AMT22 Cruise Report

RRS James Cook JCO79

(10 October – 24 November 2012)

Principal Scientist: Glen Tarran
Plymouth Marine Laboratory

PML | Plymouth Marine Laboratory

Oceans 2025

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

CONTENTS

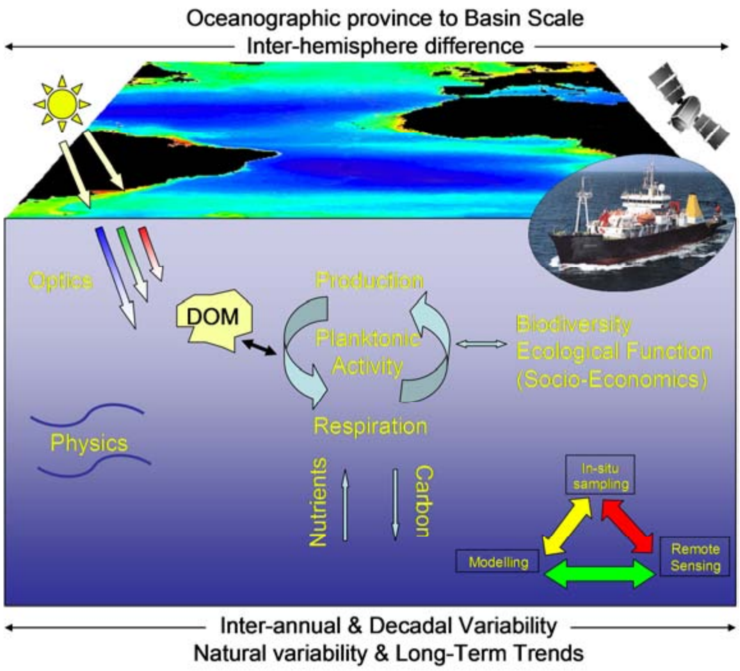
The Atlantic Meridional Transect programme

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 22nd in the series of research cruises which have involved over 220 scientists from 18 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-22 cruise was, from my own personal perspective as Principal Scientist (PSO) a highly successful endeavour. The RRS James Cook completed the cruise track without any deviations and we only lost 2 stations due to bad weather. In addition to our regular twice-daily stations to conduct science operations and the constant underway scientific measurements we were also engaged in deploying a total of 14 Argo floats for the UK Met Office and RemOcean project, collaborating with NASA to sea-truth developmental instrumentation for earth observation from space, recovering two sediment trap moorings from the middle of the South Atlantic Oligotrophic Gyre and deploying a new sediment trap mooring at the same site for a further 12 months. None of this happens without an awful lot of help.

So, to begin with, I would like to thank all the National Marine Facilities-Sea Systems people, both onshore and at sea for their work during the preparation for the cruise, mobilisation and during the cruise itself. Bill Richardson 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, for looking after the scientists on board and for their efficient, professional and enthusiastic deployment and recovery of the scientific equipment throughout the cruise. 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, encouragement and enthusiasm every day as we trundled our way from the UK all the way to Punta Arenas, over 8,500 nautical miles of ocean. Finally, I'd like to thank Andy Rees and particularly Chris Wing who organised the scientific party on and off the ship, with all that that entails and answered a host of questions to help the scientists realise their goals. Thanks to you all.

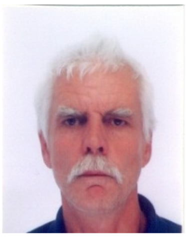
Glen

AMT22 Scientific personnel

Glen Tarran
PSO/Flow Cytometry
Plymouth Marine Laboratory

Plymouth Marine Laboratory

Giorgio Dall'Olmo
Optics/phytoplankton carbon relationships



Chris Gallienne
Optics/Zooplankton

Carolyn Harris
Nutrients

Vas Kitidis
O_2/Carbon Chemistry

Gavin Tilstone
Primary production, CDOM

Ming-Xi Yang
Oxygenated volatile organic compounds

National Oceanography Centre, Southampton

Urania Christaki
Heterotrophic microbes/flow cytometry

Sara Cregeen
Microplankton communities, copepod gut flora

Mike Zubkov
Microbial dynamics

MPI Bremen

Rudi Amann
Microbial community composition

Greta Reintjes
Microbial community composition

Martha Schattenhofer
Microbial community composition

Joerg Wulf
Microbial community composition

University of Vigo

Jose Lozano
Community production/respiration, O_2

Pablo Serret
Community production/respiration, O_2

University of East Anglia

Liam Pollard
Aerosols

Natalie Wager
Trace gases, production

University of Hawai'i at Mānoa

Erica Goetze
Zooplankton molecular ecology

University of York

Sina Hackenberg
Terpene emmissions

University of Rio Grande

Priscila Lange
POGO Fellow/primary production

Bigelow Laboratory for Ocean Sciences

Laura Lubelczyk
Coccolithophore-Remote Sensing Relationship

Univsity of Amsterdam

Katja Peijnenburg
Zooplankton molecular ecology

University of Warwick

Fran Pitt
Synechococcus molecular ecology

Oregon State University

Kristen Reifel
Optics/phytoplankton carbon relationships

Virginie van Dongen-Vogels
Optics/phytoplankton carbon relationships

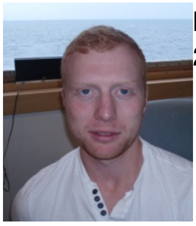
British Oceanographic Data Centre

Rob Thomas
Data Management/
Instrument Calibration

Ship's Officers

Bill Richardson
Master

Richard Warner
Mate/Chief Officer

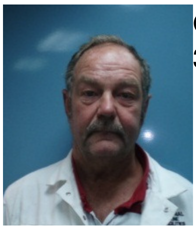


Iain Macleod
2nd Officer

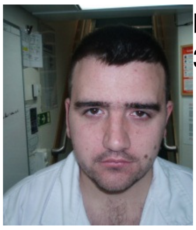
Declan Morrow
3rd Officer

Bob Lucas
Chief Engineer

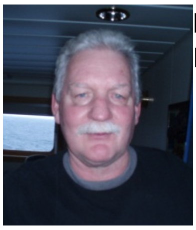
Chris Kemp
2nd Engineer



Gary Slater
3rd Engineer

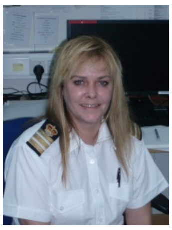


Mick Murren
3rd Engineer



Dave Clark
Electrical Technical Officer

Alan Rogers
Junior Electrical Technical Officer



Paula McDougall
Purser

Ship's Crew

Mich Minnock
Chief Petty Officer, Scientific

Andy MacLean
Chief Petty Officer, Deck

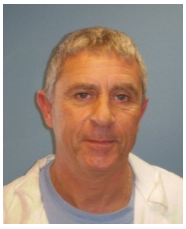
Dave Price
Petty Officer, Deck

Nathan Gregory
Able Seaman

Ken Sims
Able Seaman

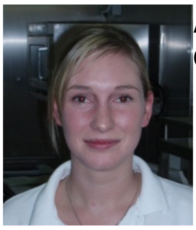
Alex McCall
Able Seaman

Pete Smith
Able Seaman

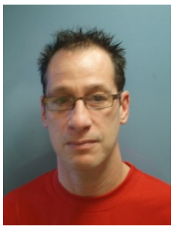


Duncan Lawes
Engine Room Petty Officer

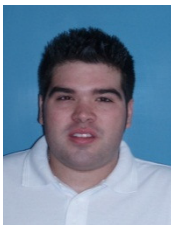
Darren Caines
Head Chef



Amy Whalen
Chef



Pete Robinson
Steward



Callum McLaughlin
Assistant Steward

Captain's Cruise Diary JC079

October

Ships Time: UTC +1
DTG: 10-10-12 13:30
a. 10:30 All check-lists received and in good order.
b. F.O. loaded 404t.
c. FO ROB 612t.
d. FW taken 98t. FW ROB 184t.
e. 45 persons disembarked, 54 persons embarked. 54 persons onboard.
f. 11:07 Clear of Berth
g. POB 10:50, Pilot away 12:05.
h. Clear of Port approaches (Needles) 13:20.
i. Commence transit towards Sci station 1, 49 24'.0N 11 00'.0W.

Ships Time: UTC
DTG: 11-10-12 12:00
Posn: 49 38'.3 N 7 59'.3 W.
Course: 263 Speed: 8kn
WX: NW 7. Rough seas, mod swell.
Status: 10-10-12
11:07 Clear of berth.
13:20 FAOP.
16:15 Emergency and boat muster conducted.
11-10-12 Passage towards initial scientific station continues.
Intentions. Conduct single, shallow CTD trial this pm - Wx permitting.
Continue passage towards 49 24'.0N 11 00'.0W, comm sci ops 02:00 12-10-12.

Ships Time: UTC
DTG: 12-10-12 12:00
Posn: 49º 16'.1 N 12º 49'.5 W.
Course: 264º T Speed: 9.5kn
WX: WNW 7. Rough seas, mod swell.
Status: 11-10-12
15:12 V/L in posn 49º 36'2N 08º 29'.6W. CTD deployed (trial)
15:50 Resume passage.
12-10-12
04:06 V/L in posn 49º 22'.8N 11º 17'.4W. Comm CTD and vertical net ops.
05:36 Ops complete. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit to W.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC
DTG: 13-10-12 12:00
Posn: 48º 00'.0 N 17º 10'.8 W.
Course: 205º T Speed: 10 kn
WX: N 3. Slight seas, mod swell.
Status: 12-10-12
13:04 V/L in posn 49º 14'9 N 13º 03'.1 W. Comm CTD and Optical Rig deployments.
14:25 ops completed. Set on.
13-10-12
Clocks retarded 1hr to UTC.
01:59 V/L in posn 49º 01'.8 N 16º 05'.5 W. Comm towed net op.
03:06 Net op completed. Set on.
04:30 V/L in posn 48º 55'.7 N 16º 22'.2 W. Comm CTD and vertical net ops.
05:30 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.

Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC
DTG: 14-10-12 12:00
Posn: 44º 53'.1 N 19º 14'.8 W.
Course: 205º T Speed: 10 kn
WX: WNW 3. Mod seas and swell.
Status: 13-10-12
13:01 V/L in posn 47º 57'.9N 17º 16'.0W. Comm CTD and Optical Rig deployments.
14:00 Ops completed. Set on.
14-10-12
02:02 V/L in posn 46º 03'.4 N 18º 29'.1 W. Comm towed net op.
03:00 Net op completed. Set on.
04:30 V/L in posn 45º 52'.6 N 18º 36'.5 W. Comm CTD and vertical net ops.
05:20 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC
DTG: 15-10-12 12:00
Posn: 41º 47'.0 N 21º 11'.1 W.
Course: 205º T Speed: 10 kn
WX: N 3. Slight seas, mod swell.
Status: 14-10-12
12:57 V/L in posn 44º 45'.5N 19º 19'.4W. Comm CTD, Optical Rig and Plankton net deployments.
14:22 Ops completed. Set on.
15-10-12
03:14 V/L in posn 42º 49'.5 N 20º 32'.7 W. Comm towed net, CTD and vertical net ops.
05:14 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC
DTG: 16-10-12 12:00
Posn: 38º 40'.6 N 23º 02'.1 W.
Course: 205º T Speed: 10 kn
WX: WxN 7. Rough seas, mod swell.
Status: 15-10-12
13:00 V/L in posn 41º 39'.2N 21º 15'.9W. Comm CTD and Optical Rig deployments.
14:00 Ops completed. Set on.
15-10-12
03:21 V/L in posn 39º 36'.8 N 22º 27'.9 W. Comm towed net, CTD and vertical net ops.
05:30 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC
DTG: 17-10-12 12:00

Posn: 35º 55'.9 N 25º 28'.6 W.
Course: 228º T Speed: 10 kn
WX: NNW 7. Rough seas, mod swell.
Status: 16-10-12
13:00 V/L in posn 38º 33'.2N 23º 05'.8W. Comm CTD and Optical Rig deployments.
14:00 Ops completed. Set on.
17-10-12
03:15 V/L in posn 36º 40'.3 N 24º 26'.7 W. Comm towed net, CTD and vertical net ops.
05:16 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC
DTG: 18-10-12 12:00
Posn: 33º 38'.7 N 28º 33'.9 W.
Course: 228º T Speed: 10 kn
WX: NNE 6. Rough seas, mod swell.
Status: 17-10-12
12:53 V/L in posn 35º 50'.8N 25º 35'.6W. Comm CTD and Optical Rig deployments.
13:56 Ops completed. Set on.
18-10-12
03:14 V/L in posn 34º 20'.9 N 27º 37'.5 W. Comm towed net, CTD and vertical net ops.
05:32 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 19-10-12 12:00
Posn: 31º 11'.5 N 31º 47'.2 W.
Course: 228º T Speed: 10 kn
WX: N 3. Slight seas, low swell.
Status: 18-10-12
12:59 V/L in posn 33º 33'.6N 28º 59'.6W. Comm CTD and Optical Rig deployments.
14:00 Ops completed. Set on.
19-10-12
02:00 Ship's clocks retarded 1 hr to UTC-1.
02:41 V/L in posn 32º 00'.0 N 30º 44'.2 W. Comm towed net, CTD and vertical net ops.
04:46 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
MOB drill mid pm.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 20-10-12 12:00
Posn: 29º 01'.6 N 34º 33'.7 W.
Course: 228º T Speed: 10 kn
WX: ENE 2. Slight seas, low swell.
Status: 19-10-12

12:56 V/L in posn 31º 06'.3N 31º 54'.4W. Comm CTD, Optical Rig and vertical net deployments.
15:07 Ops completed. Set on.
20-10-12
02:46 V/L in posn 29º 47'.8 N 33º 35'.1 W. Comm towed net, CTD and vertical net ops.
04:55 Ops completed. Set on.

Ships Time: UTC -1.
DTG: 21-10-12 12:00
Posn: 26º 48'.2 N 37º 21'.5 W.
Course: 228º T Speed: 10 kn
WX: NE 4. Mod seas, low swell.
Status: 20-10-12
12:55 V/L in posn 28º 56'.1N 34º 40'.4W. Comm CTD, Optical Rig and vertical net
deployments.
14:48 Ops completed. Set on.
21-10-12
02:43 V/L in posn 27º 35'.9N 36º 22'.4W. Comm towed net, CTD and vertical net ops.
04:50 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
Conduct additional towed net op 00:01 22-10-12.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 22-10-12 12:00
Posn: 24º 40'.9 N 39º 58'.0 W.
Course: 228º T Speed: 10 kn
WX: ENE 4. Mod seas, low swell.
Status: 21-10-12
12:58 V/L in posn 28º 43'.0N 37º 28'.2W. Comm CTD, Optical Rig and vertical net
deployments.
14:45 Ops completed. Set on.
23:50 V/L in posn 25º 42'.0N 38º 43'.4W Comm towed net op.

22-10-12
00:32 Op completed. Set on.
02:44 V/L in posn 25º 28'.5N 39º 00'.0W. Comm towed net, CTD and vertical net ops.
04:49 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.
Prepare for Bio-Argo float deployment pm 23-10-12.

Ships Time: UTC -1.
DTG: 23-10-12 12:00
Posn: 22º 11'.1 N 39º 52'.8 W.
Course: 144º T Speed: 10 kn
WX: NE 4. Mod seas and swell.
Status: 22-10-12
13:59 V/L in posn 24º 35'.7N 40º 04'.5W. Comm CTD, Optical Rig and vertical

net
deployments.
14:45 Ops completed. Set on.
23-10-12
02:43 V/L in posn 23º 09'.2N 40º 37'.4W. Comm towed net, CTD and vertical net ops.
05:00 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Bio-Argo float deployment (x 4).
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 24-10-12 12:00
Posn: 19º 33'.0 N 37º 51'.5 W.
Course: 144º T Speed: 10 kn
WX: ESE 4. Mod seas and swell.
Status: 23-10-12
12:55 V/L in posn 22º 04'.5N 39º 47'.8W. Comm CTD, Optical Rig, vertical net and (4 x)
Bio-Argo float deployments.
15:32 Ops completed. Set on.
24-10-12
02:43 V/L in posn 20º 32'.8N 38º 36'.7W. Comm towed net, CTD and vertical net ops.
04:44 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 25-10-12 12:00
Posn: 16º 44'.7 N 35º 44'.7 W.
Course: 144º T Speed: 10 kn
WX: E 3. Slight seas, mod swell.
Status: 24-10-12
13:00 V/L in posn 19º 26'.6N 37º 46'.3W. Comm CTD and Optical Rig deployments.
13:57 Ops completed. Set on.
25-10-12
02:41 V/L in posn 17º 42'.1N 36º 27'.4W. Comm towed net, CTD and vertical net ops.
04:54 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
Conduct additional towed net op 00:01 26-10-12.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 26-10-12 12:00
Posn: 14º 03'.4 N 33º 44'.7 W.
Course: 144º T Speed: 10 kn
WX: E 5. Mod seas and swell.
Status: 25-10-12
12:58 V/L in posn 16º 38'.4N 35º 39'.4W. Comm CTD, Optical Rig and vertical net deployments.

14:36 Ops completed. Set on.
26-10-12
00:01 V/L in posn 15º 18'.2N 34º 39'.7W. Comm towed net op.
00:47 Op completed. Set on.
02:43 V/L in posn 15º 03'.3N 34º 28'.5W. Comm towed net, CTD and vertical net ops.
04:45 Ops completed. Set on.
Intentions. Conduct CTD and Optical Rig deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 27-10-12 12:00
Posn: 11º 13'.5 N 31º 39'.8 W.
Course: 144º T Speed: 10 kn
WX: E 3. Slight seas, low swell.
Status: 26-10-12
12:59 V/L in posn 13º 57'.3N 33º 40'.0W. Comm CTD and Optical Rig deployments.
14:00 Ops completed. Set on.
27-10-12
02:43 V/L in posn 12º 13'.6N 32º 23'.2W. Comm towed net, CTD and vertical net ops.
04:52 Ops completed. Set on.
Intentions. Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 28-10-12 12:00
Posn: 08º 24'.8 N 29º 36'.9 W.
Course: 144º T Speed: 10 kn
WX: E 3. Slight seas, low swell.
Status: 27-10-12
12:58 V/L in posn 11º 07'.0N 31º 34'.6W. Comm CTD, Optical Rig and vertical net
deployments.
14:36 Ops completed. Set on.
28-10-12
02:43 V/L in posn 09º 27'.5N 30º 21'.3W. Comm towed net, CTD and vertical net ops.
04:45 Ops completed. Set on.
Intentions. Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 29-10-12 12:00
Posn: 05º 39'.4 N 27º 37'.5 W.
Course: 144º T Speed: 10 kn
WX: Light airs. Rippled seas, low swell.
Status: 28-10-12
13:00 V/L in posn 08º 17'.8N 29º 31'.9W. Comm CTD, Optical Rig and vertical net
deployments.
14:35 Ops completed. Set on.
29:10-12

02:43 V/L in posn 06º 37'.1N 28º 18'.7W. Comm towed net, CTD and vertical net ops.
04:50 Ops completed. Set on.
Intentions. Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct additional towed net op 00:01 30-10-12.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 30-10-12 12:00
Posn: 03º 02'.2 N 25º 44'.4 W.
Course: 144º T Speed: 10 kn
WX: SW 3. Slight seas, low swell.
Status: 29-10-12
13:00 V/L in posn 05º 32'.7N 27º 32'.6W. Comm CTD, Optical Rig and vertical net
deployments.
14:40 Ops completed. Set on.
30-10-12
02:44 V/L in posn 04º 03'.0N 26º 27'.7W. Comm towed net, CTD and vertical net ops.
04:45 Ops completed. Set on.
Intentions. Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 31-10-12 12:00
Posn: 00º 05'.3 N 25º 00'.0 W.
Course: On Station. Speed: DP
WX: SE 5. Mod seas and swell.
Status: 30-10-12
12:58 V/L in posn 02º 55'.1N 25º 39'.7W. Comm CTD, Optical Rig and vertical net
deployments.
14:35 Ops completed. Set on.
31-10-12
02:42 V/L in posn 01º 08'.0N 24º 59'.6W. Comm towed net, CTD and vertical net ops.
05:00 Ops completed. Set on.
11:57 V/L in posn 00º 05'.3N 25º 00'.0W. Comm Optical rig deployment.
Intentions. Complete Optical Rig deployments at this station.
Resume transit. 180º T at 9.0kn.
Conduct pre-dawn CTD and net ops.

November

Ships Time: UTC -1.
DTG: 01-01-12 12:00
Posn: 02º 55'.3 S 25º 00'.6 W.
Course: On Station. Speed: DP
WX: E 5/6. Rough seas, mod swell.
Status: 31-10-12
12:49 Optical cast completed. Set on.
01-11-12
01:43 V/L in posn 01º 57'.2N 25º 00'.5W. Comm towed net, CTD and vertical net ops.

04:55 Ops completed. Set on.
11:55 V/L in posn 02º 55'.3S 25º 00'.6W. Comm towed net op.
Intentions. Complete Optical Rig, CTD, towed and vertical net ops at this station.
Resume transit. 180º T at 9.0kn.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 02-11-12 12:00
Posn: 5º 42'.3 S 25º 01'.8 W.
Course: 180º Speed: 9.0kn
WX: E 3. Slight seas, mod swell.
Status: 01-11-12
14:40 Optical Rig, CTD, towed and vertical net ops completed. Set on.
23:56 V/L in posn 04º 18'.7S 25º 01'.2W. Comm towed net op.
02-11-12
00:26 Op completed. Set on.
02:42 V/L in posn 04º 37'.2N 25º 01'.4W. Comm towed net, CTD and vertical net ops.
04:45 Ops completed. Set on.
Intentions. Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 03-11-12 12:00
Posn: 09º 22'.2 S 25º 03'.1 W.
Course: 180º Speed: 11.0 kn
WX: E x S 6. Rough seas, mod swell.
Status: 02-11-12
12:55 V/L in posn 05º 49'.7N 25º 01'.7W. Comm CTD, Optical Rig and vertical net
deployments.
14:32 Ops completed. Set on.
03-11-12
02:44 V/L in posn 08º 04'.6N 25º 02'.4W. Comm towed net, CTD and vertical net ops.
04:48 Ops completed. Set on.
Intentions. Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct additional towed net op 00:01 04-11-12.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 04-11-12 12:00
Posn: 12º 56'.0 S 25º 04'.1 W.
Course: 180º Speed: 11.0 kn
WX: E 4. Mod seas, low swell.
Status: 03/11/12
12:53 V/L in posn 09º 30'.8S 25º 03'.2W. Comm CTD, Optical Rig and vertical net
deployments.
14:28 OPs completed. Set on.
23:57 V/L in posn 11º 17'.7S 25º 03'.4W. Comm towed net op.
04/11/12
00:47 Op completed. Set on.
02:42 V/L in posn 11º 37'.0S 25º02'.7W. Comm towed net, CTD and vertical net ops.
04:45 OPs completed. Set on.

Intentions. Conduct CTD, Optical Rig vertical net and Argo float deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 05-11-12 12:00
Posn: 16º 36'.9 S 25º 05'.3 W.
Course: 180º Speed: 11.0 kn
WX: NE 3. Slight seas, low swell.
Status: 04-11-12
12:56 V/L in posn 09º 30'.8S 25º 03'.2W. Comm CTD, Optical Rig and vertical net
deployments.
14:22 OPs completed.
14:38 Argo float deployed in posn 13º 04'.1S 25º 03'.7W
14:40 Set on.
05-11-12
02:41 V/L in posn 15º 18'.0S 25º04'.5W. Comm towed net, CTD and vertical net ops.
04:42 OPs completed. Set on.
Intentions. Conduct CTD, Optical Rig vertical net and Argo float deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.
Conduct mooring recovery ops (x2).

Ships Time: UTC -1.
DTG: 06-11-12 12:00
Posn: 18º 32'.2 S 25º 04'.6 W.
Course: On Station Speed: DP
WX: NE 4. Mod seas, low swell.
Status: 05-11-12
12:55 V/L in posn 16º 45'.5S 25º 05'.8W. Comm CTD, Optical Rig and vertical net
deployments.
14:27 OPs completed.
14:40 Argo float deployed in posn 136º 45'.8S 25º 06'.9W. Set on.
06-11-12
02:42 V/L in posn 18º 29'.5S 25º06'.0W. Comm towed net, CTD and vertical net ops.
04:47 Ops completed.
07:08 V/L in posn 18º 32'.2S 25º04'.8W, Mooring release hook interrogated.
07:16 Release code sent.
08:35 Mooring grappled.
10:18 Mooring onboard.
11:34 V/L on stn in posn 18º 32'.2 S 25º 04'.6 W.
Intentions. Preparations for second mooring recovery op ongoing.
Conduct towed net ops overnight.
Argo float deployemt (x4)
Deploy mooring.
Resume transit.

Ships Time: UTC -1.
DTG: 07-11-12 12:00
Posn: 18º 31'.8 S 25º 07'.5 W.
Course: 090 Speed: 1kn
WX: ENE 2. Rippled seas, low swell.
Status: 06-11-12
12:55 On stn for Mooring recovery op 2. Release code sent.

14:11 Mooring grappled.
15:55 Mooring onboard.
07-11-12
02:06 V/L in posn 16º 32'.0S 25º 05'.0W. Comm towed net ops.
07:42 Comm Bio-Argo float deployments (x 4).
08:16 Float deployments completed.
11:06 Aft deck preparation completed, comm mooring deployment.
Intentions. Complete mooring deployment.
Conduct CTD, Optical rig and vertical net ops in this area.
Resume transit.

Ships Time: UTC -1.
DTG: 08-11-12 12:00
Posn: 21º 08'.2 S 24º 48'.6 W.
Course: 194ºT
Speed: 8.5kn
WX: E 3. Slight seas, low swell.
Status: 07-11-12
13:08 V/L in posn 18º 31'.78S 25º 06'.13W sediment trap mooring (SAG) sinker released.
13:37 Comm CTD, Optics rig and vertical net ops.
15:15 Ops completed. Set on.
08-11-12
02:25 V/L in posn 20º 06'.0S 24º 31'.0W. Comm towed net, CTD and vertical net ops.
04:40 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig, vertical net and Argo float deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 09-11-12 12:00
Posn: 23º 43'.6 S 25º 00'.0 W.
Course: 180ºT Speed: 8.5kn
WX: E 3. Slight seas, mod swell.
Status: 08-11-12
12:59 V/L in posn 21º 15'.1S 24º 50'.7W. Comm CTD, Optical Rig and vertical net
deployments.
14:21 Ops completed.
14:35 V/L in posn 21º 15'.3S 24º 51'.0W. Argo float deployed. Set on.
09-11-12
02:25 V/L in posn 22º 56'.9S 25º 00'.2W. Comm towed net, CTD and vertical net ops.
04:44 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Additional towed net op scheduled for 00:01 10-11-12.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 10-11-12 12:00
Posn: 26º 50'.4 S 25º 00'.0 W.
Course: 180ºT Speed: 8.5kn
WX: E 4. Slight seas, mod swell.
Status: 09-11-12
12:55 V/L in posn 24º 07'.5S 25º 00'.1W. Comm CTD, Optical Rig and vertical

net
deployments.
14:30 Ops completed. Set on.
23:57 V/L in posn 25º 29'.0S 25º 00'.1W. Comm towed net op.

10-11-12
00:50 Towed net op completed. Set on.
02:26 V/L in posn 25º 43'.5S 25º 00'.0W. Comm towed net, CTD and vertical net ops.
04:34 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig, vertical net and Argo float deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 11-11-12 12:00
Posn: 29º 02'.3 S 25º 24'.1 W.
Course: 236ºT Speed: 8.5kn
WX: Light airs. Smooth seas, low swell.
Status: 10-11-12
12:57 V/L in posn 26º 57'.3S 25º 00'.3W. Comm CTD, Optical Rig and vertical net
deployments.
14:22 Ops completed.
14:34 Argo float deployed in posn 26º 57'.6S 25º 01'.2W. Set on.
01:42 V/L in posn 28º 21'.5S 25º 29'.0W. Comm towed net, CTD and vertical net ops.
04:45 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig, vertical net and Argo float deployments early pm.
Resume transit.
Conduct towed net op 00:01 12-11-12.
Conduct pre-dawn CTD and net ops.

Ships Time: UTC -1.
DTG: 12-11-12 12:00
Posn: 30º 53'.3 S 28º 59'.9 W.
Course: 230ºT Speed: 9.5kn
WX: N 5. Rough seas, mod swell.
Status: 11-11-12
12:57 V/L in posn 29º 07'.0S 26º 30'.4W. Comm CTD, Optical Rig and vertical net deployments.
14:20 Ops completed.
14:32 Argo float deployed in posn 29º 07'.5S 26º 30'.8W. Set on.
23:55 V/L in posn 30º 00'.5S 27º 43'.0W. Comm towed net op.
12-11-12
00:49 Towed net op completed. Set on.
02:28 V/L in posn 30º 10'.5S 27º 55'.0W. Comm towed net, CTD and vertical net ops.
04:34 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.
Resume transit.

Ships Time: UTC -1.
DTG: 13-11-12 12:00

Posn: 32º 50'.2 S 31º 41'.7 W.
Course: 230ºT Speed: 4.5kn
WX: S 8/9. V. rough seas, heavy swell.
Status: 12-11-12
12:55 V/L in posn 30º 58'.2S 29º 03'.1W. Comm CTD, Optical Rig and vertical net
deployments.
13:52 Ops completed. Set on.
13-11-12
02:45 V/L in posn 32º 15'.0S 30º 52'.8W. Wx assessment made. No over side ops
possible. Set on.
Intentions: Continue transit in poor weather.
Ops this pm unlikely.
Forecast is for improvement overnight. Possible limited pre-dawn ops 14-11-12.

Ships Time: UTC -1.
DTG: 14-11-12 12:00
Posn: 34º 46'.9 S 34º 26'.0 W.
Course: 230ºT Speed: 9.0kn
WX: S 5. Rough seas, mod swell.
Status: 13-11-12
Solar noon ops cancelled due to weather. Transit continues.
14-11-12
02:41 V/L in posn 34º 07'.8S 33º 30'.2W. Comm towed net, CTD and vertical net ops.
05:23 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct towed net op 00:01 15-11-12.
Resume transit.
Conduct pre-dawn CTD and net ops.
Resume transit.

Ships Time: UTC -1.
DTG: 15-11-12 12:00
Posn: 36º 45'.4 S 37º 19'.4 W.
Course: 230ºT Speed: 9.5kn
WX: SW 4. Mod seas and swell.
Status: 14-11-12
12:55 V/L in posn 34º 51'.5S 34º 32'.3W. Comm CTD and Optical Rig
deployments.
13:57 Ops completed. Set on.
23:56 V/L in posn 35º 51'.7S 36º 00'.0W. Comm towed net ops.
15-11-12
00:56 Towed net ops completed. Set on.
02:43 V/L in posn 36º 02'.7S 36º 14'.8W. Comm towed net, CTD and vertical net ops.
05:00 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig, vertical net and Argo float deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.
Resume transit.

Ships Time: UTC -1.
DTG: 16-11-12 10:00
Posn: 38º 36'.9 S 40º 06'.9 W.

Course: 230ºT Speed: 9.5kn
WX: WSW 3. Slight seas, low swell.
Status: 15-11-12
12:55 V/L in posn 36º 50'.2S 37º 26'.3W. Comm CTD, Optical Rig and vertical net
deployments.
14:20 Ops completed.
14:34 Argo float deployed in posn 36º 50'.4S 37º 26'.3W. Set on.
16-11-12
02:40 V/L in posn 36º 02'.7S 36º 14'.8W. Comm towed net, CTD and vertical net ops.
04:50 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct towed net op 00:01 17-11-12.
Conduct pre-dawn CTD and net ops.
Resume transit.

Ships Time: UTC -1.
DTG: 17-11-12 12:00
Posn: 40º 49'.3 S 43º 30'.9 W.
Course: 230ºT Speed: 9.5kn
WX: S 3. Slight seas, low swell.
Status: 16-11-12
12:56 V/L in posn 38º 54'.5S 40º 33'.7W. Comm CTD, Optical Rig and vertical net deployments.
14:30 Ops completed. Set on.
23:55 V/L in posn 39º 52'.8S 42º 03'.1W. Comm towed net op.
17-11-12
00:46 Towed net op completed. Set on.
02:43 V/L in posn 40º 04'.3S 42º 22'.2W. Comm towed net, CTD and vertical net ops.
04:55 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.
Resume transit.

Ships Time: UTC -2.
DTG: 18-11-12 12:00
Posn: 42º 58'.4 S 46º 57'.2 W.
Course: 230ºT Speed: 9.5kn
WX: N 4. Slight seas, mod swell.
Status: 17-11-12
12:55 V/L in posn 40º 54'.3S 43º 38'.9W. Comm CTD, Optical Rig and vertical net deployments.
14:33 Ops completed. Set on.
18-11-12
02:00 Clocks retarded by 1hr to UTC -2.
01:48 V/L in posn 42º 08'.0S 45º 36'.0W. Comm towed net and CTD ops.
03:40 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops.
Resume transit.

Ships Time: UTC -2.
DTG: 19-11-12 12:00

Posn: 44º 36'.8 S 49º 39'.2 W.
Course: 230ºT Speed: 7.5kn
WX: W 4. Mod seas and swell.
Status: 18-11-12
12:57 V/L in posn 43º 02'.8S 47º 04'.7W. Comm CTD, Optical Rig and vertical net deployments.
14:30 Ops completed. Set on.
19-11-12
01:46 V/L in posn 43º 56'.1S 48º 33'.9W. Comm towed net, CTD and vertical net ops.
03:41 Ops completed. Set on.
Intentions: Conduct CTD, Optical Rig and vertical net deployments early pm.
Resume transit.
Conduct pre-dawn CTD and net ops. End of Science (over the side).
Set on for Punta Arenas.

Ships Time: UTC -2.
DTG: 20-11-12 12:00

Posn: 46º 28'.1 S 53º 22'.5 W.
Course: 236ºT Speed: 12 kn
WX: SE 5. Rough seas, mod swell.
Status: 19-11-12
12:57 V/L in posn 44º 40'.5S 49º 45'.3W. Comm CTD, Optical Rig and vertical net
deployments.
14:33 Ops completed. Set on.
20-11-12
01:48 V/L in posn 45º 30'.4S 51º 21'.0W. Comm towed net, CTD and vertical net ops.
03:42 Ops completed. Set on for Punta Arenas.
Intentions: Transit towards Punta Arenas.
All underway sampling activities cease at 18:00 20-11-12.
Pilot (Cabo Posesion) expected 02:00 LT 24-11-12.

Ships Time: UTC -2.
DTG: 21-11-12 12:00
Posn: 49º 02'.7 S 59º 01'.2 W.
Course: 236ºT Speed: 11 kn
WX: NNW 7. Rough seas, mod swell.
Status: Transit towards Punta Arenas continues.
Intentions: Pilot (Cabo Posesion) expected 02:00 LT 24-11-12.

Ships Time: UTC -3.
DTG: 22-11-12 12:00
Posn: 51º 12'.4 S 64º 03'.7 W.
Course: 236ºT Speed: 7 kn
WX: WSW 7. Rough seas, occasionally heavy swell.
Status: Transit towards Punta Arenas continues.
Clocks retarded 1 hr to UTC -3.
Intentions: Pilot (Cabo Posesion) expected 02:00 LT 24-11-12.

Ships Time: UTC -3.
DTG: 23-11-12 10:00
Posn: 52º 58'.7 S 67º 27'.6 W.
Course: Hove to. Speed: Stopped
WX: SW 6. Rough seas, low swell.
Status: Hove to.

DeMob preps as practical.
Intentions: Pilot booked for 02:00 LT 24-11-12.
ETA alongside Punta Arenas 10:00 LT 24-11-12.

Ships Time: UTC -3.
DTG: 24-11-12 14:00

Posn: Off Punta Arenas
Course: DP Speed: Stopped
WX: SWxW 5. Sheltered waters.
Status: Awaiting berth.
Intentions: Scientist departing by launch this pm.

Scientific Reports

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.

Underway samples
A total of 143 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 73 stations from 9 depths including light depths from 97, 55, 33, 14, 7, 1 & 0.1%.
A total of 657 samples were collected from the CTD casts. The depths and stations sampled are listed in Table 1.

