# AMT20 Cruise Report


**RRS James Cook JC053**
**(12 October – 25 November 2010)**

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PML | Plymouth Marine Laboratory

Oceans 2025

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

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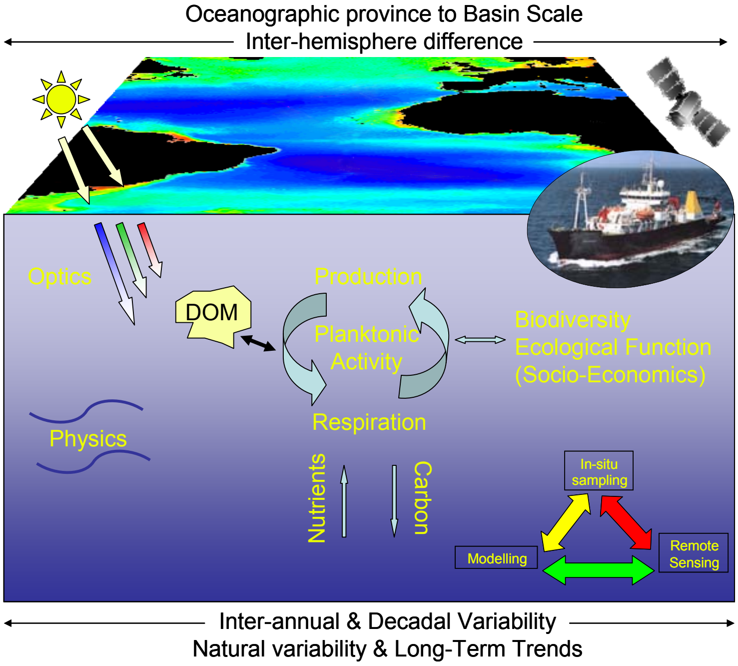
# The Atlantic Meridional Transect programme

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

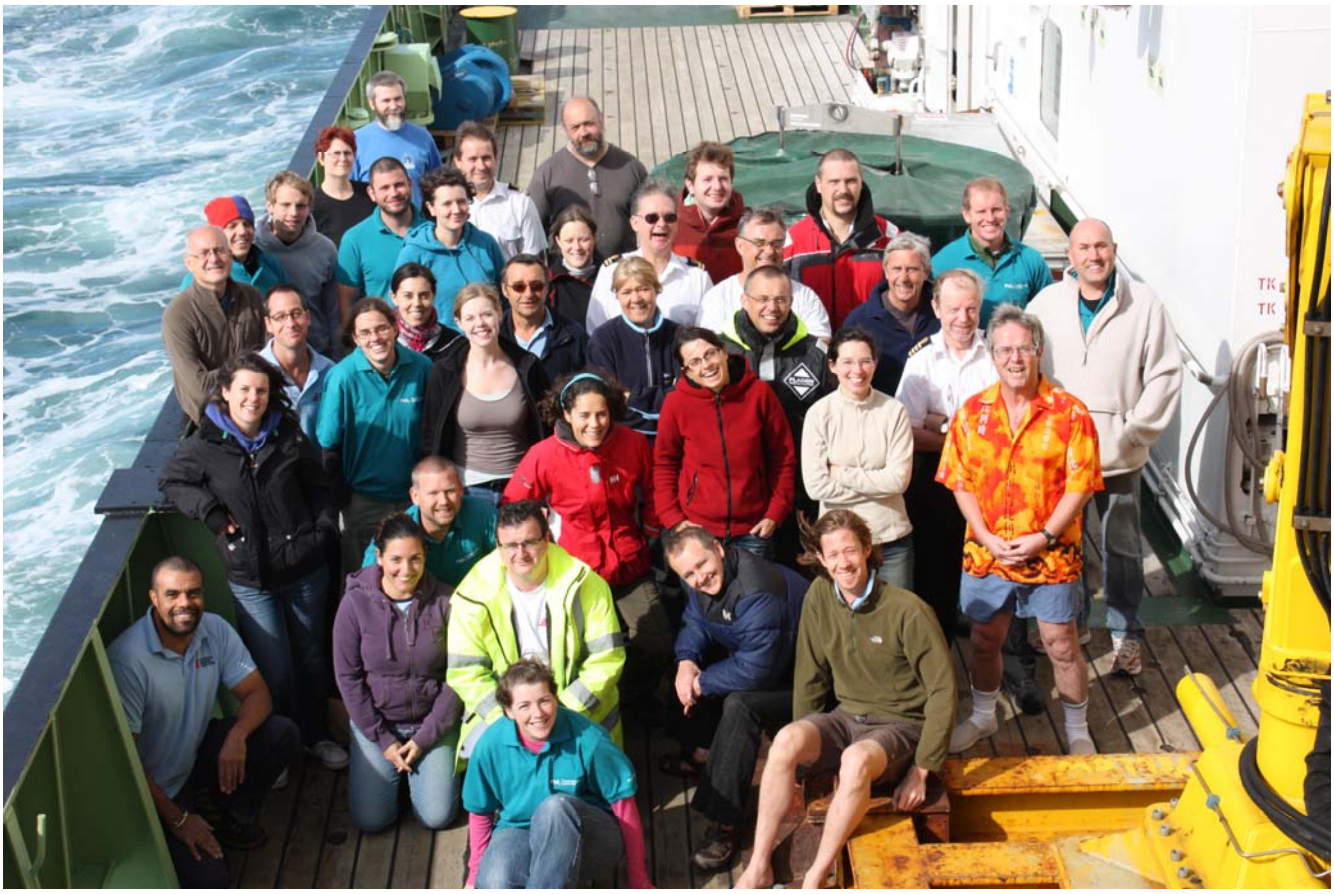



Data sets from 1995-2005 are publicly available, with CTD profiles and underway surface time series available online at: www.bodc.ac.uk/projects/uk/amt/.The remaining AMT data sets are available on request to BODC. The Oceans 2025 data policy has been designed to make the data from 2007 onwards available 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/l 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/l 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/l 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/l 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 Delgarda |
| 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/l 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/l 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 |

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|---|---|---|---|---|---|
| 21/10/2010 | 15:05 | 21/10/2010 | 23:59 | | Scientific processing in transit;  V/l 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/l 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/l 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/l 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/l 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/l to 21 45.8N  039 40.6W |

| | | | | | |
|---|---|---|---|---|---|
| 26/10/2010 | 23:59 | 27/10/2010 | 04:20 | | Scientific processing in transit to Stn 26 |

| 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/l 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/l 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/l 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/l 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/l 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/l 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/l 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/l in transit to 00 25.2S 025 00.3W; {A/c @ 2140 hrs to 180(T); V/l 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/l 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/l 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/l to 05 48.4S 025 01.7W; V/l diversion @ 2042hrs towards Ascension Is for compassionate evac. |
| 05/11/2010 | 20:42 | 05/11/2010 | 23:59 | | Scientific processing in transit; V/l 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/l to 06 35.5S 021 03.3W |
| 06/11/2010 | 23:59 | 07/11/2010 | 12:00 | | Scientific processing in transit; V/l to 06 59.8S 019 00.2W |
| 07/11/2010 | 12:00 | 07/11/2010 | 19:00 | | Scientific processing in transit; V/l 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/l in transit towards Ascension Is; V/l to 07 24.4S 016 57.3W |
| 07/11/2010 | 23:59 | 08/11/2010 | 12:00 | | V/l in transit towards Ascension Is; V/l to 07 47.9S 014 55.8W |
| 08/11/2010 | 12:00 | 08/11/2010 | 15:10 | | V/l in transit towards Ascension Is; V/l 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/l in transit SW towards extremity of Ascension Is EEZ; V/l to 09 01.3S 015 32.4W |
| 08/11/2010 | 23:59 | 09/11/2010 | 10:03 | | V/l in transit to clear Ascension Is EEZ; V/l 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/l 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/l 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/l 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/l to 18 31.82S 025 06.00W |
| 12/11/2010 | 10:13 | 12/11/2010 | 10:52 | | V/l 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 susequent triangulation of mooring; V/l final position 18 33.00S 025 06.00W |
| 12/11/2010 | 18:18 | 12/11/2010 | 23:59 | | Scientific processing in transit; V/l 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/l 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/l 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/l to 28 15.07S 030 17.69W |
| 15/11/2010 | 16:28 | 15/11/2010 | 16:58 | | V/l 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/l 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/l 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/l 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/l 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/l 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/l 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/l 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/l 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/l to  47 22.0S  054 36.2W |
| 22/11/2010 | 12:00 | 22/11/2010 | 19:00 | | Scientific processing in transit;  V/l 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 |

# Scientific personnel

**Andy Rees**
PSO
Plymouth Marine Laboratory

## Plymouth Marine Laboratory

**Chris Galliene**
Optics/zooplankton

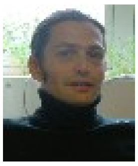
**Rachel Harmer**
Zooplankton/MAAs

**Carolyn Harris**
Nutrients

**Joseph Nissimov**
Virus

**John Stephens**
P:R

**Glen Tarran**
Flow cytometry



**Gavin Tilstone**
Primary Production

## National Oceanography Centre, Southampton

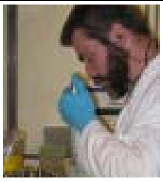
**Dave Aldridge**
Microplankton

**Paola Gomez-Pereira**
Microbial Ecology

**Manuela Hartmann**
Algal mixotrophy

**Ross Holland**
Flow Cytometry

**National Oceanography Centre, Southampton**



**Mike Zubkov**
Microbial activity

**University of Vigo**

**Elena Garcia-Martin**
Microbial respiration

**Bigelow Laboratory for Ocean Sciences**

**Dave Drapeau**
Calcite remote sensing

**Education Through Expeditions**

**Ella Darlington**
Outreach/Education

**Dalhousie University**

**Mike Fraser**
Nitrogen fixation

**University of Oxford**

**Maeve Eason-Hubbard**
Mecahanisms of carbon assimilation

**University of East Anglia**

**Johanna Gloel**
Community production ($O_2$/Ar, $^{17}O/^{16}O$ and $^{18}O/^{16}O$)

**Imke Grefe**
$N_2O$

**Raf Nobili**
Zooplankton metabolism

**Polish Academy of Sciences**

**Piotr Kowalczuk**
CDOM remote sensing

**Monika Zablocka**
CDOM remote sensing

**Academy of Sciences of the Czech Republic**

**Barbora Hoskova**
**POGO Fellow**
Ocean Acidification

**British Oceanographic Data Centre**

**Rob Thomas**
Data management
Instrument calibration

**University of Warwick**

**Carolina Grob**
Picophytoplankton

# Ship's Crew

**Kevin Luckhurst**
CPO(D)

**Philip Alison**
PO(D)

**John Hodgson**
A/B

**John Dale**
A/B

**Darren Caines**
Head Chef

**Pete Robinson**
Steward

**Steve Smith**
CPO

**Steve Day**
A/B

**Steve Gallagher**
A/B

**Duncan Lawes**
ERPO

**Dean Hope**
Chef

**Brian Conteh**
Assistant Steward

# Ship's Officers

**Peter Sarjeant**
**Master**

**Richard Warner**
CO

**Malcolm Graves**
2/O

**Euan Doig**
3/O

**George Parkinson**
C/E

**Chris Kemp**
2/E

**Chris Uttley**
**3/E**

**Viv Wythe**
D/E

**Phil Appleton**
ETO

**Paul Lucas**
Purser

# Scientific Reports:

## Preservation of ceratium for molecular analysis and microplankton grazing experiments

**David Aldridge**
*National Oceanography Centre, Southampton*

### 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 bacteriovory, 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 though 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$^o$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$^o$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 20ºC, 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 0.2µm 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$^o$ from nadir and the sky-viewing radiance sensor was set to view the sky 40$^o$ 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$^o$ 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$^o$ 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 20º 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.

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

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

# Seawater sampling for stable isotope analysis of $N_2O$ and continuous measurements of $N_2O$ concentrations in the surface ocean

**Imke Grefe and Jan Kaiser**
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**Background**

Stable isotopes analysis is a useful tool to trace different pathways of biogeochemical $N_2O$ cycling. The oxygen isotope anomaly $^{17}\Delta$ in $N_2O$ 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 $N_2O$ 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.

$N_2O$ 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 $N_2O$ 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 $HgCl_2$ (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 $N_2O$ 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 $^{15}N$ 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 |

*$N_2O$ underway measurements*

Concentrations of dissolved $N_2O$ in surface waters were measured with a $N_2O$/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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*University of East Anglia*

**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 oligotropic 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:

<u>Zooplankton Sampling</u>: 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.

<u>Food Quality Sampling</u>: 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. <u>Winkler Titration</u>: Dissolved $O_2$ 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 $O_2$ 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 $O_2$ bottles were removed from the incubators, fixed and analysed for $O_2$. The specimen was subsequently fixed in 4% formalin and stored for later size determination.

<u>Planar Optode</u>: Dissolved $O_2$ 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 | 4.800866667 | -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 euphoic zone following the methods described in *Tilstone et al.* (2009). The samples were transferred from Niskin bottles to black carboys to prevent shock to the photosynthetic lamellae of the phytoplankton cells. Water from each sample was sub sampled into three 75 ml clear polycarbonate bottles and three black polycarbonate bottle; all bottles were pre cleaned following JGOFS protocols (IOC, 1994), to reduce trace metal contamination. Each sample was inoculated with between 185 and 740 kBq (5 - 15 µCi) $NaH^{14}CO_3$ according to the biomass of phytoplankton. The polycarbonate bottles were transferred to an on deck (simulated in situ) incubation system using neutral density and blue filters to simulate subsurface irradiance over depth to 97%, 55%, 33%, 20%, 14%, 7%, 3%, 1% or 0.1% of the surface value and incubated from local dawn to dusk (10 – 16 h). The incubators were maintained at surface temperature by pumping sea water from a depth of ~7 m through the upper light level incubators (97, 55, 33 & 14%) and from a chiller maintained at ±3°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 0.2µm, 2µm 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.

