AMT21 Cruise Report

RRS Discovery D371

(29 September – 14 November 2011)

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PML | Plymouth Marine Laboratory

Oceans 2025

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

CONTENTS

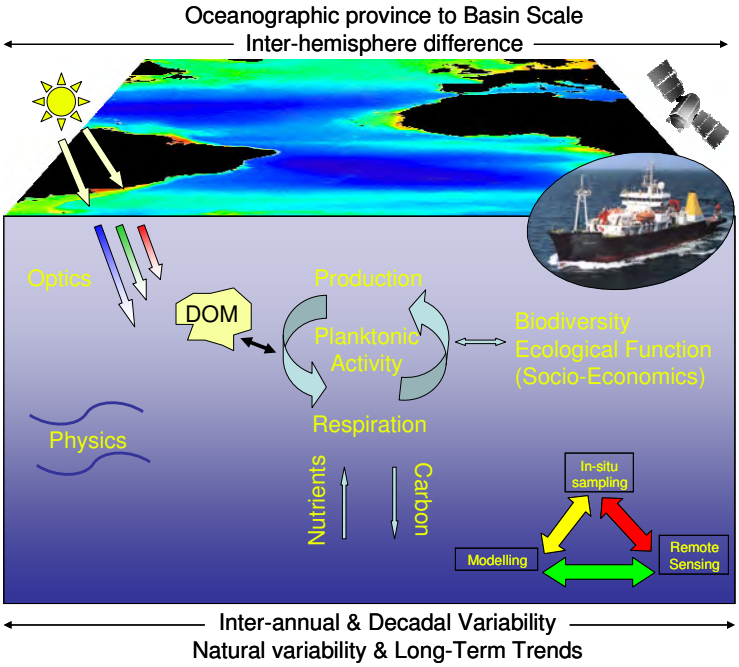
The Atlantic Meridional Transect programme

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 21st in the series of research cruises which have involved over 200 scientists from 20 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

The AMT-21 cruise was my sixth AMT cruise and my first ever cruise as Principal Scientist (PSO). The RRS Discovery completed the cruise track without any deviations (the previous three AMT cruises had to divert for various reasons en route), made it to Punta Arenas in Chile two days early, despite bad weather in the southern Atlantic (which cost us five stations) and I was invited to act as Principal Scientist on AMT-22. So, something definitely went right. But how did it all happen?

To begin with, there were the National Marine Facilities-Sea Systems people, both onshore and at sea and I would like to thank them for their work during the preparation for the cruise, mobilisation and during the cruise itself. Captain Antonio Gatti and his officers and crew provided an excellent service and I would like to thank them for all of their efforts to ensure smooth running of the ship. Our shore-based support during the cruise included regular updates on oceanographic conditions from the remote sensing team at NEODAAS, including Raquel Alegre-Gonzalez. Their images provided great insight and context to what we were doing on the ship, particularly as we crossed the boundaries of major water masses and when rough weather was imminent. I would also like to thank all the scientists on the cruise for their company and for making my first time as PSO a much more enjoyable experience than perhaps I had envisaged. In particular, Rob Thomas from BODC who managed sensor calibrations, data processing and archiving and typing up the scientific rough logs, which enabled me to carry out some of my own science activities. I'd also like to thank Rob Ellis, who did an excellent job with the blog to keep the wider world appraised of what we were all doing on the cruise. Finally, I'd like to thank Chris Wing who, despite being employed part time, organised the scientific party on and off the ship, home again, has prepared this cruise report and has helped with any number of other aspects of the AMT programme. Thanks to you all.

Glen

Cruise Timetable of Events D371

Start		End			Comment
Date	**Time**	**Date**	**Time**		**All times GMT**
27/09/2011	08:00	29/09/2011	07:30		Mobilisation including bunkers
29/09/2011	07:30	29/09/2011	08:55		Pilotage leaving Avonmouth
29/09/2011	08:55	29/09/2011	15:10		Passage to test CTD and Optics
29/09/2011	15:10	29/09/2011	15:45		Test CTD and Optics
29/09/2011	15:45	30/09/2011	04:26		Reposition to next station
30/09/2011	04:26	30/09/2011	05:15		Stn 1. CTD and Bongo Nets
30/09/2011	05:15	30/09/2011	13:09		Reposition to next station
30/09/2011	13:09	30/09/2011	14:00		Stn 2. CTD and Optics
30/09/2011	14:00	01/10/2011	04:27		Reposition to next station. Clocks retarded to GMT
01/10/2011	04:27	01/10/2011	05:35		Stn 3. CTD and Bongo Nets
01/10/2011	05:35	01/10/2011	13:00		Reposition to next station
01/10/2011	13:00	01/10/2011	15:10		Stn 4. CTD, Optics and Microplankton Net
01/10/2011	15:10	02/10/2011	04:28		Reposition to next station
02/10/2011	04:28	02/10/2011	05:28		Stn 5. CTD and Bongo Nets
02/10/2011	05:28	02/10/2011	13:02		Reposition to next station
02/10/2011	13:02	02/10/2011	14:52		Stn 6. CTD, Optics and Microplankton Net
02/10/2011	14:52	03/10/2011	04:27		Reposition to next station
03/10/2011	04:27	03/10/2011	05:34		Stn 7. CTD and Bongo Nets
03/10/2011	05:34	03/10/2011	13:02		Reposition to next station
03/10/2011	13:02	03/10/2011	14:44		Stn 8. CTD, Optics and Microplankton Net
03/10/2011	14:44	04/10/2011	04:26		Reposition to next station
04/10/2011	04:26	04/10/2011	05:20		Stn 9. CTD and Bongo Nets
04/10/2011	05:20	04/10/2011	13:00		Reposition to next station
04/10/2011	13:00	04/10/2011	14:35		Stn 10. CTD, Optics and Microplankton Net
04/10/2011	14:35	05/10/2011	04:28		Reposition to next station
05/10/2011	04:28	05/10/2011	05:25		Stn 11. CTD and Bongo Nets
05/10/2011	05:25	05/10/2011	13:00		Reposition to next station
05/10/2011	13:00	05/10/2011	14:20		Stn 12. CTD, Optics and Microplankton Net
05/10/2011	14:20	06/10/2011	04:28		Reposition to next station

Start		End			Comment
Date	**Time**	**Date**	**Time**		**All times GMT**
06/10/2011	04:28	06/10/2011	05:31		Stn 13. CTD and Bongo Nets
06/10/2011	05:31	06/10/2011	13:02		Reposition to next station
06/10/2011	13:02	06/10/2011	14:55		Stn 14. CTD, Optics and Microplankton Net
06/10/2011	14:55	07/10/2011	04:28		Reposition to next station
07/10/2011	04:28	07/10/2011	05:21		Stn 15. CTD and Bongo Nets
07/10/2011	05:21	07/10/2011	13:00		Reposition to next station
07/10/2011	13:00	07/10/2011	14:37		Stn 16. CTD, Optics and Microplankton Net
07/10/2011	14:37	08/10/2011	04:26		Reposition to next station
08/10/2011	04:26	08/10/2011	05:29		Stn 17. CTD and Bongo Nets
08/10/2011	05:29	08/10/2011	13:00		Reposition to next station
08/10/2011	13:00	08/10/2011	14:34		Stn 18. CTD, Optics and Microplankton Net
08/10/2011	14:34	09/10/2011	04:29		Reposition to next station. Clocks retarded to GMT-1
09/10/2011	04:29	09/10/2011	05:49		Stn 19. CTD and Bongo Nets
09/10/2011	05:49	09/10/2011	13:01		Reposition to next station
09/10/2011	13:01	09/10/2011	14:48		Stn 20. CTD, Optics and Microplankton Net
09/10/2011	14:48	10/10/2011	04:28		Reposition to next station
10/10/2011	04:28	10/10/2011	05:36		Stn 21. CTD and Bongo Nets
10/10/2011	05:36	10/10/2011	12:58		Reposition to next station
10/10/2011	12:58	10/10/2011	14:47		Stn 22. CTD, Optics and Microplankton Net
10/10/2011	14:47	11/10/2011	04:28		Reposition to next station
11/10/2011	04:28	11/10/2011	05:30		Stn 23. CTD and Bongo Nets
11/10/2011	05:30	11/10/2011	13:00		Reposition to next station
11/10/2011	13:00	11/10/2011	14:55		Stn 24. CTD, Optics and Microplankton Net
11/10/2011	14:55	12/10/2011	04:28		Reposition to next station
12/10/2011	04:28	12/10/2011	05:30		Stn 25. CTD and Bongo Nets
12/10/2011	05:30	12/10/2011	12:59		Reposition to next station
12/10/2011	12:59	12/10/2011	14:40		Stn 26. CTD, Optics and Microplankton Net
12/10/2011	14:40	13/10/2011	04:26		Reposition to next station
13/10/2011	04:26	13/10/2011	05:39		Stn 27. CTD and Bongo Nets
13/10/2011	05:39	13/10/2011	12:58		Reposition to next station
13/10/2011	12:58	13/10/2011	14:47		Stn 28. CTD, Optics and Microplankton Net
13/10/2011	14:47	14/10/2011	04:26		Reposition to next station

Start		End			Comment
Date	**Time**	**Date**	**Time**		**All times GMT**
14/10/2011	04:26	14/10/2011	05:23		Stn 29. CTD and Bongo Nets
14/10/2011	05:23	14/10/2011	12:59		Reposition to next station
14/10/2011	12:59	14/10/2011	14:54		Stn 30. CTD, Optics and Microplankton Net
14/10/2011	14:54	15/10/2011	04:25		Reposition to next station
15/10/2011	04:25	15/10/2011	05:41		Stn 31. CTD and Bongo Nets
15/10/2011	05:41	15/10/2011	12:58		Reposition to next station
15/10/2011	12:58	15/10/2011	14:44		Stn 32. CTD, Optics and Microplankton Net
15/10/2011	14:44	16/10/2011	04:25		Reposition to next station
16/10/2011	04:25	16/10/2011	05:27		Stn 33. CTD and Bongo Nets
16/10/2011	05:27	16/10/2011	12:59		Reposition to next station
16/10/2011	12:59	16/10/2011	14:47		Stn 34. CTD, Optics and Microplankton Net
16/10/2011	14:47	17/10/2011	04:24		Reposition to next station
17/10/2011	04:24	17/10/2011	05:28		Stn 35. CTD and Bongo Nets
17/10/2011	05:28	17/10/2011	13:03		Reposition to next station
17/10/2011	13:03	17/10/2011	14:30		Stn 36. CTD, Optics and Microplankton Net
17/10/2011	14:30	18/10/2011	04:23		Reposition to next station
18/10/2011	04:23	18/10/2011	05:22		Stn 37. CTD and Bongo Nets
18/10/2011	05:22	18/10/2011	13:00		Reposition to next station
18/10/2011	13:00	18/10/2011	14:38		Stn 38. CTD, Optics and Microplankton Net
18/10/2011	14:38	19/10/2011	04:25		Reposition to next station
19/10/2011	04:25	19/10/2011	05:33		Stn 39. CTD and Bongo Nets
19/10/2011	05:33	19/10/2011	06:40		Reposition to next station
19/10/2011	06:40	19/10/2011	06:46		Recover PES Fish - fault
19/10/2011	06:46	19/10/2011	13:00		Reposition to next station
19/10/2011	13:00	19/10/2011	14:45		Stn 40. CTD, Optics and Microplankton Net
19/10/2011	14:45	20/10/2011	04:27		Reposition to next station
20/10/2011	04:27	20/10/2011	05:26		Stn 41. CTD and Bongo Nets
20/10/2011	05:26	20/10/2011	12:29		Reposition to next station
20/10/2011	12:29	20/10/2011	14:05		Stn 42. CTD, Optics and Microplankton Net
20/10/2011	14:05	21/10/2011	04:24		Reposition to next station
21/10/2011	04:24	21/10/2011	05:27		Stn 43. CTD and Bongo Nets
21/10/2011	05:27	22/10/2011	04:22		Reposition to next station

Start		End			Comment
Date	**Time**	**Date**	**Time**		**All times GMT**
22/10/2011	04:22	22/10/2011	05:33		Stn 44. CTD and Bongo Nets
22/10/2011	05:33	22/10/2011	12:30		Reposition to next station
22/10/2011	12:30	22/10/2011	13:31		Stn 45. CTD, Optics and Microplankton Net
22/10/2011	13:31	23/10/2011	04:27		Reposition to next station
23/10/2011	04:27	23/10/2011	05:29		Stn 46. CTD and Bongo Nets
23/10/2011	05:29	23/10/2011	12:29		Reposition to next station
23/10/2011	12:29	23/10/2011	14:15		Stn 47. CTD, Optics and Microplankton Net
23/10/2011	14:15	24/10/2011	04:24		Reposition to next station
24/10/2011	04:24	24/10/2011	05:15		Stn 48. CTD and Bongo Nets
24/10/2011	05:15	24/10/2011	12:31		Reposition to next station
24/10/2011	12:31	24/10/2011	14:19		Stn 49. CTD, Optics and Microplankton Net
24/10/2011	14:19	25/10/2011	04:24		Reposition to next station
25/10/2011	04:24	25/10/2011	05:31		Stn 50. CTD and Bongo Nets
25/10/2011	05:31	25/10/2011	09:55		Reposition to next station
25/10/2011	09:55	25/10/2011	15:25		Stn 51. CTD to 5100m to test accoustic release for mooring, Optics and Microplankton Net
25/10/2011	15:25	26/10/2011	03:55		Reposition to next station
26/10/2011	03:55	26/10/2011	04:55		Stn 52. CTD and Bongo Nets
26/10/2011	04:55	26/10/2011	12:28		Reposition to next station
26/10/2011	12:28	26/10/2011	14:22		Stn 53. CTD, Optics and Microplankton Net
26/10/2011	14:22	27/10/2011	03:55		Reposition to next station
27/10/2011	03:55	27/10/2011	05:50		Stn 54. CTD and Bongo Nets
27/10/2011	05:50	27/10/2011	12:40		Various attempts made to release SAG mooring and seas surface searches made. All unsuccessful
27/10/2011	12:40	27/10/2011	13:06		Reposition for new SAG mooring deployment
27/10/2011	13:06	27/10/2011	15:05		Deployment of SAG mooring
27/10/2011	15:05	27/10/2011	17:40		Triangulation of SAG mooring
27/10/2011	17:40	28/10/2011	03:57		Reposition to next station
28/10/2011	03:57	28/10/2011	04:54		Stn 56. CTD and Bongo Nets
28/10/2011	04:54	28/10/2011	12:35		Reposition to next station
28/10/2011	12:35	28/10/2011	14:12		Stn 57. CTD, Optics and Microplankton Net
28/10/2011	14:12	29/10/2011	03:56		Reposition to next station
29/10/2011	03:56	29/10/2011	04:49		Stn 58. CTD and Bongo Nets
29/10/2011	04:49	29/10/2011	12:32		Reposition to next station

Start		End			Comment
Date	**Time**	**Date**	**Time**		**All times GMT**
29/10/2011	12:32	29/10/2011	14:03		Stn 59. CTD, Optics and Microplankton Net
29/10/2011	14:03	30/10/2011	03:56		Reposition to next station
30/10/2011	03:56	30/10/2011	04:48		Stn 60. CTD and Bongo Nets
30/10/2011	04:48	30/10/2011	12:29		Reposition to next station
30/10/2011	12:29	30/10/2011	14:10		Stn 61. CTD, Optics and Microplankton Net. ARGO float deployed on departure
30/10/2011	14:10	31/10/2011	03:56		Reposition to next station
31/10/2011	03:56	31/10/2011	05:12		Stn 62. CTD and Bongo Nets
31/10/2011	05:12	31/10/2011	12:31		Reposition to next station
31/10/2011	12:31	31/10/2011	13:41		Stn 63. CTD, Optics and Microplankton Net
31/10/2011	13:41	01/11/2011	03:57		Reposition to next station
01/11/2011	03:57	01/11/2011	04:56		Stn 64. CTD and Bongo Nets
01/11/2011	04:56	01/11/2011	12:31		Reposition to next station
01/11/2011	12:31	01/11/2011	14:20		Stn 65. CTD, Optics and Microplankton Net. ARGO float deployed on departure
01/11/2011	14:20	02/11/2011	03:59		Reposition to next station
02/11/2011	03:59	02/11/2011	05:14		Stn 66. CTD and Bongo Nets
02/11/2011	05:14	02/11/2011	12:35		Reposition to next station
02/11/2011	12:35	02/11/2011	13:40		Stn 67. CTD aborted due to kink in wire. Vessel remain on stn while wire is cropped and prepared for termination.
02/11/2011	13:40	03/11/2011	04:00		Reposition to next station. New termination tested - all Ok. 0400 aborted due weather.
03/11/2011	04:00	03/11/2011	12:26		Stn 68. ARGO float deployed at 12:26. 12:30 station aborted due to the weather. Continue on AMT track to next stn.
03/11/2011	12:26	04/11/2011	04:00		04:00 station aborted due to the weather. Continue on AMT track to next stn.
04/11/2011	04:00	04/11/2011	12:25		Stn 69. ARGO float deployed at 12:26. 12:30 station aborted due to the weather. Continue on AMT track to next stn.
04/11/2011	12:25	05/11/2011	03:59		Continue on AMT track to next stn. Weather easing overnight.
05/11/2011	03:59	05/11/2011	05:00		Stn 70. CTD and Bongo Nets
05/11/2011	05:00	05/11/2011	12:34		Reposition to next station
05/11/2011	12:34	05/11/2011	14:10		Stn 71. CTD, Optics and Microplankton Net. ARGO float deployed on departure
05/11/2011	14:10	06/11/2011	02:56		Reposition to next station. Clocks retarded to GMT-2
06/11/2011	02:56	06/11/2011	04:08		Stn 72. CTD and Bongo Nets
06/11/2011	04:08	06/11/2011	12:32		Reposition to next station
06/11/2011	12:32	06/11/2011	14:11		Stn 73. CTD, Optics and Microplankton Net. ARGO float deployed on departure
06/11/2011	14:11	07/11/2011	02:56		Reposition to next station
07/11/2011	02:56	07/11/2011	04:00		Stn 74. CTD and Bongo Nets
07/11/2011	04:00	07/11/2011	12:29		Reposition to next station

Start		End			Comment
Date	**Time**	**Date**	**Time**		**All times GMT**
07/11/2011	12:29	07/11/2011	14:00		Stn 75. CTD, Optics and Microplankton Net.
07/11/2011	14:00	08/11/2011	02:56		Reposition to next station
08/11/2011	02:56	08/11/2011	04:14		Stn 76. CTD and Bongo Nets
08/11/2011	04:14	08/11/2011	12:29		Reposition to next station
08/11/2011	12:29	08/11/2011	14:29		Stn 77. CTD, Optics and Microplankton Net. End of Science - Set Course for Punta Arenas
08/11/2011	14:29	12/11/2011	06:53		Passage to Punta Arenas
12/11/2011	06:53	12/11/2011	15:04		Pilotage
12/11/2011	15:04	12/11/2011	21:37		Vessel to anchor due high winds then slow steaming due to dragging, awaiting moderation of winds for berthing
12/11/2011	21:37	12/11/2011	22:30		Pilotage to berth
12/11/2011	22:30	13/11/2011	17:00		Demob

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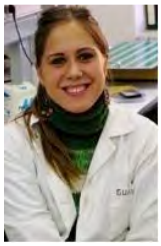

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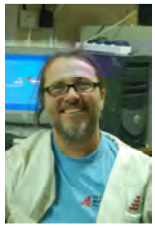

John Hagan
2nd Engineer

Gary Slater
3rd Engineer

Kevin Morrison
3rd Engineer

Dennis Jakobaufderstroht
Electrical Officer

Graham Bullimore
Purser

Ship's Crew

Greg Lewis
Bosun, Deck

John Smyth
Motorman

Mark Squibb
Bosun, Scientific

Robert Spencer
Bosun's Mate

Ian Mills
Deck Hand

Willie McLennan
Deck Hand

Andy Watkinson
Deck Hand

John MacDonald
Deck Hand

John Haughton
Head Chef

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Scientific Reports

Collection of aerosol and rainwater samples: the iodine chemistry in marine aerosol

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Iodine chemistry in the atmosphere has turned out to be one of the contested research topics which require further detailed investigations, particularly the behaviour of iodine species in marine aerosols. The biogeochemical cycle of iodine is very complex, which involves processes of ocean release, air-sea transfer, photochemical transformation and aerosol uptake. The pathways of iodine in the atmosphere play an important role of the dissociation of ozone molecules. Details of these pathways have not been fully explained. Data from current research both field observations and modelling studies have been used to explain such complexity. However, gaps of knowledge related to iodine chemistry in marine aerosols are still a remaining challenge to be truly understood.

The objective of this research is to investigate the characteristics of marine aerosol iodine species of the Atlantic Ocean. This study will also investigate the iodine speciation of rainwater samples across the Atlantic. Results from both aerosol and rainwater sample analysis could be used to improve understanding of the iodine chemistry in marine aerosols. The findings from the AMT21 data will be used to bridge the gap of iodine chemistry between modelling studies and observational results.

During this AMT21, aerosol samples were collected on filters and will be used to analyse major ions and trace metals. Rainwater samples were collected to analyse its chemical composition. Studying the concentration of major ions and trace metals in the atmosphere could lead to achieve better understanding of the major controls on and the influences of aerosol inputs on ocean biogeochemistry.

Aerosol Sampling
Aerosol samples were collected by using a high volume air sampler. Two collectors were set up on the monkey island in order to collect aerosol samples for analysing major ions and trace metals. Both aerosol collectors were connected to the wind sector controller. This automatic wind sector controller operates when the relative wind is between 280 - 140 degrees. Both collectors were calibrated and the flow rate set to about 1.10 m^3 per minute. Cleaned filters were loaded into filter holders on a daily basis or every two days when the air was cleaner in the southern hemisphere (after 20°S).

Glass microfiber filters were used to collect major ion aerosol samples. These filters were prepared by Milli-Q rinsing and baked at 450℃ overnight to remove organic matter. Cellulose filters were used for trace metal aerosol samples. These cellulose filters were washed by acid. For each aerosol collector, both coarse and fine particles were collected using slotted filters (the cascade impactor stage 3 & 4) and the back up filters (20 cm x 25 cm) respectively. Loading and collecting filters was carried out in a dust-free environment inside the laminar flow hood. Each filter was packed and sealed separately in plastic bags. During the AMT21, 33 stations of aerosol samples were collected. Details of aerosol sample collection are shown in Table 1. Aerosol samples were stored in the freezer at -20ºC for future analysis after the samples arrive back to the UK.

For the experimental analysis of iodine concentration in the atmosphere, one quarter of major ion aerosol samples will be used to analyse the iodine concentration and its speciation. Filters will be extracted by using Milli-Q water. However, the exact extraction method has not yet been decided. Then, the liquid will be filtered and the total soluble iodine will be analysed by using the inductively coupled plasma mass spectrometry (ICP-MS). Inorganic iodine such as iodide can be detected by the electrochemical method, the cathodic stripping square wave voltammetry (CSSWV), and the UV-spectrophometric method will be used to analyse iodate (Baker 2004; Baker 2005). The expected date for completing analysing iodine concentration in the atmosphere and its speciation will be at the end of September 2012.

Analysing other major ions and trace metals in aerosol samples will be conducted by Dr Alex Baker at the School of Environmental Sciences, University of East Anglia.

Table 1: Aerosol sample collection for major ions (I) and trace metal (M) analysis

Samples	Sampling Duration (hours)	Start Sampling				End Sampling			
		Date	Time (GMT)	Latitude	Longitude	Date	Time (GMT)	Latitude	Longitude
AMT21 I04	9.85	1.10.11	16:15	49 °07.39' N	014°48.44' W	2.10.11	12:40	47°03.86' N	017°49.05' W
AMT21 M04	9.94								
AMT21 I05	20.13	2.10.11	17:00	46°41.32' N	018°04.03' W	3.10.11	12:40	43°49.38' N	019°55.17' W
AMT21 M05	20.08								
AMT21 I06	21.58	3.10.11	15:31	43°40.91' N	019°59.81' W	4.10.11	12:36	40°42.17' N	021°50.28' W
AMT21 M06	21.57								
AMT21 I07	20.97	4.10.11	16:10	40°26.83' N	021°59.47' W	5.10.11	12:40	37°20.18' N	023°48.50' W
AMT21 M07	20.96								
AMT21 I08	18.27	5.10.11	14:40	37°15.72' N	023°50.56' W	6.10.11	12:40	34°91.76' N	026°85.50' W
AMT21 M08	18.32								
AMT21 I09	18.59	6.10.11	14:15	34°53.62' N	026°51.77' W	7.10.11	12:35	32°50.59' N	029°37.72' W
AMT21 M09	18.61								
AMT21 I10	10.49	7.10.11	14:23	32°48.04' N	029°38.10' W	8.10.11	12:30	30°54.08' N	032°09.96' W
AMT21 M10	10.54								
AMT21 I11	18.75	8.10.11	14:11	30°53.37' N	032°11.05' W	9.10.11	13:22	28°53.02' N	034°44.79' W
AMT21 M11	18.81								
AMT21 I12	22.84	9.10.11	15:08	28°50.33' N	034°48.33' W	10.10.11	13:42	26°55.84' N	037°11.86' W
AMT21 M12	22.84								
AMT21 I13	22.54	10.10.11	15:12	26°55.21' N	037°12.56' W	11.10.11	13:30	24°58.84' N	039°36.15' W
AMT21 M13	22.52								
AMT21 I14	21.29	11.10.11	16:08	24°55.40' N	039°41.19' W	12.10.11	13:40	22°47.44' N	040°21.32' W
AMT21 M14	21.30								
AMT21 I15	21.16	12.10.11	16:50	22°39.04' N	040°14.85' W	13.10.11	13:42	20°24.48' N	038°33.60' W
AMT21 M15	21.16								
AMT21 I16	19.56	13.10.11	15:55	20°23.46' N	038°32.49' W	14.10.11	11:15	18°15.00' N	036°59.58' W
AMT21 M16	19.55								
AMT21 I17	17.59	14.10.11	15:32	18°01.30' N	036°50.20' W	15.10.11	12:03	15°51.99' N	035°19.04' W
AMT21 M17	17.64								
AMT21 I18	20.83	15.10.11	15:40	15°39.76' N	035°10.96' W	16.10.11	12:17	12°59.20' N	033°21.32' W
AMT21 M18	20.82								
AMT21 I19	21.58	16.10.11	15:05	12°45.27' N	033°12.04' W	17.10.11	13:07	09°45.78' N	031°13.45' W
AMT21 M19	21.64								
AMT21 I20	22.10	17.10.11	15:10	09°38.77' N	031°08.44' W	18.10.11	12:50	06°39.55' N	029°13.10' W
AMT21 M20	22.09								
AMT21 I21	22.18	18.10.11	14:37	06°31.24' N	029°07.69' W	19.10.11	12:22	03°88.29' N	027°45.10' W
AMT21 M21	22.18								
AMT21 I22	20.88	19.10.11	15:45	03°41.25' N	027°17.72' W	20.10.11	12:15	01°10.90' N	025°44.69' W
AMT21 M22	20.93								
AMT21 I23	19.65	20.10.11	14:35	01°01.99' N	025°38.96' W	21.10.11	10:35	01°40.13' S	025°00.51' W
AMT21 M23	19.65								
AMT21 I24	24.06	21.10.11	12:10	01°56.55' S	025°00.61' W	22.10.11	11:47	05°24.46' S	025°01.43' W
AMT21 M24	24.05								

Samples	Sampling Duration (hours)	Start Sampling	End Sampling						
		Date	Time (GMT)	Latitude	Longitude	Date	Time (GMT)	Latitude	Longitude
AMT21 M25	22.22								
AMT21 I26	23.38	23.10.11	14:21	08° 42.22' S	025° 03.35' W	24.10.11	13:20	11° 39.82' S	025° 03.91' W
AMT21 M26	23.37								
AMT21 I27	23.22	24.10.11	15:20	11° 39.23' S	025° 03.63' W	25.10.11	14:09	14° 10.60' S	025° 04.59' W
AMT21 M27	23.22								
AMT21 I28	21.69	25.10.11	15:41	14° 10.34' S	025° 04.48' W	26.10.11	13:15	16° 57.42' S	025° 05.48' W
AMT21 M28	21.70								
AMT21 I29	23.23	26.10.11	15:24	16° 56.83' S	025° 04.94' W	27.10.11	14:44	18° 31.79' S	025° 06.01' W
AMT21 M29	23.24								
AMT21 I30	19.80	27.10.11	16:28	18° 31.91' S	025° 04.60' W	28.10.11	13:18	21° 05.76' S	025° 04.44' W
AMT21 M30	19.84								
AMT21 I31	15.85	28.10.11	15:08	21° 05.03' S	025° 04.64' W	30.10.11	11:15	26° 52.08' S	025° 00.73' W
AMT21 M31	15.91								
AMT21 I32	31.87	30.10.01	13:27	27° 09.40' S	025° 00.17' W	1.11.11	13:17	31° 26.45' S	029° 42.05' W
AMT21 M32	31.93								
AMT21 I33	32.14	1.11.11	15:15	31° 26.52' S	029° 41.33' W	3.11.11	13:40	35° 22.42' S	035° 16.68' W
AMT21 M33	32.23								
AMT21 I34	43.92	3.11.11	15:40	35° 31.55' S	035° 30.85' W	5.11.11	11:10	38° 48.46' S	040° 24.34' W
AMT21 M34	43.92								
AMT21 I35	15.07	5.11.11	15:39	39° 05.13' S	040° 46.69' W	7.11.11	12:15	42° 55.11' S	046° 51.87' W
AMT21 M35	15.06								
AMT21 I36	33.06	7.11.11	14:30	43° 06.55' S	047° 10.79' W	9.11.11	10:52	46° 57.28' S	054° 43.48' W
AMT21 M36	33.12								

Rainwater Sampling

Rainwater samples were collected by using rain funnels, which were set up in the monkey island. Two rain funnels were used to collect rainwater samples for analysing both major ions and trace metals. Rainwater samples were collected 7 events during this AMT21. Details of rainwater sample collection are shown in Table 2. There have been many attempted events to collect rainwater samples, however, the collected volume of those samples were not sufficient. After collecting, rainwater samples were stored in the freezer at -20ºC for future analysis after the samples arrive back to the UK.

For future analysis, rainwater samples will be filtered through 0.45 µm filters. Similarly to aerosol samples, total soluble iodine and iodine species such as iodide and iodate will be analysed by similar methods as aerosol samples. In addition, ion chromatography-inductively coupled plasma mass spectrometry (IC-ICP-MS) will be developed to analyse the iodine speciation in the future (Lai et al., 2008).

Analysing other major ions and trace metals in rainwater samples will be conducted by Dr Alex Baker at the School of Environmental Sciences, University of East Anglia.

Table 2: Rainwater sample collection for major ions (RI) and trace metals (RT) analysis

Samples	Approx. Collected Volume (mL)	Start Sampling				End Sampling			
		Date	Time (GMT)	Latitude	Longitude	Date	Time (GMT)	Latitude	Longitude
AMT21 RI02	130	30.9.11	09:20	50° 08.58' N	008° 30.03' W	30.9.11	12:00	49° 57.28' N	009° 07.47' W
AMT21 RT02									
AMT21 RI03	100	11.10.11	19:49	24° 33.75' N	040° 06.76' W	12.10.11	09:24	23° 18.72' N	040° 45.43' W
AMT21 RT03									
AMT21 RI04	125	12.10.11	11:08	23° 05.40' N	040° 35.14' W	12.10.11	12:55	22° 52.60' N	040° 25.25' W
AMT21 RT04									
AMT21 RI05	400	12.10.11	14:55	22° 46.25' N	040° 20.90' W	12.10.11	16:00	22° 43.86' N	040° 18.53' W
AMT21 RT05									
AMT21 RI06	200	16.10.11	19:53	12° 09.09' N	032° 47.85' W	16.10.11	20:48	12° 01.30' N	032° 42.68' W
AMT21 RT06									
AMT21 RI07	225	17.10.11	06:38	10° 45.09' N	031° 52.76' W	17.10.11	11:46	09° 58.80' N	031° 21.92' W
AMT21 RT07									
AMT21 RI08	240	31.10.11	20:45	29° 57.02' S	027° 38.72' W	1.11.11	09:40	31° 05.96' S	029° 13.63' W
AMT21 RT08									

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Gilfedder, B.S., S.C. Lai, M. Petri, Biester, H., and T. Hoffmann (2008). “Iodine speciation in rain, snow and aerosols.” Atmos. Chem. Phys. **8**: 6069-6084.

Sample collection for quantification of phytoplankton pigments using High Performance Liquid Chromatography (HPLC)

Rob Ellis
Plymouth Marine Laboratory

Rob Ellis conducted the sample collection and filtration for HPLC pigments. Fresh seawater samples from 6 of 7 light depths (97, 55, 33, 14, 7, 1 and 0.1% of surface light). Additionally to 6 light depths, the deep chlorophyll maximum (DCM) was also measured. If the DCM was found to be the same depth as either the 7% or 1% light depth, an additional depth was measured between 7% and 1%. Seawater samples were collected into 9.5 L polypropylene carboys covered in black plastic to keep out light. Duplicate 1-3 L samples (depending on phytoplankton abundance) 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 -80ºC. Table 1.: summarises the CTD casts sampled during the cruise. Samples will be analysed by HPLC after the cruise.

Table 1: CTD casts sampled for phytoplankton pigments.

Date	Ctd	Time on deck (gmt)	Lat	Long	Depths sampled (m)
30.9.11	001	04:05	50° 27.23' N	07° 26.72' W	2 10 15 20 25 30
30.9.11	002	12:14	49° 57.23' N	09° 07.56' W	2 10 15 20 25 30 40
1.10.11	003	05:32	49° 16.86' N	12° 43.19' W	2 5 10 20 30 40 50
1.10.12	004	13:59	49° 08.76' N	14° 30.95' W	2 5 10 20 30 40 50
2.10.11	005	05:27	48° 08.00' N	17° 06.21' W	2 7 13 24 32 45 55
2.10.11	006	13:52	47° 01.68' N	17° 50.45' W	2 7 13 24 32 55 80
3.10.11	007	05:33	44° 54.47' N	19° 13.38' W	2 7 12 22 29 40 55
3.10.11	008	13:49	43° 46.80' N	19° 56.81' W	2 7 12 22 29 50 55
4.10.11	009	05:23	41° 47.60' N	21° 10.57' W	2 9 16 28 38 63 65
4.10.12	010	13:50	40° 39.93' N	21° 51.55' W	2 9 16 28 38 60 65
5.10.11	011	05:24	38° 30.91' N	23° 07.63' W	2 9 17 30 41 60 70
5.10.11	012	13:40	37° 18.04' N	23° 49.70' W	2 11 20 37 50 87 87
6.10.11	013	05:31	35° 41.51' N	25° 48.89' W	2 14 25 45 61 78 105
6.10.11	014	14:13	34° 53.92' N	26° 52.96' W	2 15 28 49 66 82 115
7.10.11	015	05:20	33° 30.11' N	28° 45.21' W	2 11 20 36 49 80 84
7.10.11	016	13:56	32° 49.17' N	29° 39.51' W	2 13 24 43 58 75 103
8.10.11	017	05:30	31° 32.85' N	31° 19.53' W	2 14 25 44 59 88 103
8.10.11	018	13:55	30° 52.87' N	32° 11.71' W	2 14 25 44 59 75 103
9.10.11	019	06:45	29° 29.07' N	33° 58.30' W	2 15 27 48 65 102 112
9.10.11	020	14:53	28° 50.35' N	34° 48.45' W	2 15 27 48 65 95 112
10.10.11	021	06:35	27° 34.85' N	36° 22.84' W	2 14 25 44 60 85 105
10.10.11	022	14:53	26° 54.91' N	37° 12.82' W	2 16 29 52 70 100 120
11.10.11	023	06:23	25° 37.52' N	38° 48.24' W	2 16 29 52 70 90 120
11.10.11	024	15:10	24° 56.55' N	39° 38.98' W	2 16 29 52 70 110 120
12.10.11	025	06:20	23° 37.72' N	41° 00.66' W	2 16 29 52 70 90 120
12.10.11	026	14:51	22° 46.17' N	40° 20.66' W	2 16 29 52 70 110 120
13.10.11	027	06:39	21° 12.96' N	39° 09.20' W	2 16 29 52 70 85 120

Date	Ctd	Time on deck (gmt)	Lat	Long	Depths sampled (m)
13.10.11	028	14:57	20° 23.43' N	38° 33.00' W	2 18 32 58 78 115 135
14.10.11	029	06:22	18° 49.40' N	37° 23.94' W	2 17 31 56 75 90 130
14.10.11	030	15:06	18° 00.94' N	36° 49.82' W	2 15 28 50 68 100 120
15.10.11	031	06:41	16° 28.70' N	35° 44.42' W	2 14 26 46 62 90 107
15.10.11	032	14:47	15° 39.02' N	35° 10.23' W	2 12 22 39 52 70 90
16.10.11	033	06:21	13° 47.12' N	33° 53.72' W	2 11 20 36 49 75 85
16.10.11	034	14:55	12° 45.38' N	33° 12.24' W	2 11 20 36 49 65 85
17.10.11	035	06:21	10° 45.43' N	31° 52.40' W	2 9 17 30 41 54 70
17.10.11	036	15:03	09° 39.48' N	31° 09.19' W	2 9 16 28 38 59 65
18.10.11	037	06:21	07° 35.39' N	29° 48.62' W	2 10 20 33 44 65 77
18.10.11	038	14:50	06° 31.34' N	29° 07.96' W	2 11 20 33 44 55 75
19.10.11	039	06:33	04° 37.59' N	27° 55.16' W	2 14 26 46 62 80 107
19.10.11	040	14:50	03° 40.96' N	27° 19.26' W	2 11 20 35 47 74 82
20.10.11	041	06:19	01° 55.70' N	26° 13.20' W	2 11 20 36 49 70 85
20.10.11	042	14:20	01° 02.12' N	25° 39.07' W	2 11 20 36 49 76 85
21.10.11	043	06:24	01° 01.90' S	25° 00.27' W	2 12 22 39 52 70 90
22.10.11	044	06:34	04° 40.59' S	25° 01.35' W	2 11 20 35 47 80 85
22.10.11	045	14:27	05° 36.91' S	25° 01.80' W	2 12 22 39 52 60 90
23.10.11	046	06:27	07° 42.52' S	25° 02.34' W	2 13 24 43 58 94 100
23.10.11	047	14:27	08° 42.36' S	25° 03.35' W	2 12 24 43 58 95 100
24.10.11	048	06:15	10° 41.25' S	25° 03.34' W	2 15 28 49 66 95 115
24.10.11	049	14:32	11° 39.80' S	25° 03.89' W	2 17 31 56 75 110 130
25.10.11	050	06:31	13° 34.85' S	25° 04.09' W	2 20 36 65 87 130 140
25.10.11	051	16:24	14° 11.02' S	25° 04.55' W	2 15 28 50 68 118 142
26.10.11	052	05:55	15° 55.52' S	25° 05.39' W	2 15 28 50 68 118 160
26.10.11	053	14:35	16° 57.62' S	25° 05.65' W	2 15 28 50 68 118 160
27.10.11	054	05:52	18° 31.50' S	25° 06.08' W	2 20 33 58 78 135 160
28.10.11	055	05:53	20° 00.85' S	25° 05.46' W	2 20 33 58 78 135 160
28.10.11	056	14:27	21° 05.73' S	25° 04.56' W	2 20 33 58 78 135 160
29.10.11	057	05:48	23° 04.58' S	25° 03.43' W	2 17 31 55 74 128 140
29.10.11	058	14:21	24° 06.80' S	25° 02.69' W	2 17 31 55 74 128 140
30.10.11	059	05:48	26° 05.53' S	25° 01.49' W	2 17 31 55 74 128 140
30.10.11	060	14:26	27° 09.40' S	25° 00.70' W	2 17 30 54 73 120 125
31.10.11	061	06:11	28° 48.13' S	25° 57.09' W	2 15 27 48 65 91 104
31.10.11	062	14:40	29° 22.68' S	26° 51.72' W	13 24 43 58 80 90 100
1.11.11	063	05:56	30° 44.11' S	28° 43.84' W	2 12 22 39 52 70 90
1.11.11	064	14:36	31° 27.07' S	29° 42.38' W	2 15 28 50 68 95 120
2.11.11	065	06:12	32° 43.55' S	31° 33.07' W	2 12 22 40 53 90 92
5.11.11	067	06:01	38° 13.33' S	39° 31.12' W	2 6 11 20 27 36 45
5.11.11	068	14:28	39° 02.12' S	40° 44.55' W	2 6 11 15 20 25 30
6.11.11	069	06:08	40° 20.22' S	42° 45.28' W	2 5 8 15 20 25 34
6.11.11	070	15:32	41° 07.54' S	43° 58.95' W	3 5 10 17 23 40 50

Date	Ctd	Time on deck (gmt)	Lat	Long	Depths sampled (m)
7.11.11	071	06:00	42° 18.87' S	45° 53.70' W	2 7 14 24 32 50 56
7.11.11	072	15:18	43° 06.56' S	47° 10.77' W	2 7 14 24 33 45 56
8.11.11	073	06:13	44° 20.01' S	49° 11.62' W	2 5 8 15 20 25 35
8.11.11	074	15:34	45° 05.67' S	50° 29.87' W	2 7 13 18 25 30 40

Study of nitrogen fixation genes in marine waters

Rob Ellis
Plymouth Marine Laborratory

Rob Ellis conducted the sample collection and filtration for nitrogen fixation genes. Sample collection commenced on 8.10.11 and was undertaken at every noon CTD station until 28.10.11. At each afternoon station water was collected from the 97% light depth in to a 20 L polypropylene carboy covered in black plastic to keep out light. DNA samples were collected by filtering seawater through a 0.22µm sterivex filter using a peristaltic pump, samples were run for 1 hour which equated to 9-12 L. Low flux velocity was used to not damage the cells. Samples were then sealed with bluetac and stored in a -80 ºC freezer for transport back to the UK. Data will be analysed at PML by Dr Andy Rees.

Table 2: CTD casts sampled for nitrogen fixation genes during AMT21.

Date	Ctd	Time on deck (gmt)	Lat	Long	Depth sampled (m)
8.10.11	018	13:55	30° 52.87' N	32° 11.71' W	2
9.10.11	020	14:53	28° 50.35' N	34° 48.45' W	2
10.10.11	022	14:53	26° 54.91' N	37° 12.82' W	2
11.10.11	024	15:10	24° 56.55' N	39° 38.98' W	2
12.10.11	026	14:51	22° 46.17' N	40° 20.66' W	2
13.10.11	028	14:57	20° 23.43' N	38° 33.00' W	2
14.10.11	030	15:06	18° 00.94' N	36° 49.82' W	2
15.10.11	032	14:47	15° 39.02' N	35° 10.23' W	2
16.10.11	034	14:55	12° 45.38' N	33° 12.24' W	2
17.10.11	036	15:03	09° 39.48' N	31° 09.19' W	2
18.10.11	038	14:50	06° 31.34' N	29° 07.96' W	2
19.10.11	040	14:50	03° 40.96' N	27° 19.26' W	2
20.10.11	042	14:20	01° 02.12' N	25° 39.07' W	2
22.10.11	045	14:27	05° 36.91' S	25° 01.80' W	2
23.10.11	047	14:27	08° 42.36' S	25° 03.35' W	2
24.10.11	049	14:32	11° 39.80' S	25° 03.89' W	2
25.10.11	051	16:24	14° 11.02' S	25° 04.55' W	2
26.10.11	053	14:35	16° 57.62' S	25° 05.65' W	2
28.10.11	056	14:27	21° 05.73' S	25° 04.56' W	2

CTD and underway sensor calibrations

Rob Thomas
British Oceanographic Data Centre

CTD profiles

A total of 74 CTD casts were completed during the cruise. All casts were conventional profiling casts with water sampling by 24 x 20L OTE Niskin bottles. Casts were carried out pre-dawn and at solar noon each day. All times quotes are GMT/UT.

CTD casts were recorded using the Sea-Bird data collection software Seasave-Win32. The software outputs were then processed following the BODC recommended guidelines using SBE Data Processing-Win32 v7.20g; the processing routines are named after each stage in brackets < >. The software applied the calibrations as appropriate through the instrument configuration file to the data in engineering units output by the CTD hardware.

An ascii file (CNV) containing the 24 Hz data for up and down casts was generated from the binary Sea-Bird files <DatCnv> for each cast. Files were created for each cast containing the mean values of all the variables at the bottle firing events <Bottle Summary>. Using the CNV files processing routines were applied to remove pressure spikes <WildEdit>, the oxygen sensor was then shifted relative to the pressure by 2 seconds, to compensate for the lag in the sensor response time <AlignCTD> and the effect of thermal 'inertia' on the conductivity cells was removed <CellTM>. The surface soak was identified for each cast, removed and LoopEdit run. Salinity and oxygen concentration were rederived and density (sigma-T with channel 1 and sigma-theta with channel 2) were derived <Derive> after the corrections for sensor lag and thermal 'inertia' had been applied. The CTD files produced from Sea-Bird processing were converted from 24 Hz ascii files into 2 Hz ascii files of the complete cast (down and upcasts) with all channels for archive at BODC and also to 1 dbar downcast files for calibration and visualisation onboard <BinAverage>. The initial salinity and oxygen channels produced at the DatCnv stage along with the conductivity, voltage and altimeter channels removed from the 1 dbar downcast files <Strip>.

The Sea-Bird 1 dbar downcast files were converted from the Sea-Bird CNV format to the tab delimited ODV format using the mapping described below:

Parameter Name in Sea-Bird CNV	Units	Parameter Name in ODV file	Units	Comments
prDM: Pressure, Digiquartz	dbar	Pressure	dbar	-
t090C: Temperature	ITS-90, ℃	Temperature_1	ITS-90, ℃	-
t190C: Temperature, 2	ITS-90, ℃	Temperature_2	ITS-90, ℃	-
flC: Fluorescence, Chelsea Aqua 3 Chl Con	µg l^{-1}	Fluo_notional	mg m^{-3}	Units equivalent. No conversion applied.
par: PAR/Irradiance, Biospherical/Licor	W m^{-2}	PAR_down	W m^{-2}	-
par1: PAR/Irradiance, Biospherical/Licor, 2	W m^{-2}	PAR_up	W m^{-2}	-
turbWETbb0: Turbidity, WET Labs ECO BB	m^{-1} sr^{-1}	Backscatter	m^{-1} sr^{-1}	Provisional calibration applied during the cruise. Final calibration to be applied post cruise and data supplied as a separate series.
xmiss: Beam Transmission, Chelsea/Seatech/WET Labs CStar	%	Beam_trans	%	Provisional calibration applied during the cruise. Final calibration to be applied post cruise and data supplied as a separate series.
bat: Beam Attenuation, Chelsea/Seatech/WET Labs CStar	m^{-1}	Beam_attn	m^{-1}	Provisional calibration applied during the cruise. Final calibration to be applied post cruise and data supplied as a separate series.
sal00: Salinity, Practical	PSU	Salinity_1_SBEcal	dimensionless	-
sal11: Salinity, Practical, 2	PSU	Salinity_2_SBEcal	dimensionless	-
sbeox0ML/L: Oxygen, SBE 43	ml l^{-1}	Oxy_conc_ml	ml l^{-1}	-

Parameter Name in Sea-Bird CNV	Units	Parameter Name in ODV file	Units	Comments
sbeox0Mg/L: Oxygen, SBE 43	mg l^{-1}	Oxy_conc_mg	mg l^{-1}	-
sigma-t00: Density	kg m^{-3}	Density_1	kg m^{-3}	-
sigma-é11: Density, 2	kg m^{-3}	Density_2	kg m^{-3}	-

The sensor values at bottle firing were collated from the files generated by the Sea-Bird processing Bottle Summary routine. These were matched to samples water samples that had been collected from each cast for measurement of salinity (bench salinometer) and chlorophyll-a (filtration, acetone extraction and fluorometer measurement) and from the pre-dawn cast each day for oxygen (Winkler titration). These data were used to generate calibrations for the salinity, oxygen and fluorometer channels.

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

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

Offset = a * Discrete sample + b

Where offset = Discrete sample – Sensor value

To give Calibrated value = 1/(1-a) * Sensor value + b/(1-a)

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

In the case of the fluorometer where the regression changed along the cruise track calibrations were derived on a cast by cast basis. All calibration datasets are available upon request from BODC post cruise.