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

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

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

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

Date and time (GMT)	Lat (+ve N)	Lon (+ve E)	CTD	Niskin Bottle	Depth (m)
2012-10-12T12:12:00	49.2494	-13.0522	CTD02	2, 4, 5, 6, 8, 12, 17, 18,23	200, 100, 60, 55, 30, 20, 15, 10,5
2012-10-13T04:33:00	48.9277	-16.3695	CTD03	2, 4, 5, 7, 9, 12, 15, 18, 24	200, 100, 75, 51, 40, 30, 20, 11, 2
2012-10-13T13:01:00	47.8818	-17.2666	CTD04	2, 3, 6, 7, 8, 10, 17, 19, 23	200,150, 100, 55, 40, 30, 20, 10, 2
2012-10-14T04:30:00	45.8775	-18.6081	CTD05	2, 4, 5, 6, 8, 11, 16, 18, 24	200, 100, 75, 51, 47, 30, 20, 11, 2
2012-10-14T13:04:00	44.7599	-19.3245	CTD06	2, 4, 5, 6, 7, 8, 19, 21, 24	200, 100, 75, 50, 40, 34, 20, 11, 2
2012-10-15T04:25:00	42.8174	-20.5779	CTD07	2, 4, 5, 6, 8, 12, 16, 18, 24	200, 100, 75, 51, 40, 30, 20, 11, 2
2012-10-15T13:03:00	41.6542	-21.2649	CTD08	2, 4, 5, 6, 9, 10, 11, 18, 24	200, 100, 75, 60, 51, 38, 30, 20, 2
2012-10-16T04:43:00	39.6543	-22.5095	CTD09	2, 3, 5, 7, 9, 12, 19, 21, 24	200, 150, 100, 70, 60, 40, 17, 9, 2
2012-10-16T12:59:00	38.5545	-23.0971	CTD10	3, 4, 5, 8, 12, 13, 15, 19, 24	200, 150, 105, 85, 60, 53, 30, 20, 4
2012-10-17T04:26:00	36.6863	-24.4688	CTD11	1, 2, 4, 7, 9, 11, 15, 19, 24	300, 200, 135, 90, 85, 55, 38, 20, 2

Date and time (GMT)	Lat (+ve N)	Lon (+ve E)	CTD	Niskin Bottle	Depth (m)
2012-10-17T12:58:00	35.8470	-25.5943	CTD12	3, 4, 5, 8, 10, 11, 12, 14, 24	200, 150, 135, 100, 69, 52, 38, 22, 2
2012-10-18T04:30:00	34.3828	-27.6375	CTD13	3, 4, 6, 8, 11, 12, 14, 20, 24	200, 150, 105, 70, 60, 53, 40, 17, 4
2012-10-18T12:59:00	33.5608	-28.6892	CTD14	2, 3, 5, 6, 10, 12, 14, 16, 24	300, 200, 150, 125, 110, 98, 57, 24, 2
2012-10-19T04:56:00	32.0224	-30.7364	CTD15	1, 2, 4, 5, 7, 9, 10, 14, 24	300, 200, 150, 125, 100, 90, 75, 42, 2
2012-10-19T13:57:00	31.1057	-31.9078	CTD16	1, 2, 4, 5, 7, 9, 10, 14, 24	300, 200, 150, 125, 100, 90, 75, 42, 2
2012-10-20T04:58:00	29.8077	-33.5500	CTD17	2, 3, 6, 8, 10, 13, 15, 18, 24	300, 200, 150, 122, 105, 80, 61, 24, 2
2012-10-20T13:57:00	28.9361	-34.6744	CTD18	2, 3, 4, 7, 9, 11, 13, 15, 24	300, 200, 157, 130, 105, 80, 61, 25, 2
2012-10-21T04:55:00	27.6147	-36.3470	CTD19	2, 3, 6, 8, 11, 13, 15, 18, 24	300, 200, 150, 120, 110, 86, 63, 27, 2
2012-10-21T14:00:00	26.7169	-37.4708	CTD20	2, 3, 6, 9, 10, 11, 13, 16, 24	300, 200, 135, 120, 110, 86, 63, 27, 2
2012-10-22T04:55:00	27.6147	-36.3470	CTD21	2, 3, 6, 10, 11, 13, 15, 18, 24	300, 200, 150, 120, 110, 88, 66, 28, 2
2012-10-22T14:02:00	24.5951	-40.0754	CTD22	2, 3, 5, 7, 9, 10, 12, 14, 24	300, 200, 150, 120, 100, 88, 66, 28, 2
2012-10-23T04:55:00	23.1639	-40.6037	CTD23	2, 3, 6, 9, 11, 13, 16, 18, 24	300, 200, 150, 130, 105, 88, 49, 28, 2
2012-10-23T14:01:00	22.0750	-39.7977	CTD24	2, 3, 5, 7, 9, 10, 12, 14, 24	300, 200, 150, 120, 105, 88, 66, 28, 2
2012-10-24T04:52:00	20.5651	-38.5932	CTD25	2, 3, 6, 9, 11, 13, 14, 16, 24	300, 200, 150, 130, 115, 88, 66, 49, 2
2012-10-24T14:01:00	19.4429	-37.7720	CTD26	2, 3, 5, 6, 10, 12, 14, 15, 24	300, 200, 150, 130, 106, 88, 66, 49, 2
2012-10-25T04:55:00	17.7095	-36.4282	CTD27	2, 3, 6, 7, 11, 13, 14, 16, 24	300, 200, 150, 120, 96, 82, 62, 46, 2
2012-10-25T14:00:00	16.6414	-35.6575	CTD28	2, 3, 5, 7, 10, 12, 14, 16, 23	300, 200, 150, 110, 86, 62, 46, 26, 2
2012-10-26T04:53:00	15.0621	-34.4472	CTD29	2, 3, 6, 9, 12, 14, 17, 18, 24	300, 200, 120, 82, 76, 62, 46, 26, 2
2012-10-26T14:00:00	13.9556	-33.6672	CTD30	2, 3, 5, 8, 11, 12, 14, 16, 24	300, 200, 130, 95, 77, 62, 46, 26, 2
2012-10-27T04:55:00	12.2243	-32.3605	CTD31	3, 4, 6, 7, 10, 14, 16, 18, 24	200, 150, 125, 105, 84, 58, 48, 36, 2
2012-10-27T13:58:00	11.1153	-31.5773	CTD32	3, 4, 5, 6, 7, 10, 12, 20, 24	200, 150, 100, 84, 75, 52, 36, 20, 2
2012-10-28T04:52:00	9.4525	-30.3282	CTD33	3, 4, 6, 7, 9, 13, 17, 20, 24	200, 150, 100, 75, 67, 47, 28, 16, 2
2012-10-28T14:00:00	8.2967	-29.5326	CTD34	2, 3, 4, 6, 10, 12, 13, 20, 24	200, 150, 100, 84, 60, 39, 28, 16, 2
2012-10-29T04:53:00	6.6212	-28.3419	CTD35	3, 4, 6, 7, 8, 11, 14, 16, 24	200, 150, 100, 88, 78, 65, 39, 28, 2
2012-10-29T14:00:00	5.5454	-27.5432	CTD36	3, 4, 5, 7, 10, 12, 14, 15, 24	200, 150, 100, 85, 76, 60, 41, 28, 2
2012-10-30T04:53:00	4.0284	-26.4693	CTD37	2, 3, 4, 6, 9, 12, 15, 17, 24	300, 200, 150, 100, 70, 51, 39, 28, 2
2012-10-30T14:01:00	2.9197	-25.6617	CTD38	1, 2, 3, 4, 7, 9, 10, 11, 24	300, 200, 150, 100, 80, 51, 39, 28, 2
2012-10-31T04:53:00	1.1078	-24.9844	CTD39	2, 3, 4, 7, 9, 12, 16, 17, 24	300, 200, 150, 100, 85, 68, 49, 36, 2
2012-11-01T05:01:00	-1.8837	-24.9563	CTD40	2, 3, 4, 8, 11, 12, 14, 17, 24	300, 200, 150, 100, 87, 75, 65, 36, 2
2012-11-01T14:00:00	-2.9299	-24.9841	CTD41	2, 3, 4, 6, 8, 11, 12, 15, 24	300, 200, 150, 115, 90, 76, 65, 36, 2
2012-11-02T04:51:00	-4.6230	-25.0038	CTD42	2, 3, 4, 8, 9, 13, 16, 18, 24	300, 200, 150, 102, 92, 76, 44, 25, 2
2012-11-02T13:56:00	-5.8294	-25.0299	CTD43	2, 3, 4, 5, 8, 10, 12, 13, 24	300, 200, 150, 125, 95, 78, 44, 25, 2
2012-11-03T04:51:00	-8.0891	-25.0142	CTD44	2, 3, 4, 6, 8, 12, 16, 18, 24	300, 200, 150, 120, 100, 78, 44, 25, 2
2012-11-03T13:56:00	-9.5135	-25.0535	CTD45	2, 3, 4, 6, 9, 11, 13, 14, 23	300, 200, 150, 110, 90, 70, 44, 25, 2
2012-11-04T04:47:00	-11.6218	-25.0205	CTD46	2, 3, 5, 7, 10, 13, 15, 17, 24	300, 200, 150, 132, 100, 78, 59, 44, 2

Date and time (GMT)	Lat (+ve N)	Lon (+ve E)	CTD	Niskin Bottle	Depth (m)
2012-11-04T13:58:00	-13.0735	-25.0667	CTD47	2, 3, 4, 6, 8, 10, 11, 12, 23	300, 200, 150, 130, 102, 78, 59, 44, 2
2012-11-05T04:49:00	-15.2871	-25.1344	CTD48	2, 3, 5, 9, 12, 15, 16, 18, 22	300, 200, 180, 145, 105, 70, 52, 29, 5
2012-11-05T14:00:00	-16.7597	-25.0977	CTD49	2, 3, 4, 7, 9, 14, 15, 16, 24	300, 200, 180, 159, 135, 70, 52, 29, 2
2012-11-06T04:56:00	-18.5160	-25.1012	CTD50	1, 2, 4, 7, 10, 14, 15, 17, 24	300, 200, 182, 161, 121, 70, 52, 29, 2
2012-11-07T14:38:00	-18.5298	-25.1015	CTD51	2, 3, 4, 7, 9, 11, 13, 15, 24	300, 200, 182, 155, 121, 92, 52, 30, 2
2012-11-08T04:49:00	-20.1212	-25.4969	CTD52	2, 4, 5, 7, 9, 11, 15, 19, 24	300, 220, 185, 160, 135, 117, 89, 37, 2
2012-11-08T14:01:00	-21.2527	-24.8455	CTD53	2, 3, 5, 7, 9, 10, 12, 13, 24	300, 220, 175, 150, 117, 105, 65, 37, 2
2012-11-09T04:41:00	-22.9647	-24.9805	CTD54	2, 4, 5, 8, 11, 15, 16, 18, 24	300, 200, 175, 150, 120, 78, 58, 33, 2
2012-11-09T13:57:00	-24.1254	-25.0029	CTD55	2, 3, 4, 6, 9, 12, 13, 15, 24	300, 197, 175, 150, 120, 78, 58, 33, 2
2012-11-10T04:40:00	-25.7495	-24.9908	CTD56	2, 3, 5, 8, 11, 12, 15, 18, 24	300, 200, 182, 158, 121, 105, 70, 29, 2
2012-11-10T13:59:00	-26.9560	-25.0062	CTD57	2, 3, 4, 5, 8, 9, 11, 13, 24	300, 200, 182, 162, 121, 105, 70, 29, 2
2012-11-11T04:45:00	-28.3879	-25.4750	CTD58	2, 3, 5, 7, 11, 14, 16, 18, 24	300, 200, 177, 150, 118, 90, 50, 28, 2
2012-11-11T13:58:00	-29.1152	-26.5070	CTD59	2, 3, 4, 7, 9, 11, 14, 15, 24	300, 200, 177, 140, 118, 90, 50, 28, 2
2012-11-12T04:42:00	-30.1998	-27.9188	CTD60	2, 3, 5, 7, 10, 13, 15, 18, 24	300, 200, 154, 115, 100, 78, 59, 25, 2
2012-11-12T13:57:00	-30.9701	-29.0523	CTD61	2, 3, 4, 6, 8, 9, 10, 12, 24	300, 200, 180, 160, 120, 90, 70, 29, 2
2012-11-14T04:56:00	-34.1474	-33.4924	CTD62	2, 3, 6, 8, 9, 11, 15, 17, 24	300, 200, 91, 80, 70, 60, 35, 26, 5
2012-11-14T13:55:00	-34.8577	-34.5375	CTD63	2, 3, 4, 5, 7, 9, 10, 11, 23	300, 200, 91, 80, 60, 46, 35, 26, 5
2012-11-15T04:54:00	-36.0694	-36.2557	CTD64	2, 3, 4, 7, 9, 10, 17, 20, 24	300, 200, 100, 70, 60, 53, 35, 14, 3
2012-11-15T13:56:00	-36.8372	-37.4390	CTD65	2, 3, 4, 7, 9, 10, 14, 20, 24	300, 200, 100, 75, 60, 50, 35, 14, 2
2012-11-16T04:54:00	-38.1057	-39.3287	CTD66	2, 3, 4, 5, 8, 14, 18, 21, 24	300, 200, 100, 80, 50, 30, 20, 10, 2
2012-11-16T13:58:00	-38.9092	-40.5631	CTD67	2, 3, 4, 6, 9, 14, 19, 21, 24	300, 200, 100, 80, 60, 35, 20, 10, 2
2012-11-17T04:54:00	-40.1024	-42.3831	CTD68	2, 3, 4, 5, 7, 10, 17, 21, 24	300, 200, 100, 80, 60, 40, 25, 10, 3
2012-11-17T13:57:00	-40.9063	-43.6493	CTD69	2, 3, 4, 6, 8, 10, 13, 22, 24	300, 200, 100, 80, 60, 40, 25, 10, 2
2012-11-18T04:54:00	-42.1372	-45.6269	CTD70	2, 3, 4, 5, 8, 10, 17, 20, 24	300, 200, 100, 80, 60, 43, 20, 8, 3
2012-11-18T14:58:00	-43.0468	-47.0785	CTD71	2, 3, 4, 6, 8, 14, 19, 21, 24	300, 200, 100, 80, 60, 40, 20, 8, 3
2012-11-19T04:50:00	-43.9230	-48.5654	CTD72	2, 3, 4, 5, 9, 13, 18, 21, 24	300, 200, 100, 80, 60, 35, 20, 8, 3
2012-11-19T14:58:00	-44.6753	-49.7588	CTD73	2, 3, 4, 6, 8, 10, 19, 21, 24	300, 200, 100, 80, 60, 40, 20, 10, 2
2012-11-20T04:55:00	-45.5006	-51.3197	CTD74	2, 3, 4, 5, 8, 11, 14, 19, 24	300, 200, 100, 80, 60, 40, 30, 16, 2

Microbial community composition of the Atlantic Ocean

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Objectives

1. Collection of samples for the analysis of the bacterioplankton community composition using fluorescence *in situ* hybridization and catalyzed reporter deposition (CARD-FISH) to determine if:
   a) The composition of the microbial communities in surface waters is substantially different from that in the deep chlorophyll maximum (DCM) and mesopelagic water layers,
   b) Microbial groups differ in their horizontal distribution in the North and South Atlantic Ocean,
   c) Automatic microscopy is feasible onboard for determining microbial abundances.

2. Collection of samples for the analysis of the bacterioplankton and picoeukaryotic community composition in different size fractions via DNA extraction, PCR and comparative SSU rRNA sequence analysis. The aims of this part are to determine if:
   a) The composition of the microbial community varies between the different size fractions.
   b) There are specific associations between distinct bacterioplankton and picoeukaryote clades.

3. Analysis of the biochemical potential of the bacterioplanktonic community in contrasting oceanic provinces using polysaccharide incubation experiments and FISH to determine if:
   a) The substrate utilization varies in the different oceanic provinces sampled during AMT22.
   b) Polysaccharide incubations cause a selection of specific microbial taxa.
   c) What are the rates of substrate hydrolysis among mid-Atlantic microbial communities?

1. Sampling and Methodology

1.1. Fluorescence in situ hybridization with catalyzed reporter deposition (CARD-FISH)

Fresh seawater samples were collected from a Seabird CTD system fitted with 24 x 20 l Niskin bottles at each predawn and noon CTD cast for molecular identification of microorganisms using CARD-FISH. Samples were taken from the surface water layer (20 m), the deep chlorophyll maximum (DCM) layer and additionally at 1 - 2 depths below the DCM down to 300 m, representing the mesopelagic (upper aphotic) water layers. After fixation with particle-free formaldehyde solution (final concentration, 1% v/v) for 1-2 hours at room temperature the samples were filtered onto polycarbonate filters (type GTTP; pore size, 0.2 µm; diameter, 47 mm; Whatman, Florham Park, USA) and stored at -20 °C until further analysis. Prior to CARD-FISH, filters were cut into sections and embedded in agarose to avoid cell loss. For permeabilization of microbial cell walls, filter sections were incubated in lysozyme (10 mg mL^{-1}; Fluka, Taufkirchen, Germany) for 1 h at 37°C. Endogenous peroxidases were inactivated by using 3% H_2O_2 at room temperature for 3 min. Hybridization with HRP-labeled oligonucleotide probes and tyramide signal amplification was done according to the protocol by Pernthaler et al. (Pernthaler et al., 2002) with a hybridization of 3 hours and amplification of 45 min.

1.2. DNA extraction and PCR

Seawater samples were taken from the Seabird CTD system at every afternoon CTD cast. Samples were taken from 20 m depth. Between 10-40 L of seawater was filtered on 10 µm, 3 µm and 0.2 µm membrane filters. From all size fractions microbial DNA was extracted using the MoBio Ultra-clean Soil DNA Extraction Kit (MoBio Laboratories, Inc., Carlsbad, CA) and eukaryotic DNA was extracted using the DNeasy Plant Kit (Qiagen, Germany). Polymerase chain reaction (PCR) was performed using domain-specific primers to exponentially amplify a sequence of DNA. For bacteria and Archaea we targeted the 16S rRNA genes and for eukaryotes the 28S rRNA genes using universal primers. The PCR amplicons were visualized using an Invitrogen Gel and Go portable gel electrophoresis kit. The amplicons will be sequenced for in depth community analysis back in the laboratory.

1.3. Substrate incubations for measuring polysaccharide hydrolysis rates

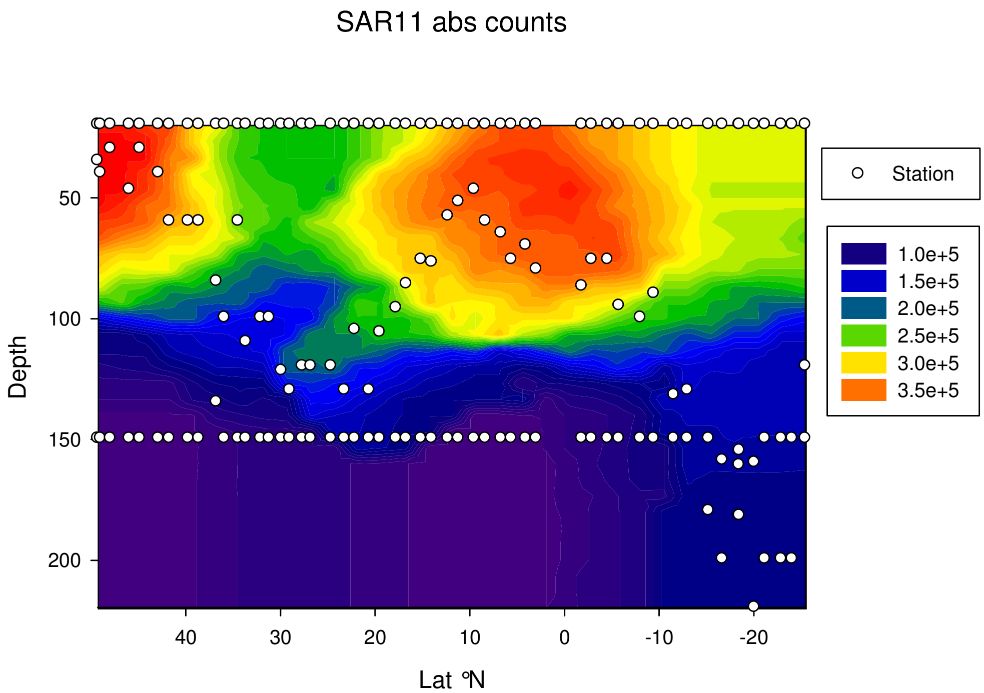
Substrate incubations were done with surface water samples from 6 CTD casts taken in different oceanic regions (NADR, NAG, WTRA, SAG). Subsamples of 500 mL were incubated for 18 days with one of 6 different fluorescein-labeled polysaccharides (laminarin, xylan, arabinogalactose, fucodian, chondroitin sulfate, and pullulan). Over the course of incubations, samples for DNA, FISH and hydrolysis rate analysis according to Arnosti (1995) were taken at 0, 3, 6, 12 and 18 days. The individual substrates were chosen based on their environmental relevance and linkage types. All time points of the incubation experiment will subsequently be analysed for the rate of polysaccharide degradation by capillary electrophoresis. This will give an indication of the enzymatic potential of the organisms present. FISH will be performed to analyse the microbial community change within the individual substrate incubation experiments. Additionally, the FISH filters will be analysed for fluorescein-incorporation.

CTD Samples analysed:

Samples were analysed from all 73 vertical CTD profiles taken during the AMT22 cruise. The depths analysed were; surface mixed layer (S 0 20 m), DCM (D, variable depth) and one or two deeper samples (150 m, 200 m or 300 m). They are listed in Table 1 (of this report) where we also indicated the stations from which substrate incubation experiments were performed, and the noon stations at which we performed fractionated filtration (>10 µm, >3 µm and > 0.2 µm) of mostly the 20 m sample.

Initial Results of CARD-FISH

First analyses by CARD-FISH were done onboard in order to determine the abundance of major bacterioplankton groups like SAR 11, Bacteroidetes and *Prochlorococcus* as well as some minor populations (Euryarchaea, Crenarchaea, *Roseobacter* etc). Preliminary results by automatic and manual microscope counting showed as a new finding that the abundance of SAR11 was similar in the surface waters of the North and South Atlantic Gyre, accounting for 30 - 40% of total bacteria (Fig. 1). The absolute cell numbers for SAR11 ranged between 1 – 5 x 10^5 mL^{-1}. Bacteroidetes were most abundant in temperate waters with a maximum of 5.7 x 10^5 mL^{-1} cells at the surface at station 68. *Synechococcus* and *Prochlorococcus* were distributed according to text book with *Prochlorococcus* dominating subtropical and tropical waters, and *Synechococcus* reaching a maximum of more than 0.5 x 10^6 ml^{-1} at the temperate station 68 in surface waters.



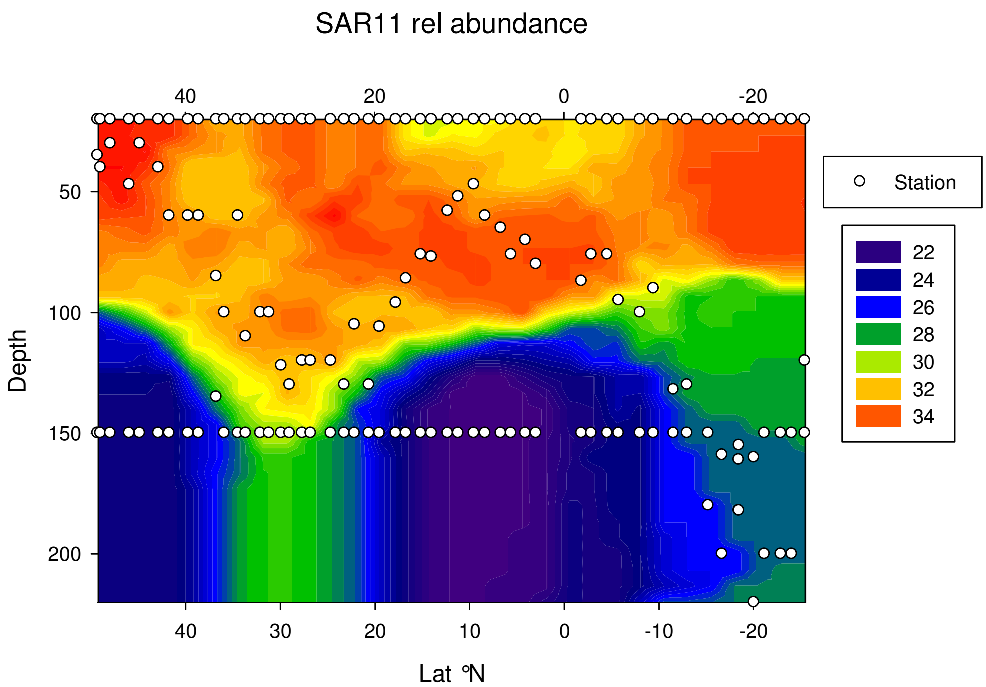


Figure 1 shows the absolute cell numbers (upper panel) and relative abundances (lower panel) of SAR11 as determined by automatic microscope counting along the cruise track.

Preliminary results of substrate incubations

During the cruise we examined individual substrate incubations and found that the microbial community changed quite rapidly during the first days of incubation. The change in the community is different from the no substrate control, which, however, also had a “bottle effect” as detected by changes in cell morphologies and counts. The change of community within individual substrate incubations also varies, which was observed through cell morphology and by FISH. Analyses of cell fluorescence also suggests significant differences in the uptake of the individual fluorescein-labeled polysaccharides over time.

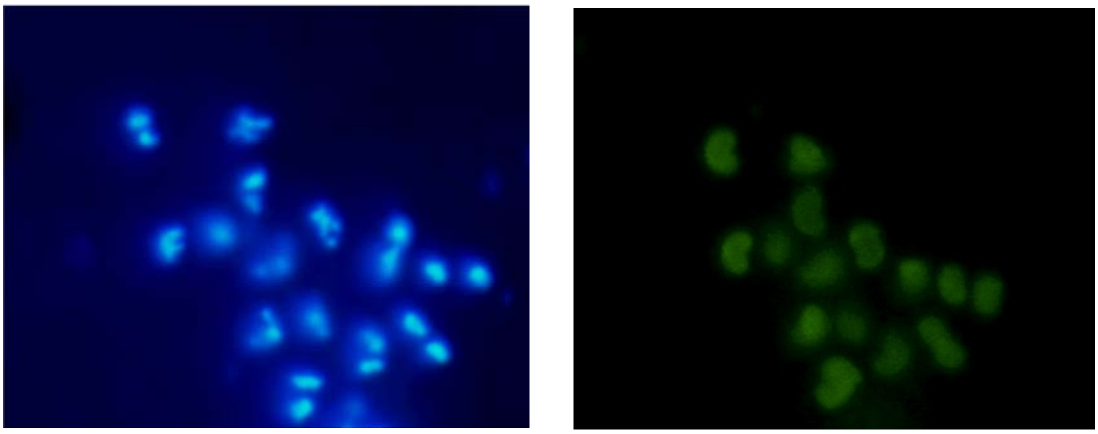


Figure 2. The image on the left shows cellular DNA stained with DAPI. DAPI is excited at 350 nm and emits a blue colour at 450 nm. The blue rod-shaped areas identify individual bacterial cells in a microcolony which had formed in a laminarin incubation by day 3. The image on the right shows the same microscopic field excited at 490 nm. The green colour is light emitting at 520 nm, indicative of fluorescein that the cells have incorporated when degrading the polysaccharide laminarin. In separate FISH experiments we gathered preliminary evidence for affiliation of these cells with Bacteroidetes.

Table 1: AMT 22 - Microbial Analysis - CTD Sampling Summary

CTD No	Latitude (°N)	Longitude (°E)	Date	Measurement	Substrate Incubation	DNA
2	49,249	-13,136	12-Oct-12	CARDFISH		+
3	48,928	-16,370	13-Oct-12	CARDFISH		
4	47,882	-17,267	13-Oct-12	CARDFISH	+	+
5	45,877	-18,608	14-Oct-12	CARDFISH		
6	44,760	-19,325	14-Oct-12	CARDFISH		+
7	42,801	-20,578	15-Oct-12	CARDFISH		
8	41,654	-21,265	15-Oct-12	CARDFISH		+
9	39,654	-22,510	16-Oct-12	CARDFISH		
10	38,555	-23,097	16-Oct-12	CARDFISH		+
11	36,686	-24,469	17-Oct-12	CARDFISH		
12	35,847	-25,594	17-Oct-12	CARDFISH	+	+
13	34,383	-27,638	18-Oct-12	CARDFISH		
14	33,561	-28,689	18-Oct-12	CARDFISH		+
15	32,022	-30,736	19-Oct-12	CARDFISH		
16	31,106	-31,908	19-Oct-12	CARDFISH		+
17	29,808	-33,550	20-Oct-12	CARDFISH		
18	28,936	-34,674	20-Oct-12	CARDFISH		+
19	27,615	-36,347	21-Oct-12	CARDFISH		
20	26,717	-37,471	21-Oct-12	CARDFISH		+
21	25,499	-38,983	22-Oct-12	CARDFISH		
22	24,595	-40,075	22-Oct-12	CARDFISH		+
23	23,164	-40,604	23-Oct-12	CARDFISH		
24	22,075	-39,798	23-Oct-12	CARDFISH	+	+
25	20,565	-38,593	24-Oct-12	CARDFISH		
26	19,443	-37,772	24-Oct-12	CARDFISH		+
27	17,710	-36,428	25-Oct-12	CARDFISH		
28	16,641	-35,657	25-Oct-12	CARDFISH		+
29	15,062	-34,447	26-Oct-12	CARDFISH		
30	13,956	-33,667	26-Oct-12	CARDFISH		+
31	12,219	-32,361	27-Oct-12	CARDFISH		
32	11,115	-31,577	27-Oct-12	CARDFISH		+
33	9,453	-30,328	28-Oct-12	CARDFISH		
34	8,297	-29,533	28-Oct-12	CARDFISH		+
35	6,621	-28,342	29-Oct-12	CARDFISH		
36	5,512	-27,543	29-Oct-12	CARDFISH		+
37	4,028	-26,469	30-Oct-12	CARDFISH		
38	2,920	-25,662	30-Oct-12	CARDFISH	+	+
39	1,108	-24,984	31-Oct-12	CARDFISH		
40	-1,108	-24,956	01-Nov-12	CARDFISH		+
41	-2,930	-24,984	01-Nov-12	CARDFISH		
42	-4,623	-25,004	02-Nov-12	CARDFISH		+
43	-5,829	-25,030	02-Nov-12	CARDFISH		
44	-8,089	-25,014	03-Nov-12	CARDFISH		+
45	-9,513	-25,053	03-Nov-12	CARDFISH		
46	-11,622	-25,021	04-Nov-12	CARDFISH	+	+
47	-13,073	-25,067	04-Nov-12	CARDFISH		

48	-15,287	-25,051	05-Nov-12	CARDFISH		+
49	-16,760	-25,098	05-Nov-12	CARDFISH		
50	-18,516	-25,101	06-Nov-12	CARDFISH		+
51	-18,530	-25,101	07-Nov-12	CARDFISH		+
52	-20,121	-24,497	08-Nov-12	CARDFISH		
53	-21,253	-24,846	08-Nov-12	CARDFISH		+
54	-22,965	-24,981	09-Nov-12	CARDFISH		
55	-24,125	-25,003	09-Nov-12	CARDFISH		+
56	-25,750	-24,991	10-Nov-12	CARDFISH	+	
57	-26,956	-25,006	10-Nov-12	CARDFISH		+
58	-28,388	-25,475	11-Nov-12	CARDFISH		
59	-29,115	-26,507	11-Nov-12	CARDFISH		+
60	-30,200	-27,919	12-Nov-12	CARDFISH		
61	-30,970	-29,052	12-Nov-12	CARDFISH		+
62	-34,147	-33,492	14-Nov-12	CARDFISH		
63	-34,858	-34,537	14-Nov-12	CARDFISH		+
64	-36,069	-36,256	15-Nov-12	CARDFISH		
65	-36,837	-37,439	15-Nov-12	CARDFISH		+
66	-38,106	-39,329	16-Nov-12	CARDFISH		
67	-38,909	-40,563	16-Nov-12	CARDFISH		+
68	-40,102	-42,383	17-Nov-12	CARDFISH		
69	-40,906	-43,649	17-Nov-12	CARDFISH		+
70	-42,137	-45,627	18-Nov-12	CARDFISH		
71	-43,047	-47,079	18-Nov-12	CARDFISH		+
72	-43,923	-48,565	19-Nov-12	CARDFISH		
73	-44,675	-49,759	19-Nov-12	CARDFISH		+
74	-455,006	-513,197	20-Nov-12	CARDFISH		

References

Arnosti, C. (1995) Measurement of depth- and site-related differences in polysaccharide hydrolysis rates in marine sediments. Geochim. Cosmochim. Acta 59: 4247-4257.

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Abundance and Composition of Microbial Plankton Communities by flow cytometry

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Objective

To determine the distribution, abundance and community structure of nano- and picophytoplankton, heterotrophic bacteria and heterotrophic nano- and picoplankton from CTD casts by flow cytometry.

Phytoplankton community structure and abundance by flow cytometry.

Fresh seawater samples were collected in clean 250 mL polycarbonate bottles 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. 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 generally analysed flow cytometrically within 4 hours of surfacing. Each stained sample was run twice through a Becton Dickinson FACSort flow cytometer: once to analyse sub-micron sized 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 & abundance**

DATE	STATION	CTD	TIME on deck (GMT)	LAT +N, -S	LONG W	DEPTHS
12-Oct	2	2	13:16	49.25	13.13	5 10 15 20 25 30 35 55 60 100 150 200
13-Oct	3	3	05:28	48.93	16.37	2 5 7 11 20 30 40 45 51 75 100 150 200
13-Oct	4	4	13:52	47.88	17.27	2 5 10 15 20 25 30 40 55 100 150 200
14-Oct	5	5	05:17	45.88	18.61	3 5 11 20 30 38 47 51 75 100 150 200
14-Oct	6	6	13:59	44.76	19.32	2 5 7 11 20 30 34 40 50 75 100 150 200
15-Oct	7	7	05:12	42.82	20.58	3 5 7 11 20 30 38 40 51 75 100 150 200
15-Oct	8	8	13:56	41.65	21.26	2 5 7 11 20 30 38 51 60 75 100 150 200
16-Oct	9	9	05:26	39.65	22.51	3 5 9 17 20 30 40 53 60 70 100 105 150 200
16-Oct	10	10	13:54	38.55	23.10	4 9 17 20 30 40 53 60 70 85 90 105 150 200
17-Oct	11	11	05:14	36.69	24.47	2 12 20 22 38 55 69 85 90 110 135 200
17-Oct	12	12	13:50	35.85	25.59	4 12 20 22 30 38 52 69 90 100 110 135 150 200
18-Oct	13	13	05:30	34.38	27.64	9 17 20 40 53 60 70 105 125 150 200
18-Oct	14	14	13:50	33.56	28.69	13 24 42 57 75 98 110 125 150 200
19-Oct	15	15	04:45	32.02	30.74	2 5 13 20 24 42 57 75 90 100 125 150 200
19-Oct	16	16	14:48	31.11	31.91	2 13 20 24 42 57 75 90 100 125 150 200
20-Oct	17	17	05:52	29.81	33.55	2 5 14 20 25 45 61 80 105 122 150 200
20-Oct	18	18	14:50	28.94	34.67	2 14 20 25 45 61 70 80 90 105 115 130 150 157 200
21-Oct	19	19	05:47	27.61	36.35	2 5 14 20 27 47 63 86 110 120 150 164 200
21-Oct	20	20	14:51	26.72	37.47	2 14 20 27 47 63 86 110 120 135 150 164 200

22-Oct	21	21	05:47	25.50	38.98	2 5 15 20 28 49 66 88 110 120 135 150 173 200
22-Oct	22	22	14:56	24.60	40.08	2 15 20 28 49 66 75 88 100 115 120 150 173 200
23-Oct	23	23	05:57	23.16	40.60	2 5 15 20 28 49 66 88 105 120 130 150 173 200
23-Oct	24	24	14:56	22.08	39.80	2 15 20 28 49 66 75 88 105 120 135 150 173 200
24-Oct	25	25	05:43	20.57	38.59	2 5 15 20 28 49 66 88 115 130 150 173 200
24-Oct	26	26	14:53	19.44	37.77	2 15 20 28 49 66 75 88 106 115 130 150 173 200
25-Oct	27	27	05:55	17.71	36.43	2 5 14 20 26 46 62 82 96 105 120 150 160 200
25-Oct	28	28	14:50	16.64	35.66	2 14 20 26 46 55 62 75 86 100 110 125 150 200
26-Oct	29	29	05:41	15.13	34.45	2 5 14 20 26 46 62 76 82 120 150 200
26-Oct	30	30	14:53	13.96	33.67	2 14 20 26 46 52 62 77 82 95 107 120 130 150 200
27-Oct	31	31	05:50	12.22	32.36	2 5 11 20 36 48 58 64 75 84 105 125 150 200
27-Oct	32	32	14:45	11.12	31.58	2 5 11 20 25 36 48 52 64 75 84 125 150 200
28-Oct	33	33	05:43	9.45	30.33	2 5 9 20 28 47 51 67 75 100 150 200
28-Oct	34	34	14:52	8.30	29.53	2 9 16 20 28 39 51 60 67 74 84 94 100 150 200
29-Oct	35	35	05:45	6.62	28.34	5 9 16 20 28 39 51 65 78 88 100 150 200
29-Oct	36	36	14:58	5.55	27.54	2 9 16 20 28 41 51 60 67 76 85 93 100 150 200
30-Oct	37	37	05:43	4.03	26.47	2 5 9 16 20 28 39 51 65 70 100 150 200
30-Oct	38	38	14:48	2.92	25.66	2 5 9 16 20 28 39 51 67 80 90 100 150 200
31-Oct	39	39	05:04	1.11	24.98	2 5 11 20 36 49 57 68 100 128 150 200
01-Nov	41	40	05:52	-1.88	24.96	2 5 11 20 36 49 65 75 87 100 128 150 200
01-Nov	42	41	14:50	-2.93	24.83	2 11 20 36 49 57 65 76 85 90 100 115 128 150 200
02-Nov	43	42	05:42	-4.62	25.00	2 5 13 20 25 44 59 76 84 92 102 120 150 200
02-Nov	44	43	14:47	-5.83	25.03	2 13 20 25 44 59 78 90 95 102 125 150 200
03-Nov	45	44	05:44	-8.09	25.01	2 5 13 20 25 44 59 70 78 90 100 120 150 200
03-Nov	46	45	14:45	-9.51	25.05	2 13 20 25 44 59 70 78 90 100 110 125 150 200
04-Nov	47	46	05:40	-11.62	25.02	2 13 20 25 44 59 70 78 90 100 120 132 150 200
04-Nov	48	47	14:46	-13.07	25.07	2 13 20 25 44 59 78 90 102 120 130 150 200
05-Nov	49	48	05:37	-15.29	25.05	5 16 20 29 52 70 92 105 120 145 150 180 200
05-Nov	50	49	14:56	-16.76	25.10	2 20 29 52 70 80 92 100 115 135 145 159 170 180 200
06-Nov	51	50	05:43	-18.52	25.10	2 16 20 29 52 70 92 105 121 140 161 182 200
07-Nov	51	51	15:31	-18.53	25.10	2 16 20 30 40 52 70 92 105 121 137 155 168 182 200
08-Nov	52	52	05:37	-20.12	24.50	2 5 20 37 65 77 89 105 117 135 160 185 220
08-Nov	53	53	14:55	-21.25	24.85	2 5 20 37 65 89 105 117 135 150 175 200
09-Nov	54	54	05:39	-22.96	24.98	2 16 20 33 58 78 95 110 120 135 150 175 200
09-Nov	55	55	14:50	-24.13	25.00	2 16 20 33 45 58 78 95 108 120 130 140 150 175 200
10-Nov	56	56	05:29	-25.75	24.99	2 5 16 20 29 52 70 92 105 121 140 158 182 200
10-Nov	57	57	14:47	-26.96	25.01	2 16 20 29 52 70 92 105 121 140 162 182 200
11-Nov	58	58	04:41	-28.39	25.48	2 15 20 28 50 68 90 105 118 135 150 177 200
11-Nov	59	59	14:47	-29.12	26.51	2 15 20 28 50 68 80 90 105 118 140 160 177 200
12-Nov	60	60	05:31	-30.20	27.92	2 13 20 25 44 59 78 90 100 115 130 154 200
12-Nov	61	61	14:50	-30.97	29.05	2 15 20 29 50 70 90 120 140 160 180 200
14-Nov	62	62	06:16	-34.15	33.49	5 8 15 20 26 35 46 60 70 80 91 100 200
14-Nov	63	63	14:52	-34.86	34.54	5 8 15 20 26 35 46 53 60 80 91 200
15-Nov	64	64	05:54	-36.07	36.26	2 8 14 20 26 35 46 53 60 70 85 100 200
15-Nov	65	65	14:50	-36.84	37.61	2 10 14 20 26 35 40 50 60 65 75 85 90 100 200
16-Nov	66	66	05:47	-38.11	39.33	2 10 20 25 30 35 40 45 50 60 80 100 200
16-Nov	67	67	14:45	-38.91	40.56	2 10 15 20 25 35 40 45 50 60 70 80 100 200
17-Nov	68	68	04:49	-40.10	42.38	3 10 15 20 25 30 35 40 50 60 70 80 100 200
17-Nov	69	69	14:44	-40.91	43.65	2 10 15 20 25 30 40 50 60 70 80 100 200
18-Nov	70	70	05:40	-42.14	45.63	2 8 16 20 27 37 43 50 60 69 80 200
18-Nov	71	71	15:44	-43.05	47.08	2 8 16 20 27 33 40 50 55 60 69 80 100 200
19-Nov	72	72	05:37	-43.92	48.57	2 5 8 16 20 25 30 35 40 50 60 69 80 100 200
19-Nov	73	73	15:40	-44.68	49.76	2 10 15 20 25 30 40 50 60 70 80 100 200
20-Nov	74	74	05:39	-45.50	51.32	2 8 16 20 25 30 35 40 50 60 70 80 100 200

Quantifying marine terpene emissions

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Background

The influence of isoprene (C_5H_8) and monoterpenes ($C_{10}H_{16}$) on climate through their effects on cloud formation and cloud microphysical properties in the remote marine boundary layer is currently poorly understood, mainly due to a lack of measurements in these regions (Shaw et al. 2010, Yassaa et al. 2008, Colomb et al. 2009). Isoprene and monoterpenes, highly reactive biogenic volatile organic compounds thought to be emitted by phytoplankton, are transferred to the atmosphere where they may react to form secondary organic aerosol (SOA). SOA in turn can act as cloud condensation nuclei, increasing cloud albedo (reflectivity) and hence radiative cooling through increasing the cloud droplet number concentration.

