09S 022 41.88W to 06 16.1S 022 41.6W; Es 268 to 271 inc; Optics; CTD(S); Bucket; Towed Net
06/11/2010	14:01	06/11/2010	23:59	Scientific processing in transit; V/I to 06 35.5S 021 03.3W
06/11/2010	23:59	07/11/2010	12:00	Scientific processing in transit; V/I to 06 59.8S 019 00.2W
07/11/2010	12:00	07/11/2010	19:00	Scientific processing in transit; V/I to 07 14.0S 017 48.0W; Cease on-line monitoring @ 1900hrs - entering Ascension Is EEZ
07/11/2010	19:00	07/11/2010	23:59	V/I in transit towards Ascension Is; V/I to 07 24.4S 016 57.3W
07/11/2010	23:59	08/11/2010	12:00	V/I in transit towards Ascension Is; V/I to 07 47.9S 014 55.8W
08/11/2010	12:00	08/11/2010	15:10	V/I in transit towards Ascension Is; V/I to heave-to position, Catherine Pt 187 deg x 0.66nm
08/11/2010	15:10	08/11/2010	15:17	Boat transfer, compassionate evacuation CPO(D), Clarence Bay, completed
08/11/2010	15:17	08/11/2010	23:59	V/I in transit SW towards extremity of Ascension Is EEZ; V/I to 09 01.3S 015 32.4W
08/11/2010	23:59	09/11/2010	10:03	V/I in transit to clear Ascension Is EEZ; V/I to 10 21.0S 016 51.1W; Clear of EEZ @ 1003hrs; res. on-line monitoring via non-toxic
09/11/2010	10:03	09/11/2010	13:03	Scientific processing in transit to Stn 49
09/11/2010	13:03	09/11/2010	14:07	Stn 49; 10 43.87S 017 13.51W to 10 43.79S 017 13.47W; Es 272 to 275 inc; Optics; Bucket; 11m Net x2
09/11/2010	14:07	09/11/2010	14:45	Assessing problems with ODIM system that prevented parallelogram extension & deployment of CTD; Es 276, 277; Buckets x2
09/11/2010	14:45	09/11/2010	23:59	Scientific processing in transit; V/I to 11 57.4S 018 27.2W
09/11/2010	23:59	10/11/2010	04:30	Scientific processing in transit to Stn 50
10/11/2010	04:30	10/11/2010	05:45	Stn 50; 12 31.75S 19 01.32W; Es 278 to 281 inc; CTD(S); Bongo Net x3
10/11/2010	05:45	10/11/2010	13:03	Scientific processing in transit to Stn 51
10/11/2010	13:03	10/11/2010	14:12	Stn 51; 13 28.40S 019 57.99W to 13 28.39S 019 57.79W; Es 282 to 286 inc; CTD(S); Bucket; Optics; Towed Net x2
10/11/2010	14:12	10/11/2010	23:59	Scientific processing in transit; V/I to 14 46.0S 021 16.4W
10/11/2010	23:59	11/11/2010	04:22	Scientific processing in transit to Stn 52
11/11/2010	04:22	11/11/2010	05:30	Stn 52; 15 19.88S 021 50.47W; Es 287 to 290; CTD(S); Bongo Nets x3
11/11/2010	05:30	11/11/2010	13:03	Scientific processing in transit to Stn 53
11/11/2010	13:03	11/11/2010	14:02	Stn 53; 16 18.97S 022 50.50W to 16 18.93S 022 50.50W; Es Optics; CTD(S); Bucket; 11m Net x2; Argo float released

RStart		End		Comment
11/11/2010	14:02	11/11/2010	23:59	Scientific processing in transit; V/I to 17 32.8S 024 12.2W
11/11/2010	23:59	12/11/2010	06:42	Scientific processing in transit to S. Atlantic Gyre mooring position; 18 31.88S 025 06.16W
12/11/2010	06:42	12/11/2010	10:13	Stn 54r; E 297; Release, ascent, grappling & recovery of SAG mooring; V/I to 18 31.82S 025 06.00W
12/11/2010	10:13	12/11/2010	10:52	V/I repositioning to 18 32.2S 025 07.7W & CTD preparation
12/11/2010	10:52	12/11/2010	11:36	Stn 55; E 298; CTD(S) to 300m
12/11/2010	11:36	12/11/2010	12:40	Complete preparing deck for Mooring redeployment; waiting for solar noon
12/11/2010	12:40	12/11/2010	13:35	Stn 55 contd; 18 32.26S 025 08.04W to 18 32.20S 025 07.92W; Es 299 & 300; Optics & Towed Net
12/11/2010	13:35	12/11/2010	15:56	Stn 54d; E 301; SAG mooring re-deployed; Commence stream from 18 32.19S 025 07.75W; Released in 18 31.714S 025 05.873W
12/11/2010	15:56	12/11/2010	18:18	Stn 54d contd; Monitoring descent and subsequent triangulation of mooring; V/I final position 18 33.00S 025 06.00W
12/11/2010	18:18	12/11/2010	23:59	Scientific processing in transit; V/I to 19 34.7S 025 05.5W
12/11/2010	23:59	13/11/2010	04:28	Scientific processing in transit to Stn 56
13/11/2010	04:28	13/11/2010	05:28	Stn 56; 20 22.77S 025 05.35W; Es 302 to 305 inc; Bongo Net; CTD(S); Bongo Net x3
13/11/2010	05:28	13/11/2010	13:03	Scientific processing in transit to Stn 57
13/11/2010	13:03	13/11/2010	14:00	Stn 57; 21 42.35S 025 05.81W to 21 42.24S 25 05.67W; Es 306 to 311 inc; Optics; Bucket; CTD(S); 11m Net x2; Argo float
13/11/2010	14:00	13/11/2010	14:24	Azimuth thruster trials
13/11/2010	14:24	13/11/2010	23:59	Scientific processing in transit; V/I to 23 12.1S 026 03.1W
13/11/2010	23:59	14/11/2010	04:35	Scientific processing in transit to Stn 58
14/11/2010	04:35	14/11/2010	05:50	Stn 58; 23 50.26S 026 33.98W; Es 312 to 315 inc; Bongo Net; CTD(S); Bongo Net x2
14/11/2010	05:50	14/11/2010	13:07	Scientific processing in transit to Stn 59
14/11/2010	13:07	14/11/2010	14:28	Stn 59; 24 49.14S 027 21.46W to 24 49.36S 027 21.70W; Es 316 to 319 inc; Optics; CTD(S); Towed Net; Argo float
14/11/2010	14:28	14/11/2010	23:59	Scientific processing in transit; V/I to 26 11.0S 028 30.4W
14/11/2010	23:59	15/11/2010	04:26	Scientific processing in transit to Stn 60; Clocks retarded 1 hr to GMT -1 @ 0200 hrs
15/11/2010	04:26	15/11/2010	05:35	Stn 60; 26 51.45S 029 04.07W to 26 42.46S 029 03.83W; Es 320 to 323 inc; Bongo Net; CTD(S); Bongo Net x2
15/11/2010	05:35	15/11/2010	13:00	Scientific processing in transit to Stn 61
15/11/2010	13:00	15/11/2010	14:07	Stn 61; 27 54.95S 029 59.20W to 27 55.03S 029 58.81W; Es 324 to 329 inc; Optics; CTD(S); Bucket; 11m Net x2; Argo float
15/11/2010	14:07	15/11/2010	16:28	Scientific processing in transit; V/I to 28 15.07S 030 17.69W
15/11/2010	16:28	15/11/2010	16:58	V/I hove-to for swinging of lifeboats; preceded by Emergency exercise and lifeboat muster @ 1616 hrs
15/11/2010	16:58	15/11/2010	23:59	Scientific processing in transit; V/I to 29 17.9S 031 14.3W
15/11/2010	23:59	16/11/2010	04:25	Scientific processing in transit to Stn 62
16/11/2010	04:25	16/11/2010	05:30	Stn 62; 29 56.61S 031 49.41W to 29 56.40S 031 49.34W; Es 330 to 333 inc; Bongo Net; CTD(S);

				Bongo Net x2
RStart		End		Comment
16/11/2010	05:30	16/11/2010	13:11	Scientific processing in transit to Stn 63
16/11/2010	13:11	16/11/2010	14:15	Stn 63; 30 59.73S 032 48.84W to 31 00.13S 032 49.51W; Es 334 to 337 inc; Bucket; Optics; CTD(S); Towed Net
16/11/2010	14:15	16/11/2010	19:18	Scientific processing in transit to Stn 64; V/I to 31 45.0S 033 33.4W
16/11/2010	19:18	16/11/2010	19:36	Stn 64; 31 45.73S 033 33.49W; Argo float deployed
16/11/2010	19:36	16/11/2010	23:59	Scientific processing in transit; V/I to 32 24.1S 034 11.1W
16/11/2010	23:59	17/11/2010	04:25	Scientific processing in transit to Stn 65
17/11/2010	04:25	17/11/2010	05:30	Stn 65; 33 02.66S 034 50.72W; Es 339 to 342 inc; Bongo Net; CTD(S); Bongo Net x2
17/11/2010	05:30	17/11/2010	13:07	Scientific processing in transit to Stn 66
17/11/2010	13:07	17/11/2010	14:16	Stn 66; 34 06.45S 035 55.53W to 34 06.91S 035 55.56W; Es 343 to 347 inc; Optics; Bucket; CTD(S); Towed Net; Argo float
17/11/2010	14:16	17/11/2010	23:59	Scientific processing in transit; V/I to 35 30.2S 037 25.9W
17/11/2010	23:59	18/11/2010	04:27	Scientific processing in transit to Stn 67
18/11/2010	04:27	18/11/2010	05:35	Stn 67; 36 05.44S 038 05.26W to 36 04.98S 038 05.46W; Es 348 to 351 inc; Bongo Net; CTD(S); Bongo Net x2
18/11/2010	05:35	18/11/2010	13:06	Scientific processing in transit to Stn 68
18/11/2010	13:06	18/11/2010	14:00	Stn 68; 37 05.63S 039 13.83W to 37 05.62S 039 13.69W; Es 352 to 354 inc; Optics; CTD(S); 5m Net
18/11/2010	14:00	18/11/2010	23:59	Scientific processing in transit; V/I to 38 20.4S 040 45.3W
18/11/2010	23:59	19/11/2010	04:25	Scientific processing in transit to Stn 69
19/11/2010	04:25	19/11/2010	05:55	Stn 69; 38 55.52S 041 27.06W to 38 55.15S 041 28.04W; Es 355 to 358 inc; Bongo Net; CTD(S); Bongo Net x2
19/11/2010	05:55	19/11/2010	13:09	Scientific processing in transit to Stn 70; Safety Committee Meeting conducted @ 1030 hrs
19/11/2010	13:09	19/11/2010	14:06	Stn 70; 039 47.48S 042 33.11W; Es 359 to 361 inc; Optics; CTD(S); Towed Net
19/11/2010	14:06	19/11/2010	23:59	Scientific processing in transit; V/I to 40 59.4S 044 10.0W
19/11/2010	23:59	20/11/2010	04:33	Scientific processing in transit to Stn 71; Clocks retarded 1 hr @ 0200 hrs to GMT-2
20/11/2010	04:33	20/11/2010	05:47	Stn 71; 41 39.34S 045 05.58W to 41 39.17S 045 05.78W; Es 362 to 365 inc; Bongo Net; CTD(S); Bongo Net x2
20/11/2010	05:47	20/11/2010	13:09	Scientific processing in transit to Stn 72;
20/11/2010	13:09	20/11/2010	13:59	Stn 72; 42 29.88S 046 17.77W; Es 366 to 369 inc; Optics; CTD(S); 5m Net x2
20/11/2010	13:59	20/11/2010	23:59	Scientific processing in transit; V/I to 43 40.8S 048 07.1W
20/11/2010	23:59	21/11/2010	04:25	Scientific processing in transit to Stn 73
21/11/2010	04:25	21/11/2010	05:32	Stn 73; 44 11.98S 048 56.29W to 44 12.05S 48 56.58W; Es 370 to 373 inc; Bongo Net; CTD(S); Bongo Net x2
21/11/2010	05:32	21/11/2010	13:09	Scientific processing in transit to Stn 74
21/11/2010	13:09	21/11/2010	14:03	Stn 74; 45 00.99S 050 17.07W to 45 00.87S 050 17.00W; Es 374 to 376 inc; Optics; CTD(S); Towed

				Net
21/11/2010	14:03	21/11/2010	23:59	Scientific processing in transit; V/I to 46 05.0S 052 10.5W
RStart		End		Comment
21/11/2010	23:59	22/11/2010	12:00	Scientific processing in transit; V/I to 47 22.0S 054 36.2W
22/11/2010	12:00	22/11/2010	19:00	Scientific processing in transit; V/I to 48 05.7S 056 06.0W
22/11/2010	19:00	22/11/2010	23:59	Passage to 48 35.9S 057 10.6W
22/11/2010	23:59	23/11/2010	12:00	Passage to 49 42.7S 059 42.8W
23/11/2010	12:00	23/11/2010	23:59	Passage to 50 49.1S 062 17.7W
23/11/2010	23:59	24/11/2010	12:00	Passage to 51 53.0S 065 31.6W; Clocks retarded 1 hr to GMT -3 (Chilean time)
24/11/2010	12:00	24/11/2010	23:43	Passage to A/c position - approaches to Magellan Straits
24/11/2010	23:43	25/11/2010	06:00	Passage to Cabo Posesion - pilot boarding position
25/11/2010	06:00	25/11/2010	15:30	Pilotage to anchorage, Punta Arenas

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Elena Garcia-Martin
Microbial respiration

Education Through Expeditions



Ella Darlington
Outreach/Education

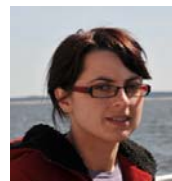
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Dean Hope
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Pete Robinson
Steward



Brian Conteh
Assistant Steward

Ship's Officers



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Master



Richard Warner
CO



Malcolm Graves
2/O



Euan Doig
3/O



George Parkinson
C/E



Chris Kemp
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Purser

Scientific Reports:

Preservation of ceratium for molecular analysis and microplankton grazing experiments

David Aldridge

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Objectives

- To preserve ceratium specimens for later molecular analysis of 18s/28s rRNA in order to obtain data on: intra-specific genetic diversity, and genetic variability between north, south, and equatorial Atlantic populations.
- Look for direct and/or indirect effects of microplankton on bacterial populations, e.g. through bacterioivory, mixotrophy, or toxicity.
- Enumeration and characterisation of microplankton in 20um, 40um, and 100um size fractions.

Methods

Sample collection: samples were collected using an 11m size-fractionating microzooplankton net (Table 1). The net was deployed vertically to 100m in the water column and then slowly raised to the surface at approximately 10m/minute; Size fractions collected were 20um, 40um, and 100um.

FloCam measurements: 49 ml of each size fraction sample collected from the net was passed through a FloCam, using a syringe pump, for 7 minutes at a rate of 7ml/minute in order to characterise the microplankton population in the top 100m of the water column. Approximate species abundances are obtainable by taking into account: the size of the net opening, the amount of water the net travelled through, and the volume of water in the sample collection bottles.

Isolation of ceratium for molecular analysis: 2ml of sample was pipetted into a Sedgewick-Rafter chamber. Individual ceratium species were transferred into another S-R chamber containing 2ml of seawater filtered through a 0.2um filter. Individuals were photographed prior to being picked using a 0.10ul micropipette and placed into individual PCR viles. Samples were then flash-frozen in liquid nitrogen and stored at -80°C. Between 5 and 30 individuals were isolated from each net sample.

Sample preservation: Remaining sample from each size fraction was concentrated (using a 20um mesh) down to 6.5ml. 5ml was preserved with lugols solution in 15ml falcon tubes and stored in the dark. 1.5ml was preserved with paraformaldehyde (PFA; final concentration of 1%) and stored in 2ml cryoviles; PFA samples were flash-frozen in liquid nitrogen and stored at -80°C.

Incubations of microplankton with seawater: Incubations of trichodesmium and nauplii were carried out in seawater collected from the CTD from a depth of 20m (see table 2 for details). 500ml glass bottles were sterilised by filling with 10% HCL for 24 hrs. Before samples were collected bottles were rinsed thoroughly with MilliQ. In separate experiments, different concentrations of trichodesmium and nauplii were added to between 200 and 500ml of seawater. Over a time period of up to 50hrs three 2ml sub-samples were taken, fixed with PFA and analysed using a FACScalibur flow cytometer in order to monitor changes in concentrations of heterotrophic eukaryotes, photosynthetic eukaryotes, and bacteria.

Net no.	Event number	Date	Depth (m)	Latitude	Longitude	Time in (GMT)	Time out
1	12	14/10/2010	200	49.2772	-12.8844	14:42	15:06
2	22	15/10/2010	100	48.1225	-17.3333	14:19	14:29
3	34	16/10/2010	100	45.2081	-19.9342	14:21	14:34
4	46	17/10/2010	100	42.7764	-22.0461	14:23	14:44

5	58	18/10/2010	100	40.1350	-24.1992	14:24	14:36
6	70	20/10/2010	100	34.9442	-28.9503	16:25	16:34
7	80	21/10/2010	100	33.8486	-30.2058	14:17	14:31
8	91	22/10/2010	100	31.7397	-32.5719	15:15	15:27
9	105	23/10/2010	100	29.6169	-34.9022	15:16	15:25
10	117	24/10/2010	100	27.4531	-37.2333	15:16	15:26
11	141	26/10/2010	100	22.9725	-40.5422	15:13	15:23
12	156	27/10/2010	100	20.4414	-36.7419	15:16	15:25
13	168	28/10/2010	100	17.9222	-36.9842	15:11	15:21
14	182	29/10/2010	100	15.4294	-35.2869	15:11	15:21
15	194	30/10/2010	100	12.5536	-33.3369	15:16	15:26
16	208	31/10/2010	100	9.7531	-31.4617	15:24	15:34
17	220	01/11/2010	100	6.7900	-29.4844	15:17	15:31
18	234	02/11/2010	100	3.8872	-27.5747	14:14	14:25
19	243	03/11/2010	100	1.1378	-25.7608	14:20	14:29
20	260	05/11/2010	100	-4.8950	-25.0378	14:15	14:23
21	274	09/11/2010	100	-10.7400	-17.2303	13:48	14:00
22	293	11/11/2010	100	-16.1928	-22.8472	13:40	13:50
23	309	13/11/2010	100	-21.7086	-25.1064	13:34	13:46
24	326	15/11/2010	100	-27.9250	-29.9839	14:42	14:50
25	354	18/11/2010	100	-37.1003	-39.2358	14:40	14:50
26	368	20/11/2010		-42.5075	-46.3052	15:37	15:48

Table 1: Details of size-fractionating microzooplankton net samples

CTD No.	Event No.	Time (GMT)	Latitude	Longitude	Depth (m)	Bottle No.
30-S	113	14:03	27.4525	-37.2333	20	16
37-S	141	14:08	22.9733	-40.5422	20	16
43-S	164	14:06	17.9213	-36.9841	20	16
52-S	204	14:12	9.7511	-31.4958	20	14
58-S	232	14:06	3.8869	-27.5747	20	14
Bucket	277	14:35	-10.7400	-17.2303	Surface	NA
70-S	292	13:07	-16.3272	-22.8469	20	16
73-S	308	13:05	-21.7058	-25.0969	20	
77-S	325	14:10	-27.9264	-29.9881	20	16
87-S	367	15:12	-42.5077	-46.3047	20	12

Table 2: Details of CTD samples taken for incubations

A proposal for refinement of the MODIS calcite algorithm and Cal/Val activities towards assembly of earth system data records.

David Drapeau

Bigelow Laboratory for Ocean Sciences

Cruise Objectives:

1. Collection of CTD and underway (approximately samples day⁻¹) samples for analysis of particulate organic carbon (POC), particulate inorganic carbon (PIC), coccolith enumeration and biogenic silica concentration (BSi). The purpose of these samples was to provide an assessment of the inorganic and organic particle concentrations in surface water, provide indices of community composition, and analytical means to calibrate satellite PIC algorithms.
2. Operation of an along-track flow-through system from the ship's non-toxic seawater system to characterize the fine-scale hydrographic and bio-optical variability of the various water masses for satellite development of the NASA PIC algorithm.
3. Water-leaving radiance measurements in the visible and near infra red taken from the ship's meteorological platform, for characterizing the particulate content of the seawater and to provide sea-truth data for NASA's MODIS-Terra and Aqua satellite-based radiance measurements.

UW sampling

Discrete underway samples were collected from the ship's Surf-Met (underway surface and meteorological data collection) flow system in the CTD hanger lab 4 times per day. Samples for POC, PIC, BSi, and coccolith enumeration were obtained along with chlorophyll samples taken for fluorometer calibration (UW chlorophylls measured by Ella Darlington, ETE, and Rob Thomas, BODC). PIC samples were collected on 0.4 μm polycarbonate filters, rinsed with potassium tetraborate buffer and stored in metal free centrifuge tubes. These will be analyzed by ICPOES for particulate calcium. Coccolith and cell counts are collected on Millipore HA (nitrocellulose) filters, rinsed with potassium tetraborate buffer, frozen at 20°C, dried, then mounted onto slides using Norland Optical Adhesive. They will later be enumerated by birefringence microscopy. Biogenic silica (BSi) samples were filtered onto 0.4 μm polycarbonate filters, dried in clean centrifuge tubes, and will be analyzed following the protocol of *Brzezinski* and Nelson (1989). POC samples were filtered onto pre-combusted glass fiber filters, dried, will later be fumed with concentrated HCL to remove inorganic carbon. They will be analyzed for ashore at the University of Maine's Darling Marine Center.

CTD sampling

During the pre-dawn CTD (second cast of the day) six light depths (1%, 7%, 14%, 33%, 55%, 97%) and at least one below mixed layer deeper (down to 200m) depths were analyzed for POC, PIC, BSi, and coccolith enumeration as described above. Seven depths (DMC and several depths above and below) were also analyzed for PIC and BSi with only surface for CHN and Cell counts from the local noon CTD each day.

Flow-through bio-optical system

This system operates semi-continuously with water from the ships non-toxic sea water supply flowing at a rate of 4 liters per minute. Every 5-7 minutes temperature and salinity are measured (with a SeaBird sensor), chlorophyll fluorescence (WETLabs Wet star), total backscattering at 532nm (bb_{tot} ; WETLabs ECO-VSF), acidified backscattering (bb_{acid} ; backscattering of the seawater suspension after the pH has been lowered to dissolve calcite and aragonite), and acid labile backscattering (bb' ; the difference between the bb_{tot} and bb_{acid}). A WETLabs ac-9 is used to measure absorption and attenuation at 9 visible wavelengths (412, 440, 488, 510, 555, 630, 650, 676, and 715 nm) (every 4 minutes) and absorption and attenuation at the same wavelengths after the water was routed through a serially-mounted 1 μm poresize, then 0.2 μm poresize filter (during the intervening 4 minute segments).

Above-Water Radiance Measurements

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

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

Sensors were rinsed regularly with Milli-Q water in order to remove salt deposits and any dust. The water radiance sensor was able to view over an azimuth range of ~180° across the ship's heading with no contamination from the ship's deck or wake. The direction of the sensor was adjusted constantly to view the water 120° from the sun's azimuth, to minimize sun glint. This was done using a computer-based system that calculated the sun's azimuth angle relative to the ship's heading and elevation constantly. The system used the ship's gyro-compass to determine the heading of the ship. Depending on the ship's course, the computer controlled a stepper motor that turned the sensors to the proper viewing angle. Protocols for operation and calibration were performed according to Mueller (Mueller et al. 2003a; Mueller et al. 2003b; Mueller et al. 2003c). Data were collected between about 1000 and 1900 GMT when the sun was above 20° elevation. Post-cruise, the 16Hz data will be filtered to remove as much residual white cap and glint as possible (we accept the lowest 5% of the data). Calibrations with 10% reflectance plaque were performed during the cruise in order to assess the status of the radiometric calibrations. A factory calibration of the radiometers was performed before the cruise.

Sampling Metrics

Flow through optics and above water radiance measurements: 41 days
UW Samples: 134
CTD casts: 60

References:

- Brzezinski, M.A., Nelson, D.M.**, 1989. Seasonal changes in the silicon cycle within a Gulf Stream warm-core ring. *Deep-Sea Research* 36, 1009–1030.
- Mueller J.L., Austin R.W., Morel A., Fargion G.S., McClain C.R.** 2003a. Ocean optics protocols for satellite ocean color sensor validation, Revision 4, Volume I: Introduction, background, and conventions. Greenbelt, MD: Goddard Space Flight Center. 50 p.
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Seawater sampling for stable isotope analysis of N₂O and continuous measurements of N₂O concentrations in the surface ocean

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Background

Stable isotopes analysis is a useful tool to trace different pathways of biogeochemical N₂O cycling. The oxygen isotope anomaly $^{17}\Delta$ in N₂O is currently not fully understood, bacterial processes might account for a significant part of this signature [Kaiser *et al.*, 2004]. The position-dependent ^{15}N enrichment offers additional information about N₂O production pathways [Sutka *et al.*, 2006]. CTD depth profiles were taken for GC-IRMS (Gas Chromatography-Isotope Ratio Mass Spectrometry) analysis at the University of East Anglia, Norwich.

N₂O concentrations in surface waters were continuously measured using cavity ring down spectroscopy. Those measurements will be used to infer air-sea gas exchange and to gain a better understanding of source and sink regions of N₂O in the Atlantic Ocean.

Methods

CTD samples for isotope analysis

Water for isotope analysis were collected from CTD casts before any other samples. Sample size was 1.5 l (in 3x 500 ml serum vials) for $^{17}\Delta$ - and 125 ml for ^{15}N analysis. Sample vials were flushed with at least two times the sampling volume, care was taken not to trap air bubbles. The sampling flasks were sealed with butyl rubber stoppers and aluminium crimp seals. Immediately after collection, samples were poisoned with 0.25 (125 ml samples) to 0.5 ml HgCl₂ (500 ml samples) and 1 to 2 ml CP grade He were injected to avoid over-pressurisation and subsequent failure of the seal when water samples are exposed to temperature changes. Samples were stored at room temperature until analysis at UEA. CTD casts sampled for N₂O isotope analysis are summarised in Table 1 and Table 2.

Table 1: Isotope samples for $^{17}\Delta$ analysis

Date	CTD ID	Latitude (+ve N)	Longitude (+ve E)	Depth
14/10/10	CTD002t	49.4060	-11.1648	75
14/10/10	CTD003s	49.4060	-11.1648	175, 50, 40, surface
15/10/10	CTD006s	49.0485	-16.4304	300, 45, surface
16/10/10	CTD008t	46.0553	-19.1910	500
16/10/10	CTD009s	46.0562	-19.1978	70, 30
17/10/10	CTD011t	43.5496	-21.3642	1000, 500
17/10/10	CTD012s	43.5496	-21.3642	60, surface
19/10/10	CTD017t	38.2815	-25.6456	1000, 790, 465, 67, 45, surface
20/10/10	CTD019s	34.9397	-28.9438	500
23/10/10	CTD025t	30.2848	-34.1790	500
23/10/10	CTD026s	30.2933	-34.1832	250, surface
26/10/10	CTD035t	23.7710	-41.1076	1000, 800, 200, surface
29/10/10	CTD044t	16.1906	-35.8061	500, 440
29/10/10	CTD045s	16.1883	-35.8047	300, 140, 60, surface
31/10/10	CTD050t	10.5667	-31.9951	500, 80, surface
02/11/10	CTD056t	4.8040	-28.1658	500, 120, surface
05/11/10	CTD061t	-3.8515	-25.0176	300, 80, surface
06/11/10	CTD066s	-6.0548	-23.7607	300, 90, surface
10/11/10	CTD067s	-12.5292	-19.0220	300, 170, surface
12/11/10	CTD071s	-18.5370	-25.1296	300, 200, 140, 20
16/11/10	CTD078s	-29.9435	-31.8234	300, 170, surface
17/11/10	CTD080s	-33.0444	-34.8454	300, 200, 125, surface
19/11/10	CTD084s	-38.9246	-41.4525	300, 100, 80, surface

Table 2: Isotope samples for ¹⁵N analysis

Date	CTD ID	Latitude (+ve N)	Longitude (+ve E)	Depth
15/10/10	CTD007s	48.1162	-17.3243	50, 20, surface
16/10/10	CTD009s	46.0562	-19.1978	70, 30
18/10/10	CTD015s	40.9943	-23.4794	300, 80, 65, 30, surface
20/10/10	CTD019s	34.9397	-28.9438	500
22/10/10	CTD022t	32.4257	-31.8001	1000, 500
22/10/10	CTD024s	31.7298	-32.5626	110, 60, surface
24/10/10	CTD028t	28.1122	-36.5163	1000, 800, 500
24/10/10	CTD029s	28.1128	-36.5084	250, 170, surface
25/10/10	CTD032t	25.9836	-38.7830	500, 300, 200, 150, 100, surface
27/10/10	CTD038t	21.2119	-39.2931	500, 380, 300, 200, 115, 50, surface
30/10/10	CTD047t	13.4629	-33.9504	500, 350, 100, 30, surface
01/11/10	CTD053t	7.8141	-30.1596	500, 100, surface
06/11/10	CTD064t	-6.0575	-23.7629	300, 125, surface
11/11/10	CTD069s	-15.3313	-21.8412	300, 145, surface
13/11/10	CTD072s	-20.3796	-25.0892	300, 100, surface
14/11/10	CTD074s	-23.8377	-26.5665	300, 200, surface
15/11/10	CTD076s	-26.8575	-29.0676	300, 120, surface
18/11/10	CTD082s	-36.0907	-38.0878	300, 220, 120, 75, surface
20/11/10	CTD086s	-41.6557	-45.0930	300, 200, 100, 45, surface
21/11/10	CTD088s	-44.1998	-48.9385	300, 200, 75, surface

***N₂O* underway measurements**

Concentrations of dissolved N₂O in surface waters were measured with a N₂O/CO analyser from Los Gatos Research, using Off-Axis ICOS technology (Integrated Cavity Output Spectroscopy). The concentration of trace gases is inferred from the ring-down time of a laser beam between mirrors in the measurement cell. An equilibrator filled with Raschig rings was connected to the ship's non-toxic supply. The gas phase of the equilibrator was continuously pumped through the analyser, temperatures in the water and the gas were recorded to correct for temperature effects.

References:

- Kaiser, J., et al.** (2004), Contribution of mass-dependent fractionation to the oxygen isotope anomaly of atmospheric nitrous oxide, *Journal of Geophysical Research-Atmospheres*, 109(D3), D03305.
- Sutka, R. L., et al.** (2006), Distinguishing nitrous oxide production from nitrification and denitrification on the basis of isotopomer abundances, *Applied and Environmental Microbiology*, 72(1), 638-644.

Zooplankton Respiration and Metabolic Rates

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Aims & Objectives

Mesozooplankton contributes to the marine biogeochemical cycles of carbon and nitrogen through their physiological processes. Copepods are the most abundant zooplanktonic taxa in marine ecosystems and their distribution and community structure varies greatly across eutrophic and oligotrophic waters. Copepods metabolic activity plays a major role in the biogeochemical dynamics of the world ocean and the AMT programme presents an ideal opportunity to study the different biogeochemical interactions of zooplankton within the euphotic zone of temperate, tropical and equatorial regions of the North and South Atlantic Ocean.

The aims of the investigations were:

- How do the different metabolic rates change throughout the latitudinal transect?
- How do the different metabolic rates change with size?
- How does food quality change throughout the different biogeochemical provinces (Longhurst 1995)?
- To determine the distribution, abundance and community structure of zooplankton throughout the latitudinal transect.

Methodology

1.1 Sampling Strategy:

Zooplankton Sampling: A 200µm WP2 bongo net was deployed daily from the 13th of October 2010 to the 21st of November 2010. 200m vertical net hauls were carried out at pre-dawn. Every other day live zooplankton specimens were selected for metabolic rates experiments. Adult females of different species and size ranges were handpicked and incubated as shown in table 1.

Food Quality Sampling: Water samples collected at ChL maximum were utilized for food quality analysis and experiments. DCM (Deep Chlorophyll Maximum) Seawater was collected every other day from the pre-dawn CTD depth profile in 20 L acid-washed carboys. The water was subsequently screened through a 200µm sieve to remove larger grazers and then filtered through GF/F filters for the following analyses:

- POC/PON
- POP
- ChLa
- Fatty Acids/Proteins

2.2 Experimental Design:

Incubators were set at 3 different temperatures selected daily and based on DCM and surface water temperatures. Adult females of different species and sizes of copepods were selected; respiration, feeding and egg production rates were measured. The animals were incubated for 24 hours and the incubators were kept in dim light and temperature controlled in order to simulate a series of acclimatised (*in situ*) and acute conditions.

Respiration rates were measured using 2 techniques. Winkler Titration: Dissolved O₂ was determined by automated Winkler titration with photometric end-point detection. The concentration of thiosulphate was calibrated every 2 days. Respiration experiments were carried out according to Ikeda *et al.* (2001), single adult female copepods of different species were incubated for 24 hours in 60ml bottles filled with O₂ saturated 0.2µm filtered DCM water. Additional subsamples were fixed and analysed at the start of the incubation ('zero' sub-samples). At the end of the 24 hours the O₂ bottles were removed from the incubators, fixed and analysed for O₂. The specimen was subsequently fixed in 4% formalin and stored for later size determination.

Planar Optode: Dissolved O₂ was determined by incubating single adult female copepods at *in situ* temperature in 7ml bottles for 2-3 hours in 0.2µm filtered DCM water and continuously recorded. The probe was single-point calibrated at the beginning of the experiment with 100% saturated (bubbled) milliQ water. A 7ml control bottle with the filtered water was set up as control and monitored for 1 hour. The specimen was subsequently fixed in 4% formalin and stored for later size determination.

Egg Production rates experiments were carried out in 120ml plastic containers with netting. Single females were incubated in 0.2µm filtered DCM water for 24 hours at 3 temperatures. The samples were subsequently fixed in 4% formalin and stored for later analysis.

Feeding experiments were carried out by incubating adult females of 1 species of copepod in 1 litre/500ml bottles filled with DCM water mounted on a deck cooled plankton wheel for 24 hours. 3 bottles were fixed at the start of the incubation (time zero), 3 bottles with no animals were incubated alongside the bottled with the animals as controls. 200ml of water from the bottles was sub-sampled and fixed with lugol then stored for later analysis.

DATE	STATION	CTD CAST	LATITUDE	LONGITUDE	DCM DEPTH (m)	DCM T°C	INCUBATIONS	DCM SAMPLES
14/10/2010	JC53 02	03-S	49.26983333	-11.86816667	20	15.74	Feeding, Optode	POC/PON, POP, ChLa & Fatty Acids/Proteins
15/10/2010	JC53 04	06-S	49.04816667	-16.4305	35	16.5	Optode, Egg Production, Feeding	POC/PON, POP, ChLa & Fatty Acids/Proteins
16/10/2010	JC53 06	09-S	46.05616667	-19.19733333	40	16.78	Feeding, Optode	POC/PON, POP, ChLa & Fatty Acids/Proteins
17/10/2010	JC53 08	12-S	43.5496	-21.36418333	40	16.62	Optode, Egg Production, Feeding	POC/PON, POP, ChLa & Fatty Acids/Proteins
19/10/2010	JC53 12	18-S	38.28146667	-25.64566667	65	16	Winkler, Egg Production	POC/PON, POP, ChLa & Fatty Acids/Proteins
21/10/2010	JC53 14	20-S	34.2182	-29.7617	95	18.17	Optode, Winkler, Egg Production	POC/PON, POP, ChLa & Fatty Acids/Proteins
22/10/2010	JC53 16	23-S	32.42845	-31.80473333	110	18.87	Feeding	POC/PON, POP, ChLa & Fatty Acids/Proteins
23/10/2010	JC53 18	26-S	30.28485	-34.17901667	118	19.59	Winkler, Egg Production, Feeding	POC/PON, POP, ChLa & Fatty Acids/Proteins
25/10/2010	JC53 22	33-S	25.98355	-38.7997	100	22.66	Winkler, Egg Production	POC/PON, POP, ChLa & Fatty Acids/Proteins
27/10/2010	JC53 26	39-S	21.21225	-39.29226667	115	22.25	Optode, Winkler, Egg Production, Feeding	POC/PON, POP, ChLa & Fatty Acids/Proteins
29/10/2010	JC53 30	45-S	16.18828333	-35.80486667	60	23.05	Winkler, Egg Production	POC/PON, POP, ChLa & Fatty Acids/Proteins
31/10/2010	JC53 34	51-S	10.57091667	-31.99778333	55	19.79	Winkler, Egg Production	POC/PON, POP, ChLa & Fatty Acids/Proteins
02/11/2010	JC53 38	57-S	4.80086667	-28.16221667	70	26.81	Optode, Winkler, Egg Production	POC/PON, POP, ChLa & Fatty Acids/Proteins
05/11/2010	JC53 45	62-S	-3.848833333	-25.01533333	85	20.1	Winkler, Egg Production	POC/PON, POP, ChLa & Fatty Acids/Proteins
10/11/2010	JC53 50	67-S	-12.52918333	-19.022	130	22.23	Winkler	POC/PON, POP, ChLa & Fatty Acids/Proteins
13/11/2010	JC53 56	72-S	-20.380	-25.089	165	21.1	Optode, Winkler	POC/PON, POP, ChLa & Fatty Acids/Proteins
15/11/2010	JC53 60	76-S	-26.858	-29.06796667	120	19.75	Winkler, Egg Production	POC/PON, POP, ChLa & Fatty Acids/Proteins
18/11/2010	JC53 67	82-S	-36.090	-38.088	48	15.96	Optode, Winkler, Egg Production	POC/PON, POP, ChLa & Fatty Acids/Proteins
20/11/2010	JC53 71	86-S	-41.656	-45.094	30	11.7	Winkler, Egg Production	POC/PON, POP, ChLa & Fatty Acids/Proteins

Table1: CTD casts sampled for water biochemistry and zooplankton metabolic rates.

References:

- Ikeda, T., Kanno, Y., Ozaki, K., Shinada, A.** 2001. Metabolic rates of epipelagic copepods as a function of body mass and temperature. *Marine Biology*. 139: 587-596.
- Longhurst, A.** 1995. Seasonal cycles of pelagic production and consumption. *Prog. Oceanogr.* 36:77-167.

Phytoplankton Photosynthesis, Primary Production and Coloured Dissolved Organic Material.

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Objectives

During AMT20 integrated Primary production measurements were made at 31 stations on three size classes of phytoplankton from measurements taken from six to eight depths. Photosynthesis-irradiance curves and measurements of the emission spectra of photosynthesis were made at 19 stations at one to two depths in the water column. The absorption coefficient of coloured dissolved organic material from 250 to 800nm ($a_{CDOM}(250-800)$) was determined at 34 stations for between four to six depths in the water column. These measurements aim to fulfil the following objectives within Oceans 2025:

- *The main deliverable of Theme 10a, AMT is to provide an unique time series (1995-2011) 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 AMT18 using methods synonymous to those used in previous AMT cruises.*
- *As part of Theme 2 key rates of climatically important microbial and photochemical processes will be measured. These will include the photo-degradation of dissolved organic material.*
- *We also assessed the effect of Ocean acidification on phytoplankton community structure and photosynthesis.*

Methods

Primary production. Water samples were taken from pre-dawn (03:15-05:15 GMT) deployments of 21 x 10 + 3 x 20l SeaBird CTD rosette sampler on a stainless steel frame from between 6-8 depths in the euphotic 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 μ Ci) $\text{NaH}^{14}\text{CO}_3$ according to the biomass of phytoplankton. The polycarbonate bottles were transferred to an on deck (simulated in situ) incubation system using neutral density and blue filters to simulate subsurface irradiance over depth to 97%, 55%, 33%, 20%, 14%, 7%, 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%) and from a chiller maintained at $\pm 3^\circ\text{C}$ of in situ temperature for the lower light level incubators (7, 3, 1, 0.1%). To terminate the incubations, suspended material were filtered sequentially through 0.2 μm , 2 μm and 10 μm polycarbonate nucleopore filters to measure the pico, nano and micro-phytoplankton production respectively. The filters were exposed to concentrated HCl fumes for 12 h immersed in scintillation cocktail and ^{14}C disintegration time per minute (DPM) was measured on board using a Packard, Tricarb 2900 liquid scintillation counter and the external standard and the channel ratio methods were applied to correct for quenching.

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Photosynthesis-Irradiance Curves.

Photosynthesis-Irradiance experiments were conducted at 19 stations at two depths in the water column in photosynthetrons illuminated by 50 W, 12 V tungsten halogen lamps 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 μ Ci) and 370 kBq (15 μ Ci) of 14 C labelled bicarbonate. The samples were maintained at *in situ* temperature using the ships non-toxic supply. After 1 to 2 h of incubation, the suspended material were filtered through 25 mm Whatman GF/F filters to measure the total production. The filters were exposed to concentrated HCl fumes for 12 h immersed in scintillation cocktail and 14 C disintegration time per minute (DPM) was measured on board using a WinSpectral 1414 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 $^{-1}$ (μ mol m $^{-2}$ s $^{-1}$) $^{-1}$] was estimated by fitting the data to the model of Platt *et al.* (Platt *et al.*, 1980).

Ocean Acidification (OA) Experiments. Five stations were occupied in the North Atlantic at which pCO $_2$ enrichment experiments were run for 48 hrs. A bulk quantity of sea water (80 l) was collected from the ships underway supply at 04:00 GMT coincident with the pre-dawn CTD cast. The water was initially characterised for Alkalinity, pH, pCO $_2$, Chla, Flow Cytometry and photosynthesis-irradiance curves. The water was then sub-divided into 4 litre sub-samples in polycarbonate bottles which were bubbled with either pCO $_2$ or pre-mixed air for 12 hrs and a further 4 hrs after 24 hrs under ambient temperature and irradiance. Measurements of , pH, pCO $_2$, Chla, and Flow Cytometry were taken in triplicate and single measurements of photosynthesis-irradiance curves, low temperature emission spectra and alkalinity were made at 12, 24 and 48 hrs of incubation.

CDOM absorption coefficients ($a_{CDOM}(\lambda)$). Seawater samples from 4 to 6 depths in the water column were filtered through 0.2 μ m 25mm Whatman Anodisc filters using acid cleaned glassware. The first two 0.25l of the filtered seawater were discarded. The absorption properties of the third sample were determined in an 10 cm quartz cuvettes from 350 to 750 nm relative to a bi-distilled MilliQ reference blank using a Perkin Elmer Lambda 35 spectrophotometers. $a_{CDOM}(\lambda)$ was calculated from the optical density of the sample and the cuvette path length (Tilstone *et al.* 2004).

Table 1. Stations at which size fractionated primary production (PP), phytoplankton photosynthesis (PE curves), Ocean Acidification (OA) experiments and $a_{CDOM}(\lambda)$.

CTD No.	Date	Time In water GMT	Lat	Long	depths (m)	Measurements taken†
001	13 Oct		49° 40.32' N	07° 41.06' W	30	CDOM
002	14 Oct	04:35	49° 24.35' N	11° 09.88' W	0, 5, 10, 20, 30, 50	PP size fractionated, PE Curves, OA experiments
004	14 Oct	13:04	49° 16.19' N	12° 53.04' W	0, 30, 50, 200	CDOM
005	15 Oct	04:33	49° 02.18' N	16° 25.87' W	0, 5, 10, 20, 25, 45	PP size fractionated
007	15 Oct	13:06	48° 06.97' N	17° 19.49' W	0, 20, 50, 100, 200, 300	CDOM
008	16 Oct	04:53	46° 03.32' N	19° 11.46' W	0, 10, 15, 30, 40, 70	PP size fractionated
0010	16 Oct	13:04	45° 11.81' N	19° 56.02' W	0, 50, 58, 300	CDOM
0011	17 Oct	04:25	43° 32.99' N	21° 21.85' W	0, 8, 16, 29, 39, 68	PP size fractionated
0013	17 Oct	13:07	42° 46.03' N	22° 02.08' W	0, 25, 50, 100	CDOM
0014	18 Oct	04:29	40° 59.66' N	23° 28.76' W	0, 15, 28, 50, 60,	PP size fractionated, PE Curves,

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CTD No.	Date	Time In water GMT	Lat	Long	118	OA experiments
					depths (m)	Measurements taken†
0016	18 Oct	13:05	40° 07.88' N	24° 11.57' W	0, 70, 200, 300	CDOM
0019	20 Oct	16:17	34° 56.42' N	28° 56.62' W	0, 32, 65, 200, 300	CDOM
0020	21 Oct	05:31	34° 13.09' N	29° 45.70' W	0, 10, 25, 40, 55, 95	PP size fractionated
0021	21 Oct	14:06	33° 50.54' N	30° 12.21' W	0, 55, 110, 200, 300	CDOM
0022	22 Oct	05:28	32° 25.54' N	31° 48.01' W	0, 15, 25, 45, 65, 100, 165	PP size fractionated
0024	22 Oct	14:08	31° 43.80' N	32° 33.77' W	0, 40, 90, 200, 300	CDOM, PE Curves
0025	23 Oct	05:27	30° 17.09' N	34° 10.74' W	0, 26, 47, 63, 84, 110, 165	PP size fractionated
0027	23 Oct	14:10	29° 36.60' N	34° 54.08' W	0, 60, 100, 200, 300	CDOM, PE Curves
0028	24 Oct	05:29	28° 06.73' N	36° 30.98' W	0, 27, 49, 66, 87, 115, 172	PP size fractionated, PE Curves, OA experiments
0030	24 Oct	14:03	27° 27.09' N	37° 14.00' W	0, 80, 120, 200, 300	CDOM
0032	25 Oct	05:28	25° 59.94' N	38° 46.98' W	0, 25, 45, 60, 80, 100, 150	PP size fractionated
0034	25 Oct	14:09	25° 16.19' N	39° 31.82' W	0, 60, 125, 200, 300	CDOM
0035	26 Oct	05:23	23° 46.26' N	41° 06.46' W	0, 30, 50, 70, 90, 120, 180	PP size fractionated
0037	26 Oct	14:02	22° 57.81' N	40° 31.92' W	0, 70, 125, 200, 300	CDOM
0038	27 Oct	05:27	21° 12.71' N	39° 17.59' W	0, 25, 50, 65, 85, 115, 170	PP size fractionated
0040	27 Oct	14:08	20° 25.86' N	38° 14.34' W	0, 65, 115, 200, 300	CDOM, PE Curves
0041	28 Oct	05:34	18° 41.49' N	37° 31.37' W	0, 30, 55, 70, 95, 125, 190	PP size fractionated, PE Curves, OA experiments
0043	28 Oct	14:06	17° 54.77' N	36° 59.03' W	0, 60, 110, 200, 300	CDOM
0044	29 Oct	05:26	16° 11.44' N	35° 48.37' W	0, 22, 40, 54, 71, 94, 141	PP size fractionated
0046	29 Oct	14:06	15° 25.43' N	35° 17.13' W	0, 55, 90, 200, 300	CDOM
0047	30 Oct	05:43	13° 27.78' N	33° 57.03' W	0, 15, 25, 30, 40,	PP size fractionated

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					55, 100	
CTD No.	Date	Time In water GMT	Lat	Long	depths (m)	Measurements taken†
0049	30 Oct	14:08	12° 32.73' N	33° 19.73' W	0, 40, 60, 200, 300	CDOM
0050	31 Oct	05:30	10° 34.00' N	31° 59.70' W	0, 15, 25, 35, 40, 66, 100	PP size fractionated
0052	31 Oct	14:12	09° 45.04' N	31° 27.46' W	0, 50, 100, 200, 300	CDOM
0053	01 Nov	05:28	07° 48.85' N	30° 09.58' W	0, 15, 30, 40, 50, 65, 100	PP size fractionated, PE Curves, OA experiments
0055	01 Nov	14:04	06° 47.24' N	29° 29.04' W	0, 65, 100, 200, 300	CDOM
0056	02 Nov	04:30	04° 48.24' N	28° 09.95' W	0, 20, 35, 45, 60, 80, 120	PP size fractionated
0058	02 Nov	14:06	03° 53.14' N	27° 33.89' W	0, 30, 68, 110, 300	CDOM
0061	05 Nov	04:53	03° 51.08' S	25° 01.06' W	0, 15, 30, 40, 55, 70, 110	PP size fractionated
0063	05 Nov	13:09	04° 53.44' S	25° 01.78' W	0, 55, 100, 200, 300	CDOM
0064	06 Nov	04:31	06° 03.45' S	23° 45.77' W	0, 25, 40, 55, 75, 100, 150	PP size fractionated
0066	06 Nov	13:07	06° 16.09' S	27° 41.89' W	0, 55, 90, 200, 300	CDOM
0067	10 Nov	04:43	12° 31.75' S	19° 01.32' W	0, 30, 55, 75, 100, 130, 200	PP size fractionated
0068	10 Nov	13:07	13° 28.40' S	19° 57.99' W	0, 60, 135, 210, 300	CDOM
0069	11 Nov	04:25	15° 19.88' S	21° 50.48' W	0, 35, 65, 85, 115, 145, 225	PP size fractionated
0070	11 Nov	13:07	16° 18.97' S	22° 50.50' W	0, 65, 150, 180, 300	CDOM, PE Curves
0071	12 Nov	10:59	18° 32.22' S	25° 07.78' W	0, 60, 145, 215, 300	CDOM, PE Curves
0072	13 Nov	04:30	20° 22.78' S	25° 05.35' W	0, 20, 40, 74, 100, 130, 165, 250	PP size fractionated
0073	13 Nov	13:05	21° 42.35' S	25° 05.81' W	0, 65, 150, 225, 300	CDOM, PE Curves
0074	14 Nov	04:30	23° 50.27' S	26° 34.02' W	0, 36, 64, 87, 114, 150, 225	PP size fractionated
0075	14 Nov	13:30	24° 49.14' S	27° 21.50' W	0, 55, 130, 250,	CDOM, PE Curves

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CTD No.	Date	Time In water GMT	Lat	Long	300 depths (m)	Measurements taken†
0076	15 Nov	5:35	26° 51.45' S	29° 04.08' W	0, 30, 55, 70, 95, 120, 190	PP size fractionated
0077	15 Nov	14:10	27° 54.95' S	29° 59.20' W	0, 60, 100, 200, 300	CDOM, PE Curves
0078	16 Nov	05:30	29° 56.61' S	31° 49.40' W	0, 35, 60, 85, 110, 145, 200	PP size fractionated
0079	16 Nov	14:07	30° 59.73' S	32° 48.84' W	0, 65, 100, 200, 300	CDOM, PE Curves
0080	17 Nov	05:32	33° 02.67' S	34° 50.73' W	0, 20, 36, 48, 65, 85, 125	PP size fractionated
0081	17 Nov	14:12	34° 06.45' S	35° 55.53' W	0, 70, 110, 140, 300	CDOM, PE Curves
0082	18 Nov	05:30	36° 05.46' S	38° 05.26' W	0, 12, 20, 30, 40, 50, 75	PP size fractionated
0083	18 Nov	14:09	37° 05.63' S	39° 13.83' W	0, 65, 100, 200, 300	CDOM, PE Curves
0084	19 Nov	05:30	38° 55.52' S	41° 27.08' W	0, 10, 20, 34, 46, 80	PP size fractionated
0085	19 Nov	14:12	39° 47.48' S	42° 33.13' W	0, 35, 60, 100, 200, 300	CDOM, PE Curves
0086	20 Nov	06:30	41° 39.36' S	45° 05.57' W	0, 5, 10, 15, 20, 30, 45	PP size fractionated
0087	20 Nov	15:12	42° 29.88' S	46° 17.77' W	0, 30, 100, 200, 300	CDOM, PE Curves
0088	21 Nov	06:31	44° 11.99' S	48° 56.31' W	0, 5, 10, 15, 20, 30, 45	PP size fractionated
0089	21 Nov	15:12	45° 00.99' S	50° 17.07' W	0, 30, 100, 200, 300	CDOM, PE Curves

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Quantification and variation in cellular DMSP contents of prokaryotes

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Aim: To determine the cellular dimethylsulphoniopropionate (DMSP) contents of prokaryotic bacteria and cyanobacteria within planktonic communities, inhabiting the euphotic zone of temperate, tropical and equatorial regions of the North and South Atlantic Ocean.

Why?: There is a large percentage of sulphur unaccounted for in the sulphur cycling budget of the ocean. Initial studies (unpublished) point to bacteria and cyanobacteria as a significant pool of sulphur in the form of DMSP.

Approach: Flow cytometric cell sorting of heterotrophic bacteria (live-stained with Sybr Green I), and the cyanobacterial genera *Synechococcus* and *Prochlorococcus* spp. onboard ship, followed by post-cruise analysis of samples by gas chromatography (GC).

Methods

For each experiment, two seawater samples were collected in clean 10 and 20 L polypropylene carboys from a Seabird CTD system containing a 24 bottle rosette of 20 L Niskin bottles from predawn CTD casts. One sample was taken either from the mixed layer or 7% light level for cell sorting and the other sample was taken from 300 m to provide a source of water with low DMSP concentration. Approx. 8 L of the 300 m sample was gravity filtered through a 0.2 µm Whatman cartridge filter to provide sheath fluid for flow cytometry. Approx. 5-8 L of the other sample was gravity filtered through two 0.2 µm Sterivex filters over 2-4 h to provide concentrated samples for flow sorting of cyanobacteria. Heterotrophic bacteria were sorted using unconcentrated seawater. Samples were measured and flow-sorted using a Becton Dickinson FACSort flow cytometer which characterised and enumerated *Prochlorococcus* sp. and *Synechococcus* sp. (cyanobacteria), and heterotrophic bacteria based on their light scattering and fluorescence properties. The flow cytometer was set up with the 0.2µm filtered 300 m seawater as sheath fluid and the cell sorting mechanism of the flow cytometer was left to warm up for at least 15 minutes. Samples of filtered 300 m seawater, concentrated seawater, unconcentrated seawater, and seawater stained with Sybr Green I were analysed and population sorting gates decided upon. To check the purity and efficiency of sorting, samples of sorted cells/beads were first re-analysed on the flow cytometer. The following groups were selected for sorting: *Synechococcus* and *Prochlorococcus* spp. (cyanobacteria), heterotrophic bacteria and 0.5 µm beads suspended in natural seawater stained with Sybr Green I to act as a non-DMSP control. For each group a series of 5 sorts was conducted of either 20k, 40k, 60k, 80k, 100k cells/beads or 30k, 60k, 90k, 120k, 150k cells/beads. Sorted cells, diluted in sheath fluid, were dripped onto a 25 mm Advantec GF75 filter and very gently vacuum filtered. Filters with sorted cells were then placed in glass vials containing 35 µL 50% sulphuric acid and 7 mL Milli-Q water to preserve them for GC analysis of their DMSP content back in the laboratory.

Table 1. summarises the CTD casts sampled for DMSP sorting experiments during the cruise.