Temperature

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

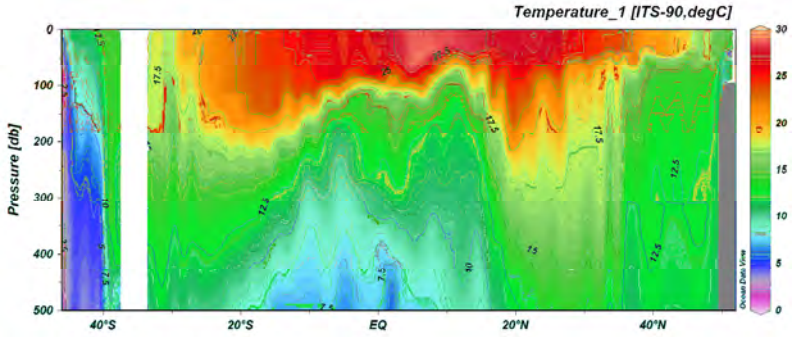

Fig. 1: Temperature section plot along the AMT21 transect by latitude from the frame mounted sensor.

Salinity
The salinity channels were calibrated against bench salinometer measurements. Further details of these measurements can be found in the NMF-SS cruise report section.

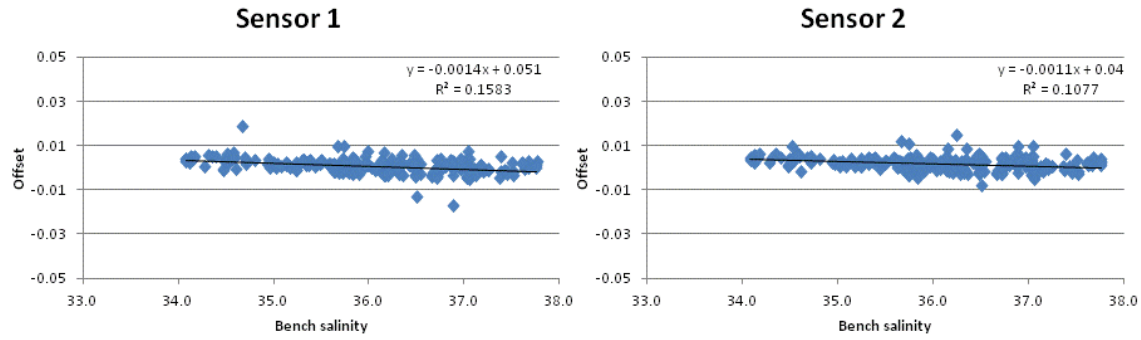

Fig. 2: Salinity offsets for each sensor against discrete sample salinity measured with a bench salinometer.

The conductivity sensors operated without problem during the cruise. The calibration equations for the sensors were:

Sensor 1 - Calibrated = 0.9986 * sensor + 0.0509 (n = 283; r^2 = 0.158; p <0.001):

Sensor 2 - Calibrated = 0.9989 * sensor + 0.0400 (n = 283; r^2 = 0.108; p <0.001):

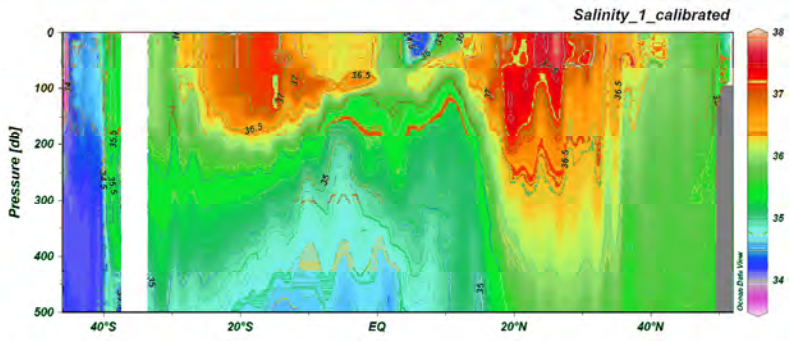

Fig. 3: Salinity section plot along the AMT21 transect by latitude from the frame mounted sensor calibrated against bench salinometer samples.

Oxygen
The oxygen sensor was calibrated against discrete oxygen sample Winkler titration measurements from up to 9 samples collected from the pre-dawn CTD. More details can be found in Elena Garcia and Maria Aranguren's report.

The Winkler titration samples from casts 23, 25 and 65 did not fit the pattern observed with the data from the other casts. After discussion with Elena Garcia and Maria Aranguren these data were excluded from the calibration data set.

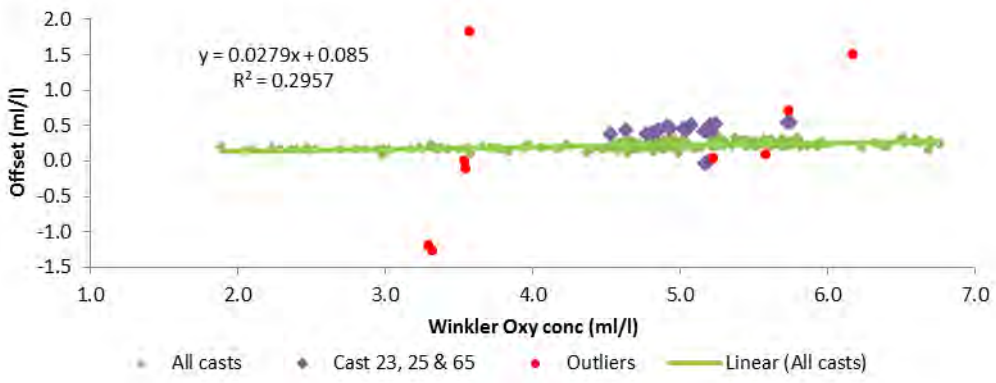

Fig. 4: Oxygen concentration offsets against Winkler titration measurements from discrete samples.

The oxygen sensor operated without problem during the cruise. The offset regression against Winkler titration oxygen concentration was significant (n = 286; r^2 = 0.295; p <0.001). The calibration equation for the sensor was

ml/l: Calibrated = 1.0287 * sensor + 0.0874

umol/l: Calibrated = 1.0287 * sensor + 3.9051

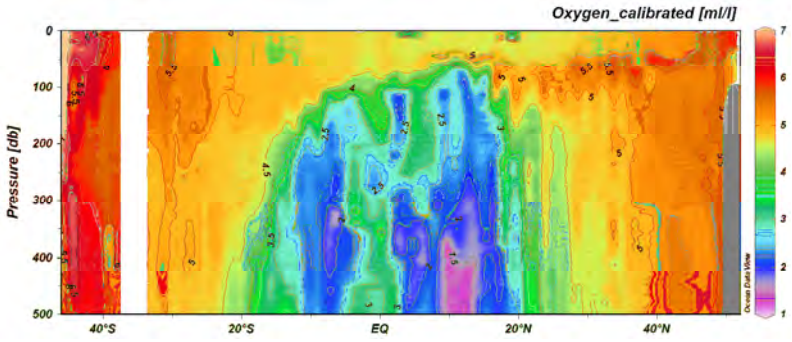

Fig. 5: Oxygen concentration section plot along the AMT21 transect by latitude from the SBE43 oxygen sensor calibrated against Winkler titration samples.

Fluorometer

The CTD fluorometer operated without problem during the cruise. It was calibrated against extracted chlorophyll-a measurements made on seawater samples collected from 8-10 depths at each station. More details of the samples collected and protocols can be found in the appropriate cruise report section.

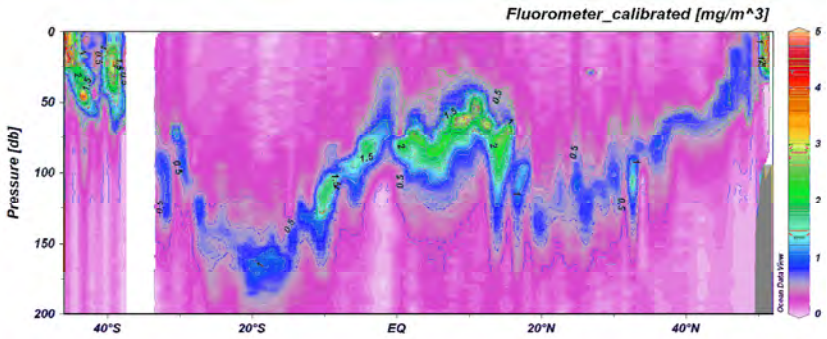

Fig. 6: Chlorophyll-a section plot along the AMT21 transect by latitude.

The calibration was carried out on a cast by cast basis and further details are available in the BODC CTD documentation supplied with the profiles online after the cruise.

Underway sensors

The ship's underway meteorological and surface systems were run continuously through the cruise. The system started logging from 30/09/2011 08:00 (UT) and was switched off outside the 200 nm limit of Falkland Island and Argentinean territorial waters at 09/11/2011 14:00 (UT).
Samples were collected to calibrate the TSG and fluorometer connected to the ship's non-toxic flow-through system, which draws water from approximately 5 m below the water line.

SST – hull mounted sensor

The hull temperature sensor was calibrated against the CTD temperature sensor values at each station. There was no significant regression of the offset and CTD sensor values ($n = 60$; $r^2 = 0.006$; $p = 0.54$). There was a significant linear drift in the offset with time ($n = 60$; $r^2 = 0.076$; $p = 0.019$).

Offset at 30/09/2011 08:00 (UT) = 0.0036 deg. C
Offset at 09/11/2011 14:00 (UT) = -0.0077 deg. C

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

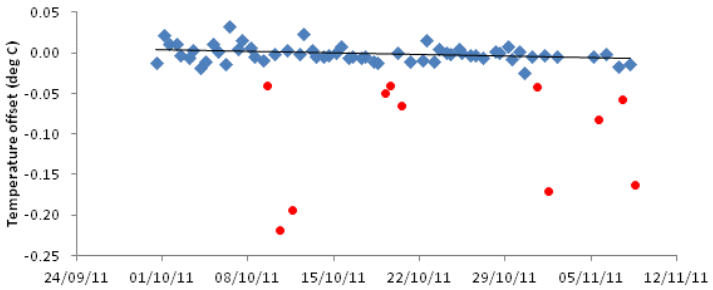

Fig. 7: Hull sensor temperature offsets against surface CTD temperature measurements.

Salinity

The TSG sensor salinity data were calibrated against samples collected and analysed with a bench salinometer. Five samples were collected each day at four hourly intervals starting 30 minutes before the pre-dawn station. There were significant regressions of the offset with bench salinity measurement ($r^2 = 0.18$; $n = 167$; $F = 38.0$; $p < 0.001$) and time ($r^2 = 0.43$; $n = 167$; $F = 127.3$; $p < 0.001$).

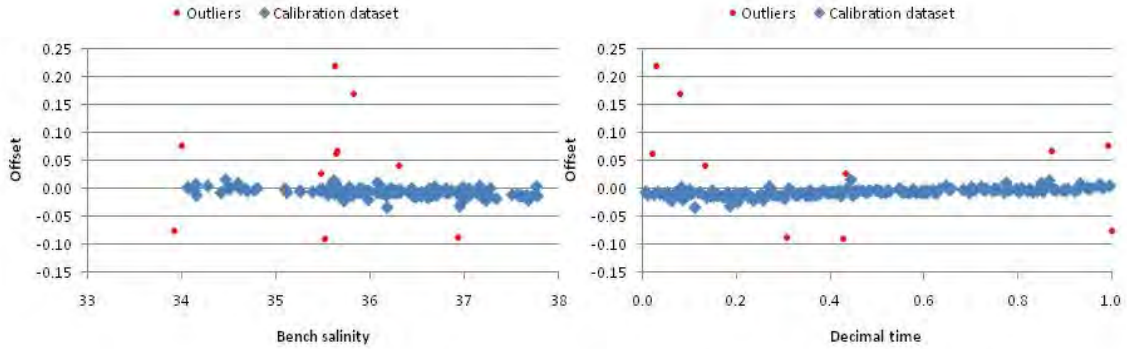

Fig. 8: Salinity offsets against bench salinometer measurements on discrete underway samples and decimalised time (30/09/2011 08:00 = 0 and 09/11/2011 14:00 = 1).

Since both regressions were significant the calibration data set was corrected by each regression equation and the RMS, mean, SD, min and max offsets for each calibration compared. The correction based on linear drift with time gave the greatest reduction in the RMS and minimised and centred the offset range closest to zero.

	Uncalibrated	Linear drift calibration	Bench salinity calibration
n (offset)	168	168	168
mean (offset)	-0.007	0.000	0.000
SD (offset)	0.0073	0.0055	0.0065
min (offset)	-0.035	-0.021	-0.028
max (offset)	0.015	0.023	0.019
SS	0.0169	0.0050	0.0071
RMS	0.010	0.005	0.007

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

Offset at 30/09/2011 08:00 (UT) = -0.0151
Offset at 09/11/2011 14:00 (UT) = 0.0017

Fluorometer
The underway fluorometer data were calibrated against samples collected and analysed with a bench fluorometer to give discrete extracted chlorophyll-a (extr chl-a) measurements. Five samples were collected each day at four hourly intervals starting 30 minutes before the pre-dawn station. More details of the samples collected and protocols can be found in the appropriate cruise report section. The fluorometer voltages were treated as “Raw Fluorescence Units” and the offset from the discrete sample extr chl-a plotted against decimal time and discrete sample extr chl-a.

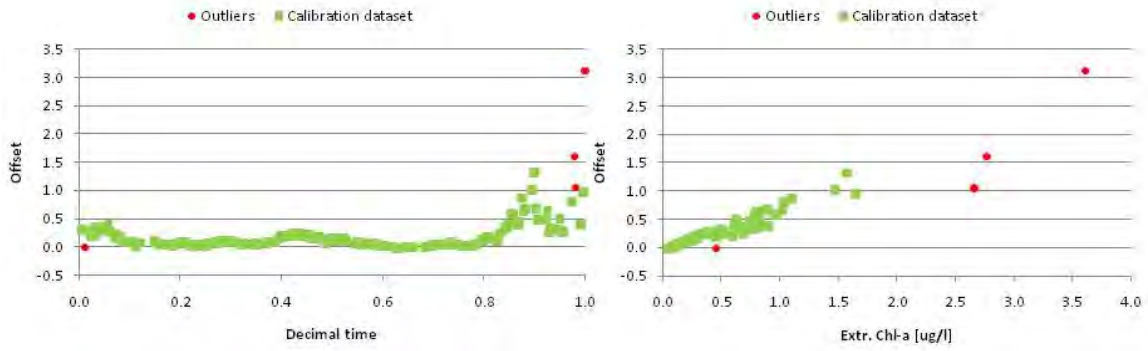

Fig. 9: Fluorescence offsets against decimalised time (30/09/2011 08:00 = 0 and 09/11/2011 14:00 = 1) and extr chl-a measurements on discrete underway samples.

Outliers were identified and based on a preliminary calibration against extracted chl-a, which over stated the chlorophyll concentrations at the start of the cruise; it was decided to split the dataset for calibration. The calibration was split at the fluorometer cleaning event at 03/10/2011 13:04.

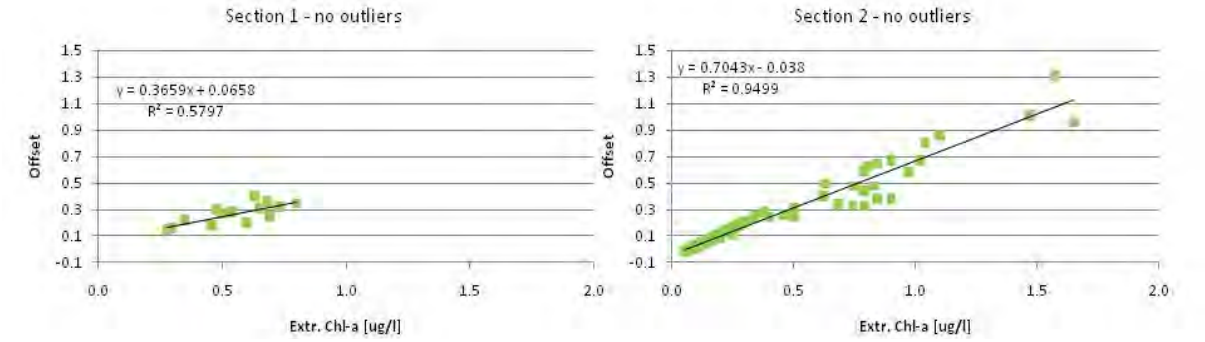

Fig. 10: Fluorescence offsets against extr chl-a measurements on discrete underway samples split between 30/09/2011 08:00 to 03/10/2011 13:04 (section 1) and 03/10/2011 13:04 to 09/11/2011 14 (section2).

The regression of offset with time was influenced by the high extr chl-a measurements in the South Atlantic and was disregarded. There were significant regressions of the offset with extr chl-a for both section 1 (r^2 = 0.54; n = 14; F = 16.5; p = 0.002) and section 2 (r^2 = 0.95; n = 157; F = 2941.3; p <0.001).

Section 1: Calibrated chl-a [in mg m^{-3}] = 1.5771 * voltage [in V] - 0.1038
Section 2: Calibrated chl-a [in mg m^{-3}] = 3.3824 * voltage [in V] - 0.1286

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

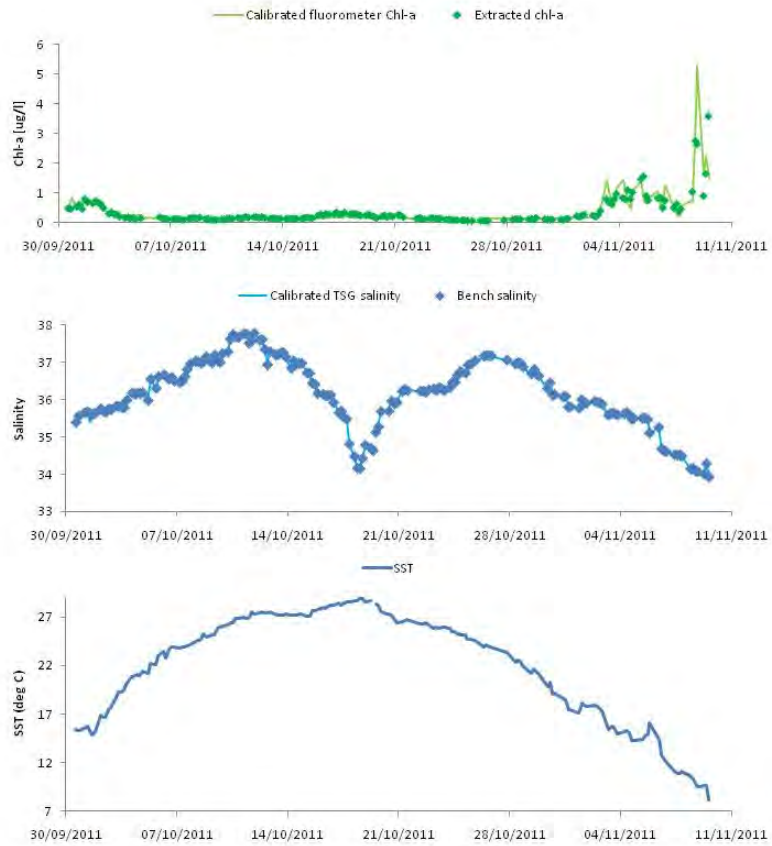

Fig. 11: Calibrated surface fluorometer (chl-a) with discrete samples, calibrated TSG salinity with bench salinity and calibrated hull sensor temperature measurements along the AMT21 cruise track.

Abundance and composition of microbial plankton communities by flow cytometry

Glen Tarran[(1)], Ross Holland[(2)]
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[(2)]*National Oceanography Centre, Southampton*

Objective
To determine the distribution, abundance and community structure of nano- and picophytoplankton, heterotrophic bacteria and heterotrophic nano- and picoplankton from CTD casts and the ship's pumped seawater supply by flow cytometry.

Phytoplankton community structure and abundance by flow cytometry.
Fresh seawater samples were collected in clean 125 mL polycarbonate bottles from a Seabird CTD system containing a 24 bottle rosette of 20 L Niskin bottles from all CTD casts. Samples were stored in a refrigerator and analysed within 2 hours of collection. Fresh samples were measured using a Becton Dickinson FACSort flow cytometer which characterised and enumerated *Prochlorococcus* sp. and *Synechococcus* sp. (cyanobacteria) and pico- and eucaryote phytoplankton, based on their light scattering and autofluorescence properties. Data were saved in listmode format and will be analysed ashore. Table 1 summarises the CTD casts sampled and analysed during the cruise.

Samples for bacteria and heterotrophic flagellate enumeration from CTD casts were 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 24 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 µm in diameter. Data were saved in listmode format and will be analysed ashore.

Table 1: CTD casts sampled for phytoplankton, heterotrophic bacteria and heterotrophic flagellate community structure and abundance

Date	Stn	CTD	Time on deck (GMT)	Lat + =N - = S	Long(W)	Depths
30-Sep	1	1	03:35	50.45	7.45	2 10 20 25 30 40 50 60 70 75 80 85
30-Sep	2	2	12:51	49.95	9.13	2 10 20 25 30 40 50 60 70 75 80 90 100
01-Oct	3	3	05:32	49.28	12.72	2 5 10 20 30 40 50 60 75 100 125 150 200 250 300
01-Oct	4	4	13:59	49.15	14.52	2 5 10 20 30 40 50 60 75 85 100 125 150 200 300
02-Oct	5	5	05:27	48.13	17.10	2 7 13 20 24 32 45 55 70 80 100 125 150 200 300
02-Oct	6	6	13:52	47.03	17.84	2 7 13 20 24 32 40 55 70 80 90 100 125 150 200 250 300
03-Oct	7	7	05:33	44.91	19.22	2 7 12 20 22 29 40 55 65 83 100 125 150 200 300
03-Oct	8	8	13:47	43.78	19.95	2 7 12 20 22 29 50 55 70 83 90 100 125 150 200 250 300
04-Oct	9	9	05:23	41.79	21.18	2 9 16 20 28 38 50 63 65 80 90 110 150 200 300
04-Oct	10	10	13:50	40.67	21.86	2 9 16 20 28 38 50 60 65 75 85 110 150 200 300
05-Oct	11	11	05:24	38.52	23.13	2 9 17 20 30 41 50 60 70 80 90 110 150 200 300
05-Oct	12	12	13:40	37.30	23.83	2 11 20 37 50 65 75 87 90 110 150 200 250 300
06-Oct	13	13	05:31	35.69	25.81	2 14 20 25 45 50 61 78 90 105 125 150 175 200 300
06-Oct	14	14	14:13	34.90	26.88	2 15 20 28 49 66 75 82 95 105 115 130 150 175 200 300
07-Oct	15	15	05:20	33.50	28.75	2 11 20 36 49 80 84 100 200 300
07-Oct	16	16	13:56	32.82	29.66	2 13 20 24 43 58 75 90 103 120 135 150 175 300
08-Oct	17	17	05:30	31.55	31.33	2 14 20 25 44 59 75 83 103 125 150 175 200 300
08-Oct	18	18	13:55	30.88	32.20	2 14 20 25 44 59 65 75 90 103 115 125 150 175 200 300
09-Oct	19	19	06:45	29.48	33.97	2 15 20 27 48 65 85 102 112 130 170 200 300
09-Oct	20	20	14:53	28.84	34.81	2 15 20 27 48 65 75 95 112 120 130 150 170 200 300

Date	Stn	CTD	Time on deck (GMT)	Lat + =N - = S	Long (W)	Depths
10-Oct	21	21	06:35	27.58	36.38	2 14 20 25 44 60 75 85 95 105 125 157 175 200 300
10-Oct	22	22	14:53	26.92	37.21	2 16 20 29 52 70 80 100 120 140 160 175 200 300
11-Oct	23	23	06:23	25.63	38.80	2 16 20 29 52 70 90 110 120 150 175 200 300
11-Oct	24	24	15:07	24.94	39.65	2 16 20 29 52 70 75 90 110 120 130 140 175 200 300
12-Oct	25	25	06:20	23.63	41.01	2 16 20 29 52 70 90 110 120 150 175 200 300
12-Oct	26	26	14:51	22.77	40.34	2 16 20 29 52 70 90 110 120 130 140 150 175 200 300
13-Oct	27	27	05:39	21.22	39.15	2 16 20 29 52 70 85 105 120 140 175 200 300
13-Oct	28	28	14:57	20.39	38.55	2 18 20 32 58 78 95 115 135 145 155 165 175 200 300
14-Oct	29	29	06:22	18.82	37.40	2 17 20 31 56 75 90 110 130 150 150 175 200 300
14-Oct	30	30	15:05	18.02	36.83	2 15 20 28 50 68 80 90 100 115 120 130 150 175 200 300
15-Oct	31	31	06:41	16.48	35.74	2 14 20 26 46 62 75 90 107 127 160 200 300 1000
15-Oct	32	32	14:47	15.65	35.17	2 12 20 22 39 52 60 65 70 80 90 110 130 150 200
16-Oct	33	33	14:21	13.79	33.90	2 11 20 36 49 65 75 85 95 128 200 300
16-Oct	34	34	14:55	12.76	33.20	2 11 20 36 49 60 65 75 85 90 100 128 150 200
17-Oct	35	35	06:21	10.76	31.87	2 9 17 20 30 41 47 54 63 70 88 106 200 300
17-Oct	36	36	15:03	9.66	31.15	2 9 16 20 28 38 41 45 50 65 72 80 100 150 200
18-Oct	37	37	06:21	7.59	29.81	2 10 20 33 44 65 77 90 115 150 200 300
18-Oct	38	38	14:50	6.52	29.13	2 11 20 33 44 55 65 75 85 95 115 150 200 300
19-Oct	39	39	06:33	4.63	27.92	2 14 20 26 46 62 70 80 107 135 160 200 300
19-Oct	40	40	14:50	3.68	27.32	2 11 20 35 47 65 74 77 82 95 110 125 150 200
20-Oct	41	41	06:18	1.93	26.22	2 11 20 25 36 49 60 70 85 110 128 150 200 300
20-Oct	42	42	14:20	1.04	25.65	2 11 20 28 36 49 76 80 85 95 110 128 150 200 300
21-Oct	43	43	06:22	-1.03	25.00	2 12 20 22 39 52 60 70 90 110 128 150 200 300
22-Oct	44	44	06:32	-4.68	25.02	2 11 20 35 47 65 80 85 100 125 200 300
22-Oct	45	45	14:26	-5.62	25.03	2 12 20 22 39 52 60 70 80 90 110 120 130 150 200 300
23-Oct	46	46	06:27	-7.71	25.04	2 13 20 24 43 58 75 94 100 110 130 150 200 300
23-Oct	47	47	14:27	-8.71	25.06	2 12 20 24 43 58 70 80 90 95 100 115 130 150 200 300
24-Oct	48	48	16:15	-10.69	25.06	2 15 20 28 49 66 95 115 160 200
24-Oct	49	49	14:32	-11.66	25.06	2 17 20 31 56 75 95 110 120 130 140 150 175 200 300
25-Oct	50	50	06:21	-13.58	25.07	2 20 30 36 65 87 105 120 130 140 150 175 200 300
25-Oct	51	51	16:24	-14.18	25.08	2 15 20 28 50 68 110 118 142 175 200 500 1000 3000 5100
26-Oct	52	52	05:55	-15.93	25.09	2 15 20 28 50 68 90 105 118 135 145 160 175 200 300
26-Oct	53	53	14:35	-16.96	25.09	2 15 20 28 50 68 90 104 118 125 145 160 177 200 300
27-Oct	54	54	05:52	-18.53	25.10	2 20 33 58 78 100 120 135 147 160 175 200 300 500
28-Oct	55	55	05:53	-20.01	25.09	2 20 33 58 78 100 120 135 160 200 300
28-Oct	56	56	14:27	-21.10	25.08	2 20 33 58 78 100 120 135 143 152 160 175 200 300
29-Oct	57	57	05:48	-23.08	25.06	2 17 20 31 55 74 90 110 128 140 155 175 200 300
29-Oct	58	58	14:21	-24.11	25.04	2 17 20 31 55 74 95 105 120 128 140 150 160 175 200 300
30-Oct	59	59	05:48	-26.09	25.02	2 17 20 31 55 74 90 110 128 140 150 175 200 300
30-Oct	60	60	14:26	-27.16	25.01	2 17 20 30 54 73 85 95 110 120 125 140 160 175 200 300
31-Oct	61	61	06:11	-28.70	25.95	2 15 20 27 48 65 78 91 104 120 140 170 200 300 1000
31-Oct	62	62	14:40	-29.38	26.86	2 13 20 24 43 58 70 80 90 100 120 150 170 200 300
01-Nov	63	63	05:56	-30.74	28.73	2 12 20 22 39 52 58 65 70 80 90 115 135 200 300
01-Nov	64	64	14:36	-31.45	29.71	2 15 20 28 50 68 82 95 108 120 140 150 175 200 300
02-Nov	65	65	06:12	-32.73	31.50	2 12 20 22 40 53 65 77 90 92 120 140 170 200 300
05-Nov	69	67	06:01	-38.22	39.52	2 6 11 20 27 36 45 55 70 90 120 150 175 200 300
05-Nov	70	68	14:28	-39.04	40.74	2 6 11 15 20 23 25 30 40 55 70 90 120 170 200 300
06-Nov	71	69	06:08	-40.34	42.75	2 5 8 15 20 25 34 40 50 75 100 150 200 300 1000
06-Nov	72	70	15:32	-41.12	43.98	3 5 10 17 20 23 30 40 50 60 75 100 150 200 300

Date	Stn	CTD	Time on deck (GMT)	Lat + =N - = S	Long (W)	Depths
07-Nov	73	71	06:00	-42.31	45.90	2 7 14 20 24 32 40 50 56 70 120 150 200 300
07-Nov	74	72	15:18	-43.11	47.18	2 7 14 20 24 33 38 45 56 65 84 100 150 200 300
08-Nov	75	73	06:13	-44.33	49.19	2 5 8 15 20 25 35 40 50 75 100 150 200 300 1000
08-Nov	76	74	15:34	-45.09	50.50	3 7 13 18 20 25 30 35 40 50 60 100 150 200 300

Underway samples were collected from the ship's non-toxic seawater supply by an automated liquid handling robot (Tecan Miniprep 60, Tecan, Reading, UK). Samples were drawn every hour and fixed instantly with paraformaldehyde and analysed flow cytometrically within 24 hours. Underway sampling began at 1700 on 01/10/11 and ended at 1800 on 08/11/11.

Microbial community composition analyses: diversity, distribution and abundances of free-living bacteria on a 50° N to 50° S transect

Christin Bennke
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The aim of this study is to examine the phylogenetic composition, analysing the abundance and distribution of dominant bacterial groups inhabiting temperate, tropical and equatorial regions of the North and South Atlantic Ocean, by fluorescence *in-situ* hybridisation. The major focus of this study is the phylum *Bacteroidetes*, better known as *Flavobacteria*. Little is known about their subgroup distribution in the entire Atlantic Ocean and therefore specific *Bacteroidetes* 16s rRNA clone libraries will be prepared and used to design specific bacteroidetal subgroup targeting 16s rRNA probes.

Microbial community structure and abundance by FISH
Seawater for filtration was collected from every pre-dawn CTD, and some solar noon CTD casts. From every pre-dawn cast 1 L of fresh seawater were collected from several depths, ranging from 300 m up to surface waters. For DNA samples, up to 6 l of fresh seawater was collected each from 20 m depth and the DCM-layer. The DNA samples were processed immediately after retrieval and filtered onto a 1.2 µm polycarbonate membrane filter for pre-filtration and then onto a 0.2 µm Cellulose-Acetate membrane filter. Filters, the pre-filtration and DNA filters were frozen in liquid nitrogen and stored at -80°C until further procedure.

Samples for microbial abundances were fixed with Formaldehyde (final conc. 1%) for 1 h at room temperature and then filtered in varying volumes (25, 50, 100 and 200 ml) onto 0.2 µm polycarbonate membrane filters without pre-filtration and in replicates. Either they were directly cut into small filter sections and prepared for total cell counts in staining them with the DNA stain DAPI (4,6-diamidino-2-phenylindole) or prepared for FISH. Then they were stored at -20°C until further procedure. First microscopic observations were done on board with a Zeiss Axioskop. Table 1 summarises the CTD casts sampled.

Additionally, cell concentrations from the DCM-layer of the pre-dawn CTD casts were prepared and will be used for cell sorting ashore. After seawater collection, 300 ml were fixed with Formaldehyde (final conc. 1%) for 1 h at room temperature and subsequently added Pluronic (final conc. 0.05%). Using a syringe pump the sample were gently pressed with 2 ml/min through a 47 mm Swinnex-type syringe filter holder (Millipore) containing a 0.1 µm polycarbonate membrane filter. Cell concentrates were aliquot and frozen by -80°C until further usage. Occasionally, from the deep-CTD casts (5000, 3000, 1000 and 500 m), 10 L of seawater were taken for DNA samples as well for community composition and abundance analyses

Underway samples were taken in the Southern Atlantic (from 35° S on, table 2), where the chlorophyll a concentration increased strongly. While collecting heterotrophic water masses every 2 to 4 h samples (depending on chlorophyll a concentrations) from the Non-toxic-Underway system were taken for filtration and later they will be analysed by FISH.

All data analyses will take approximately 6 months.

Tabel 1: CTD casts sampled for microbial diversity and abundaces

Date	Event Nb.	Time (GMT)	St.	Latitude	Longitude	sampled Depth [m]								
30.09.2011	D371_001	03:30	1	50°27.230 N	07° 26.720 W	80	50	40	25	20	15			
01.10.2011	D371_006	04:00	3	49°16.899 N	12° 43.192 W	300	150	60	40	20	10			
01.10.2011	D371_008	13:05	4	49°08.766 N	14°30.951 W	20								
02.10.2011	D371_012	04:30	5	48°08.006 N	17°06.216 W	200	150	70	45	32	20	13		
02.10.2011	D371_015	13:01	6	47°01.680 N	17°50.540 W	40	20							

Date	Event Nb.	Time (GMT)	St.	Latitude	Longitude	sampled Depth [m]								
03.10.2011	D371_018	04:33	7	44°54.473 N	19°13.387 W	200	65	55	29	20	12			
03.10.2011	D371_020	13:01	8	43°46.807 N	19°56.814 W	55	20							
04.10.2011	D371_024	04:29	9	41°47.607 N	21°10.576 W	200	80	63	38	20	16			
04.10.2011	D371_027	13:02	10	40°39.933 N	21°51.556 W	60	20							
05.10.2011	D371_030	04:32	11	38°30.916 N	23°07.633 W	300	150	80	60	41	20	17		
05.10.2011	D371_032	13:00	12	37°18.047 N	23°49.701 W	87	20							
06.10.2011	D371_037	04:32	13	35°41.519 N	25°48.890 W	300	150	90	78	45	20	14		
07.10.2011	D371_042	04:28	15	33°30.110 N	28°45.212 W	300	100	80	49	20	11			
08.10.2011	D371_048	04:32	17	31°32.852 N	31°19.537 W	300	150	103	88	59	20	14		
09.10.2011	D371_054	05:33	19	29°29.076 N	33°58.307 W	1000	500	300	170	112	102	65	20	15
10.10.2011	D371_061	05:32	21	27°34.857 N	36°22.840 W	300	157	105	95	60	20	14		
11.10.2011	D371_069	05:28	23	25°37.525 N	38°48.245 W	300	175	120	110	70	52	20	16	
12.10.2011	D371_077	05:28	25	23°37.727 N	41°00.668 W	300	175	120	110	70	52	20	16	
13.10.2011	D371_085	05:29	27	21°12.964 N	39°09.203 W	1000	500	300	175	120	70	52	20	16
14.10.2011	D371_093	05:29	29	18°49.400 N	37°23.940 W	300	175	130	75	31	20	17		
15.10.2011	D371_101	05:29	31	16°28.707 N	35°44.427 W	1000	300	160	107	62	46	20	14	
16.10.2011	D371_109	05:28	33	13°47.121 N	33°53.728 W	300	128	75	49	20				
17.10.2011	D371_117	05:29	35	10°45.434 N	31°52.403 W	300	106	70	54	41	20	17		
17.10.2011	D371_121	14:04	36	09°39.481 N	31°09.197 W	59	20							
18.10.2011	D371_125	05:26	37	07°35.394 N	29°48.621 W	300	150	90	65	44	20	10		
18.10.2011	D371_128	14:00	38	06°07.964 N	29°07.964 W	75	20							
19.10.2011	D371_133	05:25	39	04°37.593 N	27°55.164 W	1000	300	160	107	80	62	46	20	14
19.10.2011	D371_136	14:00	40	03°40.960 N	27°19.266 W	75	20							
20.10.2011	D371_141	05:27	41	01°55.701 N	26°13.207 W	300	150	110	70	49	20	11		
20.10.2011	D371_144	13:29	42	01°02.124 N	25°39.071 W	76	20							
21.10.2011	D371_149	05:30	43	01°01.908 S	25°00.271 W	300	150	90	70	52	20	12		
22.10.2011	D371_152	05:27	44	04°40.598 S	25°01.356 W	1000	300	128	80	47	20	11		
22.10.2011	D371_154	13:31	45	05°36.910 S	25°01.807 W	90	20							
23.10.2011	D371_157	05:30	46	07°42.520 S	25°02.348 W	300	150	100	94	58	20	13		
24.10.2011	D371_163	05:25	48	10°41.254 S	25°03.349 W	200	160	115	66	49	20	15		
25.10.2011	D371_169	05:33	50	13°34.852 S	25°04.094 W	300	175	130	87	36	20			

Date	Event Nb.	Time (GMT)	St.	Latitude	Longitude	sampled Depth [m]								
25.10.2011	D371_171	11:00	51	14°11.012 S	25°04.550 W	5000	3000	1000	500	142	118	50	20	
26.10.2011	D371_174	04:56	52	15°55.524 S	25°05.394 W	300	175	160	90	50	20	15		
27.10.2011	D371_180	04:55	54	18°31.502 S	25°06.088 W	500	300	175	160	100	78	33	20	
28.10.2011	D371_183	04:57	55	20°00.853 S	25°05.467 W	300	200	160	120	78	33	20		
29.10.2011	D371_189	04:57	57	23°04.584 S	25°03.431 W	300	175	140	110	74	31	20	17	
30.10.2011	D371_195	04:57	59	26°05.532 S	25°01.499 W	300	175	140	110	74	31	20	17	
31.10.2011	D371_202	04:56	61	28°42.137 S	25°57.090 W	1000	300	170	104	78	48	20	15	
01.11.2011	D371_207	04:59	63	30°44.117 S	28°43.847 W	300	200	135	90	70	52	39	20	12
02.11.2011	D371_214	05:59	65	32°43.554 S	31°30.071 W	300	170	120	90	77	53	40	20	12
05.11.2011	D371_219	05:58	69	38°13.336 S	39°31.128 W	300	175	120	70	45	36	20	11	6
05.11.2011	D371_221	13:35	70	39°02.122 S	40°44.555 W	300	170	90	55	30	25	20	11	6
06.11.2011	D371_226	04:56	71	40°20.220 S	42°45.284 W	1000	300	150	75	50	34	25	20	15
06.11.2011	D371_229	14:34	72	41°07.548 S	43°58.958 W	300	150	75	50	40	30	20	10	
07.11.2011	D371_233	04:56	73	42°18.874 S	45°53.702 W	300	150	70	50	40	32	20	14	7
07.11.2011	D371_235	14:29	74	43°06.569 S	47°10.778 W	300	150	65	45	33	20	14		
08.11.2011	D371_239	04:57	75	44°20.013 S	49°11.623 W	1000	300	150	75	35	25	20	8	
08.11.2011	D371_241	14:29	76	45°05.637 S	50°29.875 W	300	150	60	40	20	18	7		

Tabel 2: Sample list Underway

Underway ID	Date	Time (GMT)	Latitude	Longitude
U1	03.11.2011	11:00	35°09.717 S	34°59.161 W
U2	03.11.2011	13:00	35°20.159 S	35°14.332 W
U3	03.11.2011	14:15	35°25.002 S	35°20.944 W
U4	03.11.2011	18:00	35°41.930 S	35°46.052 W
U5	03.11.2011	21:00	35°54.866 S	36°05.002 W
U6	04.11.2011	05:00	36°26.917 S	36°52.111 W
U7	04.11.2011	09:00	36°42.793 S	37°15.587 W
U8	04.11.2011	17:00	37°10.842 S	37°57.272 W
U9	04.11.2011	20:00	37°24.190 S	38°17.175 W
U10	05.11.2011	05:00	38°13.324 S	39°31.178 W
U11	05.11.2011	08:00	38°25.791 S	39°49.899 W
U12	05.11.2011	11:00	38°46.650 S	40°21.575 W
U13	05.11.2011	13:00	39°00.264 S	40°42.339 W
U14	05.11.2011	17:00	39°12.158 S	41°00.159 W
U15	05.11.2011	20:00	39°28.249 S	41°25.236 W
U16	06.11.2011	06:00	40°20.222 S	42°45.285 W
U17	06.11.2011	09:00	40°37.117 S	43°12.193 W
U18	06.11.2011	12:00	40°54.528 S	43°39.356 W
U19	06.11.2011	14:00	41°05.656 S	43°53.866 W
U20	06.11.2011	21:00	41°34.389 S	44°42.316 W
U21	07.11.2011	06:00	42°18.514 S	45°53.581 W
U22	07.11.2011	08:00	42°30.229 S	46°11.663 W
U23	07.11.2011	10:00	42°42.332 S	46°31.155 W
U24	07.11.2011	16:00	43°06.615 S	47°09.871 W
U25	08.11.2011	06:00	44°20.013 S	49°11.623 W
U26	08.11.2011	08:00	44°29.661 S	49°27.263 W
U27	08.11.2011	09:00	44°35.138 S	49°27.263 W
U28	08.11.2011	10:00	44°42.056 S	49°47.907 W
U29	08.11.2011	18:00	45°29.661 S	50°50.307 W
U30	08.11.2011	21:45	45°36.289 S	51°39.290 W
U31	09.11.2011	06:00	46°26.805 S	53°33.666 W
U32	09.11.2011	09:00	46°46.444 S	54°18.648 W
U33	09.11.2011	10:00	46°52.603 S	54°32.892 W
U34	09.11.2011	12:00	47°04.448 S	55°00.100 W
U35	09.11.2011	14:00	47°16.423 S	55°27.830 W

Phytoplankton photosynthesis, primary production and coloured dissolved organic material.

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OBJECTIVES.

During AMT21 integrated Primary production measurements were made at 36 stations on three size classes of phytoplankton from measurements taken from six depths. Photosynthesis-irradiance curves were made at 34 stations at two or three depths in the water column. The absorption coefficient of phytoplankton from 350 to 750nm (a_{ph}) was determined at 34 stations at three depths in the water column. These measurements aim to fulfil the following objectives:

- *The main deliverable 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 AMT21 using methods synonymous to those used in previous AMT cruises.*
- *We also assessed the variation in photosynthesis in phytoplankton communities along the Atlantic Meridional transect.*

METHODS.

Primary production. Water samples were taken from pre-dawn deployments of a 24 x 20l SeaBird CTD rosette sampler on a stainless steel frame from 6 depths in the euphoic zone following the methods described in *Tilstone et al.* (2009). The samples were transferred from Niskin bottles to black carboys to prevent shock to the photosynthetic lamellae of the phytoplankton cells. Water from each sample was sub sampled into three 75 ml clear polycarbonate bottles and three polycarbonate bottles which are then covered in tin foil; all bottles were pre cleaned following JGOFS protocols (IOC, 1994), to reduce trace metal contamination. Each sample was inoculated with between 185 and 555 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 (appox.12 h). The incubators were maintained at surface temperature by pumping sea water from a depth of ~7 m through the upper light level incubators (97, 55, 33 & 14%) and from a chiller maintained at ±3°C of in situ temperature for the lower light level incubators (7, 3, 1, 0.1%). To terminate the incubations, suspended material was filtered sequentially through 10µm, 2µm and 0.2µm polycarbonate Nuclepore filters to measure the micro, nano and pico-phytoplankton production respectively. The filters were exposed to concentrated HCl fumes for 12 h immersed in scintillation cocktail and ^{14}C disintegration time per minute (DPM) was measured on board using a 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 34 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 (10 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 was filtered through 25 mm Whatman GF/F filters to measure the total production. The filters were exposed to concentrated HCl fumes for 12 h immersed in scintillation cocktail and ^{14}C disintegration time per minute (DPM) was measured on board using a WinSpectral 1414 liquid scintillation counter and the external standard and the channel ratio methods to correct for quenching. The broadband light-saturated Chla-specific rate of photosynthesis P_m^B [mg C (mg chl a)$^{-1}$ h^{-1}] and the light limited slope α^B [mg C (mg chl a)$^{-1}$ h^{-1} (µmol m^{-2} s^{-1})$^{-1}$] was estimated by fitting the data to the model of Platt *et al.* (Platt et al., 1980).