Aims

- Use of the measured concentrations in air and water alongside modelling approaches to infer sea-air fluxes in the remote marine boundary layer
- Investigation of links between phytoplankton communities and emissions
- Comparison of cruise data with isoprene data from the Cape Verde Atmospheric Observatory
- Model studies of the impact of oceanic terpenes on marine SOA and atmospheric chemistry (in collaboration with Dr Steve Arnold, University of Leeds).

Methods

Discrete air samples of 10 min (1 L air; increased to 20 min (2 L) during the cruise) sampling time were continuously sampled along the cruise track, alternating with water samples (2 min sampling time (84 mL water, purged with 1 L gas)); with a duration of 1.25-1.5 h per sampling cycle. Instrument problems resulted in several periods of missing or poor quality data and/or irregular sampling (see Table 1). Instrument sensitivity also decreased significantly throughout the cruise, resulting in much higher limits of detection and quantification towards the end.

Water samples were taken from the non-toxic seawater supply or from CTD casts at varying intervals and depths (see Table 2) and dissolved gases extracted using a purge-and-trap method similar to that described by Broadgate et al. (1997).

Analysis was performed on a coupled Thermal Desorption- Gas Chromatography- Mass Spectrometry system (TD-GC-MS; with automated purge & trap for water samples (Andrews et al., in preparation)).

Atmospheric ozone levels were measured with a photometric ozone analyser along the cruise track from the same air inlet as the GC-MS air samples (inlet on the monkey island).

Results/ Analysis

Ozone data will be quality controlled post-cruise. GC-MS data will be analysed to determine mixing ratios/concentrations of isoprene and several monoterpenes (focussing on α-pinene) in air and water samples.

Results will be quality controlled and filtered for pollution from the ship's exhaust based on wind direction and speed from the ship's meteorological data (reducing the dataset further than indicated in Table 1). We will determine sea-air fluxes using the measured concentrations in air and water and investigate correlations with chlorophyll-a/phytoplankton abundance (and functional type if available), light levels and wind data.

Table 1: Periods of missing data (preliminary)

Date (GMT) (start-end)	Approx. lat. / lon. (start-end)	Comment
22/10-23/10/2012	24°-22° N, 40° W	Data unusable for some analytes (esp. isoprene in air)
31/10-02/11/2012	0°-2.5° S, 25° W	No data collected
02/11/2012	5° S, 25° W	No data collected
05/11-11/11/2012	15° - 27° S, 25° W	Essentially no data collected

Table 2: Samples taken at stations

Date	Station #	CTD #	Time (GMT)	Latitude (N +, S -)	Longitude (W)	Niskin #	Depth (m)
12/10/2012	02	02	12:14	49°14.962’	13°3.129’	16, 17, 19, 22	20, 15, 10, 5
15/10/2012	07	07	4:25	42°49.045’	20°34.674’	4, 9, 12, 16, 18, 20, 24	100, 40, 30, 20, 11, 7, 2
17/10/2012	11	11	4:26	36°41.180’	24°28.127’	24	2
19/10/2012	16	16	13:57	31°06.342’	31°54.468’	5, 7, 9, 12, 21, 23, 24	125, 100, 75, 24, 20, 5 (x2), 2
23/10/2012	23	23	4:55	23°09.838’	40°36.221’	6, 8, 13, 14, 20, 22, 24	150, 130, 88, 66, 20 (x2), 5, 2
24/10/2012	26	26	14:01	19°26.572’	37°46.319’	23	2
26/10/2012	30	30	14:00	13°57.337’	33`40.031’	7, 10, 12, 14, 20, 21, 23	107, 77, 62, 46 (x2), 20, 14, 2
28/10/2012	34	34	14:06	08°17.77’	29°31.782’	22	5
30/10/2012	37	37	4:53	04°01.703’	26°28.158’	6, 8, 13, 19, 21, 22, 24	100 (x2), 70, 51, 20, 9, 5, 2
03/11/2012	46	45	13:56	-09°30.809’	25°03.209’	22	5
04/11/2012	48	47	13:58	-13°04.408’	25°04.002’	4, 6, 12, 20, 21, 22, 24	150, 130, 44 (x2), 20, 13, 5, 2
06/11/2012	51	50	4:56	-18°30.96’	25°06.07’	4	182
11/11/2012	58	58	4:45	-28°23.274’	25°28.501’	22, 24	5, 2
11/11/2012	59	59	13:58	-29°06.912’	26°30.421’	22, 24	5 (x2), 2
12/11/2012	61	61	13:49	-30°58.27'	29°03.12'	22, 24	5, 2
14/11/2012	62	62	4:56	-34°08.845’	33°29.543’	6, 11, 14, 19, 20, 22, 24	91, 62, 46, 20, 15, 8 (x2), 5
15/11/2012	64	64	4:54	-36°04.162’	36°15.344’	1, 16, 22, 24	500, 26, 5, 3
15/11/2012	65	65	13:56	-36°50.23’	37°26.34’	22, 23, 24	5, 3, 3
16/11/2012	66	66	4:54	-38°6.340’	39°19.721’	1, 22, 24	500, 5, 2
16/11/2012	67	67	13:58	-38°54.55’	40°33.788’	4, 10, 14, 18, 20, 21, 24	100, 50, 35, 20, 15, 10, 2
17/11/2012	68	68	4:54	-40°06.142’	42°22.984’	22, 24	5, 3
17/11/2012	69	69	13:07	-40°54.38'	43°38.959'	23, 24	5
18/11/2012	70	70	4:54	-42°08.231’	45°37.615’	21, 24	5, 3
18/11/2012	71	71	14:58	-43°02.81’	47°04.71’	1	500 (x3)
19/11/2012	72	72	4:50	-43°55.381’	48°33.922’	9, 13, 15, 18, 19, 21, 22, 24	60, 35, 25, 20, 15, 8, 5, 3
20/11/2012	74	74	4:55	-45°30.037’	51°19.182’	1, 22	500 (x2), 5

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Gross primary production, dark community respiration and net community production

Size-fractionated (> 0.8 µm, 0.8-0.2µm) respiration

Dissolved oxygen concentration in seawater (incl. CTD & underway calibrations)

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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. Net community production (NCP) is the balance between gross primary production (GPP) and community respiration (CR), and 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. In the long term, NCP represents the planktonic contribution to the marine and atmospheric CO_2 balances.
Bacteria play an important role in this balance, although their contribution to community respiration has been difficult to characterize because of the methodological difficulty in separating it from the rest of the community respiration. Most data are based on the size fractionation of a natural community and later incubation for 24 h. Recent methods based on the determination of the *in vivo* electron transport system activity (ETS-*iv*) allow size fractionation without distorting the natural community as the size-fraction is performed after the incubation. In addition, the short incubation time (2-4 h), reduces the liklihood of community structure changes and agrees with incubation times for bacterial production estimations.

The aims of this work are:

- To measure the dissolved oxygen concentration in the seawater.
- To calibrate the oxygen sensors on the CTD profiler and the underway supply of seawater.
- To determine the daily balance of gross primary production (GPP) and community respiration (CR).
- To determine the temporal variability of community respiration during the 24 h incubations.
- To determine the portion of respiration attributable to microbial plankton size-classes (> 0.8 µm; 0.8-0.2 µm).

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 to a c.v. of ca. 10^{-6}. For CTD and underway calibrations, 8 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, 37 profiles were carried out for the oxygen sensor calibration (Table 1) (see Thomas, this report). Each day, 5 samples were also collected from the underway seawater supply to compare with the optode O_2 measurements and with the O_2 concentration from the 5m Niskin bottle at the two CTD casts (pre-dawn and midday) (see Wager this report).
For the GPP, CR and NCP measurements, seawater from 6 depths down to the depth of the 0.1% incident irradiance were collected daily from the pre-dawn CTD into 10 L carboys. Each carboy was immediately sub-sampled into 12 125 mL glass O_2 bottles (4 light and 8 dark bottles). 4 dark bottles were immediately fixed for O_2 concentration, the remaining (4 dark, 4 light) bottles were placed in deck incubators for 24 hours. The incubators were covered with

neutral and blue density light filters simulating the PAR light at the corresponding dephts in the water column. Temperatures were simulated with the underway water for the upper 4 depths above the thermocline (down to ca. 3% light) and with refrigerated water for the samples collected at 1% and 0.1% light depths. Incubated light and dark O_2 bottles were removed from the incubators after the 24h incubation period and fixed and analysed for O_2. Production and respiration rates were calculated from the difference between the means of the replicated light and dark incubated bottles and zero time analyses (CR= Zero-Dark; NCP = Light-Zero; GPP = NCP + CR).

In total, 37 experiments were carried out for the determination of community production/respiration along the cruise (Table 1).

CR at the subsurface chlorophyl-a maximum (DCM) was also determined from *in vitro* changes in dissolved oxygen concentration continuously measured by an oxygen microprobe (Unisense Micro-respiration system) and recorded by a computer every 10 seconds. A seawater sample was collected from the DCM depth from the pre-dawn cast into a 10L polypropylene aspirator. After the subsampling of the 12 125 ml glass bottles for the GPP, NCP and CR incubations (see above), the water was siphoned from the aspirator into one 85 ml borosilicate glass chamber that was incubated in the dark in a temperature-controlled water bath at *in situ* temperature (± 0.3ºC). The oxygen microprobe was maintained continuously in the chamber. In total, 37 experiments were carried out for the determination of community production/respiration along the cruise (Table 1).

Size fractionated respiration (> 0.8 µm; 0.8-0.2 µm) was determined from the *in vivo* electron transport system (ETS) activity after 3 h dark incubations, following the procedure in Martínez-García *et al.* (2009). Seawater samples were collected from the surface and the deep chlorophyll-a maximum from the pre-dawn depth profiles into a 10L polypropylene aspirator. After the subsampling of the 12 125 ml glass bottles for the GPP, NCP and CR incubations, the water was siphoned from the aspirators into 4 250 ml glass bottles. 1 replicate was immediately fixed by adding formaldehyde (2% w/v final concentration) and used as a killed-control. After 15 minutes, the four samples were inoculated with a solution of 8 mM 2-para (iode-phenyl)-3(nitrophenyl)-5(phenyl) tetrazolium chloride (INT) to a final concentration of 0.6 mM. The solution was freshly prepared every two days using Milli-Q water. The water samples were incubated for 3 hours in the dark in the corresponding deck incubators. After incubation, the three live samples were fixed by adding formaldehyde (2% w/v final concentration). After 15 minutes, samples were filtered through 0.8 and 0.2 µm pore size polycarbonate filters, and stored frozen for further processing. In total, 37 experiments were carried out at the same stations as the P/CR incubations (Table 1).

Results

Productivity and respiration analyses (Winkler and microelectrode) were all performed on board, but data will be processed on return. Community and bacterial respiration measured with the in vivo ETS technique will be analyzed in the lab. during the following months. It is expected that all GPP, NCP and CR data will be deposited at BODC by June 2013.

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Table 1. Stations where GPP, CR and NCP were measured.

yyyy-mm-ddThh:mm:ss	Latitude [+ve deg N]	Longitude [+ve deg E]	CTD
2012-10-13T04:33:00	48,9277	-16,3695	CTD03
2012-10-14T04:30:00	45,8775	-18,6081	CTD05
2012-10-15T04:25:00	42,8174	-20,5779	CTD07
2012-10-16T04:43:00	39,6543	-22,5095	CTD09
2012-10-17T04:26:00	36,6863	-24,4688	CTD11
2012-10-18T04:30:00	34,3828	-27,6375	CTD13
yyyy-mm-ddThh:mm:ss	Latitude [+ve deg N]	Longitude [+ve deg E]	CTD
2012-10-19T04:56:00	32,0224	-30,7364	CTD15
2012-10-20T04:58:00	29,8077	-33,5500	CTD17
2012-10-21T04:55:00	27,6147	-36,3470	CTD19
2012-10-22T04:55:00	27,6147	-36,3470	CTD21
2012-10-23T04:55:00	23,1639	-40,6037	CTD23
2012-10-24T04:52:00	20,5651	-38,5932	CTD25
2012-10-25T04:55:00	17,7095	-36,4282	CTD27
2012-10-26T04:53:00	15,0621	-34,4472	CTD29
2012-10-27T04:55:00	12,2243	-32,3605	CTD31
2012-10-28T04:52:00	9,4525	-30,3282	CTD33
2012-10-29T04:53:00	6,6212	-28,3419	CTD35
2012-10-30T04:53:00	4,0284	-26,4693	CTD37
2012-10-31T04:53:00	1,1078	-24,9844	CTD39
2012-11-01T05:01:00	-1,8837	-24,9563	CTD40
2012-11-02T04:51:00	-4,6230	-25,0038	CTD42
2012-11-03T04:51:00	-8,0891	-25,0142	CTD44
2012-11-04T04:47:00	-11,6218	-25,0205	CTD46
2012-11-05T04:49:00	-15,2871	-25,1344	CTD48

yyyy-mm-ddThh:mm:ss	Latitude [+ve deg N]	Longitude [+ve deg E]	CTD
2012-11-06T04:56:00	-18,5160	-25,1012	CTD50
2012-11-08T04:49:00	-20,1212	-25,4969	CTD52
2012-11-09T04:41:00	-22,9647	-24,9805	CTD54
2012-11-10T04:40:00	-25,7495	-24,9908	CTD56
2012-11-11T04:45:00	-28,3879	-25,4750	CTD58
2012-11-12T04:42:00	-30,1998	-27,9188	CTD60
2012-11-14T04:56:00	-34,1474	-33,4924	CTD62
2012-11-15T04:54:00	-36,0694	-36,2557	CTD64
2012-11-16T04:54:00	-38,1057	-39,3287	CTD66
2012-11-17T04:54:00	-40,1024	-42,3831	CTD68
2012-11-18T04:54:00	-42,1372	-45,6269	CTD70
2012-11-19T04:50:00	-43,9230	-48,5654	CTD72
2012-11-20T04:55:00	-45,5006	-51,3197	CTD74

Phytoplankton Photosynthesis, Primary Production and Coloured Dissolved Organic Material

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OBJECTIVES.
During AMT22 integrated rimary production measurements were made at 37 stations on three size classes of phytoplankton from measurements taken from six to eight depths. Photosynthesis-irradiance curves were made at 36 stations at three depths in the water column. These measurements aim to fulfil the following objectives:

- *Provide an unique time series of spatially extensive and internally consistent observations on the structure and biogeochemical properties of planktonic ecosystems in the Atlantic Ocean that are required to validate models addressing questions related to the global carbon cycle. One of the key parameters is phytoplankton production. To this end a continuous long track series of primary production measurements has been made on AMT22 using methods synonymous to those used on previous AMT cruises.*
- *Assessment of the variation in photosynthesis in phytoplankton communities along the Atlantic Meridional transect.*
- *Measeurement of the absorption coefficient of Coloured dissolved organic material for satellite algorithm development.*

METHODS.
Primary production. Simulated *in situ* primary production was measured at 37 stations. Water samples were taken from pre-dawn (03:15-05:15 GMT) deployments of a SeaBird CTD rosette sampler with 24 x 20 L Niskin bottles on a stainless steel frame from 6 depths in the euphoic zone following the methods described in Tilstone et al. (2009). The samples were transferred from Niskin bottles to black carboys to prevent shock to the photosynthetic lamellae of the phytoplankton cells. Water from each sample was sub-sampled into three 75 mL clear polycarbonate bottles and three black polycarbonate bottles; all bottles were pre-cleaned following JGOFS protocols (IOC, 1994), to reduce trace metal contamination. Each sample was inoculated with between 185 and 740 kBq (5 - 15 µCi) $NaH^{14}CO_3$ according to the biomass of phytoplankton. The polycarbonate bottles were transferred to an on-deck (simulated *in situ*) incubation system using neutral density and blue filters to simulate subsurface irradiance over depth to 97%, 55%, 33%, 20%, 14%, 7%, 3%, 1% or 0.1% of the surface value and incubated from local dawn to dusk (10 – 16 h). The incubators were maintained at surface temperature by pumping sea water from a depth of ~7 m through the upper light level incubators (97, 55, 33, 14, 7 & 3 %) and from a chiller maintained at ±1°C of *in situ* temperature for the lower light level incubators (1 & 0.1%). To terminate the incubations, suspended material was filtered sequentially through 0.2µm, 2µm and 10 µm polycarbonate filters to measure pico-, nano- and microphytoplankton production respectively. The filters were exposed to concentrated HCl fumes for 8-12 h, immersed in scintillation cocktail and ^{14}C disintegration time per minute (DPM) was measured on board using a Packard, Tricarb 2900 liquid scintillation counter and the external standard and the channel ratio methods were applied to correct for quenching.

Photosynthesis-Irradiance Curves.

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

CDOM absorption coefficients ($a_{CDOM}(\lambda)$).

$a_{CDOM}(\lambda)$ was determined from 22-Oct to 19-Nov-2012 from surface water taken from CTD Niskin bottles. The seawater samples were filtered through 0.2 µm 25 mm Sartorius polycarbonate filters using acid-cleaned glassware. The first two 0.25 L of the filtered seawater was discarded. The absorption properties of the third sample were determined in 10 cm quartz cuvettes from 350 to 750 nm relative to a bi-distilled Milli-Q reference blank using a Perkin Elmer Lambda 35 spectrophotometer. $a_{CDOM}(\lambda)$ was calculated from the optical density of the sample and the cuvette path length (Tilstone et al. 2004).

Initial Results:

Figure 1 shows the variability in primary production along the cruise track in total and the three size fractions. Higher values are associated with both micro- and pico- production in the Bay of Biscay (~400 mg C m^{-2} d^{-1}), the equatorial upwelling (500-650 mg C m^{-2} d^{-1}) and the Patagonia shelf region (900-1600 mg C m^{-2} d^{-1}), whereas lower values predominantly from pico-production occur in the North Atlantic (100-300 mg C m^{-2} d^{-1}) and South Atlantic Gyres (150-250 mg C m^{-2} d^{-1}).

References:

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

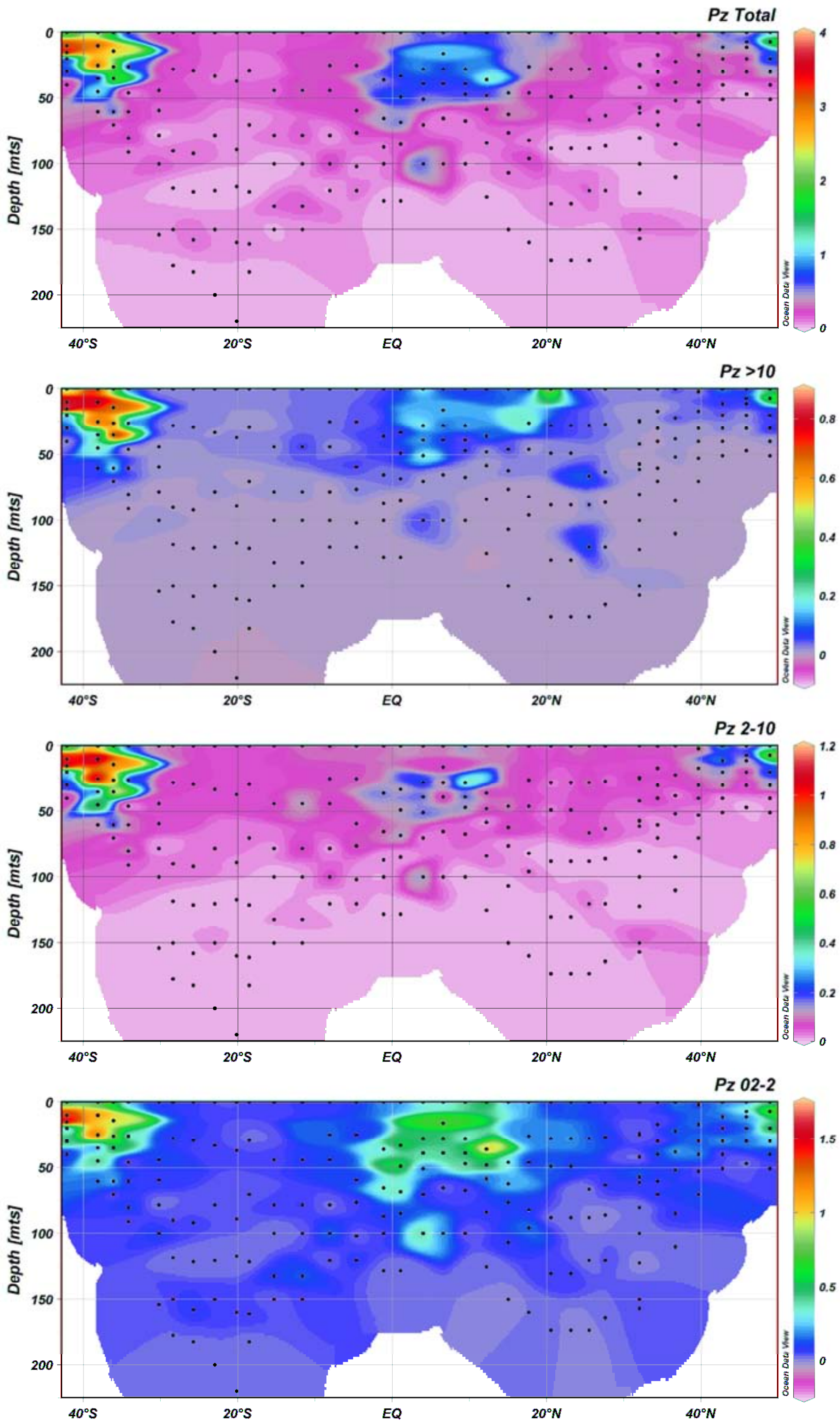
Tilstone, G.H., Smyth, T.J., Poulton, A, Hutson R. 2009. Measured and remotely sensed estimates of primary production in the Atlantic Ocean from 1998 to 2005. Deep-Sea Research, 56(15), 918-930.

Table 1. Stations at which size fractionated primary production (PP), phytoplankton photosynthesis (PE curves) and $a_{CDOM}(\lambda)$ ("PE curves" from 22-Oct to 19-Nov) were measured.

Latitude (dec deg)	Longitude (dec deg)	Date	Julian Day	Time	CTD No	Measurement
49.249	-13.136	12-Oct-12	286	12:10	2	PE Curves
48.928	-16.370	13-Oct-12	287	04:35	3	SIS PP
47.882	-17.267	13-Oct-12	287	13:01	4	PE Curves
45.877	-18.608	14-Oct-12	288	04:31	5	SIS PP
44.760	-19.325	14-Oct-12	288	13:03	6	PE Curves
42.801	-20.578	15-Oct-12	289	04:05	7	SIS PP
41.654	-21.265	15-Oct-12	289	13:03	8	PE Curves
39.654	-22.510	16-Oct-12	290	04:43	9	SIS PP
38.555	-23.097	16-Oct-12	290	12:59	10	PE Curves
36.686	-24.469	17-Oct-12	291	04:26	11	SIS PP
35.847	-25.594	17-Oct-12	291	12:58	12	PE Curves
34.383	-27.638	18-Oct-12	292	04:30	13	SIS PP
33.561	-28.689	18-Oct-12	292	12:59	14	PE Curves
32.022	-30.736	19-Oct-12	293	04:56	15	SIS PP
31.106	-31.908	19-Oct-12	293	13:57	16	PE Curves
29.808	-33.550	20-Oct-12	294	04:53	17	SIS PP
28.936	-34.674	20-Oct-12	294	13:57	18	PE Curves
27.615	-36.347	21-Oct-12	295	04:53	19	SIS PP
26.717	-37.471	21-Oct-12	295	14:00	20	PE Curves
25.499	-38.983	22-Oct-12	296	04:53	21	SIS PP
24.595	-40.075	22-Oct-12	296	14:02	22	PE Curves
23.164	-40.604	23-Oct-12	297	04:55	23	SIS PP
22.075	-39.798	23-Oct-12	297	14:01	24	PE Curves
20.565	-38.593	24-Oct-12	298	04:52	25	SIS PP
19.443	-37.772	24-Oct-12	298	14:01	26	PE Curves
17.710	-36.428	25-Oct-12	299	04:55	27	SIS PP
16.641	-35.657	25-Oct-12	299	14:00	28	PE Curves
15.062	-34.447	26-Oct-12	300	04:53	29	SIS PP
13.956	-33.667	26-Oct-12	300	14:00	30	PE Curves
12.219	-32.361	27-Oct-12	301	04:55	31	SIS PP
11.115	-31.577	27-Oct-12	301	13:58	32	PE Curves
9.453	-30.328	28-Oct-12	302	04:52	33	SIS PP
8.297	-29.533	28-Oct-12	302	14:00	34	PE Curves
6.621	-28.342	29-Oct-12	303	04:53	35	SIS PP
5.512	-27.543	29-Oct-12	303	14:00	36	PE Curves
4.028	-26.469	30-Oct-12	304	04:53	37	SIS PP
2.920	-25.662	30-Oct-12	304	14:01	38	PE Curves
1.108	-24.984	31-Oct-12	305	04:53	39	SIS PP + PE Curves
-1.108	-24.956	01-Nov-12	306	05:01	40	SIS PP

-2.930	-24.984	01-Nov-12	306	13:59	41	PE Curves
-4.623	-25.004	02-Nov-12	307	04:51	42	SIS PP
-5.829	-25.030	02-Nov-12	307	13:56	43	PE Curves
-8.089	-25.014	03-Nov-12	308	04:51	44	SIS PP
-9.513	-25.053	03-Nov-12	308	13:56	45	PE Curves
-11.622	-25.021	04-Nov-12	309	04:47	46	SIS PP
-13.073	-25.067	04-Nov-12	309	13:58	47	PE Curves
-15.287	-25.051	05-Nov-12	310	04:49	48	SIS PP
-16.760	-25.098	05-Nov-12	310	14:00	49	PE Curves
-18.516	-25.101	06-Nov-12	311	04:56	50	SIS PP
-18.530	-25.101	07-Nov-12	312	14:38	51	PE Curves
-20.121	-24.497	08-Nov-12	313	04:49	52	SIS PP
-21.253	-24.846	08-Nov-12	313	14:01	53	PE Curves
-22.965	-24.981	09-Nov-12	314	04:41	54	SIS PP
-24.125	-25.003	09-Nov-12	314	13:57	55	PE Curves
-25.750	-24.991	10-Nov-12	315	04:40	56	SIS PP
-26.956	-25.006	10-Nov-12	315	13:59	57	PE Curves
-28.388	-25.475	11-Nov-12	316	04:45	58	SIS PP
-29.115	-26.507	11-Nov-12	316	13:58	59	PE Curves
-30.200	-27.919	12-Nov-12	317	04:42	60	SIS PP
-30.970	-29.052	12-Nov-12	317	13:57	61	PE Curves
-32.867	-31.731	13-Nov-12	318	13:30	UW1	PE Curves
-34.147	-33.492	14-Nov-12	319	04:54	62	SIS PP
-34.858	-34.537	14-Nov-12	319	13:55	63	PE Curves
-36.069	-36.256	15-Nov-12	320	04:54	64	SIS PP
-36.837	-37.439	15-Nov-12	320	13:56	65	PE Curves
-38.106	-39.329	16-Nov-12	321	04:54	66	SIS PP
-38.909	-40.563	16-Nov-12	321	13:58	67	PE Curves
-40.102	-42.383	17-Nov-12	322	04:56	68	SIS PP
-40.906	-43.649	17-Nov-12	322	13:57	69	PE Curves
-42.137	-45.627	18-Nov-12	323	04:54	70	SIS PP
-43.047	-47.079	18-Nov-12	323	14:58	71	PE Curves
-43.923	-48.565	19-Nov-12	324	04:50	72	SIS PP
-44.675	-49.759	19-Nov-12	324	13:58	73	PE Curves
-45.5006	-51.3197	20-Nov-12	325	04:55	74	SIS PP

Figure 1. AMT22 Primary production (mg m^{-3} d^{-1}) in total (Pz Total), micro- (Pz >10), nano- (Pz 2-10), picophytoplankton (Pz 0.2-2) size fractions.



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), coccolithophore/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 provide 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.

Underway sampling

Discrete underway samples were collected from the ship's Surf-Met (underway surface and meteorological data collection) flow system in the CTD hangar lab 2 to 4 times per day. Samples for POC, PIC, BSi, and coccolithophore/coccolith enumeration were obtained along with chlorophyll samples taken for fluorometer calibration (underway 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.

Samples for coccolith and coccolithophore cell counts were collected on 0.45 µm Millipore HA (nitrocellulose) filters, rinsed with potassium tetraborate buffer, dried, mounted onto slides using Norland Optical Adhesive and then frozen at -20ºC. They will later be enumerated by birefringence microscopy.

Biogenic silica (BSi) samples were filtered onto 0.4 µm polycarbonate filters and dried in clean centrifuge tubes. The samples will be analyzed following the protocol of *Brzezinski* and Nelson (1989).

POC samples were filtered onto pre-combusted glass fiber filters, rinsed with 0.2 µm filtered seawater and dried. They were then fumed with concentrated HCl to remove inorganic carbon. They will be analyzed ashore at the University of Maine's Darling Marine Center.

Blanks for all filtered samples were collected weekly.

CTD sampling

During the pre-dawn CTD, five light depths and three deeper depths down to 500 m were typically analyzed for POC, PIC, BSi, and coccolith enumeration as described above. Typically, six light depths and two deeper depths down to 200m were also analyzed for PIC and BSi with only surface samples 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 ship's non-toxic sea water supply flowing at a rate of 3-4 liters per minute. Every 5-10 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 pore size, then 0.2µm pore size filter (during the intervening 4 minute segments).

Each morning an AC-9 and bb calibration was performed using 0.2 µm (absolute) filtered seawater. Once per week the entire system was disassembled, cleaned, and calibrated.

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 James Cook* using a Satlantic SeaWiFS Aircraft Simulator (MicroSAS). The same wavelengths are measured with the MicroSAS as are 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 the ship).

The system consists of a down-looking ocean radiance sensor and an up-looking sky-viewing radiance sensor, both mounted on the meteorological platform. The water-viewing radiance detector was set to view the ocean surface at 40^{o} from nadir and the sky-viewing radiance sensor was set to view the sky 40^{o} from zenith (used in the correction for Fresnel reflectance) as recommended by Mueller et al. (2003b). The downwelling irradiance sensor was mounted at the top of the pole holding the other sensors. Data from these sensors will be used to calculate spectral normalized water-leaving radiance (after filtering out white-caps and high pitch/roll anomalies) for comparison to the satellite estimates of normalized water-leaving radiance.