Table 1: CTD casts sampled for DMSP sorting experiments

DATE	CTD	LAT (N+, S-)	LONG W	Sample depth (m)
16-Oct	009S	46.06	19.20	20
17-Oct	012S	43.55	21.36	20
22-Oct	023S	32.43	31.80	45
24-Oct	029S	28.11	36.51	65
26-Oct	036S	23.77	41.11	30
28-Oct	042S	18.69	37.52	70
01-Nov	54S	7.82	30.16	30
06-Nov	65S	-5.95	23.76	30
11-Nov	69S	-14.68	21.84	30
14-Nov	74S	-23.84	26.57	40
16-Nov	78S	-29.94	31.82	20
19-Nov	84S	-38.92	41.45	10

Net community production estimates from dissolved oxygen/argon ratios measured by membrane inlet mass spectrometry (MIMS) and gross productivity estimates from $^{17}\text{O}/^{16}\text{O}$ and $^{18}\text{O}/^{16}\text{O}$ isotope ratios of dissolved oxygen

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Rationale and objectives

The dissolved oxygen (O_2) concentration of seawater varies because of fundamental physical and biological processes. These include photosynthesis (P) and respiration (R), diffusive and bubble mediated gas exchange, temperature and pressure changes, lateral mixing and vertical diffusion. In the absence of physical effects, dissolved O_2 constrains the difference between P and R , i.e., net community production (N). Thus, O_2 can be used as a geochemical tracer that reflects carbon fluxes integrated over characteristic response times. Warming and bubble injection lead to O_2 supersaturation, posing a challenge to this approach. Craig and Hayward (1987) used oxygen/argon (O_2/Ar) ratios to separate O_2 supersaturations into a biological and a physical component. This method is based on the similar solubility characteristics of O_2 and Ar with respect to temperature and pressure changes as well as bubble injection. $\Delta \text{O}_2/\text{Ar}$ essentially records the difference between photosynthetic O_2 production and respiration. The measured $\Delta \text{O}_2/\text{Ar}$ values can be used in conjunction with suitable wind-speed gas-exchange parameterizations to calculate biologically induced air-sea O_2 fluxes and, where conditions are appropriate, N . The inferred N values represent rates integrated over the characteristic mixed layer gas exchange times (ratio of mixed layer thickness and piston velocity), typically between 10 and 30 days. Kaiser et al. (2005) introduced a method of continuous measurements of O_2 , Ar, N_2 and CO_2 with a Membrane Inlet Mass Spectrometer. This allows thorough characterisations of the cruise track.

A non-mass dependent isotope reaction in the stratosphere leads to anomalous isotopic compositions of oxygen ($\Delta^{17}\text{O}$), which is introduced into the troposphere and the ocean. Photosynthesis adds oxygen without this anomaly to the ocean. The extent of the anomaly is a measure for gross production (Luz and Barkan, 2000). Triple oxygen isotope measurements combined with O_2/Ar data can be used to estimate the ratio of net community production (N) to gross production (P) and the ratio of gas exchange to gross production. Again, in combination with suitable wind-speed gas-exchange parameterizations this can be used to estimate gross production over large regional scales at timescales of weeks to months.

Methodology

O_2/Ar and O_2 were analysed continuously from the non-toxic underway system. For O_2/Ar measurements, the ship's underway sampling system was used to pump water through an exchange chamber with a tubular Teflon AF membrane (Random Technologies) mounted on the inside. The membrane was connected to the vacuum of a quadrupole mass spectrometer (Pfeiffer Vacuum Prisma). The intake of the underway sampling system is located at the bow of the ship at approximately 5 m. The water from the underway sampling system passed through a $50\mu\text{m}$ filter and an open bucket at several litres per minute to remove macroscopic bubbles and particles and to avoid pressure bursts. A flow of about 38 ml/min was continuously pumped from the bucket through the membrane chamber, using a gear pump (Micropump). The membrane was kept at a temperature at least two degrees less than the sea water to avoid outgassing and keep the measurement stable. This was at 10, 15 or 8 °C and changed several times during the cruise track.

The flight tube of the mass spectrometer was in a thermally insulated box maintained at 70°C. In addition to the continuous measurements, 7-9 discrete samples were analysed for each pre dawn and solar noon cast (65 casts altogether) to define a depth profile.

The O_2/Ar data will have to be calibrated from discrete samples taken from the non-toxic supply twice daily at approximately 12 hour intervals. For this, 200-300 mL were drawn into pre-evacuated bottles containing 0.1 mL saturated HgCl_2 solution and will be analysed with an Isotope Ratio Mass Spectrometer (IRMS) at UEA once the samples have arrived in the UK. This analysis is more accurate and can correct for possible shifts in the MIMS measurements due to temperature influences of the lab or flow rate changes.

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Sampling had to be stopped from 19/10/10 to 20/10/11 in the evening for stopping at the Azores and from 07/11 – 09/11/10 for stopping at Ascension Island.

O₂ was measured in the non-toxic sea water supply by an Aandera optode during the whole duration of the cruise, with an exception of the dates already mentioned for the O₂/Ar data. The optode was calibrated with discrete Winkler samples 2-3 times a day, which were taken in duplicates. The signal of the measurements was generally stable, but showed lots of little peaks towards the end of the cruise, probably due to small bubbles in the pipes.

Comparisons between Winkler samples from Niskin bottles fired at the surface and Winkler samples taken from the non-toxic supply at the same time of the surface firing agreed well. No consumption of O₂ in the pipes as described elsewhere could be detected. MIMS samples from CTD surface sampling were sometimes slightly oversaturated in O₂/Ar, but this could be the case because of several reasons. As the samples weren't poisoned or fixed in any way, a direct comparison between Niskin and non-toxic sea water supply was not possible. The ratio could change either during the transect through the pipes or going through the filters before entering the membrane, if the filter wasn't cleaned often enough. Samples for oxygen isotope analysis to determine P and for O₂/Ar calibration were taken twice daily from the non-toxic supply and from the solar-noon cast from 2 Niskin bottles (surface and below the mixed layer). The CTD samples were first taken every second day, after about half the cruise every day as stations were missed due to stops on the Azores and Ascension Island.

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Calibration of CTDO₂

Discrete Winkler samples were taken from 6 Niskin bottles to calibrate the optode of the CTD. For the first half of the cruise, until reaching Ascension Island, this was done at the pre dawn cast for the Titanium CTD (21 casts) and at the solar noon cast for the Stainless steel CTD (32 casts altogether). As the titanium CTD wasn't used anymore after Ascension Island, only one calibration per day at the solar noon cast was conducted. Samples from a Niskin bottle fired at the surface were still collected at the pre dawn cast for comparison of O₂ content to the non-toxic sea water supply. Samples were drawn carefully into borosilicate glass bottles and later analysed by whole-bottle Winkler titration to a photometric endpoint. A thiosulphate solution of about 0.1770 mol/L was used, standardised with a KIO₃ solution of 0.1N (prepared gravimetrically at UEA and shipped as a solution). Blanks were determined in MQ water (Dickson, 1996). Samples from cold water or with very low O₂ content showed less agreement with CTD data, and the time between sampling and fixing of the samples was identified as a possible reason. Fixing of the samples was from then on done by Elena Garcia-Martin immediately after sampling and a better relationship between Winkler and CTD could be obtained. Calibration of the oxygen sensors was then done by Rob Thomas from BODC.

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Optical characterization of Dissolved Organic Matter and underway optical measurement for validation and calibration of the ocean color satellite imagery along the Atlantic Meridional Transect.

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1. Background

Oceans play a crucial role in controlling the World's climate through the regulation of CO₂ level by ocean-atmosphere exchange processes. Dissolved organic matter, is by far the largest pool of organic matter in the sea. About 97% of all organic carbon in the sea is bound in DOM (Hansell and Carlson, 1998). The estimated mass of DOC is 685 Giga tons of carbon (Hansell and Carlson, 2001). The mass of DOC in the sea is comparable with the mass of the carbon bound in the Earth's atmosphere as CO₂ and the amount of carbon bound in terrestrial ecosystems. An understanding of the mechanisms and processes regulating the amount of DOM in the sea is critical for our ability to understand the global carbon cycle. Therefore, research on marine DOM has intensified over last 30 years. The main results of recent DOM gave information on spatial and temporal variability of DOC in oceanic systems and its sources and sinks in different time scales (Hedges, 2002). The dominating source of organic matter in the worlds' ocean is autochthonous production, that account of more than 95% of total organic matter. The input of terrestrial DOM represents only 2-3% of the total oceanic DOM pool, although in may be dominant source of DOM in coastal seas (Opsahl and Benner, 1997). In the past the DOM has been regarded as a large inert reservoir of carbon in the ocean that below the oceans' mixed layer is excluded from current carbon cycle. Results of recent studies have revealed that DOM is an active and most dynamic component carbon biogeochemical cycles and plays important roles in marine ecosystems (e.g. Mopper et al., 1991). Optically active fraction of DOM is one of the major determinants of the optical properties of natural waters and hence directly affects both the availability and spectral quality of light in the water column (Jerlov, 1976; Blough and Del Vecchio, 2002). Through its effects on the attenuation of light in the water column, CDOM may stimulate or hinder primary production, temperature stratification and exposure of marine organisms to harmful UV radiation (e.g. Mopper and Kieber, 2002). Photochemical reactions of CDOM produce inorganic carbon, low-molecular-weight organic compounds, trace gases, and phosphorus- and nitrogen-rich compounds (e.g. Vähätalo and Zepp, 2005, Stedmon et al., 2007). DOM has the ability to complex with trace metals that are later released to the marine environment during DOM remineralization. Therefore, the ability to differentiate and quantify sources of CDOM in the oceans and the factors underlying its variability is fundamentally important to understand biogeochemical cycles in the oceans.

Interest in CDOM and its characterization has grown recently for several reasons: i) remote sensing of ocean color is related to organic carbon cycling (Blough and Del Vecchio 2002); ii) possible interference with remote sensing measurements of chlorophyll as an indicator of primary productivity; iii) air-sea exchange of important trace gases, namely CO, CO₂ and COS; iv) the formation of reactive oxygen species and their potential impact on biological processes and geochemical cycling; v) as a tracer of riverine input of organic carbon to the ocean and carbon cycling in coastal waters; vi) the attenuation of ultraviolet light in surface waters.

The optical properties of CDOM in natural waters have been studied for many decades by researchers of ocean color remote sensing and aquatic optics (see review by Blough and Del Vecchio, 2002 and references therein). Optical properties of CDOM enable the application of remote sensing methods to study its distribution and dynamics on global and regional scales (Siegel et al., 2002, 2005). Many physical, chemical and biological processes influence the distribution and optical properties of CDOM. Among the most important in open marine areas is dilution of terrestrially-derived CDOM, photochemical bleaching, bacterial degradation, and autochthonous production of CDOM by plankton (Whitehead et al., 2000; Rochelle-Newall and Fisher, 2002; Osburn and Morris, 2003; Zepp, 2003).

A component of CDOM fluoresces (FDOM). This property of DOM has been known for a long time (Duursma, 1974) and it has been used to estimate CDOM levels in marine waters. Numerous investigators have observed linear relationships between fluorescence and absorption (Vodacek et al., 1997; Ferrari and Dowell, 1998; Ferrari, 2000). Recent advances in fluorescence spectroscopy have resulted in the development of Excitation Emission Matrix (EEM) fluorescence spectroscopy. EEM spectra (EEMs) are obtained by acquiring emission spectra at a series of successively increasing excitation wavelengths. The emission spectra are concatenated to generate a plot in which the fluorescence is displayed as a function of excitation and emission

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wavelengths. Although slower to collect, EEMs provide a more complete picture of CDOM emission properties and can often be used to discriminate among different classes of fluorophores of terrestrial, marine and anthropogenic origin based on their excitation/emission maxima. It is also possible to use EEMs to track changes in CDOM resulting from biological or physical processing of the material. Coble (1996) was first to successfully apply this method to field data analysis with descriptions of CDOM in the Caribbean, Arabian Sea and Gulf of Mexico (e.g. Coble et al., 1998; Del Castillo et al., 1999). The EEMs of fluorescent DOM from natural waters are composed of various types of overlapping fluorophores, and it may be difficult to assess dynamics of DOM aquatic environment based solely on the EEMs "peak picking" technique (Coble, 1996). Recently, Stedmon et al. (2003) applied a statistical modeling approach called Parallel Factor Analysis (PARAFAC) to decompose EEMs into individual fluorescent components. This new approach provides a considerable advantage over traditional methods in interpreting the multidimensional nature of EEMs data sets. The PARAFAC model has been used to study variability of DOM in coastal areas (Stedmon and Markager, 2005a), to observe effects of production and degradation processes of DOM fluorescence in marine environments (Stedmon and Markager, 2005b), and to trace anthropogenic pollutants in oceanic DOM (Murphy et al., 2006).

2. Cruise objectives

The main objectives of the optical measurements performed by the IOPAS team during the AMT20 cruise were:

1. Characterization of different DOM classes identified by PARAFAC model in the Excitation Emission Matrix spectra measured in samples collected in different aquatic environments in terms of their optical properties.
2. Identify processes that drive the quantitative and qualitative variability in DOM in time and space?
3. Link the optical properties of CDOM with the concentration of the Dissolved Organic Carbon.
4. Use of the underway measurements of inherent and apparent optical properties of oceanic water to extend the spatial distribution of DOM optical properties characterized with fluorescence spectroscopy.
5. Measure spectral values of the remote sensing reflectance using underway above water radiometry system for validation and calibration of satellite ocean color imagery products.

3. Methods

3.1 Measurements of CDOM optical properties.

Water samples for determining CDOM absorption, CDOM fluorescence and DOC concentration were collected at fixed depths with Niskin bottles attached to CTD rosette during solar noon casts. Water sample depths were determined upon features of the vertical profiles of the chlorophyll fluorescence: at all stations following depths were sampled: 300 m, 200 m, 100 m or Deep Chlorophyll Maximum (whichever deeper), bottom of the mixed layer, middle of the mixed layer and the water surface. Water samples for determination of CDOM absorption, fluorescence EEM and DOC concentrations underwent a two-step filtration process. The first filtration was through acid-washed Whatman glass fibre filters (GF/F, nominal pore size 0.7 μ m). The water was then passed through Sartorius 0.2 μ m pore cellulose membrane filters to remove fine-sized particles. Spectral absorption by CDOM was measured in the laboratory on board RRS James Cook.

The CDOM absorption coefficient was measured with liquid capillary wave guide cell system – LWCC with the nominal optical pathlength of 1.094 m, according to procedures described by D'Sa et al., (1999) and Miller et al., (2002). The World Precision Instruments capillary waveguide has the liquid forming the optical core contained by a rigid quartz capillary tubing that is coated by an amorphous polymer optical cladding with a refractive index less than that of an aqueous solution. Source light that is axially introduced into the waveguide via an optical fiber is transmitted and constrained within the capillary cell by total internal reflection because of the higher refractive index of the seawater in relation to the cell wall. At the opposite end of the waveguide, a detection fiber conducts the light that is not absorbed by the aqueous medium to a fiber-optics-based spectrometer that uses a diffraction grating to disperse the transmitted light into a CCD detector array. There is an inlet or outlet connection at each end of the waveguide for injecting filtered seawater samples or any other aqueous solution. The injected volume of sample was usually less than 4-5 ml. After injection of the sample volume the capillary waveguide cells were flushed with the small aliquot of the MilliQ water. Then 4-5 ml volume of MilliQ water has been measured as the blank. A deuterium lamp was used as a light source for UV wavelengths, and a halogen lamp

provided visible wavelengths. Using electronically controlled shutters, source light from either of the lamps was coupled into the waveguide using an optical fiber that was attached to the ST connector. The option of combining the UV and visible waveband spectra at a particular wavelength was provided through software, Spectral Suite, by Ocean Optics, Inc. USA. Each sample has been measured at the LWCC system in triplicate, to ensure the repeatability of the CCD detector. Raw recorded spectra were sent to Rüdiger Röttgers (Institute for Coastal Research, GKSS Research Centre Geesthacht, Max Planck Strasse 1, D-21502 Geesthacht, Germany, e-mail: rroettgers@gkss.de) for processing and calculations of the true CDOM absorption spectra with necessary corrections procedures applied. The LWCC system has been also used for calibration of the point source integrating cavity absorption meter – PSICAM. The absorption coefficient of the solution of Nigrosine has been measured first in the LWCC system, and then the same solution have been measured with PSICAM. The calibration procedure has been repeated every second day.

The 0.22- μm filtered sample water is measured as soon as possible with the PSICAM system as described in Röttgers et al. (2005). Therefore the cavity of the PSICAM is filled with purified water, air bubbles are removed from the cavity wall and the central light sphere by gentle shaking, and the reference intensity spectrum is recorded between 350 and 726 nm (or up to 800 nm, dependent on the detector type). Afterwards, the filtered sample water is poured into the cavity in the same way, and the sample intensity spectrum is recorded. The cavity is rinsed and filled with purified water again, and a second reference intensity spectrum is recorded. The two reference spectra are used to calculate two “transmissions” (sample/reference) and, further, two absorption coefficient spectra. The mean of these two spectra is taken as the real absorption coefficient spectrum. This procedure corrects for small but constant intensity shifts in the PSICAM induced by unstable light focusing onto the fiber-optic connection. Each sample is measured at least two times in this way to control repeatability. Collected spectra measured with the PSICAM spectrophotometers were sent to Rüdiger Röttgers (Institute for Coastal Research, GKSS Research Centre Geesthacht, Max Planck Strasse 1, D-21502 Geesthacht, Germany, e-mail: rroettgers@gkss.de) for processing and calculations of the true CDOM absorption spectra with corrections procedures applied, described in details by Röttgers and Doerffer (2007).

Samples for fluorescence were treated in the same manner as those for absorption measurements. Before spectroscopic scans of DOM, the samples were allowed to warm to room temperature. DOM fluorescence measurements were made on a Varian Cary Eclipse scanning spectrofluorometer. A series of emission scans (280–600 nm, 2 nm resolution) were collected over excitation wavelengths ranging from 240 to 500 nm by 5-nm increments. The instrument was configured to collect the signal using maximum lamp energy and 5 nm band pass on both the excitation and emission monochromators. Collected Excitation Emission spectra will be further processed using DOM fluorescence toolbox developed by Stedmon and Bro (2007). Samples will be spectrally corrected with set of instrument dependent correction coefficients and calibrated against the water Raman scatter peak (excitation wavelength of 350 nm) of a Milli-Q water sample, run the same day. Then a Raman normalized Milli-Q EEM will be subtracted from the data to remove the Raman signal. The Raman normalization and correction procedures will result in spectra that are in Raman units ($\text{R.U.}, \text{nm}^{-1}$) and are directly comparable to corrected spectra measured on other machines. The corrected and calibrated EEM spectra will be statistically analyzed with the method described by Stedmon et al., (2003), and the PARAFAC model will be derived with use of the in MATLAB using the “N-way toolbox for MATLAB ver. 2.0” (Andersson and Bro, 2002). PARAFAC aids the characterization of fluorescent DOM by decomposing the fluorescence matrices into different independent fluorescent components.

3.2 DOC concentration.

Samples for DOC measurements were passed through 0.2 μm pre-cleaned membrane filters. A total of 40 ml aliquots of filtrate were acidified with 150 μl 0.1 M HCl and stored in the dark at 5°C until laboratory analysis. Samples will be shipped in the conditioned container to Institute of Oceanology, Polish Academy of Sciences, Sopot, Poland for estimation of the DOC concentration in the laboratory. These will be done in a ‘HyPerTOC’ analyser (Thermo Electron Corp., The Netherlands) using UV/persulphate oxidation and non-dispersive infrared detection (Sharp 2002). Measurements of each sample using the standard addition method (potassium hydrogen phthalate) will be performed in triplicate. Quality control of DOC concentrations will be performed with reference material supplied by Hansell Laboratory, University of Miami. The methodology will ensure satisfactory accuracy. The quality assessment performed in the previous studies in the Baltic Sea have given following results: average recovery 95%; $n = 5$; CRM = 44 – 46 $\mu\text{M C}$; our results = 42 – 43 $\mu\text{M C}$ and precision characterized by a relative standard deviation (RSD) of 2% (Kowalczyk et al., 2010).

3.3 Underway optical measurements of spectral attenuation and absorption coefficients, CDOM fluorescence and particles size distributions.

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In addition to collecting water samples for spectroscopic measurements in the laboratory of the inherent optical properties of the sea water, inherent optical properties were also measured in situ, along the ship track, using Integrated Optical-Hydrological Probe. The TRIOS MicroFlu-CDOM fluorometer and SeaBird SB47 CTD were coupled with the WETLabs ac-9 plus spectrophotometer, which functioned as the data integrator. The instrument setup, referred to as the Integrated Optical-Hydrological Probe, was fitted into one rig and connected by telemetry cable with the power supply and data transmission and control deck unit. The ac-9 plus and CTD water intakes were installed on the same horizontal plane as the optical window of the fluorometer. The signals from all the sensors were transmitted in real time via the telemetry cable to a laptop on board, where they were merged and synchronized along with their time stamps with WAP 4.25 software supplied by WETLabs Inc. USA. All of the signals were processed further using software written in the Matlab® environment. This had calibration procedures for all the sensors, and it merged all the measured geophysical parameters and calibrated values in physical units into a depth binned matrix.

The Integrated Optical-Hydrological probe was deployed as the quasi-flow through instrument for continuous underway measurements of inherent optical properties of sea water. It was placed in the tank filled with flowing water pumped from the ships non-toxic water supply system. The retention time of water present in the tank was estimated for ca. 3 minutes. Assuming and average ship cruising speed for 10 knots and average retention time of water in the tank, this gives ca. 900 m spatial displacement between place where water volume was taken by the non-toxic water supply and actual ships position during measurement time in the tank. The underway measurements of inherent optical properties started on October 13, 2010 and were continued until November 22, 2010. The measurements were suspended on October 19, 2010 and November 9, 2010, during the ship's passage through the Economic Exclusion Zone around Azores and Ascension Island. During the Integrated Optical-Hydrological probe deployment period readings received from instruments were monitored continuously for bio-fouling effects. When the anomalous readings were noticed, measurement were suspended, the instruments were disconnected, and taken to the laboratory for cleaning, maintenance and field calibration procedures recommended in each instrument manual. In the oligotrophic gyres in the North and South Atlantic the maintenance was performed once a week, in the more productive waters of the western European Shelf, Equatorial Upwelling and the approaches to Patagonian Shelf the maintenance was more frequent.

The inherent optical properties of the sea water were measured using an ac-9 plus (WETLabs Inc., USA) spectral attenuation and absorption meter. In situ measurements of the light absorption a and attenuation c were performed at wavelengths of 412, 440, 488, 510, 532, 555, 650, 676 and 715 nm. The instrument was calibrated in pure water and routinely checked for stability with air-readings. Air offset, temperature and salinity corrections were applied according to the manual. Since the ac-9 absorption signal needs correction for scattering, the so-called 'Zaneveld method' was applied, which assumes zero absorption for 715 nm (Zaneveld et al. 1995).

CDOM fluorescence was measured with a MicroFlu-CDOM fluorometer (TRIOS GmbH, Germany), which is suitable for in situ measurements without the prior filtration of the water. The MicroFlu-CDOM fluorometer uses UV-LED in pulse mode as the excitation light source. The maximum of the excitation light spectrum is 370 nm. A small percentage of light is reflected by the dichroic beam splitter and is used as the reference signal for calculating the excitation energy. The fluorometer excites samples of a small volume of water at the front of the optical window at a focal length of 15 mm. It uses a photo-diode with an interference filter as the light detector. The maximum emission of the light detector is set at 460 nm. Specially developed circuitry eliminates the influence of ambient light. The MicroFlu-CDOM fluorometer was calibrated by the manufacturer annually during the deployment period (2008–2010). The measured signal was transmitted to the via telemetry cable to a deck power supply and telemetry control unit in the form of the analog DC voltages. The voltages were converted to QSE calibrated units, as described in details by Kowalczyk et al., (2010).

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10-Nov-2010. Time:14:16:00--12:57:23

Route:..JC053;Δ t=30s

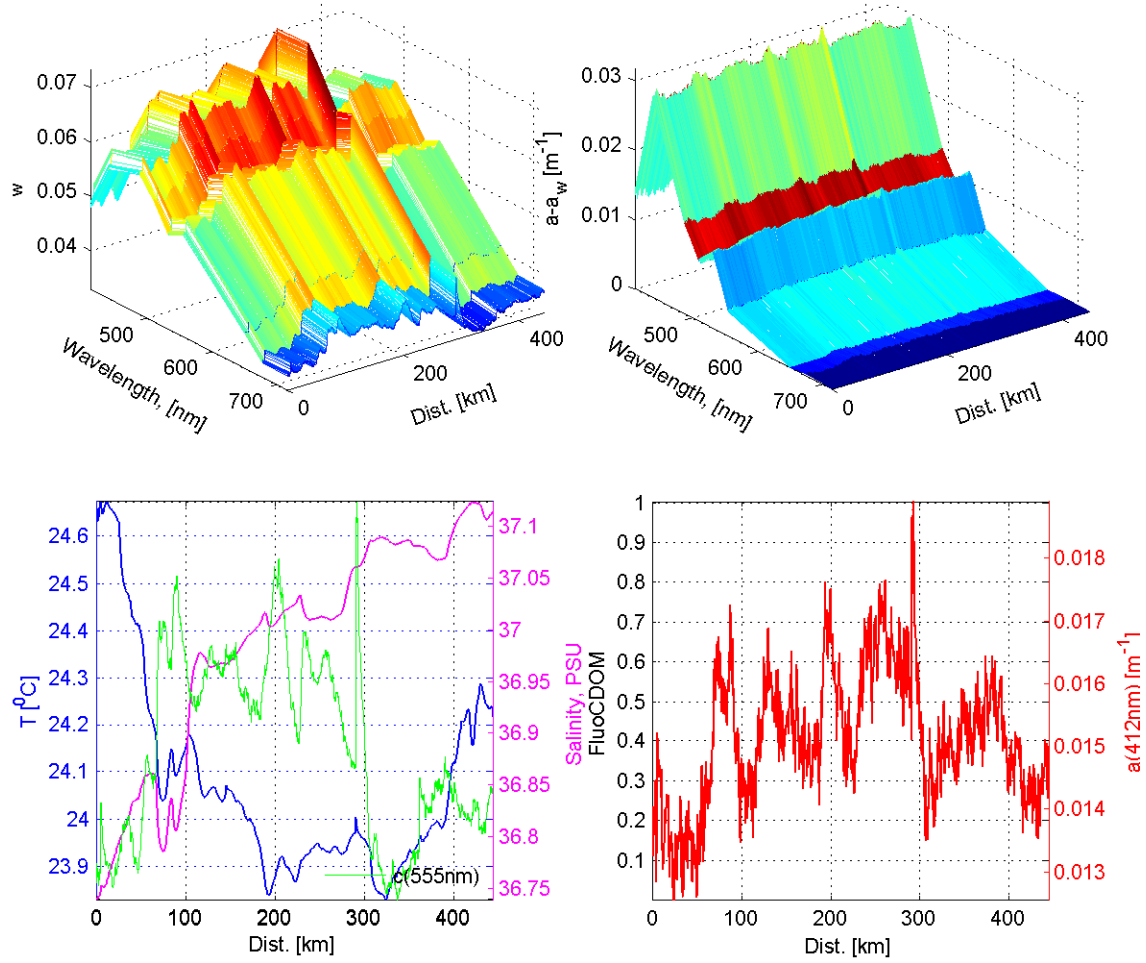


Figure 1. Example of the spectral attenuation, spectral absorption and CDOM fluorescence measurements acquired with the underway deployment of the Integrated Optical-Hydrological probe in the center of the Southern Atlantic oligotrophic gyre. Transect presented on the figure has started on 10 November 2010 at 14:16 GMT, on the station JC053_051 and finished on 11 November 2010 at 12:57 GMT, on the station JC053_053.

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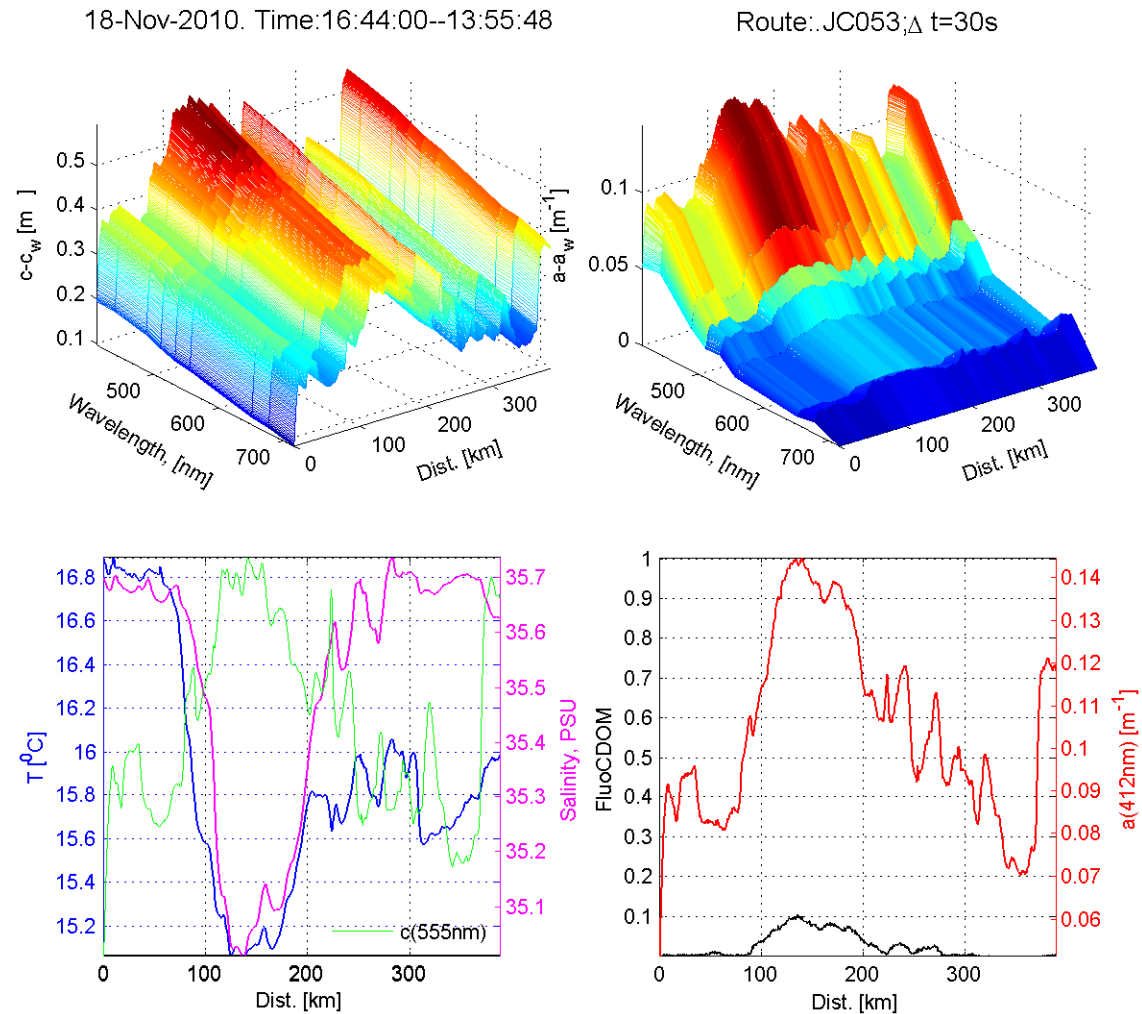


Figure 2. Example of the spectral attenuation, spectral absorption and CDOM fluorescence measurements acquired with the underway deployment of the Integrated Optical-Hydrological probe in the Southern Atlantic. Transect presented on the figure has started on 18 November 2010 at 16:44 GMT, on the station JC053_068 and finished on 19 November 2010 at 13:58 GMT, on the station JC053_070.

The laser in situ scattering and attenuation meter LIIST 100X (Sequoia Instruments, Inc., USA) was deployed along with the Integrated Optical-Hydrological probe for continuous underway measurements of particle size distribution. This instrument was equipped with flow through measurements chamber fed with the marine water from the ship's non-toxic water supply system. This self-contained instrument consists of the a solid-state laser operating at 670 nm wavelength and fiber-optically connected to a laser beam collimating system, a beam manipulation and orienting system, a scattered-light receiving lens, the specially designed 32-ring detector, preamplifier electronics, a ring-selecting multiplexer circuitry, and a data logger. The principal measurement—angular scattering distribution—is obtained over 32 ring-detectors whose radii increase logarithmically from 102 to 20,000 microns. The detector is placed in the focal plane of the receiving lens. The rings cover an angular range from 0.0017 to 0.34 radians. This angular range corresponds, respectively, to size ranges from 1.2 to 250 microns. The laser diffraction method for sizing particles is a used for determining size distribution for the simple reason that for laser diffraction, the composition or refractive index of the particles is not important. This method determines size distribution of an ensemble of particles, as opposed to counting type devices that size one particle at a time (Agrawal, et al., 2008). The cleaning, maintenance and field calibration schedule was the same as for the Integrated Optical-Hydrological probe.

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The inherent optical properties spectra collected during the underway deployment of the Integrated Optical-Hydrological probe would require the post cruise reprocessing for removal of spikes and unusual features in spectral distribution of the absorption coefficient and attenuation coefficient spectra. This was particularly prominent in the clean waters in oligotrophic gyres in the Northern and Southern Atlantic, see Figure 1. The spectra measure in more turbid water of the Western English Channel and Patagonian Shelf water were less affected by the unusual spectral distribution in the absorption and attenuation coefficient spectra. After the AMT20 cruise, the ac9 instrument will be sent to manufacture for annual calibration, and post cruise calibration coefficients will be used for the reprocessing of collected data set.

3.4. Underway above water radiometric measurement.

The daily radiometric measurements were performed to contribute to the calibration- validation effort of ocean color satellite imagery products. The free of atmospheric error, water-leaving radiance, sky radiance and downwelling irradiance were measured from the bow platform of the RRS James Cook. Measurements were conducted along ship track in day light between 09:30 and 17:30 local time, daily. The measurements were also conducted when the ship was stopped on station, around the local solar noon. Measurements started on October 13, 2010 and were conducted every day until November 22, 2010. The measurements were suspended on October 19, 2010 and November 9, 2010, during the ship's passage through the Economic Exclusion Zone around Azores and Ascension Island. Measurements were not performed on October 26, 2010 due to heavy rain event. The sensors were calibrated in air and rain droplets on the optical lenses and cosine collector of irradiance sensor change the radiometers readings and deteriorate their accuracy.

The measurement system consists of set of RAMSES hyperspectral radiometers manufactured by TRIOS Optical Systems, TRIOS GmbH, Germany: a down-looking radiance radiometer, a sky-viewing radiance radiometer, downwelling irradiance radiometer. All radiometer were calibrated at the manufacturer laboratory on annual basis. All radiometers were mounted on the bow platform in the specially designed deployment rig, that enabled the angular adjustments in the vertical (nadir) and horizontal (azimuth) planes. Radiometers were connected with the deck unit telemetry control and the power supply deck unit, which was linked with the laptop computer through the RS232 serial port. The measurements were controlled by the MSDA_ex software. All radiometers were measuring radiometric quantities simultaneously triggered by the software trigger every 20 s. The data were collected in the spectral range from 350 nm to 850 nm with 2 nm resolution. The signal integration time varied from 6 ms to 128 ms depending on the illumination conditions by the incident solar radiation. These data were then used to estimate normalized water-leaving radiance as a function of wavelength. The radiance detector was set to view the water at 45 degrees from nadir as recommended by Mueller et al. (2003b). Sensors were rinsed regularly with Milli-Q water in order to remove salt deposits and any dust. The water radiance radiometer was able to view over an azimuth range of ~180 degrees across the ship's heading with no contamination from the ship's wake. The direction of the sensor was manually adjusted every hour to view the water between 90 - 120 degrees range from the sun's azimuth, to minimize sun glint. Protocols for operation and calibration were performed according to Mueller (Hooker et al., 2003; Mueller et al., 2003a; Mueller et al., 2003b).

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4. List of collected water samples for measurements of CDOM absorption spectra, CDOM fluorescence Excitation Emission Matrix spectra and DOC concentration.

No.	Collection date	Station	CTD	Time in (GMT)	Decima Latitude	Decima Longitude	Depth (m)	aCDOM LWCC	aCDOM PSICAM	FDO M EEM	DOC
1	2010-10-13	JC053_001	CTD001s	14:57	49,6718	-7,6842	0	y	y	y	y
2	2010-10-13	JC053_001	CTD001s	14:57	49,6718	-7,6842	10	y	y	y	y
3	2010-10-13	JC053_001	CTD001s	14:57	49,6718	-7,6842	20	y	y	y	y
4	2010-10-13	JC053_001	CTD001s	14:57	49,6718	-7,6842	30	y	y	y	y
5	2010-10-13	JC053_001	CTD001s	14:57	49,6718	-7,6842	60	y	y	y	y
6	2010-10-13	JC053_001	CTD001s	14:57	49,6718	-7,6842	100	y	y	y	y
7	2010-10-14	JC053_003	CTD004s	13:05	49,2698	-12,8839	0	y	y	y	y
8	2010-10-14	JC053_003	CTD004s	13:05	49,2698	-12,8839	10	y	y	y	y
9	2010-10-14	JC053_003	CTD004s	13:05	49,2698	-12,8839	25	y	y	y	y
10	2010-10-14	JC053_003	CTD004s	13:05	49,2698	-12,8839	30	y	y	y	y
11	2010-10-14	JC053_003	CTD004s	13:05	49,2698	-12,8839	200	y	y	y	y
12	2010-10-14	JC053_003	CTD004s	13:05	49,2698	-12,8839	300	y	y	y	y
13	2010-10-15	JC053_005	CTD007s	13:07	48,1162	-17,3243	0	y	y	y	y
14	2010-10-15	JC053_005	CTD007s	13:07	48,1162	-17,3243	20	y	y	y	y
15	2010-10-15	JC053_005	CTD007s	13:07	48,1162	-17,3243	50	y	y	y	y
16	2010-10-15	JC053_005	CTD007s	13:07	48,1162	-17,3243	100	y	y	y	y
17	2010-10-15	JC053_005	CTD007s	13:07	48,1162	-17,3243	200	y	y	y	y
18	2010-10-15	JC053_005	CTD007s	13:07	48,1162	-17,3243	300	y	y	y	y
19	2010-10-16	JC053_007	CTD010s	13:05	45,1969	-19,9337	0	y	y	y	y
20	2010-10-16	JC053_007	CTD010s	13:05	45,1969	-19,9337	20	y	y	y	y
21	2010-10-16	JC053_007	CTD010s	13:05	45,1969	-19,9337	50	y	y	y	y

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No.	Collection date	Station	CTD	Time in (GMT)	Decima Latitude	Decima Longitude	Depth (m)	aCDOM LWCC	aCDOM PSICAM	FDO M EEM	DOC
22	2010-10-16	JC053_007	CTD010s	13:05	45,1969	-19,9337	58	y	y	y	y
23	2010-10-16	JC053_007	CTD010s	13:05	45,1969	-19,9337	100	y	y	y	y
24	2010-10-16	JC053_007	CTD010s	13:05	45,1969	-19,9337	200	y	y	y	y
25	2010-10-16	JC053_007	CTD010s	13:05	45,1969	-19,9337	300	y	y	y	y
26	2010-10-17	JC053_009	CTD013s	13:07	42,7669	-22,0346	0	y	y	y	y
27	2010-10-17	JC053_009	CTD013s	13:07	42,7669	-22,0346	10	y	y	y	y
28	2010-10-17	JC053_009	CTD013s	13:07	42,7669	-22,0346	25	y	y	y	y
29	2010-10-17	JC053_009	CTD013s	13:07	42,7669	-22,0346	50	y	y	y	y
30	2010-10-17	JC053_009	CTD013s	13:07	42,7669	-22,0346	100	y	y	y	y
31	2010-10-17	JC053_009	CTD013s	13:07	42,7669	-22,0346	200	y	y	y	y
32	2010-10-17	JC053_009	CTD013s	13:07	42,7669	-22,0346	300	y	y	y	y
33	2010-10-18	JC053_011	CTD016s	13:06	40,1265	-24,1928	0	y	y	y	y
34	2010-10-18	JC053_011	CTD016s	13:06	40,1265	-24,1928	30	y	y	y	y
35	2010-10-18	JC053_011	CTD016s	13:06	40,1265	-24,1928	70	y	y	y	y
36	2010-10-18	JC053_011	CTD016s	13:06	40,1265	-24,1928	130	y	y	y	y
37	2010-10-18	JC053_011	CTD016s	13:06	40,1265	-24,1928	200	y	y	y	y
38	2010-10-18	JC053_011	CTD016s	13:06	40,1265	-24,1928	300	y	y	y	y
39	2010-10-20	JC053_013	CTD019s	16:17	34,9397	-28,9438	0	y	y	y	y
40	2010-10-20	JC053_013	CTD019s	16:17	34,9397	-28,9438	30	y	y	y	y
41	2010-10-20	JC053_013	CTD019s	16:17	34,9397	-28,9438	60	y	y	y	y
42	2010-10-20	JC053_013	CTD019s	16:17	34,9397	-28,9438	140	y	y	y	y
43	2010-10-20	JC053_013	CTD019s	16:17	34,9397	-28,9438	200	y	y	y	y
44	2010-10-20	JC053_013	CTD019s	16:17	34,9397	-28,9438	300	y	y	y	y
45	2010-10-21	JC053_015	CTD021s	14:03	33,8424	-30,2035	0	y	y	y	y
46	2010-10-21	JC053_015	CTD021s	14:03	33,8424	-30,2035	30	y	y	y	y

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No.	Collection date	Station	CTD	Time in (GMT)	Decima Latitude	Decima Longitude	Depth (m)	aCDOM LWCC	aCDOM PSICAM	FDO M EEM	DOC
47	2010-10-21	JC053_015	CTD021s	14:03	33,8424	-30,2035	55	y	y	y	y
48	2010-10-21	JC053_015	CTD021s	14:03	33,8424	-30,2035	110	y	y	y	y
49	2010-10-21	JC053_015	CTD021s	14:03	33,8424	-30,2035	200	y	y	y	y
50	2010-10-21	JC053_015	CTD021s	14:03	33,8424	-30,2035	300	y	y	y	y
51	2010-10-22	JC053_017	CTD024s	14:09	31,7298	-32,5626	0	y	y	y	y
52	2010-10-22	JC053_017	CTD024s	14:09	31,7298	-32,5626	25	y	y	y	y
53	2010-10-22	JC053_017	CTD024s	14:09	31,7298	-32,5626	90	y	y	y	y
54	2010-10-22	JC053_017	CTD024s	14:09	31,7298	-32,5626	200	y	y	y	y
55	2010-10-22	JC053_017	CTD024s	14:09	31,7298	-32,5626	300	y	y	y	y
56	2010-10-23	JC053_019	CTD027s	14:10	29,6100	-34,9013	0	y	y	y	y
57	2010-10-23	JC053_019	CTD027s	14:10	29,6100	-34,9013	25	y	y	y	y
58	2010-10-23	JC053_019	CTD027s	14:10	29,6100	-34,9013	60	y	y	y	y
59	2010-10-23	JC053_019	CTD027s	14:10	29,6100	-34,9013	100	y	y	y	y
60	2010-10-23	JC053_019	CTD027s	14:10	29,6100	-34,9013	200	y	y	y	y
61	2010-10-23	JC053_019	CTD027s	14:10	29,6100	-34,9013	300	y	y	y	y
62	2010-10-24	JC053_021	CTD030s	14:03	27,4516	-37,2334	0	y	y	y	y
63	2010-10-24	JC053_021	CTD030s	14:03	27,4516	-37,2334	30	y	y	y	y
64	2010-10-24	JC053_021	CTD030s	14:03	27,4516	-37,2334	80	y	y	y	y
65	2010-10-24	JC053_021	CTD030s	14:03	27,4516	-37,2334	118	y	y	y	y
66	2010-10-24	JC053_021	CTD030s	14:03	27,4516	-37,2334	200	y	y	y	y
67	2010-10-24	JC053_021	CTD030s	14:03	27,4516	-37,2334	300	y	y	y	y
68	2010-10-25	JC053_023	CTD034s	14:10	25,1699	-39,5302	0	y	y	y	y
69	2010-10-25	JC053_023	CTD034s	14:10	25,1699	-39,5302	30	y	y	y	y
70	2010-10-25	JC053_023	CTD034s	14:10	25,1699	-39,5302	60	y	y	y	y
71	2010-10-25	JC053_023	CTD034s	14:10	25,1699	-39,5302	120	y	y	y	y

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No.	Collection date	Station	CTD	Time in (GMT)	Decima Latitude	Decima Longitude	Depth (m)	aCDOM LWCC	aCDOM PSICAM	FDO M EEM	DOC
72	2010-10-25	JC053_023	CTD034s	14:10	25,1699	-39,5302	200	y	y	y	y
73	2010-10-25	JC053_023	CTD034s	14:10	25,1699	-39,5302	300	y	y	y	y
74	2010-10-26	JC053_025	CTD037s	14:06	22,9636	-40,5320	0	y	y	y	y
75	2010-10-26	JC053_025	CTD037s	14:06	22,9636	-40,5320	30	y	y	y	y
76	2010-10-26	JC053_025	CTD037s	14:06	22,9636	-40,5320	70	y	y	y	y
77	2010-10-26	JC053_025	CTD037s	14:06	22,9636	-40,5320	125	y	y	y	y
78	2010-10-26	JC053_025	CTD037s	14:06	22,9636	-40,5320	190	y	y	y	y
79	2010-10-26	JC053_025	CTD037s	14:06	22,9636	-40,5320	300	y	y	y	y
80	2010-10-27	JC053_027	CTD040s	14:08	20,4177	-38,7390	0	y	y	y	y
81	2010-10-27	JC053_027	CTD040s	14:08	20,4177	-38,7390	25	y	y	y	y
82	2010-10-27	JC053_027	CTD040s	14:08	20,4177	-38,7390	65	y	y	y	y
83	2010-10-27	JC053_027	CTD040s	14:08	20,4177	-38,7390	115	y	y	y	y
84	2010-10-27	JC053_027	CTD040s	14:08	20,4177	-38,7390	300	y	y	y	y
85	2010-10-28	JC053_029	CTD043s	14:07	17,9128	-36,9839	0	y	y	y	y
86	2010-10-28	JC053_029	CTD043s	14:07	17,9128	-36,9839	30	y	y	y	y
87	2010-10-28	JC053_029	CTD043s	14:07	17,9128	-36,9839	60	y	y	y	y
88	2010-10-28	JC053_029	CTD043s	14:07	17,9128	-36,9839	110	y	y	y	y
89	2010-10-28	JC053_029	CTD043s	14:07	17,9128	-36,9839	180	y	y	y	y
90	2010-10-28	JC053_029	CTD043s	14:07	17,9128	-36,9839	300	y	y	y	y
91	2010-10-29	JC053_031	CTD046s	14:07	15,4238	-35,2855	0	y	y	y	y
92	2010-10-29	JC053_031	CTD046s	14:07	15,4238	-35,2855	20	y	y	y	y
93	2010-10-29	JC053_031	CTD046s	14:07	15,4238	-35,2855	55	y	y	y	y
94	2010-10-29	JC053_031	CTD046s	14:07	15,4238	-35,2855	90	y	y	y	y
95	2010-10-29	JC053_031	CTD046s	14:07	15,4238	-35,2855	300	y	y	y	y
96	2010-10-30	JC053_033	CTD049s	14:08	12,5454	-33,3289	0	y	y	y	y

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No.	Collection date	Station	CTD	Time in (GMT)	Decima Latitude	Decima Longitude	Depth (m)	aCDOM LWCC	aCDOM PSICAM	FDO M EEM	DOC
97	2010-10-30	JC053_033	CTD049s	14:08	12,5454	-33,3289	20	y	y	y	y
98	2010-10-30	JC053_033	CTD049s	14:08	12,5454	-33,3289	40	y	y	y	y
99	2010-10-30	JC053_033	CTD049s	14:08	12,5454	-33,3289	60	y	y	y	y
100	2010-10-30	JC053_033	CTD049s	14:08	12,5454	-33,3289	200	y	y	y	y
101	2010-10-30	JC053_033	CTD049s	14:08	12,5454	-33,3289	300	y	y	y	y
102	2010-10-31	JC053_035	CTD052s	14:12	9,7506	-31,4576	0	y	y	y	y
103	2010-10-31	JC053_035	CTD052s	14:12	9,7506	-31,4576	30	y	y	y	y
104	2010-10-31	JC053_035	CTD052s	14:12	9,7506	-31,4576	50	y	y	y	y
105	2010-10-31	JC053_035	CTD052s	14:12	9,7506	-31,4576	100	y	y	y	y
106	2010-10-31	JC053_035	CTD052s	14:12	9,7506	-31,4576	200	y	y	y	y
107	2010-10-31	JC053_035	CTD052s	14:12	9,7506	-31,4576	300	y	y	y	y
108	2010-11-01	JC053_037	CTD055s	14:04	6,7873	-29,4841	0	y	y	y	y
109	2010-11-01	JC053_037	CTD055s	14:04	6,7873	-29,4841	25	y	y	y	y
110	2010-11-01	JC053_037	CTD055s	14:04	6,7873	-29,4841	60	y	y	y	y
111	2010-11-01	JC053_037	CTD055s	14:04	6,7873	-29,4841	100	y	y	y	y
112	2010-11-01	JC053_037	CTD055s	14:04	6,7873	-29,4841	200	y	y	y	y
113	2010-11-01	JC053_037	CTD055s	14:04	6,7873	-29,4841	300	y	y	y	y
114	2010-11-02	JC053_039	CTD058s	14:06	3,8861	-27,5639	0	y	y	y	y
115	2010-11-02	JC053_039	CTD058s	14:06	3,8861	-27,5639	30	y	y	y	y
116	2010-11-02	JC053_039	CTD058s	14:06	3,8861	-27,5639	68	y	y	y	y
117	2010-11-02	JC053_039	CTD058s	14:06	3,8861	-27,5639	110	y	y	y	y
118	2010-11-02	JC053_039	CTD058s	14:06	3,8861	-27,5639	300	y	y	y	y
119	2010-11-04	JC053_042	CTD060s	13:40	-1,4794	-25,0060	0	y	y	y	y
120	2010-11-04	JC053_042	CTD060s	13:40	-1,4794	-25,0060	20	y	y	y	y
121	2010-11-04	JC053_042	CTD060s	13:40	-1,4794	-25,0060	50	y	y	y	y

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No.	Collection date	Station	CTD	Time in (GMT)	Decima Latitude	Decima Longitude	Depth (m)	aCDOM LWCC	aCDOM PSICAM	FDO M EEM	DOC
122	2010-11-04	JC053_042	CTD060s	13:40	-1,4794	-25,0060	90	y	y	y	y
123	2010-11-04	JC053_042	CTD060s	13:40	-1,4794	-25,0060	200	y	y	y	y
124	2010-11-04	JC053_042	CTD060s	13:40	-1,4794	-25,0060	300	y	y	y	y
125	2010-11-05	JC053_046	CTD063s	13:11	-4,8906	-25,0296	0	y	y	y	y
126	2010-11-05	JC053_046	CTD063s	13:11	-4,8906	-25,0296	25	y	y	y	y
127	2010-11-05	JC053_046	CTD063s	13:11	-4,8906	-25,0296	55	y	y	y	y
128	2010-11-05	JC053_046	CTD063s	13:11	-4,8906	-25,0296	98	y	y	y	y
129	2010-11-05	JC053_046	CTD063s	13:11	-4,8906	-25,0296	200	y	y	y	y
130	2010-11-05	JC053_046	CTD063s	13:11	-4,8906	-25,0296	300	y	y	y	y
131	2010-11-06	JC053_048	CTD066s	13:09	-6,2683	-22,6981	0	y	y	y	y
132	2010-11-06	JC053_048	CTD066s	13:09	-6,2683	-22,6981	25	y	y	y	y
133	2010-11-06	JC053_048	CTD066s	13:09	-6,2683	-22,6981	55	y	y	y	y
134	2010-11-06	JC053_048	CTD066s	13:09	-6,2683	-22,6981	90	y	y	y	y
135	2010-11-06	JC053_048	CTD066s	13:09	-6,2683	-22,6981	200	y	y	y	y
136	2010-11-06	JC053_048	CTD066s	13:09	-6,2683	-22,6981	300	y	y	y	y
137	2010-11-10	JC053_050	CTD068s	4:30	-12,5292	-19,0220	0	y	y	y	y
138	2010-11-10	JC053_050	CTD068s	4:30	-12,5292	-19,0220	30	y	y	y	y
139	2010-11-10	JC053_050	CTD068s	4:30	-12,5292	-19,0220	55	y	y	y	y
140	2010-11-10	JC053_050	CTD068s	4:30	-12,5292	-19,0220	130	y	y	y	y
141	2010-11-10	JC053_050	CTD068s	4:30	-12,5292	-19,0220	200	y	y	y	y
142	2010-11-10	JC053_050	CTD068s	4:30	-12,5292	-19,0220	300	y	y	y	y
143	2010-11-10	JC053_051	CTD069s	13:07	-13,4733	-19,9666	0	y	y	y	y
144	2010-11-10	JC053_051	CTD069s	13:07	-13,4733	-19,9666	20	y	y	y	y
145	2010-11-10	JC053_051	CTD069s	13:07	-13,4733	-19,9666	60	y	y	y	y
146	2010-11-10	JC053_051	CTD069s	13:07	-13,4733	-19,9666	135	y	y	y	y

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No.	Collection date	Station	CTD	Time in (GMT)	Decima Latitude	Decima Longitude	Depth (m)	aCDOM LWCC	aCDOM PSICAM	FDO M EEM	DOC
147	2010-11-10	JC053_051	CTD069s	13:07	-13,4733	-19,9666	210	y	y	y	y
148	2010-11-10	JC053_051	CTD069s	13:07	-13,4733	-19,9666	300	y	y	y	y
149	2010-11-11	JC053_053	CTD070s	13:07	-16,3162	-22,8417	0	y	y	y	y
150	2010-11-11	JC053_053	CTD070s	13:07	-16,3162	-22,8417	35	y	y	y	y
151	2010-11-11	JC053_053	CTD070s	13:07	-16,3162	-22,8417	65	y	y	y	y
152	2010-11-11	JC053_053	CTD070s	13:07	-16,3162	-22,8417	145	y	y	y	y
153	2010-11-11	JC053_053	CTD070s	13:07	-16,3162	-22,8417	180	y	y	y	y
154	2010-11-11	JC053_053	CTD070s	13:07	-16,3162	-22,8417	300	y	y	y	y
155	2010-11-12	JC053_055	CTD071s	11:00	-18,5370	-25,1296	0	y	y	y	y
156	2010-11-12	JC053_055	CTD071s	11:00	-18,5370	-25,1296	35	y	y	y	y
157	2010-11-12	JC053_055	CTD071s	11:00	-18,5370	-25,1296	60	y	y	y	y
158	2010-11-12	JC053_055	CTD071s	11:00	-18,5370	-25,1296	140	y	y	y	y
159	2010-11-12	JC053_055	CTD071s	11:00	-18,5370	-25,1296	215	y	y	y	y
160	2010-11-12	JC053_055	CTD071s	11:00	-18,5370	-25,1296	300	y	y	y	y
161	2010-11-13	JC053_057	CTD073s	13:05	-21,7059	-25,0969	0	y	y	y	y
162	2010-11-13	JC053_057	CTD073s	13:05	-21,7059	-25,0969	35	y	y	y	y
163	2010-11-13	JC053_057	CTD073s	13:05	-21,7059	-25,0969	65	y	y	y	y
164	2010-11-13	JC053_057	CTD073s	13:05	-21,7059	-25,0969	150	y	y	y	y
165	2010-11-13	JC053_057	CTD073s	13:05	-21,7059	-25,0969	225	y	y	y	y
166	2010-11-13	JC053_057	CTD073s	13:05	-21,7059	-25,0969	300	y	y	y	y
167	2010-11-14	JC053_059	CTD075s	13:30	-24,8190	-27,3573	0	y	y	y	y
168	2010-11-14	JC053_059	CTD075s	13:30	-24,8190	-27,3573	30	y	y	y	y
169	2010-11-14	JC053_059	CTD075s	13:30	-24,8190	-27,3573	55	y	y	y	y
170	2010-11-14	JC053_059	CTD075s	13:30	-24,8190	-27,3573	130	y	y	y	y
171	2010-11-14	JC053_059	CTD075s	13:30	-24,8190	-27,3573	250	y	y	y	y
172	2010-11-14	JC053_059	CTD075s	13:30	-24,8190	-27,3573	300	y	y	y	y

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No.	Collection date	Station	CTD	Time in (GMT)	Decima Latitude	Decima Longitude	Depth (m)	aCDOM LWCC	aCDOM PSICAM	FDO M EEM	DOC
173	2010-11-15	JC053_061	CTD077s	12:10	-27,9159	-29,9866	0	y	y	y	y
174	2010-11-15	JC053_061	CTD077s	12:10	-27,9159	-29,9866	25	y	y	y	y
175	2010-11-15	JC053_061	CTD077s	12:10	-27,9159	-29,9866	60	y	y	y	y
176	2010-11-15	JC053_061	CTD077s	12:10	-27,9159	-29,9866	105	y	y	y	y
177	2010-11-15	JC053_061	CTD077s	12:10	-27,9159	-29,9866	200	y	y	y	y
178	2010-11-15	JC053_061	CTD077s	12:10	-27,9159	-29,9866	300	y	y	y	y
179	2010-11-16	JC053_063	CTD079s	14:23	-30,9956	-32,8140	0	y	y	y	y
180	2010-11-16	JC053_063	CTD079s	14:23	-30,9956	-32,8140	25	y	y	y	y
181	2010-11-16	JC053_063	CTD079s	14:23	-30,9956	-32,8140	65	y	y	y	y
182	2010-11-16	JC053_063	CTD079s	14:23	-30,9956	-32,8140	100	y	y	y	y
183	2010-11-16	JC053_063	CTD079s	14:23	-30,9956	-32,8140	200	y	y	y	y
184	2010-11-16	JC053_063	CTD079s	14:23	-30,9956	-32,8140	300	y	y	y	y
185	2010-11-17	JC053_066	CTD081s	14:12	-30,9956	-32,8140	0	y	y	y	y
186	2010-11-17	JC053_066	CTD081s	14:12	-34,1075	-35,9255	35	y	y	y	y
187	2010-11-17	JC053_066	CTD081s	14:12	-34,1075	-35,9255	70	y	y	y	y
188	2010-11-17	JC053_066	CTD081s	14:12	-34,1075	-35,9255	110	y	y	y	y
189	2010-11-17	JC053_066	CTD081s	14:12	-34,1075	-35,9255	140	y	y	y	y
190	2010-11-17	JC053_066	CTD081s	14:12	-34,1075	-35,9255	300	y	y	y	y
191	2010-11-18	JC053_068	CTD083s	14:09	-37,0939	-39,2306	0	y	y	y	y
192	2010-11-18	JC053_068	CTD083s	14:09	-37,0939	-39,2306	30	y	y	y	y
193	2010-11-18	JC053_068	CTD083s	14:09	-37,0939	-39,2306	65	y	y	y	y
194	2010-11-18	JC053_068	CTD083s	14:09	-37,0939	-39,2306	100	y	y	y	y
195	2010-11-18	JC053_068	CTD083s	14:09	-37,0939	-39,2306	200	y	y	y	y
196	2010-11-18	JC053_068	CTD083s	14:09	-37,0939	-39,2306	300	y	y	y	y
197	2010-11-19	JC053_070	CTD085s	14:12	-39,7913	-42,5520	0	y	y	y	y

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No.	Collection date	Station	CTD	Time in (GMT)	Decima Latitude	Decima Longitude	Depth (m)	aCDOM LWCC	aCDOM PSICAM	FDO M EEM	DOC
198	2010-11-19	JC053_070	CTD085s	14:12	-39,7913	-42,5520	35	y	y	y	y
199	2010-11-19	JC053_070	CTD085s	14:12	-39,7913	-42,5520	60	y	y	y	y
200	2010-11-19	JC053_070	CTD085s	14:12	-39,7913	-42,5520	100	y	y	y	y
201	2010-11-19	JC053_070	CTD085s	14:12	-39,7913	-42,5520	200	y	y	y	y
202	2010-11-19	JC053_070	CTD085s	14:12	-39,7913	-42,5520	300	y	y	y	y
203	2010-11-20	JC053_072	CTD087s	15:12	-42,4978	-46,2964	0	y	y	y	y
204	2010-11-20	JC053_072	CTD087s	15:12	-42,4978	-46,2964	30	y	y	y	y
205	2010-11-20	JC053_072	CTD087s	15:12	-42,4978	-46,2964	45	y	y	y	y
206	2010-11-20	JC053_072	CTD087s	15:12	-42,4978	-46,2964	100	y	y	y	y
207	2010-11-20	JC053_072	CTD087s	15:12	-42,4978	-46,2964	200	y	y	y	y
208	2010-11-20	JC053_072	CTD087s	15:12	-42,4978	-46,2964	300	y	y	y	y
209	2010-11-21	JC053_074	CTD089s	15:12	-45,0165	-50,2845	0	y	y	y	y
210	2010-11-21	JC053_074	CTD089s	15:12	-45,0165	-50,2845	30	y	y	y	y
211	2010-11-21	JC053_074	CTD089s	15:12	-45,0165	-50,2845	45	y	y	y	y
212	2010-11-21	JC053_074	CTD089s	15:12	-45,0165	-50,2845	100	y	y	y	y
213	2010-11-21	JC053_074	CTD089s	15:12	-45,0165	-50,2845	200	y	y	y	y
214	2010-11-21	JC053_074	CTD089s	15:12	-45,0165	-50,2845	300	y	y	y	y

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Measurements of community and bacterial respiration by three techniques: changes in O₂ concentration after 24 hours incubation, enzymatic in vivo respiration and continuous oxygen decrease using oxygen microelectrodes.