Table 1. *Stations at which size fractionated primary production (PP), phytoplankton photosynthesis (PE curves), and $a_{ph}(\lambda)$.*

CTD No.	Date	Time In water GMT	Lat	Long	Depths (m)	Measurements taken
001	30 Sep	03:30	50° 27.23' N	07° 26.72' W	0, 10, 15, 20, 25, 30	PP size fractionated
002	30 Sep	12:09	49° 57.23' N	9° 7.56' W	2, 40, 100	PE Curves, a_{ph}
003	01 Oct	04:33	49° 16.87' N	12° 43.19' W	0, 5, 10, 30, 40, 50	PP size fractionated
004	01 Oct	13:05	49° 08.766' N	14° 30.951' W	2, 50, 300	PE Curves, a_{ph}
005	02 Oct	04:30	48° 8.006' N	17° 6.216' W	0, 7, 13, 32, 45, 55	PP size fractionated
006	02 Oct	13:03	47° 01.68' N	17° 50.45' W	2, 13, 300	PE Curves, a_{ph}
007	03 Oct	04:33	44° 54.473' N	19° 13.387' W	0, 7, 12, 22, 40, 55	PP size fractionated
008	03 Oct	13:01	43° 46.807' N	19° 56.814' W	2, 55, 300	PE Curves, a_{ph}
009	04 Oct	04:29	41° 47.607' N	21° 10.576' W	0, 9, 16, 38, 63, 65	PP size fractionated
0010	04 Oct	13:02	40° 39.933' N	20° 51.556' W	2, 60, 75	PE Curves, a_{ph}
0011	05 Oct	04:32	38° 30.916' N	23° 7.633' W	0, 9, 17, 41, 60, 70	PP size fractionated,
0012	05 Oct	12:59	37° 18.047' N	23° 49.701' W	2, 87, 110	PE Curves, a_{ph}
0013	06 Oct	04:32	35° 41.519' N	25° 48.89' W	0, 14, 25, 61, 78, 105	PP size fractionated
0014	06 Oct	13:04	34° 53.928' N	26° 52.96' W	2, 82, 105	PE Curves, a_{ph}
0015	07 Oct	04:28	33° 30.11' N	28° 45.212' W	0, 11, 20, 49, 80, 84	PP size fractionated
0016	07 Oct	13:05	32° 49.177' N	29° 39.511' W	2, 103, 120	PE Curves, a_{ph}
0017	08 Oct	04:32	31° 32.852' N	31° 19.537' W	0, 14, 25, 59, 88, 103	PP size fractionated
0018	08 Oct	12:59	30° 52.871' N	32° 11.715' W	2, 103, 125	PE Curves, a_{ph}
0019	09 Oct	05:33	29° 29.076' N	33° 58.307' W	0, 15, 27, 65, 102, 112	PP size fractionated
0020	09 Oct	14:01	28° 50.352' N	34° 48.454' W	2, 112, 130	PE Curves, a_{ph}
0021	10 Oct	05:32	27° 34.857' N	36° 22.84' W	0, 14, 25, 60, 85, 105	PP size fractionated
0022	10 Oct	13:58	26° 54.914' N	37° 12.82' W	2, 120, 140	PE Curves, a_{ph}
0023	11 Oct	05:28	25° 37.525' N	38° 48.245' W	0, 16, 29, 52, 70, 120	PP size fractionated
0024	11 Oct	14:01	24° 56.55' N	39° 38.985' W	2, 110	PE Curves, a_{ph}
0025	12 Oct	05:28	23° 37.727' N	41° 0.668' W	0, 16, 29, 52, 70, 120	PP size fractionated
0026	12 Oct	13:58	23° 37.727' N	41° 0.668' W	No work	PE Curves, a_{ph}
0027	13 Oct	05:53	21° 12.964' N	39° 9.203' W	0, 16, 29, 52, 70, 120	PP size fractionated
0028	13 Oct	13:58	20° 23.430' N	38° 33.002' W	2, 135	PE Curves, a_{ph}
0029	14 Oct	05:42	18° 49.400' N	37° 23.94' W	0, 17, 31, 75, 90, 130	PP size fractionated
0030	14 Oct	14:00	18° 00.944' N	36° 49.82' W	2, 100	PE Curves, a_{ph}
0031	15 Oct	05:26	16° 28.707' N	35° 44.427' W	0, 14, 26, 46, 62, 107	PP size fractionated
0032	15 Oct	13:59	15° 39.025' N	35° 10.237' W	2, 70	PE Curves, a_{ph}

CTD No.	Date	Time In water GMT	Lat	Long	Depths (m)	Measurements taken
0033	16 Oct	05:48	13° 47.121' N	33° 53.728' W	0, 11, 20, 49, 75, 95	PP size fractionated
0034	16 Oct	13:59	12° 45.38' N	33° 12.244' W	2,65	PE Curves, a_{ph}
0035	17 Oct	05:44	10° 45.434' N	31° 52.403' W	0, 9, 17, 41, 54, 70	PP size fractionated
0036	17 Oct	14:04	9° 39.481' N	31° 9.197' W	2, 50	PE Curves, a_{ph}
0037	18 Oct	05:26	07° 35.394' N	29° 48.621' W	0, 10, 20, 44, 65, 77	PP size fractionated
0038	18 Oct	14:00	06° 31.346' N	29° 7.964' W	2, 75	PE Curves, a_{ph}
0039	19 Oct	05:25	04° 37.593' N	27° 55.164' W	0, 14, 26, 62, 80, 107	PP size fractionated
0040	19 Oct	14:00	03° 40.96' N	27° 19.266' W	2, 74	PE Curves, a_{ph}
0041	20 Oct	05:27	01° 55.701' N	26° 13.207' W	0, 11, 20, 49, 70, 85	PP size fractionated
0042	20 Oct	13:29	01° 2.124' N	25° 39.071' W	2, 76	PE Curves, a_{ph}
0044	22 Oct	05:44	04° 40.598' S	25° 1.356' W	0, 11, 20, 47, 80, 85	PP size fractionated
0045	22 Oct	13:31	05° 36.91' S	025° 1.807' W	2, 90	PE Curves, a_{ph}
0046	23 Oct	05:30	7° 42.52' S	25° 2.348' W	0, 13, 24, 58, 94, 100	PP size fractionated
0047	23 Oct	14:28	8° 42.367' S	25° 3.358' W	2,100	PE Curves, a_{ph}
0048	24 Oct	05:25	10° 41.254' S	25° 3.349' W	0, 15, 28, 49, 95, 115	PP size fractionated
0049	24 Oct	13:31	11° 39.807' S	25° 3.896' W	2, 130	PE Curves, a_{ph}
0050	25 Oct	05:33	13° 34.852' S	25° 4.094' W	0, 20, 36, 87, 130, 140	PP size fractionated
0051	25 Oct	11:00	14° 11.022' S	25° 4.55' W	2, 118	PE Curves, a_{ph}
0052	26 Oct	04:56	15° 55.524' S	25° 5.934' W	0, 15, 28, 68, 118, 160	PP size fractionated
0053	26 Oct	13:32	16° 57.625' S	25° 5.652' W	2, 160	PE Curves, a_{ph}
0054	27 Oct	04:55	18° 31.502' S	25° 06.088' W	0, 20, 33, 78, 135, 160	PP size fractionated
0055	28 Oct	04:57	20° 0.853' S	25° 5.467' W	0, 20, 33, 78, 135, 160	PP size fractionated
0056	28 Oct	13:31	21° 5.732' S	25° 4.562' W	2, 160	PE Curves, a_{ph}
0057	29 Oct	04:57	23° 4.584' S	25° 3.431' W	0, 17, 31, 74, 128, 140	PP size fractionated
0058	29 Oct	13:31	24° 6.805' S	25° 2.697' W	2, 140	PE Curves, a_{ph}
0059	30 Oct	04:57	26° 5.532' S	25° 1.499' W	0, 17, 31, 74, 128, 140	PP size fractionated
0060	30 Oct	13:29	27° 9.404' S	25° 0.708' W	2, 120	PE Curves, a_{ph}
0061	31 Oct	04:56	28° 42.137 S	25° 57.09' W	0, 15, 27, 65, 91, 104	PP size fractionated
0062	31 Oct	13:32	29° 22.683 S	26° 51.727' W	5, 90	PE Curves, a_{ph}
0063	01 Nov	04:59	30° 44.117' S	28° 43.847' W	0, 12, 22, 52, 70, 90	PP size fractionated
0064	01 Nov	13:32	31° 27.074' S	29° 42.389' W	2, 120	PE Curves, a_{ph}
0065	02 Nov	04:59	32° 43.554' S	31° 30.071' W	0, 12, 22, 40, 53, 90	PP size fractionated
0069	05 Nov	04:58	38° 13.336' S	39° 31.128' W	0, 6, 11, 20, 27, 45	PP size fractionated

CTD No.	Date	Time In water GMT	Lat	Long	Depths (m)	Measurements taken
0070	05 Nov	13:35	39° 02.122' S	40° 44.555' W	2, 25	PE Curves, a_{ph}
0071	06 Nov	04:56	40° 20.220' S	42' 45.284' W	0, 8, 15, 20, 25, 34	PP size fractionated
0072	06 Nov	14:34	41° 07.548' S	43° 58.958' W	3, 40	PE Curves, a_{ph}
0073	07 Nov	04:56	42° 18.874' S	45° 53.702' W	0, 14, 24, 32, 50, 95	PP size fractionated
0074	07 Nov	14:29	43° 6.569' S	47° 10.778' W	2, 50	PE Curves, a_{ph}

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

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Cruise Objectives:

1. Collection of CTD and underway samples for analysis of particulate organic carbon (POC), particulate inorganic carbon (PIC), coccolith enumeration (cell counts) 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 infrared 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 water bottle annex lab 3-4 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 Rob Thomas, BODC). PIC samples were collected on 0.4 µm polycarbonate filters, rinsed with potassium tetraborate buffer, dried and stored in metal free centrifuge tubes. These will be analyzed by ICPOES for particulate calcium. Coccolith and cell counts 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 ashore at the University of Maine's Darling Marine Center.

CTD sampling
During the pre-dawn CTD six light depths and two below mixed layer deeper depths were analyzed for POC, PIC, BSi, and coccolith enumeration as described above. Typically, six light depths (including DCM) were also analyzed for PIC and BSi with only surface for POC 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 3-4 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 on the *RRS Discovery* 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 bow. The water-viewing radiance detector was set to view the ocean surface at 40° from nadir and the sky-viewing radiance sensor was set to view the sky 40° from zenith (used in the correction for Fresnel reflectance) as recommended by Mueller et al. (2003b). The downwelling irradiance sensor was mounted at the top of the main mast so as to minimize any shading from the ship's superstructure. Data from these sensors will be used to calculate spectral normalized water-leaving radiance (after filtering out white-caps and high pitch/roll anomalies) for comparison to the satellite estimates of normalized water-leaving radiance.

Sensors were rinsed regularly with Milli-Q water in order to remove salt deposits and any dust. The water radiance sensor was able to view over an azimuth range of ~180° across the ship's heading with no contamination from the ship's deck or wake. The direction of the sensor was adjusted constantly to view the water 120° from the sun's azimuth, to minimize sun glint. This was done using a computer-based system that calculated the sun's azimuth angle relative to the ship's heading and elevation constantly. The system used the ship's gyro-compass to determine the heading of the ship. Depending on the ship's course, the computer controlled a stepper motor that turned the sensors to the proper viewing angle. Protocols for operation and calibration were performed according to Mueller (Mueller et al. 2003a; Mueller et al. 2003b; Mueller et al. 2003c). Data were collected between 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: 41 days
Above water radiance measurements: 41 days
UW Samples: 89
CTD casts: 73 (533 total samples)

CTD Discrete Samples

Date	Station #	Lat (+=N,-=S)	Lon (E)	Depths Sampled	Samples Taken
30/09/2011	1	50.45	-7.45	85m, 75m, 40m, 30m, 20m, 10m, 2m,	POC, PIC, Bsi, cell count
30/09/2011	2	49.95	-9.13	100m, 75m, 40m, 30m, 20m, 10m, 2m,	PIC, Bsi; POC and cell count for surface only
01/10/2011	3	49.28	-12.72	300m, 200m, 125m, 50m, 40m, 20m, 10m, 2m,	POC, PIC, Bsi, cell count
01/10/2011	4	49.15	-14.52	250m, 100m, 50m, 40m, 30m, 20m, 10m, 2m,	PIC, Bsi; POC and cell count for surface only
02/10/2011	5	48.13	-17.10	200m, 125m, 55m, 45m, 32m, 24m, 13m, 2m,	POC, PIC, Bsi, cell count
02/10/2011	6	47.03	-19.84	300m, 55m, 40m, 32m, 24m, 13m, 7m, 2m,	PIC, Bsi; POC and cell count for surface only
03/10/2011	7	44.91	-19.22	200m, 55m, 40m, 29m, 22m, 12m, 2m,	POC, PIC, Bsi, cell count
03/10/2011	8	43.78	-19.95	300m, 125m, 55m, 50m, 29m, 22m, 12m, 2m,	PIC, Bsi; POC and cell count for surface only
04/10/2011	9	41.79	-21.18	200m, 110m, 63m, 38m, 28m, 9m, 2m,	POC, PIC, Bsi, cell count
04/10/2011	10	40.67	-20.86	300m, 110m, 65m, 60m, 38m, 28m, 16m, 2m,	PIC, Bsi; POC and cell count for surface only
05/10/2011	11	38.52	-23.13	300m, 200m, 70m, 60m, 41m, 30m, 17m, 2m,	POC, PIC, Bsi, cell count
05/10/2011	12	37.30	-23.83	300m, 200m, 87m, 50m, 37m, 20m, 11m, 2m,	PIC, Bsi; POC and cell count for surface only
06/10/2011	13	35.69	-25.81	300m, 150m, 105m, 78m, 61m, 45m, 25m, 2m,	POC, PIC, Bsi, cell count
06/10/2011	14	34.90	-26.88	300m, 175m, 82m, 66m, 49m, 28m, 15m, 2m,	PIC, Bsi; POC and cell count for surface only

Date	Station #	Lat (+=N,-=S)	Lon(E)	Depths Sampled	Samples Taken
07/10/2011	15	33.50	-28.75	300m, 100m, 80m, 49m, 36m, 20m, 11m, 2m,	POC, PIC, Bsi, cell count
07/10/2011	16	32.82	-29.66	300m, 150m, 103m, 58m, 43m, 24m, 13m, 2m,	PIC, Bsi; POC and cell count for surface only
08/10/2011	17	31.55	-31.33	300m, 150m, 103m, 88m, 59m, 44m, 25m, 2m,	POC, PIC, Bsi, cell count
08/10/2011	18	30.88	-32.20	200m, 150m, 103m, 59m, 44m, 25m, 2m,	PIC, Bsi; POC and cell count for surface only
09/10/2011	19	29.48	-33.97	1000m, 300m, 170m, 102m, 65m, 48m, 15m, 2m,	POC, PIC, Bsi, cell count
09/10/2011	20	28.84	-34.81	200m, 112m, 65m, 27m, 2m,	PIC, Bsi; POC and cell count for surface only
10/10/2011	21	27.58	-36.38	300m, 157m, 105m, 60m, 44m, 25m, 14m, 2m,	POC, PIC, Bsi, cell count
10/10/2011	22	26.92	-37.21	300m, 175m, 120m, 70m, 52m, 29m, 16m, 2m,	PIC, Bsi; POC and cell count for surface only
11/10/2011	23	25.63	-38.80	300m, 175m, 120m, 70m, 52m, 29m, 16m, 2m,	POC, PIC, Bsi, cell count
11/10/2011	24	24.94	-39.65	300m, 175m, 120m, 103m, 70m, 52m, 29m, 2m,	PIC, Bsi; POC and cell count for surface only
12/10/2011	25	23.63	-41.01	300m, 175m, 120m, 70m, 52m, 29m, 16m, 2m,	POC, PIC, Bsi, cell count
12/10/2011	26	22.77	-40.34	300m, 175m, 120m, 110m, 70m, 52m, 29m, 2m,	PIC, Bsi; POC and cell count for surface only
13/10/2011	27	21.22	-39.15	1000m, 300m, 175m, 120m, 70m, 52m, 20m, 2m,	POC, PIC, Bsi, cell count
13/10/2011	28	20.39	-38.55	300m, 175m, 135m, 58m, 32m, 2m,	PIC, Bsi; POC and cell count for surface only
14/10/2011	29	18.82	-37.40	200m, 175m, 130m, 75m, 56m, 31m, 20m, 2m,	POC, PIC, Bsi, cell count
14/10/2011	30	18.02	-36.83	175m, 120m, 100m, 68m, 50m, 15m, 2m,	PIC, Bsi; POC and cell count for surface only
15/10/2011	31	16.48	-35.74	1000m, 300m, 160m, 107m, 62m, 46m, 26m, 2m,	POC, PIC, Bsi, cell count
15/10/2011	32	15.65	-35.17	150m, 90m, 70m, 52m, 39m, 12m, 2m,	PIC, Bsi; POC and cell count for surface only
16/10/2011	33	13.79	-33.90	300m, 200m, 128m, 75m, 49m, 20m, 2m,	POC, PIC, Bsi, cell count
16/10/2011	34	12.76	-33.20	200m, 128m, 85m, 65m, 36m, 20m, 2m,	POC, PIC, Bsi, cell count
17/10/2011	35	10.76	-31.87	300m, 200m, 106m, 70m, 54m, 30m, 7m, 2m,	POC, PIC, Bsi, cell count
17/10/2011	36	9.66	-31.15	100m, 65m, 59m, 38m, 16m, 2m,	PIC, Bsi; POC and cell count for surface only
18/10/2011	37	7.59	-29.81	300m, 200m, 115m, 77m, 65m, 44m, 33m, 2m,	POC, PIC, Bsi, cell count
18/10/2011	38	6.52	-29.13	115m, 75m, 44m, 20m, 2m,	PIC, Bsi; POC and cell count for surface only
19/10/2011	39	4.63	-27.92	300m, 160m, 107m, 80m, 62m, 46m, 26m, 2m,	POC, PIC, Bsi, cell count

Date	Station #	Lat (+=N,-=S)	Lon(E)	Depths Sampled	Samples Taken
19/10/2011	40	3.68	-27.32	125m, 82m, 74m, 47m, 20m, 2m,	PIC, Bsi; POC and cell count for surface only
20/10/2011	41	1.93	-26.22	300m, 200m, 110m, 70m, 49m, 36m, 20m, 2m,	POC, PIC, Bsi, cell count
20/10/2011	42	1.04	-25.65	128m, 85m, 76m, 49m, 36m, 20m, 2m,	PIC, Bsi; POC and cell count for surface only
21/10/2011	43	-1.03	-25.00	300m, 200m, 128m, 90m, 70m, 52m, 22m, 2m,	POC, PIC, Bsi, cell count
22/10/2011	44	-4.68	-25.02	300m, 125m, 80m, 47m, 35m, 20m, 11m, 2m,	POC, PIC, Bsi, cell count
22/10/2011	45	-5.62	-25.03	130m, 90m, 52m, 39m, 22m, 2m,	PIC, Bsi; POC and cell count for surface only
23/10/2011	46	-7.71	-25.04	300m, 200m, 150m, 100m, 53m, 43m, 24m, 2m,	POC, PIC, Bsi, cell count
23/10/2011	47	-8.71	-25.06	300m, 130m, 100m, 58m, 24m, 2m,	PIC, Bsi; POC and cell count for surface only
24/10/2011	48	-10.69	-25.06	200m, 160m, 115m, 66m, 49m, 28m, 15m, 2m,	POC, PIC, Bsi, cell count
24/10/2011	49	-11.66	-25.06	200m, 130m, 75m, 56m, 31m, 2m,	PIC, Bsi; POC and cell count for surface only
25/10/2011	50	-13.58	-25.07	300m, 175m, 130m, 87m, 65m, 36m, 20m, 2m,	POC, PIC, Bsi, cell count
25/10/2011	51	-14.18	-25.08	500m, 200m, 118m, 68m, 28m, 2m,	PIC, Bsi; POC and cell count for surface only
26/10/2011	52	-15.93	-25.09	300m, 200m, 160m, 118m, 68m, 50m, 28m, 2m,	POC, PIC, Bsi, cell count
26/10/2011	53	-16.96	-25.09	177m, 160m, 125m, 68m, 28m, 2m,	PIC, Bsi; POC and cell count for surface only
27/10/2011	54	-18.53	-25.10	500m, 300m, 160m, 135m, 78m, 58m, 33m, 2m,	POC, PIC, Bsi, cell count
28/10/2011	55	-20.01	-25.09	300m, 200m, 160m, 135m, 78m, 58m, 33m, 2m,	POC, PIC, Bsi, cell count
28/10/2011	56	-21.10	-25.08	200m, 160m, 135m, 78m, 33m, 2m,	PIC, Bsi; POC and cell count for surface only
29/10/2011	57	-23.08	-25.06	300m, 200m, 140m, 128m, 74m, 55m, 31m, 2m,	POC, PIC, Bsi, cell count
29/10/2011	58	-24.11	-25.04	175m, 140m, 128m, 74m, 31m, 2m,	PIC, Bsi; POC and cell count for surface only
30/10/2011	59	-26.09	-25.02	300m, 200m, 140m, 128m, 74m, 55m, 31m, 2m,	POC, PIC, Bsi, cell count
30/10/2011	60	-27.16	-25.01	175m, 140m, 120m, 73m, 54m, 2m,	PIC, Bsi; POC and cell count for surface only
31/10/2011	61	-28.80	-25.95	1000m, 300m, 170m, 104m, 65m, 48m, 27m, 2m,	POC, PIC, Bsi, cell count
31/10/2011	62	-29.38	-26.86	120m, 100m, 90m, 58m, 43m, 5m,	PIC, Bsi; POC and cell count for surface only
01/11/2011	63	-30.74	-28.73	300m, 200m, 90m, 70m, 52m, 39m, 22m, 2m,	POC, PIC, Bsi, cell count

Date	Station #	Lat (+=N,-=S)	Lon(E)	Depths Sampled	Samples Taken
01/11/2011	64	-31.45	-29.71	150m, 120m, 68m, 50m, 28m, 2m,	PIC, Bsi; POC and cell count for surface only
02/11/2011	65	-32.73	-31.50	300m, 200m, 90m, 53m, 40m, 22m, 12m, 2m,	POC, PIC, Bsi, cell count
05/11/2011	69	-38.22	-39.52	300m, 200m, 90m, 45m, 20m, 11m, 2m,	POC, PIC, Bsi, cell count
05/11/2011	70	-39.04	-40.74	90m, 30m, 25m, 15m, 11m, 2m,	PIC, Bsi; POC and cell count for surface only
06/11/2011	71	-40.34	-42.75	300m, 200m, 100m, 34m, 25m, 20m, 15m, 2m,	POC, PIC, Bsi, cell count
06/11/2011	72	-41.13	-43.98	75m, 40m, 23m, 17m, 10m, 3m,	PIC, Bsi; POC and cell count for surface only
07/11/2011	73	-42.31	-45.90	300m, 200m, 70m, 50m, 32m, 24m, 14m, 2m,	POC, PIC, Bsi, cell count
07/11/2011	74	-43.11	-47.18	84m, 56m, 45m, 33m, 14m, 2m,	PIC, Bsi; POC and cell count for surface only
08/11/2011	75	-44.33	-49.19	1000m, 300m, 200m, 100m, 35m, 25m, 15m, 2m,	POC, PIC, Bsi, cell count
08/11/2011	76	-45.09	-50.50	200m, 40m, 30m, 18m, 13m, 3m,	PIC, Bsi; POC and cell count for surface only

Underway Discrete Samples

Date	Station #	Lat (+=N,-=S)	Lon(E)	Depths Sampled	Samples Taken
30/09/2011	AAA	49.82	-9.59	6m	POC, PIC, Bsi, cell count
30/09/2011	AAB	49.56	-10.46	6m	POC, PIC, Bsi, cell count
01/10/2011	AAD	49.27	-13.27	6m	POC, PIC, Bsi, cell count
01/10/2011	AAF	49.13	-14.73	6m	POC, PIC, Bsi, cell count
01/10/2011	AAG	49.05	-15.76	6m	POC, PIC, Bsi, cell count
02/10/2011	AAK	46.86	-17.96	6m	POC, PIC, Bsi, cell count
02/10/2011	AAL	46.21	-18.38	6m	POC, PIC, Bsi, cell count
03/10/2011	AAN	44.52	-19.48	6m	POC, PIC, Bsi, cell count
03/10/2011	AAP	43.61	-20.06	6m	POC, PIC, Bsi, cell count
03/10/2011	AAQ	43.03	-20.42	6m	POC, PIC, Bsi, cell count
04/10/2011	AAV	40.31	-21.97	6m	POC, PIC, Bsi, cell count
04/10/2011	AAW	39.87	-22.33	6m	POC, PIC, Bsi, cell count
05/10/2011	ABA	36.57	-24.60	6m	POC, PIC, Bsi, cell count
06/10/2011	ABD	35.43	-26.15	6m	POC, PIC, Bsi, cell count
06/10/2011	ABF	34.80	-27.00	6m	POC, PIC, Bsi, cell count
06/10/2011	ABG	34.38	-27.59	6m	POC, PIC, Bsi, cell count
07/10/2011	ABI	33.28	-29.05	6m	POC, PIC, Bsi, cell count
07/10/2011	ABK	32.72	-29.74	6m	POC, PIC, Bsi, cell count
07/10/2011	ABL	32.33	-30.31	6m	POC, PIC, Bsi, cell count
08/10/2011	ABN	31.33	-31.62	6m	POC, PIC, Bsi, cell count
08/10/2011	ABQ	30.36	-32.86	6m	POC, PIC, Bsi, cell count
09/10/2011	ABS	29.27	-34.23	6m	POC, PIC, Bsi, cell count
09/10/2011	ABU	28.73	-34.95	6m	POC, PIC, Bsi, cell count

Date	Station #	Lat (+=N,-=S)	Lon(E)	Depths Sampled	Samples Taken
09/10/2011	ABV	28.36	-35.40	6m	POC, PIC, Bsi, cell count
10/10/2011	ABX	27.36	-36.66	6m	POC, PIC, Bsi, cell count
10/10/2011	ACA	26.42	-37.75	6m	POC, PIC, Bsi, cell count
11/10/2011	ACC	25.37	-39.12	6m	POC, PIC, Bsi, cell count
11/10/2011	ACF	24.47	-40.22	6m	POC, PIC, Bsi, cell count
12/10/2011	ACH	23.37	-40.80	6m	POC, PIC, Bsi, cell count
12/10/2011	ACK	22.13	-39.85	6m	POC, PIC, Bsi, cell count
13/10/2011	ACM	20.94	-38.96	6m	POC, PIC, Bsi, cell count
13/10/2011	ACP	19.83	-38.13	6m	POC, PIC, Bsi, cell count
14/10/2011	ACR	18.54	-37.20	6m	POC, PIC, Bsi, cell count
14/10/2011	ACU	17.45	-36.43	6m	POC, PIC, Bsi, cell count
15/10/2011	ACW	16.23	-35.57	6m	POC, PIC, Bsi, cell count
15/10/2011	ADA	14.93	-34.68	6m	POC, PIC, Bsi, cell count
16/10/2011	ADC	13.43	-33.66	6m	POC, PIC, Bsi, cell count
16/10/2011	ADF	11.99	-32.69	6m	POC, PIC, Bsi, cell count
17/10/2011	ADK	8.88	-30.65	6m	POC, PIC, Bsi, cell count
18/10/2011	ADM	7.22	-29.58	6m	POC, PIC, Bsi, cell count
18/10/2011	ADP	5.76	-28.64	6m	POC, PIC, Bsi, cell count
19/10/2011	ADR	4.35	-27.75	6m	POC, PIC, Bsi, cell count
19/10/2011	ADV	2.97	-26.87	6m	POC, PIC, Bsi, cell count
20/10/2011	ADX	1.61	-26.02	6m	POC, PIC, Bsi, cell count
20/10/2011	AEA	0.00	-25.15	6m	POC, PIC, Bsi, cell count
21/10/2011	AEC	-1.40	-25.01	6m	POC, PIC, Bsi, cell count
21/10/2011	AED	-2.07	-25.01	6m	POC, PIC, Bsi, cell count
22/10/2011	AEE	-5.04	-25.03	6m	POC, PIC, Bsi, cell count
22/10/2011	AEH	-6.54	-25.03	6m	POC, PIC, Bsi, cell count
23/10/2011	AEJ	-8.05	-25.04	6m	POC, PIC, Bsi, cell count
23/10/2011	AEM	-9.52	-25.05	6m	POC, PIC, Bsi, cell count
24/10/2011	AEO	-11.06	-25.06	6m	POC, PIC, Bsi, cell count
24/10/2011	AER	-12.42	-25.07	6m	POC, PIC, Bsi, cell count
25/10/2011	AET	-13.90	-25.07	6m	POC, PIC, Bsi, cell count
25/10/2011	AEV	-14.65	-25.08	6m	POC, PIC, Bsi, cell count
26/10/2011	AEW	-16.36	-25.09	6m	POC, PIC, Bsi, cell count
26/10/2011	AEZ	-17.61	-25.09	6m	POC, PIC, Bsi, cell count
27/10/2011	AFA	-18.71	-25.09	6m	POC, PIC, Bsi, cell count
28/10/2011	AFB	-20.44	-25.08	6m	POC, PIC, Bsi, cell count
28/10/2011	AFE	-21.82	-25.07	6m	POC, PIC, Bsi, cell count
29/10/2011	AFF	-23.54	-25.05	6m	POC, PIC, Bsi, cell count
29/10/2011	AFI	-24.81	-25.04	6m	POC, PIC, Bsi, cell count
30/10/2011	AFJ	-26.57	-25.02	6m	POC, PIC, Bsi, cell count
30/10/2011	AFM	-27.83	-25.00	6m	POC, PIC, Bsi, cell count
31/10/2011	AFN	-28.96	-26.29	6m	POC, PIC, Bsi, cell count
31/10/2011	AFQ	-29.88	-27.54	6m	POC, PIC, Bsi, cell count

Date	Station #	Lat (+=N,-=S)	Lon(E)	Depths Sampled	Samples Taken
01/11/2011	AFR	-31.04	-29.14	6m	POC, PIC, Bsi, cell count
01/11/2011	AFU	-31.87	-30.30	6m	POC, PIC, Bsi, cell count
02/11/2011	AFV	-32.97	-31.85	6m	POC, PIC, Bsi, cell count
02/11/2011	AFY	-33.87	-33.12	6m	POC, PIC, Bsi, cell count
03/11/2011	AGA	-35.01	-34.77	6m	POC, PIC, Bsi, cell count
03/11/2011	AGB	-35.33	-35.23	6m	POC, PIC, Bsi, cell count
03/11/2011	AGC	-35.60	-35.63	6m	POC, PIC, Bsi, cell count
03/11/2011	AGD	-35.83	-35.96	6m	POC, PIC, Bsi, cell count
04/11/2011	AGE	-36.49	-36.92	6m	POC, PIC, Bsi, cell count
04/11/2011	AGF	-36.71	-37.26	6m	POC, PIC, Bsi, cell count
04/11/2011	AGG	-36.95	-37.62	6m	POC, PIC, Bsi, cell count
04/11/2011	AGH	-37.20	-37.99	6m	POC, PIC, Bsi, cell count
04/11/2011	AGI	-37.40	-38.28	6m	POC, PIC, Bsi, cell count
05/11/2011	AGJ	-38.54	-40.01	6m	POC, PIC, Bsi, cell count
05/11/2011	AGM	-39.47	-41.42	6m	POC, PIC, Bsi, cell count
06/11/2011	AGN	-40.71	-43.34	6m	POC, PIC, Bsi, cell count
06/11/2011	AGQ	-41.57	-44.70	6m	POC, PIC, Bsi, cell count
07/11/2011	AGR	-42.69	-46.49	6m	POC, PIC, Bsi, cell count
07/11/2011	AGU	-43.53	-47.86	6m	POC, PIC, Bsi, cell count
08/11/2011	AGV	-44.70	-49.79	6m	POC, PIC, Bsi, cell count
08/11/2011	AGY	-45.55	-51.52	6m	POC, PIC, Bsi, cell count
09/11/2011	AHA	-46.87	-54.54	6m	POC, PIC, Bsi, cell count
09/11/2011	AHB	-47.27	-55.46	6m	POC, PIC, Bsi, cell count

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Zooplankton community size structure

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Introduction
The mesozooplankton sampling programme aboard AMT21 had three principal components. The first two were based on a daily vertical double (Bongo) net haul before dawn. One of the net samples was run through the Optical Plankton Counter (OPC) and Line Scanning Zooplankton Analyser (LiZA) to give a reliable indication of size-distributed mesozooplankton biomass at each station, together with images of each organism for classification by the Artificial Neural Network Classifier (ANNC) post-cruise. The sample from the second net on the Bongo system was preserved in buffered 4% formaldehyde solution for subsequent taxonomic analysis in the laboratory. Thirdly, throughout the cruise transect the OPC/LiZA combination sampled the ships non-toxic seawater supply (depth 6m) to give a continuous measure of size-distributed mesozooplankton biomass together with imagery for subsequent classification.

Methods:
Vertical net hauls were made each day at the pre-dawn station between year days 273 and 312 (29th September to 8th November). A double (bongo) net frame was deployed, with 0.57m diameter openings and carrying 2 WP2 nets with 200µm nylon mesh, fitted with cod ends with 200 µm mesh windows.

OPC biomass size distribution:
The OPC is capable of reliable and rapid characterization of marine zooplankton populations between 0.25 and 16mm equivalent spherical diameter (ESD, Herman, 1992) in up to 4096 size classes and at data rates of up to 200 events sec^{-1}. The OPC measures cross-sectional area of each particle passing between a collimated rectangular beam of red light and a rectangular light sensor as digital size. This digital size is converted to ESD using a semi-empirical formula, representing the diameter of a spherical particle presenting the same cross-sectional area as that detected for the particle. In our work on the AMT series (Gallienne & Robins, 1998; Gallienne & Robins, 2001; Gallienne et al., 2001), we have substituted a formula representing an ellipsoidal rather than a spherical model of particle size as being more representative of typical mesozooplankton shape. The volume of the ellipsoid determined in this way is calculated, and presented as biovolume in mm^3 m^{-3}. We convert biovolume to biomass using an empirical factor of 0.0475, derived from a regression analysis of biovolume against analytic carbon content (Gallienne et al, 2001).

Figure 1 OPC-1L used during AMT21

Figure 2 below shows a typical size-distribution of abundance and biomass for a net sample taken on day 312. The biomass maximum occurs at an ESD of 1.56mm (body length ~2.8mm, width ~0.9mm).

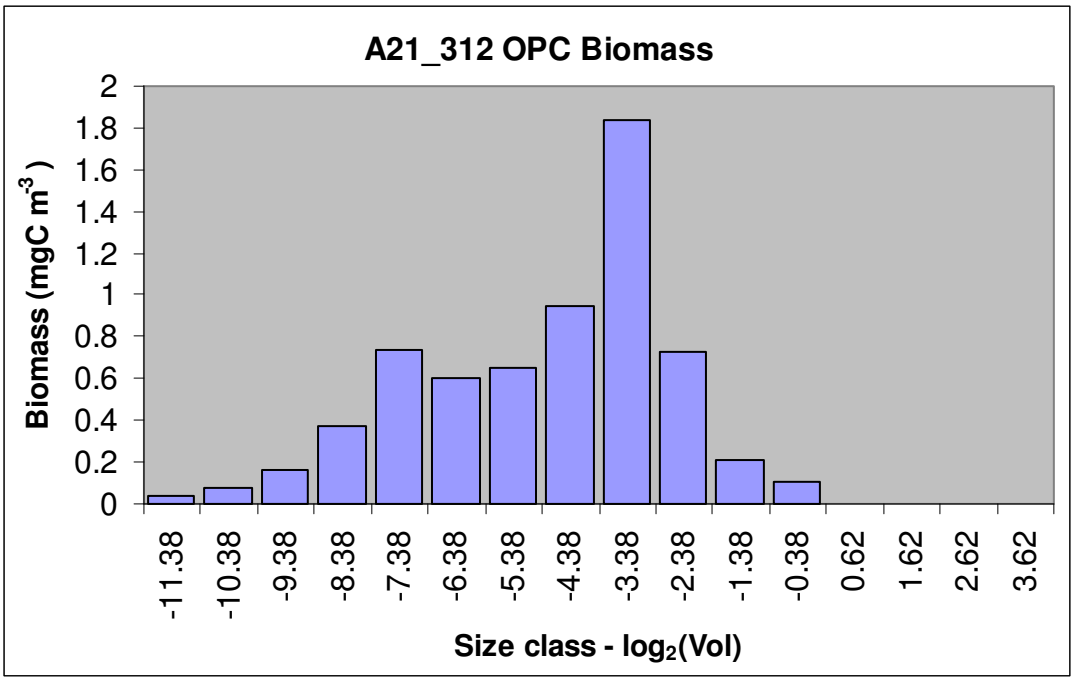

Figure 2 OPC Biomass from net cast on Year Day 312 (8th November).

LiZA Imaging System:

The Line Scanning Zooplankton Analyser (LiZA) is a video zooplankton analyzer and classifier system developed by the author at PML in collaboration with Dr Phil Culverhouse at the University of Plymouth. In 2003 an EU Craft grant enabled the adaptation of this prototype instrument, combined with the University of Plymouth DiCANN neural network classifier, to the detection of harmful dinoflagellate species for aquaculture sites (HAB-Buoy, 2006). HAB-buoy instruments are now operational at three aquaculture sites in Galway (Irish Republic), Ria Arosa (Spain) and Trieste (Italy). The successful proof and application of this technology led us to the development of the LiZA/DiCANN technology for automated marine mesozooplankton analysis to enable the routine gathering of in-situ real-time data on size- and taxonomic-distributions of mesozooplankton, from which estimates of rates such as growth, mortality and secondary production can be derived. It will also provide for analysis of large AMT sample archives that might otherwise be uneconomic to analyse by conventional means.

Figure 3 below shows sample images from the LiZA system taken early in the cruise from net hauls .

Figure 3: Sample images from LiZA analysis of net hauls from AMT21. Left to Right: Calanoid Copepod, decapod larval stage, Hyperiid Amphipod (id. courtesy R. Williams).

Results - OPC:

The size-distributed biomass from the whole AMT21 transect of net hauls is shown below in Figure.4. Detailed analysis, together with analysis of the continuous underway sampling through the OPC, must await further data processing post-cruise.

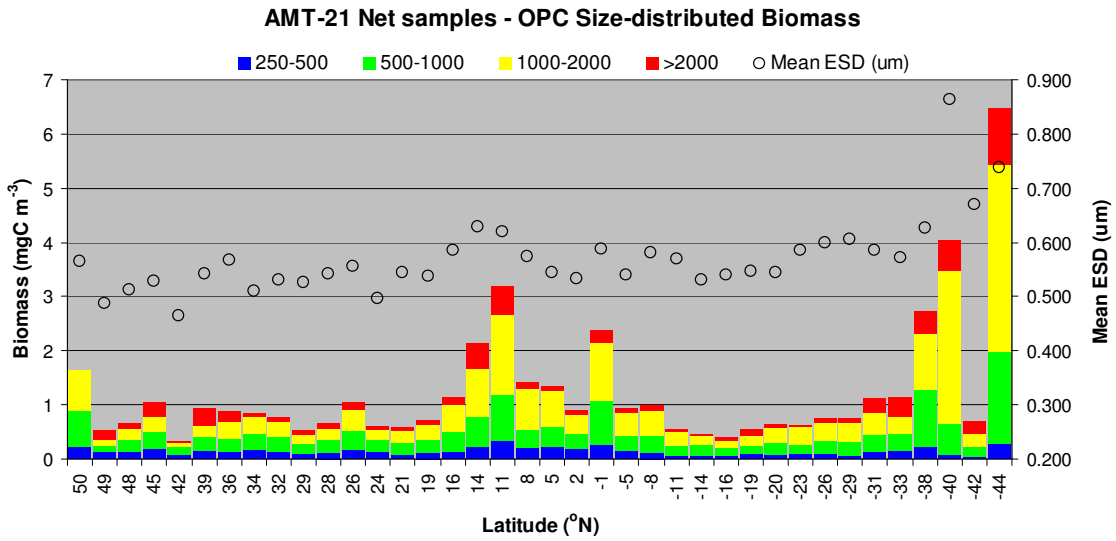

Figure 4: OPC Size-distributed biomass for net samples throughout AMT21

Results - LiZA:

Early in the cruise, a hardware fault caused the failure of the strobe timing board which controls the strobed LED illumination system The fault was not repairable in the field, so the system was run using camera controlled exposure to simulated strobed illumination. This produced acceptable images, but due to reduction in illumination during exposure periods, reduced depth of field due to the need to use an increased camera aperture, some blurring and other image degradation is evident. Nevertheless, overall results were acceptable.

During the AMT21 transect a total of 959,000 images were acquired from 39 net samples and 880 hours of near-continuous sampling of the ships seawater supply which draws water from approximately 6m depth. Post-cruise, a training sub-set of images will be selected and identified by a human expert taxonomist. The descriptors derived from this training set will then be used to train the artificial neural network classifier, which will then be used to quantify and classify the remaining images. In parallel, a traditional statistical classifier will be derived from the training set and used to quantify and classify the remaining images. The performance of the ANN and statistical classifiers will then be compared. The image in Figure 5, below, shows a typical sub-sample of images obtained.

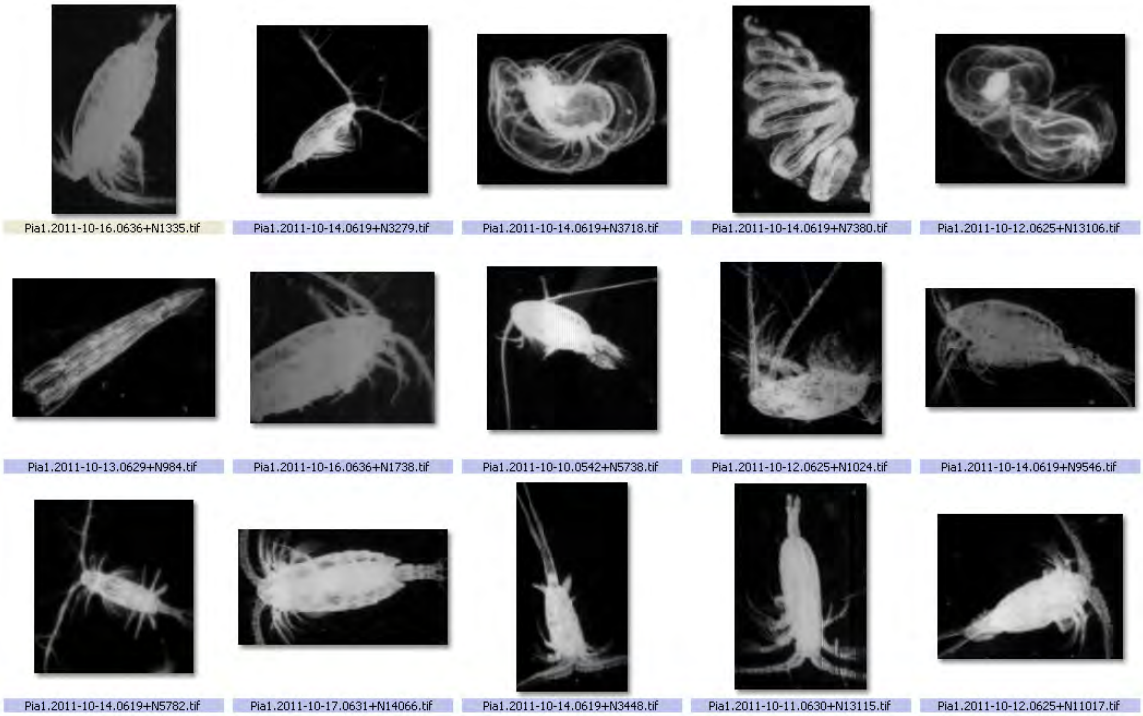

Figure 5: LiZA images from the AMT21 cruise

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In-water and above-surface optics

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Aims and objectives

Prior to the cruise, and as part of the SOLAS programme, a coupled atmospheric in-water UV optical model has been developed at PML. The model requires measurements of chlorophyll and CDOM to extrapolate the signal measured in the visible (400 – 700 nm) to the UV (300 – 400 nm) light spectrum. On AMT21 measurements of spectral inherent optical properties were made (using an ac-9) with which to better parameterise the model, and coincidental in-water spectral UV measurements were taken with which to validate the model. The atmospheric component of the model would be validated against the deck measured incident UV measurements.

In addition, measurements of phytoplankton physiology have been made using an FRRF. PAR measurements were made to determine the light levels through the water column for the various incubation experiments. Opportunistic measurements of aerosol optical depth have been made for the NASA AERONET project. The optical data (deck and in-water) fit within the wider optical aims of the AMT vis a vis: the characterisation of waters of different optical properties with particular interest in the backscatter signal; the development and validation of optical algorithms within the context of remote sensing; and the description using FRRF of the different phytoplankton physiology.

Methodology

In-water optics

On the optics rig the following instruments were deployed: Wet Labs ac-9; Wet Labs flow cells; Fast Repetition Rate Fluorometer (NMF supplied); Satlantic UV sensor; Seabird SBE19+ CTD; WET Labs ECO-BB3 backscatter sensor. The optics rig was deployed from a crane on the starboard aft quarter of the ship using 350 m of 10mm wire on the deck winch. Profiles were made at or within one hour of local solar noon. Optical protocols state that deployments should be on the sunward side of the ship; this criterion was not met as often as would have been hoped. The instruments were switched on and the instrument package lowered into the water and kept at the surface for three minutes. The rig was then lowered at a fairly fast rate (0.5 m/s) down to 200m depth. The upcast is the important part of the deployment and this was carried out at 0.2 m/s. Upon recovery, data from the instruments was downloaded: hyperterminal was used to download the FRRF; WLHost the ac-9, UV sensor, CTD and bb3.

Light depth profiles were calculated daily from the PAR data from the FRRF in order to help inform the choice of depths for CTD bottle firing the following day. The data from the FRRF will be processed using V6 of the Sam Laney (WHOI) Matlab code. This requires the FRRF to be characterised using 0.2 µm filtered water, at each of the gain settings (0, 1, 4, 16, 64, 256) for both the light and dark chambers, in a black bucket. The primary outputs of the FRRF data stream are the maximum fluorescence (Fm) and the ratio of the variable to maximum fluorescence (Fv/Fm). The final FRRF data product will consist of the phytoplankton physiological parameters binned to 2 m depth resolution.

The ac-9 data will be pre-processed using the Wetlabs WAP (v4.28a) software which essentially extracts the separate data streams from the instrument binary and then merges the different datastreams back into ascii format. The ac9 data need to be corrected for the effects of temperature, salinity and scattering (Zanefeld et al. scheme) which is done using bespoke IDL routines. The ac-9 also needs to have regular field calibrations done by running 0.1 µm filtered milliQ water through a thoroughly cleaned instrument (methanol used to clean optics and tubes). This was done oncw prior to the transect and the necessary offsets removed. The final ac-9 product will consist of the spectral ac-9 signal merged with the Satlantic UV-sensor (4 channels); CTD and flow cells.

The bb3 data will be processed in the laboratory as processing requires a further post-cruise calibration and the processed ac9 data for correction purposes.

Atmospheric optics

Surface UV measurements

A Trios Rameses ACC UV sensor was set up high on the ships starboard winch control cabin and configured to log hyperspectal UV between 200 and 500 nm at 2.5 nm resolution every 5 minutes through daylight hours. The data can either be kept as hyperspectral (to force e.g. in-water light field models) or integrated over broadband (UV-A and UV-B) ranges.

Satlantic Hypersas

A Satlantic HyperSAS system was also mounted high on the ships starboard winch control cabin. The instrument has three sensors measuring: i) sea upwelling radiance (angled at 45 degrees downwards); ii) sky downwelling radiance (angled at 45 degrees upwards) and iii) downwelling radiance (pointing vertically). The data is merged with GPS information and data processing for water leaving reflectance will be carried out back at the laboratory.

Microtops sun photometer

A Solar light Co. microtops sunphotometer was opportunistically used to determine the spectral aerosol optical thickness at 340, 440, 675 and 870 nm as part of the NASA AERONET project. The instrument was used throughout the AMT and data processing done by Dr. Sasha Smirnov.

optical characterization of dissolved organic matter along the Atlantic Meridional Transect.

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1. Background

Oceans play a crucial role in controlling the World's climate through the regulation of CO2 level by ocean-atmosphere exchange processes. Dissolved organic matter, is by far the largest pool of organic matter in the sea. About 97% of all organic carbon in the sea is bound in DOM (Hansell and Carlson, 1998). The estimated mass of DOC is 685 Giga tons of carbon (Hansell and Carlson, 2001). The mass of DOC in the sea is comparable with the mass of the carbon bound in the Earth's atmosphere as CO2 and the amount of carbon bound in terrestrial ecosystems. An understanding of the mechanisms and processes regulating the amount of DOM in the sea is critical for our ability to understand the global carbon cycle. Therefore, research on marine DOM has intensified over last the 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 over different time scales (Hedges, 2002). The dominating source of organic matter in the worlds' ocean is autochthonous production that accounts for more than 95% of total organic matter. The input of terrestrial DOM represents only 2-3% of the total oceanic DOM pool, although it may be a 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 the current carbon cycle. Results of recent studies have revealed that DOM is an active and most dynamic component of carbon biogeochemical cycles and plays important roles in marine ecosystems (e.g. Mopper et al., 1991). The 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 AMT21 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

3. Methods

3.1 Measurements of CDOM optical properties.

Water samples for determining CDOM absorption, CDOM fluorescence and DOC concentration were collected at fixed depths with Niskin bottles attached to a CTD rosette during solar noon casts. Water sample depths were determined upon features of the vertical profiles of the chlorophyll a fluorescence: at all stations the following depths were sampled: 300 m, 200 m, 100 m or Deep Chlorophyll Maximum (which ever was 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 filtration through 0.2 µm hydrophilic syringe filters. Spectral absorption by CDOM was measured in the laboratory on board RRS Discovery.

The CDOM absorption coefficient was measured with a liquid capillary wave guide cell system – LWCC with the nominal optical pathlength of 2 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 a small aliquot of Milli-Q water. Then 4-5 ml volume of Milli-Q water was 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 was measured on the LWCC system in triplicate, to ensure the repeatability of the CCD detector. 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 a DOM fluorescence toolbox developed by Stedmon and Bro (2007). Samples will be spectrally corrected with a

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 PARAFAC model will be derived with use of 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 hydrophilic syringe filters. A total of 40 ml aliquots of filtrate were acidified with 200µl of 0.1 M HCl and stored in the dark at 5^{o}C until laboratory analysis. Samples will be shipped to the 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 the following results: average recovery 95%; n = 5; CRM = 44 − 46 _M C; our results = 42 − 43 _M C and precision characterized by a relative standard deviation (RSD) of 2% (Kowalczuk et al., 2010).

1. List of collected water samples for measurements of CDOM absorption spectra, CDOM fluorescence Excitation Emission Matrix spectra and DOC concentration, AMT 21 (29.09.2011 – 13.11.2011).