Sensors were rinsed regularly with Milli-Q water in order to remove salt deposits and any dust. The water radiance sensor was able to view over an azimuth range of ~180^{o} across the ship's heading with no contamination from the ship's deck or wake. The direction of the sensor was adjusted constantly to view the water 120^{o} from the sun's azimuth, to minimize sun glint. This was done using a computer-based system that calculated the sun's azimuth angle relative to the ship's heading and elevation constantly. The system used the ship's gyro-compass to determine the heading of the ship. Depending on the ship's course, the computer controlled a stepper motor that turned the sensors to the proper viewing angle. Protocols for operation and calibration were performed according to Mueller (Mueller et al. 2003a; Mueller et al. 2003b; Mueller et al. 2003c). Data were collected 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: 42 days
Above-water radiance measurements: 42 days
Underway samples: 84
CTD casts sampled: 72

CTD bottles sampled: 543

Total PIC samples collected: 627
Total POC samples collected: 418
Total coccolith enumeration samples collected: 419
Total biogenic silica samples collected: 627

Table 1: CTD discrete samples collected

Date	Station	CTD Cast	Latitude (N)	Longitude (E)	Depths Sampled
12/10/2012	2	2	49.25	13.13	300, 200, 60, 35, 25, 20, 10, 5
13/10/2012	3	3	48.93	16.37	300, 200, 51, 40, 30, 20, 11, 2
13/10/2012	4	4	47.88	17.27	200, 100, 55, 40, 30, 25, 15, 2
14/10/2012	5	5	45.88	18.61	300, 100, 51, 47, 38, 20, 11, 2
14/10/2012	6	6	44.76	19.32	300, 200, 50, 40, 34, 20, 11, 2
15/10/2012	7	7	42.82	20.58	300, 51, 40, 30, 20, 11, 7
15/10/2012	8	8	41.65	21.26	200, 75, 60, 51, 30, 20, 11, 2
16/10/2012	9	9	39.65	22.51	300, 200, 105, 70, 60, 40, 30, 2
16/10/2012	10	10	38.55	23.1	500, 300, 150, 105, 85, 60, 40, 20, 4
17/10/2012	11	11	36.69	24.47	300, 200, 135, 90, 85, 52, 38, 2
17/10/2012	12	12	35.85	25.59	500, 200, 100, 69, 52, 30, 12, 4
18/10/2012	13	13	34.38	27.64	500, 300, 105, 70, 60, 40, 17, 4
18/10/2012	14	14	33.56	28.69	200, 125, 110, 75, 57, 20, 3
19/10/2012	15	15	32.02	30.74	298, 150,100, 75, 57, 42, 24, 2
20/10/2012	17	17	29.81	33.55	500, 300, 150, 122, 105, 61, 45, 2
20/10/2012	18	18	28.94	34.67	157, 130, 105, 80, 61, 45, 25, 2
21/10/2012	19	19	27.61	36.35	500, 300, 150, 120, 86, 47, 27, 2
21/10/2012	20	20	26.72	37.47	164, 120, 110, 86, 63, 47, 27, 2
22/10/2012	21	21	25.5	38.98	500, 300, 200, 173, 120, 66, 49, 2
22/10/2012	22	22	24.6	40.08	200, 173, 120, 88, 66, 49, 28, 2
23/10/2012	23	23	23.16	40.6	500, 300, 200, 173, 130, 66, 49, 2
23/10/2012	24	24	22.08	39.8	173, 120, 105, 88, 66, 49, 28, 2
24/10/2012	25	25	20.57	38.59	500, 300, 200, 173, 130, 66, 49, 2
24/10/2012	26	26	19.44	37.77	173, 115, 106, 88, 66, 49, 28, 2
25/10/2012	27	27	17.71	36.43	500, 300, 200, 160, 96, 62, 46, 2
25/10/2012	28	28	16.64	35.66	160, 110, 86, 62, 46, 26, 14, 2
26/10/2012	29	29	15.13	34.45	500, 300, 200, 150, 76, 62, 46, 2
26/10/2012	30	30	13.96	33.67	150, 107, 82, 77, 62, 26, 14, 2
27/10/2012	31	31	12.22	32.36	500, 300, 200, 125, 84, 58, 36, 2
27/10/2012	32	32	11.12	31.58	2
28/10/2012	33	33	9.45	30.33	500, 300, 200, 100, 67, 47, 28, 2
28/10/2012	34	34	8.3	29.53	100, 67, 60, 39, 28, 16, 9, 5
29/10/2012	35	35	6.62	28.34	500, 300, 200, 100, 65, 39, 28, 5
29/10/2012	36	36	5.55	27.54	100, 76, 67, 51, 41, 28, 16, 2
30/10/2012	37	37	4.03	26.47	500, 300, 200, 100, 70, 51, 28, 2
30/10/2012	38	38	2.92	25.66	100, 80, 67, 51, 39, 28, 9, 2
31/10/2012	39	39	1.11	24.98	500, 300, 200, 128, 68, 49, 36, 2
01/11/2012	41	40	-1.88	24.96	500, 128, 87, 2
01/11/2012	42	41	-2.93	24.83	128, 85, 76, 65, 49, 36, 11, 2
02/11/2012	43	42	-4.62	25	500, 300, 200, 150, 76, 59, 44, 2
02/11/2012	44	43	-5.83	25.03	200, 150, 95, 78, 59, 44, 13, 2
03/11/2012	45	44	-8.09	25.01	500, 300, 200, 150, 100, 59, 44, 2
03/11/2012	46	45	-9.51	25.05	90, 2
04/11/2012	47	46	-11.62	25.02	300, 132, 100, 59, 44, 25, 2

Date	Station	CTD Cast	Latitude (N)	Longitude (E)	Depths Sampled
04/11/2012	48	47	-13.07	25.07	150, 130, 78, 59, 44, 25, 13, 2
05/11/2012	49	48	-15.29	25.05	500, 300, 200, 145, 120, 70, 29, 5
05/11/2012	50	49	-16.76	25.1	200, 180, 159, 135, 92, 29, 2
06/11/2012	51	50	-18.52	25.1	300, 200, 161, 121, 92, 70, 29, 2
07/11/2012	51	51	-18.53	25.1	200, 155, 121, 92, 52, 30, 16, 2
08/11/2012	52	52	-20.12	24.5	500, 300, 220, 160, 117, 77, 37, 2
08/11/2012	53	53	-21.25	24.85	220, 150, 89, 65, 37, 20, 2
09/11/2012	54	54	-22.96	24.98	500, 300, 200, 150, 120, 78, 58, 2
09/11/2012	55	55	-24.13	25	197, 150, 95, 78, 58, 33, 16, 2
10/11/2012	56	56	-25.75	24.99	500, 300, 200, 158, 121, 70, 29, 2
10/11/2012	57	57	-26.96	25.01	162, 2
11/11/2012	58	58	-28.39	25.48	300, 150, 118, 68, 50, 28, 2
11/11/2012	59	59	-29.12	26.51	177, 140, 105, 80, 50, 28, 15, 2
12/11/2012	60	60	-30.2	27.92	500, 300, 154, 100, 78, 59, 44, 2
12/11/2012	61	61	-30.97	29.05	200, 160, 120, 90, 70, 50, 29, 2
14/11/2012	62	62	-34.15	33.49	500, 200, 91, 60, 46, 26, 15, 5
14/11/2012	63	63	-34.86	34.54	200, 91, 60, 46, 35, 26, 15, 5
15/11/2012	64	64	-36.07	36.26	500, 200, 100, 60, 46, 35, 14, 3
15/11/2012	65	65	-36.84	37.61	200, 100, 80, 65, 50, 35, 20, 3
16/11/2012	66	66	-38.11	39.33	500, 200, 100, 50, 35, 20, 10, 2
16/11/2012	67	67	-38.91	40.56	200, 100, 60, 45, 35, 20, 10, 2
17/11/2012	68	68	-40.1	42.38	500, 200, 100, 50, 30, 20, 10, 3
17/11/2012	69	69	-40.91	43.65	40, 5
18/11/2012	70	70	-42.14	45.63	500, 300, 60, 37, 27, 20, 8, 3
18/11/2012	71	71	-43.05	47.08	200, 100, 60, 40, 27, 16, 8, 3
19/11/2012	72	72	-43.92	48.57	500, 300, 100, 60, 35, 25, 16, 3
19/11/2012	73	73	-44.68	49.76	200, 100, 50, 40, 30, 20, 10, 2
20/11/2012	74	74	-45.5	51.32	500, 200, 100, 60, 30, 20, 8, 2

Underway discrete samples collected

Sample	Date and Time (UT)	Latitude N	Longitude E
AA	11/10/2012 19:00	49.5253	-9.3922
AC	12/10/2012 7:24	49.3215	-11.9602
AF	12/10/2012 19:09	49.1497	-14.3943
AH	13/10/2012 08:28	48.5399	-16.8182
AK	13/10/2012 20:07	46.9283	-17.9025
AL	14/10/2012 08:05	45.4891	-18.8551
AO	14/10/2012 20:14	43.8589	-19.8883
AQ	15/10/2012 08:05	42.3826	-20.8038
AT	15/10/2012 20:10	40.7053	-21.8363
AV	16/10/2012 08:05	39.2826	-22.6723
AY	16/10/2012 20:05	37.6307	-23.6302
AZ	17/10/2012 08:04	36.3626	-24.8553
BC	17/10/2012 19:59	35.1611	-26.5278
BE	18/10/2012 08:04	34.0797	-27.9544
BH	18/10/2012 20:17	32.8237	-29.6502
BI	19/10/2012 08:59	31.6561	-31.1808
BK	19/10/2012 17:05	30.9993	-32.0387
BL	20/10/2012 20:55	28.3574	-35.4185
BM	20/10/2012 09:01	29.4822	-33.9841

Sample	Date and Time (UT)	Latitude N	Longitude E
BO	20/10/2012 21:04	28.3403	-35.4401
BP	21/10/2012 09:02	27.2547	-36.7943
BS	21/10/2012 20:51	26.1388	-38.1782
BT	22/10/2012 09:02	25.1347	-39.4099
BW	22/10/2012 21:00	24.0081	-40.7972
BX	23/10/2012 09:12	22.713	-40.2976
BY	23/10/2012 20:59	21.4671	-39.3262
BZ	23/10/2012 09:04	22.7318	-40.3114
CB	24/10/2012 20:59	18.6072	-37.1453
CC	25/10/2012 09:14	17.2566	-36.1283
CE	25/10/2012 21:00	15.869	-35.0943
CF	26/10/2012 09:01	14.6011	-34.1546
CH	26/10/2012 20:34	13.1949	-33.1089
CI	27/10/2012 09:01	11.7868	-32.0714
CL	27/10/2012 21:03	10.3576	-31.0328
CM	28/10/2012 08:57	9.0016	-30.0301
CP	28/10/2012 21:04	7.5278	-28.9587
CQ	29/10/2012 08:57	6.2165	-28.02
CT	29/10/2012 21:23	4.7308	-26.9616
CU	30/10/2012 09:16	3.5654	-26.1256
CX	30/10/2012 21:08	2.1528	-25.1094
CY	31/10/2012 09:08	0.644	-25.0008
CZ	31/10/2012 13:00	0.0895	-24.9992
DA	1/11/2012 9:05	-2.3525	-25.0126
DC	1/11/2012 21:12	-3.7759	-25.026
DD	2/11/2012 9:01	-5.1041	-25.0343
DF	2/11/2012 21:01	-6.8648	-25.0348
DG	3/11/2012 9:07	-8.6648	-25.0456
DI	3/11/2012 17:04	-9.8086	-25.0539
DJ	3/11/2012 21:04	-10.5604	-25.0548
DK	4/11/2012 9:16	-12.2548	-25.0636
DN	4/11/2012 21:04	-14.0847	-25.0789
DO	5/11/2012 9:11	-15.9092	-25.0675
DR	5/11/2012 21:02	-17.5871	-25.0951
DS	6/11/2012 9:05	-18.5358	-25.0828
DU	6/11/2012 20:36	-18.502	-25.1206
DW	7/11/2012 21:00	-19.2159	-24.8243
DX	8/11/2012 9:09	-20.5791	-24.66
EA	8/11/2012 21:05	-22.0361	-24.9954
EB	9/11/2012 9:18	-23.4813	-25.0044
ED	9/11/2012 20:57	-24.9264	-25.005
EE	10/11/2012 9:02	-26.2526	-25.0061
EF	10/11/2012 17:15	-27.2018	-25.0169
EH	11/11/2012 9:08	-28.6774	-25.9126
EI	11/11/2012 20:59	-29.6467	-27.2312
EJ	12/11/2012 9:04	-30.4951	-28.3748
EL	12/11/2012 20:25	-31.5464	-29.8363
EM	13/11/2012 09:02	-32.6091	-31.3737
EN	13/11/2012 17:08	-33.1721	-32.1343
EO	13/11/2012 21:05	-33.5633	-32.651
EP	14/11/2012 09:00	-34.3805	-33.8707

Sample	Date and Time (UT)	Latitude N	Longitude E
ER	14/11/2012 21:05	-35.4806	-35.447
ES	15/11/2012 09:21	-36.376	-36.7719
EU	15/11/2012 20:58	-37.4008	-38.2689
EV	16/11/2012 08:59	-38.4209	-39.8055
EX	16/11/2012 17:17	-39.0978	-40.8457
EY	16/11/2012 20:35	-39.4437	-41.3788
EZ	17/11/2012 09:02	-40.4053	-42.8866
FB	17/11/2012 16:58	-41.0431	-43.8819
FC	17/11/2012 21:05	-41.4809	-44.5303
FD	18/11/2012 10:05	-42.5755	-46.3034
FG	18/11/2012 22:05	-43.4903	-47.8067
FH	19/11/2012 10:01	-44.3005	-49.1018
FK	19/11/2012 22:02	-45.111	-50.5294
FL	20/11/2012 10:01	-45.9943	-52.3657
FM	20/11/2012 13:56	-46.4623	-53.3593

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Aerosol Organic Nitrogen

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Rationale

Organic nitrogen compounds are thought to comprise between 20 – 30 % of total nitrogen in aerosols, however, very little is known about their composition or sources in comparison with the more widely studied inorganic nitrogen compounds. Furthermore, the open ocean environment is under-represented in current datasets. AMT therefore provides an excellent opportunity to sample over a large spatial range, under different atmospheric regimes, in the open ocean environment and increase the data available for these environments. By quantifying and further characterizing this important organic nitrogen component, the data obtained can be included in nitrogen nutrient budgets and determine possible effects on primary production.

Sample Collection

Two high volume air samplers were mounted on the monkey island of the ship. Both samplers were equipped with cascade impactors to allow size-segregated collection of aerosols (broadly into submicron and supermicron size categories). One collector was loaded with cellulose filters (cellulose filters were acid-washed in HCl and HNO_3) for the collection of samples for trace metal analysis. The other collector was loaded with glass microfibre filters (washed in Milli-Q water and ashed for 6 hours at 450 ^oC), for the collection of samples for major ion and organic matter analysis. Both samplers were operated using an air flow of 1 m^3 min^{-1} and were calibrated every other day. To prevent contamination of the samples by the ship stack the samplers were controlled using a wind sector controller (WSC). The WSC automatically shut down the samplers under meteorological conditions that were likely to lead to contamination. Samplers were operated for a 24 hour period at a time for the majority of the cruise. However, cleaner atmospheric conditions in the southern hemisphere meant that sampling was switched to 48 hours toward the end of the cruise. Once collected, the filters were frozen at -20 ^{o} C and they will remain frozen until the ship returns to the UK. Table 1 shows the details of the samples collected.

Analysis

Aqueous extraction of the filters will be followed by a range of analyses to characterize the nutrient content of the aerosols. Ion Chromatography will be used for major ion analysis (including NH_4^+, NO_3^- and NO_2^-). Bulk organic nitrogen will be calculated by difference from measurements of total nitrogen and the sum of the inorganic components (NH_4^+, NO_3^- and NO_2^-). Methods are currently being developed at UEA that will allow a more speciated analysis of the bulk organic nitrogen present in the aerosols.

Table 1:Aerosol sampling days. ‘I’ in the sample name indicates a major ion (glass microfibre) sample. ‘M’ indicates a trace metal (cellulose filter) sample.

Sample Name	Sampling Start			Sampling End		
	Date	Latitude	Longitude	Date	Latitude	Longitude
AMT22I03 AMT22M03	13/10/12	47° 55.83 N	17° 14.04 W	14/10/12	44° 26.08 N	19° 31.75 W
AMT22I04 AMT22M04	14/10/12	44° 26.08 N	19°31.75 W	15/10/12	41°43.69 N	21°3.12 W
AMT22I05 AMT22M05						
AMT22I06 AMT22M06	16/10/12	37°45.84 N	23°33.11 W	17/10/12	36°61 N	25°54.55 W
AMT22I07 AMT22M07	17/10/12	35°10.50 N	26°30.58 W	18/10/12	33°16.23 N	29°3.7 W

AMT22I08 AMT22M08	19/10/12	31°6.41 N	31°54.37 W	20/10/12	28°57.75 N	34°38 W
AMT22I09 AMT22M09	20/10/12	28°56.16 N	34°40.46 W	21/10/12	26°43.11 N	37°28.36 W
AMT22I10 AMT22M10	21/10/12	26°29.07 N	37°45.40 W	22/10/12	24°9.01 N	40°37.13 W
AMT22I11 AMT22M11	22/10/12	24°2.5 N	40°45.3 W	23/10/12	21°32.2 N	39°22.7 W
AMT22I12 AMT22M12	23/10/12	21°32.2 N	39°22.7 W	24/10/12	18°47.68 N	37°17.11 W
AMT22I13 AMT22M13	24/10/12	18°35.6 N	37°8.1 W	25/10/12	15°49.84 N	35°3.89 W
AMT22I14 AMT22M14	25/10/12	15°49.84 N	35°3.89 W	26/10/12	13°11.82 N	33°6.6 W
AMT22I15 AMT22M15	26/10/12	13°11.82 N	33°6.6 W	27/10/12	10°20.7 N	31°1.41 W
AMT22I16 AMT22M16	27/10/12	10°20.7 N	31°1.41 W	28/10/12	7°43.3 N	29°6.1 W
AMT22I17 AMT22M17	28/10/12	7°31.7 N	28°57.5 W	29/10/12	5°32.77 N	27°32.5 W
AMT22I18 AMT22M18	29/10/12	5°32.77 N	27°32.W	30/10/12	3°2.29 N	25°44.5 W
AMT22I19 AMT22M19	30/10/12	2°18.07 N	25°12.9 W	01/11/12	2°42.8 S	25°0.80 W
AMT22I20 AMT22M20	01/11/12	2°55.79 S	24°59.04 W	02/11/12	5°42.90 S	25°1.82 W
AMT22I21 AMT22M21	02/11/12	5°9.76 S	25°1.79 W	03/11/12		
AMT22I22 AMT22M22	03/11/12			04/11/12	13°4.33 S	25°3.42 W
AMT22I23 AMT22M23	04/11/12	13°4.33 S	25°3.42 W	05/11/12	16°.41.57 S	25°5.52 W
AMT22I24 AMT22M24	05/11/12	16°.41.57 S	25°5.52 W	06/11/12	18° 32 S	25°5.7 W
AMT22I25 AMT22M25	06/11/12	18°320.6 S	25°5.39 W	07/11/12	18°31.7 S	25° 7.0 W
AMT22I26 AMT22M26	07/11/12	18°31.7 S	25°6.0 W	08/11/12	22°5.5 S	24°59.68 W
AMT22I27 AMT22M27	08/11/12	22°5.5 S	24°59.68 W	09/11/12	24°11.2 S	25°0.4 W
AMT22I28 AMT22M28	09/11/12	26°50 S	25° 0 W	10/11/12	26°57 S	25°0.57 W
AMT22I29 AMT22M29	10/11/12	26°57 S	25°0.57 W	11/11/12	29°69 S	26°30 W
AMT22I30 AMT22M30	11/11/12	29°14.9 S	26°41 W	12/11/12	30°56.1 S	28°59 W
AMT22I31 AMT22M31	12/11/12	31°6 S	29°14.9 W	14/11/12	34°51.46 S	34°31 W
AMT22I32 AMT22M32	14/11/12	34°56 S	34° 38 W	16/11/12	38°50.7 S	40°27.9 W
AMT22I33 AMT22M33	16/11/12	39°25.6 S	41°21.1 W	18/11/12	43°047 S	47°079 W
AMT22I34 AMT22M34	18/11/12	43°31.39 S	47°51.37 W	20/11/12		

Pigments for HPLC analysis

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Seawater samples were collected from the predawn and noon CTD casts. Seawater was sampled 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 at Plymouth Marine Laboratory after the cruise.

Table 1: CTDs sampled, light level and depth.

CTD number	Light / %	Depths / m
002	1 7 14 33 55 97	
003	1 7 14 33 55 97	
004	1 7 14 33 55 97	
005	DCM 7 14 33 55 97	47 30 20 20 7 3
006	1 DCM 14 33 55 97	50 34 20 11 7 2
007	1 DCM 7 14 33 97	51 40 30 20 11 2
008	DCM 1 3 7 33 97	63 51 38 30 11 2
009	1 3 7 14 33 97	70 53 40 30 17 3
010	DCM DCM2 7 14 33 97	85 60 40 30 17 4
011	DCM DCM 7 14 33 97	110 85 52 38 22 2
012	0.1 DCM 3 7 33 97	135 100 69 52 22 4
013	1 DCM 7 14 33 97	70 60 40 30 17 4
014	DCM 7 14 33 97	125 110 57 42 24 3
015	0.1 DCM 7 14 33 97	150 100 57 42 24 2
016	0.1 DCM 7 14 33 97	150 100 75 42 24 2
017	0.1 DCM 3 7 33 97	157 122 80 61 25 2
018	0.1 DCM 1 7 33 97	157 130 105 61 25 2
019	0.1 DCM 3 7 33 97	164 120 8663 27 2
020	0.1 DCM 3 7 33 97	164 120 86 63 27 2
021	0.1 DCM 3 7 33 97	173 120 88 66 28 2
022	0.1 DCM 3 14 33 97	173 120 88 49 28 2
023	0.1 DCM 3 14 33 97	173 130 88 49 28 2
024	0.1 DCM 3 14 33 97	173 105 80 66 28 2
025	0.1 DCM 3 14 33 97	173 130 88 49 28 2
026	0.1 DCM 3 14 33 97	173 106 88 66 25 2
027	0.1 DCM 3 14 33 97	160 96 82 46 26 2
028	0.1 DCM 3 14 33 97	160 86 62 46 26 2
029	0.1 1 DCM 7 14 97	150 107 76 62 46 2
030	0.1 1 DCM 7 14 97	150 107 77 46 16 2
031	0.1 1 DCM 7 14 97	125 84 58 48 36 2
032	0.1 1 DCM 7 14 97	125 84 52 36 20 2
033	0.1 1 DCM 7 14 97	100 67 47 39 28 2
034	0.1 DCM 7 14 33 97	100 60 39 28 16 2
035	0.1 DCM 7 14 33 97	100 65 39 28 16 2
036	0.1 DCM 1 7 33 97	100 76 67 41 16 2
037	0.1 DCM 3 7 14 97	100 70 51 39 28 2
038	0.1 DCM 1 3 14 97	100 80 67 51 28 2

039	0.1 1 DCM 7 33 97	128 85 68 49 20 2
CTD number	Light / %	Depths / m
041	0.1 DCM 7 33 97	128 100 57 65 36 4.5
042	0.1 DCM 3 14 97	128 100 76 65 36 2
043	0.1 1 DCM 7 33 97	120 102 76 59 25 2
044	0.1 1 DCM 3 7 97	125 102 95 78 44 2
045	DCM 3 14 33 97	120 100 76 44 25 2
046	0.1 DCM DCM2 3 14 97	150 110 90 78 44 2
047	0.1 DCM 1 3 14 97	150 132 100 78 44 2
048	0.1 DCM 1 3 14 97	150 130 102 78 44 2
049	0.1 DCM 1 7 33 97	180 145 120 70 29 2
050	DCM 14 97	200 159 115 80 52 2
051	0.1 DCM 1 7 33 97	182 161 121 70 29 2
051		182 155 121 70 40 2
052	0.1 DCM 3 7 33 97	220 160 117 89 37 2
053	DCM 3 7 33 97	200 150 117 89 37 2
054	0.1 DCM 3 7 33 97	200 150 120 78 33 2
055	0.1 DCM 3 7 33 97	197 150 120 78 33 2
056	0.1 DCM 1 3 33 97	182 158 121 92 29 2
057	0.1 DCM 1 7 33 97	182 162 121 70 29 2
058	0.1 DCM 1 3 33 97	177 150 118 90 28 2
059	0.1 DCM 1 3 33 97	177 140 118 90 28 2
060	0.1 DCM 3 7 14 97	154 100 78 59 44 2
061	0.1 DCM 1 7 14 97	180 160 120 70 50 2
062	0.1 DCM 3 14 97	91 80 60 46 26 5
063	0.1 1 DCM 14 33 97	91 80 60 46 26 5
064	0.1 1 DCM 14 33 97	70 60 35 26 14 3
065	0.1 DCM 3 7 33 97	75 60 35 26 14 2
066	0.1 1 DCM 7 33 97	60 45 35 25 15 2
067	0.1 3 DCM 7 33 97	70 60 35 25 15 2
068	0.1 1 DCM 14 33 97	40 30 20 15 10 3
069	0.1 1 DCM 14 33 97	40 30 25 15 10 2
070	0.1 1 3 DCM 33 97	60 37 27 20 8 3
071	0.1 DCM 7 33 97	69 55 40 20 8 3
072		69 60 35 20 8 3
073		60 40 30 20 10 2
074	0.1 1 DCM 7 33 97	60 40 30 20 8 2

Understanding The Relationship Between Phytoplankton Carbon And Optical Scattering

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Goals

The overall goal of our project is to devise a remote-sensing algorithm to estimate phytoplankton carbon biomass from space, independently of chlorophyll concentration. To this aim, two steps are required: 1) to measure phytoplankton carbon (C_{phyto}) within the variety of water masses and phytoplankton communities encountered along the AMT transect and 2) to relate C_{phyto} to optical measurements retrievable from space.

Methods

Discrete samples were collected from the ship's underway seawater supply. For each of these underway samples (see Table 1), the following parameters were determined (corresponding references in brackets):

1) phytoplankton carbon biomass (Graff et al. 2012)
2) flow-cytometric analysis (Graff et al. 2012)
3) particle size distribution (e.g., Dall'Olmo et al. 2009)
4) particulate organic carbon (Behrenfeld and Boss 2006)
5) phytoplankton pigments (High Performance Liquid Chromatography, Van Heukelem and Thomas 2001)

In addition, the following optical measurements from the ship's underway water were determined quasi-continuously (Dall'Olmo et al. 2009; Behrenfeld et al. 2006):

1) particulate backscattering coefficient (470 and 532 nm)
2) particulate beam-attenuation and absorption coefficients (400 – 750 nm)
3) particulate beam-attenuation coefficient (532 and 650 nm)
4) fast repetition rate fluorescence

References

Behrenfeld et al. (2006) Controls on tropical Pacific Ocean productivity revealed through nutrient stress diagnostics. Nature, 442, 1025–1028.

Behrenfeld, M.J. and Boss, E. (2006) Beam attenuation and chlorophyll concentration as alternative optical indices of phytoplankton biomass, J. Mar. Res., 64, 431–451.

Dall'Olmo et al. (2009) Significant contribution of large particles to optical backscattering in the open ocean. Biogeosciences, 6, 947–967.

Graff, J.R., Milligan, A.J., Behrenfeld, M.J. (in press) The measurement of phytoplankton biomass using flow-cytometric sorting and elemental analysis of carbon. Limnol. Oceanogr.: Methods.

Van Heukelem, L. and Thomas, C.S. (2001) Computer-assisted high performance liquid chromatography method development with applications to the isolation and analysis of phytoplankton pigments, J. Chromatogr. A, 910, 31–49.

Table 1. Sample summary

ID#	Date	Time (UCT)	Lon (Dec.Degree)	Lat + =N - =S (Dec.Degree)	POC	HPLC	D	Influx	Coulter counter
F1	11-Oct-12	18:25	9.25	49.53	Y	Y			
F2	12-Oct-12	9:28	12.47	49.29	Y	Y			
F3	12-Oct-12	15:21	13.50	49.22	Y	Y	Y		
F4	12-Oct-12	21:20	14.95	49.11	Y	Y			
F5	13-Oct-12	7:42	16.74	48.65	Y	Y			
F6	13-Oct-12	13:22	17.27	47.88	Y	Y			
F7	13-Oct-12	18:40	17.76	47.15	Y	Y			
F8	14-Oct-12	1:32	18.45	46.10	Y	Y			
F9	14-Oct-12	8:49	18.92	45.39	Y	Y			
F10	14-Oct-12	13:29	19.33	44.76	Y	Y			
F11	14-Oct-12	18:30	19.72	44.13	Y	Y			
F12	15-Oct-12	1:17	20.38	43.09	Y	Y			
F13	15-Oct-12	10:46	21.07	41.97	Y	Y	Y		
F14	15-Oct-12	13:26	21.26	41.65	Y	Y			
F15	15-Oct-12	15:15	21.38	41.46	Y	Y		Y	
F16	15-Oct-12	18:46	21.71	40.92	Y	Y			
F17	16-Oct-12	1:18	22.31	39.93	Y	Y			
F18	16-Oct-12	7:47	22.65	39.33	Y	Y			
F19	16-Oct-12	14:22	23.12	38.51	Y	Y		Y	
F20	16-Oct-12	18:34	23.50	37.86	Y	Y		Y	
F21	17-Oct-12	1:18	24.17	36.87	Y	Y		Y	
F22	17-Oct-12	7:38	24.79	36.41	Y	Y		Y	
F23	17-Oct-12	10:46	25.28	36.07	Y	Y	Y	Y	
F24	17-Oct-12	13:31	25.59	35.85	Y	Y		Y	
F25	17-Oct-12	18:36	26.32	35.32	Y	Y	Y	Y	
F26	18-Oct-12	1:44	27.41	34.50	Y	Y	Y	Y	
F27	18-Oct-12	7:57	27.93	34.10	Y	Y	Y	Y	
F28	18-Oct-12	11:59	28.56	33.65	Y	Y		Y	
F29	18-Oct-12	15:25	28.91	33.40	Y	Y		Y	
F30	18-Oct-12	19:48	29.57	32.88	Y	Y		Y	
F31	19-Oct-12	1:30	30.43	32.24	Y	Y		Y	
F32	19-Oct-12	9:47	31.30	31.57	Y	Y		Y	
F33	19-Oct-12	14:22	31.91	31.11	Y	Y	Y	Y	
F34	19-Oct-12	19:40	32.40	30.72	Y	Y		Y	
F35	20-Oct-12	2:46	33.48	29.88	Y	Y		Y	
F36	20-Oct-12	7:17	33.73	29.67	Y	Y		Y	
F37	20-Oct-12	15:20	34.00	28.94	Y	Y		Y	
F38	20-Oct-12	20:33	35.37	28.40	Y	Y		Y	
F39	21-Oct-12	2:32	36.23	27.71	Y	Y		Y	
F40	21-Oct-12	8:50	36.77	27.28	Y	Y		Y	
F41	21-Oct-12	14:26	37.47	26.72	Y	Y		Y	
F42	21-Oct-12	20:29	38.13	26.18	Y	Y		Y	
F43	21-Oct-12	23:18	38.52	25.86	Y	Y		Y	
F44	22-Oct-12	3:26	38.99	25.48	Y	Y	Y	Y	
F45	22-Oct-12	9:13	39.44	25.11	Y	Y		Y	
F46	22-Oct-12	15:06	40.07	24.60	Y	Y		Y	Y
F47	22-Oct-12	21:06	40.00	23.99	Y	Y		Y	Y
F48	23-Oct-12	2:41	40.73	23.27	Y	Y		Y	Y

ID#	Date	Time (UCT)	Lon (Dec.Degree)	Lat + =N - =S (Dec.Degree)	POC	HPLC	D	Influx	Coulter counter
F49	23-Oct-12	5:48	40.60	23.16	Y	Y		Y	Y
F50	23-Oct-12	9:14	40.29	22.71	Y	Y		Y	Y
F51	23-Oct-12	13:34	39.82	22.10	Y	Y		Y	Y
F52	24-Oct-12	21:52	39.23	21.35	Y	Y		Y	Y
F53	24-Oct-12	2:40	38.71	20.67	Y	Y	Y	Y	Y
F54	24-Oct-12	5:53	38.59	20.56	Y	Y		Y	Y
F55	24-Oct-12	10:19	38.14	19.91	Y	Y		Y	Y
F56	24-Oct-12	12:54	37.87	19.56	Y	Y		Y	Y
F57	24-Oct-12	20:45	37.16	18.63	Y	Y		Y	Y
F58	24-Oct-12	23:27	36.88	18.26	Y	Y		Y	Y
F59	25-Oct-12	2:41	36.54	17.81	Y	Y		Y	Y
F60	25-Oct-12	5:37	36.40	17.71	Y	Y		Y	Y
F61	25-Oct-12	13:05	35.73	16.73	Y	Y		Y	Y
F62	25-Oct-12	17:28	35.48	16.40	Y	Y		Y	Y
F63	25-Oct-12	21:36	35.03	15.78	Y	Y	Y	Y	Y
F64	26-Oct-12	2:10	34.61	15.26	Y	Y		Y	Y
F65	26-Oct-12	6:00	34.43	15.04	Y	Y		Y	Y
F66	26-Oct-12	10:33	34.00	14.39	Y	Y		Y	Y
F67	26-Oct-12	13:41	33.68	13.96	Y	Y		Y	Y
F68	26-Oct-12	19:18	33.24	13.37	Y	Y		Y	Y
F69	26-Oct-12	22:59	32.87	12.86	Y	Y		Y	Y
F70	27-Oct-12	2:10	32.54	12.41	Y	Y		Y	Y
F71	27-Oct-12	6:51	32.28	17.10	Y	Y		Y	Y
F72	27-Oct-12	14:16	31.58	11.12	Y	Y		Y	Y
F73	27-Oct-12	17:46	31.36	10.81	Y	Y	Y	Y	Y
F74	27-Oct-12	23:42	30.76	9.99	Y	Y		Y	Y
F75	28-Oct-12	2:18	30.49	9.63	Y	Y		Y	Y
F76	28-Oct-12	6:11	30.29	9.40	Y	Y		Y	Y
F77	28-Oct-12	10:50	29.83	8.73	Y	Y		Y	Y
F78	28-Oct-12	16:26	29.42	8.17	Y	Y		Y	Y
F79	28-Oct-12	20:28	29.02	7.61	Y	Y		Y	Y
F80	28-Oct-12	23:32	8.72	7.18	Y	Y		Y	Y
F81	29-Oct-12	2:31	28.27	6.76	Y	Y		Y	Y
F82	29-Oct-12	6:31	28.27	6.54	Y	Y		Y	Y
F83	29-Oct-12	11:17	27.80	5.89	Y	Y	Y	Y	Y
F84	29-Oct-12	13:26	27.58	5.60	Y	Y		Y	Y
F85	29-Oct-12	18:58	27.20	5.08	Y	Y		Y	Y
F86	29-Oct-12	23:17	26.77	4.47	Y	Y		Y	Y
F87	30-Oct-12	1:47	26.64	4.25	Y	Y		Y	Y
F88	30-Oct-12	6:14	26.38	3.99	Y	Y		Y	Y
F89	30-Oct-12	10:50	25.95	3.33	Y	Y		Y	Y
F90	30-Oct-12	17:04	25.51	2.72	Y	Y		Y	Y
F91	30-Oct-12	19:43	25.24	2.34	Y	Y		Y	Y
F92	30-Oct-12	23:20	25.00	1.83	Y	Y		Y	Y
F93	31-Oct-12	2:11	25.00	1.35	Y	Y		Y	Y
F94	31-Oct-12	6:30	24.98	1.04	Y	Y		Y	Y
F95	31-Oct-12	11:18	25.00	0.32	Y	Y	Y	Y	Y
F96	31-Oct-12	13:05	25.00	0.09	Y	Y		Y	Y
F97	31-Oct-12	21:17	25.01	-1.04	Y	Y		Y	Y
F98	1-Nov-12	2:18	25.01	-1.82	Y	Y		Y	Y

ID#	Date	Time (UCT)	Lon (Dec.Degree)	Lat + =N - =S (Dec.Degree)	POC	HPLC	D	Influx	Coulter counter
F99	1-Nov-12	7:16	24.99	-2.08	Y	Y		Y	Y
F100	1-Nov-12	13:16	25.00	-2.92	Y	Y		Y	Y
F101	1-Nov-12	16:36	25.00	-3.06	Y	Y		Y	Y
F102	1-Nov-12	19:39	25.04	-3.53	Y	Y		Y	Y
F103	1-Nov-12	23:35	25.02	-4.14	Y	Y	Y	Y	Y
F104	2-Nov-12	2:34	25.03	-4.47	Y	Y		Y	Y
F105	2-Nov-12	5:52	25.00	-5.62	Y	Y		Y	Y
F106	2-Nov-12	11:35	25.03	-5.49	Y	Y		Y	Y
F107	2-Nov-12	15:23	25.03	-5.83	Y	Y		Y	Y
F108	2-Nov-12	18:42	25.04	-6.43	Y	Y		Y	Y
F109	3-Nov-12	00;24	25.04	-7.50	Y	Y		Y	Y
F110	3-Nov-12	2:29	25.05	-7.88	Y	Y		Y	Y
F111	3-Nov-12	6:19	25.02	-8.17	Y	Y		Y	Y
F112	3-Nov-12	13:42	25.06	-9.50	Y	Y		Y	Y
F113	3-Nov-12	19:27	25.05	-10.26	Y	Y		Y	Y
F114	3-Nov-12	23:38	25.06	-11.07	Y	Y		Y	Y
F115	4-Nov-12	2:30	25.04	-11.42	Y	Y	Y	Y	Y
F116	4-Nov-12	6:13	25.02	-11.70	Y	Y		Y	Y
F117	4-Nov-12	13:26	25.07	-13.01	Y	Y		Y	Y
F118	4-Nov-12	19:27	25.09	-13.78	Y	Y		Y	Y
F119	5-Nov-12	0:29	25.08	-14.73	Y	Y		Y	Y
F120	5-Nov-12	3:19	25.08	-15.27	Y	Y		Y	Y
F121	5-Nov-12	7:25	25.06	-15.59	Y	Y		Y	Y
F122	5-Nov-12	11:34	25.09	-16.35	Y	Y		Y	Y
F123	5-Nov-12	15:52	25.11	-16.78	Y	Y	Y	Y	Y
F124	5-Nov-12	19:43	25.09	-17.39	Y	Y		Y	Y
F125	5-Nov-12	23:47	25.10	-17.99	Y	Y		Y	Y
F126	6-Nov-12	3:39	25.10	-18.49	Y	Y		Y	Y
F127	6-Nov-12	7:17	25.11	-18.53	Y	Y		Y	Y
F128	7-Nov-12	9:40	25.12	-18.52	Y	Y		Y	Y
F129	7-Nov-12	15:33	25.10	-18.53	Y	Y	Y	Y	Y
F130	7-Nov-12	19:43	24.89	-19.03	Y	Y		Y	Y
F131	7-Nov-12	23:42	24.66	-19.60	Y	Y		Y	Y
F132	8-Nov-12	3:16	24.52	-20.10	Y	Y		Y	Y
F133	8-Nov-12	7:20	24.56	-20.33	Y	Y	Y	Y	Y
F134	8-Nov-12	13:21	24.83	-21.19	Y	Y		Y	Y
F135	8-Nov-12	19:28	24.99	-21.81	Y	Y		Y	Y
F136	8-Nov-12	23:40	25.00	-22.41	Y	Y		Y	Y
F137	9-Nov-12	3:22	25.00	-22.95	Y	Y		Y	Y
F138	9-Nov-12	7:13	25.00	-23.18	Y	Y		Y	Y
F139	9-Nov-12	13:48	25.00	-24.13	Y	Y		Y	Y
F140	9-Nov-12	19:16	25.00	-24.68	Y	Y		Y	Y
F141	9-Nov-12	23:50	25.00	-25.35	Y	Y		Y	Y
F142	10-Nov-12	3:40	25.00	-25.73	Y	Y		Y	Y
F143	10-Nov-12	6:48	25.01	-25.93	Y	Y		Y	Y
F144	10-Nov-12	13:15	25.00	-26.88	Y	Y	Y	Y	Y
F145	10-Nov-12	19:28	25.01	-27.53	Y	Y		Y	Y
F146	10-Nov-12	23:51	25.14	-28.10	Y	Y		Y	Y
F147	11-Nov-12	2:35	25.48	-28.36	Y	Y		Y	Y
F148	11-Nov-12	6:54	25.62	-28.48	Y	Y		Y	Y

ID#	Date	Time (UCT)	Lon (Dec.Degree)	Lat + =N - =S (Dec.Degree)	POC	HPLC	D	Influx	Coulter counter
F149	11-Nov-12	14:26	26.51	-29.12	Y	Y		Y	Y
F150	11-Nov-12	19:30	27.04	-29.51	Y	Y		Y	Y
F151	11-Nov-12	23:49	27.60	-29.92	Y	Y		Y	Y
F152	12-Nov-12	2:34	27.81	-30.11	Y	Y		Y	Y
F153	12-Nov-12	6:56	28.09	-30.31	Y	Y	Y	Y	Y
F154	12-Nov-12	13:25	28.99	-30.93	Y	Y		Y	Y
F155	12-Nov-12	19:35	29.72	-31.46	Y	Y		Y	Y
F156	13-Nov-12	0:32	30.42	-31.96	Y	Y		Y	Y
F157	13-Nov-12	13:25	30.74	-32.18	Y	Y		Y	Y
F158	13-Nov-12	7:16	31.18	-32.50	Y	Y		Y	Y
F159	13-Nov-12	13:33	31.73	-32.87	Y	Y		Y	Y
F160	13-Nov-12	18:50	32.36	-33.34	Y	Y		Y	Y
F161	13-Nov-12	23:41	33.00	-33.78	Y	Y		Y	Y
F162	14-Nov-12	2:23	33.34	-34.02	Y	Y		Y	Y
F163	14-Nov-12	7:15	33.62	-34.22	Y	Y		Y	Y
F164	14-Nov-12	13:18	34.48	-34.81	Y	Y		Y	Y
F165	14-Nov-12	19:32	35.22	-35.32	Y	Y		Y	Y
F166	14-Nov-12	20:37	35.38	-35.43	Y	Y		Y	Y
F167	15-Nov-12	0:29	35.96	-35.83	Y	Y	Y	Y	Y
F168	15-Nov-12	2:42	36.12	-35.97	Y	Y	Y	Y	Y
F169	15-Nov-12	4:26	36.25	-36.07	Y	Y		Y	Y
F170	15-Nov-12	7:41	36.51	-36.21	Y	Y		Y	Y
F171	15-Nov-12	14:15	37.44	-36.84	Y	Y		Y	Y
F172	15-Nov-12	19:26	38.03	-37.24	Y	Y		Y	Y
F173	15-Nov-12	23:28	38.68	-37.67	Y	Y	Y	Y	Y
F174	16-Nov-12	1:50	39.05	-37.91	Y	Y		Y	Y
F175	16-Nov-12	6:45	39.47	-38.19	Y	Y		Y	Y
F176	16-Nov-12	14:14	40.56	-38.91	Y	Y		Y	Y
F177	16-Nov-12	19:31	41.21	-39.33	Y	Y		Y	Y
F178	16-Nov-12	23:20	41.82	-39.73	Y	Y		Y	Y
F179	17-Nov-12	2:34	42.21	-39.98	Y	Y	Y	Y	Y
F180	17-Nov-12	7:15	42.60	-40.23	Y	Y		Y	Y
F181	17-Nov-12	13:23	43.58	-40.86	Y	Y		Y	Y
F182	17-Nov-12	19:17	44.25	-41.29	Y	Y		Y	Y
F183	17-Nov-12	23:42	44.97	-41.74	Y	Y		Y	Y
F184	18-Nov-12	4:12	45.61	-42.14	Y	Y		Y	Y
F185	18-Nov-12	7:17	45.84	-42.30	Y	Y		Y	Y
F186	18-Nov-12	14:25	47.05	-43.03	Y	Y		Y	Y
F187	18-Nov-12	20:19	47.57	-43.35	Y	Y		Y	Y
F188	19-Nov-12	0:52	48.17	-43.72	Y	Y		Y	Y
F189	19-Nov-12	3:37	48.53	-43.94	Y	Y		Y	Y
F190	19-Nov-12	7:23	48.78	-44.07	Y	Y		Y	Y
F191	19-Nov-12	14:29	49.72	-44.65	Y	Y		Y	Y
F192	19-Nov-12	20:35	50.01	-45.01	Y	Y		Y	Y
F193	20-Nov-12	0:46	50.93	-45.30	Y	Y		Y	Y
F194	20-Nov-12	3:40	51.35	-45.51	Y	Y		Y	Y
F195	20-Nov-12	7:18	51.70	-45.67	Y	Y		Y	Y
F196	20-Nov-12	13:47	53.32	-46.45	Y	Y		Y	Y

Zooplankton Community Size Structure

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Introduction

The mesozooplankton sampling programme aboard AMT22 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 ship's non-toxic seawater supply (depth 7m) 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 286 and 325 (12th October to 20th November). A double (bongo) net frame was deployed, with 0.57m diameter openings and carrying 2 WP2 nets with 200 µm nylon mesh, fitted with cod ends with 200 µm mesh windows.