**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 µCi) and 370 kBq (15 µCi) of $^{14}C$ labelled bicarbonate. The samples were maintained at *in situ* temperature using the ships non-toxic supply. 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 $\alpha^B$ [mg C (mg chl a)$^{-1}$ h$^{-1}$ (µmol m$^{-2}$ s$^{-1}$)$^{-1}$] was estimated by fitting the data to the model of Platt *et al.* (Platt et al., 1980).

**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, pCO2, 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, pCO2, 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 µm 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, |

| CTD No. | Date | Time In water GMT | Lat | Long | depths (m) | Measurements taken† |
|---|---|---|---|---|---|---|
| | | | | | 118 | OA experiments |
| 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 |

| CTD No. | Date | Time In water GMT | Lat | Long | depths (m) | Measurements taken† |
|---|---|---|---|---|---|---|
| | | | | | 55, 100 | |
| 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 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 300 | |
| **CTD No.** | **Date** | **Time In water GMT** | **Lat** | **Long** | **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 |

**References:**

**Platt, T., Gallegos, C.L. and Harrison, W.**G., 1980. Photoinhibition of photosynthesis in natural assemblage of marine phytoplankton. J Mar Res, 38: 687-701.

**Tilstone, G.H., Figueiras, F.G., Lorenzo, L.M. and Arbones, B**., 2003. Phytoplankton composition, photosynthesis and primary production during different hydrographic conditions at the Northwest Iberian upwelling system. Marine Ecology-Progress Series, 252: 89-104.

**Tilstone, G. H**., et al. 2004. *REVAMP Protocols; Regional Validation of MERIS chlorophyll products in North Sea coastal waters.*, 77 pp., Working meeting on MERIS and AATSR Calibration and Geophysical Validation (MAVT 2003). European Space Agency, ESRIN, Italy, 20-24 Oct 2004.

**Tilstone, G.H., Smyth, T.J., Poulton, A, Hutson R**. 2009. Measured and remotely sensed estimates of primary production in the Atlantic Ocean from 1998 to 2005. Deep-Sea

Research, 56(15), 918-930.

## 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/argonratios measured by membrane inlet mass spectrometry (MIMS) and gross productivity estimates from $^{17}O/^{16}O$ and $^{18}O/^{16}O$ isotoperatios 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 O2supersaturation, posing a challenge to this approach. Craig and Hayward (1987) used oxygen/argon (O2/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. $\Delta$ $O_2$/Ar essentially records the difference between photosynthetic $O_2$ production and respiration. The measured $\Delta$ $O_2$/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 ($\Delta^{17}O$), 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 an 50µm 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.

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.

$O_2$ 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 $O_2$/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 $O_2$ in the pipes as described elsewhere could be detected. MIMS samples from CTD surface sampling were sometimes slightly oversaturated in $O_2$/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 $O_2$/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.

**Craig, H. and Hayward, T**.: Oxygen supersaturation in the ocean: Biological versus physical contributions, Science, 235, 199-202, 1987.

**Kaiser, J., Reuer, M. K., Barnett, B., and Bender, M. L**.: Marine productivity estimates from continuous oxygen/argon ratio measurements by shipboard membrane inlet mass spectrometry, Geophys. Res. Lett., 32, L19605, doi:10.1029/2005GL023459, 2005.

**Luz, B. and Barkan, E**.: Assessment of oceanic productivity with the triple-isotope composition of dissolved oxygen, Science, 288, 2028-2031, 2000.

***Calibration of CTDO$_2$***

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 $O_2$ 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 thiosulpohate solution of about 0.1770 mol/L was used, standardised with a $KIO_3$ 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 $O_2$ 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.

**References**

**Dickson, A. G**.: Determination of dissolved oxygen in seawater by Winkler titration, in WOCEOperations Manual. Volume 3: The Observational Programme. Section 3.1: WOCE HydrographicProgramme. Part 3.1.3: WHP Operations and Methods, edited by World Ocean Circulation Experiment, Woods Hole, Massachussetts, USA, 1996.

# 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 $CO_2$ 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 $CO_2$ 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 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 op 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 at to CTD rosette during solar noon casts. Water samples depths were determined upon features of the vertical profiles of the chlorophyll a fluorescence: at all stations following depths were sampled: 300 m, 200 m, 100 m or Deep Chlorophyll Maximum (which ever 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 µm). The water was then passed through Sartorius 0.2 µm 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 samples volume the capillary waveguide cells were flushed with the small aliquot of the MiliQ water. Then 4-5 ml volume of MiliQ 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 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 than 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 send 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 (R.U., $nm^{-1}$) 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 PARAFC 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 μM C; our results = 42 − 43 μM C and precision characterized by a relative standard deviation (RSD) of 2% (Kowalczuk et al., 2010).

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

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, 20101 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 dicroitic 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 Kowalczuk et al., (2010).

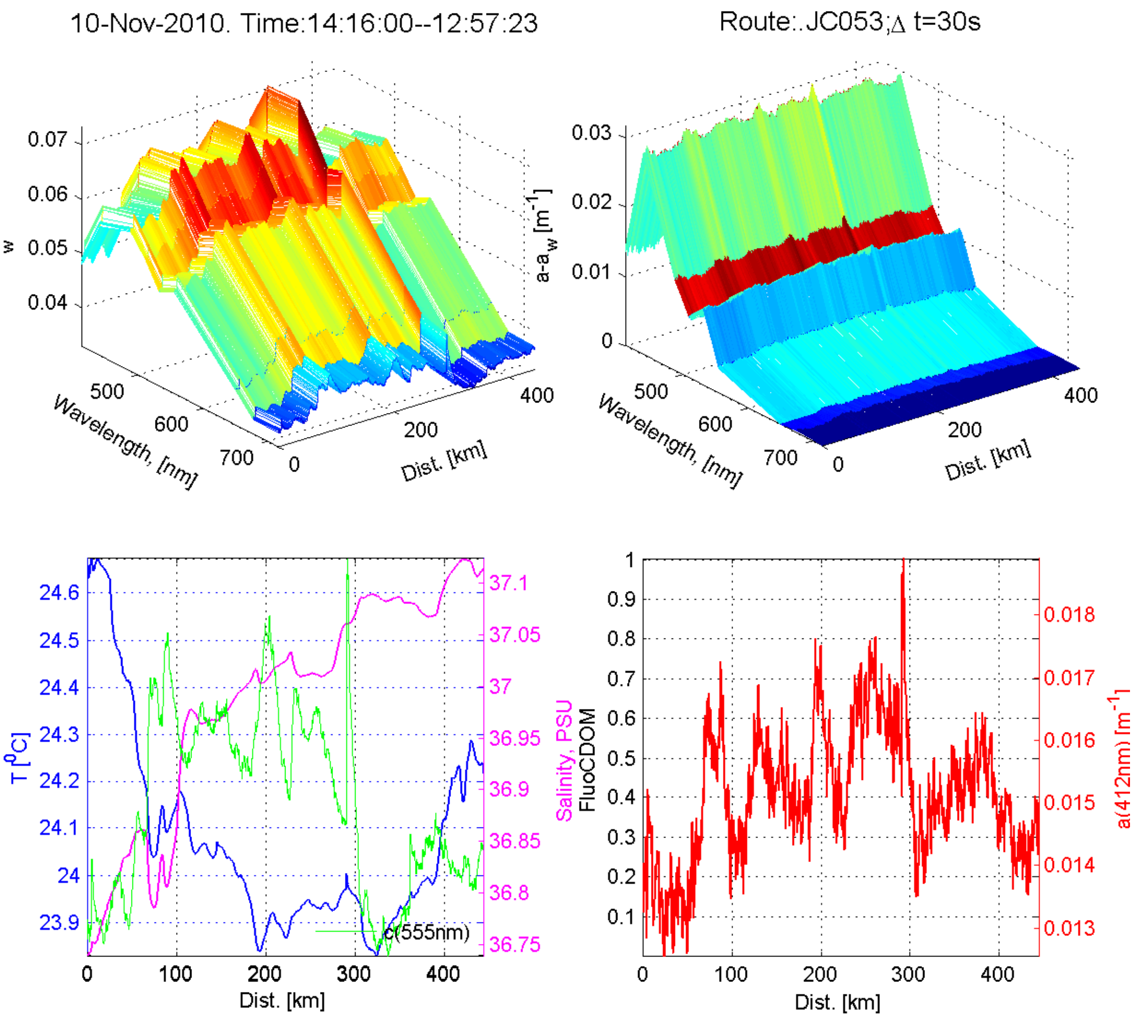


Figure 1. Example of the spectral attenuation, spectral absorption and CDOM fluorescence measurements acquired with the underway deployment of the Integrated Optical-Hydrological probe in the center of the Southern Atlantic oligotrophic gyre. Transect presented on the figure has started on 10 November 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.

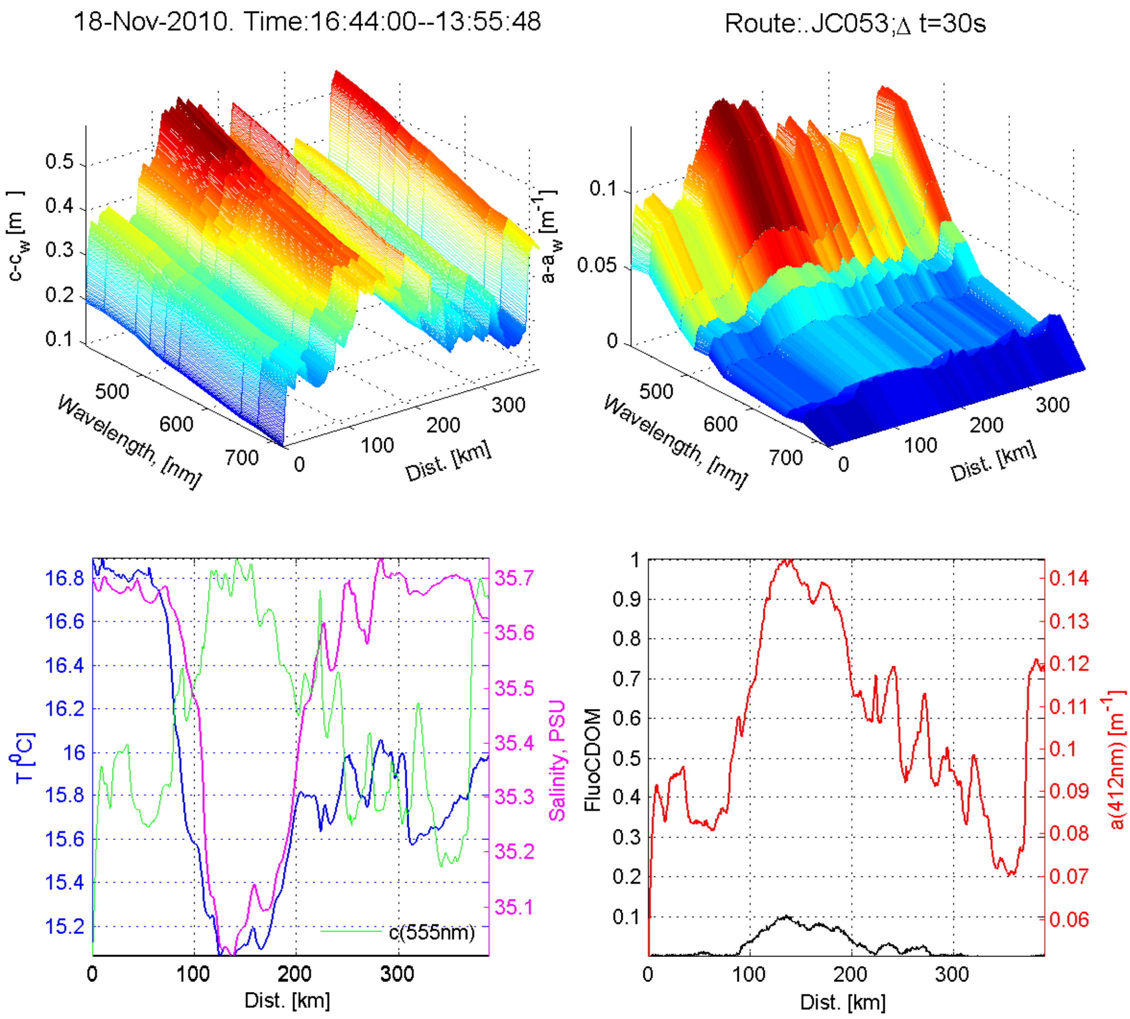


Figure 2. Example of the spectral attenuation, spectral absorption and CDOM fluorescence measurements acquired with the underway deployment of the Integrated Optical-Hydrological probe in the Southern Atlantic. Transect presented on the figure has started on 18 November 2010 at 16:44 GMT, on the station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

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, 20101 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 basisi. 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 intergration time vaired 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).