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
1	2011-09-30	D371_001	D371_001	03:30	50,454	7,445	20	yes	yes	yes
2	2011-09-30	D371_001	D371_001	03:30	50,454	7,445	30	yes	yes	yes
3	2011-09-30	D371_001	D371_001	03:30	50,454	7,445	40	yes	yes	yes
4	2011-09-30	D371_001	D371_001	03:30	50,454	7,445	50	yes	yes	yes
5	2011-09-30	D371_001	D371_001	03:30	50,454	7,445	75	yes	yes	yes
6	2011-09-30	D371_001	D371_001	03:30	50,454	7,445	85	yes	yes	yes
7	2011-09-30	D371_001	D371_001	03:30	50,454	7,445		yes	yes	yes
8	2011-09-30	D371_002	D371_002	12:09	49,954	9,126	2	yes	yes	yes
9	2011-09-30	D371_002	D371_002	12:09	49,954	9,126	20	yes	yes	yes
10	2011-09-30	D371_002	D371_002	12:09	49,954	9,126	40	yes	yes	yes
11	2011-09-30	D371_002	D371_002	12:09	49,954	9,126	50	yes	yes	yes
12	2011-09-30	D371_002	D371_002	12:09	49,954	9,126	75	yes	yes	yes
13	2011-09-30	D371_002	D371_002	12:09	49,954	9,126	100	yes	yes	yes
14	2011-10-01	D371_003	D371_003	04:33	49,273	12,720	2	yes	yes	yes
15	2011-10-01	D371_003	D371_003	04:33	49,273	12,720	20	yes	yes	yes
16	2011-10-01	D371_003	D371_003	04:33	49,273	12,720	40	yes	yes	yes
17	2011-10-01	D371_003	D371_003	04:33	49,273	12,720	50	yes	yes	yes
18	2011-10-01	D371_003	D371_003	04:33	49,273	12,720	75	yes	yes	yes
19	2011-10-01	D371_003	D371_003	04:33	49,273	12,720	200	yes	yes	yes
20	2011-10-01	D371_003	D371_003	04:33	49,273	12,720	300	yes	yes	yes
21	2011-10-01	D371_004	D371_004	13:05	49,146	14,516	2	yes	yes	yes
22	2011-10-01	D371_004	D371_004	13:05	49,146	14,516	20	yes	yes	yes
23	2011-10-01	D371_004	D371_004	13:05	49,146	14,516	40	yes	yes	yes
24	2011-10-01	D371_004	D371_004	13:05	49,146	14,516	50	yes	yes	yes

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
25	2011-10-01	D371_004	D371_004	13:05	49,146	14,516	75	yes	yes	yes
26	2011-10-01	D371_004	D371_004	13:05	49,146	14,516	200	yes	yes	yes
27	2011-10-01	D371_004	D371_004	13:05	49,146	14,516	300	yes	yes	yes
28	2011-10-02	D371_005	D371_005	04:30	48,133	17,104	2	yes	yes	yes
29	2011-10-02	D371_005	D371_005	04:30	48,133	17,104	13	yes	yes	yes
30	2011-10-02	D371_005	D371_005	04:30	48,133	17,104	24	yes	yes	yes
31	2011-10-02	D371_005	D371_005	04:30	48,133	17,104	45	yes	yes	yes
32	2011-10-02	D371_005	D371_005	04:30	48,133	17,104	55	yes	yes	yes
33	2011-10-02	D371_005	D371_005	04:30	48,133	17,104	80	yes	yes	yes
34	2011-10-02	D371_005	D371_005	04:30	48,133	17,104	200	yes	yes	yes
35	2011-10-02	D371_006	D371_006	13:03	47,028	17,841	2	yes	yes	yes
36	2011-10-02	D371_006	D371_006	13:03	47,028	17,841	13	yes	yes	yes
37	2011-10-02	D371_006	D371_006	13:03	47,028	17,841	84	yes	yes	yes
38	2011-10-02	D371_006	D371_006	13:03	47,028	17,841	55	yes	yes	yes
39	2011-10-02	D371_006	D371_006	13:03	47,028	17,841	80	yes	yes	yes
40	2011-10-02	D371_006	D371_006	13:03	47,028	17,841	200	yes	yes	yes
41	2011-10-02	D371_006	D371_006	13:03	47,028	17,841	300	yes	yes	yes
42	2011-10-03	D371_007	D371_007	04:33	44,908	19,223	2	yes	yes	yes
43	2011-10-03	D371_007	D371_007	04:33	44,908	19,223	22	yes	yes	yes
44	2011-10-03	D371_007	D371_007	04:33	44,908	19,223	40	yes	yes	yes
45	2011-10-03	D371_007	D371_007	04:33	44,908	19,223	55	yes	yes	yes
46	2011-10-03	D371_007	D371_007	04:33	44,908	19,223	83	yes	yes	yes
47	2011-10-03	D371_007	D371_007	04:33	44,908	19,223	200	yes	yes	yes
48	2011-10-03	D371_008	D371_008	13:01	43,780	19,947	2	yes	yes	yes
49	2011-10-03	D371_008	D371_008	13:01	43,780	19,947	22	yes	yes	yes
50	2011-10-03	D371_008	D371_008	13:01	43,780	19,947	50	yes	yes	yes
51	2011-10-03	D371_008	D371_008	13:01	43,780	19,947	55	yes	yes	yes
52	2011-10-03	D371_008	D371_008	13:01	43,780	19,947	83	yes	yes	yes
53	2011-10-03	D371_008	D371_008	13:01	43,780	19,947	200	yes	yes	yes
54	2011-10-03	D371_008	D371_008	13:01	43,780	19,947	300	yes	yes	yes
55	2011-10-04	D371_009	D371_009	04:29	41,793	21,176	2	yes	yes	yes
56	2011-10-04	D371_009	D371_009	04:29	41,793	21,176	28	yes	yes	yes
57	2011-10-04	D371_009	D371_009	04:29	41,793	21,176	63	yes	yes	yes
58	2011-10-04	D371_009	D371_009	04:29	41,793	21,176	65	yes	yes	yes
59	2011-10-04	D371_009	D371_009	04:29	41,793	21,176	110	yes	yes	yes
60	2011-10-04	D371_009	D371_009	04:29	41,793	21,176	200	yes	yes	yes
61	2011-10-04	D371_010	D371_010	13:02	40,666	20,859	2	yes	yes	yes
62	2011-10-04	D371_010	D371_010	13:02	40,666	20,859	28	yes	yes	yes
63	2011-10-04	D371_010	D371_010	13:02	40,666	20,859	60	yes	yes	yes
64	2011-10-04	D371_010	D371_010	13:02	40,666	20,859	65	yes	yes	yes
65	2011-10-04	D371_010	D371_010	13:02	40,666	20,859	110	yes	yes	yes
66	2011-10-04	D371_010	D371_010	13:02	40,666	20,859	200	yes	yes	yes
67	2011-10-04	D371_010	D371_010	13:02	40,666	20,859	300	yes	yes	yes

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
68	2011-10-05	D371_011	D371_011	04:32	38,515	23,127	2	yes	yes	yes
69	2011-10-05	D371_011	D371_011	04:32	38,515	23,127	30	yes	yes	yes
70	2011-10-05	D371_011	D371_011	04:32	38,515	23,127	60	yes	yes	yes
71	2011-10-05	D371_011	D371_011	04:32	38,515	23,127	70	yes	yes	yes
72	2011-10-05	D371_011	D371_011	04:32	38,515	23,127	110	yes	yes	yes
73	2011-10-05	D371_011	D371_011	04:32	38,515	23,127	200	yes	yes	yes
74	2011-10-05	D371_011	D371_011	04:32	38,515	23,127	300	yes	yes	yes
75	2011-10-05	D371_012	D371_012	12:59	37,301	23,828	2	yes	yes	yes
76	2011-10-05	D371_012	D371_012	12:59	37,301	23,828	37	yes	yes	yes
77	2011-10-05	D371_012	D371_012	12:59	37,301	23,828	87	yes	yes	yes
78	2011-10-05	D371_012	D371_012	12:59	37,301	23,828	110	yes	yes	yes
79	2011-10-05	D371_012	D371_012	12:59	37,301	23,828	200	yes	yes	yes
80	2011-10-05	D371_012	D371_012	12:59	37,301	23,828	300	yes	yes	yes
81	2011-10-06	D371_013	D371_013	04:30	35,692	25,815	2	yes	yes	yes
82	2011-10-06	D371_013	D371_013	04:30	35,692	25,815	45	yes	yes	yes
83	2011-10-06	D371_013	D371_013	04:30	35,692	25,815	78	yes	yes	yes
84	2011-10-06	D371_013	D371_013	04:30	35,692	25,815	105	yes	yes	yes
85	2011-10-06	D371_013	D371_013	04:30	35,692	25,815	175	yes	yes	yes
86	2011-10-06	D371_013	D371_013	04:30	35,692	25,815	200	yes	yes	yes
87	2011-10-06	D371_013	D371_013	04:30	35,692	25,815	300	yes	yes	yes
88	2011-10-07	D371_015	D371_015	04:28	33,502	28,754	2	yes	yes	yes
89	2011-10-07	D371_015	D371_015	04:28	33,502	28,754	36	yes	yes	yes
90	2011-10-07	D371_015	D371_015	04:28	33,502	28,754	80	yes	yes	yes
91	2011-10-07	D371_015	D371_015	04:28	33,502	28,754	84	yes	yes	yes
92	2011-10-07	D371_015	D371_015	04:28	33,502	28,754	100	yes	yes	yes
93	2011-10-07	D371_015	D371_015	04:28	33,502	28,754	200	yes	yes	yes
94	2011-10-07	D371_015	D371_015	04:28	33,502	28,754	300	yes	yes	yes
95	2011-10-08	D371_017	D371_017	04:30	31,548	31,326	2	yes	yes	yes
96	2011-10-08	D371_017	D371_017	04:30	31,548	31,326	44	yes	yes	yes
97	2011-10-08	D371_017	D371_017	04:30	31,548	31,326	88	yes	yes	yes
98	2011-10-08	D371_017	D371_017	04:30	31,548	31,326	103	yes	yes	yes
99	2011-10-08	D371_017	D371_017	04:30	31,548	31,326	175	yes	yes	yes
100	2011-10-08	D371_017	D371_017	04:30	31,548	31,326	2000	yes	yes	yes
101	2011-10-08	D371_017	D371_017	04:30	31,548	31,326	300	yes	yes	yes
102	2011-10-09	D371_019	D371_019	05:33	29,485	33,972	2	yes	yes	yes
103	2011-10-09	D371_019	D371_019	05:33	29,485	33,972	48	yes	yes	yes
104	2011-10-09	D371_019	D371_019	05:33	29,485	33,972	102	yes	yes	yes
105	2011-10-09	D371_019	D371_019	05:33	29,485	33,972	112	yes	yes	yes
106	2011-10-09	D371_019	D371_019	05:33	29,485	33,972	170	yes	yes	yes
107	2011-10-09	D371_019	D371_019	05:33	29,485	33,972	200	yes	yes	yes
108	2011-10-09	D371_019	D371_019	05:33	29,485	33,972	300	yes	yes	yes
109	2011-10-10	D371_021	D371_021	05:32	27,581	36,381	2	yes	yes	yes
110	2011-10-10	D371_021	D371_021	05:32	27,581	36,381	44	yes	yes	yes

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
111	2011-10-10	D371_021	D371_021	05:32	27,581	36,381	105	yes	yes	yes
112	2011-10-10	D371_021	D371_021	05:32	27,581	36,381	157	yes	yes	yes
113	2011-10-10	D371_021	D371_021	05:32	27,581	36,381	175	yes	yes	yes
114	2011-10-10	D371_021	D371_021	05:32	27,581	36,381	200	yes	yes	yes
115	2011-10-10	D371_021	D371_021	05:32	27,581	36,381	300	yes	yes	yes
116	2011-10-10	D371_022	D371_022	13:58	26,915	37,214	2	yes	yes	yes
117	2011-10-10	D371_022	D371_022	13:58	26,915	37,214	29	yes	yes	yes
118	2011-10-10	D371_022	D371_022	13:58	26,915	37,214	52	yes	yes	yes
119	2011-10-10	D371_022	D371_022	13:58	26,915	37,214	120	yes	yes	yes
120	2011-10-10	D371_022	D371_022	13:58	26,915	37,214	160	yes	yes	yes
121	2011-10-10	D371_022	D371_022	13:58	26,915	37,214	175	yes	yes	yes
122	2011-10-10	D371_022	D371_022	13:58	26,915	37,214	300	yes	yes	yes
123	2011-10-11	D371_023	D371_023	05:28	25,625	38,804	2	yes	yes	yes
124	2011-10-11	D371_023	D371_023	05:28	25,625	38,804	29	yes	yes	yes
125	2011-10-11	D371_023	D371_023	05:28	25,625	38,804	52	yes	yes	yes
126	2011-10-11	D371_023	D371_023	05:28	25,625	38,804	120	yes	yes	yes
127	2011-10-11	D371_023	D371_023	05:28	25,625	38,804	175	yes	yes	yes
128	2011-10-11	D371_023	D371_023	05:28	25,625	38,804	200	yes	yes	yes
129	2011-10-11	D371_023	D371_023	05:28	25,625	38,804	300	yes	yes	yes
130	2011-10-11	D371_024	D371_024	14:01	24,943	39,650	2	yes	yes	yes
131	2011-10-11	D371_024	D371_024	14:01	24,943	39,650	29	yes	yes	yes
132	2011-10-11	D371_024	D371_024	14:01	24,943	39,650	70	yes	yes	yes
133	2011-10-11	D371_024	D371_024	14:01	24,943	39,650	103	yes	yes	yes
134	2011-10-11	D371_024	D371_024	14:01	24,943	39,650	120	yes	yes	yes
135	2011-10-11	D371_024	D371_024	14:01	24,943	39,650	140	yes	yes	yes
136	2011-10-11	D371_024	D371_024	14:01	24,943	39,650	175	yes	yes	yes
137	2011-10-11	D371_024	D371_024	14:01	24,943	39,650	300	yes	yes	yes
138	2011-10-12	D371_026	D371_026	13:58	22,770	40,344	2	yes	yes	yes
139	2011-10-12	D371_026	D371_026	13:58	22,770	40,344	29	yes	yes	yes
140	2011-10-12	D371_026	D371_026	13:58	22,770	40,344	70	yes	yes	yes
141	2011-10-12	D371_026	D371_026	13:58	22,770	40,344	110	yes	yes	yes
142	2011-10-12	D371_026	D371_026	13:58	22,770	40,344	120	yes	yes	yes
143	2011-10-12	D371_026	D371_026	13:58	22,770	40,344	150	yes	yes	yes
144	2011-10-12	D371_026	D371_026	13:58	22,770	40,344	175	yes	yes	yes
145	2011-10-12	D371_026	D371_026	13:58	22,770	40,344	300	yes	yes	yes
146	2011-10-13	D371_028	D371_028	13:58	20,391	38,550	2	yes	yes	yes
147	2011-10-13	D371_028	D371_028	13:58	20,391	38,550	32	yes	yes	yes
148	2011-10-13	D371_028	D371_028	13:58	20,391	38,550	78	yes	yes	yes
149	2011-10-13	D371_028	D371_028	13:58	20,391	38,550	135	yes	yes	yes
150	2011-10-13	D371_028	D371_028	13:58	20,391	38,550	165	yes	yes	yes
151	2011-10-13	D371_028	D371_028	13:58	20,391	38,550	175	yes	yes	yes
152	2011-10-13	D371_028	D371_028	13:58	20,391	38,550	300	yes	yes	yes
153	2011-10-14	D371_029	D371_029	05:29	18,823	37,399	2	yes	yes	yes

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
154	2011-10-14	D371_029	D371_029	05:29	18,823	37,399	31	yes	yes	yes
155	2011-10-14	D371_029	D371_029	05:29	18,823	37,399	56	yes	yes	yes
156	2011-10-14	D371_029	D371_029	05:29	18,823	37,399	90	yes	yes	yes
157	2011-10-14	D371_029	D371_029	05:29	18,823	37,399	130	yes	yes	yes
158	2011-10-14	D371_029	D371_029	05:29	18,823	37,399	175	yes	yes	yes
159	2011-10-14	D371_029	D371_029	05:29	18,823	37,399	200	yes	yes	yes
160	2011-10-14	D371_029	D371_029	05:29	18,823	37,399	300	yes	yes	yes
161	2011-10-14	D371_030	D371_030	14:00	18,016	36,830	2	yes	yes	yes
162	2011-10-14	D371_030	D371_030	14:00	18,016	36,830	28	yes	yes	yes
163	2011-10-14	D371_030	D371_030	14:00	18,016	36,830	68	yes	yes	yes
164	2011-10-14	D371_030	D371_030	14:00	18,016	36,830	100	yes	yes	yes
165	2011-10-14	D371_030	D371_030	14:00	18,016	36,830	150	yes	yes	yes
166	2011-10-14	D371_030	D371_030	14:00	18,016	36,830	175	yes	yes	yes
167	2011-10-14	D371_030	D371_030	14:00	18,016	36,830	300	yes	yes	yes
168	2011-10-15	D371_031	D371_031	05:26	16,478	35,740	2	yes	yes	yes
169	2011-10-15	D371_031	D371_031	05:26	16,478	35,740	46	yes	yes	yes
170	2011-10-15	D371_031	D371_031	05:26	16,478	35,740	75	yes	yes	yes
171	2011-10-15	D371_031	D371_031	05:26	16,478	35,740	107	yes	yes	yes
172	2011-10-15	D371_031	D371_031	05:26	16,478	35,740	160	yes	yes	yes
173	2011-10-15	D371_031	D371_031	05:26	16,478	35,740	200	yes	yes	yes
174	2011-10-15	D371_031	D371_031	05:26	16,478	35,740	300	yes	yes	yes
175	2011-10-15	D371_032	D371_032	13:59	15,650	35,171	2	yes	yes	yes
176	2011-10-15	D371_032	D371_032	13:59	15,650	35,171	22	yes	yes	yes
177	2011-10-15	D371_032	D371_032	13:59	15,650	35,171	52	yes	yes	yes
178	2011-10-15	D371_032	D371_032	13:59	15,650	35,171	70	yes	yes	yes
179	2011-10-15	D371_032	D371_032	13:59	15,650	35,171	90	yes	yes	yes
180	2011-10-15	D371_032	D371_032	13:59	15,650	35,171	130	yes	yes	yes
181	2011-10-15	D371_032	D371_032	13:59	15,650	35,171	150	yes	yes	yes
182	2011-10-15	D371_032	D371_032	13:59	15,650	35,171	200	yes	yes	yes
183	2011-10-16	D371_033	D371_033	05:28	13,785	33,895	2	yes	yes	yes
184	2011-10-16	D371_033	D371_033	05:28	13,785	33,895	20	yes	yes	yes
185	2011-10-16	D371_033	D371_033	05:28	13,785	33,895	36	yes	yes	yes
186	2011-10-16	D371_033	D371_033	05:28	13,785	33,895	75	yes	yes	yes
187	2011-10-16	D371_033	D371_033	05:28	13,785	33,895	85	yes	yes	yes
188	2011-10-16	D371_033	D371_033	05:28	13,785	33,895	128	yes	yes	yes
189	2011-10-16	D371_033	D371_033	05:28	13,785	33,895	200	yes	yes	yes
190	2011-10-16	D371_033	D371_033	05:28	13,785	33,895	300	yes	yes	yes
191	2011-10-16	D371_034	D371_034	13:59	12,756	33,204	2	yes	yes	yes
192	2011-10-16	D371_034	D371_034	13:59	12,756	33,204	20	yes	yes	yes
193	2011-10-16	D371_034	D371_034	13:59	12,756	33,204	49	yes	yes	yes
194	2011-10-16	D371_034	D371_034	13:59	12,756	33,204	65	yes	yes	yes
195	2011-10-16	D371_034	D371_034	13:59	12,756	33,204	85	yes	yes	yes
196	2011-10-16	D371_034	D371_034	13:59	12,756	33,204	128	yes	yes	yes

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
197	2011-10-16	D371_034	D371_034	13:59	12,756	33,204	150	yes	yes	yes
198	2011-10-16	D371_034	D371_034	13:59	12,756	33,204	200	yes	yes	yes
199	2011-10-17	D371_035	D371_035	05:29	10,757	31,873	2	yes	yes	yes
200	2011-10-17	D371_035	D371_035	05:29	10,757	31,873	17	yes	yes	yes
201	2011-10-17	D371_035	D371_035	05:29	10,757	31,873	30	yes	yes	yes
202	2011-10-17	D371_035	D371_035	05:29	10,757	31,873	54	yes	yes	yes
203	2011-10-17	D371_035	D371_035	05:29	10,757	31,873	70	yes	yes	yes
204	2011-10-17	D371_035	D371_035	05:29	10,757	31,873	106	yes	yes	yes
205	2011-10-17	D371_035	D371_035	05:29	10,757	31,873	200	yes	yes	yes
206	2011-10-17	D371_035	D371_035	05:29	10,757	31,873	300	yes	yes	yes
207	2011-10-17	D371_036	D371_036	14:04	9,658	31,153	2	yes	yes	yes
208	2011-10-17	D371_036	D371_036	14:04	9,658	31,153	16	yes	yes	yes
209	2011-10-17	D371_036	D371_036	14:04	9,658	31,153	20	yes	yes	yes
210	2011-10-17	D371_036	D371_036	14:04	9,658	31,153	38	yes	yes	yes
211	2011-10-17	D371_036	D371_036	14:04	9,658	31,153	59	yes	yes	yes
212	2011-10-17	D371_036	D371_036	14:04	9,658	31,153	65	yes	yes	yes
213	2011-10-17	D371_036	D371_036	14:04	9,658	31,153	100	yes	yes	yes
214	2011-10-17	D371_036	D371_036	14:04	9,658	31,153	300	yes	yes	yes
215	2011-10-18	D371_037	D371_037	05:26	7,593	29,811	2	yes	yes	yes
216	2011-10-18	D371_037	D371_037	05:26	7,593	29,811	20	yes	yes	yes
217	2011-10-18	D371_037	D371_037	05:26	7,593	29,811	33	yes	yes	yes
218	2011-10-18	D371_037	D371_037	05:26	7,593	29,811	65	yes	yes	yes
219	2011-10-18	D371_037	D371_037	05:26	7,593	29,811	77	yes	yes	yes
220	2011-10-18	D371_037	D371_037	05:26	7,593	29,811	150	yes	yes	yes
221	2011-10-18	D371_037	D371_037	05:26	7,593	29,811	300	yes	yes	yes
222	2011-10-18	D371_038	D371_038	14:00	6,522	29,133	2	yes	yes	yes
223	2011-10-18	D371_038	D371_038	14:00	6,522	29,133	20	yes	yes	yes
224	2011-10-18	D371_038	D371_038	14:00	6,522	29,133	44	yes	yes	yes
225	2011-10-18	D371_038	D371_038	14:00	6,522	29,133	75	yes	yes	yes
226	2011-10-18	D371_038	D371_038	14:00	6,522	29,133	115	yes	yes	yes
227	2011-10-18	D371_038	D371_038	14:00	6,522	29,133	150	yes	yes	yes
228	2011-10-18	D371_038	D371_038	14:00	6,522	29,133	300	yes	yes	yes
229	2011-10-19	D371_039	D371_039	05:25	4,627	27,919	2	yes	yes	yes
230	2011-10-19	D371_039	D371_039	05:25	4,627	27,919	46	yes	yes	yes
231	2011-10-19	D371_039	D371_039	05:25	4,627	27,919	80	yes	yes	yes
232	2011-10-19	D371_039	D371_039	05:25	4,627	27,919	107	yes	yes	yes
233	2011-10-19	D371_039	D371_039	05:25	4,627	27,919	160	yes	yes	yes
234	2011-10-19	D371_039	D371_039	05:25	4,627	27,919	200	yes	yes	yes
235	2011-10-19	D371_039	D371_039	05:25	4,627	27,919	300	yes	yes	yes
236	2011-10-19	D371_040	D371_040	14:00	3,683	27,321	2	yes	yes	yes
237	2011-10-19	D371_040	D371_040	14:00	3,683	27,321	20	yes	yes	yes
238	2011-10-19	D371_040	D371_040	14:00	3,683	27,321	47	yes	yes	yes
239	2011-10-19	D371_040	D371_040	14:00	3,683	27,321	74	yes	yes	yes

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
240	2011-10-19	D371_040	D371_040	14:00	3,683	27,321	82	yes	yes	yes
241	2011-10-19	D371_040	D371_040	14:00	3,683	27,321	125	yes	yes	yes
242	2011-10-19	D371_040	D371_040	14:00	3,683	27,321	300	yes	yes	yes
243	2011-10-20	D371_041	D371_041	05:27	1,928	26,220	2	yes	yes	yes
244	2011-10-20	D371_041	D371_041	05:27	1,928	26,220	20	yes	yes	yes
245	2011-10-20	D371_041	D371_041	05:27	1,928	26,220	36	yes	yes	yes
246	2011-10-20	D371_041	D371_041	05:27	1,928	26,220	70	yes	yes	yes
247	2011-10-20	D371_041	D371_041	05:27	1,928	26,220	85	yes	yes	yes
248	2011-10-20	D371_041	D371_041	05:27	1,928	26,220	150	yes	yes	yes
249	2011-10-20	D371_041	D371_041	05:27	1,928	26,220	300	yes	yes	yes
250	2011-10-20	D371_042	D371_042	13:29	1,035	25,651	2	yes	yes	yes
251	2011-10-20	D371_042	D371_042	13:29	1,035	25,651	20	yes	yes	yes
252	2011-10-20	D371_042	D371_042	13:29	1,035	25,651	49	yes	yes	yes
253	2011-10-20	D371_042	D371_042	13:29	1,035	25,651	76	yes	yes	yes
254	2011-10-20	D371_042	D371_042	13:29	1,035	25,651	85	yes	yes	yes
255	2011-10-20	D371_042	D371_042	13:29	1,035	25,651	128	yes	yes	yes
256	2011-10-20	D371_042	D371_042	13:29	1,035	25,651	300	yes	yes	yes
257	2011-10-21	D371_043	D371_043	05:30	-1,032	25,005	2	yes	yes	yes
258	2011-10-21	D371_043	D371_043	05:30	-1,032	25,005	22	yes	yes	yes
259	2011-10-21	D371_043	D371_043	05:30	-1,032	25,005	39	yes	yes	yes
260	2011-10-21	D371_043	D371_043	05:30	-1,032	25,005	70	yes	yes	yes
261	2011-10-21	D371_043	D371_043	05:30	-1,032	25,005	90	yes	yes	yes
262	2011-10-21	D371_043	D371_043	05:30	-1,032	25,005	200	yes	yes	yes
263	2011-10-21	D371_043	D371_043	05:30	-1,032	25,005	300	yes	yes	yes
264	2011-10-22	D371_045	D371_045	13:31	-5,615	25,030	2	yes	yes	yes
265	2011-10-22	D371_045	D371_045	13:31	-5,615	25,030	22	yes	yes	yes
266	2011-10-22	D371_045	D371_045	13:31	-5,615	25,030	52	yes	yes	yes
267	2011-10-22	D371_045	D371_045	13:31	-5,615	25,030	90	yes	yes	yes
268	2011-10-22	D371_045	D371_045	13:31	-5,615	25,030	130	yes	yes	yes
269	2011-10-22	D371_045	D371_045	13:31	-5,615	25,030	150	yes	yes	yes
270	2011-10-22	D371_045	D371_045	13:31	-5,615	25,030	300	yes	yes	yes
271	2011-10-23	D371_046	D371_046	05:30	-7,709	25,039	2	yes	yes	no
272	2011-10-23	D371_046	D371_046	05:30	-7,709	25,039	24	yes	yes	no
273	2011-10-23	D371_046	D371_046	05:30	-7,709	25,039	43	yes	yes	no
274	2011-10-23	D371_046	D371_046	05:30	-7,709	25,039	94	yes	yes	no
275	2011-10-23	D371_046	D371_046	05:30	-7,709	25,039	100	yes	yes	no
276	2011-10-23	D371_046	D371_046	05:30	-7,709	25,039	150	yes	yes	no
277	2011-10-23	D371_046	D371_046	05:30	-7,709	25,039	300	yes	yes	no
278	2011-10-23	D371_047	D371_047	13:29	-8,706	25,056	2	yes	yes	yes
279	2011-10-23	D371_047	D371_047	13:29	-8,706	25,056	24	yes	yes	yes
280	2011-10-23	D371_047	D371_047	13:29	-8,706	25,056	58	yes	yes	yes
281	2011-10-23	D371_047	D371_047	13:29	-8,706	25,056	90	yes	yes	yes
282	2011-10-23	D371_047	D371_047	13:29	-8,706	25,056	100	yes	yes	yes

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
283	2011-10-23	D371_047	D371_047	13:29	-8,706	25,056	150	yes	yes	yes
284	2011-10-23	D371_047	D371_047	13:29	-8,706	25,056	300	yes	yes	yes
285	2011-10-24	D371_048	D371_048	05:25	-10,688	25,056	2	yes	yes	no
286	2011-10-24	D371_048	D371_048	05:25	-10,688	25,056	49	yes	yes	no
287	2011-10-24	D371_048	D371_048	05:25	-10,688	25,056	95	yes	yes	no
288	2011-10-24	D371_048	D371_048	05:25	-10,688	25,056	115	yes	yes	no
289	2011-10-24	D371_048	D371_048	05:25	-10,688	25,056	300	yes	yes	no
290	2011-10-24	D371_049	D371_049	13:31	-11,663	25,065	2	yes	yes	yes
291	2011-10-24	D371_049	D371_049	13:31	-11,663	25,065	31	yes	yes	yes
292	2011-10-24	D371_049	D371_049	13:31	-11,663	25,065	75	yes	yes	yes
293	2011-10-24	D371_049	D371_049	13:31	-11,663	25,065	130	yes	yes	yes
294	2011-10-24	D371_049	D371_049	13:31	-11,663	25,065	150	yes	yes	yes
295	2011-10-24	D371_049	D371_049	13:31	-11,663	25,065	175	yes	yes	yes
296	2011-10-24	D371_049	D371_049	13:31	-11,663	25,065	300	yes	yes	yes
297	2011-10-25	D371_050	D371_050	05:33	-13,581	25,068	2	yes	yes	no
298	2011-10-25	D371_050	D371_050	05:33	-13,581	25,068	36	yes	yes	no
299	2011-10-25	D371_050	D371_050	05:33	-13,581	25,068	65	yes	yes	no
300	2011-10-25	D371_050	D371_050	05:33	-13,581	25,068	130	yes	yes	no
301	2011-10-25	D371_050	D371_050	05:33	-13,581	25,068	140	yes	yes	no
302	2011-10-25	D371_050	D371_050	05:33	-13,581	25,068	175	yes	yes	no
303	2011-10-25	D371_050	D371_050	05:33	-13,581	25,068	300	yes	yes	yes
304	2011-10-25	D371_051	D371_051	11:00	-13,184	25,076	2	yes	yes	yes
305	2011-10-25	D371_051	D371_051	11:00	-13,184	25,076	28	yes	yes	yes
306	2011-10-25	D371_051	D371_051	11:00	-13,184	25,076	68	yes	yes	yes
307	2011-10-25	D371_051	D371_051	11:00	-13,184	25,076	118	yes	yes	yes
308	2011-10-25	D371_051	D371_051	11:00	-13,184	25,076	142	yes	yes	yes
309	2011-10-25	D371_051	D371_051	11:00	-13,184	25,076	200	yes	yes	yes
310	2011-10-26	D371_052	D371_052	04:56	-15,925	25,090	2	yes	yes	no
311	2011-10-26	D371_052	D371_052	04:56	-15,925	25,090	50	yes	yes	no
312	2011-10-26	D371_052	D371_052	04:56	-15,925	25,090	118	yes	yes	no
313	2011-10-26	D371_052	D371_052	04:56	-15,925	25,090	160	yes	yes	no
314	2011-10-26	D371_052	D371_052	04:56	-15,925	25,090	175	yes	yes	no
315	2011-10-26	D371_052	D371_052	04:56	-15,925	25,090	200	yes	yes	no
316	2011-10-26	D371_052	D371_052	04:56	-15,925	25,090	300	yes	yes	no
317	2011-10-26	D371_053	D371_053	13:32	-16,960	25,094	2	yes	yes	yes
318	2011-10-26	D371_053	D371_053	13:32	-16,960	25,094	28	yes	yes	yes
319	2011-10-26	D371_053	D371_053	13:32	-16,960	25,094	68	yes	yes	yes
320	2011-10-26	D371_053	D371_053	13:32	-16,960	25,094	118	yes	yes	yes
321	2011-10-26	D371_053	D371_053	13:32	-16,960	25,094	160	yes	yes	yes
322	2011-10-26	D371_053	D371_053	13:32	-16,960	25,094	177	yes	yes	yes
323	2011-10-26	D371_053	D371_053	13:32	-16,960	25,094	300	yes	yes	yes
324	2011-10-27	D371_054	D371_054	04:55	-18,525	25,101	2	yes	yes	no
325	2011-10-27	D371_054	D371_054	04:55	-18,525	25,101	33	yes	yes	no

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
326	2011-10-27	D371_054	D371_054	04:55	-18,525	25,101	58	yes	yes	no
327	2011-10-27	D371_054	D371_054	04:55	-18,525	25,101	135	yes	yes	no
328	2011-10-27	D371_054	D371_054	04:55	-18,525	25,101	160	yes	yes	no
329	2011-10-27	D371_054	D371_054	04:55	-18,525	25,101	300	yes	yes	no
330	2011-10-27	D371_054	D371_054	04:55	-18,525	25,101	500	yes	yes	no
331	2011-10-28	D371_056	D371_056	13:35	-21,096	25,076	2	yes	yes	yes
332	2011-10-28	D371_056	D371_056	13:35	-21,096	25,076	33	yes	yes	yes
333	2011-10-28	D371_056	D371_056	13:35	-21,096	25,076	78	yes	yes	yes
334	2011-10-28	D371_056	D371_056	13:35	-21,096	25,076	135	yes	yes	yes
335	2011-10-28	D371_056	D371_056	13:35	-21,096	25,076	160	yes	yes	yes
336	2011-10-28	D371_056	D371_056	13:35	-21,096	25,076	175	yes	yes	yes
337	2011-10-28	D371_056	D371_056	13:35	-21,096	25,076	300	yes	yes	yes
338	2011-10-29	D371_058	D371_058	13:30	-24,113	25,045	2	yes	yes	yes
339	2011-10-29	D371_058	D371_058	13:30	-24,113	25,045	31	yes	yes	yes
340	2011-10-29	D371_058	D371_058	13:30	-24,113	25,045	74	yes	yes	yes
341	2011-10-29	D371_058	D371_058	13:30	-24,113	25,045	128	yes	yes	yes
342	2011-10-29	D371_058	D371_058	13:30	-24,113	25,045	140	yes	yes	yes
343	2011-10-29	D371_058	D371_058	13:30	-24,113	25,045	175	yes	yes	yes
344	2011-10-29	D371_058	D371_058	13:30	-24,113	25,045	300	yes	yes	yes
345	2011-10-30	D371_060	D371_060	13:29	-27,157	25,012	2	yes	yes	yes
346	2011-10-30	D371_060	D371_060	13:29	-27,157	25,012	30	yes	yes	yes
347	2011-10-30	D371_060	D371_060	13:29	-27,157	25,012	54	yes	yes	yes
348	2011-10-30	D371_060	D371_060	13:29	-27,157	25,012	73	yes	yes	yes
349	2011-10-30	D371_060	D371_060	13:29	-27,157	25,012	120	yes	yes	yes
350	2011-10-30	D371_060	D371_060	13:29	-27,157	25,012	125	yes	yes	yes
351	2011-10-30	D371_060	D371_060	13:29	-27,157	25,012	300	yes	yes	yes
352	2011-10-31	D371_062	D371_062	13:32	-29,378	26,862	2	yes	yes	yes
353	2011-10-31	D371_062	D371_062	13:32	-29,378	26,862	24	yes	yes	yes
354	2011-10-31	D371_062	D371_062	13:32	-29,378	26,862	58	yes	yes	yes
355	2011-10-31	D371_062	D371_062	13:32	-29,378	26,862	90	yes	yes	yes
356	2011-10-31	D371_062	D371_062	13:32	-29,378	26,862	100	yes	yes	yes
357	2011-10-31	D371_062	D371_062	13:32	-29,378	26,862	170	yes	yes	yes
358	2011-10-31	D371_062	D371_062	13:32	-29,378	26,862	300	yes	yes	yes
359	2011-11-01	D371_063	D371_063	04:59	-30,735	28,731	2	yes	yes	no
360	2011-11-01	D371_063	D371_063	04:59	-30,735	28,731	22	yes	yes	no
361	2011-11-01	D371_063	D371_063	04:59	-30,735	28,731	39	yes	yes	no
362	2011-11-01	D371_063	D371_063	04:59	-30,735	28,731	70	yes	yes	no
363	2011-11-01	D371_063	D371_063	04:59	-30,735	28,731	90	yes	yes	no
364	2011-11-01	D371_063	D371_063	04:59	-30,735	28,731	135	yes	yes	no
365	2011-11-01	D371_063	D371_063	04:59	-30,735	28,731	300	yes	yes	no
366	2011-11-01	D371_064	D371_064	13:32	-31,451	29,706	2	yes	yes	yes
367	2011-11-01	D371_064	D371_064	13:32	-31,451	29,706	28	yes	yes	yes
368	2011-11-01	D371_064	D371_064	13:32	-31,451	29,706	68	yes	yes	yes

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
369	2011-11-01	D371_064	D371_064	13:32	-31,451	29,706	95	yes	yes	yes
370	2011-11-01	D371_064	D371_064	13:32	-31,451	29,706	120	yes	yes	yes
371	2011-11-01	D371_064	D371_064	13:32	-31,451	29,706	175	yes	yes	yes
372	2011-11-01	D371_064	D371_064	13:32	-31,451	29,706	300	yes	yes	yes
373	2011-11-02	D371_065	D371_065	04:59	-32,726	31,501	2	yes	yes	no
374	2011-11-02	D371_065	D371_065	04:59	-32,726	31,501	22	yes	yes	no
375	2011-11-02	D371_065	D371_065	04:59	-32,726	31,501	40	yes	yes	no
376	2011-11-02	D371_065	D371_065	04:59	-32,726	31,501	90	yes	yes	no
377	2011-11-02	D371_065	D371_065	04:59	-32,726	31,501	92	yes	yes	no
378	2011-11-02	D371_065	D371_065	04:59	-32,726	31,501	170	yes	yes	no
379	2011-11-02	D371_065	D371_065	04:59	-32,726	31,501	300	yes	yes	no
380	2011-11-05	D371_069	D371_067	04:58	-38,222	39,519	2	yes	yes	no
381	2011-11-05	D371_069	D371_067	04:58	-38,222	39,519	11	yes	yes	no
382	2011-11-05	D371_069	D371_067	04:58	-38,222	39,519	20	yes	yes	no
383	2011-11-05	D371_069	D371_067	04:58	-38,222	39,519	45	yes	yes	no
384	2011-11-05	D371_069	D371_067	04:58	-38,222	39,519	175	yes	yes	no
385	2011-11-05	D371_069	D371_067	04:58	-38,222	39,519	200	yes	yes	no
386	2011-11-05	D371_069	D371_067	04:58	-38,222	39,519	300	yes	yes	no
387	2011-11-05	D371_070	D371_068	13:35	-39,035	40,743	2	yes	yes	yes
388	2011-11-05	D371_070	D371_068	13:35	-39,035	40,743	11	yes	yes	yes
389	2011-11-05	D371_070	D371_068	13:35	-39,035	40,743	25	yes	yes	yes
390	2011-11-05	D371_070	D371_068	13:35	-39,035	40,743	70	yes	yes	yes
391	2011-11-05	D371_070	D371_068	13:35	-39,035	40,743	120	yes	yes	yes
392	2011-11-05	D371_070	D371_068	13:35	-39,035	40,743	170	yes	yes	yes
393	2011-11-05	D371_070	D371_068	13:35	-39,035	40,743	300	yes	yes	yes
394	2011-11-06	D371_071	D371_069	04:56	-40,337	42,755	2	yes	yes	no
395	2011-11-06	D371_071	D371_069	04:56	-40,337	42,755	5	yes	yes	no
396	2011-11-06	D371_071	D371_069	04:56	-40,337	42,755	20	yes	yes	no
397	2011-11-06	D371_071	D371_069	04:56	-40,337	42,755	25	yes	yes	no
398	2011-11-06	D371_071	D371_069	04:56	-40,337	42,755	34	yes	yes	no
399	2011-11-06	D371_071	D371_069	04:56	-40,337	42,755	150	yes	yes	no
400	2011-11-06	D371_071	D371_069	04:56	-40,337	42,755	300	yes	yes	no
401	2011-11-06	D371_072	D371_070	14:34	-41,126	43,983	3	yes	yes	yes
402	2011-11-06	D371_072	D371_070	14:34	-41,126	43,983	10	yes	yes	yes
403	2011-11-06	D371_072	D371_070	14:34	-41,126	43,983	23	yes	yes	yes
404	2011-11-06	D371_072	D371_070	14:34	-41,126	43,983	40	yes	yes	yes
405	2011-11-06	D371_072	D371_070	14:34	-41,126	43,983	60	yes	yes	yes
406	2011-11-06	D371_072	D371_070	14:34	-41,126	43,983	150	yes	yes	yes
407	2011-11-06	D371_072	D371_070	14:34	-41,126	43,983	300	yes	yes	yes
408	2011-11-07	D371_073	D371_071	04:56	-42,315	45,895	2	yes	yes	no
409	2011-11-07	D371_073	D371_071	04:56	-42,315	45,895	14	yes	yes	no
410	2011-11-07	D371_073	D371_071	04:56	-42,315	45,895	24	yes	yes	no
411	2011-11-07	D371_073	D371_071	04:56	-42,315	45,895	50	yes	yes	no

No.	Collection date	Station	CTD	Time (GMT)	Lat (+=N, -=S)	Lon (W).	Depth (m)	a_{CDOM} LWCC	EEM	DOC
412	2011-11-07	D371_073	D371_071	04:56	-42,315	45,895	150	yes	yes	no
413	2011-11-07	D371_073	D371_071	04:56	-42,315	45,895	200	yes	yes	no
414	2011-11-07	D371_073	D371_071	04:56	-42,315	45,895	300	yes	yes	no
415	2011-11-07	D371_074	D371_072	14:29	-43,109	47,180	2	yes	yes	yes
416	2011-11-07	D371_074	D371_072	14:29	-43,109	47,180	14	yes	yes	yes
417	2011-11-07	D371_074	D371_072	14:29	-43,109	47,180	33	yes	yes	yes
418	2011-11-07	D371_074	D371_072	14:29	-43,109	47,180	56	yes	yes	yes
419	2011-11-07	D371_074	D371_072	14:29	-43,109	47,180	150	yes	yes	yes
420	2011-11-07	D371_074	D371_072	14:29	-43,109	47,180	200	yes	yes	yes
421	2011-11-07	D371_074	D371_072	14:29	-43,109	47,180	300	yes	yes	yes
422	2011-11-08	D371_075	D371_073	04:57	-44,334	49,194	2	no	yes	no
423	2011-11-08	D371_075	D371_073	04:57	-44,334	49,194	5	no	yes	no
424	2011-11-08	D371_075	D371_073	04:57	-44,334	49,194	20	no	yes	no
425	2011-11-08	D371_075	D371_073	04:57	-44,334	49,194	25	no	yes	no
426	2011-11-08	D371_075	D371_073	04:57	-44,334	49,194	35	no	yes	no
427	2011-11-08	D371_075	D371_073	04:57	-44,334	49,194	150	no	yes	no
428	2011-11-08	D371_075	D371_073	04:57	-44,334	49,194	300	no	yes	no
429	2011-11-08	D371_076	D371_074	14:29	-45,094	50,498	3	no	yes	yes
430	2011-11-08	D371_076	D371_074	14:29	-45,094	50,498	7	no	yes	yes
431	2011-11-08	D371_076	D371_074	14:29	-45,094	50,498	18	no	yes	yes
432	2011-11-08	D371_076	D371_074	14:29	-45,094	50,498	25	no	yes	yes
433	2011-11-08	D371_076	D371_074	14:29	-45,094	50,498	35	no	yes	yes
434	2011-11-08	D371_076	D371_074	14:29	-45,094	50,498	150	no	yes	yes
435	2011-11-08	D371_076	D371_074	14:29	-45,094	50,498	300	no	yes	yes

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Bacterial activity along an Atlantic Meridional Transect

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1. Objectives

- To measure bacterial production (BP) in parallel to leucine dilution bioassays to compare leucine uptake data from two methods and to measure the proportion of leucine that is respired using the two methods
- To assess the effect of light on the uptake rate of amino acids by *Prochlorococcus* cyanobacteria

2. Methods

2.1 Sampling

Seawater samples were collected from 20-170 m depth, mostly from the noon CTD casts (Table 1). Seawater was decanted into 1 L acid-cleaned glass thermos flasks using acid-soaked silicone tubing. Radioactively labelled leucine uptake and respiration incubations were initiated within 1 h of sampling.

2.2 Measurement of ^{3}H-Leucine uptake rates

Ambient concentrations and turnover rates of leucine (Leu) and methionine (Met) were estimated using a bioassay technique of radiotracer dilution (Wright and Hobbie, 1966) with untreated live samples, as described previously for AMT cruises (Hill et al.; Mary et al., 2008; Zubkov et al., 2008).

Briefly, L-[4,5-^{3}H]leucine (specific activity 5.18 TBq mmol^{-1}) was added in a concentration series of 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 nM. Additional samples were incubated with 2 nM ^{3}H-Leucine and 18 nM unlabeled leucine to give a measurement of BP. Triplicate samples (1.6 mL) for each concentration were incubated in 2 mL polypropylene screw cap vials. One sample from each concentration was fixed at 10, 20 and 30 min by the addition of 20% paraformalydehyde (1% v/w final concentration). Due to the short incubation times, it was not possible to work in the dark; however, incubations were kept in dim indirect light at roughly ambient temperature. Fixed cells were filtered onto 0.2 µm polycarbonate membrane filters soaked in non-labelled leucine solution to reduce adsorption of tracer. Filtered samples were washed twice with 4 mL deionised water. Radioactivity of samples was measured as counts per minute (CPM) by liquid scintillation counting.

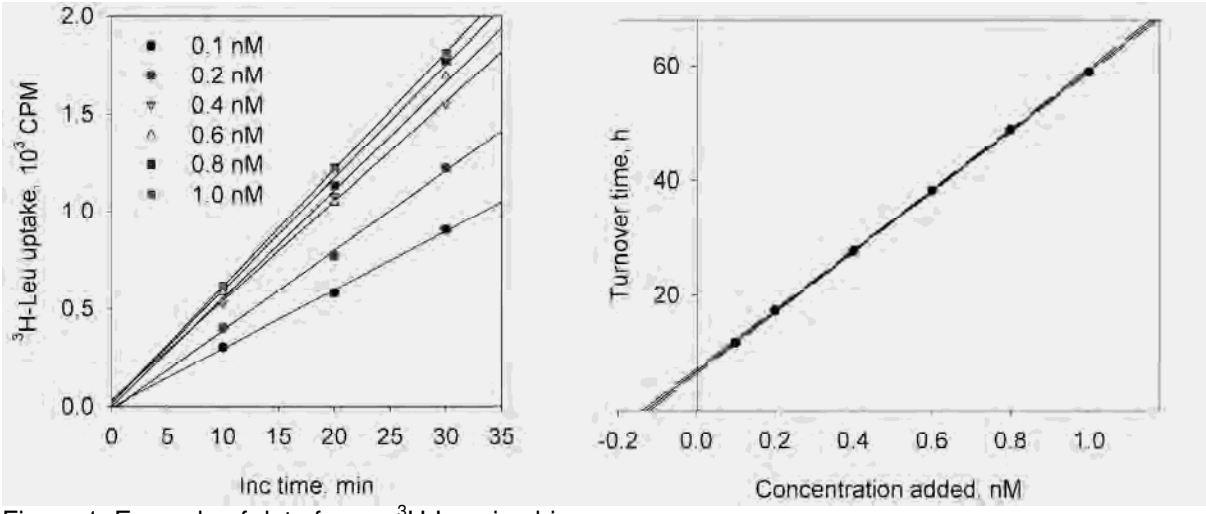

Figure 1: Example of data from a ^{3}H-Leucine bioassay.

An example of the data achieved from a ^{3}H-Leu bioassay are given in Figure 1. ^{3}H-Leu uptake rates were calculated at each addition concentration as the slope of the linear regression of community assimilated radioactivity (CPM) against incubation time (Figure 1, left), from which turnover time could be calculated. The turnover time for each added concentration was then plotted against its concentration (Figure 1, right). Ambient Leu uptake rate, *V*, was estimated from the slope of the linear regression, assuming constant rate of removal and regeneration (Wright and Hobbie, 1966). Leu turnover time (*t*) at ambient concentration was estimated as the *y* intercept of this regression. From these estimates, ambient concentration (*S*) was estimated from the equation $S + K_t = V \times t$ where K_t is a measure of the affinity of the uptake system for a

substrate (with a range of zero to one), with a low K_t indicating high affinity (Wright and Hobbie, 1966). Here we assume that ambient bacterioplankton are efficient in Leu uptake at ambient concentration and thus have a negligible K_t compared to Leu concentration; however, we accept that this provides an upper estimate of ambient concentration and, consequently, *V*.

The methionine bioassay was performed in a similar manner, with the exception that the L-[35S]methionine (specific activity 1000 Ci/mmol) was added at a standard concentration of 0.13 nM and diluted with non-labelled methionine using a dilution series of 0.2, 0.5, 1.0, 1.5 and 2.0 nM.

2.3 Measurement of ^{14}C-Leucine uptake & respiration

The uptake rate of ^{14}C-Leu into biomass was measured in 30 mL Schott bottles and respiration measured in 100 mL soda bottles, which were sealed using crimped Teflon lids. The acid cleaned bottles were rinsed three times with seawater sample and ^{14}C-Leu added at 0.4 nM or 2 nM (plus 18 nM unlabeled Leu) to four of both types of bottle. At each incubation time point (e.g. 1, 2, 3, 4 h), biomass samples were terminated by pouring into a 50 mL falcon tube containing 1.5 mL of 20% PFA. Respiration samples were terminated by the addition of 1 mL of 10% HCl through the lid using a hypodermic needle and syringe, which also acidified the samples to <pH2, thereby driving any $^{14}CO_2$ out of solution. Biomass samples were filtered onto 0.2 µm polycarbonate membrane filters. Respiration bottles were bubbled for 2 h with CO_2-free air and evolved CO_2 trapped by Carbo-sorb bubblers. Radioactivity of samples was measured as disintegrations per minute (DPM) by liquid scintillation counting.