OPC biomass size distribution:

The OPC (Figure XX.1) 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 XX.1. OPC-1L used during AMT22

Figure XX.2 below shows a typical size-distribution of abundance and biomass for a net sample taken on the previous cruise, AMT21. The biomass maximum occurs at an ESD of 1.56mm (body length ~2.8mm, width ~0.9mm).

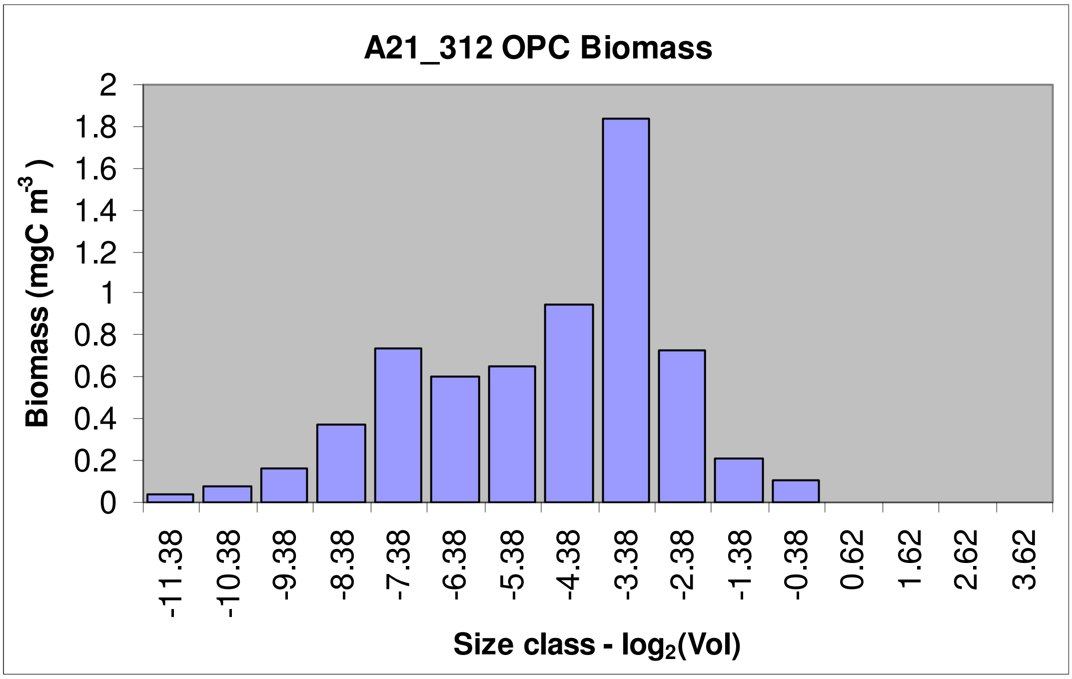

Figure XX.2. OPC Biomass from net cast on AMT21.

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, for 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 XX.3 below shows sample images from the LiZA system taken during the AMT21 cruisefrom net hauls.

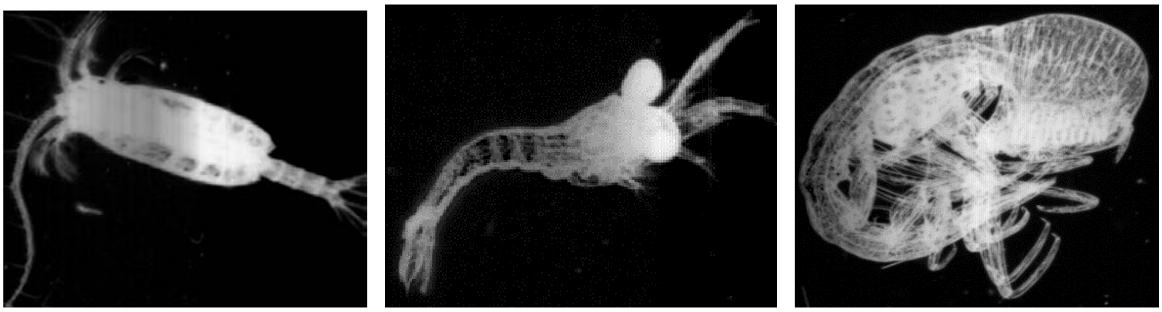

Figure XX.3: Sample images from LiZA analysis of net hauls from AMT21. Left to Right: Calanoid Copepod, decapod larval stage, Hyperiid Amphipod (id. courtesy R. Williams).

Results - OPC:

Figure XX.4 below shows size-distributed biomass for all net samples taken on AMT22. The values for carbon biomass are derived from OPC biovolume using a robust relationship between these two quantities (Gallienne & Robins, 2001). Minima can be seen in the two central gyres, with enhanced biomass at the equatorial upwelling and in the southern Atlantic due to mixing, possibly generated by weather, or by the confluence of the Brazil and Falkland currents. The two values at latitude -40.1 and -43.9 are off the scale on this chart, and in fact, at 34.59 and 37.12 are some 5 to 6 times higher than any values previously recorded on 12 AMT cruises. These samples contained very large quantities (40-50,000 in each net sample) of red-coloured calanoid copepods around 1.6mm ESD.

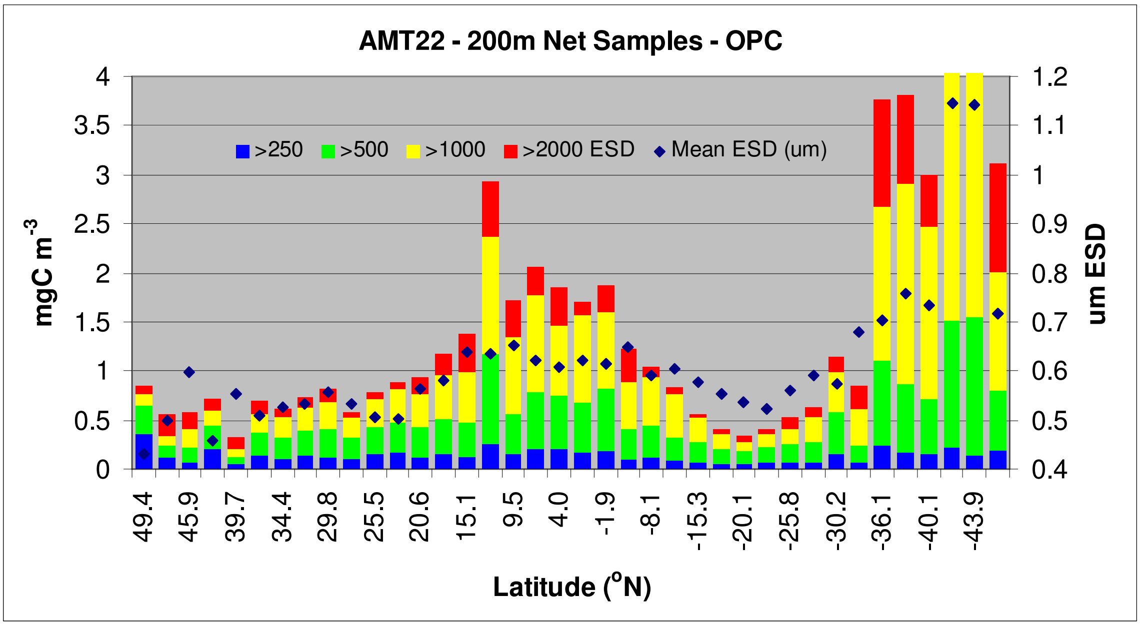

Figure XX.4. OPC size-distributed biomass from all net casts on AMT22.

Results - LiZA:

During the AMT22 transect a total of 460,000 images were acquired from 38 net samples and 800 hours of near-continuous sampling of the ship's seawater supply which draws water from approximately 7m 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.

References:

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Herman, A.W., 1992. Design and calibration of a new optical plankton counter capable of sizing small zooplankton. Deep-Sea Research, 39, 395-415.

Elucidating Niche Adaptation Mechanisms In The Ubiquitous Marine Prototroph *Synechococcus*

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Aim

The central aim of this project is to elucidate functional potential (genomics) and activity (transciptomics) in natural populations of an ecologically important marine phototroph, *Synechococcus*, which inhabits the euphotic zone of temperate, tropical and equatorial regions of the North and South Atlantic Ocean.

1. Phylogenetic analysis of *Synechococcus* spp. diversity and distribution along the Atlantic meridional transect: size fractionated single membrane water filtration

Objectives:

- To determine the distribution and abundance of marine *Synechococcus* from predawn and solar noon CTD casts using a targeted pyrosequencing approach to determine fine scale community structure.

- Sampling strategy:

  Bulk community DNA was collected from predawn and mid-day CTDs from a range of light depths (97 - 0.1%). Up to 10 l vol from each depth was pre-filtered through 100 µm mesh and 10.0 µm polycarbonate (PC) filters while the 0.45 µm (Supor) fractions were retained and flash frozen (in liquid nitrogen) in 3.0 mL of lysis buffer and stored at -80˚C.

Proposed analysis:

DNA will be extracted from filters using established techniques and analysed by a variety of methods in the laboratory. Quantitative estimates of the abundance of *Synechococcus* (*Syn*) genotypes will be carried out via pyrosequencing using selected multi-locus markers such as *petB* (Mazard et al., 2011.). Estimates of species/ribotype abundance will complement the flow cytometric analsyses of underway and CTD samples (Glen Tarran Core AMT measurement) as well as allow for direct comparison with similar data obtained on AMT18 and 19 (Ostrowski, unpublished), AMT-15 (Zwirglmaier et al., 2008) and AMT-13 (Johnson et al., 2006).

Table 1: Bulk Community DNA Sample Log:

Date	Stn	CTD	Lat +N, -S	Lon W	Time GMT	Bottle No.	Depth	Light %	Vol.
13.10.12	3	3	48° 55.66	16° 22.17	06.25	22	5m		10 litres
						19/20	7m	55	10 litres
						15	20m	15	10 litres
						10	40m		10 litres
14.10.12	5	5	45° 52.65	18° 36.49	04.31	8	47m	DCM	10 litres
						12	30m	7	10 litres
						15	20m	14	10 litres
						22	5m	100	10 litres

Date	**Stn**	**CTD**	**Lat +N, -S**	**Lon W**	**Time GMT**	**Bottle No.**	**Depth**	**Light %**	**Vol.**
15.10.12	7	7	42^o 49.05	20^o 34.67	04.25	8 12	40m 30m	DCM 7	10 litres 10 litres
						16 21	20m 5m	14 100	10 litres 10 litres
16.10.12	9	9	39^o 39.26	22^o 30.57	04.43	9 14	60m 30m	DCM 14	10 litres 10 litres
						20/21 22	9m 5m	55 97	10 litres 10 litres
17.10.12	11	11	36^o 41.18	24^o 28.13	4.26	9 10	85m 69m	DCM 3	10 litres 10 litres
						21 22	12m 5m	55 80	10 litres 10 litres
						17 11	22m 55m	33 DCM2	10 litres 10 litres
18.10.12	13	13	34^o 22.97	27^o 38.51	04.30	11 18	60m 20m	DCM 30	10 litres 10 litres
						14 22	40m 5m	7 97	10 litres 10 litres
19.10.12	15	15	32^o 01.34	30^o 44.18	04.56	4 8	150m 100m	0.1 DCM1	10 litres 10 litres
						14 21	42m 5m	14 87	10 litres 10 litres
20.10.12	17	17	29^o 48.43	33^o 33.00	4.53	8 13	122m 80m	DCM 3	10 litres 10 litres
						16 22	45m 5m	14 80	10 litres 10 litres
21.10.12	19	19	27^o 36.88	36^o 20.82	04.55	3 9	200m 120m	- DCM	10 litres 10 litres

Date	Stn	CTD	Lat +N, -S	Lon W	Time GMT	Bottle No.	Depth	Light %	Vol.
21.10.12						15 22	63m 5m	7 80	10 litres 10 litres
22.10.12	21	21	25° 29.96	38° 58.96	04.53	8 13	200m 120m	- DCM	10 litres 10 litres
						16 22	66m 5m	 80	10 litres 10 litres
23.10.12	23	23	23° 09.84	40° 36.22	04.53	3 9	200m 130m	0.1 DCM	10 litres 10 litres
						14 22	66m 5m	7 80	10 litres 10 litres
24.10.12	25	25	20° 33.91	35° 35.59	04.53	3 8	200m 130m	- DCM	10 litres 10 litres
						14 22	66m 5m	7 80	10 litres 10 litres
25.10.12	27	27	17° 42.57	36° 25.69	04.55	6 10	150m 96m	- DCM	10 litres 10 litres
						14 22	62m 5m	7 80	10 litres 10 litres
26.10.12	29	29	15° 03.72	34° 26.83	04.53	6 11	120m 76m	- DCM	10 litres 10 litres
						16 22	46m 5m	14 -	10 litres 10 litres
27.10.12	31	31	12° 13.46	32° 21.63	04.55	7 14	105m 58m	- DCM	10 litres 10 litres
						20 22	20m 5m	33 -	10 litres 10 litres
28.10.12	33	33	09° 27.15	30° 19.69	04.52	6 13	100m 47m	0.1 DCM	10 litres 10 litres

Date	Stn	CTD	Lat +N, -S	Lon W	Time GMT	Bottle No.	Depth	Light %	Vol.
28.10.12						19 22	20m 5m	40 -	10 litres 10 litres
29.10.12	35	35	06° 37.27	28° 20.51	04.55	6 10	100m 65m	0.1 DCM	10 litres 10 litres
						16 21/22	28m 5m	14 -	10 litres 10 litres
30.10.12	37	37	04° 01.70	28° 20.51	04.53	6 9	100m 70m	0.1 DCM	10 litres 10 litres
						15 22	39m 5m	7 -	10 litres 10 litres
31.10.12	39	39	01° 06.47	24° 59.07	04.53	6 11	120m 68m	0.1 DCM	10 litres 10 litres
						17 22	14m 5m	 -	10 litres 10 litres
01.11.12	41	40	-01° 53.02	24° 57.38	05:01	4 11	150m 87m	0.1 DCM	10 litres 10 litres
						17 22	36m 5m	33 -	10 litres 10 litres
2.11.12	43	42	-04° 37.38	25° 00.23	04:51	4 13	150m 76m	0.1 DCM	10 litres 10 litres
						16 22	44m 5m	 -	10 litres 10 litres
3.11.12	45	44	-08° 05.35	25° 00.85	04:51	4 8	150m 100m	0.1 DCM	10 litres 10 litres
						14 22	59m 5m	7 -	10 litres 10 litres
4.11.12	47	45	-11° 37.31	25° 01.23	04:47	2 7	300m 132m	0.1 DCM	10 litres 10 litres

Date	**Stn**	**CTD**	**Lat +N, -S**	**Lon W**	**Time GMT**	**Bottle No.**	**Depth**	**Light %**	**Vol.**
4.11.12						15 22	59m 5m	 -	10 litres 10 litres
5.11.12	49	48	-15° 17.22	25° 8.07	04:49	2 8	300m 145m	 DCM	10 litres 10 litres
						15 22	70m 5m	 -	10 litres 10 litres
6.11.12	51	50	-18° 30.96	25° 06.07	04:49	1 + 2 6	200/300m 161m	 DCM	10 litres 10 litres
						14 21	70m 5m	7 -	10 litres 10 litres
8.11.12	52	52	-20° 07.27	24° 29.81	04:49	2 8	300m 160m	0.1 DCM	10 litres 5 litres
						17 22	65m 5m	33 -	9 litres 10 litres
9.11.12	54	54	-22° 57.88	24° 58.83	04:41	2 7	300m 150m	0.1 DCM	10 litres 10 litres
						15 22	78m 5m	7 -	10 litres 10 litres
10.11.12	56	56	-25° 44.97	24° 59.45	04:40	2 7	300m 158m	0.1 DCM	10 litres 5 litres
						15 22	70m 5m	7 -	10 litres 10 litres
11.11.12	58	58	-28° 23.27	25° 28.50	04:47	2 7	300m 1350m	0.1 DCM	10 litres 10 litres
						15 22	68m 5m	 -	10 litres 10 litres
12.11.12	60	60	-30° 11.99	27° 55.13	04:42	3 9	200m 100m	 DCM	10 litres 10 litres
						13 22	78m 5m	 -	10 litres 10 litres

Date	Stn	CTD	Lat +N, -S	Lon W	Time GMT	Bottle No.	Depth	Light %	Vol.
14.11.12	62	62	-34° 8.85	33° 29.54	04:56	6 12	91m 60m	 DCM	10 litres 10 litres
						15 22	35m 5m	7 -	10 litres 10 litres
15.11.12	64	64	-36° 04.16	36° 15.34	04:54	9 13	60m 35m	0.1 DCM	9 litres 9 litres
						20 22	14m 5m	33 -	9 litres 9 litres
16.11.12	66	66	-38° 6.34	39° 19.72	04:54	7 13	60m 35m	0.1 DCM	10 litres 10 litres
						18 22	20m 5m	14 -	10 litres 10 litres
17.11.12	68	68	-40° 06.14	42° 22.98	04:40	10 17	40m 20m	0.1 DCM	10 litres 5 litres
						21 22	10m 5m	33 55	10 litres 10 litres
18.11.12	70	70	-40° 06.14	42° 22.98	04:47	14 17	27m 20m	0.1 DCM	10 litres 10 litres
						20 21	8m 5m	33 55	10 litres 10 litres
19.11.12	72	72	-43° 55.38	48° 33.92	04:50	7 13	69m 35m	 DCM	10 litres 10 litres
						19 22	16m 5m	14 55	10 litres 10 litres
20.11.12	74	74	-45° 30.04	51° 19.18	04:55	8 14	60m 30m	 DCM	10 litres 10 litres
						21 22	8m 5m	33 55	10 litres 10 litres

2. *Synechococcus* population genomics and transcriptomics of distinct communities along ecological gradients: size fractionated water filtration with cell recovery from ceramic filter units (cell traps)

Objectives:

- To determine the factors that dictate *Synechococcus* community structure and the relationship between environmental niche and genetic potential (i.e. gene complement).

  To compare the genomic potential of specific *Synechococcus* populations with the actual genes expressed i.e. a population genome versus population transcriptome comparison.

- Sampling strategy:

  Seawater was sampled from both the onboard underway (UW) water supply (200 litres) and noon CTD (60-80 litres) at a depth of 20m. Water was pre-filtered with a 35 micron cartridge filter, with large volumes (>100 litres) filtered via CellTrap 400 filters (CT400 Memteq) and lower volumes (<100 litres) filtered via CellTrap100 filters (CT100 Memteq). Cells were recovered from the ceramic filter filaments via elution into 20-50ml centrifuge tubes and snap frozen in liquid nitrogen prior to -80^{o}C storage. Total filtration time for transcriptomic profiling was restricted to 20 minutes. Cell Traps were re-used to collect DNA samples from the remaining seawater collected.

Proposed analysis:

DNA and RNA will be extracted from targeted populations of *Synechococcus*, sorted using flow cytometry. Both amplified and non-amplified nucleic acids will then be sequenced to a high depth of coverage using illumina sequencing at the NERC Molecular Genetics Facility (Liverpool).

CT100/CT400 Sample Log:

Date	Station	CTD	Underway supply	Latitude +N, -S	Longitude	Cell trap
13.10.12	3		UW			400
14.10.12	6	6		44^{o} 45.59	19^{o} 19.475	100
15.10.12	7	7				100
18.10.12	12		UW	33^{o} 33.646	28^{o} 41.353	400
19.10.12	16	16		31^{o} 06.342	31^{o} 54.468	100
20.10.12	18	18		28^{o} 56.168	34^{o} 40.466	100
21.10.12	20		UW	26^{o} 43.012	37^{o} 28.249	400
23.10.12	24	24		22^{o} 04.502	39^{o} 47.861	100
26.10.12	30	30		13^{o} 57.337	33^{o} 40.031	400
28.10.12	34	34		08^{o} 17.802	29^{o} 31.956	100
30.10.12	38	38		02^{o} 55.182	25^{o} 39.701	400
1.11.12	42		UW			400
5.11.12	48	46				400
6.11.12	50		UW	-16^{o} 45.584	25^{o} 05.860	400
7.11.12	51		UW	-18^{o} 31.788	25^{o} 06.088	400
8.11.12	52		UW	-20^{o} 07.274	24^{o} 29.813	400

Date	Station	CTD	Underway supply	Latitude +N, -S	Longitude	Cell trap
8.11.12	53	53		-21° 15.161	24° 50.731	400
9.11.12	55	55		-24° 07.523	25° 00.172	400
10.11.12	57	57		-26° 57.360	25° 00.374	400
11.11.12	58		UW	-28° 14.4721	25° 19.489	400
11.11.12	59		UW	-29° 06.912	26° 30.421	400
13.11.12	61		UW	-32° 06.163	30° 37.527	100
13.11.12	62	62		-33° 01.430	31° 55.697	100
14.11.12	63	63		-34° 51.464	34° 32.248	100
15.11.12	64		UW	-35° 54.185	36° 01.710	100
15.11.12	65		UW	-36° 51.543	37° 27.997	100
17.11.12	69	69		-40° 54.385	43° 38.959	100
18.11.12	70		UW	-42° 01.069	45° 24.864	400
18.11.12	71	71		-43° 02.81	47° 04.710	400
19.11.12	73	73		-44° 40.515	49° 45.530	100
20.11.12	75		UW	-46° 50.054	54° 09.116	400

3. Isolation of novel *Synechococcus* clades: liquid and solid plate culturing

Objectives:

- Trial novel culturing techniques to allow isolation of previously uncultured, yet numerically abundant *Synechococcus* spp.

  Perform different nutrient enrichments within a liquid culture system to see if different *Synechococcus* spp. respond with growth and batch culture conditions.

- Sampling strategy:

  Water samples were taken roughly every three days from the surface, the DCM or both to set up *Synechococcus* cultures. In most cases cells were first concentrated via CT40 cell traps (memteq) with ~ 2 litres of seawater. The cell traps were then eluted in water from the same depth, from the DCM or from 300 m previously filtered through 0.2 µm and kept in polystyrene culture flasks at constant temperature (~ 21ºC) and under a 12:12hrs light regime in an incubator. In some cases the water sample was mixed directly with surface, DCM or 300 m water filtered through 0.2 µm without pre-concentrating the cells. Cultures were enriched with different N sources and some cell trap concentrates were pour plated onto SN media.

Proposed analysis:

Genome sequencing of novel isolates numerically abundant along the AMT transect will not only increase our knowledge of the identified ‘core’ (i.e. shared by all) genome and ‘accessory’ or ‘niche-specific’ components of the genome. (Dufresne et al., 2008 Genome Biol 9:R90). It will also allow an increased recruitment of sequence reads from both the metagenomic and transcriptomic sequencing.

Carbonate System: Total Alkalinity (A_T) and pH

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Rationale and Method

Dissolved CO_2 reacts with water 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 ions. 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 cast numbers and Niskin bottle numbers for all samples collected. A_T samples were collected in 250 mL borosilicate glass bottles with glass stoppers (Schott, Duran) and preserved with $HgCl_2$ until analysis at PML (100 µL of saturated $HgCl_2$ added). The glass stoppers were greased with Apiezon-M grease.

The pH_T method employed here has typical precision in the low 10^{-3} to 10^{-4} pH-unit range. 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 NIST-traceable thermometer. pH_T measurements were corrected for the pH_T change due to the addition of dye according to Dickson et al. (2007). Figure 1 shows preliminary data for pH_T along-track for AMT 22 (JC079) (stations 2-70). Additional experiments for the determination of DIC uptake and production during gross community production and respiration respectively were carried out in the incubators on the aft-deck. Briefly, 12 L of water were collected from the CTD and sub-sampled into clear 250 mL borosilicate bottles. A_T and pH were determined as above in three subsets of replicate samples: a) initial, b) light and c) dark (double-wrapped in Al-foil). Light and dark samples were incubated for 24 hours at ambient temperature ±2 ^oC and light field under neutral density light-filters. Preliminary results show a reduction in pH_T in the dark treatment compared to initial and higher pH_T in the light treatment compared to dark. pH_T in the light treatment was not always higher than initial, suggesting that the respective plankton community was net heterotrophic.

Final quality controlled A_T and pH_T data will be submitted to BODC within 12 months.

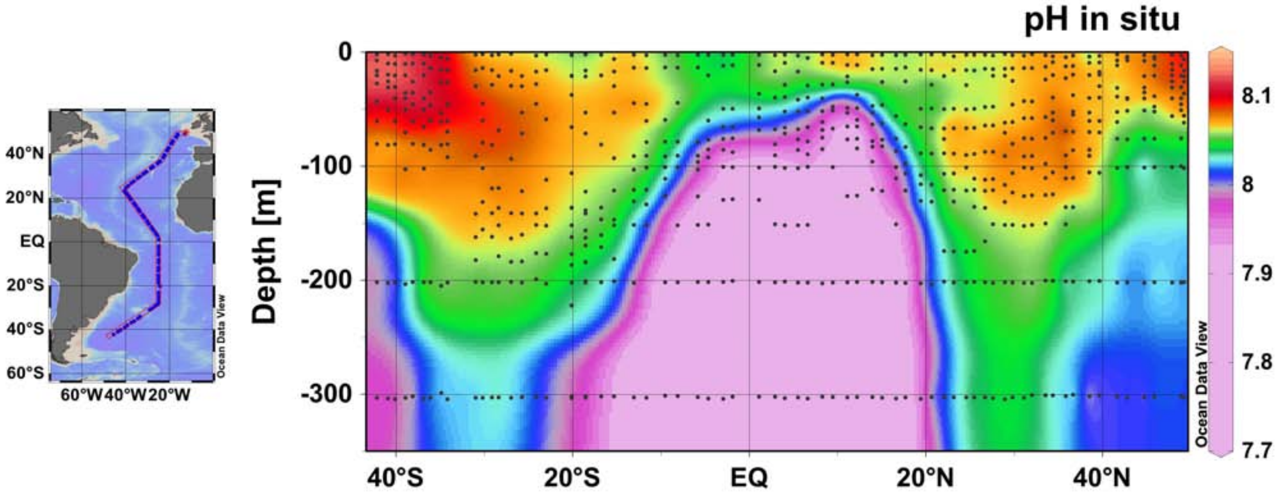

Figure 1: Preliminary pH$_T$ data along-track for AMT 22 (JC079) (stations 2-70). Dots show samples location.

Table 1: Samples collected from CTD hydrocast. Figure in brackets under incubation, show the light intensity in the incubator as a percentage of surface irradiance.

Date	CTD cast no.	A_T (Niskin no.)	pH_T (Niskin no.)	Incubation (Niskin) [%I_o]
12/10/12	C-002	1,16,23	1,2,4,5,6,7,9,16,17,23	
13/10/12	C-003	1,9,23	1,2,4,5,6,8,9,11,13,17,23	
13/10/12	C-004	1,10,24	1,2,6,7,8,10,12,17,18,20,24	
14/10/12	C-005	8,24	1,2,4,5,6,8,10,16,18,21,24	
14/10/12	C-006A	1,8,24	1,2,4,5,6,7,8,9,19,22,24	
15/10/12	C-007	1,8,24	1,2,4,5,6,7,8,9,19,22,24	10 [3%]
15/10/12	C-008	1,7,24	1,2,4,5,7,9,10,11,20,21,24	
16/10/12	C-009	1,9,24	1,2,4,7,9,12,14,16,19,21,24	20 [33%]
16/10/12	C-010	8,24	2,3,5,6,8,10,12,13,14,19,21,24	
17/10/12	C-011	1,9,24	1,2,4,5,9,10,11,13,15,19,20,24	
17/10/12	C-012	2,8,24	2,3,4,5,6,8,9,10,14,22,24	
18/10/12	C-013	2,8,24	2,3,5,6,8,11,12,14,18,21,24	
18/10/12	C-014	2,10,24	2,3,5,6,10,11,13,14,16,21,24	
19/10/12	C-015	1,8,24	1,2,4,5,8,9,10,12,14,20,24	20 [33%]
19/10/12	C-016	2,7,24	2,3,4,5,7,8,9,10,11,22,24	
20/10/12	C-017	2,9,24	2,3,6,9,10,13,15,16,18,21,24	11 [1%]
20/10/12	C-018	2,7,24	2,3,5,7,8,10,12,13,21,22,24	
21/10/12	C-019	2,8,24	2,3,6,8,10,13,15,16,20,21,24	
21/10/12	C-020	2,9,24	2,3,4,6,9,10,11,13,14,21,24	
22/10/12	C-021	2,10,24	2,3,5,7,10,11,13,15,16,21,24	13 [7%]
22/10/12	C-022	7,24	2,3,4,7,9,10,12,13,14,21,24	
23/10/12	C-023	2,8,24	2,3,5,8,10,11,13,14,16,21,24	
23/10/12	C-024	2,9,24	2,3,4,7,9,10,11,12,13,20,24	
24/10/12	C-025	9,24	2,3,9,10,13,14,16,18,21,24	18 [33%]

Date	CTD cast no.	A_T (Niskin no.)	pH_T (Niskin no.)	Incubation (Niskin) [%I_o]
24/10/12	C-026	10,24	2,3,6,7,10,12,14,15,21,24	
25/10/12	C-027	2,11,24	2,3,7,8,11,13,14,18,21,24	
25/10/12	C-028	2,10,24	2,3,5,7,8,10,11,13,21,24	
26/10/12	C-029	2,12,24	2,3,6,9,12,14,17,18,21,24	17 [14%]
26/10/12	C-030	11,24	2,3,6,8,9,11,12,13,14,21,24	
27/10/12	C-031	2,14,24	2,3,6,10,11,12,14,16,18,21,24	16 [7%]
27/10/12	C-032	2,10,24	2,3,5,7,8,10,11,13,20,21,24	
28/10/12	C-033	2,13,24	2,3,6,9,10,13,17,21,24	
28/10/12	C-034	-	1,2,6,7,8,10,11,12,13,21,24	
29/10/12	C-035	2,11,22	2,3,4,6,7,8,11,12,14,16,22	14 [7%]
29/10/12	C-036	2,10,24	2,3,4,5,7,10,11,13,14,20,24	
30/10/12	C-037	2,8,24	2,3,4,6,8,10,13,15,17,21,24	
30/10/12	C-038	1,6,24	1,2,3,4,5,6,8,10,20,24	
31/10/12	C-039	2,12,24	2,3,6,7,12,13,16,17,21,24	
01/11/12	C-040	2,11,24	2,3,6,8,11,12,14,15,21,24	24 [97%]
01/11/12	C-041	11,24	2,3,5,7,9,11,12,14,21,24	
02/11/12	C-042	2,13,24	2,3,4,9,10,13,15,20,24	
02/11/12	C-043	2,8,24	2,3,4,5,6,8,9,10,21,24	16 [14%]
03/11/12	C-044	2,8,24	2,3,4,8,10,12,16,21,24	
03/11/12	C-045	2,7,24	2,3,5,6,7,9,10,12,21,24	
04/11/12	C-046	2,10,24	2,5,7,8,10,11,13,15,17,21,24	
04/11/12	C-047	2,6,24	2,3,4,6,7,8,9,12,21,24	
05/11/12	C-048	2,9,22	2,3,5,6,9,11,13,16,18,21,22	12 [1%]
05/11/12	C-049	2,7,24	2,3,5,7,8,9,13,20,24	
06/11/12	C-050	1,7,24	1,2,4,7,8,10,15,20,24	
07/11/12	C-051	2,7,24	2,3,4,5,7,8,12,20,24	
08/11/12	C-052	2,8,24	2,4,5,8,9,13,17,19,21,24	15 [7%]
08/11/12	C-053	2,7,24	2,3,4,5,7,8,12,21,24	
09/11/12	C-054	2,8,24	2,4,5,8,9,12,16,21,24	
09/11/12	C-055	2,6,24	2,3,4,6,7,14,16,21,24	
10/11/12	C-056	2,8,24	2,3,5,8,9,11,15,16,18,20,24	18 [33%]
10/11/12	C-057	2,6,24	2,3,4,6,7,10,13,22,24	
01/11/12	C-058	2,8,24	2,3,5,8,9,11,15,20,24	
11/11/12	C-059	2,7,24	2,3,5,7,9,12,15,20,24	
12/11/12	C-060	2,5,24	2,3,5,6,9,13,15,16,21,24	15 [7%]
12/11/12	C-061	2,6,24	2,3,4,6,7,9,12,21,24	
14/11/12	C-062	2,12,24	2,3,6,8,9,12,14,17,21,24	21 [97%]
14/11/12	C-063	2,7,24	2,3,5,7,8,11,20,24	
15/11/12	C-064	2,14,24	2,3,5,9,11,14,20,24	
15/11/12	C-065	2,12,24	2,3,4,6,8,10,12,19,21,24	

Date	CTD cast no.	A_T (Niskin no.)	pH_T (Niskin no.)	Incubation (Niskin) [%I_o]
16/11/12	C-066	2,13,24	2,3,5,6,9,13,16,21,24	10 [1%]
16/11/12	C-067	2,14,24	2,3,4,7,10,12,14,19,21,24	
17/11/12	C-068	2,17,24	2,3,5,7,10,13,17,21,24	
17/11/12	C-069	2,13,24	2,3,6,9,11,13,20,22,24	
18/11/12	C-070	2,17,24	2,3,5,8,10,14,17,18,20,24	23 [97%]
18/11/12	C-071	2,14,24	2,3,6,8,11,14,15,20,24	
19/11/12	C-072	2,13,24	2,3,5,9,11,13,19,24	
19/11/12	C-073	2,19,24	2,3,4,7,9,11,19,20,21,24	
20/11/12	C-074	2,14,24	2,3,4,6,9,11,12,14,15,19,24	

Reference

Dickson, A.G., Sabine, C.L. and J.R. Christian (eds.), 2007, Guide to Best Practice for Ocean CO_2 Measurements, PICES Special Publication 3, 191p.