**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 | FDOM 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 |

| No. | Collection date | Station | CTD | Time in (GMT) | Decima Latitude | Decima Longitude | Depth (m) | aCDOM LWCC | aCDOM PSICAM | FDOM 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 |

| No. | Collection date | Station | CTD | Time in (GMT) | Decima Latitude | Decima Longitude | Depth (m) | aCDOM LWCC | aCDOM PSICAM | FDOM 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 |

| No. | Collection date | Station | CTD | Time in (GMT) | Decima Latitude | Decima Longitude | Depth (m) | aCDOM LWCC | aCDOM PSICAM | FDOM 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 |

| No. | Collection date | Station | CTD | Time in (GMT) | Decima Latitude | Decima Longitude | Depth (m) | aCDOM LWCC | aCDOM PSICAM | FDOM 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 |

| No. | Collection date | Station | CTD | Time in (GMT) | Decima Latitude | Decima Longitude | Depth (m) | aCDOM LWCC | aCDOM PSICAM | FDOM 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 |

| No. | Collection date | Station | CTD | Time in (GMT) | Decima Latitude | Decima Longitude | Depth (m) | aCDOM LWCC | aCDOM PSICAM | FDOM 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 |

| No. | Collection date | Station | CTD | Time in (GMT) | Decima Latitude | Decima Longitude | Depth (m) | aCDOM LWCC | aCDOM PSICAM | FDOM 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 |

| No. | Collection date | Station | CTD | Time in (GMT) | Decima Latitude | Decima Longitude | Depth (m) | aCDOM LWCC | aCDOM PSICAM | FDOM 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 |

**References:**


**Agrawal Y.C., A. Whitmire, O. A. Mikkelsen and H. C. Pottsmith**, 2008. Light scattering by random shaped particles and consequences on measuring suspended sediments by laser diffraction. Journal of Geophysical Research, 113, C04023, doi:10.1029/2007JC004403

**Andersson, C. A., and R. Bro**, 2000. The N-way toolbox for MATLAB. Chemometrics Intelligent Laboratory System 52, 1–4.

**Blough, N.V. and Del Vecchio, R**., 2002. Chromophoric DOM in the coastal environment. In: D. Hansell and C. Carlson (eds.), Biogeochemistry of marine dissolved organic matter. Academic Press, New York, 509-546.

**Coble, P. G**., 1996. Characterization of marine and terrestrial DOM in seawater using excitation–emission matrix spectroscopy. Marine Chemistry 51, 325–346.

**Coble, P. G., C. E. Del Castillo and B. Avril**, 1998. Distribution and optical properties of CDOM in the Arabian Sea during the 1995 Southwest Monsoon. Deep-Sea Research II 45, 2195–2223.

**Del Castillo, C.E., P. G. Coble, J. M. Morell, J. M. Lopez and J. E. Corredor**, 1999. Analysis of the optical properties of the Orinoco River plume by absorption and fluorescence spectroscopy. Marine Chemistry 66, 35–51.

**D'Sa, E. J., R. G. Steward, A. Vodacek, N. V. Blough and D. Phinney**, 1999. Determining optical absorption of colored dissolved organic matter in seawater with a liquid capillary waveguide. Limnology and Oceanography, 44:1142-1148.

**Duursma, E.K.**, 1974. The fluorescence of dissolved organic matter in the sea. In: Jerlov, N.G., Steeman Nielsen, E. (Eds.), Optical Aspects of Oceanography. Academic Press, New York, pp. 237–256.

**Ferrari, G**., 2000. The relationship between chromophoric dissolved organic matter and dissolved organic carbon in the European Atlantic coastal area and in the West Mediterranean Sea (Gulf of Lions). Marine Chemistry 70 (4), 339–357.

**Ferrari, G., and M. Dowell**, 1998. CDOM absorption characteristics with relation to fluorescence and salinity in coastal areas of the southern Baltic Sea. Estuarine Coastal and Shelf Science 47 (1), 91–105.

**Hansell, D. A. and Carlson, C. A**., 1998. Deep-ocean gradients in the concentration of dissolved organic carbon. Nature, 395(6699): 263-266.

**Hansell D.A., Carlson C.A**., 2001, Marine Dissolver Organic Matter and the Carbon Cycle, 2001. Oceanography, 14(4), 41-49.

**Hedges J I**., Why Dissolved Organic Matter? In Hansell and C. Carlson (eds.), Biogeochemistry of marine dissolved organic matter. Academic Press, New York, 1-33.

**Hooker S. B., C. D. Mobley, S. McLean, B. Holben, M. Miller, C. Pietras, K. D. Knobelspiesse, G. S. Fargion J. Porter and K. Voss**, 2003b. Ocean optics protocols for satellite ocean color sensor validation, Revision 4, Volume III: Radiometric measurements and data analysis protocols. Greenbelt, MD: Goddard Space Flight Center. 78 p.

**Jerlov, N.G**., 1976, Marine Optics. Elsevier, New York, 231 pp.

**Kowalczuk P., M. Zabłocka, S. Sagan and K. Kuliński**, 2010. Fluorescence measured in situ as a proxy of CDOM absorption and DOC concentration in the Baltic Sea. Oceanologia, 52 (3), 431–471.

**Miller, R. L., M. Belz, C. Del Castillo, and R. Trzaska**. 2002. Determining CDOM absorption spectra in diverse coastal environments using a multiple pathlength, liquid core waveguide system. Continental Shelf Research, 22:1301-1310.

**Mopper, K., X., Zhou R. J. Kieber, D. J. Kieber, R. J. Sikorski, and R. D. Jones**, 1991. Photochemical degradation of dissolved organic carbon and its impact on the oceanic carbon cycle. Nature, 353, 60-62.

**Mopper, K. and D. J. Kieber,** 2002. Photochemistry and the cycling of carbon, sulfur, nitrogen and phosphorus, In: D. A. Hansell and C.A. Carlson, (eds.), Biogeochemistry of Marine Dissolved Organic Matter, Academic Press, New York, 455-507.

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

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

**Murphy, K. R., G. M. Ruiz, W. T. M. Dunsmuir and T. D. Waite**, 2006. Optimized parameters for fluorescence-based verification of ballast water exchange by ships. Environmental Science and Technology 40 (7), 2357–2362.

**Opsahl, S., and R. Benner,** 1997. Distribution and cycling of terrigenous dissolved organic matter in the ocean. Nature, 386, 480–482.

**Osburn, C.L. and D. P. Morris**, 2003. Photochemistry of chromophoric dissolved organic matter in natural waters. In: Helbling, E.W., Zagarese, H. (Eds.), UV Effects in Aquatic Organisms and Ecosystems, vol. 1. The Royal Society of Chemistry, Cambridge UK, pp. 185–217.

**Rochelle-Newall, E. J., and T. R. Fisher**, 2002. Production of chromophoric dissolved organic matter fluorescence in marine and estuarine environments: an investigation into a role of phytoplankton. Marine Chemistry 77, 7–21.

**Röttgers, R., W. Schönfeld, P. -R. Kipp, and R. Doerffer**. 2005. Practical test of a point-source integrating cavity absorption meter: the performance of different collector assemblies. Applied Optics 44:5549-5560.

**Röttgers, R. and R. Doerffer**, 2007, Measurements of optical absorption by chromophoric dissolved organic matter using a point-source integrating-cavity absorption meter. Limnology and Oceanography: Methods 5, 126–135.

**Siegel, D.A., S. Maritorena, N. B. Nelson, D. A. Hansell and M. Lorenzi-Kayser**, 2002. Global distribution and dynamics of colored dissolved and detrital organic materials. Journal of Geophysical Research 107 (C12), 3228. doi:10.1029/2001JC000965.

**Siegel, D. A., S. Maritorena, N. B. Nelson, M. J. Behrenfeld and C. R. McClain**, 2005. Colored dissolved organic matter and its influence on the satellite-based characterization of the ocean biosphere. Geophysical Research Letters 32, L20605. doi:10.1029/2005GL024310.

**Stedmon, C. A. and S. Markager**, 2005a. Resolving the variability in dissolved organic matter fluorescence in a temperate estuary and its catchment using PARAFAC analysis. Limnology and Oceanography 50, 686–697.

**Stedmon, C. A. and S. Markager**, 2005b. Tracing the production and degradation of autochthonous fractions of dissolved organic matter using fluorescence analysis. Limnology and Oceanography 50, 1415–1426.

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

**Stedmon, C. A., S., Markager L. Tranvik, L. Kronberg, T. Slätis, and W. Martinsen**, 2007. Photochemical production of ammonium and transformation of dissolved organic matter in the Baltic Sea. Marine Chemistry, 104, 227–240.

**Stedmon, C. A. and R. Bro**, 2008. Characterizing dissolved organic matter fluorescence with parallel factor analysis: a tutorial. mnology and Oceanography: Methods 6, 572–579.

**Whitehead, R.F., S. de Mora, S. Demers, M. Gosselin, P. Monfort and B. Mostajir**, 2000. Interactions of ultraviolet-B radiation, mixing, and biological activity on photobleaching of natural chromophoric dissolved organic matter: a mesocosm study. Limnology and Oceanography 45, 278–291.

**Vodacek, A., N. V. Blough, M. D. DeGrandpre, E. T. Peltzer and R. K. Nelson,** 1997. Seasonal variation of CDOM and DOC in the Middle Atlantic Bight: terrestrial inputs and photooxidation. Limnology and Oceanography 42 (2), 674–686.

**Vähätalo, A.V., Zepp, R.G**., 2005. Photochemcial mineralisation of dissolved organic nitrogen to ammonium in the Baltic Sea. Environmental Science and Technology, 39, 6985–6992.

**Zaneveld J. R. V., J. C. Kitchen and C. Moore**, 1994. The scattering error correction of reflecting-tube absorption meters, Ocean Optics XII, Proc. SPIE, 2258, 44–55.

**Zepp, R.G**., 2003. Solar ultraviolet radiation and aquatic biogeochemical cycles. In: Helbling, E.W., Zagarese, H. (Eds.), UV Effects in Aquatic Organisms and Ecosystems, vol. 1. The Royal Society of Chemistry, Cambridge UK, pp. 137–184.

# Measurements of community and bacterial respiration by three techniques: changes in $O_2$ 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 $O_2$ 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 $O_2$ 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 $O_2$ 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 $O_2$ 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 citometry (see Holland, this report).

**Continuous monitoring of in vitro $O_2$ 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

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 |

| 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 |

**References**:

**García-Martín E.E, Serret P, Pérez-Lorenzo M**. Testing potential bias in marine plankton respiration rates by dark bottle incubations in the NW Iberian Shelf: incubation time and bottle volume. *Continental shelf research* (doi:10.1016/j.csr.2010.07.006).

**Martínez Martínez-García S., Fernández E., Aranguren-Gassis M., Teira E**., 2009. In vivo electron transport system activity: a method to estimate respiration in natural marine microbial planktonic communities. *Limnology and Oceanography Methods* 7: 459–469.

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

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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 $^{15}N_2$ 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 discreet 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.

Discreet 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 discreet 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 $^{15}N_2$ 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, longtitude 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 |

| 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 |

**References:**

**Moore, R.M., Punshon, S., Mahaffey, C. and Karl, D**. (2009). The relationship between dissolved hydrogen and nitrogen fixation in ocean waters. *Deep-Sea Research I*. **56**, 1449-1458.

**Wilson, S.T., Foster, R.A., Zehr, J.P. and Karl, D**. (2010). Hydrogen production by Trichodesmium erythraeum, Cyanothece sp. and Crocosphaera watsonii. *Aquatic Microbial Ecology*. **59**, 197-206.

## 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.

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

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.

| **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 $T_0$ 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 $T_0$ 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 $T_0$) 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.

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.

**References:**

**Hylander*, S.,* Boeing, W.J., Granéli, W., Karlsson, J. von Einem, J., Gutseit, K., Hansson, L.,** *2009.* Complementary UV protective compounds in zooplankton. Limnol. Oceanogr., 54(6), 1883–1893

**Hylander, S., Jephson, T.,** 2010. UV protective compounds transferred from a marine dinoflagellate to its copepod predator. J. Exp. Mar. Biol. Ecol. 389, 38-44.

**Naganuma, T., Inoue, T., Uye, S**., 1997. Photoreactivation of UV-induced damage to embryos of a planktonic copepod. J. Plankton Res. 19 (6), 783-787

**Yu, J., Yang, G., Tian, J**., 2009. Effects of UV-B radiation on ingestion, fecundity, population dynamics and antioxidant enzyme activities of *Schmackeria inopinus* (Copepoda Calanoida). J. Exp. Mar. Biol. Ecol. 381,74-81.

# 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 *Emiliania huxleyi* virus- 86 (EhV-86) and *Emiliania 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 *Emiliania 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%.

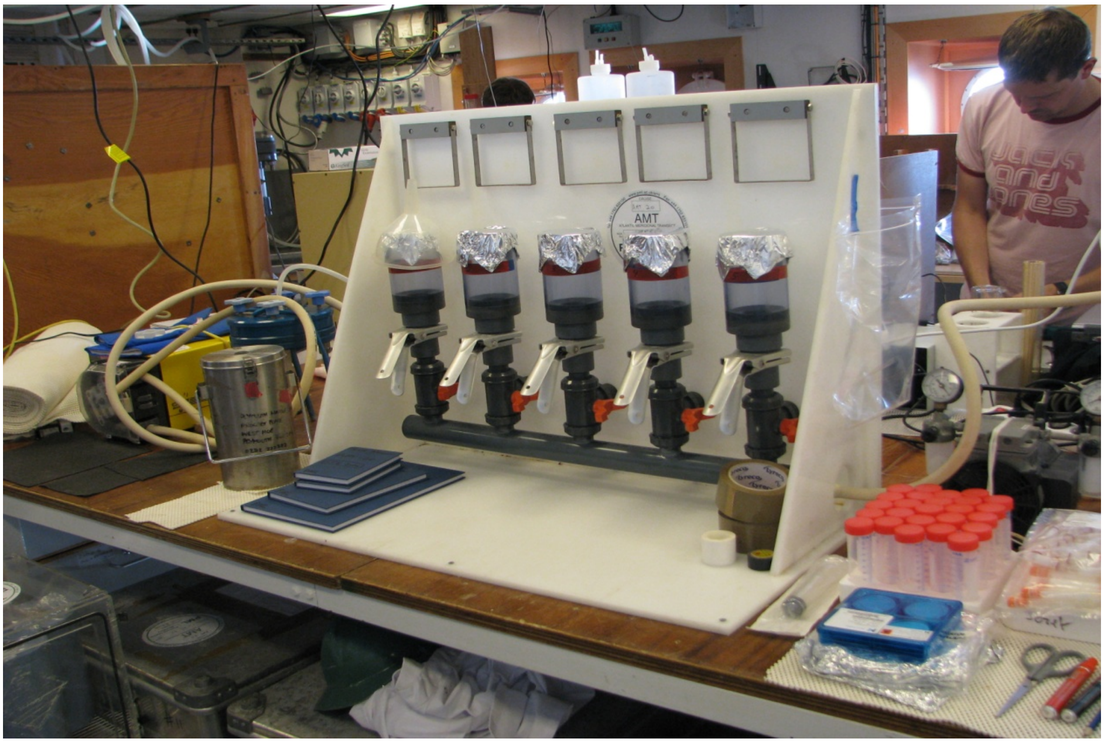


**Fig. 1** The rack used for the filtration of the five depths sampled daily along the AMT-20 transect.

10L of seawater from these depths were filtered via a 0.2 um (47 mm) Millipore nitrocelulose 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 um GF/C filter. All samples were snap- frozen and stored in -80°C for further analysis.