2.4 Effect of light on amino acid uptake by Prochlorococcus *cells*

Radioactive tracers, ^{35}S-Methionine and ^{3}H-Leu, were added to 50 mL seawater samples in acid cleaned Schott bottles. Samples were incubated in a water bath set to *in situ* temperature, either in the dark or in the presence of light (different light intensities). At the end of each incubation period (usually 2 and 4 h), samples were fixed using paraformaldehyde (1% final concentration) and concentrated using 0.6 µm polycarbonate filters to exclude smaller cells. Samples were stained with SYBR Green I and the *Prochlorococcus* population was sorted by flow cytometry, using a plot of side scatter against green fluorescence. Sorted cells were filtered onto 0.2 µm polycarbonate filters and the activity measured by liquid scintillation counting. Separately, for each incubation time point, the uptake of the total community was determined by filtering a known volume (e.g. 1ml) of incubation sample on 0.22 µm polycarbonate filters and measuring the activity by liquid scintillation counting.

Separately, samples for Fluorescence *in situ* Hybridization (FISH) were collected, from not incubated seawater, at time 0. Shortly, 4x50 ml water samples were fixed in 1%PFA for 1h at room temperature. From these, 2x50 ml samples were filtered on 0.2 µm, 47 mm Polycarbonate filters. The other 2x50 ml were concentrated on 0.2 µm, 25 mm Polycarbonate filters. Both filters and cell concentrates were stored at -80°C for further analysis on shore.

2.5 Sampled stations

Table 1: List of sampled stations

Date	CTD	Time on deck	Latitude	Longitude	Bottle	Depth (m)	Volume (L)	Leucine bioassay	Methionine bioassay	^{14}C-Leucine uptake & respiration	Leu/Met uptake experiment	FISH sample	
												conc	filt
01.10.11	04	13:59	49° 08.76' N	14° 30.95' W	16	20	1	+		+			
02.10.11	05	05:27	48° 08.00' N	17° 06.21' W	10	45 (DCM)	1	+		+	+		
04.10.11	09	05:23	41° 47.60' N	21° 10.57' W		63 (DCM)	3	+		+	+		
05.10.11	11	05:24	38° 30.91' N	23° 07.63' W		(DCM)	3	+	+	+	+		
06.10.11	13	05:31	35° 41.51' N	25° 48.89' W		90	3	+	+	+	+		
07.10.11	15	05:20	33° 30.11' N	28° 45.21' W			3	+	+	+	+		
08.10.11	17	05:30	31° 32.85' N	31° 19.53' W	5	125	1			+	+ *		
					7	103	1			+	+ *		
					9	88 (DCM)	1			+	+ *		
					12	75	1			+	+ *		
					19	20	1			+	+ *		
08.10.11	18	13:55	30° 52.87' N	32° 11.71' W		D1	1			+	+ *		
						D2	1			+	+ *		
						D3	1			+	+ *		
09.10.11	20	14:53	28° 50.35' N	34° 48.45' W	7	(DCM)	1			+	+**		
10.10.11	22	14:53	26° 54.91' N	37° 12.82' W	8	120 (DCM)	3	+	+	+	+		
12.10.11	25	06:20	23° 37.72' N	41° 00.66' W		150	1			+	+**		
12.10.11	26	14:51	22° 46.17' N	40° 20.66' W	6	130	3	+	+	+	+	+	
14.10.11	30	15:06	18° 00.94' N	36° 49.82' W	7	120	3	+	+	+	+	+	
17.10.11	36	15:03	09° 39.48' N	31° 09.19' W	5	80	3	+	+	+	+	+	
18.10.11	38	14:50	06° 31.34' N	29° 07.96' W	5	95	3	+	+	+	+		
20.10.11	42	14:20	01° 02.12' N	25° 39.07' W	10	76 (DCM)	3		+	+	+***		
23.10.11	47	14:27	08° 42.36' S	25° 03.35' W	7	100 (DCM)	3	+	+	+	+	+	+
24.10.11	49	14:32	11° 39.80' S	25° 03.89' W	4	150	3	+	+	+	+	+	+
25.10.11	51	16:24	14° 11.02' S	25° 04.55' W	11	118	3	+	+	+	+		+

Date	CTD	time on deck	Latitude	Longitude	Bottle	Depth (m)	Volume (L)	Leucine bioassay	Methionine bioassay	^{14}C-Leucine uptake & respiration	Leu/Met uptake experiment	FISH sample	
26.10.11	53	14:35	16° 57.62' S	25° 05.65' W	6	160	3	+	+	+	+	+	+
29.10.11	58	14:21	24° 06.80' S	25° 02.69' W	10	128	3	+	+	+	+	+	+
30.10.11	60	14:26	27° 09.40' S	25° 00.70' W	5	140	3	+	+	+	+	+	+
31.10.11	62	14:40	29° 22.68' S	26° 51.72' W	12	80	3	+	+	+	+	+	+
01.10.11	64	14:36	31° 27.07' S	29° 42.38' W	5	140	3	+	+	+	+	+	+

*(no tracer)
** testing cell concentration procedures
*** only methionine, only total uptake measured

3. Results & Discussion

3.1 BP vs. Leu dilution bioassay

The uptake rate of ^{3}H-Leucine was generally comparable between the two methods. However, when samples were given 20 nM ^{14}C-Leucine, the proportion of leucine that was respired, compared to the proportion of leucine that was incorporated into biomass, was 2-16 times higher than for the low (0.4 nM) additions. Furthermore, respiration of 0.4 nM ^{14}C-Leucine was immeasurable in incubations that lasted less than ~1-2 h. Samples will be recounted at NOCS on a low background LSC to achieve improved counts and more reliable data, before any conclusions will be made.

3.2 Amino acid uptake by Prochlorococcus *cells*

Because the samples were double labelled with ^{3}H-Leucine and ^{35}S-Methionine, only 35S-Methionine was counted on board. The 3H-Leucine will be counted on shore, at NOCS, on a low background LSC. The uptake rates for Methionine generally agreed with the one observed in previous studies (Mary et al, 2008, Zubkov et al, 2004). A light stimulation of the amino acid uptake was observed and different light intensities seem to make a difference. The *Prochlorococcus* community will be analysed by FISH at MPI, and the different abundances of the Low Light versus High Light adapted *Prochlorococcus* will be determined. Further on shore analysis is required to determine the effect of light on the amino acid uptake.

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Glucose uptake in *Prochlorococcus*, sugar utilization and gene expression

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1. INTRODUCTION

Cyanobacteria are naturally photoautotrophic organisms, although approximately half of the tested strains are capable of heterotrophic growth [1]. Previous studies from our group demonstrated that the ubiquitous marine cyanobacterium *Prochlorococcus* takes up glucose from the medium at very high rates [2].

2. OBJETIVES

During AMT21, integrated bioassays of glucose measurements were made at 38 stations, analyzing in all of them the possibility of sorting the *Prochlorococcus* population in order to perform glucose uptake tests, with the objective of demonstrating the utilization of glucose in natural samples of *Prochlorococcus*.
The possible utilization of different sugars was determinated in 11 stations, to test if marine bacteria (including *Prochlorococcus*) prefer to use glucose as a source of energy, or whether they are also able to use other sugars. This goal is important because if we can understand which sugars can be taken up by *Prochlorococcus*, it also helps us to understand the mechanism used to transport sugar.
Finally, samples were collected and filtered from the surface and from the DCM at 13 stations, in order to obtaine RNA preparations. These samples will be analysed by qRT-PCR to quantify the expression of different genes involved in the metabolism of carbon, in order to complement the results obtained in this cruise.

3. MATERIALS AND METHODS

3. 1 Biossays of glucose concentration and glucose uptake in *Prochlorococcus*

The ambient concentrations and the turnover times studied were estimated using a concentration series bioassay [3], [4] [5] of untreated live samples.
D-[5,6 3H]glucose (specific activity 60 Ci/mmol) was added in a final concentration range from 0.25 to 1.25 nM.
The samples (1.6 mL) were incubated onto 2 mL capped screw top sterile polypropylene microcentrifuge tubes in the dark at *in situ* temperatures and were fixed with 1% PFA at 30, 50, 70 and 90 min respectively. The samples were filtered in 0.2 mm polycarbonate filters and the radioactivity retained on filters was measured as disintegrations per minute using a liquid scintillation counter.
The rate of precursor uptake was calculated as the slope of the linear regression of radioactivity against incubation time and used to compute an organic molecule turnover time by dividing the amount of radioactivity added to a sample by the rate of its uptake per time unit, e.g. hour. Turnover time is the time required to take up the whole pool of bioavailable nutrient, without any replenishment. The resulting turnover times were plotted against a corresponding concentration of added organic molecule and extrapolated using linear regressions. The slope of the regression line gave an estimate of molecule uptake rate at ambient concentration, V. The y-axis intercept of the regression line gave an estimate of molecule turnover time, t, at the sum of the ambient concentration, S, plus the transport constant, KT [3]:
$S + KT = V \times t$.
The KT is a measure of the affinity of the microbial uptake system for an organic molecule. Considering that microorganisms are well adapted to living at ambient concentrations of the studied organic molecules, we hypothesized that their KT could be negligibly small compared with natural concentrations of molecules, $KT << S$, and therefore, the bioavailable ambient concentrations should be treated as upper estimates.
However, whilst this tells us how much glucose all the bacteria have taken up, to understand how much of the glucose was taken up by *Prochlorococcus*, the sample was incubated for 4h to have more radioactivity and the bacteria separated using a flow cytometer.
In most samples it was impossible to see a clear *Prochlorococcus* population at depth because it was mixed with heterotrophic bacteria. Moreover, the glucose uptake by total bacteria had to be high enough to sort out *Prochlorococcus* in order to see a clear uptake only from this population. So only a few samples were sorted, which showed a *Prochlorococcus* cluster that had clear extra red fluorescence, allowing an optimal separation of this population.
The samples collected for the glucose uptake in *Prochlorococcus* and the biossays are shown in the table 1. These data will be analyzed and processed in the laboratory during the following months. All final data will be submitted to BODC by the end of September 2012.

Table 1: CTD casts sampled for bioassays of glucose

Date	Ctd	Time on deck (gmt)	Lat	Long	Depths sampled (m)
30.9.11	001	04:05	50° 27.23' N	07° 26.72' W	2
30.9.11	002	12:14	49° 57.23' N	09° 07.56' W	10
1.10.11	003	05:32	49° 16.86' N	12° 43.19' W	20
2.10.11	005	05:27	48° 08.00' N	17° 06.21' W	20
3.10.11	007	05:33	44° 54.47' N	19° 13.38' W	20
3.10.11	008	13:49	43° 46.80' N	19° 56.81' W	20
5.10.11	011	05:24	38° 30.91' N	23° 07.63' W	20
6.10.11	013	05:31	35° 41.51' N	25° 48.89' W	78 DCM
7.10.11	015	05:20	33° 30.11' N	28° 45.21' W	80 DCM
7.10.11	016	13:56	32° 49.17' N	29° 39.51' W	103 DCM
9.10.11	019	06:45	29° 29.07' N	33° 58.30' W	102 DCM
10.10.11	021	06:35	27° 34.85' N	36° 22.84' W	105 DCM
11.10.11	023	06:23	25° 37.52' N	38° 48.24' W	120 DCM
12.10.11	025	06:20	23° 37.72' N	41° 00.66' W	120 DCM
13.10.11	028	14:57	20° 23.43' N	38° 33.00' W	135 DCM
14.10.11	030	15:06	18° 00.94' N	36° 49.82' W	100 DCM
16.10.11	033	06:21	13° 47.12' N	33° 53.72' W	20
17.10.11	035	06:21	10° 45.43' N	31° 52.40' W	47
18.10.11	037	06:21	07° 35.39' N	29° 48.62' W	44
18.10.11	038	14:50	06° 31.34' N	29° 07.96' W	55
19.10.11	039	06:33	04° 37.59' N	27° 55.16' W	80 DCM
20.10.11	041	06:19	01° 55.70' N	26° 13.20' W	85 DCM
22.10.11	044	06:34	04° 40.59' S	25° 01.35' W	80 DCM
23.10.11	046	06:27	07° 42.52' S	25° 02.34' W	94 DCM
24.10.11	048	06:15	10° 41.25' S	25° 03.34' W	115 DCM
25.10.11	050	06:31	13° 34.85' S	25° 04.09' W	130 DCM
26.10.11	052	05:55	15° 55.52' S	25° 05.39' W	160 DCM
27.10.11	054	05:52	18° 31.50' S	25° 06.08' W	160 DCM
28.10.11	055	05:53	20° 00.85' S	25° 05.46' W	20
29.10.11	057	05:48	23° 04.58' S	25° 03.43' W	20
30.10.11	059	05:48	26° 05.53' S	25° 01.49' W	20
31.10.11	061	06:11	28° 48.13' S	25° 57.09' W	104 DCM
1.11.11	063	05:56	30° 44.11' S	28° 43.84' W	70 DCM
2.11.11	065	06:12	32° 43.55' S	31° 33.07' W	90 DCM, 77
5.11.11	067	06:01	38° 13.33' S	39° 31.12' W	20
6.11.11	069	06:08	40° 20.22' S	42° 45.28' W	20
7.11.11	071	06:00	42° 18.87' S	45° 53.70' W	20
8.11.11	073	06:13	44° 20.01' S	49° 11.62' W	20

3. 2 Possible preference for specific sugar uptake

For this experiment the D-[5,6-3H]glucose (specific activity 60 Ci/mmol) was added at a final concentration of 1 nM. Other sugars, without radioactive labelling, were added, like fructose, galactose, sacarose and melibiose at a final concentration of 0.5 nM and 2 nM. Hence, the final concentration in each vial was 1.5 nM and 3 nM.

The samples (1.6 mL) were incubated in 2 mL capped screw top sterile polypropylene microcentrifuge tubes in the dark at *in situ* temperatures and were fixed with 1% PFA at 45, 90, 135 and 180 min respectively.

The samples were filtered onto 0.2 mm polycarbonate filters and the radioactivity retained on filters was measured as disintegrations per minute using a liquid scintillation counter. The samples collected in this experiment are shown in the table 2. These data will be analyzed and processed in the laboratory during the following months. All final data will be submitted to BODC by the end of September 2012.

Table 2: CTD casts sampled for competition of sugars

Date	CTD	TIME on deck (GMT)	Lat	Long	Depths sampled (m)
28.10.11	055	05:53	20° 00.85' S	25° 05.46' W	20
29.10.11	057	05:48	23° 04.58' S	25° 03.43' W	20
30.10.11	059	05:48	26° 05.53' S	25° 01.49' W	20
31.10.11	061	06:11	28° 48.13' S	25° 57.09' W	20
2.11.11	065	06:12	32° 43.55' S	31° 33.07' W	20
5.11.11	067	06:01	38° 13.33' S	39° 31.12' W	20
6.11.11	069	06:08	40° 20.22' S	42° 45.28' W	20
6.11.11	070	15:32	41° 07.54' S	43° 58.95' W	20
7.11.11	071	06:00	42° 18.87' S	45° 53.70' W	20
7.11.11	072	15:18	43° 06.56' S	47° 10.77' W	20
8.11.11	073	06:13	44° 20.01' S	49° 11.62' W	20

3. 3 RNA sample collection to quantify gene expression

The seawater was vacuum filtered on 0.2 µm filters for each sample (Table 3). Filters were immersed in 4 ml of RNA resuspension buffer (20 mM EDTA; 400 mM NaCl; 0.75 mM sucrose; 50 mM Tris (pH 7) and immediately frozen in liquid nitrogen [6].

The expression of the genes will be analyzed in the laboratory during the following months by quantitative RT-PCR. All final data will be submitted to BODC by the end of September 2012.

TabLe 3: CTD casts sampled for ARN

Date	CTD	Time on deck (gmt)	Lat	Long	Depths sampled (m)
4.10.11	009	05:23	41° 47.60' N	21° 10.57' W	2, 63 DCM
11.10.11	023	06:23	25° 37.52' N	38° 48.24' W	2, 120 DCM
12.10.11	025	06:20	23° 37.72' N	41° 00.66' W	2, 120 DCM
13.10.11	028	14:57	20° 23.43' N	38° 33.00' W	2, 135 DCM
15.10.11	031	06:41	16° 28.70' N	35° 44.42' W	2, 107 DCM
16.10.11	033	06:21	13° 47.12' N	33° 53.72' W	2, 85 DCM
18.10.11	038	14:50	06° 31.34' N	29° 07.96' W	2, 75 DCM
19.10.11	040	14:50	03° 40.96' N	27° 19.26' W	2, 74 DCM
23.10.11	047	14:27	08° 42.36' S	25° 03.35' W	2, 100 DCM
24.10.11	049	14:32	11° 39.80' S	25° 03.89' W	2, 130 DCM
26.10.11	053	14:35	16° 57.62' S	25° 05.65' W	2, 160 DCM
28.10.11	056	14:27	21° 05.73' S	25° 04.56' W	2, 160 DCM
29.10.11	058	14:21	24° 06.80' S	25° 02.69' W	2, 140 DCM

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Carbonate system: A_T and Ph

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Rationale and Method

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

Table 1 lists the samples collected from each station. A_T samples were collected in 125 mL screwcap amber bottles and preserved with $HgCl_2$ until analysis at PML (100 µL of saturated $HgCl_2$ added). pH_T samples were collected in 500 mL amber glass bottles and placed in a water bath at 25 ^oC. pH_T was determined spectrophotometrically using the m-cresol-purple dye (Dickson et al., 2007). The dye has two absorbance maxima at 434 nm and 578 nm, the ratio of which is pH-, T- and salinity-dependent. Absorbance measurements of the seawater blank, and following addition of dye (100 µL of a 2 mmol L^{-1} solution), were carried out on a Perkin Elmer, lamda 35 spectrophotometer, using 10 cm cells. The temperature of the sample was recorded in the spectrophotometer cell with a Digitron 2028T thermometer. pH_T measurements were corrected for the pH_T change due to the addition of dye according to Dickson et al. (2007). Additional samples were collected from the underway water supply (forward sink in chem-lab) to coincide with the surface CTD bottles. Preliminary data show that underway and surface CTD samples were indistinguishable (mean in situ CTD-underway offset -0.0004 pH_T units, n=15). This is equivalent to <1 µatm pCO_2 suggesting that underway pCO_2 data can be used in conjunction with A_T and pH_T data to describe the surface water carbonate system (pCO_2 seawater supply in aft sink chem-lab).

All A_T and pH_T data will be submitted to BODC within 12 months.

Table 1: Samples collected from CTD hydrocast

Date	CTD cast no.	A_T (Niskin no.)	pH_T (Niskin no.)
30/9/2011	C-001	10,22,24	4,5,6,7,8,9,10,13,15,18,22,24
30/9/2011	C-002	2,10,24	2,4,5,7,8,9,10,13,18,20,22,24
1/10/2011	C-003	1,24	1,3,5,6,7,8,10,11,17,19,21,24
1/10/2011	C-004	1,10,24	1,3,6,7,8,9,10,13,18,20,22,24
2/10/2011	C-005	2,11,24	2,3,4,5,6,7,9,11,14,19,21,24
2/10/2011	C-006	1,10,24	1,3,6,7,8,9,10,13,15,20,22,24
3/10/2011	C-007	2,10,24	2,4,6,7,8,9,10,13,15,20,22,24
3/10/2011	C-008	1,24	1,3,6,7,9,10,13,15,20,22,24
4/10/2011	C-009	2,24	2,4,5,6,11,12,14,16,19,21,24
4/10/2011	C-010	1,24	1,3,5,8,9,12,13,15,20,22,24
5/10/2011	C-011	1,24	1,2,4,6,8,11,12,14,16,21,24
5/10/2011	C-012	1,24	1,3,4,5,6,7,11,15,20,22,24
6/10/2011	C-013	1,24	1,2,4,7,8,11,13,14,16,21,24
6/10/2011	C-014	1,23	1,2,3,4,6,10,12,13,15,16,22,23

Date	**CTD cast no.**	**A_T (Niskin no.)**	**pH_T (Niskin no.)**
7/10/2011	C-015	1,20	1,2,3,5,8,10,12,14,17,20
7/10/2011	C-016	1,24	1,2,4,6,7,10,12,15,16,22,24
8/10/2011	C-017	1,24	1,2,3,4,5,7,11,12,14,16,21,24
8/10/2011	C-018	2,7,23	2,4,5,6,7,10,11,12,15,21,23
9/10/2011	C-019	1,11,22	1,2,3,4,6,8,11,12,14,16,21,22
9/10/2011	C-020	7,23	1,2,4,5,7,11,12,14,15,21,23
10/10/2011	C-021	1,22	1,2,3,4,5,7,10,1214,16,21,22
10/10/2011	C-022	1,7,23	1,3,4,5,6,7,12,14,15,21,23
11/10/2011	C-023	1,9,21	1,2,3,4,9,10,11,13,15,17,20,21
11/10/2011	C-024	1,23	1,2,4,6,9,11,12,14,15,21,23
12/10/2011	C-025	1,9,21	1,2,3,4,9,10,11,13,15,17,20,21
12/10/2011	C-026	10,23	1,2,4,5,6,7,10,12,14,15,21,23
13/10/2011	C-027	1,10,22	1,2,3,5,6,10,11,12,14,16,18,22
13/10/2011	C-028	1,7,23	1,2,3,5,6,7,12,14,15,18,21,23
14/10/2011	C-029	2,6,24	2,3,4,6,10,11,13,15,17,20,21
14/10/2011	C-030	1,6,23	1,2,4,6,8,10,12,14,15,18,21,23
15/10/2011	C-031	1,7,22	1,2,3,4,5,7,10,11,13,15,20,22
15/10/2011	C-032	2,6,23	2,3,5,6,8,10,12,14,15,18,21,23
16/10/2011	C-033	1,10,21	1,2,3,4,6,10,11,13,15,17,20,21
16/10/2011	C-034	2,10,23	2,3,5,6,7,10,12,14,15,18,21,23
17/10/2011	C-035	1,8,18,21	1,2,3,4,7,8,11,13,15,18,20,21
17/10/2011	C-036	1,9,19,23	1,2,4,6,7,9,12,14,15,19,21,23
18/10/2011	C-037	1,8,18,21	1,2,3,4,5,7,8,11,13,15,18,20,21
18/10/2011	C-038	1,7,19,23	1,2,4,5,6,7,11,12,14,15,19,21,23
19/10/2011	C-039	1,10,15,22	1,2,3,4,5,7,10,13,15,20,22
19/10/2011	C-040	1,10,19,23	1,2,4,5,6,7,10,12,14,15,19,21,23
20/10/2011	C-041	1,8,21	1,2,4,5,7,8,11,13,15,18,20,21
20/10/2011	C-042	1,10,23	1,2,3,4,5,6,7,10,12,14,21,23
21/10/2011	C-043	1,8,21	1,2,3,4,5,7,8,11,13,15,17,21
22/10/2011	C-044	1,8,22	1,2,3,4,5,7,8,13,15,17,20,22
22/10/2011	C-045	1,6,23	1,2,3,4,5,6,8,12,14,16,21,23
23/10/2011	C-046	1,8,21	1,2,3,4,5,7,8,11,13,14,19,21
23/10/2011	C-047	1,6,23	1,2,3,4,5,6,9,11,12,15,21,23
24/10/2011	C-048	1,4,19	1,2,4,9,11,13,16,19
24/10/2011	C-049	1,8,23	1,2,3,4,5,8,11,12,14,15,18,21,23
25/10/2011	C-050	1,7,23	1,2,3,5,7,10,11,13,15,17,20,23
25/10/2011	C-051	3,10,23	3,4,5,6,7,10,13,15,16,19,21,23
26/10/2011	C-052	1,4,22	1,2,3,4,7,8,10,11,13,16,21,22
26/10/2011	C-053	1,5,23	1,2,3,5,7,10,11,12,14,15,21,23

Date	**CTD cast no.**	**A_T (Niskin no.)**	**pH_T (Niskin no.)**
27/10/2011	C-054	1,5,22	1,2,3,4,5,8,10,11,14,16,20,22
28/10/2011	C-055	1,5,20	1,2,5,7,8,11,13,15,17,20
28/10/2011	C-056	1,4,23	1,2,3,4,9,11,12,14,15,18,21,23
29/10/2011	C-057	1,6,22	1,2,3,5,6,10,11,14,16,18,21,22
29/10/2011	C-058	1,6,24	1,2,3,5,6,9,11,12,15,16,22,24
30/10/2011	C-059	1,6,22	1,2,3,5,6,10,11,14,16,18,21,22
30/10/2011	C-060	2,8,24	2,3,6,8,11,12,15,16,22,24
31/10/2011	C-061	1,7,23	1,2,3,4,5,6,7,11,12,16,21,23
31/10/2011	C-062	1,8,23	1,2,3,5,6,8,12,13,15,19,21,23
1/11/2011	C-063	1,8,22	1,2,3,6,7,8,11,14,16,18,21,22
1/11/2011	C-064	1,6,24	1,2,3,5,6,10,11,12,14,15,21,24
2/11/2011	C-065	1,8,22	1,2,3,5,7,8,11,14,18,21,22
5/11/2011	C-067	1,10,22	1,2,3,5,6,8,10,13,16,19,21,22
5/11/2011	C-068	1,12,24	1,2,3,5,7,8,9,12,17,19,21,24
6/11/2011	C-069	1,11,23	1,2,3,4,5,10,11,15,18,20,23
6/11/2011	C-070	1,10,24	1,2,3,5,6,10,14,16,19,21,24
7/11/2011	C-071	1,9,22	1,2,3,4,6,8,9,14,16,21,22
7/11/2011	C-072	1,9,24	1,2,3,5,7,9,12,14,15,21,24
8/11/2011	C-073	1,11,23	1,2,3,4,5,10,11,15,18,20,23
8/11/2011	C-074	1.13.24	1.2.3.5.8.9.11.13.16.19.24

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Microbial plankton community size – structure, distribution and respiration

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Background

Morphological characteristics of cells can influence their performance and cell size in particular can play an important role because of its influence in the trophic relationships between organisms (Straza.,2009). In addition, from cell size, it is possible to calculate the biovolume, which in combination with the abundance allows us to estimate the biomass of microorganisms (Gundersen et al., 2002, Lee and Fuhrman., 1987). It is therefore important to determine the enviromental factors that control variation in cell biovolume (e.g. Straza, 2009).

Traditionally, cell size has been studied using microscopy. There have been studies of cell volume using microscope images with DNA, usually using DAPI and protein stains like SYPRO Ruby. Straza et al (2009) have observed greater variations when biovolume is measured staining cellular proteins than when cells where stained with DAPI. This is because the measures using the protein stain contain a better appreciation of the change in cell size becuase they stain the cell wall as opposed to the cell nuclei (Straza., 2009). The main problem is that microscopy techniques do not allow large-scale studies, due to the large volume of samples generated during these type of surveys (Gasol., 2000).

Since the 90's, microscopy techniques to count bacterioplankton have been replaced by the use of flow cytometry. In addition, cytometry can give us an indirect measure of cell size measured as the particle side scatter. The way in which a cell scatters light when it passes through the cytometer laser will depend mainly on its volume, but also on its shape (Gasol.,2000). The relationship between the size of a cell and the scattering of light (side scatter) has been studied repeatedly (Burkill et al., 1993, Zubkov et al., 1998), including both bacteria and groups of picophytoplankton. But we lack a general relationship between two variables (cell size and side scatter) obtained in a wide range of environmental conditions that would allow a general calibration of side scatter and its use to understand large scale variations in bacterioplankton cell size. The central aim of this work was to collect samples to stain both with DAPI and SYPRO to measure bacterioplankton cell size and to perform sequential filtering side scatter calibration experiments for the same samples. In addition, filters were collected to do FISH to understand whether changes in cell size were related to changes in composition.
Cell size is know to control metabolic rates so to understand the relationship between community cell size and respiration rates we also performed experiments to measure respiration of each size- fraction of bacterioplankton.
Finally, as ancillary data for the phytoplankton size calibration experiments and to understand the factors that control bacterioplankton abundance and size structure we also collected size-fractionated chlorophyll samples.

Methods

Size-structure calibration of microbial plankton community

This relationship has been studied using flow cytometry. For the study of the relationship between the size of each cell and its value in side scatter we used the sequential filtration technique as described by Burkill et al., 1993. This is done using Nuclepore filters of different pore size (0.2, 0.4, 0.6, 0.8, 1.0, 3.0, 5.0, 10 um) and one sample without filter. Each filtrate is analysed by Flow cytometry and the average population cell size determined by the filter size that retains 50% of the population. The experiment was repeated at the different sampling stations in order to obtain a calibration between cell size and SSC.

For each predawn CTD (see table 1), 50ml were sampled for do the size-calibration of pico and nanophytoplankton and bacterioplankton. The live-samples were analyzed using a FACSort cytometer following the same protocols as described by Glen Tarran for phytoplankton and the bacterioplankton samples were analyzed using a FACSCalibur cytometer following the methodoolgy described by Ross Holland for heterotrophic bacterioplankton.

Microscopy cells - size studies
30ml of sample for the same depths that the others studies were collected. 10 ml of this sample was pre-filtered though 1.0um pore size polycarbonate filters. Then both samples were fixed with formaldehyde 37% diluted in the sampling until at a final concentration of 2%. Then a volume between 2-6 mL, depending of the concentration of bacteria in the ocean, were filtered using 0.22um polycarbonate filters. 5 filters were used (2 for DAPI staining (one prefiltered and the other not prefiltered), 1 to stain with SYPRO and 2 for FISH) and frozen at -20ºC until further processing.

In vivo INT-reduction analysis
Samples were collected every day from the predawn CTD (see table 1). They were analysed using the method as described by Aranguren-Gassis and Garcia-Martín. Except that for this analysis the samples were size- fractionated using 0.8, 0.6, 0.4, 0.2 µm pore size polycarbonate filters and stored at -20ºC until further processing.

Size-fractionated chlorophyll
For same depth as the other analyses we collected samples for size-fractionated chlorophyll measurements. 250mL were filtered through 10.0, 3.0 and 0.2 µm pore size polycarbonate filters and stored at -20ºC until further processing.

Table 1. The above sampling procedures were applied to water obtained from the following sampling stations along the AMT-21 transect.

Date	Station No	CTD No	Lat	Lon	Niskin No	Depth(m)	Time GMT
30/09/11	1	1	50°27.23N	7°26.72W	23	2	03:30:00
01/10/11	3	3	49°16.86N	12°43.16W	15	20	04:33:00
02/10/11	5	5	48°08.006N	17°06.215W	17	20	04:30:00
03/10/11	7	7	44°54.973N	19°13.387W	8	55	04:33:00
04/10/11	9	9	41°47.607N	21°10.576W	10	63	04:29:00
05/10/11	11	11	38°30.916'N	23°7.633'W	10	60	04:32:00
06/10/11	13	13	35°4.519'N	25°48.890'W	10	78	04:32:00
07/10/11	15	15	33°30.11'N	28°45.212'W	7	80	04:28:00
08/10/11	17	17	31°32.852'N	31°19.537W	10	88	04:32:00
09/10/11	19	19	29°29.076'N	33°58.307'W	10	102	05:33:00
10/10/11	21	21	27°34.857'N	36°22.84'W	6	105	05:32:00
11/10/11	23	23	25°37.525'N	38°48.245'W	8	120	05:28:00
12/10/11	25	25	23°37.727'N	41°0.668'W	8	120	05:28:00
13/10/11	27	27	21°12.964'N	39°9.203'W	10	120	05:29:00
14/10/11	29	29	18°49.400'N	37°23.94'W	9	130	05:29:00
15/10/11	31	31	16°28.707'N	35°44.427'W	8	107	05:26:00
16/10/11	33	33	13°47.121'N	33°53.728W	23	2	05:28:00
17/10/11	35	35	10°45.434'N	31°52.403'W	23	2	05:29:00
18/10/11	37	37	7°35.594'N	29°48.64'W	9	65	05:26:00
19/10/11	39	39	4°37.503'N	27°55.164'W	9	80	05:25:00
20/10/11	41	41	1°55.701'N	26°13.207'W	23	2	05:27:00
21/10/11	43	43	1°1.908'S	25°0.271'W	9	70	05:30:00
22/10/11	44	44	4°40.598'S	25°1.356'W	10	80	05:27:00
23/10/11	46	46	7°42.52'S	25°2.348'W	9	94	05:30:00
24/10/11	48	48	10°41.254'S	25°3.349'W	19	2	05:25:00
25/10/11	50	50	13°34.852'S	25°4.094'W	7	130	05:33:00
26/10/11	52	52	15°55.5245'S	25°5.394'W	4	160	04:56:00
27/10/11	54	54	18°31.502'S	25°6.088'W	5	160	04:55:00
28/10/11	56	55	20°0.853'S	25°5.467'W	5	160	04:57:00
29/10/11	57	57	23°4.584'S	25°3.431'W	7	140	04:57:00
30/10/11	59	59	26°5.532'S	25°1.499'W	6	140	04:57:00
31/10/11	61	61	28°48.137'S	25°57.09'W	10	104	04:56:00
01/11/11	63	63	30°44.117'S	28°43.847'W	8	70	04:59:00
02/11/11	65	65	32°43.554'S	31°30.07'W	8	90	04:59:00
05/11/11	69	67	38°13.336'S	39°31.128'W	24	2	04:58:00
06/11/11	71	69	40°20.220'S	42°45.284'W	13	25	04:56:00
07/11/11	73	71	42°18.874'S	45°53.702'W	9	50	04:56:00
08/11/11	75	73	44°20.0123'S	49°11.623W	13	25	04:57:00

Results

Cytometry files will be processed at NOCS after the cruise and the filters collected will be analysed in Spain during the following months. Int-reduction experiments will be processed at the University of Vigo and chlorophyll and filters collected for cell size measurement will be analysed at the Spanish Institute of Oceanography of Gijón. All data will be submitted to BODC by the end of September of 2012.

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Finally I would like to thank Pablo Serret, Elena Garcia and Maria Aranguren from Vigo University for their help and collaboration with the ETS experiments.

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Study of the surface plankton community response to simulated water inputs in the North and South Atlantic Gyres

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Background

Characterization of microbial plankton metabolism in oligotrophic oceans is of relevance for the quantification of the global carbon balance. However, whether plankton community metabolism in oligotrophic gyres is net autotrophic or heterotrophic is still under debate. Many studies based on incubation measurements have repeatedly reported a net heterotrophic microbial metabolism in oligotrophic waters (e.g. Duarte and Agustí 1998; Robinson et al. 2002) while others have estimated net autotrophic metabolism (Williams and Purdie. 1991; Serret et al. 2006). From these observations, some authors defend the dependence of net community production (NCP) on factors controlling gross primary production (GPP), while other authors argue that net heterotrophy in oligotrophic waters is a consequence of previous episodic autotrophic events. On the other hand, other investigations highlight that the microbial metabolic balance in oligotrophic waters is not only controlled by the autotrophic activity. The heterotrophic component of planktonic food webs has also been identified as a key factor in the variability of plankton community metabolic balance.

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 study the surface plankton community response to two different simulated inputs in three different regions of the oligotrophic gyres (edge of the North Atlantic Gyre, edge and center of the South Atlantic Gyre) :

- Addition of nutrients and organic matter rich surface waters (simulating lateral inputs).
- Addition of nutrient rich deep waters (simulating upwelling inputs).

Methodology

Experiment design

Surface and deep waters for the additions were sampled at station number 004 for the North Atlantic gyre and station number 044 for the South Atlantic Gyre (Table 1). Water was filtered, 0,2 µm, collected in acid cleaned carboys and frozen at -20 ºC until the day before the experiment. The day before the experiment, one carboy from each depth was thawed in the fridge and then at air temperature to prevent any temperature shock in the microcosms.

Three experiments were performed along the AMT 21 cruise (station numbers in Table 1). Eighty litres of surface water were collected and distributed to six 10 L microcosms. Two of them were used as controls (C1, C2), while the other four received two different treatments: a) 640 mL of filtered surface water (S1, S2); b) 120 mL of the filtered deep water plus 520 mL of 0,2 µm filtered water from the experiment station (D1, D2). The same volume (640 mL) was extracted from the control treatments and substituted with 0.2 µm filtered water in order to keep the same dilution in all treatments. Microcosms were incubated up to 48 h on deck and temperature was maintained with the underway water system (see figure 1).

Samples for nutrients, Chl-a, phytoplankton and bacterial cytometry, bacterial production, primary production, community respiration and in vivo ETS enzymatic respiration were collected at 0, 24, 48 h.

Nutrients. 30 mL of water were collected from each microcosm and analysed at time 48h (see Beesley nutrient analysis report).

Chl-a. 200 mL were collected at time 0, 24 and 48 h from each microcosm and were filtered subsequently through three different sizes (20, 2 and 0,2 µm). Filters were frozen for future processing.

Cytometry. 15 ml samples were collected at time 0, 24 and 48 h for phytoplankton and bacteria cytometry countings (see Tarran and Holland reports).

Bacterial production. 30 mL samples were collected at the same times for bacterial production (see Hill cruise report)

Primary production and community respiration. 6 x 60 ml dark Winkler bottles and three light Winkler bottles were filled up with water from each microcosm at times 0, 24 and 48h. Three dark replicates were fixed immediately while the other six were incubated for 24 hours in the same microcosm incubator system. Samples were analyzed following Aranguren-Gassis and García-Martín's cruise report.

In vivo ETS respiration (Community respiration and Bacterial respiration). Four replicates of 200 mL samples were taken from each treatment at times 0, 24, 48 and 72 h. Measurements were performed following Aranguren-Gassis and García-Martín's cruise report.

Results.
Experimental data for the determination of nutrients, cytometry, bacterial production, primary production-community respiration are not yet fully quality controlled and will be subject to further revision.
Chlorophyll-a, in vivo ETS respiration will be further analyzed in the lab during the following months.

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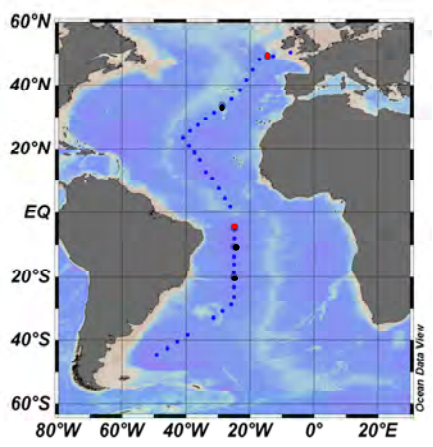
Table 1. Stations sampled for the experiments

Date	Cruise Number	CTD ID	Latitude +=N, - =S	Longitude W	Niskin sampled	Sampling depth (m)	Fraction filtered (µm)	Purpose
01/10/2011	D371	CTD_004	49º 8.766	-14º 30.95	24, 1	2, 300	0.2	Addition
07/10/2011	D371	CTD_15	33º 33.110	-28º 45.212	24, 23, 22, 21	2		Experiment
22/10/2011	D371	CTD_44	-4º 40.598	-25º 01.356	21, 1	2, 1000	0.2	Addition
24/10/2011	D371	CTD_48	-10º 41.254	-25º 3.249	23, 22, 21, 20	2		Experiment
28/10/2011	D371	CTD_55	-20º 00.853	-25º 05.469	24, 23, 22, 21	2		Experiment



- Collected water for addition (AW)
- Collected water for experiment (EW)

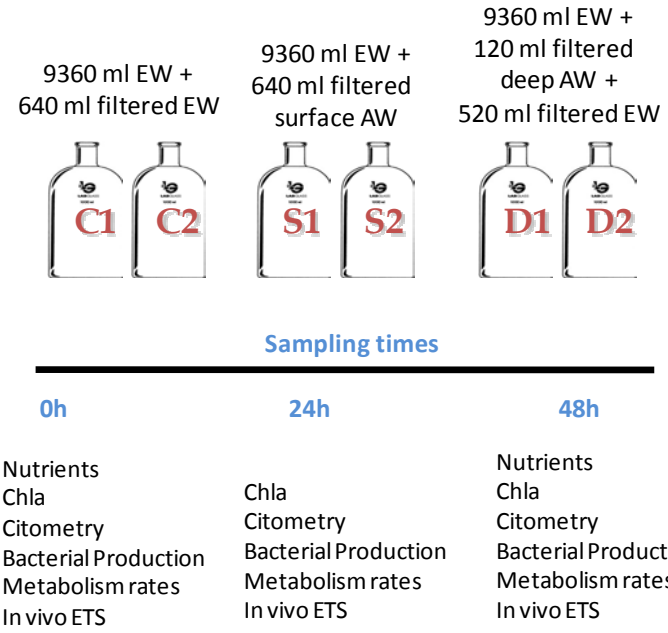


Figure 1. Experiment methodology ilustrative scheme

Effect of nutrient limitation on *Trichodesmium* distribution and nitrogen fixation in the tropical Atlantic,

Joe Snow
National Oceanography Centre, Southampton

Community Nitrogen Fixation Incubations and Nitrate isotope sample collection

Nitrogen Fixation Sampling Method
Samples were collected at each pre-dawn station from the CTD at four depths per cast (between surface and the deep chlorophyll maximum) for the preparation of nitrogen fixation incubations. Clear 4 ½ litre Nalgene bottles were coated with neutral density optical filters to achieve light intensities representing 100%, 69%, 20% and 0.1% ambient light. These bottles were filled with seawater (care was taken to ensure no air bubbles remained in the bottle when closing). The bottles were then 'spiked' with 4ml of $^{15}N_2$ gas through a septum closure using a gas-tight syringe. The bottles were then placed in an incubator on the aft-deck using water from the non-toxic underway supply, keeping them at surface temperature. After 24 hours, the bottles were removed and their contents filtered onto ashed GF/F filters (0.7µm pore size, Fisherbrand MF 300). Filters were then folded into eppendorfs tubes, dried at 30°C for 24 hours before being sealed and stored in a cool dry place. Samples will be analysed for $^{14}N/^{15}N$ ratios, PON concentrations and POC concentrations via elemental analyser isotope ratio mass spectrometry
.

Nitrate Isotope sample collection
From each pre-dawn CTD nitrate isotope samples were collected from the DCM bottle and the next lowest depth. Samples were collected into acid washed 125ml Nalgene bottles and frozen at -20°C for analysis back at NOCS

List of Samples collected
A total of 34 pre-dawn CTD deployments were sampled from, Time zero samples and nitrogen fixation incubations were setup for 4 depths per CTD cast. This totaled 272 PON/POC/Nfix samples. A total of 68 samples were collected for nitrate isotope analysis. Sample details including station/CTD numbers, postions, time and niskin bottles sampled from are listed below
.

Station No.	CTD No.	Julian Day	Date	CTD Time	Lat (+=N, -=S)	Lon (W)	Nitrogen Fixation				Time Zero (% Light)				Spike Time	Filtered Time (+24 hours)	Nitrate Isotopes
							100%	69%	20%	0.1%	100%	69%	20%	0.1%			
1	1	273	30/09/2011	03:30	50°027.23'	7°26.720'	24	20	15	11	24	20	15	11	05:20	06:30	-
3	3	274	01/10/2011	04:30	49°16.866'	12°49.192'	22	19	13	11	22	18	14	12	06:20	06:10	8 11
5	5	275	02/10/2011	04:30	48°08.006'	17°06.216'	22	18	13	12	23	19	14	11	06:30	06:10	7 11
7	7	276	03/10/2011	04:33	44°54.473'	19°13.387'	22	18	13	9	23	19	14	10	06:30	06:04	7 9
9	9	277	04/10/2011	04:29	41°47.607'	21°10.576'	22	18	13	10	23	19	14	11	06:22	06:15	6 8
11	11	278	05/10/2011	04:32	38°30.916'	23°07.633'	22	18	13	11	23	19	14	10	06:30	06:20	6 10
13	13	279	06/10/2011	04:32	35°41.519'	25°48.890'	22	17	12	10	23	18	13	11	06:35	06:05	8 10
15	15	280	07/10/2011	04:28	33°30.110'	28°45.212'	18	13	9	7	19	14	10	8	06:15	06:05	3 7
17	17	281	08/10/2011	04:32	31°32.852'	31°19.537'	22	17	13	10	23	18	14	11	06:25	07:35	8 10
19	19	282	09/10/2011	05:33	29°29.076'	33°58.307'	22	17	13	10	23	18	14	11	07:25	07:50	6 10
21	21	283	10/10/2011	05:32	27°34.857'	36°22.840'	22	17	13	6	23	18	14	8	07:40	07:25	6 8
23	23	284	11/10/2011	05:28	25°37.525'	38°48.245'	21	16	12	8	22	17	13	9	07:40	07:20	9 10
25	25	285	12/10/2011	05:28	23°27.727'	41°00.668'	21	16	12	8	22	17	13	9	07:10	07:40	9 10
27	27	286	13/10/2011	05:28	21°12.964'	39°09.203'	23	18	14	10	22	17	13	7	07:30	07:20	7 11
29	29	287	14/10/2011	05:29	18°49.400'	37°33.940'	23	17	13	8	22	16	12	7	07:15	07:50	4 9
31	31	288	15/10/2011	05:26	16°28.707'	35°44.427'	23	17	13	8	22	16	12	6	07:45	07:20	5 6
33	33	289	16/10/2011	05:28	13°47.121'	33°53.728'	22	16	12	7	23	17	13	8	07:15	07:15	5 9
35	35	290	17/10/2011	05:29	10°45.434'	31°52.403'	22	17	12	8	23	18	13	10	07:15	07:15	7 11
37	37	291	18/10/2011	05:26	7°35.394'	29°48.621'	22	17	12	8	23	18	13	10	07:10	07:40	6 8
39	39	292	19/10/2011	05:25	4°37.593'	27°55.164'	22	16	12	9	23	NaN	13	10	07:40	07:25	6 9
41	41	293	20/10/2011	05:27	1°55.701'	26°13.207'	22	16	12	8	23	17	13	10	07:10	07:15	6 8
43	43	294	21/10/2011	05:30	-1°1.908'	25°00.271'	22	16	12	8	23	17	13	10	07:15	07:25	6 8
44	44	295	22/10/2011	05:27	-4°40.598'	25°01.356'	22	16	12	8	23	17	13	10	07:25	06:45	
46	46	296	23/10/2011	05:30	-7°42.52'	25°02.348'	22	16	12	8	23	17	13	10	07:15	07:10	6 8
48	48	297	24/10/2011	05:25	-10°41.254'	10°41.254'	17	12	8	5	18	13	9	6	07:15	07:30	6 2
50	50	298	25/10/2011	05:33	-13°34.852'	25°04.097'	22	16	12	7	23	17	13	9	07:25	06:45	7 5
52	52	299	26/10/2011	04:56	-15°55.524'	25°05.394'	23	17	13	4	24	18	14	6	06:50	06:42	6 3
54	54	300	27/10/2011	04:55	-18°31.502'	25°06.088'	23	17	10	5	24	18	11	7	06:45	06:45	4,6
55	55	301	28/10/2011	04:57	-20°00.853'	25°05.467'	18	14	13	3	19	15	14	4	06:50	06:50	2,4
57	57	302	29/10/2011	04:57	-23°04.584'	25°03.431'	23	17	13	7,6	24	18	14	6	06:55	06:45	5,8
59	59	303	30/10/2011	04:57	-26°05.532'	25°01.499'	23	17	13	6	24	18	14	8	06:50	06:55	5,8
61	61	304	31/10/2011	04:56	-28°48.157'	25°57.09'	23	17	13	9	24	18	14	10	07:00	06:50	6,10
63	63	305	01/11/2011	04:59	-30°44.117'	28°43.847'	23	17	13	8	24	18	14	10	07:00	07:10	7,8
65	65	306	02/11/2011	04:59	-32°43.554'	31°33.071'	23	17	13	8	24	18	14	10	07:15	08:40	7,8
67	67	307	03/11/2011	04:58	-38°13.366'	39°31.128'	24	18	14	11	23	19	-	12	06:50	06:55	8,9
71	69	308	04/11/2011	04:56	-40°20.220'	42°45.284'	23	19	14	12	24	20	15	13	07:00	07:05	10,12
73	71	309	05/11/2011	04:56	-42°18.874'	45°53.702'	23	18	13	9	24	19	14	10	06:50	06:50	8,10
75	73	310	06/11/2011	04:57	-44°20.013'	49°11.623'	23	19	14	12	-	20	15	13	07:00	07:40	12,11

Trace metal tow fish deployment and underway sampling

Trace Metal Tow Fish
A trace metal clean tow fish was deployed on the 3rd of October using the port-side aft davit. The fish sat approx. 2.5m below the surface and remained in the water for the entire cruise until adverse weather prompted it's recovery on the 2nd of November 2011. Acid-cleaned polypropylene tubing was fed through the fish, up the wire and to a peristaltic pump sat in the foyer of the ultra-clean chem container. From the pump it was fed through to the sink where the outlet was double bagged in plastic ziplock bags whenever not in use. The fish was periodically brought to the surface for visual inspection of the tubing and minor repairs were made to the tape holding the tubing to the wire. Sampling was initiated around 30mins after leaving each station, following this; the pump was run for a further 30 minutes before a Sartobran P300 0.22um filter was attached, samples were collected for dissolved iron and nanonutrients. Details of sampling are given below:

Dissolved Iron:
125ml Nalgene bottles were prepared pre-cruise at NOCS by first soaking in Decon for a week, rinsed in RO water, placed in a 50% HCl bath for a week, rinsed with RO once again and then placed in a 50% HNO_3 bath for a further week. Following this, bottles were taken into a class-100 clean lab, rinsed with ultra-clean MilliQ water and double bagged with plastic zip lock bags.
During sampling bottles were rinsed both inside and outside ensuring the bottle cap and thread was rinsed. This was repeated 3 times before the sample was collected, bottle sealed and placed back into plastic bags before being frozen at -20℃. Bottles will be acidified on return to NOCS. Some samples were collected in triplicate, these are indicated in the underway sampling table below.