Microbial plankton community dynamics

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Aims:
To measure rates of phosphate uptake by microbial groups and to assess the contribution of each group to total microbial phosphate uptake in the oligotrophic North Atlantic gyre.
To measure rates of carbon fixation by microbial groups and to assess the contribution of each group to total carbon fixation in the South Atlantic gyre.

Objectives:
- To estimate turnover rates of dissolved bio-available phosphate using ^{33}P- & ^{32}P-phosphate tracers.
- To estimate carbon fixation rates of dominate phototrophic microbes.

Microbial inorganic phosphorus uptake was determined in the phosphate-depleted North Atlantic gyre (Table 1, top section) to estimate ambient concentrations and turnover rates of the bioavailable fraction. The relative contributions of the dominant prokaryotic and eukaryotic groups to phosphate dynamics were determined using flow cytometric cell sorting.

Sodium ^{14}C-bicarbonate was used in a series of experiments to trace photosynthetic fixation by microbes. Relative contributions by dominant groups of microorganisms to the carbon cycle were determined using flow cytometric cell sorting. Seawater samples were incubated for 12 hours at ~350 µmol photons m^{-2} s^{-1} at *in situ* temperature and subsequently fixed with paraformaldehyde (1% final concentration). Carbon fixation rate experiments were performed with samples collected at pre-dawn casts (Table 1, bottom section).

Table 1: Stations sampled at a standard depth of 20 m.

Station	Date	Time on deck (GMT)	Lat +N, -S	Lon W
11	17-Oct	05:14	36.69	24.47
13	18-Oct	05:30	34.38	27.64
14	18-Oct	13:50	33.56	28.69
15	19-Oct	04:45	32.02	30.74
17	20-Oct	05:52	29.81	33.55
19	21-Oct	05:47	27.61	36.35
21	22-Oct	05:47	25.5	38.98
23	23-Oct	05:57	23.16	40.60
25	24-Oct	05:43	20.57	38.59
29	26-Oct	05:41	15.13	34.45
31	27-Oct	05:50	12.22	32.36
37	30-Oct	05:43	4.03	26.47
39	31-Oct	05:04	1.11	24.98
41	01-Nov	05:52	-1.88	24.96
43	02-Nov	05:42	-4.62	25.00
45	03-Nov	05:44	-8.09	25.01
47	04-Nov	05:40	-11.62	25.02
49	05-Nov	05:37	-15.29	25.05
51	06-Nov	05:43	-18.52	25.10
52	08-Nov	05:37	-20.12	24.50
54	09-Nov	05:39	-22.96	24.98
56	10-Nov	05:29	-25.75	24.99
58	11-Nov	04:41	-28.39	25.48
60	12-Nov	05:31	-30.2	27.92
62	14-Nov	06:16	-34.15	33.49

Station	Date	Time on deck (GMT)	Lat +N, -S	Lon W
64	15-Nov	05:54	-36.07	36.26
66	16-Nov	05:47	-38.11	39.33
68	17-Nov	04:49	-40.1	42.38
70	18-Nov	05:40	-42.14	45.63
72	19-Nov	05:37	-43.92	48.57

Initial scintillation counting was carried out on board the ship (Packard Tri-Carb 2900). After the cruise, the collected tracer samples of flow sorted cells will be further analysed using low background counters within the next 12 months.

Can microbial communities in marine copepods reveal important biogeochemical processes in the water column?

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Objectives
Microbial populations in the pelagic environment are pivotal to global biogeochemical cycling as major producers and degraders of organic matter in the oceans and copepods modify organic matter in the water column, which makes it more accessible to other organisms. The usually nutrient-poor, open ocean pelagic environments present an interesting study site for microbial communities associated with nutrient rich habitats such as those found in copepod digestive tracts. The question, ‘could copepod microflora be used as an indicator of biogeochemical cycling of organic matter in the water column’ remains unanswered.

The main objectives, of this study are:
1. To determine the community structure of the copepod gut microflora.
2. To determine the factors influencing the gut microflora composition.
3. To determine a link between the gut microflora and water-column microbes.

Methods
Copepod samples were collected using a size-factionating micronet (see separate report). Additional samples were obtained from vertical net hauls made at the pre-dawn station by Chris Gallienne. All samples were imaged live using a FlowCAM. Three samples were obtained from a bongo net tow done by Erica Goetze and Katja Peijnenburg.

Micronet samples were pooled for each of the nets. All samples were fixed in 1% paraformaldehyde in filtered seawater overnight at 4 °C. They were then washed twice in Milli-Q water, twice in 30% ethanol and twice in 50% ethanol. After washing they were transferred to 50% ethanol and stored at 4 °C until further processing.

In addition, a copepod nauplii feeding experiments were undertaken at the southern hemisphere stations. 50 mL of 100-180 µm fraction seawater (where most of the nauplii were expected to be) was mixed with 70 mL of 20 µm fraction seawater (representing the nauplii food) and incubated for 2 h at room temperature. In parallel, 50 ml samples of the 100-180 µm seawater fraction was incubated for the same period but without any food. After the incubation, samples were fixed and processed for storage as described above.

Fluorescence *in-situ* hybridisations were carried out on select samples to get preliminary results of the presence of gut microflora in adult copepods and their nauplii larvae. The preliminary results showed that bacteria are present in copepod guts and that they mostly belong to the γ-proteobacteria.

Samples will be further analysed at the National Oceanography Centre, Southampton. Analysis will be done within the next 12 months.

Table 2: Sample list

Date	Station	Latitude (+=N, -=S)	Longitude (W)	Activity
15/10/2012	7	42 49.05	20 34.67	Sample from pre-dawn net haul
16/10/2012	9	39 39.25	22 30.57	Sample from pre-dawn net haul
17/10/2012	11	37 29.8	23 42.47	Sample from pre-dawn net haul
18/10/2012	13	34 22.92	27 38.23	Sample from pre-dawn net haul
19/10/2012	16	31 6.342	31 54.468	Samples from micronet
20/10/2012	17	29 48.462	33 33.001	Sample from pre-dawn net haul
20/10/2012	18	28 56.168	34 40.466	Samples from micronet
21/10/2012	19	27 36.881	36 20.82	Sample from pre-dawn net haul
21/10/2012	20	26 43.012	37 28.249	Samples from micronet
22/10/2012	21	25 29.939	38 58.956	Sample from pre-dawn net haul
22/10/2012	22	24 35.720	40 04.519	Samples from micronet
23/10/2012	23	23 9.838	40 36.221	Sample from pre-dawn net haul
23/10/2012	24	22 04.5224	39 47.900	Samples from micronet
24/10/2012	25	20 33.906	38 35.594	Sample from pre-dawn net haul
25/10/2012	27	17 42.570	36 25.693	Sample from pre-dawn net haul
25/10/2012	28	16 38.591	35 39.435	Samples from micronet
26/10/2012	29	15 3.724	34 26.831	Sample from towed bongo net
27/10/2012	31	12 13.16	32 21.631	Sample from pre-dawn net haul
27/10/2012	32	11 06.917	31 34.634	Samples from micronet
28/10/2012	33	9 27.152	30 19.694	Sample from pre-dawn net haul
28/10/2012	33	9 27.152	30 19.694	Sample from towed bongo net
28/10/2012	34	8 17.808	29 31.965	Samples from micronet
29/10/2012	35	6 37.273	28 20.513	Sample from pre-dawn net haul
29/10/2012	36	5 32.759	27 32.500	Samples from micronet
30/10/2012	37	4 1.703	26 28.158	Sample from pre-dawn net haul
30/10/2012	38	2 55.239	25 39.650	Samples from micronet; feeding experiment
31/10/2012	39	1 6.467	24 59.066	Sample from pre-dawn net haul
01/11/2012	41	-1 53.024	24 57.38	Sample from pre-dawn net haul
01/11/2012	42	- 2 55.793	24 59.047	Samples from micronet; feeding experiment
02/11/2012	43	- 4 37.379	25 0.229	Sample from pre-dawn net haul
02/11/2012	44	- 5 49.763	25 1.792	Samples from micronet; feeding experiment
03/11/2012	45	- 8 5.347	25 0.854	Sample from pre-dawn net haul
03/11/2012	46	-9 30.810	25 03.210	Samples from micronet; feeding experiment
04/11/2012	47	-11 37.31	25 1.23	Sample from pre-dawn net haul
04/11/2012	48	-13 04.336	25 03.960	Samples from micronet; feeding experiment
05/11/2012	49	-15 17.224	25 3.066	Sample from pre-dawn net haul
05/11/2012	50	-16.45.68	25 05.88	Samples from micronet; feeding experiment
06/11/2012	51	-18 30.96	25 6.07	Sample from pre-dawn net haul
07/11/2012	51	-18 30.96	25 6.07	Samples from micronet; feeding experiment
08/11/2012	52	-20 7.274	24 29.813	Sample from pre-dawn net haul
08/11/2012	53	-21 15.203	24 50.776	Samples from micronet; feeding experiment

Date	Station	Latitude (+=N, -=S)	Longitude (W)	Activity
09/11/2012	54	-22 57.884	24 58.831	Sample from pre-dawn net haul
09/11/2012	55	-24 07.567	25 00.312	Samples from micronet; feeding experiment
10/11/2012	56	-25 44.97	24 59.45	Sample from pre-dawn net haul
10/11/2012	57	-26 57.408	25 00.567	Samples from micronet; feeding experiment
11/11/2012	58	-28 23.274	25 28.501	Sample from pre-dawn net haul
11/11/2012	59	-29 06.948	26 30.445	Samples from micronet; feeding experiment
12/11/2012	60	-30 11.987	27 55.13	Sample from towed bongo net
12/11/2012	60	-30 11.987	27 55.13	Sample from pre-dawn net haul
14/11/2012	62	-34 8.845	33 29.543	Sample from pre-dawn net haul
15/11/2012	64	-36 4.162	36 15.344	Sample from pre-dawn net haul
15/11/2012	65	-36 50.234	37 26.343	Samples from micronet; feeding experiment
16/11/2012	66	-38 6.34	39 19.721	Sample from pre-dawn net haul
16/11/2012	67	-38 54.481	40 33.881	Samples from micronet; feeding experiment
17/11/2012	68	-40 6.142	42 22.984	Sample from pre-dawn net haul
17/11/2012	69	-40 54.382	43 38.961	Samples from micronet; feeding experiment
18/11/2012	70	-42 8.231	45 37.613	Sample from pre-dawn net haul
18/11/2012	71	-43 02.671	47 04.616	Samples from micronet; feeding experiment
19/11/2012	72	-43 55.387	48 33.922	Sample from pre-dawn net haul
19/11/2012	73	-44 40.555	49 45.563	Samples from micronet; feeding experiment
20/1102012	74	-45 30.037	51 19.182	Sample from pre-dawn net haul

Micronet sampling and analysis of microplankton using FlowCAM

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Objectives
To determine the community composition and relative abundance of microplankton along the Atlantic Meridional Transect.

Methods
Microplankton samples were collected using an *in-situ* size-fractionating microplankton net (Micronet) with a double net frame deployed at noon stations to 200m depth (when weather conditions were favourable; windspeed less than Beafourt force 5). The size fractions were as follows: >180 µm, 100-180 µm, 40-100 µm and 20-40 µm. Samples were collected in 500 mL acid washed bottles and imaged live using a FlowCAM.

One of the net frames was equipped with a current meter and pressure sensor that activated a ball valve and enabled sampling at a predetermined depth range. A depth range of 100m was sampled at each deployment to enable sampling of the DCM depth. The second net frame was open and sampled the whole 200m.

Samples from the open net were split. One half was used for copepod gut microflora analysis (see separate report) and the other half was preserved in Lugol's iodine. Additionally, unconcentrated samples were collected from CTD casts at the same stations and preserved in Lugol's iodine. All Lugol's samples will be re-analysed in the UK.

Table 1: Micronet deployments

Date	Station	Latitude (+=N, -=S)	Longitude (W)	Depth range sampled
19/10/2012	16	31 6.342	31 54.468	150-50 m
20/10/2012	18	28 56.168	34 40.466	150-50 m
21/10/2012	20	26 43.012	37 28.249	150-50 m
22/10/2012	22	24 35.720	40 04.519	150-50 m
23/10/2012	24	22 04.5224	39 47.900	150-50 m
25/10/2012	28	16 38.591	35 39.435	150-50 m
27/10/2012	32	11 06.917	31 34.634	130-30 m
28/10/2012	34	8 17.808	29 31.965	130-30 m
29/10/2012	36	5 32.759	27 32.500	130-30 m
30/10/2012	38	2 55.239	25 39.650	130-30 m
01/11/2012	42	- 2 55.793	24 59.047	130-30 m
02/11/2012	44	- 5 49.763	25 1.792	130-30 m
03/11/2012	46	-9 30.810	25 03.210	130-30 m
04/11/2012	48	-13 04.336	25 03.960	150-50 m
05/11/2012	50	-16.45.68	25 05.88	170-70 m
07/11/2012	51	-18 30.96	25 6.07	170-70 m
08/11/2012	53	-21 15.203	24 50.776	170-70 m
09/11/2012	55	-24 07.567	25 00.312	170-70 m
10/11/2012	57	-26 57.408	25 00.567	170-70 m
11/11/2012	59	-29 06.948	26 30.445	130-30 m

Date	Station	Latitude (+=N, -=S)	Longitude (W)	Depth range sampled
15/11/2012	65	-36 50.234	37 26.343	130-30 m
16/11/2012	67	-38 54.481	40 33.881	130-30 m
17/11/2012	69	-40 54.382	43 38.961	130-30 m
18/11/2012	71	-43 02.671	47 04.616	130-30 m
19/11/2012	73	-44 40.555	49 45.563	130-30 m

Molecular Ecology of Zooplankton

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Introduction and Objectives

A few of the primary goals of the AMT programme are to provide a means to assess biodiversity trends in relation to environmental change, improve our understanding of the structure and functioning of marine ecosystems, and understand the impact of climate change on the ocean. Our research is related to these efforts in that 1) we aim to assess biodiversity (both at specific and genetic levels) of several important components of pelagic foodwebs (copepods, chaetognaths and pteropods), and 2) the ability of zooplankton to respond to future changes in the ocean depends on the genetic structure of populations over space and time.

Our primary research objectives on this cruise were to obtain material for studies in:

1. Population genetic structure and gene flow at basin spatial scales in key zooplankton taxa,
2. Assess temporal stability in spatial genetic patterns by repeat transect sampling on AMT,
3. Test hypotheses about mechanisms that underly genetic breaks known to occur across the equatorial upwelling zone in a number of key zooplankton species,
4. Assess species boundaries and adaptive potential of pteropods, with regards to ocean acidification
5. Determine if there are community-wide patterns in the spatial distribution of genetic variation in the holozooplankton, through comparative community-wide genetic studies.

We have also collected material for a range of exploratory and early-stage projects that were secondary objectives on this cruise (e.g., mating dynamics and reproductive ecology of target species, material for 454 pyrosequencing on additional taxa).

Methods

Sample collection. Plankton samples were collected with 0.71m- diameter bongo nets (200, 333 µm), and with an RMT1 midwater trawl (333 µm) that has a nominal mouth area of 1m^2. A total of 50 plankton tows were conducted along the cruise leg (Table 1), with 35 tows conducted using the bongo and 14 samples collected with the RMT net. The bongo tows were oblique tows that sampled from between 211 to 488 m depth and the surface (324m average maximum depth of tow). The bongo samples will be used for quantitative estimates of animal abundance along the cruise leg (target species only, tows conducted with time-depth-recorder and flowmeter). The RMT tows were also oblique tows that sampled between 62 to 216 m depth and the surface (153 m average maximum depth of tow). All tows except one (station 42) were conducted at night, in order to efficiently sample the migratory community.

Sample handling and preservation. All plankton from the 200 µm mesh bongo net was preserved immediately in 100% ethyl alcohol for use in molecular studies, including DNA sequencing and microsatellite genotyping (and possibly RAD tag sequencing), in addition to estimates of abundance of target species. Plankton material from the 333 µm mesh bongo net and the RMT net was sorted live immediately following collection, and animals were individually identified, and preserved in acetone, RNALater, cryopreserved, and in some cases used for live imaging prior to preservation. These animals will be used for molecular, genomic and transcriptomic analyses. Both RNA/DNA ratios and prosome length – dry weight relationships will be used as measures of animal condition in copepods. In total, over 17,000 animals from 40 target species were individually sorted and preserved for this panel of measurements. Following live sorting and imaging of the 333 µm samples, the remaining plankton was preserved either in 4% buffered formalin or 100% ethyl alcohol for morphological studies.

Egg production experiments. Twelve egg production experiments were conducted between 34° N and 28° S latitude, on target copepod species *Haloptilus longicornis*, *Pleuromamma xiphias*, and *Pleuromamma abdominalis*. These experiments were conducted in 500 mL bottles, 6-well sterile plates, or individual 60 x 15mm petri dishes, depending on adult female body size. All dishes were checked for new eggs at 12 and 24-hours, and newly laid eggs were transferred to a new dish to assess hatching rates (over a 3-day period). At the end of each experiment, all females and nauplii were preserved for use in studies of mating dynamics in these species. We hope to genotype both nauplii and adults using microsatellite markers already developed in the Goetze lab (Andrews et al, in prep), and complete paternity analyses on single egg clutches in both *H. longicornis* and *P. xiphias*. New data on reproductive rates obtained from these experiments will be used in ongoing modelling efforts in particle release and dispersal experiments (to test hypotheses about gene flow among populations across the Atlantic basin).

Imaging. A wide range of animals were imaged live to create an image bank for use in education and outreach. Live plankton images were obtained using a Leica MZ9.5 stereomicroscope and a SPOT Insight Mozaic camera, with animals collected using both the bongo and RMT nets. A selection of these images was incorporated in Katja's online blog (see below). We will continue to use these images in graduate and undergraduate teaching, and also for science outreach projects in Hawaii and the Netherlands. A few examples of our images are included below; we intend to make a subset of our images available to the AMT programme and cruise participants following the cruise.

Science outreach. Prior to the cruise, Katja visited a primary school in Amsterdam to talk about ocean science and the AMT cruise to school children (ages 4 to 12 years). She also blogged (in Dutch) about ocean sciences during the cruise, and specifically targeted this age group (katjapeijnenburg.wordpress.com). The blog was used for teaching purposes at this school, and received quite a bit of additional attention and referrals through posts by the Naturalis Biodiversity Center (http://www.naturalis.nl/nl/kennis/blogs-en-expedities/oceaanexpeditie/) and the University of Amsterdam (in English: http://ibed.uva.nl/news-events/news/content/2012/10/follow-marine-biologist-katja-peijnenburg-on-her-scientific-expedition-on-the-atlantic.html). Blogs were also re-posted on a site for scuba diving enthusiasts (for adults): http://duiken.nl/site/duikenblog/oceaanexpeditie. By the end of the cruise, the blog contained 38 posts, attracted 49 followers, and received 149 comments. It was viewed > 5,800 times during the cruise period (from 32 countries), with 109 views on average per day. In addition, Katja collected footage while at sea for a Dutch television news programme (EenVandaag, www.eenvandaag.nl), with the intention that this programme will broadcast an ~10 minute segment featuring an interview with Katja on ocean research and the AMT22 cruise.

Figure 1. Three examples of the live plankton images obtained during the cruise. (Left) *Cuvierina atlantica*, a target species for K. Peijnenburg, (Middle) *Sapphirina* spp, a common

subtropical cyclopoid copepod genus (abundant in the gyres), and (Right) an unidentified hyperiid amphipod. These images were included in the 'Beast of the week' competition on board.

Figure 2. (Left) 36 jars of plankton collected at station 72 ! (Right) What to do with all this plankton?

Table 1. List of all plankton tows conducted during AMT22. Time is local time, CalBOBL indicates bongo oblique tows (quantitative tows), and RMT1 tows used the midwater trawl. Bongo – non-quantative tows were used to collect animals for egg production experiments and live sorting for other purposes (imaging, individual preservation). Latitude and longitude were recorded at the start of each tow.

Station	Latitude	Longitude	Date	Tow type	Start time	End Time
AMT22-03	49° 1.02279 N	16° 5.61981 W	10/13/12	CalBOBL	1:58	3:01
AMT22-05	46° 3.53774 N	18° 29.25264 W	10/14/12	CalBOBL	2:02	2:50
AMT22-07	42° 49.51514 N	20° 32.7898 W	10/15/12	CalBOBL	3:14	4:06
AMT22-09	39° 38.82233 N	22° 27.97545 W	10/16/12	RMT1	3:23	4:23
AMT22-11	36° 40.36117 N	24° 26.82598 W	10/17/12	CalBOBL	3:17	4:08
AMT22-13	34° 21.99546 N	27° 37.90642 W	10/18/12	RMT1	3:14	4:14
AMT22-15	32° 0.04411 N	30° 44.2138 W	10/19/12	CalBOBL	2:41	3:28
AMT22-17	29° 47.85955 N	33° 35.16879 W	10/20/12	RMT1	2:45	3:43
AMT22-19	27° 35.97242 N	36° 22.42594 W	10/21/12	CalBOBL	2:43	3:39
AMT22-21a	25° 42.02956 N	38° 43.34622 W	10/21/12	bongo, non-Quant	23:58	0:22
AMT22-21	25° 28.57077 N	39° 0.010931 W	10/22/12	CalBOBL	2:44	3:36
AMT22-23	23° 9.14204 N	40° 37.55777 W	10/23/12	CalBOBL	2:43	3:31
AMT22-25	20° 23.95484 N	38° 36.68987 W	10/24/12	CalBOBL	2:45	3:32
AMT22-27	17° 42.17357 N	36° 27.35440 W	10/25/12	CalBOBL	2:41	3:31
AMT22-29a	15° 18.25038 N	34° 39.59520 W	10/26/12	RMT1	0:00	0:41
AMT22-29	15° 3.37813 N	34° 28.44571 W	10/26/12	CalBOBL	2:42	3:31
AMT22-31	12° 13.59024 N	32° 23.19925 W	10/27/12	CalBOBL	2:40	3:28
AMT22-33	9° 27.51059 N	30° 21.24688 W	10/28/12	CalBOBL	2:43	3:32
AMT22-35	6° 37.12870 N	28° 18.99615 W	10/29/12	CalBOBL	2:44	3:36
AMT22-37a	4° 15.51862 N	26° 37.25690 W	10/30/12	RMT1	0:01	0:50
AMT22-37	4° 2.96024 N	26° 27.773997 W	10/30/12	CalBOBL	2:42	3:35
AMT22-39	1° 7.90509 N	24° 59.64028 W	10/31/12	CalBOBL	2:40	3:33
AMT22-41	1° 51.27662 S	25° 0.56319 W	11/1/12	RMT1	1:44	2:33
AMT22-41	1° 52.24994 S	24° 58.80352 W	11/1/12	CalBOBL	2:47	n.r.
AMT22-42	2° 55.30948 S	25° 0.73372 W	11/1/12	RMT1	11:54	12:45
AMT22-43a	4° 18.95708 S	25° 1.33545 W	11/1/12	CalBOBL	23:54	1:24
AMT22-43	4° 37.28990 S	25° 1.39361 W	11/2/12	CalBOBL	2:42	3:30
AMT22-45	8° 4.63185 S	25° 2.39218 W	11/3/12	CalBOBL	2:42	3:32
AMT22-47a	11° 17.69048 S	25° 3.28145 W	11/3/12	RMT1	23:57	0:45
AMT22-47	11° 36.92311 S	25° 2.73712 W	11/4/12	CalBOBL	2:41	3:28

AMT22-49	15° 17.99014 S	25° 4.47576 W	11/5/12	CalBOBL	2:39	3:27
AMT22-51	18° 29.56997 S	25° 6.02604 W	11/6/12	CalBOBL	2:42	3:30
AMT22-51b	18° 31.92807 S	25° 4.95871 W	11/7/12	RMT1	2:04	2:52
Station	**Latitude**	**Longitude**	**Date**	**Tow type**	**Start time**	**End Time**
AMT22-51c	18° 30.37741 S	25° 4.96623 W	11/7/12	bongo, non-Quant	3:03	3:29
AMT22-52	20° 6.17534 S	24° 30.99523 W	11/8/12	CalBOBL	2:24	3:02
AMT22-54	22° 56.96736 S	25° 0.17236 W	11/9/12	CalBOBL	2:25	3:13
AMT22-56a	25° 29.05877 S	25° 0.04118 W	11/9/12	RMT1	23:53	0:42
AMT22-56	25° 43.65371 S	24° 59.94407 W	11/10/12	CalBOBL	2:24	3:11
AMT22-58a	28° 21.50617 S	25° 28.44395 W	11/11/12	RMT1	1:43	2:28
AMT22-58	28° 21.69753 S	25° 27.26772 W	11/11/12	CalBOBL	2:38	3:28
AMT22-60a	30° 0.75950 S	27° 42.95436 W	11/12/12	RMT1	0:00	0:45
AMT22-60	30° 10.46520 S	27° 54.36398 W	11/12/12	CalBOBL	2:25	3:13
AMT22-62	34° 7.09132 S	33° 30.18522 W	11/14/12	CalBOBL	2:39	3:27
AMT22-64a	35° 51.72866 S	36° 0.06177 W	11/14/12	RMT1	23:53	0:40
AMT22-64	36° 2.77738 S	36° 14.83477 W	11/15/12	CalBOBL	2:42	3:31
AMT22-66	38° 4.84649 S	39° 18.66999 W	11/16/12	CalBOBL	2:43	3:33
AMT22-68a	39° 52.80418 S	42° 3.10266 W	11/16/12	RMT1	23:57	0:46
AMT22-68	40° 4.39249 S	42° 22.27527 W	11/17/12	CalBOBL	2:41	3:29
AMT22-70	42° 8.00962 S	45° 36.01692 W	11/18/12	CalBOBL	1:46	2:32
AMT22-74	45° 30.44287 S	51° 20.88000 W	11/19/12	CalBOBL	1:46	2:33

Air-Sea Exchange of Oxygenated Volatile Organic Compounds

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Introduction

Oxygenated Volatile Organic Compounds (OVOCs), such as methanol, acetone, and acetaldehyde, are low molecular weight carbon-containing compounds found ubiquitously in the lower atmosphere. They can be emitted from natural or anthropogenic sources, (photo)chemically produced or destroyed in air, and lost to the surface via deposition. OVOCS are important in atmospheric chemistry and climate because they alter the tropospheric oxidative capacity by influencing the cycling of ozone and the hydroxyl radical (OH). Due to the scarcity of air-sea flux and concentration measurements, the role of the ocean to these compounds remains poorly quantified. Some OVOCs may be produced in the ocean and emitted to the atmosphere, while others are released to the air from other sources and dissolve into the ocean. On AMT22, I aimed to directly quantify the air-sea exchange of OVOCs.

Observations

- Continuous concentration measurements of atmospheric methanol, acetone, and acetaldehyde
- Direct quantification of the air-sea fluxes of methanol, acetone, and acetaldehyde, sensible heat, and momentum with the eddy covariance method
- Discrete near-surface seawater concentrations of these OVOCs

Analytical Methods

Atmospheric Concentrations

Concentrations of atmospheric as well as seawater OVOCs were quantified by a proton-transfer-reaction mass spectrometer (PTR-MS) located in the meteorological lab. The PTR-MS performed well during the cruise, with good sensitivity and without any notable issues, even in rough weather.

For ~19 hours per day, the PTR-MS operated under atmospheric mode and continuously measured at ~2.1 Hz. Air was drawn in from the meteorological platform above the bow via ~25 m of ¼ inch internal diameter PFA tubing by a vacuum pump. The manifold flow rate was ~23 standard litres per minute, as monitored by a digital mass flow meter. For most of the cruise, methanol, acetone, and acetaldehyde were measured simultaneously. Between 3 Nov and 16 Nov, only methanol and acetone were measured because the level of acetaldehyde was near the instrument's detection limit. Dueterated methanol and acetone gas standards were injected continuously into the inlet line. The standard flow was regulated by a digital thermal mass flow controller. Ambient concentrations of those OVOCs were then calculated from the ratio of the natural and dueterated signals. The use of dueterated standards minimizes uncertainties due to instrumental drift and variable efficiencies. Background values were taken by directing ambient air through a catalytic converter, which removes organic compounds, for two minutes at the top of every hour.

A plastic funnel, which was attached to the front of the gas inlet to keep out rain droplets, was unexpectedly found to emit acetone and acetaldehyde, presumably due to photochemical degradation. The artifact (positive bias) was especially severe in warm air and under direct sunlight. The funnel was removed on 29 Oct and the problem resolved thereafter. However, acetone and acetaldehyde data collected before that date are highly uncertain, with daytime concentrations most likely unusable. I have corrected the remaining nighttime data with a simple exponential fit to temperature. While the results look reasonable visually, the validity of the correction cannot be verified. Methanol was fortunately not affected. Hourly averaged atmospheric concentrations will be submitted within a year, after post-cruise calibrations.

Air-sea Fluxes

Direct air-sea flux measurements require ambient vertical wind velocity. Wind measurements on a ship are, however, influenced by the ship's motion itself. Thus a motion correction on measured relative winds is necessary. A sonic anemometer and a motion sensor were mounted together with the gas inlet on the starboard side of the meteorological platform. To minimize disturbance of wind by the ship's headlight in the center of the platform, the sensors were rotated 44 degrees towards the starboard. Three dimensional (3D) wind velocities were continuously recorded at 10 Hz for the entire cruise. Wind speeds and directions from my instrument generally matched very well with the ship's wind measurements. The exception is when winds were from the port/port-stern sector, when my wind sensor underestimates wind speed because of airflow distortion caused by the ship's headlight.

Linear accelerations and rotational rates were measured at ~15 Hz. The motion data were later interpolated to match the sampling frequency of the wind data. Following Edson et al. (1998), the motion data were rotated and integrated to generate the 3D velocities of the ship, which were then subtracted from the measured relative winds to yield the true (ambient) winds. The motion-corrected vertical wind velocity may then be used to correlate with OVOCs, temperature, and horizontal wind velocity to generate the air-sea fluxes of OVOCs, sensible heat, and momentum, respectively. The actual flux calculations are computationally intensive. Detections of fluxes depend on the strength of the ambient signals as well as the sampling conditions (wind directions, ship's maneuvres etc). Thus, the flux results will likely not be ready until at least 2 years after the cruise. Raw wind and motion data recorded for the entire cruise at high frequency take up several gigabytes of storage space, and may be of little value to most scientists. I can provide the high frequency (or averaged) wind and motion data upon personal request.

Seawater Concentrations

Discrete seawater OVOC concentrations were measured from CTD as well as underway samples. To minimize microbial loss, water samples were kept at ambient water temperature in opaque glass bottles and analyzed within 3 hours of sampling. OVOCs were extracted from seawater samples across a semi-permeable membrane into a supply of clean nitrogen flowing directly into the PTR-MS. The extraction of OVOCs from the water phase into the gas phase does not need to be (and may not be) complete. Rather, the system was calibrated using water standards prepared by serial dilution of reagent-grade methanol, acetone, and acetaldehyde approximately every two weeks. For details of the seawater analytical method, please refer to Beale et al. (2011). Unfortunately, a leakage in the membrane system compromised measurements early on during the cruise. Thus data prior to 16 Oct are therefore subject to greater uncertainty. Otherwise the system worked well.

Near-surface seawater was taken from the CTD (nominally at 5 m depth) at every station, while the Niskin was yet to be opened. Triplicate samples were collected from the same Niskin bottle. The first was used to condition the membrane; reported concentrations of methanol, acetone, and acetaldehyde represent the average of the latter two samples. In addition, a single sample from the deepest bottle of the CTD (nominally at 500 m depth) was taken at casts at noon. OVOC concentrations from the deep samples were always lower than from the surface (and also lower than OVOC concentrations in the Milli-Q water). In addition, several underway samples were taken on 22 Oct, when winds were unfavorable for atmospheric sampling, on 13 Nov, when no CTD was commenced in the presence of a storm, and on 20 Nov, after the completion of CTD work. The aforementioned seawater concentrations will be submitted within a year, after post-cruise calibrations.

References

Beale R., Dixon JL., Liss PS., Nightingale PD. (2011) Quantification of oxygenated volatile organic compounds in seawater by membrane inlet-proton transfer reaction/mass spectrometry. *Analytica Chimica Acta* 706: 128-134.

Edson, J.B., A.A. Hinton, K.E. Prada, J.E. Hare, and C.W. Fairall (1998), Direct covariance flux estimates from mobile platforms at sea, *J. Atmos. Oceanic Technol.*, 15, 547–

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Table 1. Near-surface CTD samples

Station	Cast	Bottle	MM/DD/YY UTC	Lat. +N,-S	Lon. W	Depth (m)
2	2	22	10/12/12 12:14	49.2494	13.0521	5
3	3	22	10/13/12 4:33	48.9277	16.3695	5
4	4	23	10/13/12 13:01	47.8818	17.2666	5
5	5	21	10/14/12 4:31	45.8774	18.6081	5
6	6	23	10/14/12 13:08	44.7599	19.3246	5
7	7	22	10/15/12 4:25	42.8174	20.5779	5
8	8	22	10/15/12 13:03	41.6542	21.2649	5
9	9	22	10/16/12 4:43	39.6543	22.5095	5
10	10	22	10/16/12 12:59	38.5545	23.0971	5
11	11	22	10/17/12 4:26	36.6863	24.4688	5
12	12	23	10/17/12 12:58	35.847	25.5943	5
13	13	22	10/18/12 4:30	34.3828	27.6375	5
14	14	22	10/18/12 12:59	33.5608	28.6892	5
15	15	21	10/19/12 4:56	32.0224	30.7364	5
16	16	23	10/19/12 13:57	31.1057	31.9078	5
17	17	22	10/20/12 4:58	29.8077	33.55	5
18	18	23	10/20/12 13:57	28.9361	34.6744	5
19	19	22	10/21/12 4:55	27.6147	36.347	5
20	20	22	10/21/12 14:00	26.7169	37.4708	5
21	21	22	10/22/12 4:53	25.4993	38.9826	5
22	22	22	10/22/12 14:02	24.5951	40.0754	5
23	23	22	10/23/12 4:55	23.164	40.6037	5
24	24	22	10/23/12 14:01	22.075	39.7977	5
25	25	22	10/24/12 4:52	20.5651	38.5932	5
26	26	23	10/24/12 14:01	19.4429	37.772	2
27	27	22	10/25/12 4:55	17.7095	36.4282	5

Station	Cast	Bottle	MM/DD/YY UTC	Lat. +N, -S	Lon. W	Depth (m)
28	28	22	10/25/12 14:00	16.6414	35.6575	5
29	29	22	10/26/12 4:53	15.0621	34.4472	5
30	30	22	10/26/12 14:00	13.9556	33.6672	5
31	31	22	10/27/12 4:55	12.2243	32.3605	5
32	32	22	10/27/12 13:58	11.1153	31.5773	5
33	33	22	10/28/12 4:52	9.45253	30.3282	5
34	34	22	10/28/12 14:00	8.2967	29.5326	5
35	35	22	10/29/12 4:43	6.62122	28.3419	5
36	36	22	10/29/12 14:00	5.54538	27.5432	5
37	37	22	10/30/12 4:53	4.02838	26.4693	5
38	38	22	10/30/12 14:01	2.9197	25.6617	5
39	39	22	10/31/12 4:53	1.10778	24.9844	5
41	40	22	11/1/12 5:01	-1.88373	24.9563	5
42	41	22	11/1/12 14:00	-2.92988	24.9841	5
43	42	22	11/2/12 4:51	-4.62298	25.0038	5
44	43	22	11/2/12 13:56	-5.82938	25.0299	5
45	44	22	11/3/12 4:51	-8.08912	25.0142	5
46	45	22	11/3/12 13:56	-9.51348	25.0535	5
47	46	22	11/4/12 4:47	-11.6218	25.0205	5
48	47	22	11/4/12 13:58	-13.0735	25.0667	5
49	48	23	11/5/12 4:49	-15.2871	25.1344	2
50	49	22	11/5/12 14:00	-16.7597	25.0977	5
51	50	21	11/6/12 4:56	-18.516	25.1012	5
51	51	22	11/7/12 14:38	-18.5298	25.1015	5
52	52	22	11/8/12 4:49	-20.1212	24.4969	5
53	53	22	11/8/12 14:01	-21.2527	24.8455	5
54	54	22	11/9/12 4:41	-22.9647	24.9805	5
55	55	22	11/9/12 13:57	-24.1254	25.0029	5

Station	Cast	Bottle	MM/DD/YY UTC	Lat. +N, -S	Lon. W	Depth (m)
56	56	22	11/10/12 4:40	-25.7495	24.9908	5
57	57	23	11/10/12 13:59	-26.9562	25.0062	5
58	58	22	11/11/12 4:45	-28.3879	25.475	5
59	59	21	11/11/12 13:58	-29.1152	26.507	5
60	60	22	11/12/12 4:42	-30.1998	27.9188	5
61	61	22	11/12/12 13:57	-30.9701	29.0522	5
62	62	24	11/14/12 4:56	-34.1474	33.4924	5
63	63	22	11/14/12 13:55	-34.8577	34.5375	5
64	64	22	11/15/12 4:54	-36.0694	36.2557	5
65	65	22	11/15/12 13:56	-36.8372	37.439	5
66	66	22	11/16/12 4:54	-38.1057	39.3287	5
67	67	22	11/16/12 13:58	-38.9092	40.5631	5
68	68	22	11/17/12 4:54	-40.1024	42.3831	5
69	70	23	11/17/12 13:57	-40.9063	43.6493	5
70	71	21	11/18/12 4:54	-42.1372	45.6269	5
71	71	22	11/18/12 14:58	-43.0468	47.0785	5
72	72	22	11/19/12 4:50	-43.923	48.5654	5
73	73	22	11/19/12 14:58	-44.6763	49.7588	5
74	74	22	11/20/12 4:55	-45.5006	51.3197	5

Table 2. Deep CTD Samples

Station	Cast	Bottle	MM/DD/YY UTC	Lat. +N,-S	Lon. W	Depth (m)
10	10	1	10/16/12 12:59	38.5545	23.0971	500
12	12	1	10/17/12 12:58	35.847	25.5943	500
14	14	1	10/18/12 12:59	33.5608	28.6892	500
16	16	1	10/19/12 13:57	31.1057	31.9078	500
18	18	2	10/20/12 13:57	28.9361	34.6744	300
24	24	1	10/23/12 14:01	22.075	39.7977	500

Station	Cast	Bottle	MM/DD/YY UTC	Lat. +N,-S	Lon. W	Depth (m)
26	26	1	10/24/12 14:01	19.4429	37.772	500
28	28	1	10/25/12 14:00	16.6414	35.6575	500
30	30	1	10/26/12 14:00	13.9556	33.6672	500
32	32	1	10/27/12 13:58	11.1153	31.5773	500
34	34	1	10/28/12 14:00	8.2967	29.5326	300
36	36	1	10/29/12 14:00	5.54538	27.5432	500
38	38	1	10/30/12 14:01	2.9197	25.6617	300
42	41	1	11/1/12 14:00	-2.92988	24.9841	500
44	43	1	11/2/12 13:56	-5.82938	25.0299	500
48	47	1	11/4/12 13:58	-13.0735	25.0667	500
50	49	1	11/5/12 14:00	-16.7597	25.0977	500
51	51	1	11/7/12 14:38	-18.5298	25.1015	500
53	53	1	11/8/12 14:01	-21.2527	24.8455	500
55	55	1	11/9/12 13:57	-24.1254	25.0029	500
57	57	1	11/10/12 13:59	-26.9562	25.0062	500
59	59	1	11/11/12 13:58	-29.1152	26.507	500
65	65	1	11/15/12 13:56	-36.8372	37.439	500
67	67	1	11/16/12 13:58	-38.9092	40.5631	500
69	69	1	11/17/12 13:57	-40.9063	43.6493	500
71	71	1	11/18/12 14:58	-43.0468	47.0785	500

Table 3. Underway Water Samples

MM/DD/YY UTC	Lat.+N,-S	Lon. W	Depth (m)
10/22/12 7:53	25.2727	39.2508	5
10/22/12 8:26	25.2059	39.3273	5
10/22/12 9:08	25.123	39.4234	5
10/22/12 9:44	25.0515	39.5057	5
10/22/12 10:23	24.9777	39.5976	5

MM/DD/YY UTC	Lat.+N,-S	Lon. W	Depth (m)
10/22/12 11:00	24.907	39.6852	5
10/22/12 11:38	24.8344	39.776	5
10/22/12 12:15	24.7661	39.8639	5
10/22/12 12:51	24.7	39.9476	5
11/13/12 7:45	-32.5355	31.2359	5
11/13/12 7:45	-32.5355	31.2359	5
11/13/12 14:59	-32.9783	31.8701	5
11/13/12 16:52	-33.1462	32.0985	5
11/13/12 20:11	-33.4771	32.5314	5
11/20/12 14:57	-46.5775	53.604	5
11/20/12 14:57	-46.5775	53.604	5

Nutrients

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OBJECTIVES:

To investigate the spatial variations of the micro-molar nutrient species nitrate, nitrite, phosphate, silicate and ammonium along the Atlantic Meridional Transect (AMT) cruise track, departing from Southampton, UK and sailing through the North Atlantic Gyre (NAG), south to the equator, through the South Atlantic Gyre (SAG), before turning south-west to end the cruise at Punta Arenas, Chile.