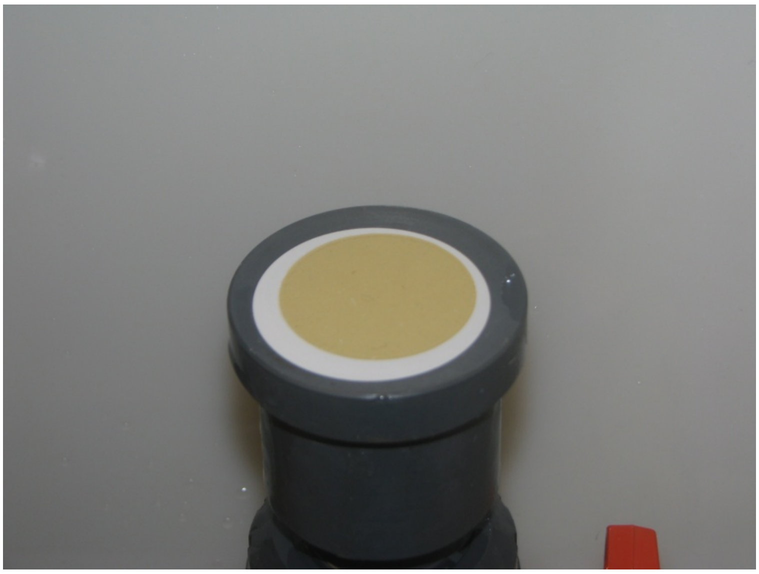

**Fig. 2** Millipore nitrocelulose membrane filter after the filtration of 10 L surface water from a productive area near the Patagonianshelf of southern South America.

A volume of 1 ml of each sampled depth was also stored in 10 ul 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 um 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 um of ~15,000 L of surface seawater was also filtered through a 0.2 um 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.

**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 |

| 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 coccolithopjhore 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 Chanel 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 sphoingolipids 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.

**References:**

**Allen MJ, Schroeder D, Donkin A, Crawfurd K, Wilson, WH** (2006) Genome comparison of two Coccolithoviruses. Virology Journal 3: 15

**Charlson RJ, Lovelock JE, Andreae MO, Warren SG** (1987) Oceanic phytoplankton, atmospheric sulphur, cloud albedo and climate. Nature 326: 655-661

**Falkowski PG, Barber R, Smetacek V** (1998) Biogeochemical controls and feedbacks on ocean primary production. Science 281: 200

**Pagarete A, Allen MJ, Wilson WH, Kimmance SA, De Vargas C** (2009) Host–virus shift of the sphingolipid pathway along an *Emiliania huxleyi* bloom: survival of the fattest. Environmental Microbiology 11: 2840–2848

**Schroeder DC, Oke J, Malin G, Wilson WH** (2002) Coccolithovirus (Phycodnaviridae): Characterisation of a new large dsDNA algal virus that infects Emiliania huxleyi. Archives of Virology 147: 1685 – 1698

**Schroeder DC, Oke J, Hall M, Malin G, Wilson WH** (2003) Virus Succession Observed during an Emiliania huxleyi Bloom. Applied Environmental Microbiology 69: 2484 - 2490

**Wilson WH, Tarran GA, Schroeder DC, Cox M, Oke J, Malin G** (2002) Isolation of viruses responsible for the demise of an Emiliania huxleyi bloom in the English Channel. Journal of the Marine Biological Association of the United Kingdom 82: 369-377

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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 $CO_2$) may affect phytoplankton ecology, and ultimately the global carbon cycle, in the future.

Marine phytoplankton face several challenges in acquiring sufficient $CO_2$ for photosynthesis from the environment. First, the primary enzyme involved in net carbon assimilation, ribulose-1,5-biphoshate carboxylase-oxygenase (Rubisco), has a surprisingly low affinity for its substrate, $CO_2$. Under standard atmospheric conditions, Rubisco functions at less than half of its catalytic capacity in most species. Second, the rate of diffusion of $CO_2$ 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 ($C_i = CO_2$ + HCO3-) levels and pH. This variation affects the availability of $CO_2$ and $HCO_3$- 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 $CO_2$ concentrating mechanism (CCM) that acts to augment supply of $CO_2$ 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, $pCO_2$, 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 $CO_2$ concentration [$CO_2$ (aq)], marine organic $\delta^{13}C$ ($\delta^{13}$Corg), and the activity of CCMs utilised by marine phytoplankton. Marine phytoplankton discriminate strongly against $^{13}C$ during the photosynthetic process. In some cases, the degree of discrimination has been shown to correlate strongly with concentrations of [$CO_2$ (aq)] in surface water, with marine plankton being most depleted in $^{13}C$ 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 $CO_2$ concentrations in ocean surface waters. Factors other than $CO_2$, 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 $pCO_2$, DIC $\delta^{13}C$ and POC $\delta^{13}C$ 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 (midmorning). 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 mm 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 mm 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, 400mmol $L^{-1}$ NaCl, 20mmol $L^{-1}$ 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 25μL 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 (I2-) 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 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 pk2 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 | JCO53_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 |
| 12.1110 | 10.59 | JCO53_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 |

**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 |

**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. & Christian J. R**. (Eds.), 2007. Guide to best practices for ocean CO2 measurements. *PICES Special Publication,* 3:1-191

**Fuller, N.J., Tarran, G.A., Cummings, D.G., Woodward, M.S., Orcutt, K.M., Yallop, M., Le Gall, F. and Scanlan, D.J**. (2006). Molecular analysis of photosynthetic picoeukaryote community structure along an Arabian Sea transect. *Limnology and Oceanography*, **51**(6): 2502-2514.

**Sarazin, G., Michard, G. and Prevot, F**. (1999). A rapid and accurate spectroscopic method for alkalinity measurements in sea water samples. *Water Research*, **33**(1): 290-294.

**Zhang and Byrne**, 1996. Spectrophotometric pH measurements of surface seawater at in-situ conditions: absorbance and protonation behavior of thymol blue. *Marine Chemistry*, 52(1):17-25

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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 FACSort 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 FACSort 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.

**Table 1.1:** CTD casts sampled for phytoplankton, heterotrophic bacteria and heterotrophic flagellate commumity 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 |

| 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$^{o}$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 |

| 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 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 $^{32}$P 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 analsyses 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 (Zwirglmaier 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 | 42º46.02 N | 22º02.08 | - | - | Btl 13, 25 m | Btl 4, 100 m |
| 21/10 | 021-S | 33º50.594 N | 30º12.212 | - | - | Btl 13, 45 m | Btl 3, 165 m |
| 22/10 | 024-S | 31º43.79 N | 32º33.763 | Btl 20 | Btl 4, 90 m | Btl 11, 35 m | Btl 3, 145 m |
| 23/10 | 027-S | 29º36.602 N | 34º54.08 | Btl 20 | Btl 4, 100 m | Btl 10, 45 m | Btl 3, 150 m |
| 24/10 | 030-S | 27º27.094 N | 37º14.000 | - | - | Btl 12, 50 m | Btl 3, 175 m |
| 25/10 | 034-S | 25º16.129 N | 39º31.895 | Btl 20 | Btl 4, 120 m | Btl 12, 60 m | Btl 3, 180 m |
| 26/10 | 037-S | 22º57.814 N | 40º31.920 | Btl 20 | Btl 4, 125 m | Btl 12, 55 m | Btl 3, 190 m |
| 27/10 | 040-S | 20º25.862 N | 38º44.337 | - | - | Btl 13, 50 m | Btl 3, 170 m |
| 28/10 | 043-S | 17º54.766 N | 36º59.033 | Btl 20 | Btl 4, 110 m | Btl 12, 60 m | Btl 3, 180 m |
| 29/10 | 046-S | 15º25.428 N | 35º17.131 | - | - | - | Btl 3, 140 m |
| 30/10 | 049-S | 12º32.726 N | 33º19.731 | Btl 20 | Btl 4, 60 m | Btl 12, 30 m | Btl 3, 115 m |
| 31/10 | 052-S | 09º45.035 N | 31º27.448 | - | - | Btl 13, 30 m | Btl 3, sample compromised |

| Date | CTD | LAT | LON | Surf | DCM | 14% | 0.1% |
|---|---|---|---|---|---|---|---|
| 01/10 | 055-S | 06º47.23 N | 29º29.04 | Btl 20 | Btl 4, 60 m | Btl 13, 25 m | Btl 3, 100 m |
| 02/11 | 058-S | 3º53.139 N | 27º33.892 | - | - | Btl 13, 30 m | Btl 3, 110 m |
| 05/11 | 063-S | 4º53.437 S | 25º1.778 | - | - | Btl 12, 40 m | Btl 3, 150 m |
| 06/11 | 066-S | 6º16.086 S | 22º41.879 | Btl 20 | Btl 4, 95 m | Btl 12, 40 m | Btl 3, 145 m |
| 10/11 | 068-S | 13º28.399 S | 19º57.996 | - | - | Btl 12, 60 m | Btl 3, 210 m |
| 11/11 | 070-S | 16º18.975 S | 22º50.499 | Btl 20 | Btl 4, 145 m | Btl 12, 65 m | leak |
| 12/11 | 071-S | 18º32.2235 S | 25º07.775 | - | - | Btl 13, 60 m | Btl 3, 215 m |
| 13/11 | 073-S | 21º42.336 S | 25º05.818 | Btl 20 | Btl 4, 150 m | Btl 12, 65 m | Btl 2, 225 m |
| 14/11 | 075-S | 24º49.14 S | 27º21.52 | - | - | Btl 12, 55 m | Btl 3, 200 m |
| 15/11 | 077-S | 27º54.952 S | 29º59.174 | Btl 20 (leak) | Btl 4, 105 m | Btl 12, 45 m | Btl 3, 150 m |
| 16/11 | 079-S | 30º59.75 S | 32º48.90 | - | - | Btl 12, 25 m | Btl 3, 100 m |
| 17/11 | 081-S | 34º0.644 S | 35º55.52 | Btl 20 | Btl 5, 70 m | Btl 13, 35 m | Btl 4, 110 m |
| 18/11 | 083-S | 37º05.63 S | 39º13.83 | - | - | Btl 12, 30 m | Btl 3, 100 m |
| 19/11 | 085-S | 39º47.477 S | 42º33.131 | - | - | Btl 13, 35 m | Btl 3, 100 m |
| 20/11 | 087-S | 42º29.855 S | 46º17.772 | - | - | Btl 16, 10 m | Btl 5, 45 m |
| 21/11 | 089-S | 45º00.99 S | 50º17.07 | 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 (~ 21ºC) 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 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 | 49º16.20 N | 12º53.04 | Btl 20 | Btl 10, 30 m |
| 15/10 | 007-S | 48º06.97 N | 17º19.46 | Btl 20 | Btl 5, 50 m |
| 17/10 | 013-S | 42º46.02 N | 22º02.08 | Btl 20 | Btl 12, 40 m |
| 21/10 | 021-S | 33º50.594 N | 30º12.212 | Btl 20 | Btl 4, 110 m |
| 24/10 | 030-S | 27º27.094 N | 37º14.000 | Btl 20 | Btl 4, 118 m |
| 27/10 | 040-S | 20º25.862 N | 38º44.337 | Btl 20 | Btl 4, 115 m |
| 29/10 | 046-S | 15º25.428 N | 35º17.131 | Btl 19 | Btl 4, 90 m |
| 31/10 | 052-S | 09º45.035 N | 31º27.448 | Btl 20 | Btl 5, 50 m |
| 02/11 | 058-S | 3º53.139 N | 27º33.892 | Btl 20 | Btl 4, 68m, |
| 05/11 | 063-S | 4º53.437 S | 25º1.778 | Btl 20 | Btl 4, 98 m |
| 10/11 | 068-S | 13º28.399 S | 19º57.996 | Btl 20 | Btl 4, 135 m |
| 12/11 | 071-S | 18º32.2235 S | 25º07.775 | Btl 20 | Btl 4, 140 m |
| 14/11 | 075-S | 24º49.14 S | 27º21.52 | Btl 19 | Btl 4, 130 m |
| 16/11 | 079-S | 30º59.75 S | 32º48.90 | Btl 21 | Btl 4, 65 m |
| 18/11 | 083-S | 37º05.63 S | 39º13.83 | Btl 20 | Btl 4, 65 m |
| 19/11 | 085-S | 39º47.477 S | 42º33.131 | Btl 20 | Btl 6, 60 m |
| 20/11 | 087-S | 42º29.855 S | 46º17.772 | 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 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 |

| CTD | Date | Time | Latitude | Longitude | Depth | Bottle |
|---|---|---|---|---|---|---|
| 80-S | 17/11/2010 | 04:30 | 33°02.666 S | 34°50.726 W | 20 | 14 |
| 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 Celltrap™ 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 eukarotic 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

**E. Elena García-Martín**
*University of Vigo*

### 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 ºC 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 (Illonois, 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 |

| 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

**Carolyn Harris**
*Plymouth Marine Laboratory*

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 the 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 |

| 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 |

**References**:

**Brewer and Riley**, 1965. The automatic determination of nitrate in seawater. *Deep Sea Research*, 12: 765-772

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

**Kirkwood, D.S**. 1989. Simultaneous determination of selected nutrients in sea-water, *ICES CM* 1989/C:29

**Mantoura, R.F.C. and Woodward, E.M.S**-., 1983. *Estuarine, Coastal and Shelf Science,* 17, 219-224.

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 ($O_2$) in seawater is produced by photosynthesis and consumed by respiration and photochemical reactions in the surface waters. Equilibrium between dissolved $O_2$ in seawater and $O_2$ 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 $O_2$ 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 $O_2$ 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 $O_2$ across diverse marine biomes.
The aim of this work is to quantify gross community production and respiration of $O_2$ in surface waters.