Nanonutrient
50ml polypropylene centrifuge tubes were soaked in a 10% acid bath for between 24 hours and 4 days before being rinsed with MilliQ water. Sample tubes were rinsed inside and out 3 times before samples were collected. Caps were replaced before being sealed with Parafilm, labeled then frozen at -20℃. Samples will be stored frozen until analysed back at NOCS.

Underway Sampling
Samples were collected from the ships non-toxic supply in the water bottle annex. Samples were filtered for bulk community DNA, particulate organic nitrogen and particulate organic phosphorus. Details of sampling procedures are below:

Community DNA:
Bulk community DNA samples were collected once daily in duplicate. One set of samples was collected for Dr Sarah Reynolds at the University of Liverpool. Water from the ships non-toxic supply was filtered through a 0.22µm Sterivex filter cartridge for 30 minutes before being sealed with parafilm and frozen in liquid nitrogen. The volume of water filtered was recorded upon completion of the 30 minutes.

Particulate organic Nitrogen and Phosphorus
4L of water collected from the ships non-toxic supply was filtered through an ashed (and acid washed for POP) Fisherbrand MF300 glass fibre filter (0.7um pore size). Filters for PON were placed in cryovials and frozen at -80℃. Filters for POP were placed in ashed and acid washed 13mm culture tubes, sealed with aluminium foil and parafilm and frozen at -80℃.

Fish and Underway Sampling Log:

Fish No.	Jday	Date	Time	Lat (+=N, -=S)	Lon (W)	Dissolved Fe	Nano Nutrients	PON	POP	Volume Filtered Protein	Volume Filtered DNA
1	274	01/10/2011	16:00	49°07.790'	14°43.290'	-	-	-	-	6.3	7.6
2	275	02/10/2011	09:20	47°34.490'	17°28.470'	-	-	4L	4L	6.1	8.3
3	276	03/10/2011	16:15	43°34.320'	20°04.667'	-	-	4L	4L	6.2	8.1
4	277	04/10/2011	08:14	41°20.605'	21°27.130'	125ml	2x 50ml	-	-		
5	277	04/10/2011	16:19	40°25.855'	22°00.040'	125ml	2x 50ml	4L	4L	7	7.1
6	278	05/10/2011	08:44	38°02.525'	23°24.166'	125ml	2x 50ml	-	-		
7	278	05/10/2011	16:05	37°02.290'	23°58.705'	125ml	2x 50ml	4L	4L	7.1	7.7
8	279	06/10/2011	07:18	35°30.591'	26°03.072'	125ml	2x 50ml	-	-		
9	279	06/10/2011	16:27	34°44.576'	27°05.510'	125ml	2x 50ml	4L	4L	6.4	6.9
10	280	07/10/2011	07:10	33°22.465'	28°54.521'	125ml	2x 50ml	-	-		
11	280	07/10/2011	15:35	32°43.092'	29°44.833'	125ml	2x 50ml	4L	4L	6.8	8
12	281	08/10/2011	07:15	31°22.926'	31°32.549'	125ml	2x 50ml	-	-		
13	281	08/10/2011	15:44	30°47.17'	32°18.880'	125ml	2x 50ml	4L	4L		
14	282	09/10/2011	08:25	29°17.860'	34°16.430'	125ml	2x 50ml	-	-		
15	282	09/10/2011	16:40	28°39.237'	35°02.235'	3 x 125ml	2x 50ml	4L	4L	5.8	5.5
16	283	10/10/2011	08:20	27°25.000'	36°34'	125ml	2x 50ml	-	-		
17	283	10/10/2011	17:03	26°47.867'	37°21.760'	3 x 125ml	2x 50ml	4L	4L	6.2	7.5
18	284	11/10/2011	08:53	25°24.824'	39°04.334'	125ml	2x 50ml	-	-		
19	284	11/10/2011	17:08	24°49.477'	39°47.593'	125ml	2x 50ml	4L	4L	5	6.2
20	285	12/10/2011	08:30	23°26'	41°18'	125ml	2x 50ml	-	-		
21	285	12/10/2011	17:01	22°37.560'	40°13.895'	125ml	2x 50ml	4L	4L	5.8	6.1
22	286	13/10/2011	08:40	20°59'	38°58'	125ml	2x 50ml	-	-		
23	286	13/10/2011	17:06	20°15.104'	38°26.683'	125ml	2x 50ml	4L	4L	6.5	6.4
24	287	14/10/2011	08:55	18°32.314'	37°11.993'	125ml	2x 50ml	-	-		
25	287	14/10/2011	17:35	17°51.247'	36°42.657'	125ml	2x 50ml	4L	4L	6.4	6.4
26	288	15/10/2011	09:00	16°16'	35°35'	125ml	2x 50ml	-	-		
27	288	15/10/2011	17:09	15°28.370'	35°02.714'	125ml	2x 50ml	4L	4L	6.1	6.1
28	289	16/10/2011	08:58	13°27.000'	33°40.018'	125ml	2x 50ml	-	-		
29	289	16/10/2011	17:21	12°31.933'	33°03.079'	125ml	2x 50ml	4L	4L	1.8	6.3
30	290	17/10/2011	09:12	10°22.128'	31°37.193'	3 x 125ml	2x 50ml	-	-		
31	290	17/10/2011	17:27	9°25.533'	31°00.230'	125ml	2x 50ml	4L	4L	4.8	6.7
32	291	18/10/2011	08:58	7°12.910'	29°34.480'	125ml	2x 50ml	-	-		
33	291	18/10/2011	17:35	6°14.787'	28°57.256'	125ml	2x 50ml	4L	4L	#VALUE!	6.7
34	292	19/10/2011	09:01	4°16'	27°41.924'	125ml	2x 50ml	-	-		
35	292	19/10/2011	17:03	3°30.758'	27°12.798'	125ml	2x 50ml	4L	4L	5.9	6.1
36	293	20/10/2011	16:16	-00°53.278'	25°33.565'	125ml	2x 50ml	4L	4L	5.4	5.7
37	294	21/10/2011	08:20	-01°23'	25°00.432'	125ml	2x 50ml	-	-		
38	294	21/10/2011	14:07	-2°15.261'	25°00.712'	125ml	2x 50ml	4L	4L	5.3	6
39	295	22/10/2011	08:26	-4°57.140'	25°01.573'	125ml	2x 50ml	-	-		
40	295	22/10/2011	15:50	-5°46.027'	25°01.608'	3 x 125ml	2x 50ml	4L	4L	3.9	6.4
41	296	23/10/2011	07:50	-7°53.641'	25°02.096'	125ml	2x 50ml	-	-		
42	296	23/10/2011	16:47	-8°54.51'	25°02.836'	125ml	2x 50ml	4L	4L	4.4	5.7
43	297	24/10/2011	08:00	-10°55.201'	25°03.384'	125ml	2x 50ml	-	-		
44	297	24/10/2011	16:35	-11°49.179'	25°03.789'	125ml	2x 50ml	4L	4L	5	6.1
45	298	25/10/2011	08:00	-13°45'	25°04'	125ml	2x 50ml	-	-		
46	298	25/10/2011	17:27	-14°17.855'	25°04.457'	125ml	2x 50ml	4L	4L	3.7	5.9
47	299	26/10/2011	07:25	-16°07'	25°05.234'	3 x 125ml	2x 50ml	-	-		
48	299	26/10/2011	16:48	-17°08.177'	25°05.318'	125ml	2x 50ml	4L	4L	5.9	5.9
49	301	28/10/2011	07:26	-20°13.099'	25°05.022'	125ml	2x 50ml	-	-		
50	301	28/10/2011	16:40	-21°17.756'	25°04.340'	125ml	2x 50ml	4L	4L	6	6.7
51	302	29/10/2011	07:53	-23°21.604'	25°03.034'	125ml	2x 50ml	-	-		
52	302	29/10/2011	16:26	-24°17.701'	25°02.052'	125ml	2x 50ml	4L	4L	5.8	6.7
53	303	30/10/2011	07:30	-26°19.347'	25°01.073'	125ml	2x 50ml	-	-		
54	303	30/10/2011	16:29	-27°19.924'	25°00.160'	125ml	2x 50ml	4L	4L	6.2	7
55	304	31/10/2011	07:42	-28°50.192'	26°07.664'	3 x 125ml	2x 50ml	-	-		
56	304	31/10/2011	16:07	-29°29.645'	27°01.117'	125ml	2x 50ml	4L	4L	6.1	6.4
57	305	01/11/2011	07:31	-30°53.314'	28°56.054'	125ml	2x 50ml	-	-		
58	305	01/11/2011	16:27	-31°31.734'	29°49.166'	125ml	2x 50ml	4L	4L	5.6	6
58	305	01/11/2011	16:27	-31°31.734'	29°49.166'	125ml	2x 50ml	4L	4L	5.6	6
59	306	02/11/2011	08:06	-32°53.065'	31°43.541'	125ml	2x 50ml	4L	4L		
60	306	02/11/2011	17:17	-33°30.309'	32°53.065'	-	-	4L	4L	4.6	5.9
61	307	03/11/2011	17:06	-35°37.872'	35°40.071'	-	-	3.45L	3.20L	3.6	4.6
62	308	04/11/2011	17:04	-37°11.540'	37°58.302'	-	-	4L	4L	5.3	7.5
63	309	05/11/2011	16:32	-39°09.437'	40°54.860'	-	-	3.08L	2.86L	5.2	5.5
64	310	06/11/2011	18:07	-41°16.986'	44°14.727'	-	-	3.20L	2.8L	4.8	5
65	311	07/11/2011	18:09	-43°18.217'	47°29.488'	-	-	2.7L	2.2L	5	5.4
66	312	08/11/2011	17:52	-45°13.325'	50°47.712'	-	-	1.4L	1.2L	2.9	2.9

Trichodesmium Sampling from Plankton Nets

Sampling Method

Pre-dawn and mid-day drift net tows were performed at every station from 22 to 43 via the starboard side, aft crane using nylon coated wire. Each deployment consisted of two 100µm 50cm diameter nets deployed to 10 and 15m respectively for between 7-10 minutes based on presumed water column biomass. The shallower of the two nets consisted of a rope bridle, acid-cleaned plastic cod end and great care was taken to minimise ship borne contamination during deployment. Following sample collection the cod-end bottles were kept sealed until placed under laminar flow in the ships ultra clean container. *Trichodesmium* colonies were picked for a number of different parameters briefly listed below:

Molecular analysis:

a. Under laminar flow 100 colonies were suspended in 0.22µm filtered TowFish water then filtered onto 5.0µm polycarbonate filters and flash frozen in cryo-vials within 30 minutes of the plankton net arriving back on deck.

b. Frozen samples will be kept in the -80°C freezer until return to Southampton. Upon return the samples will be prepared for, then analysed by targeted protein mass spectroscopy (LC-MS/MS).

c. Samples were picked in triplicate.

Metal analysis:

a. Under a laminar flow hood, 100 colonies were picked onto acid-cleaned 5.0µm polycarbonate filters.

b. The filters and biomass were then cleaned using the Oxalate Wash reagent described by Tang and Morel 2006, the filters were submerged in this reagent for 2 x 10 minute time periods before being washed 15 times with 0.22µm filtered TowFish water.

c. Collected samples were then flash frozen in liquid nitrogen and will be kept frozen until they can be analysed via ICP-MS for their intracellular metal concentrations. Metals to be analysed include P, Fe, Zn, Mo, Cd, Co, V, Ni, Cu and Mn.

CHN Samples:

a. 50 colonies were picked onto ashed Fisherbrand MF300 glass fibre filters and flash frozen in cryo-vials.

b. The samples will be kept for analysis upon return to Southampton where they will be analysed for colony specific carbon and nitrogen concentration.

Phosphate:

a. 50 colonies were picked then filtered onto ashed and then acid-washed Fisherbrand MF300 glass fibre filters, placed into ashed then acid-washed 13mm glass culture tubes sealed with tinfoil and parafilm then placed into the -80°C freezer.

b. If phosphorus concentration data is unachievable via ICP-MS, these samples will be analysed for P concentration.

Lipid:

a. Using minimal plastics, with the exception of the plastic cod end and the plastic inoculating loop, 50 Trichodesmium colonies were picked onto ashed Fisherbrand MF300 glass fibre filters and stored in 13mm glass test tubes, sealed with tinfoil and parafilm. They were then placed into the -80°C freezer for storage.

b. They will be kept frozen until return to Southampton where they will be analysed via GC-MS for lipid ratios previously identified by Van Mooy 2006,2009 as indicating phosphate limitation.

***Trichodesmium* Chlorophyll:**

10 colonies were picked into 0.22um filtered TowFish water, filtered onto 2.0µm polycarbonate filters and the chlorophyll extracted using 8ml of 90% acetone, the samples were then kept in the -20°C freezer for 24 hours. Chlorophyll fluorescence was measured using a Turner Designs Trilogy Fluorometer.

***Trichodesmium* Abundance:**
A full 20L surface niskin bottle from the stainless CTD was filtered through a 47mm 10µm polycarbonate filter, the collected biomass was resuspended in approximately 50ml of filtered seawater and spiked with ~6ml acid lugol's. These will be analysed upon return to NOCS using light microscopy.

***Trichodesmium* specific Nitrogen Fixation Incuabtions:**
Two sets of 50 colonies were picked, placed in 125ml polycarbonate bottles and spiked with 0.5ml $^{15}N_2$ gas. A control was set up consisting of 50 colonies in a polycarbonate bottle that were *not* spiked with the ^{15}N gas. The incubations were then placed in the deck board incubator for 24 hours. After 24 hours the entire incubations were filtered onto ashed Fisherbrand MF300 glass-fibre filters and placed in a drying oven for 24 hours. They will be analysed upon return to NOCS via the elemental analyser isotope ratio mass spectrometer.

***Trichodesmium* F_v/F_m**
Approximately 15-20 colonies were picked into ~5ml of filtered seawater. These colonies were then dark acclimatised for ~10mins before being analysed via Fastracka FRRF.

List of Samples taken
A total of 443 samples were collected from the *Trichodesmium* drift nets during D371 spanning 24 deployments along with 16 *Trichodesmium* abundance samples collected from the pre-dawn CTDs.

Details of each sample are listed below

Stn	Net						Nitrogen Fixation							
No.	No.	Jday	Time	Protein	Metals	CHN	Colonies	Spike Time	Filter Time	POP	Lipids	FIRe File	Chl a	Abundance
20	1	282	PM	3 x 100	3 x 100	3x50				3 x 50				
21	2	283	AM	3 x 100	3 x 100	-	3x50	07:50	07:45	-		TN002	5 x 10	CTD021_24
22	3	283	PM	3 x 100	3 x 100	3x50	-			3 x 50	3 x 50	TN003	5 x 10	
23	4	284	AM	3 x 100	3 x 100	3x50	3x50	07:50	07:50	3 x 50	-	TN004	5 x 10	CTD023_24
24	5	284	PM	3 x 100	3 x 100	3x50	-			3 x 50	3 x 50	TN005	5 x 10	
25	6	285	AM	3 x 100	3 x 100	3x50	3x50	07:50	08:20	3 x 50	-	TN006	5 x 10	CTD025_24
26	7	285	PM	3 x 100	3 x 100	3x50	-			3 x 50	3 x 50	TN007	5 x 10	
27	8	286	AM	3 x 100	3 x 100	3x50	3x50	08:10	08:30	3 x 50	-	TN008	5 x 10	CTD027_24
28	9	286	PM	3 x 100	3 x 100	3x50	-			3 x 50	3 x 50	TN009	5 x 10	
29	10	287	AM	3 x 100	3 x 100	3x50	3x50	07:50	08:20	3 x 50	-	TN010	5 x 10	CTD029_24
30	11	287	PM	3 x 100	3 x 100	3x50	-			3 x 50	3 x 50	TN011	5 x 10	
31	12	288	AM	3 x 100	3 x 100	3x50	3x50	08:10	07:35	3 x 50	-	TN012	5 x 10	CTD031_24
32	13	288	PM	3 x 100	3 x 100	3x50	-			3 x 50	3 x 50	TN013	5 x 10	
33	14	289	AM	3 x 100	3 x 100	3x50	3x50	07:50	07:55	3 x 50	-	TN014	5 x 10	CTD033_24
34	15	289	PM	3 x 100	3 x 100	3x50	-			3 x 50	3 x 50	TN015	5 x 10	
35	16	290	AM	3 x 100	3 x 100	3x50	3x50	07:55	07:50	3 x 50	-	TN016	5 x 10	CTD035_24
36	17	290	PM	3 x 100	3 x 100	3x50	-			3 x 50	3 x 50	TN017	5 x 10	
37	18	291	AM	3 x 100	3 x 100	3x50	3x50	07:50	08:00	3 x 50	-	TN018	5 x 10	CTD037_24
38	19	291	PM	3 x 100	3 x 100	3x50	-			3 x 50	3 x 50	TN019	5 x 10	
39	20	292	AM	3 x 100	3 x 100	3x50	3x50	08:00	08:40	3 x 50	-	TN020	5 x 10	CTD039_24
40	21	292	PM	3 x 100	3 x 100	3x50	-			-	-	TN021	5 x 10	
41	22	293	AM	3 x 100	3 x 100	3x50	3x50	08:00	07:25	-	-	TN022	5 x 10	CTD041_24
42	23	293	PM	-	-	-	-			-	-	TN023	-	
43	24	294	AM	-	-	-	-			-	-	-	-	CTD043_24
46		296	AM	-	-	-	-			-	-	-	-	CTD046_24
48		297	AM	-	-	-	-			-	-	-	-	CTD048_24
50		298	AM	-	-	-	-			-	-	-	-	CTD050_24

Measurements of dissolved oxygen concentration, gross primary production, community respiration and net community production. Measurements of size fractionated in vivo ETS respiration (>0.8 µm and 0.8-0.2 µm).

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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. The relationship between the production (P) and community respiration (CR) represents the magnitude of biologically fixed carbon that is available for export to the deep ocean or for transference to upper levels of the marine food-web. Moreover, P/CR represents the planktonic contribution to the marine and atmospheric CO_2 balance, as equilibrium between dissolved O_2 in seawater and the atmosphere is maintained through air-sea gas exchange.
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 (BR) is not an easy task, not only because of their low rates, but also due to the difficulty for isolating them from the whole community. 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 reduces the possibility of community structure changes.

The AMT programme presents an ideal opportunity to study the biogeochemical interactions between photosynthesis and respiration and their effect on the dynamics of dissolved O_2 across diverse marine biomes.

The aims of this work are:
1. To quantify gross primary production (GPP) and community respiration (CR) by dissolved O_2 changes in photic waters with the Winkler technique.
2. To calibrate the O_2 sensor on the CTD.
3. To measure community respiration and bacterial respiration with enzymatic techniques.

Methods
Discrete dissolved oxygen concentration was measured by automated precision Winkler titration performed with a Metrohm 848 Titrino, utilising a potentiometric end point as described in Serret et al. (1999). The concentration of thiosulphate was calibrated every day.
CTD calibration. Eight glass 125 mL bottles were filled with seawater taken directly from the Niskin bottles at 8 different depths using a silicone tube. Samples were fixed immediately and analysed during the following 24 hours.
In total, 42 profiles were carried out for the oxygen sensor calibration (Table 1).

For the P and CR measurements, seawater samples were collected daily from the pre-dawn CTD in 10 L carboys (6 depths within the euphotic zone). Each carboy was sub-sampled into 125 mL glass O_2 bottles (light and dark bottles) which were placed in ondeck incubators for 24 hours. The incubators were covered with neutral and blue density light filters simulating the PAR light in the water column, and temperature incubator was maintained with the underway water. Additional subsamples were fixed at the start of the incubation ('zero' sub-samples). Light and dark O_2 bottles were removed from the incubators after the 24h incubation period and fixed and analysed for O_2. Each treatment for each depth (Zero, Light and Dark) was replicated four times.
Production and respiration rates were calculated from the difference between the means of the replicate light and dark incubated bottles and zero time analyses (CR= Dark-Zero; Net community production (NCP) = Light-Dark; GPP = NCP + CR).
In total, 37 experiments were carried out for the determination of community production/respiration along the cruise (Table 2).

In vivo ETS-reduction analysis
Three depths were analyzed with this enzymatic technique at each station. Four replicates of 200-250 mL seawater samples were poured from the 10L carboys into plastic bottles.
One replicate was immediately fixed by adding formaldehyde (2% w/v final concentration) and used as killed controls. Twenty minutes later the other three replicates 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. After incubation (2 – 4 h), samples were fixed by adding formaldehyde in the same way as for the killed controls. After 20 minutes, samples were filtered sequentially 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 –20°C until further processing.

In total, 38 experiments were carried out at the same stations as the P/CR incubations (Table 3).

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. GPP, NCP and CR data will be delivered to BODC by September 2012.

Community and bacterial respiration measured with the in vivo ETS technique will be analyzed in the lab during the following months. BR and CR data will be delivered to BODC by September 2012.

References:

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Table 2. Station log for samples collected for dissolved oxygen profiles during AMT21

Date	Cruise Number	CTD ID	Lat (+=N, -=S)	Lon (-E)	Niskin sampled	Sampling depth (m)
30/09/2011	D371	CTD_001	50º 27.236	-7º 26.716	24, 22, 20, 18, 15, 13, 3	2, 10,15, 20, 25, 30, 85
01/10/2011	D371	CTD_003	49º 16.85	-12º 43.16	24, 21, 19, 17, 14, 10, 4, 1	2, 5, 10, 20, 30, 50, 150, 300
02/10/2011	D371	CTD_005	48º 08.006	-17º 06.215	24, 19, 16, 14, 12, 9, 3, 2	2, 13, 24, 32, 45, 55, 150, 200
03/10/2011	D371	CTD_007	44º 54.473	-19º 13.387	24, 21, 19, 16, 12, 10, 3, 1	2, 7, 12, 22, 40, 55, 150, 300
04/10/2011	D371	CTD_009	41º 47.609	-21º 10.576	24, 21, 19, 14, 12, 11, 8, 3	2, 9, 16, 38, 50, 63, 65, 150
05/10/2011	D371	CTD_011	38º 30.916	-23º 7.633	24, 21, 19, 14, 12, 11, 8, 1	2, 9, 17, 41, 50, 60, 70, 300
06/10/2011	D371	CTD_13	35º 41.522	-25º 47.887	24, 21, 18, 16, 14, 11, 7, 1	2, 14, 25, 45, 50, 78, 105, 300
07/10/2011	D371	CTD_15	33º 33.110	-28º 45.212	20, 16, 14, 12, 10, 8, 5, 1	2, 11, 20, 36, 49, 80, 84, 300
08/10/2011	D371	CTD_17	31º 32.852	-31º 19.557	24, 21, 18, 16, 14, 11, 7, 1	2, 14, 25, 44, 59, 88, 103, 300
09/10/2011	D371	CTD_19	29º 29.076	-33º 58.307	22, 18, 16, 14, 11, 8, 2, 1	2, 27, 48, 65, 102, 112, 500, 1000
10/10/2011	D371	CTD_21	27º 34.857	-36º 22.84	22, 21, 18, 16, 14, 7, 5, 1	2, 14, 25, 44, 60, 105, 125, 300
11/10/2011	D371	CTD_23	25º 37.525	-38º 48.245	21, 20, 17, 15, 13, 9, 3, 1	2, 16, 29, 52, 70, 120, 175, 300
12/10/2011	D371	CTD_25	23º 37.727	-41º 0.668	21, 20, 17, 15, 13, 9, 3, 1	2, 16, 29, 52, 70, 120, 175, 300
13/10/2011	D371	CTD_27	21º 12.964	-39º 9.203	22, 18, 16, 14, 12, 10, 2, 1	2, 29, 52, 70, 85, 120, 500, 1000
13/10/2011	D371	CTD_28	20º 23.43	-38º 33.002	23, 18, 15, 14, 12, 7, 2, 1	2, 32, 58, 78, 95, 135, 200, 300
14/10/2011	D371	CTD_29	18º 49.4	-37º 23.94	21, 20, 17, 15, 13, 10, 6, 1	2, 17, 31, 56, 75, 110, 130, 300
14/10/2011	D371	CTD_30	18º 0.944	-36º 49.82	22, 18, 15, 14, 12, 7, 2, 1	2, 28, 50, 68, 100, 120, 200, 300
15/10/2011	D371	CTD-31	16º 28.707	-35º 44.427	22, 20, 17, 15, 13, 7, 2, 1	2, 14, 26, 46, 63, 107, 300, 1000
15/10/2011	D371	CTD_32	15º 39.035	-35º 10.237	22, 21, 18, 15, 14, 9, 3, 2	2, 12, 22, 39, 52, 70, 150, 200
16/10/2011	D371	CTD_33	13º 47.121	-33º 53.728	21, 20, 17, 15, 13, 10, 6, 1	2, 11, 20, 36, 49, 75, 85, 300
16/10/2011	D371	CTD_34	12º 45.38	-33º 12.241	23, 18, 15, 14, 10, 7, 2	2, 22, 36, 49, 65, 85, 200
17/10/2011	D371	CTD_35	10º 46.434	-31º 52.403	21, 18, 15, 13, 8, 6, 2, 1	2, 17, 30, 41, 54, 70, 200, 300
18/10/2011	D371	CTD_37	7º 35.594	-29º 48.64	21, 18, 15, 13, 8, 7, 3, 1	2, 20, 33, 44, 65, 77, 150, 300

Date	Cruise Number	CTD ID	Lat (+=N, -=S)	Lon (E)	Niskin sampled	Sampling depth
19/10/2011	D371	CTD_39	4º 37.593	-27º 55.164	22, 20, 17, 15, 13, 10, 7, 1	2, 14, 26, 46, 62, 80, 107, 1000
20/10/2011	D371	CTD_41	1º 55.701	-26º 13.207	21, 18, 15, 13, 8, 7, 4, 1	2, 20, 36, 49, 70, 85,128, 300
21/10/2011	D371	CTD_43	-1º 1.908	-25º 00.271	21, 17, 15, 13, 8, 7, 3, 1	2, 22, 39, 52, 70, 90, 150, 300
22/10/2011	D371	CTD_44	-4º 40.598	-25º 01.356	22, 20, 17, 15, 13, 8, 7, 1	2, 11, 20, 35, 47, 80, 85, 1000
23/10/2011	D371	CTD_46	-7º 42.52	-25º 2.348	21, 17, 14, 13, 8, 7, 3, 1	2, 24, 43, 58, 94, 100, 150, 300
24/10/2011	D371	CTD_48	-10º 41.254	-25º 3.249	19, 16, 13, 11, 9, 4, 2, 1	2, 15, 28, 49, 66, 115, 160, 200
25/10/2011	D371	CTD_50	-13º 34.852	-25º 4.094	23, 20, 17, 15, 13, 7, 2, 1	2, 20, 36, 65, 87, 130, 200, 300
26/10/2011	D371	CTD_52	-15º 55.524	-25º 5.394	22, 21, 18, 13, 10, 4, 2, 1	2, 15, 28, 68, 118, 116, 200, 300
27/10/2011	D371	CTD_54	-18º 31.501	-25º 06.058	22, 21, 18, 14, 10, 5, 2, 1	2, 20, 33, 78, 135, 160, 300, 500
28/10/2011	D371	CTD_55	-20º 00.853	-25º 05.469	22, 17, 15, 13, 11, 7, 5, 1	2, 20, 33, 58, 78, 135, 160, 300
29/10/2011	D371	CTD_57	-23º 04.584	-25º 03.431	22, 21, 18, 14, 10, 6, 2, 1	2, 17, 31, 74, 128, 140, 200, 300
30/10/2011	D371	CTD_59	-26º 5.332	-25º 01.449	22, 21, 18, 14, 10, 6, 2, 1	2, 17, 31, 74, 128, 140, 200, 300
31/10/2011	D371	CTD_61	-28º 42.137	-25º 57.09	23, 21, 18, 16, 14, 7, 2, 1	2, 15, 27, 48, 65, 104, 300, 1000
01/11/2011	D371	CTD_63	-30º 44.117	-28º 43.847	22, 21, 18, 14, 8, 6, 2, 1	2, 12, 22, 52, 70, 90, 200, 300
02/11/2011	D371	CTD_65	-32º 43.554	-31º 30.071	22, 21, 18, 14, 8, 7, 2, 1	5, 12, 22, 53, 90, 92, 200, 300
05/11/2011	D371	CTD_67	-38º 13.360	-39º 31.128	22, 21, 19, 16, 15, 10, 2, 1	2, 6, 11, 20, 27, 45, 200, 300
06/11/2011	D371	CTD_69	-40º 20.22	-42º 45.284	23, 20, 18, 15, 11, 10, 2, 1	2, 8, 15, 20, 25, 34, 300, 1000
07/11/2011	D371	CTD_71	-42º 18.874	-45º 53.702	22, 21, 19, 14, 9, 8, 2, 1	2, 7, 14, 32, 50, 56, 200, 300
08/11/2011	D371	CTD_73	-44º 20.012	-49º 11.623	23, 20, 18, 15, 11, 10, 2, 1	2, 8, 15, 20, 25, 35, 300, 1000

Table 3. Station log for samples collected for NCP, GPP and CR measurements

Date	Cruise Number	CTD ID	Lat (+=N, -=S)	Lon (E)	Niskin sampled	Sampling depth (m)
30/09/2011	D371	CTD_001	50º 27.236	-7º 26.716	24, 22, 20, 18, 15, 13	2, 10,15, 20, 25, 30
01/10/2011	D371	CTD_003	49º 16.85	-12º 43.16	24, 21, 19, 17, 14, 10	2, 5, 10, 20, 30, 50
02/10/2011	D371	CTD_005	48º 08.006	-17º 06.215	24, 21, 19, 14, 12, 9	2, 7, 13, 32, 45, 55
03/10/2011	D371	CTD_007	44º 54.473	-19º 13.387	24, 21, 19, 16, 12, 10	2, 7, 12, 22, 40, 55
04/10/2011	D371	CTD_009	41º 47.609	-21º 10.576	24, 21, 19, 14, 11, 8	2, 9, 16, 38, 63, 65
05/10/2011	D371	CTD_011	38º 30.916	-23º 7.633	24, 21, 19, 14, 11, 8	2, 9, 17, 41, 60, 70
06/10/2011	D371	CTD_13	35º 41.522	-25º 47.887	24, 21, 18, 13, 11, 7	2, 14, 25, 61, 78, 105
07/10/2011	D371	CTD_15	33º 33.110	-28º 45.212	20, 17, 14, 10, 8, 5	2, 11, 20, 49, 80, 84
08/10/2011	D371	CTD_17	31º 32.852	-31º 19.557	24, 21, 18, 14, 11, 7	2, 14, 25, 59, 88, 103
09/10/2011	D371	CTD_19	29º 29.076	-33º 58.307	23, 21, 18, 14, 11, 8	2, 15, 27, 65, 102, 112
10/10/2011	D371	CTD_21	27º 34.857	-36º 22.84	22, 21, 18, 16, 14, 7	2, 14, 25, 44, 60, 105
11/10/2011	D371	CTD_23	25º 37.525	-38º 48.245	22, 20, 17, 15, 13, 9	2, 16, 29, 52, 70, 120
12/10/2011	D371	CTD_25	23º 37.727	-41º 0.668	22, 20, 17, 15, 13, 9	2, 16, 29, 52, 70, 120
13/10/2011	D371	CTD_27	21º 12.964	-39º 9.203	22, 20, 18, 16, 14, 8	2, 16, 29, 57, 70, 120
14/10/2011	D371	CTD_29	18º 49.4	-37º 23.94	21, 20, 17, 15, 13, 6	2, 17, 31, 56, 75, 130
15/10/2011	D371	CTD_31	16º 28.707	-35º 44.427	23, 20, 17, 15, 13, 7	2, 14, 26, 46, 62, 107
16/10/2011	D371	CTD_33	13º 47.121	-33º 53.728	21, 20, 17, 13, 10, 6	2, 11, 20, 49, 75, 85
17/10/2011	D371	CTD_35	10º 46.434	-31º 52.403	21, 20, 18, 13, 10, 6	2, 9, 17, 41, 54, 70
18/10/2011	D371	CTD_37	7º 35.594	-29º 48.64	21, 20, 18, 13, 10, 7	2, 10, 20, 44, 65, 77
19/10/2011	D371	CTD_39	4º 37.593	-27º 55.164	23, 20, 17, 13, 10, 7	2, 14, 26, 62, 80, 107
20/10/2011	D371	CTD_41	1º 55.701	-26º 13.207	21, 20, 18, 13, 10, 7	2, 11, 20, 49, 70, 85
22/10/2011	D371	CTD_44	-4º 40.598	-25º 01.356	23, 20, 17, 13, 8, 7	2, 11, 20, 47, 80, 85
23/10/2011	D371	CTD_46	-7º 42.52	-25º 2.348	21, 19, 17, 13, 10, 7	2, 13, 24, 58, 94, 100
24/10/2011	D371	CTD_48	-10º 41.254	-25º 3.249	19, 16, 13, 11, 9, 4	2, 15, 28, 49, 66, 115
25/10/2011	D371	CTD_50	-13º 34.852	-25º 4.094	23, 20, 17, 15, 13, 9	2, 20, 36, 65, 87, 130
26/10/2011	D371	CTD_52	-15º 55.524	-25º 5.394	22, 21, 18, 13, 10, 6	2, 15, 28, 68, 118, 160
27/10/2011	D371	CTD_54	-18º 31.501	-25º 06.058	22, 21, 18, 14, 10, 7	2, 20, 33, 78, 135, 160
28/10/2011	D371	CTD_55	-20º 00.853	-25º 05.469	20, 17, 15, 11, 7, 5	2, 20, 33, 78, 135, 160
29/10/2011	D371	CTD_57	-23º 04.584	-25º 03.431	22, 21, 18, 14, 10, 6	2, 17, 31, 74, 128, 140
30/10/2011	D371	CTD_59	-26º 5.332	-25º 01.449	22, 21, 18, 14, 10, 8	2, 17, 31, 74, 128, 140
31/10/2011	D371	CTD_61	-28º 42.137	-25º 57.09	24, 21, 18, 16, 14, 7	2, 15, 27, 48, 65, 104
01/11/2011	D371	CTD_63	-30º 44.117	-28º 43.847	22, 21, 18, 14, 10, 6	2, 12, 22, 52, 70, 90
02/11/2011	D371	CTD_65	-32º 43.554	-31º 30.071	22, 21, 18, 16, 14, 10	5, 12, 22, 40, 53, 90
05/11/2011	D371	CTD_67	-38º 13.360	-39º 31.128	22, 21, 19, 17, 15, 10	2, 6, 11, 20, 27, 45
06/11/2011	D371	CTD_69	-40º 20.22	-42º 45.284	24, 20, 18, 15, 11, 10	2, 8, 15, 20, 25, 34
07/11/2011	D371	CTD_71	-42º 18.874	--45º 53.702	22, 19, 16, 14, 11, 8	2, 14, 24, 32, 50, 56
08/11/2011	D371	CTD_73	-44º 20.012	--49º 11.623	24, 20, 18, 15, 11, 10	2, 8, 15, 20, 25, 35

Table 4. Station log for samples collected for in vivo ETS respiration

Date	Cruise Number	CTD ID	Lat (+=N, -=S)	Lon (E)	Niskin sampled	Sampling depth (m)
30/09/2011	D371	CTD_001	50º 27.236	-7º 26.716	24, 20, 13	2, 15, 85
01/10/2011	D371	CTD_003	49º 16.85	-12º 43.16	24, 19, 10	2, 10, 50
02/10/2011	D371	CTD_005	48º 08.006	-17º 06.215	24, 12, 9	2, 45, 55
03/10/2011	D371	CTD_007	44º 54.473	-19º 13.387	24, 12, 10	2, 12, 55
04/10/2011	D371	CTD_009	41º 47.609	-21º 10.576	24, 11, 8	2, 63, 65,
05/10/2011	D371	CTD_011	38º 30.916	-23º 7.633	24, 11, 8	2, 60, 70
06/10/2011	D371	CTD_13	35º 41.522	-25º 47.887	24, 11, 7	2, 78, 105
07/10/2011	D371	CTD_15	33º 33.110	-28º 45.212	20, 8, 5	2, 80, 84
08/10/2011	D371	CTD_17	31º 32.852	-31º 19.557	24, 11, 7	2, 88, 103
09/10/2011	D371	CTD_19	29º 29.076	-33º 58.307	23, 11, 8	2, 102, 112
10/10/2011	D371	CTD_21	27º 34.857	-36º 22.84	22, 18, 7	2, 25, 105
11/10/2011	D371	CTD_23	25º 37.525	-38º 48.245	22, 17, 9	2, 29, 120
12/10/2011	D371	CTD_25	23º 37.727	-41º 0.668	22, 17, 9	2, 29, 120
13/10/2011	D371	CTD_27	21º 12.964	-39º 9.203	22, 18, 8	2, 29, 120
14/10/2011	D371	CTD_29	18º 49.4	-37º 23.94	21, 17, 6	2, 31, 130
15/10/2011	D371	CTD_31	16º 28.707	-35º 44.427	23, 17, 7	2, 26, 107
16/10/2011	D371	CTD_33	13º 47.121	-33º 53.728	21, 10, 6	2, 75, 85
17/10/2011	D371	CTD_35	10º 46.434	-31º 52.403	21, 10, 6	2, 54, 70
18/10/2011	D371	CTD_37	7º 35.594	-29º 48.64	21, 20, 7	2, 65, 77
19/10/2011	D371	CTD_39	4º 37.593	-27º 55.164	23, 20, 7	2, 80, 107
20/10/2011	D371	CTD_41	1º 55.701	-26º 13.207	21, 20, 7	2, 70, 85
21/10/2011	D371	CTD_43	-1º 1.908	-25º 00.271	21, 8, 7	2, 70, 90
22/10/2011	D371	CTD_44	-4º 40.598	-25º 01.356	23, 8, 7	2, 80, 85
23/10/2011	D371	CTD_46	-7º 42.52	-25º 2.348	21, 10, 7	2, 94, 100
24/10/2011	D371	CTD_48	-10º 41.254	-25º 3.249	19, 13, 4	2, 28, 115
25/10/2011	D371	CTD_50	-13º 34.852	-25º 4.094	23, 17, 9	2, 36, 130
26/10/2011	D371	CTD_52	-15º 55.524	-25º 5.394	22, 10, 6	2, 118, 160
27/10/2011	D371	CTD_54	-18º 31.501	-25º 06.058	22, 10, 5	2, 135, 160
28/10/2011	D371	CTD_55	-20º 00.853	-25º 05.469	20, 7, 5	2, 135, 160
29/10/2011	D371	CTD_57	-23º 04.584	-25º 03.431	22, 10, 6	2, 128, 140
30/10/2011	D371	CTD_59	-26º 5.332	-25º 01.449	22, 10, 8	2, 128, 140
31/10/2011	D371	CTD_61	-28º 42.137	-25º 57.09	24, 18, 7	2, 27, 104
01/11/2011	D371	CTD_63	-30º 44.117	-28º 43.847	22, 10, 6	2, 70, 90
02/11/2011	D371	CTD_65	-32º 43.554	-31º 30.071	22, 18, 10	5, 22, 90
05/11/2011	D371	CTD_67	-38º 13.360	-39º 31.128	22, 19, 10	2, 11, 45
06/11/2011	D371	CTD_69	-40º 20.22	--42º 45.284	24, 11, 10	2, 25, 34
07/11/2011	D371	CTD_71	-42º 18.874	-45º 53.702	22, 11, 8	2, 50, 56
08/11/2011	D371	CTD_73	-44º 20.012	-49º 11.623	24, 11, 10	2, 25, 35

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

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Samples of seawater from CTD niskin bottles and the ship's non-toxic supply were taken to calibrate the CTD and underway system fluorometers following Welschmeyer (1994). Samples of 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 24 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 total of 180 samples were collected from the underway supply. A list of date, time and position for the underway samples can be found in the appendices.

CTD samples
Samples were collected at 74 stations from an average of 9 depths including light depths from 97, 55, 33, 14, 7, 1 & 0.1%.
A total of 655 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-band phaeopigments. *Limnology and Oceanography*, 39:1985-1992

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

Time (GMT)	Lat (+ve N)	Lon (+ve E)	CTD	Niskin Bottle	Depth (m)
30/09/2011 03:35	50.45	-7.44	CTD 001	7, 8, 9, 13, 17, 19, 21, 23	70, 60, 50, 30, 20, 15, 10, 2
30/09/2011 12:09	49.95	-9.12	CTD 002	7, 8, 9, 11, 13, 17, 21, 23	70, 60, 50, 40, 30, 20, 10, 2
01/10/2011 04:33	49.28	-12.71	CTD 003	3, 6, 7, 10, 12, 16, 18, 23	200, 100, 75, 50, 40, 20, 10, 2
01/10/2011 13:00	49.14	-14.51	CTD 004	3, 6, 8, 11, 13, 17, 19, 23	200, 100, 75, 50, 40, 20, 10, 2
02/10/2011 04:28	48.13	-17.10	CTD 005	2, 5, 6, 9, 12, 15, 18, 23	200, 100, 80, 55, 45, 24, 13, 2
02/10/2011 13:02	47.02	-17.84	CTD 006	3, 6, 8, 11, 13, 17, 19, 23	200, 100, 80, 55, 40, 24, 13, 2
03/10/2011 04:33	44.90	-19.22	CTD 007	2, 5, 6, 8, 9, 10, 12, 15, 18, 23	200, 100, 83, 55, 55, 55, 40, 22, 12, 2
03/10/2011 13:02	43.77	-19.94	CTD 008	3, 6, 8, 10, 11, 12, 13, 17, 19, 23	200, 100, 83, 55, 55, 50, 50, 22, 12, 2
04/10/2011 04:28	41.79	-21.17	CTD 009	2, 4, 5, 10, 11, 11, 12, 15, 19, 23	200, 110, 90, 63, 63, 63, 50, 28, 16, 2
04/10/2011 13:00	40.66	-21.85	CTD 010	3, 5, 9, 12, 12, 15, 17, 19, 23, 23	200, 110, 65, 60, 60, 38, 28, 16, 2, 2

Time (GMT)	Lat (+ve N)	Lon (+ve E)	CTD	Niskin Bottle	Depth (m)
05/10/2011 04:32	38.51	-23.12	CTD 011	2, 4, 5, 8, 10, 11, 15, 19, 23, 24	200, 110, 90, 70, 60, 60, 30, 17, 2, 2
05/10/2011 13:00	37.30	-23.82	CTD 012	3, 4, 5, 8, 10, 15, 17, 19, 22, 23	200, 150, 110, 87, 87, 50, 37, 20, 11, 2
06/10/2011 04:31	35.69	-25.79	CTD 013	2, 4, 6, 10, 10, 15, 18, 20, 23, 23	200, 150, 105, 78, 78, 45, 25, 14, 2, 2
06/10/2011 13:00	34.89	-26.88	CTD 014	2, 3, 4, 8, 12, 15, 17, 18, 22, 23	250, 200, 175, 115, 82, 66, 49, 28, 15, 2
07/10/2011 04:28	33.50	-28.75	CTD 015	2, 3, 5, 8, 10, 11, 14, 19	200, 100, 84, 80, 49, 36, 20, 1
07/10/2011 13:00	32.81	-29.65	CTD 016	3, 4, 6, 8, 15, 17, 18, 24	175, 150, 120, 103, 58, 43, 24, 2
08/10/2011 04:32	31.54	-31.32	CTD 017	2, 3, 5, 7, 9, 14, 15, 18, 23	200, 175, 125, 103, 88, 44, 44, 25, 2
08/10/2011 13:00	30.88	-32.19	CTD 018	2, 4, 5, 9, 14, 16, 17, 23	200, 150, 125, 103, 59, 44, 25, 2
09/10/2011 05:33	29.48	-33.97	CTD 019	4, 6, 8, 9, 13, 15, 18, 23	200, 130, 112, 102, 65, 48, 27, 2
09/10/2011 14:01	28.83	-34.80	CTD 020	2, 3, 8, 14, 16, 17, 21, 23	200, 170, 112, 65, 48, 27, 15, 2
10/10/2011 05:31	27.58	-36.38	CTD 021	2, 4, 5, 8, 14, 15, 18, 21, 23	200, 157, 125, 105, 60, 44, 25, 14, 2
10/10/2011 13:58	26.91	-37.21	CTD 022	2, 3, 8, 14, 16, 17, 20, 23	200, 175, 120, 70, 52, 29, 16, 2
11/10/2011 05:28	25.62	-38.80	CTD 023	2, 4, 6, 13, 14, 17, 20, 22	200, 180, 120, 70, 52, 29, 16, 2
11/10/2011 14:00	24.9424	-39.64	CTD 024	2, 3, 7, 9, 14, 15, 17, 20, 23	200, 175, 120, 110, 70, 52, 29, 16, 2
12/10/2011 05:28	23.62	-41.0111	CTD 025	2, 3, 4, 7, 13, 14, 17, 20, 22	200, 175, 150, 120, 70, 52, 29, 16, 2
12/10/2011 13:59	22.76	-40.34	CTD 026	2, 3, 4, 8, 10, 14, 16, 17, 20, 23	200, 175, 150, 120, 110, 70, 52, 29, 16, 2
13/10/2011 05:29	21.21	-39.15	CTD 027	4, 5, 6, 8, 13, 15, 18, 20, 23	200, 175, 140, 120, 70, 52, 29, 16, 2
13/10/2011 13:58	20.39	-38.55	CTD 028	2, 3, 5, 8, 14, 16, 17, 21, 23	200, 175, 155, 135, 78, 58, 32, 18, 2
14/10/2011 05:29	18.82	-37.39	CTD 029	2, 3, 4, 6, 13, 14, 16, 19, 22	200, 175, 150, 130, 75, 56, 31, 17, 2
14/10/2011 13:59	18.01	-36.83	CTD 030	2, 3, 4, 7, 10, 14, 16, 17, 21, 23	200, 175, 150, 120, 100, 68, 50, 28, 15, 2
15/10/2011 05:26	16.47	-35.74	CTD 031	3, 4, 5, 7, 12, 14, 17, 20, 23	200, 160, 127, 107, 62, 46, 26, 14, 2
15/10/2011 13:58	15.65	-35.17	CTD 032	2, 3, 4, 7, 10, 14, 16, 17, 21, 23	200, 150, 130, 90, 70, 52, 39, 22, 12, 2
16/10/2011 05:28	13.78	-33.89	CTD 033	2, 3, 6, 8, 13, 14, 16, 19, 22	200, 128, 85, 75, 49, 36, 20, 11, 2
16/10/2011 13:59	12.75	-33.20	CTD 034	2, 4, 8, 11, 14, 16, 17, 21, 23	200, 128, 85, 65, 49, 36, 20, 11, 2
17/10/2011 05:28	10.75	-31.87	CTD 035	2, 3, 6, 9, 13, 14, 17, 20, 22	200, 106, 70, 54, 41, 30, 17, 9, 2
17/10/2011 14:03	9.65	-31.15	CTD 036	2, 4, 7, 10, 14, 16, 18, 21, 23	200, 100, 65, 50, 38, 28, 16, 9, 2
18/10/2011 05:26	7.59	-29.81	CTD 037	2, 4, 7, 9, 13, 14, 17, 19, 22	200, 115, 77, 65, 44, 33, 19, 10, 2
18/10/2011 14:00	6.52	-29.13	CTD 038	2, 3, 4, 8, 14, 16, 18, 21, 22	200, 150, 115, 75, 44, 33, 20, 11, 2

Time (GMT)	Lat (+ve N)	Lon (+ve E)	CTD	Niskin Bottle	Depth (m)
19/10/2011 05:25	4.62	-27.91	CTD 039	3, 4, 7, 8, 12, 14, 17, 19, 23	200, 160, 107, 80, 62, 46, 26, 14, 2
19/10/2011 14:00	3.68	-27.32	CTD 040	2, 4, 7, 11, 14, 16, 18, 21, 23	200, 125, 82, 74, 47, 35, 20, 11, 2
20/10/2011 05:27	1.92	-26.21	CTD 041	2, 4, 7, 9, 13, 14, 17, 20, 22	200, 128, 85, 70, 49, 36, 20, 11, 2
20/10/2011 13:29	1.03	-25.65	CTD 042	2, 4, 7, 11, 14, 14, 16, 21, 23	200, 128, 85, 76, 49, 49, 36, 11, 2
21/10/2011 05:30	-1.03	-25.00	CTD 043	2, 4, 7, 9, 13, 14, 16, 20, 22	200, 128, 90, 70, 52, 39, 22, 12, 2
22/10/2011 05:27	-4.67	-25.02	CTD 044	3, 4, 7, 9, 12, 14, 17, 20, 23	200, 125, 85, 80, 47, 35, 20, 11, 2
22/10/2011 13:30	-5.61	-25.03	CTD 045	2, 3, 4, 7, 14, 16, 18, 20, 23	200, 150, 130, 90, 52, 39, 22, 12, 2
23/10/2011 05:38	-7.70	-25.04	CTD 046	2, 3, 7, 9, 13, 14, 16, 20, 22	200, 150, 100, 94, 58, 43, 24, 13, 2
23/10/2011 13:29	-8.70	-25.05	CTD 047	2, 3, 4, 7, 14, 16, 17, 21, 23	200, 150, 130, 100, 58, 43, 24, 12, 2
24/10/2011 05:24	-10.68	-25.05	CTD 048	1, 2, 4, 7, 9, 10, 13, 15, 18	200, 160, 115, 95, 66, 49, 28, 15, 2
24/10/2011 13:31	-11.66	-25.06	CTD 049	2, 3, 4, 6, 7, 8, 14, 18, 23	200, 175, 150, 130, 130, 130, 75, 31, 2
25/10/2011 05:32	-13.58	-25.06	CTD 050	2, 3, 4, 6, 7, 8, 13, 16, 23	200, 175, 150, 130, 130, 130, 87, 36, 2
25/10/2011 10:59	-14.18	-25.07	CTD 051	5, 6, 7, 10, 11, 12, 15, 18, 23	200, 175, 142, 118, 118, 118, 68, 28, 2
26/10/2011 04:55	-15.92	-25.09	CTD 052	2, 3, 4, 5, 6, 10, 15, 17, 23	200, 175, 160, 160, 160, 118, 50, 28, 2
26/10/2011 13:32	-16.96	-25.09	CTD 053	2, 3, 5, 6, 10, 14, 16, 17, 23	200, 177, 160, 160, 118, 68, 50, 28, 2
27/10/2011 04:55	-18.52	-25.10	CTD 054	3, 4, 5, 6, 7, 10, 14, 17, 23	200, 175, 160, 160, 160, 135, 78, 33, 2
28/10/2011 04:57	-20.01	-25.09	CTD 055	2, 3, 4, 5, 7, 11, 12, 15, 19	200, 160, 160, 160, 135, 78, 58, 33, 2
28/10/2011 13:35	-21.09	-25.07	CTD 056	2, 3, 4, 5, 6, 10, 14, 17, 23	200, 175, 160, 160, 160, 135, 78, 33, 2
29/10/2011 04:56	-23.07	-25.05	CTD 057	2, 3, 6, 7, 8, 10, 13, 17, 23	200, 175, 140, 140, 140, 128, 74, 31, 2
29/10/2011 13:32	-24.11	-25.04	CTD 058	2, 3, 6, 7, 8, 15, 17, 18, 24	200, 175, 140, 140, 140, 74, 55, 31, 2
30/10/2011 04:56	-26.09	-25.02	CTD 059	2, 3, 6, 7, 10, 14, 15, 17, 23	200, 175, 140, 140, 128, 128, 74, 31, 2
30/10/2011 13:29	-27.15	-25.01	CTD 060	2, 3, 7, 8, 10, 15, 17, 18, 24	200, 175, 125, 120, 120, 73, 54, 30, 2
31/10/2011 04:56	-28.70	-25.95	CTD 061	2, 3, 7, 8, 9, 14, 15, 18, 23	300, 200, 104, 104, 104, 65, 48, 27, 2
31/10/2011 13:31	-29.37	-26.86	CTD 062	2, 3, 7, 8, 10, 15, 17, 18, 23	200, 170, 100, 90, 90, 58, 43, 24, 5
01/11/2011 04:57	-30.73	-28.73	CTD 063	2, 3, 6, 9, 14, 15, 17, 23, 23	200, 135, 90, 70, 52, 39, 22, 2, 2
01/11/2011 13:31	-31.45	-29.70	CTD 064	2, 3, 7, 9, 10, 14, 16, 17, 24	200, 175, 120, 120, 108, 68, 50, 28, 2
02/11/2011 04:59	-32.72	-31.50	CTD 065	2, 3, 4, 9, 14, 15, 17, 21, 23	200, 170, 140, 90, 53, 40, 22, 12, 2
05/11/2011 04:59	-38.22	-39.51	CTD 067	2, 3, 5, 7, 10, 14, 16, 18, 23	200, 175, 120, 70, 45, 27, 20, 11, 2
05/11/2011 13:34	-39.03	-40.74	CTD 068	2, 3, 5, 7, 12, 16, 18, 21, 24	200, 170, 120, 70, 25, 15, 11, 6, 2

Time (GMT)	Lat (+ve N)	Lon (+ve E)	CTD	Niskin Bottle	Depth (m)
06/11/2011 04:56	-40.33	-42.75	CTD 069	3, 4, 5, 10, 11, 15, 17, 20, 24	200, 150, 100, 34, 25, 20, 15, 8, 2
06/11/2011 14:32	-41.12	-43.98	CTD 070	2, 3, 4, 5, 9, 14, 17, 18, 24	200, 150, 100, 75, 40, 23, 17, 10, 3
07/11/2011 04:56	-42.31	-45.89	CTD 071	2, 3, 4, 5, 10, 14, 15, 18, 23	200, 150, 120, 85, 50, 32, 24, 14, 2
07/11/2011 14:29	-43.10	-47.17	CTD 072	2, 3, 4, 5, 9, 14, 17, 18, 24	200, 150, 100, 75, 40, 23, 17, 10, 3
08/11/2011 04:56	-44.33	-49.19	CTD 073	3, 4, 5, 10, 11, 15, 17, 20, 24	200, 150, 100, 35, 25, 20, 15, 8, 2
08/11/2011 14:34	-45.09	-50.49	CTD 074	2, 3, 4, 6, 9, 13, 17, 18, 24	200, 150, 100, 50, 30, 18, 13, 7, 3

Micronet sampling and analysis of microplankton community composition using FlowCAM

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Objectives:
To assess microplankton community composition, and relative abundance on a 50° N to 50° S transect.
Then further identify bacteria attached to the plankton. Of special interest is the Phylum *Bacteroidetes* and the identification of bacteroidetal subgroups which appear attached. These data will be compared to the regular diversity samples from the CTD casts.