SAMPLING and METHODOLOGY

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

Water samples were taken from a 24 x 20 litre bottle stainless steel framed CTD / Rosette system (Seabird). These were sub-sampled into clean (acid-washed) 60ml HDPE (Nalgene) sample bottles. Subsequent nutrient analysis was complete within 3-4 hours of sampling.

CTD SAMPLES ANALYSED

A total of 73 vertical profiles were analysed along the transect of the AMT and are listed in the table below, (CTD geographic positions and corrected bottle firing depths are available from the CTD Log.) :-

Table : AMT 22 - Nutrient Analysis - Station & CTD Sampling Summary

Date	Time (GMT)	Ship Stn	CTD ID	Niskin sampled
12.10.2012	12:15	JCO79-002	CTD-002S	23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
13.10.2012	04.33	JCO79-003	CTD-003S	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
13.10.2012	13:01	JCO79-004	CTD-004S	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
14.10.2012	04:31	JCO79-005	CTD-005S	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
14.10.2012	13:03	JCO79-06A	CTD--006AS	24,23,22,21,19,16,14,10,9,8,7,6,5,4,3,2,1
15.10.2012	04:25	JCO79-07	CTD-007S	24,22,21,20,18,16,14,12,10,9,8,6,5,4,3,2,1
15.10.2012	15:03	JCO79-08	CTD-08	24,23,22,21,20,18,17,16,15,12,11,10,9,8,7,6,5,4,3,2,1
16.10.2012	04:43	JCO79-09	CTD-09	24,23,22,21,19,18,17,16,
16.10.2012	12:59	JCO79-010	CTD-010	24,23,22,21,20,19,16,15,14,13,12,11,10,8,7,6,5,4,3,2,1
17.10.2012	04:26	JCO79-011	CTD-011	24,23,22,21,20,19,18,17,16,15,14,13,11,10,9,8,7,6,5,4,2,1
17.10.2012	12:58	JCO79-012	CTD-012	24,23,22,21,17,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
18.10.2012	04:30	JCO79-013	CTD-013	24,23,22,21,20,19,18,17,16,14,13,12,11,10,9,8,7,6,5,4,3,2,1
18.10.2012	12:57	JCO79-014	CTD-014	24,23,22,21,20,17,16,15,14,13,12,11,10,9,7,6,5,4,3,2,1
19.10.2012	04:56	JCO79-015	CTD-015	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
19.10.2012	13:57	JCO79-016	CTD-016	24,23,22,21,17,13,12,11,10,9,8,7,6,5,4,3,2,1
20.10.2012	04:58	JCO79-017	CTD-017	24,23,22,21,20,19,18,17,16,15,14,13,12,10,9,8,7,6,4,3,2,1
20.10.2012	13:57	JCO79-018	CTD-018	24,23,22,21,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2
21.10.2012	04:55	JCO79-019	CTD-019	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
21.10.2012	14:00	JCO79-020	CTD-020	24,23,22,21,20,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
22.10.2012	04:53	JCO79-021	CTD-021	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
22.10.2012	14:02	JCO79-022	CTD-022	24,23,22,21,20,17,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
23.10.2012	04:55	JCO79-023	CTD-023	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
23.10.2012	14:01	JCO79-024	CTD-024	24,23,22,21,20,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
24.10.2012	04:52	JCO79-025	CTD-025	24,23,22,21,20,19,18,17,16,15,14,13,12,10,9,8,7,6,5,4,3,2,1
24.10.2012	14:01	JCO79-026	CTD-026	24,23,21,20,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
25.10.2012	04:55	JCO79-027	CTD-027	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2
25.10.2012	14:00	JCO79-028	CTD-028	24,23,22,21,20,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1

26.10.2012	04:53	JCO79-029	CTD-029	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,6,5,4,3,2,1
26.10.2012	14:00	JCO79-030	CTD-030	23,22,21,20,19,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
27.10.2012	04:55	JCO79-031	CTD-031	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,7,6,5,4,3,2,1
27.10.2012	13:58	JCO79-032	CTD-032	24,23,22,21,20,19,16,14,13,12,11,10,9,8,7,6,5,4,3,2,1
28.10.2012	04:52	JCO79-033	CTD-033	24,23,22,21,19,18,17,16,14,13,12,11,10,9,8,7,6,5,43,2,1
28.10.2012	14:00	JCO79-034	CTD-034	24,23,22,21,20,19,18,14,13,12,11,10,9,8,7,6,5,4,3,2,1
29.10.2012	04:53	JCO79-035	CTD-035	23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
29.10.2012	14:00	JCO79-036	CTD-036	24,23,22,21,20,19,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
30.10.2012	04:53	JCO79-037	CTD-037	24,23,22,21,20,19,18,17,16,15,14,13,12,10,9,8,7,6,5,4,3,2,1
30.10.2012	14:00	JCO79-038	CTD-038	24,23,22,21,20,19,16,12,11,10,9,8,7,6,5,4,3,2,1
31.10.2012	04:53	JCO79-039	CTD-039	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,7,6,5,4,3,2,1
01.11.2012	05:01	JCO79-041	CTD-040	24,23,22,21,20,18,17,16,15,14,13,12,11,10,8,7,6,5,4,3,2,1
01.11.2012	14:00	JCO79-042	CTD-041	24,23,22,20,19,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
02.11.2012	04:51	JCO79-043	CTD-042	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,4,3,2,1
02.11.2012	13:56	JCO79-044	CTD-043	24,23,22,21,20,18,14,13,12,11,10,9,8,7,6,5,4,3,2,1
03.11.2012	04:51	JCO79-045	CTD-044	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,8,7,6,5,4,3,2,1
03.11.2012	13:56	JCO79-046	CTD-045	24,23,22,21,20,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
04.11.2012	04:47	JCO79-047	CTD-046	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,2
04.11.2012	15:38	JCO79-048	CTD-047	24,23,22,21,20,18,14,13,12,11,10,9,8,7,6,5,4,3,2,1
05.11.2012	04:49	JCO79-049	CTD-048	23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
05.11.2012	14:00	JCO79-050	CTD-049	24,23,22,20,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
06.11.2012	04:56	JCO79-051	CTD-050	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,43,2,1
07.11.2012	14:38	JCO79-051	CTD-051	24,23,22,21,20,19,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
08.11.2012	04:49	JCO79-052	CTD-052	24,23,22,21,20,19,18,17,16,15,14,13,11,10,9,8,7,6,5,4,3,2,1
08.11.2012	14:01	JCO79-053	CTD-053	24,23,22,21,18,14,13,12,11,10,9,8,7,6,5,4,3,2,1
09.11.2012	04:41	JCO79-054	CTD-054	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
09.11.2012	13:57	JCO79-055	CTD-055	24,23,22,21,20,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
10.11.2012	04:40	JCO79-056	CTD-056	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
10.11.2012	13:59	JCO79-057	CTD-057	24,23,22,21,18,14,13,12,11,10,9,8,7,6,5,4,3,2,1
11.11.2012	04:45	JCO79-	CTD-	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2

		058	058	
11.11.2012	13:58	JCO79-059	CTD-059	24,23,22,21,20,19,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
12.11.2012	04:42	JCO79-060	CTD-060	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
12.11.2012	13:57	JCO79-061	CTD-061	24,23,22,21,20,17,13,12,11,10,9,8,7,6,5,4,3,2,1
14.11.2012	04:56	JCO79-062	CTD-062	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
14.11.2012	13:55	JCO79-063	CTD-063	24,23,22,21,20,19,16,12,11,10,9,8,7,6,5,4,3,2,1
15.11.2012	04:54	JCO79-064	CTD-064	24,23,22,21,20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1
15.11.2012	13:56	JCO79-065	CTD-065	24,23,22,21,20,29,16,15,14,13,12,10,9,8,7,6,5,4,3,2,1
16.11.2012	04:54	JCO79-066	CTD-066	24,23,22,21,19,18,16,14,12,11,9,8,6,5,4,3,2,1
16.11.2012	13:58	JCO79-067	CTD-067	24,22,21,20,19,15,14,12,11,10,9,8,7,6,5,4,3,2,1
17.11.2012	04:54	JCO79-068	CTD-068	24,22,20,18,15,14,12,11,9,8,7,6,5,4,3,2,1
17.11.2012	13:57	JCO79-069	CTD-069	24,23,22,21,18,12,11,10,9,8,7,5,4,3,2,1
18.11.2012	04:54	JCO79-070	CTD-070	24,21,20,19,18,17,14,12,10,9,8,6,5,3,2,1
18.11.2012	14:58	JCO79-071	CTD-071	24,22,21,20,19,16,15,14,11,10,7,6,4,3,2,1
19.11.2012	04:50	JCO79-072	CTD-072	24,22,21,19,16,15,13,11,9,8,7,5,4,3,2,1
19.11.2012	14:58	JCO79-073	CTD-073	24,23,22,21,20,19,12,11,10,9,8,7,6,4,3,2,1
20.11.2012	04:55	JCO79-074	CTD-074	24,22,21,19,18,15,14,12,11,9,8,6,5,4,3,2,1

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

Links between biological production rates and trace gas exchange fluxes of CO_2, N_2O, CH_4 and CO, using Los Gatos ICOS analysers and O_2/Ar ratios.

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Rationale

Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are long-lived climatically active gases with atmospheric lifetimes of decades to centuries (Cicerone and Oremland, 1988; Nevison et al., 1995; Solomon et al., 2007). Carbon monoxide (CO) is a short lived greenhouse gas which indirectly influences the atmospheric residence times of other climatically active gases, such as methane, by acting as the primary determinant of tropospheric hydroxyl radical (OH) concentration (Stubbins, 2006). There are currently large uncertainties over the air-sea exchange rates of these four trace gases due to the spatial and temporal sparseness of available data (Solomon et al., 2007).

Aquatic photosynthesis (P) and respiration (R) are drivers of the biogeochemical budgets of many climate-relevant gases, and it is therefore crucial to be able to accurately determine P and R in the ocean. This project aims to find links between biological production rates and trace gas exchange fluxes. We expect areas of CO_2 drawdown to correspond to net sources of O_2. In contrast, the link between N_2O, CH_4 and CO fluxes and O_2 fluxes is less obvious because their production is tied to biological processes below the mixed layer.

Objectives

- To quantify air-sea exchange fluxes of CO_2, CH_4, N_2O and CO along the AMT22 transect from Southampton, UK to Punta Arenas, Chile.
- To derive estimates of mixed layer net community production
- To derive estimates of photosynthetic gross production
- To establish empirical relationships between trace gas fluxes and productivity estimates
- To compare UEA's ICOS analyser dry mixing ratio measurements to the $p(CO_2)$ measurements made during the AMT22 transect (Vassilis Kitidis, PML).
- To compare estimates of mixed layer net community production and photosynthetic gross production by Membrane Inlet Mass Spectrometry (MIMS) to estimates obtained from oxygen titration (Pablo Serret & Jose Lozano, Universidad de Vigo) and from incubation studies measuring ^{14}C distintegration time (Gavin Tilstone[1] & Pricilla Lange[2], PML[1], Federal University of Rio Grande, Brazil[2]).

Work on the ship

A glass-bed equilibrator was connected to the uncontaminated water sampling system of *RRS* James Cook. The headspace was sampled continuously by a daisy-chain of two Los Gatos ICOS analysers, one for combined $CO_2/CH_4/H_2O$ measurements, the other for combined $N_2O/CO/H_2O$ measurements. The analysers provide dry mixing ratios of CO_2, CH_4, N_2O and CO. Measurements were made continuously throughout the cruise transect, only interrupted by daily calibrations with three standard gas mixtures, running 20 min each, and regular analyses of clean air (5 min every four hours). The resolution (e-folding time) is 2 min for CO_2 and N_2O and about 20 min for the less soluble gases CH_4 and CO. The resolution is limited by the replacement time of the headspace in the equilibrator (Gülzow et al., 2011). This provides a spatial resolution of 0.5 to 5 km, depending on the gas. The results will be combined with ship-based wind-speed measurements and suitable wind speed-gas exchange parameterisations (Ho et al., 2006; Nightingale et al., 2000; Sweeney et al., 2007) to calculate air-sea gas exchange fluxes.

An optode was used to continuously measure oxygen concentration and saturation, as well as the water temperature from the underway water supply. The optode will be calibrated by shipboard

Winkler O_2 titrations, which were collected and analysed approximately every eight hours throughout the cruise (Pablo Serret & Jose Lozano).

Membrane-inlet mass spectrometry (MIMS) was used to continuously measure dissolved oxygen-argon (O_2/Ar) ratios from the underway water supply of the ship (from approximately 5m) across the AMT22 transect from Southampton to Punta Arenas. This data will be used to calculate biological oxygen fluxes (Kaiser et al., 2005).

Discrete water samples were collected approximately every 12 hours from the underway seawater supply throughout the cruise in 300 mL air-evacuated glass bottles. These will be utilised for both calibrating the O_2/Ar measurements made by MIMS and for analysing the triple oxygen isotope composition of dissolved oxygen. The ^{17}O isotope excess in the dissolved O_2 will be used to estimate the contribution of atmospheric and photosynthetic O_2 in the mixed layer. This will in turn be used to calculate gross productivity using suitable wind-speed gas exchange parameterisations (Kaiser 2011). Air-evacuated discrete water samples were also taken simultaneously from Niskin bottles (5 m) and the underway seawater supply to establish whether there is any offset between the ship's non toxic pumped seawater supply and clean surface seawater.

Comparisons of both net and gross community production will be made between estimates derived from MIMS and triple oxygen isotope sample measurements and those calculated from oxygen titration (Pablo Serret & Jose Lozano) and ^{14}C measurements from incubation studies (Gavin Tilstone & Pricilla Lange) during the AMT22 cruise.

Water samples were collected from the CTD into 500 mL glass bottles with glass stoppers. The bottles were rinsed with Milli-Q water prior to sampling and the volume of the bottle was replaced with seawater from the Niskin bottle at least once before the sample was collected. With the exception of 3 casts (CTD casts 049, 051 & 053) 7 or 8 depths were collected at each cast. At the three casts mentioned replicate samples were taken at the same depth to test the accuracy and precision of the MIMS. The water samples were measured by MIMS from 32 daily solar noon and 3 pre-dawn casts across the AMT22 transect (Table 1) (pre-dawn casts were made due to the solar noon casts being cancelled on those days) (Table 1). The seawater samples were collected from the surface waters, the mixed layer, the deep chlorophyll max (DCM), the oxygen max, the top and bottom of the oxycline, and from 300-500 m. These depth profiles will be used to correct for the vertical entrainment of thermocline waters, which may otherwise bias net community production estimates.

Table 1. Samples collected for the vertical depth profiles of O_2/Ar (analysed by MIMS)

Date	**CTD Type**	**CTD cast**	**Latitude**	**Longitude**	**Depths sampled (m)**
12.10.12	Solar noon	2	49 14.96'N	13 03.12'W	5,10,15,20,30,60,300
14.10.12	Solar noon	6	44 45.59'N	19 19.47'W	5,20,30,34,40,50,200,300
15.10.12	Solar noon	8	41 39.25'N	21 15.89'W	5,20,38,51,60,75,150,300
17.10.12	Solar noon	12	35 50.82'N	25 35.65'W	5,20,30,52,69,100,200,500
18.10.12	Solar noon	14	33 33.68'N	28 41.40'W	3,5,42,57,98,110,150,500
19.10.12	Solar noon	16	31 06.34'N	31 54.46'W	5,20,57,75,90,100,200,500
20.10.12	Solar noon	18	28 56.19'N	34 40.19'W	5,20,45,61,70,80,105,500
21.10.12	Solar noon	20	26 43.02'N	37 28.25'W	5,20,47,63,86,120,164,500
22.10.12	Solar noon	22	24 35.70'N	40 04.52'W	5,28,49,75,115,120,150,500
23.10.12	Solar noon	24	22 04.52'N	39 47.89'W	5,28,49,75,105,135,173,500
24.10.12	Solar noon	26	19 26.66'N	37 46.35'W	5,20,28,75,88,106,150,500
25.10.12	Solar noon	28	16 38.62'N	35 39.43'W	5,20,26,55,86,100,150,500
26.10.12	Solar noon	30	13 57.32'N	33 40.02'W	5,20,26,52,95,150,200,500
27.10.12	Solar noon	32	11 06.92'N	31 34.64'W	5,20,25,36,52,125,200,500
28.10.12	Solar noon	34	08 17.77'N	29 31.78'W	5,16,20,39,60,100,150,300
30.10.12	Solar noon	38	03 02.29'N	25 44.51'W	5,20,39,51,80,150,300
31.10.12	Pre-dawn	39	01 06.54'N	24 58.78'W	5,11,20,36,68,85,100,300
01.11.12	Solar noon	40	02 55.79'S	24 59.05'W	5,20,36,65,76,90,200,500
02.11.12	Solar noon	43	05 49.76'S	25 01.79'W	5,20,44,95,102,125,150,200
03.11.12	Solar noon	45	09 30.81'S	25 03.21'W	5,20,44,90,110,200,300,500

04.11.12	Solar noon	47	13 04.41'S	25 04.00'W	5,20,25,102,130,200,300,500
05.11.12	Solar noon	49	16 45.58'S	25 05.86'W	5(x2),100(x2),159(x2),200,500
06.11.12	Pre-dawn	50	18 30.96'S	25 06.07'W	5,20,29,52,161,200,300
07.11.12	Solar noon	51	18 31.78'S	25 06.08'W	5,20(x2),70,155(x3),300
08.11.12	Solar noon	53	21 15.16'S	24 50.73'W	5(x2),20(x2),89,150,300(x2)
09.11.12	Solar noon	55	24 07.52'S	25 00.17'W	5,16,20,45,150,300,500
10.11.12	Solar noon	57	26 57.36'S	25 00.37'W	5,16,20,52,92,162,200,500
11.12.12	Solar noon	59	29 07.05'S	26 30.51'W	2,5,15,50,140,300,500
12.11.12	Solar noon	61	30 58.21'S	29 03.14'W	5,13,20,90,160,200,500
14.11.12	Solar noon	63	34 51.46'S	34 31.98'W	5,15,20,60,80,200,500
15.11.12	Solar noon	65	36 50.23'S	37 26.34'W	5,14,20,60,100,300,500
16.11.12	Solar noon	67	38 54.55'S	40 33.79'W	5,10,20,35,60,80,200,500
17.11.12	Solar noon	69	40 54.38'S	43 38.96'W	5,10,15,20,80,100,200,500
18.11.12	Solar noon	71	43 02.81'S	47 04.71'W	5,8,33,40,80,200,500
19.11.12	Solar noon	73	44 40.52'S	49 45.54'W	5,10,20,30,60,100,200,500

The results from this cruise are expected to be available by July 2014

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AMT22 EVENT LOG

C		End		Comment			
Date	Time	Date	Time	All times UTC	Indicator	dd hh:mm	hours
06/10/2012	07:00	10/10/2012	10:00	Mobilisation.	Dem/Mob	4 03:00	99.00
10/10/2012	10:00	11/10/2012	14:12	Passage	Pass	1 04:12	28.20
11/10/2012	14:12	11/10/2012	14:50	Trial CTD deployment. Comms issue. Re-term required.	DTTech	0 00:38	0.63
12/10/2012	03:15	12/10/2012	03:33	Preps	RWP	0 00:18	0.30
12/10/2012	03:33	12/10/2012	04:36	CTD and vertical net ops	Stat	0 01:03	1.05
12/10/2012	04:36	12/10/2012	12:04	Transit	RWP	0 07:28	7.47
12/10/2012	12:04	12/10/2012	14:25	Optics and CTD ops	Stat	0 02:21	2.35
12/10/2012	14:25	13/10/2012	01:59	Transit	RWP	0 11:34	11.57
13/10/2012	01:59	13/10/2012	03:06	Towed net op.	Tow	0 01:07	1.12
13/10/2012	03:06	13/10/2012	04:30	Transit	RWP	0 01:24	1.40
13/10/2012	04:30	13/10/2012	05:30	CTD and vertical net ops	Stat	0 01:00	1.00
13/10/2012	05:30	13/10/2012	13:01	Transit	RWP	0 07:31	7.52
13/10/2012	13:01	13/10/2012	13:58	Optics and CTD ops	Stat	0 00:57	0.95
13/10/2012	13:58	14/10/2012	02:02	Transit	RWP	0 12:04	12.07
14/10/2012	02:02	14/10/2012	03:00	Towed net op.	Tow	0 00:58	0.97
14/10/2012	03:00	14/10/2012	04:30	Transit	RWP	0 01:30	1.50
14/10/2012	04:30	14/10/2012	05:20	CTD and vertical net ops	Stat	0 00:50	7.38
14/10/2012	05:20	14/10/2012	12:57	Transit	RWP	0 07:37	7.62
14/10/2012	12:57	14/10/2012	14:22	Vertical net, Optics and CTD ops	Stat	0 01:25	1.42
14/10/2012	14:22	15/10/2012	03:14	Transit	RWP	0 12:52	12.87
15/10/2012	03:14	15/10/2012	04:10	Towed net op.	Tow	0 00:56	0.93
15/10/2012	04:10	15/10/2012	05:14	Vertical net, Optics and CTD ops	Stat	0 01:04	1.07
15/10/2012	05:14	15/10/2012	13:00	Transit	RWP	0 07:46	7.77
15/10/2012	13:00	15/10/2012	14:00	Optics and CTD ops	Stat	0 01:00	1.00
15/10/2012	14:00	16/10/2012	03:21	Transit	RWP	0 13:21	13.35
16/10/2012	03:21	16/10/2012	04:25	Towed net op.	Tow	0 01:04	1.07
16/10/2012	04:25	16/10/2012	04:42	Preps	RWP	0 00:17	0.28
16/10/2012	04:42	16/10/2012	05:28	CTD and vertical net ops	Stat	0 00:46	0.77

C		End		Comment			
Date	Time	Date	Time	All times UTC	Indicator	dd hh:mm	hours
16/10/2012	05:28	16/10/2012	13:00	Transit	RWP	0 07:32	7.53
16/10/2012	13:00	16/10/2012	14:00	Optics and CTD ops	Stat	0 01:00	1.00
16/10/2012	14:00	17/10/2012	03:15	Transit	RWP	0 13:15	13.25
17/10/2012	03:15	17/10/2012	04:10	Towed net op.	Tow	0 00:55	0.92
17/10/2012	04:10	17/10/2012	04:25	Preps	RWP	0 00:15	0.25
17/10/2012	04:25	17/10/2012	05:16	CTD and vertical net ops	Stat	0 00:51	0.85
17/10/2012	05:16	17/10/2012	12:53	Transit	RWP	0 07:37	7.62
17/10/2012	12:53	17/10/2012	13:56	Optics and CTD ops	Stat	0 01:03	1.05
17/10/2012	13:56	18/10/2012	03:14	Transit	RWP	0 13:18	13.30
18/10/2012	03:14	18/10/2012	04:15	Towed net op.	Tow	0 01:01	1.02
18/10/2012	04:15	18/10/2012	04:28	Preps	RWP	0 00:13	0.22
18/10/2012	04:28	18/10/2012	05:32	CTD and vertical net ops	Stat	0 01:04	1.07
18/10/2012	05:32	18/10/2012	12:55	Transit	RWP	0 07:23	7.38
18/10/2012	12:55	18/10/2012	14:00	Optics and CTD ops	Stat	0 01:05	1.08
18/10/2012	14:00	19/10/2012	03:41	Transit	RWP	0 13:41	13.68
19/10/2012	03:41	19/10/2012	04:30	Towed net op.	Tow	0 00:49	0.82
19/10/2012	04:30	19/10/2012	04:50	Preps	RWP	0 00:20	0.33
19/10/2012	04:50	19/10/2012	05:46	CTD and vertical net ops	Stat	0 00:56	0.93
19/10/2012	05:46	19/10/2012	13:56	Transit	RWP	0 08:10	8.17
19/10/2012	13:56	19/10/2012	16:07	Vertical net, Optics and CTD ops	Stat	0 02:11	2.18
19/10/2012	16:07	20/10/2012	03:46	Transit	RWP	0 11:39	11.65
20/10/2012	03:46	20/10/2012	04:48	Towed net op.	Tow	0 01:02	1.03
20/10/2012	04:48	20/10/2012	04:55	Preps	RWP	0 00:07	0.12
20/10/2012	04:55	20/10/2012	05:55	CTD and vertical net ops	Stat	0 01:00	1.00
20/10/2012	05:55	20/10/2012	13:55	Transit	RWP	0 08:00	8.00
20/10/2012	13:55	20/10/2012	15:48	Vertical net, Optics and CTD ops	Stat	0 01:53	1.88
20/10/2012	15:48	21/10/2012	03:43	Transit	RWP	0 11:55	11.92
21/10/2012	03:43	21/10/2012	04:43	Towed net op.	Tow	0 01:00	1.00
21/10/2012	04:43	21/10/2012	04:55	Preps	RWP	0 00:12	0.20
21/10/2012	04:55	21/10/2012	05:50	CTD and vertical net ops	Stat	0 00:55	0.92
21/10/2012	05:50	21/10/2012	13:58	Transit	RWP	0 08:08	8.13
21/10/2012	13:58	21/10/2012	15:48	Vertical net, Optics and CTD ops	Stat	0 01:50	1.83
21/10/2012	15:48	22/10/2012	00:59	Transit	RWP	0 09:11	9.18

C		End		Comment			
Date	Time	Date	Time	All times UTC	Indicator	dd hh:mm	hours
22/10/2012	00:59	22/10/2012	01:32	Towed net op.	Tow	0 00:33	0.55
22/10/2012	01:32	22/10/2012	03:45	Transit	RWP	0 02:13	2.22
22/10/2012	03:45	22/10/2012	04:40	Towed net op.	Tow	0 00:55	0.92
22/10/2012	04:40	22/10/2012	04:54	Preps	RWP	0 00:14	0.23
22/10/2012	04:54	22/10/2012	05:49	CTD and vertical net ops	Stat	0 00:55	0.92
22/10/2012	05:49	22/10/2012	13:59	Transit	RWP	0 08:10	8.17
22/10/2012	13:59	22/10/2012	15:45	Vertical net, Optics and CTD ops	Stat	0 01:46	1.77
22/10/2012	15:45	23/10/2012	03:43	Transit	RWP	0 11:58	11.97
23/10/2012	03:43	23/10/2012	04:35	Towed net op.	Tow	0 00:52	0.87
23/10/2012	04:35	23/10/2012	04:54	Preps	RWP	0 00:19	0.32
23/10/2012	04:54	23/10/2012	06:00	CTD and vertical net ops	Stat	0 01:06	1.10
23/10/2012	06:00	23/10/2012	14:00	Transit	RWP	0 08:00	8.00
23/10/2012	14:00	23/10/2012	15:22	Vertical net, Optics and CTD ops	Stat	0 01:22	1.37
23/10/2012	15:22	23/10/2012	16:11	Preps	RWP	0 00:49	0.82
23/10/2012	16:11	23/10/2012	16:32	Bio-Argo float deployment	Stat	0 00:21	0.35
23/10/2012	16:32	24/10/2012	03:43	Transit	RWP	0 11:11	11.18
24/10/2012	03:43	24/10/2012	04:32	Towed net op.	Tow	0 00:49	0.82
24/10/2012	04:32	24/10/2012	04:49	Preps	RWP	0 00:17	0.28
24/10/2012	04:49	24/10/2012	05:44	CTD and vertical net ops	Stat	0 00:55	0.92
24/10/2012	05:44	24/10/2012	14:00	Transit	RWP	0 08:16	8.27
24/10/2012	14:00	24/10/2012	14:57	Optics and CTD ops	Stat	0 00:57	0.95
24/10/2012	14:57	25/10/2012	03:41	Transit	RWP	0 12:44	12.73
25/10/2012	03:41	25/10/2012	04:35	Towed net op.	Tow	0 00:54	0.90
25/10/2012	04:35	25/10/2012	04:56	Preps	RWP	0 00:21	0.35
25/10/2012	04:56	25/10/2012	05:54	CTD and vertical net ops	Stat	0 00:58	0.97
25/10/2012	05:54	25/10/2012	13:58	Transit	RWP	0 08:04	8.07
25/10/2012	13:58	25/10/2012	15:36	Vertical net, Optics and CTD ops	Stat	0 01:38	1.63
25/10/2012	15:36	26/10/2012	01:00	Transit	RWP	0 09:24	9.40
26/10/2012	01:00	26/10/2012	01:45	Towed net op.	Tow	0 00:45	0.75
26/10/2012	01:45	26/10/2012	03:43	Transit	RWP	0 01:58	1.97
26/10/2012	03:43	26/10/2012	05:42	CTD and vertical net ops	Stat	0 01:59	1.98
26/10/2012	05:42	26/10/2012	13:59	Transit	RWP	0 08:17	8.28
26/10/2012	13:59	26/10/2012	15:00	Optics and CTD ops	Stat	0 01:01	1.02

C		End		Comment			
Date	Time	Date	Time	All times UTC	Indicator	dd hh:mm	hours
26/10/2012	15:00	27/10/2012	03:43	Transit	RWP	0 12:43	12.72
27/10/2012	03:43	27/10/2012	05:52	CTD and vertical net ops	Stat	0 02:09	2.15
27/10/2012	05:52	27/10/2012	13:58	Transit	RWP	0 08:06	8.10
27/10/2012	13:58	27/10/2012	15:36	Vertical net, Optics and CTD ops	Stat	0 01:38	1.63
27/10/2012	15:36	28/10/2012	03:43	Transit	RWP	0 12:07	12.12
28/10/2012	03:43	28/10/2012	04:36	Towed net op.	Tow	0 00:53	0.88
28/10/2012	04:36	28/10/2012	04:52	Preps	RWP	0 00:16	0.27
28/10/2012	04:52	28/10/2012	05:45	CTD and vertical net ops	Stat	0 00:53	0.88
28/10/2012	05:45	28/10/2012	14:00	Transit	RWP	0 08:15	8.25
28/10/2012	14:00	28/10/2012	15:35	Vertical net, Optics and CTD ops	Stat	0 01:35	1.58
28/10/2012	15:35	29/10/2012	03:43	Transit	RWP	0 12:08	12.13
29/10/2012	03:43	29/10/2012	04:38	Towed net op.	Tow	0 00:55	0.92
29/10/2012	04:38	29/10/2012	04:54	Preps	RWP	0 00:16	0.27
29/10/2012	04:54	29/10/2012	05:50	CTD and vertical net ops	Stat	0 00:56	0.93
29/10/2012	05:50	29/10/2012	13:57	Transit	RWP	0 08:07	8.12
29/10/2012	13:57	29/10/2012	15:40	Optics and CTD ops	Stat	0 01:43	1.72
29/10/2012	15:40	30/10/2012	01:00	Transit	RWP	0 09:20	9.33
30/10/2012	01:00	30/10/2012	01:55	Towed net op.	Tow	0 00:55	0.92
30/10/2012	01:55	30/10/2012	03:44	Transit	RWP	0 01:49	1.82
30/10/2012	03:44	30/10/2012	05:45	CTD and vertical net ops	Stat	0 02:01	2.02
30/10/2012	05:45	30/10/2012	13:58	Transit	RWP	0 08:13	8.22
30/10/2012	13:58	30/10/2012	15:35	CTD and vertical net ops	Stat	0 01:37	1.62
30/10/2012	15:35	31/10/2012	03:42	Transit	RWP	0 12:07	12.12
31/10/2012	03:42	31/10/2012	04:42	Towed net op.	Tow	0 01:00	1.00
31/10/2012	04:42	31/10/2012	04:52	Preps	RWP	0 00:10	0.17
31/10/2012	04:52	31/10/2012	06:00	CTD and vertical net ops	Stat	0 01:08	1.13
31/10/2012	06:00	31/10/2012	12:57	Transit	RWP	0 06:57	6.95
31/10/2012	12:57	31/10/2012	13:49	Single optical rig deployment.	Stat	0 00:52	0.87
31/10/2012	13:49	01/11/2012	02:43	Transit	RWP	0 12:54	12.90
01/11/2012	02:43	01/11/2012	03:36	Towed net op.	Tow	0 00:53	0.88
01/11/2012	03:36	01/11/2012	03:47	Preps	RWP	0 00:11	0.18
01/11/2012	03:47	01/11/2012	05:55	CTD and vertical net ops	Stat	0 02:08	2.13
01/11/2012	05:55	01/11/2012	12:55	Transit	RWP	0 07:00	7.00