### Methods

Dissolved $O_2$ 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 $O_2$ 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) $O_2$ bottles were removed after the 24 hour incubation and fixed and analysed for $O_2$. Each treatment for each depth ($T_{ZERO}$, Light and Dark) was replicated four times (12 bottles per depth).
Community respiration (CR) was calculated as $O_2$ consumption in the Dark samples (Dark – $T_{ZERO}$).
Net community production was calculated as $O_2$ 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 $O_2$ 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 |

| 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:**

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

**Robinson, C. et a**l., 2002. Plankton respiration in the Eastern Atlantic Ocean. *Deep-Sea Research Part I - Oceanographic Research Papers*, 49(5): 787-813.

**Serret, P., Robinson, C., Fernandez, E., Teira, E. and Tilstone, G**., 2001. Latitudinal variation of the balance between plankton photosynthesis and respiration in the eastern Atlantic Ocean. *Limnology and Oceanography*, 46(7): 1642-1652.

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

**Rob Thomas[1], Ella Darlington[2] and Andy Rees[3]**
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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 Wechmeyer. 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 |

| 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 calibration 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:

Offset = a * Discrete +b

where offset = Discrete – Nominal calibration

to give Calibration = 1/(1-a) * 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.

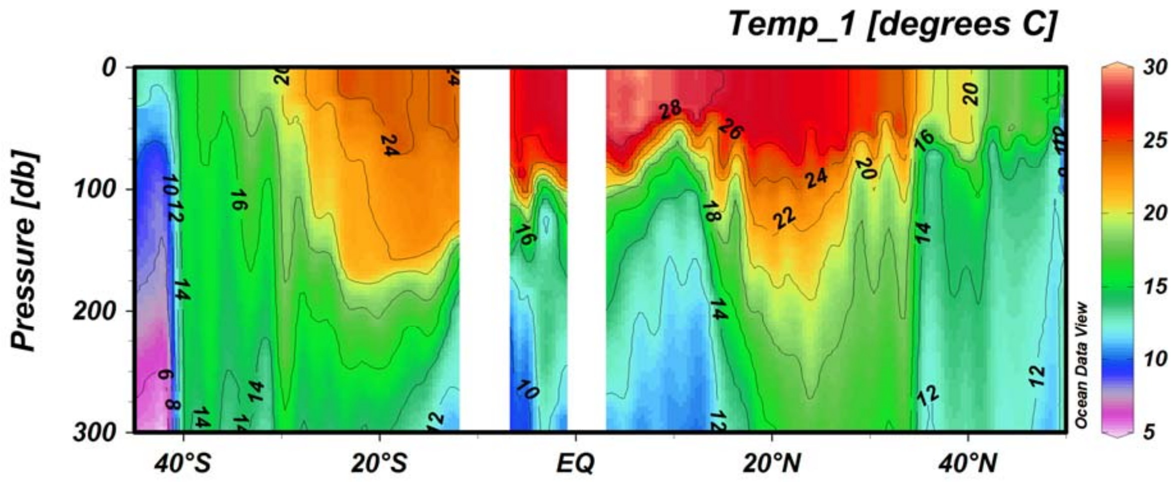


Fig. 1: Section plot of temperature along the AMT20 transect by latitude from the frame mounted sensor on the stainless steel CTD rig. Breaks in the plot where sampling could not be carried out.

***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.

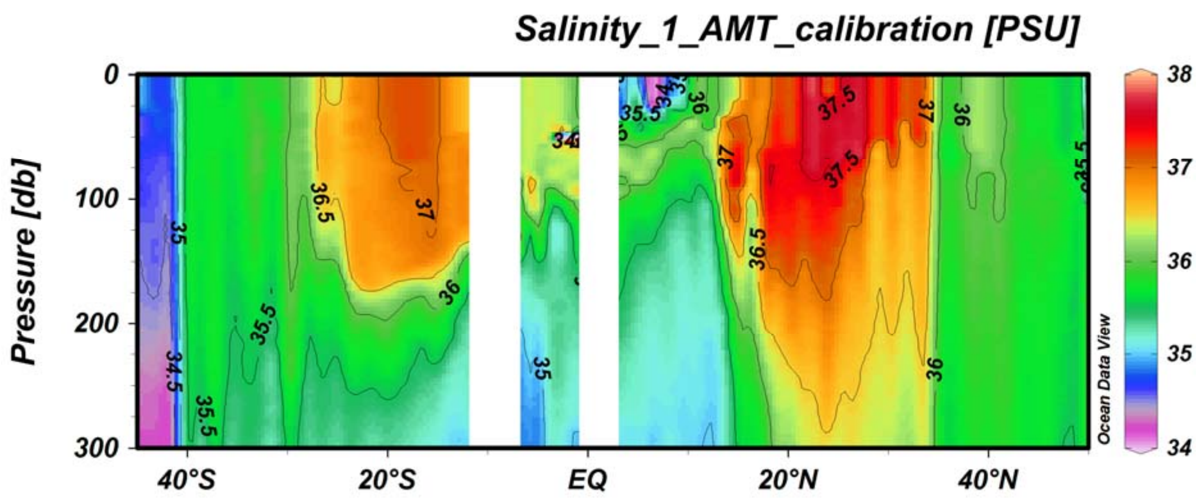


Fig. 2: Section plot of salinity along the AMT20 transect by latitude from the frame mounted sensor on the stainless steel CTD rig calibrated against bench salinometer samples. Breaks in the plot where sampling could not be carried out.

**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) |

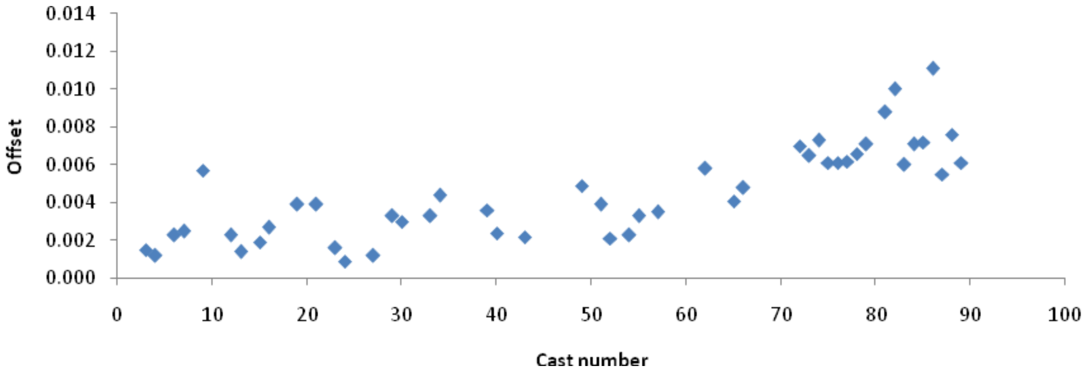


Fig. 3: Offset against cast number for the bench salinometer data and sensor 1 measurements. Outliers outside plot scale.

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) |

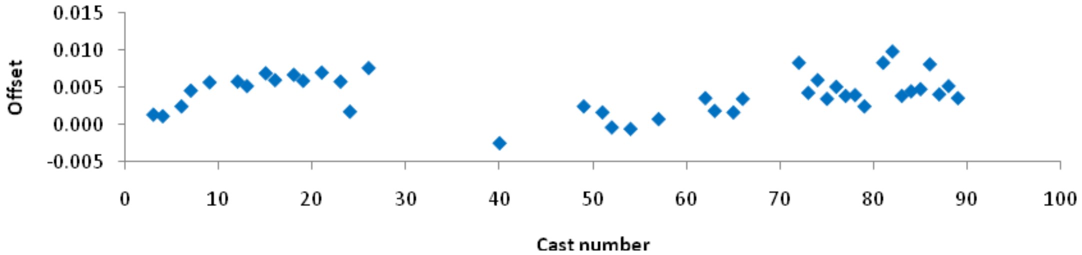


Fig. 4: Offset against cast number for the bench salinometer data and sensor 2 measurements. Outliers outside plot scale.

**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) |

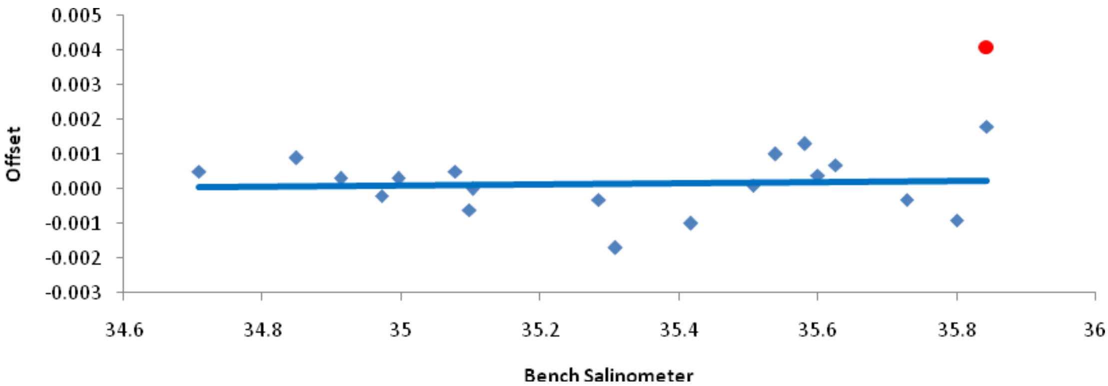


Fig. 5: Offset against bench salinometer measurements pre-calibration for titanium rig frame mounted sensor 1. Additional outliers outside plot scale.

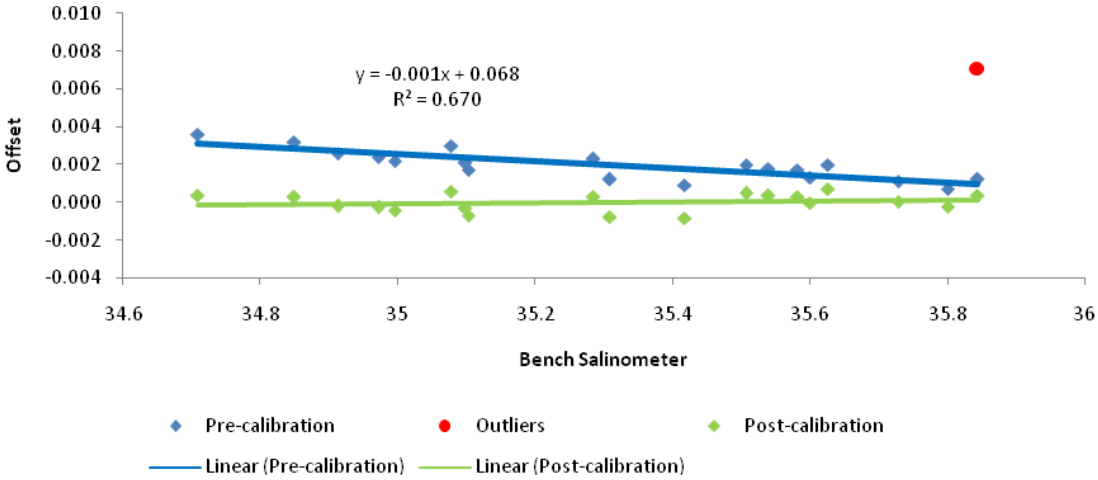


Fig. 6: Offset against bench salinometer measurements pre and post calibration for titanium rig vane mounted sensor 2. Additional outliers outside plot scale.