Method:
An in-situ size-fractionating microplankton net (Micronet) was deployed daily to a depth of 100m where weather conditions were favourable (Windspeeds <12m/s) (See table 1). Size fractions collected were 100 – 180µm, 40 - 100µm and 20-40µm.
Samples were collected in 500ml acid washed glass bottles. Samples were analysed live and imaged using a FlowCAM apparatus within 20 minutes of sampling Data will be analysed ashore.
The remaining samples were further filtered onto 3 µm polycarbonate filters and stored at -20°C until further procedure. From selected stations fluorescence in situ hybridisations were carried out and analysed under the microscope with a x63 objective (Axioskop, Zeiss). The first preliminary results show, that *Bacteroidetes* succeed in attaching to plankton.

All data analyses will take approximately 6 months.

Tabel 3: Micronet sampling list

Date	Event No.	Time at 100 m (GMT)	Station	Latitude	Longitude
01.10.2011	D371_011	14:35	4	49°08.766 N	14°30.951 W
02.10.2011	D371_017	14:20	6	47°01.68 N	17°50.540 W
03.10.2011	D371_023	14:13	8	43°46.807 N	19°56.814 W
04.10.2011	D371_029	14:14	10	40°39.933 N	21°51.556 W
05.10.2011	D371_035	13:57	12	37°18.047 N	23°49.701 W
06.10.2011	D371_041	14:38	14	34°53.889 N	26°52.858 W
07.10.2011	D371_047	14:21	16	32°49.177 N	29°39.511 W
08.10.2011	D371_053	14:21	18	30°52.871 N	32°11.715 W
09.10.2011	D371_059	15:28	20	28°50.352 N	34°48.454 W
10.10.2011	D371_067	15:23	22	26°54.914 N	37°12.826 W
11.10.2011	D371_076	15:35	24	24°56.550 N	39°38.985 W
12.10.2011	D371_083	15:23	26	22°46.174 N	40°20.663 W
13.10.2011	D371_092	15:25	28	20°23.436 N	38°33.002 W
14.10.2011	D371_100	15:35	30	18°00.944 N	36°49.820 W
15.10.2011	D371_107	15:17	32	15°39.035 N	35°10.237 W
16.10.2011	D371_115	15:21	34	12°45.380 N	33°12.241 W
17.10.2011	D371_124	15:27	36	09°39.481 N	31°09.197 W
18.10.2011	D371_131	15:15	38	06°07.964 N	29°07.964 W
19.10.2011	D371_139	15:17	40	03°40.960 N	27°19.266 W
20.10.2011	D371_147	14:45	42	01°02.124 N	25°39.071 W
23.10.2011	D371_161	14:54	47	08°42.367 S	25°03.358 W
22.10.2011	D371_168	14:58	49	11°39.807 S	25°03.896 W
26.10.2011	D371_179	15:03	53	16°57.625 S	25°05.652 W
28.10.2011	D371_188	14:55	56	21°05.732 S	25°04.568 W
29.10.2011	D371_194	14:48	58	24°06.805 S	25°02.697 W
30.10.2011	D371_200	14:50	60	27°09.404 S	25°00.708 W
01.11.2011	D371_212	15:01	64	31°27.074 S	29°42.389 W
05.11.2011	D371_224	15:53	70	39°02.122 S	40°44.555 W
06.11.2011	D371_231	15:50	72	41°07.548 S	43°58.958 W
07.11.2011	D371_238	16:40	74	43°06.569 S	47°10.778 W
08.11.2011	D371_244	16:01	76	45°05.637 S	50°29.875 W

Effect of nutrient limitation

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Objective:
To investigate the spatial and temporal variations of the micro-molar nutrient species Nitrate, Nitrite, Phosphate and Silicate along the Atlantic Meridional Transect (AMT) cruise track, departing from Avonmouth, 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.

Methodology:
Micro-molar nutrient analysis was carried out using a 4 channel (nitrate (Brewer & Riley, 1965), nitrite (Grasshoff, K., 1976), phosphate & silicate (Kirkwood, D.S., 1989) Bran & Luebbe AAIII segmented flow, colorimetric, auto-analyser.

Clean handling techniques were employed to avoid contamination of the samples.
Water samples were taken from each of the 24 x 20 litre bottle stainless steel framed CTD / Rosette system (Seabird) into clean (acid-washed) 60ml HDPE (Nalgene) sample bottles. Subsequent nutrient analysis was complete within 1-2 hours of sampling.

CTD Samples Analysed:
A total of 74 vertical profiles were analysed along the axis of the AMT and are listed in the table below;

AMT21 - Nutrient Analysis - Station & CTD Sampling Summary

Date	Time GMT	CTD No.	Station No.	Latitude	Longitude	Depth sampled (m)
30/09/2011	3.30	1	1	50°27.23N	007°26.72W	85 x 4, 80, 75, 70, 60, 50, 40 x2, 30 x2, 25 x2, 20 x2, 15 x2, 10 x2, 2 x2.
30/09/2011	12.09	2	2	49'57.23N	009°07.56W	90 x2, 80, 75, 70, 60, 50, 40 x2, 30 x2, 25 x2, 20 x2, 15 x2, 10 x2, 2 x2
01/10/2011	4.33	3	3	49°16.866N	12°43.192W	300, 250, 200, 150, 125, 100, 75, 60, 50 x2, 40 x2, 30 x2, 20 x3, 10 x2, 5 x2, 2 x3
01/10/2011	13.05	4	4	49°08.766N	014°30.951W	300, 250, 200, 150, 125, 100, 85, 75, 60, 50 x2, 40 x2, 30 x2, 20 x3, 10 x2, 5 x2, 2 x2
02/10/2011	4.30	5	5	48°08.006N	017°06.216W	200, 150, 125, 100, 80, 70, 55 x2, 45 x3, 32 x2, 24 x2, 20, 13 x2, 7 x2, 2 x3
02/10/2011	13.03	6	6	47°01.68N	017°50.45N	300, 250, 200, 150, 125, 100, 90, 80, 70, 55 x2, 40 x2, 32 x2, 24 x2, 20, 13 x2, 7, 2 x2
03/10/2011	4.33	7	7	44°54.473N	19°13.387W	200, 150, 125,100, 83, 65, 55 x3, 40 x2, 29 x2, 22 x2, 20, 12 x2, 7, 2 x3
03/10/2011	13.01	8	8	43°46.807N	19°56.814W	300, 250, 200, 150, 100, 90, 80, 70, 55 x2, 50 x2, 29 x2, 22 x2, 20, 12 x2, 7 x2, 2 x2
04/10/2011	4.29	9	9	41°47.607N	21°10.576W	200, 150, 110, 90, 80, 65 x2, 63 x3, 50, 38 x2, 28 x2, 20, 16 x2, 9 x2, 2 x3
04/10/2011	13.02	10	10	40°39.933N	20°51.556W	300, 250, 200, 150, 110, 90, 85, 75, 65 x2, 60 x2, 50, 38 x2, 28 x2, 20, 16 x2, 9 x2, 2 x2
05/10/2011	4.32	11	11	38°30.916N	23°07.633W	300, 200, 150, 110, 90, 80, 70 x2, 60 x3, 50, 41 x2, 30 x2, 20, 17 x2, 9 x2, 2 x3
05/10/2011	12.59	12	12	37°18.047N	23°49.701W	300, 250, 200, 150, 110, 90, 87 x4, 75, 65, 50 x3, 37 x2, 20 x3, 11 x2, 2 x2
06/10/2011	4.32	13	13	35°41.519N	25°48.890W	300, 200, 175, 150, 125, 105 x2, 90, 78 x3, 61 x2, 50, 45 x2, 25 x2, 20, 14 x2, 2 x3
06/10/2011	14.13	14	14	34'53.928N	26°52.965W	300, 250, 200, 175, 150, 130, 115 x2, 105, 95, 82 x2, 75, 66 x2, 49 x2, 28, 15 x2, 3
07/10/2011	4.28	15	15	33°30.11N	28°45.212W	300, 200, 100, 84 x2, 80 x3, 49 x2, 36 x2, 20 x3, 11 x2, 2 x3
07/10/2011	12.59	16	16	32°49.177N	29°39.511W	300, 250, 175, 150, 135, 120, 103 x5, 90, 75, 58 x2, 43 x2, 24 x2, 20, 13 x2, 2 x2
08/10/2011	4.32	17	17	31°32.852N	31°19.537W	300, 200, 175,150, 125, 103 x3, 88 x3, 75, 59 x2, 44 x2, 25 x2, 20, 14, 2 x3

Date	Time GMT	CTD No.	Station No.	Latitude	Longitude	Depth sampled (m)
08/10/2011	12.59	18	18	30°52.871N	32°11.715W	200, 175, 150, 130, 115, 103 x3, 90, 75, 65, 59 x2, 44 x2, 25 x2, 20, 14 x2, 2 x2
09/10/2011	5.33	19	19	29°29.076N	33°58.307W	1000, 500, 300, 200, 170, 130, 112 x2, 102 x3, 85, 65 x2 48 x2, 27 x2, 20, 15 x2, 2 x3
09/10/2011	14.01	20	20	28°50.352N	34°48.454W	300, 200, 170, 150, 130, 120, 112 x4, 95, 75, 65 x2, 48 x2, 27 x2, 20, 15, 2 x3
10/10/2011	5.32	21	21	27°34.857N	36°22.84W	300, 200, 175, 157, 125, 105 x3, 95, 85, 75, 60 x2, 44 x2, 25 x2, 20, 14 x2, 2 x3
10/10/2011	13.58	22	22	26°54.914N	37°12.826W	300, 200, 175, 160, 150, 140, 120 x3, 100, 80, 70 x2, 52 x2, 29 x2, 20, 16 x2, 2 x3
11/10/2011	5.28	23	23	25°37.525N	38°48.245W	300, 200, 175, 150, 120 x5, 110, 90, 70 x2, 52 x2, 29 x2, 20, 16 x2, 2 x4
11/10/2011	14.01	24	24	24°56.55N	39°38.985W	300, 200, 175, 140, 130, 120 x2, 110 x3, 90, 75, 70 x2, 52 x2, 29 x2, 20, 16 x2, 2 x3
12/10/2011	5.28	25	25	23°37.727N	41°00.668W	300, 200, 175, 150, 120 x5, 110, 90, 70 x2, 52 x2, 29 x2, 20, 16 x2, 2 x4
12/10/2011	13.58	26	26	22°46.174N	40°20.663W	300, 200, 175, 150, 140, 130, 120 x2, 110 x3, 75, 70 x2, 52 x2, 29 x2,20, 16 x2, 2 x3
13/10/2011	5.29	27	27	21°12.964N	39°9.203W	1000, 500, 300, 200, 175, 140, 120 x3, 105, 85, 70 x2, 52 x2, 29 x2, 20, 16, 2 x3
13/10/2011	13.58	28	28	20°23.430N	38°33.002W	300, 200, 175, 165, 155, 145, 135 x4, 115, 95, 78 x2, 58 x2, 32 x2, 20, 18 x2, 2 x3
14/10/2011	5.29	29	29	18°49.400N	37°23.940W	200, 175, 150, 130 x5, 110,90, 75 x2, 56 x2, 31 x2, 20, 17 x2, 2 x4
14/10/2011	14.00	30	30	18°00.944N	36°49.82W	300, 200, 175, 150, 130, 120 x2, 115, 100 x2, 90, 80, 68 x2, 50 x2, 28 x2, 20, 15 x2, 2 x3
15/10/2011	5.26	31	31	16°28.70N	35°44.427W	1000, 300, 200, 160, 127, 107 x4, 90, 75, 62 x2, 46 x2, 26 x2, 20, 14 x2, 2 x4
15/10/2011	13.59	32	32	15°39.035N	35°10.237W	200, 150, 130, 110, 90 x2, 80, 70 x2, 65, 60, 52 x2, 39 x2, 22 x2, 20, 12 x2, 2 x3
16/10/2011	5.28	33	33	13°47.121N	33°53.728W	300, 200, 128, 95, 85 x2, 75 x4, 65, 49 x2, 36 x2, 20 x3, 11 2 x4
16/10/2011	13.59	34	34	12°45.38N	33°12.241W	200, 150, 128, 100, 90, 85 x2, 75, 65 x2, 60, 49 x2, 36 x2, 20 x3, 11 x2, 2 x3

Date	Time GMT	CTD No.	Station No.	Latitude	Longitude	Depth sampled (m)
17/10/2011	5.29	35	35	10°43.434N	31°52.403W	300, 200, 106, 88, 70 x2, 67, 54 x2, 47, 41 x2, 30 x2, 20, 17 x2, 9 x2, 2 x4
17/10/2011	14.04	36	36	09°39.481N	31°09.197W	300, 200, 150, 100, 80, 72, 65 x2, 50 x2, 45, 41, 38 x2, 28, 20, 16 x2, 9 x2, 2 x3
18/10/2011	5.26	37	37	07°35.594N	29°48.64W	300, 200, 150, 115, 90, 77 x2, 65 x3, 55, 44 x2, 33 x2, 20 x3, 10 x2, 2 x4
18/10/2011	14.00	38	38	06°31.346N	29°07.964W	300, 200, 150, 115, 95, 85, 75 x4, 65, 55, 44 x2, 33 x2, 20 x3, 11 x2, 2 x3
19/10/2011	5.25	39	39	04°37.593N	27°55.164W	1000, 300, 200, 160, 135, 107 x2, 80 x3, 70, 62 x2, 46 x2, 26, 20, 14 x2, 2 x3
19/10/2011	14.00	40	40	03°40.96N	27°19.260W	300, 150, 115, 110, 95, 82 x2, 77, 74 x2, 47 x2, 35 x2, 20 x3, 11 x2, 2 x3
20/10/2011	5.27	41	41	01°55.701N	26°13.207W	300, 200, 150, 128, 110, 85 x2, 70 x3, 60, 49 x2, 36 x2, 25, 20 x2, 11 x2, 2 x4
20/10/2011	13.29	42	42	01°02.124N	25°39.071W	300, 200, 150, 128, 110, 95, 85 x2, 80, 76 x2, 65, 49 x2, 36 x2, 28, 20 x2, 11 x2, 2 x3
21/10/2011	5.30	43	43	01°01.908N	25°00.271W	300, 200, 150, 128, 110, 90 x2, 70 x3, 60, 52 x2, 39 x2, 22 x2, 20, 12 x2, 2 x4
22/10/2011	5.27	44	44	04°40.598S	25°01.356W	1000,300, 200, 125, 100, 85 x2, 80 x3, 65, 47 x2, 35 x2, 20 x3, 11 x2, 2 x3
22/10/2011	13.31	45	45	05°36.91S	25°01.807W	300, 200, 150, 130, 120, 110, 90 x3, 80, 70, 60, 52 x3, 39, 22 x2, 20, 12 x2, 2 x3
23/10/2011	5.30	46	46	07°42.52S	25°02.348W	300, 200, 150, 130, 110, 100 x2, 94 x3, 75, 58 x2, 43, 24 x2, 20, 13, 2 x4
23/10/2011	14.28	47	47	08°42.367S	25°03.358W	300, 200, 150, 130, 115, 100 x3, 95, 90, 80, 70, 58 x2, 43 x2, 24 x2, 20, 12 x2, 2 x3
24/10/2011	6.15	48	48	10°41.254S	25°03.349W	200, 160, 115 x4, 95, 66 x2, 49 x2, 28 x2, 20, 15 x2, 2 x7
24/10/2011	13.31	49	49	11°39.807S	25°03.896W	300, 200, 175, 150, 140, 130 x4, 120, 110, 95, 75 x2, 56 x2, 31 x2, 17 x2, 2 x3
25/10/2011	5.33	50	50	13°34.852S	25°04.494W	300, 200, 175, 150, 140, 130 x4, 120, 105, 87 x2, 65 x2, 36 x2, 30, 20 x2, 2 x3
25/10/2011	11.00	51	51	14°11.022S	25°04.55W	1000, 500, 200, 175, 142 x3, 118 x3, 110, 68 x2, 50 x2, 28 x2, 20, 15, 2 x3
26/10/2011	4.56	52	52	15°55.524S	25°05.394W	300,200, 175, 160 x3, 145, 135, 118 x2, 105, 90, 68, 50 x2, 28 x2, 20, 15 x2, 2 x3

Date	Time GMT	CTD No.	Station No.	Latitude	Longitude	Depth sampled (m)
26/10/2011	13.32	53	53	16°57.625S	25°05.652W	300, 200, 177 x2, 160 x2, 145, 125, 118, 104, 90, 68 x2, 50 x2, 28 x2, 20, 15 x2, 2 x3
27/10/2011	4.55	54	54	18°31.502S	25°06.088W	500, 300, 200, 175, 160 x3, 147, 135 x2, 120, 100, 78 x2, 58 x2, 33 x2, 20 x3, 2 x3
28/10/2011	4.57	55	55	20°00.853S	25°05.467W	300, 200, 160 x3, 135 x2, 120, 100, 78 x2, 58 x2, 33 x2, 20 x2, 2 x7
28/10/2011	13.35	56	56	21°05.732S	25°04.568W	300, 200, 175, 160 x3, 152, 143, 135 x2, 120, 100, 78 x2, 58 x2, 33 x2, 20 x3, 2 x3
29/10/2011	4.57	57	57	23°04.584S	25°03.431W	300, 200, 175 x2, 155, 140 x3, 128 x2, 110, 90, 74 x2, 55 x2, 31 x2, 20, 17 x2, 2 x3
29/10/2011	13.31	58	58	24°06.805S	25°02.697W	300, 200, 175, 160, 150, 140 x3, 128 x2, 120, 105, 95, 74 x2, 55 x2, 31 x2, 20, 17 x2, 2 x2
30/10/2011	4.57	59	59	26°05.532S	25°01.499W	300, 200, 175 x2, 150, 140 x3, 128 x2, 110, 90, 74 x2, 55 x2, 31 x2, 20, 17 x2, 2 x3
30/10/2011	13.29	60	60	27°09.404S	25°00.708W	200, 175, 160, 140, 125 x2, 120 x3, 110, 95, 85, 73 x2, 54 x2, 30 x2, 20, 17 x2, 2 x2
31/10/2011	4.56	61	61	28°48.137S	25°57.09W	1000, 300, 200, 170, 140, 120, 104 x4, 91, 78, 65 x2, 48 x2, 27 x2, 20, 15 x2, 2 x3
31/10/2011	13.32	62	62	29°22.683S	26°51.727W	300, 200, 170, 120, 100 x2, 90 x4, 80, 70, 58 x2, 43 x2, 24 x2, 20, 13 x2, 5
01/11/2011	4.59	63	63	30°44.117S	28°43.847W	300, 200, 135, 115, 90 x2, 80, 70 x3, 65, 58, 52 x2, 39 x2, 22 x2, 20, 12 x2, 2 x3
01/11/2011	13.32	64	64	31°27.074S	29°42.389W	300, 200, 175, 150, 140, 120 x4, 108, 95, 82, 68 x2, 50 x2, 28 x2, 20, 15 x2, 2 x3
02/11/2011	4.59	65	65	32°43.554S	31°30.071W	300, 200, 170, 140, 120, 92 x2, 90 x3, 77, 65, 53 x2, 40 x2, 22 x2, 20, 12 x2, 5 x3
05/11/2011	4.58	67	67	38°13.336S	39°31.128W	300, 200, 175, 150, 120, 90, 70, 55, 45 x4, 36, 27, 20 x2, 11 x2, 6 x2, 2 x3
05/11/2011	13.35	68	68	39°02.122S	40°44.555W	300, 200, 170, 120, 90, 70, 55, 40, 30, 25 x3, 23, 20, 15 x2, 11 x2, 6 x2, 2 x3
06/11/2011	4.56	69	69	40°20.220S	42°45.284W	1000, 300, 200, 150, 100, 75, 50, 40, 34 x2, 25 x3, 20 x3, 15 x2, 8 x2, 5 x2, 2 x2
06/11/2011	14.34	70	70	41°07.548S	43°58.958W	300, 200, 150, 100, 75, 60, 50, 40 x4, 30, 23 x2, 20, 17 x2, 10 x2, 5 x2, 2 x3
07/11/2011	4.56	71	71	42°18.874S	45°53.702W	300, 200, 150, 120, 70, 56 x2, 50 x3, 40, 32 x2, 24 x2, 20, 14 x2, 7 x2, 2 x3

Date	Time GMT	CTD No.	Station No.	Latitude	Longitude	Depth sampled (m)
07/11/2011	14.29	72	72	43°06.569S	47°10.778W	300, 200, 150, 100, 84, 65, 56 x2, 45 x3, 38, 33 x2, 24 x2, 20, 14 x2, 7 x2, 2 x3
08/11/2011	4.57	73	73	44°20.123S	49°11.623W	1000, 300, 200, 150, 100, 75, 50, 40, 35 x2, 25 x3, 20 x3, 15 x2, 8 x2, 5 x2, 2 x2
08/11/2011	14.29	74	74	45°05.637S	50°29.875W	300, 200, 150, 100, 60, 50, 40, 35, 30, 25, 20, 18 x3, 13 x2, 7 x2, 5 x2, 3 x3

References:

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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

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I would like to take this opportunity to thank colleagues and the officers & crew of the RRS Discovery for making the cruise a pleasant and rewarding trip.

AMT21 Event Log

Event No.	Date	Station	Activity	CTD ID	Ship Time Start	Ship Time End	GMT Start	GMT End	Lat (+ve N) Start	Lon (+ve E)	Lat (+ve N) End	Lon (+ve E)	Comments
	29/09/2011		Depart Avonmouth		09:15		08:15						Ship time = GMT+1
	29/09/2011	D371_test	CTD	CTD_test	15:10	15:26	14:10	14:26	51.2602	-4.4482	51.2606	-4.4430	
	29/09/2011		OPTICS	OPTICS_test	15:26	15:45	14:26	14:45	51.2606	-4.4430	51.2618	-4.4394	
	30/09/2011	D371_001			04:26								On station
1	30/09/2011		CTD	CTD001	04:35	05:05	03:35	04:05	50.4536	-7.4454	50.4607	-7.4409	
2	30/09/2011		BONGO		04:45	04:55	03:45	03:55	50.4558	-7.4449	50.4582	-7.4430	
	30/09/2011				05:15		04:15						Resume passage
3	30/09/2011	D371_002	OPTICS		13:09	13:25	12:09	12:25	49.9542	-9.1256	49.9521	-9.1312	
4	30/09/2011		CTD	CTD002	13:09	13:52	12:09	12:52	49.9542	-9.1256	49.9499	-9.1415	
5	30/09/2011		OPTICS		13:25	13:52	12:25	12:52	49.9521	-9.1312	49.9499	-9.1415	
	01/10/2011		Clocks set back 1 hour		02:00		01:00						Ship time = GMT+0
	01/10/2011						04:27						On station
6	01/10/2011	D371_003	CTD	CTD003			04:33	05:33	49.2806	-12.7197	49.2937	-12.7206	
7	01/10/2011		BONGO				04:43	05:23	49.2828	-12.7203	49.2913	-12.7212	
	01/10/2011		TMFISH				05:33						Deployed port quarter
	01/10/2011						05:35						Resume passage
	01/10/2011						13:00						On station
8	01/10/2011	D371_004	CTD	CTD004			13:00	14:05	49.1466	-14.5148	49.1443	-14.5187	
9	01/10/2011		OPTICS				13:00	13:50	49.1466	-14.5148	49.1444	-14.5174	
10	01/10/2011		OPTICS				13:50	14:28	49.1444	-14.5174	49.1449	-14.5214	
11	01/10/2011		ZNET				14:28	14:51	49.1449	-14.5214	49.1472	-14.5227	
	01/10/2011						15:10						Resume passage
	02/10/2011						04:28						On station

Event No.	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
					Start	End	Start	End	Start		End		
12	02/10/2011	D371_005	CTD	CTD005			04:28	05:28	48.1328	-17.1024	48.1411	-17.1119	
13	02/10/2011		BONGO				04:36	05:15	48.1339	-17.1050	48.1386	-17.1100	
	02/10/2011						05:28						Resume passage
	02/10/2011						13:02						On station
14	02/10/2011	D371_006	CTD	CTD006			13:02	14:15	47.0282	-17.8424	47.0235	-17.8264	
15	02/10/2011		OPTICS				13:02	13:43	47.0282	-17.8424	47.0253	-17.8314	
16	02/10/2011		OPTICS				13:43	14:30	47.0253	-17.8314	47.0223	-17.8244	
17	02/10/2011		ZNET				14:15	14:30	47.0235	-17.8264	47.0223	-17.8244	
	02/10/2011						14:52						Resume passage
	03/10/2011						04:27						On station
18	03/10/2011	D371_007	CTD	CTD007			04:33	05:34	44.9079	-19.2232	44.8945	-19.2142	
19	03/10/2011		BONGO				04:44	05:22	44.9060	-19.2210	44.8977	-19.2149	
	03/10/2011						05:34						Resume passage
	03/10/2011						13:02						On station
20	03/10/2011	D371_008	CTD	CTD008			13:02	13:48	43.7796	-19.9470	43.7844	-19.9347	
21	03/10/2011		OPTICS				13:02	13:31	43.7796	-19.9470	43.7843	-19.9408	
22	03/10/2011		OPTICS				13:31	14:06	43.7843	-19.9408	43.7871	-19.9297	
23	03/10/2011		ZNET				14:06	14:25	43.7871	-19.9297	43.7882	-19.9236	
	03/10/2011		TM FISH				14:34						Deployed port quarter
	03/10/2011						14:44						Resume passage
	04/10/2011						04:26						On station

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
24	04/10/2011	D371_009	CTD	CTD009			04:28	05:20	41.7934	-21.1762	41.7960	-21.1808	
24	04/10/2011		BONGO				04:36	05:00	41.7939	-21.1771	41.7957	-21.1794	
	04/10/2011						05:20						Resume passage
	04/10/2011						10:00						On station
26	04/10/2011	D371_010	CTD	CTD010			13:00	13:50	40.6655	-21.8594	40.6666	-21.8515	
27	04/10/2011		OPTICS				13:00	13:31	40.6655	-21.8594	40.6665	-21.8550	
28	04/10/2011		OPTICS				13:31	14:00	40.6665	-21.8550	40.6668	-21.8495	
29	04/10/2011		ZNET				14:00	14:49	40.6668	-21.8495	40.6406	-21.8560	
	04/10/2011						14:35						Resume passage
	05/10/2011						04:28						On station
30	05/10/2011	D371_011	CTD	CTD011			04:32	05:25	38.5160	-23.1264	38.5086	-23.1375	
31	05/10/2011		BONGO				04:36	05:00	38.5150	-23.1273	38.5112	-23.1320	
	05/10/2011						05:25						Resume passage
	05/10/2011						13:00						On station
32	05/10/2011	D371_012	CTD	CTD012			13:00	13:42	37.3005	-23.8279	37.2996	-23.8230	
33	05/10/2011		OPTICS				13:00	13:31	37.3005	-23.8279	37.2996	-23.8245	
34	05/10/2011		OPTICS				13:31	14:01	37.2996	-23.8245	37.2992	-23.8205	
35	05/10/2011		ZNET				13:45	14:06	37.2995	-23.8225	37.2991	-23.8199	
	05/10/2011						14:20						Resume passage
	06/10/2011						04:28						On station
36	06/10/2011	D371_013	BONGO				04:29	04:55	35.6914	-25.7989	35.6961	-25.7957	

Event No.	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
					Start	End	Start	End	Start		End		
37	06/10/2011		CTD	CTD013			04:31	05:31	35.6917	-25.7987	35.7019	-25.7926	
	06/10/2011						05:31						Resume passage
	06/10/2011						13:00						On station
38	06/10/2011	D371_014	OPTICS				13:00	13:35	34.8988	-26.8829	34.8951	-26.8724	
39	06/10/2011		CTD	CTD014			13:00	14:10	34.8988	-26.8829	34.8945	-26.8659	
40	06/10/2011		OPTICS				13:35	14:04	34.8951	-26.8724	34.8942	-26.8658	
41	06/10/2011		ZNET				14:20	14:45	34.8933	-26.8622	34.8903	-26.8534	
	06/10/2011						14:55						Resume passage
	07/10/2011						04:28						On station
42	07/10/2011	D371_015	CTD	CTD015			04:28	05:21	33.5016	-28.7535	33.5152	-28.7484	
43	07/10/2011		BONGO				04:32	04:58	33.5028	-28.7535	33.5096	-28.7510	
	07/10/2011						05:21						Resume passage
	07/10/2011						13:00						On station
44	07/10/2011	D371_016	CTD	CTD016			13:00	13:58	32.8194	-29.6583	32.8086	-29.6436	
45	07/10/2011		OPTICS				13:00	13:31	32.8194	-29.6583	32.8134	-29.6504	
46	07/10/2011		OPTICS				13:31	14:08	32.8134	-29.6504	32.8060	-29.6407	
47	07/10/2011		ZNET				14:08	14:37	32.8060	-29.6407	32.7958	-29.6296	
	07/10/2011						14:37						Resume passage
	08/10/2011						04:26						On station
48	08/10/2011	D371_017	CTD	CTD017			04:32	05:29	31.5475	-31.3255	31.5548	-31.3237	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
49	08/10/2011		BONGO				04:38	05:01	31.5482	-31.3262	31.5511	-31.3254	
	08/10/2011						05:29						Resume passage
	08/10/2011						13:00						On station
50	08/10/2011	D371_018	CTD	CTD018			13:00	13:55	30.8812	-32.1953	30.8877	-32.1868	
51	08/10/2011		OPTICS				13:00	13:35	30.8812	-32.1953	30.8848	-32.1899	
52	08/10/2011		OPTICS				13:35	14:07	30.8848	-32.1899	30.8890	-32.1851	
53	08/10/2011		ZNET				14:07	14:34	30.8890	-32.1851	30.8907	-32.1801	
	08/10/2011						14:34						Resume passage
	09/10/2011		Clocks set back 1 hour										Ship time = GMT-1
	09/10/2011				04:29		05:29						On station
54	09/10/2011	D371_019	CTD	CTD019	04:33	05:10	05:33	06:10	29.4846	-33.9718	29.4799	-33.9713	1000m cast
55	09/10/2011		BONGO		04:40	05:46	05:40	06:46	29.4834	-33.9722	29.4765	-33.9667	
	09/10/2011				05:49		06:49						Resume passage
	09/10/2011				13:01		14:01						On station
56	09/10/2011	D371_020	CTD	CTD020	13:01	13:53	14:01	14:53	28.8392	-34.8075	28.8395	-34.8072	
57	09/10/2011		OPTICS		13:00	13:31	14:00	14:31	28.8392	-34.8074	28.8399	-34.8086	
58	09/10/2011		OPTICS		13:31	14:00	14:31	15:00	28.8399	-34.8086	28.8391	-34.8065	
59	09/10/2011		MP NET		14:08	14:48	15:08	15:48	28.8387	-34.8057	28.8358	-34.8012	
60	09/10/2011		Trich NET		14:15	14:39	15:15	15:39	28.8388	-34.8053	28.8361	-34.8018	
	09/10/2011				14:48		15:48						Resume passage
	10/10/2011				04:28		05:28						On station

Event No.	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
					Start	End	Start	End	Start		End		
61	10/10/2011	D371_021	CTD	CTD021	04:31	05:36	05:31	06:36	27.5812	-36.3807	27.5760	-36.3803	
62	10/10/2011		BONGO		04:37	05:03	05:37	06:03	27.5802	-36.3808	27.5787	-36.3805	
63	10/10/2011		Drift net		05:10	05:32	06:10	06:32	27.5783	-36.3806	27.5764	-36.3804	
	10/10/2011				05:36		06:36						Resume passage
	10/10/2011				12:58		13:58						On station
64	10/10/2011	D371_022	CTD	CTD022	12:58	13:53	13:58	14:53	26.9152	-37.2138	26.9184	-37.2117	
65	10/10/2011		OPTICS		12:58	13:31	13:58	14:31	26.9152	-37.2138	26.9168	-37.2127	
66	10/10/2011		OPTICS		13:31	13:59	14:31	14:59	26.9168	-37.2127	26.9188	-37.2113	
67	10/10/2011		MP NET		14:06	14:41	15:06	15:41	26.9195	-37.2104	26.9172	-37.2110	
68	10/10/2011		Trich NET		14:06	14:12	15:06	15:12	26.9195	-37.2104	26.9199	-37.2098	
	10/10/2011				14:47		15:47						Resume passage
	11/10/2011				04:28		05:28						On station
69	11/10/2011	D371_023	CTD	CTD023	04:28	05:23	05:28	06:23	25.6254	-38.8042	25.6285	-38.8034	
70	11/10/2011		BONGO		04:36	05:01	05:36	06:01	25.6258	-38.8036	25.6271	-38.8034	
71	11/10/2011		Drift net		05:12	05:30	06:12	06:30	25.6277	-38.8033	25.6286	-38.8030	
	11/10/2011				05:30		06:30						Resume passage
	11/10/2011				13:00		14:00						On station
72	11/10/2011	D371_024	CTD	CTD024	13:00	14:08	14:00	15:08	24.9424	-39.6495	24.9452	-39.6572	
73	11/10/2011		OPTICS		13:00	13:29	14:00	14:29	24.9424	-39.6495	24.9443	-39.6529	
74	11/10/2011		OPTICS		13:29	14:02	14:29	15:02	24.9443	-39.6529	24.9453	-39.6563	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
75	11/10/2011		Trich NET		14:08	14:23	15:08	15:23	24.9452	-39.6572	24.9447	-39.6587	
76	11/10/2011		MP NET		14:18	14:55	15:18	15:55	24.9448	-39.6582	24.9436	-39.6648	
	11/10/2011				14:55		15:55						Resume passage
	12/10/2011				04:28		05:28						On station
77	12/10/2011	D371_025	CTD	CTD025	04:28	05:22	05:28	06:22	23.6289	-41.0111	23.6248	-41.0105	
78	12/10/2011		BONGO		04:36	05:03	05:36	06:03	23.6280	-41.0109	23.6259	-41.0109	
79	12/10/2011		Drift net		05:12	05:30	06:12	06:30	23.6253	-41.0109	23.6247	-41.0105	
	12/10/2011				05:30		06:30						Resume passage
	12/10/2011				12:59		13:59						On station
80	12/10/2011	D371_026	CTD	CTD026	12:59	13:53	13:59	14:53	22.7696	-40.3443	22.7706	-40.3485	
81	12/10/2011		OPTICS		12:59	13:28	13:59	14:28	22.7696	-40.3443	22.7697	-40.3470	
82	12/10/2011		OPTICS		13:28	14:02	14:28	15:02	22.7697	-40.3470	22.7712	-40.3479	
83	12/10/2011		MP NET		14:02	14:40	15:02	15:40	22.7712	-40.3479	22.7762	-40.3496	
84	12/10/2011		Trich NET		14:07	14:22	15:07	15:22	22.7717	-40.3472	22.7743	-40.3471	
	12/10/2011				14:40		15:40						Resume passage
	13/10/2011				04:26		05:26						On station
85	13/10/2011	D371_027	CTD	CTD027	04:29	05:39	05:29	06:39	21.2160	-39.1534	21.2222	-39.1509	1000m cast
86	13/10/2011		BONGO		04:37	05:04	05:37	06:04	21.2166	-39.1535	21.2183	-39.1538	
87	13/10/2011		Drift net		05:09	05:30	06:09	06:30	21.2188	-39.1538	21.2213	-39.1515	
	13/10/2011				05:39		06:39						Resume passage
	13/10/2011				12:58		13:58						On station

Event No.	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
					Start	End	Start	End	Start		End		
88	13/10/2011	D371_028	CTD	CTD028	12:58	14:59	13:58	15:59	20.3905	-38.5501	20.3856	-38.5386	
89	13/10/2011		OPTICS		12:58	13:32	13:58	14:32	20.3905	-38.5501	20.3918	-38.5514	
90	13/10/2011		OPTICS		13:32	14:59	14:32	15:59	20.3918	-38.5514	20.3856	-38.5386	
91	13/10/2011		Trich NET		14:07	14:21	15:07	15:21	20.3949	-38.5520	20.3958	-38.5520	
92	13/10/2011		MP NET		14:07	14:47	15:07	15:47	20.3949	-38.5520	20.3974	-38.5498	
	13/10/2011				14:47		15:47						Resume passage
	14/10/2011				04:26		05:26						On station
93	14/10/2011	D371_029	CTD	CTD029	04:29	05:23	05:29	06:23	18.8234	-37.3989	18.8254	-37.3988	
94	14/10/2011		BONGO		04:33	04:56	05:33	05:56	18.8232	-37.3993	18.8230	-37.3995	
95	14/10/2011		Drift net		05:04	05:20	06:04	06:20	18.8235	-37.3993	18.8251	-37.3987	
	14/10/2011				05:23		06:23						Resume passage
	14/10/2011				12:59		13:59						On station
96	14/10/2011	D371_030	CTD	CTD030	12:59		13:59	01:00	18.0157	-36.8301	19.3354	-37.7749	
97	14/10/2011		OPTICS		12:59	13:30	13:59	14:30	18.0157	-36.8301	18.0169	-36.8336	
98	14/10/2011		OPTICS		13:30	14:01	14:30	15:01	18.0169	-36.8336	18.0196	-36.8346	
99	14/10/2011		Trich NET		14:10	14:27	15:10	15:27	18.0201	-36.8351	18.0208	-36.8361	
100	14/10/2011		MP NET		14:18	14:54	15:18	15:54	18.0204	-36.8355	18.0230	-36.8384	
	14/10/2011				14:54		15:54						Resume passage
	15/10/2011				04:25		05:25						On station
101	15/10/2011	D371_031	CTD	CTD031	04:26	05:41	05:26	06:41	16.4784	-35.7403	16.4889	-35.7464	1000m cast