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Background

The accurate determination of the balance between plankton production and respiration in the ocean is important for carbon budgets and global change predictions. Bacteria play an important role in this balance, as in low productive areas, they are responsible for a large fraction of the respiration in the water column. Measuring bacteria respiration is a not easy task, not only because of their low rates, but also due to the difficulty for isolating them from the whole community. The standard method for bacteria respiration (BR) is the determination of in vitro changes in O₂ concentration after 24 hours incubations of 0,8-1 µm filtered seawater samples. This method has the advantage of being similar to the method used for community metabolism, thus helping in comparing bacterial with total R; however the incubation of a separate size-fraction of the whole community during 24 hours, may bias the results due to the exclusion of predators and /or competitors from the sample. Recent methods, for example the determination of the in vivo electron transport system activity (ETS in vivo), allow the estimation of the BR together with the CR without distorting the natural community as the size-fraction is performed after the incubation. Moreover, the short incubation time needed reduce the possibility of community structure changes.

The aims of this work were:

1. To quantify in vitro changes of O₂ concentration after 24h incubations of 1,0 µm filtered natural seawater to determine bacterial respiration.
2. To measure community respiration and bacterial respiration with enzymatic techniques (ETS in vivo).
3. To compare the above methods to study the effect that incubation time and the disruption of the community could have on the CR and BR estimations.
2. To log and quantify continuously the decrease of O₂ with a microelectrode, in order to study the linearity of the respiration during 24 h incubations.

Methods

Discrete dissolved oxygen concentration

Dissolved O₂ was determined by automated Winkler titration with photometric end-point detection (Williams and Jenkinson 1982). Thiosulphate concentration was calibrated every two days. For the BR measurements, seawater samples were collected daily from the predawn depth profile CTD in 10 L carboys. Four litres of the surface and DCM waters were filtrated by 1,0 µm (Millipore Opticap XL10 Polysep II 1.0 µm) using a peristaltic pump at low flow rates. Water was collected in 5 L carboys and sub-sampled into ten gravimetrically calibrated, 65 mL dark borosilicate glass bottles. Five replicate bottles of the two depths were fixed immediately for initial oxygen concentrations, and the rest were incubated in darkness in a temperature controlled water bath at in situ temperature. After 24 hours, the incubated bottles were fixed, sealed and maintained in a water bath until their analysis within the following hours. Bacterial respiration rates were calculated as the difference between the means of the O₂ concentration in the zero time and the incubated samples. For the CR see Stephen and García-Martín (this report). Samples for bacterial cells counting were taken before and after CR and BR incubation. Samples were analyzed by flow cytometry (see Holland, this report).

Continuous monitoring of in vitro O₂ evolution.

Eighty mL borosilicate respiration chambers (Unisense) were filled with seawater from the 10L carboy. Chambers (two replicates from one depth) were sealed with a lid and put inside the temperature controlled incubation bath in darkness. Measurements of the dissolved oxygen were made using a Unisense microrespiration system (Unisense S/A, Aarhus, Denmark) with an internal tip diameter of 500 µm. Prior to each measurement, the microelectrode was daily calibrated using a two-point procedure with a 0 and a 100 % saturation dissolved oxygen concentration endpoints at in situ temperature (extended protocol in García-Martín et al. 2010). Oxygen concentration was recorded every 5 second during 20-24 h on a chart recorder. Oxygen

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consumption rates were determined as the slope of the oxygen concentration decrease as a function of time. A sample for bacterial count was taken after the incubation period.

In vivo INT-reduction analysis

Three or four depths were analyzed with this enzymatic technique from the predawn depth profile CTD station. Surface and DCM were always included in the sampling. Four replicates of 200 mL seawater samples were taken from the 10L carboys into 250 mL plastic bottles.

One replicate was immediately fixed by adding formaldehyde (2% w/v final concentration) and used as killed controls. Twenty minutes later all bottles were inoculated with a sterile solution of 7.9 mM INT to a final concentration of 0.8 mM. The solution was freshly prepared for each experiment using Milli-Q water. Samples were incubated in the temperature controlled water bath for 4 – 6 h (at the northern and southern gyre) and 2-3 h (rest of the track). Afterwards, samples were fixed by adding formaldehyde in the same way as for the killed controls and filtered through 0.8 and 0.2 µm pore size polycarbonate filters, air-dried for 1 min approximately, and stored frozen in 1.5 mL cryovials at –80°C until further processing (Martinez-García et al. 2009).

Results

In total 31 stations were sampled for in vitro changes of oxygen concentration (BR) and for ETS in vivo (CR + BR) and 27 for continuous oxygen decrease (Table 1, Table 2).

Bacterial respiration measured by in vitro changes of oxygen concentration showed a wide range contribution to total respiration ranging from 6 to 130 % and 6 to 230% of CR at surface and DCM, respectively. Data will be revised in the following months as bacterial cells counts need to be taken into account to check for differences in community abundance and community structure. Results obtained with the oxygen electrode will be further revised and data will be complimented and corrected with temperature changes inside the water bath.

Community and bacterial respiration measured with the INT technique will be analyzed in the lab during the following months. All final data will be submitted to BODC by the end of June 2011.

Table 3. Station log for samples collected for bacterial respiration (BR) during AMT20. The mark (*) indicates water sample collected also for oxygen microelectrode measurements.

Date	Station	CTD ID	Latitude Decimals	Longitude Decimals	Niskin No.	Depth (m)
14/10/2010	JC05302	CTD_002T	49,406	-11,165	23*, 6	2, 50
15/10/2010	JC05304	CTD_005T	49,036	-16,431	23, 6	2, 50
16/10/2010	JC05306	CTD_008T	46,055	-19,242	23*, 7	2, 70
17/10/2010	JC05308	CTD_011T	43,550	-21,364	23, 7	2, 70
18/10/2010	JC05310	CTD_014T	40,994	-23,479	23, 6	2, 120
21/10/2010	JC05314	CTD_020T	34,218	-29,762	23, 7*	2, 95
22/10/2010	JC05316	CTD_022T	32,426	-32,800	23, 7*	2, 100
23/10/2010	JC05318	CTD_025T	30,028	-34,179	23, 7*	2, 110
24/10/2010	JC05320	CTD_028T	28,112	-36,516	23, 7	2, 110
25/10/2010	JC05322	CTD_032T	25,984	-38,750	23, 8*	2, 100
26/10/2010	JC05324	CTD_035T	23,771	-41,108	23, 7*	2, 120
27/10/2010	JC05326	CTD_038T	21,212	-39,293	23, 7*	2, 115
28/10/2010	JC05328	CTD_041T	18,691	-37,523	23, 9*	2, 125
29/10/2010	JC05330	CTD_044T	16,191	-35,806	23, 10*	2, 70
30/10/2010	JC05332	CTD_047T	13,463	-33,117	23, 7*	2, 55
31/10/2010	JC05334	CTD_050T	10,567	-31,995	23, 10*	2, 40
01/11/2010	JC05336	CTD_053T	7,814	-30,160	23, 6*	2, 65
02/11/2010	JC05338	CTD_056T	4,804	-28,166	23, 6*	2, 80
05/11/2010	JC05345	CTD_061T	-3,852	-25,018	23, 7*	2, 70
06/11/2010	JC05347	CTD_064T	-6,057	-23,763	23, 7*	2, 100
10/11/2010	JC05350	CTD_067S	-12,529	-19,022	24, 8*	2, 130
11/11/2010	JC05352	CTD_069S	-15,331	-21,841	24, 7*	2, 165
13/11/2010	JC05356	CTD_072S	-20,380	-25,089	24, 7*	2, 165
14/11/2010	JC05358	CTD_074S	-23,838	-26,566	24, 6*	2, 150
15/11/2010	JC05360	CTD_076S	-26,858	-29,068	24, 8*	2, 120
16/11/2010	JC05362	CTD_078S	-29,943	-31,823	24, 7*	2, 145
17/11/2010	JC05365	CTD_080S	-33,044	-34,846	24*, 8	2, 80
18/11/2010	JC05367	CTD_082S	-36,090	-38,088	24*, 8	2, 48

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Date	Station	CTD ID	Latitude Decimals	Longitude Decimals	Niskin No.	Depth (m)
19/11/2010	JC05369	CTD_084S	-38,924	-41,453	24, 6*	2, 80
20/11/2010	JC05371	CTD_086S	-41,656	-45,093	24, 9*	2, 30
21/11/2010	JC05373	CTD_88S	-44,200	-48,939	24, 9*	2, 30

Table 4. Station log for samples collected for community and bacterial respiration (CR, BR) for the enzymatic technique during AMT20.

Date	Station	CTD ID	Latitude Decimals	Longitude Decimals	Niskin No.	Depth (m)
14/10/2010	JC05302	CTD_002T	49,406	-11,165	23, 16, 6	2, 10, 50
15/10/2010	JC05304	CTD_005T	49,036	-16,431	23, 16, 6	2, 10, 50
16/10/2010	JC05306	CTD_008T	46,055	-19,242	23, 16, 7	2, 10, 70
17/10/2010	JC05308	CTD_011T	43,550	-21,364	23, 16, 7	2, 15, 70
18/10/2010	JC05310	CTD_014T	40,994	-23,479	23, 9, 6	2, 60, 120
21/10/2010	JC05314	CTD_020T	34,218	-29,762	23, 17, 7	2, 25, 95
22/10/2010	JC05316	CTD_022T	32,426	-32,800	23, 16, 7	2, 25, 100
23/10/2010	JC05318	CTD_025T	30,028	-34,179	23, 18, 7	2, 25, 110
24/10/2010	JC05320	CTD_028T	28,112	-36,516	23, 19, 7	2, 25, 110
25/10/2010	JC05322	CTD_032T	25,984	-38,750	23, 18, 8	2, 25, 100
26/10/2010	JC05324	CTD_035T	23,771	-41,108	23, 18, 7	2, 30, 120
27/10/2010	JC05326	CTD_038T	21,212	-39,293	23, 18, 7	2, 25, 115
28/10/2010	JC05328	CTD_041T	18,691	-37,523	23, 18, 9	2, 30, 125
29/10/2010	JC05330	CTD_044T	16,191	-35,806	23, 10, 7	2, 70, 95
30/10/2010	JC05332	CTD_047T	13,463	-33,117	23, 18, 7	2, 15, 55
31/10/2010	JC05334	CTD_050T	10,567	-31,995	23, 10, 7	2, 40, 65
01/11/2010	JC05336	CTD_053T	7,814	-30,160	23, 18, 6	2, 25, 65
02/11/2010	JC05338	CTD_056T	4,804	-28,166	23, 18, 6	2, 20, 80
05/11/2010	JC05345	CTD_061T	-3,852	-25,018	23, 18, 7	2, 15, 70
06/11/2010	JC05347	CTD_064T	-6,057	-23,763	23, 18, 7	2, 25, 100
10/11/2010	JC05350	CTD_067S	-12,529	-19,022	24, 17, 8	2, 30, 130
11/11/2010	JC05352	CTD_069S	-15,331	-21,841	24, 16, 10, 7	2, 35, 85, 165
13/11/2010	JC05356	CTD_072S	-20,380	-25,089	24, 18, 11, 7	2, 40, 100, 165
14/11/2010	JC05358	CTD_074S	-23,838	-26,566	24, 18, 10, 6	2, 35, 85, 150
15/11/2010	JC05360	CTD_076S	-26,858	-29,068	24, 17, 11, 8	2, 30, 70, 120
16/11/2010	JC05362	CTD_078S	-29,943	-31,823	24, 16, 10, 7	2, 35, 85, 145
17/11/2010	JC05365	CTD_080S	-33,044	-34,846	24, 19, 8	2, 10, 80
18/11/2010	JC05367	CTD_082S	-36,090	-38,088	24, 19, 8	2, 10, 48
19/11/2010	JC05369	CTD_084S	-38,924	-41,453	24,15, 6	2, 20, 80
20/11/2010	JC05371	CTD_086S	-41,656	-45,093	24, 20, 9	2, 5, 30
21/11/2010	JC05373	CTD_88S	-44,200	-48,939	24, 20, 9	2, 5, 30

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Dissolved hydrogen measurements

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Background

Concentrations of dissolved hydrogen in the ocean are balanced by production, through processes including CDOM photodegradation and nitrogenase mediated nitrogen fixation, and consumption processes, including hydrogenase mediated uptake as well as loss to the atmosphere. It has been demonstrated in the equatorial and subtropical Pacific (Moore *et al*, 2009) as well as in laboratory experiments (Wilson *et al*, 2010) that hydrogen supersaturations and rates of nitrogen fixation have a strong correlation. It is proposed that this relationship can be utilised to aid researchers in sampling locations of $^{15}\text{N}_2$ fixation measurements.

Objectives

1. To obtain high resolution surface hydrogen concentrations as well as vertical profiles along the Atlantic Meridional Transect cruise track.
2. In collaboration with Andy Rees compare hydrogen concentrations with ^{15}N -derived nitrogen fixation rates, both from samples collected at station and from incubations.

Sampling and analytical methodology

Gas samples obtained from water samples by using an air-segmented continuous-flow equilibrator was used to obtain gas samples from either, the underway non-toxic system or from discrete samples from the CTD. These were then analysed using a reducing gas analyser using the reduction of mercuric oxide principle. In order to calculate dissolved hydrogen concentrations, gas standards of known concentration are also measured to provide a calibration factor.

Discrete water samples were taken from the titanium CTD in the pre-dawn cast and from the stainless steel CTD in the noon cast. Typically 6 samples were taken from a range of depths, always including the surface, the DCM and the deepest sample (between 300-1000m).

Continuous measurements were made every 3.5 minutes with water from the ship's non-toxic water supply (when not analysing the discrete CTD samples.)

Bucket samples, collected as soon as the ship came onto station for the noon cast in an attempt to get a "clean" sample, were difficult to obtain due to the length of time it took the ship to completely stop.

Incubations

A subsample of the water taken using the bucket was spiked with $^{15}\text{N}_2$ and incubated for 24 hours, along with a filtered sample, and the change in H_2 concentration measured. The samples were filtered for later analysis.

Table 1. Date, cast number, latitude, longitude and depths sampled for dissolved hydrogen analysis on AMT 20.

Date	Cast #	Latitude	Longitude	Depths(m)
15-Oct-2010	CTD007s	48.116	-17.324	1, 10, 20, 35, 50
16-Oct-2010	CTD008t	46.055	-19.191	1, 10, 30, 70, 500
16-Oct-2010	CTD009s	46.056	-19.197	70
16-Oct-2010	CTD010s	45.198	-19.934	1, 10, 20, 30, 50, 58
17-Oct-2010	CTD011t	43.550	-21.364	1, 10, 30, 70, 1000
17-Oct-2010	CTD012s	43.550	-21.364	10
17-Oct-2010	CTD013s	42.767	-22.035	1, 10, 25, 80, 300
18-Oct-2010	CTD014t	40.994	-23.479	1, 30, 50, 120, 300
18-Oct-2010	CTD015s	40.994	-23.479	1, 30, 50, 70, 90, 300
18-Oct-2010	CTD016s	40.126	-24.193	1, 35, 45, 57, 80, 1000
20-Oct-2010	CTD019s	34.940	-28.944	1, 20, 40, 60, 140, 300
21-Oct-2010	CTD020t	34.218	-29.762	1, 10, 40, 95, 125, 500
21-Oct-2010	CTD021s	33.842	-30.204	1, 30, 55, 110, 165, 300

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Date	Cast #	Latitude	Longitude	Depths(m)
22-Oct-2010	CTD022t	32.426	-31.800	1, 25, 45, 100, 300, 1000
22-Oct-2010	CTD024s	31.730	-32.563	1, 25, 55, 90, 145, 300
23-Oct-2010	CTD025t	30.285	-34.179	1, 25, 45, 110, 200, 500
23-Oct-2010	CTD027s	29.610	-34.901	1, 25, 60, 100, 150, 300
24-Oct-2010	CTD028t	28.112	-36.516	1, 25, 50, 65, 110, 1000
24-Oct-2010	CTD030s	27.452	-37.233	1, 30, 70, 118, 175
25-Oct-2010	CTD032t	25.984	-38.783	1, 25, 45, 100
25-Oct-2010	CTD034s	25.270	-39.530	1, 30, 70, 120, 180, 300
26-Oct-2010	CTD035t	23.771	-41.108	1, 30, 50, 120, 200, 500
26-Oct-2010	CTD037s	22.964	-40.532	15, 30, 70, 125, 190, 300
27-Oct-2010	CTD038t	21.212	-39.293	1, 25, 50, 115, 200, 380
27-Oct-2010	CTD040s	20.431	-38.739	1, 25, 65, 115, 170, 300
28-Oct-2010	CTD041t	18.691	-37.523	1, 55, 125, 200, 300, 1000
28-Oct-2010	CTD043s	17.913	-36.984	1, 30, 110, 300
29-Oct-2010	CTD044t	16.191	-35.806	1, 20, 40, 300, 440
29-Oct-2010	CTD046s	15.424	-35.286	1, 20, 55, 90, 140, 300
30-Oct-2010	CTD047t	13.463	-33.950	1, 15, 25, 55, 500
30-Oct-2010	CTD049s	12.545	-33.329	1, 20, 40, 60, 115, 300
31-Oct-2010	CTD050t	10.567	-31.995	1, 15, 25, 65, 200, 500
31-Oct-2010	CTD052s	9.751	-31.458	1, 15, 40, 50, 100, 300
1-Nov-2010	CTD053t	7.814	-30.160	1, 15, 30, 200, 500
1-Nov-2010	CTD055s	6.787	-29.484	1, 15, 35, 60, 100, 300
2-Nov-2010	CTD056t	4.804	-28.166	1, 35, 78, 120, 200, 500
2-Nov-2010	CTD058s	3.886	-27.565	1, 15, 40, 68, 110, 300
5-Nov-2010	CTD061t	-3.852	-25.018	1, 15, 30, 70, 200, 300
5-Nov-2010	CTD063s	-4.891	-25.030	1, 25, 55, 98, 150, 300
6-Nov-2010	CTD064t	-6.057	-23.763	1, 25, 40, 100, 150, 300
6-Nov-2010	CTD066s	-6.268	-22.698	1, 25, 55, 130, 200, 300
10-Nov-2010	CTD067s	-12.529	-19.022	1, 30, 55, 130, 200, 300
10-Nov-2010	CTD068s	-13.473	-19.967	1, 35, 80, 135, 210, 300
11-Nov-2010	CTD069s	-15.331	-21.841	1, 35, 65, 145, 200, 300
11-Nov-2010	CTD070s	-16.316	-23.010	1, 35, 85, 140, 200, 300
12-Nov-2010	CTD071s	-18.537	-25.130	1, 35, 85, 140, 200, 300
13-Nov-2010	CTD072s	-20.380	-25.089	1, 40, 75, 165, 200, 300
13-Nov-2010	CTD073s	-21.706	-25.097	1, 35, 85, 150, 225, 300
14-Nov-2010	CTD074s	-23.838	-26.566	1, 65, 150, 200, 300
14-Nov-2010	CTD075s	-24.819	-27.358	1, 30, 75, 130, 300
15-Nov-2010	CTD076s	-26.858	-29.068	1, 30, 55, 120, 190, 300
15-Nov-2010	CTD077s	-27.916	-29.986	1, 25, 60, 105, 150, 300
16-Nov-2010	CTD078s	-29.944	-31.824	1, 35, 60, 240, 300
16-Nov-2010	CTD079s	-30.996	-32.814	1, 15, 35, 65, 100, 300
17-Nov-2010	CTD080s	-33.044	-34.845	1, 20, 35, 80, 200, 300
17-Nov-2010	CTD081s	-34.107	-35.925	1, 20, 45, 70, 110, 300
18-Nov-2010	CTD082s	-36.090	-38.088	1, 20, 48, 120, 220, 300
18-Nov-2010	CTD083s	-37.094	-39.231	1, 15, 65, 100, 200, 300
19-Nov-2010	CTD084s	-38.924	-41.453	1, 20, 35, 80, 200, 300
19-Nov-2010	CTD085s	-39.791	-42.552	1, 20, 45, 60, 100, 300
20-Nov-2010	CTD086s	-41.656	-45.094	1, 10, 30, 45, 100, 300

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The use of MAAs as photoprotective pigments by copepods in the defence against high UV stress along the AMT.

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Background

It is believed that ultraviolet radiation at equatorial latitudes is increasing, despite human efforts to reduce CFCs released into the atmosphere in order to reduce damage to the Earth's ozone layer. UVB radiation with wavelengths of 270-315 nm is the higher energy UV radiation usually absorbed by ozone, and this can be harmful to organisms due to either direct or indirect damage to DNA. Zooplanktonic organisms that dwell in the surface layers of the ocean in order to feed on phytoplankton are particularly vulnerable to UVB radiation, so they have developed a number of strategies in order to protect themselves from DNA damage. Vertical migration during daylight is a behavioral response of some planktonic organisms and is thought to allow avoidance of UVR, as well as being a defense against predators that feed at the surface. The other strategy employed by zooplankton is the accumulation of photoprotective pigments into tissues, such as carotenoids and mycosporine-like amino acids (MAAs), which either act as sunscreens or scavenge photo-produced radicals. Zooplankton may also utilize enzymes to repair DNA already damaged by UV.

Copepod juveniles and eggs can be very abundant at the surface of the ocean and so can be exposed to high doses of UV during these life-stages. It is known that UV irradiation can lead to reduced egg hatching success, deformation of nauplii and increased mortality (Naganuma *et al.*, 1997; Yu *et al.*, 2009).

It is thought that zooplanktonic organisms such as copepods are unable to produce MAAs themselves as they lack the shikimate pathway by which these compounds are synthesized, and so these must be acquired from the diet. Among the organisms that produce MAAs are cyanobacteria, dinoflagellates and diatoms, which also utilize these pigments as a physical barrier against UVB radiation. MAAs can be transferred to copepods through their algal food. MAA production has an energetic cost (Hylander and Jephson, 2010), if no UVR is present, it has been shown that dinoflagellates will cease to produce MAAs. The same effect is found in copepods, which accumulate more MAAs when exposed to high UVR (Hylander *et al.*, 2009).

The focus of this study will be upon the dynamics behind the transfer of MAAs from the phytoplankton communities found in the different regimes covered by the AMT, to the adult copepods that feed at the ocean's surface during the daytime (and therefore presumably require photoprotective pigments). Using traditional egg production incubation experiments, we will determine the transfer of MAAs from female copepods to their eggs and nauplii, and the effect this has on hatching success.

Objectives:

- 1) Determine the abundance and distribution of mycosporine-like amino acids (MAAs) in the plankton of surface waters along the AMT
- 2) Determine the vertical distribution and species composition of phytoplankton and microzooplankton along the transect.
- 3) Determine the abundance and distribution of surface dwelling zooplankton along the AMT at pre-dawn and midday to assess the importance of vertical migration as a defence against UVR. Molecular techniques may be utilised to increase the species resolution of morphologically indistinguishable copepods.
- 4) Determine the MAA content of surface dwelling copepods, nauplii and their eggs and compare with UV measurements made along the transect to relate MAA content of copepods to their environment.
- 5) Determine the egg production rate and hatching success of surface dwelling copepod species along the AMT
- 6) Collection of eggs and nauplii from incubation experiments to determine transfer of maternal MAAs to offspring. Also to determine whether high MAAs in copepod females translate to higher hatching success.
- 7) Collect copepod eggs and nauplii directly from the surface water to determine MAA content. These will be characterised to species level where possible by DNA barcoding.

Methods

MAAs in surface phytoplankton

Surface water was collected at each dawn and noon CTD station. Water was vacuum filtered in three replicates onto 25 mm GF/F filters (usually 3 L per replicate), then flash frozen in liquid nitrogen and stored in the onboard -80°C freezer. These are to be returned to PML for HPLC pigment analysis, to determine abundance and distribution of MAAs in the surface community.

Phytoplankton community

250 ml Lugols samples were taken from surface water at the dawn CTD cast, and three depths were sampled at the noon CTD (usually surface, 55% and 33% light levels).

MAAs in zooplankton

A floating neuston net with a 50 µm mesh size (see picture) was deployed whenever possible, see table for details of sampling. A total of 7 predawn stations were sampled along the transect, and 27 noon time stations were sampled. The net was lowered into the water and then towed at low speed for 10-20 mins depending on abundance of plankton and time available. Noon tows were on a daily basis until the detour to the Ascension Island, from which point neuston tows were conducted on alternate days.

Female copepods which represented the most abundant species present, were picked from the sample.. These were then incubated for 3 hours in 0.2µm filtered sea water to evacuate the gut. The aim was to pick out three replicates of 20 females for each species, but if numbers were insufficient then as many as possible were picked out. These copepods were then flash frozen in liquid nitrogen and stored at -80°C for later HPLC analysis. Specimens of each species sampled were also frozen onto GF/F for CHN analysis, and others were picked into tubes of ethanol or formalin for molecular or taxonomic identification respectively. At several stations copepod eggs and nauplii were picked out of the plankton samples, some stored in ethanol for molecular identification and some flash frozen and stored at -80°C for MAA analysis of the larval community. The remainder of the neuston tow was then split in half. One half was stored in 4% borax buffered formalin, and the other into 95% EtOH for later analysis of community structure.



Fig 2. A female *Calanus* sp, one of the species picked out for MAA analysis

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Pre-dawn sample date	Station Number	Tow Duration (mins)	Noon sample date	Station Number	Tow Duration (mins)
18/10/2010	10	20	15/10/2010	5	15
23/10/2010	18	20	16/10/2010	7	15
27/10/2010	26	15	17/10/2010	9	14
29/10/2010	30	15	18/10/2010	11	15
31/10/2010	34	15	21/10/2010	15	15
02/11/2010	38	15	22/10/2010	17	15
05/11/2010	45	15	23/10/2010	19	15
			24/10/2010	21	20
			25/10/2010	23	20
			26/10/2010	25	20
			27/10/2010	27	20
			28/10/2010	29	17
			29/10/2010	31	20
			30/10/2010	33	20
			31/10/2010	35	20
			01/11/2010	37	15
			02/11/2010	39	10
			03/11/2010	41	10
			05/11/2010	46	15
			06/11/2010	48	10
			10/11/2010	51	15
			12/11/2010	55	15
			14/11/2010	59	15
			16/11/2010	63	15
			17/11/2010	66	15
			19/11/2010	70	15
			21/11/2010	74	15

Table 1. Details of neuston tow samples collected. Total 7 pre-dawn and 27 noon samples taken.

Nauplii feeding experiments

Five feeding experiments were conducted in the Southern hemisphere, to assess the grazing impact of copepod nauplii on the natural plankton assemblage.

A total of 360 nauplii were picked from noon neuston net hauls, and left to acclimatize overnight in filtered seawater. 20 litres of surface water was collected from the non-toxic supply at the noon station, and screened through a 40 µm mesh bag, to remove any other nauplii or copepod eggs. The bottles were stored until T₀ in an on-deck incubator to maintain SSW temperature.

The experiment was set up by filling 8 x 1 litre plastic bottles with the screened water, and then pipetting 60 nauplii into 4 of these, leaving 4 bottles for controls. The bottles were filled to the top to exclude as much air as possible and then placed into the incubator for 24 hours. The remaining water was used to collect T₀ sub-samples. Three replicates of 500 mls were filtered through GF/F and frozen for chlorophyll analysis. Three 500 ml sub-samples were fixed in acid Lugol's (2% final concentration) for subsequent microplankton counts, and 2 mls were fixed in paraformaldehyde (PFA) for flow cytometric analysis. The remaining nauplii were kept for CHN analysis and molecular identification.

After 24 hours the bottles were removed from the incubator and the nauplii were removed from the experimental bottles using a 50 µm sieve. The living nauplii from each bottle were counted and then pipetted into ethanol. A second set of sub-samples (as described for T₀) was taken from control and experimental bottles.

Sampling for Erica Goetze (University of Hawaii)

Pre-dawn vertical net hauls were collected at 33 stations along the transect. Originally sampled from 300 m to surface, this was reduced to 200 m after the Ascension Island detour to reduce sampling time. All samples were stored in 95% ethanol. The bongo net was divided up as follows: one side to Hawaii for Erica. A half split of the other side to be sent to Mark Ohman's lab at Scripps Institute of Oceanography, and the other half split to PML.

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Erica will use her share of the sample to conduct a comparative study of the population genetic structures of eight planktonic copepods that utilize strikingly different depth-related habitats, in order to test key predictions of genetic structure based on the interaction of organismal depth with the oceanographic environment.

Cruise Results and Summary

No data have been analysed from samples taken on this cruise. Will await the arrival of samples back to the UK in the next couple of months to begin the analysis. Attempts were made at conducting egg production experiments, but these were largely unsuccessful. The reduction in number of neuston net samples in the Southern hemisphere, and the decline of copepod biomass in the oligotrophic regions will have a big impact on the detail that can be obtained from the copepod MAA dataset, but a lot of information has been collected for the Northern hemisphere. Luckily the strong presence of copepod nauplii even in the oligotrophic regions facilitated the feeding experiments, so data could be collected even when adult female copepods were scarce.

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Biogeography and genetic diversity of coccolithophores and their viruses on the Atlantic Transect

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Background and objectives:

Coccolithophores are very important for primary production and the biogeochemistry of the oceans (Charlson et al. 1987, Falkowski et al. 1998) and are susceptible to virus infection and death (Schroeder et al. 2002, 2003). So far research on coccolithoviruses has been focused mainly on Norwegian and English Channel isolates (Schroeder et al. 2002, Wilson et al. 2002). Some of these isolates such as *Emiliana huxleyi* virus- 86 (EhV-86) and *Emiliana huxleyi* virus - 163 (EhV-163) have been sequenced and shown to have significant differences in their genomic content, especially with regards to the presence or absence of a gene that encodes for membrane phosphate permease protein (Allen & Wilson 2006, Allen et al. 2006). We believe that this gene is expressed under low phosphate conditions.

The acquisition of phosphate is essential for successful virus replication and the termination of phytoplankton blooms. In our preliminary research in the laboratory we have shown that these two strains that are geographically distinct and live in environments with different annual phosphate levels have differences in the way they infect and replicate in the algal host under different phosphate concentrations. We have isolated many more “Northern” viruses and their whole genome sequencing is expected to be done by the end of this year. However information on other geographically distinct coccolithoviruses from a transect in the Atlantic Ocean is lacking. From our preliminary research and other previous work within my group it seems that the Norwegian strain EhV-163 that is found in higher mean annual phosphate concentrations, and the EhV-86 strain from the English Channel that is usually found in lower phosphate concentration waters, thus have completely different mechanisms for phosphate acquisition during infection within the same host.

By obtaining samples during the AMT transect we hoped to look for these genes and support our hypothesis that the presence or absence of such genes in coccolithoviruses is linked to environmental phosphate availability and that evolutionary differences between host specific strains exist. Once we analyse these samples in the laboratory we can also compare the data from the Atlantic to our long term samples of L4 from the last 10 years. Molecular data of coccolithoviruses from the Atlantic is imperative to our understanding of the influence that nutrients in the oceans have on virus diversity and as a consequence, the role that viruses play in controlling algal blooms and biogeochemical cycling in the Atlantic Ocean.

The second objective was to look for sphingolipid genes in coccolithoviruses and coccolithophores across the AMT transect in the Atlantic Ocean and determine how this correlates to natural community sphingolipid and fatty acid composition. Research within my group has already discovered a new sphingolipid pathway induced by viral infection in *Emiliana huxleyi* (Pagarete et al. 2009). Such pathways are important in the suppression or induction of host cell death and molecular work on related virus strains with similar function is essential. The discovery of similar pathways will not only contribute to our understanding of the cellular mechanisms of phytoplankton death and biomass loss in the environment but also benefit the medical community where this pathway has been targeted for many years in the field of cancer research

Sampling methods:

Vertical profiles from CTD niskin bottles at stations along the cruise track (Table 1) before dawn and at solar noon (total CTD stations- 66) were obtained and water was filtered on a standard 5 arms filtration rack (Figure 1) from the following five depths from each station that corresponded to the nominal depths of 97%, 55%, 33%, 14% and 1%.



Fig. 1 The rack used for the filtration of the five depths sampled daily along the AMT-20 transect.

10L of seawater from these depths were filtered via a 0.2 μ m (47 mm) Millipore nitrocellulose membrane filters (Figure 2) for DNA extraction and analysis of coccolithophores and associated viruses. Additional 20L were taken from 97% and 33% at each CTD station and filtered for total lipids analysis via a 1.2 μ m GF/C filter. All samples were snap-frozen and stored in -80°C for further analysis.



Fig. 2 Millipore nitrocellulose membrane filter after the filtration of 10 L surface water from a productive area near the Patagonianshelf of southern South America.

A volume of 1 ml of each sampled depth was also stored in 10 μ l of glutaraldehyde fixative for future Flow Cytometry (FC) analysis and enumeration of coccolithophores, viruses and bacteria. 50 ml from each depth were also syringe filtered via a 0.2 μ m filter for the isolation of free viruses into a 50 ml falcon tube and stored at 4°C for further analysis (such as plaque essays). Finally, a 1.5 L concentrate in the range of 0.2 – 1 μ m of $\sim 15,000$ L of surface seawater was also filtered through a 0.2 μ m filter on four occasions during the cruise for DNA analysis. Three samples of 50 ml from this concentrate were stored in 4°C and fixed samples were snap-frozen for FC.

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Table 1. The above sampling procedures were applied to water obtained from each and one of the following sampling stations along the AMT-20 transect.

Date	Time (GMT)	Ship Station	CTD ID (cast)
14.10.10	05:39	JC053_02	CTD_003S*
14.10.10	13:04	JC053_03	CTD_004S
15.10.10	05:43	JC053_04	CTD_006S
15.10.10	13:00	JC053_05	CTD_007S
16.10.10	05:51	JC053_06	CTD_009S
16.10.10	13:04	JC053_07	CTD_010S
17.10.10	05:58	JC053_08	CTD_012S
17.10.10	13:00	JC053_09	CTD_013S
18.10.10	05:37	JC053_10	CTD_015S
18.10.10	13:00	JC053_11	CTD_016S
19.10.10	06:01	JC053_12	CTD_018S
21.10.10	05:31	JC053_14	CTD_020T**
21.10.10	14:06	JC053_15	CTD_021S
22.10.10	06:55	JC053_16	CTD_023S
22.10.10	14:08	JC053_17	CTD_024S
23.10.10	06:39	JC053_18	CTD_026S
23.10.10	14:10	JC053_19	CTD_027S
24.10.10	07:00	JC053_20	CTD_029S
24.10.10	14:03	JC053_21	CTD_030S
25.10.10	06:42	JC053_22	CTD_033S
25.10.10	14:09	JC053_23	CTD_034S
26.10.10	06:51	JC053_24	CTD_036S
26.10.10	13:06	JC053_25	CTD_037S
27.10.10	06:40	JC053_26	CTD_039S
27.10.10	14:08	JC053_27	CTD_040S
28.10.10	07:01	JC053_28	CTD_042S
28.10.10	14:06	JC053_29	CTD_043S
29.10.10	06:43	JC053_30	CTD_045S
29.10.10	14:06	JC053_31	CTD_046S
30.10.10	07:00	JC053_32	CTD_048S
30.10.10	14:08	JC053_33	CTD_049S
31.10.10	07:18	JC053_34	CTD_051S
31.10.10	14:12	JC053_35	CTD_052S
01.11.10	06:43	JC053_36	CTD_054S
01.11.10	14:10	JC053_37	CTD_055S
02.11.10	05:51	JC053_38	CTD_057S
02.11.10	13:16	JC053_39	CTD_058S
05.11.10	06:06	JC053_45	CTD_062S
05.11.10	13:09	JC053_46	CTD_063S
06.11.10	05:46	JC053_47	CTD_065S
06.11.10	13:08	JC053_48	CTD_066S
10.11.10	04:34	JC053_50	CTD_067S
10.11.10	13:07	JC053_51	CTD_068S
11.11.10	04:25	JC053_52	CTD_069S
11.11.10	13:07	JC053_53	CTD_070S
12.11.10	10:59	JC053_55	CTD_071S
13.11.10	04:34	JC053_56	CTD_072S
13.11.10	13:05	JC053_57	CTD_073S
14.11.10	04:58	JC053_58	CTD_074S
14.11.10	13:30	JC053_59	CTD_075S
15.11.10	05:35	JC053_60	CTD_076S

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Date	Time (GMT)	Ship Station	CTD ID (cast)
15.11.10	14:10	JC053_61	CTD_077S
16.11.10	05:30	JC053_62	CTD_078S
16.11.10	14:22	JC053_63	CTD_079S
17.11.10	05:32	JC053_65	CTD_080S
17.11.10	14:12	JC053_66	CTD_081S
18.11.10	05:35	JC053_67	CTD_082S
18.11.10	14:09	JC053_68	CTD_083S
19.11.10	05:39	JC053_69	CTD_084S
19.11.10	14:12	JC053_70	CTD_085S
20.11.10	06:41	JC053_71	CTD_086S
20.11.10	15:12	JC053_72	CTD_087S
21.11.10	06:31	JC053_73	CTD_088S
21.11.10	15:12	JC053_74	CTD_089S

* S- stainless rosette

** T- titanium rosette

Post cruise analysis:

Once in the laboratory, the DNA from all the 0.2 um filters will be extracted and amplified by a two step nested PCR using specific known primers. The coccolithophore primers we will use will be DNA polymerase and GPA. We will use MCP (major capsid protein) primers and primers for the detection of phosphate permease and sphingolipid genes in the coccolithophore associated viruses. Then all products will be DGGE analysed for polymorphism and the results will be compared to strains from our library that consists of strains from the English Channel and Norway.

The filtered seawater will be used for plaque essays and the detection and possible isolation of new coccolithoviruses. Flow Citometry analysis will be performed on all samples in order to detect and enumerate coccolithophores and coccolithoviruses along the transect.

The filters used for the total lipids analysis will be send to Charlotte Worthy at the University of Nottingham in the UK, where she will use various methods to look for sphingolipids associated with the cell death mechanism of the coccolithophores.

All data will be looked at in detail for interesting trends and possible correlations with the CTD and nutrient data obtained during the cruise.

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Mechanisms of carbon assimilation utilised by marine phytoplankton along the Atlantic Meridional Transect

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OBJECTIVES

The primary aim of our research was to characterise the mechanisms of carbon assimilation utilised by marine phytoplankton and, more specifically, to determine how their function and/or regulation may be related to interacting environmental variables. Marine phytoplankton account for approximately 40% of the world's carbon fixation and thus constitute a crucial component of the global carbon cycle. There is urgent need to understand the factors limiting, and otherwise influencing, both the distribution of biomass and rate of primary production of these organisms. This will enable more accurate prediction of how changing environmental conditions (e.g. anthropogenic emissions of CO₂) may affect phytoplankton ecology, and ultimately the global carbon cycle, in the future.

Marine phytoplankton face several challenges in acquiring sufficient CO₂ for photosynthesis from the environment. First, the primary enzyme involved in net carbon assimilation, ribulose-1,5-biphosphate carboxylase-oxygenase (Rubisco), has a surprisingly low affinity for its substrate, CO₂. Under standard atmospheric conditions, Rubisco functions at less than half of its catalytic capacity in most species. Second, the rate of diffusion of CO₂ in an aqueous solution is approximately 10,000 times slower than that in air. Third, marine phytoplankton are often exposed to considerable variation in inorganic carbon (C_i = CO₂ + HCO₃⁻) levels and pH. This variation affects the availability of CO₂ and HCO₃⁻ for photosynthesis.

In response to these challenges, marine phytoplankton have coevolved two key functional strategies to maximise photosynthetic productivity in carbon-limited environmental conditions: (i) forms of Rubisco with varying catalytic efficiency, and (ii) an inducible CO₂ concentrating mechanism (CCM) that acts to augment supply of CO₂ to the catalytic site of Rubisco. The objective of our project was to conduct a comparative genetic analysis of the kinetics, specificity, and similarity of genes involved in photosynthesis (e.g. Rubisco) and CCMs (e.g. CAs, Ci transport molecules) in phytoplankton taxa sampled from across a of bio-geographic and ecological regions. Data for key environmental parameters (e.g. DIC, pCO₂, pH, T_{alkalinity}) was collected concurrently from each sample site. This research will provide insight into the intrinsic constraints on the ability of phytoplankton to assimilate carbon in relation to environmental conditions and hence, more broadly, into the factors that control phytoplankton distribution and growth.

An additional aim of this research project was to investigate the relationship between molecular CO₂ concentration [CO₂ (aq)], marine organic δ¹³C (δ¹³C_{org}), and the activity of CCMs utilised by marine phytoplankton. Marine phytoplankton discriminate strongly against ¹³C during the photosynthetic process. In some cases, the degree of discrimination has been shown to correlate strongly with concentrations of [CO₂ (aq)] in surface water, with marine plankton being most depleted in ¹³C at high latitudes. It has therefore been proposed that isotopic measurements of sedimentary organic matter may serve as a useful proxy for the reconstruction of ancient CO₂ concentrations in ocean surface waters. Factors other than CO₂, however, may also have a significant impact on the isotopic composition in marine phytoplankton. With the apparent ubiquitous nature of CCM ability, the influence of active uptake on carbon isotope fractionation must be considered when developing such models of fractionation based on CO₂ concentration. In this study, samples for pCO₂, DIC δ¹³C and POC δ¹³C have been taken across the broad latitudinal range afforded by the AMT transect and will be analysed with reference to the available molecular genetic data on the carbon assimilation mechanisms utilised by the phytoplankton assemblage at each sample site.

SAMPLING PROTOCOLS

Samples for each parameter listed below were taken daily from (i) the solar noon CTD (at a minimum of three depths, in order to generate a vertical profile) and (ii) the underway supply (mid-

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morning). Details of the location and depth of CTD and underway samples are provided in Table 1 and Table 2 respectively. All samples were pre-filtered through 200 μm nylon mesh prior to sampling.

RNA/DNA

For each location and depth listed in Table 1, 10-15L of seawater was transferred from the Niskin bottle to a light-impermeable carboy for the subsequent collection of RNA and DNA samples.

RNA samples were immediately concentrated by peristaltic filtration through a 0.22 μm Supor membrane filter held within a polycarbonate in-line filter holder. The filtration process was not allowed to exceed 10 min, following which the membrane was folded with forceps and transferred to a Cryovial containing 3ml of RNAlater solution. Samples were immediately frozen in liquid nitrogen and subsequently stored at -80°C until their return for the UK for analysis. The volume of seawater filtered for RNA varied between samples but was generally in the range of 3-5 litres.

Upon completion of RNA sampling, DNA samples were similarly concentrated by peristaltic filtration through a 0.22 μm Supor membrane filter held within a polycarbonate in-line filter holder.

Filtration was allowed to proceed until 8-10 litres of seawater had been filtered, following which the membrane was folded with forceps and transferred to a Cryovial containing 3ml of DNA lysis buffer (0.75 mol L^{-1} sucrose, 400 mmol L^{-1} NaCl, 20 mmol L^{-1} EDTA, and 50 mmol L^{-1} Tris-HCl [pH 9.0]; Fuller *et al.*, 2006). Samples were immediately frozen in liquid nitrogen and subsequently stored at -80°C until their return for the UK for analysis of the kinetics, specificity, and similarity of genes involved in photosynthesis by phytoplankton taxa sampled along the AMT20 transect.

DIC

DIC was sampled immediately following the collection of seawater at each location and depth listed in Table 1. Seawater was taken in a 50ml disposable syringe and passed through a sterile 0.2 μm filter into a 12ml borosilicate Exetainer vial, which had been pre-poisoned with 25 μL of HgCl_2 . Vials were sealed without headspace and stored immediately in the dark at 4°C until their return to the UK for analysis of relative DIC abundance and isotopic composition by mass spectrometry. Two replicate samples were taken for each location and depth.

POC

POC samples were collected by vacuum filtration of approximately 3-5 litres of seawater through pre-combusted (4h at 500°C) 25mm, 0.7mm GF/F membranes using a pre-combusted glass filtration unit. Vacuum pressure was not allowed to exceed 20kPa. Upon completion of filtration, membranes were rinsed with deionised (DI) water to remove any Cl^{-} ions present. Membranes were folded in half, wrapped in an envelope of pre-combusted aluminium foil, and stored at -20°C until their return to the UK for processing and analysis of relative POC abundance and isotopic composition by mass spectrometry. A blank (control) sample was taken daily, which consisted of a GF/F membrane, rinsed with DI water in the vacuum filtration unit and stored as described for seawater samples above. All carboys, filtration units and membrane forceps were systematically rinsed with HCl and DI water between each sample to prevent cross-contamination.

pH

Borosilicate bottles were filled without headspace immediately after the collection of seawater and left to equalise to laboratory temperature. pH samples were analysed onboard using a Perkin Elmer Lambda35 UV/VIS spectrophotometer with the UV lamp turned off.

Samples collected prior to 20.10.10 were stained with thymol blue and pH calculation based on Zhang and Byrne (1996). A 2 mmol L^{-1} stock solution of thymol blue Sodium salt (0.9771 g in 1 L Milli-Q) was prepared. The absorbance of seawater blank was measured at 435 and 596 nm. 50 μL of stock was added to 50 mL seawater and the absorbance measured again at 435 and 596 nm. Upon return to the UK, the seawater 'blank' absorbance values will be subtracted from seawater absorbance after addition of thymol blue and, together with the sample temperature and salinity, used to derive the sample pH.

Samples collected from 20.10.10 onwards were stained with m-cresol purple, following the technique outlined by Dickson *et al.* (2007). A ≥ 2 mmol L^{-1} stock solution of m-cresol Sodium salt (0.9771 g in 1 L Milli-Q) was used to stain samples. The absorbance of a seawater blank at 578 and 434 nm (absorbance maxima of base (I^{-}) and acid (HI^{-}) respectively) and 730 nm (non-absorbing wavelength) were measured. 300 μL of stock was added to 50 ml of each seawater sample, shaken to mix, and the absorbance of each wavelength measured again. The amount of

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dye required was that which was determined onboard to produce absorbance values of between 0.4 and 1.0 at the two absorbance peaks. The seawater 'blank' absorbance values were subtracted from seawater absorbance after m-cresol addition for all three wavelengths. The non-absorbing wavelength was used to monitor baseline shifts due to cuvette repositioning errors or instrumental drift. The difference should be no greater than ± 0.001 . Upon return to the UK, the pH value for each sample will be determined from the salinity, temperature (at measurement) and absorbances, using pK_2 from Clayton and Byrne (1993).

Total Alkalinity

Total alkalinity samples were collected in a 50ml disposable syringe and passed through a sterile 0.2 μm filter into a 12ml borosilicate Exetainer vial. Vials were sealed without headspace and stored immediately in the dark at 4°C until their return to the UK. Two replicate samples were taken for each sampling location and depth. Upon return to the UK, samples will be analysed using the spectroscopic method described by Sarazin *et al.* (1999).

Table 1. All of the above sampling procedures were applied to water obtained from each of the following solar-noon CTD sampling stations along the AMT-20 transect.

Date	Time (GMT)	Ship Station	CTD ID (cast)	Depths (m)
16.10.10	13:04	JC053_07	CTD_010S	Surface, 30, 58
17.10.10	13:00	JC053_09	CTD_013S	Surface, 25, 40
18.10.10	13:00	JC053_11	CTD_016S	Surface, 50, 70
20.10.10	16:17	JC053_13	CTD_019S	Surface, 40, 60
21.10.10	14:06	JC053_15	CTD_021S	Surface, 55, 110
22.10.10	14:08	JC053_17	CTD_024S	Surface, 35, 90
23.10.10	14:10	JC053_19	CTD_027S	Surface, 45, 100
24.10.10	14:03	JC053_21	CTD_030S	Surface, 50, 118
25.10.10	14:09	JC053_23	CTD_034S	Surface, 60, 120
26.10.10	13:06	JC053_25	CTD_037S	Surface, 70, 125
27.10.10	14:08	JC053_27	CTD_040S	Surface, 50, 115
28.10.10	14:06	JC053_29	CTD_043S	Surface, 60, 110
29.10.10	14:06	JC053_31	CTD_046S	Surface, 20, 90
30.10.10	14:08	JC053_33	CTD_049S	Surface, 40, 60
31.10.10	14:12	JC053_35	CTD_052S	Surface, 30, 50
01.11.10	14:10	JC053_37	CTD_055S	Surface, 35, 60
02.11.10	13:16	JC053_39	CTD_058S	Surface, 40, 68
05.11.10	13:09	JC053_46	CTD_063S	Surface, 55, 98
06.11.10	13:08	JC053_48	CTD_066S	Surface, 55, 90
10.11.10	13:07	JC053_51	CTD_068S	Surface, 80, 135
11.11.10	13:07	JC053_53	CTD_070S	Surface, 85, 145
12.11.10	10:59	JC053_55	CTD_071S	Surface, 85, 140
13.11.10	13:05	JC053_57	CTD_073S	Surface, 85, 150
14.11.10	13:30	JC053_59	CTD_075S	Surface, 75, 130
15.11.10	14:10	JC053_61	CTD_077S	Surface, 60, 105
16.11.10	14:22	JC053_63	CTD_079S	Surface, 25, 65
17.11.10	14:12	JC053_66	CTD_081S	Surface, 35, 70
18.11.10	14:09	JC053_68	CTD_083S	Surface, 40, 65
19.11.10	14:12	JC053_70	CTD_085S	Surface, 45, 60
20.11.10	15:12	JC053_72	CTD_087S	Surface, 15, 30
21.11.10	15:12	JC053_74	CTD_089S	Surface, 15, 30

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Table 2. All of the above sampling procedures were applied to water obtained from the underway (non-toxic) supply at the following locations along the AMT-20 transect.