***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.

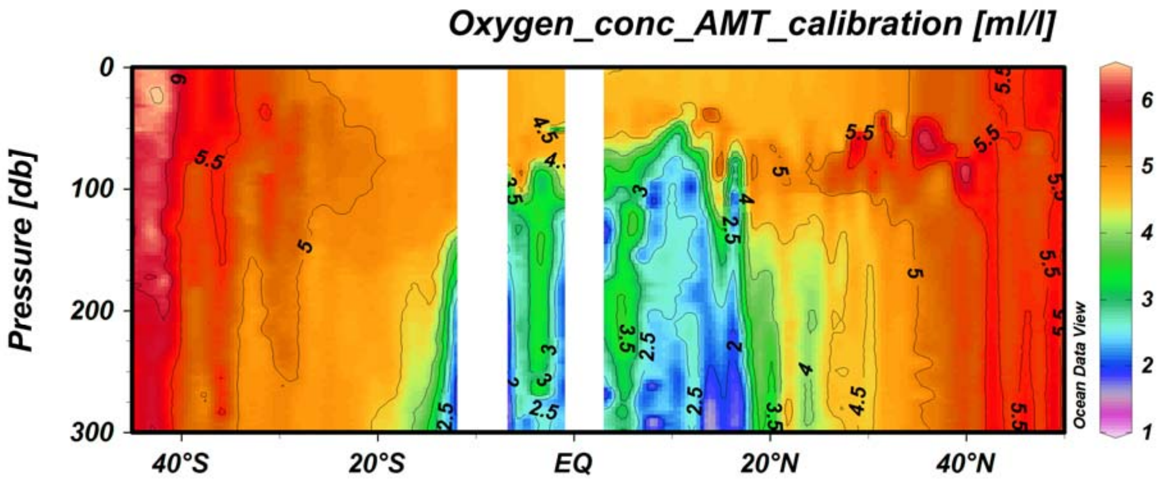


Fig. 7: Section plot of dissolved oxygen concentration (ml/l) along the AMT20 transect by latitude from the frame mounted sensor on the stainless steel CTD rig calibrated against Winkler titration samples. Breaks in the plot where sampling could not be carried out.

**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 $O_2$ conc$^n$ (in ml/l) = 1.1064 * SBE oxygen (in ml/l) + 0.1287

Casts 67-89 Dissolved $O_2$ conc$^n$ (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).

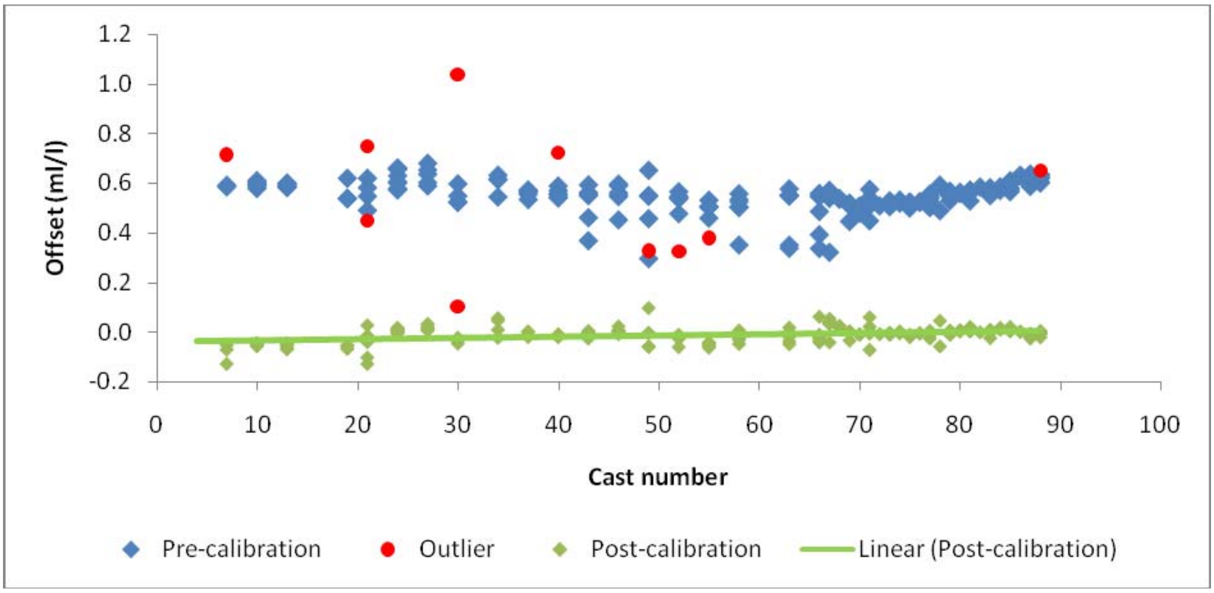


Fig. 8: Offset against cast number for pre and post calibration for stainless steel rig oxygen sensor.

**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 $O_2$ conc$^n$ (in ml/l) = SBE oxygen (in ml/l) + 0.0679

Casts 20-64 Dissolved $O_2$ conc$^n$ (in ml/l) = 1.0361 * SBE oxygen (in ml/l) + 0.0134

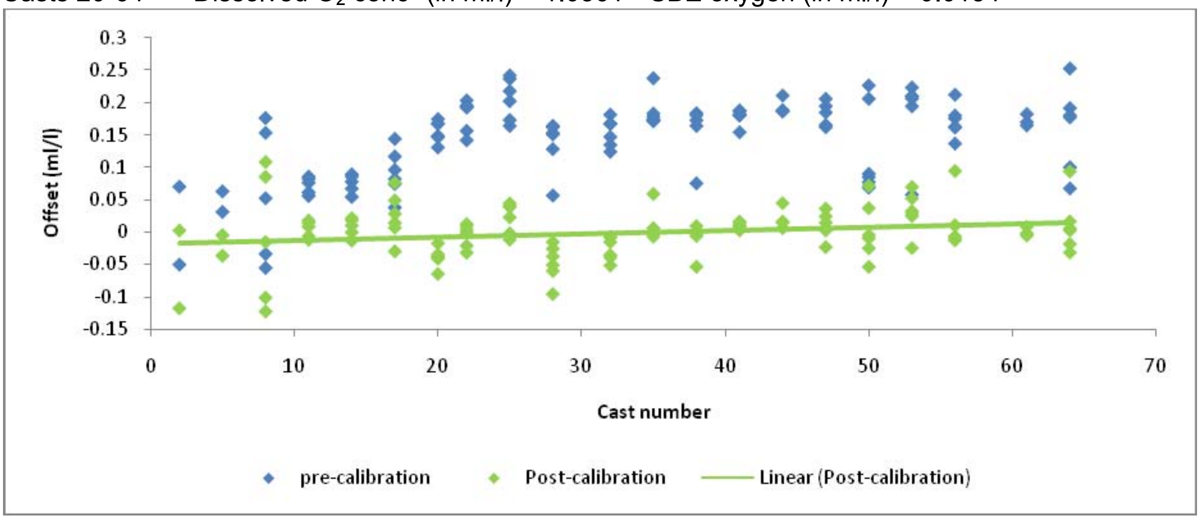


Fig. 9: Offset against cast number for pre and post calibration for titanium rig oxygen sensor.

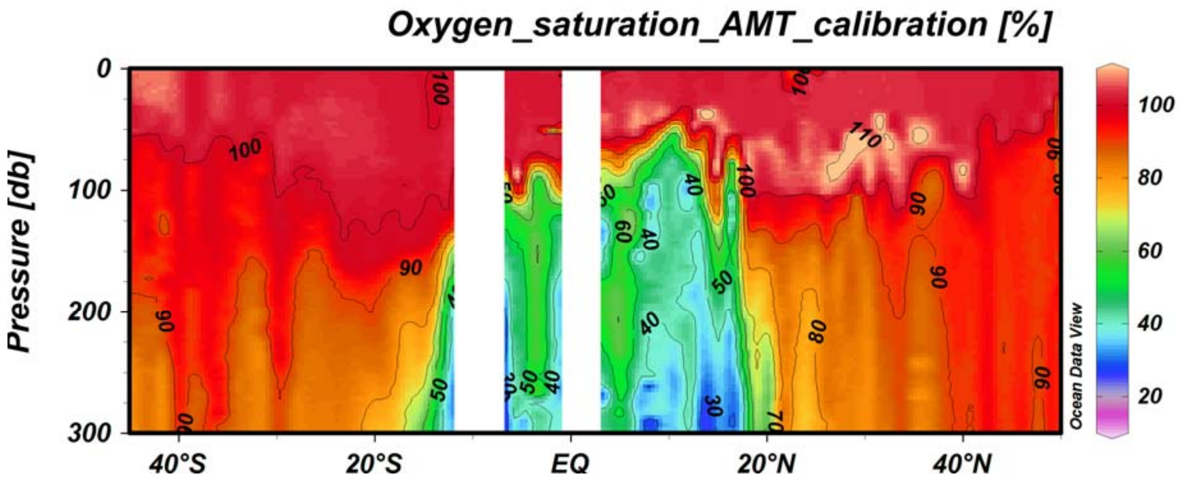

Fig. 10: Section plot of oxygen saturation (%) along the AMT20 transect by latitude from the frame mounted sensor on the stainless steel CTD rig. Saturation calculated with calibrated oxygen concentration and calibrated salinity values. Breaks in the plot where sampling could not be carried out.

***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.

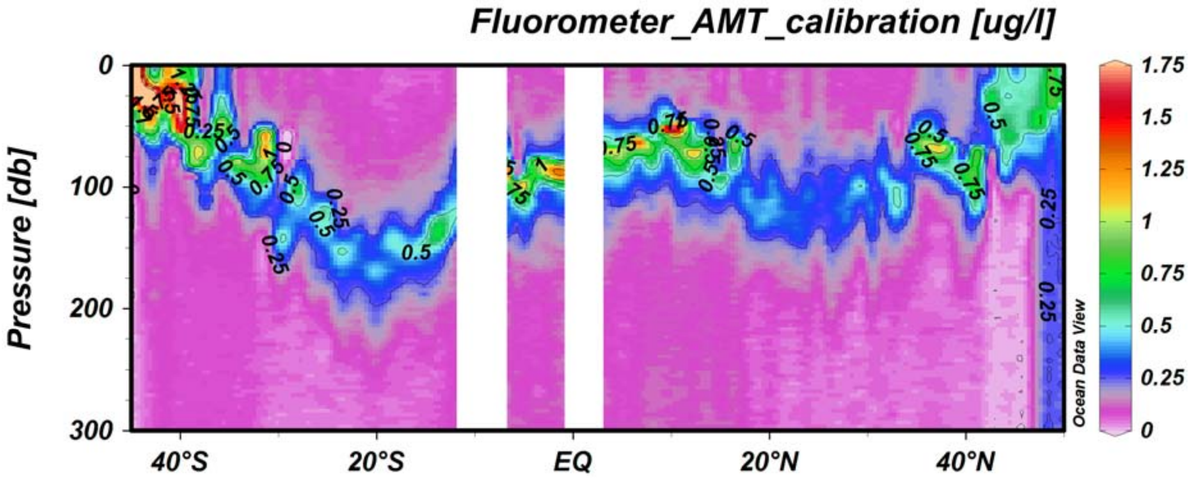


Fig. 11: Section plot of calibrated fluorescence as chl-a (µg/l) along the AMT20 transect by latitude from the frame mounted sensor on the stainless steel CTD rig. Breaks in the plot where sampling could not be carried out.

**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 (µg/L) = 1.4544 * Nominal calibration | (n=9; $r^2$=0.79) |
| Casts 9-13 | Chl-a (µg/L) = 2.0345 * Nominal calibration | (n= 10; $r^2$= 0.89) |
| Casts 15-79 | Chl-a (µg/L) = 3.0583 * Nominal calibration | (n=110; $r^2$= 0.97) |
| Casts 80-85 | Chl-a (µg/L) = 2.0718 * Nominal calibration | (n=22; $r^2$=0.94) |
| Cast 87 | Chl-a (µg/L) = 2.0386 * Nominal calibration | (n=9 ; $r^2$=0.79) |
| Cast 88 | Chl-a (µg/L) = 1.4179 * Nominal calibration | (n=3 ; $r^2$=0.50) |
| Cast 89 | Chl-a (µg/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).

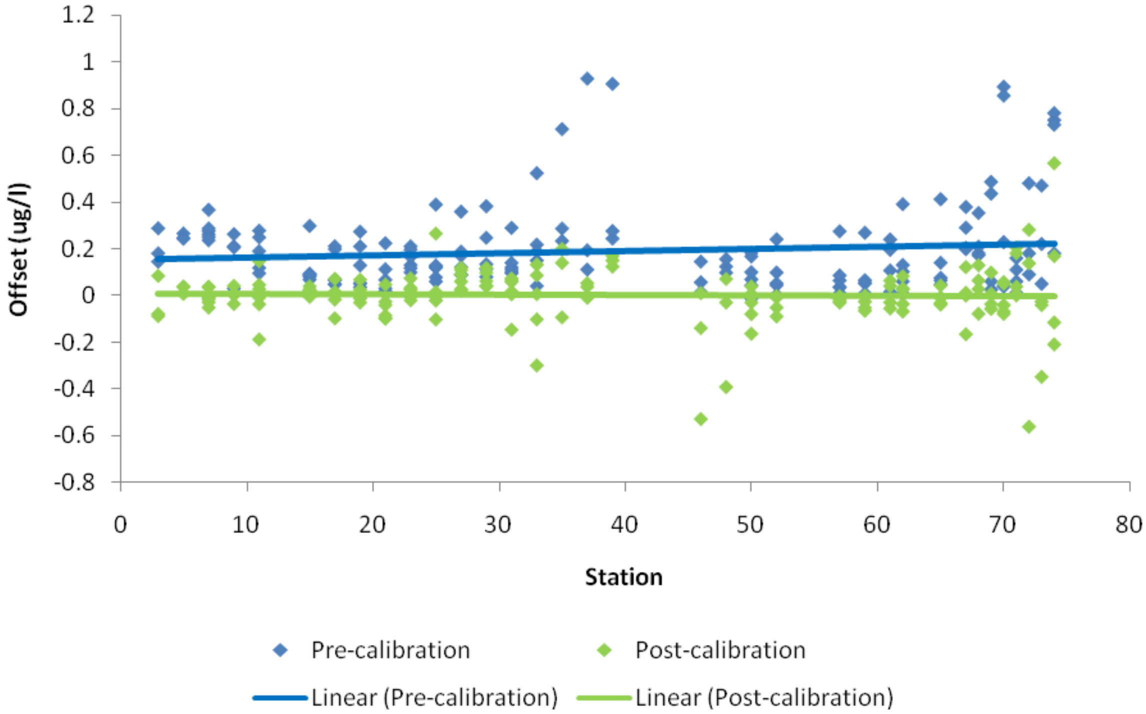


Fig. 12: Plot of offset pre- and post calibration against station for the stainless steel CTD rig.