C		End		Comment			
Date	**Time**	**Date**	**Time**	**All times UTC**	**Indicator**	**dd hh:mm**	**hours**
01/11/2012	12:55	01/11/2012	13:52	Towed net op.	Tow	0 00:57	0.95
01/11/2012	13:52	01/11/2012	13:59	Preps	RWP	0 00:07	0.12
01/11/2012	13:59	01/11/2012	15:40	Vertical net, Optics and CTD ops	Stat	0 01:41	1.68
01/11/2012	15:40	02/11/2012	00:56	Transit	RWP	0 09:16	9.27
02/11/2012	00:56	02/11/2012	01:26	Towed net op.	Tow	0 00:30	0.50
02/11/2012	01:26	02/11/2012	03:42	Transit	RWP	0 02:16	2.27
02/11/2012	03:42	02/11/2012	04:36	Towed net op.	Tow	0 00:54	0.90
02/11/2012	04:36	02/11/2012	04:50	Preps	RWP	0 00:14	0.23
02/11/2012	04:50	02/11/2012	05:45	CTD and vertical net ops	Stat	0 00:55	0.92
02/11/2012	05:45	02/11/2012	13:55	Transit	RWP	0 08:10	8.17
02/11/2012	13:55	02/11/2012	15:32	Vertical net, Optics and CTD ops	Stat	0 01:37	1.62
02/11/2012	15:32	03/11/2012	03:44	Transit	RWP	0 12:12	12.20
03/11/2012	03:44	03/11/2012	04:44	Towed net op.	Tow	0 01:00	1.00
03/11/2012	04:44	03/11/2012	04:52	Preps	RWP	0 00:08	0.13
03/11/2012	04:52	03/11/2012	05:48	CTD and vertical net ops	Stat	0 00:56	0.93
03/11/2012	05:48	03/11/2012	13:53	Transit	RWP	0 08:05	8.08
03/11/2012	13:53	03/11/2012	15:28	Vertical net, Optics and CTD ops	Stat	0 01:35	1.58
03/11/2012	15:28	04/11/2012	00:57	Transit	RWP	0 09:29	9.48
04/11/2012	00:57	04/11/2012	01:47	Towed net op.	Tow	0 00:50	0.83
04/11/2012	01:47	04/11/2012	03:42	Transit	RWP	0 01:55	1.92
04/11/2012	03:42	04/11/2012	04:30	Towed net op.	Tow	0 00:48	0.80
04/11/2012	04:30	04/11/2012	04:47	Preps	RWP	0 00:17	0.28
04/11/2012	04:47	04/11/2012	05:45	CTD and vertical net ops	Stat	0 00:58	0.97
04/11/2012	05:45	04/11/2012	13:56	Transit	RWP	0 08:11	8.18
04/11/2012	13:56	04/11/2012	15:22	Vertical net, Optics and CTD ops	Stat	0 01:26	1.43
04/11/2012	15:22	04/11/2012	15:40	Argo float deployment	Stat	0 00:18	0.30
04/11/2012	15:40	05/11/2012	03:41	Transit	RWP	0 12:01	12.02
05/11/2012	03:41	05/11/2012	04:32	Towed net op.	Tow	0 00:51	0.85
05/11/2012	04:32	05/11/2012	04:46	Preps	RWP	0 00:14	0.23
05/11/2012	04:46	05/11/2012	05:42	CTD and vertical net ops	Stat	0 00:56	0.93
05/11/2012	05:42	05/11/2012	13:55	Transit	RWP	0 08:13	8.22
05/11/2012	13:55	05/11/2012	15:27	Vertical net, Optics and CTD ops	Stat	0 01:32	1.53
05/11/2012	15:27	05/11/2012	15:40	Argo float deployment	Stat	0 00:13	0.22

C		End		Comment			
Date	**Time**	**Date**	**Time**	**All times UTC**	**Indicator**	**dd hh:mm**	**hours**
05/11/2012	15:40	06/11/2012	03:42	Transit	RWP	0 12:02	12.03
06/11/2012	03:42	06/11/2012	05:47	CTD and vertical net ops	Stat	0 02:05	2.08
06/11/2012	05:47	06/11/2012	08:16	Positioning and awaiting daylight for mooring recovery ops	RWP	0 02:29	2.48
06/11/2012	08:16	06/11/2012	11:18	Mooring recovered.	Tow	0 03:02	3.03
06/11/2012	11:18	06/11/2012	13:55	Positioning for mooring 2 op.	RWP	0 02:37	2.62
06/11/2012	13:55	06/11/2012	16:55	Mooring recovered.	Tow	0 03:00	3.00
06/11/2012	16:55	07/11/2012	03:06	Standing by for net ops	RWP	0 10:11	10.18
07/11/2012	03:06	07/11/2012	04:35	Towed net op.	Tow	0 01:29	1.48
07/11/2012	04:35	07/11/2012	08:42	Standing by for Bio Argo float deployment.	RWP	0 04:07	4.12
07/11/2012	08:42	07/11/2012	09:16	4 x Bio Argo floats deployed	Stat	0 00:34	0.57
07/11/2012	09:16	07/11/2012	12:04	Aft deck preparations for mooring deployment op	RWP	0 02:48	2.80
07/11/2012	12:04	07/11/2012	14:08	Mooring deployment	Tow	0 02:04	2.07
07/11/2012	14:08	07/11/2012	14:37	Preps	RWP	0 00:29	0.48
07/11/2012	14:37	07/11/2012	16:15	Vertical net, Optics and CTD ops	Stat	0 01:38	1.63
07/11/2012	16:15	08/11/2012	03:25	Transit	RWP	0 11:10	11.17
08/11/2012	03:25	08/11/2012	04:17	Towed net op.	Tow	0 00:52	0.87
08/11/2012	04:17	08/11/2012	04:47	Preps	RWP	0 00:30	0.50
08/11/2012	04:47	08/11/2012	05:40	CTD and vertical net ops	Stat	0 00:53	0.88
08/11/2012	05:40	08/11/2012	13:59	Transit	RWP	0 08:19	8.32
08/11/2012	13:59	08/11/2012	15:21	Vertical net, Optics and CTD ops	Stat	0 01:22	1.37
08/11/2012	15:21	08/11/2012	15:35	Argo float deployment	Stat	0 00:14	0.23
08/11/2012	15:35	09/11/2012	03:25	Transit	RWP	0 11:50	11.83
09/11/2012	03:25	09/11/2012	04:25	Towed net op.	Tow	0 01:00	1.00
09/11/2012	04:25	09/11/2012	04:40	Preps	RWP	0 00:15	0.25
09/11/2012	04:40	09/11/2012	05:44	CTD and vertical net ops	Stat	0 01:04	1.07
09/11/2012	05:44	09/11/2012	13:55	Transit	RWP	0 08:11	8.18
09/11/2012	13:55	09/11/2012	15:30	Vertical net, Optics and CTD ops	Stat	0 01:35	1.58
09/11/2012	15:30	10/11/2012	00:57	Transit	RWP	0 09:27	9.45
10/11/2012	00:57	10/11/2012	01:50	Towed net op.	Tow	0 00:53	0.88
10/11/2012	01:50	10/11/2012	03:26	Transit	RWP	0 01:36	1.60
10/11/2012	03:26	10/11/2012	04:20	Towed net op.	Tow	0 00:54	0.90
10/11/2012	04:20	10/11/2012	04:38	Preps	RWP	0 00:18	0.30
10/11/2012	04:38	10/11/2012	05:34	CTD and vertical net ops	Stat	0 00:56	0.93

C		End		Comment			
Date	**Time**	**Date**	**Time**	**All times UTC**	**Indicator**	**dd hh:mm**	**hours**
10/11/2012	05:34	10/11/2012	13:57	Transit	RWP	0 08:23	8.38
10/11/2012	13:57	10/11/2012	15:22	Vertical net, Optics and CTD ops	Stat	0 01:25	1.42
10/11/2012	15:22	10/11/2012	15:34	Argo float deployment	Stat	0 00:12	0.20
10/11/2012	15:34	11/11/2012	02:42	Transit	RWP	0 11:08	11.13
11/11/2012	02:42	11/11/2012	04:32	Towed net op.	Tow	0 01:50	1.83
11/11/2012	04:32	11/11/2012	04:45	Preps	RWP	0 00:13	0.22
11/11/2012	04:45	11/11/2012	05:45	CTD and vertical net ops	Stat	0 01:00	1.00
11/11/2012	05:45	11/11/2012	13:57	Transit	RWP	0 08:12	8.20
11/11/2012	13:57	11/11/2012	15:20	Vertical net, Optics and CTD ops	Stat	0 01:23	1.38
11/11/2012	15:20	11/11/2012	15:32	Argo float deployment	Stat	0 00:12	0.20
11/11/2012	15:32	12/11/2012	00:55	Transit	RWP	0 09:23	9.38
12/11/2012	00:55	12/11/2012	01:49	Towed net op.	Tow	0 00:54	0.90
12/11/2012	01:49	12/11/2012	03:28	Transit	RWP	0 01:39	1.65
12/11/2012	03:28	12/11/2012	04:18	Towed net op.	Tow	0 00:50	0.83
12/11/2012	04:18	12/11/2012	04:41	Preps	RWP	0 00:23	0.38
12/11/2012	04:41	12/11/2012	05:34	CTD and vertical net ops	Stat	0 00:53	0.88
12/11/2012	05:34	12/11/2012	13:57	Transit	RWP	0 08:23	8.38
12/11/2012	13:57	12/11/2012	14:52	Optics and CTD ops	Stat	0 00:55	0.92
12/11/2012	14:52	14/11/2012	03:41	Science stations cancelled due to weather.Transit throughout.	RWP	1 12:49	36.82
14/11/2012	03:41	14/11/2012	04:33	Towed net op.	Tow	0 00:52	0.87
14/11/2012	04:33	14/11/2012	04:55	Preps	RWP	0 00:22	0.37
14/11/2012	04:55	14/11/2012	06:23	CTD and vertical net ops	Stat	0 01:28	1.47
14/11/2012	06:23	14/11/2012	13:55	Transit	RWP	0 07:32	7.53
14/11/2012	13:55	14/11/2012	14:57	Optics and CTD ops	Stat	0 01:02	1.03
14/11/2012	14:57	15/11/2012	00:56	Transit	RWP	0 09:59	9.98
15/11/2012	00:56	15/11/2012	01:56	Towed net op.	Tow	0 01:00	1.00
15/11/2012	01:56	15/11/2012	03:43	Transit	RWP	0 01:47	1.78
15/11/2012	03:43	15/11/2012	04:37	Towed net op.	Tow	0 00:54	0.90
15/11/2012	04:37	15/11/2012	04:56	Preps	RWP	0 00:19	0.32
15/11/2012	04:56	15/11/2012	06:00	CTD and vertical net ops	Stat	0 01:04	1.07
15/11/2012	06:00	15/11/2012	13:55	Transit	RWP	0 07:55	7.92
15/11/2012	13:55	15/11/2012	15:20	Vertical net, Optics and CTD ops	Stat	0 01:25	1.42

C		End		Comment			
Date	Time	Date	Time	All times UTC	Indicator	dd hh:mm	hours
15/11/2012	15:20	15/11/2012	15:34	Argo float deployment	Stat	0 00:14	0.23
15/11/2012	15:34	16/11/2012	03:40	Transit	RWP	0 12:06	12.10
16/11/2012	03:40	16/11/2012	04:38	Towed net op.	Tow	0 00:58	0.97
16/11/2012	04:38	16/11/2012	04:53	Preps	RWP	0 00:15	0.25
16/11/2012	04:53	16/11/2012	05:50	CTD and vertical net ops	Stat	0 00:57	0.95
16/11/2012	05:50	16/11/2012	13:56	Transit	RWP	0 08:06	8.10
16/11/2012	13:56	16/11/2012	15:30	Vertical net, Optics and CTD ops	Stat	0 01:34	1.57
16/11/2012	15:30	17/11/2012	00:55	Transit	RWP	0 09:25	9.42
17/11/2012	00:55	17/11/2012	01:46	Towed net op.	Tow	0 00:51	0.85
17/11/2012	01:46	17/11/2012	03:43	Transit	RWP	0 01:57	1.95
17/11/2012	03:43	17/11/2012	04:40	Towed net op.	Tow	0 00:57	0.95
17/11/2012	04:40	17/11/2012	04:50	Preps	RWP	0 00:10	0.17
17/11/2012	04:50	17/11/2012	05:55	CTD and vertical net ops	Stat	0 01:05	1.08
17/11/2012	05:55	17/11/2012	13:55	Transit	RWP	0 08:00	8.00
17/11/2012	13:55	17/11/2012	15:33	Vertical net, Optics and CTD ops	Stat	0 01:38	1.63
17/11/2012	15:33	18/11/2012	03:46	Transit	RWP	0 12:13	12.22
18/11/2012	03:46	18/11/2012	04:38	Towed net op.	Tow	0 00:52	0.87
18/11/2012	04:38	18/11/2012	04:52	Preps	RWP	0 00:14	0.23
18/11/2012	04:52	18/11/2012	05:40	CTD ops	Stat	0 00:48	0.80
18/11/2012	05:40	18/11/2012	14:57	Transit	RWP	0 09:17	9.28
18/11/2012	14:57	18/11/2012	16:30	Vertical net, Optics and CTD ops	Stat	0 01:33	1.55
18/11/2012	16:30	19/11/2012	03:46	Transit	RWP	0 11:16	11.27
19/11/2012	03:46	19/11/2012	04:35	Towed net op.	Tow	0 00:49	0.82
19/11/2012	04:35	19/11/2012	04:50	Preps	RWP	0 00:15	0.25
19/11/2012	04:50	19/11/2012	05:41	CTD and vertical net ops	Stat	0 00:51	0.85
19/11/2012	05:41	19/11/2012	14:57	Transit	RWP	0 09:16	9.27
19/11/2012	14:57	19/11/2012	16:33	Vertical net, Optics and CTD ops	Stat	0 01:36	1.60
19/11/2012	16:33	20/11/2012	03:48	Transit	RWP	0 11:15	11.25
20/11/2012	03:48	20/11/2012	04:38	Towed net op.	Tow	0 00:50	0.83
20/11/2012	04:38	20/11/2012	04:54	Preps	RWP	0 00:16	0.27
20/11/2012	04:54	20/11/2012	05:42	CTD and vertical net ops	Stat	0 00:48	0.80

C		End		Comment			
Date	**Time**	**Date**	**Time**	**All times UTC**	**Indicator**	**dd hh:mm**	**hours**
20/11/2012	05:42	24/11/2012	05:00	Passage towards PA	Pass	3 23:18	95.30
24/11/2012	05:00	24/11/2012	15:00	Pilotage	Pass	0 10:00	10.00
24/11/2012	15:00	25/11/2012	20:00	Estimated. Berth unavailable.	Dem/Mob	1 05:00	29.00

Abbreviations: RWP- No idea, Stat- station, Pass- passage, Dem- demobilisation, Mob- mobilisation

APPENDIX 1: AMT22 UNDERWAY SAMPLE LOG

Sample	Julian Day	Time (UT)	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG sal.	SST – hull deg. C)	Fluor (volts)	Salinity Sample	Salinity Reading	Chl-a (ug/l)	Comments
	285	08:50	11/10/2012 08:50	49.6770	-7.5027							Underway switched on
AA	285	19:00	11/10/2012 19:00	49.5253	-9.3922	35.1643	14.619	0.234	-		1.38	
AB	286	03:06	12/10/2012 03:06	49.3793	-11.2907	35.4008	14.443	0.224	-		0.79	
AC	286	07:24	12/10/2012 07:24	49.3215	-11.9602	35.4499	15.031	0.214	-		0.69	
AD	286	11:02	12/10/2012 11:02	49.2672	-12.8341	35.5238	15.212	0.147	-		0.36	
	286	12:40	12/10/2012 12:40									Off for cleaning
	286											Trans open 4.749 volts; closed 0.0587 volts.
	286	13:14	12/10/2012 13:14									On after cleaning
AE	286	15:00	12/10/2012 15:00	49.2259	-13.4146	35.5185	15.446	0.188	-		0.90	
AF	286	19:09	12/10/2012 19:09	49.1497	-14.3943	35.3928	14.904	0.234	-		0.75	
AG	287	04:20	13/10/2012 04:20	48.9270	-16.3627	35.4361	14.954	0.213	4-73	35.4464	0.81	
AH	287	08:28	13/10/2012 08:28	48.5399	-16.8182	35.4626	16.088	0.199	-		1.00	
AI	287	12:00	13/10/2012 12:00	48.0098	-17.1784	35.6094	16.977	0.105	4-75	35.6155	0.94	
AJ	287	16:02	13/10/2012 16:02	47.5736	-17.4749	35.5180	16.686	0.140	4-76	35.5258	0.82	
AK	287	20:07	13/10/2012 20:07	46.9283	-17.9025	35.4863	16.728	0.223	4-77	35.4962	0.85	
AL	288	08:05	14/10/2012 08:05	45.4891	-18.8551	35.7252	18.240	0.098	4-78	35.7303	0.54	
AM	288	11:58	14/10/2012 11:58	44.8904	-19.2422	35.7394	18.176	0.079	4-79	35.7501	0.51	
	288	13:33	14/10/2012 13:33									Off for cleaning
	288											Trans open 4.73 volts; closed 0.05875 volts.
	288	13:48	14/10/2012 13:48									On after cleaning
AN	288	16:09	14/10/2012 16:09	44.5002	-19.4887	35.6256	18.196	0.090	4-80	35.6355	0.57	
AO	288	20:14	14/10/2012 20:14	43.8589	-19.8883	35.6628	18.132	0.098	4-81	35.6718	0.47	
AP	289	04:17	15/10/2012 04:17	42.8174	-20.5779	35.5331	17.578	0.114	4-82	35.5392	0.37	
AQ	289	08:05	15/10/2012 08:05	42.3826	-20.8038	35.6747	18.379	0.088	4-83	35.6815	0.58	
AR	289	12:07	15/10/2012 12:07	41.7631	-21.1974	35.9492	19.177	0.075	4-84	35.9301	0.40	
	289	13:20	15/10/2012 13:20									Off for cleaning

Sample	Julian Day	Time (UT)	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG sal.	SST – hull deg. C)	Fluor (volts)	Salinity Sample	Salinity Reading	Chl-a (ug/l)	Comments
	289	14:07	15/10/2012 14:07									Trans open 4.740 volts; closed 0.0587 volts.
	289	14:24	15/10/2012 14:24									On after cleaning
AS	289	16:02	15/10/2012 16:02	41.3414	-21.4580	35.9125	19.794	0.074	4-85	35.9263	0.36	
AT	289	20:10	15/10/2012 20:10	40.7053	-21.8363	35.8136	19.616	0.074	-		0.34	
AU	290	04:11	16/10/2012 04:11	39.6528	-22.4987	35.9574	20.064	0.068	4-87	35.9616	0.26	
AV	290	08:05	16/10/2012 08:05	39.2826	-22.6723	36.3609	21.605	0.067	4-88	36.3666	0.29	
AW	290	12:01	16/10/2012 12:01	38.6770	-23.0360	36.1275	21.362	0.065	4-89	36.1346	0.16	
AX	290	16:04	16/10/2012 16:04	38.2489	-23.2839	36.2616	21.408	0.067	4-90	36.2633	0.27	
AY	290	20:05	16/10/2012 20:05	37.6307	-23.6302	36.0872	21.459	0.065	4-91	36.0831	0.18	
AZ	291	08:04	17/10/2012 08:04	36.3626	-24.8553	36.5963	22.277	0.063	4-92	36.6067	0.16	
BA	291	12:06	17/10/2012 12:06	35.9207	-25.4910	36.4671	22.586	0.063	4-93	36.4719	0.18	
	291	13:13	17/10/2012 13:13									Flow rate check
BB	291	16:04	17/10/2012 16:04	35.6017	-25.9205	36.3826	22.441	0.065	4-94	36.3847	0.20	
BC	291	19:59	17/10/2012 19:59	35.1611	-26.5278	36.4140	22.438	0.065	4-95	36.4146	0.18	
BD	292	04:14	18/10/2012 04:14	34.3811	-27.6369	36.4127	22.258	0.064	4-96	36.4147	0.17	
BE	292	08:04	18/10/2012 08:04	34.0797	-27.9544	36.6009	22.898	0.065	3-49	36.6003	0.21	
BF	292	12:06	18/10/2012 12:06	33.6369	-28.5763	36.7054	22.894	0.062	3-50	36.7109	0.19	
	292	13:24	18/10/2012 13:24									Flow rate check
BG	292	16:02	18/10/2012 16:02	33.3234	-28.9997	36.8128	22.976	0.063	3-51	36.7964	0.19	
BH	292	20:17	18/10/2012 20:17	32.8237	-29.6502	36.8024	23.017	0.066	3-52	36.8027	0.19	
BI	293	08:59	19/10/2012 08:59	31.6561	-31.1808	36.6101	23.096	0.064	3-53	36.6125	0.17	
BJ	293	13:04	19/10/2012 13:04	31.1847	-31.7977	36.6711	23.392	0.062	3-54	36.6589	0.17	
BK	293	17:05	19/10/2012 17:05	30.9993	-32.0387	36.6402	23.450	0.063	3-55	36.6399	0.12	
	293	19:50	19/10/2012 19:50									Flow rate check
BL	294	20:55	20/10/2012 20:55	28.3574	-35.4185	37.4582	25.332	0.061	3-56	36.6708	0.15	
BM	294	09:01	20/10/2012 09:01	29.4822	-33.9841	37.0994	24.497	0.063	3-57	37.0998	0.13	
BN	294	12:59	20/10/2012 12:59	29.0275	-34.5601	37.2077	24.819	0.060	3-58	37.2099	0.11	
BO	294	21:04	20/10/2012 21:04	28.3403	-35.4401	37.5424	25.319	0.062	3-59	37.5455	0.12	
BP	295	09:02	21/10/2012 09:02	27.2547	-36.7943	37.5129	25.735	0.062	3-60	37.4940	0.14	
BQ	295	13:04	21/10/2012 13:04	26.7966	-37.3665	37.5059	25.967	0.060	3-61	37.5071	0.13	
	295	14:44	21/10/2012 14:44									Flow rate check

Sample	Julian Day	Time (UT)	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG sal.	SST – hull deg. C)	Fluor (volts)	Salinity Sample	Salinity Reading	Chl-a (ug/l)	Comments
BR	295	17:38	21/10/2012 17:38	26.5120	-37.7247	37.6817	26.420	0.063	3-62	37.6840	0.18	
BS	295	20:51	21/10/2012 20:51	26.1388	-38.1782	37.6647	26.612	0.064	3-63	37.6548	0.12	
BT	296	09:02	22/10/2012 09:02	25.1347	-39.4099	37.5015	26.543	0.065	3-64	37.5034	0.18	
BU	296	13:16	22/10/2012 13:16	24.6518	-40.0053	37.4556	26.481	0.061	3-65	37.4560	0.14	
	296	14:00	22/10/2012 14:00									Off for cleaning
	296											Trans open 4.739 volts; closed 0.0587 volts.
	296	14:15	22/10/2012 14:15									On after cleaning
BV	296	17:18	22/10/2012 17:18	24.4284	-40.2775	37.4808	26.676	0.061	3-66	37.4818	0.14	
BW	296	21:00	22/10/2012 21:00	24.0081	-40.7972	37.4558	26.414	0.060	3-67	37.4552	0.10	
BX	297	09:12	23/10/2012 09:12	22.7130	-40.2976	37.3378	26.940	0.064	3-68	37.3449	0.22	
BY	297	20:59	23/10/2012 20:59	21.4671	-39.3262	37.3804	26.989	0.062	3-69	37.3800	0.23	
BZ	297	09:04	23/10/2012 09:04	22.7318	-40.3114	37.3291	26.938	0.064	3-70	37.1773	0.20	
CA	298	16:58	24/10/2012 16:58	19.1720	-37.5744	37.0853	27.405	0.062	3-71	37.0843	0.21	
CB	298	20:59	24/10/2012 20:59	18.6072	-37.1453	36.8023	27.528	0.061	3-72	36.8047	0.18	
CC	299	09:14	25/10/2012 09:14	17.2566	-36.1283	36.4157	27.479	0.062	4-73	36.4208	0.21	
CD	299	16:59	25/10/2012 16:59	16.4558	-35.5213	36.3967	27.743	0.061	4-74	36.4067	0.19	
CE	299	21:00	25/10/2012 21:00	15.8690	-35.0943	36.4932	27.744	0.062	4-75	36.4910	0.19	
CF	300	09:01	26/10/2012 09:01	14.6011	-34.1546	36.3125	27.449	0.065	4-76	36.3093	0.36	
CG	300	16:55	26/10/2012 16:55	13.7050	-33.4911	36.0829	27.743	0.064	4-77	36.0843	0.34	
CH	300	20:34	26/10/2012 20:34	13.1949	-33.1089	36.0601	27.810	0.067	4-78	36.0573	0.31	
CI	301	09:01	27/10/2012 09:01	11.7868	-32.0714	35.7039	28.170	0.068	4-79	35.7112	0.45	
CJ	301	12:56	27/10/2012 12:56	11.2352	-31.6703	35.5348	28.345	0.062	4-80	35.5364	0.32	
	301	14:16	27/10/2012 14:16									Off for cleaning
	301											Trans open 4.7395 volts; closed 0.0587 volts.
	301	14:31	27/10/2012 14:31									On after cleaning
CK	301	17:01	27/10/2012 17:01	10.9135	-31.4322	35.4771	28.523	0.062	4-81	35.4893	0.27	
CL	301	21:03	27/10/2012 21:03	10.3576	-31.0328	35.4261	28.563	0.062	4-82	35.4286	0.23	
CM	302	08:57	28/10/2012 08:57	9.0016	-30.0301	33.9670	28.799	0.065	4-83	33.9725	0.29	
CN	302	13:05	28/10/2012 13:05	8.4025	-29.6075	34.2058	28.933	0.062	4-84	34.2237	0.33	
CO	302	17:03	28/10/2012 17:03	8.0771	-29.3826	34.9569	28.862	0.065	4-85	34.9532	0.40	

Sample	Julian Day	Time (UT)	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG sal.	SST – hull deg. C)	Fluor (volts)	Salinity Sample	Salinity Reading	Chl-a (ug/l)	Comments
CP	302	21:04	28/10/2012 21:04	7.5278	-28.9587	34.7314	28.737	0.065	4-86	34.7199	0.34	
CQ	303	08:57	29/10/2012 08:57	6.2165	-28.0200	35.5198	28.495	0.068	4-87	35.5255	0.51	
CR	303	13:12	29/10/2012 13:12	5.6288	-27.6062	35.4868	28.508	0.062	4-88	35.5090	0.36	
	303	14:35	29/10/2012 14:35									Flow check - flow increased to check for leaks.
CS	303	17:03	29/10/2012 17:03	5.3526	-27.3861	35.4389	28.828	0.064	4-89	35.3869	0.34	
CT	303	21:23	29/10/2012 21:23	4.7308	-26.9616	34.7622	28.566	0.064	4-90	34.7733	0.37	
CU	304	09:16	30/10/2012 09:16	3.5654	-26.1256	34.8711	28.015	0.067	4-91	34.8738	0.39	
CV	304	12:55	30/10/2012 12:55	0.0000	0.0000	34.7450	27.848	0.064	4-92	34.8143	0.35	
CW	304	17:08	30/10/2012 17:08	2.7060	-25.5086	35.3124	27.945	0.067	4-93	35.3181	0.38	
CX	304	21:08	30/10/2012 21:08	2.1528	-25.1094	35.7379	27.621	0.064	4-94	35.7465	0.31	
CY	305	09:08	31/10/2012 09:08	0.6440	-25.0008	35.9875	26.704	0.078	4-95	35.9861	0.65	
CZ	305	13:00	31/10/2012 13:00	0.0895	-24.9992	36.1333	26.615	0.080	4-96	36.1353	0.90	
DA	306	09:05	01/11/2012 09:05	-2.3525	-25.0126	36.3733	26.467	0.074	4-49	36.3754	0.43	
DB	306	17:06	01/11/2012 17:06	-3.1345	-25.0088	36.1679	26.276	0.062	4-50	36.1692	0.22	
DC	306	21:12	01/11/2012 21:12	-3.7759	-25.0260	36.1469	25.870	0.071	4-51	36.1496	0.29	
DD	307	09:01	02/11/2012 09:01	-5.1041	-25.0343	36.0008	25.482	0.068	4-52	36.0036	0.31	
DE	307	17:03	02/11/2012 17:03	-6.1218	-25.0377	36.0058	25.684	0.065	4-53	36.0077	0.28	
DF	307	21:01	02/11/2012 21:01	-6.8648	-25.0348	36.0379	25.592	0.066	4-54	36.0408	0.20	
DG	308	09:07	03/11/2012 09:07	-8.6648	-25.0456	36.2823	25.435	0.063	4-55	36.2829	0.24	
	308	11:26	03/11/2012 11:26									Flow check - flow increased to check for leaks.
DH	308	13:16	03/11/2012 13:16	-9.4191	-25.0529	36.3393	25.492	0.059	4-57	36.3408	0.15	
	308	13:57	03/11/2012 13:57									Off for cleaning
	308											Trans open 4.724 volts; closed 0.0587 volts.
	308	14:26	03/11/2012 14:26									On after cleaning
DI	308	17:04	03/11/2012 17:04	-9.8086	-25.0539	36.3497	25.587	0.060	4-56	36.3496	0.14	
DJ	308	21:04	03/11/2012 21:04	-10.5604	-25.0548	36.5065	25.384	0.061	4-58	36.5093	0.12	
DK	309	09:16	04/11/2012 09:16	-12.2548	-25.0636	36.8030	24.767	0.060	4-59	36.8420	0.10	
DL	309	13:00	04/11/2012 13:00	-12.9325	-25.0688	36.9576	24.804	0.059	4-60	36.9703	0.09	
DM	309	17:00	04/11/2012 17:00	-13.3111	-25.0624	36.9556	24.824	0.060	4-61	36.9649	0.09	
DN	309	21:04	04/11/2012 21:04	-14.0847	-25.0789	37.0269	24.422	0.060	4-62	37.0279	0.09	

Sample	Julian Day	Time (UT)	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG sal.	SST – hull deg. C)	Fluor (volts)	Salinity Sample	Salinity Reading	Chl-a (ug/l)	Comments
DO	310	09:11	05/11/2012 09:11	-15.9092	-25.0675	37.2498	24.460	0.060	4-63	37.2494	0.08	
DP	310	12:40	05/11/2012 12:40	-16.5534	-25.0883	37.2161	24.404	0.059	4-64	37.2242	0.08	
DQ	310	17:09	05/11/2012 17:09	-16.9966	-25.1009	37.2478	24.518	0.059	4-65	37.2518	0.07	
DR	310	21:02	05/11/2012 21:02	-17.5871	-25.0951	37.1926	24.169	0.060	4-66	37.1948	0.06	
DS	311	09:05	06/11/2012 09:05	-18.5358	-25.0828	37.0523	23.860	0.062	4-67	37.0538	0.07	
DT	311	16:59	06/11/2012 16:59	-18.5551	-25.1098	37.0494	23.931	0.062	4-68	37.0531	0.08	
DU	311	20:36	06/11/2012 20:36	-18.5020	-25.1206	37.0532	23.924	0.062	4-69	37.0553	0.08	
DV	312	09:27	07/11/2012 09:27	-18.5271	-25.0973	37.0504	23.832	0.062	4-70	37.0532	0.08	
DW	312	21:00	07/11/2012 21:00	-19.2159	-24.8243	37.0591	23.848	0.063	4-71	37.0597	0.07	
DX	313	09:09	08/11/2012 09:09	-20.5791	-24.6600	37.0223	23.502	0.065	4-72	37.0243	0.05	
DY	313	13:13	08/11/2012 13:13	-21.1678	-24.8203	36.9884	23.482	0.065	4-73	37.0503	0.05	
	313	14:09	08/11/2012 14:09									Off for cleaning
	313											Trans open 4.733 volts; closed 0.0587 volts.
	313	14:51	08/11/2012 14:51									On after cleaning
DZ	313	17:20	08/11/2012 17:20	-21.4893	-24.9066	36.8883	23.379	0.062	4-74	36.9163	0.09	
EA	313	21:05	08/11/2012 21:05	-22.0361	-24.9954	36.9334	23.117	0.061	4-75	36.9364	0.09	
EB	314	09:18	09/11/2012 09:18	-23.4813	-25.0044	36.9241	22.965	0.061	4-76	36.9314	0.10	
EC	314	13:03	09/11/2012 13:03	-24.0208	-25.0000	36.9333	23.289	0.058	4-77	36.9458	0.07	
ED	314	20:57	09/11/2012 20:57	-24.9264	-25.0050	36.8925	23.111	0.060	4-78	36.9037	0.08	
EE	315	09:02	10/11/2012 09:02	-26.2526	-25.0061	36.4248	22.382	0.061	4-79	36.4404	0.13	
EF	315	17:15	10/11/2012 17:15	-27.2018	-25.0169	36.4093	22.318	0.060	4-80	36.4230	0.10	
EG	315	21:13	10/11/2012 21:13	-27.7812	-25.0047	36.2695	21.947	0.061	4-81	36.2860	0.11	
EH	316	09:08	11/11/2012 09:08	-28.6774	-25.9126	36.2955	21.870	0.061	4-82	36.3095	0.13	
EI	316	20:59	11/11/2012 20:59	-29.6467	-27.2312	36.3570	22.004	0.060	4-83	36.3680	0.11	
EJ	317	09:04	12/11/2012 09:04	-30.4951	-28.3748	36.2424	21.687	0.064	4-84	36.2560	0.15	
EK	317	17:28	12/11/2012 17:28	-31.2328	-29.4152	36.1929	21.390	0.064	4-85	36.2072	0.15	
EL	317	20:25	12/11/2012 20:25	-31.5464	-29.8363	36.1793	21.153	0.064	4-86	36.1923	0.14	
EM	318	09:02	13/11/2012 09:02	-32.6091	-31.3737	36.0270	19.467	0.066	4-87	36.0402	0.18	
EN	318	17:08	13/11/2012 17:08	-33.1721	-32.1343	35.9045	19.297	0.068	4-88	35.9188	0.27	
EO	318	21:05	13/11/2012 21:05	-33.5633	-32.6510	35.6365	17.766	0.071	4-89	35.6488	0.11	
EP	319	09:00	14/11/2012 09:00	-34.3805	-33.8707	35.5930	16.997	0.090	4-90	35.6101	0.46	

Sample	Julian Day	Time (UT)	Date and time (UT)	Lat (+ve N)	Lon (+ve E)	TSG sal.	SST – hull deg. C)	Fluor (volts)	Salinity Sample	Salinity Reading	Chl-a (ug/l)	Comments
EQ	319	13:13	14/11/2012 13:13	-34.8037	-34.4640	35.6820	17.188	0.074	4-91	35.6935	0.52	
ER	319	21:05	14/11/2012 21:05	-35.4806	-35.4470	35.6335	16.881	0.121	4-92	35.6495	0.60	
ES	320	09:21	15/11/2012 09:21	-36.3760	-36.7719	35.5904	16.284	0.119	4-93	35.5986	1.00	
ET	320	13:13	15/11/2012 13:13	-36.7796	-37.3580	35.6796	16.661	0.090	4-94	35.6903	0.80	
EU	320	20:58	15/11/2012 20:58	-37.4008	-38.2689	35.5448	16.507	0.211	4-95	35.5578	1.41	
EV	321	08:59	16/11/2012 08:59	-38.4209	-39.8055	35.2177	15.352	0.173	4-96	35.2055	1.46	
EW	321	13:24	16/11/2012 13:24	-38.8679	-40.4992	35.6652	16.657	0.094	-		0.99	
	321	13:59	16/11/2012 13:59									Off for cleaning Trans open 4.7235 volts; closed 0.0587 volts.
	321	14:27	16/11/2012 14:27									On after cleaning
EX	321	17:17	16/11/2012 17:17	-39.0978	-40.8457	35.7212	17.548	0.091	4-50	35.6944	0.79	
EY	321	20:35	16/11/2012 20:35	-39.4437	-41.3788	35.1578	16.704	0.100	4-51	35.1723	0.48	
EZ	322	09:02	17/11/2012 09:02	-40.4053	-42.8866	34.7720	14.610	0.206	4-52	34.7867	1.63	
FA	322	13:16	17/11/2012 13:16	-40.8497	-43.5630	34.9174	14.650	0.122	4-53	34.9345	0.87	
FB	322	16:58	17/11/2012 16:58	-41.0431	-43.8819	34.9301	15.790	0.119	4-54	34.9418	0.91	
FC	322	21:05	17/11/2012 21:05	-41.4809	-44.5303	34.7296	14.890	0.160	4-55	34.7447	0.61	
FD	323	10:05	18/11/2012 10:05	-42.5755	-46.3034	34.4571	12.960	0.189	4-56	34.4722	0.80	
FE	323	13:10	18/11/2012 13:10	-42.8903	-46.8183	34.4042	12.938	0.097	4-57	34.4010	0.83	
	323	13:15	18/11/2012 13:15									Off for cleaning Trans open 4.7206 volts; closed 0.0587 volts.
	323	13:28	18/11/2012 13:28									On after cleaning
FF	323	17:58	18/11/2012 17:58	-43.1641	-47.2562	34.2277	11.982	0.108	4-58	34.2430	0.75	
FG	323	22:05	18/11/2012 22:05	-43.4903	-47.8067	34.5200	13.751	0.356	4-59	34.5336	1.24	
FH	324	10:01	19/11/2012 10:01	-44.3005	-49.1018	34.4518	13.018	0.183	4-60	34.5108	0.65	
FI	324	14:00	19/11/2012 14:00	-44.6144	-49.6539	34.3337	12.576	0.225	4-61	34.3499	1.24	
FJ	324	18:05	19/11/2012 18:05	-44.8079	-49.9741	34.5952	12.406	0.497	4-62	34.5980	2.75	
FK	324	22:02	19/11/2012 22:02	-45.1110	-50.5294	34.4395	12.506	0.176	4-63	34.4730	0.72	
FL	325	10:01	20/11/2012 10:01	-45.9943	-52.3657	34.5752	12.520	0.565	4-64	34.5821	3.54	
FM	325	13:56	20/11/2012 13:56	-46.4623	-53.3593	34.7511	13.046	0.129	4-65	34.7600	1.08	
			20/11/2012 20:00									Underway switched off

APPENDIX 2: AMT22 CRUISE TRACK