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
102	15/10/2011		BONGO		04:33	05:00	05:33	06:00	16.4788	-35.7415	16.4833	-35.7431	
103	15/10/2011		Drift net		05:10	05:27	06:10	06:27	16.4843	-35.7437	16.4867	-35.7447	
	15/10/2011				05:41		06:41						Resume passage
	15/10/2011				12:58		13:58						On station
104	15/10/2011	D371_032	CTD	CTD032	12:58	13:48	13:58	14:48	15.6502	-35.1705	15.6572	-35.1759	
105	15/10/2011		OPTICS		12:58	13:30	13:58	14:30	15.6502	-35.1705	15.6553	-35.1734	
106	15/10/2011		OPTICS		13:30	14:00	14:30	15:00	15.6553	-35.1734	15.6583	-35.1773	
107	15/10/2011		MP NET		14:00	14:44	15:00	15:44	15.6583	-35.1773	15.6627	-35.1825	
108	15/10/2011		Trich NET		14:07	14:24	15:07	15:24	15.6587	-35.1782	15.6608	-35.1794	
	15/10/2011				14:44		15:44						Resume passage
	16/10/2011				04:25		05:25						On station
109	16/10/2011	D371_033	CTD	CTD033	04:28	05:21	05:28	06:21	13.7853	-33.8955	13.7886	-33.8926	
110	16/10/2011		BONGO		04:36	05:01	05:36	06:01	13.7858	-33.8947	13.7869	-33.8945	
111	16/10/2011		Drift net		05:07	05:27	06:07	06:27	13.7875	-33.8941	13.7892	-33.8919	
	16/10/2011				05:27		06:27						Resume passage
	16/10/2011				12:59		13:59						On station
112	16/10/2011	D371_034	CTD	CTD034	12:59	13:55	13:59	14:55	12.7563	-33.2042	12.7548	-33.2017	
113	16/10/2011		OPTICS		12:59	13:31	13:59	14:31	12.7563	-33.2042	12.7559	-33.2021	
114	16/10/2011		OPTICS		13:31	13:55	14:31	14:55	12.7559	-33.2021	12.7548	-33.2017	
115	16/10/2011		MP NET		14:05	14:47	15:05	15:47	12.7542	-33.2014	12.7560	-33.2036	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
116	16/10/2011		Trich NET		14:05	14:27	15:05	15:27	12.7542	-33.2014	12.7561	-33.2001	
	16/10/2011				14:47		15:47						Resume passage
	17/10/2011				04:24		05:24						On station
117	17/10/2011	D371_035	CTD	CTD035	04:28	05:20	05:28	06:20	10.7575	-31.8731	10.7564	-31.8814	
118	17/10/2011		BONGO		04:36	05:05	05:36	06:05	10.7562	-31.8742	10.7562	-31.8784	
119	17/10/2011		Drift net		05:10	05:28	06:10	06:28	10.7566	-31.8793	10.7560	-31.8830	
	17/10/2011				05:28		06:28						Resume passage
	17/10/2011				13:03		14:03						On station
120	17/10/2011	D371_036	OPTICS		13:04	13:34	14:04	14:34	9.6581	-31.1534	9.6543	-31.1477	
121	17/10/2011		CTD	CTD036	13:03	13:34	14:03	14:34	9.6583	-31.1536	9.6543	-31.1477	
122	17/10/2011		OPTICS		13:34	14:04	14:34	15:04	9.6543	-31.1477	9.6480	-31.1418	
123	17/10/2011		Trich NET		14:13	14:27	15:13	15:27	9.6460	-31.1405	9.6431	-31.1377	
124	17/10/2011		MP NET		14:13	14:50	15:13	15:50	9.6460	-31.1405	9.6355	-31.1374	
	17/10/2011				14:50		15:50						Resume passage
	18/10/2011				04:23		05:23						On station
125	18/10/2011	D371_037	CTD	CTD037	04:26	05:22	05:26	06:22	7.5900	-29.8106	7.5869	-29.8047	
126	18/10/2011		BONGO		04:31	05:55	05:31	06:55	7.5896	-29.8094	7.5251	-29.7632	
127	18/10/2011		Drift net		05:03	05:22	06:03	06:22	7.5879	-29.8069	7.5869	-29.8047	
	18/10/2011				05:22		06:22						Resume passage
	18/10/2011				13:00		14:00						On station
128	18/10/2011	D371_038	CTD	CTD038	13:00	13:51	14:00	14:51	6.5225	-29.1328	6.5195	-29.1244	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
129	18/10/2011		OPTICS		13:00	13:29	14:00	14:29	6.5225	-29.1328	6.5209	-29.1292	
130	18/10/2011		OPTICS		13:29	13:59	14:29	14:59	6.5209	-29.1292	6.5196	-29.1230	
131	18/10/2011		MP NET		13:59	14:26	14:59	15:26	6.5196	-29.1230	6.5185	-29.1168	
132	18/10/2011		Trich NET		14:08	14:38	15:08	15:38	6.5194	-29.1213	6.5172	-29.1132	
	18/10/2011				14:38		15:38						Resume passage
	19/10/2011				04:25		05:25						On station
133	19/10/2011	D371_039	CTD	CTD039	04:25	05:33	05:25	06:33	4.6265	-27.9195	4.6273	-27.9124	
134	19/10/2011		BONGO		04:36	04:58	05:36	05:58	4.6270	-27.9185	4.6270	-27.9159	
135	19/10/2011		Drift net		05:04	05:25	06:04	06:25	4.6273	-27.9154	4.6275	-27.9135	
	19/10/2011				05:33		06:33						Resume passage
	19/10/2011				13:00		14:00						On station
136	19/10/2011	D371_040	CTD	CTD040	13:00	13:50	14:00	14:50	3.6826	-27.3212	3.6876	-27.3127	
137	19/10/2011		OPTICS		13:00	13:30	14:00	14:30	3.6826	-27.3212	3.6859	-27.3170	
138	19/10/2011		OPTICS		13:30	14:02	14:30	15:02	3.6859	-27.3170	3.6882	-27.3096	
139	19/10/2011		MP NET		14:02	14:45	15:02	15:45	3.6882	-27.3096	3.6915	-27.2988	
140	19/10/2011		Trich NET		14:06	14:21	15:06	15:21	3.6888	-27.3087	3.6897	-27.3049	
	19/10/2011				14:45		15:45						Resume passage
	20/10/2011				04:27		05:27						On station
141	20/10/2011	D371_041	CTD	CTD041	04:27	05:18	05:27	06:18	1.9283	-26.2199	1.9311	-26.2249	
142	20/10/2011		BONGO		04:36	05:00	05:36	06:00	1.9289	-26.2218	1.9299	-26.2234	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
143	20/10/2011		Drift net		05:05	05:26	06:05	06:26	1.9302	-26.2239	1.9317	-26.2255	
	20/10/2011				05:26		06:26						Resume passage
	20/10/2011				12:29		13:29						On station
144	20/10/2011	D371_042	CTD	CTD042	12:29		13:29	01:00	1.0355	-25.6512	2.4841	-26.5662	
145	20/10/2011		OPTICS		12:29	13:00	13:29	14:00	1.0355	-25.6512	1.0341	-25.6509	
146	20/10/2011		OPTICS		13:00	13:35	14:00	14:35	1.0341	-25.6509	1.0332	-25.6496	
147	20/10/2011		MP NET		13:31	14:05	14:31	15:05	1.0334	-25.6500	1.0328	-25.6468	
148	20/10/2011		Trich NET		13:44	13:58	14:44	14:58	1.0328	-25.6486	1.0320	-25.6467	
	20/10/2011				14:05		15:05						Resume passage
	21/10/2011				04:24		05:24						On station
149	21/10/2011	D371_043	CTD	CTD043	04:30	05:22	05:30	06:22	-1.0318	-25.0045	-1.0312	-25.0009	
150	21/10/2011		BONGO		04:36	05:03	05:36	06:03	-1.0319	-25.0046	-1.0321	-25.0028	
151	21/10/2011		Drift net		05:10	05:27	06:10	06:27	-1.0318	-25.0022	-1.0307	-25.0006	
	21/10/2011				05:27		06:27						Resume passage
	22/10/2011				04:22		05:22						On station
152	22/10/2011	D371_044	CTD	CTD044	04:27	05:33	05:27	06:33	-4.6766	-25.0226	-4.6743	-25.0210	1000m cast
153	22/10/2011		BONGO		04:36	04:58	05:36	05:58	-4.6765	-25.0226	-4.6757	-25.0221	
	22/10/2011				05:33		06:33						Resume passage
	22/10/2011				12:30		13:30						On station
154	22/10/2011	D371_045	CTD	CTD045	12:30	13:27	13:30	14:27	-5.6156	-25.0301	-5.6059	-25.0241	
155	22/10/2011		OPTICS		12:30	13:00	13:30	14:00	-5.6156	-25.0301	-5.6103	-25.0275	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
156	22/10/2011		OPTICS		13:01	13:31	14:01	14:31	-5.6102	-25.0275	-5.6053	-25.0235	
	22/10/2011				13:31		14:31						Resume passage
	23/10/2011				04:27		05:27						On station
157	23/10/2011	D371_046	CTD	CTD046	04:30	05:27	05:30	06:27	-7.7087	-25.0390	-7.7038	-25.0410	
158	23/10/2011		BONGO		04:38	05:01	05:38	06:01	-7.7085	-25.0406	-7.7076	-25.0412	
	23/10/2011				05:29		06:29						Resume passage
	23/10/2011				12:29		13:29						On station
159	23/10/2011	D371_047	CTD	CTD047	12:29	13:28	13:29	14:28	-8.7061	-25.0559	-8.7037	-25.0558	
160	23/10/2011		OPTICS		12:29	13:01	13:29	14:01	-8.7061	-25.0559	-8.7047	-25.0553	
161	23/10/2011		OPTICS		13:01	13:31	14:01	14:31	-8.7047	-25.0553	-8.7035	-25.0557	
162	23/10/2011		MP NET		13:37	14:15	14:37	15:15	-8.7033	-25.0556	-8.6993	-25.0533	
	23/10/2011				14:15		15:15						Resume passage
	24/10/2011				04:24		05:24						On station
163	24/10/2011	D371_048	CTD	CTD048	04:24	05:15	05:24	06:15	-10.6875	-25.0559	-10.6880	-25.0526	
164	24/10/2011		BONGO		04:33	04:59	05:33	05:59	-10.6878	-25.0552	-10.6883	-25.0540	
	24/10/2011				05:15		06:15						Resume passage
	24/10/2011				12:31		13:31						On station
165	24/10/2011	D371_049	CTD	CTD049	12:31	13:33	13:31	14:33	-11.6635	-25.0650	-11.6592	-25.0662	
166	24/10/2011		OPTICS		12:31	13:05	13:31	14:05	-11.6635	-25.0650	-11.6611	-25.0651	
167	24/10/2011		OPTICS		13:05	13:43	14:05	14:43	-11.6611	-25.0651	-11.6582	-25.0652	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
168	24/10/2011		MP NET		13:43	14:19	14:43	15:19	-11.6582	-25.0652	-11.6511	-25.0627	
	24/10/2011				14:19		15:19						Resume passage
	25/10/2011				04:24		05:24						On station
169	25/10/2011	D371_050	CTD	CTD050	04:32	05:31	05:32	06:31	-13.5808	-25.0684	-13.5816	-25.0664	
170	25/10/2011		BONGO		04:42	05:16	05:42	06:16	-13.5809	-25.0681	-13.5814	-25.0664	
	25/10/2011				05:31		06:31						Resume passage
	25/10/2011				09:56		10:56						On station
171	25/10/2011	D371_051	CTD	CTD051	09:59		10:59	01:00	-14.1835	-25.0758	-12.9638	-25.0694	5100m cast
172	25/10/2011		OPTICS		12:29	13:02	13:29	14:02	-14.1786	-25.0751	-14.1769	-25.0763	
173	25/10/2011		OPTICS		13:02	13:29	14:02	14:29	-14.1769	-25.0763	-14.1753	-25.0769	
	25/10/2011				15:25		16:25						Resume passage
	26/10/2011				03:55		04:55						On station
174	26/10/2011	D371_052	CTD	CTD052	03:55	04:55	04:55	05:55	-15.9255	-25.0900	-15.9239	-25.0889	
175	26/10/2011		BONGO		04:05	04:29	05:05	05:29	-15.9254	-25.0890	-15.9245	-25.0892	
	26/10/2011				04:55		05:55						Resume passage
	26/10/2011				12:28		13:28						On station
176	26/10/2011		OPTICS		12:28	13:05	13:28	14:05	-16.9607	-25.0947	-16.9572	-25.0923	
177	26/10/2011	D371_053	CTD	CTD053	12:32	13:37	13:32	14:37	-16.9605	-25.0943	-16.9542	-25.0912	
178	26/10/2011		OPTICS		13:05	13:42	14:05	14:42	-16.9572	-25.0923	-16.9538	-25.0906	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
179	26/10/2011		MP NET		13:47	14:22	14:47	15:22	-16.9530	-25.0902	-16.9460	-25.0848	
	26/10/2011				14:22		15:22						Resume passage
	27/10/2011				01:30		02:30						On station
180	27/10/2011	D371_054	CTD	CTD054	03:55	04:53	04:55	05:53	-18.5250	-25.1013	-18.5254	-25.1025	
181	27/10/2011		BONGO		05:03	05:40	06:03	06:40	-18.5252	-25.1026	-18.5232	-25.1033	
	27/10/2011		SAG MOORING RELEASE		06:27		07:27		-18.5250	-25.1083			
	27/10/2011		MOORING SEARCH		11:38	12:40	12:38	13:40	-18.5292	-25.1238	-18.5431	-25.1030	
182	27/10/2011		SAG MOORING DEPLOYMENT		13:06	15:05	14:06	16:05	-18.5294	-25.1065	-18.5325	-25.0754	
	27/10/2011				17:30		18:30		-18.5293	-25.0734			PES fish recovered
	27/10/2011				17:40		18:40						Resume passage
	28/10/2011				03:57		04:57						On station
183	28/10/2011	D371_055	CTD	CTD055	03:57	04:54	04:57	05:54	-20.0143	-25.0912	-20.0081	-25.0896	
184	28/10/2011		BONGO		04:05	04:35	05:05	05:35	-20.0139	-25.0904	-20.0114	-25.0889	
	28/10/2011				04:54		05:54						Resume passage
	28/10/2011				12:35		13:35						On station
185	28/10/2011	D371_056	CTD	CTD056	12:35	13:28	13:35	14:28	-21.0956	-25.0761	-21.0903	-25.0776	
186	28/10/2011		OPTICS		12:40	13:15	13:40	14:15	-21.0950	-25.0761	-21.0914	-25.0775	
187	28/10/2011		OPTICS		13:15	13:45	14:15	14:45	-21.0914	-25.0775	-21.0884	-25.0772	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
188	28/10/2011		MP NET		13:38	14:12	14:38	15:12	-21.0893	-25.0777	-21.0840	-25.0774	
	28/10/2011				14:12		15:12						Resume passage
	29/10/2011				03:56		04:56						On station
189	29/10/2011	D371_057	CTD	CTD057	03:56	04:49	04:56	05:49	-23.0766	-25.0574	-23.0695	-25.0538	
190	29/10/2011		BONGO		04:05	04:30	05:05	05:30	-23.0753	-25.0565	-23.0722	-25.0553	
	29/10/2011				04:49		05:49						Resume passage
	29/10/2011				12:32		13:32						On station
191	29/10/2011	D371_058	CTD	CTD058	12:32	13:22	13:32	14:22	-24.1134	-25.0450	-24.1101	-25.0426	
192	29/10/2011		OPTICS		12:32	13:00	13:32	14:00	-24.1134	-25.0450	-24.1118	-25.0435	
193	29/10/2011		OPTICS		13:00	13:29	14:00	14:29	-24.1118	-25.0435	-24.1096	-25.0429	
194	29/10/2011		MP NET		13:32	14:03	14:32	15:03	-24.1092	-25.0428	-24.1037	-25.0361	
	29/10/2011				14:03		15:03						Resume passage
	30/10/2011				03:56		04:56						On station
195	30/10/2011	D371_059	CTD	CTD059	03:56	04:48	04:56	05:48	-26.0923	-25.0249	-26.0882	-25.0258	
196	30/10/2011		BONGO		04:10	04:34	05:10	05:34	-26.0912	-25.0251	-26.0893	-25.0252	
	30/10/2011				04:48		05:48						Resume passage
	30/10/2011				12:29		13:29						On station
197	30/10/2011	D371_060	OPTICS		12:29	13:02	13:29	14:02	-27.1568	-25.0120	-27.1581	-25.0082	
198	30/10/2011		CTD	CTD060	12:29	13:27	13:29	14:27	-27.1568	-25.0120	-27.1589	-25.0043	
199	30/10/2011		OPTICS		13:02	13:34	14:02	14:34	-27.1581	-25.0082	-27.1590	-25.0035	
200	30/10/2011		MP NET		13:34	14:05	14:34	15:05	-27.1590	-25.0035	-27.1553	-24.9994	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
201	30/10/2011		ARGO FLOAT RELEASE		14:10		15:10		-27.1545	-24.9979			
	30/10/2011				14:10		15:10						Resume passage
	31/10/2011				03:56		04:56						On station
202	31/10/2011	D371_061	CTD	CTD061	03:56	05:12	04:56	06:12	-28.7023	-25.9512	-28.6983	-25.9478	
203	31/10/2011		BONGO		04:02	04:32	05:02	05:32	-28.7022	-25.9507	-28.7004	-25.9488	
	31/10/2011				05:12		06:12						Resume passage
	31/10/2011				12:31		13:31						On station
204	31/10/2011	D371_062	CTD	CTD062	12:31	13:41	13:31	14:41	-29.3780	-26.8624	-29.3755	-26.8546	
205	31/10/2011		OPTICS		12:31	13:00	13:31	14:00	-29.3780	-26.8624	-29.3777	-26.8593	
206	31/10/2011		OPTICS		13:00	13:27	14:00	14:27	-29.3777	-26.8593	-29.3764	-26.8561	
	31/10/2011				13:41		14:41						Resume passage
	01/11/2011				03:57		04:57						On station
207	01/11/2011	D371_063	CTD	CTD063	03:57	04:56	04:57	05:56	-30.7351	-28.7300	-30.7354	-28.7438	
208	01/11/2011		BONGO		04:07	04:32	05:07	05:32	-30.7356	-28.7325	-30.7355	-28.7386	
	01/11/2011				04:56		05:56						Resume passage
	01/11/2011				12:31		13:31						On station
209	01/11/2011	D371_064	CTD	CTD064	12:31	13:37	13:31	14:37	-31.4513	-29.7066	-31.4466	-29.6987	
210	01/11/2011		OPTICS		12:31	13:04	13:31	14:04	-31.4513	-29.7066	-31.4496	-29.7027	
211	01/11/2011		OPTICS		13:04	13:37	14:04	14:37	-31.4496	-29.7027	-31.4466	-29.6987	
212	01/11/2011		MP NET		13:45	14:14	14:45	15:14	-31.4457	-29.6977	-31.4423	-29.6901	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
213	01/11/2011		ARGO FLOAT RELEASE		14:20		15:20		-31.4419	-29.6878			
	01/11/2011				14:20		15:20						Resume passage
	02/11/2011				03:59		04:59						On station
214	02/11/2011	D371_065	CTD	CTD065	03:59	05:14	04:59	06:14	-32.7258	-31.5015	-32.7264	-31.4842	
215	02/11/2011		OPTICS		04:10	04:43	05:10	05:43	-32.7258	-31.4993	-32.7264	-31.4922	
	02/11/2011				05:14		06:14						Resume passage
	02/11/2011				12:35		13:35						On station
216	02/11/2011	D371_066	CTD	CTD066	12:35		13:35		-33.3638	-32.4134			CTD cancelled
	03/11/2011				04:00		05:00						Station cancelled
217	03/11/2011	D371_068	ARGO FLOAT RELEASE		12:26		13:26		-35.3597	-35.2653			
	04/11/2011				04:00		05:00						Station cancelled
218	04/11/2011	D371_069	ARGO FLOAT RELEASE		12:29		13:29		-36.9774	-37.6505			
	05/11/2011				03:59		04:59						On station
219	05/11/2011	D371_070	CTD	CTD067	03:59	05:00	04:59	06:00	-38.2223	-39.5188	-38.2184	-39.5207	
220	05/11/2011		BONGO		04:11	04:35	05:11	05:35	-38.2221	-39.5197	-38.2204	-39.5203	
	05/11/2011				05:00		06:00						Resume passage
	05/11/2011				12:34		13:34						On station
221	05/11/2011	D371_071	CTD	CTD068	12:34	13:29	13:34	14:29	-39.0352	-40.7422	-39.0468	-40.7476	
222	05/11/2011		OPTICS		12:34	13:06	13:34	14:06	-39.0352	-40.7422	-39.0412	-40.7448	
223	05/11/2011		OPTICS		13:06	13:37	14:06	14:37	-39.0412	-40.7448	-39.0486	-40.7483	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
224	05/11/2011		MP NET		13:37	14:01	14:37	15:01	-39.0486	-40.7483	-39.0504	-40.7492	
225	05/11/2011		ARGO FLOAT RELEASE		14:10		15:10		-39.0500	-40.7487			
	05/11/2011				14:10		15:10						Resume passage
	06/11/2011		Clocks set back 1 hour		02:00		03:00						Ship time = GMT-2
	06/11/2011				02:56		04:56						On station
226	06/11/2011	D371_072	CTD	CTD069	02:56	04:08	04:56	06:08	-40.3370	-42.7547	-40.3398	-42.7704	
227	06/11/2011		BONGO		03:07	03:32	05:07	05:32	-40.3376	-42.7568	-40.3375	-42.7615	
	06/11/2011				04:08		06:08						Resume passage
	06/11/2011				12:32		14:32						On station
228	06/11/2011	D371_073	OPTICS		12:32	13:01	14:32	15:01	-41.1244	-43.9836	-41.1250	-43.9757	
229	06/11/2011		CTD	CTD070	12:32	13:30	14:32	15:30	-41.1244	-43.9836	-41.1273	-43.9692	
230	06/11/2011		OPTICS		13:01	13:30	15:01	15:30	-41.1250	-43.9757	-41.1273	-43.9692	
231	06/11/2011		MP NET		13:38	14:01	15:38	16:01	-41.1278	-43.9677	-41.1264	-43.9629	
232	06/11/2011		ARGO FLOAT RELEASE		14:11		16:11		-41.1254	-43.9609			
	06/11/2011				14:11		16:11						Resume passage
	07/11/2011				02:56		04:56						On station
233	07/11/2011	D371_074	CTD	CTD071	02:56	04:00	04:56	06:00	-42.3146	-45.8950	-42.3089	-45.8940	
234	07/11/2011		BONGO		03:10	03:34	05:10	05:34	-42.3132	-45.8950	-42.3111	-45.8952	
	07/11/2011				04:00		06:00						Resume passage
	07/11/2011				12:29		14:29						On station
235	07/11/2011	D371_075	CTD	CTD072	12:29	13:20	14:29	15:20	-43.1095	-47.1797	-43.1107	-47.1794	

Event	Date	Station	Activity	CTD ID	Ship Time		GMT		Lat (+ve N)	Lon (+ve E)	Lat (+ve N)	Lon (+ve E)	Comments
No.					Start	End	Start	End	Start		End		
236	07/11/2011		OPTICS		12:31	13:02	14:31	15:02	-43.1096	-47.1795	-43.1103	-47.1788	
237	07/11/2011		OPTICS		13:02	13:31	15:02	15:31	-43.1103	-47.1788	-43.1108	-47.1789	
238	07/11/2011		MP NET		13:31	14:00	15:31	16:00	-43.1108	-47.1789	-43.1081	-47.1732	
	07/11/2011				14:00		16:00						Resume passage
	08/11/2011				02:56		04:56						On station
239	08/11/2011	D371_076	CTD	CTD073	02:56	04:14	04:56	06:14	-44.3336	-49.1937	-44.3308	-49.1898	
240	08/11/2011		BONGO		03:10	03:34	05:10	05:34	-44.3327	-49.1931	-44.3322	-49.1919	
	08/11/2011				04:14		06:14						Resume passage
	08/11/2011				12:34		14:34						On station
241	08/11/2011	D371_077	CTD	CTD074	12:34	13:29	14:34	15:29	-45.0951	-50.4978	-45.1050	-50.5022	
242	08/11/2011		OPTICS		12:34	13:06	14:34	15:06	-45.0951	-50.4978	-45.1001	-50.4990	
243	08/11/2011		OPTICS		13:06	13:37	15:06	15:37	-45.1001	-50.4990	-45.1066	-50.5030	
244	08/11/2011		MP NET		13:37	14:01	15:37	16:01	-45.1066	-50.5030	-45.1108	-50.5065	
	08/11/2011				14:10		16:10						Resume passage

Appendix 1: AMT21 Underway Sample Log

Sample ID	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG salinity	SST - hull (deg. C)	Trans (volts)	Fluor (volts)	Bench salinity		Chl-a (ug/l)	Comments
								ID	Reading		
	30/09/2011 08:00	50.2335	-8.1920								Underway switched on
AAA	30/09/2011 15:04	49.8226	-9.5823	35.4021	15.389	4.535	0.180	121	35.3954	0.48	
AAB	30/09/2011 18:59	49.5664	-10.4438	35.5698	15.344	4.494	0.471	122	35.5579	0.46	
AAC	01/10/2011 04:07	49.2785	-12.6719	35.5852	15.514	4.529	0.263	123	35.6471	0.54	
AAD	01/10/2011 08:02	49.2358	-13.2660	35.6875	15.785	4.483	0.401	124	35.6763	0.60	
AAE	01/10/2011 12:11	49.1576	-14.3369	35.4140	15.307	4.530	0.277	125	35.6330	0.46	
AAF	01/10/2011 16:00	49.1293	-14.7264	35.6129	14.852	4.427	0.454	126	35.6059	0.80	
AAG	01/10/2011 20:00	49.0543	-15.7543	35.6399	15.204	4.468	0.441	127	35.6296	0.69	
AAH	02/10/2011 04:04	48.1697	-17.0710	35.7638	16.886	4.525	0.340	128	35.7523	0.65	
AAI	02/10/2011 08:01	47.7742	-17.3400	35.7039	16.629	4.511	0.410	129	35.6939	0.73	
AAJ	02/10/2011 12:01	47.1700	-17.7467	35.6696	16.655	4.486	0.320	130	35.6615	0.68	
AAK	02/10/2011 16:02	46.8568	-17.9556	35.7638	17.458	4.501	0.232	131	35.7502	0.63	
AAL	02/10/2011 19:58	46.2102	-18.3835	35.7524	17.710	4.505	0.228	132	35.7295	0.50	
AAM	03/10/2011 04:05	44.9459	-19.2049	35.8376	18.680	4.565	0.143	133	35.8293	0.30	
AAN	03/10/2011 07:59	44.5243	-19.4750	35.8295	19.240	4.569	0.133	134	35.8155	0.35	
	03/10/2011 13:04										uway off for TSG/fluor/trans cleaning
	03/10/2011 13:13										transmissometer open in air
	03/10/2011 13:14										transmissometer dark blank
	03/10/2011 13:26										uway back on for TSG/fluor/trans
AAO	03/10/2011 12:37	43.8156	-19.9242	35.6630	19.233	4.559	0.132	135	35.8314	0.28	
AAP	03/10/2011 16:01	43.6094	-20.0539	35.7837	19.497	4.589	0.098	136	35.7853	0.28	
AAQ	03/10/2011 19:58	43.0323	-20.4152	36.0069	20.020	4.600	0.097	137	35.9858	0.19	
AAR	04/10/2011 04:09	41.8172	-21.1637	36.1908	20.827	4.587	0.088	138	36.1781	0.16	
AAS	04/10/2011 08:55	41.2616	-21.5010	36.1459	20.984	4.618	0.083	139	36.1432	0.18	
AAT	04/10/2011 12:00	40.7911	-21.7849	36.1953	21.030	4.602	0.077	140	36.1848	0.15	
AAV	04/10/2011 16:01	40.4753	-21.9737	36.1750	20.972	4.606	0.085	141	36.1667	0.16	

Sample ID	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG salinity	SST - hull (deg. C)	Trans (volts)	Fluor (volts)	Bench salinity		Chl-a (ug/l)	Comments
								ID	Reading		
AAW	04/10/2011 20:01	39.8746	-22.3310	36.2189	21.426	4.588	0.084	142	36.1843	0.10	
AAX	05/10/2011 04:14	38.5333	-23.1182	35.9834	21.222	4.610	0.080	143	35.9749	0.15	
AAY	05/10/2011 08:10	38.0542	-23.3955	36.5545	22.241	4.620	0.082	144	36.5470		chl-a samples lost
AAZ	05/10/2011 16:27	36.9840	-24.0211	36.2640	22.091	4.595	0.089	97	36.3042		chl-a samples lost
ABA	05/10/2011 20:10	36.5721	-24.5928	36.6331	23.001	4.608	0.078	98	36.6161		chl-a samples lost
ABC	06/10/2011 04:16	35.6926	-25.8004	36.6754	23.421	4.612	0.077	99	36.6613		chl-a samples lost
ABD	06/10/2011 07:58	35.4362	-26.1512	36.6180	22.794	4.616	0.081	100	36.6136	0.18	
ABE	06/10/2011 11:46	35.0137	-26.7253	36.5595	23.667	4.615	0.075	101	36.5447	0.15	
	06/10/2011 13:51										uway off for TSG/fluor/trans cleaning
	06/10/2011 13:55										transmissometer open in air
	06/10/2011 13:57										uway back on for TSG/fluor/trans
ABF	06/10/2011 16:03	34.7969	-27.0187	36.6038	23.884	4.615	0.077	102	36.5923	0.13	
ABG	06/10/2011 20:02	34.3768	-27.5848	36.5136	23.934	4.613	0.077	103	36.5007	0.12	
ABH	07/10/2011 04:01	33.5314	-28.7160	36.4774	23.773	4.621	0.077	104	36.4626	0.12	
ABI	07/10/2011 08:00	33.2772	-29.0535	36.5039	23.914	4.621	0.078	105	36.4880	0.12	
ABJ	07/10/2011 12:04	32.8929	-29.5626	36.6341	23.857	4.619	0.078	106	36.6189	0.12	
ABK	07/10/2011 15:33	32.7210	-29.7412	36.8168	24.064	4.616	0.077	107	36.8088	0.11	
ABL	07/10/2011 20:03	32.3262	-30.3091	36.9874	24.159	4.611	0.077	108	36.9550	0.09	
ABM	08/10/2011 04:10	31.5621	-31.3075	37.0422	24.497	4.616	0.081	109	37.0269	0.14	
ABN	08/10/2011 08:04	31.3237	-31.6178	37.0184	24.607	4.619	0.079	110	37.0098	0.14	
ABO	08/10/2011 11:56	30.9621	-32.0867	37.0013	24.737	4.613	0.077	111	36.9762	0.16	
	08/10/2011 13:15										uway off for TSG/fluor/trans cleaning
	08/10/2011 13:18										transmissometer open in air
	08/10/2011 13:21										uway back on for TSG/fluor/trans
ABP	08/10/2011 15:47	30.7825	-32.3190	37.0227	25.219	4.602	0.084	112	37.0053	0.14	
ABQ	08/10/2011 20:11	30.3659	-32.8554	37.1593	24.906	4.602	0.085	113	37.1491	0.17	
ABR	09/10/2011 05:12	29.5086	-33.9526	36.9906	25.140	4.611	0.095	114	36.9832	0.11	

Sample ID	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG salinity	SST - hull (deg. C)	Trans (volts)	Fluor (volts)	Bench salinity		Chl-a (ug/l)	Comments
								ID	Reading		
ABS	09/10/2011 09:06	29.2750	-34.2322	37.2076	25.125	4.611	0.081	115	37.1914	0.13	
ABT	09/10/2011 13:36	28.8606	-34.7758	37.0657	25.786	4.603	0.073	116	37.0512	0.10	
ABU	09/10/2011 17:04	28.7263	-34.9456	37.0174	25.919	4.607	0.076	117	36.9999	0.08	
ABV	09/10/2011 20:54	28.3666	-35.3995	37.2550	26.017	4.607	0.076	118	37.2327	0.09	
ABW	10/10/2011 05:12	27.5941	-36.3700	37.2950	26.143	4.610	0.075	119	37.2800	0.11	
ABX	10/10/2011 08:59	27.3640	-36.6576	37.6400	26.441	4.600	0.083	120	37.6260	0.10	
ABY	10/10/2011 12:56	26.9985	-37.1107	37.7567	26.435	4.603	0.074	121	37.7453	0.13	
ABZ	10/10/2011 16:49	26.8233	-37.3297	37.7035	26.874	4.593	0.076	122	37.6819	0.14	
ACA	10/10/2011 21:01	26.4268	-37.8229	37.6832	26.798	4.586	0.083	123	37.6699	0.13	
ACB	11/10/2011 05:18	25.6279	-38.8077	37.7638	26.925	4.596	0.081	124	37.7669	0.17	
ACC	11/10/2011 09:21	25.3707	-39.1246	37.7615	26.814	4.597	0.084	125	37.7511	0.13	
ACD	11/10/2011 13:11	25.0070	-39.5697	37.5224	26.993	4.598	0.076	126	37.5107	0.16	
	11/10/2011 14:09										uway off for TSG/fluor/trans cleaning
	11/10/2011 14:13										transmissometer open in air
	11/10/2011 14:16										uway back on for TSG/fluor/trans
ACE	11/10/2011 17:05	24.8278	-39.7890	37.5801	27.465	4.535	0.083	127	37.5690	0.19	
ACF	11/10/2011 20:45	24.4761	-40.2177	37.7924	27.301	4.516	0.085	128	37.7785	0.17	
ACG	12/10/2011 05:08	23.6456	-41.0183	37.6068	27.361	4.548	0.082	129	37.5927	0.18	
ACH	12/10/2011 08:56	23.3650	-40.7993	37.6228	27.475	4.545	0.087	130	37.6090	0.19	
ACI	12/10/2011 13:01	22.8666	-40.4137	37.3639	27.406	4.555	0.087	131	37.3449	0.16	
ACJ	12/10/2011 16:56	22.6411	-40.2402	37.0195	27.371	4.537	0.089	132	36.9332	0.18	
ACK	12/10/2011 21:20	22.1359	-39.8547	37.2809	27.558	4.509	0.091	133	37.2803	0.16	
ACL	13/10/2011 05:09	21.2255	-39.1679	37.2068	27.288	4.561	0.081	134	37.2003	0.12	Logging failed. Used time of 05:09 for data
ACM	13/10/2011 09:03	20.9477	-38.9602	37.2122	27.174	4.547	0.084	135	37.2008	0.15	
ACN	13/10/2011 13:07	20.4766	-38.6107	37.2594	27.131	4.562	0.080	136	37.2457	0.13	
ACO	13/10/2011 16:56	20.2719	-38.4597	37.2695	27.193	4.557	0.082	137	37.2575	0.13	

Sample ID	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG salinity	SST - hull (deg. C)	Trans (volts)	Fluor (volts)	Bench salinity		Chl-a (ug/l)	Comments
								ID	Reading		
ACP	13/10/2011 20:49	19.8268	-38.1329	37.1544	27.346	4.553	0.083	138	37.1457	0.13	
ACQ	14/10/2011 05:17	18.8225	-37.4033	36.8470	27.228	4.561	0.080	139	36.8379	0.12	
ACR	14/10/2011 08:55	18.5390	-37.2003	37.0525	27.216	4.564	0.081	140	37.0392	0.14	
ACS	14/10/2011 13:04	18.1089	-36.8927	36.9652	27.168	4.566	0.076	141	36.9522	0.12	
	14/10/2011 14:24										uway off for TSG/fluor/trans cleaning
	14/10/2011 14:32										transmissometer open in air
	14/10/2011 14:35										uway back on for TSG/fluor/trans
ACT	14/10/2011 16:50	17.9454	-36.7764	36.9727	27.252	4.521	0.080	142	36.9688	0.13	
ACU	14/10/2011 21:00	17.4523	-36.4266	36.9877	27.322	4.549	0.083	143	36.9736	0.13	
ACV	15/10/2011 05:13	16.4848	-35.7470	36.7250	27.027	4.512	0.078	144	36.7125	0.13	
ACW	15/10/2011 09:00	16.2300	-35.5695	36.7101	27.120	4.605	0.083	25	36.7013	0.16	
ACX	15/10/2011 13:01	15.7487	-35.2359	36.4524	27.609	4.601	0.077	26	36.4422	0.17	
ACZ	15/10/2011 17:03	15.4887	-35.0565	36.4140	27.686	4.597	0.080	27	36.4073	0.16	
ADA	15/10/2011 20:56	14.9329	-34.6751	36.1673	27.793	4.590	0.080	28	36.1635	0.15	
ADB	16/10/2011 05:16	13.7845	-33.8983	36.1546	27.988	4.594	0.085	29	36.1451	0.24	
ADC	16/10/2011 09:04	13.4376	-33.6590	36.1116	27.894	4.598	0.090	30	36.1047	0.28	
ADD	16/10/2011 12:51	12.9028	-33.2993	36.1170	28.087	4.583	0.084	31	36.1088	0.24	
ADE	16/10/2011 16:45	12.6237	-33.1129	36.1318	28.164	4.573	0.095	32	36.1243	0.29	
ADF	16/10/2011 21:02	11.9874	-32.6884	35.9281	28.148	4.573	0.093	33	35.9200	0.28	
ADG	17/10/2011 05:12	10.7607	-31.8778	35.6528	28.394	4.580	0.090	34	35.6486	0.29	
ADH	17/10/2011 08:58	10.4059	-31.6445	35.7058	28.214	4.581	0.093	35	35.6912	0.34	
ADI	17/10/2011 12:40	9.8413	-31.2751	35.6180	28.444	4.575	0.088	36	35.5273	0.28	
	17/10/2011 14:24										uway off for TSG/fluor/trans cleaning
	17/10/2011 14:30										transmissometer open in air
	17/10/2011 14:34										uway back on for TSG/fluor/trans
ADJ	17/10/2011 17:20	9.4441	-31.0168	35.4511	28.583	4.565	0.094	37	35.4788	0.28	
ADK	17/10/2011 21:00	8.8802	-30.6503	34.8106	28.557	4.521	0.102	38	34.8104	0.34	

Sample ID	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG salinity	SST - hull (deg. C)	Trans (volts)	Fluor (volts)	Bench salinity		Chl-a (ug/l)	Comments
								ID	Reading		
ADL	18/10/2011 05:12	7.5970	-29.8207	34.4595	28.700	4.581	0.088	39	34.4747	0.27	
ADM	18/10/2011 08:55	7.2248	-29.5810	34.1786	28.681	4.583	0.092	40	34.1655	0.30	Logging gap.Used time of 08:55 for data
ADN	18/10/2011 13:06	6.6266	-29.1978	34.1542	28.824	4.564	0.093	41	34.1493	0.30	
ADO	18/10/2011 17:00	6.3299	-29.0078	34.4317	28.861	4.548	0.091	42	34.4235	0.26	
ADP	18/10/2011 21:09	5.7573	-28.6423	34.7840	28.562	4.548	0.090	43	34.7801	0.23	
ADQ	19/10/2011 05:17	4.6290	-27.9231	34.7111	28.679	4.566	0.088	44	34.7060	0.24	
ADR	19/10/2011 08:57	4.3549	-27.7503	0.0000	0.000	4.568	0.089	45	34.6297	0.27	05:19 - 09:05 no salinity or SST logged
ADT	19/10/2011 13:00	3.7943	-27.3946	35.1295	28.306	4.563	0.080	46	35.1214	0.22	
ADU	19/10/2011 17:07	3.5065	-27.2093	35.2769	28.239	4.561	0.080	47	35.2715	0.20	
ADV	19/10/2011 21:10	2.9713	-26.8738	35.6884	27.647	4.548	0.083	48	35.6837	0.15	
ADW	20/10/2011 05:15	1.9344	-26.2197	35.7282	27.330	4.549	0.086			0.21	
ADX	20/10/2011 08:58	1.6156	-26.0183	35.6904	27.338	4.542	0.089	49	35.6873	0.24	
ADY	20/10/2011 13:01	1.0795	-25.6800	35.9698	27.127	4.548	0.077	50	35.9652	0.18	
ADZ	20/10/2011 17:07	0.7768	-25.4897	35.8932	26.849	4.537	0.082	51	35.8879	0.23	
AEA	20/10/2011 21:00	0.2654	-25.1672	35.9298	26.417	4.512	0.108	52	35.9221	0.20	
AEB	21/10/2011 05:16	-1.0308	-25.0040	36.2304	26.536	4.491	0.141	53	36.2227	0.25	
AEC	21/10/2011 08:51	-1.3940	-25.0073	36.2734	26.622	4.489	0.096	54	36.2693	0.24	
AED	21/10/2011 13:00	-2.0718	-25.0108	36.2536	26.739	4.491	0.079	55	36.2477	0.18	
AEE	22/10/2011 08:55	-5.0287	-25.0266	36.2268	26.288	4.434	0.082	56	36.2265	0.13	
AEF	22/10/2011 13:08	-5.5859	-25.0265	36.2323	26.234	4.447	0.077	57	36.2255	0.16	
	22/10/2011 14:02										uway off for TSG/fluor/trans cleaning
	22/10/2011 14:06										transmissometer open in air
	22/10/2011 14:09										uway back on for TSG/fluor/trans
AEG	22/10/2011 17:04	-5.9420	-25.0309	36.2035	26.366	4.562	0.078	58	36.1969	0.12	
AEH	22/10/2011 21:18	-6.5351	-25.0346	36.2698	26.149	4.580	0.081	59	36.2626	0.11	

Sample ID	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG salinity	SST - hull (deg. C)	Trans (volts)	Fluor (volts)	Bench salinity		Chl-a (ug/l)	Comments
								ID	Reading		
AEI	22/10/2011 05:14	-4.6754	-25.0227	36.2456	26.267	4.449	0.082	60	36.2861	0.14	
AEJ	23/10/2011 08:52	-8.0430	-25.0349	36.2514	25.906	4.583	0.086	61	36.2447	0.16	
AEK	23/10/2011 13:15	-8.6981	-25.0525	36.3218	25.835	4.583	0.075	62	36.3199	0.13	
AEL	23/10/2011 17:19	-8.9837	-25.0480	36.2923	25.944	4.577	0.077	63	36.2855	0.12	
AEM	23/10/2011 21:01	-9.5206	-25.0505	36.2502	25.981	4.579	0.084	64	36.2423	0.14	
AEN	24/10/2011 05:24	-10.6875	-25.0559	36.3292	25.856	4.589	0.077	65	36.3212	0.10	
AEO	24/10/2011 08:55	-11.0485	-25.0590	36.4640	25.539	4.589	0.076	66	36.4602	0.10	
AEP	24/10/2011 13:04	-11.6323	-25.0621	36.4706	25.433	4.582	0.071	67	36.4617	0.09	
AEQ	24/10/2011 16:53	-11.8634	-25.0635	36.6519	25.315	4.581	0.074	68	36.6464	0.08	
AER	24/10/2011 21:07	-12.4213	-25.0665	36.7594	25.149	4.577	0.076	69	36.7537	0.08	
AES	25/10/2011 05:18	-13.5801	-25.0699	36.7136	25.154	4.410	0.074	70	36.7098	0.08	
AET	25/10/2011 08:52	-13.9008	-25.0746	36.9356	24.703	4.595	0.075	71	36.9279	0.08	
AEU	25/10/2011 13:21	-14.1789	-25.0749	36.9554	24.731	4.593	0.071	72	36.9467	0.05	
	25/10/2011 14:18										uway off for TSG/fluor/trans cleaning
	25/10/2011 14:22										transmissometer open in air
	25/10/2011 14:24										uway back on for TSG/fluor/trans
AEV	25/10/2011 19:58	-14.6511	-25.0785	37.0466	24.600	4.610	0.074	73	37.0453	0.05	
AEW	26/10/2011 09:00	-16.3508	-25.0877	37.1622	23.938	4.616	0.071	74	37.1664	0.06	
AEX	26/10/2011 12:51	-16.8990	-25.0910	37.1863	24.116	4.614	0.070	75	37.1859	0.06	
AEY	26/10/2011 16:55	-17.1529	-25.0890	37.1777	23.920	4.612	0.072	76	37.1751	0.06	
AEZ	26/10/2011 20:01	-17.6083	-25.0949	37.1767	23.851	4.610	0.076	80	37.1761	0.06	
AFA	27/10/2011 19:56	-18.7078	-25.0898	37.0636	23.325	4.609	0.080	81	37.0606	0.08	
AFB	28/10/2011 08:53	-20.4278	-25.0814	36.9632	22.306	4.618	0.077	86	36.9553	0.10	
AFC	28/10/2011 12:52	-21.0337	-25.0752	36.9877	22.491	4.615	0.072	79	36.9893	0.12	
AFD	28/10/2011 16:50	-21.3182	-25.0723	36.9682	22.439	4.612	0.076	78	36.9664	0.12	
AFE	28/10/2011 20:11	-21.8163	-25.0669	36.8775	21.979	4.610	0.080	84	36.8734	0.11	
AFF	29/10/2011 08:59	-23.5262	-25.0485	36.6889	21.218	4.587	0.074	82	36.6914	0.11	

Sample ID	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG salinity	SST - hull (deg. C)	Trans (volts)	Fluor (volts)	Bench salinity		Chl-a (ug/l)	Comments
								ID	Reading		
AFG	29/10/2011 13:10	-24.0901	-25.0429	36.8084	21.623	4.615	0.069	77	36.8075	0.12	
AFH	29/10/2011 17:02	-24.3802	-25.0399	36.6839	21.282	4.607	0.072	83	36.6802	0.10	
AFI	29/10/2011 19:55	-24.7971	-25.0350	36.6354	21.052	4.604	0.078	86	36.6342	0.16	
AFJ	30/10/2011 09:14	-26.5723	-25.0154	36.3028	19.879	4.599	0.074	87	36.2976	0.11	
AFK	30/10/2011 13:01	-27.1122	-25.0099	36.4469	20.268	4.596	0.075	88	36.4462	0.10	
	30/10/2011 14:42										uway off for TSG/fluor/trans cleaning
	30/10/2011 14:46										transmissometer open in air
	30/10/2011 14:50										uway back on for TSG/fluor/trans
AFL	30/10/2011 16:59	-27.4008	-25.0069	36.1291	19.027	4.599	0.073	89	36.1261	0.09	
AFM	30/10/2011 19:59	-27.8299	-25.0020	36.1358	19.105	4.598	0.078	90	36.1341	0.10	
AFN	31/10/2011 08:55	-28.9540	-26.2866	36.0822	18.615	4.437	0.080	91	36.0743	0.10	
AFO	31/10/2011 12:59	-29.3484	-26.8226	36.0727	18.529	4.608	0.077	92	36.0824	0.09	
AFP	31/10/2011 16:54	-29.5671	-27.1201	35.8051	17.497	4.592	0.083	93	35.8029	0.12	
AFQ	31/10/2011 20:01	-29.8751	-27.5414	35.8113	17.482	4.588	0.086	94	35.8073	0.13	
AFR	01/11/2011 09:00	-31.0326	-29.1342	35.7719	17.095	4.563	0.095	95	35.7700	0.22	
AFS	01/11/2011 12:57	-31.4134	-29.6625	36.0008	18.161	4.605	0.075	86	35.9963	0.18	
AFT	01/11/2011 16:49	-31.5624	-29.8696	35.9216	17.943	4.593	0.076	121	35.9149	0.24	
AFU	01/11/2011 20:00	-31.8693	-30.2975	35.8978	17.824	4.584	0.094	122	35.8981	0.27	
AFV	02/11/2011 09:02	-32.9707	-31.8457	35.9632	17.851	4.597	0.095	123	35.9581	0.24	Logging gap. Used time of 09:02 for data
AFW	02/11/2011 13:11	-33.3592	-32.3968	35.9262	17.740	4.587	0.085	124	35.9241	0.19	
AFX	02/11/2011 17:06	-33.5889	-32.7238	35.9184	17.565	4.573	0.095	125	35.9139	0.27	
AFY	02/11/2011 20:09	-33.8636	-33.1156	35.8823	17.350	4.544	0.154	126	35.8746	0.40	
AFZ	03/11/2011 05:17	-34.6802	-34.2876	35.5894	15.433	4.442	0.464	127	35.5843	0.79	
AGA	03/11/2011 09:07	-35.0109	-34.7666	35.6293	15.627	4.365	0.338	128	35.6285	0.68	
AGB	03/11/2011 13:00	-35.3284	-35.2273	35.6337	15.727	4.062	0.218	129	35.6430	0.62	
AGC	03/11/2011 16:47	-35.6031	-35.6272	35.6115	15.224	4.371	0.200	130	35.6053	0.79	

Sample ID	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG salinity	SST - hull (deg. C)	Trans (volts)	Fluor (volts)	Bench salinity		Chl-a (ug/l)	Comments
								ID	Reading		
AGD	03/11/2011 19:55	-35.8321	-35.9624	35.5860	14.989	4.392	0.391	131	35.5918	0.97	
AGE	04/11/2011 05:27	-36.4844	-36.9213	35.6065	15.205	0.480	0.462	132	35.6203	0.84	
AGF	04/11/2011 09:05	-36.7112	-37.2565	35.5893	15.355	2.257	0.351	133	35.6569	0.79	
AGG	04/11/2011 12:51	-36.9533	-37.6159	35.5940	15.041	4.452	0.237	134	35.5928	1.10	
AGH	04/11/2011 17:01	-37.1883	-37.9655	35.4735	14.323	4.497	0.175	135	35.4705	0.80	
AGI	04/11/2011 20:00	-37.4015	-38.2835	35.5033	14.296	4.423	0.350	136	35.4992	1.02	
AGJ	05/11/2011 09:00	-38.5432	-40.0029	35.5033	14.440	4.376	0.455	137	35.4995	1.47	
AGK	05/11/2011 12:55	-38.9893	-40.6818	35.5090	14.705	4.298	0.256	138	35.5055	1.57	
	05/11/2011 14:58										uway off for TSG/fluor/trans cleaning
	05/11/2011 15:01										transmissometer open in air
	05/11/2011 15:03										uway back on for TSG/fluor/trans
AGL	05/11/2011 17:01	-39.1956	-40.9883	35.4756	14.958	4.398	0.229	139	35.4715	0.90	
AGM	05/11/2011 19:53	-39.4691	-41.4175	35.1076	16.120	4.370	0.275	140	35.1061	0.75	
AGN	06/11/2011 10:00	-40.7030	-43.3326	35.2638	14.455	4.353	0.354	141	35.2583	0.83	
AGO	06/11/2011 14:06	-41.0999	-43.9562	34.6852	12.847	4.362	0.193	142	34.6833	0.84	
AGP	06/11/2011 17:48	-41.2533	-44.1920	34.6360	12.511	4.456	0.252	143	34.6341	0.50	
AGQ	06/11/2011 21:02	-41.5672	-44.6960	34.5955	12.116	4.430	0.405	144	34.6041	0.74	
AGR	07/11/2011 09:57	-42.6868	-46.4886	34.5242	11.108	4.516	0.187	25	34.5243	0.5	
AGS	07/11/2011 14:05	-43.0888	-47.1407	34.5125	10.891	4.484	0.134	26	34.5122	0.63	
AGT	07/11/2011 18:05	-43.2957	-47.4778	34.5172	10.892	4.541	0.102	27	34.5166	0.38	
AGU	07/11/2011 20:30	-43.5311	-47.8630	34.4888	11.116	4.504	0.201	28	34.4888	0.46	
AGV	08/11/2011 10:01	-44.6947	-49.7876	34.1380	10.651	4.314	0.256	29	34.1426		
AGW	08/11/2011 13:50	-45.0512	-50.4135	34.1546	10.292	4.273	0.238	30	34.1613	1.04	
AGX	08/11/2011 18:35	-45.2915	-50.9499	34.0724	9.610	3.765	1.165	31	34.0730	2.77	
AGY	08/11/2011 21:03	-45.5418	-51.5109	34.0727	9.514	4.052	1.607	32	34.0739	2.66	
AGZ	09/11/2011 06:21	-46.4917	-53.6628	33.9281	9.624	4.363	0.516	40	34.0044	0.9	
AHA	09/11/2011 10:00	-46.8756	-54.5452	34.2817	9.669	4.288	0.692	39	34.2859	1.65	
AHB	09/11/2011 13:56	-47.2718	-55.4590	34.0035	8.224	4.103	0.487	38	33.9290	3.61	
	09/11/2011 14:00										Underway switched off

Appendix 2: AMT21 Cruise Track