**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 (µg/L) = 1.7130 * Nominal calibration | (n=15 ; $r^2$=0.90) |
| Casts 14-28 | Chl-a (µg/L) = 5.3169 * Nominal calibration – 0.0606 | (n= 33; $r^2$= 0.99) |
| Casts 32-41 | Chl-a (µg/L) = 4.4718 * Nominal calibration – 0.0957 | (n= 24; $r^2$= 0.98) |
| Casts 44-53 | Chl-a (µg/L) = 6.4238 * Nominal calibration – 0.1933 | (n= 18; $r^2$= 0.98) |
| Casts 56-64 | Chl-a (µg/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).

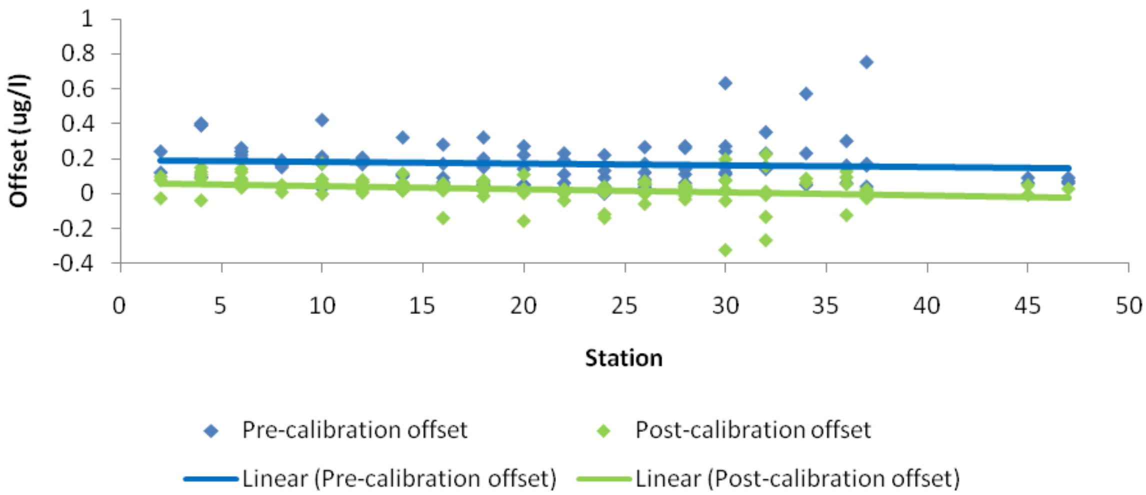


Fig. 13: Plot of offset pre- and post calibration against station for the titanium CTD rig.

***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 $^{o}$C at 13/10/2010 07:00 changing to -0.0087 $^{o}$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.

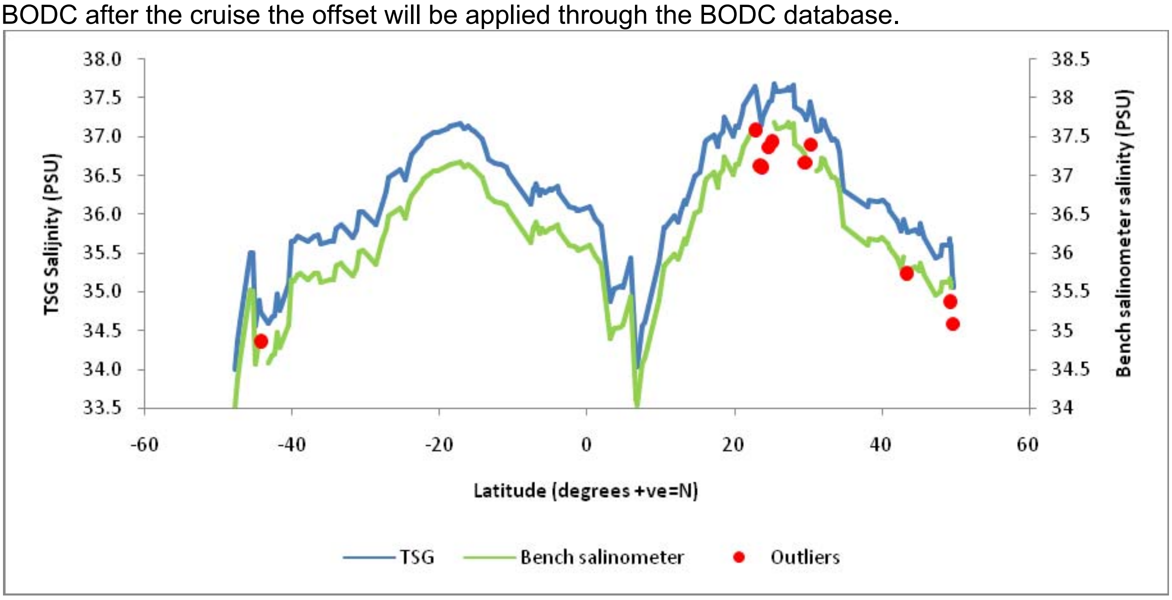


Fig. 14: Plot of TSG and bench salinometer data along the cruise track by latitude.

**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).

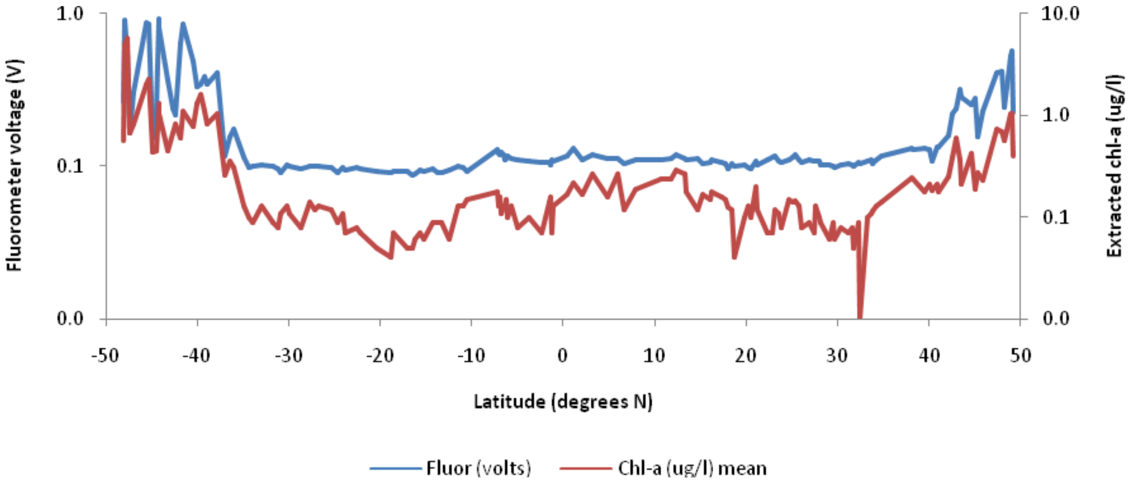


Fig. 15: Plot of fluorometer voltage and discrete sample extracted chl-a data along the cruise track by latitude. The data are represented on log scale axes.

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 generate 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 ships 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.

*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 capsulate 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

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(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 µL 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-creosol 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 µL 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 (I2-) 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 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 |

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

| Date | Time (GMT) | Station | Lat (+ve N) | Lon (+ve E) | Cast | Niskin No. | Depth (m) |
|---|---|---|---|---|---|---|---|
| 05/11/2010 | 13:09 | 46 | -4.891 | -25.030 | CTD063s | 6, 15, 24 | 98, 25, surface |
| 06/11/2010 | 04:31 | 47 | -6.057 | -23.763 | CTD064t | 6, 22 | 100, surface |
| 10/11/2010 | 04:34 | 50 | -12.529 | -19.022 | CTD067s | 7, 16, 23 | 130, 30, surface |
| 10/11/2010 | 13:07 | 51 | -13.473 | -19.967 | CTD068s | 6, 15, 24 | 135, 35, surface |
| 11/11/2010 | 04:25 | 52 | -15.331 | -21.841 | CTD069s | 6, 15, 23 | 145, 35, surface |
| 11/11/2010 | 13:07 | 53 | -16.316 | -23.010 | CTD070s | 6, 15, 23 | 145, 35, surface |
| 12/11/2010 | 10:59 | 55 | -18.537 | -25.130 | CTD071s | 7, 16, 24 | 140, 35, surface |
| 13/11/2010 | 04:34 | 56 | -20.380 | -25.089 | CTD072s | 6, 17, 23 | 165, 40, surface |
| 13/11/2010 | 13:05 | 57 | -21.706 | -25.097 | CTD073s | 6, 15, 24 | 150, 35, surface |
| 14/11/2010 | 04:58 | 58 | -23.838 | -26.566 | CTD074s | 5, 10, 23 | 150, 85, surface |
| 14/11/2010 | 13:30 | 59 | -24.819 | -27.358 | CTD075s | 6, 15, 24 | 130, 30, surface |
| 15/11/2010 | 05:35 | 60 | -26.858 | -29.068 | CTD076s | 7, 13, 23 | 120, 35, surface |
| 15/11/2010 | 14:10 | 61 | -27.916 | -29.986 | CTD077s | 4, 15, 24 | 105, 25, surface |
| 16/11/2010 | 05:36 | 62 | -29.944 | -31.824 | CTD078s | 8, 10, 23 | 145, 85, surface |
| 16/11/2010 | 14:22 | 63 | -30.996 | -32.814 | CTD079s | 6, 15, 24 | 65, 15, surface |
| 17/11/2010 | 05:32 | 65 | -33.044 | -34.845 | CTD080s | 7, 18, 23 | 80, 20, surface |
| 17/11/2010 | 14:12 | 66 | -34.107 | -35.925 | CTD081s | 7, 18, 24 | 70, 10, surface |
| 18/11/2010 | 05:35 | 67 | -36.090 | -38.088 | CTD082s | 7, 18, 24 | 48, 10, surface |
| 18/11/2010 | 14:09 | 68 | -37.094 | -39.231 | CTD083s | 6, 17, 24 | 65, 15, surface |
| 19/11/2010 | 05:39 | 69 | -38.924 | -41.453 | CTD084s | 5, 14, 23 | 80, 20, surface |
| 19/11/2010 | 14:25 | 70 | -39.791 | -42.552 | 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 | -12.884 | CTD004s | 5, 7, 11, 17, 19, 24 | 50, 30, 25, 15, 10, surface | TB |
| 15/10/2010 | 04:30 | 4 | 49.035 | -16.432 | CTD005t | 5, 9, 12, 16, 18, 22 | 45, 25, 20, 10, 5, surface | TB |
| 15/10/2010 | 13:02 | 5 | 48.116 | -17.324 | CTD007s | 3, 6, 10, 14, 17, 24 | 100, 50, 35, 20, 10, surface | TB |
| 16/10/2010 | 04:49 | 6 | 46.055 | -19.191 | CTD008t | 6, 10, 12, 15, 18, 22 | 70, 40, 30, 15, 10, surface | TB |
| 16/10/2010 | 13:04 | 7 | 45.198 | -19.934 | CTD010s | 4, 7, 13, 16, 19, 24 | 80, 58, 30, 20, 10, surface | TB |
| 17/10/2010 | 04:25 | 8 | 43.550 | -21.364 | CTD011t | 6, 10, 12, 15, 18, 22 | 70, 40, 30, 20, 10, surface | TB |