Date	Time (GMT)	Latitude	Longitude
16.10.10	11:12	45° 23.80 N	19° 45.88 W
17.10.10	17:20	42° 29. 95 N	22° 15.06 W
18.10.10	11:10	40° 22.82 N	23° 59.15 W
21.10.10	12:12	33° 56.57 N	30° 04.86 W
22.10.10	11:28	31° 53.48 N	32° 24.00 W
23.10.10	12:12	29° 47.60 N	34° 42.57 W
24.10.10	12:00	27° 39.62 N	37° 01.55 W
25.10.10	11:58	25° 28.95 N	39° 18.93 W
26.10.10	12:03	23° 11.99 N	40° 41.58 W
27.10.10	11:59	20° 40.88 N	38° 55.07 W
28.10.10	11:51	18° 10.47 N	37° 10.41 W
29.10.10	12:04	15° 39.14 N	35° 26.66 W
30.10.10	12:25	12° 45.89 N	33° 28.85 W
31.10.10	11:49	10° 03.54 N	31° 40.04 W
01.11.10	11:54	07° 07.09 N	29° 41.55 W
02.11.10	10:51	04° 12.23 N	27° 46.31 W
03.11.10	10:33	01° 19.75 N	25° 52.76 W
04.11.10	10:55	01° 19.94 S	24° 59.84 W
05.11.10	11:04	04° 33.50 S	25° 01.97 W
06.11.10	10:59	06° 11.97 S	23° 02.34 W
07.11.10	10:54	06° 57.79 S	19° 11.33 W
09.11.10	11:08	10° 29.26 S	16° 59.72 W
10.11.10	10:43	13° 10.89 S	19° 40.27 W
11.11.10	10:48	16° 01.37 S	22° 32.37 W
13.11.10	10:49	21° 20.19 S	25° 06.59 W
14.11.10	10:46	24° 30.99 S	27° 07.11 W
15.11.10	11:44	27° 35.49 S	29° 42.49 W
16.11.10	11:58	30° 42.59 S	32° 32.89 W
17.11.10	11:43	33° 46.66 S	35° 35.71 W
18.11.10	11:49	36° 47.52 S	38° 53.41 W
19.11.10	11:40	39° 30.53 S	42° 11.85 W
20.11.10	12:38	42° 13.29 S	45° 54.55 W
21.11.10	12:29	44° 45.35 S	49° 51.03 W

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Microbial plankton community abundance, structure and dynamics

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Main Aim: To examine abundance, phylogenetic composition, metabolic activities and bacterivory of dominant microbial groups within planktonic communities, inhabiting the euphotic zone of temperate, tropical and equatorial regions of the North and South Atlantic Ocean.

1. Abundance and Composition of Microbial Plankton Communities: flow cytometry and pigment analyses (Tarran, Holland, Zubkov)

Objectives

- To determine the distribution, abundance and community structure of nano- and picophytoplankton, heterotrophic bacteria and heterotrophic nano- and picoplankton from predawn and solar noon CTD casts by flow cytometry. *AMT core measurement.*
- To determine the distribution, abundance and community structure of planktonic phototrophic and heterotrophic bacteria and protists (flagellates) from high frequency underway sampling from the ship's pumped seawater supply by flow cytometry. *AMT core measurement.*
- Collect and filter seawater samples for the post-cruise quantification of phytoplankton pigments using High Performance Liquid Chromatography (HPLC) from predawn and solar noon CTD casts. *AMT core measurement.*
- To determine community composition of microplankton protist communities (size range 20-200 µm). Trials of newly developed tandem microplankton net and FlowCAM flow cytometer *AMT core measurement.*

1.1. Phytoplankton community structure and abundance by flow cytometry. *AMT core measurement*

Fresh seawater samples were collected in clean 250 mL polycarbonate bottles from a Seabird CTD system containing a 24 bottle rosette of 10 and 20 L Niskin bottles from 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 FACSsort flow cytometer which characterised and enumerated *Prochlorococcus* sp. and *Synechococcus* sp. (cyanobacteria), pico-eucaryotes, cryptophytes, coccolithophores and other nanophytoplankton based on their light scattering and autofluorescence properties. The data were immediately stored on disk and will be analysed back in the UK. Table 1.1. summarises the CTD casts sampled and analysed during the cruise.

Samples were drawn from all pre-dawn and noon CTD casts, kept refrigerated and fixed with paraformaldehyde within half an hour of surfacing. Both CTD and Underway samples (see below) were stained with the DNA stain SYBR Green I (Sigma) in order to separate particles in suspension based on DNA content and light scattering properties. Samples were analysed flow cytometrically within 4 hours of surfacing. Each stained sample was run twice through a Becton Dickinson FACSsort flow cytometer; once to analyse sub-micron particles and once to analyse particles greater than 1 micron in diameter. Data were saved and will be analysed ashore. Concentrations per ml of Heterotrophic bacteria, Viruses, Protists, Picophytoplankton and Nanophytoplankton will be calculated.

Underway samples were drawn every hour from the ship's non-toxic seawater supply (Tecan Miniprep 60, Tecan, Reading, UK). Samples were fixed instantly with paraformaldehyde and analysed flow cytometrically within 8 hours.

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Table 1.1: CTD casts sampled for phytoplankton, heterotrophic bacteria and heterotrophic flagellate community structure & abundance

DATE	CTD	TIME on deck (GMT)	LAT (N+, S-)	LONG W	DEPTHS SAMPLED (m)
14-Oct	003S	06:15	49.41	11.16	2 5 10 20 30 40 50 75 100 125 150 176
14-Oct	004S	13:53	49.27	12.88	2 10 15 25 30 51 76 101 200
15-Oct	006S	06:25	49.05	16.43	2 5 10 20 25 35 45 60 80 100 150 200
15-Oct	007S	13:54	48.12	17.32	2 5 10 20 35 50 75 100 200
16-Oct	009S	06:28	46.06	19.20	2 10 15 30 40 50 70 100 150 200
16-Oct	010S	13:47	45.20	19.93	2 10 20 30 50 58 80 100 200
17-Oct	012S	06:38	43.55	21.36	2 10 15 30 40 60 70 100 150 200
17-Oct	013S	13:54	42.77	22.03	2 10 25 40 50 60 80 100 200
18-Oct	015S	06:17	40.99	23.48	2 15 30 50 65 80 100 120 150 200
18-Oct	016S	14:00	40.13	24.19	2 15 30 50 68 90 130 200
19-Oct	018S	06:47	38.28	25.65	2 10 20 30 45 65 100 150 200
20-Oct	019S	16:59	34.94	28.94	2 20 30 40 62 140 200
21-Oct	020T	06:13	34.22	29.76	2 10 25 40 55 95 125 150
21-Oct	021S	14:53	33.84	30.20	2 15 30 45 55 85 110 165 200
22-Oct	023S	07:32	32.43	31.80	2 15 25 45 60 100 110 150 200
22-Oct	024S	15:04	31.73	32.56	2 10 25 35 55 70 90 145 200
23-Oct	026S	07:20	30.29	34.18	2 15 25 45 65 85 118 165 200
23-Oct	027S	14:59	29.58	34.61	2 15 25 45 60 80 100 150 200
24-Oct	029S	07:44	28.11	36.51	2 15 25 50 65 90 112 170 200
24-Oct	030S	14:53	27.45	37.23	2 15 30 50 70 80 118 175 200
25-Oct	033S	07:22	25.98	38.78	2 15 25 45 60 80 100 150 200
25-Oct	034S	14:56	25.27	39.53	2 15 30 60 70 95 120 180 200
26-Oct	036S	07:31	23.77	41.11	2 15 30 50 70 90 110 180 200
26-Oct	037S	14:55	22.96	40.53	2 15 30 55 70 95 125 190
27-Oct	039S	07:21	21.21	39.29	2 15 25 50 65 85 115 170 200
27-Oct	040S	14:56	20.43	38.74	2 15 25 50 65 85 115 170
28-Oct	042S	07:43	18.69	37.52	2 15 30 55 70 95 120 150 200
28-Oct	043S	14:53	17.91	36.98	2 15 30 60 75 90 110 180 200
29-Oct	045S	07:24	16.19	35.80	2 10 20 40 55 60 95 140 200
29-Oct	046S	15:00	15.42	35.29	2 10 20 40 55 70 90 140
30-Oct	048S	07:40	13.47	33.95	2 15 25 30 40 65 70 100 150 200
30-Oct	049S	15:11	12.55	33.33	2 10 20 30 40 55 60 115 200
31-Oct	051S	08:03	10.57	32.00	2 10 15 25 35 55 65 100 150 200
31-Oct	052S	15:40	9.75	31.46	2 10 15 30 40 50 70 100 200
01-Nov	54S	07:23	7.82	30.16	2 10 15 30 40 50 65 100 150 200
01-Nov	55S	15:35	6.79	29.48	2 10 15 25 35 50 60 100 200
02-Nov	57S	06:33	4.80	28.16	2 10 20 35 45 60 70 120 200
02-Nov	58S	14:56	3.89	27.56	2 10 15 30 40 55 68 110
05-Nov	62S	06:44	-3.85	25.02	2 10 15 30 40 55 85 120 150 200
05-Nov	63S	13:51	-4.89	25.03	2 10 25 40 55 75 98 150 200
06-Nov	65S	06:27	-6.05	23.76	2 10 25 40 55 70 100 150 200
06-Nov	66S	13:47	-6.27	22.70	2 10 25 40 55 70 90 145 200
10-Nov	67S	05:15	-12.53	19.02	5 30 55 75 100 130 170 200
10-Nov	68S	13:47	-13.47	19.97	2 20 35 60 80 105 135
11-Nov	69S	05:07	-15.32	21.84	2 20 35 65 85 115 145 200
11-Nov	70S	13:49	-16.32	22.84	2 20 35 65 85 115 145 180
12-Nov	71S	11:34	-18.54	25.13	2 20 35 60 85 115 140 200
13-Nov	72S	05:16	-20.38	26.09	2 20 40 75 100 130 150 165 200
13-Nov	73S	13:43	-21.71	25.10	2 20 35 65 85 115 150 180
14-Nov	74S	05:40	-23.84	26.57	2 20 35 65 85 115 150 200

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DATE	CTD	TIME on deck (GMT)	LAT (N+, S-)	LONG W	DEPTHS SAMPLED (m)
14-Nov	75S	14:07	-24.82	27.36	2 15 30 55 75 100 130
15-Nov	76S	06:18	-26.86	29.07	2 15 30 55 70 95 120 150 190
15-Nov	77S	14:54	-27.92	29.99	2 15 25 45 60 80 105 150 200
16-Nov	78S	06:10	-29.94	31.82	2 20 35 60 85 110 145 170 200
16-Nov	79S	14:56	-31.00	32.81	2 10 15 25 35 50 65 100 200
17-Nov	80S	06:16	-33.04	34.85	2 10 20 35 50 65 80 125 200
17-Nov	81S	14:59	-34.11	35.93	2 10 20 35 45 60 70 110 140
18-Nov	82S	06:19	-36.09	38.09	2 5 10 20 30 40 48 75 120
18-Nov	83S	14:55	-37.09	39.23	2 10 15 30 40 55 65 100 200
19-Nov	84S	06:21	-38.92	41.45	2 10 20 35 45 60 80 100 200
19-Nov	85S	14:57	-39.79	42.55	2 10 20 35 45 60 80 100 200
20-Nov	86S	07:24	-41.66	-44.91	2 5 10 15 20 30 45 75 100 200
20-Nov	87S	15:48	-42.50	46.30	2 5 10 15 20 30 45 75 100 200
21-Nov	88S	07:11	-44.20	48.94	2 5 10 15 20 30 45 75 100 150 200
21-Nov	89S	15:51	-45.02	50.28	2 5 10 15 20 30 45 65 100 150 200

1.2. Sample collection for quantification of phytoplankton pigments using High Performance Liquid Chromatography (HPLC). *AMT core measurement*

Rob Thomas from NOC, Liverpool and Eleanor Darlingotn from Education through Expeditions conducted the sample collection and filtration for HPLC pigments. Many thanks to them both for taking on this task.

Fresh seawater samples from 6 light depths (97, 55, 33, 14, 3 and 1% of surface light. 1% was sometimes substituted with deep chlorophyll maximum (DCM)) were collected into 7 L polypropylene carboys covered in black plastic to keep out light. Duplicate 1-2 L samples were decanted into rinsed polypropylene bottles with siphon tubes and inverted into a 6 port vacuum filtration rig at a vacuum of 10-15 inches of mercury. Samples were filtered through 25 mm Advantec® GF75 glass fibre filters and the resulting sample filters were folded into 2 mL cryovials (Starlab®), flash frozen in liquid nitrogen and stored at -80°C.

Table 1.2.: summarises the CTD casts sampled during the cruise. Samples will be analysed by HPLC after the cruise.

Table 1.2: CTD casts sampled for phytoplankton pigments.

DATE	CTD	TIME on deck (GMT)	LAT (N+, S-)	LONG W	DEPTHS SAMPLED (m)
14-Oct	003S	06:15	49.41	11.16	2 5 10 20 40 50
14-Oct	004S	13:53	49.27	12.88	2 10 15 25 30
15-Oct	006S	06:25	49.05	16.43	2 5 10 20 25 45
15-Oct	007S	13:54	48.12	17.32	2 5 10 20 35 50
16-Oct	009S	06:28	46.06	19.20	2 10 15 30 40 70
16-Oct	010S	13:47	45.20	19.93	2 10 20 30 50 58
17-Oct	012S	06:38	43.55	21.36	2 10 15 30 40 70
17-Oct	013S	13:54	42.77	22.03	2 10 25 40 50 80
18-Oct	015S	06:17	40.99	23.48	2 15 30 65 80 120
18-Oct	016S	14:00	40.13	24.19	2 15 30 50 70 130
19-Oct	018S	06:47	38.28	25.65	2 10 20 30 45 65
21-Oct	021S	14:53	33.84	30.20	2 15 30 45 85 110
22-Oct	023S	07:32	32.43	31.80	2 15 25 45 60 110
22-Oct	024S	15:04	31.73	32.56	2 10 25 35 70 90
23-Oct	026S	07:20	30.29	34.18	2 25 45 65 85 118
23-Oct	027S	14:59	29.58	34.61	2 15 25 60 100

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DATE	CTD	TIME on deck (GMT)	LAT (N+, S-)	LONG W	DEPTHS SAMPLED (m)
24-Oct	029S	07:44	28.11	36.51	2 25 50 65 90 112
24-Oct	030S	14:53	27.45	37.23	2 15 30 50 118
25-Oct	033S	07:22	25.98	38.78	2 25 45 60 80 100
25-Oct	034S	14:56	25.27	39.53	2 15 30 60 70 120
26-Oct	036S	07:31	23.77	41.11	2 30 50 70 90 110
26-Oct	037S	14:55	22.96	40.53	2 15 30 55 70 125
27-Oct	039S	07:21	21.21	39.29	2 25 50 65 85 115
27-Oct	040S	14:56	20.43	38.74	2 15 25 50 65 115
28-Oct	042S	07:43	18.69	37.52	2 30 55 70 95 120
28-Oct	043S	14:53	17.91	36.98	2 15 30 60 110
29-Oct	045S	07:24	16.19	35.80	2 20 40 55 60 95
29-Oct	046S	15:00	15.42	35.29	2 10 20 40 55 90
30-Oct	048S	07:40	13.47	33.95	2 15 25 30 40 70
30-Oct	049S	15:11	12.55	33.33	2 10 20 30 40 60
31-Oct	051S	08:03	10.57	32.00	2 10 15 25 35 65
31-Oct	052S	15:40	9.75	31.46	10 15 30 50 70
01-Nov	54S	07:23	7.82	30.16	2 15 30 40 50 65
01-Nov	55S	15:35	6.79	29.48	2 10 15 25 35 60
02-Nov	57S	06:33	4.80	28.16	2 20 35 45 60 70
02-Nov	58S	14:56	3.89	27.56	2 10 15 30 40 68
05-Nov	62S	06:44	-2.15	25.02	2 10 15 30 40 85
05-Nov	63S	13:51	-3.11	25.03	2 10 25 55 98
06-Nov	65S	06:27	-5.95	23.76	2 10 25 40 55 100
06-Nov	66S	13:47	-5.73	22.70	2 10 25 40 55 90
10-Nov	67S	05:15	-11.47	19.02	2 15 30 55 75 130
10-Nov	68S	13:47	-13.47	19.97	2 20 35 60 80 135
11-Nov	69S	05:07	-15.32	21.84	2 35 65 85 115 145
11-Nov	70S	13:49	-16.32	22.84	2 20 35 65 85 145
12-Nov	71S	11:34	-18.54	25.13	2 20 35 60 85 140
13-Nov	72S	05:16	-20.38	26.09	2 40 75 100 130 165
13-Nov	73S	13:43	-21.71	25.10	2 25 35 65 85 150
14-Nov	74S	05:40	-23.84	26.57	2 35 65 85 115 150
14-Nov	75S	14:07	-24.82	27.36	2 30 55 75 100 130
15-Nov	76S	06:18	-26.86	29.07	2 30 55 70 95 120
15-Nov	77S	14:54	-27.92	29.99	2 15 25 45 60 105
16-Nov	78S	06:10	-29.94	31.82	2 20 60 85 110 145
16-Nov	79S	14:56	-31.00	32.81	2 10 15 25 50 65
17-Nov	80S	06:16	-33.04	34.85	2 20 35 50 65 80
17-Nov	81S	14:59	-34.11	35.93	2 10 20 35 45 70
18-Nov	82S	06:19	-36.09	38.09	2 10 20 30 40 48
18-Nov	83S	14:55	-37.09	39.23	2 10 15 30 40 65
19-Nov	84S	06:21	-38.92	41.45	2 10 20 35 45 80
19-Nov	85S	14:57	-39.79	42.55	2 10 20 35 45 60
20-Nov	86S	07:24	-41.66	-44.91	2 5 10 15 20 30
20-Nov	87S	15:48	-42.50	46.30	2 5 10 15 20 30
21-Nov	88S	07:11	-44.20	48.94	2 5 10 15 20 30
21-Nov	89S	15:51	-45.02	50.28	2 5 10 15 20 30

1.3. Characterisation of microplankton communities using net hauls and FlowCAM. *AMT core measurement development.*

A microplankton net containing a series of 4 conical nets with mesh sizes 180, 100, 40 and 20 μm was deployed from the aft starboard crane immediately after the solar noon CTDs on a daily basis during the cruise. At each site, plankton samples were collected on vertical net hauls from 100 m to the surface. 20-40 μm , 40-100 μm and 100-180 μm fractions were collected in their respective

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cod ends and then analysed on a FlowCAM (Fluid Imaging inc.) with a 300 µm path length flow cell, a 4x microscope objective and a CCD camera operating in trigger mode at a frame grab rate of 7 frames per second. Data files were stored on the FlowCAM computer's hard drive and will be analysed back in the lab.

Factors Affecting Community Structure of Marine Picophytoplankton (University of Warwick, C. Grob)

1. Distribution of *Prochlorococcus*, *Synechococcus* and photosynthetic picoeukaryotes

a) Sampling strategy

Bulk community DNA was collected at the mid-day CTDs from a range of light depths (97, 14, 1 and 0.1%). Up to 7 L vol from each depth was pre-filtered through 100 µm mesh and 10.0 µm polycarbonate (PC) filters while the 0.45 µm (Supor) fractions were retained and flash frozen (in liquid nitrogen) in 3.0 mL of lysis buffer and stored at -80°C.

b) Proposed analyses

DNA will be extracted from filters using established techniques and analysed by a variety of methods in the laboratory. Quantitative estimates of the abundance of *Synechococcus* (*Syn*) and *Prochlorococcus* (*Pro*) genotypes will be carried out on large-scale clone libraries (2,000+ clones) using selected multi-locus markers such as *petB* (Mazard et al., in prep.). The relative abundance of photosynthetic picoeukaryotes (peuks) will be assessed with up to 10 plastidic probes using dotblots and ³²P labelled probes. Supporting analyses include construction of clone libraries for 16S/18S ribosomal RNA and internal transcribed spacer (ITS) regions, clone libraries and (t)RFLP analyses of MLSA marker genes (such as *petB*). Estimates of species/ribotype abundance will complement the flow cytometric analyses of underway and CTD samples (Tarran/Holland) as well as allow for direct comparison with similar data obtained on AMT18 and 19 (Ostrowski, unpublished), AMT-15 (Zwirgmaier et al., 2008) and AMT-13 (Johnson et al., 2006). A total of 28 stations were sampled for a total volume of ~448 L of seawater filtered.

Table 1. Summary of DNA samples. For each sample, up to 7 L were pre-filtered through 100 µm mesh and 10.0 µm filters and retained on 0.45 µm filters and flash frozen (in liquid nitrogen) in 3.0 mL of lysis buffer and stored at -80°C. Samples were taken at the surface (Surf), deep chlorophyll maximum (DCM) and at the depths where the light corresponded to 14 and 0.1% of that reaching the surface.

Date	CTD	LAT	LON	Surf	DCM	14%	0.1%
17/10	013-S	42°46.02 N	22°02.08	-	-	Btl 13, 25 m	Btl 4, 100 m
21/10	021-S	33°50.594 N	30°12.212	-	-	Btl 13, 45 m	Btl 3, 165 m
22/10	024-S	31°43.79 N	32°33.763	Btl 20	Btl 4, 90 m	Btl 11, 35 m	Btl 3, 145 m
23/10	027-S	29°36.602 N	34°54.08	Btl 20	Btl 4, 100 m	Btl 10, 45 m	Btl 3, 150 m
24/10	030-S	27°27.094 N	37°14.000	-	-	Btl 12, 50 m	Btl 3, 175 m
25/10	034-S	25°16.129 N	39°31.895	Btl 20	Btl 4, 120 m	Btl 12, 60 m	Btl 3, 180 m
26/10	037-S	22°57.814 N	40°31.920	Btl 20	Btl 4, 125 m	Btl 12, 55 m	Btl 3, 190 m
27/10	040-S	20°25.862 N	38°44.337	-	-	Btl 13, 50 m	Btl 3, 170 m
28/10	043-S	17°54.766 N	36°59.033	Btl 20	Btl 4, 110 m	Btl 12, 60 m	Btl 3, 180 m
29/10	046-S	15°25.428 N	35°17.131	-	-	-	Btl 3, 140 m
30/10	049-S	12°32.726 N	33°19.731	Btl 20	Btl 4, 60 m	Btl 12, 30 m	Btl 3, 115 m
31/10	052-S	09°45.035 N	31°27.448	-	-	Btl 13, 30 m	Btl 3, sample compromised

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Date	CTD	LAT	LON	Surf	DCM	14%	0.1%
01/10	055-S	06°47.23 N	29°29.04	Btl 20	Btl 4, 60 m	Btl 13, 25 m	Btl 3, 100 m
02/11	058-S	3°53.139 N	27°33.892	-	-	Btl 13, 30 m	Btl 3, 110 m
05/11	063-S	4°53.437 S	25°1.778	-	-	Btl 12, 40 m	Btl 3, 150 m
06/11	066-S	6°16.086 S	22°41.879	Btl 20	Btl 4, 95 m	Btl 12, 40 m	Btl 3, 145 m
10/11	068-S	13°28.399 S	19°57.996	-	-	Btl 12, 60 m	Btl 3, 210 m
11/11	070-S	16°18.975 S	22°50.499	Btl 20	Btl 4, 145 m	Btl 12, 65 m	leak
12/11	071-S	18°32.2235 S	25°07.775	-	-	Btl 13, 60 m	Btl 3, 215 m
13/11	073-S	21°42.336 S	25°05.818	Btl 20	Btl 4, 150 m	Btl 12, 65 m	Btl 2, 225 m
14/11	075-S	24°49.14 S	27°21.52	-	-	Btl 12, 55 m	Btl 3, 200 m
15/11	077-S	27°54.952 S	29°59.174	Btl 20 (leak)	Btl 4, 105 m	Btl 12, 45 m	Btl 3, 150 m
16/11	079-S	30°59.75 S	32°48.90	-	-	Btl 12, 25 m	Btl 3, 100 m
17/11	081-S	34°0.644 S	35°55.52	Btl 20	Btl 5, 70 m	Btl 13, 35 m	Btl 4, 110 m
18/11	083-S	37°05.63 S	39°13.83	-	-	Btl 12, 30 m	Btl 3, 100 m
19/11	085-S	39°47.477 S	42°33.131	-	-	Btl 13, 35 m	Btl 3, 100 m
20/11	087-S	42°29.855 S	46°17.772	-	-	Btl 16, 10 m	Btl 5, 45 m
21/11	089-S	45°00.99 S	50°17.07	Btl 20	Btl 7, 30 m	Btl 16, 10 m	Btl 6, 45 m

2. Isolation of *Synechococcus*, *Prochlorococcus* and photosynthetic picoeukaryotes cultures

Water samples were taken roughly every other day from the surface, the DCM or both to set up picophytoeukaryote cultures (peuks). In most cases cells were first concentrated into 0.6 µm filters by filtering ~ 50 mL of seawater gravitationally. The filters were then rinsed in water from the same depth, from the DCM or from 300 m previously filtered through 0.2 µm and kept in polystyrene culture flasks at constant temperature (~ 21°C) and under a 12:12hrs light regime in an incubator. In some cases the water sample was mixed directly with surface, DCM or 300 m water filtered through 0.2 µm without pre-concentrating the cells. All cultures were analyzed at the end of the cruise using flow cytometry to confirm the presence of picophytoplanktonic cells. Back in the laboratory, these environmental samples will be used to generate unialgal cultures. Novel unialgal cultures will mainly be used to design specific oligonucleotide probes at the class level based on the chloroplast 16S rRNA gene.

3. Metagenomics and transcriptomics of *Synechococcus*, *Prochlorococcus* and photosynthetic picoeukaryotes populations at selected stations

a) Sampling strategy

Seawater (20 L each time) was collected from the surface and the deep chlorophyll maximum (DCM, ~1% of surface light) at a total of 17 stations along the cruise (Table 2) and collected in Cell Traps (0.22 µm) after pre-filtering through 100 µm mesh and 10 µm PC filter membranes from carboys wrapped in black plastic. Samples for RNA (transcriptomics) were harvested from the first 1.5-2.5 L of filtered sample and flash frozen in liquid nitrogen within 18 min of beginning the filtration. The flash-freezing of samples was generally achieved within a total of 30 min of the CTD

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coming on board. After taking samples for RNA, Cell Traps were re-used to collect DNA samples from the remaining seawater collected. In each case between 2 and 16 L of seawater were filtered for DNA at both depths.

b) Proposed analyses

DNA and RNA will be extracted from populations of *Synechococcus*, *Prochlorococcus* and photosynthetic picoeukaryotes populations sorted using flow cytometry and amplified using a commercial kit (after reverse transcription for RNA). Amplified nucleic acids will then be sequenced to a high depth-of coverage using 454 sequencing at a NERC Molecular Genetics Facility.

Table 2. Summary of samples taken for metagenomics and meta-transcriptomics work. Samples were collected in duplicate after pre-filtering through 100 µm mesh and 10.0 µm PC filters. The initial concentrates used for RNA sampling, corresponding to 1.5-2.5 l of seawater, were extracted within 30 min of the CTD coming on board.

Date	CTD	LAT	LON (W)	Surf	DCM
14/10	004-S	49°16.20 N	12°53.04	Btl 20	Btl 10, 30 m
15/10	007-S	48°06.97 N	17°19.46	Btl 20	Btl 5, 50 m
17/10	013-S	42°46.02 N	22°02.08	Btl 20	Btl 12, 40 m
21/10	021-S	33°50.594 N	30°12.212	Btl 20	Btl 4, 110 m
24/10	030-S	27°27.094 N	37°14.000	Btl 20	Btl 4, 118 m
27/10	040-S	20°25.862 N	38°44.337	Btl 20	Btl 4, 115 m
29/10	046-S	15°25.428 N	35°17.131	Btl 19	Btl 4, 90 m
31/10	052-S	09°45.035 N	31°27.448	Btl 20	Btl 5, 50 m
02/11	058-S	3°53.139 N	27°33.892	Btl 20	Btl 4, 68m,
05/11	063-S	4°53.437 S	25°1.778	Btl 20	Btl 4, 98 m
10/11	068-S	13°28.399 S	19°57.996	Btl 20	Btl 4, 135 m
12/11	071-S	18°32.2235 S	25°07.775	Btl 20	Btl 4, 140 m
14/11	075-S	24°49.14 S	27°21.52	Btl 19	Btl 4, 130 m
16/11	079-S	30°59.75 S	32°48.90	Btl 21	Btl 4, 65 m
18/11	083-S	37°05.63 S	39°13.83	Btl 20	Btl 4, 65 m
19/11	085-S	39°47.477 S	42°33.131	Btl 20	Btl 6, 60 m
20/11	087-S	42°29.855 S	46°17.772	Btl 20	Btl 7, 30 m

3. Dynamics, metabolic activities and phylogenetic composition of dominant microbial groups (Grob, Hartmann, Gomez-Pereira, Zubkov)

Aims:

Assess metabolic activities of dominant prokaryotic and eukaryotic groups within the planktonic communities in the oligotrophic North Atlantic gyre and South Atlantic gyre.

To evaluate the effect of light on microbial activity.

To measure rates of carbon fixation by microbial groups and to assess the contribution of each group to total carbon fixation.

To taxonomically identify and quantify the dominant prokaryotic and eukaryotic groups in order to link community composition and function.

Objectives:

To estimate turnover rates of dissolved organic nutrients and phosphorus using methionine, leucine, adenosine tri-phosphate and phosphate tracers.

To estimate carbon fixation rates of dominate phototrophic microbes.

To collect concentrated seawater samples for molecular analysis in order to phylogenetically identify the composition of the flow-sorted groups. Prokaryotes and eukaryotic groups will be identified by 16S- and 18S-rDNA clone libraries respectively, and quantified by fluorescence *in situ* hybridisation (FISH).

Estimations of turnover rates and concentrations of dissolved organic nutrients and bioavailable phosphate

Ambient concentrations as well as uptake rates of the amino acids leucine and methionine, phosphate and ATP by total microbial plankton were measured using isotopic dilution time-series

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incubations (Zubkov et al 2004, Zubkov et al 2007). Their uptake evaluated under different light conditions in order to assess the effect of light on main prokaryotic groups. Microbial inorganic phosphorus uptake was determined in the phosphate-depleted North Atlantic gyre (Table 1, stations marked with a star) to estimate ambient concentrations and turnover rates of the bioavailable fraction. The relative contributions of the dominant prokaryotic and eukaryotic groups to the amino acid and phosphate cycle were determined using flow cytometric cell sorting.

Table 1: Sampling stations including CTD no., dates, bottle no. and depth. At stations marked with a * ambient concentrations of bioavailable, inorganic phosphate were determined.

CTD	Date	Time	Latitude	Longitude	Depth	Bottle
04-S	14/10/2010	13:04	49°16.20 N	12°53.04 W	20	14
07-S	15/10/2010	13:06	48°06.97 N	17°19.48 W	20	11
09-S	16/10/2010	05:51	46°03.37 N	19°11.89 W	20	17
12-S	17/10/2010	05:58	43°32.98 N	21°21.85 W	20	16
13-S	17/10/2010	13:07	42°46.02 N	22°02.08 W	20	17
15-S	18/10/2010	05:57	40°59.65 N	23°28.76 W	20	18
16-S	18/10/2010	13:00	40°07.65 N	24°11.56 W	20	17
18-S	19/10/2010	06:01	38°16.88 N	25°38.74 W	20	18
19-S	20/10/2010	16:05	34°56.419 N	28°56.618 W	20	17
21-S	21/10/2010	14:01	33°50.544 N	30°12.212 W	20	17
23-S*	22/10/2010	06:55	32°25.69 N	31°48.26 W	20	18
24-S*	22/10/2010	14:00	31°43.802 N	32°33.771 W	20	17
26-S*	23/10/2010	06:35	30°17.58 N	34°10.99 W	20	18
27-S*	23/10/2010	14:04	29°36.602 N	34°54.078 W	20	17
29-S*	24/10/2010	07:00	28°06.766 N	36°30.516 W	20	17
33-S*	25/10/2010	06:40	25°59.011 N	38°46.982 W	20	17
34-S*	25/10/2010	14:03	25°16.189 N	39°31.815 W	20	17
36-S*	26/10/2010	06:50	23°45.913 N	41°06.442 W	20	17
37-S*	26/10/2010	14:00	22°57.814 N	40°31.920 W	20	17
39-S*	27/10/2010	06:40	21°12.738 N	39°17.542 W	20	18
42-S*	28/10/2010	07:00	18°41.459 N	37°31.369 W	20	17
43-S	28/10/2010	14:03	17°54.766 N	36°59.033 W	20	17
45-S*	29/10/2010	06:40	16°11.296 N	35°48.282	20	17
46-S	29/10/2010	14:00	15°25.428 N	35°17.132 W	20	17
48-S*	30/10/2010	06:55	13°27.911 N	33°57.197 W	20	17
49-S*	30/10/2010	14:00	12°33.727 N	33°19.733 W	20	17
51-S*	31/10/2010	07:15	10°34.246 N	31°59.860 W		
52-S*	31/10/2010	14:11	09°45.035 N	31°27.457 W		
54-S	01/01/2010	06:40	07°48.99 N	30°09.59 W	20	15
55-S	01/01/2010	14:00	06°47.242 N	29°29.044 W	20	14
57-S*	02/11/2010	05:50	04°48.074 N	28°09.754 W	20	18
62-S	05/11/2010	06:00	1°19.5 S	25°00.927 W	20	14, 15
65-S	06/11/2010	05:40	06°03.312 S	23°45.661 W	20, 70	18, 9
67-S	10/11/2010	04:30	12°31.751 S	19°01.322 W	20	18, 19
69-S	11/11/2010	04:30	15°19.88 S	21°50.47 W	20	18, 19
71-S	12/11/2010	10:55	18°32.223 S	25°07.775 W	20	18
72-S	13/11/2010	04:30	20°22.774 S	25°05.351 W	150	9
73-S*	13/11/2010	13:03	21°42.353 S	25°05.811 W	20	17
74-S	14/11/2010	04:52	23°50.270 S	26°34.024W	20, 85	18, 11
75-S	14/11/2010	13:27	24°49.144 S	27°21.498 W	20	16
76-S	15/11/2010	05:30	26°51.452 S	29°04.077 W	20	18, 19
78-S	16/11/2010	05:30	29°56.623 S	31°49.414 W	20	18,19
79-S	16/11/2010	14:19	30°59.732 S	32°48.841 W	surface	18

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80-S	17/11/2010	04:30	33°02.666 S	34°50.726 W	20	14
CTD	Date	Time	Latitude	Longitude	Depth	Bottle
81-S	17/11/2010	14:08	34°06.449 S	35°55.528 W	surface	19
82-S	18/11/2010	05:30	36°05.460 S	38°05.262 W	20	14, 15
83-S	18/11/2010	14:05	37°05.619 S	39°13.837 W	20	14
84-S	19/11/2010	05:30	38°55.522 S	41°27.079 W	20	16
86-S	20/11/2010	06:40	41°39.357 S	45°05.571 W	20	11, 12

Estimation of carbon fixation rates by dominant microbial groups

Sodium ^{14}C -bicarbonate was used in a series of experiments to trace photosynthetic fixation by microbes. In addition, the relative contributions by dominant groups of microorganisms to the carbon cycle were determined using flow cytometric cell sorting. Seawater samples were incubated for 10h in ambient light conditions, subsequently fixed with paraformaldehyde (PFA, 1% final concentration) and filtered on 0.2 μm pore size polycarbonate filter to determine total carbon uptake. Carbon fixation rates experiments were performed with samples collected at the pre-dawn casts.

Collection of eukaryotic and prokaryotic cells for molecular analyses of phylogenetic composition of the dominant groups

For the identification and quantification of photosynthetic picoeukaryotes (PPEs) and prokaryotic microbes samples were collected in the stations listed in table 1. Unconcentrated 1.6 ml samples were fixed with 1% PFA, incubated for 1 hour at 4°C and subsequently flash frozen with liquid nitrogen and stored at -80°C. These samples will be used for cell sorting of the most abundant prokaryotic groups. Additionally, seawater samples were concentrated for cell sorting and identification of eukaryotes and low abundance prokaryotes. Concentration of seawater samples was done in the pre-dawn casts.

Two different approaches were used to concentrate microbial cells: (1) 2 L of seawater sample were concentrated using a CelltrapTM ceramic filtration unit after pre-filtration with a 20 μm pore-size mesh, to screen out larger organisms. 1.6 mL of this concentrate were fixed with 1% PFA, 1% glutaraldehyde or Lugol and 1% PFA, incubated for 1 hour at 4°C, and subsequently flash frozen with liquid nitrogen and stored at -80°C. (2) 150 mL of 1% PFA fixed seawater sample were concentrated on 0.1 μm filter using a syringe pump. Samples were flash frozen immediately after concentration and stored at -80°C or fixed with 1% PFA prior to freeze. Additionally, microbial cells were flow sorted on board from both concentrated and unconcentrated samples. The major prokaryotes and eukaryotes groups were flow sorted and further filtered onto 13 mm polycarbonate filters.

Taxonomic identification of the eukaryotic and prokaryotic groups will be performed by rRNA gene clone libraries. Gene libraries will be constructed using eukaryotic 18S rDNA and prokaryotic 16S rDNA primer pairs. This approach will be combined with FISH to assess the distribution, the abundance and the contribution of specific groups to the total eukaryotic and prokaryotic biomass. Moreover, the results of the molecular analysis will be compared to those of the tracer experiments.

Preliminary observations

Initial scintillation counts were carried out on board the ship (Packard Tri-Carb 3100). Bioassayed concentrations of methionine and leucine ranged between 0.05-1.0 nM and 0.12-0.75 nM, respectively. The estimated turnover of these amino acid molecules ranged between 5-120 and 3-44 hours, respectively. After the cruise, the collected tracer samples of flow sorted cells will be further analysed using low background counters. The detailed data set will allow estimation of rates of metabolic activity of bacterioplankton and phytoplankton, as well as production and mortality. Moreover, completion of molecular analysis will enable us to link prokaryotic and eukaryotic community composition and function.

Study of microbial genetic diversity in marine waters

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Rationale

Plant and animal biodiversity is known to increase from the poles to the tropic, but little is known about this latitudinal gradient in bacteria. Despite their higher abundance, dispersal capabilities and their ability to colonize severe regions, bacteria have been also reported to show a latitudinal gradient. Several studies have found that this latitudinal gradient is linked to the latitude, and water temperature, although other studies have found no relations with these variables, but with pH and salinity. During the AMT 20, bacteria DNA samples have been collected to study their richness and biodiversity in order to relate them with the natural environmental characteristics and bring into light more knowledge about these small unicellular organisms.

Methods

Three depths (Surface, DCM and other depth in-between) were sampled from the predawn depth profile CTD station. DNA samples (2 replicates from each depth) have been collected by filtering 2-4 L through 0.22µm sterivex filter using a peristaltic pump. Low flux velocity was used to not damage the cells. Samples were then sealed with parafilm and stored in a -80 °C freezer for transport back to the UK.

Samples collected

176 samples were collected from 31 pre-dawn stations for DNA analysis (Table 1).

Data will be analysed in the Argonne National Laboratory (Illinois, USA) by Dr. Jack Gilbert (gilbertjack@anl.gov).

Table 5. Station log for samples collected for bacterial DNA during AMT20. Water for different Niskin bottles was collected from the same depth.

Date	Station ID	CTD ID	Latitude Decimals	Longitude Decimals	Niskin No.	Depth (m)
14/10/2010	JC05302	CTD_002T	49,406	-11,165	23/22, 16, 6/7	2, 10, 50
15/10/2010	JC05304	CTD_005T	49,036	-16,431	23/22, 16, 6/7	2, 10, 50
16/10/2010	JC05306	CTD_008T	46,055	-19,242	23/22, 16, 6/7	2, 10, 70
17/10/2010	JC05308	CTD_011T	43,550	-21,364	23/22, 16, 6/7	2, 15, 70
18/10/2010	JC05310	CTD_014T	40,994	-23,479	23/22, 9, 6/5	2, 60, 120
21/10/2010	JC05314	CTD_020T	34,218	-29,762	23/22, 17, 6/7	2, 25, 95
22/10/2010	JC05316	CTD_022T	32,426	-32,800	23/22, 16, 6/7	2, 25, 100
23/10/2010	JC05318	CTD_025T	30,028	-34,179	23/22, 18, 6/7	2, 25, 110
24/10/2010	JC05320	CTD_028T	28,112	-36,516	23/22, 19, 6/7	2, 25, 110
25/10/2010	JC05322	CTD_032T	25,984	-38,750	23/22, 18, 8/7	2, 25, 100
26/10/2010	JC05324	CTD_035T	23,771	-41,108	23/22, 18, 6/7	2, 30, 120
27/10/2010	JC05326	CTD_038T	21,212	-39,293	23/22, 18, 6/7	2, 25, 115
28/10/2010	JC05328	CTD_041T	18,691	-37,523	21/23, 18, 9/7	2, 30, 125
29/10/2010	JC05330	CTD_044T	16,191	-35,806	23/21, 10/11, 7	2, 70, 95
30/10/2010	JC05332	CTD_047T	13,463	-33,117	23/21, 18, 7/6	2, 15, 55
31/10/2010	JC05334	CTD_050T	10,567	-31,995	23/21, 10/12, 7	2, 40, 65
01/11/2010	JC05336	CTD_053T	7,814	-30,160	23/21, 18, 6/5	2, 25, 65
02/11/2010	JC05338	CTD_056T	4,804	-28,166	23/21, 18, 6/5	2, 20, 80
05/11/2010	JC05345	CTD_061T	-3,852	-25,018	23/21, 18, 7/6	2, 15, 70
06/11/2010	JC05347	CTD_064T	-6,057	-23,763	23/21, 18, 7/6	2, 25, 100
10/11/2010	JC05350	CTD_067S	-12,529	-19,022	24/23, 17, 8/7	2, 30, 130
11/11/2010	JC05352	CTD_069S	-15,331	-21,841	24/23, 16, 7/6	2, 35, 85, 165
13/11/2010	JC05356	CTD_072S	-20,380	-25,089	24/23, 18, 7/6	2, 40, 100, 165
14/11/2010	JC05358	CTD_074S	-23,838	-26,566	24/23, 18, 6/5	2, 35, 85, 150
15/11/2010	JC05360	CTD_076S	-26,858	-29,068	24/23, 17, 8/7	2, 30, 70, 120
16/11/2010	JC05362	CTD_078S	-29,943	-31,823	24/23, 16, 7	2, 35, 85, 145
17/11/2010	JC05365	CTD_080S	-33,044	-34,846	24/23, 19, 8/7	2, 10, 80

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Date	Station ID	CTD ID	Latitude Decimals	Longitude Decimals	Niskin No.	Depth (m)
18/11/2010	JC05367	CTD_082S	-36,090	-38,088	24/23, 19, 8/7	2, 10, 48
19/11/2010	JC05369	CTD_084S	-38,924	-41,453	24/23, 15, 6/5	2, 20, 80
20/11/2010	JC05371	CTD_086S	-41,656	-45,093	24/23, 20, 9/8	2, 5, 30
21/11/2010	JC05373	CTD_088S	-44,200	-48,939	24/23, 20, 9/8	2, 5, 30

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Nutrients

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OBJECTIVES:

To investigate the spatial and temporal variations of the micro-molar nutrient species Nitrate, Nitrite, Phosphate, Silicate and Ammonium 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.

SAMPLING and METHODOLOGY

Micro-molar nutrient analysis was carried out using a 5 channel (nitrate (Brewer & Riley, 1965), nitrite (Grasshoff, K., 1976), phosphate, silicate (Kirkwood, D.S., 1989) & ammonium (Mantoura, R.F.C. & Woodward, E.M. S., 1983) Bran & Luebbe AAIII segmented flow, colourimetric, auto-analyser. Established, proven analytical protocols were used.

Water samples were taken from a 24 x 20 litre bottle stainless steel framed CTD / Rosette system (Seabird). These were sub-sampled into clean (acid-washed) 60ml HDPE (Nalgene) sample bottles. Subsequent nutrient analysis was complete within 1-2 hours of sampling. Clean handling techniques were employed to avoid contamination of the samples (particularly the ammonium) and none of the samples were frozen or stored for later analysis.

CTD SAMPLES ANALYSED

A total of 64 vertical profiles were analysed along the axis of the AMT and are listed in the table below, (CTD geographic positions and corrected bottle firing depths being available from the CTD Log.) :-

Table : AMT20 - Nutrient Analysis - Station & CTD Sampling Summary

Date	Time (GMT)	Ship Stn.	CTD ID	Niskin sampled
14.10.10	05:39	JC053_02	CTD_003S	1,2,3,4,5,6,9,10,11,17,19
14.10.10	13:04	JC053_03	CTD_004S	1,2,3,4,5,7,11,17,19,24
15.10.10	05:43	JC053_04	CTD_006S	1,2,3,4,5,6,7,9,13,14,15,18,19,24
15.10.10	13:00	JC053_05	CTD_007S	1,2,3,4,7,10,14,17,19,24
16.10.10	05:51	JC053_06	CTD_009S	1,2,3,4,5,7,9,13,15,19,20,24
16.10.10	13:04	JC053_07	CTD_010S	1,2,3,4,7,10,13,14,18,24
17.10.10	05:58	JC053_08	CTD_012S	1,2,3,4,5,7,8,10,15,19,20,24
17.10.10	13:00	JC053_09	CTD_013S	1,2,3,6,7,9,11,16,18,24
18.10.10	05:37	JC053_10	CTD_015S	1,2,3,4,5,7,9,12,14,15,23
18.10.10	13:00	JC053_11	CTD_016S	1,2,3,5,7,13,16,19,24
19.10.10	06:01	JC053_12	CTD_018S	1,2,3,4,5,11,13,15,17,19,24
21.10.10	05:31	JC053_14	CTD_020T	1,2,3,4,9,10,12,15,18,21
21.10.10	14:06	JC053_15	CTD_021S	1,2,3,6,9,10,13,16,19,24
22.10.10	06:55	JC053_16	CTD_023S	1,3,4,5,8,10,11,14,17,19,24
22.10.10	14:08	JC053_17	CTD_024S	1,2,3,6,8,9,11,15,18,24
23.10.10	06:39	JC053_18	CTD_026S	1,2,3,4,9,10,11,13,14,19,24
23.10.10	14:10	JC053_19	CTD_027S	1,2,3,6,8,9,10,15,19,24
24.10.10	07:00	JC053_20	CTD_029S	1,3,4,5,8,9,11,13,16,19,24
24.10.10	14:03	JC053_21	CTD_030S	1,2,3,6,8,9,12,15,18,23
25.10.10	06:42	JC053_22	CTD_033S	1,2,3,4,9,10,11,13,16,19,24
25.10.10	14:09	JC053_23	CTD_034S	1,2,3,4,8,9,12,15,19,24
26.10.10	06:51	JC053_24	CTD_036S	1,2,4,5,8,9,10,11,16,19,24
26.10.10	13:06	JC053_25	CTD_037S	1,2,4,8,9,12,15,19,24

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Date	Time (GMT)	Ship Stn.	CTD ID	Niskin sampled
27.10.10	06:40	JC053_26	CTD_039S	1,2,3,4,9,10,11,13,16,19,24
27.10.10	14:08	JC053_27	CTD_040S	1,3,6,9,10,13,16,18,23
28.10.10	07:01	JC053_28	CTD_042S	1,3,4,5,8,9,10,12,16,19,24
28.10.10	14:06	JC053_29	CTD_043S	1,2,3,4,8,12,15,19,24
29.10.10	06:43	JC053_30	CTD_045S	1,2,3,4,6,7,11,13,16,19,24
29.10.10	14:06	JC053_31	CTD_046S	1,3,6,8,9,15,19,24
30.10.10	07:00	JC053_32	CTD_048S	1,2,3,4,5,7,9,10,12,15,18,23
30.10.10	14:08	JC053_33	CTD_049S	1,2,3,6,8,9,12,15,19,24
31.10.10	07:18	JC053_34	CTD_051S	1,2,3,4,6,10,12,14,18,19,24
31.10.10	14:12	JC053_35	CTD_052S	1,2,3,4,7,10,13,17,19,24
01.11.10	06:43	JC053_36	CTD_054S	1,3,4,5,7,9,10,13,19,24
01.11.10	14:10	JC053_37	CTD_055S	1,2,3,6,8,9,13,17,19,24
02.11.10	05:51	JC053_38	CTD_057S	1,2,3,4,9,10,11,13,17,20,24
02.11.10	13:16	JC053_39	CTD_058S	1,3,6,8,10,13,16,19,24
05.11.10	06:06	JC053_45	CTD_062S	1,2,3,4,9,10,11,12,18,19,24
05.11.10	13:09	JC053_46	CTD_063S	1,2,3,6,8,9,12,15,19,24
06.11.10	05:46	JC053_47	CTD_065S	2,3,4,5,8,10,11,12,17,19,24
06.11.10	13:08	JC053_48	CTD_066S	1,2,3,6,8,10,12,15,19,24
10.11.10	04:34	JC053_50	CTD_067S	1,2,3,4,9,10,11,12,16,20,23
10.11.10	13:07	JC053_51	CTD_068S	1,2,3,6,8,9,12,15,19,24
11.11.10	04:25	JC053_52	CTD_069S	1,2,4,5,8,9,10,12,15,20,23
11.11.10	13:07	JC053_53	CTD_070S	1,3,6,8,9,12,15,19,23
12.11.10	10:59	JC053_55	CTD_071S	1,2,3,4,7,9,10,13,16,19,24
13.11.10	04:34	JC053_56	CTD_072S	1,2,3,8,10,12,14,17,20,23
13.11.10	13:05	JC053_57	CTD_073S	1,2,3,6,8,9,12,15,19,24
14.11.10	04:58	JC053_58	CTD_074S	1,3,4,7,8,10,13,16,20,23
14.11.10	13:30	JC053_59	CTD_075S	1,2,6,8,9,12,15,18,24
15.11.10	05:35	JC053_60	CTD_076S	1,2,3,4,9,10,11,13,16,20,23
15.11.10	14:10	JC053_61	CTD_077S	1,2,3,5,8,9,12,15,19,24
16.11.10	05:30	JC053_62	CTD_078S	1,3,4,5,8,9,10,12,15,20,23
16.11.10	14:22	JC053_63	CTD_079S	1,2,3,6,8,9,12,15,17,24
17.11.10	05:32	JC053_65	CTD_080S	1,2,3,9,10,11,13,18,20,23
17.11.10	14:12	JC053_66	CTD_081S	1,3,4,7,9,10,13,16,18,24
18.11.10	05:35	JC053_67	CTD_082S	1,2,3,4,9,10,11,13,18,20,23
18.11.10	14:09	JC053_68	CTD_083S	1,2,3,6,9,12,17,18,24
19.11.10	05:39	JC053_69	CTD_084S	1,3,4,7,8,9,11,14,20,23
19.11.10	14:12	JC053_70	CTD_085S	1,2,3,4,8,10,13,16,18,24
20.11.10	06:41	JC053_71	CTD_086S	1,2,3,4,5,10,13,14,15,19,23
20.11.10	15:12	JC053_72	CTD_087S	1,2,3,4,5,9,12,13,16,19,24
21.11.10	06:31	JC053_73	CTD_088S	1,2,3,4,5,6,10,13,14,16,19,23
21.11.10	15:12	JC053_74	CTD_089S	1,2,3,4,5,6,9,12,13,16,19,24

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I would like to thank colleagues and the officers & crew of the RRS James Cook for making the cruise a pleasant and rewarding trip.

Dissolved Oxygen

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Background

Dissolved oxygen (O₂) in seawater is produced by photosynthesis and consumed by respiration and photochemical reactions in the surface waters. Equilibrium between dissolved O₂ in seawater and O₂ in the atmosphere is maintained through air-sea gas exchange. Previous work on the AMT programme has shown that gross community respiration may at times exceed production of O₂ integrated over the euphotic zone (Robinson *et al.*, 2002; Serret *et al.*, 2001). Several cruises have shown that this result is not consistent in either space or time suggesting transient net heterotrophy in the open ocean. The net trophic state of the oceans (autotrophic vs. heterotrophic) ultimately determines whether they act as a source or a sink for atmospheric carbon dioxide. Understanding the dynamics of O₂ is therefore necessary in order to improve biogeochemical models and associated climate change predictions. The AMT programme presents an ideal opportunity to study the biogeochemical interactions between photosynthesis and respiration on the dynamics of dissolved O₂ across diverse marine biomes.

The aim of this work is to quantify gross community production and respiration of O₂ in surface waters.

Methods

Dissolved O₂ was determined by automated Winkler titration with photometric end-point detection (Carritt & Carpenter, 1966). The concentration of thiosulphate was calibrated every 3 days. Gross community production and respiration experiments were carried out according to Robinson *et al.* (2002). In brief, seawater samples were collected daily from the pre-dawn depth profile in 10 L acid-washed carbuoys (6 depths within the euphotic zone). Each carbuoy was sub-sampled into 125 ml glass O₂ bottles which were placed in on-deck incubators for 24 hours. The incubators were covered with neutral density light filters and temperature controlled in order to simulate *in-situ* conditions. Additional sub-samples were taken and fixed at the start of the incubation (T_{ZERO} sub-samples). Light and Dark (aluminium foil wrapped) O₂ bottles were removed after the 24 hour incubation and fixed and analysed for O₂. Each treatment for each depth (T_{ZERO}, Light and Dark) was replicated four times (12 bottles per depth).

Community respiration (CR) was calculated as O₂ consumption in the Dark samples (Dark – T_{ZERO}).

Net community production was calculated as O₂ production in Light samples (Light – Dark).

In total, 31 experiments were carried out for the determination of community production/respiration along the transect and the station summary is listed in Table 1.

Results

Experimental data for the determination of community production/respiration is not yet fully quality controlled and will be subject to further analysis before any inferences or conclusions can be drawn.

Table 6: Station log for samples collected for production/respiration of O₂ during AMT 20 (JC_053). Station geographic location (latitude & longitude) and actual sampled depth (rather than nominal depth) can be obtained from the cruise CTD log.

Date	Time (GMT)	Ship Stn.	CTD ID	Niskin sampled
14.OCT.2010	04:35	JC053_002	CTD_002T	7, 10, 13, 17, 19, 24
15.OCT.2010	04:35	JC053_004	CTD_005T	7, 10, 13, 17, 19, 24
16.OCT.2010	04:55	JC053_006	CTD_008T	8, 11, 13, 17, 19, 24
17.OCT.2010	04:35	JC053_008	CTD_011T	8, 11, 13, 17, 19, 24
18.OCT.2010	04:30	JC053_010	CTD_014T	7, 12, 14, 17, 19, 24
21.OCT.2010	05:30	JC053_014	CTD_020T	8, 11, 13, 17, 19, 24
22.OCT.2010	05:30	JC053_015	CTD_022T	8, 11, 13, 17, 19, 24

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Date	Time (GMT)	Ship Stn.	CTD ID	Niskin sampled
23.OCT.2010	05:30	JC053_018	CTD_025T	8, 11, 13, 16, 19, 24
24.OCT.2010	05:30	JC053_020	CTD_028T	8, 11, 13, 15, 18, 24
25.OCT.2010	05:30	JC053_022	CTD_032T	9, 12, 14, 16, 19, 24
26.OCT.2010	05:30	JC053_024	CTD_035T	8, 11, 13, 14, 19, 24
27.OCT.2010	05:30	JC053_026	CTD_038T	8, 11, 13, 15, 19, 24
28.OCT.2010	05:30	JC053_028	CTD_041T	8, 11, 13, 15, 19, 24
29.OCT.2010	05:30	JC053_030	CTD_044T	8, 12, 14, 16, 19, 24
30.OCT.2010	05:30	JC053_032	CTD_047T	8, 11, 13, 15, 19, 24
31.OCT.2010	05:30	JC053_034	CTD_050T	8, 11, 14, 16, 19, 24
01.NOV.2010	05:30	JC053_036	CTD_053T	7, 10, 13, 15, 19, 24
02.NOV.2010	04:30	JC053_038	CTD_056T	7, 11, 13, 14, 19, 24
05.NOV.2010	04:55	JC053_045	CTD_061T	8, 11, 13, 15, 19, 24
06.NOV.2010	04:30	JC053_047	CTD_064T	8, 11, 13, 15, 19, 24
10.NOV.2010	04:30	JC053_050	CTD_067S	8, 10, 11, 13, 17, 24
11.NOV.2010	04:30	JC053_052	CTD_069S	7, 9, 10, 11, 16, 24
13.NOV.2010	04:30	JC053_056	CTD_072S	7, 10, 11, 13, 18, 24
14.NOV.2010	04:30	JC053_058	CTD_074S	6, 9, 10, 12, 18, 24
15.NOV.2010	05:30	JC053_060	CTD_076S	8, 10, 11, 12, 17, 24
16.NOV.2010	05:30	JC053_062	CTD_078S	7, 9, 10, 11, 16, 24
17.NOV.2010	05:30	JC053_065	CTD_080S	8, 10, 11, 12, 19, 24
18.NOV.2010	05:30	JC053_067	CTD_082S	8, 10, 11, 12, 19, 24
19.NOV.2010	05:30	JC053_069	CTD_084S	6, 9, 10, 15, 19, 24
20.NOV.2010	05:30	JC053_071	CTD_086S	9, 13, 14, 16, 20, 24
21.NOV.2010	05:30	JC053_073	CTD_088S	9, 13, 14, 15, 20, 24

References:

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Extracted chlorophyll-a sampling for calibration of CTD and underway fluorometers

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Samples of seawater from CTD niskin bottles and the ship's non-toxic supply were taken to calibrate the CTD and underway system fluorometers following Wechemeyer. Samples of up to 250 ml were filtered through 47mm 0.2 um polycarbonate filters. The filters were then placed in a vial with 10 ml 90% acetone and left in a freezer for at least 12 hours. The samples were then analysed on a pre-calibrated Turner Designs Trilogy fluorometer with a non-acidified chl module (CHL NA #046) fitted. The calibration was checked against dilutions of pure chlorophyll stock during the cruise and no modifications to the calibration were necessary.

See the calibrations section for details of the CTD and Surfmet fluorometer calibrations.

Underway samples

A list of date, time and position for the underway samples can be found in the appendices.

CTD samples

Samples were collected at 56 stations from up to 6 light depths from 97, 55, 33, 14, 7, 1 & 0.1%. A total of 288 samples were collected from the CTD casts. The depths and stations sampled are listed in Table 1.

Data submission

The dataset will be submitted to BODC at the end of the cruise.

References:

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

Table 1: List of stations and depths sampled for extracted chlorophyll-a measurement

Date	Time (GMT)	Station	Lat (+ve N)	Lon (+ve E)	Cast	Niskin No.	Depth (m)
14/10/2010	04:35	2	49.406	-11.165	CTD002t	5, 9, 12, 15, 18, 22	50, 30, 20, 10, 5, surface
14/10/2010	13:04	3	49.270	-12.884	CTD004s	5, 6, 11, 17, 19, 24	50, 30, 25, 15, 10, surface
15/10/2010	04:33	4	49.036	-16.431	CTD005t	5, 9, 12, 16, 18, 22	45, 25, 20, 10, 5, surface
15/10/2010	13:06	5	48.116	-17.324	CTD007s	6, 10, 14, 17, 24	50, 35, 20, 10, surface
16/10/2010	04:53	6	46.055	-19.192	CTD008t	6, 10, 12, 15, 18, 22	70, 40, 30, 15, 10, surface
16/10/2010	13:04	7	45.198	-19.934	CTD010s	7, 10, 13, 16, 19, 24	58, 50, 30, 20, 10, surface
17/10/2010	04:25	8	43.550	-21.364	CTD011t	6, 10, 12, 15, 18, 22	70, 40, 30, 15, 10, surface
17/10/2010	13:07	9	42.767	-22.035	CTD013s	5, 8, 15, 18, 24	80, 50, 25, 10, surface
18/10/2010	04:29	10	40.994	-23.479	CTD014t	5, 11, 13, 16, 18, 22	120, 60, 50, 30, 15, surface
18/10/2010	13:05	11	40.126	-24.193	CTD016s	4, 7, 12, 14, 19, 23	130, 70, 50, 30, 15, surface
19/10/2010	04:31	12	38.281	-25.646	CTD017t	12, 14, 16, 18, 20, 22	58, 45, 35, 20, 10, surface
21/10/2010	05:31	14	34.218	-29.762	CTD020t	6, 10, 12, 15, 18, 22	95, 55, 40, 25, 10, surface
21/10/2010	14:06	15	33.842	-30.204	CTD021s	6, 10, 13, 16, 19, 24	110, 55, 45, 30, 15, surface
22/10/2010	05:28	16	32.426	-31.800	CTD022t	6, 10, 12, 15, 18, 22	100, 65, 45, 23, 15, surface
22/10/2010	14:08	17	31.730	-32.563	CTD024s	6, 9, 11, 14, 18, 24	90, 55, 35, 25, 10, surface

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Date	Time (GMT)	Station	Lat (+ve N)	Lon (+ve E)	Cast	Niskin No.	Depth (m)
23/10/2010	05:27	18	30.285	-34.179	CTD025t	6, 10, 12, 15, 17, 22	110, 85, 65, 45, 25, surface
23/10/2010	14:10	19	29.610	-34.901	CTD027s	6, 9, 10, 15, 19, 24	100, 60, 45, 25, 15, surface
24/10/2010	05:29	20	28.112	-36.516	CTD028t	6, 10, 12, 14, 17, 22	110, 85, 65, 50, 25, surface
24/10/2010	14:03	21	27.452	-37.233	CTD030s	6, 9, 12, 15, 18, 23	118, 70, 50, 30, 15, surface
25/10/2010	05:28	22	25.984	-38.783	CTD032t	7, 11, 13, 15, 17, 22	100, 80, 60, 45, 25, surface
25/10/2010	14:09	23	25.270	-39.530	CTD034s	4, 9, 12, 15, 19, 24	120, 70, 60, 30, 15, surface
26/10/2010	05:23	24	23.771	-41.108	CTD035t	6, 10, 12, 15, 17, 22	120, 90, 70, 50, 30, surface
26/10/2010	14:02	25	22.964	-40.532	CTD037s	4, 9, 12, 15, 19, 22	125, 70, 55, 30, 15, surface
27/10/2010	05:27	26	21.362	-39.293	CTD038t	6, 10, 12, 14, 17, 22	118, 85, 65, 50, 25, surface
27/10/2010	14:08	27	20.431	-38.739	CTD040s	6, 10, 13, 16, 18, 23	115, 65, 50, 25, 15, surface
28/10/2010	05:34	28	18.691	-37.523	CTD041t	6, 10, 12, 14, 17, 22	125, 95, 70, 55, 30, surface
28/10/2010	14:06	29	17.913	-36.984	CTD043s	4, 12, 15, 19, 24	115, 60, 30, 15, surface
29/10/2010	05:26	30	16.191	-35.806	CTD044t	6, 11, 13, 15, 18, 22	95, 72, 55, 40, 20, surface
29/10/2010	14:06	31	15.424	-35.286	CTD046s	6, 9, 10, 15, 19, 24	90, 55, 40, 20, 10, surface
30/10/2010	05:43	32	13.463	-33.950	CTD047t	6, 10, 12, 14, 17, 22	55, 40, 30, 25, 15, surface
30/10/2010	14:08	33	12.545	-33.329	CTD049s	3, 6, 9, 15, 24	115, 60, 40, 20, surface
31/10/2010	05:30	34	10.567	-31.995	CTD050t	6, 10, 15, 22	65, 40, 25, surface
31/10/2010	14:12	35	9.751	-31.458	CTD052s	7, 10, 24	50, 40, surface
01/11/2010	05:28	36	7.814	-30.160	CTD053t	4, 5, 12, 22	100, 65, 40, surface
01/11/2010	14:04	37	6.787	-29.484	CTD055s	6, 9, 24	60, 35, surface
02/11/2010	04:30	38	4.804	-28.166	CTD056t	4, 5, 12, 22	120, 78, 45, surface
02/11/2010	14:06	39	3.886	-27.565	CTD058s	6, 10, 24	68, 40, surface
05/11/2010	04:53	45	-3.852	-25.018	CTD061t	4, 6, 14, 22	110, 70, 40, surface
05/11/2010	13:09	46	-4.891	-25.030	CTD063s	6, 9, 24	98, 55, surface
06/11/2010	04:31	47	-6.057	-23.763	CTD064t	3, 6, 12, 22	150, 100, 55, surface
06/11/2010	13:07	48	-6.268	-22.698	CTD066s	6, 10, 24	90, 55, surface
10/11/2010	04:43	50	-12.529	-19.022	CTD067s	3, 7, 11, 12, 16, 23	200, 130, 75, 55, 30, surface
11/11/2010	04:25	52	-15.331	-21.841	CTD069s	4, 6, 10, 15, 23	225, 145, 85, 35, surface
13/11/2010	04:34	56	-20.380	-25.089	CTD072s	2, 6, 12, 14, 17, 23	250, 165, 100, 75, 40, surface
14/11/2010	04:58	58	-23.838	-26.566	CTD074s	3, 5, 10, 16, 23	225, 150, 85, 35, surface
15/11/2010	05:35	60	-26.858	-29.068	CTD076s	3, 7, 11, 23	190, 120, 70, surface
16/11/2010	05:36	62	-29.944	-31.824	CTD078s	4, 8, 10, 12, 23	200, 145, 85, 60, surface
17/11/2010	05:32	65	-33.044	-34.845	CTD080s	3, 7, 11, 18, 23	125, 80, 50, 20, surface
18/11/2010	05:35	67	-36.090	-38.088	CTD082s	4, 7, 11, 23	75, 48, 30, surface
18/11/2010	14:09	68	-37.094	-39.231	CTD083s	3, 6, 9, 24	100, 65, 40, surface
19/11/2010	05:39	69	-38.924	-41.453	CTD084s	4, 5, 9, 23	100, 80, 45, surface
19/11/2010	14:25	70	-39.791	-42.552	CTD085s	3, 4, 10, 13	100, 80, 45, 35
20/11/2010	06:41	71	-41.656	-45.094	CTD086s	3, 4, 8, 14, 23	100, 75, 30, 15, surface
20/11/2010	15:12	72	-42.498	-46.296	CTD087s	3, 4, 13	100, 75, 15
21/11/2010	06:31	73	-44.200	-48.939	CTD088s	5, 6, 8, 14, 23	75, 45, 30, 15, surface
21/11/2010	15:12	74	-45.017	-50.285	CTD089s	6, 9, 13, 16, 19, 24	45, 30, 15, 10, 5, surface

CTD and underway sensor calibration

Rob Thomas

British Oceanographic Data Centre

CTD profiles

A total of 89 CTD casts were completed during the cruise. All 89 casts were conventional profiling casts with water sampling. Both a stainless steel (SS) and a titanium (TT) CTD system were used. The SS frame was normally deployed daily at ~05:30 and ~13:00 ship time. The TT frame was normally deployed daily at ~04:30 to 500m or 1000m on alternate days; however from 9th November only the SS frame was used with deployments at ~04:30 and ~13:00 each day. A total of 22 titanium and 67 stainless steel profiles were completed.

The winch for deploying the CTD suffered problems on 2nd - 3rd November and no casts were able to be made between 03°N and 01°S. Once the winch returned to use, wire termination failures at 500m on both cast 59 and 60, resulted in no water collection and data was only acquired from the down casts. A detour to Ascension Island postponed science 7th-9th November and no CTD casts were made between 06°S and 12°S. After the termination problems both occurred at 500m combined with the reduced time available for science from the 9th November casts were limited to a depth of 300m.

The CTD profiles were processed on board by the NMF-SS technicians Jeff Benson and Peter Keen using SeaBird processing software v7.21 according to the suggested BODC protocols. The final files generated for submission post-cruise were 2 Hz binned down and up cast data files (.CNV) and sensor values at the time of each bottle firing (.BTL). The data from the bottle files were used to generate calibrations for the salinity, oxygen and fluorescence channels.

Samples were collected for measurement of salinity (bench salinometer), dissolved oxygen (Winkler titration) and chlorophyll-a (filtration, acetone extraction and fluorometric measurement) each day from each rig. These data were then used to calibrate the salinity, oxygen and fluorescence measurements.

The method used for calibration was to generate an offset between the discrete measurement (salinity/oxygen/extracted chl-a) and the nominal value from the manufacturer's calibration of the sensor from the SeaBird .BTL file. This offset was then plotted against the discrete value and a linear regression applied. Where the linear regression was significant the calibration was derived by rearranging the regression equation:

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

where offset = Discrete – Nominal calibration

to give Calibration = $1/(1-a) * \text{Nominal calibration} + b/(1-a)$

Where the linear regression was not significant the mean value of the offset was applied.

In cases where it appeared there was drift with time or changing conditions affecting the sensor, more than one calibration was derived. The calibrated offsets were then checked for drift over time by plotting the offset against cast or station number.

N.B. All calibrations have been based on datasets that may change after quality control by BODC post cruise. Therefore they should be considered provisional until the data are made available through the BODC website (www.bodc.ac.uk).

Temperature

There were no independent measurements of temperature made during the cruise and the sensors on each rig returned consistent data. No further calibration of these sensors has been carried out. The section generated from the frame mounted sensor on the stainless steel rig is provided in fig. 1.

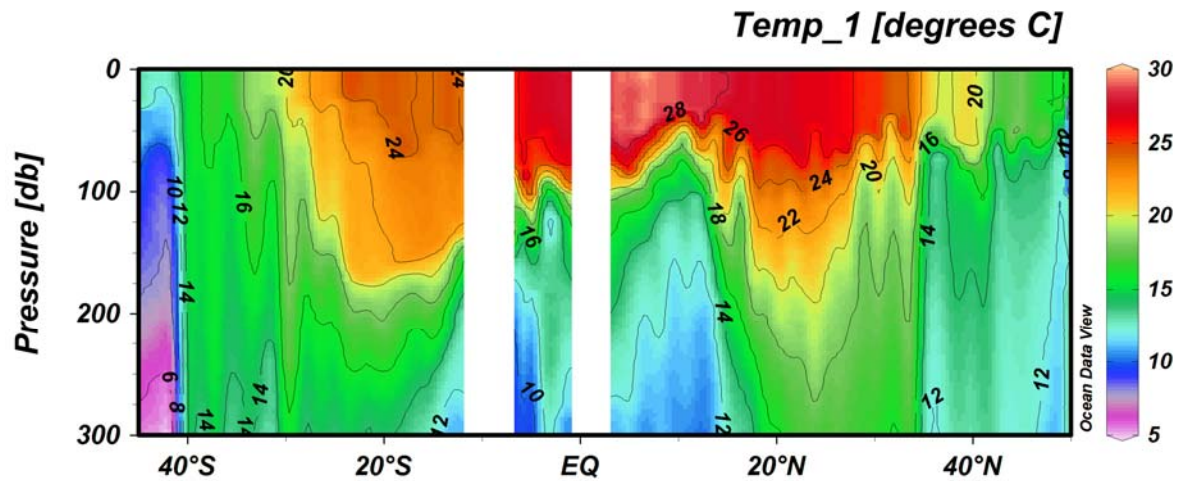


Fig. 1: Section plot of temperature along the AMT20 transect by latitude from the frame mounted sensor on the stainless steel CTD rig. Breaks in the plot where sampling could not be carried out.

Salinity

The SeaBird conductivity sensors were calibrated against bench salinometer measurements made on seawater collected by Niskin bottles from the deepest depth on each cast. Further details of these measurements can be found in the NMF-SS cruise report section.

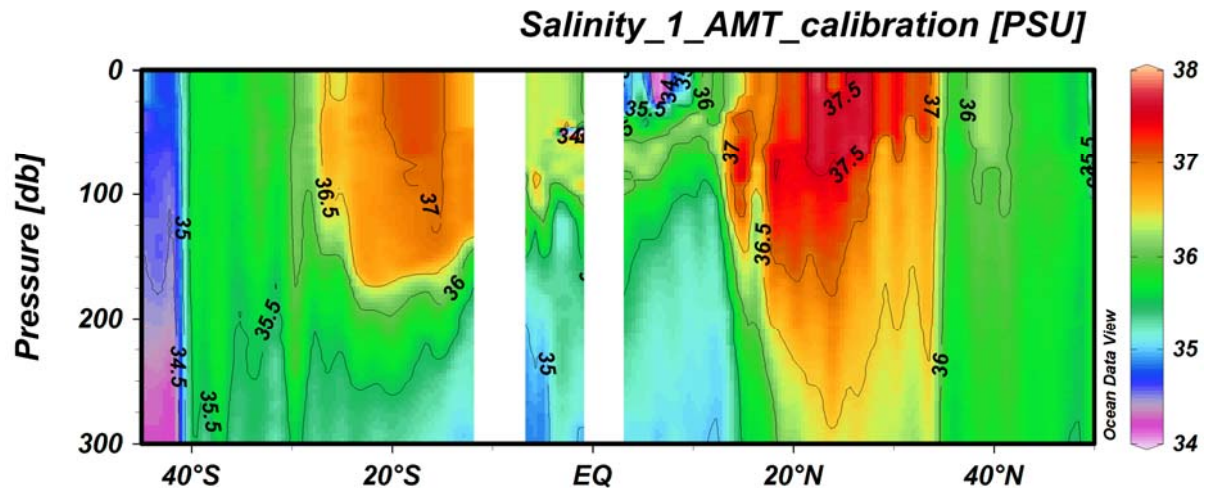


Fig. 2: Section plot of salinity along the AMT20 transect by latitude from the frame mounted sensor on the stainless steel CTD rig calibrated against bench salinometer samples. Breaks in the plot where sampling could not be carried out.

Stainless steel

The linear regressions of offset against bench salinometer data were not significant and so offsets were generated. All sensors appeared to show a drift with time (see fig. 3 for sensor 1 data and fig. 4 for sensor 2 data), however with only one sample collected from the deepest sampled depth on each cast this could not be investigated further as it was not possible to determine if the offset was fixed or varied with salinity for each cast. Three offsets were applied to sensor 1 for casts 1-59, 60-69 and 70-89.

Sensor 1:

Casts 1-59	Salinity = SeaBird salinity + 0.0028	(n= 27; stdev=0.0013)
Casts 60-69	Salinity = SeaBird salinity + 0.0049	(n= 3; stdev=0.0015)
Casts 70-89	Salinity = SeaBird salinity + 0.0072	(n= 17; stdev=0.0015)

AMT20 Cruise Report

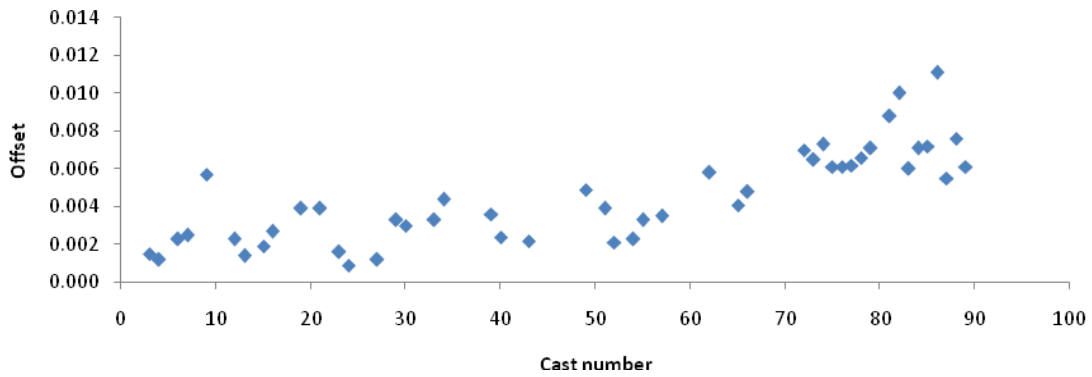


Fig. 3: Offset against cast number for the bench salinometer data and sensor 1 measurements. Outliers outside plot scale.

Sensor 2:

Casts 1-29 Salinity = SeaBird salinity +0.0049 (n=15; stdev=0.0022)

Casts 30-89 Salinity = SeaBird salinity +0.0038 (n=27; stdev=0.0028)

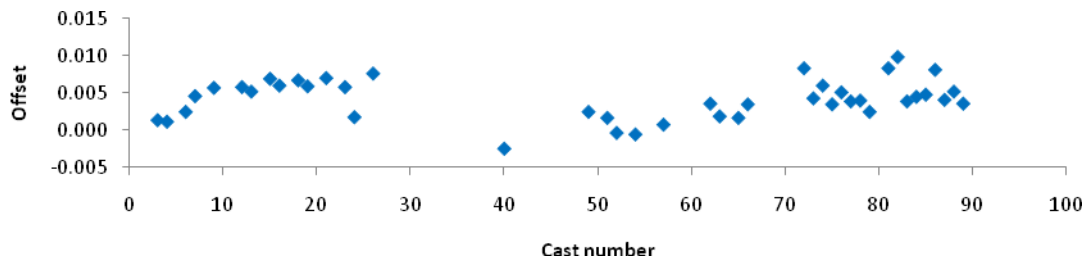


Fig. 4: Offset against cast number for the bench salinometer data and sensor 2 measurements. Outliers outside plot scale.

Titanium

There were no problems with the conductivity sensors deployed on the titanium rig.

Sensor 1 had a small offset of +0.0001 (Fig. 5) which was consistent over time and with sensor 2 the offset had a significant linear regression with the bench salinometer measurements and a subsequent offset of +0.0016 once the trend was corrected (Fig. 6).

Sensor 1: Salinity = SeaBird salinity + 0.0001 (n= 19; stdev=0.0010)

Sensor 2: Salinity = 0.9979 * SeaBird salinity +0.0761 (n=20; $r^2=0.64$; $p<0.001$)

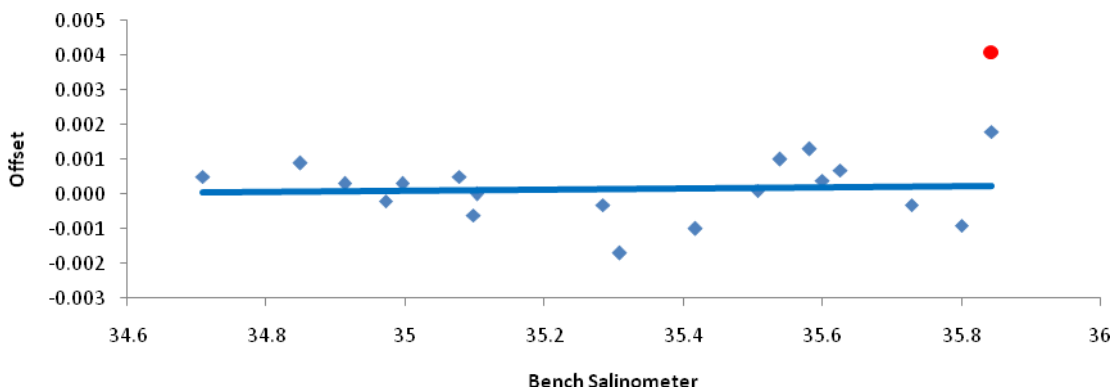


Fig. 5: Offset against bench salinometer measurements pre-calibration for titanium rig frame mounted sensor 1. Additional outliers outside plot scale.

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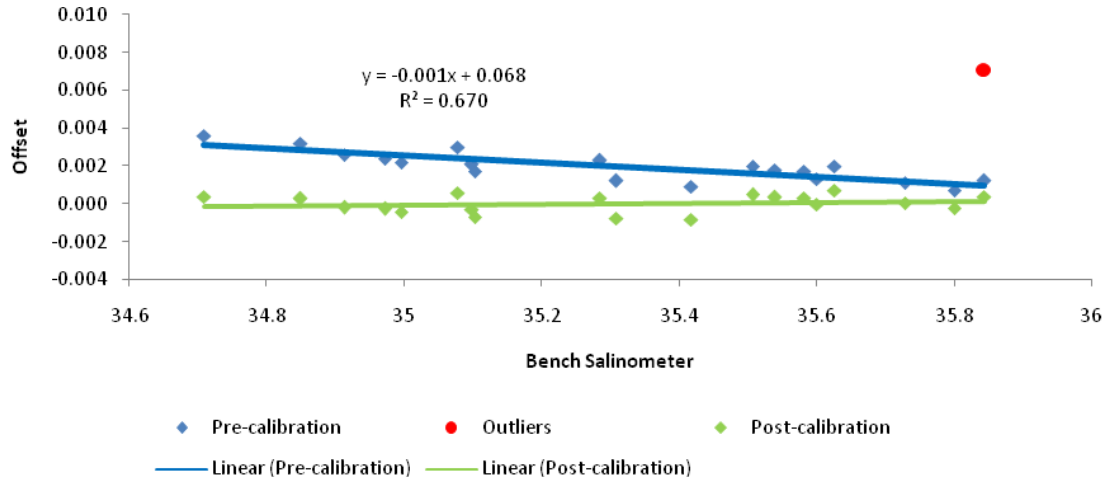


Fig. 6: Offset against bench salinometer measurements pre and post calibration for titanium rig vane mounted sensor 2. Additional outliers outside plot scale.

Oxygen

The CTD SeaBird oxygen sensors were calibrated against discrete oxygen sample measurements made on seawater collected by Niskin bottles from up to 6 depths at each station. The dissolved oxygen concentrations were determined by Winkler titration. When both CTD rigs were being deployed each CTD was sampled once per day. After Ascension Island when the stainless steel rig was used for all casts only the pre-dawn cast was sampled. More details of the samples collected can be found in Johanna Gloel's cruise report section. The section plot of the calibrated dissolved oxygen concentration and saturation measured by the stainless steel deployed sensor are provided in fig. 7 and 10.

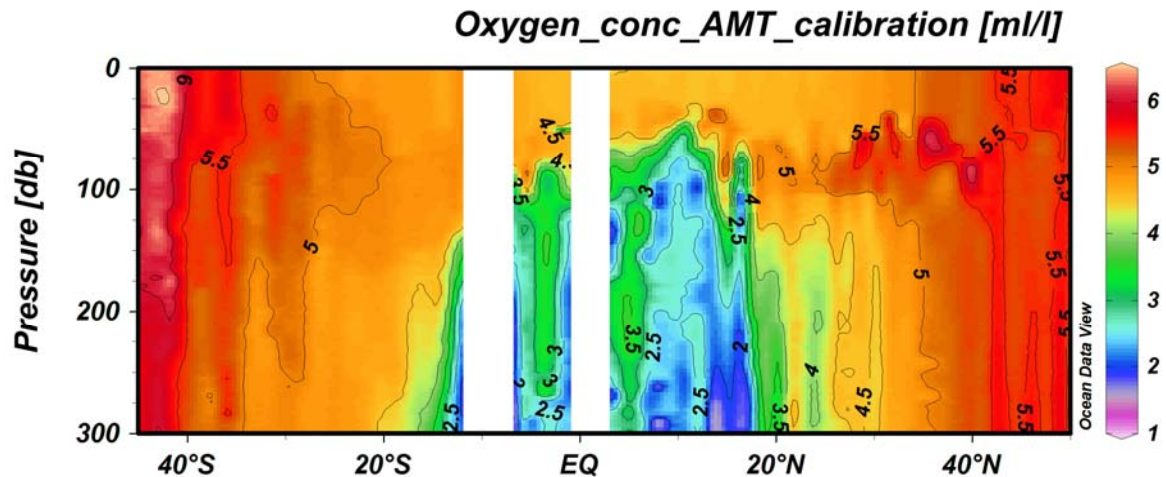


Fig. 7: Section plot of dissolved oxygen concentration (ml/l) along the AMT20 transect by latitude from the frame mounted sensor on the stainless steel CTD rig calibrated against Winkler titration samples. Breaks in the plot where sampling could not be carried out.

Stainless steel

The oxygen sensor operated without problem during the cruise. 206 samples were taken from the stainless steel rig casts during the cruise. An initial calibration was made with the dataset as a whole; however this led to surface O₂ saturation levels less than 100% except for the last few casts. The calibration was therefore carried out for two sections which split as the casts made before and after Ascension Island (casts 1-67 and 68-89) (see fig. 8). The linear regression of offset against Winkler oxygen concentration was significant for both calibrations ($n=97$; $r^2=0.84$; $p<0.001$ and $n=88$; $r^2=0.84$; $p<0.001$) and the following calibrations were derived:

Casts 1-66 Dissolved O₂ concⁿ (in ml/l) = 1.1064 * SBE oxygen (in ml/l) + 0.1287

Casts 67-89 Dissolved O₂ concⁿ (in ml/l) = 1.0800 * SBE oxygen (in ml/l) + 0.1701

After the calibrations were applied the offsets were recalculated and the change in the Root Mean Square of the offset gives an indication of whether the fit has been improved (Table 1).

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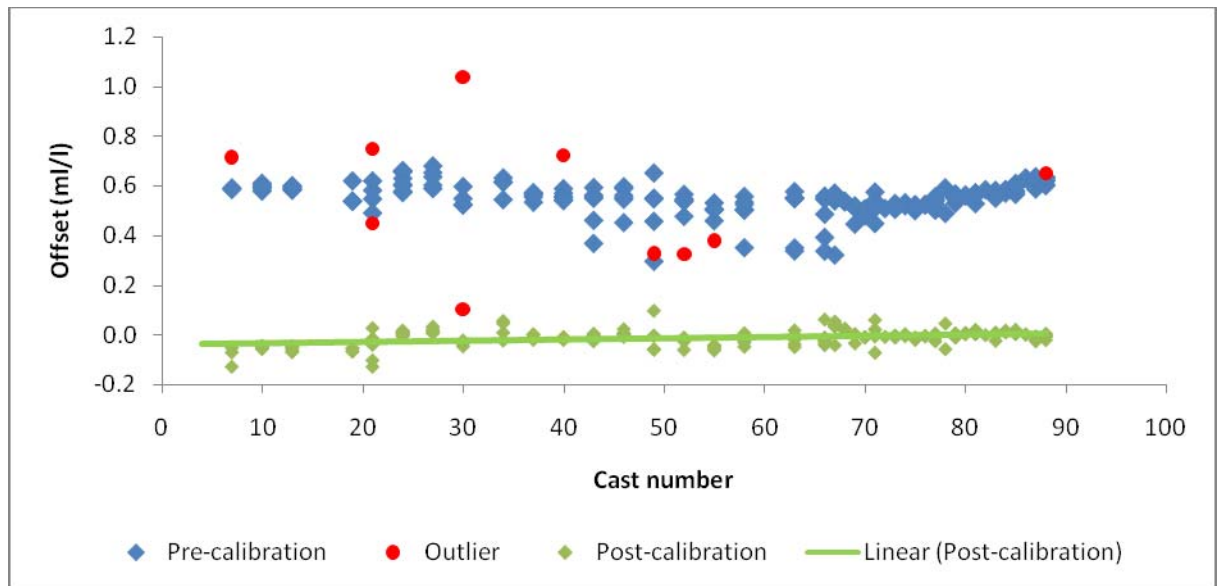


Fig. 8: Offset against cast number for pre and post calibration for stainless steel rig oxygen sensor.

Titanium

The oxygen sensor operated without problem during the cruise. 121 samples were taken from the titanium rig casts during the cruise. Considering the calibration dataset in its entirety the regression of the offset against Winkler oxygen concentration is not significant ($n=108$; $r^2<0.001$; $p=0.99$), however when the offset was plotted against cast number a step in the offsets became apparent (see fig. 9). Therefore the calibration was split into 2 groups (casts 2-17 and cast 20-64).

Casts 2-17 Dissolved O_2 concⁿ (in ml/l) = SBE oxygen (in ml/l) + 0.0679

Casts 20-64 Dissolved O_2 concⁿ (in ml/l) = 1.0361 * SBE oxygen (in ml/l) + 0.0134

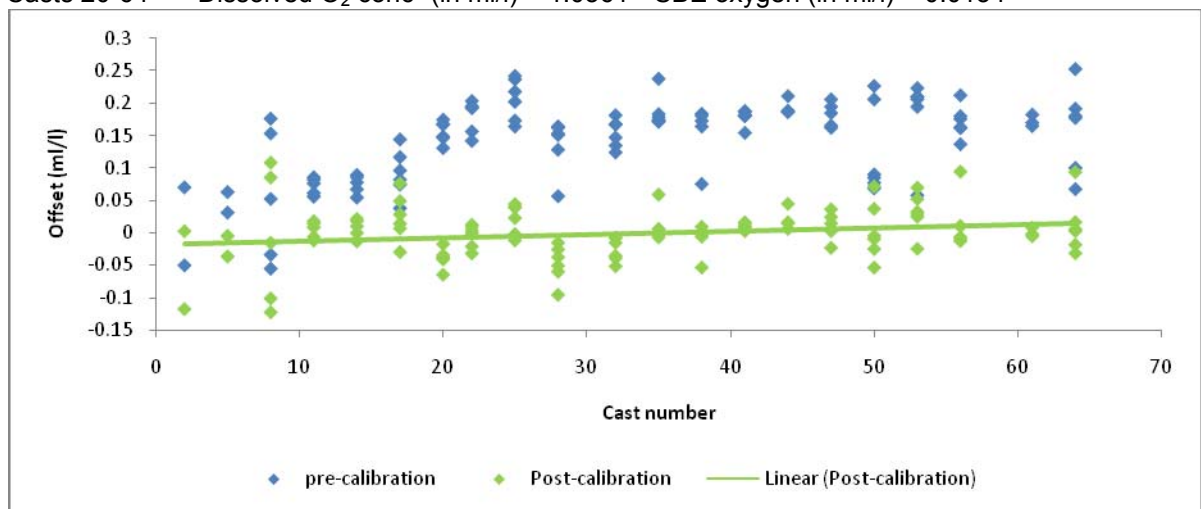
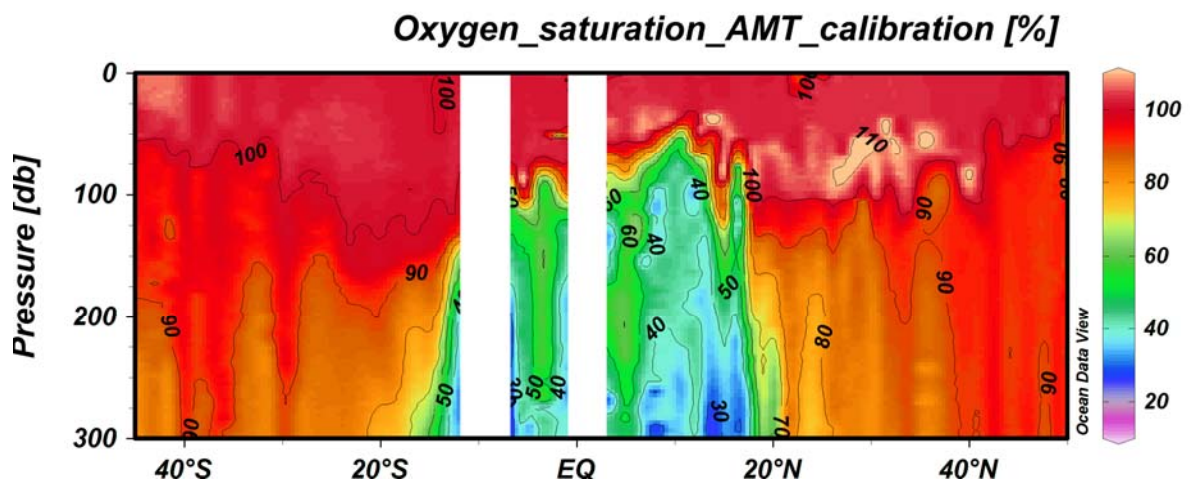


Fig. 9: Offset against cast number for pre and post calibration for titanium rig oxygen sensor.



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Fig. 10: Section plot of oxygen saturation (%) along the AMT20 transect by latitude from the frame mounted sensor on the stainless steel CTD rig. Saturation calculated with calibrated oxygen concentration and calibrated salinity values. Breaks in the plot where sampling could not be carried out.

Fluorometer/Chl-a

The CTD deployed fluorometers were calibrated against extracted chlorophyll-a measurements made on seawater collected by Niskin bottles from up to 6 depths at each station. When both CTD rigs were being deployed each CTD was sampled once per day. After Ascension Island when the stainless steel rig was used for all casts, a reduced number of samples were taken from the noon cast. More details of the samples collected can be found in the appropriate cruise report section.

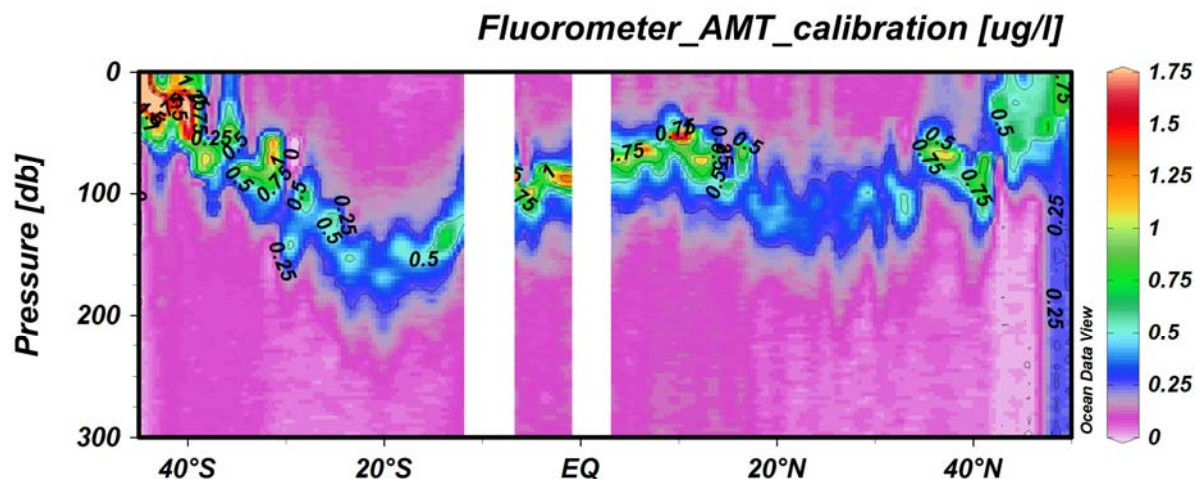


Fig. 11: Section plot of calibrated fluorescence as chl-a ($\mu\text{g/l}$) along the AMT20 transect by latitude from the frame mounted sensor on the stainless steel CTD rig. Breaks in the plot where sampling could not be carried out.

Stainless steel

The fluorometer operated without problems until cast 86 when the voltage dropped out during the up-cast. The cable was tightened before cast 87 and then changed before cast 88; while the down-cast on all three casts appeared to be OK the drop outs on the up-cast persisted for both casts 87 and 88. This resulted in the bottle firing data for these casts being unreliable for use in the calibration. Casts 86, 87 and 88 were calibrated taking the nominal chl-a values from the down-cast at the relevant bottle firing depths. The fluorometer was then replaced for the final cast 89. The calibration was split between four regions along the cruise track for the fluorometer in use from casts 4 to 85, with separate calibrations for each of the suspect casts and for the final cast with the new fluorometer. Casts 1, 3 and 86 were not calibrated.

Casts 4-7	Chl-a ($\mu\text{g/L}$) = 1.4544 * Nominal calibration	(n=9; $r^2=0.79$)
Casts 9-13	Chl-a ($\mu\text{g/L}$) = 2.0345 * Nominal calibration	(n= 10; $r^2= 0.89$)
Casts 15-79	Chl-a ($\mu\text{g/L}$) = 3.0583 * Nominal calibration	(n=110; $r^2= 0.97$)
Casts 80-85	Chl-a ($\mu\text{g/L}$) = 2.0718 * Nominal calibration	(n=22; $r^2=0.94$)
Cast 87	Chl-a ($\mu\text{g/L}$) = 2.0386 * Nominal calibration	(n=9 ; $r^2=0.79$)
Cast 88	Chl-a ($\mu\text{g/L}$) = 1.4179 * Nominal calibration	(n=3 ; $r^2=0.50$)
Cast 89	Chl-a ($\mu\text{g/L}$) = 1.9910 * Nominal calibration	(n=4; $r^2=0.66$)

These calibration equations were applied to the calibration dataset with outliers removed and post-calibration offsets generated (Discrete chl-a – Calibrated chl-a) and the calibrated offsets did not show any trend with time/station (Fig. 12). The mean offset and stdev were reduced, as was the RMS error and the range of the offsets was reduced and centred closer to zero (see table 2).

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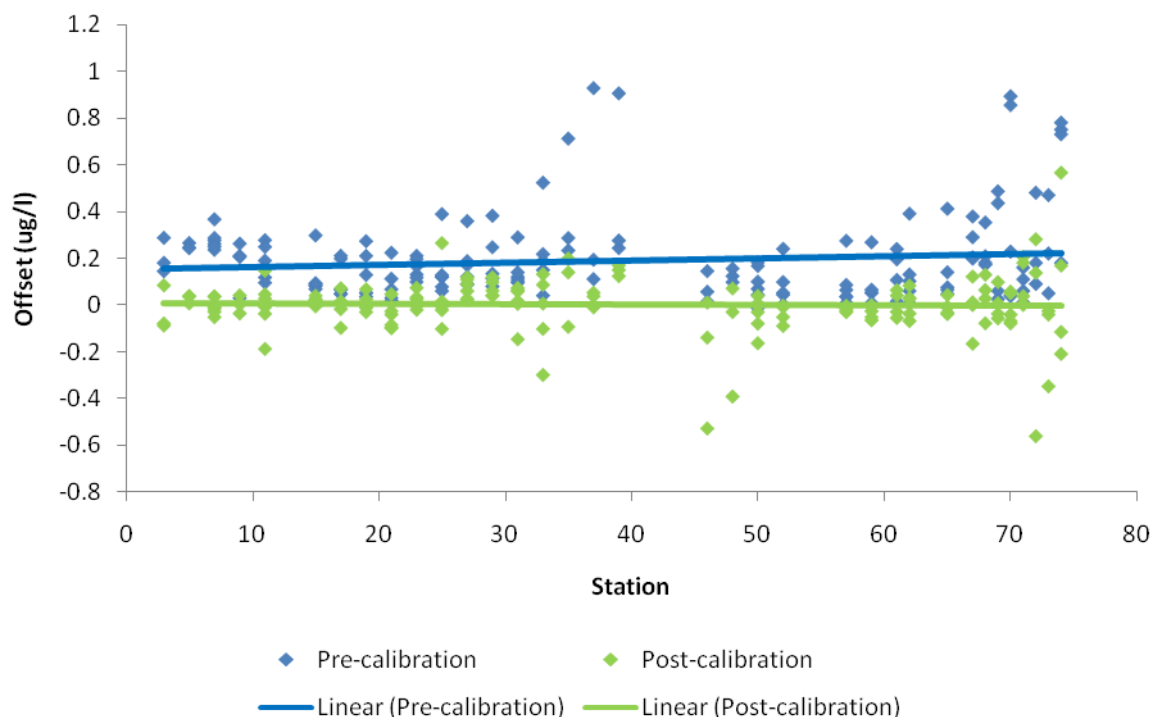


Fig. 12: Plot of offset pre- and post calibration against station for the stainless steel CTD rig.

Titanium

The fluorometer operated without problems until cast 41 when the voltage dropped out during the up-cast. The problem reappeared consistently from cast 47. The cable was tightened and changed on successive casts but the problem persisted; while the down-casts appeared to be OK. This resulted in the bottle firing data for these casts being unreliable for use in the calibration. All casts were therefore calibrated taking the nominal chl-a values from the down-cast at the relevant bottle firing depths for consistency. The fluorometer was then replaced after cast 64 but the titanium rig was not used again on the cruise after Ascension Island due to reduced sampling time for the duration of the cruise. The calibration was split between five regions along the cruise track.

Casts 2-11	Chl-a ($\mu\text{g/L}$) = 1.7130 * Nominal calibration	(n=15 ; $r^2=0.90$)
Casts 14-28	Chl-a ($\mu\text{g/L}$) = 5.3169 * Nominal calibration – 0.0606	(n= 33; $r^2= 0.99$)
Casts 32-41	Chl-a ($\mu\text{g/L}$) = 4.4718 * Nominal calibration – 0.0957	(n= 24; $r^2= 0.98$)
Casts 44-53	Chl-a ($\mu\text{g/L}$) = 6.4238 * Nominal calibration – 0.1933	(n= 18; $r^2= 0.98$)
Casts 56-64	Chl-a ($\mu\text{g/L}$) = 3.8976 * Nominal calibration – 0.0791	(n= 12; $r^2= 0.99$)

These calibration equations were applied to the calibration dataset with outliers removed and post-calibration offsets generated (Discrete chl-a – Calibrated chl-a) and the calibrated offsets did not show any trend with time/station (Fig. 13). The mean offset and stdev were reduced, as was the RMS error and the range of the offsets was reduced and centred closer to zero (see table 2).

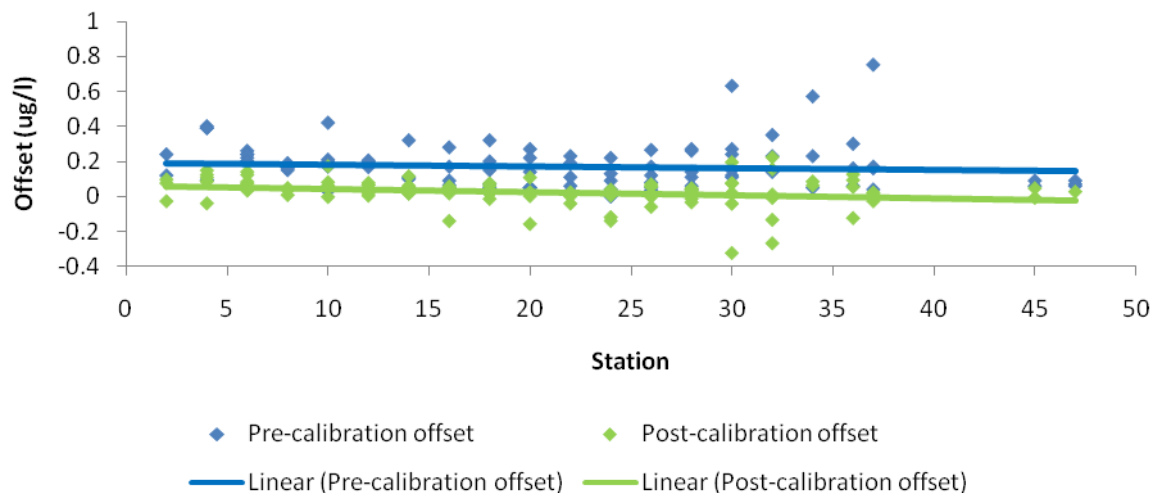


Fig. 13: Plot of offset pre- and post calibration against station for the titanium CTD rig.

Surfmet

The ship's underway meteorological and surface systems were run continuously through the cruise with the exception of the period going alongside at Ponta Delgada in the Azores and also within 200 nautical miles of Ascension Island (see Underway Log in the Appendices for exact date and times). The system stopped logging outside the 200 nautical mile limits of Falkland Island and Argentinean waters on 22/11/2010 at 21:05 GMT.

Samples were collected to calibrate the TSG and fluorometer sensors connected to the ship's non-toxic flow-through system, which draws water from approximately 6m below the water line.

Temperature

Hull sensor

The hull sensor data were calibrated on return to the UK against the values returned by the CTD sensors in the surface at each station. The data from the CTD profiles were averaged over 5 decibars at the surface. Data values with high standard deviations were removed from the calibration set and an offset calculated between CTD and hull sensor temperature. The offset was then plotted against time and CTD temperature. There was a significant drift with time ($p=0.0029$) but no regression with CTD temperature ($p=0.669$).

The linear offset to be applied was -0.0012 °C at 13/10/2010 07:00 changing to -0.0087 °C at 22/11/2010 21:05 (both times GMT).

TSG

The data from the TSG temperature sensor drifts from that of the surface temperature measured by the hull mounted sensor during the cruise as the seawater is pumped through the ship. The drift will depend on the sea and air temperature differential along with the temperature of the vessel in the areas through which the pipes pass. This channel will not be calibrated.

Salinity

171 samples were collected from the non-toxic supply along the cruise track at approximately 4 hour intervals from 04:00 to 20:00 ship's time each day the underway supply was running (fig. 14). Of these 160 were used in the calibration dataset. There was no significant relationship between the offset and the bench salinometer measurements ($n=160$; $r^2=0.01$; $p>0.05$) but there was a slight drift with time ($n=160$; $r^2=0.05$; $p=0.003$). The offset to be applied is 0.01 at 13/10/2010 12:00 reducing to 0 at 22/11/2010 21:05 (both times GMT). Once the data have been screened by BODC after the cruise the offset will be applied through the BODC database.

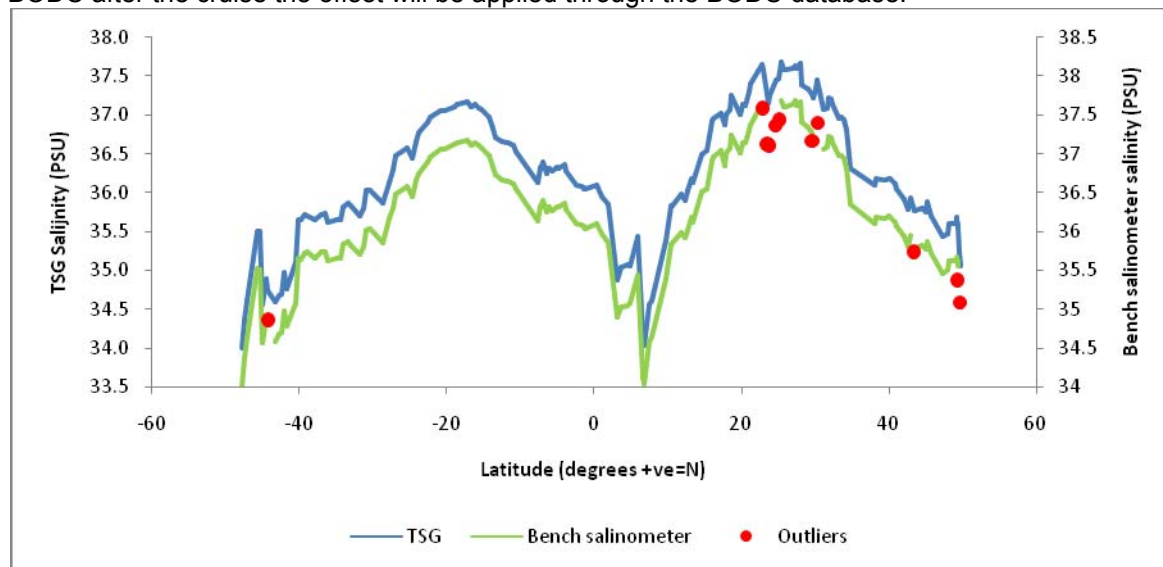


Fig. 14: Plot of TSG and bench salinometer data along the cruise track by latitude.

Fluorometer/chl-a

154 samples were collected from the non-toxic supply along the cruise track at approximately 4 hour intervals from 04:00 to 20:00 ship's time each day the underway supply was running (Fig. 15).

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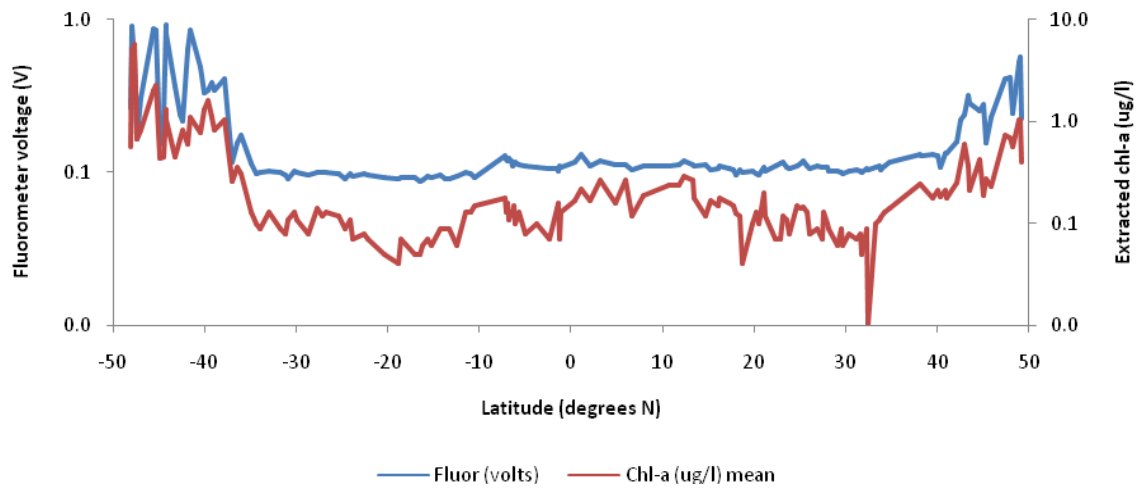


Fig. 15: Plot of fluorometer voltage and discrete sample extracted chl-a data along the cruise track by latitude. The data are represented on log scale axes.

The dataset was split into a number of sections to correct for differing periods of drift in the sensor and different periods where the non-toxic system had been switch off/on and/or cleaned. The calibration details are available along with the data from BODC (www.bodc.ac.uk).