| 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 |

| Date | Time (GMT) | Station | Lat (+ve N) | Lon (+ve E) | Cast | Niskin No. | Depth (m) | Dye |
|---|---|---|---|---|---|---|---|---|
| 05/11/2010 | 04:53 | 45 | -3.852 | -25.018 | CTD061t | 6, 10, 12, 14, 17, 22 | 70, 55, 40, 30, 15, surface | m-cp |
| 05/11/2010 | 13:09 | 46 | -4.891 | -25.030 | CTD063s | 6, 9, 12, 15, 19, 24 | 98, 55, 40, 25, 10, surface | m-cp |
| 06/11/2010 | 04:31 | 47 | -6.057 | -23.763 | CTD064t | 6, 10, 12, 14, 17, 22 | 100, 75, 55, 40, 25, surface | m-cp |
| 06/11/2010 | 13:07 | 48 | -6.268 | -22.698 | CTD066s | 6, 10, 12, 15, 19, 24 | 90, 55, 40, 25, 10, surface | m-cp |
| 10/11/2010 | 04:34 | 50 | -12.529 | -19.022 | CTD067s | 7, 11, 12, 16, 23 | 130, 75, 55, 30, surface | m-cp |
| 10/11/2010 | 13:07 | 51 | -13.473 | -19.967 | CTD068s | 6, 9, 12, 15, 19, 24 | 135, 80, 60, 35, 20, surface | m-cp |
| 11/11/2010 | 04:25 | 52 | -15.331 | -21.841 | CTD069s | 6, 9, 10, 12, 15, 23 | 145, 115, 85, 65, 35, surface | m-cp |
| 11/11/2010 | 13:07 | 53 | -16.316 | -23.010 | CTD070s | 6, 9, 12, 15, 19, 23 | 145, 85, 65, 35, 20, surface | m-cp |
| 12/11/2010 | 10:59 | 55 | -18.537 | -25.130 | CTD071s | 7, 10, 13, 16, 19, 24 | 140, 85, 60, 35, 20, surface | m-cp |
| 13/11/2010 | 04:34 | 56 | -20.380 | -25.089 | CTD072s | 6, 10, 12, 14, 17, 23 | 165, 130, 100, 75, 40, surface | m-cp |
| 13/11/2010 | 13:05 | 57 | -21.706 | -25.097 | CTD073s | 6, 9, 12, 15, 19, 24 | 150, 85, 65, 35, 25, surface | m-cp |
| 14/11/2010 | 04:58 | 58 | -23.838 | -26.566 | CTD074s | 5, 8, 10, 13, 16, 23 | 150, 115, 85, 65, 35, surface | m-cp |
| 14/11/2010 | 13:30 | 59 | -24.819 | -27.358 | CTD075s | 6, 9, 12, 15, 18, 24 | 130, 75, 55, 30, 15, surface | m-cp |
| 15/11/2010 | 05:35 | 60 | -26.858 | -29.068 | CTD076s | 7, 10, 11, 13, 23 | 120, 95, 70, 35, surface | m-cp |
| 15/11/2010 | 14:10 | 61 | -27.916 | -29.986 | CTD077s | 4, 9, 12, 15, 19, 24 | 105, 60, 45, 25, 15, surface | m-cp |
| 16/11/2010 | 05:36 | 62 | -29.944 | -31.824 | CTD078s | 4, 8, 9, 10, 12, 15, 23 | 200, 145, 110, 85, 60, 35, surface | both |
| 16/11/2010 | 14:22 | 63 | -30.996 | -32.814 | CTD079s | 6, 9, 12, 15, 17, 24 | 65, 35, 25, 15, 10, surface | m-cp |
| 17/11/2010 | 05:32 | 65 | -33.044 | -34.845 | CTD080s | 3, 7, 10, 11, 13, 18, 23 | 125, 80, 65, 50, 35, 20, surface | both |
| 17/11/2010 | 14:12 | 66 | -34.107 | -35.925 | CTD081s | 7, 10, 13, 16, 18, 24 | 70, 45, 35, 20, 10, surface | m-cp |
| 18/11/2010 | 05:35 | 67 | -36.090 | -38.088 | CTD082s | 1, 2, 7, 10, 11, 18, 24 | 300, 220, 48, 40, 30, 10, surface | both |
| 18/11/2010 | 14:09 | 68 | -37.094 | -39.231 | CTD083s | 6, 9, 12, 17, 24 | 65, 40, 30, 15, surface | m-cp |
| 19/11/2010 | 05:39 | 69 | -38.924 | -41.453 | CTD084s | 1, 5, 8, 9, 11, 14, 23 | 300, 80, 60, 45, 35, 20, surface | both |
| 19/11/2010 | 14:25 | 70 | -39.791 | -42.552 | CTD085s | 8, 10, 13, 16, 18, 24 | 60, 45, 35, 20, 10, surface | m-cp |
| 20/11/2010 | 06:41 | 71 | -41.656 | -45.094 | CTD086s | 1, 2, 3, 8, 15, 19, 23 | 300, 200, 100, 75, 30, 10, surface | both |
| 20/11/2010 | 15:12 | 72 | -42.498 | -46.296 | CTD087s | 1, 2, 3, 9, 13, 24 | 300, 200, 100, 30, 15, surface | both |
| 21/11/2010 | 06:31 | 73 | -44.200 | -48.939 | CTD088s | 1, 2, 4, 5, 6, 8, 14, 23 | 300, 200, 100, 75, 45, 30, 15, surface | both |
| 21/11/2010 | 15:12 | 74 | -45.017 | -50.285 | CTD089s | 1, 2, 4, 6, 9, 13, 16, 19, 24 | 300, 200, 100, 45, 30, 15, 10, 5, surface | both |

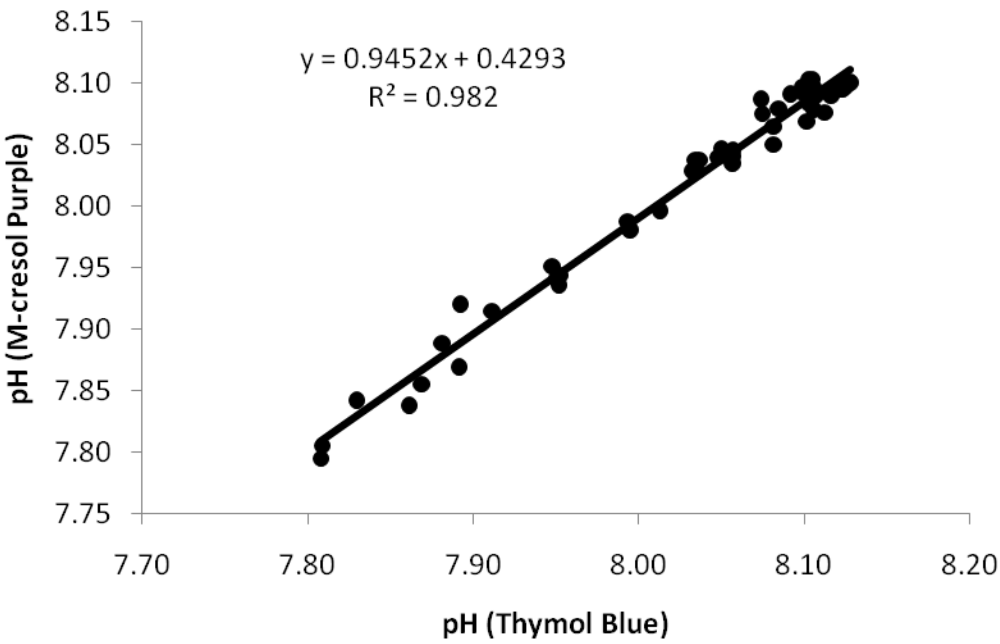


**Fig.1:** Comparison of spectrophotometrically determined pH values using thymol blue and m-cresol purple staining techniques.

**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

**Zhang and Byrne**, 1996. Spectrophotometric pH measurements of surface seawater at in-situ conditions: absorbance and protonation behavior of thymol blue*. Marine Chemistry*, 52(1):17-25

## Nitrogen fixation

**Andy Rees**
*Plymouth Marine Laboratory*

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 connecter 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

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 10th<br>• 28560 thereafter | • April 2011<br>• April 2011 |
| • PTIR | • 973134 | • April 2011 |
| • STIR | • 973135 | • April 2011 |
| • Pressure | • R0450005 | • September 2011 |
| • Anenometer | • 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

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 nclistit 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.

**Gravitimeter.**

The gravitimeter 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 Methylotroph 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 -80ºC 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 methylotrophic bacteria. This will be done by conducting PCR using specific gene primers targeting *mxaF gene* used for utilisation of methanol as a carbon and energy source to create *mxaF* clone libaries.

Stable Isotope Probing (SIP) experiments.
Stable isotope probing (SIP) experiments were conducted within the northern Atlantic gyre (NAG) between 34ºN and 21ºN 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 $^{13}$C 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, $^{13}$C or $^{12}$C 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 -80ºC 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 |

| | | | | | |
|---|---|---|---|---|---|
| **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 Alphatracka 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 9*plus* 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:

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 9*plus* 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.

**<u>Appendix A:</u> 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:

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
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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
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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 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 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |

| 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 | | | | |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Delgada | | | | | | | | | | | |
| 19/10/2010 | | | Non-toxic switched off | | 08:49 | | 08:49 | | 38.0526 | -25.8312 | | | | |
| 19/10/2010 | | | Arrive Ponta Delgada | | 13:36 | | 13:36 | | 37.7129 | -25.6303 | | | | |
| 19/10/2010 | | | Leave Ponta Delgada | | 21:00 | | 21:00 | | 37.6219 | -25.7831 | | | | |
| 19/10/2010 | | | Non-toxic switched on | | 21:22 | | 21:22 | | 37.5669 | -25.8458 | | | | |
| 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 | | | | |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |

| 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 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |

| 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 | | | | |

| 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 |

| 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. Retermination 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. |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | | | | | | | | |

| 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 | | | | |

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | |

| 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. |

| 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 | | | | |

# Appendix 1 : Underway Log – JCO53

| 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 | |
| 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 | | |

| Sample ID | Date | Time (GMT) | Latitude (+ve N) | Longitude (+ve E) | TSG sal. (PSU) | SST - hull sensor (deg. C) | Fluor (volts) | Salinity Sample btl | Salinity (PSU) | Chl-a (ug/l) mean | Chl-a (ug/l) stdev | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | #18 | | | | |
| | 17/10/2010 | 04:03 to 06:00 | | | | | | | | | | transmissometer data dubious |
| AAS | 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 | | | | | | | | | | tranmissometer data dubious - probable electrical fault |
| 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 | | | | | | | | | | transmissometer dubious |
| | 18/10/2010 | 13:20 | | | | | | | | | | underway sampling stopped |
| | 18/10/2010 | 13:50 | | | | | | | | | | transmissometer s/n CST1132PR removed and replaced with CST1131PR |
| | 18/10/2010 | 14:00 | | | | | | | | | | underway sampling resumed |
| AAZ | 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 | | | | | | | | | | underway sampling stopped prior to arriveal in Ponta Delgada, Azores |
| | 19/10/2010 | 21:22 | | | | | | | | | | underway sampling resumed after leaving Ponta Delgada, Azores |
| | 20/10/2010 | 08:25 | | | | | | | | | | bubbles in transmissometer |
| | 20/10/2010 | 10:27 | | | | | | | | | | raw water stopped to transmissometer |
| | 20/10/2010 | 11:35 | | | | | | | | | | transmissometer s/n CST1131PR removed and replaced with CST1132PR. Sampling |

| Sample ID | Date | Time (GMT) | Latitude (+ve N) | Longitude (+ve E) | TSG sal. (PSU) | SST - hull sensor (deg. C) | Fluor (volts) | Salinity Sample btl | Salinity (PSU) | Chl-a (ug/l) mean | Chl-a (ug/l) stdev | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | resumed |
| ABD | 20/10/2010 | 20:55 | 34.7420 | -29.1593 | 36.3173 | 22.0413 | 0.1177 | Crate 4 - #78 | 36.3451 | 0.14 | | |
| 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 | | | | | | | | | | 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. |
| 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 | | | | | | | | | | Logging stopped for 2 minute to reboot PC |
| ABK | 22/10/2010 | 13:23 | 31.7882 | -32.5046 | 37.2239 | 24.4897 | 0.1005 | Crate 4 - #85 | 37.2348 | 0.05 | | |
| 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 | | |

| Sample ID | Date | Time (GMT) | Latitude (+ve N) | Longitude (+ve E) | TSG sal. (PSU) | SST - hull sensor (deg. C) | Fluor (volts) | Salinity Sample btl | Salinity (PSU) | Chl-a (ug/l) mean | Chl-a (ug/l) stdev | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | | | | | | | +1 hPa jump in atmospheric pressure |
| | 26/10/2010 | 12:23 | | | | | | | | | | Barometer on bridge shows 1012.8 hPa; Surfmet shows 1005.8 hPa |
| 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 | |
| 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 | | |

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

| Sample ID | Date | Time (GMT) | Latitude (+ve N) | Longitude (+ve E) | TSG sal. (PSU) | SST - hull sensor (deg. C) | Fluor (volts) | Salinity Sample btl | Salinity (PSU) | Chl-a (ug/l) mean | Chl-a (ug/l) stdev | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | #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 |
| | 02/11/2010 | 13:20-13:35 | | | | | | | | | | technicians at the met platform checking on instruments. Spikes in temperature, humidity and pressure data. |
| 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 | | |

| Sample ID | Date | Time (GMT) | Latitude (+ve N) | Longitude (+ve E) | TSG sal. (PSU) | SST - hull sensor (deg. C) | Fluor (volts) | Salinity Sample btl | Salinity (PSU) | Chl-a (ug/l) mean | Chl-a (ug/l) stdev | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |

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

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

| Sample ID | Date | Time (GMT) | Latitude (+ve N) | Longitude (+ve E) | TSG sal. (PSU) | SST - hull sensor (deg. C) | Fluor (volts) | Salinity Sample btl | Salinity (PSU) | Chl-a (ug/l) mean | Chl-a (ug/l) stdev | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | #86 | | | | |
| AFT | 18/11/2010 | 05:01 | -36.0500 | -38.0482 | 35.6179 | 16.2911 | 0.1759 | 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 | |

| Sample ID | Date | Time (GMT) | Latitude (+ve N) | Longitude (+ve E) | TSG sal. (PSU) | SST - hull sensor (deg. C) | Fluor (volts) | Salinity | | Chl-a (ug/l) | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Sample btl | (PSU) | mean | stdev | |
| AGN | 22/11/2010 | 10:07 | -46.9688 | -53.8327 | 34.6169 | 12.4629 | 0.3062 | Crate 3 - #58 | 34.6265 | 0.82 | | |
| AGO | 22/11/2010 | 13:51 | -47.3547 | -54.5780 | 34.3584 | 12.1173 | 0.1655 | Crate 3 - #59 | 34.3687 | 0.67 | | |
| AGP | 22/11/2010 | 17:48 | -47.7591 | -55.4053 | 33.9957 | 9.0520 | 0.5505 | Crate 3 - #60 | 34.0117 | 5.82 | 1.18 | |
| AGQ | 22/11/2010 | 20:12 | -48.0050 | -55.9136 | 34.0329 | 8.8814 | 0.9092 | | | 4.94 | 0.19 | |
| AGR | 22/11/2010 | 21:05 | -48.0985 | -56.1063 | 34.0190 | 7.3488 | 0.2617 | | | 0.56 | 0.22 | |
| | 22/11/2010 | 21:05 | | | | | | | | | | Underway sampling stopped - 200 nm from Falkland Islands |

# Appendix 2 : AMT20 cruise track