Education and Outreach

Eleanor Darlington

Education Through Expeditions, University of Plymouth

Aims

- Maintain links with school children on land to give a sense of Life At Sea
- Work with schools and colleges to develop resources which will aid in making science exciting and applicable for young people
- Develop projects which educate the next generation on our global climate, promote ocean and environmental sciences, and highlight alternative career paths
- *Objectives:*
- Maintain frequent updates on the AMT Blog (www.amtblog.org.uk)
- Create an 'expedition hub' on the Education Through Expeditions website (www.etelive.org/amt20)
- Sustain links with schools, providing the opportunity for school children to ask questions by e-mail and Skype text chat
- Create videos and sound files

Outcomes

School Contact:

Prior to the cruise I gave a school talk at St. Andrews High School for Boys, Worthing. This was well received and was followed by questions sent by e-mail. An educational resource pack was sent out to all schools in Plymouth, highlighting the aims of the cruise, and how classes could get involved. This initiated questions from Wembury Primary School and interest from Devonport High School for Girls, as well as Leigham, Hyde Park and St Peter's Primary Schools. Links from friends and family forged communications with: Whytmead First School, Davison CE High School for Girls, Charleton Primary School and Bolot in Siberia. Scientist Dave Drapeau maintained contact with his son's school, Boothbay Regional Elementary, Maine, USA. Regular questions were exchanged via e-mail as well as position updates so that the classes could track RRS James Cook using atlases and Google Earth.

Media Contact:

Prior to the cruise I gave a live interview on BBC Radio Solent, highlighting the aims and objectives of the cruise as well as inviting people to ask questions and instigate contact with schools. During the cruise Dr. Andy Rees and PhD student Elena Garcia-Marin gave an interview to BBC World Service which was published online in Spanish. An open question session for the general public followed this which was fruitful. Photos were provided for this article, uploaded to the PML ftp site with the aid of NMF technicians Gareth Knight and Jon Seddon. Interest for an interview for news channel NTN24, who broadcast over the South, Central and North Americas was shown. Unfortunately we couldn't get a phone connection so the interview never came of anything.

Blog:

A total of 35 blog entries have been published on www.amtblog.org.uk. These have covered day to day events, the science and life at sea looking into the jobs of the crew.

Film Footage:

Working with the HD film files was difficult. At present there isn't any free software to convert AVCHD files to Mpeg4 files which can be viewed in Quick Time player and subsequently made small enough to upload to the internet. NMF technician Jon Seddon wrote some Unix software to crudely convert the files. This was suitable for small film files, which could then be edited and converted to Mpeg4 on the ship's iMac. In addition to suitable software, a computer with a suitably powerful media card is required. Because of this, the majority of film footage has not been viewed at sea and only written to an external hard drive for processing in the UK.

Photography:

Over 1000 photos have been taken to capture the science and life at sea. These will be contributed to future outreach projects.

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On Return to the UK:

- The film footage is to be processed by PML.
- An annotated book of photographs, acting as a 'picture diary' will be put together by Eleanor Darlington.
- Follow up talks and workshops are to be given in schools as well as working in classes with smaller scale workshops, coordinated by Education Through Expeditions.

Future Development

The AMT20 cruise has highlighted that the most effective communications were maintained when the school was visited prior to departure. In light of this, to enhance school involvement much more planning is needed. A 6-7 week lesson plan of activities is needed to capsule teachers' attention. Proposed outline:

- School visit prior to departure
- A different topic of focus each week including the science, oceans impact on climate, technologies used, jobs at sea (e.g. engineering and catering), navigation
- Regular blogs
- A weekly recorded voice blog or video, depending on ships communication links
- Use resources from AMT20 to create educational PowerPoint slides as classroom aids
- Ensure resources and blogs are aimed at specific age groups. E.g. Early Years, Key Stage 3, GCSE and A-level

Whilst at sea contact has been made with the Royal Geographical Society and the Earth Sciences Teaching Association. These links will be followed up to establish how teaching resources can be developed and implemented for a future AMT cruise.

Acknowledgements

I would like to thank Anthony Jinman and Laura Hobbs from ETE, and Kelly-Marie Davidson, Dawn Ashby, and Juliet Thompson from PML for their shore based support. In addition I'd like to thank all the scientists and crew for their help and enthusiasm, making this such an enjoyable trip.

Total alkalinity (TA) and pH measurements from CTD bottle samples

Rob Thomas⁽¹⁾, Ella Darlington⁽²⁾, Barbora Hoskova⁽³⁾, Andy Rees⁽⁴⁾, Gavin Tilstone⁽⁴⁾

⁽¹⁾ BODC

⁽²⁾ Education Through Expeditions

⁽³⁾ Academy of Sciences of the Czech Republic

⁽⁴⁾ Plymouth Marine Laboratory

Total Alkalinity

A total of 169 samples were collected from 57 stations at up to 3 depths from the CTD niskin bottles; the 97% (or surface), 33, 14% or 1% (or DCM) light (see Table 1). The samples were collected into borosilicate bottles and 100 μ L of mercuric chloride added to preserve the samples. The samples will be analysed back in the UK according to Dickson *et al.* (2007).

pH

Samples were taken at 63 stations from up to 9 depths (usually 6 light depths from 97, 55, 33, 14, 7, 3 & 1%). Borosilicate bottles were filled from the CTD niskin bottles and left to equalise to laboratory temperature. pH samples were analysed onboard using a Perkin Elmer Lambda35 UV/VIS spectrophotometer with the UV lamp turned off. Two staining techniques used on previous AMT cruises were applied for comparison; thymol blue (AMT18) and m-cresol purple (AMT19). A comparison of the pH values obtained by each technique was used to inter-calibrate the samples from all 3 cruises (see fig. 1).

Thymol blue

The pH calculation in seawater was based on Zhang and Byrne (1996). A 2 mmol L⁻¹ stock solution of thymol blue Sodium salt (0.9771 g in 1 L Milli-Q) was prepared. The absorbance of seawater blank was measured at 435 and 596 nm. 50 μ L of stock was added to 50 mL seawater and the absorbance measured again at 435 and 596 nm. The seawater 'blank' absorbance values were subtracted from seawater absorbance after thymol blue addition and together with the sample temperature and salinity were used to derive the sample pH.

M-cresol purple

The m-cresol purple technique followed that outlined by Dickson *et al.* (2007). A ≥ 2 mmol L⁻¹ stock solution of m-cresol Sodium salt (0.9771 g in 1 L Milli-Q) was used to stain samples. The absorbance of a seawater blank at 578 and 434 nm (absorbance maxima of base (I⁻) and acid (HI⁻)) respectively and 730 nm (non-absorbing wavelength) were measured. 300 μ L of stock was added to 50 ml of each seawater sample, shaken to mix, and the absorbance of each wavelength measured again. The amount of dye required was that which was determined onboard to produce absorbance values of between 0.4 and 1.0 at the two absorbance peaks. The seawater 'blank' absorbance values were subtracted from seawater absorbance after m-cresol addition for all three wavelengths. The non-absorbing wavelength was used to monitor baseline shifts due to curvette repositioning errors or instrumental drift. The difference should be no greater than ± 0.001 . The pH value for each sample was then determined from the salinity, temperature at measurement and absorbances using pk2 from Clayton and Byrne (1993).

Data submission

The pH dataset will be submitted to BODC at the end of the cruise.

Table 1: List of stations and depths sampled for TA analysis.

Date	Time (GMT)	Station	Lat (+ve N)	Lon (+ve E)	Cast	Niskin No.	Depth (m)
15/10/2010	04:30	4	49.035	- 16.432	CTD005t	5, 16, 22	45, 10, surface
15/10/2010	13:02	5	48.116	- 17.324	CTD007s	6, 17, 24	50, 10, surface
16/10/2010	04:49	6	46.055	- 19.191	CTD008t	6, 15, 22	70, 15, surface
16/10/2010	13:04	7	45.198	- 19.934	CTD010s	7, 16, 24	58, 20, surface
17/10/2010	04:25	8	43.550	- 21.364	CTD011t	6, 15, 22	70, 20, surface
17/10/2010	13:07	9	42.767	- 22.035	CTD013s	5, 15, 24	80, 25, surface

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Date	Time (GMT)	Station	Lat (+ve N)	Lon (+ve E)	Cast	Niskin No.	Depth (m)
18/10/2010	04:29	10	40.994	-	CTD014t	5, 16, 22	120, 30, surface
				23.479			
18/10/2010	13:05	11	40.126	-	CTD016s	5, 12, 23	130, 50, surface
				24.193			
19/10/2010	04:31	12	38.281	-	CTD017t	12, 18, 22	57, 20, surface
				25.646			
21/10/2010	05:31	14	34.218	-	CTD020t	6, 12, 22	95, 40, surface
				29.762			
21/10/2010	14:06	15	33.842	-	CTD021s	6, 16, 24	110, 30, surface
				30.204			
22/10/2010	05:28	16	32.426	-	CTD022t	6, 15, 22	100, 25, surface
				31.800			
22/10/2010	14:08	17	31.730	-	CTD024s	6, 11, 24	90, 35, surface
				32.563			
23/10/2010	05:27	18	30.285	-	CTD025t	6, 17, 22	110, 25, surface
				34.179			
23/10/2010	14:10	19	29.610	-	CTD027s	6, 10, 24	100, 45, surface
				34.901			
24/10/2010	05:29	20	28.112	-	CTD028t	6, 14, 22	110, 50, surface
				36.516			
24/10/2010	14:03	21	27.452	-	CTD030s	6, 12, 23	118, 50, surface
				37.233			
25/10/2010	05:28	22	25.984	-	CTD032t	7, 17, 22	100, 25, surface
				38.783			
25/10/2010	14:09	23	25.270	-	CTD034s	4, 15, 24	120, 30, surface
				39.530			
26/10/2010	05:23	24	23.771	-	CTD035t	6, 17, 22	120, 30, surface
				41.108			
26/10/2010	14:02	25	22.964	-	CTD037s	4, 15, 22	125, 30, surface
				40.532			
27/10/2010	05:27	26	21.212	-	CTD038t	6, 17, 22	118, 25, surface
				39.293			
27/10/2010	14:08	27	20.431	-	CTD040s	6, 16, 23	115, 25, surface
				38.739			
28/10/2010	05:34	28	18.691	-	CTD041t	6, 17, 22	125, 30, surface
				37.523			
28/10/2010	14:06	29	17.913	-	CTD043s	4, 15, 24	115, 30, surface
				36.984			
29/10/2010	05:26	30	16.191	-	CTD044t	6, 18, 22	95, 20, surface
				35.806			
29/10/2010	14:06	31	15.424	-	CTD046s	6, 15, 24	90, 20, surface
				35.286			
30/10/2010	05:43	32	13.463	-	CTD047t	6, 17, 22	55, 15, surface
				33.950			
30/10/2010	14:08	33	12.545	-	CTD049s	6, 19, 24	60, 10, surface
				33.329			
31/10/2010	05:30	34	10.567	-	CTD050t	6, 15, 22	65, 25, surface
				31.995			
31/10/2010	14:12	35	9.751	-	CTD052s	7, 17, 24	50, 15, surface
				31.458			
01/11/2010	05:28	36	7.814	-	CTD053t	5, 17, 22	65, 15, surface
				30.160			
01/11/2010	14:04	37	6.787	-	CTD055s	6, 17, 24	60, 15, surface
				29.484			
02/11/2010	04:30	38	4.804	-	CTD056t	5, 17, 22	78, 20, surface
				28.166			
02/11/2010	14:06	39	3.886	-	CTD058s	6, 16, 24	68, 15, surface
				27.565			
05/11/2010	04:53	45	-3.852	-	CTD061t	6, 17, 22	70, 15, surface
				25.018			

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Date	Time (GMT)	Station	Lat (+ve N)	Lon (+ve E)	Cast	Niskin No.	Depth (m)
05/11/2010	13:09	46	-4.891	-	CTD063s	6, 15, 24	98, 25, surface
06/11/2010	04:31	47	-6.057	-	CTD064t	6, 22	100, surface
10/11/2010	04:34	50	-	-	CTD067s	7, 16, 23	130, 30, surface
10/11/2010	13:07	51	-	-	CTD068s	6, 15, 24	135, 35, surface
11/11/2010	04:25	52	-	-	CTD069s	6, 15, 23	145, 35, surface
11/11/2010	13:07	53	-	-	CTD070s	6, 15, 23	145, 35, surface
12/11/2010	10:59	55	-	-	CTD071s	7, 16, 24	140, 35, surface
13/11/2010	04:34	56	-	-	CTD072s	6, 17, 23	165, 40, surface
13/11/2010	13:05	57	-	-	CTD073s	6, 15, 24	150, 35, surface
14/11/2010	04:58	58	-	-	CTD074s	5, 10, 23	150, 85, surface
14/11/2010	13:30	59	-	-	CTD075s	6, 15, 24	130, 30, surface
15/11/2010	05:35	60	-	-	CTD076s	7, 13, 23	120, 35, surface
15/11/2010	14:10	61	-	-	CTD077s	4, 15, 24	105, 25, surface
16/11/2010	05:36	62	-	-	CTD078s	8, 10, 23	145, 85, surface
16/11/2010	14:22	63	-	-	CTD079s	6, 15, 24	65, 15, surface
17/11/2010	05:32	65	-	-	CTD080s	7, 18, 23	80, 20, surface
17/11/2010	14:12	66	-	-	CTD081s	7, 18, 24	70, 10, surface
18/11/2010	05:35	67	-	-	CTD082s	7, 18, 24	48, 10, surface
18/11/2010	14:09	68	-	-	CTD083s	6, 17, 24	65, 15, surface
19/11/2010	05:39	69	-	-	CTD084s	5, 14, 23	80, 20, surface
19/11/2010	14:25	70	-	-	CTD085s	8, 24	60, surface

Table 2: List of stations bottles and depths sampled for pH and method used for analysis (TB=thymol-blue; m-cp=m-cresol purple; both=both stains used for comparison).

Date	Time (GMT)	Station	Lat (+ve N)	Lon (+ve E)	Cast	Niskin No.	Depth (m)	Dye
14/10/2010	13:00	3	49.270	-	CTD004s	5, 7, 11, 17, 19, 24	50, 30, 25, 15, 10, surface	TB
15/10/2010	04:30	4	49.035	-	CTD005t	5, 9, 12, 16, 18, 22	45, 25, 20, 10, 5, surface	TB
15/10/2010	13:02	5	48.116	-	CTD007s	3, 6, 10, 14, 17, 24	100, 50, 35, 20, 10, surface	TB
16/10/2010	04:49	6	46.055	-	CTD008t	6, 10, 12, 15, 18, 22	70, 40, 30, 15, 10, surface	TB
16/10/2010	13:04	7	45.198	-	CTD010s	4, 7, 13, 16, 19, 24	80, 58, 30, 20, 10, surface	TB
17/10/2010	04:25	8	43.550	-	CTD011t	6, 10, 12, 15, 18, 22	70, 40, 30, 20, 10, surface	TB

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Date	Time (GMT)	Station	Lat (+ve N)	Lon (+ve E)	Cast	Niskin No.	Depth (m)	Dye
17/10/2010	13:07	9	42.767	- 22.035	CTD013s	5, 8, 15, 18, 24	80, 50, 25, 10, surface	both
18/10/2010	04:29	10	40.994	- 23.479	CTD014t	5, 11, 13, 16, 18, 22	120, 60, 50, 30, 15, surface	m- cp
18/10/2010	13:05	11	40.126	- 24.193	CTD016s	5, 7, 12, 14, 19, 23	130, 70, 50, 30, 15, surface	m- cp
19/10/2010	04:31	12	38.281	- 25.646	CTD017t	12, 14, 16, 18, 20, 22	57, 45, 35, 20, 10, surface	m- cp
21/10/2010	05:31	14	34.218	- 29.762	CTD020t	6, 10, 12, 15, 18, 22	95, 55, 40, 25, 10, surface	m- cp
21/10/2010	14:06	15	33.842	- 30.204	CTD021s	6, 10, 13, 16, 19, 24	110, 55, 45, 30, 15, surface	m- cp
22/10/2010	05:28	16	32.426	- 31.800	CTD022t	6, 10, 12, 15, 18, 22	100, 65, 45, 25, 15, surface	m- cp
22/10/2010	14:08	17	31.730	- 32.563	CTD024s	6, 9, 11, 14, 18, 24	90, 55, 35, 25, 10, surface	m- cp
23/10/2010	05:27	18	30.285	- 34.179	CTD025t	6, 10, 12, 15, 17, 22	110, 85, 65, 45, 25, surface	m- cp
23/10/2010	14:10	19	29.610	- 34.901	CTD027s	6, 9, 10, 15, 19, 24	100, 60, 45, 25, 15, surface	m- cp
24/10/2010	05:29	20	28.112	- 36.516	CTD028t	6, 10, 12, 14, 17, 22	110, 85, 65, 50, 25, surface	m- cp
24/10/2010	14:03	21	27.452	- 37.233	CTD030s	6, 9, 12, 15, 18, 23	118, 70, 50, 30, 15, surface	m- cp
25/10/2010	05:28	22	25.984	- 38.783	CTD032t	7, 11, 13, 15, 17, 22	100, 80, 60, 45, 25, surface	m- cp
25/10/2010	14:09	23	25.270	- 39.530	CTD034s	4, 9, 12, 15, 19, 24	120, 70, 60, 30, 15, surface	m- cp
26/10/2010	05:23	24	23.771	- 41.108	CTD035t	6, 10, 12, 15, 17, 22	120, 90, 70, 50, 30, surface	m- cp
26/10/2010	14:02	25	22.964	- 40.532	CTD037s	4, 9, 12, 15, 19, 22	125, 70, 55, 30, 15, surface	m- cp
27/10/2010	05:27	26	21.212	- 39.293	CTD038t	6, 10, 12, 14, 17, 22	118, 85, 65, 50, 25, surface	m- cp
27/10/2010	14:08	27	20.431	- 38.739	CTD040s	6, 10, 13, 16, 18, 23	115, 65, 50, 25, 15, surface	m- cp
28/10/2010	05:34	28	18.691	- 37.523	CTD041t	6, 10, 12, 14, 17, 22	125, 95, 70, 55, 30, surface	m- cp
28/10/2010	14:06	29	17.913	- 36.984	CTD043s	4, 12, 15, 19, 24	115, 60, 30, 15, surface	m- cp
29/10/2010	05:26	30	16.191	- 35.806	CTD044t	6, 11, 13, 15, 18, 22	95, 72, 55, 40, 20, surface	m- cp
29/10/2010	14:06	31	15.424	- 35.286	CTD046s	6, 9, 10, 15, 19, 24	90, 55, 40, 20, 10, surface	m- cp
30/10/2010	05:43	32	13.463	- 33.950	CTD047t	6, 10, 12, 14, 17, 22	55, 40, 30, 25, 15, surface	m- cp
30/10/2010	14:08	33	12.545	- 33.329	CTD049s	6, 9, 12, 15, 19, 24	60, 40, 30, 20, 10, surface	m- cp
31/10/2010	05:30	34	10.567	- 31.995	CTD050t	6, 10, 13, 15, 18, 22	65, 40, 35, 25, 15, surface	m- cp
31/10/2010	14:12	35	9.751	- 31.458	CTD052s	7, 10, 13, 17, 19, 24	50, 40, 30, 15, 10, surface	m- cp
01/11/2010	05:28	36	7.814	- 30.160	CTD053t	5, 9, 12, 14, 17, 22	65, 50, 40, 30, 15, surface	m- cp
01/11/2010	14:04	37	6.787	- 29.484	CTD055s	6, 9, 13, 17, 19, 24	60, 35, 25, 15, 10, surface	m- cp
02/11/2010	04:30	38	4.804	- 28.166	CTD056t	5, 10, 12, 15, 17, 22	78, 60, 45, 35, 20, surface	m- cp
02/11/2010	14:06	39	3.886	- 27.565	CTD058s	6, 10, 13, 16, 19, 24	68, 40, 30, 15, 10, surface	m- cp

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Date	Time (GMT)	Station	Lat (+ve N)	Lon (+ve E)	Cast	Niskin No.	Depth (m)	Dye
05/11/2010	04:53	45	-3.852	-	CTD061t	6, 10, 12, 14, 17, 22	70, 55, 40, 30, 15, surface	m- cp
05/11/2010	13:09	46	-4.891	-	CTD063s	6, 9, 12, 15, 19, 24	98, 55, 40, 25, 10, surface	m- cp
06/11/2010	04:31	47	-6.057	-	CTD064t	6, 10, 12, 14, 17, 22	100, 75, 55, 40, 25, surface	m- cp
06/11/2010	13:07	48	-6.268	-	CTD066s	6, 10, 12, 15, 19, 24	90, 55, 40, 25, 10, surface	m- cp
10/11/2010	04:34	50	-	-	CTD067s	7, 11, 12, 16, 23	130, 75, 55, 30, surface	m- cp
10/11/2010	13:07	51	-	-	CTD068s	6, 9, 12, 15, 19, 24	135, 80, 60, 35, 20, surface	m- cp
11/11/2010	04:25	52	-	-	CTD069s	6, 9, 10, 12, 15, 23	145, 115, 85, 65, 35, surface	m- cp
11/11/2010	13:07	53	-	-	CTD070s	6, 9, 12, 15, 19, 23	145, 85, 65, 35, 20, surface	m- cp
12/11/2010	10:59	55	-	-	CTD071s	7, 10, 13, 16, 19, 24	140, 85, 60, 35, 20, surface	m- cp
13/11/2010	04:34	56	-	-	CTD072s	6, 10, 12, 14, 17, 23	165, 130, 100, 75, 40, surface	m- cp
13/11/2010	13:05	57	-	-	CTD073s	6, 9, 12, 15, 19, 24	150, 85, 65, 35, 25, surface	m- cp
14/11/2010	04:58	58	-	-	CTD074s	5, 8, 10, 13, 16, 23	150, 115, 85, 65, 35, surface	m- cp
14/11/2010	13:30	59	-	-	CTD075s	6, 9, 12, 15, 18, 24	130, 75, 55, 30, 15, surface	m- cp
15/11/2010	05:35	60	-	-	CTD076s	7, 10, 11, 13, 23	120, 95, 70, 35, surface	m- cp
15/11/2010	14:10	61	-	-	CTD077s	4, 9, 12, 15, 19, 24	105, 60, 45, 25, 15, surface	m- cp
16/11/2010	05:36	62	-	-	CTD078s	4, 8, 9, 10, 12, 15, 23	200, 145, 110, 85, 60, 35, surface	both
16/11/2010	14:22	63	-	-	CTD079s	6, 9, 12, 15, 17, 24	65, 35, 25, 15, 10, surface	m- cp
17/11/2010	05:32	65	-	-	CTD080s	3, 7, 10, 11, 13, 18, 23	125, 80, 65, 50, 35, 20, surface	both
17/11/2010	14:12	66	-	-	CTD081s	7, 10, 13, 16, 18, 24	70, 45, 35, 20, 10, surface	m- cp
18/11/2010	05:35	67	-	-	CTD082s	1, 2, 7, 10, 11, 18, 24	300, 220, 48, 40, 30, 10, surface	both
18/11/2010	14:09	68	-	-	CTD083s	6, 9, 12, 17, 24	65, 40, 30, 15, surface	m- cp
19/11/2010	05:39	69	-	-	CTD084s	1, 5, 8, 9, 11, 14, 23	300, 80, 60, 45, 35, 20, surface	both
19/11/2010	14:25	70	-	-	CTD085s	8, 10, 13, 16, 18, 24	60, 45, 35, 20, 10, surface	m- cp
20/11/2010	06:41	71	-	-	CTD086s	1, 2, 3, 8, 15, 19, 23	300, 200, 100, 75, 30, 10, surface	both
20/11/2010	15:12	72	-	-	CTD087s	1, 2, 3, 9, 13, 24	300, 200, 100, 30, 15, surface	both
21/11/2010	06:31	73	-	-	CTD088s	1, 2, 4, 5, 6, 8, 14, 23	300, 200, 100, 75, 45, 30, 15, surface	both
21/11/2010	15:12	74	-	-	CTD089s	1, 2, 4, 6, 9, 13, 16, 19, 24	300, 200, 100, 45, 30, 15, 10, 5, surface	both

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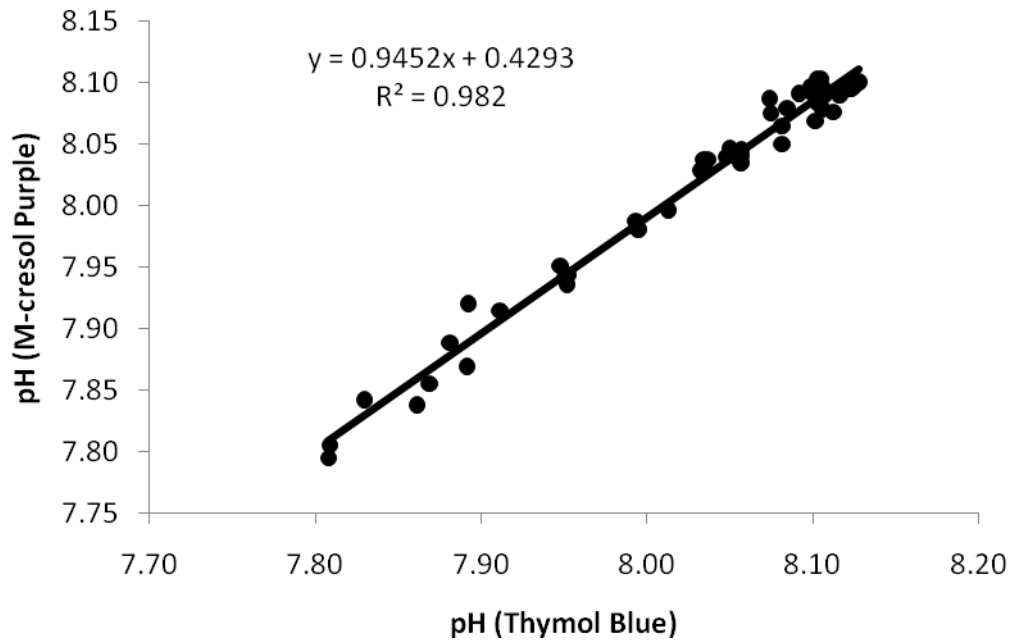


Fig.1: Comparison of spectrophotometrically determined pH values using thymol blue and m-cresol purple staining techniques.

References:

- Clayton and Byrne**, 1993. Spectrophotometric seawater pH measurements: total hydrogen ion concentration scale calibration of m-cresol purple and at sea results. *Deep-Sea Research I*, 40:2115-2129
- Dickson A. G., Sabine C. L. and Christian J. R.** (Eds.), 2007. Guide to best practices for ocean CO₂ measurements. *PICES Special Publication*, 3:1-191
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Nitrogen fixation

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Nitrogen fixation, in which dinitrogen gas (N_2) is converted by diazotrophic microorganisms to ammonium (NH_4^+), represents a potentially important source of nitrogen in nutrient poor regions of the Atlantic Ocean. Incubations using ^{15}N - N_2 additions were performed in order to:

1. To quantify nitrogen fixation rates in surface waters of the Atlantic.
2. Assess the differences between traditional methodology and a recently published method (Mohr et al 2010)
3. Provide comparative rates for the work performed during this cruise by Michael Fraser.
4. Investigate the impact of ocean acidification on nitrogen fixation rates – see Tilstone report.

Methodology

Seawater was distributed into triplicate 1 litre polycarbonate bottles and amended with 2 ml of ^{15}N - N_2 at stations indicated below. Following incubation in the on-deck incubators for approx 24 hours, experiments were terminated by filtration onto 25 mm GF/F filters which were dried onboard and pelleted into tin capsules prior to stable isotope mass spectrometer analysis at PML. Particulate nitrogen (PN) and ^{15}N atom% were measured using continuous-flow stable isotope mass-spectrometry (Rees et al 2009).

References

Mohr W, Großkopf T, Wallace DWR, LaRoche J (2010) Methodological Underestimation of Oceanic Nitrogen Fixation Rates. PLoS ONE 5(9): e12583. doi:10.1371/journal.pone.0012583

Rees A.P., J. A. Gilbert, B. A. Kelly-Gerreyn (2009). Nitrogen fixation in the western English Channel (NE Atlantic Ocean). Mar. Ecol. Prog. Ser. 374, 7- 12. doi:10.3354/meps07771

Station	Date	Lat	Long	CTD	depth
JC053-16	22/10/2010	32°25.541N	31°48.288W	CTD023-S	Surface, 25m, 100m
JC053-18	23/10/2010	30°17.593N	34°10.990W	CTD026-S	Surface, 25m, 100m
JC053-20	24/10/2010	28°06.766N	36°30.512W	CTD029-S	Surface, 25m, 112m
JC053-22	25/10/2010	25°59.013N	38°46.982W	CTD033-S	Surface, 25m, 100m
JC053-24	26/10/2010	23°45.903N	41°06.441W	CTD036-S	Surface, 30m
JC053-26	27/10/2010	21°12.735N	39°17.536W	CTD039-S	Surface, 25m, 115m
JC053-28	28/10/2010	18°41.459N	37°31.367W	CTD042-S	Surface, 30m, 120m
JC053-30	29/10/2010	16°11.297N	35°48.283W	CTD042-S	Surface, 20m, 95m
JC053-32	30/10/2010	13°27.917N	33°57.204W	CTD048-S	Surface, 25m, 70m
JC053-34	31/10/2010	10°34.276N	31°59.879W	CTD051-S	Surface, 15m, 65m
JC053-36	01/11/2010	7°48.846N	30°9.576W	CTD054-S	Surface, 25m, 112m
JC053-38	02/11/2010	04°48.04N	28°09.73W	CTD057-S	Surface, 20m, 70m
JC053-45	05/11/2010	03°50.882S	25°00.884W	CTD062-S	Surface, 15m, 85m
JC053-47	06/11/2010	06°03.282S	28°09.73W	CTD057-S	Surface, 25m, 100m
JC053-50	10/11/2010	12°31.751S	19°01.320W	CTD067-S	Surface, 30m, 130m
JC053-52	11/11/2010	15°19.881S	21°50.473W	CTD069-S	Surface, 35m, 145m
JC053-56	13/11/2010	20°22.774S	25°05.349W	CTD072-S	Surface, 40m, 165m
JC053-58	14/11/2010	23°50.26S	26°33.98W	CTD074-S	Surface, 35m, 150m
JC053-60	15/11/2010	26°51.451S	29°04.078W	CTD076-S	Surface, 30m, 120m
JC053-62	16/11/2010	29°56.606S	31°49.399W	CTD078-S	Surface, 35m, 145m
JC053-65	17/11/2010	33°02.66S	34°50.73W	CTD080-S	Surface, 20m, 80m

Equipment Summary

All times in the following sections are given in UT.

75 and 150 kHz ADCP System.

Dr Stuart Painter from NOC Southampton configured both ADCP systems during the mobilization using a modified version of the AMT19 ADCP setup. The systems were run in bottom tracking mode to allow a calibration of the sensors' positions to be made until we reached deep water at 08:55 on 14th October. The drop keels were left in the up position, flush with the ship's hull, throughout the cruise. New PCs had been installed prior to the cruise; the 150 kHz PC rebooted after automatically applying operating system updates at 07:00 on 14th October. There was a gap in the data until 08:55 on the same day. Automatic updates were disabled on both PCs. The time on both PCs was set to UK time with automatic adjustment for daylight savings time. Therefore the PC time was in UT + 1 hour until 31st October and UT thereafter. The GPS time was in UT throughout the cruise.

Every evening logging was stopped and then resumed to start a new file and prevent the file size limit being reached. The previous 24 hours data files were then manually backed-up to the network storage area.

The 150 kHz deck unit failed at 07:08 on 3rd November with a suspected power supply failure; the PC could not communicate with it and there were no lights or messages on the front panel. The power supply was integral to the unit and so could not be replaced. A spare deck unit was available but contained a 75 kHz mother board. The mother board was replaced with a 150 kHz board and data collection was resumed at 10:55.

Sea Surface Monitoring System/ Meteorology Monitoring Package.

The ship's non-toxic sea water supply was stopped between 08:49 and 21:22 on 19th October during the port call in the Azores. It was again stopped between 07:30 and 15:58 on 8th November during the boat transfer at Ascension Island.

For the first few days there was noise in the transmissometer data that started whenever the ship stopped on DP for a CTD cast. Initially there was concern that this was due to a fault with the equipment and so transmissometer was stopped briefly at 11:35 on 18th October to replace CST 1132PR with CST 1131PR. The problems continued and then it was realized that they were due to bubbles becoming trapped in the transmissometer. Logging was stopped again between 10:27 and 11:35 on 20th October; CST 1132PR was inserted again and the plumbing to it was changed so that it remained mounted vertically but with water entering at the bottom of the transmission tube and leaving at the top, with the hope that any bubbles would travel out of the top of the transmission tube with the water exiting it. This was successful and noise was not seen again in the instrument.

At 19:32 on 25th October there was a spike in the atmospheric pressure value and then a 8 hPa drop. There were further drops in the sensor's output during the day and at 21:27 on the same day the pressure sensor was reading 1001.2 hPa while the bridge's BATOS pressure sensor read 1009.2 hPa. Heavy rain prevented the met platform junction box from being opened for several days. When the rain stopped it was found that a connector above the pressure sensor had worked loose and rain water had dripped past the connector's gasket and onto the pressure sensor. The connector was tightened. The other pressure sensor was not on-board as it was being calibrated. Gradually the pressure sensor's reading approached a similar value to BATOS' but with high frequency noise of magnitude 0.3 to 0.4 hPa superimposed on it. There were also occasional steps away from the true value, e.g. between 13:55 and 15:10 on November 19th.

For several days the processed true wind speed from the Surfmet and Level-C systems showed a decrease from the rest of the days' true wind speed when the ship was stopped for CTDs. The met platform was visited and it was found that although the anemometer was situated above everything else on the met platform, when the wind came over the port bow, the search light and ocean colour monitoring experiments caused turbulence to the air flow that reduced the velocity of the wind passing through the anemometer. When the ship was steaming the wind came from a different angle and so the correct wind velocity was measured. At 10:55 on 29th October the anemometer was raised by 0.65 m in the hope that it would then be above the turbulence from other items on the met platform. No further drops in wind velocity were observed as the ship turned.

From 04:00 until 12:00 on 2nd November the temperature and humidity probe's data was incorrect. Heavy rain appeared to have got into the screen protecting the probe. After the rain had stopped, the probe quickly dried out and the data returned to normal. We visited the met platform checking

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all of instruments between 13:20 and 13:35 on the same day resulting in spikes in the data. A further event happened between 03:42 and 06:20 on November 21st.

The BODC data scientist on the cruise was concerned at the fluorimeter's lack of response to very low magnitude changes that were being observed by the CTD after we had crossed the equator. While data collection was stopped during the visit to Ascension Island on 8th November 2010, tests and cleaning of the transmissometer and fluorimeter were therefore carried out. Between 13:37:25 and 13:41:30 Milli-Q water was pumped through these instruments. They were then cleaned. At 13:54:00 they had been dried and were run with air in them, but moisture in the air prevented them from achieving a steady-state value. Black tape was then added to the outlet tube of the fluorimeter to prevent external light from entering the instrument. All data prior to this time may have been affected by this light pollution. The transmissometer's receiver was blacked off with the end cap from the transmission tube and black tape to record a dark value at 14:22:50. At 14:29:50 the instruments were again run with air in them. At 14:51:30 these two instruments were again run with Milli-Q pumped through them. The dark, air and clean water readings taken after cleaning matched the data sheet values well.

When the port and starboard PAR sensors were plotted with their calibration factors applied there was a consistent difference between the two sensors. Therefore on 8th November the spare PAR sensor was swapped with both of the sensors in use. The following sensors were in use on this day:

• Start Time	• SPAR	• PPAR
• 09:28	• 28560	• 28561
• 11:02	• 28562	• 28560
• 16:00	• 28562	• 28561

After applying each sensor's calibration factor it was obvious that 28562 was under reading by around 5%. At 11:05 on 10th November 28562 was replaced with 28560 in the SPAR position. The PAR sensor 28562 was however just within specification at 5% of true reading when compared to the other sensors and had six months to go before another calibration was due.

The following sensors were used during this cruise:

• Sensor	• Serial Number	• Calibration Due
• Transmissometer	• CST 1132PR *	• June 2011
• Fluorimeter	• WS3S-246	• July 2011
• Thermosalinograph	• 4548881-0233	• March 2011
• Remote Temperature	• SBE3853440-0416	• March 2011
• PPAR	• 28561 †	• April 2011
• SPAR	• 28562 until November 10 th • 28560 thereafter	• April 2011 • April 2011
• PTIR	• 973134	• April 2011
• STIR	• 973135	• April 2011
• Pressure	• R0450005	• September 2011
• Anemometer	• 064537	• N/A
• Temperature and Humidity	• C1320001	• April 2011

* Transmissometer CST 1132PR was replaced with CST 1131PR from 13:50 18th November until 11:35 on 20th November for fault finding.

† On 8th November the PAR sensors were swapped around on several occasions. The table earlier in this report describes the positions and sensors in use during this day.

Techsas Data Logging System.

To test the spare Techsas data logging system, jc-logger2 was run in parallel with the primary Techsas data logger on the afternoon of 13th October. At this time the Surfmet system began to suffer delays in updating its numeric display. Shortly afterwards the primary Techsas data logging program was found to have crashed and was restarted. No NetCDF data was logged by Techsas between 18:29:58 and 19:02:52. During this time Techsas continued to broadcast UDP packets, which were recorded by the RVS Level-C system and so no data was lost. Logging was

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immediately stopped on jc-logger2 and no further problems were encountered.

Level-C Data Processing System.

For the first two days of the cruise there was a bug in the Level-C system's fromtechsas.ini configuration file. This caused several Surfmet variables to be incorrectly logged in the Level-C data processing system. This was fixed at 14:55:19 on 14th October. The values logged incorrectly were:

• Level-C Variable	• Actual Value Logged
• direct	• airtemp
• airtemp	• humidity
• humidity	• press
• press	• ppar
• ppar	• spar
• spar	• ptir
• ptir	• stir
• stir	• 0 (no value logged)

The data was still logged correctly in the Techsas NetCDF files. The data was read on the Level-C system from the NetCDF files using nclstl and then into a Level-C stream using titsil. This corrected stream was used to prepare the daily hour, and five and one-minute average Surfmet data files.

Cook4, the Level-C data processing server crashed at 21:40:06 24th October. Logging on the Level-C system was resumed at 07:30:29 on 25th October. Data was again read from the NetCDF files into additional streams on the Level-C system for the generation of the daily Surfmet summary files.

WAMOS Wave Monitoring System.

After the radar's maintenance during this year's refit the WAMOS wave radar has worked well during the cruise. It was run for around 40 days; approximately 960 hours of magnetron use either in standby or transmitting. The PC rebooted frequently at times and a new PC is being sourced.

GPS'.

On several occasions on 6th November Techsas reported that the Seapath 200 had not output any data. At around 19:20 on the same day it was seen to reboot. It hung while starting its software. It was manually rebooted and hung during the BIOS memory check. It failed to even start during subsequent reboots. No loose connections or obvious visible problems were seen on opening the unit. The power supply voltages were all good. Kongsberg have been informed and agreed to send a loan unit to Punta Arenas. Our unit will be returned to the UK and sent to Kongsberg for repair.

On 16th November Techsas reported that the POSMV had not output any gyro data for several seconds but had since resumed. For several hours afterwards the gyro accuracy signal was red. The data file was examined and no POSMV data was output between 22:27:45 and 22:28:12. The GPS data resumed immediately. The gyro took another minute before it started outputting data. The manufacturers were informed and they requested that certain data items be logged to the monitoring PC so that they have more information if this happens again.

The ADU5 was not run during the cruise, although some data from it will have been logged.

Gravimeter.

The gravimeter was run throughout the cruise. Shortly after it was installed it was noticed that the clamp indicator was flickering on and off and there was a periodic disturbance in the gravity display. After consulting the manufacturer's the control module was swapped with the spare on 26th October and it worked well after this.

Methanol Oxidation and Methyлотroph Diversity

Andy Rees, Stephanie Sargeant and Joanna Dixon

Plymouth Marine Laboratory

DNA sterivex filters.

DNA samples have been collected throughout the Atlantic transect by filtering approximately 20L of surface seawater (collected from the surface during the pre-dawn station) through 0.22µm sterivex filter using a peristaltic pump. Samples were then stored in a -80°C freezer for transport back to the UK.

DNA will be extracted from the sterivex filters using a phenol chloroform extraction method. Once DNA has been extracted it will be used for DNA identification of methyлотrophic bacteria. This will be done by conducting PCR using specific gene primers targeting *mxoF* gene used for utilisation of methanol as a carbon and energy source to create *mxoF* clone libraries.

Stable Isotope Probing (SIP) experiments.

Stable isotope probing (SIP) experiments were conducted within the northern Atlantic gyre (NAG) between 34°N and 21°N where methanol oxidation rates were previously found to be particularly high (measurements conducted on AMT 19). Stable isotope probing is a technique which is used to identify the microorganisms in the environmental samples that use a particular growth substrate, in this case ¹³C methanol (Dumont and Murrell, 2005). This allows us to link microbial identity to functionality.

1L plastic tissue culture bottles were filled with 750ml of surface seawater, ¹³C or ¹²C methanol and marine ammonium mineral salts (MAMS). The bottles were then incubated for 7 days on their side in the dark. Once incubated the 750ml of sample were filtered through a 0.22µm sterivex filter unit to terminate the incubation. Samples were then stored in a -80°C freezer.

Dumont, M.G., and Murrell, J.C. (2005) Stable isotope probing - linking microbial identity to function. *Nature Reviews* 3: 499-504.

DATE	STATION	CTD No.	Sample ID	Depth (m)	Vol Filt (L)
16.10.10	JC05306	09-S	#01	SURF	15
17.10.10	JC05308	012-S	#02	SURF	15
18.10.10	JC05310	015-S	#03	SURF	15
19.10.10	JC05312	018-S	#04	SURF	15
21.10.10	JC05314	Non-tox	#05	SURF	19
22.10.10	JC05316	Non-tox	#06	SURF	17
23.10.10	JC05318	Non-tox	#07	SURF	19
24.10.10	JC05320	Non-tox	#08	SURF	17
25.10.10	JC05322	Non-tox	#09	SURF	19
26.10.10	JC05324	Non-tox	#10	SURF	17
27.10.10	JC05326	Non-tox	#11	SURF	19
28.10.10	JC05328	Non-tox	#12	SURF	20
29.10.10	JC05330	Non-tox	#13	SURF	20
30.10.10	JC05332	Non-tox	#14	SURF	20
31.10.10	JC05334	Non-tox	#15	SURF	20
01.11.10	JC05336	Non-tox	#16	SURF	20
02.11.10	JC05338	Non-tox	#17	SURF	20
05.11.10	JC05345	Non-tox	#18	SURF	20
06.11.10	JC05347	Non-tox	#19	SURF	20
11.11.10	JC05352	Non-tox	#20	SURF	20
13.11.10	JC05356	Non-tox	#21	SURF	20
14.11.10	JC05358	Non-tox	#22	SURF	20
15.11.10	JC05360	Non-tox	#23	SURF	20
16.11.10	JC05362	Non-tox	#24	SURF	20
17.11.10	JC05365	Non-tox	#25	SURF	20

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18.11.10	JC05367	Non-tox	#26	SURF	20
19.11.10	JC05369	Non-tox	#27	SURF	20
20.11.10	JC05371	Non-tox	#28	SURF	20
SIP Experiments					
20.10.10	JC05314	Non-tox	SIP#1		
22.10.10	JC05316	Non-tox	SIP#2		
23.10.10	JC05318	Non-tox	SIP#3		
24.10.10	JC05320	Non-tox	SIP#4		
25.10.10	JC05322	Non-tox	SIP#5		
26.10.10	JC05324	Non-tox	SIP#6		
27.10.10	JC05326	Non-tox	SIP#7		

NMF-SS Sensors & Moorings Cruise Report

Cruise: JC053

PSO: Dr. A. Rees

J Benson, P Keen, NMF-SS

CTD system configuration

1) Two CTD systems were prepared; the first water sampling arrangement was a NOC 24-way stainless steel frame system, (s/n SBE CTD1), and the initial sensor configuration was as follows:

Sea-Bird 9plus underwater unit, s/n 09P-54047-0943
Sea-Bird 3P temperature sensor, s/n 03P-4151, Frequency 0 (primary)
Sea-Bird 4C conductivity sensor, s/n 04C-3054, Frequency 1 (primary)
Digiquartz temperature compensated pressure sensor, s/n110557, Frequency 2
Sea-Bird 3P temperature sensor, s/n 03P-2919, Frequency 3 (secondary, vane mounted)
Sea-Bird 4C conductivity sensor, s/n 04C-3698, Frequency 4 (secondary, vane mounted)
Sea-Bird 5T submersible pump, s/n 05T-3607, (primary)
Sea-Bird 5T submersible pump, s/n 05T-3195, (secondary, vane mounted)
Sea-Bird 32 Carousel 24 position pylon, s/n 32-19817-0243
Sea-Bird 11plus deck unit, s/n 11P-34173-0676

2) The auxiliary input initial sensor configuration was as follows:

Sea-Bird 43 dissolved oxygen sensor, s/n 43-0363 (V0)
Chelsea MKIII Aquatracka fluorometer, s/n 88-2615-124 (V2)
Benthos PSA-916T altimeter, s/n 41302 (V3)
Chelsea 2-pi PAR irradiance sensor, DWIRR, s/n PAR05 (V4)
Chelsea 2-pi PAR irradiance sensor, UWIRR, s/n PAR01 (V5)
WETLabs light scattering sensor, red LED, 650nm, s/n BBRTD-759R (V6)
Chelsea MKII 10cm path Alphantracka transmissometer, s/n 161050 (V7)

3) Additional instruments:

Ocean Test Equipment 20L ES-120B water samplers, s/n's 1A through 12A, 15A through 21A, 24A, 26A, 34A, 45A, 47A, 14, 22 and 23
Sonardyne HF Deep Marker beacon, s/n 213797-001
Chelsea MKI Fast Repetition Rate Fluorometer, 2-pi PAR sensor & battery pack, s/n 182043

4) Sea-Bird 9plus configuration file 0943.xmlcon was used for initial stainless steel frame CTD casts, with 0943_no_NMEA.xmlcon used for the back-up, simultaneous logging desktop computer. Both PAR sensors were removed for any cast deeper than 500 metres.

5) The second water sampling arrangement was a NOC 24-way titanium frame system, (s/n SBE CTD TITA1), and the initial sensor configuration was as follows:

Sea-Bird 9plus underwater unit, s/n 09P-24680-0637
Sea-Bird 3P temperature sensor, s/n 03P-4712, Frequency 0 (primary)
Sea-Bird 4C conductivity sensor, s/n 04C-3567, Frequency 1 (primary)
Digiquartz temperature compensated pressure sensor, s/n 79501, Frequency 2
Sea-Bird 3P temperature sensor, s/n 03P-4593, Frequency 3 (secondary, vane mounted)
Sea-Bird 4C conductivity sensor, s/n 04C-3272, Frequency 4 (secondary, vane mounted)
Sea-Bird 5T submersible pump, s/n 05T-4513, (primary)
Sea-Bird 5T submersible pump, s/n 05T-4510, (secondary, vane mounted)
Sea-Bird 32 Carousel 24 position pylon, s/n 32-60380-0805
Sea-Bird 11plus deck unit, s/n 11P-34173-0676

6) The auxiliary input initial sensor configuration was as follows:

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Sea-Bird 43 dissolved oxygen sensor, s/n 43-0862 (V0)
Tirtech PA200 altimeter, s/n 6196.112522 (V2)
Chelsea MKIII Aquatracka fluorometer, s/n 88-2960-160 (V3)
Chelsea 2-pi PAR irradiance sensor, DWIRR, s/n PAR04 (V5)
Chelsea MKII 25cm path Alphatracka transmissometer, s/n 161048 (V6)
WETLabs light scattering sensor, green LED, 532nm, s/n BBRTD-756 (V7)

7) Additional instruments:

Ocean Test Equipment 10L ES-110B trace metal-free water samplers, s/n's 1T through 30T

8) Sea-Bird *9plus* configuration file 0637.xmlcon was used for initial titanium frame CTD casts, with 0637_no_NMEA.xmlcon used for the back-up, simultaneous logging desktop computer. The PAR sensor was removed for any cast deeper than 500 metres.

Other instruments

- 1) Autosal salinometer---One salinometer was configured for salinity analysis, and the instrument details are as below:

Guildline Autosal 8400B, s/n 65764, installed in Electronics Workshop as the primary instrument, Autosal set point 24C.

- 2) Fast Repetition Rate Fluorometer---Two FRRF systems were installed as follows:

Chelsea MKI, s/n 182039---Configured for underway sampling, located in Deck Laboratory.

Chelsea MKI, s/n 182041---Configured for PML Optics Rig.

Appendix A: Technical detail report

S/S CTD

Changed out CTG UWIRR 2pi-PAR sensor s/n 01 for s/n 06 beginning cast CTD15_s, as PAR01 was displaying voltage spikes at depths 200 – 500m.

Changed out secondary conductivity sensor s/n 04C-3698 for s/n 04C-3850 beginning cast CTD30_s, as 3698 was noisy/spiking through thermocline, as well as offset to negative on up cast. New configuration files written: 0943_ctd30.xmlcon and 0943_ctd30_no_NMEA.xmlcon.

DWIRR PAR & UWIRR PAR multiplier changed to 1.0 as per BODC beginning cast CTD34_s. New configuration files written: 0943_ctd34.xmlcon and 0943_ctd34_no_NMEA.xmlcon.

Light scattering sensor s/n BBRTD-759R detector blanked on cast CTD34_s to verify calibration sheet zero output value of 0.0480V.

New pump s/n 05T-4539 replaced s/n 05T-3195 on secondary sensors beginning cast CTD39_s; (resolved noise/spiking issues from cast CTD29_s through CTD37_s).

Light scattering sensor s/n BBRTD-759R exchanged with s/n BBRTD-756 on titanium frame beginning cast CTD67_s. New configuration files written: 0943_ctd34_BBRTD.xmlcon and 0943_ctd34_BBRTD_no_NMEA.xmlcon.

Light scattering sensor s/n BBRTD-756 detector blanked on cast CTD80_s to verify zero output value.

Fluorometer displaying 0V at 300-45m on up cast from Station JC05371; replaced with serial number 088195 after Station JC05373. New configuration files written:

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0943_ctd34_BBRTD_Fluor.xmlcon and 0943_ctd34_BBRTD_Fluor_no_NMEA.xmlcon.

Ti CTD

Light scattering sensor s/n BBRTD-756 detector blanked on cast CTD35_t to verify calibration sheet zero output value of 0.710V.

New blank value of 0.0543V entered for light scattering sensor s/n BBRTD-756 on cast CTD38_t. New configuration files written: 0637_BBRTD.xmlcon and 0637_BBRTD_no_NMEA.xmlcon.

Light scattering sensor s/n BBRTD-756 exchanged with s/n BBRTD-759R on stainless steel frame after Station JC05347. Fluorometer displaying 0V on up cast, removed from frame. New configuration files written: 0637_BBRTD_fluor.xmlcon and 0637_BBRTD_fluor_no_NMEA.xmlcon.

Total number of casts -67 S/S frame, 22 Ti frame.
Casts deeper than 500m - 1 S/S frame, 6 Ti frame.
Deepest casts - 545m S/S frame, 1000m Ti frame.

Autosal

Serial number 68426 will not advance in positive readings any higher than 1.7+nnnn (measured both standard seawater with known value of 1.9+9994 and surface seawater at 2.0+1555); replaced with s/n 65764 (JD302). Standby readings not stable over period of 48 hours, indicates problem with thermistor board and temperature stability.

Serial number 65764 continues to have problems with air bubbles in conductivity cell, repeat flushing required. Soaked for 24 hours with 5% Decon, 10% methanol and 85% Milli-Q water; flushed 200ml solution repeatedly through cell.

FRRF's

Battery charging plug dislodged from socket & board, repaired on vessel. (Station JC05306) Recommend replacing board, as board has endured three repairs & is no longer robust.

Battery charging plug dislodged from socket & board again (Station JC05317), not repairable as pins too short on socket & not enough material left on through-plate/board, replaced on Optics Rig with battery pack from s/n 182039. (Station JC05318)

Underway sampling instrument s/n 182039 began saturating after number of hours continuous operation, replaced with s/n 182042. (Station JC05314)

PML Optics rig instrument s/n 182041 had corrupted data from two profiles (Stations JC05324 and JC05325); replaced with s/n 182042. (Station JC05326)

Serial number 182041 re-formatted with default settings, installed as underway sampling instrument after receiving advice from PML and Chelsea (Station JC05329). Periodically gives error messages of low voltage and error writing to file, and instrument displays internal temperature over 40C; increasing frequency of occurrence.

Replaced power supply board (DC/DC converter board) in s/n 182041 with board from s/n 182039 (JD310), and re-installed s/n 182041 as underway sampling instrument. Bench-tested s/n 182039 with PS board from s/n 182041. No change to either instrument; s/n 182039 is still giving saturated values and s/n 182041 is still exhibiting low voltage and error writing to file. Exchanged second board set (TT8) with mounted DC/DC converter; s/n 182041 operated for over 36 hours before failing as before. Internal temperature still high.

J. Benson/P. Keen
25 November 2010

AMT20 Cruise Report

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AMT20 Event Log

Date	Station	Event No.	Activity	ID	Time Start Ship's Time	End	Time Start (GMT)	End	Latitude Start (+ve N)	Longitude Start (+ve E)	Latitude End (+ve N)	Longitude End (+ve E)	~Water Depth (m)	Comments
12/10/2010			Ship's clocks set to BST - local time GMT+1											
13/10/2010	1		On station		15:50		14:50		49.6713	-7.6840				
13/10/2010	1	1	CTD	CTD001s	15:57	16:20	14:57	15:20	49.6713	-7.6839	49.6713	-7.6839	131	CTD shake-down station - cast to 110m
13/10/2010	1	1a	O/BPUMP	OBP_trial	16:15	16:25	15:15	15:25	49.6723	-7.6845	49.6723	-7.6845	131	Overside floating pump trial
13/10/2010	1		Leave station		16:28		15:28		49.6733	-7.6850				
14/10/2010			Ship's clocks retarded 1 hour - Local time now GMT											
14/10/2010	2		On station		04:20		04:20		49.4060	-11.1648				
14/10/2010	2	2	CTD	CTD002t	04:32	05:07	04:32	05:07	49.4060	-11.1648	49.4060	-11.1648	200	Cast to 175m
14/10/2010	2	3	BONGO	Rach_01	04:40	04:55	04:40	04:55	49.4060	-11.1648	49.4060	-11.1648	200	Haul from 300m
14/10/2010	2	4	BONGO	Raf	05:00	05:14	05:00	05:14	49.4060	-11.1648	49.4060	-11.1648	200	Haul from 200m
14/10/2010	2	5	BONGO	ChrisG_005	05:16	05:30	05:16	05:30	49.4060	-11.1648	49.4060	-11.1648	200	Haul from 200m
14/10/2010	2	6	CTD	CTD003s	05:40	06:16	05:40	06:16	49.4060	-11.1648	49.4060	-11.1648	200	Cast to 175m
14/10/2010	2		Leave station		06:20		06:20		49.4060	-11.1648				
14/10/2010	3		On station		12:59		12:59		49.2698	-12.8839				
14/10/2010	3	7	CTD	CTD004s	13:05	13:56	13:05	13:56	49.2698	-12.8839	49.2698	-12.8839	1572	Cast to 300m
14/10/2010	3	8	OPTICS	EVENT_008	13:08	13:34	13:08	13:34	49.2698	-12.8839	49.2698	-12.8839	1572	Cast from 200m
14/10/2010	3	9	OPTICS	EVENT_009	13:36	14:06	13:36	14:06	49.2709	-12.8839	49.2709	-12.8839	1572	Cast from 200m
14/10/2010	3	10	O/BPUMP	OBP_01	14:13	14:29	14:13	14:29	49.2724	-12.8840	49.2724	-12.8840	1572	Pumping unsuccessful. Sampling method abandoned.
14/10/2010	3	11	ZOONET	-	14:38	14:39	14:38	14:39	49.2728	-12.8840	49.2728	-12.8840	1572	Net wash
14/10/2010	3	12	ZOONET	ZOONET_01	14:43	15:07	14:43	15:07	49.2731	-12.8840	49.2731	-12.8840	1572	Haul from 100m
14/10/2010	3	13	ZOONET	-	15:13	15:14	15:13	15:14	49.2748	-12.8840	49.2748	-12.8840	1572	Net wash
14/10/2010	3		Leave station		15:28		15:28		49.2792	-12.9037				
15/10/2010	4		On station		04:30		04:30		49.0364	-16.4311				
15/10/2010	4	14	CTD	CTD005t	04:30	05:20	04:30	05:20	49.0364	-16.4311	49.0364	-16.4311	4805	Cast to 500m
15/10/2010	4	15	BONGO	Rach_02	04:40	05:07	04:40	05:07	49.0367	-16.4315	49.0367	-16.4315	4805	Haul from 300m
15/10/2010	4	16	BONGO	Raf	05:10	05:30	05:10	05:30	49.0426	-16.4319	49.0426	-16.4319	4805	Haul from 200m

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Date	Station	Event No.	Activity	ID	Time Start	End	Time Start	End	Latitude Start	Longitude Start	Latitude End	Longitude End	~Water Depth (m)	Comments
15/10/2010	4	17	BONGO	ChrisG_017	05:32	05:50	05:32	05:50	49.0473	-16.4309	49.0473	-16.4309	4805	Haul from 200m
15/10/2010	4	18	CTD	CTD006s	05:38	06:25	05:38	06:25	49.0485	-16.4304	49.0485	-16.4304	4805	Cast 300m
15/10/2010	4		Leave station		06:20		06:20		49.0562	-16.4265				
15/10/2010	5		On station		13:02		13:02		48.1163	-17.3243				
15/10/2010	5	19	CTD	CTD007s	13:07	13:56	13:07	13:56	48.1162	-17.3243	48.1162	-17.3243	4475	Cast to 500m
15/10/2010	5	20	OPTICS	EVENT_020	13:10	13:39	13:10	13:39	48.1164	-17.3244	48.1164	-17.3244	4475	Cast from 200m
15/10/2010	5	21	OPTICS	EVENT_021	13:42	14:10	13:42	14:10	48.1184	-17.3256	48.1184	-17.3256	4475	Cast from 200m
15/10/2010	5	22	ZOONET	ZOONET_02	14:19	14:30	14:19	14:30	48.1200	-17.3265	48.1200	-17.3265	4475	Haul from 100m
15/10/2010	5	23	ZOONET	-	14:38	14:40	14:38	14:40	48.1215	-17.3273	48.1215	-17.3273	4475	Net wash
15/10/2010	5	24	TOWNET	101015_noon	14:45	15:00	14:45	15:00	48.1220	-17.3276	48.1220	-17.3276	4475	
15/10/2010	5		Leave station		15:06		15:06		48.1262	-17.3221				
16/10/2010	6		On station		04:20		04:20		46.0545	-19.1914				
16/10/2010	6	25	BONGO	Rach_03	04:22	05:17	04:22	05:17	46.0553	-19.1910	46.0553	-19.1910	4448	Haul from 300m
16/10/2010	6	26	CTD	CTD008t	04:50	05:30	04:50	05:30	46.0553	-19.1910	46.0553	-19.1910	4448	Cast to 1000m
16/10/2010	6	27	BONGO	Raf	05:18	05:40	05:18	05:40	46.0557	-19.1940	46.0557	-19.1940	4448	Haul from 200m
16/10/2010	6	28	BONGO	ChrisG_028	05:44	06:07	05:44	06:07	46.0561	-19.1971	46.0561	-19.1971	4448	Haul from 200m
16/10/2010	6	29	CTD	CTD009s	05:50	06:28	05:50	06:28	46.0562	-19.1978	46.0562	-19.1978	4448	Cast to 300m
16/10/2010	6		Leave station		06:30		06:30		46.0569	-19.2022				
16/10/2010	7		On station		12:58		12:58		45.1969	-19.9336				
16/10/2010	7	30	CTD	CTD010s	13:05	13:50	13:05	13:50	45.1969	-19.9336	45.1969	-19.9336	3947	Cast to 500m
16/10/2010	7	31	OPTICS	EVENT_031	13:07	13:37	13:07	13:37	45.1969	-19.9336	45.1969	-19.9336	3947	Cast from 200m
16/10/2010	7	32	OPTICS	EVENT_032	13:39	14:10	13:39	14:10	45.1976	-19.9337	45.1976	-19.9337	3947	Cast from 200m
16/10/2010	7	33	ZOONET	-	14:15	14:18	14:15	14:18	45.1976	-19.9337	45.1976	-19.9337	3947	Net wash
16/10/2010	7	34	ZOONET	ZOONET_03	14:22	14:35	14:22	14:35	45.1979	-19.9338	45.1979	-19.9338	3947	Haul from 100m
16/10/2010	7	35	TOWNET	101016_noon	14:48	15:03	14:48	15:03	45.1986	-19.9338	45.1986	-19.9338	3947	
16/10/2010	7		Leave station		15:08		15:08		45.2018	-19.9250				
17/10/2010	8		On station		04:18		04:18		43.5496	-21.3642				
17/10/2010	8	36	CTD	CTD011t	04:24	05:32	04:24	05:32	43.5496	-21.3642	43.5496	-21.3642	3076	Cast to 1000m
17/10/2010	8	37	BONGO	Rach_04	04:27	05:00	04:27	05:00	43.5496	-21.3641	43.5496	-21.3641	3076	Haul from 300m
17/10/2010	8	38	BONGO	Raf	05:02	05:20	05:02	05:20	43.5496	-21.3642	43.5496	-21.3642	3076	Haul from 200m
17/10/2010	8	39	BONGO	ChrisG_039	05:23	05:44	05:23	05:44	43.5496	-21.3642	43.5496	-21.3642	3076	Haul from 200m
17/10/2010	8	40	BONGO	Raf	05:45	06:04	05:45	06:04	43.5496	-21.3642	43.5496	-21.3642	3076	Haul from 200m
17/10/2010	8	41	CTD	CTD012s	05:52	06:36	05:52	06:36	43.5496	-21.3642	43.5496	-21.3642	3076	Cast to 300m

AMT20 Cruise Report

Date	Station	Event No.	Activity	ID	Time Start Ship's Time	End	Time Start (GMT)	End	Latitude Start (+ve N)	Longitude Start (+ve E)	Latitude End (+ve N)	Longitude End (+ve E)	~Water Depth (m)	Comments
17/10/2010	8		Leave station		06:46		06:46		43.5487	-21.3651				
17/10/2010	9		On station		13:02		13:02		42.7669	-22.0345				
17/10/2010	9	42	CTD	CTD013s	13:07	13:55	13:07	13:55	42.7669	-22.0345	42.7669	-22.0345	3579	Cast to 500m
17/10/2010	9	43	OPTICS	EVENT_043	13:10	13:41	13:10	13:41	42.7671	-22.0346	42.7671	-22.0346	3579	Cast from 200m
17/10/2010	9	44	OPTICS	EVENT_044	13:43	14:16	13:43	14:16	42.7692	-22.0367	42.7692	-22.0367	3579	Cast from 200m
17/10/2010	9	45	ZOONET	-	14:21	14:22	14:21	14:22	42.7717	-22.0398	42.7717	-22.0398	3579	Net wash
17/10/2010	9	46	ZOONET	ZOONET_04	14:25	14:45	14:25	14:45	42.7721	-22.0403	42.7721	-22.0403	3579	Haul from 100m
17/10/2010	9	47	TOWNET	101017_noon	14:53	15:09	14:53	15:09	42.7757	-22.0433	42.7757	-22.0433	3579	
17/10/2010	9		Leave station		15:11		15:11		42.7798	-22.0430				
18/10/2010	10		On station		04:25		04:25		40.9943	-23.4794				
18/10/2010	10	48	CTD	CTD014t	04:25	05:12	04:25	05:12	40.9943	-23.4794	40.9943	-23.4794	3495	Cast to 500m
18/10/2010	10	49	BONGO	Rach_05	04:30	05:00	04:30	05:00	40.9943	-23.4794	40.9943	-23.4794	3495	Haul from 300m
18/10/2010	10	50	BONGO	Raf	05:02	05:24	05:02	05:24	40.9943	-23.4794	40.9943	-23.4794	3495	Haul from 200m
18/10/2010	10	51	BONGO	ChrisG_051	05:27	05:47	05:27	05:47	40.9943	-23.4794	40.9943	-23.4794	3495	Haul from 200m
18/10/2010	10	52	CTD	CTD015s	05:35	06:18	05:35	06:18	40.9943	-23.4794	40.9943	-23.4794	3495	Cast to 300m
18/10/2010	10	53	TOWNET	101018_dawn	06:25	06:46	06:25	06:46	40.9951	-23.4787	40.9951	-23.4787	3495	
18/10/2010	10		Leave station		06:50		06:50		40.9979	-23.4767				
18/10/2010	11		On station		13:01		13:01		40.1264	-24.1928				
18/10/2010	11	54	CTD	CTD016s	13:06	13:59	13:06	13:59	40.1264	-24.1928	40.1264	-24.1928	3515	Cast to 500m
18/10/2010	11	55	OPTICS	EVENT_055	13:08	13:40	13:08	13:40	40.1265	-24.1928	40.1265	-24.1928	3515	Cast from 200m
18/10/2010	11	56	OPTICS	EVENT_056	13:42	14:15	13:42	14:15	40.1276	-24.1928	40.1276	-24.1928	3515	Cast from 200m
18/10/2010	11	57	ZOONET	-	14:20	14:22	14:20	14:22	40.1276	-24.1928	40.1276	-24.1928	3515	Net wash
18/10/2010	11	58	ZOONET	ZOONET_05	14:26	14:37	14:26	14:37	40.1276	-24.1928	40.1276	-24.1928	3515	Haul from 100m
18/10/2010	11	59	TOWNET	101018_noon	14:48	15:06	14:48	15:06	40.1284	-24.1926	40.1284	-24.1926	3515	
18/10/2010	11		Leave station		15:07		15:07		40.1318	-24.1910				
19/10/2010	12		On station		04:20		04:20		38.2815	-25.6457				
19/10/2010	12	60	CTD	CTD017t	04:30	05:35	04:30	05:35	38.2815	-25.6456	38.2815	-25.6456	2500	Cast to 1000m
19/10/2010	12	61	BONGO	Rach_06	04:32	04:51	04:32	04:51	38.2815	-25.6456	38.2815	-25.6456	2500	Haul from 300m
19/10/2010	12	62	BONGO	Raf	04:54	05:22	04:54	05:22	38.2815	-25.6456	38.2815	-25.6456	2500	Haul from 200m
19/10/2010	12	63	BONGO	ChrisG_063	05:25	05:45	05:25	05:45	38.2815	-25.6457	38.2815	-25.6457	2500	Haul from 200m
19/10/2010	12	64	BONGO	Raf	05:49	06:07	05:49	06:07	38.2815	-25.6457	38.2815	-25.6457	2500	Haul from 200m
19/10/2010	12	65	CTD	CTD018s	06:00	06:48	06:00	06:48	38.2815	-25.6456	38.2815	-25.6456	2500	Cast to 300m
19/10/2010	12		Leave station and head to Ponta		07:00		07:00		38.2813	-25.6457				

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Date	Station	Event No.	Activity	ID	Time Start	End	Time Start	End	Latitude Start	Longitude Start	Latitude End	Longitude End	~Water Depth (m)	Comments
19/10/2010			Delgada		08:49		08:49		38.0526	-25.8312				
19/10/2010			Non-toxic switched off		13:36		13:36		37.7129	-25.6303				
19/10/2010			Arrive Ponta Delgada		21:00		21:00		37.6219	-25.7831				
19/10/2010			Leave Ponta Delgada		21:22		21:22		37.5669	-25.8458				
20/10/2010			Non-toxic switched on											
20/10/2010			Ship's clocks retarded 1 hour - Local time now GMT-1											
20/10/2010	13		On station		15:17		16:17		34.9397	-28.9438				
20/10/2010	13	66	CTD	CTD019s	15:17	16:01	16:17	17:01	34.9397	-28.9438	34.9397	-28.9438	3752	Cast to 500m
20/10/2010	13	67	OPTICS	EVENT_067	15:18	15:48	16:18	16:48	34.9398	-28.9437	34.9398	-28.9437	3752	Cast from 200m
20/10/2010	13	68	OPTICS	EVENT_068	15:50	16:18	16:50	17:18	34.9398	-28.9434	34.9398	-28.9434	3752	Cast from 200m
20/10/2010	13	69	ZOONET	-	16:25	16:25	17:25	17:25	34.9398	-28.9434	34.9398	-28.9434	3752	Net wash
20/10/2010	13	70	ZOONET	ZOONET_06	16:30	16:38	17:30	17:38	34.9398	-28.9434	34.9398	-28.9434	3752	Haul from 100m
20/10/2010	13		Leave station		16:38		17:38		34.9398	-28.9434				
21/10/2010	14		On station		04:25		05:25		34.2182	-29.7617				
21/10/2010	14	71	CTD	CTD020t	04:25	05:15	05:25	06:15	34.2182	-29.7617	34.2182	-29.7617	4003	Cast to 500m. Problem with CTD hauler - wire damaged. Wire to be re-terminated. No second CTD cast for this station.
21/10/2010	14	72	BONGO	Rach_07	04:30	05:07	05:30	06:07	34.2182	-29.7617	34.2182	-29.7617	4003	Haul from 300m
21/10/2010	14	73	BONGO	Raf	05:10	05:33	06:10	06:33	34.2165	-29.7552	34.2165	-29.7552	4003	Haul from 200m
21/10/2010	14	74	BONGO	ChrisG_074	05:36	05:58	06:36	06:58	34.2149	-29.7501	34.2149	-29.7501	4003	Haul from 200m
21/10/2010	14	75	BONGO	Raf	06:00	06:22	07:00	07:22	34.2127	-29.7465	34.2127	-29.7465	4003	Haul from 200m
21/10/2010	14		Leave station		06:25		07:25		34.2096	-29.7431				
21/10/2010	15		On station		12:58		13:58		33.8424	-30.2035				
21/10/2010	15	76	CTD	CTD021s	13:03	13:56	14:03	14:56	33.8424	-30.2035	33.8424	-30.2035	1646	Cast to 500m
21/10/2010	15	77	OPTICS	EVENT_077	13:08	13:40	14:08	14:40	33.8424	-30.2035	33.8424	-30.2035	1646	Cast from 200m
21/10/2010	15	78	OPTICS	EVENT_078	13:42	14:13	14:42	15:13	33.8425	-30.2035	33.8425	-30.2035	1646	Cast from 200m
21/10/2010	15	79	ZOONET	-	14:18	14:19	15:18	15:19	33.8425	-30.2035	33.8425	-30.2035	1646	Net wash
21/10/2010	15	80	ZOONET	ZOONET_07	14:21	14:35	15:21	15:35	33.8424	-30.2035	33.8424	-30.2035	1646	Haul from 100m
21/10/2010	15	81	ZOONET	-	14:41	14:42	15:41	15:42	33.8425	-30.2035	33.8425	-30.2035	1646	Net wash
21/10/2010	15	82	TOWNET	101021_noon	14:47	15:02	15:47	16:02	33.8425	-30.2035	33.8425	-30.2035	1646	
21/10/2010	15		Leave station		15:05		16:05		33.8457	-30.2019				

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Date	Station	Event No.	Activity	ID	Time Start	End	Time Start	End	Latitude Start	Longitude Start	Latitude End	Longitude End	~Water Depth (m)	Comments
22/10/2010	16		On station		04:27		05:27		32.4257	-31.8001				
22/10/2010	16	83	CTD	CTD022t	04:27	05:34	05:27	06:34	32.4257	-31.8001	32.4257	-31.8001	3934	Cast to 1000m
22/10/2010	16	84	BONGO	Rach_08	04:31	05:04	05:31	06:04	32.4258	-31.8003	32.4258	-31.8003	3934	Haul from 300m
22/10/2010	16	85	BONGO	Raf	05:06	05:28	06:06	06:28	32.4268	-31.8022	32.4268	-31.8022	3934	Haul from 200m
22/10/2010	16	86	BONGO	ChrisG_086	05:30	05:52	06:30	06:52	32.4277	-31.8034	32.4277	-31.8034	3934	Haul from 200m
22/10/2010	16	87	CTD	CTD023s	05:56	06:39	06:56	07:39	32.4285	-31.8048	32.4285	-31.8048	3934	Cast to 300m
22/10/2010	16		Leave station		06:44		07:44		32.4262	-31.8088				
22/10/2010	17		On station		13:03		14:03		31.7297	-32.5626				
22/10/2010	17	88	CTD	CTD024s	13:09	14:08	14:09	15:08	31.7298	-32.5626	31.7298	-32.5626	4277	Cast to 500m
22/10/2010	17	89	OPTICS	EVENT_089	13:11	13:39	14:11	14:39	31.7299	-32.5626	31.7299	-32.5626	4277	Cast from 200m
22/10/2010	17	90	OPTICS	EVENT_090	13:40	14:10	14:40	15:10	31.7305	-32.5632	31.7305	-32.5632	4277	Cast from 200m
22/10/2010	17	91	ZOONET	ZOONET_08	14:16	14:27	15:16	15:27	31.7305	-32.5632	31.7305	-32.5632	4277	Haul from 100m
22/10/2010	17	92	ZOONET	-	14:34	14:35	15:34	15:35	31.7305	-32.5632	31.7305	-32.5632	4277	Net wash
22/10/2010	17	93	TOWNET	101022_noon	14:40	14:56	15:40	15:56	31.7305	-32.5632	31.7305	-32.5632	4277	
22/10/2010	17		Leave station		15:05		16:05		31.7342	-32.5579				
23/10/2010	18		On station		04:25		05:25		30.2848	-34.1790				
23/10/2010	18	94	CTD	CTD025t	04:25	05:14	05:25	06:14	30.2848	-34.1790	30.2848	-34.1790	4459	Cast to 500m
23/10/2010	18	95	BONGO	Rach_09	04:30	05:00	05:30	06:00	30.2850	-34.1792	30.2850	-34.1792	4459	Haul from 300m
23/10/2010	18	96	BONGO	Raf	05:02	05:20	06:02	06:20	30.2885	-34.1817	30.2885	-34.1817	4459	Haul from 200m
23/10/2010	18	97	BONGO	ChrisG_097	05:22	05:42	06:22	06:42	30.2915	-34.1827	30.2915	-34.1827	4459	Haul from 200m
23/10/2010	18	98	CTD	CTD026s	05:35	06:20	06:35	07:20	30.2933	-34.1832	30.2933	-34.1832	4459	Cast to 300m
23/10/2010	18	99	BONGO	Raf	05:47	06:06	06:47	07:06	30.2948	-34.1836	30.2948	-34.1836	4459	Haul from 200m
23/10/2010	18	100	TOWNET	101023_dawn	06:25	06:45	07:25	07:45	30.2992	-34.1837	30.2992	-34.1837	4459	
23/10/2010	18		Leave station		06:45		07:45		30.3022	-34.1801				
23/10/2010	19		On station		12:55		13:55		29.6101	-34.9013				
23/10/2010	19	101	BUCKET	BUCKET_01	13:00		14:00		29.6100	-34.9013			4641	
23/10/2010	19	102	CTD	CTD027s	13:10	14:05	14:10	15:05	29.6100	-34.9013	29.6100	-34.9013	4641	Cast to 500m
23/10/2010	19	103	OPTICS	EVENT_103	13:11	13:41	14:11	14:41	29.6100	-34.9013	29.6100	-34.9013	4641	Cast from 200m
23/10/2010	19	104	OPTICS	EVENT_104	13:42	14:12	14:42	15:12	29.6102	-34.9013	29.6102	-34.9013	4641	Cast from 200m
23/10/2010	19	105	ZOONET	ZOONET_09	14:16	14:26	15:16	15:26	29.6102	-34.9013	29.6102	-34.9013	4641	Haul from 100m
23/10/2010	19	106	ZOONET	-	14:32	14:32	15:32	15:32	29.6102	-34.9013	29.6102	-34.9013	4641	Net wash
23/10/2010	19	107	TOWNET	101023_noon	14:36	14:53	15:36	15:53	29.6103	-34.9013	29.6103	-34.9013	4641	
23/10/2010	19		Leave station		14:55		15:55		29.6125	-34.8977				

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Date	Station	Event No.	Activity	ID	Time Start	End	Time Start	End	Latitude Start	Longitude Start	Latitude End	Longitude End	~Water Depth (m)	Comments
24/10/2010	20		On station		04:08		05:08		28.1213	-36.5139				
24/10/2010	20	108	CTD	CTD028t	04:30	05:37	05:30	06:37	28.1122	-36.5163	28.1122	-36.5163	5163	Cast to 1000m
24/10/2010	20	109	BONGO	Rach_10	04:32	05:00	05:32	06:00	28.1122	-36.5162	28.1122	-36.5162	5163	Haul from 300m
24/10/2010	20	110	BONGO	Raf	05:04	05:24	06:04	06:24	28.1123	-36.5134	28.1123	-36.5134	5163	Haul from 200m
24/10/2010	20	111	BONGO	ChrisG_111	05:27	05:50	06:27	06:50	28.1125	-36.5112	28.1125	-36.5112	5163	Haul from 200m
24/10/2010	20	112	CTD	CTD029s	06:00	06:45	07:00	07:45	28.1128	-36.5084	28.1128	-36.5084	5163	Cast to 300m
24/10/2010	20		Leave station		06:50		07:50		28.1128	-36.5083				
24/10/2010	21		On station		12:59		13:59		27.4516	-37.2334				
24/10/2010	21	113	CTD	CTD030s	13:03	13:52	14:03	14:52	27.4516	-37.2334	27.4516	-37.2334	4469	Cast to 300m
24/10/2010	21	115	BUCKET	BUCKET_02	13:05		14:05		27.4516	-37.2334			4469	
24/10/2010	21	114	OPTICS	EVENT_114	13:05	13:37	14:05	14:37	27.4516	-37.2334	27.4516	-37.2334	4469	Cast from 200m
24/10/2010	21	116	OPTICS	EVENT_116	13:39	13:50	14:39	14:50	27.4516	-37.2334	27.4516	-37.2334	4469	Cast from 200m
24/10/2010	21	117	ZOONET	ZOONET_10	14:17	14:28	15:17	15:28	27.4516	-37.2334	27.4516	-37.2334	4469	Haul from 100m
24/10/2010	21	118	ZOONET	-	14:35	14:35	15:35	15:35	27.4522	-37.2333	27.4522	-37.2333	4469	Net wash
24/10/2010	21	119	CTD	CTD031s	14:38	14:50	15:38	15:50	27.4523	-37.2333	27.4523	-37.2333	4469	Cast to 20m
24/10/2010	21	120	TOWNET	101024_noon	14:44	15:08	15:44	16:08	27.4522	-37.2333	27.4522	-37.2333	4469	
24/10/2010	21		Leave station		15:15		16:15		27.4555	-37.2278				
25/10/2010	22		On station		04:20		05:20		25.9836	-38.7830				
25/10/2010	22	121	CTD	CTD032t	04:27	05:15	05:27	06:15	25.9836	-38.7830	25.9836	-38.7830	4601	Cast to 500m
25/10/2010	22	122	BONGO	Rach_11	04:30	05:00	05:30	06:00	25.9836	-38.7830	25.9836	-38.7830	4601	Haul from 300m
25/10/2010	22	123	BONGO	Raf	05:03	05:23	06:03	06:23	25.9836	-38.7830	25.9836	-38.7830	4601	Haul from 200m
25/10/2010	22	124	BONGO	ChrisG_124	05:26	05:47	06:26	06:47	25.9836	-38.7830	25.9836	-38.7830	4601	Haul from 200m
25/10/2010	22	125	CTD	CTD033s	05:39	06:22	06:39	07:22	25.9835	-38.7830	25.9835	-38.7830	4601	Cast to 300m
25/10/2010	22	126	BONGO	Raf	05:50	06:12	06:50	07:12	25.9836	-38.7830	25.9836	-38.7830	4601	Haul from 200m
25/10/2010	22		Leave station		06:30		07:30		25.9844	-38.7837				
25/10/2010	23		On station		13:00		14:00		25.2698	-39.5302				
25/10/2010	23	127	CTD	CTD034s	13:10	13:56	14:10	14:56	25.2698	-39.5302	25.2698	-39.5302	5025	Cast to 500m
25/10/2010	23	128	OPTICS	EVENT_128	13:12	13:38	14:12	14:38	25.2699	-39.5302	25.2699	-39.5302	5025	Cast from 200m
25/10/2010	23	129	BUCKET	BUCKET_03	13:19		14:19		25.2704	-39.5304			5025	
25/10/2010	23	130	OPTICS	EVENT_130	13:39	14:07	14:39	15:07	25.2704	-39.5305	25.2704	-39.5305	5025	Cast from 200m
25/10/2010	23	131	TOWNET	101025_noon	14:10	14:31	15:10	15:31	25.2703	-39.5304	25.2703	-39.5304	5025	
25/10/2010	23		Leave station		14:42		15:42		25.2748	-39.5235				
26/10/2010	24		On station		04:20		05:20		23.7710	-41.1076				

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Date	Station	Event No.	Activity	ID	Time Start	End	Time Start	End	Latitude Start	Longitude Start	Latitude End	Longitude End	~Water Depth (m)	Comments
26/10/2010	24	132	CTD	CTD035t	04:25	05:48	05:25	06:48	23.7710	-41.1076	23.7710	-41.1076	4266	Cast to 1000m
26/10/2010	24	133	BONGO	Rach_12	04:26	04:56	05:26	05:56	23.7710	-41.1076	23.7710	-41.1076	4266	Haul from 300m
26/10/2010	24	134	BONGO	Raf	05:00	05:18	06:00	06:18	23.7690	-41.1075	23.7690	-41.1075	4266	Haul from 200m
26/10/2010	24	135	BONGO	ChrisG_135	05:21	05:43	06:21	06:43	23.7673	-41.1074	23.7673	-41.1074	4266	Haul from 200m
26/10/2010	24	136	CTD	CTD036s	05:48	06:32	06:48	07:32	23.7651	-41.1074	23.7651	-41.1074	4266	Cast to 300m
26/10/2010	24		Leave station		06:36		07:36		23.7651	-41.1073				
26/10/2010	25		On station		12:58		13:58		22.9636	-40.5320				
26/10/2010	25	137	CTD	CTD037s	13:06	14:00	14:06	15:00	22.9636	-40.5320	22.9636	-40.5320	5408	Cast to 500m
26/10/2010	25	138	BUCKET	BUCKET_04	13:07		14:07		22.9636	-40.5320			5408	
26/10/2010	25	139	OPTICS	EVENT_139	13:09	13:39	14:09	14:39	22.9636	-40.5320	22.9636	-40.5320	5408	Cast from 200m
26/10/2010	25	140	OPTICS	EVENT_140	13:41	14:09	14:41	15:09	22.9636	-40.5320	22.9636	-40.5320	5408	Cast from 200m
26/10/2010	25	141	ZOONET	ZOONET_11	14:14	14:25	15:14	15:25	22.9635	-40.5320	22.9635	-40.5320	5408	Haul from 100m
26/10/2010	25	142	ZOONET	-	14:31	14:33	15:31	15:33	22.9635	-40.5320	22.9635	-40.5320	5408	Net wash
26/10/2010	25	143	TOWNET	101026_noon	14:38	14:57	15:38	15:57	22.9635	-40.5320	22.9635	-40.5320	5408	
26/10/2010	25		Leave station		15:01		16:01		22.9621	-40.5265				
27/10/2010	26		On station		04:20		05:20		21.2119	-39.2931				
27/10/2010	26	144	CTD	CTD038t	04:25	05:16	05:25	06:16	21.2119	-39.2931	21.2119	-39.2931	4825	Cast to 500m
27/10/2010	26	145	BONGO	Rach_13	04:30	05:00	05:30	06:00	21.2119	-39.2931	21.2119	-39.2931	4825	Haul from 300m
27/10/2010	26	146	BONGO	Raf	05:02	05:20	06:02	06:20	21.2119	-39.2931	21.2119	-39.2931	4825	Haul from 200m
27/10/2010	26	147	BONGO	ChrisG_147	05:23	05:43	06:23	06:43	21.2119	-39.2931	21.2119	-39.2931	4825	Haul from 200m
27/10/2010	26	148	CTD	CTD039s	05:40	06:20	06:40	07:20	21.2124	-39.2922	21.2124	-39.2922	4825	Cast to 300m
27/10/2010	26	149	BONGO	Raf	05:50	06:05	06:50	07:05	21.2128	-39.2915	21.2128	-39.2915	4825	Haul from 200m
27/10/2010	26	150	TOWNET	101027_dawn	06:25	06:50	07:25	07:50	21.2131	-39.2904	21.2131	-39.2904	4825	
27/10/2010	26		Leave station		06:55		07:55		21.2061	-39.2837				
27/10/2010	27		On station		13:01		14:01		20.4310	-38.7390				
27/10/2010	27	151	BUCKET	BUCKET_05	13:07		14:07		20.4310	-38.7390			5049	
27/10/2010	27	152	CTD	CTD040s	13:08	14:00	14:08	15:00	20.4310	-38.7390	20.4310	-38.7390	5049	Cast to 500m
27/10/2010	27	153	OPTICS	EVENT_153	13:11	13:38	14:11	14:38	20.4310	-38.7390	20.4310	-38.7390	5049	Cast from 200m
27/10/2010	27	154	OPTICS	EVENT_154	13:39	14:06	14:39	15:06	20.4310	-38.7389	20.4310	-38.7389	5049	Cast from 200m
27/10/2010	27	155	ZOONET	-	14:12	14:13	15:12	15:13	20.4310	-38.7389	20.4310	-38.7389	5049	Net wash
27/10/2010	27	156	ZOONET	ZOONET_12	14:16	14:26	15:16	15:26	20.4312	-38.7387	20.4312	-38.7387	5049	Haul from 100m
27/10/2010	27	158	TOWNET	101027_noon	14:25	14:55	15:25	15:55	20.4314	-38.7385	20.4314	-38.7385	5049	
27/10/2010	27	157	ZOONET	-	14:31	14:32	15:31	15:32	20.4314	-38.7385	20.4314	-38.7385	5049	Net wash

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Date	Station	Event No.	Activity	ID	Time Start Ship's Time	End	Time Start (GMT)	End	Latitude Start (+ve N)	Longitude Start (+ve E)	Latitude End (+ve N)	Longitude End (+ve E)	~Water Depth (m)	Comments
27/10/2010	27		Leave station		14:57		15:57		20.4297	-38.7344				
28/10/2010	28		On station		04:20		05:20		18.6910	-37.5228				
28/10/2010	28	159	CTD	CTD041t	04:33	05:40	05:33	06:40	18.6910	-37.5228	18.6910	-37.5228	5209	Cast to 1000m
28/10/2010	28	160	BONGO	Rach_14	04:36	05:06	05:36	06:06	18.6910	-37.5228	18.6910	-37.5228	5209	Haul from 300m
28/10/2010	28	161	BONGO	Raf	05:08	05:28	06:08	06:28	18.6910	-37.5228	18.6910	-37.5228	5209	Haul from 200m
28/10/2010	28	162	BONGO	ChrisG_162	05:30	05:53	06:30	06:53	18.6910	-37.5228	18.6910	-37.5228	5209	Haul from 200m
28/10/2010	28	163	CTD	CTD042s	06:00	06:45	07:00	07:45	18.6910	-37.5228	18.6910	-37.5228	5209	Cast to 300m
28/10/2010	28		Leave station		06:50		07:50		18.6910	-37.5228				
28/10/2010	29		On station		13:00		14:00		17.9128	-36.9839				
28/10/2010	29	165	BUCKET	BUCKET_06	13:07		14:07		17.9128	-36.9839			4610	
28/10/2010	29	164	CTD	CTD043s	13:07	13:59	14:07	14:59	17.9128	-36.9839	17.9128	-36.9839	4610	Cast to 500m
28/10/2010	29	166	OPTICS	EVENT_166	13:08	13:38	14:08	14:38	17.9128	-36.9839	17.9128	-36.9839	4610	Cast from 200m
28/10/2010	29	167	OPTICS	EVENT_167	13:39	14:07	14:39	15:07	17.9128	-36.9839	17.9128	-36.9839	4610	Cast from 200m
28/10/2010	29	168	ZOONET	ZOONET_13	14:12	14:22	15:12	15:22	17.9128	-36.9839	17.9128	-36.9839	4610	Haul from 100m
28/10/2010	29	169	ZOONET	-	14:27	14:28	15:27	15:28	17.9145	-36.9839	17.9145	-36.9839	4610	Net wash
28/10/2010	29	170	TOWNET	101028_noon	14:33	14:52	15:33	15:52	17.9151	-36.9839	17.9151	-36.9839	4610	
28/10/2010	29		Leave station		14:54		15:54		17.9184	-36.9807				
29/10/2010	30		On station		04:20		05:20		16.1906	-35.8061				
29/10/2010	30	171	CTD	CTD044t	04:25	05:20	05:25	06:20	16.1906	-35.8061	16.1906	-35.8061	5046	Cast to 500m
29/10/2010	30	172	BONGO	Rach_15	04:28	04:58	05:28	05:58	16.1906	-35.8061	16.1906	-35.8061	5046	Haul from 300m
29/10/2010	30	173	BONGO	Raf	05:00	05:18	06:00	06:18	16.1887	-35.8048	16.1887	-35.8048	5046	Haul from 200m
29/10/2010	30	174	BONGO	ChrisG_174	05:21	05:40	06:21	06:40	16.1884	-35.8047	16.1884	-35.8047	5046	Haul from 200m
29/10/2010	30	175	CTD	CTD045s	05:41	06:25	06:41	07:25	16.1883	-35.8047	16.1883	-35.8047	5046	Cast to 300m
29/10/2010	30	176	BONGO	Raf	05:44	06:03	06:44	07:03	16.1883	-35.8047	16.1883	-35.8047	5046	Haul from 200m
29/10/2010	30	177	TOWNET	101029_dawn	06:33	06:50	07:33	07:50	16.1887	-35.8038	16.1887	-35.8038	5046	
29/10/2010	30		Leave station		06:50		07:50		16.1896	-35.8015				
29/10/2010	31		On station		12:57		13:57		15.4238	-35.2855				
29/10/2010	31	178	BUCKET	BUCKET_07	13:04		14:04		15.4238	-35.2855				
29/10/2010	31	179	CTD	CTD046s	13:07	14:05	14:07	15:05	15.4238	-35.2855	15.4238	-35.2855	5132	Cast to 300m
29/10/2010	31	180	OPTICS	EVENT_180	13:08	13:37	14:08	14:37	15.4238	-35.2855	15.4238	-35.2855	5132	Cast from 200m
29/10/2010	31	181	OPTICS	EVENT_181	13:38	14:07	14:38	15:07	15.4238	-35.2855	15.4238	-35.2855	5132	Cast from 200m
29/10/2010	31	182	ZOONET	ZOONET_14	14:12	14:20	15:12	15:20	15.4239	-35.2855	15.4239	-35.2855	5132	Haul from 100m
29/10/2010	31	183	ZOONET	-	14:22	14:28	15:22	15:28	15.4246	-35.2856	15.4246	-35.2856	5132	Net wash

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Date	Station	Event No.	Activity	ID	Time Start	End	Time Start	End	Latitude Start	Longitude Start	Latitude End	Longitude End	~Water Depth (m)	Comments
29/10/2010	31	184	TOWNET	101029_noon	14:31	14:52	15:31	15:52	15.4252	-35.2857	15.4252	-35.2857	5132	
29/10/2010	31		Leave station		15:12		16:12		15.4129	-35.2761				
30/10/2010	32		On station		04:20		05:20		13.4629	-33.9504				
30/10/2010	32	185	CTD	CTD047t	04:45	05:35	05:45	06:35	13.4629	-33.9504	13.4629	-33.9504	5840	Cast to 500m
30/10/2010	32	186	BONGO	Rach_16	04:50	05:18	05:50	06:18	13.4630	-33.9504	13.4630	-33.9504	5840	Haul from 300m
30/10/2010	32	187	BONGO	Raf	05:20	05:40	06:20	06:40	13.4641	-33.9519	13.4641	-33.9519	5840	Haul from 200m
30/10/2010	32	188	BONGO	ChrisG_188	05:43	06:04	06:43	07:04	13.4649	-33.9529	13.4649	-33.9529	5840	Haul from 200m
30/10/2010	32	189	CTD	CTD048s	06:00	06:40	07:00	07:40	13.4655	-33.9537	13.4655	-33.9537	5840	Cast to 300m
30/10/2010	32		Leave station		06:40		07:40		13.4658	-33.9539				
30/10/2010	33		On station		13:00		14:00		12.5454	-33.3289				
30/10/2010	33	190	BUCKET	BUCKET_08	13:03		14:03		12.5454	-33.3289			5147	
30/10/2010	33	191	CTD	CTD049s	13:08	14:16	14:08	15:16	12.5455	-33.3289	12.5455	-33.3289	5147	Cast to 500m
30/10/2010	33	192	OPTICS	EVENT_192	13:10	13:42	14:10	14:42	12.5455	-33.3289	12.5455	-33.3289	5147	Cast from 200m
30/10/2010	33	193	OPTICS	EVENT_193	13:44	14:13	14:44	15:13	12.5455	-33.3289	12.5455	-33.3289	5147	Cast from 200m
30/10/2010	33	194	ZOONET	ZOONET_15	14:17	14:27	15:17	15:27	12.5455	-33.3289	12.5455	-33.3289	5147	Haul from 100m
30/10/2010	33	195	ZOONET	-	14:33	14:34	15:33	15:34	12.5455	-33.3288	12.5455	-33.3288	5147	Net wash
30/10/2010	33	196	TOWNET	101030_noon	14:38	14:59	15:38	15:59	12.5455	-33.3289	12.5455	-33.3289	5147	
30/10/2010	33		Leave station		15:06		16:06		12.5511	-33.3227				
31/10/2010	34		On station		04:20		05:20		10.5667	-31.9951				
31/10/2010	34	197	CTD	CTD050t	04:30	05:55	05:30	06:55	10.5667	-31.9951	10.5667	-31.9951	5312	Cast to 500m
31/10/2010	34	198	BONGO	Rach_17	04:42	05:12	05:42	06:12	10.5667	-31.9951	10.5667	-31.9951	5312	Haul from 300m
31/10/2010	34	199	BONGO	Raf	05:15	05:40	06:15	06:40	10.5682	-31.9960	10.5682	-31.9960	5312	Haul from 200m
31/10/2010	34	200	BONGO	ChrisG_200	05:42	06:03	06:42	07:03	10.5694	-31.9968	10.5694	-31.9968	5312	Haul from 200m
31/10/2010	34	201	BONGO	Raf	06:05	06:26	07:05	07:26	10.5705	-31.9975	10.5705	-31.9975	5312	Haul from 200m
31/10/2010	34	202	CTD	CTD051s	06:14	07:05	07:14	08:05	10.5709	-31.9978	10.5709	-31.9978	5312	Cast to 300m
31/10/2010	34	203	TOWNET	101031_dawn	07:10	07:27	08:10	08:27	10.5727	-31.9977	10.5727	-31.9977	5312	
31/10/2010	34		Leave station		07:30		08:30		10.5737	-31.9940				
31/10/2010	35		On station		12:56		13:56		9.7506	-31.4576				
31/10/2010	35	204	CTD	CTD052s	13:12	14:47	14:12	15:47	9.7508	-31.4575	9.7508	-31.4575	5150	Cast to 500m
31/10/2010	35	205	BUCKET	BUCKET_09	13:13		14:13		9.7509	-31.4575			5150	
31/10/2010	35	206	OPTICS	EVENT_206	13:15	13:48	14:15	14:48	9.7509	-31.4575	9.7509	-31.4575	5150	Cast from 200m
31/10/2010	35	207	OPTICS	EVENT_207	13:50	14:21	14:50	15:21	9.7517	-31.4571	9.7517	-31.4571	5150	Cast from 200m
31/10/2010	35	208	ZOONET	ZOONET_16	14:26	14:35	15:26	15:35	9.7517	-31.4571	9.7517	-31.4571	5150	Haul from 100m

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Date	Station	Event No.	Activity	ID	Time Start Ship's Time	End	Time Start (GMT)	End	Latitude Start (+ve N)	Longitude Start (+ve E)	Latitude End (+ve N)	Longitude End (+ve E)	~Water Depth (m)	Comments
31/10/2010	35	209	ZOONET	-	14:41	14:43	15:41	15:43	9.7518	-31.4571	9.7518	-31.4571	5150	Net wash
31/10/2010	35	210	TOWNET	101031_noon	14:46	15:09	15:46	16:09	9.7518	-31.4571	9.7518	-31.4571	5150	
31/10/2010	35		Leave station		15:13		16:13		9.7517	-31.4512				
01/11/2010	36		On station		04:25		05:25		7.8141	-30.1596				
01/11/2010	36	211	CTD	CTD053t	04:29	05:15	05:29	06:15	7.8141	-30.1596	7.8141	-30.1596	4587	Cast to 500m
01/11/2010	36	212	BONGO	Rach_18	04:33	05:04	05:33	06:04	7.8141	-30.1596	7.8141	-30.1596	4587	Haul from 300m
01/11/2010	36	213	BONGO	Raf	05:05	05:30	06:05	06:30	7.8156	-30.1598	7.8156	-30.1598	4587	Haul from 200m
01/11/2010	36	214	BONGO	ChrisG_214	05:31	05:55	06:31	06:55	7.8163	-30.1599	7.8163	-30.1599	4587	Haul from 200m
01/11/2010	36	215	CTD	CTD054s	05:39	06:27	06:39	07:27	7.8166	-30.1599	7.8166	-30.1599	4587	Cast to 300m
01/11/2010	36		Leave station		06:28		07:28		7.8173	-30.1598				
01/11/2010	37		On station		13:06		14:06		6.7873	-29.4840				
01/11/2010	37	216	OPTICS	EVENT_216	13:07	13:38	14:07	14:38	6.7873	-29.4840	6.7873	-29.4840	4176	Cast from 200m
01/11/2010	37	217	BUCKET	BUCKET_10	13:10		14:10		6.7873	-29.4840			4176	
01/11/2010	37	218	CTD	CTD055s	13:12	14:39	14:12	15:39	6.7873	-29.4840	6.7873	-29.4840	4176	Cast to 544m - problems with winch comms, system re-booted during cast. No problems with cast data or bottle firing.
01/11/2010	37	219	OPTICS	EVENT_219	13:39	14:13	14:39	15:13	6.7873	-29.4840	6.7873	-29.4840	4176	Cast from 200m
01/11/2010	37	220	ZOONET	ZOONET_17	14:18	14:31	15:18	15:31	6.7873	-29.4840	6.7873	-29.4840	4176	Haul from 100m
01/11/2010	37	221	ZOONET	-	14:37	14:38	15:37	15:38	6.7873	-29.4840	6.7873	-29.4840	4176	Net wash
01/11/2010	37	222	TOWNET	101101_noon	14:42	14:58	15:42	15:58	6.7873	-29.4840	6.7873	-29.4840	4176	
01/11/2010	37		Leave station		15:08		16:08		6.7899	-29.4780				
02/11/2010			Ship's clocks advanced 1 hour - Local time now GMT											
02/11/2010	38		On station		04:29		04:29		4.8040	-28.1658				
02/11/2010	38	223	CTD	CTD056t	04:32	05:26	04:32	05:26	4.8040	-28.1658	4.8040	-28.1658	3838	Cast to 500m
02/11/2010	38	224	BONGO	Rach_19	04:33	05:11	04:33	05:11	4.8040	-28.1658	4.8040	-28.1658	3838	Haul from 300m
02/11/2010	38	225	BONGO	Raf	05:13	05:37	05:13	05:37	4.8030	-28.1645	4.8030	-28.1645	3838	Haul from 200m
02/11/2010	38	226	BONGO	ChrisG_226	05:40	06:02	05:40	06:02	4.8016	-28.1629	4.8016	-28.1629	3838	Haul from 200m
02/11/2010	38	227	CTD	CTD057s	05:51	06:35	05:51	06:35	4.8009	-28.1623	4.8009	-28.1623	3838	Cast to 300m
02/11/2010	38	228	BONGO	Raf	06:04	06:29	06:04	06:29	4.8002	-28.1615	4.8002	-28.1615	3838	Haul from 200m
02/11/2010	38	229	TOWNET	101102_dawn	06:45	07:01	06:45	07:01	4.7990	-28.1592	4.7990	-28.1592	3838	
02/11/2010	38		Leave station		07:15		07:15		4.7741	-28.1360				
02/11/2010	39		On station		13:10		13:10		3.8856	-27.5648				

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Date	Station	Event No.	Activity	ID	Time Start Ship's Time	End	Time Start (GMT)	End	Latitude Start (+ve N)	Longitude Start (+ve E)	Latitude End (+ve N)	Longitude End (+ve E)	~Water Depth (m)	Comments
02/11/2010	39	230	OPTICS	EVENT_230	13:13	13:43	13:13	13:43	3.8857	-27.5649	3.8857	-27.5649	3693	Cast from 200m
02/11/2010	39	231	BUCKET	BUCKET_11	13:16		13:16		3.8857	-27.5649			3693	
02/11/2010	39	232	CTD	CTD058s	13:17	15:01	13:17	15:01	3.8856	-27.5649	3.8856	-27.5649	3693	Cast to 500m. Problems with winch left CTD hanging at 20m for 40m while fixed. Rig retruned to surface and dcast recommenced at 14:06
02/11/2010	39	233	OPTICS	EVENT_233	13:45	14:10	13:45	14:10	3.8856	-27.5648	3.8856	-27.5648	3693	Cast from 200m
02/11/2010	39	234	ZOONET	ZOONET_18	14:15	14:26	14:15	14:26	3.8856	-27.5649	3.8856	-27.5649	3693	Haul from 100m
02/11/2010	39	235	ZOONET	-	14:31	14:31	14:31	14:31	3.8856	-27.5648	3.8856	-27.5648	3693	Net wash
02/11/2010	39	236	TOWNET	101102_noon	14:58	15:10	14:58	15:10	3.8856	-27.5648	3.8856	-27.5648	3693	
02/11/2010	39		Leave station		15:12		15:12		3.8883	-27.5642				
03/11/2010	40		On station		04:32		04:32		1.9625	-26.2993				
03/11/2010	40	237	CTD		04:35		04:35		1.9625	-26.2993				Problem with cable resulted in retermination being required. Cast cancelled.
03/11/2010	40	238	BONGO	Rach_20	04:48	05:18	04:48	05:18	1.9625	-26.2992	1.9625	-26.2992		Haul from 300m
03/11/2010	40	239	BONGO	Raf	05:22	05:40	05:22	05:40	1.9629	-26.2981	1.9629	-26.2981		Haul from 200m
03/11/2010	40	240	BONGO	ChrisG_240	05:43	06:00	05:43	06:00	1.9631	-26.2975	1.9631	-26.2975		Haul from 200m
03/11/2010	40		Leave station		06:06		06:06		1.9633	-26.2969				
03/11/2010	41		On station		12:12		12:12		1.1360	-25.7498				
03/11/2010	41	241	OPTICS	EVENT_241	12:14	12:42	12:14	12:42	1.1360	-25.7498	1.1360	-25.7498		Cast from 200m
03/11/2010	41	242	OPTICS	EVENT_242	12:44	13:14	12:44	13:14	1.1360	-25.7498	1.1360	-25.7498		Cast from 200m
03/11/2010	41	243	ZOONET	ZOONET_19	13:20	13:30	13:20	13:30	1.1360	-25.7498	1.1360	-25.7498		Haul from 100m
03/11/2010	41	244	ZOONET	-	13:35	13:35	13:35	13:35	1.1360	-25.7498	1.1360	-25.7498		Net wash
03/11/2010	41	245	TOWNET	101103_noon	13:39	13:50	13:39	13:50	1.1360	-25.7498	1.1360	-25.7498		
03/11/2010	41		Leave station		13:54		13:54		1.1422	-25.7513				
04/11/2010	42		On station		04:32		04:32		-1.1719	-25.0007				
04/11/2010	42	246a	CTD	CTD059t	04:32	05:20	04:32	05:20	-1.1719	-25.0007	-1.1719	-25.0007	4869	Cast to 500m. Communication failure at 500m. No bottles fired on upcast. Only downcast data recorded. Retermination required.
04/11/2010	42	246b	BONGO		04:38	04:57	04:38	04:57	-1.1720	-25.0007	-1.1720	-25.0007	4869	Bongo net caught in strong

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Date	Station	Event No.	Activity	ID	Time Start Ship's Time	End	Time Start (GMT)	End	Latitude Start (+ve N)	Longitude Start (+ve E)	Latitude End (+ve N)	Longitude End (+ve E)	~Water Depth (m)	Comments
														current at ~90m and caught around CTD. Haul aborted.
04/11/2010	42	246c	BUCKET	BUCKET_12	05:41		05:41		-1.1695	-24.9981			4869	
04/11/2010	42		Leave station		06:52		06:52		-1.1694	-24.9918				
04/11/2010	43		On station		09:00		09:00		-1.3324	-25.0041				
04/11/2010	43	247	ACOUSTIC_TRIAL		09:03	11:50	09:03	11:50	-1.3324	-25.0041	-1.3324	-25.0041		Trial of acousitic device and transducer prior to arrival at the SAG mooring for release of the current mooring before deploying the new mooring.
04/11/2010	43		Leave station		11:56		11:56		-1.3327	-24.9936				
04/11/2010	44		On station		13:07		13:07		-1.4797	-25.0081				
04/11/2010	44	248	OPTICS	EVENT_248	13:08	13:40	13:08	13:40	-1.4797	-25.0081	-1.4797	-25.0081	4729	Cast from 200m
04/11/2010	44	249a	CTD	CTD060s	13:38	15:04	13:38	15:04	-1.4794	-25.0061	-1.4794	-25.0061	4729	Cast to 500m. Communication failure at 500m. No bottles fired on upcast. Only downcast data recorded. Re termination required.
04/11/2010	44	249b	OPTICS	EVENT_249b	13:42	14:14	13:42	14:14	-1.4793	-25.0058	-1.4793	-25.0058	4729	Cast from 200m
04/11/2010	44		Leave station		15:18		15:18		-1.4783	-24.9999				
05/11/2010	45		On station		04:25		04:25		-3.8515	-25.0177				
05/11/2010	45	249c	BONGO	Rach_21	04:49	05:19	04:49	05:19	-3.8515	-25.0177	-3.8515	-25.0177	5509	Haul from 300m
05/11/2010	45	250	CTD	CTD061t	04:55	05:39	04:55	05:39	-3.8515	-25.0176	-3.8515	-25.0176	5509	Cast to 300m.
05/11/2010	45	251	BONGO	ChrisG_251	05:20	05:42	05:20	05:42	-3.8503	-25.0167	-3.8503	-25.0167	5509	Haul from 200m
05/11/2010	45	252	BONGO	Raf	05:42	06:02	05:42	06:02	-3.8494	-25.0159	-3.8494	-25.0159	5509	Haul from 200m
05/11/2010	45	253	CTD	CTD062s	06:07	06:45	06:07	06:45	-3.8482	-25.0149	-3.8482	-25.0149	5509	Cast to 300m.
05/11/2010	45	254	BONGO	Raf	06:08	06:25	06:08	06:25	-3.8481	-25.0148	-3.8481	-25.0148	5509	Haul from 200m
05/11/2010	45	255	TOWNET	101105_dawn	06:50	07:06	06:50	07:06	-3.8469	-25.0132	-3.8469	-25.0132	5509	
05/11/2010	45		Leave station		07:06		07:06		-3.8477	-25.0102				
05/11/2010	46		On station		13:03		13:03		-4.8906	-25.0296				
05/11/2010	46	256	OPTICS	EVENT_256	13:05	13:38	13:05	13:38	-4.8906	-25.0296	-4.8906	-25.0296	5476	Cast from 200m
05/11/2010	46	257	BUCKET	BUCKET_13	13:09		13:09		-4.8906	-25.0296			5476	
05/11/2010	46	258	CTD	CTD063s	13:11	13:58	13:11	13:58	-4.8906	-25.0296	-4.8906	-25.0296	5476	Cast to 300m.

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Date	Station	Event No.	Activity	ID	Time Start	End	Time Start	End	Latitude Start	Longitude Start	Latitude End	Longitude End	~Water Depth (m)	Comments
05/11/2010	46	259	OPTICS	EVENT_259	13:40	14:10	13:40	14:10	-4.8906	-25.0296	-4.8906	-25.0296	5476	Cast from 200m
05/11/2010	46	260	ZOONET	ZOONET_20	14:14	14:25	14:14	14:25	-4.8906	-25.0295	-4.8906	-25.0295	5476	Haul from 100m
05/11/2010	46	261	ZOONET	-	14:30	14:31	14:30	14:31	-4.8904	-25.0294	-4.8904	-25.0294	5476	Net wash
05/11/2010	46	262	TOWNET	101105_noon	14:35	14:54	14:35	14:54	-4.8904	-25.0294	-4.8904	-25.0294	5476	
05/11/2010	46		Leave station		14:59		14:59		-4.8921	-25.0264				
05/11/2010			Change course for Ascension Island		20:43		20:43							
06/11/2010	47		On station		04:30		04:30		-6.0575	-23.7629				
06/11/2010	47	263	CTD	CTD064t	04:30	05:18	04:30	05:18	-6.0575	-23.7629	-6.0575	-23.7629	5564	Cast to 300m.
06/11/2010	47	264	BONGO	Rach_22	04:36	05:05	04:36	05:05	-6.0575	-23.7629	-6.0575	-23.7629	5564	Haul from 300m
06/11/2010	47	265	BONGO	Raf	05:07	05:28	05:07	05:28	-6.0563	-23.7619	-6.0563	-23.7619	5564	Haul from 200m
06/11/2010	47	266	BONGO	ChrisG_266	05:30	05:50	05:30	05:50	-6.0555	-23.7612	-6.0555	-23.7612	5564	Haul from 200m
06/11/2010	47	267	CTD	CTD065s	05:46	06:35	05:46	06:35	-6.0548	-23.7607	-6.0548	-23.7607	5564	Cast to 300m.
06/11/2010	47		Leave station		06:36		06:36		-6.0550	-23.7580				
06/11/2010	48		On station		13:07		13:07		-6.2683	-22.6981				
06/11/2010	48	268	OPTICS	EVENT_268	13:08	13:42	13:08	13:42	-6.2683	-22.6981	-6.2683	-22.6981	4891	Cast from 200m
06/11/2010	48	269	CTD	CTD066s	13:09	13:50	13:09	13:50	-6.2682	-22.6981	-6.2682	-22.6981	4891	Cast to 300m.
06/11/2010	48	270	BUCKET	BUCKET_14	13:10		13:10		-6.2682	-22.6981			4891	
06/11/2010	48	271	TOWNET	101106_noon	13:45	14:01	13:45	14:01	-6.2667	-22.6968	-6.2667	-22.6968	4891	
06/11/2010	48		Leave station		14:40		14:40		-6.2892	-22.5912				
08/11/2010			200 nm from Ascension: non-toxic turned off		07:30		07:30		-7.6515	-15.6957				
09/11/2010			200 nm from Ascension: non-toxic supply turned on		10:03		10:03		-10.3466	-16.8502				
09/11/2010	49		On station		13:05		13:05		-10.7312	-17.2252				
09/11/2010	49	272	OPTICS	EVENT_272	13:05	13:39	13:05	13:39	-10.7312	-17.2252	-10.7312	-17.2252		Cast from 200m
09/11/2010	49	273	BUCKET	BUCKET_15	13:10		13:10		-10.7312	-17.2251				
09/11/2010	49	274	ZOONET	ZOONET_21	13:48	14:00	13:48	14:00	-10.7311	-17.2251	-10.7311	-17.2251		Haul from 100m
09/11/2010	49	275	ZOONET	-	14:06	14:07	14:06	14:07	-10.7302	-17.2246	-10.7302	-17.2246		Net wash
09/11/2010	49	276	BUCKET	BUCKET_16	14:21		14:21		-10.7299	-17.2244				
09/11/2010	49	277	BUCKET	BUCKET_17	14:29		14:29		-10.7299	-17.2245				
09/11/2010	49		Leave station		14:45		14:45		-10.7304	-17.2236				
10/11/2010	50		On station		04:30		04:30		-12.5292	-19.0220				
10/11/2010	50	278	CTD	CTD067s	04:30	05:17	04:30	05:17	-12.5292	-19.0220	-12.5292	-19.0220	4488	Cast to 300m.
10/11/2010	50	279	BONGO	Rach_23	04:37	04:55	04:37	04:55	-12.5292	-19.0220	-12.5292	-19.0220	4488	Haul from 200m

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Date	Station	Event No.	Activity	ID	Time Start	End	Time Start	End	Latitude Start	Longitude Start	Latitude End	Longitude End	~Water Depth (m)	Comments
					Ship's Time		(GMT)		(+ve N)	(+ve E)	(+ve N)	(+ve E)		
10/11/2010	50	280	BONGO	Raf	04:58	05:18	04:58	05:18	-12.5292	-19.0220	-12.5292	-19.0220	4488	Haul from 200m
10/11/2010	50	281	BONGO	ChrisG_281	05:19	05:40	05:19	05:40	-12.5292	-19.0220	-12.5292	-19.0220	4488	Haul from 200m
10/11/2010	50		Leave station		05:45		05:45		-12.5293	-19.0215				
10/11/2010	51		On station		13:03		13:03		-13.4733	-19.9666				
10/11/2010	51	282	OPTICS	EVENT_282	13:06	13:38	13:06	13:38	-13.4733	-19.9666	-13.4733	-19.9666	4420	Cast from 200m
10/11/2010	51	283	CTD	CTD068s	13:07	13:51	13:07	13:51	-13.4733	-19.9666	-13.4733	-19.9666	4420	Cast to 300m.
10/11/2010	51	284	BUCKET	BUCKET_18	13:08		13:08		-13.4734	-19.9666			4420	
10/11/2010	51	285	TOWNET	-	13:53	13:56	13:53	13:56	-13.4733	-19.9665	-13.4733	-19.9665	4420	Net wash
10/11/2010	51	286	TOWNET	101110_noon	13:57	14:11	13:57	14:11	-13.4731	-19.9664	-13.4731	-19.9664	4420	
10/11/2010	51		Leave station		14:38		14:38		-13.5005	-19.9928				
11/11/2010	52		On station		04:22		04:22		-15.3314	-21.8412				
11/11/2010	52	287	CTD	CTD069s	04:30	05:17	04:30	05:17	-15.3313	-21.8412	-15.3313	-21.8412	5069	Cast to 300m.
11/11/2010	52	288	BONGO	Rach_24	04:27	04:45	04:27	04:45	-15.3314	-21.8412	-15.3314	-21.8412	5069	Haul from 200m
11/11/2010	52	289	BONGO	Raf	04:47	05:05	04:47	05:05	-15.3313	-21.8412	-15.3313	-21.8412	5069	Haul from 200m
11/11/2010	52	290	BONGO	ChrisG_290	05:08	05:28	05:08	05:28	-15.3313	-21.8412	-15.3313	-21.8412	5069	Haul from 200m
11/11/2010	52		Leave station		05:30		05:30		-15.3313	-21.8407				
11/11/2010	53		On station		13:03		13:03		-16.3162	-22.8417				
11/11/2010	53	291	OPTICS	EVENT_291	13:05	13:36	13:05	13:36	-16.3162	-22.8417	-16.3162	-22.8417	4766	Cast from 200m
11/11/2010	53	292	CTD	CTD070s	13:07	13:52	13:07	13:52	-16.3162	-22.8417	-16.3162	-22.8417	4766	Cast to 300m.
11/11/2010	53	293	BUCKET	BUCKET_19	13:08		13:08		-16.3162	-22.8417			4766	
11/11/2010	53	294	ZOONET	ZOONET_22	13:40	13:51	13:40	13:51	-16.3162	-22.8417	-16.3162	-22.8417	4766	Haul from 100m
11/11/2010	53	295	ZOONET	-	13:56	13:56	13:56	13:56	-16.3155	-22.8418	-16.3155	-22.8418	4766	Net wash
11/11/2010	53	296	ARGO		14:02		14:02		-16.3155	-22.8417			4766	
11/11/2010	53		Leave station		14:38		14:38		-16.3746	-22.9007				
12/11/2010	54		On station		06:42		06:42		-18.5315	-25.1027				
12/11/2010	54	297	Mooring recovery		07:55	10:13	07:55	10:13	-18.5319	-25.1056	-18.5319	-25.1056		
12/11/2010	55		On station		10:52		10:52		-18.5371	-25.1295				
12/11/2010	55	298	CTD	CTD071s	11:00	11:36	11:00	11:36	-18.5370	-25.1296	-18.5370	-25.1296	5325	Cast to 300m.
12/11/2010	55	299	OPTICS	EVENT_299	12:40	13:15	12:40	13:15	-18.5378	-25.1341	-18.5378	-25.1341	5325	Cast from 200m
12/11/2010	55	300	TOWNET	101112_noon	13:17	13:35	13:17	13:35	-18.5373	-25.1341	-18.5373	-25.1341	5325	
12/11/2010	54B	301	Mooring deployment		13:40	15:56	13:40	15:56	-18.5363	-25.1313	-18.5363	-25.1313		
12/11/2010			Mooring triangulation		16:49	18:18	16:49	18:18	-18.5293	-25.0973	-18.5293	-25.0973		
12/11/2010	54B		Leave station											

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Date	Station	Event No.	Activity	ID	Time Start Ship's Time	End	Time Start (GMT)	End	Latitude Start (+ve N)	Longitude Start (+ve E)	Latitude End (+ve N)	Longitude End (+ve E)	~Water Depth (m)	Comments
13/11/2010	56		On station		04:28		04:28		-20.3796	-25.0892				
13/11/2010	56	302	BONGO	Rach_25	04:28	04:45	04:28	04:45	-20.3796	-25.0892	-20.3796	-25.0892	5217	Haul from 200m
13/11/2010	56	303	CTD	CTD072s	04:31	05:18	04:31	05:18	-20.3796	-25.0892	-20.3796	-25.0892	5217	Cast to 300m.
13/11/2010	56	304	BONGO	Raf	04:47	05:05	04:47	05:05	-20.3796	-25.0891	-20.3796	-25.0891	5217	Haul from 200m
13/11/2010	56	305	BONGO	ChrisG_305	05:07	05:28	05:07	05:28	-20.3796	-25.0891	-20.3796	-25.0891	5217	Haul from 200m
13/11/2010	56		Leave station		05:28		05:28		-20.3796	-25.0891				
13/11/2010	57		On station		13:03		13:03		-21.7058	-25.0969				
13/11/2010	57	306	OPTICS	EVENT_306	13:03	13:32	13:03	13:32	-21.7058	-25.0969	-21.7058	-25.0969	5058	Cast from 200m
13/11/2010	57	307	BUCKET	BUCKET_20	13:04		13:04		-21.7058	-25.0969			5058	
13/11/2010	57	308	CTD	CTD073s	13:05	13:50	13:05	13:50	-21.7058	-25.0969	-21.7058	-25.0969	5058	Cast to 300m.
13/11/2010	57	309	ZOONET	ZOONET_23	13:36	13:45	13:36	13:45	-21.7051	-25.0972	-21.7051	-25.0972	5058	Haul from 100m
13/11/2010	57	310	ZOONET	-	13:48	13:50	13:48	13:50	-21.7051	-25.0972	-21.7051	-25.0972	5058	Net wash
13/11/2010	57	311	ARGO		13:54		13:54		-21.7047	-25.0966			5058	
13/11/2010	57		Leave station		14:25		14:25		-21.7274	-25.0981				
14/11/2010	58		On station		04:00		04:00		-23.7972	-26.5229				
14/11/2010	58	312	BONGO	Rach_26	04:35	05:00	04:35	05:00	-23.8379	-26.5670	-23.8379	-26.5670	5048	Haul from 200m
14/11/2010	58	313	CTD	CTD074s	04:55	05:45	04:55	05:45	-23.8377	-26.5665	-23.8377	-26.5665	5048	Cast to 300m.
14/11/2010	58	314	BONGO	Raf	05:02	05:18	05:02	05:18	-23.8378	-26.5665	-23.8378	-26.5665	5048	Haul from 200m
14/11/2010	58	315	BONGO	ChrisG_315	05:20	05:40	05:20	05:40	-23.8378	-26.5665	-23.8378	-26.5665	5048	Haul from 200m
14/11/2010	58		Leave station		05:50		05:50		-23.8376	-26.5657				
14/11/2010	59		On station		13:07		13:07		-24.8190	-27.3572				
14/11/2010	59	316	OPTICS	EVENT_316	13:21	13:52	13:21	13:52	-24.8191	-27.3583	-24.8191	-27.3583	5225	Cast from 200m
14/11/2010	59	317	CTD	CTD075s	13:30	14:11	13:30	14:11	-24.8190	-27.3585	-24.8190	-27.3585	5225	Cast to 300m.
14/11/2010	59	318	TOWNET	101114_noon	13:59	14:15	13:59	14:15	-24.8191	-27.3602	-24.8191	-27.3602	5225	
14/11/2010	59	319	ARGO		14:18		14:18		-24.8191	-27.3607			5225	
14/11/2010	59		Leave station		14:28		14:28		-24.8213	-27.3612				
15/11/2010			Ship's clocks retarded 1 hour - Local time now GMT-1											
15/11/2010	60		On station		04:26		05:26		-26.8576	-29.0679				
15/11/2010	60	320	BONGO	Rach_27	04:26	04:45	05:26	05:45	-26.8576	-29.0679	-26.8576	-29.0679	5320	Haul from 200m
15/11/2010	60	321	CTD	CTD076s	04:36	05:20	05:36	06:20	-26.8575	-29.0676	-26.8575	-29.0676	5320	Cast to 300m.
15/11/2010	60	322	BONGO	Raf	04:47	05:08	05:47	06:08	-26.8574	-29.0667	-26.8574	-29.0667	5320	Haul from 200m
15/11/2010	60	323	BONGO	ChrisG_323	05:18	05:30	06:18	06:30	-26.8572	-29.0650	-26.8572	-29.0650	5320	Haul from 200m
15/11/2010	60		Leave station		05:35		06:35		-26.8571	-29.0638				

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Date	Station	Event No.	Activity	ID	Time Start	End	Time Start	End	Latitude Start	Longitude Start	Latitude End	Longitude End	~Water Depth (m)	Comments
15/11/2010	61		On station		13:00		14:00		-27.9159	-29.9866				
15/11/2010	61	324	OPTICS	EVENT_324	13:09	13:39	14:09	14:39	-27.9159	-29.9866	-27.9159	-29.9866	4817	Cast from 200m
15/11/2010	61	325	CTD	CTD077s	13:10	13:58	14:10	14:58	-27.9158	-29.9865	-27.9158	-29.9865	4817	Cast to 300m.
15/11/2010	61	326	BUCKET	BUCKET_21	13:11		14:11		-27.9158	-29.9864			4817	
15/11/2010	61	327	ZOONET	ZOONET_24	13:44	13:51	14:44	14:51	-27.9152	-29.9839	-27.9152	-29.9839	4817	Haul from 100m
15/11/2010	61	328	ZOONET	-	13:57		14:57		-27.9150	-29.9827			4817	Net wash
15/11/2010	61	329	ARGO		14:03		15:03		-27.9149	-29.9822			4817	
15/11/2010	61		Leave station		14:03		15:03		-27.9149	-29.9822				
16/11/2010	62		On station		04:25		05:25		-29.9438	-31.8236				
16/11/2010	62	330	BONGO	Rach_28	04:25	04:43	05:25	05:43	-29.9438	-31.8236	-29.9438	-31.8236	4000	Haul from 200m
16/11/2010	62	331	CTD	CTD078s	04:31	05:12	05:31	06:12	-29.9435	-31.8234	-29.9435	-31.8234	4000	Cast to 300m.
16/11/2010	62	332	BONGO	Raf	04:43	05:03	05:43	06:03	-29.9430	-31.8231	-29.9430	-31.8231	4000	Haul from 200m
16/11/2010	62	333	BONGO	ChrisG_333	05:05	05:30	06:05	06:30	-29.9414	-31.8227	-29.9414	-31.8227	4000	Haul from 200m
16/11/2010	62		Leave station		05:30		06:30		-29.9399	-31.8214				
16/11/2010	63		On station		13:11		14:11		-30.9956	-32.8140				
16/11/2010	63	334	BUCKET	BUCKET_22	13:11		14:11		-30.9956	-32.8140				
16/11/2010	63	335	OPTICS	EVENT_335	13:21	13:52	14:21	14:52	-30.9959	-32.8150	-30.9959	-32.8150	1751	Cast from 200m
16/11/2010	63	336	CTD	CTD079s	13:23	13:59	14:23	14:59	-30.9959	-32.8150	-30.9959	-32.8150	1751	Cast to 300m.
16/11/2010	63	337	TOWNET	101116_noon	13:57	14:11	14:57	15:11	-30.9995	-32.8181	-30.9995	-32.8181	1751	
16/11/2010	63		Leave station		14:15		15:15		-31.0019	-32.8243				
16/11/2010	64	338	ARGO		19:28		20:28		-31.7622	-33.5582				
17/11/2010	65		On station		04:25		05:25		-33.0444	-34.8454				
17/11/2010	65	339	BONGO	Rach_29	04:25	04:42	05:25	05:42	-33.0444	-34.8454	-33.0444	-34.8454	4018	Haul from 200m
17/11/2010	65	340	CTD	CTD080s	04:30	05:17	05:30	06:17	-33.0444	-34.8454	-33.0444	-34.8454	4018	Cast to 300m.
17/11/2010	65	341	BONGO	Raf	04:44	05:07	05:44	06:07	-33.0444	-34.8454	-33.0444	-34.8454	4018	Haul from 200m
17/11/2010	65	342	BONGO	ChrisG_342	05:07	05:30	06:07	06:30	-33.0444	-34.8454	-33.0444	-34.8454	4018	Haul from 200m
17/11/2010	65		Leave station		05:30		06:30		-33.0445	-34.8454				
17/11/2010	66		On station		13:07		14:07		-34.1075	-35.9254				
17/11/2010	66	343	OPTICS	EVENT_343	13:08	13:37	14:08	14:37	-34.1075	-35.9254	-34.1075	-35.9254	4415	Cast from 200m
17/11/2010	66	344	BUCKET	BUCKET_23	13:09		14:09		-34.1074	-35.9255			4415	Cast to 300m.
17/11/2010	66	345	CTD	CTD081s	13:12	14:04	14:12	15:04	-34.1075	-35.9255	-34.1075	-35.9255	4415	Cast to 300m.
17/11/2010	66	346	TOWNET	101117_noon	13:41	13:57	14:41	14:57	-34.1074	-35.9253	-34.1074	-35.9253	4415	
17/11/2010	66	347	ARGO		14:10		15:10		-34.1070	-35.9250			4415	

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Date	Station	Event No.	Activity	ID	Time Start Ship's Time	End	Time Start (GMT)	End	Latitude Start (+ve N)	Longitude Start (+ve E)	Latitude End (+ve N)	Longitude End (+ve E)	~Water Depth (m)	Comments
17/11/2010	66		Leave station		14:16		15:16		-34.1147	-35.9252				
18/11/2010	67		On station		04:27		05:27		-36.0910	-38.0877				
18/11/2010	67	348	BONGO	Rach_30	04:27	04:46	05:27	05:46	-36.0910	-38.0877	-36.0910	-38.0877	4839	Haul from 200m
18/11/2010	67	349	CTD	CTD082s	04:32	05:22	05:32	06:22	-36.0907	-38.0878	-36.0907	-38.0878	4839	Cast to 300m.
18/11/2010	67	350	BONGO	Raf	04:48	05:07	05:48	06:07	-36.0885	-38.0887	-36.0885	-38.0887	4839	Haul from 200m
18/11/2010	67	351	BONGO	ChrisG_351	05:12	05:30	06:12	06:30	-36.0854	-38.0900	-36.0854	-38.0900	4839	Haul from 200m
18/11/2010	67		Leave station		05:35		06:35		-36.0824	-38.0909				
18/11/2010	68		On station		13:00		14:00		-37.0932	-39.2319				
18/11/2010	68	352	OPTICS	EVENT_352	13:00	13:37	14:00	14:37	-37.0932	-39.2319	-37.0932	-39.2319	4965	Cast from 200m
18/11/2010	68	353	CTD	CTD083s	13:11	14:00	14:11	15:00	-37.0939	-39.2305	-37.0939	-39.2305	4965	Cast to 300m.
18/11/2010	68	354	ZOONET	ZOONET_25	13:41	13:52	14:41	14:52	-37.0935	-39.2285	-37.0935	-39.2285	4965	Haul from 100m
18/11/2010	68		Leave station		14:10		15:10		-37.0990	-39.2279				
19/11/2010	69		On station		04:25		05:25		-38.9255	-41.4509				
19/11/2010	69	355	BONGO	Rach_31	04:27	04:46	05:27	05:46	-38.9255	-41.4509	-38.9255	-41.4509	5082	Haul from 200m
19/11/2010	69	356	CTD	CTD084s	04:38	05:24	05:38	06:24	-38.9246	-41.4525	-38.9246	-41.4525	5082	Cast to 300m.
19/11/2010	69	357	BONGO	Raf	04:48	05:10	05:48	06:10	-38.9236	-41.4541	-38.9236	-41.4541	5082	Haul from 200m
19/11/2010	69	358	BONGO	ChrisG_358	05:12	05:36	06:12	06:36	-38.9212	-41.4579	-38.9212	-41.4579	5082	Haul from 200m
19/11/2010	69		Leave station		05:55		06:55		-38.9192	-41.4673				
19/11/2010	70		On station		13:09		14:09		-39.7913	-42.5521				
19/11/2010	70	359	OPTICS	EVENT_359	13:09	13:37	14:09	14:37	-39.7913	-42.5521	-39.7913	-42.5521	5131	Cast from 200m
19/11/2010	70	360	CTD	CTD085s	13:12	13:57	14:12	14:57	-39.7913	-42.5520	-39.7913	-42.5520	5131	Cast to 300m.
19/11/2010	70	361	TOWNET	101119_noon	13:43	13:59	14:43	14:59	-39.7915	-42.5515	-39.7915	-42.5515	5131	
19/11/2010	70		Leave station		14:12		15:12		-39.7937	-42.5591				
20/11/2010			Ship's clocks retarded 1 hour - Local time now GMT-2											
20/11/2010	71		On station		04:33		06:33		-41.6559	-45.0928				
20/11/2010	71	362	BONGO	Rach_32	04:35	05:00	06:35	07:00	-41.6559	-45.0928	-41.6559	-45.0928	5123	Haul from 200m
20/11/2010	71	363	CTD	CTD086s	04:41	05:25	06:41	07:25	-41.6557	-45.0930	-41.6557	-45.0930	5123	Cast to 300m.
20/11/2010	71	364	BONGO	Raf	05:03	05:23	07:03	07:23	-41.6548	-45.0940	-41.6548	-45.0940	5123	Haul from 200m
20/11/2010	71	365	BONGO	ChrisG_365	05:27	05:47	07:27	07:47	-41.6538	-45.0953	-41.6538	-45.0953	5123	Haul from 200m
20/11/2010	71		Leave station		05:55		07:55		-41.6534	-45.0900				
20/11/2010	72		On station		13:09		15:09		-42.4981	-46.2962				
20/11/2010	72	366	OPTICS	EVENT_366	13:11	13:37	15:11	15:37	-42.4981	-46.2962	-42.4981	-46.2962	5205	Cast from 200m
20/11/2010	72	367	CTD	CTD087s	13:12	13:51	15:12	15:51	-42.4981	-46.2962	-42.4981	-46.2962	5205	Cast to 300m.

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Date	Station	Event No.	Activity	ID	Time Start Ship's Time	End	Time Start (GMT)	End	Latitude Start (+ve N)	Longitude Start (+ve E)	Latitude End (+ve N)	Longitude End (+ve E)	~Water Depth (m)	Comments
20/11/2010	72	368	ZOONET	ZOONET_26	13:41	13:52	15:41	15:52	-42.4980	-46.2962	-42.4980	-46.2962	5205	Haul from 100m
20/11/2010	72	369	ZOONET	-	13:55	13:55	15:55	15:55	-42.4976	-46.2967	-42.4976	-46.2967	5205	Net wash
20/11/2010	72		Leave station		13:59		15:59		-42.4976	-46.2968				
21/11/2010	73		On station		04:25		06:25		-44.1997	-48.9383				
21/11/2010	73	370	BONGO	Rach_33	04:25	04:45	06:25	06:45	-44.1997	-48.9383	-44.1997	-48.9383	5223	Haul from 200m
21/11/2010	73	371	CTD	CTD088s	04:30	05:12	06:30	07:12	-44.1998	-48.9385	-44.1998	-48.9385	5223	Cast to 300m.
21/11/2010	73	372	BONGO	Raf	04:48	05:09	06:48	07:09	-44.2001	-48.9399	-44.2001	-48.9399	5223	Haul from 200m
21/11/2010	73	373	BONGO	ChrisG_373	05:11	05:32	07:11	07:32	-44.2005	-48.9415	-44.2005	-48.9415	5223	Haul from 200m
21/11/2010	73		Leave station		05:35		07:35		-44.2005	-48.9432				
21/11/2010	74		On station		13:09		15:09		-45.0165	-50.2845				
21/11/2010	74	374	OPTICS	EVENT_374	13:10	13:38	15:10	15:38	-45.0165	-50.2845	-45.0165	-50.2845	5695	Cast from 200m
21/11/2010	74	374	CTD	CTD089s	13:12	13:54	15:12	15:54	-45.0165	-50.2845	-45.0165	-50.2845	5695	Cast to 300m.
21/11/2010	74	376	TOWNET	101121_noon	13:43	14:01	15:43	16:01	-45.0165	-50.2845	-45.0165	-50.2845	5695	
21/11/2010	74		Leave station		14:03		16:03		-45.0150	-50.2842				
22/11/2010			200 nm from the Falkland Islands: non-toxic turned off		19:05		21:05		-48.0985	-56.1063				

AMT20 Cruise Report

Appendix 1 : Underway Log – JCO53

Sample ID	Date	Time (GMT)	Latitude	Longitude	TSG sal. (PSU)	SST - hull sensor (deg. C)	Fluor (volts)	Salinity		Chl-a (ug/l)		Comments
			(+ve N)	(+ve E)				Sample btl	(PSU)	mean	stdev	
AAA	13/10/2010	12:00	49.7162	-6.9215	35.0549	15.9492	0.3245	Crate 1 - #01	35.0698			freezer broken - chl-a sample discarded
AAB	13/10/2010	16:03	49.6672	-7.7947	35.0754	15.7387	0.3401	Crate 1 - #02	35.0816			freezer broken - chl-a sample discarded
AAC	13/10/2010	20:03	49.6084	-8.8597	35.2328	15.9243	0.3805	Crate 1 - #03	35.0898			freezer broken - chl-a sample discarded
AAD	14/10/2010	04:15	49.4046	-11.1671	35.5457	15.7649	0.5064	Crate 1 - #04	35.5613			freezer broken - chl-a sample discarded
AAE	14/10/2010	07:57	49.3758	-11.5183	35.5946	16.1891	0.4004	Crate 1 - #05	35.6106			freezer broken - chl-a sample discarded
AAF	14/10/2010	12:00	49.2779	-12.6505	35.6513	16.6653	0.2627	Crate 1 - #06	35.6695			freezer broken - chl-a sample discarded
AAG	14/10/2010	16:11	49.2695	-13.1043	35.6855	16.4407	0.3951	Crate 1 - #07	35.3610			freezer broken - chl-a sample discarded
AAH	14/10/2010	20:00	49.1743	-14.1689	35.6032	16.6961	0.2246	Crate 1 - #08	35.6226	0.40		
AAI	15/10/2010	04:18	49.0353	-16.4327	35.6057	15.7518	0.5681	Crate 1 - #09	35.6195	1.03		
AAJ	15/10/2010	08:04	48.8560	-16.6355	35.6070	15.9105	0.5308	Crate 1 - #10	35.6273	1.03		
AAK	15/10/2010	12:13	48.2191	-17.2433	35.6031	16.6673	0.2454	Crate 1 - #11	35.6237	0.56	0.036	
AAL	15/10/2010	16:09	47.9759	-17.4540	35.4703	16.0180	0.4187	Crate 1 - #12	35.5087	0.69		
AAM	15/10/2010	20:00	47.3671	-17.9954	35.4435	15.9078	0.4099	Crate 1 - #13	35.4616	0.73		
AAN	16/10/2010	08:10	45.8197	-19.4134	35.7087	17.1766	0.2284	Crate 1 - #14	35.7221	0.23		
AAO	16/10/2010	12:00	45.2902	-19.8542	35.8766	17.9807	0.1567	Crate 1 - #15	35.8773	0.28	0.112	
AAP	16/10/2010	16:36	45.0224	-20.0955	35.7594	17.8330	0.2798	Crate 1 - #16	35.7725	0.19		
AAQ	16/10/2010	19:56	44.6052	-20.4619	35.8054	17.9953	0.2530	Crate 1 - #17	35.8182	0.42		
AAR	17/10/2010	04:03	43.5592	-21.3525	35.7670	17.2964	0.2869	Crate 1 -	35.7841	0.21		

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Sample ID	Date	Time (GMT)	Latitude	Longitude	TSG sal.	SST - hull sensor	Fluor	Salinity		Chl-a (ug/l)		Comments
			(+ve N)	(+ve E)	(PSU)	(deg. C)	(volts)	Sample btl	(PSU)	mean	stdev	
								#18				
AAS	17/10/2010	04:03 to 06:00										transmissometer data dubious
	17/10/2010	08:02	43.3919	-21.4970	35.8258	17.4295	0.3185	Crate 1 - #19	35.7282	0.37		
AAT	17/10/2010	11:55	42.8894	-21.9351	35.9270	17.6652	0.2374	Crate 1 - #20	35.9478	0.60		
AAU	17/10/2010	16:40	42.5970	-22.1824	35.7913	17.4781	0.2193	Crate 1 - #21	35.8015	0.38	0.012	
AAV	17/10/2010	20:35	42.0857	-22.6045	35.9194	18.6328	0.1598	Crate 1 - #22	35.9415	0.25		
AAW	18/10/2010	04:55	40.9943	-23.4794	36.0510	19.3721	0.1342	Crate 1 - #23	36.0742	0.18		
	18/10/2010	05:00 to 10:05										
AAX	18/10/2010	08:00	40.8403	-23.6090	36.1130	19.4776	0.1338	Crate 1 - #24	36.1120	0.21		
AAY	18/10/2010	12:01	40.2556	-24.0887	36.1812	20.0247	0.1087	Crate 4 - #73	36.1934	0.18	0.015	
	18/10/2010	12:04										
	18/10/2010	13:20										transmissometer dubious underway sampling stopped transmissometer s/n CST1132PR removed and replaced with CST1131PR underway sampling resumed
	18/10/2010	13:50										
AAZ	18/10/2010	14:00										
	18/10/2010	16:07	40.0009	-24.2905	36.1848	20.0648	0.1284	Crate 4 - #74	36.2015	0.21		
ABA	18/10/2010	20:06	39.4312	-24.7461	36.1575	19.8462	0.1310	Crate 4 - #75	36.1749	0.18		
ABB	19/10/2010	04:10	38.2871	-25.6489	36.1754	20.1142	0.1295	Crate 4 - #76	36.1883	0.24		
ABC	19/10/2010	07:58	38.1626	-25.7428	36.0981	20.0016	0.1306	Crate 4 - #77	36.1059	0.25	0.051	
	19/10/2010	08:49										
	19/10/2010	21:22										
	20/10/2010	08:25										
	20/10/2010	10:27										
	20/10/2010	11:35										raw water stopped to transmissometer transmissometer s/n CST1131PR removed and replaced with CST1132PR. Sampling

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Sample ID	Date	Time (GMT)	Latitude	Longitude	TSG sal.	SST - hull sensor	Fluor	Salinity		Chl-a (ug/l)		Comments
			(+ve N)	(+ve E)	(PSU)	(deg. C)	(volts)	Sample btl	(PSU)	mean	stdev	
												resumed
ABD	20/10/2010	20:55	34.7420	-29.1593	36.3173	22.0413	0.1177	Crate 4 - #78	36.3451	0.14		rubber tubing connecting air pressure transducer to outside world had fallen off the transducer at some point since installation in Soton. Reconnected at this time.
ABE	21/10/2010	05:00	34.2309	-29.7479	36.8074	23.4468	0.1103	Crate 4 - #79	36.8099	0.13		
	21/10/2010	09:40										
ABF	21/10/2010	13:24	33.8683	-30.1703	36.9412	23.5570	0.1039	Crate 4 - #80	36.9445	0.12	0.015	
ABG	21/10/2010	17:54	33.6638	-30.4048	36.9725	23.4957	0.1108	Crate 4 - #81	36.9797	0.11		
ABH	21/10/2010	21:02	33.3171	-30.7905	36.9629	23.4728	0.1073	Crate 4 - #82	36.9729	0.10		
ABI	22/10/2010	05:01	32.4536	-31.7643	37.1426	24.2263	0.1049	Crate 4 - #83	37.1487	0.00		
ABJ	22/10/2010	09:16	32.2516	-31.9981	37.2070	24.4366	0.1058	Crate 4 - #84	37.2180	0.09		
	22/10/2010	10:16										
ABK	22/10/2010	13:23	31.7882	-32.5046	37.2239	24.4897	0.1005	Crate 4 - #85	37.2348	0.05		Logging stopped for 2 minute to reboot PC
ABL	22/10/2010	17:04	31.6325	-32.6758	37.0824	24.2682	0.1026	Crate 4 - #86	37.0902	0.08		
ABM	22/10/2010	21:02	31.1984	-33.1653	37.0694	24.5719	0.1042	Crate 4 - #87	37.0687	0.07		
ABN	23/10/2010	05:00	30.3047	-34.1620	37.4516	25.3335	0.1022	Crate 4 - #88	37.4038	0.08		
ABO	23/10/2010	09:02	30.1636	-34.3280	37.3363	25.2691	0.1043	Crate 4 - #89	37.3430	0.01		
ABP	23/10/2010	12:57	29.7105	-34.7981	37.2294	25.2630	0.0981	Crate 4 - #90	37.1684	0.06		
ABQ	23/10/2010	17:00	29.5096	-35.0173	37.2744	25.4246	0.1001	Crate 4 - #91	37.2831	0.09		
ABR	23/10/2010	21:01	29.0494	-35.5187	37.3405	25.3925	0.1018	Crate 4 - #92	37.3453	0.06		
ABS	24/10/2010	05:00	28.1365	-36.4977	37.3928	25.7836	0.1027	Crate 4 - #93	37.4055	0.09		
ABT	24/10/2010	09:06	27.9735	-36.6544	37.6627	26.2197	0.1085	Crate 4 - #94	37.6651	0.10		

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Sample ID	Date	Time (GMT)	Latitude	Longitude	TSG sal.	SST - hull sensor	Fluor	Salinity		Chl-a (ug/l)		Comments
			(+ve N)	(+ve E)	(PSU)	(deg. C)	(volts)	Sample btl	(PSU)	mean	stdev	
ABU	24/10/2010	12:57	27.5542	-37.1344	37.6039	26.2981	0.1082	Crate 4 - #95	37.6173	0.13	0.010	
ABV	24/10/2010	17:10	27.3698	-37.3208	37.6392	26.2349	0.1078	Crate 4 - #96	37.6822	0.07		
ABW	24/10/2010	20:56	26.9423	-37.7764	37.6056	26.3504	0.1096	Crate 7 - #25	37.6452	0.09		
ABX	25/10/2010	04:50	26.0246	-38.7437	37.5934	26.4793	0.1068	Crate 7 - #26	37.5990	0.08		
ABY	25/10/2010	08:58	25.8264	-38.9544	37.5872	26.5184	0.1098	Crate 7 - #27	37.5985	0.13		
ABZ	25/10/2010	13:08	25.3497	-39.4525	37.6821	26.6022	0.1185	Crate 7 - #28	37.6826	0.14	0.015	
ACA	25/10/2010	17:29	25.0828	-39.7350	37.4625	26.4558	0.1148	Crate 7 - #29	37.4318	0.14		
ACB	25/10/2010	21:16	24.6484	-40.1864	37.4586	26.6219	0.1107	Crate 7 - #30	37.3733	0.15		
ACC	26/10/2010	04:52	23.7755	-41.0912	37.2505	26.7910	0.1055	Crate 7 - #31	37.0956	0.08		
ACD	26/10/2010	08:56	23.6126	-40.9940	37.1542	26.8729	0.1076	Crate 7 - #32	37.1163	0.11		
	26/10/2010	09:30										
	26/10/2010	12:23										
ACE	26/10/2010	13:03	23.0708	-40.6006	37.5868	26.6148	0.1169	Crate 7 - #33	37.6197	0.12	0.052	+1 hPa jump in atmospheric pressure Barometer on bridge shows 1012.8 hPa; Surfmet shows 1005.8 hPa
ACF	26/10/2010	17:06	22.8264	-40.4274	37.6556	26.6616	0.1158	Crate 7 - #34	37.5756	0.07		
ACG	26/10/2010	20:56	22.3140	-40.0646	37.5702	26.7588	0.1110	Crate 7 - #35	37.5632	0.07		
ACH	27/10/2010	04:54	21.2445	-39.3109	37.3962	27.2776	0.1031	Crate 7 - #36	37.3731	0.12		
ACI	27/10/2010	09:07	21.0540	-39.1768	37.3091	27.2592	0.1081	Crate 7 - #37	37.3076	0.20		
ACJ	27/10/2010	13:00	20.5524	-38.8209	37.1284	27.4516	0.0973	Crate 7 - #38	37.1444	0.10		
ACK	27/10/2010	17:14	20.2866	-38.6388	37.1347	27.5632	0.0988	Crate 7 - #39	37.1420	0.13		
ACL	27/10/2010	21:02	19.7825	-38.2888	37.0027	27.3509	0.1017	Crate 7 - #40	37.0136	0.10		
ACM	28/10/2010	04:54	18.7285	-37.5541	37.2609	27.1907	0.1011	Crate 7 -	37.2505	0.04		

AMT20 Cruise Report

Sample ID	Date	Time (GMT)	Latitude	Longitude	TSG sal.	SST - hull sensor	Fluor	Salinity		Chl-a (ug/l)		Comments
			(+ve N)	(+ve E)	(PSU)	(deg. C)	(volts)	Sample btl	(PSU)	mean	stdev	
								#41				
ACN	28/10/2010	09:28	18.4832	-37.3871	37.0814	27.2793	0.1044	Crate 7 -	37.0822	0.12		
ACO	28/10/2010	13:01	18.0242	-37.0662	37.0138	27.3674	0.0973	#42 Crate 7 -	37.0137	0.13	0.006	
ACP	28/10/2010	17:37	17.7072	-36.8492	36.8728	27.6492	0.1033	#43 Crate 7 -	36.8537	0.15		
ACQ	28/10/2010	20:56	17.2723	-36.5506	37.0186	27.3642	0.1063	#44 Crate 7 -	37.0391	0.16		
ACR	29/10/2010	04:54	16.2312	-35.8363	36.9587	27.4019	0.1114	#45 Crate 7 -	36.9590	0.18		
ACS	29/10/2010	08:55	16.0573	-35.7210	36.9210	27.3916	0.1061	#46 Crate 7 -	36.9088	0.15		
ACT	29/10/2010	17:01	15.2976	-35.2032	36.5409	28.0918	0.1041	#47 Crate 7 -	36.5572	0.17		
ACU	29/10/2010	21:08	14.6843	-34.7855	36.4967	28.1565	0.1128	#48 Crate 5 -	36.5163	0.12		
ACV	30/10/2010	04:59	13.4944	-33.9762	36.1309	28.1180	0.1097	#98 Crate 5 -	36.1151	0.18		
ACW	30/10/2010	09:03	13.2803	-33.8376	36.1798	28.1947	0.1130	#99 Crate 5 -	36.1865	0.27		
ACX	30/10/2010	12:55	12.6914	-33.4310	36.0257	28.3279	0.1103	#100 Crate 5 -	36.0272	x		
ACY	30/10/2010	17:26	12.3547	-33.2041	35.9029	28.4707	0.1201	#101 Crate 5 -	35.9156	0.29		
ACZ	30/10/2010	20:58	11.8011	-32.8361	35.9836	28.4221	0.1134	#102 Crate 5 -	35.9874	0.24		
ADA	31/10/2010	04:58	10.5990	-32.0245	35.8429	28.4419	0.1108	#103 Crate 5 -	35.8628	0.24		
ADB	31/10/2010	09:16	10.4645	-31.9294	35.8389	28.4528	0.1146	#104 Crate 5 -	35.8442	x		
ADC	31/10/2010	13:08	9.8567	-31.5317	35.3899	28.8642	0.1130	#106 Crate 5 -	35.3993	x		
ADD	01/11/2010	04:58	7.8488	-30.1892	34.6052	29.2274	0.1095	#107 Crate 5 -	34.6425	0.19		
ADE	01/11/2010	09:00	7.5847	-30.0146	34.5549	29.1504	0.1123	#108 Crate 5 -	34.5794	x		
ADF	01/11/2010	13:09	6.9109	-29.5641	34.0303	29.6087	0.1020	#109 Crate 5 -	34.0382	x		
ADG	01/11/2010	17:00	6.6490	-29.3904	34.1300	29.6650	0.1049	#110 Crate 5 -	34.1217	0.12		

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Sample ID	Date	Time (GMT)	Latitude	Longitude	TSG sal.	SST - hull sensor	Fluor	Salinity		Chl-a (ug/l)		Comments
			(+ve N)	(+ve E)	(PSU)	(deg. C)	(volts)	Sample btl	(PSU)	mean	stdev	
								#111				
ADH	01/11/2010	21:03	5.9688	-28.9403	35.4373	29.3299	0.1131	Crate 5 - #112	35.4432	0.27		
ADI	02/11/2010	03:58	4.8519	-28.2014	35.0557	29.1234	0.1119	Crate 5 - #113	35.0731	0.16		
ADJ	02/11/2010	08:17	4.6083	-28.0365	35.0786	28.9238	0.1163	Crate 5 - #114	35.0487	x		
	02/11/2010	04:00-12:00										heavy rain appears to have got into the screen for the air temperature and humidity probe and data between these times should be considered suspect technicians at the met platform checking on instruments. Spikes in temperature, humidity and pressure data.
	02/11/2010	13:20-13:35										
ADK	02/11/2010	16:12	3.7573	-27.4772	35.0412	29.1795	0.1075	Crate 5 - #115	35.0293	x		
ADL	02/11/2010	20:10	3.1788	-27.0832	34.8840	29.0307	0.1188	Crate 5 - #116	34.8925	0.27		
ADM	03/11/2010	03:54	2.0398	-26.3447	35.8526	27.7299	0.1096	Crate 5 - #117	35.8558	0.17		
ADN	03/11/2010	12:31	1.1360	-25.7498	35.9576	27.5429	0.1317	Crate 4 - #73	35.9657	0.22		
ADO	03/11/2010	18:50	0.4163	-25.2758	36.0947	27.7679	0.1168	Crate 4 - #74	36.1006	0.17		
ADP	04/11/2010	04:00	-1.1217	-25.0050	36.0436	27.5210	0.1089	Crate 4 - #75	36.0452	0.13		
ADQ	04/11/2010	08:02	-1.2630	-25.0012	36.0481	27.5036	0.1107	Crate 4 - #76	36.0546	0.07		
ADR	04/11/2010	12:03	-1.3407	-24.9926	36.0622	27.6934	0.1018	Crate 4 - #77	36.0651	0.16		
ADS	04/11/2010	16:13	-1.6043	-25.0090	36.0891	27.9481	0.1053	Crate 4 - #78	36.0923	0.14		
ADT	04/11/2010	19:56	-2.3028	-25.0111	36.0984	27.6823	0.1068	Crate 4 - #79	36.1110	0.07		
ADU	05/11/2010	03:55	-3.7884	-25.0203	36.2810	27.2274	0.1079	Crate 4 - #80	36.2914	0.10		
ADV	05/11/2010	07:56	-3.9629	-25.0133	36.3583	27.0823	0.1095	Crate 4 - #81	36.3667	x		
ADW	05/11/2010	12:26	-4.8031	-25.0321	36.3215	26.9203	0.1076	Crate 4 - #82	36.3201	x		

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Sample ID	Date	Time (GMT)	Latitude	Longitude	TSG sal.	SST - hull sensor	Fluor	Salinity		Chl-a (ug/l)		Comments
			(+ve N)	(+ve E)	(PSU)	(deg. C)	(volts)	Sample btl	(PSU)	mean	stdev	
ADX	05/11/2010	16:07	-5.0252	-25.0274	36.3235	27.0321	0.1102	Crate 4 - #83	36.3257	0.08		
ADY	05/11/2010	19:54	-5.6747	-25.0297	36.2743	26.2894	0.1126	Crate 4 - #84	36.2666	0.13		
ADZ	06/11/2010	04:00	-6.0483	-23.8035	36.3131	26.0548	0.1177	Crate 4 - #85	36.3208	0.10		
AEA	06/11/2010	11:59	-6.2334	-22.8713	36.3066	26.0127	0.1116	Crate 4 - #86	36.3108	0.15		
AEB	06/11/2010	16:00	-6.3317	-22.3735	36.3086	26.3811	0.1103	Crate 4 - #87	36.3208	0.13		
AEC	06/11/2010	19:58	-6.4600	-21.7265	36.2459	26.5693	0.1196	Crate 4 - #88	36.2498	0.13		
AED	07/11/2010	07:55	-6.8607	-19.6999	36.3898	26.1253	0.1232	Crate 4 - #89	36.4000	0.11		
AEE	07/11/2010	12:26	-7.0132	-18.9247	36.3484	26.0104	0.1188	Crate 4 - #90	36.3503	0.16		
AEF	07/11/2010	16:06	-7.1407	-18.2916	36.3076	25.7203	0.1208	Crate 4 - #91	36.3101	0.13		
AEG	07/11/2010	18:37	-7.2265	-17.8625	36.3268	25.9445	0.1298	Crate 4 - #92	36.3401	0.18		
AEH	08/11/2010	06:45	-7.6255	-15.8221	36.1326	24.9887	0.1555	Crate 4 - #93	36.1377	x		
	08/11/2010	07:30										Underway sampling stopped prior to entering within 200nm of Ascension Island
	08/11/2010	09:28										SPAR sn 28560 and PPAR sn 28561 fitted and logging
	08/11/2010	11:02										SPAR sn 28562 and PPAR sn 28560 fitted and logging
	08/11/2010	13:37										MilliQ pumped through fluorometer and transmissometer until 13:42 to obtain blank values pre-cleaning
	08/11/2010	13:50										transmissometer and fluorometer cleaned
	08/11/2010	13:54										transmissometer run with air in the tube - steady state value not obtained due to moisture in the tube
	08/11/2010	14:05										outlet tubing from fluorometer blacked out with tape
	08/11/2010	14:22										transmissometer blacked out for Vdark measurement
	08/11/2010	14:29										transmissometer run with air in the tube

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Sample ID	Date	Time (GMT)	Latitude	Longitude	TSG sal.	SST - hull sensor	Fluor	Salinity		Chl-a (ug/l)		Comments
			(+ve N)	(+ve E)	(PSU)	(deg. C)	(volts)	Sample btl	(PSU)	mean	stdev	
	08/11/2010	14:51										MilliQ pumped through fluorometer and transmissometer to obtain blank values post cleaning
AEI	08/11/2010	16:00										SPAR sn 28562 and PPAR sn 28561 fitted and logging SPAR s/n 28562 removed and s/n 28560 installed in its place
AEJ	09/11/2010	12:00	-10.6103	-17.1142	36.5257	24.1425	0.0927	Crate 4 - #94	36.5467	0.15		
AEK	09/11/2010	16:38	-10.9610	-17.4618	36.6125	24.1630	0.0991	Crate 4 - #95	36.6122	0.13		
AEL	09/11/2010	20:40	-11.5080	-18.0056	36.6490	24.3809	0.1008	Crate 4 - #96	36.6505	0.13		
	10/11/2010	03:57	-12.4786	-18.9757	36.6542	24.1500	0.0955	Crate 5 - #98	36.6646	0.06		
AEM	10/11/2010	11:05										
AEN	10/11/2010	11:57	-13.3410	-19.8397	36.7083	24.3943	0.0915	Crate 5 - #99	36.7235	0.09		
AEO	10/11/2010	15:55	-13.6704	-20.1764	36.8281	24.2620	0.0913	Crate 5 - #100	36.8292	0.09		
AEP	10/11/2010	20:08	-14.2571	-20.7629	36.9759	23.9985	0.0966	Crate 5 - #101	36.9841	0.09		
AEQ	11/11/2010	03:58	-15.2959	-21.8110	37.0723	23.9411	0.0934	Crate 5 - #102	37.0724	0.06		
AER	11/11/2010	08:08	-15.6601	-22.1776	37.0980	23.8058	0.0946	Crate 5 - #103	37.1040	0.07		
AES	11/11/2010	11:57	-16.1819	-22.7027	37.1347	24.0127	0.0890	Crate 5 - #104	37.1427	0.06		
AET	11/11/2010	15:54	-16.5491	-23.0815	37.1092	24.0514	0.0874	Crate 5 - #105	37.1159	0.05		
AEU	11/11/2010	19:50	-17.0848	-23.6320	37.1769	24.3792	0.0925	Crate 5 - #106	37.1796	0.05		
AEV	12/11/2010	08:01	-18.5312	-25.1055	37.1401	24.2837	0.0935	Crate 5 - #107	37.1406	0.07		
AEW	12/11/2010	12:08	-18.5370	-25.1296	37.1434	24.3384	0.0904	Crate 5 - #108	37.1483	x		
AEX	12/11/2010	20:02	-18.8597	-25.1010	37.1128	24.4530	0.0909	Crate 5 - #109	37.1226	0.04		
AEY	13/11/2010	04:00	-20.3325	-25.0994	37.0578	24.3078	0.0925	Crate 5 - #110	37.0628	0.05		
	13/11/2010	08:04	-20.8346	-25.0988	37.0628	24.3162	0.0947	Crate 5 -	37.0695	x		

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Sample ID	Date	Time (GMT)	Latitude	Longitude	TSG sal.	SST - hull sensor	Fluor	Salinity		Chl-a (ug/l)		Comments
			(+ve N)	(+ve E)	(PSU)	(deg. C)	(volts)	Sample btl	(PSU)	mean	stdev	
AEZ	13/11/2010	16:47	-22.1358	-25.2067	36.9729	24.3567	0.0969	#111 Crate 5 -	36.9702	0.07		
AFA	13/11/2010	19:59	-22.6168	-25.5851	36.9049	24.5539	0.0976	#112 Crate 5 -	36.8924	0.08		
AFB	14/11/2010	03:57	-23.7900	-26.5172	36.7730	24.5936	0.0937	#113 Crate 5 -	36.7527	0.07		
AFC	14/11/2010	07:55	-24.1205	-26.7824	36.6655	24.0143	0.0986	#114 Crate 5 -	36.6682	0.11		
AFD	14/11/2010	11:57	-24.6814	-27.2521	36.4387	23.5581	0.0911	#115 Crate 5 -	36.4514	0.09		
AFE	14/11/2010	18:07	-25.3528	-27.7955	36.5812	22.9718	0.0986	#116 Crate 5 -	36.5882	0.12		
AFF	15/11/2010	04:53	-26.8098	-29.0320	36.4775	22.4410	0.1007	#117 Crate 4 -	36.4828	0.13		
AFG	15/11/2010	08:54	-27.1720	-29.3479	36.2955	21.9214	0.0996	#73 Crate 4 -	36.2960	0.12		
AFH	15/11/2010	13:06	-27.7949	-29.8845	36.1383	21.7517	0.0999	#74 Crate 4 -	36.1719	0.14		
AFI	15/11/2010	20:51	-28.6868	-30.6615	35.8634	20.1815	0.0970	#75 Crate 4 -	35.8598	0.08		
AFJ	16/11/2010	04:57	-29.8996	-31.7892	35.9808	20.0155	0.1009	#76 Crate 4 -	35.9805	0.11		
AFK	16/11/2010	08:57	-30.2718	-32.1351	36.0308	20.0859	0.1029	#77 Crate 4 -	36.0385	0.13		
AFL	16/11/2010	13:08	-30.8781	-32.7012	36.0267	19.8690	0.0915	#78 Crate 4 -	36.0265	0.11		
AFM	16/11/2010	16:57	-31.2538	-33.0753	35.8038	19.1784	0.0961	#79 Crate 4 -	35.8054	0.08		
AFN	16/11/2010	20:45	-31.7869	-33.5814	35.7091	18.3708	0.1002	#80 Crate 4 -	35.7131	0.09		
AFO	17/11/2010	04:55	-32.9975	-34.7930	35.8283	18.6706	0.1028	#81 Crate 4 -	35.8234	0.13		
AFP	17/11/2010	08:52	-33.3620	-35.1649	35.8626	18.7302	0.0997	#82 Crate 4 -	35.8665	x		
AFQ	17/11/2010	12:54	-33.9503	-35.7716	35.8233	18.1658	0.1008	#83 Crate 4 -	35.8352	0.09		
AFR	17/11/2010	17:21	-34.4092	-36.2566	35.6544	17.5392	0.0990	#84 Crate 4 -	35.6578	0.10		
AFS	17/11/2010	21:06	-34.9532	-36.8398	35.6593	17.1927	0.1157	#85 Crate 4 -	35.6617	0.13		

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Sample ID	Date	Time (GMT)	Latitude	Longitude	TSG sal.	SST - hull sensor	Fluor	Salinity		Chl-a (ug/l)		Comments
			(+ve N)	(+ve E)	(PSU)	(deg. C)	(volts)	Sample btl	(PSU)	mean	stdev	
AFT	18/11/2010	05:01	-36.0500	-38.0482	35.6179	16.2911	0.1759	#86 Crate 4 - #87	35.6277	0.31		
AFU	18/11/2010	08:58	-36.3996	-38.4434	35.7317	16.4076	0.1568	Crate 4 - #88	35.7427	0.36		
AFV	18/11/2010	12:58	-36.9548	-39.0757	35.7190	16.4538	0.1159	Crate 4 - #89	35.7352	0.26		
AFW	18/11/2010	20:52	-37.8031	-40.0744	35.6498	15.9079	0.4075	Crate 4 - #90	35.6542	1.05		
AFX	19/11/2010	05:03	-38.9029	-41.4284	35.7029	15.8790	0.3474	Crate 4 - #91	35.7444	0.83		
AFY	19/11/2010	09:06	-39.1841	-41.7920	35.7128	15.7291	0.3853	Crate 4 - #92	35.7281	1.09		
AFZ	19/11/2010	13:17	-39.7077	-42.4452	35.6454	15.5065	0.3432	Crate 4 - #93	35.6460	1.62		
AGA	19/11/2010	17:07	-40.0334	-42.8794	35.6556	15.5816	0.3293	Crate 4 - #94	35.6587	1.30		
AGB	19/11/2010	20:53	-40.4949	-43.4927	35.1024	14.8175	0.4931	Crate 4 - #95	35.0804	0.78		
AGC	20/11/2010	06:03	-41.6069	-45.0288	34.7664	12.8257	0.8569	Crate 4 - #96	34.7881	1.10		
AGD	20/11/2010	10:10	-41.9223	-45.4759	34.9714	13.4426	0.6431	Crate 3 - #49	34.9770	0.60		
AGE	20/11/2010	14:00	-42.3847	-46.1482	34.6887	12.2237	0.2152	Crate 3 - #50	34.6935	0.83		
AGF	20/11/2010	18:03	-42.7157	-46.6397	34.6740	12.5927	0.2413	Crate 3 - #51	34.6803	0.67		
AGG	20/11/2010	21:59	-43.1894	-47.3565	34.5896	11.6594	0.3634	Crate 3 - #52	34.5919	0.45	0.03	
AGH	21/11/2010	05:59	-44.1677	-48.8973	34.7399	12.8167	0.8107	Crate 3 - #53	34.8520	1.04		
AGI	21/11/2010	07:00	-44.2003	-48.9407	34.8867	13.0111	0.9207			1.30	0.12	
AGJ	21/11/2010	09:59	-44.4655	-49.3853	34.8895	13.4787	0.2352	Crate 3 - #54	34.8900	0.45	0.01	
AGK	21/11/2010	14:09	-44.9316	-50.1571	34.5553	13.2372	0.1540	Crate 3 - #55	34.5660	0.44		
AGL	21/11/2010	19:07	-45.3256	-50.8341	35.4996	14.3338	0.8524	Crate 3 - #56	35.5073	2.25	0.11	
AGM	21/11/2010	21:54	-45.6316	-51.3556	35.5121	14.2981	0.8787	Crate 3 - #57	35.5234	2.05	0.50	

AMT20 Cruise Report

[illegible]

Appendix 2 : AMT20 cruise track

